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ENERGY COMMISSION

Edmund G. Brown Jr., Governor

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DISCLAIMER

This draft report was prepared under the *2013 Integrated Energy Policy Report* proceeding, Docket #13-IEP-1A. The draft report will be considered for adoption by the full Energy Commission at its Business Meeting on January 8, 2014. The views and recommendations contained in this document are not official policy of the Energy Commission until the report is adopted.

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PREFACE

Senate Bill 1389 (Bowen, Chapter 568, Statutes of 2002) requires the California Energy Commission to prepare a biennial integrated energy policy report that assesses major energy trends and issues facing the state's electricity, natural gas, and transportation fuel sectors and provides policy recommendations to conserve resources; protect the environment; ensure reliable, secure, and diverse energy supplies; enhance the state's economy; and protect public health and safety (Public Resources Code § 25301[a]). The Energy Commission prepares these assessments and associated policy recommendations every two years, with updates in alternate years, as part of the *Integrated Energy Policy Report*. Preparation of the *Integrated Energy Policy Report* involves close collaboration with federal, state, and local agencies and a wide variety of stakeholders in an extensive public process to identify critical energy issues and develop strategies to address those issues.

ABSTRACT

The *2013 Integrated Energy Policy Report Update* provides the results of the California Energy Commission's assessments of a wide variety of energy issues currently facing California. These issues include future demand for electricity, natural gas, and transportation fuels; energy efficiency in California's existing buildings; publicly owned utilities' progress toward achieving 10-year energy efficiency targets; the definition of zero-net-energy and its inclusion in state building standards; challenges to increased use of geothermal heat pump/ground loop technologies and procurement of biomethane; using demand response to meet California's energy needs and integrate renewable technologies; bioenergy development; California's electricity infrastructure needs given potential retirement of power plants and the closure of the San Onofre Nuclear Generating Station; potential electricity system needs in 2030; new generation costs for utility-scale renewable and fossil-fueled generation; the need for investments in new or upgraded transmission infrastructure; utility progress in implementing past recommendations related to nuclear power plants; natural gas market trends; the Alternative and Renewable Fuel and Vehicle Technology Program; and potential vulnerability of California's energy supply and demand infrastructure to the effects of climate change. Definitions for technical terms can be found in the glossary.

Keywords: California Energy Commission, energy efficiency, demand response, electricity, electricity demand, electricity infrastructure, hydraulic fracturing, natural gas demand, natural gas pipelines, renewable, climate change, biomethane, bioenergy, geothermal

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TABLE OF CONTENTS

EXECUTIVE SUMMARY **9**

CHAPTER 1: Energy Efficiency **23**

The Benefits of Energy Efficiency Standards 23
Comprehensive Energy Efficiency Program for Existing Buildings 24
Zero-Net-Energy Buildings 26
Utility Progress Toward Achieving Energy Efficiency Targets 31
Geothermal Heat Pump and Ground Loop Technologies 34
Recommendations 36

CHAPTER 2: Demand Response **40**

Demand Response Efforts in California 42
Demand Response Challenges 48
Recommendations 50

CHAPTER 3: Bioenergy Status and Issues **54**

Biomass Technical Potential and Development Goals 54
Biopower Status 55
Biofuels Production 62
Biomethane Production 64
Recommendations 71

CHAPTER 4: Electricity **73**

Renewed Focus on Interagency Coordination 73
Preliminary Forecast of California Energy Demand 76
Resource Adequacy of Publicly Owned Utilities 87
The Need for New Electricity Infrastructure 88
Updated Estimates of New Generation Costs 99
Recommendations 103

CHAPTER 5: Strategic Transmission Investment Plan **105**

Approved Transmission Projects to Meet 2020 Renewable Goals 105
California ISO's Potential Long-Term Transmission Alternatives in Light of San Onofre Shutdown 110
In-State Coordinated Land-Use and Transmission Planning Efforts 111
Transmission Opportunities to Enable Higher Levels of Renewables 119
Emerging Trends in the Western Interconnection 126
Recommendations 129

CHAPTER 6: Nuclear Power Plants **131**

Background 132
Implementing AB 1632 Report and *2011 IEPR* Recommendations 133
Diablo Canyon 134
San Onofre Nuclear Generating Station 143
Japan Lessons Learned - NRC Near-Term Task Force Recommendations 146
Federal Efforts on Nuclear Waste Transport, Storage, and Disposal 148
Permanent Closure of San Onofre Nuclear Generating Station 151
Recommendations 154

CHAPTER 7: Natural Gas **157**

Natural Gas Outlook 159
Natural Gas from Shale Formations 160
Natural Gas and Electricity Generation Industry Interface 162
Natural Gas Infrastructure 165
Other Natural Gas Issues 169
Recommendations 172

CHAPTER 8: Transportation Energy **173**

Alternative and Renewable Fuel and Vehicle Technology Program 173
Transportation Energy Trends 182
Transportation Demand Forecast and Supply Demand Balance 195
Challenges to Achieve Alternative Fuel Growth Potential and Ensure an Adequate Transportation Energy System 199
Recommendations 201

CHAPTER 9: Climate Change **203**

Climate Change Consensus Document 204
Climate Change Research and Projections 205
Impacts of Climate Change on Energy Supply 206
Impacts of Climate Change on Energy Demand 207
Climate Readiness Strategies 207
Future Climate Change Research Needs 208
California's 2030 Electricity System 209
Recommendations 221

ACRONYMS **223**

GLOSSARY **226**

APPENDIX A: Detailed Description of Approved Transmission Line Projects **A-1**

APPENDIX B: Strategic Transmission Investment Plan Workshop Summaries **B-1**

APPENDIX C: California Independent System Operator *Demand Response and Energy Efficiency Roadmap* **C-1**

APPENDIX D: California Public Utilities Commission Staff Comments on the Draft Demand Response and Energy Efficiency Roadmap D-1

APPENDIX E: Approach to Estimating Alternative and Renewable Fuel and Vehicle Program Benefits E-1

APPENDIX F: Renewable Identification Numbers Under the Renewable Fuels Standard.. F-1

APPENDIX G: Transportation Demand Forecast and Supply/Demand Balance G-1

APPENDIX H: NRC Post-Fukushima Activities H-1

APPENDIX I: Summary and Status of 2011 IEPR Nuclear Policy Recommendations I-1

LIST OF FIGURES AND TABLES

Figure 1: Standards on the Home Energy Rating System (HERS) Scale 29
Figure 2: Projected Net Load Curve With Expanded Renewable Generation in 2020 41
Figure 3: IOU Demand Response 2008-2013 43
Figure 4: Statewide Annual Electricity Consumption 80
Figure 5: Statewide Annual Noncoincident Peak Demand 81
Figure 6: Capacity of Large Publicly Owned Utilities and Forecast Peak-Hour Requirements ... 88
Figure 7: Renewable Technology Instant Cost Trends 100
Figure 8: Instant Costs of Fossil-Fueled Generation (Real 2011 $/kW) 101
Figure 9: Summary of Mid-Case Levelized Costs (LCOEs)—Start-Year=2013 102
Figure 10: Comparing LCOE Ranges for Combined-Cycle 500 MW and Solar Photovoltaic Single-Axis 100 MW 103
Figure 11: Spent Fuel Pools Versus Dry Cask Storage 145
Figure 12: Common Case Price Forecasts with Adjusted Error Bands 160
Figure 13: Cumulative Supply Cost Curves 161
Figure 14: Lower 48 Natural Gas Production 161
Figure 15: California Natural Gas Demand for Power Generation 163
Figure 16: WECC Natural Gas Demand for Power Generation 163
Figure 17: California Natural Gas Demand for CHP to Generate Electricity for Industrial and Commercial Sector Customers 164
Figure 18: Historical and Forecasted Lower 48 Exports to Mexico 167
Figure 19: Monthly Natural Gas Storage Totals in California 169
Figure 20: Monthly Natural Gas Storage Totals in California) 170
Figure 21: Cumulative 2009-13 Program Investments by Fuel Type and Supply Phase 176
Figure 22: Market Share Shifts for Transitional Market Transformations 181
Figure 23: High Energy Price Common Case 183
Figure 24: Reference Common Case 184
Figure 25: Low Energy Price Common Case 185
Figure 26: Renewable Fuel Standard Volumes by Year 186
Figure 27: Carbon Intensity for Gasoline and Substitutes 188
Figure 28: Carbon Intensity for Diesel and Substitutes 189
Figure 29: 2015-2025 ZEV Requirements 189
Figure 30: Crude Oil Price Cases 197
Figure 31: Recent Crude Oil Price Forecasts from Leading Energy Price Analysis Firms 198
Figure 32: IEPR 2013 Regular Gasoline Price Cases 198
Figure 33: IEPR 2013 Diesel and Jet Fuel Price Cases (2012$s) 199
Figure 34: California Energy Demand 2013 RPS-Eligible Retail Sales Forecast 211
Figure A-1: Map of California ISO, IID and LADWP Approved Transmission Projects A-2
Figure E-1: General Types of Benefits as a Function of Time E-2
Figure F-1: Historical RIN Price Trend F-1

Table 1: IOU and Publicly Owned Utility 2011 and 2012 Energy Savings and Program Expenditures 32
Table 2: California's Renewable Energy Potential 55
Table 3: Summary of Existing Solid-Fuel Biomass Facilities 56
Table 4: Changes in Landfill gas facilities operating in California 65
Table 5: Dairy Anaerobic Digester Gas Projects in California 65
Table 6: Comparison of Statewide Energy Demand Scenarios 79
Table 7: Projected Electricity Consumption Impacts From Climate Change by Scenario and Planning Area 83
Table 8: Projected Peak Impacts From Climate Change by Scenario and Planning Area 84
Table 9: Consumption and Peak Demand by Climate Zone 87
Table 10: Summary of Input Assumptions and Results of California ISO Local Capacity Area Studies Assuming Generation is Minimized in San Diego 92
Table 11: Statewide End-User Natural Gas Forecast Comparison (MMTherms) 158
Table 12: Assumptions for Common Cases 159
Table 13: Detailed Accounting of ARFVTP Award Categories through June 30, 2013 175
Table 14: Geographic Distribution of ARFVTP Awards 177
Table 15: Alternative and Renewable Fuel and Vehicle Technology Program and Air Quality Improvement Program Funding Impact on Infrastructure and Vehicle Deployment in California 180
Table 16: California's Transportation Energy Initiatives 187
Table 17: Alternative Fuel Growth Estimates 191
Table 18: California's RPS Portfolio, December 2012 213
Table 19: Projected Renewable Portfolio for California, 2022 214
Table 20: Renewable Energy Needs in 2030 – 2035 by RPS Percentage, GWh 219
Table 21: Capacity Provide 25,000 GWh of Energy, Selected Renewable Technologies 219
Table D-1: Mapping of California ISO Four Paths and CPUC Vision D-2
Table G-1: Forecasted Fuel Economy and Manufacturer Suggested Retail Price (2011-2030) G-1
Table H-1: NRC Post-Fukushima Activities H-1
Table I-1: Summary and Status of 2011 IEPR Nuclear Policy Recommendations I-1

EXECUTIVE SUMMARY

California is the most populous state in the nation and the eighth largest economy in the world. While California is a leader in addressing climate change, further work is needed both to reduce greenhouse gas emissions and to increase the resiliency of California's energy system to the impacts of climate change. California's energy system contributes about 85 percent of the state's greenhouse gas emissions. The state's economy, environment, and public health depend on reducing greenhouse emissions by using less energy, electrifying the transportation system and producing power both sustainably and with lower overall greenhouse gas emissions. California continues to lead the nation in designing and implementing innovative policies and strategies to use energy more efficiently, replace fossil fuels with renewable resources, and develop the power infrastructure needed to deliver safe, reliable, and affordable energy to consumers and businesses throughout the state.

The *2013 Integrated Energy Policy Report (IEPR)*looks at a variety of energy issues facing the state today. Energy efficiency (using less energy to do the same job) and demand response (manipulating energy use when needed for optimal grid operation) remain California's top priorities for meeting the state's energy needs as population continues to grow and the economy recovers. Maximizing the use of these "preferred resources" becomes even more important as California works toward reducing greenhouse gas emissions to 80 percent below 1990 levels by 2050. The state's energy efficiency standards for new buildings and appliances have saved consumers an estimated $74 billion since 1975 in reduced electricity bills, not including billions of dollars more in natural gas savings. Still, there is huge potential for additional savings by increasing the energy efficiency and optimizing the use of our existing buildings. California also has a goal of making all new buildings zero-net-energy – essentially combining energy efficiency measures and renewable power generation so that a building can produce as much power as it uses annually – by 2020 for homes and 2030 for businesses. Utilities also need to work toward meeting targets set by the California Energy Commission and the California Public Utilities Commission (CPUC) to achieve all cost-effective energy efficiency.

In addition to reducing energy demand when needed, demand response can reduce the need for new power plants and transmission lines and help integrate the high levels of renewable resources that will be needed to meet California's long-term greenhouse gas emission reduction goals. However, demand response continues to face technical, regulatory, and market barriers that need to be resolved for it to reach its full potential.

Renewable energy is another of California's top priorities, and the state continues to make progress toward achieving its goal of generating a third of its electricity using renewable resources like solar and wind. Some renewable resources, such as biomethane, still face significant barriers to development. Also, renewable energy presents challenges to the electricity system as a whole because intermittent renewable resources require integration services to minimize negative effects on the electricity grid. Further, California needs to better synchronize the planning and permitting processes for renewable generation and the power lines needed to bring that generation to market.

The electricity system in Southern California faces a multifaceted set of challenges. Emission offsets in Southern California are scare due to stringent air quality regulations, but such offsets are needed to repower or to provide replacement power for power plants that must comply with the phase-out of once-through cooling. Southern California also faces new challenges from the permanent closure of one of the state's two nuclear power plants and the potential effects of that closure on electric supplies and reliability. There are also seismic safety and spent fuel storage concerns with the remaining nuclear plant in the wake of the Fukushima, Japan, nuclear disaster in 2011.

To help ensure progress towards its 2050 greenhouse gas reduction goals, California needs to determine what the electricity system should look like in 2030 as an interim target. Similarly, California must assess and plan for the potential effects of climate change on the energy sector itself, such as increased electricity demand, decreased power plant efficiency, and changes in the availability of hydropower because of less precipitation and earlier runoff. Climate change could also affect reliability because of increased risk of wildfires that can damage power lines and of flooding in coastal power plants.

A large portion of California's energy needs have traditionally been met with natural gas. Natural gas supplies are currently plentiful and relatively inexpensive as a result of technological advances that allow recovery of natural gas from formations such as shale reservoirs that were previously inaccessible. However, potential environmental concerns are causing decision makers to reexamine the development of shale resources and consider tighter regulations, which could affect future natural gas supplies and prices.

The transportation sector contributes about 40 percent of California's greenhouse gas emissions, a fact that highlights the importance of the state's efforts to promote low-carbon alternative and renewable transportation fuels. Although gasoline consumption continues to decrease, the state's population continues to grow, and the penetration of alternative vehicles and fuels remains relatively low. Increased public and private investment in development of alternative and renewable fuel vehicles and fueling infrastructure is needed to achieve the goal of reducing the carbon intensity of California's transportation fuels at least 10 percent by 2020.

Each of these issues has been the subject of ongoing analysis and evaluation as part of the *2013 IEPR* proceeding. Results of those analyses and recommendations to address challenges facing California's energy sector are summarized below.

Energy Efficiency

Efficiency in Existing Buildings

As directed by Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009), the Energy Commission is developing a comprehensive program to improve the energy efficiency of existing buildings. After working closely with the CPUC and holding a series of statewide public workshops to get input from stakeholders, in June 2013 the Energy Commission released the *Draft Action Plan for the Comprehensive Energy Efficiency Program for Existing Buildings.* The draft plan outlines actions needed to support a strong and viable energy efficiency upgrade market for existing residential, commercial, and public buildings. The Energy Commission will

consider the final action plan for adoption in late 2013, with implementation beginning immediately. Recommendations in the draft plan include foundational actions such as improved data reporting and management to support program development and to enable the marketplace, tools and code enforcement to improve compliance with standards, education to motivate building owners and managers, and workforce training and development to ensure a skilled workforce. Other actions include: encouraging a portfolio of options for upgrades ranging from a single measure to a whole-building approach, developing standard building assessment tools, focusing attention on multifamily and smaller commercial building upgrades, working with local governments to improve public buildings, and offering innovative financing options for building owners. Adopting appliance standards that focus on reducing plug loads and that can assist in grid resilience and responsiveness will also help advance California's energy efficiency goals.

Other opportunities for advancements in energy efficiency include achieving the goals for state buildings in Governor Brown's Executive Order B-18-12 and increasing energy efficiency in schools through the use of Proposition 39 funds. In 2012 California voters passed Proposition 39, which resulted in increased tax revenue after changes to corporate income taxes. The proposition dedicated $550 million annually for five years to fund energy efficiency projects that create clean energy jobs in California. As California continues to develop and implement its energy efficiency programs, it will gain knowledge and experience that can help advance the market and further California's ongoing leadership in energy efficiency.

Zero-Net-Energy New Buildings

California has a policy goal of achieving zero-net-energy building standards by 2020 for residential buildings and by 2030 for commercial buildings. Governor Brown's Executive Order B-18-12 calls for all new State buildings and major renovations that begin design after 2025 be constructed as zero-net-energy facilities and also calls for achieving zero-net-energy for 50 percent of the square footage of existing state-owned building area by 2025.To achieve these goals and make zero-net-energy an enforceable reality, the Energy Commission needs to incorporate the zero-net-energy definition as a requirement in the California Building Energy Efficiency Standards (Title 24, Part 6). The Energy Commission has worked closely with the CPUC and stakeholders to develop the following definition:

> *A zero-net-energy code building is one where the societal value of the amount of energy provided by on-site renewable energy sources is equal to the value of the energy consumed by the building at the level of a single "project" seeking development entitlements and building code permits, measured using the California Energy Commission's Time Dependent Valuation metric. A zero-net-energy code building meets energy use intensity by building type and climate zone that reflect best practices for highly efficient buildings.*

Staff recommendations to ensure success in meeting the zero-net-energy goals as they are currently outlined include: adopting triennial building standards updates that increase the efficiency of new buildings by 20 to 30 percent in each update; developing industry-specific training and financial incentives to help achieve reach standards; tracking market progress on zero-net-energy construction and performance; coordinating with the CPUC on future investor-

owned utility new construction-related programs; collaborating with stakeholders to create workforce development programs that provide the skills needed to meet zero-net-energy goals; and including a voluntary energy tier for zero-net-energy in the California Green Building Standards Code.

Utility Energy Efficiency Targets

Assembly Bill 2021 (Levine, Chapter 734, Statutes of 2006) directs the Energy Commission and the CPUC to develop statewide energy efficiency potential estimates and targets for California's publicly owned and investor-owned utilities. In 2012, investor-owned utilities reported surpassing their energy and peak savings goals; publicly owned utilities, however, reported declines in energy savings for the third consecutive year, with a few individual exceptions. Since passage of Assembly Bill 2021, publicly owned utilities have spent more than $737 million on energy efficiency programs, resulting in energy savings of about 2,700 gigawatt hours and 515 megawatts in peak demand reduction. To ensure continued progress toward achieving higher levels of energy savings, Energy Commission staff plans to work with publicly owned utilities to encourage deeper energy savings; improve transparency about funding levels and sources; and improve the evaluation, measurement, and verification process.

The CPUC approves three-year efficiency program cycles for the investor owned utilities, and for the 2010-2012 program cycle, investor-owned utilities administered their portfolios of efficiency programs with a total budget of $3.1 billion. The CPUC's *2013 California Energy Efficiency Potential and Goals Study* is under consideration and will be released shortly.

Efforts needed to help achieve all cost-effective energy efficiency include: advancing mechanisms to finance energy efficiency measures, advancing locational and peak period energy efficiency, and increasing natural gas end-use efficiency. Also, the Energy Commission and CPUC will collaborate to analyze the near and longer-term savings from energy efficiency codes and standards and their interaction with other efficiency programs. Further, increased interagency collaboration is needed to modernize energy-related information management practices to enable robust, cross-agency data management and sharing; provide clear access procedures and timely data services to researchers; facilitate appropriately detailed reporting to the legislature; and enable greater information availability to the public.

Geothermal Heat Pump and Ground Loop Technologies

As a further means to achieve greater energy efficiency in California's buildings, Energy Commission staff evaluates technologies that may provide efficiency savings over traditional heating and cooling systems. Assembly Bill 2339 (Williams, Chapter 608, Statutes of 2012) directs the Energy Commission to evaluate policies to assist greater penetration of geothermal heat pump and ground loop technologies, and to include recommendations in the *2013 IEPR*. Geothermal heat pumps use the constant below-ground temperature of water or soil to heat and cool interior spaces. While purchase and installation costs can be higher than those of conventional heating or cooling systems, geothermal heat pump systems can use 25 percent to 50 percent less electricity. Challenges faced by the geothermal heat pump industry include: inability of approved compliance models to accurately represent efficiency gains from these systems; inconsistent local permitting requirements and fee schedules; and rules and

regulations for borehole drilling and ground loop installation. To begin addressing these barriers, the Energy Commission encourages the industry to develop an Alternative Calculation Method application to model the technology, produce a model local ordinance that could be adopted by local jurisdictions, and promote the use of California-specific geothermal heat pump standards for training and certification of industry professionals, among other recommendations.

Demand Response

Demand response can play an important role in maintaining a reliable electric system by influencing demand according to system needs and constraints, potentially offsetting the need for new power plants and transmission lines. Despite its many potential benefits and its position together with efficiency atop the Loading Order, there has been insufficient progress toward meeting demand response goals set in the early 2000s. Demand response programs created in the past were based on the technology available at the time; today proven, cost-effective technologies exist to communicate the needs of the system and responding with customer loads, both individually and collectively. Markets themselves have also evolved: outside California, successful efforts have developed wholesale and retail products that appropriately value the system benefits demand response provides. For California to catch up in this area, energy agencies must develop a workable model that stimulates scale-up of effectively useable, environmentally sound demand response resources that are palatable to end-users.

Technical, economic, market, and policy barriers currently limit the increased use of demand response. There is a need for wholesale market design to recognize the advantages and limitations of demand response as compared to traditional generation. On the one hand, customer loads cannot always be as easily and consistently manipulated as traditional generation. On the other hand, these issues are manageable by a functioning marketplace: demand response products can be composed of a large number of loads that together provide a portfolio, comprised of both load reductions and strategic load additions, that balances performance risk and customer needs. Finally, rules for participation by demand response providers in existing California Independent System Operator (California ISO) wholesale markets need to be resolved and finalized. On the technology side, current telemetry requirements are a challenge because of expensive equipment requirements to participate in the demand response market.

The various recent developments in Southern California—the San Onofre Nuclear Generating Station retirement, approaching once-through-cooling requirements, and the increasing need for flexibility to integrate intermittent renewable resources—as well as the long-term challenge of responding to the impacts of climate change, dictate that demand response play a much larger and substantially different role in electricity supply and reliability enhancement than today. Further, time-certainty is required for mobilizing fast-response demand response at relevant scale: slippage in demand response market development will necessitate more generation and/ or transmission than would otherwise be required. Given the long lead time required to develop generation and transmission, the need to prove demand response is urgent.

Intentionally enabling multiple market options in the near term decreases the risk of ongoing anemia of demand response resources.

The Energy Commission has identified five strategies to help demand response fullfill its role in California's loading order of preferred resources. These strategies are: 1) establishing rules for direct participation of demand response in California ISO markets; 2) developing and pilot testing additional market products to identify the most promising program and tariff approaches and to develop a multi-year, forward auction mechanism to target demand response in capacity constrained areas; 3) resolving regulatory barriers for the development and implementation of a multi-year reliability framework that accounts for customer attributes and the type of load reductions they can provide; 4) continuing the collaborative process among the Energy Commission, CPUC, California ISO, and Governor's Office to advance fast-response demand response, develop a joint workplan, and advance forecasting accuracy; 5) advancing customer acceptance of demand response, informed by an independent assessment of potential customer participation in a range of targeted demand response programs, communication strategies and evaluation reports, and communication lessons learned by early 2014.

Bioenergy

California is the leading producer of renewable energy nationwide and is on track to meet 33 percent of its electricity needs with renewable resources by 2020. Bioenergy is a small but important part of California's portfolio of renewable resources that still faces challenges, despite state policies to support bioenergy that have been in place for many years. The use of biomass offers many benefits including providing a pathway to low carbon fuels that can replace fossil fuels and the use of California's existing infrastructure, helping meet waste reduction goals, reducing wildfire risks, and providing local jobs.

As of 2012, there was 681 megawatts of solid-fuel biomass capacity in California, and new project development is expected to be relatively small. Biopower facilities – those that generate electricity using biomass fuel – face high costs associated with fuel collection and transport, environmental review, permitting, complying with air quality regulations, and securing financing. For biofuels for the transportation sector, in-state production capacity in 2013 was roughly 220 million gallons per year, including ethanol and biodiesel. In-state ethanol producers continue to have difficulty competing with ethanol from Midwest corn and Brazilian sugarcane, but many companies are looking at alternative fuel sources with lower carbon intensities and less competition for feedstock such as grain sorghum.

Biomass is also used to produce biomethane, which can be used to generate electricity or to produce transportation fuels. Because of unique obstacles faced by biomethane producers, Assembly Bill 1900 (Gatto, Chapter 602, Statutes of 2012) directs the Energy Commission, as part of the biennial *IEPR*, to evaluate barriers to procurement of biomethane in California and provide potential solutions. Challenges identified during the *2013 IEPR* proceeding include: regulatory uncertainty and its effect on long-term contracts; the expense of upgrading biogas to pipeline quality; limited access to natural gas distribution pipelines; lengthy and costly pipeline interconnection; pipeline safety concerns; low natural gas prices that make it difficult to

compete; and the need for technology commercialization. Research and development efforts can help address several of these issues.

Recommended strategies to address biomass challenges include: developing a statewide programmatic environmental impact report to focus on streamlining environmental reviews; expanded consideration of the benefits provided by biomass facilities as part of the CPUC's procurement process; development of sustainability standards for biomass fuel harvesting; and support research and development for advanced biofuels and for pipeline biomethane injection.

Electricity

Electricity and Natural Gas Demand Forecast

Every two years the Energy Commission prepares a 10-year electricity demand forecast. This forecast is used in many applications, including the CPUC's Long Term Procurement Planning proceeding and the California ISO's transmission planning studies. The *California Energy Demand 2014-2024 Preliminary Forecast* presents three demand scenarios: high, mid, and low, reflecting different assumptions about economic and population growth, energy efficiency savings, and electricity prices, among other factors. Average annual electricity demand growth from 2012-2024 is expected to range from 0.64 percent to 1.37 percent, an historically modest range that is a result of various drivers including lower projected population growth and new building and appliance standards introduced during the forecast period. Peak demand growth is expected to range from 0.69 percent to 1.65 percent.

To help advance energy planning, the energy agencies must continue discussions with stakeholders about the timing and alignment of the demand forecast, energy efficiency funding cycles, measurement and evaluation, transportation electrification forecasts, and agency planning cycles. The Energy Commission must also explore the use of new modeling techniques and work with the CPUC and the California ISO to determine the appropriate level of granularity for demand forecasts.

Electricity Infrastructure Needs

In addition to forecasting future demand for electricity in California, it is important to make sure that the infrastructure needed to generate and deliver that electricity is in place. Southern California is uniquely vulnerable in this regard not only because of the potential retirement of power plants that use once-through cooling, but because of the recent permanent closure of the San Onofre Nuclear Generating Station, which provided more than 2,000 megawatts of generating capacity and voltage support for the region.

California's energy agencies have been working together closely to evaluate reliability needs in Southern California and the potential to serve those needs with preferred resources such as demand response and renewable energy. A balanced portfolio of options is needed. Studies completed to date indicate the need to repower much of the once-through cooling capacity located along the Southern California coastline, with only limited ability for renewable resources or distributed generation to substitute for conventional dispatchable power plants. There will likely be a need for additional generating capacity above what is strictly required for local reliability to help integrate increasing levels of renewables; but demand response

programs could have a strong influence on the amount needed if deployed at scale. The agencies are committed to seeking 50 percent of the incremental resource need from energy efficiency, demand response, distributed generation, and storage.

However, there are significant uncertainties in all the studies to date that need to be resolved. Next steps to ensure the necessary amount of available resources include the following:

- The Energy Commission will continue to make decisions on Applications for Certification to license power plants in a timely manner that is consistent with statutory requirements and seeks to optimally reduce environmental impacts.
- The Energy Commission will continue to explore energy efficiency demand response and combined heat and power on state properties in Southern California.
- The CPUC will implement its decision, as part of its Long Term Procurement Plan proceeding, to replace San Onofre capacity and new load growth with 50 percent preferred resources and 50 percent conventional resources. Also, the CPUC will make timely decisions regarding approval of power purchase agreements for capacity.
- The California ISO will evaluate transmission alternatives, including synchronous condensers and other forms of reactive power support, to maintain reliability in its 2013-2014 Transmission Planning Process, which is currently underway.
- The Energy Commission, CPUC, and California ISO need to continue to evaluate the roles of energy efficiency and demand response in the modern grid, specifically identifying what value they can bring in capacity and ancillary services markets, and how these markets can be made operational in California.
- The Energy Commission, CPUC, and California ISO need to consider any changes needed in response to public comments on the *Preliminary Reliability Plan for LA Basin and San Diego* and submit a finalized plan to the Governor. The purpose of the plan is to ensure reliability in Southern California in light of San Onofre shutting down and the expected closure of power plants using once through cooling. Recommendations from the preliminary plan were presented by staff to the leaders of the state energy agencies, the California ISO, and the South Coast Air Quality Management District on September 9. These recommendations will culminate in an action plan, to be implemented by the agencies and closely monitored by the Governor's Office.
- The South Coast Air Quality Management District needs to determine whether the amount of repowering identified in the California ISO's local capacity studies can be permitted using its Rule 1304(a)(2).
- The Energy Commission must also evaluate whether local capacity requirements or other criteria would justify the need for exercising the provision in the State Water Resources Control Board policy to request delays in once-through cooling compliance dates.
- Contingency plans, including extensions to the schedule for once-through cooling plant retirements, fast-tracking additional conventional generation, or contingent site permits for new generation resources must also be put into place in the event preferred resources do not

materialize on schedule or in the amounts required for reliability, or in the event identified transmission projects are found infeasible or unavailable in the need time horizon

Additionally, to support the planning processes necessary to ensure California's energy infrastructure needs are met, in 2014 the Energy Commission will begin the process of updating data reporting requirements to ensure that up-to-date, appropriately granular energy data and other information is available for policy analysis and development. Finally, there is a need to complete nuclear replacement studies identified in the *2011 IEPR* to assess energy replacement options in the event of a shutdown of Diablo Canyon.

Estimates of the Costs of New Generation

Generation cost trends are important when evaluating the kinds of resources that will meet California's future energy demand and provide the infrastructure needed to maintain system reliability and reduce GHG emissions from the electricity sector. In the *2011 IEPR* proceeding, the Energy Commission evaluated its method of analyzing and estimating future generation costs, and for the *2013 IEPR* has utilized the refined methods to prepare updated estimates of generation costs for new generation. Solar photovoltaic technologies are expected to continue a rapid decline in costs, while solar thermal technologies are expected to see cost reductions as improvements are made by developers and manufacturers. Cost reductions are expected to continue, although increases in the cost of land and transmission costs are expected to offset the gains in technology cost in California. Other renewable technologies, such as biomass and geothermal, are not expected to see substantial cost reductions. For fossil-fueled technologies, the underlying technology costs for combined-cycle and combustion turbines are expected to remain flat, but there will be cost increases of roughly 15 percent over the coming decade because of costs associated with mitigating or offsetting criteria air pollutants and greenhouse gas emissions.

Strategic Transmission Investment Plan

To support the 33 percent by 2020 Renewables Portfolio Standard, California needs to ensure that transmission projects that deliver renewable energy to customers are permitted and built quickly and effectively. Eighteen transmission projects have been identified and approved for the integration of renewable resources, and the California ISO has noted that there is no need to approve any new major projects for this purpose at this time. As Governor Brown noted in his Clean Energy Jobs Plan, the energy agencies should continue to work together with a sense of urgency to permit these new transmission lines without delay. Sixteen of the projects are within the California ISO's control area, and the Energy Commission is assisting interested parties in tracking these projects by updating and posting their status annually on its website. The *2013 IEPR* provides a list of the projects but also discusses other transmission issues, such as the need to better synchronize generation and transmission planning and permitting, which typically have very different timelines; coordinating land use and transmission planning efforts through the Desert Renewable Energy Conservation Plan and the potential of using that plan as a model for other regions, like the Central Valley; opportunities to designate appropriate transmission corridors in advance of need, particularly in Southern California; and emerging trends in the Western interconnection that could affect California.

Recommendations related to transmission include state encouraging participation in the California ISO's energy imbalance market; energy agencies continuing to work together to analyze and recommend the long-term potential transmission solutions to address reliability concerns associated with the recent shutdown of San Onofre, and ways to reduce transmission permitting timelines; and identify appropriate transmission corridors. In addition, the energy agencies should evaluate the cost-effectiveness, prudency, and alternatives for requiring full deliverability for future renewable generation that is procured to meet Renewables Portfolio Standard requirements.

Nuclear Power Plants

In 2011, nuclear energy provided 18 percent of California's in-state electricity generation. However, California's two nuclear plants – the Diablo Canyon Power Plant and the San Onofre Nuclear Generating Station – are located near major earthquake faults, causing increased concern about potential safety issues, particularly given the Fukushima Daiichi nuclear disaster on March 11, 2011. The *2011 IEPR* recommended actions by Pacific Gas and Electric and Southern California Edison on issues such as spent fuel pool storage, seismic issues, station blackouts, plant liability coverage, replacement power and reliability, emergency response planning, lessons learned, relicensing, and plant safety. The *2013 IEPR* provides updates on utility progress implementing these recommendations.

Though the June 7, 2013, announcement of the permanent closure of the San Onofre Nuclear Generating Station negated many of the recommendations for Southern California Edison, the continued storage of spent nuclear fuel on site will require ongoing attention. The *2013 IEPR* discusses the events that led to the closure of San Onofre; recent federal efforts on nuclear waste transport, storage, and disposal; and pending legislative proposals on nuclear issues. It also includes new policy recommendations for comprehensive design basis seismic analyses, timely compliance with fire protection regulations, and accelerated transfer of spent fuel storage.

Natural Gas

Natural gas continues to play an important and varied role in California. In 2012, nearly 46 percent of the natural gas burned in California was used for electricity generation, and much of the remainder consumed in the residential (20.8 percent), industrial (14.5 percent), and commercial (8.6 percent) sectors. California continues to depend upon out-of-state imports for nearly 90 percent of its natural gas supply, underscoring the importance of monitoring and evaluating ongoing market trends and outlook. The most influential issues affecting natural gas supply and demand in California include development of shale deposits in North America, factors that affect natural gas-powered electricity generation and natural gas infrastructure.

No issue has done more to transform the natural gas field than the widespread development of shale gas by means of hydraulic fracturing, or "fracking." Fracking involves pumping high-pressure fluid, mostly sand and water mixed with chemicals, into the ground to fracture the rock, allowing oil and gas to be pumped out. In 2007, California appeared to be facing dwindling supplies and increased development costs. Just five years later, the country is now experiencing a period of sustained production of shale gas, leading to the lowest prices for

natural gas in a decade. On September 20, the Governor signed Senate Bill 4 (Pavley) to increase regulatory oversight for hydraulic fracturing in California which could affect shale gas supply.

Energy Commission staff produces a forecast of natural gas supply, demand, and price as part of each biennial *IEPR* process. The preliminary staff forecast indicates fairly flat gas prices after 2015, which gradually rise over the forecast period. By 2025, prices are forecast to range from $4.25 to $6.00 per million British thermal units, as compared to a 2013 price of $3.50 per million British thermal units. The Energy Commission expects to adopt the final natural gas forecast in December 2013.

Pipeline safety, in the wake of the San Bruno pipeline explosion in 2010, remains a critical concern of the Energy Commission, the California Public Utilities Commission (CPUC) and the legislature. In response to California's continued focus on pipeline safety, the Energy Commission continues to provide research, development and deployment funding to projects that explore new technologies to monitor and address pipeline safety.

The *2013 IEPR* also discusses natural gas infrastructure issues such as the need to harmonize the natural gas and electricity generation industries to support increasing use of natural gas facilities to help integrate renewable energy; the need for new pipeline development to support increasing exports to Mexico and replacement of coal plants with natural gas; and increased interest in exporting liquefied natural gas. Other issues include the use of biomethane as a renewable substitute for natural gas and the potential impact on demand from increasing use of combined heat and power facilities. Recommendations include: continuing to monitor and better integrate pipeline delivery of natural gas with electric system reliability needs; monitor the national interest in liquefied natural gas and its implications for California; and stay abreast of the changing revenue dynamics for natural gas in light of shale abundance, generation shifts away from coal, and the implications of expiring pipeline contracts for maintaining necessary supply into California.

Transportation

Transportation accounts for nearly 40 percent of California's total energy consumption and roughly 38 percent of the state's greenhouse gas emissions. While petroleum accounts for more than 90 percent of California's transportation energy sources, there could be significant changes in the fuel mix by 2020 as a result of technology advances, market trends, consumer behavior, and government policies. Compared to 2008, gasoline consumption has declined by 6 percent, due in part to the national economic recession and higher vehicle fuel economy standards. Expectations are that gasoline consumption will continue to decline over the next 10 years. At the same time, California has experienced modest but noticeable increases in alternative fuel, primarily natural gas, biofuels, and electricity, use and has increased to approximately 7 percent of total transportation fuel use. While these California trends have shown strong initial progress, new circumstances are poised to push significant advances.

In September 2013, the California legislature reauthorized the Alternative and Renewable Fuel and Vehicle Technology Program with Assembly Bill 8 (Perea, Statutes of 2013) extending program funding through January 1, 2024. The Alternative and Renewable Fuel and Vehicle

Technology Program was originally established by Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007). As of June 2013, the Energy Commission has funded 233 projects through the program, totaling more than $400 million in the categories of electric drive, hydrogen, natural gas, propane, biofuels, multiple fuel types, manufacturing, emerging opportunities, and workforce training and development. This investment supports the State's energy, clean air, and climate goals

The *IEPR* is required to report on the status of projects funded under Alternative and Renewable Fuel and Vehicle Technology Program. Program investments are adding 7,200 electric vehicle charging stations, 205 E85 (a blend of 85 percent ethanol and 15 percent gasoline) fueling stations, 50 natural gas stations, and 6 hydrogen fueling stations, along with more than 26,000 electric vehicles, 160 electric trucks, and 1,375 natural gas trucks. As a result of the Alternative and Renewable Fuel and Vehicle Technology Program, California now has the largest network of electric vehicle charging systems and hydrogen fueling stations in the country. Although still in its early years, the program is playing an important role in building the alternative fuel vehicles and support infrastructure needed for California to meet its low-carbon transportation fuel goals.

The Energy Commission is also required to include an evaluation of projects funded by the Alternative and Renewable Fuel and Vehicle Technology Program in the biennial *IEPR*, including their expected benefits and contribution toward improving air quality, reducing petroleum use and greenhouse gas emissions, and transitioning to a diverse portfolio of clean, alternative transportation fuels. The Energy Commission has contracted with the National Renewable Energy Laboratory to develop a methodology to calculate expected benefits to 2025. Benefit estimates are expected to be available for the final *2013 IEPR* and will be in a stand-alone Energy Commission Contractor Report. In addition to reporting on the status and benefits of the Alternative and Renewable Fuel and Vehicle Technology Program, the Energy Commission is required to report on transportation fuel supply, demand, and trends, each biennial *IEPR*.

In July 2013, the Energy Commission held a workshop on alternative transportation fuel scenarios at which participants provided growth projections to at least 2020 by all alternative fuels and diesel vehicles, identified challenges to continued growth, and recommended actions to achieve California's low-carbon transportation energy goals. Based on workshop findings, the Energy Commission estimated plausible growth to 2020 for several low carbon alternative fuel options, including gasoline substitutes, diesel substitutes, natural gas, electric transportation, and propane. Existing government incentives and regulations combined with alternative fuel price advantages, expected economy of sale vehicle manufacturing, and technology advances could lead to at least a three-fold increase in alternative fuel growth by 2020. This progress should allow California to fulfill 2020 goals to reduce transportation related greenhouse gas emissions, displace petroleum and develop in-state biofuel projects.

Challenges to achieving growth potential for alternative fuels include the need to balance multiple policy objectives in electrifying the transportation system; ethanol blend limits in the federal Renewable Fuel Standard; demand for alternative fuel incentives in excess of funding availability; the limited number of natural gas vehicle models; the market need for certainty

about hydrogen vehicle availability and fueling infrastructure; changing trends in gasoline, diesel, and aviation fuel consumption that may pose challenges to making needed investments in refineries; and challenges tracking and evaluating alternative fuel growth.

Recommendations to address these challenges include: implementation of actions identified in the Governor's Executive Order B-16-2012 advancing zero emission vehicles and the associated Zero Emission Vehicle Action Plan; work with utilities, the CPUC and other public and private stakeholders to balance multiple objectives with the electrification of transportation; government facilitation of investment and development; stricter adherence by obligated parties to advanced, low-carbon, Renewable Fuels Standard goals; development of a multi-year strategy to fund electric, hydrogen, and natural gas vehicle rebates and incentives for related infrastructure; evaluation of options to use state, federal, or other mechanisms to structure incentives to increase private sector project financing; and to evaluate factors affecting California's crude oil production and refining; and to expand the Energy Commission's and Air Resources Board's joint data collection authority.

Climate Change

The Governor joined more than 500 world-renowned researchers and scientists in releasing a groundbreaking call to action on climate change and other global threats to humanity. The 20-page consensus statement, produced at the Governor's urging and signed by more than 500 concerned scientists from more than 44 countries, translates key scientific findings from disparate fields into one unified message (*Scientific Consensus on Maintaining Humanity's Life Support Systems in the 21st Century: Information for Policy Makers,* May 21, 2013, http://mahb.stanford.edu/consensus-statement-from-global-scientists). The document aims to improve the nexus between scientific research and political action on climate change.

California efforts to reduce greenhouse gas emissions from the energy sector include pursuing all cost-effective energy efficiency, adding renewable generation to the state's power mix, reducing the carbon content of transportation fuels through the Low Carbon Fuel Standard, and funding investments in alternative fuels, vehicles, and infrastructure. California must be even more aggressive in developing and implementing these policies to achieve its greenhouse gas reduction goals. Also, the state needs to be prepared to deal with the effects of climate change on the energy sector itself. From direct effects such as increased electricity demand, decreased efficiency of thermal power plants, and the availability of hydropower, to indirect effects such as increased exposure of coastal power plants to flooding due to sea-level rise, policy will need to continue evolving over time to ensure the safety and reliability of California's energy infrastructure.

Since 2006, the state has sponsored a series of climate change assessments that have established that lowering greenhouse gas emissions can reduce climate change effects, emphasized adaptation as a complement to reducing emissions, and explored vulnerabilities while highlighting concrete actions to reduce climate change impacts. As part of the *2012 IEPR Update* and *2013 IEPR* proceedings, Energy Commission staff held public workshops to discuss the latest findings on climate projections relevant to the energy sector, potential impacts on California's energy supply, and responses the energy sector is taking to prepare for climate

change. A staff white paper with the results of those workshops is expected to be released in the fall of 2013 with recommendations for areas where future research is needed to support California's existing and future policy goals. In particular, research is needed on the effect of extreme weather-related events on the energy sector and on renewable energy goals, how California's energy system will need to change over the next few decades, and improvements to climate change indicators to allow better tracking, evaluation, and reporting on efforts to reduce climate change.

California's 2030 Electric System

Achieving California's 2050 greenhouse gas emission reduction goals will require substantial transformation of California's energy system. These challenges are being explored as part of the *2013 Scoping Plan* update, in particular potential targets for 2030. The analysis will focus on three strategies to reduce greenhouse gas emissions: energy efficiency, particularly in existing buildings; expanded zero-emission vehicles deployment; and decarbonizing the Western grid. The Energy Commission and California Air Resources Board will also jointly develop metrics to track progress against the *2013 Scoping Plan* update.

CHAPTER 1: Energy Efficiency

Energy efficiency remains California's highest priority resource to offset increased electricity demand. The state's loading order established by the energy agencies in 2003 calls for meeting new electricity needs first with efficiency and demand response, followed by renewable energy and distributed generation, and then with clean fossil generation.[1] Developing and enforcing energy efficiency codes and standards are critical tools for implementing the loading order.

This chapter covers four issues related to California's continuing commitment to energy efficiency. First is a status report on the Energy Commission's development of a comprehensive program to increase energy savings in existing buildings. Second a discussion of the accepted definition of "zero-net-energy" (ZNE) and development of a pathway to include ZNE buildings in California's building standards. Next is a report on the progress of California's utilities toward achieving efficiency targets.[2] Fourth is an evaluation of barriers to the use of geothermal heat pump and ground loop technologies – which can provide energy savings by reducing electricity and natural gas use. Finally, recommendations for the four efficiency topics are provided at the end of the chapter.

The Benefits of Energy Efficiency Standards

Since they were established in 1975, California's building and appliance efficiency standards have saved consumers over $74 billion for electricity alone on their energy bills. Going forward, the *2013 Building Energy Efficiency Standards* are projected to save $1.6 billion in energy costs over the next 30 years, while recently adopted appliance standards for battery chargers are expected to save 2,200 GWh per year, which would be sufficient to power 350,000 California households each year.[3]

Energy efficiency standards help overcome well-understood barriers in markets for appliances and buildings. When a consumer has limited knowledge of, or influence on the energy performance characteristics of a product, the marketplace will not tend to prioritize efficiency, even if it is simple and inexpensive to do so. Standards eliminate the least efficient products and practices from the marketplace, reaping large benefits for California's consumers. Building standards, for example, ensure that cost-effective efficiency features are incorporated into each

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1 Consumer Power and Conservation Financing Authority, California Energy Commission, and California Public Utilities Commission, *2003 Energy Action Plan*, http://www.energy.ca.gov/energy_action_plan/2003-05-08_ACTION_PLAN.PDF.

2 California Energy Commission, *Achieving Cost-Effective Energy Efficiency for California 2011-2020*, Final Staff Report, December 2011, http://www.energy.ca.gov/2011publications/CEC-200-2011-007/CEC-200-2011-007-SF.pdf.

3 California Energy Commission, http://www.energy.ca.gov/appliances/battery_chargers/documents/Chargers_FAQ.pdf.

building during construction—the ideal moment to do so, since the subsequent owner of the building cannot change the basic characteristics of the building. Similarly, purchase of an appliance represents a forward commitment by the consumer for an unknown, often large, energy cost over the lifetime of that device. Appliance standards protect consumers by ensuring that forward commitment meets a minimum bar for reasonableness.

The direct benefits —energy bill savings, improved indoor environment, increased building functionality, improved health and safety—of energy efficiency in newly constructed buildings and newly manufactured appliances or equipment appropriately accrue to the owner or user of the building or appliance. Standards are a foundational part of California's long-term goals for resource conservation and environmental stewardship: they avoid long-term lost opportunity by ensuring that builders and manufacturers make appropriate, cost-effective investments in energy efficiency, to the benefit of all Californians.

Comprehensive Energy Efficiency Program for Existing Buildings

Existing buildings represent great untapped potential for additional energy savings and account for nearly a fourth of California's greenhouse gas emissions. More than 55 percent of existing residential buildings and more than 40 percent of existing nonresidential buildings were built before California building energy efficiency standards were in place. Many more buildings constructed since then, particularly in the inland areas of the state, present very significant opportunities for energy savings. These factors underscore the need for a comprehensive program to promote efficiency improvements in all existing buildings.[4]

Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009) directs the California Energy Commission to develop and implement such a program to achieve cost-effective energy savings in California's existing residential and nonresidential buildings, and to report on the status of the program in its biennial *Integrated Energy Policy Report (IEPR).*

In June 2013, the Energy Commission issued its *Draft Action Plan for the Comprehensive Energy Efficiency Program for Existing Buildings.*[5] Public workshops were held throughout the state to solicit feedback on the draft action plan from stakeholders and the public, and the final action plan will be considered for adoption by the Energy Commission in late 2013, with implementation beginning shortly thereafter.

Purpose and Principles

In addition to implementing specific requirements contained in AB 758, the action plan seeks to establish conditions that will support a flourishing energy efficiency upgrade market using a diverse portfolio of approaches, a broad range of strategies and initiatives, and engagement

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4 California Air Resources Board. *Climate Change Scoping Plan: A Framework for Change*. 2008. http://arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm, pp.12.

5 California Energy Commission, *Draft Action Plan for the Comprehensive Energy Efficiency Program for Existing Buildings*, June 2013, http://www.energy.ca.gov/2013publications/CEC-400-2013-006/CEC-400-2013-006-D.pdf.

with all market actors. The plan represents a roadmap that encompasses all relevant energy efficiency programs in the state and encourages extensive coordination and leveraging for optimum outreach to local implementers, utilities, and existing building owners and tenants. The coordinated strategies of the plan will maximize energy efficiency for all building types, including single-family and multifamily; small, medium, and large nonresidential buildings; and public buildings.

Guiding principles in the plan include maintaining cost-effectiveness of efficiency efforts, improved data collection management and analysis, support for contractors and other building professionals, public outreach and education, increased availability of building and assessment tools, availability of rebate and financing programs where appropriate, energy performance disclosure, improved compliance and enforcement of codes and standards, and development of a robust clean energy workforce.

Implementation

Implementation will begin after the Energy Commission adopts the action plan and will focus on implementing strategies, building partnerships, and developing the market. Going forward, it will be critical to assess which areas of the energy efficiency market have reached a level of maturity that will allow public consideration of a potential transition from voluntary pathways to potential mandatory upgrades, as appropriate, to accomplish the energy savings goals of the program.

Strategies

Recommended strategies in the plan fall into three general categories.[6] **No regrets strategies** are intended to provide a strong foundation for growth in the demand for energy efficiency upgrades while supporting and streamlining current energy efficiency programs and markets. These strategies include:

- Data reporting and management to support private sector development and investment and effective program design, monitoring, and evaluation.
- Permitting support tools and code enforcement activities to improve building practices generally, and ensure compliance with existing building code.
- Education to motivate building owners and building managers to make energy efficiency upgrades.
- Workforce training and development to ensure measured scale-up of an appropriately skilled clean energy workforce.

Voluntary pathways will build on past efforts, channel existing resources, and support upgrade projects for all categories of building stock. These strategies include:

- Promoting a broad array of pathways for each building sector to achieve energy efficiency upgrades during various stages in the life of the building. These pathways could

6 Ibid, http://www.energy.ca.gov/2013publications/CEC-400-2013-006/CEC-400-2013-006-D.pdf.

incorporate a single measure, multiple measures, a whole-building approach, or self-generation projects.

- Expanding engagement with the contracting industry and related building professionals.
- Developing standardized tools for benchmarking, energy assessments and audits, and building commissioning in commercial and public buildings.
- Focusing attention on small and medium commercial building upgrades.
- Enabling efficiency solutions for multifamily rental properties, with special focus on disadvantaged communities.
- Working with local and regional governments to increase energy performance of public buildings while encouraging upgrades of privately owned buildings.
- Developing effective approaches to include energy efficiency upgrades in property valuation.
- Offering multiple innovative financing options for all building owners.

Mandatory approaches will be considered alongside other efforts. Disclosure policies are proliferating across the country and good models exist which California might emulate. Mandatory implementation of certain cost-effective upgrades may be considered, through a public process, to determine their potential and acceptance. Mandatory approaches could include:

- A statewide public disclosure program for the largest commercial and municipal buildings. This effort would coordinate with and build upon implementation of California Executive Order B-18-12 and the Green Building Action Plan, which focus on state buildings.
- Disclosure of energy performance ratings on existing residential and nonresidential buildings, and considering the case for required completion of basic energy efficiency upgrades on existing residential and nonresidential buildings.

Zero-Net-Energy Buildings

The *2011 IEPR* (and previously the *2007 IEPR*) discussed the Energy Commission's policy recommendations about the pursuit of ZNE Buildings for newly constructed buildings within the Building Energy Efficiency Standards. These policies have been supported by the California Public Utilities Commission (CPUC) in the Long-Term Energy Efficiency Strategic Plan, the ARB in the *Climate Change Scoping Plan*,[7] and Governor Brown's *Clean Energy Jobs Plan*.[8] Further, Governor Brown's Executive Order B-18-12[9] calls for all new State buildings and major renovations that begin design after 2025 be constructed as zero-net-energy facilities. The

7 California Air Resources Board. *Climate Change Scoping Plan: A Framework for Change*. 2008. http://arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm.p. 12

8 http://gov.ca.gov/docs/Clean_Energy_Plan.pdf

9 Executive Order B-18-12, April 25, 2012, http://gov.ca.gov/news.php?id=17508

Executive Order also calls for achieving zero-net-energy for 50 percent of the square footage of existing state-owned building area by 2025.

The *2011 IEPR* made the following recommendations related to ZNE delivery:

- The Energy Commission should adopt triennial building standards updates that increase the energy efficiency of newly constructed buildings by 20-30 percent in every triennial update to achieve ZNE standards for newly constructed homes by 2020.
- The Energy Commission should adopt reach standards for newly constructed buildings that provide best practices energy efficiency levels for the marketplace to strive for and to serve as a means to pull the industry rapidly to the level needed to achieve ZNE goals.
- The Energy Commission, CPUC, local governments, and builders should collaborate to encourage the building industry to reach these advanced energy efficiency levels in a substantial segment of the market through industry-specific training and financial incentives.
- The Energy Commission and CPUC should coordinate future investor-owned utility "new construction-related" programs with the Energy Commission's efforts to meet the ZNE goals through triennial updates of mandatory and reach standards. By offering incentives for achieving reach standards, providing technology demonstration and development, and conducting pilot programs for demonstrating ZNE solutions, new technologies and building practices will be integrated into upcoming triennial updates of the Building Standards quicker and with more success.
- The Energy Commission, CPUC, builders, and other stakeholders should collaborate to accomplish workforce development programs to impart the skills necessary to change building practice to accomplish ZNE in newly constructed buildings.
- The Energy Commission should adopt appliance standards that focus on reducing plug loads to enable California's ZNE goals to be achieved.

"Demand is the real opportunity."
Ed Mazria, California Energy Commission, ZNE Definition Workshop, July 18, 2013

According to the McKinsey Global Institute, "Urban World: Cities and the Rise of the Consuming Class,"[1]; by 2030 an additional 1.6 billion people will live in cities and 900 billion cubic feet of new and rebuilt buildings will be constructed in cities worldwide. Over half of this construction will occur in China, the United States, and the rest of the Pacific Rim.

"What California does influences China and, in turn, the rest of the world."
Ed Mazria, California Energy Commission, ZNE Definition Workshop, July 18, 2013

"…So where is all that building going to take place? About nine percent of that is going to take place in the Middle East. About another nine percent in Latin America; India itself will be responsible for about nine percent. Other emerging nations, mostly Southeast Asia, will be responsible for about twelve percent. The U.S. and Canada… will be responsible for about 15 percent of that total gross over the next two decades; and obviously, China is critical, it is about 38 percent.

But between China and the U.S. you have over 50 percent and if you include the rest of Southeast Asia you are well over 65 percent of the total construction in the world. That is critical, because the U.S. influences what happens in China. So you have a majority of the growth happening between those two areas.

The Energy Commission, CPUC, and partners in the building industries have together made major progress on all of these ZNE delivery recommendations, centrally including the adoption

of the 2013 T24 Building Efficiency Standards. This latest code update achieves 25 percent savings over existing code, and comes into effect January 1, 2014.

The *2011 IEPR* also made this additional recommendation related to the definition for ZNE Code Buildings:

- The Energy Commission and the CPUC should work jointly on developing a definition of ZNE that incorporates the societal value of energy (consistent with the time dependent energy valuation approach used for the California Building Energy Efficiency Standards).

The Energy Commission, working with the CPUC, has accomplished this recommendation, and proposes adoption of the following definition.

> "A ZNE Code Building is one where the societal value of the amount of energy provided by on-site renewable energy sources is equal to the value of the energy consumed annually by the building at the level of a single "project" seeking development entitlements and building code permits, measured using the California Energy Commission's Time Dependent Valuation (TDV) metric. A ZNE Code Building meets Energy Use Intensity by building type and climate zone that reflect best practices for highly efficient buildings."[10]

The adoption of this definition will enable the Energy Commission to update the California Building Energy Efficiency Standards for 2016 and 2019 with clear orientation toward the upcoming ZNE targets. Once the definition is incorporated into CPUC guidance to investor-owned utilities (IOU), it will help define activities of the utilities' emerging technology and new construction programs that will be needed to accelerate the shift to ZNE.

The goal for ZNE Code Buildings, established in the *2011 IEPR* and other California policy documents, applies to the design of the building and to its construction, before the building is occupied. The ZNE Code Building concept is that the building is designed with energy efficiency and on-site renewable energy production such that the net societal cost of the energy used over the course of a year is equal to zero. Actual energy bills will be dependent on how the building is operated by the building owners and occupants after the design/construction stage is long past, and will depend on the application of specific utility rates on their net consumption during each period of the day and month. Public education is important so that people understand that the estimated energy use for the ZNE Code Building is determined for the building design, and that the actual energy use of the building will be depend on how the building is actually operated. Public education should clarify the correct expectations for ZNE Code Buildings, and should also illuminate the benefits of ZNE Code Buildings in achieving optimum energy performance, improved statewide energy system reliability, reduced criteria

10 The ZNE Code Building definition was presented at a publicly noticed workshop at the Energy Commission on July 18, 2013, attended by the Energy Commission staff and Commissioners, the California Public Utility Commission Staff, noted national ZNE experts, and representatives from each of the IOUs and SMUD.

pollutants, and reduced greenhouse gas emissions, as well as non-energy benefits such as improved comfort and building functionality.

For a building to achieve the ZNE Code Building requirements, substantial energy efficiency advances will be required. Together, the California Building Energy Efficiency Standards, California Appliance Efficiency Standards and the federal Appliance Standards and appropriately-sized onsite renewable power production will enable newly constructed buildings in California to reach the ZNE Code Building requirements. Building owners and occupants will count on buildings that have zero or very low energy use levels, depending on how they are operated.

The California Building Energy Efficiency Standards necessarily focus on the capital improvements of the building itself (its physical assets), since those are under the control of the building designer and builder; the Standards cannot influence the portable equipment that is brought into the building later ("plug loads"). Plug loads can, however, be influenced by California and federal appliance standards that apply to portable equipment used by building occupants. The ZNE Building Code determination will be based on "typical" levels of portable "plug load" equipment.

There will be particular buildings or situations where it will be infeasible for the building to meet the ZNE Code Building requirements. In adopting the ZNE Building Code requirements, the Energy Commission will use normal building code practice to establish specific exceptions for these cases. An example of a possible exception would be allowing the use of off-site renewable energy sources where the site cannot accommodate collocated generation of any sort.

The Energy Commission's California Home Energy Rating System (HERS) Program established the California HERS Scale (Figure 1).

Figure 1: Standards on the Home Energy Rating System (HERS) Scale

Source: California Energy Commission

The California HERS Scale establishes a rating score of 0 for the ZNE Code Building. The scale benchmarks a home built to comply with the 2008 California Building Energy Efficiency Standards at a score of 100. A home built to comply with the 2013 Standards will have a HERS of around 90 (varying by climate zone). The graphic also shows a "ZNE Ready" level to

represent a home with the energy efficiency improvements that sufficiently reduce demand so that the addition of onsite renewable power production could achieve ZNE (the "ZNE Ready" level assumes that the onsite renewable power production is not actually installed). A home built to be "ZNE Ready" would have a HERS score in the range of 30 to 40.

Key Terms in the ZNE Code Building Definition

Societal Cost

The societal value of energy includes forecasted energy system costs that Californians pay for energy. This cost of delivering energy to meet building energy demand depends upon when and where it is needed. The societal value of energy is established by the concept of Time Dependent Valuation, first used in the 2005 California Building Energy Efficiency Standards.

Time Dependent Valuation

Time Dependent Valuation is based on the forecasted seasonal and hourly costs for generating, transmitting and distributing electricity, and producing and distributing natural gas and propane. TDV values are established for every hour of the year for each type of energy in each of California's 16 climate zones. The TDV values recognize the premium utility costs that must be paid for energy consumed during peak conditions compared to the substantially lower costs during off-peak conditions – as a result, energy efficiency improvements that drive lower on-peak energy use are highly valued by TDV.

The TDV values that the Energy Commission adopts are based on a forecast of the mix of energy system resources that are expected to be in operation over the 30-year time horizon analyzed for the Building Energy Efficiency Standards. For each 3-year cycle of the Standards, TDV is updated to incorporate the most recent publicly available information on energy systems costs and the forecast is re-evaluated resulting in true up adjustments to the TDV values to capture the impacts of changing energy supply and demand conditions and policies. The Energy Commission will work with all stakeholders in the 2016 Building Energy Efficiency Standards proceeding to update the current TDV values to reflect changes in California's electricity generation system resource mix.

TDV provides a systematic way to recognize the societal value of energy savings accomplished through different times of the year. In theory, buildings with low TDV energy consume less energy during peak conditions, resulting in a reduction in electricity system peak demands, saving Californians the high costs of new power plants and distribution systems on-peak and helping to make the California's energy systems more reliable. For TDV to work in practice as intended, the following is needed: 1) retail rates must reflect the cost of service, and 2) geographic and temporal variation must be taken into account in both TDV calculations and applicable rates. Achieving this requires ongoing cross-agency work on both TDV development and rate reform.

On-Site, Single Project, Renewable Energy Sources, Development Entitlements and Building Permits

ZNE Code Buildings will be required to incorporate on-site renewable sources to serve the remaining energy demands of the building after energy efficiency capital improvements. Each

single project seeking development entitlements and building permits must install enough renewable energy on-site to reduce the TDV energy of the project to zero. The single project would typically be a single building but could include a bigger project that is seeking (or has approved) development entitlements for more than one building.

Energy Use Intensities

The Building Energy Efficiency Standards will set requirements for each ZNE Code Building that include energy-use intensities for each major end-use (for example, space heating, space cooling, lighting, water heating) in TDV energy. These energy-use intensities will be based on evaluation of best practices for highly efficient buildings during Standards update proceedings.

Utility Progress Toward Achieving Energy Efficiency Targets

Utility energy efficiency programs also help reduce California's electricity demand. A wide array of energy efficiency programs for utility customers has contributed to keeping energy use per person in California relatively constant while use in the rest of the United States has increased by roughly 40 percent. California's investor- and publicly owned utilities remain key players in the state's efforts to achieve all cost-effective energy efficiency. The California Public CPUC oversees energy efficiency programs for the state's IOUs, primary among them Pacific Gas and Electric Company, Southern California Edison, Southern California Gas Company, and San Diego Gas & Electric; while California's more than 40 publicly owned utilities (POU) are responsible for their own efficiency programs.

To promote increased energy efficiency in all of California's utilities, Assembly Bill 2021 (Levine, Chapter 734, Statutes of 2006) requires the Energy Commission to develop statewide estimates of energy efficiency potential along with targets for California's investor and publicly owned utilities, and to report utility progress in implementing AB 2021 in the biennial *Integrated Energy Policy Report*. AB 2021 follows up on prior legislation, Senate Bill 1037 (Kehoe, Chapter 366, Statutes of 2005), which requires electric utilities to meet their resource needs first with energy efficiency. For IOUs, SB 1037 requires the CPUC and the Energy Commission to identify all potentially achievable cost-effective electric and natural gas energy efficiency savings and to set goals for achieving this potential.[11] The agencies are required to review the procurement plans to ensure consideration of energy efficiency and other cost-effective supply options. SB 1037 also requires publicly owned utilities, regardless of size, to report annually to their customers and to the Energy Commission investments in energy efficiency programs.

Under AB 2021, POUs are directed to identify all potentially achievable cost-effective electricity savings; establish annual targets for energy efficiency savings and demand reduction for the next 10-year period; provide an annual report to the Energy Commission on energy efficiency investments, programs, expenditures, cost-effectiveness, and results; and provide an independent evaluation of reported energy savings. In 2012, Assembly Bill 2227 (Bradford,

11 The terms "targets" and "goals" are used interchangeably here; since 2004, the CPUC and IOUs have an established convention of using the term "goals," while publicly owned utilities have adopted the term "targets" that is used in AB 2021.

Chapter 606, Statutes of 2012) consolidated the POU reporting requirements to make compliance easier and reduce reporting costs by aligning the requirements more closely with the *IEPR* timeline. This consolidation will streamline the process and allow the POUs to focus their resources on implementing efficiency programs rather than on reporting. Under the consolidated requirements, POUs will provide updated targets every four years rather than every three, as was originally required by AB 2021.

Table 1 shows the IOU and POU energy savings for electricity, peak, and natural gas in 2011 and 2012. The IOUs reported savings exceeded their energy and peak savings goals, while the POUs in general reported declines in energy savings, as discussed in more detail in the "Publicly Owned Utilities" section below.

Table 1: IOU and Publicly Owned Utility 2011 and 2012 Energy Savings and Program Expenditures

	IOUs		POUs	
	2011	**2012**	**2011**	**2012**
Gigawatt hours	3,557	3,898	456	440
Megawatts	644	678	81	82
Therms (Millions)	97	54	-	-
Expenditures ($ Millions)	$959	$1,004	$129	$127

Source: Investor-owned utilities' annual reports for 2010- 2012, http://eega.cpuc.ca.gov/Documents.aspx; California Public Utilities Commission; California Municipal Utilities Association.

Investor-Owned Utilities

The CPUC approves three-year efficiency program cycles for the IOUs. For the 2010-2012 cycle, IOUs administered their portfolios of efficiency programs under CPUC Decision 09-09-047 with a total budget of $3.1 billion. Often, three-year program cycles are followed by a "bridge" year, which extends the previous cycle's energy efficiency programs while plans for the next three-year cycle are developed. However, the CPUC issued Decision 12-05-015 in 2012 with guidance for the 2013-2014 program years, thereby establishing a two-year "transition" period that is neither a bridge year nor a full portfolio cycle.

In 2011, the CPUC began a study on energy savings potential with the primary objectives of assessing IOU energy savings potential and establishing efficiency goals for the 2013-2014 transition period.[12] Phase 2 of the study began in 2012 and will lead to broader changes for the post-2014 portfolio guidance. Looking forward to the post-2014 program cycle, the CPUC will work with the Energy Commission and the California Independent System Operator (California ISO) to help the IOUs focus their energy efficiency programs on local reliability areas and

12 California Public Utilities Commission, *Analysis to Update Energy Efficiency Potential, Goals, and Targets for 2013 and Beyond: Track 1 Statewide Investor Owned Utility Energy Efficiency Potential Study*, March 19, 2012, http://www.cpuc.ca.gov/NR/rdonlyres/5A1B455F-CC46-4B8D-A1AF-34FAAF93095A/0/2011IOUServiceTerritoryEEPotentialStudyFinalReport.pdf.

programs that target specific times of day.[13] Some of the IOU strategies intended to meet these goals include increased marketing and outreach, higher incentives, and more direct install programs.

The CPUC is currently finishing the evaluation, measurement, and verification (EM&V) studies for the 2010-2012 portfolio cycle. While some of the studies' results will be published in the CPUC's annual EM&V report to be released in fall 2013, the majority will not be completed until spring 2014. The results of these studies are important because they may result in the IOUs eliminating unsuccessful programs and revising other programs that have merit but may not be realizing full-ratepayer benefit. The CPUC also directed utilities to design their portfolios to shift from short-lived individual energy savings measures to programs that encourage utility customers to adopt more comprehensive "suites" of measures characterized by more and longer-lasting savings.

The 2013-2014 program cycle evaluations are also underway. The CPUC has announced the contractors for this cycle and will have a final evaluation plan ready this fall. Once the plan is ready, the evaluations will begin.

Publicly Owned Utilities

California's POUs deliver about 25 percent of the state's electricity and 2 percent of natural gas supply.[14] The size of POUs ranges from the largest public utility in the nation, Los Angeles Department of Water and Power, to entities such as the Lassen Municipal Utility District that serve fewer than 500 customers. The California Municipal Utilities Association (CMUA) reports to the Energy Commission annually on behalf of its members on energy efficiency progress, while the Sacramento Municipal Utility District and the Los Angeles Department of Water and Power report directly to the Energy Commission and not always during the same time frame as the CMUA, which can interfere with staff's ability to conduct its analysis of statewide progress toward meeting energy efficiency targets.

Since AB 2021 was passed in 2006, POUs have spent more than $737 million on energy efficiency programs and delivered roughly 2,700 gigawatt hours (GWhs) of energy savings and 515 megawatts (MW) of peak demand reduction. Most energy savings were attributed to lighting and heating, ventilation, and air-conditioning programs, and energy savings can differ markedly among utilities because of different customer bases, geographic locations, and size. In 2012, the POUs spent a combined total of $127 million on energy efficiency programs, which represented a 2 percent decrease from 2011, and reported combined savings of 440 GWh, a decline of 3 percent compared to 2011. This is the third consecutive year that POUs, with a few exceptions, reported declines in energy savings. Cost-effectiveness is difficult to compare

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13 California Public Utilities Commission, California Independent System Operator, California Energy Commission, letter, addressed to Senators Padilla and Fuller, February 25, 2013.

14 The number of POUs reporting energy savings is different not only from the number of POUs in the state, but from year to year. Staff performed assessments of only 36 POUs for which targets were established in 2007.

between POUs and IOUs both because of the differences in their regulatory, financing and revenue structures and for lack of data about cost-effectiveness inputs for individual POUs.

Advancing energy efficiency gains for POUs will require stimulating new program designs, tracking program accomplishments, verifying energy savings, improving program forecasts, and using this information to strive for deeper energy savings. The staff assessment of POUs' reported energy savings results revealed that several smaller and mid-sized POUs are likely to reach the 10 percent energy reduction goal contained in AB 2021; however, several are just as likely to fall short. To meet energy efficiency targets, certain POUs will need to capture significantly higher levels of energy savings and peak demand reduction going forward.

Evaluation, Measurement, and Verification of Publicly Owned Utility Efficiency Savings

Unlike the IOUs, for which the CPUC can report evaluated savings, most POUs do not have consistent independent EM&V methods. Since 2006, only half of the POUs have filed at least one EM&V impact study for program years 2007-2012. Savings reported this year were not adjusted as a result of EM&V analysis.

In 2010, the Energy Commission developed EM&V guidelines to clarify the reporting requirements needed to improve EM&V studies and reports. These guidelines included how and when to apply the framework of evaluation criteria. Some POUs indicated that size, diversity in customer base, and program types made the "one-size-fits-all" approach outlined in the guidelines impractical. As a result of utility feedback, the Energy Commission is revising the EM&V guidelines. The intent of the revised guidelines is to better meet the needs of the POUs, improve the transparency of the methods used to develop program savings estimates, and help overall credibility of the reported energy savings. The revised guidelines are expected to be completed by the end of 2013.

Geothermal Heat Pump and Ground Loop Technologies

As a further means to achieve greater energy efficiency in California's buildings, Energy Commission staff evaluates technologies that may provide efficiency savings over traditional heating and cooling systems. In 2012, Governor Brown signed Assembly Bill 2339 (Williams, Chapter 608, Statutes of 2012), which requires the Energy Commission to evaluate policies to help overcome barriers to geothermal heat pump and ground loop technologies, and to provide recommended solutions in the *2013 IEPR*.

Geothermal heat pumps have existed in the United States for more than 50 years. Using the relatively constant temperature of the ground, they perform a heat exchange to both heat and cool buildings. In winter, heat from the warmer ground is transferred to a water-source heat pump, which provides warm air for the home or business. During hot weather, the process is reversed. Geothermal heat pumps also provide domestic hot water (or chilled water in some cases) at the same time through the same process.

Challenges

A primary challenge for the geothermal heat pump industry is how buildings are modeled in *California's Building Energy Efficiency Standards*. Currently, residential and nonresidential

compliance software does not adequately model geothermal heat pump systems. Because utility rebate programs generally require modeling of a building with the Energy Commission's approved compliance models and since these models do not adequately represent the efficiency gains of geothermal heat pump systems, geothermal heat pump systems may not have sufficient access to utility rebate programs.

This unintentional barrier affects the industry in several ways. Building owners proposing to install a geothermal heat pump may not qualify for a utility rebate simply because the model does not represent geothermal heat pumps well (or at all). Further, the existing compliance models make it difficult for installation in the planning phase to demonstrate compliance with the *Building Energy Efficiency Standards* as well as to what extent the geothermal heat pump (and the rest of the building) might exceed the standards. Also, the verification of a HERS rater may be required to show that an energy efficiency measure exceeds the standards, but without an Alternative Calculation Method for geothermal heat pumps,[15] a verification system for HERS raters cannot be developed. Local jurisdictions with permitting authority have allowed geothermal heat pump advocates to use parallel building energy models (which are not approved compliance models for purposes of the state's standards) that do a better job of predicting geothermal heat pump efficiencies, and to couple those results with the Energy Commission's approved compliance models. Other challenges include the following:

- The lack of local enforcement agency knowledge of geothermal heat pump industry standards leads to inconsistent local permitting requirements and variable fee schedules. For open-loop geothermal heat pump systems, there are also multiple and inconsistent permitting requirements due to the number of permitting agencies at the federal, state, and local levels.
- Geothermal heat pump systems are often considered "renewable," by the geothermal heat pump industry, but they do not generate electricity and therefore do not meet California's statutory definition of a renewable resource eligible for California's Renewables Portfolio Standard.
- The tiered utility electric residential rate structure may not reduce the customer's utility costs even when energy consumption has been reduced.[16]
- Boreholes for closed-loop geothermal heat pumps are fundamentally different from water wells but are subject to the same rules and regulations. There is a need for state-adopted standards for geothermal heat pump boreholes and ground loop installations. In addition, it can be difficult and expensive to collect data for the proper design and installation of systems with many borehole drillers forced to rely on a limited number of publicly available well/bore logs, their own well logs, or potentially expensive onsite test drilling.

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15 *2013 California Building Energy Efficiency Standards*, (Title 24, Part 1), Section 10-109(c)(2).

16 A geothermal heat pump installation typically saves energy, both gas and electricity, in the summer months. However, in the winter months, it saves only gas while marginally increasing electricity consumption due to the pump.

Recommendations

Comprehensive Energy Efficiency Program for Existing Buildings

- **Implement the *Action Plan for the Comprehensive Energy Efficiency Program for Existing Buildings.*** The Energy Commission plans to adopt its final *Action Plan for the Comprehensive Energy Efficiency Program for Existing Buildings* in late 2013. The Action Plan and future year updates should become a core component of the California Long Term Energy Efficiency Strategic Plan and the Scoping Plan for AB 32, the Global Warming Solutions Act of 2006. It should also become a critical component of California's efforts to replace San Onofre with 50 percent preferred resources.
- **Implement energy performance disclosure requirements.** California should develop disclosure approaches and programs that build on existing efforts in California and other states, expanding them to a the broadest range of building types, including State Buildings in alignment with Governor Brown's Executive Order B-18-12.
- **Improve Title 24 Building Standard code compliance rates for existing building upgrade projects.** This will require much greater, ongoing emphasis on code-related outreach, education and training, as well as on-going enforcement action. California should consider developing or adopting low-cost permitting platforms that local building departments could adopt.
- **Enhance usability of T24 Building Standard for existing buildings.** The Energy Commission should strive for future updates to California Title 24 building efficiency standards that are highly functional for additions and alterations to existing buildings.
- **Collaborate with real estate and property management industries.** Both the Energy Commission and the California Public Utilities Commission (CPUC) should involve real estate industry stakeholders in crafting aggressive but practical solutions for achieving high penetration of efficiency upgrades to all existing buildings, placing special emphasis on improving the energy performance of class B and C commercial buildings, multifamily buildings, and rental housing.
- **Leverage Proposition 39 efforts.** As lead agency for implementation of the California Clean Energy Jobs Act (SB 73 / Proposition 39), the Energy Commission should, where possible, ensure that tools developed for program management, tracking, and impact assessment have broader applicability for public sector buildings and across the clean energy marketplace.
- **View plug loads as a grid resource.** Future California Title 20 updates and corollary collaborative work with the U.S. Department of Energy on appliance standards should focus both on realizing cost-effective energy savings and on incorporation of features that can assist in grid resilience and responsiveness. Key features to include in the standards are communication protocols and control infrastructure to receive and respond to signals which will enable visibility for grid operators.
- **Conduct new Commercial End-Use Survey**. The Energy Commission should perform a new Commercial End-Use Survey as soon as support funds can be identified. The last

Commercial End-Use Survey occurred in 2002-2003, and is now out of date. Sophisticated tools are available that, together with updated survey instruments, will allow efficient, rich, and relevant characterization of California's commercial building stock.

Zero-Net-Energy Buildings

- **Increase efficiency by 20-30 percent with each building standard update.** To achieve zero-net-energy standards for newly constructed homes by 2020, each triennial update to the building standards should increase the energy efficiency of newly constructed buildings by 20 to 30 percent.[17]
- **Develop industry-specific training and financial incentives to advance reach standards.** "Reach standards" for newly constructed buildings should provide best practices energy efficiency levels in terms of Energy Use Intensity for each building type and climate zone in California. The Energy Commission, the CPUC, local governments, builders, investor-owned utilities, and publicly owned utilities should collaborate to encourage the building industry to reach these advanced energy efficiency levels through industry-specific training and financial incentives.
- **Track market progress on zero-net-energy construction.** To inform its development of ZNE code requirements within T24, the Energy Commission will work in concert with the CPUC and California Air Resources Board to track zero-net-energy adoption rates, monitor related construction trends, assess performance of zero-net-energy buildings, and develop lessons applicable for standards.
- **Coordinate new construction and retrofit programs.** The Energy Commission and the CPUC should coordinate future investor-owned utilities new construction and retrofit related programs with the triennial updates of mandatory and reach standards. Judicious incentives for achieving reach standards, technology development, and zero-net-energy demonstration programs will facilitate integration of new technologies and practices into future updates of the building standards. The Electric Program Investment Charge research program will provide funding for technology innovations and demonstrations to achieve zero-net-energy in both new construction and retrofit applications.
- **Develop workforce to build zero-net-energy buildings.** The Energy Commission, the CPUC, Labor and Workforce Development Agency, the California Workforce Investment Board and its Green Collar Jobs Council, the Division of Apprenticeship Standards, the Community Colleges Chancellor's Office, and other stakeholders should collaborate on judiciously developed programs that provide workers with the skills needed to build new zero-net-energy buildings. Programs and resources should be aligned and leveraged to best use pooled resources.

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17 *2011 Integrated Energy Policy Report*, California Energy Commission, Sacramento, California, Publication Number CEC-100-2011-001-CMF, http://www.energy.ca.gov/2011publications/CEC-100-2011-001/CEC-100-2011-001-CMF.pdf, posted February 15, 2012.

- **Add voluntary tier for zero-net-energy to 2016 California Green Building Standards Code.** To help advance early adoption of zero-net-energy, the Energy Commission should include a voluntary energy tier for zero-net-energy in the 2016 California Green Building Standards Code (Title 24, Part 11, CALGreen Code).

Investor Owned Utility Progress Toward Achieving All Cost-Effective Efficiency Targets

- **Advance financing mechanisms.** The CPUC and Energy Commission will collaborate to evaluate what new types of savings could be expected as a result of extensive customer access to financing for energy efficiency measures, and to develop the financing mechanisms needed.
- **Advance locational and peak period energy efficiency.** The CPUC, California Independent System Operator, and Energy Commission will collaborate to develop the data and tools needed to advance energy efficiency in specific, targeted areas to avoid development or upgrades to transmission and distribution systems as well as generation.
- **Increase natural gas end-use efficiency.** The CPUC and Energy Commission will collaborate to develop the data and tools needed to further advance end-use natural gas efficiency.
- **Modernize energy-related information management practices.** Interagency collaboration should: enable robust, cross-agency data management and sharing; provide clear access procedures and timely data services to researchers; facilitate appropriately detailed reporting to the legislature; and enable greater information availability to the public. Collaboration should extend beyond the Energy Commission and CPUC to include the California Air Resources Board, Contractors State Licensing Board, Department of Water Resources, local governments, and others.
- **Analyze savings.** The CPUC and Energy Commission will collaborate to analyze the near- and longer-term savings impacts of energy efficiency codes and standards and their interaction with other efficiency programs.

Publicly Owned Utility Progress Toward Achieving Energy Efficiency Targets

To support continued progress toward achieving higher levels of energy savings, Energy Commission staff recommends the following:

- **Improve transparency.** In their 2014 report to the Energy Commission, the publicly owned utilities shall disclose data on their energy efficiency funding levels so that all investment sources can be tracked, as well as the E3 calculator inputs used to determine energy efficiency savings.
- **Improve evaluation, measurement, and verification (EM&V).** The Energy Commission aims to complete the EM&V guidelines by the end of 2013 for the publicly owned utilities to use in their next EM&V cycle to increase confidence and ensure independent verification; the publicly owned utilities should subsequently complete the development of an EM&V program tracking system within 12 months.

Geothermal Heat Pump and Ground Loop Technologies

The Energy Commission supports the proper design and installation of geothermal heat pump technologies as a strategy for meeting California's energy efficiency goals. In order to advance the design, installation, and permitting of geothermal heat pump and ground loop technologies, the Energy Commission encourages geothermal heat pump industry to:

- Submit an Alternative Calculation Methodology application to the Energy Commission consistent with the 2013 Building Energy Efficiency Standards, Section 10-109(c)(2).
- Propose protocols for the proper design, installation, site verification, and commissioning of geothermal heat pump ground loop systems.
- Standardize training and certification of industry professionals in the proper design, installation, site verification, and commissioning of ground loop systems installed in California, to provide system owners and operators with the assurance that these systems will perform as expected.
- Develop a model local ordinance. Industry should take the lead and consult with the Energy Commission, local International Code Council Chapters, Regional Water Quality Boards, the California Building Standards Commission, the California Department of Housing and Community Development, the Department of Water Resources, the Public Utilities Commission, and based on vetted industry standards that can be adopted by local jurisdictions.
- Collaborate with federal, state, and local agencies to resolve permitting issues.

CHAPTER 2:
Demand Response

Demand response (DR) shares the top slot with energy efficiency in California's loading order of preferred resources to satisfy current and future electricity demand. DR – essentially reducing electricity use or shifting it to another period – provides many benefits including a more efficient electric system with lower overall system costs, reduced need for new power plants and transmission infrastructure, and more control by customers over their electric bills. DR is a flexible resource that can play a variety of roles in the electric system. Most commonly, it can reduce demand when needed – important, for example, with the loss of more than 2,000 megawatts of generating capacity from the recent shutdown of the San Onofre Nuclear Generating Station in southern California. DR can also help integrate the renewable resources needed to meet California's 33 percent by 2020 Renewables Portfolio Standard (RPS). Importantly, DR can mitigate net load swings in either direction, by strategically increasing load (for example to accommodate plentiful wind supply in early morning) or reducing it (for example during a summer afternoon upward ramp). DR represents an important low-carbon option for load-balancing services to integrate the even higher levels of renewable resources that will be necessary to meet California's long-term (2050) greenhouse gas emission reduction goals.

This chapter discusses some of the technical, economic, market, and policy barriers to using DR and recommends actions intended to make DR a vibrant part of California's electricity market. The actions build on efforts over the past decade by the California Independent System Operator (California ISO), the California Public Utilities Commission (CPUC), and the Energy Commission to promote and facilitate DR in California.

Despite its primary position in the loading order, there has been little progress toward increasing the amount of DR used in the state. A 2012 Federal Energy Regulatory Commission (FERC) report indicated that the DR available to the California Independent System Operator remains flat, while in other areas of the country, particularly in the PJM Interconnection and the Midwest Independent System Operator, DR availability and use have significantly increased.[18]

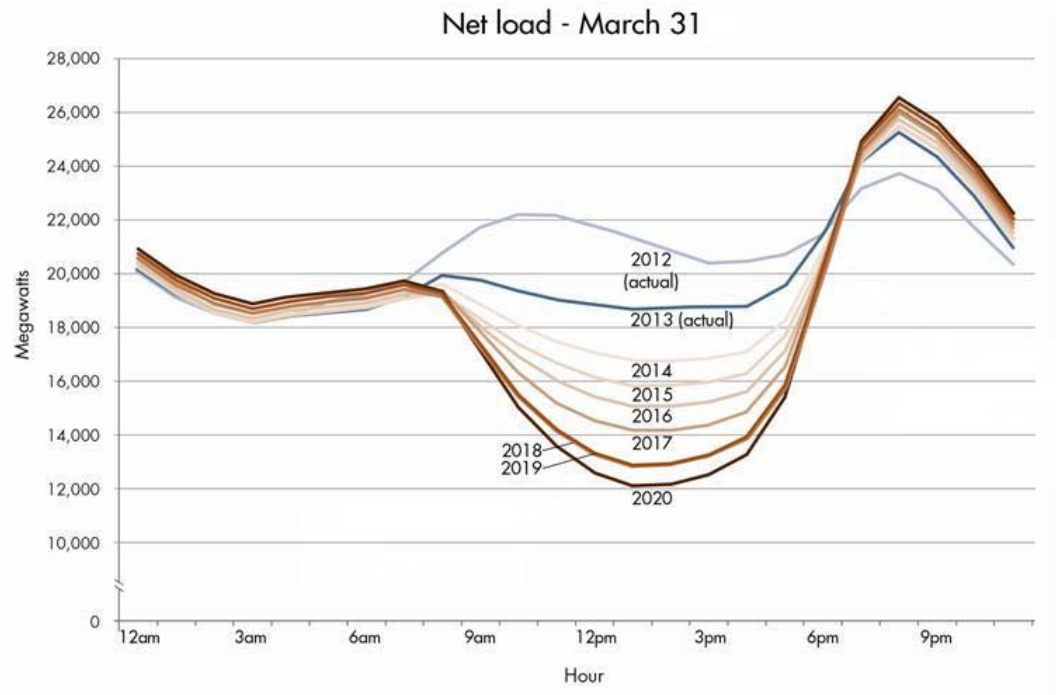
California's utility DR programs have traditionally focused on maintaining reliability either by having dependable emergency resources that can respond to rare and unpredictable generation or transmission outages, or by reducing peak demand to reduce stress on the transmission and distribution system. In addition, programs were designed before "smart grid" technologies were available so that operators telephoned large industrial customers to trigger the contracted load interruptions and utilities used broadcast radio signals to switch off large groups of air conditioners.

18 Federal Energy Regulatory Commission, *Assessment of Demand Response & Advanced Metering*, December 2012, http://www.ferc.gov/legal/staff-reports/12-20-12-demand-response.pdf, page 25.

Over the past decade, however, the same technological advancements seen in telecommunications have dramatically altered the way electricity generation and use are measured, analyzed, and managed. At the same time, sustained growth in both distributed and central-station renewable generation has made managing the electricity system more complex. Because the dominant renewable sources, wind and solar, are fundamentally variable, the electricity system operator must procure flexible resources to "firm" that variability to maintain constant voltage and frequency across the system. Whether that flexibility is provided by new fossil generation or new and expanded DR or storage will depend on the ability of state policy makers to work quickly and effectively with critical institutions and stakeholders to resolve institutional and regulatory barriers and mediate stakeholder interests.

Figure 2 was developed by the California ISO to illustrate the grid management challenge facing system operators from increasing amounts of renewable generation. The "net load curve" shows one set of scenarios, based on typical March load shapes, for future levels of demand that would need to be met by other resources after subtracting projected must-take renewable resources. Ramps in the morning and late afternoon represent substantial challenges to the system operator to maintain service voltage and frequency within required limits under variable net load.

Figure 2: Projected Net Load Curve With Expanded Renewable Generation in 2020



Source: California ISO presentation, June 17, 2013 *IEPR* Workshop

Need for ancillary services (load following, ramping, and regulation) increase substantially when load changes rapidly at the magnitude projected by the California ISO for 2020.

Traditionally, system operators have used fossil-fueled generators to provide nonspinning reserves (generators that can be started and brought to stable operation quickly), and spinning reserves ("unloaded" but running generators whose power output could be added or subtracted from the grid in real time) to balance demand. DR has shown great potential for reducing the need for fossil generation to provide ancillary services. FERC is also encouraging its use, and other system operators—notably the PJM Interconnection, the Midcontinent Independent System Operator, and the Electric Reliability Council of Texas—are already incorporating DR into their markets. However, California has not yet been successful at creating the right conditions under which DR can achieve its full potential.

There is an urgency to expand DR as a frontline resource for maintaining system reliability and taking full advantage of the contributions of low-carbon renewable generation. The necessary technology advancements – communication, monitoring, data collection, and real-time analysis – are well underway. What is lacking is a clear and consistent regulatory structure under which the necessary market designs and business models can take root and thrive.

Demand Response Efforts in California

California Public Utility Commission and Energy Commission Efforts

DR efforts in California were originally intended to support a dynamic pattern of systemwide price response that reflected actual system costs. Program goals were to enhance reliability, mitigate the market power of generators, incentivize investments in cost-effective energy efficiency and load management technologies, and minimize ratepayer costs over the long term.

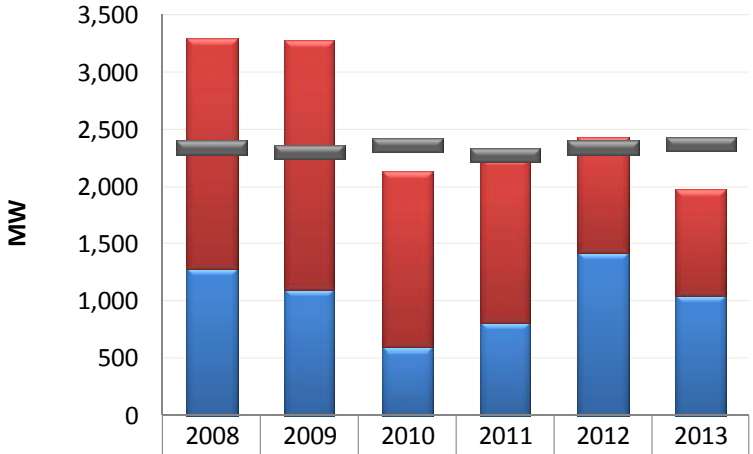
The energy agencies' *Energy Action Plan* and *Energy Action Plan II* incorporated a statewide DR goal of 5 percent of system peak demand. This goal was first articulated in CPUC Decision 03-06-032 in R.02-06-00. When that decision was adopted, most DR was available only under emergency conditions and was intended as a backstop reliability measure. DR triggers varied but were aligned with either critical supply shortages or transmission failures. Customers participating in the reliability programs were typically large manufacturing, water transport, process heat, and other facilities with substantial loads that provided significant relief to the system when curtailed. However, curtailment costs to participants could be large in terms of lost production, ruined product, restart costs, and other effects, so compensation agreements—usually a discount on the electric rate for the load subject to curtailment—contemplated infrequent curtailment calls.

From summer of 2000 to spring of 2001, California's electric system reached "critical" reliability conditions frequently due to supply shortages accompanied by extremely high prices. Reliability program participants rapidly tired of repeated unexpected curtailments, which ultimately did not prevent rolling blackouts.

A new vision for price-responsive DR was built on the idea that system reliability depended on protection from economic risk as well as the risk from physical system failures. While funding has grown to just under $450 million, participation in price-responsive DR options continues to be far below the 2007 goal (Figure 3). Large commercial and industrial investor-owned utility

(IOU) customers (whose loads peak at more than 200 kilowatts [kW]) are on a default critical peak price, but most have opted out. Small commercial customers are now seeing time-of-use prices. For residential customers, these rates are optional and largely undersubscribed.

Figure 3: IOU Demand Response 2008-2013



	2008	2009	2010	2011	2012	2013
Emergency	2,007	2,172	1,544	1,428	1,010	924
Price-Responsive	1,287	1,095	589	814	1,420	1046
5% Target	2,345	2,302	2,368	2,277	2,342	2,371

Source: California ISO presentation, June 17, 2013, *IEPR* Workshop

The *2007 Integrated Energy Policy Report* (*IEPR*) stated that, as of summer 2007, California had achieved less than half of the *Energy Action Plan II* goal of reducing peak demand by 5 percent. One impediment to reaching that goal was the lack of advanced meters needed to support dynamic pricing programs for small and medium-sized customers. Over the next few years, CPUC efforts led to the approval and deployment of the advanced metering infrastructure in all three IOU service territories. However, the presence of advanced meters has not resulted in significant levels of participation by residential customers.

DR for residential customers faces some unique barriers not faced by commercial customers, such as a lack of time-variant pricing. Assembly Bill 1X (Keeley, Chapter 4, Statutes of 2001), passed during an extraordinary legislative session in February 2001, authorized the California Department of Water Resources to issue bonds and procure power on the behalf of the struggling IOUs, and it contained a provision to partially protect residential customers from the cost of servicing those bonds. This provision has been interpreted by the CPUC to apply not only to the Department of Water Resources bond charges, but to the other underlying rate components as well—effectively freezing the price of electricity at 2001 levels for 60 percent to 75 percent of total residential consumption.

Two unintended consequences resulted: the increasing allocation of normal increases in utility costs to a smaller portion of total consumption, and the effective prohibition of time-based pricing. SB 695 (Kehoe, Chapter 337, Statutes of 2009) attempted to address some of these consequences by specifying how baseline utility rates could (gradually) be increased and by allowing time-variant pricing after 2013 under specific conditions. AB 327 (Perea 2013) has

passed the assembly and Senate and is moving toward the Governor's desk at this writing. It prohibits the CPUC from requiring utilities to implement mandatory or default "time-variant pricing" for residential customers until 2018, when the restriction would be lifted for default time-of-use rates—dynamic rates would still be prohibited except on an opt-in basis.[19] Under existing IOU programs, customers receive bill credits for manually reducing their electricity use during certain peak times, and a premium incentive for using automated enabling technologies. These event-based programs do not provide anything close to the response time and precision needed for DR to provide grid management support.

Consistent with the *2012 IEPR Update*, there is a need to reevaluate residential electricity rate structures to reflect the evolving nature of the electric system while ensuring that infrastructure investments are recovered through equitable pricing. The Commission supports the CPUC's proceeding R.12-06-013, *Order Instituting Rulemaking on Commission's Own Motion to Conduct a Comprehensive Examination of Investor Owned Electric Utilities' Residential Rate Structures, the Transition to Time Varying and Dynamic Rates, and Other Statutory Obligations*.

On the technology side, the Energy Commission established the Demand Response Research Center (DRRC) at the Lawrence Berkeley National Laboratory in 2004. The DRRC conducts research to promote the near-term adoption of DR technologies, policies, programs, strategies, and practices. The DRRC demonstrated the value of automated DR and the Energy Commission's Public Interest Energy Research Program has also helped develop the OpenADR[20] communications standards to support DR automation and integration with utility and independent system operator programs. OpenADR has been adopted as both a national and international standard for DR and distributed energy resource operations, which allows large numbers of loads to participate reliably in DR activities in other states and countries. In 2008, the Energy Commission began to develop load management standards but ultimately the proposed standards were not adopted. However, the Energy Commission continues to have broad statutory authority to adopt such standards, which could be used to require many of the activities described in this action plan.

CPUC Efforts

The CPUC developed and adopted load impact protocols in 2008 and cost-effectiveness protocols in 2010, both of which were necessary to reliably document load reductions and determine program effectiveness. Other accomplishments include approval of multiyear contracts between IOUs and aggregators, rollout of default critical peak pricing and mandatory time-of-use rates for nonresidential customers, and conversion of DR programs from emergency-based to price-based programs.

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19 At issue in A.10-08-005 is whether the CPUC can authorize Pacific Gas and Electric to adopt default time-variant price rates for all customer usage or only for usage above 130 percent of baseline. Resolution will affect pending residential rate design at Southern California Edison and San Diego Gas & Electric.

20 OpenADR is an open source communications protocol that can carry the type of information necessary (such as price data, emergency signals, specific program signals, and more) for customers to automate their DR strategies. http://www.openadr.org/

In June 2010, the CPUC issued Decision 10-06-002, stating jurisdictional authority over DR providers to establish customer protection rules and financial responsibility standards. The CPUC held two workshops in the summer of 2013 and is working with stakeholders to develop these rules under its Electric Rule 24.[21]

The CPUC's Integrated Demand Side Management (IDSM) program is a new effort to deliver all demand-side management options – efficiency, DR, energy management, and self generation – through coordinated marketing and regulatory integration. However, a recent evaluation[22] of the IDSM program found that integrating efficiency and DR into a project often reduces the anticipated DR impact for the project relative to DR without efficiency improvements. Also, the definition of IDSM is not concrete or comprehensive, making it difficult for the IOUs to achieve IDSM without a clear description of what it entails.[23]

In Decision 12-04-045, the CPUC specifically considered the potential for DR to provide the additional grid flexibility required to implement the 33 percent RPS and to participate in the California ISO's wholesale market through a broader set of resource acquisition and load aggregation programs. Several automated DR pilots were included. The decision also acknowledged a number of fundamental issues raised during the proceeding, including concern that the "utility-centric" model of DR procurement and program development was not achieving sufficient DR potential and that other models, including third party provider participation in wholesale markets, should be considered.

In May of 2013, CPUC staff released a report[24] on lessons learned from existing DR programs at Southern California Edison and Sand Diego Gas & Electric. Staff found a number of fundamental problems with the programs, including a demonstrated preference for dispatching fossil generators instead of available DR, despite state policy on the loading order of preferred resources. On September 19, 2013 the CPUC issued a new Order Instituting Rulemaking (OIR) (R.13-09-011) to, "Enhance the Role of Demand Response in Meeting the State's Resource Planning Needs and Operational Requirements."[25] This rulemaking will consider changes to the current DR program paradigm under CPUC jurisdiction to address lack of participation in and performance of existing utility programs. The OIR anticipates coordination with the California ISO and the Energy Commission to address procurement rules and market designs,

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21 See http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M037/K494/37494080.PDF and http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/128488.PDF.

22 http://www.calmac.org/publications/CPUC_IDSM_FinalReport.pdf.

23 Itron, *2010-2012 CPUC Omnibus IDSM Process Evaluation*, October 2012, http://www.calmac.org/publications/CPUC_IDSM_FinalReport.pdf.

24 http://www.cpuc.ca.gov/NR/rdonlyres/523B9D94-ABC4-4AF6-AA09-DD9ED8C81AAD/0/StaffReport_2012DRLessonsLearned.pdf.

25 California Public Utilities Commission, http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M077/K151/77151993.PDF.

categorization of DR by "supply-" and "demand-side" resources, and development of a roadmap and strategies for the future of DR in California.

California Independent System Operator Efforts

In 2008, the FERC issued Order 719, which instructed independent system operators to modify their tariffs to allow DR participation in their markets. As of June 2013, the California ISO had developed two products for DR participation, the Participating Load product and the Proxy Demand Resource product, and has been seeking approval from FERC of a third, the Reliability Demand Response Resource program, since May 2011.

Both Participating Load and Proxy Demand Resource programs give customers and DR providers an opportunity to bid load reductions into energy and nonspinning reserve markets, the major difference being that the participating load must be represented in the market by its load-serving entity, while proxy demand resources may be represented by DR providers. Moreover, proxy demand resources are subject to the DR net benefits test developed for FERC order 745 compliance. The Proxy Demand Resource program is open to both individual and aggregated loads that meet specific requirements for availability, performance, communications, and settlement capability. The Reliability Demand Response Resource program is attempting to create a pathway for retail emergency DR products to be represented in the wholesale market. The California ISO expects that further integration of DR into wholesale markets will increase competition, promote efficiency, and reduce costs, and has instituted a stakeholder process to develop a *Demand Response and Energy Efficiency Roadmap.* (See Appendix C for a summary of the roadmap.)

California ISO Demand Response and Energy Efficiency Roadmap

The California ISO Demand Response and Energy Efficiency Roadmap identified four paths to advance DR and energy efficiency that would defer or offset investment in transmission and generation infrastructure. The following provides a brief description of their purpose and goals:

- The Load Reshaping Path focuses on applying DR and energy efficiency resources to the demand side of the supply-demand balance equation. These resources can create a flatter load shape for the ISO system generally and, in specific geographic areas, reduce ISO operating needs and complexity.
- The Resource Sufficiency Path focuses on the supply-side of the balance equation to ensure sufficient resources, with needed operational characteristics, are available in the right places and at the right times. This path includes activities that specify needed resource characteristics - as well as policy developments - to guide and facilitate DR and energy efficiency procurement and program development.
- The Operations Path focuses on making the best use of any and all resources that are made available through the resource sufficiency path. It involves changing some existing policies, modifying or developing new market products to expand DR market participation, and addressing relevant technical and process requirements to achieve operational excellence.
- The Monitoring Path is the essential feedback loop for the other three paths. Systematic monitoring of each stage of activity will foster a deeper understanding of the operational capabilities of DR resources, the effectiveness of DR and energy efficiency procurement programs in aligning with system-wide and locational needs, and the impacts of energy efficiency and other load-modifying programs in reshaping load profiles both locally and at the system level.

The California ISO has also been working with the CPUC to address a number of specific issues related to the inclusion of preferred resources in a DR program without violating the California ISO's neutrality obligation toward participation in their wholesale markets. To this end, they have engaged in a number of ongoing stakeholder efforts to develop participation rules and market designs for flexible resources, capacity markets, and resource adequacy procurement.[26] These efforts are closely tied to the CPUC's Resource Adequacy[27] processes and the Joint Reliability Multi-year Framework[28] activities.

Utility Efforts

California's three largest electric IOUs (Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas & Electric Company) offer commercial AutoDR programs that use OpenADR in businesses and homes. At the end of 2012, the IOUs had just 250 megawatts (MW) of dispatchable load using OpenADR. There are pilot projects for using OpenADR for small commercial and residential facilities to support both retail and wholesale DR markets in California.

Standardization of communication and interfaces with customer-side protocols (including meters, controls systems, and so on) such as that provided by OpenADR is key to providing AutoDR capabilities securely and cost-effectively, providing customer choice for different utility or independent system operator DR programs, and preventing vendor lock-in and stranded assets. OpenADR also standardizes distributed energy resource signals to customer facilities, which can support the CPUC's Rule 21 utility and distributed energy resource interconnection guidelines.

The Sacramento Municipal Utility District (SMUD) is in a unique position to adopt DR compared to other utilities due to its independent governance structure and its additional role as balancing authority over its own (along with some smaller publicly owned utilities) service area. With supplementary funding from an American Recovery and Reinvestment Act grant, SMUD has experimented with different DR technologies and program designs while testing to establish DR capabilities. SMUD is also building the ability to use different types of DR, including AutoDR, pricing, direct load control, and energy storage to meet its system needs, including resource adequacy, reserves, regulation and renewable firming in addition to more traditional peak-load management. SMUD is actively pursuing expansion of DR programs and technologies that are proven effective and is engaged in ongoing pilot testing of additional technologies and program designs. The utility anticipates being able to achieve a DR portfolio of about 9 percent of system load by 2021 with a sustained commitment to DR.[29]

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26 http://www.caiso.com/informed/Pages/StakeholderProcesses/FlexibleCapacityProcurement.aspx

http://www.caiso.com/informed/Pages/StakeholderProcesses/DemandResponseInitiative.aspx

27 http://delaps1.cpuc.ca.gov/CPUCProceedingLookup/f?p=401:56:1334887330275601::NO:RP,57,RIR:P5_PROCEEDING_SELECT:R1110023

28 http://www.caiso.com/informed/Pages/StakeholderProcesses/Multi-YearReliabilityFramework.aspx

29 Coomes, Harlan. SMUD presentation at the 6/17/2013 IEPR workshop.

Other Models

In attempting to build a successful DR program in California, it should be noted that several approaches have been shown to be successful in other markets. PJM, a regional transmission organization that coordinates the movement of wholesale electricity in 13 states and the District of Columbia, operates a Reliability Pricing Model,[30] which allows DR to be offered as a forward capacity resource. Under their model, even infrequent resources must receive enough revenue to cover their costs. Capacity payments, or payments received in exchange for making electrical capacity available, provide a revenue stream to maintain and keep current resources operating, and to develop new resources. PJM recognizes that investors need sufficient long-term price signals to encourage the development and maintenance of generation, transmission, and demand-side resources. Their Reliability Pricing Model, which is based on making capacity commitments in advance of the energy need, creates a long-term price signal to attract needed investments for reliability in their region.

Successful DR programs not only provide reliable payments and predictability for investors, but also require accountability from load aggregators. This accountability ensures that the promised capacity will materialize, yet allows aggregators to provide flexibility to their customers by independently deciding which customers to source that capacity from.

Demand Response Challenges

The June 17, 2013, *IEPR* Workshop on "Increasing Demand Response Capabilities in California" sought public input on opportunities for and challenges to expanding DR to lower critical load in constrained areas, providing low-cost peak-reduction services and providing fast automated DR as a flexible generation like product to support renewable integration and potential future emergencies. Participants and subsequent comments identified a number of DR challenges and opportunities:

- Opportunities for customers to participate in DR are limited, and participation rules do not reflect the capabilities and limitations of customers and loads. Market rules, participation costs, and incentive structures are not as attractive in California as in other regions, such as in PJM where larger resources can bid directly into the wholesale market and tariff structures and contract agreements are consistent across multiple utilities. For example, in other states a chain such as Walmart can sign an agreement on behalf of multiple stores; in California, however, each store must sign a separate agreement, making the transaction costs unattractive compared to other states.
- Outstanding issues affecting direct participation of DR in California ISO markets include limitations on participation by bundled customers, the need for rules for direct participation by retail customers on their own or through aggregators, DR compensation, and the appropriate role for IOUs under CPUC jurisdiction between electricity customers and third-party DR providers. Allowing direct participation in wholesale markets depends on rules

30 PJM, "Reliability Pricing Model: Demand Response and Energy Efficiency" p.1 http://www.pjm.com/~/media/markets-ops/rpm/20090406-dr-ee-in-rpm-collateral.ashx

being developed through the CPUC's Rule 24 proceeding. Rules (Rule 24) governing the participation of bundled-service IOU customers in third-party DR provider aggregation programs add complexity and cost for both participants and DR providers. The CPUC is engaged with DR providers, the California ISO, IOUs, and other stakeholders in addressing some of these issues with the intent of promoting expanded participation.

- Aggregators face uncertainty regarding the time horizon of rates and program commitments. Knowing how long tariffs will last is essential for a provider to gauge its ability to honor agreements with customers. Lack of market certainty can sometimes be misinterpreted as customer reticence. However, aggregators have indicated that in other jurisdictions, they are able to participate directly in ISO markets in multiple ways, allowing them to give customers longer-term participation agreements that provide the tariff certainty needed to justify investments in DR infrastructure.
- Strict participation requirements attempt to treat DR like a generation resource which limits the appeal and availability of California ISO DR market products. This has implications for availability, visibility, dispatch, performance, verification, and payment. Unlike generation that can run any time, DR loads can be reduced only when they are actually on. In addition, generation resources are expected to perform consistently for long periods, while short commitments are preferable for DR, particularly aggregated DR, because it involves avoided consumption and reduced services that can disrupt production processes and air-conditioning use. Further, for generators, it is simple to verify performance and measure output, while for DR, load reductions are frequently calculated against a baseline of "normal" operation that adds complexity and cost to the process.
- Telemetry requirements are a challenge in California because of expensive equipment required to allow DR participants to participate as "load." Large industrial facilities that are compensated for dropping large numbers of MW can do this, but for smaller units the high cost restricts participation. Relaxed telemetry requirements and reduced technology costs could allow enrollment of large numbers of smaller loads that can provide DR benefits without significant negative effects on customers because those effects would be spread across a wider population. This could also increase portfolio diversification and improve DR performance.
- DR factors into a variety of energy agency processes that are critical to the functioning of the electricity system in California, requiring increased coordination between agencies on DR definitions and accounting methods. For example, DR triggered by discrete events throughout the year is included in the CPUC's resource adequacy and long-term procurement proceedings, while the Energy Commission includes non-event-based programs, such as time-of-use and real-time pricing and permanent load shifting, in its demand forecast. DR is categorized based on the distinction between event-based and non-event-based DR, and can be further characterized as either a load modifier or a resource. However, the way some DR programs are structured can lead to ambiguity as to whether they should be included as a resource or a load modifier in energy planning.

- Constructing participation rules that take advantage of load diversity and allow third-party aggregation, utility aggregation, or even system-operator-level portfolio development can substantially increase DR participation. For example, performance of aggregated load should be measured statistically, by measuring the aggregate impact, rather than directly by measuring the impact of each end-use load reduction. Rules that hold participating loads to high levels of performance—in terms of magnitude over the performance period and the probability of performance for each and every call—make sense for large participating loads. However, one of the major advantages of aggregated loads is the ability to assemble a portfolio of customers and end uses that together can produce more reliable, more consistent, and more flexible performance than can be achieved with individual participating loads. Aggregation can garner participation and manage customer "fatigue." For instance, a seven-hour peak load commitment could be met with successive, shorter tranches of customer loads, or with multiple consecutive-day performance commitments from different subgroups of customers. By managing the portfolio to account for nonperformance risk, an aggregator can meet contracted performance commitments while allowing additional flexibility for customers.

Recommendations

California policy must focus on scaling up development of demand response (DR) products that have the characteristics required to avoid new generation capacity and transmission. Existing DR programs in Southern California have seriously underperformed.[31] However, the various recent developments in Southern California—the San Onofre Generating Station (San Onofre) retirement, approaching once-through-cooling requirements, and the increasing need for flexibility to integrate intermittent renewable resources—as well as the long-term challenge of responding to the impacts of climate change, dictate that DR play a much larger and substantially different role in electricity supply and reliability enhancement than today. Further, time-certainty is required for mobilizing fast-response DR at relevant scale: slippage in DR market development will necessitate development of more generation and/ or transmission than would otherwise be required. Given the long lead time required to develop generation and transmission, the need to prove DR is urgent. Intentionally enabling multiple market options in the near term decreases the risk of ongoing anemia of DR resources. The Energy Commission has identified five strategies to help DR take its rightful place in California's loading order of preferred resources.

Resolve Rule 24 Issues to Enable DR Participation in the ISO Market

- **Complete the Rule 24 process.** Rule 24 terms will establish rules for direct participation of DR in the California Independent System Operator (California ISO) market, as well as enhancing customer protection and safety. Rule 24 clarity is a necessary—though not sufficient—condition for expanding DR opportunities for new customers with useable DR resources and opening opportunities for third-party aggregator to participate in wholesale

31 CPUC May 1, 2013 Staff Report: "Lessons learned from Summer 2012 Southern California Investor Owned Utilities' Demand Response Programs."

markets. Additionally, within or alongside its Order Instituting Rulemaking (OIR),[32] the CPUC should investigate and resolve the technical and process barriers to customer participation with third-party providers in both investor-owned-utility-managed and direct wholesale markets.

Develop and Pilot Test Market Products

- **Identify and explore program and tariff approaches.** The CPUC has approved funding for limited pilot activity as part of the current investor-owned utility DR program budgets (D.12-04-045). The CPUC and investor-owned utilities should collaborate with the California ISO, the Energy Commission, and stakeholders to identify promising DR program and tariff approaches being used effectively in other jurisdictions that could be adapted to California's needs.

  Innovative options should be explored to expand market and program designs along two of the paths outlined in the *Roadmap*[33]: the "resource sufficiency" and "load reshaping" paths. Agencies must efficiently address concerns related to these pathways, particularly the issue of resource adequacy value for each path. This will ensure that programs that modify the load shape are reflected in the demand forecast, thereby reducing the resource adequacy requirement and enabling these dispatchable resources to receive appropriate resource adequacy value as supply-side resources. These options should be tested and adjusted to ensure that the intent of the pilot actually meets grid needs and facilitates customer participation. Specific actions should include: review pilot proposals in process; direct the investor-owned utilities to develop proposals in concert with the California ISO; and engage stakeholders in developing the demand response proposals with the goal of offsetting the need for transmission and generation resources. Ideally a suite of DR products would be in place to procure preferred resources for the 2015 resource adequacy compliance year to help mitigate potential challenges in compensating for the loss of the San Onofre.

- **CAISO should implement a multi-year forward DR auction in the region impacted by San Onofre.** The post-San Onofre reliability plan prepared jointly by the state's energy agencies highlights preferred resources as critical both near- and long-term, and includes a goal of 50 percent preferred resources going forward.[34] This will require an aggressive set of

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32 CPUC, Order Instituting Rulemaking, To Enhance the Role of Demand Response in Meeting the State's Resource Planning Needs and Operational Requirements, http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M076/K440/76440646.docx

33 The California *ISO Demand Response and Energy Efficiency Roadmap* identified four paths to advance DR and energy efficiency that would defer or offset investment in transmission and generation infrastructure: the Load Reshaping path, the Resource Sufficiency path, the Operations path, and the Monitoring path. A detailed description of each path and their interactions can be found in the *Roadmap* itself: http://www.caiso.com/Documents/Draft-ISODemandResponseandEnergyEfficiencyRoadmap.pdf

34 *Preliminary Reliability Plan for LA Basin and San Diego,* September 9 joint Energy Commission, CPUC, and California ISO staff presentation: http://www.energy.ca.gov/2013_energypolicy/documents/2013-09-09_workshop/2013-09-09_reliability_presentation.pdf

demand response programs. California ISO should, in the near-term, develop a DR auction mechanism for the capacity areas impacted by San Onofre. If appropriately targeted to relevant load pockets, this effort could sharpen the agencies' understanding regarding locational benefits, dispatch, value, duration and availability of DR resources, as well as the extent to which these qualities interface with customer preferences and match aggregation models. The ISO DR auction could be developed in parallel, and in coordination, with CPUC efforts to update investor owned utility-driven DR procurement.

Resolve Regulatory Barriers

- **Continue development and implementation of a multi-year reliability framework.** Current drafts of the CPUC/California ISO framework[35] expand the forward resource adequacy obligations of the load-serving entities from one to 3 years, increase transparency through a joint reliability planning process 10 years ahead, and replace the California ISO's current administrative capacity procurement mechanism with a market-based capacity auction. Market products will need to reflect the attributes of these customers and the types of load reductions they can provide; this will entail looking beyond current customers toward a broad customer base and large numbers of smaller loads. Incentives and participation rules that appropriately accommodate and reward participation.
- **Timely development and conclusion of the CPUC's DR rulemaking.** The OIR anticipates turning first to the issue of continued "bridge year" funding for utility DR programs, with an anticipated Decision in the second quarter of 2015. The CPUC should engage immediately in the policy and technical issues of DR procurement and program design, in parallel if necessary, to avoid delaying resolution of the pressing procurement and program design issues this proceeding is intended to address.

Continue the Collaborative Process Among the Energy Commission, the CPUC, the California ISO, and the Governor's Office

- **Advance fast-response DR.** The agencies should focus their efforts on advancing fast-response DR, both for callable (contingency) and price-responsive DR, through the Energy Commission's *IEPR* process, the California ISO's roadmap process, and the CPUC's Rule 24 and DR OIR process.
- **Develop a joint workplan.** The energy agencies should begin addressing and resolving timelines (both timing and issue priority) developed in the California ISO's *Roadmap*, *IEPR*, and CPUC processes. By the second quarter of 2014, the agencies should develop a joint policy document that articulates the resolution of current differences and presents a unified, clearly executable path forward.
- **Improve DR forecasting techniques and methodologies.** The energy agencies should engage in research and development to improve DR forecasting. Accurate forecasting verified by actual results of DR capability in several time frames, for both planning and operations, is required to ensure that DR resources are integrated as a grid resource. In

35 http://www.caiso.com/informed/Pages/StakeholderProcesses/Multi-YearReliabilityFramework.aspx

addition to forecasting capabilities of DR programs, the agencies should support studies to determine areas and end uses with the best DR potential across the state. These findings should then be overlaid with grid needs to prioritize DR resource development.

Gain Customer Acceptance of DR.

- **Conduct independent assessment to help advance DR market outreach.** From a system perspective, expanding the customer base is critical to optimize resource availability in specific regions where it is needed for local capacity. At the same time, DR is not well-understood by customers, yet its expansion requires customer comfort and acceptance. An independent entity should assess customers and market sectors most likely and least likely to participate in a range of targeted DR programs, examine existing communication strategies and evaluation reports, and develop a set of communication lessons learned and business value cases, by early 2014. This effort should include a cost assessment to enable DR across different customer classes, especially for fast response DR.

CHAPTER 3:
Bioenergy Status and Issues

Bioenergy in California includes using biomass, biogas, and biomethane to generate electricity (biopower) and produce transportation fuels (biofuels). Bioenergy is renewable energy produced from biomass feedstocks, such as residue from forest management practices and the wood industry; agriculture and food processing wastes; organic urban waste; waste and emissions from water treatment facilities; landfill gas; and other organic waste sources.

California has adopted many policies to promote energy from biomass resources, but there are still challenges, particularly for resources such as biomethane. In 2012, Governor Brown signed Assembly Bill 1900 (Gatto, Chapter 602, Statutes of 2012), which requires the Energy Commission to identify and recommend solutions to challenges that limit procurement of biomethane in California and report on its findings in the biennial *Integrated Energy Policy* Report (*IEPR)*. Also, California's Bioenergy Interagency Working Group periodically publishes a "bioenergy action plan" that reviews biomass development and outlines opportunities and challenges, and past *IEPRs* have relied heavily on those documents to report on biomass progress.[36]

This chapter reports on the status of the industry and challenges to operating and developing bioenergy production facilities in California. The Energy Commission held public workshops in May and June 2013 to seek stakeholder input on the status of and opportunities for bioenergy development in California. This chapter summarizes the results of those workshops and subsequent staff analysis.

Biomass Technical Potential and Development Goals

Bioenergy production can provide value toward achieving California's environmental, waste reduction, and greenhouse gas reduction goals. Bioenergy can displace fossil transportation fuels and may be a source of flexible electricity generation, if cost hurdles can be overcome, to help manage growth in wind and solar electricity generation.

The technical potential for biopower, however, is relatively small compared to the total California renewable energy electricity generation potential. Table 2 compares the amount of electricity generating capacity theoretically possible given resource availability, geographical restrictions, and technical limitations for each renewable resource. In these terms, available

36 Bioenergy Interagency Working Group, *2012 Bioenergy Action Plan*, August 2012, http://www.resources.ca.gov/docs/2012_Bioenergy_Action_Plan.pdf. The Bioenergy Interagency Working Group includes representatives from the California Natural Resources Agency, the Department of Food and Agriculture, the California Environmental Protection Agency, the California Air Resources Board, the California Public Utilities Commission, the California Energy Commission, the Department of Forestry and Fire Protection, the Department of Resources Recycling and Recovery, the Central Valley Regional Water Quality Control Board, and the California Biomass Collaborative.

biomass resources (including solid-fuel biomass as well as landfill gas, dairy digester gas, and other sources of biogas) comprise about 0.02 percent of potentially available renewable energy resources for electricity generation in California.

Table 2: California's Renewable Energy Potential

Technology	Technical Potential (MW)
Biomass	3,820
Geothermal	4,825
Small Hydro	2,158
Solar	
Concentrating Solar Power	1,061,362
Photovoltaic	17,000,000
Wave and Tidal	32,763
Wind	
On-shore	34,000
Off-shore	75,400
TOTAL TECHNICAL POTENTIAL	**18,214,328**

Source: California Energy Commission, *Renewable Power in California: Status and Issues* Report

A report by the California Council of Science and Technology[37] found that substantial amounts of low-carbon biofuels are needed to reduce greenhouse gas emission 80 percent below 1990 levels by 2050, even with optimistic assumptions about efficiency, electrification, and use of other renewable energy sources. The study found that in-state supplies of biomass would meet about 7 to 22 percent of 2050 demand in a business-as-usual case and 21 to 61 percent in a more optimistic high efficiency and electrification scenario. The analysis found that, even with ambitious assumptions about the ability to gather biomass residues for energy production, in-state resources cannot meet demand by 2050.

California has had a long-standing commitment to expand in-state bioenergy production through state agency action and production targets, such as the *Bioenergy Action Plan* and Executive Order S-06-06. While California remains committed to the development of sustainable bioenergy production facilities, biomass is a limited resource for energy production. There is a desire to move toward biomass goals based on sustainable biomass yield and greenhouse gas reduction, waste reduction, recycling, composting, and environmental protection.

Biopower Status

Biopower is electricity generated from biomass materials. This section discusses the status, opportunities, and challenges of solid-fuel biomass to biopower conversion technologies and

37 Youngs, Heather and Somerville, Christopher R., California Council on Science and Technology, *California's Energy Future – the Potential for Biofuels*, May 2013. http://www.ccst.us/publications/2013/2013biofuels.pdf.

resource applications that are eligible for California's Renewables Portfolio Standard (RPS).[38] Feedstocks used to produce biogas or biomethane (such as landfill gas and dairy waste) are discussed separately in this chapter.

Existing Generation

California's fleet of existing solid-fuel biomass facilities, facilities that were online or idle in 2009, is composed primarily of biomass combustion facilities selling power under qualifying facility contracts. Most have operated continually since the 1980s. In recent years, two of California's existing in-state coal facilities converted to 100 percent solid-fuel biomass, with a third due to be 100 percent by the end of 2013. Reportedly, some of the other coal facilities are investigating the feasibility of cofiring with solid-fuel biomass. Since 2009, operating capacity at existing solid-fuel biomass facilities has declined, although two previously idle biomass facilities have successfully restarted operations – SPI Anderson and SPI Sonora.[39] Table 3 summarizes the active and idle capacity of solid-fuel biomass facilities in California.[40]

Table 3: Summary of Existing Solid-Fuel Biomass Facilities

	2009 Capacity (MW)	2012 Capacity (MW)*
Solid-Fuel Biomass	757 (139 idle)	637
Coal-Biomass Cofiring	0	44
Total	**757**	**681**

* Note that the 2012 Capacity estimates do not include biomass capacity from facilities that are not required to, fail to, or inaccurately report solid-fuel biomass generation. These facilities include small thermochemical conversion projects under 1 MW, existing solid-fuel biomass facilities, and biomass co-fired at existing in-state coal facilities. Energy Commission staff estimate that un-reported capacity is over 150 MW.

Source: California Energy Commission Quarterly Fuels Energy Report database

Capacity losses during this period were limited by successful contract price amendment renegotiations between Pacific Gas and Electric Company and many existing facilities. New contract amendments allowed facilities to operate under better price terms through the end of the 30-year contract term and avoid rates set by historically low natural gas prices. However, some facilities retired due to unfavorable economic conditions and unsuccessful attempts to amend power purchase agreements.[41]

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38 Biomass resources that are not currently eligible for the state's RPS, such as municipal solid waste using thermal energy conversion technologies are not discussed in this report. Biological conversion or anaerobic technologies are eligible for the RPS and will be discussed in the Biogas and Biomethane section of this chapter.

39 News10 (ABC), "Sawmill reopens in Sonora," October 12, 2011, http://www.news10.net/news/local/article/158686/2/Sawmill-reopens-in-Sonora, accessed June 20, 2013; also David Branchcomb, Sonora Facility Operator, e-mail correspondence, April 1, 2013.

40 Not including municipal solid waste facilities that may also be converting biomass to electricity.

41 Solid-fuel biomass facilities idle as of 2010 include Big Valley Lumber Company, Burney Mountain Power, Diamond Walnut, Eel River Power LLC, Madera Power, Mt Lassen Power, Pacific Oroville Power Inc, SPI – Loyalton/Sierra Pacific Industries, SPI – Susanville, Wheelabrator Hudson Energy.

Biopower Opportunities and Challenges

This section describes opportunities and challenges related to bioenergy development during predevelopment and operation.

Predevelopment: Project Feasibility, Permitting, Regulation, and Financing

Much of California's biomass is derived from activities such as harvesting timber, milling lumber, processing food, and collecting residential green waste as well as wildfire prevention, agriculture and dairy operations, and urban forestry. While California has an abundance of biomass and a need for alternative disposal options, the use of biomass for energy production may not be economical because it is costly to collect and distribute the material or the material is not readily available throughout the year. Studies commissioned during the predevelopment stage identify such challenges and are used to identify appropriate development locations.

As an example, wood residues from lumber harvesting or forest thinning are often expensive to procure as a result of costs associated with the collection, processing, and transportation of the feedstock. Collecting wood residues is labor-intensive because the feedstock is widely dispersed. After the wood residues have been piled, processing such as chipping is needed before transporting residues to the facility, typically by large diesel trucks. All together, the logistics of collecting, processing, and transporting wood residues can cost a facility from $45.00 to $60.00 per bone dry ton.[42] If a biopower facility is paid $90/megawatt hour (MWh) of electricity, one-half to two-thirds of revenue would be needed for solid-fuel biomass collection, processing, and transport.

Predevelopment costs for biopower projects can range from $168,000 - $765,000, which includes feasibility analysis and California Environmental Quality Act-related (CEQA) activities. Funding these costs is difficult for small developers and communities. CEQA-related costs can cause the greatest uncertainty. Stakeholders contend that the cost of completing a CEQA analysis dissuades project developers from using precommercial technologies that have not been demonstrated in California. Also, many investors are not willing to finance the planning work under CEQA on an unproven technology or development approach.[43] To address these concerns, stakeholders support developing programmatic environmental impact reports (EIR) for precommercial solid-fuel biomass development. A programmatic EIR developed for dairy digesters in California's Central Valley has been shown to make the CEQA process more straightforward for small developers.[44]

The cost of financing can also pose a barrier to development. Increasingly, bioenergy developers are transitioning from traditional conversion technologies, such as direct combustion steam turbines, to more efficient and environmentally friendly technologies. Private financers seek a high rate of return on unproven technologies and development strategies, including

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42 Fred Tornatore (TSS Consultants), op. cit., p 129.

43 Fred Tornatore (TSS Consultants), op. cit., p 133-134.

44 Transcript of Energy Commission Staff Workshop on the Status of Bioenergy Development in California, June 3, 2013, comments by Michael Boccadoro (Dolphin Group), p 137.

thermochemical conversion and anaerobic digesters. Therefore, the cost of financing these projects can be much higher than other bioenergy projects. In addition, federal incentives are declining. For instance, the American Recovery and Reinvestment Act 1603 Program[45] that provided large grants in lieu of tax credits for renewable energy property is closed to new applicants.

The CPUC has established funding and is considering investment plans for a new program to support pre-commercial clean energy technologies and strategies. This program, known as the Electric Program Investment Charge (EPIC), is designed to provide funding for research and development, technology demonstration and deployment, and market facilitation. The California Public Utilities Commission (CPUC) has identified the Energy Commission and the state's three largest investor owned utilities (IOU) to administer EPIC. The Energy Commission proposed providing a minimum of $27 million during the 2012-2014 investment cycle for bioenergy technology demonstration and deployment projects. If the plan is approved and funding is authorized, this funding could help advance the competitiveness of bioenergy. However, funding will likely be needed from other agencies, too, to help advance projects with multi-sector benefits.

Operation: operating costs, market prices, and regulatory changes

Operating costs, market prices, and regulatory changes are also important challenges for biopower. The relatively high cost to generate electricity from biomass compared to other renewable electricity sources reduces its ability to compete successfully for power purchase agreements. For example, stakeholders continue to argue that although small biopower projects cost more than other renewable resource facilities, the value that these projects can provide outweighs the cost.[46, 47]

Biomass has had little success competing in the Renewable Auction Mechanism (RAM), a simplified, market-based procurement mechanism for renewable projects sized from 3 MW to 20 MW.[48] The CPUC has directed the investor-owned utilities to procure a total of 1,299 MW of renewable capacity through the RAM process. To date, there have been three RAM auctions yielding one approved bioenergy contract for 4.5 MW out of a total of 695 MW of approved contracts. The lack of bioenergy projects participating in the RAM represents the difficulty of

45 http://www.treasury.gov/initiatives/recovery/Pages/1603.aspx

46 Kim Carr, (Sierra Nevada Conservancy), op. cit., p. 165.

47 Michael Boccadoro, (Dolphin Group), op. cit., p. 166.

48 California Public Utilities Commission, Decision Adopting the Renewable Auction Mechanism, Decision 10-12-048 issued December 17, 2010, http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/128432.htm and expanded to 1,299 MW by Decision 12-02-035 and Decision 12-02-002.

competing against other renewable energy technologies that have lower costs and/or higher subsidies.[49]

The CPUC is also implementing a Feed-in Tariff (FIT)[50] for investor owned utilities to procure power from small renewables sized up to 3 MW, including biopower. The FIT program has undergone several legislative revisions since its inception that increased the program goal from 250 MW to 500 MW, increased the maximum eligible project size from 1.5 MW to 3 MW, and expanded the scope to include all investor-owned utility service territories and other renewable energy resources.[51] Under this tariff, IOUs have signed contracts to procure 19.9 MW of renewable capacity from 15 bioenergy projects.

In May 2012, the CPUC adopted a new pricing mechanism for the FIT program that project proponents say sets the price too low to spur development of small biopower technologies.[52] The pricing mechanism is called the Renewable Market Adjusting Tariff (ReMAT) structure and the price will start out at $89 per MWh with the ability to move the price up or down based on market demand or the market price.

In 2012, the Legislature expanded this FIT program to spur development of pre-commercial small bioenergy projects. Under SB 1122[53] the CPUC is to direct the investor-owned utilities to collectively procure at least 250MW of renewable capacity from bioenergy projects of 3 MW or less. The proceeding to design and implement this portion of the FIT program is currently underway at the CPUC.[54] Project proponents state if the SB1122 FIT uses the ReMAT price mechanism, which starts at $89 per MWh, there will be delays of one to three years until the ReMAT price signal is high enough to incentivize development.[55] [56]

A study by Black and Veatch conducted for the CPUC assessed the resource potential, costs, and implementation challenges for the SB1122 FIT program.[57] To analyze potential project development delays, Black and Veatch assumed that the SB 1122 FIT will follow the general

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49 Transcript of Energy Commission Staff Workshop Status of Bioenergy Development in California, June 3, 2013, comments by Michael Boccadoro (Dolphin Group), p 166.

50 For more information, see http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/SB_1122_Bioenergy_Feed-in_Tariff.htm.

51 Legislation expanding the FIT included SB 380, SB 32, SB X1-2.

52 Michael Boccadoro (Dolphin Group), op. cit., pp. 145-146.

53 Senate Bill 1122 (Rubio, Chapter 612, Statues of 2012).

54 For more information, see http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/SB_1122_Bioenergy_Feed-in_Tariff.htm.

55 Michael Boccadoro (Dolphin Group), op. cit., p. 146.

56 Fred Tornatore, (TSS Consultants), op. cit., p. 129.

57 Black & Veatch, *Draft Consultant Report, Small-Scale Bioenergy: Resource Potential, Costs, And Feed-In Tariff Implementation Assessment*, April 2013, http://www.cpuc.ca.gov/NR/rdonlyres/9ABE17A5-3633-4562-A6DA-A090EB3F6D07/0/SmallScaleBioenergy_DRAFT_04092013.pdf.

criteria in the ReMAT. ReMAT includes viability criteria designed to screen out only the most viable projects. The draft report from Black and Veatch suggests that the screening criteria that pose the greatest challenges for biopower include the requirement that projects be "strategically located."[58] The CPUC has defined "strategically located" to mean "a generator must be interconnected to the distribution system and sited near load, meaning in an area where interconnection of the proposed generation to the distribution system requires $300,000 or less of upgrades to the transmission system." Most of the biomass in California is located in rural regions that may not be located near large load centers. Black and Veatch found very few biopower projects in the current interconnection queue that would pass the requirement that FIT projects be "strategically located."

Also, utilities have stated that biopower interconnection takes longer than other renewable resources, such as solar PV. Biopower that needs synchronous generators, unlike induction generators, must be precisely synchronized with the utility system during operation. This synchronization requires matching the frequency, phase angle, and voltage magnitude in certain parameters at the instant of interconnection of the customer's tie breaker to avoid problems with the generator or utility system equipment.[59] Biopower generators are often much larger than other customer-side-of-meter generation equipment, requiring more analysis and preparation before interconnection to the utility's electricity network.[60] The benefit to the utility is that unlike induction generators, synchronous generators can provide reactive voltage support. In the Spring of 2013, Energy Commission staff formed a working group with the CPUC, utilities, project developers, and other interested parties to focus on interconnection challenges that are unique to synchronous generators. The working group has been successful in opening a productive dialogue between utilities and developers, including providing clarity to expensive interconnection upgrade requirements, allowing developers to make better financial decisions about project size and location.

Another challenge is that biopower projects have traditionally operated as baseload generators because boiler technologies that dominate existing biopower generation could not change output quickly to meet fluctuating demand. However, there is limited interest in new baseload energy due to the growing risk of overgeneration. Instead, generation sources that have the flexibility to quickly ramp up and down are increasingly critical to maintain system reliability. As solar distributed generation deployment increases, large daily swings in net load (load minus intermittent generation) are expected to cause overgeneration during the day, even during peak load hours, followed by a sharp drop at night when PV no longer produces energy. To compensate, the system will require more flexible capability by 2015 and beyond.[61]

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58 Public Utilities Code 399.20 (b) (3)

59 Synchronous Generation, conEdison, http://www.coned.com/dg/configurations/synchronous.asp

60 Written comments by submitted by PG&E to Docket 13-IEP-1, June 19, 2013, page 4.

61 California ISO, *Comprehensive Forward Capacity Procurement Framework*, February 2013, http://www.caiso.com/Documents/CaliforniaISO-BriefingPaper-LongTermResourceAdequacySummit.pdf.

Given the changing needs of the system, new biopower installations that can provide flexible ramping capacity will provide value that could help close the price gap between biopower and renewable resources.[62] New biopower gasification and digester technologies can ramp up and down quickly.[63] [64] The approach varies by technology; for instance, gas storage is not needed for biopower gasification or other biopower thermochemical conversion technologies.[65] Covered lagoon digesters have a natural storage capability for biogas, and some developers are studying the feasibility of developing peak power digesters.[66] The feasibility will depend on actual prices paid during peak power periods compared to cost recovery,[67] which may be especially challenging given that facilities used to meet flexibility needs may operate only 40 percent of the time.

Forest Biomass Resources

Disagreement over the environmental benefits of bioenergy also poses a barrier to development. According to the Center for Biological Diversity (CBD), energy from forest biomass "entails potentially significant adverse environmental impacts and costs, particularly with respect to air pollution, greenhouse gas emissions, water supply and quality issues, and effects on forest habitat associated with the harvest and combustion of woody biomass." CBD also raises numerous concerns about greenhouse gas benefits of forest biomass in terms of rate of carbon sequestration and actual emissions.

Proponents of bioenergy projects state that removing biomass trimmings and brush material following sustainable forestry plans provides many benefits to the ecosystem, as well as greenhouse gas benefits, primarily as a result of improved forest health. Because greenhouse gas emissions from the projects are "biogenic," they are part of the natural carbon cycle.

There is disagreement on the basis for accounting for sequestration of greenhouse gas emissions from bioenergy. Proponents argue that bioenergy carbon emissions are negligible if the amount of biomass removed from the forest does not exceed growth. Opponents argue that removal of a tree, alive or dead, results in higher carbon emissions in the short term, which can take decades to sequester.

These issues are also being discussed on the federal level. The U.S. EPA is considering the scientific and technical issues associated with accounting for biogenic carbon emissions from

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62 Statement by PG&E at the June 3, 2013, Energy Commission staff IEPR workshop on the status of bioenergy development in California.

63 Michael Boccadoro (Dolphin Group), op. cit., pp. 159-160.

64 Fred Tornatore (TSS Consultants), op cit., p. 159.

65 Fred Tornatore (TSS Consultants), op cit., p. 159.

66 Michael Boccadoro (Dolphin Group), op. cit., pp. 159-160.

67 Fred Tornatore (TSS Consultants), op. cit., p. 159.

stationary sources and has developed a framework to account for those emissions. The report is under peer review by the Science Advisory Board.[68]

Further information using the best science available is needed. Research can help address questions, such as what is the maximum amount of biomass that can or should be removed from the forest before it will impact the ability of the forest to act as a carbon sink? Are federal harvest rules adequate for protecting forests from overharvest in the context of California's renewable energy policies? Are protections in place to minimize the risk of overharvest of California's forests?

Biofuels Production

Biofuels, which includes gasoline substitutes, diesel substitutes, and biomethane, currently represent the largest category of alternative fuel use in California.[69] In-state production is predominantly ethanol derived from corn grain imported from Midwest farms and biodiesel derived from waste grease and tallow and some imported virgin oils, including palm and soybean oil. However, other fuels such as biomethane, "drop-in" biomass-derived hydrocarbons (renewable diesel and gasoline components) and renewable hydrogen are also being developed.

Ethanol use dominates the biofuels market in California with nearly 1.5 billion gallons consumed in 2012, an increase of nearly one-half billion gallons since 2008, originally introduced for use as a gasoline oxygenate. A small portion is used in E85 sales (a blend of 85 percent ethanol for use in flexible fuel vehicles.) In 2012, 6.5 million gallons of E85 were sold in California.

As reported in the *2011 Bioenergy Action Plan,*[70] the five existing ethanol facilities in California were idle for much of 2009, and only one refinery reported production of ethanol in 2010. Since then, three of the five facilities have begun regular operations. Of the two remaining, one has been shut down and dismantled, and the other is operating intermittently. The increased operation of existing facilities has resulted in a significant increase in in-state biofuel production. In 2013, in-state capacity was roughly 220 million gallons (147million gge[71]) per year.

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68 U.S. Environmental Protection Agency, *Accounting Framework for Biogenic CO2 Emissions from Stationary Sources*, July 2013, http://www.epa.gov/climatechange/ghgemissions/biogenic-emissions/study.html.

69As used in the *2013-2014 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program*, "gasoline substitutes" refers to any liquid fuel that can directly displace gasoline in internal combustion engines including ethanol and renewable drop-in gasoline substitutes. Similarly, "diesel substitutes" refers to any liquid fuel that can significantly displace diesel including biodiesel, renewable diesel, and renewably derived dimethyl ether (assuming fuel system modifications).

70 O'Neill, Garry, John Nuffer. 2011. *2011 Bioenergy Action Plan.* California Energy Commission, Efficiency and Renewables Division. Publication number: CEC-300-2011-001-CTF.

71 gge = gasoline gallon equivalents.

Similar to ethanol, most of the biodiesel consumed in California is blended with conventional diesel (at levels ranging from 5 to 20 percent.) Diesel blend levels for light-duty and passenger vehicles have been limited to 5 percent because equipment manufacturers and companies offering extended warranties on their products are reluctant to guarantee their products using higher biodiesel blends. Recently, major manufacturers including VW and Audi notified vehicle owners that they will accept the use of diesel blends up to a B20 level (about 80 percent conventional diesel and 20 percent biodiesel) without voiding vehicle warranties. The Chevrolet Cruze Diesel will also accept up to B20 blends.

Progress has been difficult to track for biodiesel. Improvements in estimates of biodiesel data suggest that earlier estimates overstated its use, including estimates reported in the *2011 Bioenergy Action Plan.* While estimates continue to improve, verifiable data sources on California biodiesel production remain unavailable. Table 4 shows various estimates for the number of facilities, capacity, and production for 2009 and 2012.

While facilities are required to report production totals to the Energy Commission under the Petroleum Industry Information Act,[72] full compliance has been difficult to achieve. Energy Commission staff is working with the California Biodiesel Alliance and the California Air Resources Board (through the Low Carbon Fuel Standard Reporting Tool) to improve the accuracy of future data on biodiesel in California. Initial estimates show that in 2012 there was an installed capacity of over 80 million gallons per year of bio- and renewable diesel production in California. There was approximately 19.5 million gallons of actual production.

Challenges and Opportunities

In-state ethanol producers (especially start-up companies) continue to face challenges when competing with ethanol derived from Midwest corn and Brazilian sugarcane. Additionally, California has a limited availability of arable lands and feedstock. However, with both federal and state directives driving advances in biofuels, many companies are looking to alternative fuel sources with lower carbon intensities and less feedstock competition.

One example of an alternative feedstock is the use of grain sorghum coupled with biogas. Sorghum was recently qualified as an eligible advanced biofuel under the federal Renewable Fuel Standard (RFS2). The RFS2 allows producers and distributors of alternative fuels to generate and trade renewable identification number (RIN) credits[73] for excess renewable fuels, which may be purchased or sold for compliance purposes.[74] As a result, RIN credits can provide

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72 California Air Resources Board, *LCFS Reporting Tool*, July 2013, http://www.arb.ca.gov/fuels/lcfs/reportingtool/reportingtool.htm.

73 The RIN system allows EPA to monitor compliance with the Renewable Fuel Standard (RFS), a federal program that requires transportation fuels sold in the United States to contain minimum volumes of renewable fuels. http://www.afdc.energy.gov/laws/RIN

74 Smith, Charles, Jim McKinney. 2013. *2013-2014 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program* Commission Report. California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2012-008-CMF.

a revenue stream for fuel producers, and sorghum will provide higher RIN credits than conventional corn ethanol now that it is an eligible biofuel under RFS2. Demand for sorghum is very low as it is not found in many food products, making it more economical than corn or sugar feedstocks. The process for using grain sorghum is very similar to that of corn, so producers do not need to make major changes to their equipment to switch to grain sorghum. Additionally, grain sorghum is very appealing to California farmers because it can be planted in saline soils and requires very little water. Some California ethanol producers have started incorporating grain sorghum into their feedstock.

The number of E85 fueling stations has increased in recent years from 20 in 2009 to 83 stations in 2013.[75] However, high construction costs coupled with uncertainty in demand have hindered additional development in California, despite continuing investments through the Alternative and Renewable Fuel and Vehicle Transportation Program (ARFVTP). E85 sales have consistently grown since 2005 as more stations are installed. In addition, developers and operators are concerned about the profitability of building new fueling stations. To raise consumer demand for E85, more E85 stations are needed, and the price of ethanol must remain competitive with gasoline.

The biodiesel industry has made progress and overcome most of the fuel quality issues identified in the first generation of biodiesel fuel. The American Society for Testing and Materials has developed a new standard for biodiesel, which producers are meeting already.

While biodiesel can contribute toward reducing the carbon intensity of California's transportation sector, production costs continue to be a major challenge.

The Energy Commission has funded research, development, and demonstration projects for algal-based biodiesel production. Biodiesel from algae has long been considered a promising alternative fuel and is a "drop-in" fuel, meaning it can easily replace conventional diesel in vehicles and can use the existing infrastructure. While cost is a major challenge for this technology as well, there have been some recent projects that were able to successfully reduce costs.[76] More research is needed to fully examine the environmental impacts.

Biomethane Production

Biogas is the raw, untreated gas produced during the anaerobic decomposition of biomass and is principally composed of methane and carbon dioxide. Biomethane is the treated product of biogas where carbon dioxide and other contaminants are removed. Types of biogas and biomethane include landfill gas, anaerobic digester gas, and reformed producer gas from

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75California Energy Commission, *2013-2014 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program*, May 2013, http://www.energy.ca.gov/2012publications/CEC-600-2012-008/CEC-600-2012-008-CMF.pdf.

76 See http://idealab.talkingpointsmemo.com/2012/04/nasa-ready-to-show-off-algae-biofuel-research-project.php. Also see http://abclocal.go.com/kgo/story?section=news/business&id=8884425.

thermochemical conversion processes. Biomass feedstock sources include wastewater treatment plants, dairy and animal waste, agricultural waste, and food processing waste.

Status of Existing Biogas and Biomethane Production

As of 2012 the United States Environmental Protection Agency Landfill Methane Outreach Program reported that California landfills operate 75 landfill gas facilities (299 MW of renewable capacity). There are also 33 landfill gas facilities that have been shut down (81.5MW), 8 landfill gas facilities under construction (53.1MW), and 37 candidate[77] locations.[78] Table 5 summarizes the changes in capacity of operating, nonoperating, and proposed or under-construction facilities as well as the number of candidate landfills.

Table 4: Changes in Landfill gas facilities operating in California

	Operating MW	Nonoperating MW	Proposed/Under Construction MW	Candidate Landfills #
2009	282	No Data	57	38
2012	299	82	53	37

Source: U.S. EPA Landfill Methane Outreach Program

According to the U.S. EPA's AgSTAR Program, California is the home of 11 operating dairy digester projects that combine for a total of 3.4 MW of renewable capacity, with nine nonoperational facilities that total 5.9 MW of renewable capacity.[79] California's renewable capacity from dairy digesters has decreased as shown in Table 6.

Table 5: Dairy Anaerobic Digester Gas Projects in California

	Operating MW	Nonoperating MW	Proposed/Under Construction MW
2009	3.9	4.6	4.3
2012	3.4	5.9	0.6

Source: California Energy Commission, U.S EPA AgSTAR

Renewable natural gas or high BTU biomethane can be used as a direct replacement for natural gas in most cases and holds promise for use in California's truck fleet which is an emerging market for natural gas. Trucks represent a smaller amount of fuel use in California than

77 The Landfill Methane Outreach Program defines a candidate landfill as one that is accepting waste or has been closed for five years or less, has at least one million tons of waste, and does not have an operational or under-construction project; candidate landfills are also designated based on actual interest or planning.

78 U.S. Environmental Protection Agency, *Landfill Methane Outreach Program*, July 2013, http://www.epa.gov/lmop/documents/xls/states/lmopdataca.xls.

79 AgStar is a collaborative effort between U.S. Environmental Protection Agency, U.S. Department of Agriculture, and U.S. Department of Energy, July 2013, http://www.epa.gov/agstar/downloads/digesters_all.xlsx.

passenger vehicles, but they produce more emissions.[80] Trucks are being incentivized to use natural gas as a fuel through California's Low Carbon Fuel Standards (LCFS) and the higher cost of petroleum compared to natural gas. Although high BTU biomethane has been more expensive to produce than natural gas, it has a lower carbon intensity value (at about 11 to 13 grams of carbon dioxide per megajoule). To improve the commercial viability of high BTU biomethane, the Energy Commission has funded nine production projects through ARFVTP. As of 2013, the Energy Commission has awarded $50 million for these projects.[81]

The use of biomethane in hydrogen fuel production is also being tested. Currently, California has nine publicly available hydrogen fueling stations, 15 private hydrogen fueling stations, and 16 hydrogen fueling stations in development.[82] The ARFVTP has awarded $36.8 million dollars for fueling station infrastructure construction and $2.4 million dollars for demonstration projects since 2013.[83] However the funds have been used only for hydrogen storage tank expansion and refueling equipment; 16 of the fueling stations funded by the Energy Commission have their hydrogen fuel transported by truck, and one fueling station has onsite generation through electrolysis.

New Developments

The statutory and regulatory landscape for biomethane projects is undergoing a number of changes. For example, the RPS no longer allows biomethane delivered through the natural gas pipeline to be eligible as a renewable resource unless the project provides environmental benefits to California.[84] Also, the utilities and the CPUC must develop nondiscriminatory open-access pipeline quality standards for biomethane.

In the *2011 Bioenergy Action Plan*, the Energy Commission found that the varying pipeline quality standards and approaches to applying standards were limiting development of pipeline biomethane projects.[85] In addition, statutory restrictions created by statute referred to as "the Hayden Bill"[86] resulted in the exclusion of landfill gas from injection into natural gas pipelines. In 2012, the Legislature passed Assembly Bill 1900 (Gatto, Chapter 602, Statutes of 2012), which

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80 Transcript of Energy Commission Staff Workshop Status of Bioenergy Development in California, June 3, 2013, comments by Jim McKinney (California Energy Commission), p 24.

81 California Energy Commission Alternative and Renewable Fuel and Vehicle Technology Program Project Funding Summary. Some of the funds have been used for development of current projects or expansion of current facilities.

82 California Fuel Cell Partnership, *Station Map*, July 2013, http://cafcp.org/stationmap#st-map.

83 California Energy Commission *Alternative and Renewable Fuel and Vehicle Technology Program Project Funding Summary.*

84 Assembly Bill 2196 (Skinner, Chapter 605, Statutes of 2012).

85 California Energy Commission, *2011 Bioenergy Action Plan*, March 2011, http://www.energy.ca.gov/2011publications/CEC-300-2011-001/CEC-300-2011-001-CTF.PDF.

86 Assembly Bill 4037 (Hayden, Chapter 932, Statutes of 1988).

requires the CPUC to adopt pipeline access rules to ensure gas corporations provide nondiscriminatory open access to the pipeline system for biomethane, regardless of the type or source of the biogas.

In addition to providing biomethane producers open-access to the utility pipeline system, AB 1900 requires the CPUC to develop standards for constituents of concern[87] in biogas to protect human health and pipeline integrity and safety. The CPUC opened Rulemaking 13-02-008 for this proceeding. The bill further requires the Office of Environmental Health and Hazards Assessment and California Air Resource Board to recommend health-based exposure limits and constituents of concern in raw biogas. The agencies released their recommendations to the CPUC on May 15, 2013.[88]

Prior to the passage of AB 1900, the San Diego Point Loma Waste Water Treatment Plant was the only operating project injecting biomethane into a common carrier pipeline in California. The Point Loma Plant was adapted for pipeline injection from a combined heat and power facility that used the biogas produced to offset on-site electricity use and export excess electricity to the grid.[89] About 50 percent of the biogas produced at Point Loma was unused at the site and flared, as it was not economical for the site to produce more electricity due to its size limitations and air pollution regulations.[90] Although the gas flared met the San Diego Air Pollution Control District permit, an added benefit of using the excess methane is that the need to flare is reduced, which reduces local air pollution emissions.

BioFuels Energy LLC secured the rights for the biogas produced at the Point Loma plant in 2007 through competitive bidding. The total project cost to build the site was quoted at $45 million and took five years before becoming operational in 2012.[91] The BioFuels Energy process at the Point Loma Wastewater Treatment Plant is composed of two projects. The digester gas is first purified with the use of activated carbon polishing vessels, such that the end product meets

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87 Constituents of concern are components of biogas that could pose a health risk and that are at levels that significantly exceed the concentrations of those constituents found in natural gas.

88 California Air Resources Board, *Recommendations to the California Public Utilities Commission Regarding Health Protective Standards for the Injection of Biomethane into the Common Carrier Pipeline*, May 2013. http://www.arb.ca.gov/energy/biogas/documents/FINAL_AB_1900_Staff_Report_&_Appendices_%20051513.pdf.

89 City of San Diego, *Point Loma Waste Water Treatment Plan overview*, July 2013, http://www.sandiego.gov/mwwd/facilities/ptloma/index.shtml.

90 BioFuels Energy, LLC., *Point Loma Wastewater Treatment Plant's Beneficial Use of Digester Gas (BUDG) Project with BioFuels Energy, LLC Fact Sheet*, February 2011, http://scap1.org/POTW%20Reference%20Library/BUDG%20Projects%20Fact%20Sheet-SDGE%202-7-11%20(2).pdf.

91 Transcript of Energy Commission Staff Workshop on Challenges to Procuring Biomethane in California, May 31, 2013, comments by Frank Mazanec (Biofuels Energy, LLC.), p 98.

SDG&E's Rule 30 pipeline injection standards.[92, 93] During the second part of the process, BioFuels nominates the directed biomethane to the University of California, San Diego, and the City of San Diego South Bay Water Reclamation Plant. BioFuels owns and operates a 2.8 MW fuel cell at the University of California, San Diego; at the South Bay Reclamation Plant, there is a 1.4 MW fuel cell that BioFuels uses. The cleaned biomethane produced from the plant has 98.1 percent average methane content.[94]

In general, one of the challenges facing biomethane production facilities is uncertainty whether biogas upgrading equipment can produce biomethane gas of consistent quality.[95] To address this concern, the Biofuels Energy LLC plant is tested quarterly to ensure its biomethane continues to meet pipeline injection standards.[96]

Using Anaerobic Digesters in Organic Materials Management

The California Integrated Waste Management Act of 1989 requires that landfills divert 50 percent of all solid waste from landfill disposal or transformation, through source reduction, recycling, and composting. Assembly Bill 341 (Chesbro, Chapter 476, Statutes of 2011) updated this goal to require at least 75 percent of all solid waste generated to be source reduced, recycled, or composted by 2020.[97]

According to CalRecycle, about 15 million tons of organic material is landfilled each year.[98] To achieve the 75 percent waste reduction goal, CalRecycle seeks to increase development of anaerobic digester systems to convert organic waste to energy, compost, and biomethane. CalRecycle seeks to encourage the development of anaerobic digesters by providing funds to develop facilities and to expand existing recycling facilities. CalRecycle has additionally established the Local Enforcement Agency Grant Program to help local agencies with enforcement and inspection of solid waste plants.

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92 Southern California Gas Company, *Rule No. 30, Transportation of Customer-Owned Gas,* July 2013, www.socalgas.com/regulatory/tariffs/tm2/pdf/30.pdf.

93 Activated carbons are the adsorbents with the most favorable characteristics for ANG storage because they have a large microporous volume, are efficiently compacted into a packed bed, and can be cheaply manufactured in large quantities. Delavar, M. and A.A. Ghoreyshi, M. Jahanshahi, M. Irannejad, *Experimental Evaluation of Methane Adsorption on Granular Activated Carbon (GAC) and Determination of Model Isotherm.*2010, http://www.waset.org/journals/waset/v38/v38-9.pdf.

94 Transcript of Energy Commission Staff Workshop on Challenges to Procuring Biomethane in California, May 31, 2013, comments by Mazanec, Frank (Biofuels Energy, LLC.), p 101.

95 Ibid, Jim Lucas, (Southern California Gas Company) p 60.

96 Ibid, Mazanec, Frank, (BioFuels Energy LLC), p 94.

97 Assembly Bill 341 (Hasbro, Chapter 476, Statutes 2011) http://www.leginfo.ca.gov/pub/11-12/bill/asm/ab_0301-0350/ab_341_bill_20111006_chaptered.html

98 Cal Recycle, Organic Materials Management: Conversion Technologies, Accessed June 25, 2013. http://www.calrecycle.ca.gov/organics/Conversion/

Challenges and Opportunities for Biomethane Production

Regulatory issues, cost, safety, and technology development issues pose challenges and opportunities for biomethane production in California.

Regulatory Issues

A common concern that many project developers, utilities, and gas providers have cited is the effect of regulatory uncertainty and the effect of regulation changes on long-term contracts.[99] Uncertainty creates development risk, which increases debt financing costs and may also increase other costs. This uncertainty can jeopardize the viability of a project. For example, while there is little debate that AB 1900 will benefit development of biomethane in California, some have raised concerns regarding the increased costs to meet new biomethane pipeline quality standards.[100]

Contracting terms can aggravate or reduce regulatory uncertainty. Developers have stated concerns that gas utilities are including regulatory "out clauses"[101] in new biomethane contracts to shift regulatory risk from the utility to the developer.

Costs

One of the key challenges of developing biogas has been the cost. Biogas production facilities produce relatively small quantities of methane, and upgrading biogas to pipeline quality can be expensive. Access to pipelines for distribution of biogas can also pose a challenge. For locations that do not have feasible natural gas pipeline access, the biogas must be used for onsite generation or for transportation biofuels.

Pipeline interconnection costs have been identified by utility and project developers as major challenges contributing to the cost of producing biomethane in California. The pipeline interconnection costs can exceed $3 million,[102] but the cost depends on specifications unique to each project. Lengthy interconnection processes for biomethane facilities further increase costs

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99 Comments from Colony Energy Partners on Staff workshop Challenges to procuring biomethane in CA May 31, 2013, p 1. http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-31_workshop/comments/Kent_Hawkins_Comment_on_Challenges_to_Bio_Methane_into_Pipeline_2013-06-24_TN-71375.pdf.

100 Comments from Division of Ratepayer Advocates to the California Public Utilities Commission on opening comments to CPUC Rulemaking R. 13-02-008 February 13, 2013, p 2. http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M062/K909/62909593.PDF.

101 Out clause is a part of an agreement or contract that allows one party to cancel the agreement if the conditions of the clause are met.

102 Transcript of Staff Workshop Challenges to Procuring Biomethane in California, May 31, 2013, comments by Jim Lucas (Southern California Gas Company), p 49 ; Frank Mazanec (Biofuels Energy LLC), p 106.

for project developers. In addition, the feasibility of locating a biomethane facility near a natural gas pipeline depends on the availability of feedstock within a reasonable distance.[103]

Biomethane can be used as a direct replacement for natural gas. However, natural gas prices have been much lower than the production cost of biomethane. For example, the Point Loma Wastewater Plant produces biomethane at roughly $8.50 per mmBTU[104] compared to an average of $4.00 per mmBTU for natural gas. This price disparity, paired with the high cost of interconnection, deters development of new biomethane projects in California.

One way of addressing high production costs of renewables has been through federal and state incentives. However, federal incentives for the production of biomethane and biogas do not benefit pipeline biomethane projects because the incentives are tied only to electricity production. Southern California Gas Corporation stated it has not seen incentives for constructing biomethane production facilities.[105]

Long-term contracts requiring consistent biogas production are preferred over short-term contracts, five years or fewer, which are harder to finance because revenues and costs are harder to forecast. Long-term predictability of RIN and LCFS credits would help bring value to these credits and help provide more incentives for long-term contracts. Although RIN credits are available to renewable natural gas producers, the pricing is uncertain and prices may not be high enough to attract long term contracts.[106]

Safety

Pipeline safety is another issue for biomethane. Utilities have said that it is imperative to monitor and test biomethane going into their pipelines. While utilities have experience injecting biomethane into their pipelines, they still lack data, especially for interconnections into low-demand pipelines.[107] Some of the utilities also feel that lowering the 990 BTU per cubic foot minimum gross heating value requirement could potentially threaten the pipeline as it goes against standards set by the CPUC.[108] Utilities are also concerned that potentially blending

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103 Ibid comments by Jim Lucas (Southern California Gas Company), p 59.

104 Ibid comments by Frank Mazanec (BioFuels Energy LLC), p 108.

105 Jim Lucas, Southern California Gas Corporation. May 31, 2013 Presentation at the California Energy Commission http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-31_workshop/presentations/Jim-Lucas_Southern_California_Gas_Company.pdf.

106 Presentation from Coalition for Renewable Natural Gas on Staff Workshop regarding Challenges to Procuring Biomethane in California transcript, May 31, 2013, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-31_workshop/presentations/Evan_Williams_Impediments_and_Solutions_to_RNG_in_California.pdf.

107 Ibid comments by Bill Raymundo (Pacific Gas and Electric), p 63.

108 Approved in California Public Utilities Commission Decision 06-09-039, http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/64773.pdf.

noncompliant biomethane with compliant natural gas is unreliable and could damage pipeline integrity and compromise customer safety.[109]

Technology Commercialization Challenges

Biogas technologies have not been fully commercialized. Some biogas and biomethane technologies are in the research and development phases and need further technological advances to bring down costs; others are ready to enter the market. To enter the market successfully, emerging biogas technologies need additional performance data to help attract financing and build economies of scale that can further reduce installed costs.

Recommendations

Biopower

- **Develop programmatic Environmental Impact Report**. The Bioenergy Interagency Working Group should identify an appropriate funding source for developing a statewide programmatic Environmental Impact Report for thermochemical conversion technologies using biomass. The Environmental Impact Report should focus on streamlining the environmental review process for SB 1122-type projects.
- **Modify procurement practices to develop higher-value portfolio.** Consistent with the recommendation in the *2012 IEPR Update*, the California Public Utilities Commission should modify procurement practices to develop a higher-value portfolio. Procurement decisions should consider an expanded suite of renewable energy benefits, including RPS-eligible facilities that can provide integration benefits, reduction in forest fires that threaten public health and safety and damage transmission lines, reduce transmission and distribution costs, increase investment in disadvantaged communities, and create green jobs.
- **Develop sustainability standards for biomass harvest.** The California Air Resources Board and the Department of Forestry and Fire Protection should analyze existing forest and wildland protections to ensure biomass harvest, including biomass harvest for California's renewable energy policies, will not increase net greenhouse gas emissions from California's forests. Also, standards ensuring sustainable biomass harvest should be developed to apply to all biomass harvest, regardless of end use.

Biofuels

- **Support research and development for advanced biofuels.** The Energy Commission should continue research and development needed to reduce the cost of algal-based and other advanced biodiesel fuels.

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109 Comments from Southern California Gas/San Diego Gas &Electric) to the California Energy Commission Staff Workshop on Challenges to Procuring Biomethane in California, May 31, 2013, p 1. http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-31_workshop/comments/Southern_California_Gas_and_San_Diego_Gas_and_Electric_Joint_Comments_2013-06-14_TN-71271.pdf.

Biomethane

- **Support research and development for pipeline biomethane injection.** The Energy Commission should continue research, development, and demonstration of biogas-to-biomethane technologies and projects that inject biomethane into California's natural gas pipelines.

CHAPTER 4: Electricity

This chapter highlights energy topics related to California's electricity system. The first topic is the Energy Commission's biennial update to its 10-year forecast of annual electricity consumption and peak demand. This forecast serves as the foundation for many of the analyses contained in the *Integrated Energy Policy Report* (*IEPR*) and plays a prominent role in procurement and transmission planning at the California Public Utilities Commission (CPUC) and by the California Independent System Operator (California ISO). The *2012 IEPR Update* recommended three changes to future forecasts, which are reflected in the 2013 forecast: including climate change effects, disaggregating the forecast down to the climate zone level, and addressing the uncertainty regarding the interaction and implementation of California's policies for zero-emission vehicles, combined heat and power, and distributed generation. This chapter also includes an evaluation of the resource adequacy of the publicly owned utilities (POUs).

When crafting California's energy policy, decision makers must balance system reliability with environmental compliance and reasonable costs. Part of planning for California's energy future is not only predicting what the future will require, but assessing the current situation and what needs to be done to meet future demand. Past *IEPRs* have focused on electricity infrastructure needs in Southern California, and given the recent closure of the San Onofre Nuclear Generating Station, this topic has become even more relevant.

Finally, this chapter includes an update of estimates of generation costs for renewable and fossil-fuel generating technologies.

Renewed Focus on Interagency Coordination

On January 28, 2013, the Energy Commission, the CPUC, and the California ISO appeared at a legislative hearing called by the Chair and Vice Chair of the California State Senate Committee on Energy, Utilities, and Communications, Senator Alex Padilla and Senator Jean Fuller.[110] The hearing was called to examine how energy efficiency investments can most effectively reduce the need for future power plants and to address the Legislative Analyst's Office's December 19, 2012, report, which maintained that the three energy agencies lacked a comprehensive framework for fully coordinating state programs, and expressed concern over the steady decline of cost-effectiveness in California's IOU energy efficiency programs over the past 8 years. Robert Weisenmiller, Chair of the California Energy Commission, Keith Casey, Vice President of Markets and Infrastructure Development at the California ISO, and Edward Randolph, Energy Division Director at the CPUC provided testimony.

110 Background and Agenda for January 28, 2013, Legislative Hearing of the California State Senate Committee on Energy, Utilities, and Communications http://seuc.senate.ca.gov/sites/seuc.senate.ca.gov/files/01-28-13%20agenda.PDF.

As a result of the testimony presented, Senators Padilla and Fuller sent a letter[111] asking each of the three agencies to provide specific joint recommendations for policy or legislative changes that would address concerns discussed at the hearing. In their response,[112] the Energy Commission, CPUC, and California ISO addressed each of the issues noted in Senators Padilla and Fuller's original letter as described below.

- How can the joint agencies improve the demand forecast and procurement planning processes to more efficiently reach agreement on how to account for reduced energy demand from energy efficiency?

  Energy Commission/CPUC/California ISO response- The agencies are pursuing several reforms to the demand forecasting process: implementing a joint work plan in each *IEPR* proceeding, modifying existing Energy Commission models to support forecasting at more granular geographic levels in response to the needs of the CPUC and California ISO, developing new modeling methods at the Energy Commission to more robustly capture efficiency impacts, using the Energy Commission's expected mid-case demand forecast, adjusted by the 2012 "low" scenario for incremental uncommitted energy efficiency as the basis for the California ISO's 2013-2014 transmission planning process, agreeing on a single recommended forecast case to be used consistently in the next transmission planning and procurement cycles following the Energy Commission's adoption of the demand and additional achievable efficiency forecasts, and committing to using the current efficiency portfolio cycle to investigate additional planning improvements.

- How can the design, implementation, and coordination of energy efficiency programs be improved so that they best match grid operational requirements, including reliability and local capacity, with consideration of grid impacts from renewable energy and other state energy policies?

  Energy Commission/CPUC/California ISO response - The CPUC, in collaboration with the Energy Commission and California ISO, is exploring a range of approaches to deploy energy efficiency in a manner that best matches grid operational requirements while complying with adopted state energy policies. They are also coordinating to ensure future energy efficiency programs help to reduce the need for generation resources at critical times of the day and year. The Energy Commission and California ISO are planning to develop recommendations that can be used by the CPUC to focus utility efficiency programs on local reliability areas and specific times of day. The CPUC has taken steps toward requiring utilities to procure energy efficiency resources as part of

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111 Letter to the Energy Commission, CPUC, and California ISO from Senators Alex Padilla and Jean Fuller, http://seuc.senate.ca.gov/sites/seuc.senate.ca.gov/files/01-28-13%20group%20letter.pdf.

112 Letter from the Energy Commission, CPUC, and California ISO to Senators Alex Padilla and Jean Fuller, http://seuc.senate.ca.gov/sites/seuc.senate.ca.gov/files/CEC%20CPUC%20ISO%20response%20to%20Padilla%20and%20Fuller_02%2025%2013.pdf.

all-source procurement, meaning the utilities would procure efficiency in competition with all other resources and will more accurately balance the grid impacts of all their procurement.

- How can it be ensured that energy efficiency investments will be cost-effective as California increases its focus on "market transformation" efficiency strategies that the CPUC has stated may not be cost-effective, especially in the near term?

  Energy Commission/CPUC/California ISO response - The current CPUC process for determining cost-effectiveness for energy efficiency programs is evaluated through a portfolio approach. Under this approach, while some individual programs might not be cost-effective, the overall investment assures that for every rate payer dollar invested in energy efficiency, ratepayers will save at least $1.25. This allows the CPUC to direct utilities to pursue a variety of market transformation programs whose benefits will take longer to achieve, while balancing these efforts with more immediately cost-effective programs to ensure that the overall portfolio is cost-effective.

  As noted by the Legislative Analyst's Office, the cost-effectiveness ratio has decreased over the past few years. That downward trend is a result of several factors, including an increased size of utility energy efficiency portfolios which have added measures with lower cost-effectiveness, more stringent oversight and monitoring of program evaluations by CPUC staff, and aggressive code and standard efforts which move cost-effective technologies into code more quickly than in the past, reducing cost-effective opportunities for utility voluntary programs.

  The CPUC plans to explore improvements to the cost-effectiveness process, such as potentially adding more locational or shoulder load reduction (hours on either side of peak demand) avoided cost benefits and estimating future benefits of market transformation activities. The goal will be to achieve a high degree of confidence that real benefits to ratepayers are represented.

In addition, the CPUC, Energy Commission, and California ISO agreed to increase the transparency of and coordination between their respective procurement and transmission planning processes by using a single demand and additional achievable energy efficiency forecast that will be developed during the *Integrated Energy Policy Report* proceeding. The joint agencies are committed to ongoing coordination and collaboration.

Looking beyond 2013, the agencies see three key issues to be addressed in the next collaborative work planning effort:

- Identifying data needs and methods to advance forecast disaggregation to smaller geographic areas than climate zones.

- Increasing the level of confidence in future energy efficiency savings so that efficiency can reduce the need to generate electricity and, under certain circumstances, substitute "for investments in traditional transmission and power generation infrastructure."[113]
- Improving timing and alignment of the demand forecast, energy efficiency funding cycles, measurement and evaluation, and agency planning cycles.

Preliminary Forecast of California Energy Demand

The Energy Commission's forecasting process involves continuously developing and refining a suite of end-use and econometric models, as well as collecting and analyzing the data required to populate and run those models. Through decades of forecasting, the Energy Commission has compiled a wealth of historical information about annual retail sales and hourly electric loads, economic and demographic trends, building characteristics, the number and efficiency of appliances in the market, and daily temperature statistics, as well as demand-side management program effects and evaluation data.

Staff uses these data not only to draw a realistic picture of California's energy needs over the next decade, but to create a versatile planning tool that can be used in as many applications as needed. Toward that end, staff regularly meets with the Demand Analysis Working Group (DAWG), a group of stakeholders and organizations with an interest in the demand forecast. A primary goal of the technical advisory group is to help staff understand how the forecast is used outside the Energy Commission. The DAWG also assists in procuring additional data, comparing alternative forecasts, vetting new modeling approaches, identifying emerging problems, and brainstorming possible solutions.

Much of the work on the *2013 IEPR* forecast relates to three issues. Since the *IEPR* forecast is intended to be used to develop energy policy that ensures reliable and affordable energy amid a changing climate, staff must continue to refine its analysis of ways in which demand may be impacted by climate change. Also, because it plays a central role in California's energy system planning, it is critically important that the forecast reflect realistic assumptions concerning California's top priority preferred resources — particularly energy efficiency — and that these assumptions are consistent with those used by the CPUC and the California ISO. Finally, to identify preferred renewable development zones throughout California and improve distribution system planning, Energy Commission staff is following up on a recommendation from the *2012 IEPR Update* to further disaggregate the demand forecast at a finer geographic resolution.

This chapter summarizes the work done to address these issues as well as the work still left to do. More details are available in the *California Energy Demand Preliminary Forecast 2014-2024* (*CED 2013*).[114]

113 California ISO, Demand Response and Energy Efficiency Roadmap: Making the Most of Green Grid Resources. Draft, June 12, 2013.

Updates to the Forecast

Routine changes to the forecast include updating historical energy data. The previous long-run forecast, *CED 2011*, was based on 2011 peak demand and 2010 energy consumption. For the current forecast, staff added 2012 peak data and 2011 and 2012 energy consumption data to the historical series such that 2013 is the first forecast year for both peak demand and consumption.

As with previous demand forecasts, *CED 2013* presents three demand scenarios: high, mid, and low. These scenarios are derived by varying key input assumptions. Relative to the mid demand scenario, for example, the high demand scenario incorporates higher levels of economic and demographic growth, lower estimates of future efficiency and distributed generation impacts, and lower electricity prices. Structurally, these scenarios are similar to those developed for *CED 2011*; however, these key inputs have been updated to reflect the latest available data. Staff presented the details of these scenarios at a public workshop on February 19, 2013.

For the *2013 IEPR* cycle, staff expanded its suite of econometric models to include a model for each customer sector. This means that forecasts were developed in two ways: through the Energy Commission's existing models and through econometric models. Existing models were adjusted based on the econometric estimations, with the results compared to econometric results. In addition, staff is developing a new industrial end-use energy model that, although not yet complete, is far enough along to use in *CED 2013*.

Staff also developed a predictive model for the commercial sector that projects adoption of combined heat and power systems to replace the simple trend analysis used in previous forecasts. This effort was based on methods used by the United States Energy Information Administration, as part of its National Energy Modeling System, and by the National Renewable Energy Laboratory. Staff is developing a predictive model for commercial photovoltaic adoption as well.

Recognizing the importance of climate change considerations in planning California's energy future, staff continues to explore the potential impacts of climate change on energy demand. This forecast incorporates effects on both electricity consumption and peak demand using temperature scenarios from the Scripps Institution of Oceanography.

As part of the continuing effort to capture comprehensively the effects of energy efficiency initiatives, *CED 2013* incorporates recent revisions to Energy Commission building codes and appliance standards. These revisions include projected effects from the 2013 updates to the Title

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114 California Energy Commission, *California Energy Demand 2014-2024 Preliminary Forecast, Volume 1: Statewide Electricity Demand, End-User Natural Gas Demand, and Energy Efficiency*, Draft Staff Report, May 2013, http://www.energy.ca.gov/2013publications/CEC-200-2013-004/CEC-200-2013-004-SD-V1.pdf; and *California Energy Demand 2014-2024 Preliminary Forecast, Volume 2: Electricity Demand by Utility Planning Area*, Draft Staff Report, May 2013, http://www.energy.ca.gov/2013publications/CEC-200-2013-004/CEC-200-2013-004-SD-V2.pdf.

24 building standards and the battery charger standards that will be implemented in 2014. The forecast also updated utility program effects to include projected savings from the 2013-2014 CPUC efficiency program cycle for investor-owned utilities (IOUs) and from 2013 programs for the POUs.

Because stakeholders have expressed a strong interest in a more disaggregated demand forecast to better inform resource and infrastructure-related analyses and decisions, staff developed results at the climate zone level in addition to the usual planning area forecasts. This is a first step toward potential further disaggregation in the future. The appropriate level of disaggregation for future forecasts given data and other resource constraints will be determined after further discussion with stakeholders and Commissioners.

Statewide Forecast Results

Each new *IEPR* forecast differs from the last, reflecting recently recorded historical information, new economic and demographic projections, updated model parameters, and new analysis regarding demand modifiers such as energy efficiency, distributed generation, demand response, climate change, and electrification. A detailed description of each forecast component is available in the preliminary draft forecast report.[115]

For statewide electricity consumption, the new forecast begins about 1 percent below *CED 2011* in 2012, reflecting actual economic growth in California that was lower than predicted. Consumption in the new mid scenario grows at a slower rate through 2022 compared to the *CED 2011* mid case as a result of lower projected population growth, higher projected price effects, and the introduction of updated Title 24 and new Title 20 standards during the forecast period. By 2020, consumption is around 4 percent lower. The high demand case, with higher projected growth in consumption, matches the *CED 2011* mid case by 2022. Statewide noncoincident,[116] weather-normalized[117] 2012 peak demand is almost 3 percent lower than predicted in the *CED 2011* mid case and grows at a slower rate from 2012-2022 for the same reasons as consumption, although the difference in growth rates is not as large.

115 Ibid.

116 The state's coincident peak is the actual peak, while the noncoincident peak is the sum of actual peaks for the planning areas, which may occur at different times.

117 Peak demand is weather-normalized in 2012 to provide the proper benchmark for comparison to future peak demand, which assumes either average (normalized) weather or hotter conditions measured relative to 2012 due to climate change.

Table 6: Comparison of Statewide Energy Demand Scenarios

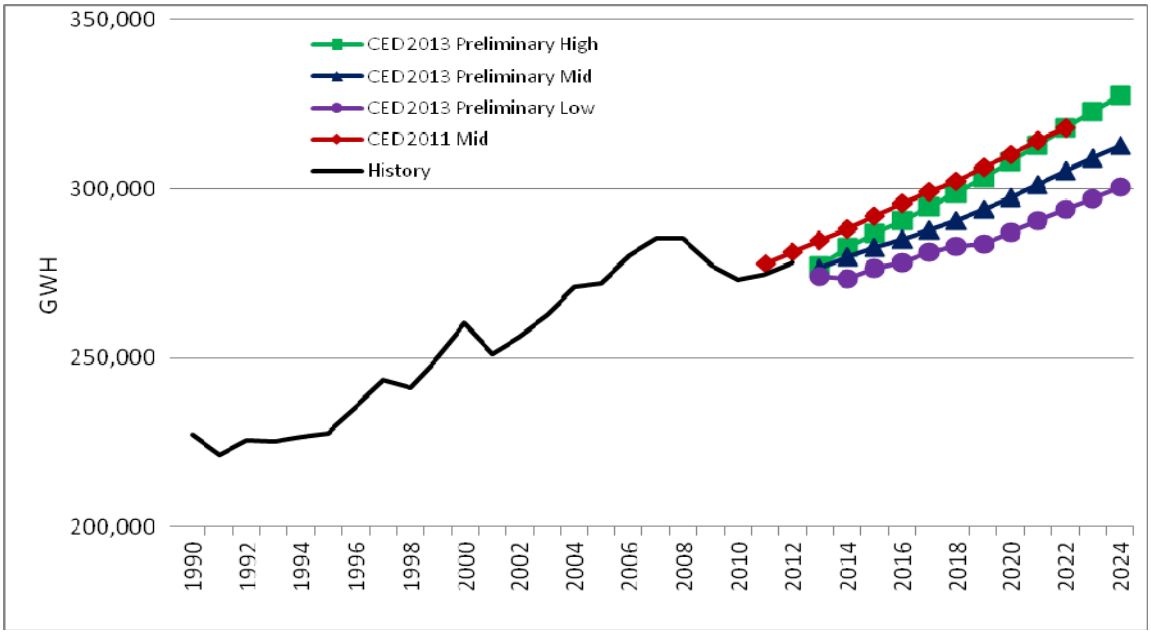
Consumption (GWh)				
	CED 2011 Mid Energy Demand	**CED 2013 Preliminary High Energy Demand**	**CED 2013 Preliminary Mid Energy Demand**	**CED 2013 Preliminary Low Energy Demand**
1990	227,586	227,576	227,576	227,576
2000	261,381	260,399	260,399	260,399
2012	281,347	278,282	278,282	278,282
2015	291,965	286,755	282,721	276,326
2020	310,210	307,944	297,422	287,192
2024	--	327,676	312,814	300,528
	Average Annual Growth Rates			
1990-2000	1.39%	1.36%	1.36%	1.36%
2000-2012	0.62%	0.56%	0.56%	0.56%
2012-2015	1.24%	1.00%	0.53%	-0.23%
2012-2022	1.20%	1.34%	0.93%	0.55%
2012-2024	--	1.37%	0.98%	0.64%
Noncoincident Peak (MW)				
	CED 2011 Mid Energy Demand	**CED 2013 Preliminary High Energy Demand**	**CED 2013 Preliminary Mid Energy Demand**	**CED 2013 Preliminary Low Energy Demand**
1990	47,546	47,543	47,543	47,543
2000	53,700	53,702	53,702	53,702
2012	--	60,119	60,119	60,119
2012*	61,796	60,001	60,001	60,001
2015	65,036	63,815	63,166	60,598
2020	69,418	68,840	66,658	62,947
2024	--	73,054	69,627	65,158
	Average Annual Growth Rates			
1990-2000	1.22%	1.23%	1.23%	1.23%
2000-2012	1.18%	0.93%	0.93%	0.93%
2012-2015	1.72%	2.08%	1.73%	0.33%
2012-2022	1.38%	1.71%	1.30%	0.68%
2012-2024	--	1.65%	1.25%	0.69%
Historical values are shaded. Weather normalized: *CED 2013 Preliminary* uses a weather-normalized peak value derived from the actual 2012 peak for calculating growth rates during the forecast period				

Source: California Energy Commission

The historical data used for the 2013 forecast differ slightly from *CED 2011* to reflect staff's effort to improve classification of data submitted by utilities. In addition, continuing review of self-generation data has found cases where onsite consumption was improperly estimated.

Figure 4 shows statewide historical electricity consumption, projected *CED 2013* consumption for the three scenarios, and the *CED 2011* mid demand consumption forecast. Growth is flat or declining in 2013 in the new forecast because (1) the number of warm days—those that lead to greater air conditioning usage—was historically high in 2012, and the forecast assumes average weather in 2013; (2) new efficiency programs not included in *CED 2011* are introduced by utilities; and (3) price effects from 2012 to 2013. *CED 2013* consumption grows at a faster average annual rate from 2012 to 2022 in the high case (1.34 percent) and a slower rate in the mid scenario (0.93 percent) relative to *CED 2011* mid case (1.20 percent).

Figure 4: Statewide Annual Electricity Consumption

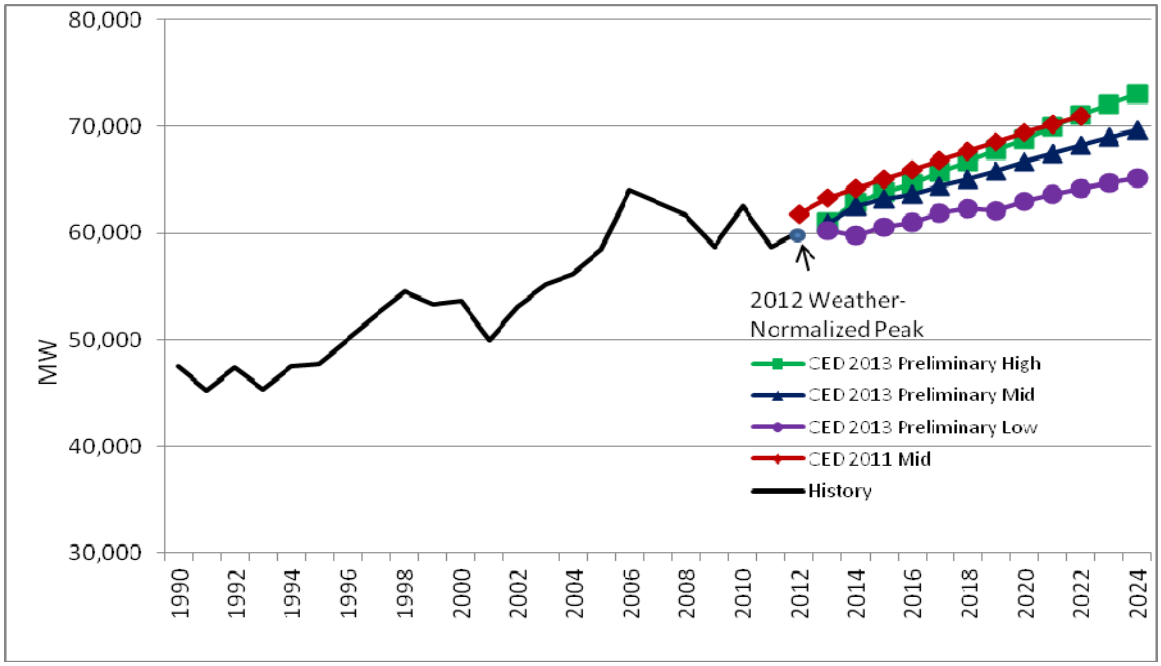


Source: California Energy Commission

Figure 5 compares *CED 2013* statewide noncoincident peak demand with the *CED 2011* mid demand case. Actual peak demand in 2012 was lower than projected in the *CED 2011* mid case, reflecting slower economic growth than was predicted in 2011. There is little growth in all three scenarios from 2012-2013, a result of efficiency improvements in 2013, price effects, and low economic growth. By 2022, the new mid case is almost 4 percent below the previous. With smaller price effects over the forecast period and higher population growth, the *CED 2013* high case reaches the *CED 2011* mid case level by 2022.

Figure 5 also shows the statewide weather-normalized peak in 2012. This is typically a very important point, since growth rates in the forecast period are calculated relative to this weather-normalized total. In *CED 2011*, for example, peak temperatures in the base year were actually relatively mild, so the peak forecast started from a weather-normalized value that was about 1,600 MW higher than the actual recorded peak. This *IEPR* forecast, however, uses 2012 as its base year. While 2012 was fairly warm overall, the highest temperatures were relatively normal, so the adjusted total is very close to the actual peak.

Figure 5: Statewide Annual Noncoincident Peak Demand



Source: California Energy Commission

The Impacts of Climate Change

CED 2013 estimates the effects of potential climate change for both energy (electricity and natural gas) and electricity peak demand. Energy effects are estimated through changes in the number of annual heating and cooling degree days,[118] while peak demand impacts are simulated through increases in annual maximum daily average temperatures.

Electricity consumption is affected by both heating and cooling degree days. The effect of increases in the average annual number of cooling degree days as a result of climate change is tempered, though, by a decreasing average number of heating degree days since both minimum and maximum temperatures increase.

To gauge the potential effect of climate change on annual degree days and average temperatures through 2024, staff used a 2012 update of a climate change impact assessment by the California Climate Change Center, sponsored by the Energy Commission.[119] The update uses 24 climate change simulations for California consisting of two scenarios for each of 12

118 Heating and cooling degree days measure the difference between daily average temperature and a reference temperature (for example, 65 degrees) summed over all days in a given year. An average temperature below the reference temperature adds to heating degree days and an average above the reference adds to cooling degree days.

119 Energy Commission, March 2009. *Climate Change Scenarios and Sea Level Rise Estimates for the California 2008 Climate Change Scenarios Assessmen*t .CEC-500-2009-014-D, http://www.energy.ca.gov/2009publications/CEC-500-2009-014/CEC-500-2009-014-D.PDF.

models, providing simulation results for daily maximum and minimum temperatures, average daily humidity, and sea level rises through 2099.

Staff chose climate change scenarios that resulted in an average temperature impact over all scenarios for the mid demand case and a relatively high temperature impact for the high demand case.[120] The low demand scenario does not include climate change impacts. Staff converted simulated daily averages for each weather station to degree days and temperature indices for each planning area by weighting each climate zone either by estimated number of air conditioners (temperature and cooling degree days) or population (heating degree days). Changes in annual degree days and maximum temperatures starting in 2013 were derived using long-term trends (2010-2040) from the two climate scenarios.[121]

Table 7 shows the projected impacts of climate change in the mid and high demand scenarios on electricity consumption for the five major planning areas and for the state as a whole. By 2024, statewide consumption impacts reach almost 1,300 GWh in the mid demand case and more than 1,800 GWh in the high demand case. Also shown are the simulated annual heating and cooling degree days (weighted by climate zone) for the two climate change scenarios used. Degree days in 2012 represent a historical 30-year average for the planning area.

These consumption increases described above and shown in Table 8 are *net* impacts, representing increasing electricity consumption from cooling minus reduced usage from less heating need. Heating impacts are typically 10-40 percent of cooling increases, depending on the planning area and year. For example, in the mid case, the roughly 1,300 gigawatt hours (GWh) of net consumption impacts represent an expected 1,500 GWh increase in consumption due to greater cooling loads, which is offset somewhat by an expected decrease in consumption of around 250 GWh due to less heating. For the state as a whole, the largest portions of the consumption increase come from the commercial sector since the effect from warmer temperatures is not mitigated by decreasing heating degree days, as in the residential sector.

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120 Staff wishes to thank Mary Tyree at the Scripps Institute of Oceanography for providing the simulation data.

121 A long-term trend was used rather than the actual temperatures in each scenario because year-to-year fluctuations simulated in the climate change models sometimes resulted in degree days or maximum temperatures in 2024 as low as or lower than in 2012.

Table 7: Projected Electricity Consumption Impacts From Climate Change by Scenario and Planning Area

		Mid Demand Scenario		High Demand Scenario			
		Annual Cooling Degree Days (65° reference)	Annual Heating Degree Days (65° reference)	Annual Cooling Degree Days (65° reference)	Annual Heating Degree Days (65° reference)	Consump. Impact, Mid Scenario (GWh)	Consump. Impact, High Scenario (GWh)
LADWP	2012	1,275	1,410	1,275	1,410	--	--
	2015	1,310	1,382	1,343	1,339	27	47
	2020	1,369	1,334	1,458	1,219	74	126
	2024	1,417	1,296	1,550	1,123	112	187
PG&E	2012	1,387	2,464	1,387	2,464	--	--
	2015	1,424	2,432	1,442	2,389	115	148
	2020	1,484	2,379	1,533	2,264	315	402
	2024	1,533	2,336	1,606	2,164	482	609
SCE	2012	1,536	1,381	1,536	1,381	--	--
	2015	1,577	1,350	1,608	1,307	95	140
	2020	1,645	1,299	1,729	1,182	260	371
	2024	1,700	1,257	1,826	1,082	394	545
SDG&E	2012	800	1,177	800	1,177	--	--
	2015	840	1,137	876	1,101	53	91
	2020	906	1,070	1,002	974	140	230
	2024	960	1,016	1,103	872	206	329
SMUD	2012	1,267	2,586	1,267	2,586	--	--
	2015	1,307	2,565	1,332	2,523	17	25
	2020	1,374	2,529	1,441	2,417	46	68
	2024	1,428	2,501	1,528	2,332	70	103
State	2015	--	--	--	--	312	462
	2020	--	--	--	--	847	1,224
	2024	--	--	--	--	1,282	1,813

Source: California Energy Commission

Table 8 shows the projected impacts of climate change in the mid and high demand scenarios on peak demand for the five major planning areas and for the state as a whole. By 2024, statewide peak impacts reach more than 1,000 MW in the mid demand case and around 1,750 MW in the high demand case. Also shown are the simulated annual maximum temperatures in degrees Fahrenheit for the two climate change scenarios used. Temperatures in 2012 represent a historical 30-year average for the planning area.

Table 8: Projected Peak Impacts From Climate Change by Scenario and Planning Area

		Annual Maximum Temperature (°F), Mid Demand Scenario	Annual Maximum Temperature (°F), High Demand Scenario	Peak Impact, Mid Scenario (MW)	Peak Impact, High Scenario (MW)
LADWP	2012	83.5	83.5	--	--
	2015	83.8	84.0	24	41
	2020	84.3	84.8	68	120
	2024	84.6	85.4	106	191
PG&E	2012	85.7	85.7	--	--
	2015	86.0	86.1	92	136
	2020	86.4	86.7	266	398
	2024	86.8	87.3	420	634
SCE	2012	85.8	85.8	--	--
	2015	86.0	86.2	87	134
	2020	86.5	86.8	252	397
	2024	86.8	87.4	397	639
SDGE	2012	78.0	78.0	--	--
	2015	78.2	78.4	18	31
	2020	78.6	79.0	51	92
	2024	78.9	79.6	80	148
SMUD	2012	85.2	85.2	--	--
	2015	85.4	85.6	8	18
	2020	85.7	86.3	23	55
	2024	85.9	86.8	36	88
State	2015	--	--	233	369
	2020	--	--	672	1,089
	2024	--	--	1,061	1,745

Source: California Energy Commission

As part of a continuous effort to refine and improve the Energy Commission's forecasting methods, staff plans to further analyze how climate change might affect the distribution of temperatures and therefore the relationship between "1 in 10" (extreme weather) and "1 in 2" (normal weather) peak demand. This is a particularly important consideration since resource adequacy requirements for load-serving entities are determined using a 1 in 10 peak forecast.

Energy Efficiency Considerations

Energy Commission demand forecasts seek to account for efficiency and conservation reasonably expected to occur. Traditionally, staff has included in the baseline demand forecast only those efficiency initiatives deemed "committed." Committed initiatives include utility and public agency programs, codes and standards, legislation and ordinances that have final authorization, firm funding, and a design that can be readily translated into characteristics that can be evaluated and used to estimate future impacts. Committed impacts also include price and other effects not directly related to a specific initiative.

While this *IEPR* continues that distinction, staff is developing "additional achievable" energy efficiency savings estimates to be used with the forecast. Additional achievable energy

efficiency savings are those that are not included in the baseline demand forecast but are still likely to occur given current state, federal, and local government policies. These estimates will be based largely on the CPUC's forthcoming *2013 California Energy Efficiency Potential and Goals Study.*

This effort will involve Energy Commission, CPUC, and California ISO staff and is critical in developing a "managed" forecast for procurement, transmission need, and resource adequacy purposes. As documented in the joint agency letter to Senators Padilla and Fuller, the agencies are working together in this and future *IEPR* cycles to arrive at a recommended forecast that encompasses both the Energy Commission-adopted electricity demand forecast and the Energy Commission-adopted additional achievable energy efficiency forecast. This coordinated effort will ensure that energy efficiency is properly and consistently accounted for by each of the planning agencies.

Transportation Electrification Considerations

Revised CED 2013 current electricity and natural gas demand forecasts include additional demand from plug-in electric and natural gas vehicles. The transportation energy demand forecast currently included is identical to that produced for the CED 2011. The low electricity demand case incorporates projections which are based on the California Air Resources Board (ARB) Zero Emission Vehicle[122] regulation's most likely compliance scenario. Although this estimate is based upon a number of assumptions, it reflects the ARB's attempt at producing a reasonable compliance future. The mid and high electricity demand cases contain additional electricity consumption significantly exceeding the ARB's regulations. Transportation natural gas demand grows slightly over the forecast period and primarily reflects existing market technology penetrations.

California ports are becoming more and more regulated as the state moves towards lower emission activities throughout the transportation sector including all areas of goods movement. The December 2007 adoption of the At-Berth Regulations[123] by the ARB implements provisions of the 2006 Goods Movement Emission Reduction Plan aimed at reducing emissions from container, passenger, and refrigerated cargo vessels docked at California ports.[124] The regulations specifically require obligated vessels to utilize electric shore power to perform services which would normally be provided by onboard auxiliary diesel engines or to implement other equivalent emission reduction strategies.[125] The revised CED 2013 demand

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122 Currently under the Air Resources Board's Advanced Clean Car program. http://www.arb.ca.gov/msprog/zevprog/zevprog.htm

123 At-Berth Regulations refer to adopted regulations titled "Airborne Toxic Control Measure For Auxiliary Diesel Engines Operated On Ocean-Going Vessels At-Berth in a California Port" adopted in 2007.

124 http://www.arb.ca.gov/ports/shorepower/finalregulation.pdf

125 Existing fleets opting for the alternative compliance methodology are currently utilizing shore power solutions but may alter their compliance strategy in the future. Personal communication with Jonathon Foster, ARB, August 30, 2013.

forecasts will include additional demand anticipated by the implementation of these regulations.

A More Disaggregated Forecast

Staff intends to provide, to the extent possible, more granular results in future demand forecasts. An important reason is to support subregional electricity system analysis for CPUC/California ISO resource adequacy and other related proceedings. Staff currently separates the planning area and climate zone forecasts to correspond to transmission control areas and congestion zones[126] in a "top down" analysis. Disaggregation of the demand forecast beyond the climate zone level would allow more refined, "bottom up" analyses for local congestion zones.

Table 9 shows the forecast results for electricity consumption and peak demand by climate zone for the mid demand scenario. For each planning area, the fastest growth in both consumption and peak demand is projected to be inland. These results reflect expected resumption of migration from coastal to inland areas, migration that decreased during the recent recession. Potential climate change impacts contribute to faster peak demand growth in the inland climate zones as well.

Separating the forecast by climate zone is only a first step. The further it can be disaggregated, the more useful the forecast will be for resource and transmission planning, particularly as those activities shift away from traditional considerations—power plants and transmission lines—to preferred resources such as targeted efficiency, demand response, and distributed generation.

As mentioned, future *IEPR* forecasts will be disaggregated at some level to better support planning efforts. That exact level of granularity will be determined by the joint energy agencies and the availability of data to support granular models. Likely, this will be an extended effort that advances incrementally over multiple *IEPR* cycles.

126 An area with concentrated load, where transmission within the area is not sufficient to allow access to competitively priced energy.

Table 9: Consumption and Peak Demand by Climate Zone

	PG&E					SCE				LADWP	
	1	2	3	4	5	7	8	9	10	11	12
	Consumption (GWh)										
2013	4,753	10,045	30,181	34,340	26,945	6,042	42,079	25,280	26,349	10,364	14,652
2024	5,327	12,078	34,917	38,390	29,411	7,174	45,362	28,765	31,428	11,392	16,609
Avg. Growth 2013-2024	1.04%	1.69%	1.33%	1.02%	0.80%	1.57%	0.69%	1.18%	1.62%	0.86%	1.15%
	Peak Demand (MW)										
2013	1,279	1,950	5,009	8,089	6,371	988	8,368	6,795	5,743	1,697	4,079
2024	1,420	2,321	6,011	9,144	6,995	1,281	9,359	7,785	6,851	1,876	4,588
Avg. Growth 2013-2024	0.96%	1.60%	1.67%	1.12%	0.85%	2.39%	1.02%	1.24%	1.62%	0.92%	1.07%

Source: California Energy Commission

Resource Adequacy of Publicly Owned Utilities

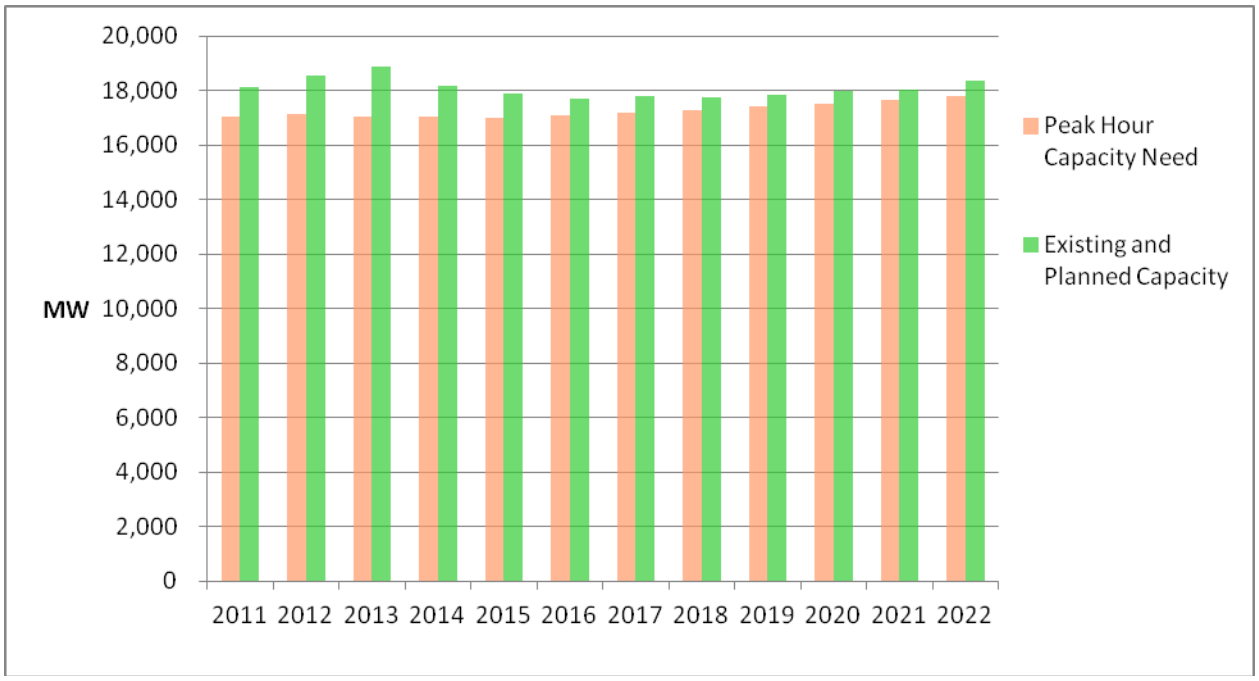
In September 2005 the Legislature passed and the Governor signed AB 380 (Núñez, Chapter 367, Statutes of 2005), which requires POU to report their respective supply circumstances to the Energy Commission so that an evaluation of their resource adequacy can be included in each *IEPR*.

In 2012, POUs represented 22.9 percent of California peak loads and 22.7 percent of energy needs. The largest 15 POUs account for 95 percent of POU peak loads and 94 percent of energy requirements.

Energy Commission staff has reviewed load and resource information from all 50 POUs in California. Based on those filings, the Energy Commission has found them to be resource adequate for both the year ahead and the long term. All POUs are complying with their resource adequacy requirements in the form of reserve margins. Under AB 380, POUs set their own requirements. The larger POUs, except LADWP, use the Western Electricity Coordinating Council's requirement of a 15 percent planning reserve margin applied to each POU's 1-in-2 forecast peak load. LADWP uses the alternative Western Electricity Coordinating Council method to use LADWP's 1-in-2 forecast peak load plus the single largest contingency. These are different from the requirements applied to the IOUs because the IOUs use the Energy Commission forecasts, and the POUs do not have month-ahead and year-ahead requirements as do the IOUs. (LADWP maintains its requirement on a daily basis.) Some POUs have projected planning reserve margins that are larger than the 15 percent requirement, such as LADWP's 16 percent for 2013. Smaller POUs have determined they need lower reserve margins, such as City of Industry's 7 percent. AB 380 allows them the discretion to do so. For the largest 15 POUs,

Figure 6 shows the existing and planned capacity resources to meet their forecast peak loads through 2022.

Figure 6: Capacity of Large Publicly Owned Utilities and Forecast Peak-Hour Requirements



Source: California Energy Commission staff and utility capacity supply plans from 2013 posted at http://energyalmanac.ca.gov/electricity/index.html

The Need for New Electricity Infrastructure

Southern California has faced electricity infrastructure planning and procurement challenges for several years. These challenges were discussed in the *2011 IEPR* and *2012 IEPR Update*, and have become more complex since the initial outage and subsequent announced retirement of the 2,200 MW San Onofre Nuclear Generating Station (San Onofre) in June, 2013.

In response to the State Water Resources Control Board's (SWRCB) policy to phase out the use of once-through cooling[127] (OTC) in power plants, most generator owners now expect to retire their facilities and to repower at the same sites using air-cooled generating technologies if they can secure CPUC-approved power purchase agreements.[128] However, a key factor in whether

127 Once-through cooling in California entails the intake of water to cool the steam that has been used to spin the turbines that generate electricity. This allows the steam to be reused; the now heated ocean water is then discharged back into the ocean. Both the intake and discharge processes have negative impacts on marine and estuarine environments.

128 Integrated utilities like Los Angeles Department of Water & Power make decisions on the basis of cost, rate impacts, access to financing and other criteria that differ somewhat from those used by merchant plants trying to secure contracts with CPUC-regulated investor-owned utilities. The

these sites can be repowered is the criteria pollutant offset rules of the South Coast Air Quality Management District (SCAQMD) and the federal government. Commercially available offsets – known as *emission reduction credits* (ERCs) – are scarce and extremely expensive in the South Coast Air Basin.[129] In 2009, Assembly Bill 1318 (V. Manuel Pérez, Chapter 285, Statutes of 2009) directed the ARB, in conjunction with various state agencies and the California ISO, to study the need for generation development in the South Coast Air Basin to assure reliability and identify whether new criteria pollutant emission rules for power plants are needed.

To help address concerns about electricity reliability, when the SWRCB adopted its OTC policy, it included two considerations. First, the compliance schedule put Southern California power plants with no known replacement facility further ahead in time to allow the energy agencies to devise infrastructure replacement projects. Second, the OTC policy included a mechanism to adjust compliance schedules for OTC facilities if the energy agencies requested such delays. This would allow for an orderly process to repower some portion of the existing OTC fleet or allow for new facilities in comparable locations, if needed. The principal force likely to justify changes in OTC compliance dates was difficulties in securing emission offsets, either directly by the generator owner in the form of ERCS or by the SCAQMD in the form of credits from its Rule 1315 internal bank.[130]

Then came the San Onofre outages in January 2012. The California ISO conducted local reliability studies for the summer of 2012, which led to broader understanding about the ramifications of the San Onofre outage on reliability in the Los Angeles Basin and in San Diego. In summer 2012, ARB decided to delay the AB 1318 report process to allow for additional analyses from the energy agencies and California ISO when it became clear that the San Onofre outage was turning into a San Onofre retirement. By spring of 2013, these studies were complete and the AB 1318 report was being drafted for public release and review.

SCE's announcement on June 7, 2013, that it would permanently close both units accelerates the need for decisions about the replacement of capacity and energy produced by San Onofre. To address this need, Governor Brown asked the leaders of the state's energy agencies to assemble a team to develop and assess options, with an initial report due in 90 days from the June 7 retirement announcement.

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department also plans to repower all of its steam boiler capacity into air-cooled modern gas turbine technology.

129 Particulate Matter 10 (PM10) has been the most scarce and expensive of the criteria pollutants.

130 SCAQMD's Rule 1315 established a bank of emissions offsets based on retired offsets, for example due to business closure, that SCAQMD can use to "provide offsets" to entities that are exempt from the requirement to purchase them, such as essential public services and those modernizing facilities, including the replacement of steam boilers.

Existing and scheduled studies will provide some of the information needed to make a decision.[131] The emphasis of these studies is on local capacity area requirements as a key component of assuring reliability. However, completed or ongoing studies are not designed to answer the question "What resources should be added that can collectively replace the energy generated by San Onofre?" because they focus on reliability, which is based on generating capacity rather than actual energy generated.

From 2001 through 2011, San Onofre operated with an average 82 percent capacity factor. In 2011, San Onofre generated about 14,500 GWh, nearly three times the energy generated by the entire fossil OTC fleet in Southern California. With San Onofre offline nearly all of 2012, the generation needed to make up for lost San Onofre energy came almost entirely from the non-OTC fossil plants in Southern California.

Electricity Infrastructure Studies

Four types of studies are relevant to the topic of replacing San Onofre. Three are oriented toward determining the amount of capacity needed to satisfy reliability standards, and the fourth looks at satisfying energy needs at lowest cost.

Local Capacity Area Requirements

Local capacity area studies identify the amount of capacity needed within a transmission-constrained area to meet 1-in-10 peak demand when the import capacity on the constraining transmission lines is at the highest level under critical contingency conditions. The California ISO has identified 10 such local capacity areas across its entire balancing authority area, three of which are in Southern California (the Los Angeles Basin, Ventura/Big Creek, and San Diego). Some of these areas also have subareas with even more localized issues of nearby generation being required to serve load.

Operating Flexibility Studies

Flexible capacity is a new concept that has emerged with increasing penetration of intermittent renewable resources. Operating flexibility studies determine the amount of flexible capacity required by a system operator to cover variable production of intermittent renewable resources like wind and solar. The idea of a net load curve (load curve less the production profile of wind and solar resources) has been developed to represent the pattern of load that dispatchable generators must serve. The dispatchable fleet must be capable of ramping output up and down rapidly and perhaps multiple times per day.

System Supply and Demand Balances

System supply/demand balances determine whether there are enough resources to satisfy summer peak demand plus a planning reserve margin that account for plant outages, extreme

131 An informal Energy Commission staff paper, "Summary of Studies of Southern California Infrastructure," provides a basic comparison of input assumptions and results for these studies. http://www.energy.ca.gov/2013_energypolicy/documents/2013-07-15_workshop/background/.

weather impacts on load, and other sources of uncertainty for an entire balancing authority area (or major subdivisions like the California ISO's SP 26 and NP26 regions[132]).

Energy Cost Minimization

These studies look at whether a given set of resources will satisfy annual energy requirements and at what cost to ratepayers. This examination is usually done by comparing alternative resource plans. All such resource mixes presumably satisfy reliability requirements at roughly equal levels because if they do not, then additional costs of customer outages would have to be accounted for. Evaluating a range of resource mixes helps to identify which mix tends to have lower expected aggregate costs through time.

Status of Infrastructure Studies and Their Results

The California ISO, utilities, and staff of the Energy Commission and CPUC each conduct studies or participate in developing some of the inputs needed by other agencies for their studies. This has involved close collaboration over the years, especially with the shared responsibility among the California ISO, the CPUC and the Energy Commission to implement the short lead time resource adequacy program. The California ISO's studies in its annual transmission planning process are designed to (1) determine whether transmission system upgrades are needed, and (2) provide locational generating capacity information to the CPUC and other entities responsible for generation planning and procurement. The CPUC is responsible for providing appropriate procurement authority to the IOUs and to base its record for such decisions on sound analytic studies submitted by the California ISO, agencies such as the Energy Commission, utilities, and interested parties.

Five studies have been completed since March 2012 that assess local capacity area requirements in Southern California. Some of these have been thoroughly documented and vetted, while others are so new that their results have not yet completed the public review process. The four local capacity area studies prepared by the California ISO all assume the San Onofre outage would be permanent and can be used to guide infrastructure planning in light of SCE's decision to retire San Onofre. A fifth study by LADWP examines only the local capacity needs of that utility, which do not interact with San Onofre in any way. The studies by the California ISO used a variety of assumptions about the development of preferred resources, OTC retirements, and non-OTC retirements. In some cases the California ISO itself selected the assumptions, while in other cases the study used inputs specified by another agency. Each study reached a different conclusion about the need for repowering OTC facilities and/or building new generation. Table 10 provides a summary of the input assumptions and repowering/new generation results of these four studies.

132 These are the portions of the California ISO balancing authority area below and above Path 26, respectively. Path 26 is the transmission corridor between the PG&E and SCE service territories.

Table 10: Summary of Input Assumptions and Results of California ISO Local Capacity Area Studies Assuming Generation is Minimized in San Diego

	Study 1 2012-2013 TPP Base LCR	Study 2 2012-2013 TPP Sensitivity	Study 3 AB1318 Low Sensitivity	Study 4 2012 LTPP Track 4 w/o SONGs
Inputs				
Incremental EE (MW)	0	0	973 MW SCE; 187 MW SDG&E	973 MW SCE (746 MW LA Basin); 187 MW SDG&E
Incremental CHP (MW)	0	0	15.1 MW SCE; 0 MW SDG&E	0 MW SCE; 0 MW SDG&E
Fast, Effective DR (MW)	0	0	382 MW SCE; 25 MW SDG&E	173 MW LA Basin; 16 MW SDG&E
Other DR (MW)	0	0	0 MW	794 MW balance of SCE; 203 MW SDG&E
DG (nameplate MW)	431 MW LA Basin 409 MW San Diego	1,538 MW LA Basin 490 MW San Diego	431 MW LA Basin 409 MW San Diego	549 MW LA Basin 467 MW San Diego
OTC Retirements (MW) (LA Basin & San Diego)	Five fossil plants- 5,875 MW San Onofre- 2,264 MW	Five fossil plants- 5,875 MW San Onofre- 2,264 MW	Five fossil plants- 5,875 MW San Onofre- 2,264 MW	Five fossil plants- 5,875 MW San Onofre- 2,264 MW
Non-OTC Retirements (MW)	0 MW LA Basin 136 MW SD	0 MW LA Basin 136 MW SD	0 LA Basin 135 MW SD	1645 LA Basin 238 MW SD
Resource Additions	1920 MW LA Basin 0 MW SD	1920 MW LA Basin 0 MW SD	1920 MW LA Basin 0 MW SD	2135 MW LA Basin 45 MW SD
Results				
OTC Repower	2,900 MW LA Basin 620-820 MW San Diego	not reported	2,900 MW LA Basin 520 MW San Diego	2,912 MW LA Basin 520 MW San Diego
New Generation	1,400-1,700 MW LA Basin 300 MW San Diego	not reported	400-560 MW LA Basin 300 MW San Diego	810 MW LA Basin 400 MW San Diego
Total Repower & New Gen	4,300-4,600 MW LA Basin 920-1,120 MW San Diego	4,112 MW LA Basin San Diego not reported	3,300-3,460 MW LA Basin 820 MW San Diego	3722 MS LA Basin 920 MW SD

Source: California Energy Commission

Studies of local capacity conducted by the California ISO and LADWP all identify the need to repower much of the OTC capacity located along the Southern California coastline from El Segundo south to Encina. The California ISO's 2011-12 Transmission Planning Process (TPP) study of OTC retirement found that a substantial percentage needed to be repowered, even with San Onofre operating. The California ISO's 2012-13 TPP study of the question of nuclear replacement found an even larger percentage had to be repowered with San Onofre offline. The ARB's AB 1318 project found that the amount of repowering needed could be decreased somewhat through increased energy efficiency and combined heat and power. The California ISO's 2012-13 Transmission Planning Process sensitivity studies of increased distributed generation found only limited ability to substitute for conventional dispatchable power plants. All of these studies assumed that the state's Renewables Portfolio Standard (RPS) was achieved by 2020 or earlier. Because most renewable projects expected to satisfy the RPS are already in the pipeline and are not "generic" plants that can be steered to the most useful location, RPS renewables make little difference in displacing capacity that must be located in transmission-constrained areas along the coast.

In addition to these formal, publicly visible studies, SCE and SDG&E have periodically provided results from their own studies that remain unpublished at this time. SCE has apparently assessed five options for resolving the San Onofre outage. Because one option was returning one or both San Onofre units to service, only the four San Onofre replacement scenarios continue to be relevant. SCE has briefed various energy agencies and the California ISO from time to time, but the detailed inputs, methods, and results have not yet been published. Similarly, SDG&E has studied the impacts of various resource and transmission options that might partly or fully alleviate the impacts of San Onofre and fossil OTC power plant retirement. SDG&E is understood to be assisting SCE by reviewing analytic results and to be gaining knowledge of benefits of transmission lines interconnecting the SDG&E and SCE systems, but details (scope, methods, assumptions, and results) are not known. Both SCE and SDG&E filed testimony in the CPUC's 2012 LTPP rulemaking (Track 4) concerning their views on the need for local capacity area resource additions.[133]

The Energy Commission and CPUC jointly hosted a workshop (with the active participation of management of the ARB, the California ISO, the SWRCB, and SCAQMD) in Los Angeles on July 15, 2013, to hear from the ISO, utilities, and agency staff about the results of these studies, and to receive comments from stakeholders and the public.[134] A panel provided independent comments about the nature and assumptions of the studies and whether to rely upon them in making San Onofre replacement decisions. Most panelists (Natural Resources Defense Council, Center for Energy Efficiency and Renewable Technologies, Division of Ratepayer Advocates) supported aggressive use of preferred resources, but acknowledged the need for monitoring

133 California ISO filed its Track 4 analyses on August 5, 2013, while the two IOUs submitted their testimony of August 26, 2013.

134 For notice, background paper, presentations, and comments, see http://www.energy.ca.gov/2013_energypolicy/documents/#07152013.

and evaluation mechanisms to assure that any such targets would actually be achieved. Communities for a Better Environment and California Environmental Justice Alliance expressed skepticism about the analytic results of the local capacity studies prepared by the ISO. The Division of Ratepayer Advocates and The Utility Reform Network both emphasized that resources must be cost-effective in order to moderate electricity affordability issues. The Independent Energy Producers stressed the need for near-term decisions to delay any OTC compliance dates since owners of the facilities are acting as though the current compliance dates will be enforced.[135] Alliance for Nuclear Responsibility stressed the need for redundant capacity additions to assure that reliability criteria could be met, for example authorizing natural gas fired peakers along with preferred resources.[136] Most public commenters, especially members of the EHC, stressed (1) a general opposition to generation additions with fossil technology and instead favored complete reliance upon preferred resources, and (2) use of public processes like the CPUC's 2012 LTPP rulemaking as a the venue for making San Onofre replacement decisions. Written comments largely echoed those delivered at the workshop. The Sierra Club's San Diego Chapter submitted an extensive assessment urging that preferred resources be used to fill the entire need with no fossil additions. The Energy Commission does not believe that Sierra Club demonstrated that this resource mix can actually satisfy local capacity requirements and maintain reliability.

Uncertainty in Fundamental Assumptions

Several fundamental assumptions being made in most studies of Southern California electricity infrastructure have yet to be proven. These assumptions affect the amount of capacity that the studies find is needed, or alter the timing of when such capacity is needed, and perhaps whether generators will be able to submit viable bids into utility requests for offers based upon procurement authority relying upon such studies.

Use of South Coast Air Quality Management District Rule 1304(a)(2) to Avoid Providing Offsets

The idea of repowering OTC sites with flexible capacity, and perhaps yet additional capacity at other greenfield sites within South Coast Air Basin, presumes use of SCAQMD's Rule 1304(a)(2) for 3,000 MW to 5,000 MW of fossil capacity construction over the next decade.[137] SCAQMD's rule relieves owners of old steam boiler capacity from the obligation to provide offsets when they repower using an advanced gas turbine technology; rather, SCAQMD itself provides the offsets from credits in its Rule 1315 bank. The original purpose of the Rule 1304(a)(2) exemption was for essential public services, and at the July 15, 2013, *IEPR* workshop, SCAQMD expressed concern about the power plant proportion of credits used during the 2000s.[138] SCAQMD will

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135 July 15, 2013 Transcript page 203 line 21 to page 204, line 5.

136 July 15, 2013 Transcript page 213, lines 2-9.

137 SCAQMD Rule 1304(a) (2) allows owners of steam generating power plants to replace them, on an equal or lesser capacity basis, with advance gas turbines power plants without providing offsets. Instead, SCAQMD satisfies federal new Source Review rule requirements by debiting credits in its internal bank pursuant to Rule 1315.

138 SCAQMD, Presentation of Mohsen Nazemi, July 15, 2013, slide 16.

address this issue through the AB 1318 process but has not yet provided any comments in public. SCAQMD's Rule 1315 may prove incapable of providing sufficient credits from a federally sanctioned internal bank to enable this degree of repowering with flexible capacity. More will be known about this issue as the AB 1318 report is finalized.

Unwillingness of the State Water Resources Control Board to Modify Once-Through Cooling Compliance Dates

The amount of capacity that the California ISO's 2012-2013 TPP studies indicate must be repowered by 2022 presumes that adopted OTC compliance dates for southern California plans are maintained. In its 2012-12 TPP studies, the California ISO made a similar assumption when it studied 2021. Generator owners have proposed changes in OTC compliance dates based on what they say are the practical considerations of repowering one or two units at a time at geographically constrained sites, presuming that total capacity at the site must be maintained to satisfy California ISO reliability standards. Generally these proposals stretch out compliance as pairs of units are built, others demolished, and eventually the entire plant is converted to modern gas turbine technology. The SWRCB's adopted OTC policy includes provisions that would allow modification of compliance dates if the energy agencies through the Statewide Advisory Committee on Cooling Water Intake Structures (SACCWIS) recommend delays due to reliability concerns.[139] At the July 15, 2013, workshop, the SWRCB representative acknowledged the importance of reliability, and indicated that compliance date changes would be considered as the need arises.[140]

California Public Utilities Commission Approval of Long-Term Power Purchase Agreements

Repowering all of the OTC capacity in southern California assumes that the owners of these facilities and load-serving entities (most likely SCE and SDG&E) can secure mutually agreeable power purchase agreements that will be approved by the CPUC. The generating industry will not build capacity on a "merchant" basis, speculating that capacity and energy products can be sold in short-term markets. The proposed Carlsbad facility at the existing Encina site illustrates a situation in which a project developer and a likely purchaser have not yet been able to come to an agreement and put a power purchase agreement before the CPUC for approval.[141] In

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139 SACCWIS was established by the SWRCB in the adopted OTC policy as a formal advisory body. Its members are representatives of the Energy Commission, CPUC, California ISO, California State Lands Commission, California Coastal Commission, ARB, and staff of the SWRCB. The adopted OTC policy establishes that SACCWIS should report annually whether it believes compliance date changes are warranted.

140 July 15, 2013 Transcript page 42, lines 20-22.

141 Despite the Energy Commission issuing a permit for Carlsbad (May 31, 2012) after a licensing proceeding that took four and a half years, SDG&E and NRG have still not come to a mutually acceptable power purchase agreement.

rejecting the Pio Pico and Quail Brush power purchase agreements, there is clear evidence that the CPUC will not approve agreements that it finds are unnecessary.[142] [143]

Role of Preferred Policy Resources

It is expected that the preferred policy resources enumerated by the Energy Commission and CPUC (energy efficiency, demand response, combined heat and power, and so forth) will play a considerable role in either reducing need for or in satisfying resource requirements. In D.13-02-015, the CPUC directed SCE to undertake a mix of preferred resources as well as authorizing replacement capacity to address OTC retirements. There has been a progression of local capacity area studies from those conducted in the California ISO's 2012-13 TPP with no inclusion of impacts from demand-side policies to the set of scenarios submitted by the California ISO into the CPUC's 2012 LTPP Track 4 that include considerable amounts of these resource types.[144] However, such studies reveal that preferred resource additions cannot provide reduction in need for repowering to satisfy local capacity requirements on a one-for-one basis.

Joint Agency Southern California Reliability Team

Following SCE's announcement of its intentions to retire San Onofre, Governor Brown directed the leaders of California's energy agencies to examine Southern California reliability issues exacerbated by the short term closure and permanent retirement of San Onofre.[145] The 90 day period allowed for this review necessitated use of existing studies rather than commissioning new ones. A preliminary plan was prepared by the staff of the member organizations and discussed at a public workshop conducted by the Energy Commission on September 9, 2013 (Commissioners from the CPUC, Board Members from the ARB and SWRCB, and executives from the California ISO and SCAQMD participated). As presented, the plan relies upon a mix of resource additions and transmission system upgrades. These include:

- A mix of near to mid-term actions that mitigate against reliability threats as a result of growing loads. These include maintaining the FlexAlert program, pursuing additional capacity with 50 percent preferred resources and 50 percent conventional generation with triggers and offramps if the preferred resources do not come to fruition, and pursuing additional transmission system upgrades.

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142 In D13-03-029 the CPUC rejected PPAs for the Pio Pico and Quail Brush projects, reasoning that SDG&E had not justified a need for the facilities on the date the projects would commence generation, given the record of the proceeding.

143 On June 25, 2013, SDG&E filed an application with the CPUC to accept a power purchase agreement with Pio Pico with different terms and conditions than in the original agreement rejected by the CPUC.

144 See Jaske and Wong, "Summary of Studies of Southern California Infrastructure," op. cit. Table 1, for a comparison of how preferred policies have been incorporated into local capacity studies.

145 Participating organizations include: Energy Commission, CPUC, California ISO, SCAQMD, SCE and SDG&E.

- Initiation of contingent permitting, timely decisions on power plants in San Diego that have construction permits, and possibly delaying the compliance date for OTC compliance for the Encina facility.
- Long term actions including expanding demand side preferred resources through new programs and/or market mechanisms, building new generation through repowering some existing facilities and at new greenfield sites as appropriate, and major transmission system upgrades.

The preliminary plan relies upon local capacity studies to establish the aggregate need for new resources, but recommends that preferred resources provide 50 percent of the needed capacity. Flexible resources that could both satisfy local capacity requirements and operate to integrate renewables were proposed for the balance of needed capacity additions.

Recommended reliance upon 50 percent preferred resources is acknowledged to require changes from business as usual. Additional energy efficiency and demand response will require active participation of customers in targeted areas of Southern California that can actually contribute to a reduction in local capacity requirements. Close monitoring of such programmatic activities is needed to determine whether energy efficiency impacts or demand response capabilities are actually being developed in the amounts and in the locations required to displace generation alternatives. If the preferred resources are not coming to fruition in the amounts and locations needed, alternatives such as conventional generation and transmission will need to be triggered. Transmission development, if found feasible and cost-effective, can be controversial and have lengthy development timelines. Generation development, whether repowering onsite or new development, will require SCAQMD to implement its Rule 1304(a)(2) exemption from offsets and such exemptions would need to be covered from credits in its internal bank.

Lastly, the preliminary plan recommends no new mechanism for planning and procuring resources. Instead, the preliminary plan relies upon the existing mechanisms of the CPUC, California ISO, and Energy Commission to develop the detailed plans, permit and authorize facilities, and to plan and implement programs and/or market mechanisms needed to develop preferred resources. The tight coordination among the staff of the organizations participating in this effort is expected to continue even though each organization would retain its existing decision-making authority. The Governor's Office would track progress of various implementation actions against the plan and validate initiating contingency actions if elements were not progressing according to plan.

The Joint Agency leadership will review the preliminary plan presented at the September 9, 2013 workshop, consider comments received orally at the workshop and submitted in writing to the Energy Commission, and submit a final plan to the Governor's Office.

Next Steps

Numerous activities are required from state agencies to enable the necessary amount of desired resource additions to move forward.

Air Quality Permits

SCAQMD needs to determine whether the amount of repowering identified in the California ISO's local capacity studies can be permitted using its Rule 1304(a)(2) exemption in conjunction with federally accepted internal credits under Rule 1315. For two large power plants, SCAQMD's Rule 1325 governing $PM^{2.5}$ emissions may limit the capacity of repowered facilities to a level less than what currently exists. To the extent that SCAQMD's rules limit capacity additions below those found necessary by the California ISO or others, then additional studies will be required to develop a mutually satisfactory resource mix.

Fossil Power Plant Permitting

Of the OTC capacity that California ISO studies indicate would be effective in replacing OTC capacity that is scheduled to be retired, only the Carlsbad and Pio Pico projects have a permit from the Energy Commission. None of the AES plants (Huntington Beach, Redondo Beach, and Alamitos) have permits, although Applications for Certification have been submitted by AES for Huntington Beach and Redondo Beach, and NRG Energy has submitted a proposed permit amendment to repower El Segundo 4. The Energy Commission's licensing process, although it incorporates SCAQMD's air permit, addresses many other factors crucial to overall licensing.

The Energy Commission currently does not have a contingency permitting process. Changes in law or regulations may be needed to issue contingent permits for generating facilities. Such permits would be finalized in an expedited manner if specific triggering conditions were satisfied, such as the failure of preferred demand-side policies to develop savings in the amounts or at the locations required, or a transmission system upgrade project fell too far behind schedule to alleviate local reliability needs. If changes in law or regulations are required, then the Energy Commission needs to take appropriate action such that the contingent permitting concept can be implemented.

Procurement Authority

In May 2013, the CPUC issued a revised scoping order and assigned commissioner ruling in the 2012 LTPP proceeding establish Track 4, which focuses on the need for resource procurement authority for capacity to satisfy local capacity requirements presuming San Onofre was offline. The California ISO studies were submitted on August 5, 2013, further studies and testimony were recently submitted, and the CPUC hopes to issue a decision in late 2013 or early 2014. The CPUC will have to determine to what extent it will choose to displace fossil capacity with assumed future demand-side policies to reduce local capacity requirements, or the extent to which supply-side additions like demand response can be used in lieu of fossil capacity to satisfy local capacity requirements. [146]

Development and Authorization of Demand-Side Policies

The CPUC, the Energy Commission, and the California ISO need time to address the design and funding for incremental energy efficiency, combined heat and power, and demand response

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146 As with D.13-02-015, the CPUC may choose to provide procurement authority only for a portion of the amount identified in California ISO studies, reasoning that further studies could be useful in finalizing the mix of procurement authority and direction to pursue demand-side policy programs.

programs that will produce effects comparable to those assumed in various studies. In the past year, as long-term local capacity studies have been completed, the California ISO has raised legitimate questions about the ability of such programs to provide the amount of savings at specific points in the electricity system that directly influence power flow modeling. While energy efficiency and demand response program impacts are equivalent to generation as a source of generic energy or capacity, a concerted multiagency effort is needed to determine whether they are also equivalent to capacity needed in specific local areas and able to operate flexibly— come on-line and move up or down quickly to match changing load. Further, the design of these demand-side programs may be novel and, to achieve the geographic targets implied in satisfying local capacity requirements, may require intensive monitoring in both development and implementation phases.

OTC Compliance Date Revisions

The SWRCB OTC policy considers the possibility that delays in adopted compliance dates might be justified by delays in developing infrastructure needed to allow a specific OTC power plant to retire. However, the energy agencies have not yet suggested to SWRCB that such a delay is needed and have not completed any studies showing that the timeline for a preferred infrastructure project needed for local capacity requirements or other criteria would justify a delay for a specific OTC facility or unit. It is unclear what constitutes enough evidence for the energy agencies to make such a recommendation or for SWRCB to accept it in the face of likely opposition from environmental advocates seeking to maintain the original OTC compliance schedule.

Inter-Agency Coordination and Tracking Progress

The joint agency leadership team will finalize a report and present it to the Governor's Office. Although a strong consensus exists among current Commissioners, Board Members and agency executives to cooperate in pursuing resolution of the Southern California reliability concern, each organization is subject to its own decision-making processes within the policy framework of each organization. Assuring reliability while trying to preserve affordability and environmental stewardship for electricity services will require ongoing attention to coordinated planning, procurement, and permitting. The Governor's Office will create a mechanism to track progress against the plan.

Updated Estimates of New Generation Costs

Generation cost trends are an important consideration when evaluating the types of resources that will be used to meet California's future energy demand and provide the infrastructure needed to maintain system reliability and reduce GHG emissions from the electricity sector. In the *2011 IEPR* proceeding, the Energy Commission evaluated its method of analyzing and estimating future generation costs. For the *2013 IEPR*, staff has prepared the following updated estimates of generation costs for new generation.

Renewable Cost Trends

The market for renewable energy has grown in the United States over the last several years as renewable resources have become more attractive due to national efforts such as investment tax

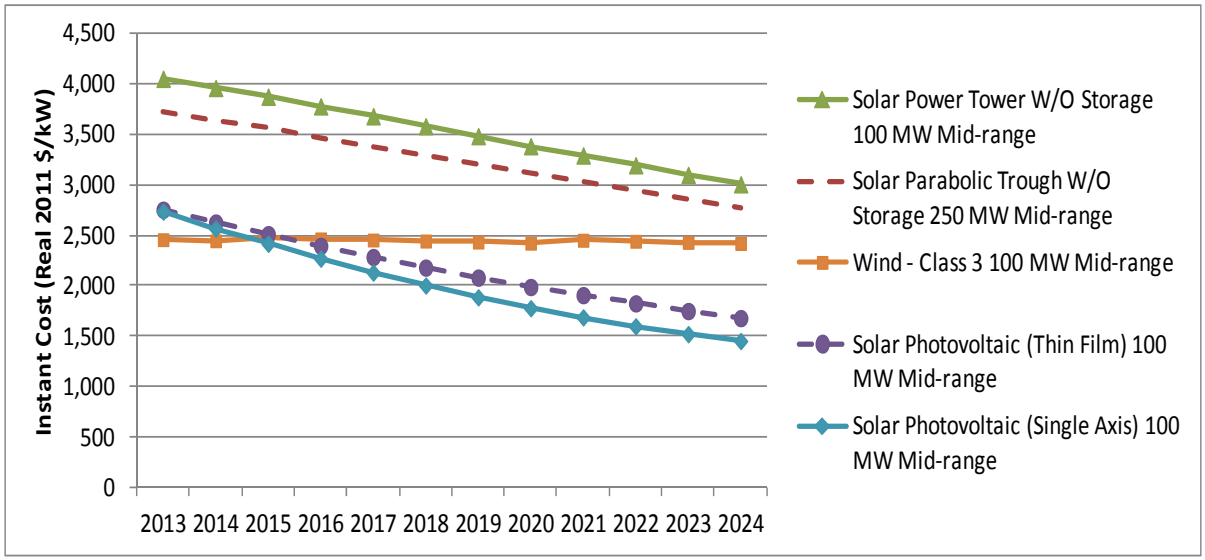
credits to make renewables more cost-competitive and funding available under the American Recovery and Reinvestment Act of 2009. This has increased the number of installations and helped drive costs lower as manufacturers and developers refine and improve technologies.

Solar photovoltaic (PV) technologies have experienced the most rapid decline in costs and are expected to continue this trend. In addition, investment in solar thermal technologies is expected to help reduce costs as rapid improvements and refinements are made by both developers and manufacturers.

Wind technology has experienced a far less dramatic reduction in cost. Cost reductions are expected to continue, although increases in the cost of land and transmission costs are expected to offset the gains in technology cost, keeping the cost before accounting for financing (known as the *instant cost*) relatively flat in California[147]. Figure 7 shows a selection of renewable technology instant costs representative of technologies being installed in California. The decline in costs for solar PV, as well as for solar thermal, is readily apparent, while the cost of wind is expected to remain stable over the next decade.

Other renewable technologies, such as biomass and geothermal, are not expected to experience the same decline in instant costs as solar technologies. Unlike wind and solar where substantial investment is fueling a learning curve, biomass and geothermal are not expected to experience substantial cost reductions over the next decade.

Figure 7: Renewable Technology Instant Cost Trends



Source: California Energy Commission

Fossil-Fueled Generation Cost Trends

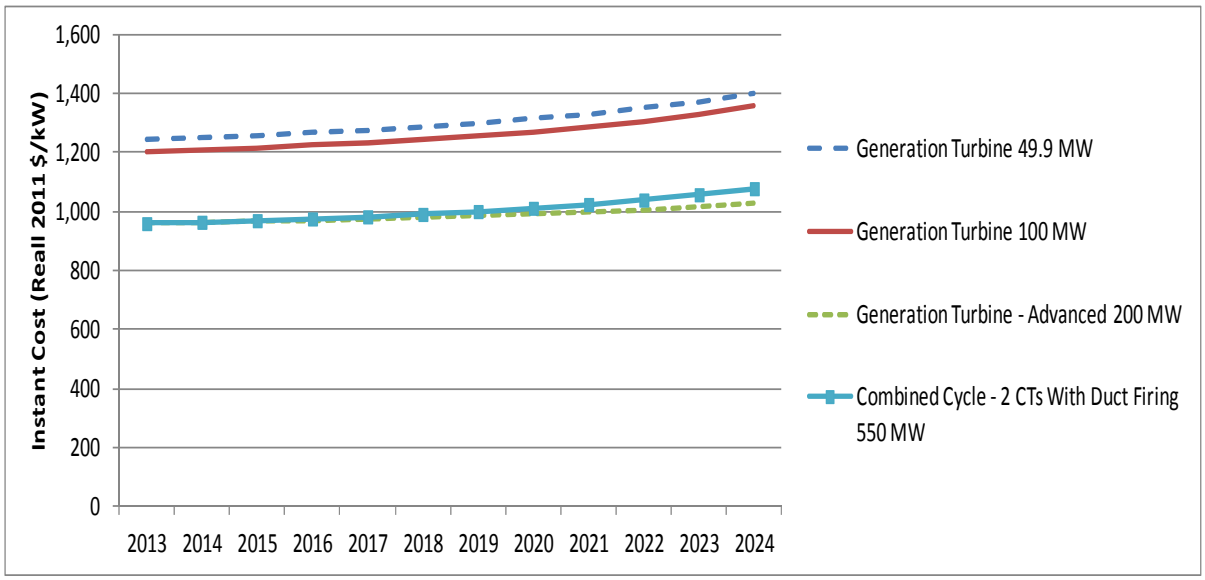
The Energy Commission conducted a survey in 2012 on both the construction and operational costs of combined-cycle and simple-cycle gas turbine generators. The results of the survey were

147 States with lower land and transmission interconnection and service costs are expected to see continued investment in wind resources as they are able to take advantage of the underlying technology cost reductions.

combined with a careful study of industry literature and expectations to estimate the future path of costs for new power plants.

Combined-cycle and combustion turbines are mature technologies that have not seen significant cost declines in several years. These resources represent a major portion of California's supply portfolio and will likely continue to play a role in the future. The underlying technology costs are expected to remain flat over the coming years. However, there are significant particulate and carbon emissions associated with these technologies. The Energy Commission estimates that increasing costs for emissions will cause a roughly 15 percent increase in instant costs per kilowatt in real dollar terms over the coming decade for simple-cycle turbines and about a 10 percent increase in combined cycles. Figure 8 shows the expected increase over the next 10 years.

Figure 8: Instant Costs of Fossil-Fueled Generation (Real 2011 $/kW)



Source: California Energy Commission

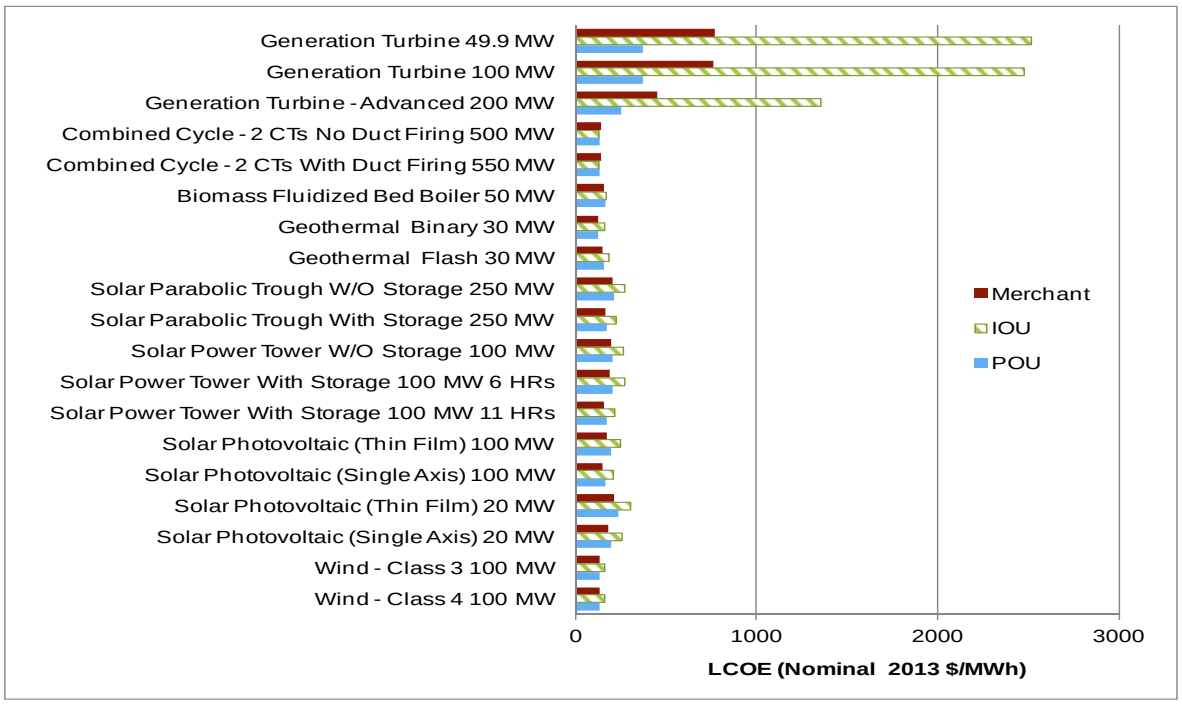
Summary of Estimated Levelized Costs

When developers negotiate the prices of contracts for energy with utilities, they must estimate how much will be expended over the contract period and translate that value into a cost per unit of energy. The most straightforward way to do this is to convert assumptions about varying costs over the life of the contract into a stream of level payments. This process is referred to as the *levelized cost* (also known as *levelized cost of energy* or LCOE) approach.

Figure 9 shows the estimated LCOE for a variety of technologies that may be built in California over the next decade, expressed in real dollars per MWh. The cost of building and operating these resources varies depending on who finances and operates them for two reasons. First, the cost of borrowing differs among IOUs, which typically have the highest cost of borrowing due to higher perceived risk in the lending market, independent merchant power plant owners, and POUs, which are able to offer municipal bonds to finance their projects, which have the lowest cost of lending due to having lower risks.

Second, the operational profile differs depending on who owns the plant. For most renewable technologies, there is no difference in operation since they are typically operated as "must take" resources, meaning they are seldom, if ever, curtailed. Fossil-fueled plants, however, participate in a market for energy. When fossil-fueled plants are operated fewer hours – either through competition with newer, more efficient resources, or as renewable resources cause them to reduce operational hours – the total cost is spread over less total energy, increasing the levelized costs. A review of historical operation profiles shows that IOUs, POUs, and merchant operators have different operational profiles and therefore different lifetime costs for fuel and maintenance.

Figure 9: Summary of Mid-Case Levelized Costs (LCOEs)—Start-Year=2013



Source: California Energy Commission

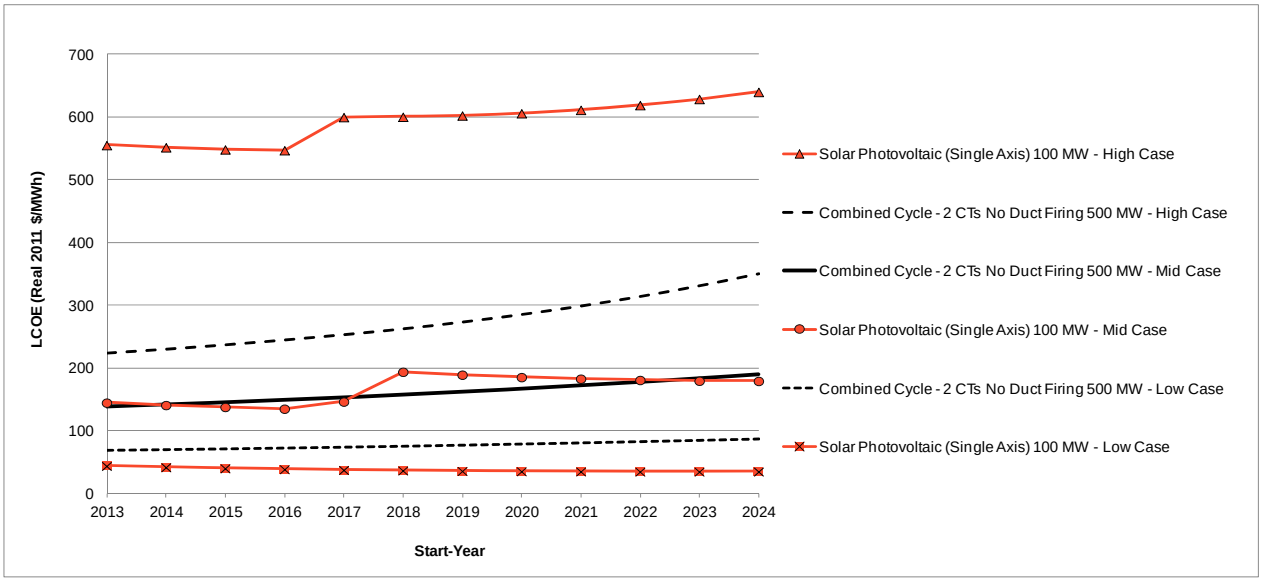
Levelized Cost Trends

One of the most significant cost trends is the steady movement of renewable technologies toward being cost-competitive with traditional fossil resources on a cost-per-unit energy basis. Specifically, solar PV LCOE has improved dramatically since the Energy Commission's last assessment in the *2009 IEPR.* The cost of new solar technologies will not be identical throughout the state, so a reasonable range was constructed to show the high, mid, and low costs of new generation in California.

Figure 10 compares the range of the current single-axis-tracking solar PV 100 MW to that of the 500 MW combined cycle. While solar installations are expected to see a wider range of costs over the next 10 years, the mid-cost estimate is very nearly aligned with the mid-cost estimate of a 500 MW combined-cycle facility on a cost-per-unit energy basis. Not only is solar more

competitive in the early years when it has the benefit of tax credits, it continues to be competitive after the tax credits are assumed to have expired between 2016 and 2018.

Figure 10: Comparing LCOE Ranges for Combined-Cycle 500 MW and Solar Photovoltaic Single-Axis 100 MW



Source: Energy Commission

Recommendations

- **Improve alignment of agency planning cycles.** Continue discussions between the Energy Commission, California Independent System Operator (California ISO), and California Public Utilities Commission (CPUC) about the timing and alignment of the demand forecast, energy efficiency funding cycles, measurement and evaluation, and agency planning cycles.
- **Explore the use of new modeling techniques.** Continue to explore and implement new modeling techniques that combine behavioral aspects related to energy use and efficiency through econometric/statistical methods and engineering aspects through end use modeling and other "bottom up" techniques.
- **Determine the appropriate level of granularity for demand forecasts.** Continue discussions with stakeholders on the appropriate granularity for location-specific demand forecasts to support subregional electricity system analysis for the CPUC and California ISO resource adequacy and other related proceedings. Determining the level of granularity will depend upon the needs of the joint energy agencies and consideration of the costs—in money, time, and data reliability—of procuring the data and developing the models necessary to meet those needs.
- **Collaborate to ensure grid reliability in Southern California.** The Energy Commission, CPUC, and California ISO will collaborate in forthcoming planning to implement near-and long-term activities identified in the joint agency examination of Southern California

reliability, including transmission system upgrades, specialized energy efficiency, and other preferred resources program designs targeted to affected areas; power purchase agreements for permitted generating facilities; and new backstop contingency permitting and procurement mechanisms if preferred resources fail to develop in the amount and on the schedule needed for local reliability. The Energy Commission will work collaboratively with the CPUC and California ISO to identify long run choices among viable sets of preferred resources, transmission system upgrades, and generating resources needed to assure local reliability. The agencies should also jointly make decisions to trigger contingency mechanisms if and when higher priority resource development falters. Where appropriate, the agencies should work with the California Air Resources Board, State Water Resources Control Board, and South Coast Air Quality Management District to coordinate their environmental protection objectives with resource development strategies, in general, and regulatory requirements for necessary generating facilities, in particular.

- **Complete nuclear replacement studies recommended in the *2011 IEPR*.** To fulfill the nuclear replacement study recommendations of the *2011 Integrated Energy Policy Report*, the CPUC, California ISO, and Energy Commission, with input from SCE and PG&E, should assess the energy replacement options in the event of the shutdown of Diablo Canyon.
- **Update the Energy Commission's data reporting requirements.** The Commission should open an administrative proceeding in 2014 to update its data reporting requirements, processes and protocols to ensure that up-to-date, appropriately granular energy data and other information from relevant stakeholders is available in timely fashion, for current and anticipated future policy analysis and development.

CHAPTER 5:
Strategic Transmission Investment Plan

California needs to plan, permit, and build appropriate transmission infrastructure to support the 33 percent by 2020 Renewables Portfolio Standard (RPS) while delivering reliable electricity service that considers environmental, land-use, and economic effects and increasing stress on the system as a result of climate change. To date, it appears that planning has been successful in identifying the transmission needed to meet the RPS. The state now needs to ensure that these projects are permitted and constructed quickly and effectively. In addition, California needs to continue coordinating with the rest of the Western Interconnection in transmission planning activities to ensure that state policy objectives are considered appropriately in those activities, including the potential for higher levels of renewables in the future.

In 2004, Senate Bill 1565 (Bowen, Chapter 692, Statutes of 2004) directed the Energy Commission, in consultation with other stakeholders, to adopt a strategic plan for the state's electric transmission grid. Subsequently, Senate Bill 1059 (Escutia and Morrow, Chapter 638, Statutes of 2006) linked transmission planning and permitting by authorizing the Energy Commission to designate transmission corridor zones on nonfederal lands that will be available in the future to allow for the timely permitting of high-voltage transmission projects, with the further requirement that any corridor proposed for designation must be consistent with the state's needs and objectives as identified in the latest adopted strategic transmission investment plan.

To follow up on transmission-related recommendations from the *2012 IEPR Update* and emerging issues and opportunities since that report was published, the Energy Commission held two workshops as part of the *2013 IEPR* proceeding to solicit input from stakeholders and develop recommendations. The first workshop was on the consideration of environmental and land-use factors in renewable scenarios for transmission planning and renewable energy project database issues, and the second focused on transmission planning and permitting issues. Summaries of these workshops are available in Appendix B.[148]

This chapter represents the Energy Commission's 2013 Strategic Transmission Investment Plan and discusses transmission challenges and opportunities in meeting California's 2020 RPS mandates, in-state coordinated land use and transmission planning, emerging trends in Western Interconnection, and recommendations for next steps.

Approved Transmission Projects to Meet 2020 Renewable Goals

To date, the California ISO, the Imperial Irrigation District (IID) and the Los Angeles Department of Water and Power (LADWP) have identified and approved 18 transmission projects for the integration of renewable resources that will enable California to meet its 33

148 The complete workshop record is available at http://www.energy.ca.gov/2013_energypolicy/documents/.

percent RPS by 2020.[149] The California ISO has noted that there is no need to approve new major transmission projects at this time to support achievement of California's 33 percent RPS, given the transmission projects already approved or progressing through the CPUC's approval process.[150]

Sixteen of the projects are within the California ISO's control area. To help interested parties track the status of these projects, the Energy Commission staff will annually update and post the status of transmission projects being developed for the integration of renewable resources on the Energy Commission website.[151]

The Energy Commission staff will work with the California ISO, LADWP, IID, investor-owned utility, and publicly owned utility staff to update this information. Project status is posted in a spreadsheet along with a map showing the approximate location of each project. The following information about each project is excerpted from detailed descriptions and citations provided in Appendix A and is in order of actual or expected in-service date.

2012 Projects

Sunrise Powerlink: On June 17, 2012, San Diego Gas & Electric Company (SDG&E) completed and energized the 117-mile 500 kV Sunrise Powerlink. Combined with the Imperial Valley (IV) Collector Station and Sycamore-Peñasquitos projects discussed below, this high-voltage transmission line increases the import capability into San Diego by 1,000 MW for a total of 1,700 MW from the renewable energy-rich Imperial Valley.

2013 Projects

Colorado River-Valley (and Red Bluff Substation): SCE's Colorado River-Valley is a 153-mile, 500 kV transmission project that includes the Colorado River-Devers project. Combined with the West of Devers project discussed below, this will allow for delivery of about 4,000 MW from Riverside County. On September 29, 2013, SCE completed and energized the Colorado River-Valley project.

Eldorado-Ivanpah: SCE's Eldorado-Ivanpah project replaces 35 miles of existing 115 kV transmission line with a double-circuit 220 kV transmission line. The project will allow for delivery of 1,400 MW of new solar energy generation in the Ivanpah Dry Lake area. On July 1, 2013, SCE completed and energized the Eldorado-Ivanpah project.

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149 The California ISO in collaboration with SCE will reevaluate the need for the Pisgah-Lugo transmission project in light of K Road, LLC filing a request with the Energy Commission to withdraw and terminate the Energy Commission license for the 850 MW Calico Solar Project on June 20, 2013.

150 California ISO Board approved 2012-2013 Transmission Plan, p. 8, http://www.caiso.com/Documents/BoardApproved2012-2013TransmissionPlan.pdf.

151 The status of the transmission projects will be posted on the Renewables/Tracking Progress/Transmission Expansion page of the Energy Commission website at http://www.energy.ca.gov/renewables/tracking_progress/.

Carrizo-Midway: PG&E's Carrizo-Midway is a 35-mile reconductoring, or upgrade, of the existing Morro Bay-Midway double-circuit 230 kV transmission line. The project will deliver up to 900 MW of new solar generation in the Carrizo Plain area. On March 20, 2013, PG&E completed reconductoring and energized the Morro Bay-Midway transmission line.

2014 Projects

SCE/IID Joint Path 42: The SCE/IID Joint Path 42 project will increase the transfer capacity from 600 MW to 1,500 MW of renewable energy from IID to SCE's portion of the California ISO's controlled grid. Upgrading Path 42 requires improvements to SCE's and IID's facilities. SCE's portion of the project includes upgrading a 15-mile double-circuit 230 kV transmission line between SCE's Devers and Mirage Substations. The IID upgrade consists of replacing 20 miles of a double-circuit 230 kV transmission line between SCE's Mirage and IID's Coachella Valley and Ramon Substations. SCE's and IID's expected in-service date is April 30, 2014.

IID Additional Upgrades: Additional IID upgrades are needed to interconnect renewable generation in the Imperial Valley. These upgrades include (1) El Centro-Highline replacing existing 161 kV and 92 kV lines with a double-circuit 230 kV line; (2) El Centro-Imperial Valley (S line) replacing an existing 230 kV line with a double-circuit 230 kV line; and (3) Midway-Bannister installing eight miles of a new 230 kV line between IID's Midway and the proposed Bannister Substation.

2015 Projects

Imperial Valley (IV) Collector Station and IV Collector Line: The IV Collector project includes a one-mile 230 kV transmission line from a new Collector Substation to the existing IV Substation. The project will allow delivery of at least 1,400 MW of renewable energy to the California ISO grid. The project qualifies for the California ISO's competitive solicitation process.[152] On July 11, 2013, the California ISO selected IID as the approved project sponsor and accepted its offer of a cost cap of $14.3 million to build the project.[153] The California ISO's expected in-service date is no later than 2015.

Tehachapi Renewable Transmission Project: SCE's Tehachapi Renewable Transmission Project (TRTP) is being built in 11 segments and includes more than 300 miles of new and upgraded 220 kV and 500 kV transmission lines and substations. On July 11, 2013, the CPUC voted in favor of President Michael Peevey's Alternate Proposed Decision and released the construction stay on the project. The decision requires SCE to build a 3.5-mile 500 kV underground cable in

152 Phase 3 of the California ISO's transmission planning process includes a competitive solicitation process where project sponsors can submit proposals to finance, construct, and own the transmission line for policy-driven and economically driven transmission projects, as well as for reliability-driven projects that provide additional policy and economic benefits.

153 The California ISO's Imperial Valley Policy Element Project Sponsor Selection Report can be found on the California ISO website at http://www.caiso.com/Documents/ImperialValleyPolicyElement-ProjectSponsorSelectionReport_Jul11_2013.pdf.

Chino Hills (Segment 8A), and remove the previously installed towers.[154] TRTP will allow delivery of 4,500 MW of renewable generation from eastern Kern and Los Angeles counties to the Los Angeles Basin. Most of the generation will be wind resources from Kern County, but the line will also accommodate planned or future solar, geothermal, and peaker projects. SCE's expected in-service date for all segments is 2015.

2016 Projects

Borden-Gregg: PG&E's Borden-Gregg project is a reconductoring of the existing Borden-Gregg 230 kV transmission line. The project will allow delivery of 800 MW of solar generation proposed near Fresno, specifically the Westlands area. According to PG&E, the project is on hold. Once the project moves forward, PG&E will submit a notice of exempt construction[155] to the CPUC. PG&E's expected in-service date is 2016.

LADWP Barren Ridge Renewable Transmission Project: LADWP's Barren Ridge Renewable Transmission Project includes 87 miles of 230 kV transmission lines. The project will provide additional transmission capacity to access 1,000 MW of wind, solar, and other renewable resources. LADWP will begin construction in 2013 with an expected in-service date of 2016.

2017 Projects

Sycamore-Peñasquitos: The Sycamore-Peñasquitos project is a 230 kV transmission line between SDG&E's Sycamore and Peñasquitos Substations. The project will ensure delivery of renewable generation and reliability benefits to the San Diego area. As part of its 2012-2013 Transmission Planning Process, the California ISO examined reliability in the absence of Diablo Canyon Power Plant and San Onofre Nuclear Generating Station (San Onofre). The Nuclear Generation Back-Up Plan study identified several transmission system upgrades that, in addition to generation replacement and mitigation measures already underway, would help manage future unplanned extended outages to the San Onofre plant. The upgrades included the installation of dynamic reactive support in the vicinity of San Onofre and the Sycamore-Peñasquitos project. Construction of this project becomes more important in light of SCE's June 7, 2013, decision to permanently retire San Onofre Units 2 and 3.[156] The project qualifies for the California ISO's competitive solicitation process.

South of Contra Costa: PG&E's South of Contra Costa project includes reconductoring of about 47 miles of existing 230 kV transmission lines south of the Contra Costa Substation. The project will allow delivery of 300 MW of wind generation in Solano County.

Warnerville-Bellota: PG&E's Warnerville-Bellota project is a reconductoring of the existing Warnerville-Bellota 230 kV transmission line. The project, along with the Wilson-Le Grand and

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154 CPUC Decision on undergrounding TRTP Segment 8A can be found on CPUC website at: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M071/K423/71423831.pdf.

155 Replacement of existing transmission lines are issued a notice of exempt construction and are exempt from CPUC CEQA review pursuant to CPUC General Order 131-D, Section III, Subsections A or B.1.

156 SCE's news release can be found on SCE website at http://edison.com/pressroom/pr.asp?id=8143.

Gates-Gregg projects discussed below, will allow delivery of 700 MW of renewable generation in the Greater Fresno, Central Valley North, Merced and Westland zones.

2018 Projects

Coolwater-Jasper-Lugo: SCE's Coolwater-Jasper-Lugo project includes the new Jasper substation, 35 miles of a new 220 kV double-circuit transmission line, and replacement of 28 miles of 220 kV transmission line with 12 miles of double-circuit 220 kV and 16 miles of 500 kV transmission lines. The project will provide an additional 1,000 MW transmission capacity in the Kramer Junction and Lucerne Valley areas (San Bernardino County) to support renewable generation development and ensure system reliability. On August 28, 2013, SCE filed a proponent's environmental assessment with the CPUC and the United States Bureau of Land Management.

2019 Projects

West of Devers: The West of Devers project consists of removing and replacing roughly 48 miles of existing 220 kV transmission lines with new double-circuit 220 kV transmission lines. The project, combined with the Colorado River-Valley project discussed earlier, will allow for delivery of about 4,000 MW from Riverside County.

2020 Projects

Wilson-Le Grand: PG&E's Wilson-Le Grand project is a reconductoring of the existing Wilson-Le Grand 115 kV transmission line. The project, along with the Warnerville-Bellota project discussed earlier and the Gates-Gregg project discussed below, will allow for the delivery of 700 MW of renewable generation in the Greater Fresno, Central Valley North, Merced and Westland zones.

2022 Projects

Gates-Gregg: PG&E's Gates-Gregg project is a new double-circuit 230 kV transmission line between PG&E's Gates and Gregg Substations. The project, along with the Warnerville-Bellota and Wilson-Le Grand projects discussed earlier, will allow for the delivery of 700 MW of renewable generation in the Greater Fresno, Central Valley North, Merced and Westland zones. The project qualifies for the California ISO's competitive solicitation process.

Project Requiring Reevaluation

Pisgah-Lugo: SCE's Pisgah-Lugo project is 125 miles of 230 kV lines that would be rebuilt to 500 kV transmission lines and provide access to 1,400 MW of renewable capacity in the Mojave Desert. Because of multiple generator withdrawals in the Mojave Desert, including the 850 MW K Road Calico Solar Project, the California ISO and SCE are reassessing the scope and need for the Pisgah-Lugo Renewable Transmission Project. If the project is determined to be unnecessary, there are still enough transmission projects already identified to support California's 33 percent RPS.

California ISO's Potential Long-Term Transmission Alternatives in Light of San Onofre Shutdown

On June 7, 2013, Southern California Edison (SCE) announced it was permanently closing San Onofre. Prior to SCE's announcement, the California ISO examined reliability in the absence of Diablo Canyon Power Plant and San Onofre Nuclear Generating Station (San Onofre) in its 2012-2013 Transmission Planning Process. At the September 9, 2013 Energy Commission *IEPR* Workshop on the Preliminary Reliability Plan for LA Basin and San Diego,[157] the California ISO presented the following transmission alternatives for consideration.

Alberhill-Suncrest 500 kV Line: A proposed 65-mile 500 kV transmission line between the existing SCE Alberhill Substation and SDG&E Suncrest Substation.[158]

Talega-Escondido/Valley-Serrano-new Case Springs 500 kV line: No additional details at this time.

Imperial Valley-San Onofre 500 kV HVDC line: A proposed 500 kV HVDC transmission line with 1,500 MW of capacity. Construction of this line would reduce San Diego generation need by 600 to 800 MW, and reduce Western Los Angeles Basin generation by about 400 MW. There are two routes being proposed by SDG&E.[159]

- Option A: 200-250 miles of 500 kV HVDC transmission line between existing SDG&E Imperial Valley Substation and San Onofre.
- Option B: 175-225 miles of 500 kV HVDC transmission line between existing SDG&E Imperial Valley Substation and future Rainbow Substation.
  - Requires upgrading the existing Escondido-Talega 230 kV transmission line

Alamitos (or San Onofre)-South Bay area 300 kV HVDC Submarine Cable: Trans Bay Cable (TBC) submitted this proposal as a reliability project in the California ISO's 2012 Request Window. The proposal is a 300 kV HVDC 600 MW unidirectional submarine cable connecting SCE's San Onofre 230 kV bus to SDG&E's Bay Blvd 230 kV bus. The project would provide reactive power support at both substations.[160]

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157 Randolph, Edward (CPUC), Sylvia Bender (Energy Commission), and Phil Pettingill (California ISO), *Southern California Reliability Preliminary Plan* presentation, presented at the Energy Commission IEPR Workshop, September 9, 2013, slide 16, http://www.energy.ca.gov/2013_energypolicy/documents/2013-09-09_workshop/2013-09-09_reliability_presentation.pdf.

158 California ISO Board approved 2012-2013 Transmission Plan, p. 187, http://www.caiso.com/Documents/BoardApproved2012-2013TransmissionPlan.pdf.

159 See SDG&E Reliability – 2013 & Beyond presentation, slides 30-32, http://www.energy.ca.gov/2013_energypolicy/documents/2013-07-15_workshop/presentations/04C_SDGE_SONGS_Reliability_7-15-13.pdf.

160 Reilly, Sean, Cheety Mamandur, and Les Guliasi, Trans Bay Cable, LLC, comments on California ISO's 2012-2013 Transmission Plan, p. 5, posted on California ISO website at: http://www.caiso.com/Documents/TransBayCableCommentsDraft2012-2013TransmissionPlan.pdf.

The energy agencies are currently working togetherto analyze these projects and recommend the appropriate solutions to address reliability concerns associated with the recent shutdown of San Onofre. The California ISO will present the results in its 2013-2014 Transmission Planning Process. The results can be used to identify potential transmission corridors for designation.

Another issue that needs to be resolved in the next ten years is the land lease agreement with the U.S. Navy (Department of Defense). The lease agreement (Mesa side) requires SCE to remove all of the buildings unless the U.S. Navy (Marine Corps) requests otherwise. The easement agreements (plant side and transmission towers) require SCE to return the land to its original condition at the conclusion of the decommissioning of San Onofre. Alternative uses of the site under easements will require agreement from the U.S. Navy and approval by Congress.[161]

The San Onofre transmission infrastructure consists of a 230 kV switchyard with nine 230 kV transmission lines and is the primary connection point between SCE's and SDG&E's transmission systems. The San Onofre switchyard needs to remain in order to flow power from the north into Northern San Diego County. The energy agencies need to work closely with SCE, U.S. Navy, and Congress to resolve the easement agreements so that the critical infrastructure remains in place.

In-State Coordinated Land-Use and Transmission Planning Efforts

Improved Coordination between Generation and Transmission Planning and Permitting

As outlined in Governor Brown's Clean Energy Jobs Plan, the Energy Commission prepared a renewable energy plan intended to "expedite permitting of the highest priority generation and transmission projects." In December 2011, the Energy Commission released the *Renewable Power in California: Status and Issues* report, which identifies high-level strategies to support renewables development. The *2011 IEPR* included a summary of the report, including transmission issues. One of the transmission issues identified by the Energy Commission in the *2011 IEPR* was the length of time required to plan and license major transmission facilities for the interconnection of renewable resources.[162] The California ISO Generator Interconnection and Deliverability Allocation Procedures (GIDAP) and Transmission Planning Process (TPP) are vast improvements on past reliance on generator interconnection procedures as the main identifier of new policy-driven transmission projects. Through the GIDAP, the California ISO can "…plan and approve major ratepayer-funded upgrades through the single holistic transmission planning process, rather than having major network upgrades that would ultimately be funded by ratepayers proceeding on one track through the transmission planning

161 Pickett, Steve, Southern California Edison, *SONGS Shutdown and Decommissioning* presentation, presented at the Senate Energy, Utilities, and Communications Committee hearing, August 13, 2013, slides 19-20, http://seuc.senate.ca.gov/sites/seuc.senate.ca.gov/files/08-13-13Edison.pdf.

162 *2011 Integrated Energy Policy Report*, p. 38, California Energy Commission, Sacramento, California, Publication Number CEC-100-2011-001-CMF, http://www.energy.ca.gov/2011publications/CEC-100-2011-001/CEC-100-2011-001-CMF.pdf, posted February 15, 2012.

process and other projects also being identified through generator interconnection process."[163] Under the GIDAP, ratepayer-funded transmission upgrades are identified only through the transmission planning process, which relies on renewable generation forecasts or scenarios provided by the Energy Commission and the CPUC. The scenarios have been used in the TPP for two years and rely largely on commercial interest[164] or developer commitment and progress to forecast future locations of generators. This is a reasonable approach but one that means generators are not included in the transmission planning process until they have spent considerable time and resources negotiating power purchase agreements (PPAs) and started the environmental permitting process.

While the California ISO's GIDAP should improve identification of transmission projects needed for policy-driven generation, such as renewables for RPS targets or greenhouse gas (GHG) reduction goals, it does not ensure that transmission will be built by the time generation is commercially available. The current process still takes six to eight years from the time a transmission project is identified and approved in the California ISO Transmission Plan to when construction is completed by the transmission developer. Generators have already made significant progress with licensing and contracting through an approved PPA before this six-to-eight-year transmission planning process begins and can likely be commercially available in three to five years. The delay or lack of synchronization creates significant risks for generators because their PPAs often require their generation to be fully deliverable during peak conditions. Full deliverability typically requires transmission upgrades. For example, Abengoa's Mojave Solar Project requires the Coolwater-Jasper-Lugo Transmission project to be able to achieve full deliverability and "if they don't get transmission in place by the on-line date of 2018, they will soon thereafter incur incredible penalties that could put the generator out of business."[165]

Going forward, if developers are unable to finance projects due to uncertainty in transmission, it could be very difficult to meet the state's renewables goals at reasonable prices based on comments made at the May 2013 *IEPR* workshop on transmission issues:

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163 Millar, Neil, California Independent System Operator, *transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues*, May 7, 2013, p. 41, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

164 The commercial interest scenario heavily weights projects with an executed or approved power purchase agreement and data adequacy for a major siting application.

165 Weiner, Peter, Paul Hasting LLP for Abengoa Solar, *transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues*, May 7, 2013, p. 75, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

"Generators may be at commercial penalties or termination, at the worst, if transmission timing and requirements cannot be made to align with generation time and requirements."[166]

"…Without a transmission schedule that aligns with contracts and COD (commercial operation date), we're unlikely to have projects that are financeable, and this is a huge issue for us."[167]

"…viable projects can be scrapped because a fully permitted project is out of sync with shared transmission upgrades required for the project to come on-line."[168]

Two areas where the synchronization of generation development and the necessary transmission to reliably interconnect and deliver that generation to load can be improved include:

1. Reducing the number of significant and costly interconnection upgrades by eliminating or modifying the deliverability requirements in PPAs for renewable generators.
2. Planning, licensing, and developing transmission to specific areas where the state wants to encourage the development of renewable resources before the generators are committed through PPAs or environmental permitting.

As noted by the California ISO during the May 2013 *IEPR* workshop, "…looking over the track record of the major projects moving forward, the most significant and costly interconnection upgrades are actually to ensure resource adequacy deliverability."[169] The Bay Area Municipal Transmission Group (BAMx) also provided some compelling information in written comments on the May 2013 workshop estimating the costs for the resource adequacy capacity as it related to the policy-driven transmission projects in the California ISO footprint. The group indicates, "the annualized transmission cost is significantly higher than the RA [resource adequacy] value

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166 Desmond, Joe, BrightSource, *transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues*, May 7, 2013, p. 70, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

167 Robin, Renee, SunPower Corporation, *transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues*, May 7, 2013, p. 84, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

168 Ross-Leach, Diane, Pacific Gas and Electric Company, *transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues*, May 7, 2013, p. 93, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

169 Millar, Neil, California Independent System Operator, *transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues*, May 7, 2013, p. 43, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

associated with the renewable resources."[170] BAMx also notes, "Currently, California ISO's TPP analysis determines policy-driven transmission based on the assumptions that it is a state policy to provide RA credits to all renewable resources needed to meet 33 percent RPS by 2020."[171] As Tony Braun, representing the California Municipal Utilities Association (CMUA), stated in the workshop, "The procurement decisions drive the transmission development and they also drive a host of other environmental and other factors that are important to achieving the overall goals of the state energy policy."[172]

Requiring full deliverability for future PPAs for renewable generators in the state may not be a cost-effective strategy and should be considered in light of the billions of dollars in transmission investments the requirement triggers. If major transmission upgrades were not required for remote renewable resources to meet the terms of their PPAs, then the synchronization issue would disappear.

In the longer term, identifying preferred development areas for renewable resources and then planning the transmission to serve those areas could alleviate issues with the current unsynchronized approach and encourage renewable development that minimizes impacts on California's environmental resources. The key to overcoming the synchronization challenge is to develop a long-term transmission plan for preferred renewable generation zones. Two efforts underway that help with synchronization are the Desert Renewable Energy Conservation Plan and the Energy Commission's corridor designation process, discussed below.

Desert Renewable Energy Conservation Plan

The purpose of the Desert Renewable Energy Conservation Plan (DRECP) is to conserve and manage plant and wildlife communities in the Mojave and Colorado Desert regions of California while helping with the timely permitting of compatible renewable energy projects. The DRECP is a collaboration being developed under the California Natural Community Conservation Planning Act and the Federal Endangered Species Act, and the Federal Land Policy and Management Act.[173] The DRECP will result in an efficient and effective biological

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170 Flynn, Barry and Dr. Pushkar Waglé, Bay Area Municipal Transmission Group, comments on the *CEC 2013 IEPR – Transmission Planning and Permitting Issues (13-IEP-1E)*, Docket 13-IEP-1E, May 21, 2013, p. 3, Table 2, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Bay_Area_Municipal_Transmission_Group_Comments_2013-05-21_TN-70932.pdf.

171 Flynn, Barry and Dr. Pushkar Waglé, Bay Area Municipal Transmission Group, comments on the *CEC 2013 IEPR – Transmission Planning and Permitting Issues (13-IEP-1E)*, Docket 13-IEP-1E, May 21, 2013, p. 4, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Bay_Area_Municipal_Transmission_Group_Comments_2013-05-21_TN-70932.pdf.

172 Braun, Tony, Braun Legal on behalf of California Municipal Utilities Association, *transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues*, May 7, 2013, p. 101, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

173 For more information, see http://www.drecp.org/whatisdrecp/.

mitigation and conservation program while providing renewable project developers with certainty about permit timing and cost under the federal and California Endangered Species Acts in a way that avoids or minimizes environmental impacts.[174]

The DRECP is focused on the desert regions and adjacent lands of seven California counties – Imperial, Inyo, Kern, Los Angeles, Riverside, San Bernardino, and San Diego – totaling roughly 2.5 million acres of federal and nonfederal California desert land. It represents an unprecedented collaboration among the Energy Commission, the California Department of Fish and Wildlife, the U.S. Bureau of Land Management, and the U.S. Fish and Wildlife Service, collectively known as the Renewable Energy Action Team (REAT), with input from local governments, environmental organizations, industry, tribes, and other interested parties. Implementation of the DRECP is intended to "provide regulatory certainty for projects that are proposed within Development Focus Areas (DFAs). Certainty will come from implementation of an integrated and coordinated multi-agency permitting process, with clear terms and conditions for permits and clear requirements for permit application from DRECP participating agencies."[175]

The REAT agencies developed several alternatives, which contain potential conservation and mitigation areas and areas in which renewable energy could be developed (DFAs). An informal document, "Description and Comparative Evaluation of Draft DRECP Alternatives." was made public in December 2012, and public comments were received.[176] The REAT agencies now are preparing the draft environmental impact report/environmental impact statement (EIR/EIS) which is scheduled for formal public review in late fall of 2013.[177]

In anticipation of the analysis that will occur in the draft plan and EIR/EIS, the REAT agencies created the Transmission Technical Group (TTG) in January 2012. The TTG includes representatives from the Energy Commission, the California ISO, the CPUC, and the U.S. Military along with experienced transmission planners from IID, LADWP, PG&E, SDG&E, and SCE. The TTG was assigned the responsibility to develop an estimate of the land (acreage) that could be affected by transmission upgrades needed to connect and deliver specific amounts of

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174 For more information, see http://www.drecp.org/ and http://www.energy.ca.gov/siting/2008-11-17_MOU_BLM_FWS_DFG_CEC.PDF, p. 1.

175 http://www.drecp.org/documents/docs/DFA_and_streamlining_concepts_papers_March_28_2013.pdf, accessed June 10, 2013.

176 http://www.drecp.org/documents/docs/2013-03-25_Message_and_proposed_covered_spps_list.pdf, dated March25, 2013.

177 http://www.drecp.org/documents/docs/2013-03-25_Message_and_proposed_covered_spps_list.pdf, dated March 25, 2013.

renewable power from within DFAs of the DRECP to the ultimate buyers of the renewable energy under various alternatives developed by the REAT.[178]

Applying the Desert Renewable Energy Conservation Plan Model to the Central Valley

After the DRECP is completed, the next logical region for a similar effort could be the San Joaquin Valley (also known as the Central Valley). In the Central Valley, some agricultural land parcels are now considered "marginal" because they may no longer be economically viable for agricultural production. This may be the result of accumulated soil contamination from leaching of naturally occurring selenium, water shortages, or overfarming.[179] According to a report by the University of California, many of these lands in the Central Valley "retain little or no agricultural or biological value."[180] Renewable energy projects sited on these lands may, therefore, be more easily permitted and require less mitigation, potentially leading to shorter development times. In addition, the heart of the Northern California section of California's high-voltage electrical transmission system (known as Path 15) runs through this area. This intersection of large amounts of degraded land, good solar resources, and the potential to interconnect to the bulk transmission system argue for this region to be considered for a DRECP-like effort. Establishing such an effort would also support Governor Brown's direction in his Clean Energy Jobs Plan to "expedite permitting of the highest priority generation and transmission projects."

The University of California report also noted that California's renewable goals could be greatly enhanced by considering large-scale solar plants located on degraded farmland. Additionally, the report argues that given the difficulties with increasing numbers of large renewable energy projects on public lands, "developers in California are increasingly looking to agricultural land to site their projects."[181] For example, the Westlands Solar Park Master Plan provides an opportunity to move forward with development of degraded lands that are close to the high-voltage transmission grid and relatively close to population centers in the Central Valley. According to the report, "up to a quarter million acres of impaired lands in the Westlands Water District in the Central Valley may soon have to be retired from agricultural production, leaving significant tracts available for renewable energy production."[182]

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178 Transmission Impacts in the DRECP, June 11, 2012. p.2, http://www.drecp.org/meetings/2012-04-25-26_meeting/background/Transmission_Planning/Transmission_Technical_Group_report_final_4_6_12.pdf .

179 Bank of America, Berkeley Law, and UCLA Law, *Harvesting Clean Energy: How California Can Deploy Large-Scale Renewable Energy Projects on Appropriate Farmland*, October 2011, http://www.law.berkeley.edu/files/HarvestingCleanEnergy.pdf.

180 Ibid.

181 Ibid.

182 Ibid, p. 1.

Potential Corridor Opportunities

The U.S. Congress enacted the Energy Policy Act of 2005 (EPAct-05), which directed the U.S. Department of Energy to conduct assessments every three years of transmission congestion in major regions of the country.[183] The first study, completed in 2009, provided a basis for the Secretary of Energy to designate National Interest Energy Transmission Corridors, including one covering most of Southern California. EPAct-05 also directed the Secretaries of Agriculture, Commerce, Defense, Energy, and the Interior to designate energy corridors on federal land in 11 Western States. More recently, President Barack Obama issued a Presidential Memorandum "Transforming our Nation's Electric Grid through Improved Siting, Permitting, and Review" in June 2013, discussed later in this chapter in the section titled "Emerging Trends in the Western Interconnection." Among other items, the Presidential Memorandum specifically references the need to "collaborate with State, local, and tribal governments to ensure, to the extent practicable, that energy corridors can connect effectively between Federal lands."[184]

As noted earlier in this chapter, SB 1059 authorizes the Energy Commission to designate transmission corridors within the state and, after designation, identify those transmission corridor zones in its subsequent strategic plans.

These factors support an effort by the Energy Commission to investigate the designation of a corridor in Southern California. Most of the area adjacent to Interstate 10 from the California – Arizona border heading west to approximately the southern border of Joshua Tree National Park has been designated as a U.S. Bureau of Land Management (BLM) Section 368 Energy Corridor.[185] California's designation of an SB 1059 corridor composed of the patchwork of nonfederal lands that lie near the Section 368 lands in this area would support the federal designation and build off the work of the TTG report to the DRECP. The combination of the federal and state designations would provide a reasonable, well-considered transmission corridor in a highly impacted part of the state, paving the way for any necessary future expansion of the high-voltage electrical transmission system in that area.

The BLM has already approved the Devers-Palo Verde No. 2 Transmission Line Project, now known as the Colorado River to Devers Transmission Line. According to the BLM:

> This 500 kV line will provide interconnection and electrical transmission for numerous solar energy facilities proposed for construction, including nine large-scale solar projects in California and Nevada with a potential output of more than 3,600 megawatts that were approved by Secretary Salazar [in 2010] … The line will extend 115 miles from the Colorado River Substation near Blythe to the Devers Substation in Palm Springs and from the Devers Substation to the Valley Substation in Romoland, Riverside County, about 41.6 miles. The

183 http://www1.eere.energy.gov/femp/pdfs/epact_2005.pdf.

184 [http://www.whitehouse.gov/the-press-office/2013/06/07/presidential-memorandum-transforming-our-nations-electric-grid-through-i]

185 [Part 1: Large Scale Base Map Series, Map D9; http://corridoreis.anl.gov/documents/fpeis/maps/Part_1/WWEC_LargeScale_BMS_D09.pdf]

line will cross 57 miles of BLM land and two miles of San Bernardino National Forest land, running primarily along the I-10 Interstate, a primary corridor for energy transmission in Southern California.[186]

In the December 2012 TTG report prepared for the DRECP, the TTG indicated the potential need for an additional high-voltage electrical transmission line parallel to the Interstate 10 corridor in four of the five alternatives that were analyzed.[187] While the TTG will update its analysis based on the alternatives that are analyzed in the draft plan and the EIR/EIS, the results will likely be reasonably similar. The BLM-controlled portion of this potential corridor has already been approved. This conceptual route could be a good candidate for linking nonfederal lands in California with the federal Section 368 corridor.

Additionally, in 2002, the IID issued a Notice of Preparation that it and the BLM were preparing a draft EIR/EIS to address the environmental impacts of constructing and maintaining a new transmission line from west of Blythe to near Palm Springs.[188] This line was approved by the BLM in 2006.[189] However, the California ISO's 2010-2011 transmission plan subsequently listed this project among those that were "not needed."[190] This area could provide another opportunity for investigation of a transmission corridor by the Energy Commission.

Because significant amounts of environmentally responsible renewable generation potential have been identified in these areas of the state and are likely to be developed, it would be prudent for California to plan the transmission upgrades necessary to interconnect large amounts of renewable resources in these areas. From a timing perspective, it makes sense to identify and designate, where appropriate, transmission corridors in advance of future generation development so that needed transmission projects can be permitted and built in an effective, environmentally responsible manner, contemporaneous with the generation development.

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186 http://www.blm.gov/wo/st/en/info/newsroom/2011/july/NR_07_14_2011A.html; http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/priority_projects.Par.1290.File.tmp/Devers_PV2_Transmission_fact_sheet.pdf and http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/priority_projects.Par.38666.File.tmp/Devers_PV2-map2.pdf.

187 http://www.drecp.org/documents/docs/alternatives_eval/Appendices/Appendix_A_TTG_Report.pdf, pp. 19 – 21

188 http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/pdfs/palmsprings_pdfs/desert_southwest/desert_southwest_appendices.Par.20839.File.dat/Appendix_A%20-DSWTP-NOP&NOI.pdf

189 See http://www.blm.gov/ca/st/en/info/newsroom/2006/09/CDDNews06-89_DSW_ROW.html

190 http://www.caiso.com/Documents/Board-approvedISO2010-2011TransmissionPlan.pdf, p. 7-399.

Transmission Opportunities to Enable Higher Levels of Renewables

California Independent System Operator Leveraging Opportunities

As California moves closer to attaining its renewable electricity goals, there is discussion about moving beyond the 33 percent by 2020 RPS. To achieve higher RPS goals, California could look to renewable resources outside California. This could be achieved in a number of ways.

Footprint Expansion

On December 14, 2011, the Federal Energy Regulatory Commission (FERC) approved the transition agreement with Valley Electric Association (VEA) allowing VEA to transition from the Nevada Power Company balancing authority area to the California ISO. The VEA is located in Pahrump, Nevada, on the border of California near the Eldorado Valley in the Mojave Desert. As part of the agreement, VEA turned over operational control of its facilities to the California ISO, merged its generator interconnection queue, and became a participating transmission owner. On January 3, 2013, VEA joined the California ISO grid. VEA becoming part of the California ISO provides additional import capability and allows the California ISO to achieve efficiencies in providing renewable resources from VEA to California. VEA's interconnection rights at LADWP's Mead Substation and a new interconnection planned at SCE's Eldorado Substation increase the California ISO's ability to access renewable resources outside California to meet California's renewable objectives. In addition, there is a 230 kV transmission line under construction from NV Energy Northwest Substation-VEA Desert View Substation-VEA Pahrump Substation. The line will provide a second 230 kV source into VEA's major system substation at Pahrump and form a looped 230 kV supply source. The project is expected to be completed in 2013.

Joint Transmission Projects with Neighboring States

In August 2012, NV Energy announced it was launching a joint project with the California ISO to study the possibility of developing transmission facilities between their two systems to share both conventional and renewable energy resources for the benefit of both parties. NV Energy's service territory stretches from Elko to Laughlin in Nevada. As part of the California ISO's 2012-2013 Transmission Planning Process, a 500 kV transmission line from NV Energy's Harry Allen Substation to SCE's Eldorado Substation was studied as an economic project. The project is located in the area being jointly studied by NV Energy and the California ISO. The California ISO recommended further evaluation as part of an ongoing joint study with NV Energy and as a possible transmission alternative in its transmission planning process.[191]

Energy Imbalance Market Expansion

On February 12, 2013, the California ISO and PacifiCorp[192] entered into a memorandum of understanding to create a real-time energy imbalance market (EIM) by October 2014. The

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191 California ISO, *2012-2013 Transmission Plan*, March 20, 2013, p. 357, http://www.caiso.com/Documents/BoardApproved2012-2013TransmissionPlan.pdf.

192 PacifiCorp operates two balancing authorities: Pacific Power in Oregon, Washington and California; and Rocky Mountain Power in Utah, Wyoming and Idaho.

California ISO currently operates a real-time, five-minute dispatch for its existing customers and will make it available to PacifiCorp and future EIM participants. The EIM being developed through a California ISO stakeholder process will be a voluntary market for procuring imbalance energy to balance supply and demand deviations in real time from 15-minute energy schedules[193] and five-minute dispatch in the combined network of the California ISO and EIM Entities. Implementation of an EIM will provide economic, reliability, and renewable integration benefits for both balancing authorities.[194] California needs to encourage adequate participation by entities within California.

On April 30, 2013, the California ISO filed an implementation agreement with FERC.[195] The agreement sets forth the terms under which the California ISO will modify its real-time energy market to provide EIM service to PacifiCorp. On June 28, 2013, FERC approved the agreement with an effective date of July 1, 2013.[196]

One of the benefits noted by the California ISO is that the EIM takes advantage of the geographical diversity of load and resources. Wind resources produce at different times in the northwest and southwest, and electric loads peak at different times across the region as the sun moves westward. For example, wind power from Wyoming can be available at critical times when California's wind is not blowing and when the load on the California's electrical grid most requires it. The EIM will move resources to take advantage of this diversity.[197] California needs to encourage entities both within and outside California to join the California ISO's EIM to take advantage of the benefits of real-time balancing of loads and resources. To support this benefit, the University of Wyoming's Wind Research Center released a report, *Wind Diversity*

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193 FERC Order 764 requires the California ISO and other entities to offer a 15-minute scheduling option in the real-time market, which will reduce barriers to integration of variable energy resources. Implementation of these real-time market changes is expected in spring 2014, prior to the implementation of the EIM. For more information on FERC Order 764, see California ISO website at http://www.caiso.com/informed/Pages/StakeholderProcesses/FERCOrderNo764MarketChanges.aspx

194 Edson, Karen, California ISO, *Decision on PacifiCorp Energy Imbalance Market Implementation Agreement Board Memo*, March 19, 2013, p. 1, http://www.caiso.com/Documents/UpdatedDecisionPacifiCorpEnergyImbalanceMarketImplementationAgreement-Memo-Mar2013.pdf.

195 The implementation agreement filing with FERC can be found on the California ISO website at http://caiso.com/Documents/Apr30_2013EnergyImbalanceMarketImplementationAgreementPacifiCorpER13-1372-000.pdf

196 FERC's Order on the implementation agreement can be found on the California ISO website at http://www.caiso.com/Documents/Jun28_2013OrderAcceptingPacifiCorpEnergyImbalanceImplementationAgreement_ER13-1372-000.pdf

197 California ISO, *Energy Imbalance Market – Revised Straw Proposal*, May 30, 2013, p. 2, http://www.caiso.com/Documents/RevisedStrawProposal-EnergyImbalanceMarket-053013.pdf.

Enhancement of Wyoming/California Wind Energy Projects,[198] focusing on the importance of geographic diversity in wind resources and the benefits of combining Wyoming and California wind resources.[199]

In addition, integration of wind generation from Wyoming has the capability to shape California's wind portfolio and result in less reliance on fossil fuels and reduced GHG emissions.[200] For example, Pathfinder Renewable Wind Energy, LLC, is building high-quality wind generation in Wyoming. Pathfinder has two projects underway, Pathfinder Zephyr Wind and Whirlwind I. Pathfinder Zephyr Wind is partnering with landowner associations, ranchers, and farmers in Platte and Laramie counties to develop 2,000 MW to 3,000 MW of wind energy. In 2010, Pathfinder bid to use 70 percent of the capacity of the Zephyr Transmission Project.[201] In 2011, Pathfinder partnered with Whirlwind, LLC, to develop the Whirlwind I project, located near the proposed terminus of the TransWest Express Transmission Project near Rawlins, Wyoming. When TransWest Express holds its open season for transmission capacity, Whirlwind I plans to bid on its available capacity.[202]

Multistate and Publicly Owned Projects in the Transmission Planning Process

Duke-American Transmission Company (DATC) will develop, construct, own, and operate the Zephyr Power Transmission Project.[203] The transmission project is an 850-mile 500 kV high-voltage, direct-current (HVDC) line with a capacity of 3,000 MW that will originate near Chugwater, Wyoming and terminate south of Las Vegas, Nevada, in the Eldorado Valley with interconnection to the California ISO grid.[204] By the end of 2013, DATC will initiate the federal

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198 Naughton, Jonathan, Thomas Parish, and Jerad Baker, *Wind Diversity Enhancement of Wyoming/California Wind Energy Projects*, issued January 2013, http://wyia.org/wp-content/uploads/2013/01/final-report-wy-ca-geo-diversity-study1.pdf.

199 Ellison, Christopher T., Attorney for Pathfinder Renewable Wind Energy and Zephyr Power Transmission, LLC, comments on the *2013 Integrated Energy Policy Report*, Docket 13-IEP-1E, May 21, 2013, p. 5, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Pathfinder_and_Zephyr_Joint_Comments_on_May_7_Workshops_in_2013_IEPR_2013-05-21_TN-70925.pdf .

200 Ellison, Christopher T., Attorney for Pathfinder Renewable Wind Energy and Zephyr Power Transmission, LLC, comments on the *2013 Integrated Energy Policy Report*, Docket 13-IEP-1E, May 21, 2013, p. 8, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Pathfinder_and_Zephyr_Joint_Comments_on_May_7_Workshops_in_2013_IEPR_2013-05-21_TN-70925.pdf .

201 Pathfinder Renewable Wind Energy, LLC website, http://www.pathfinderwind.com/index.php/projects.

202 Pathfinder Renewable Wind Energy, LLC website, http://www.pathfinderwind.com/index.php/projects.

203 Zephyr Power Transmission Project overview, p. 2, http://www.datcllc.com/wp-content/uploads/2013/05/Zephyr-Overview-04.2.13-Print.pdf.

204 Ellison, Christopher T., Attorney for Pathfinder Renewable Wind Energy and Zephyr Power Transmission, LLC, comments on the *2013 Integrated Energy Policy Report*, Docket 13-IEP-1E, May 21, 2013,

and state right-of-way permitting process. DATC's target completion date for the Zephyr project is 2020.[205]

TransWest Express, LLC, is permitting and developing the TransWest Express Transmission Project (TWE). The TWE is a 725-mile, 600 kV HVDC line with a capacity of 3,000 MW. The project will deliver renewable energy to the Desert Southwest markets in Arizona, Nevada, and Southern California and provide a transmission backbone between the Intermountain and Desert Southwest regions. About 67 percent of the proposed route is on federal land administered primarily by BLM and the U.S. Forest Service. In October 2011, TWE was one of seven transmission projects designated as a Rapid Response Project by the Department of Energy's Rapid Response Team for Transmission. On June 28, 2013 the U.S. Environmental Protection Agency published in the *Federal Register* a "Notice of Availability" for the BLM/Western Area Power Administration's TransWest Express Draft EIS with a comment period that ends on September 25, 2013.[206] Construction is slated to begin in 2015 and take roughly three years to complete.[207]

Clean Line Energy Partners LLC is developing the Centennial West Clean Line Transmission Project as an estimated 900-mile, +/- 600 kV HVDC line with a capacity of 3,500 MW that would connect wind and solar resources in New Mexico and Arizona directly to the southern California grid. The line route has not yet been determined. In January 2011, Clean Line submitted an application for right-of-way across Federal lands and a preliminary Plan of Development to the BLM. Construction is estimated to begin in 2017 and the project could begin operations by 2020.[208]

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pp. 2-3, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Pathfinder_and_Zephyr_Joint_Comments_on_May_7_Workshops_in_2013_IEPR_2013-05-21_TN-70925.pdf.

205 Zephyr Power Transmission Project overview, p. 2, see DATC website at: http://www.datcllc.com/wp-content/uploads/2013/05/Zephyr-Overview-04.2.13-Print.pdf.

206 The Notice of Availability can be found in *Federal Register*/Volume 78, No.125/Friday, June 28, 2013/Notices, p. 38975, at: http://www.gpo.gov/fdsys/pkg/FR-2013-06-28/pdf/2013-15612.pdf The Draft EIS can be found on the EPA website at http://yosemite.epa.gov/oeca/webeis.nsf/EIS01/6DDACAE22181AD1A85257B9C001BD82E?opendocument.

207 Smith, David F., TransWest Express, LLC, comments on the 2013 IEPR – Transmission Planning and Permitting Issues (13-IEP-1E), Docket 13-IEP-1E, May 22, 2013, p.1, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/TransWest_Express_LLC_Comments_re_Transmission_Planning_and_Permitting_Issues_2013-05-21_TN-70927.pdf.

208 Clean Line Energy Partners Centennial West Clean Line Website, http://www.centennialwestcleanline.com/site/home.

Startrans IO is a participating transmission owner in the California ISO balancing area authority that is requesting the California ISO to consider an alternative project as part of the 2013-2014 TPP. The Mead Upgrade Phase I involves converting the existing Mead-Adelanto[209] 500 kV transmission line from alternating current to HVDC operation that would bring in 2,200 MW of additional capacity into Southern California, and the intermittency issue would no longer need to be addressed.[210] Mead-Adelanto is owned by municipal utilities in Southern California (Southern California Public Power Authority), Western Area Power Administration, Modesto Irrigation District, City of Santa Clara and City of Redding, and Startrans.[211] The transmission line was originally designed, built, and permitted with HVDC standards.[212] The upgrade will use the existing towers and conductors, construct converter stations on a low environmental 40-acre footprint on each end, and install 13 miles of new transmission line for maintaining reliability and integrating into the existing system. Estimated completion of the project is in 2017.[213] This project provides an opportunity to take advantage of the existing unused capacity on existing conductors and bring new generation from a generation-rich region to SCE's load centers.[214]

During the California ISO's 2012-2013 TPP, the Zephyr and TransWest Express transmission projects requested to be studied as economic projects. At the May 2013 *IEPR* workshop, DATC stated there is not a mechanism in the California ISO transmission planning process that looks at out-of-state generation to get an economic study and the benefits quantified to make an informed decision. One of DATC's recommendations at the workshop was to "start planning for transmission now, plan for more than you might need because it's much easier to scale back

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209 The Mead-Adelanto project, built in 1995, is a 202-mile 500 kV AC transmission line from the existing Adelanto Substation in Southern California to the existing Marketplace Substation near Boulder City, Nevada, with a rating of 1,291 MW. See Southern California Public Power Authority website: http://www.scppa.org/pages/projects/mead_adelanto.html.

210 Amirali, Ali, Starwood Energy Group, *Transcripts From Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues*, May 7, 2013, p. 119, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

211 Southern California Public Power Authority participants include Anaheim, Azusa, Banning, Burbank, Colton, Glendale, LADWP, Pasadena and Riverside with 67.92 percent ownership rights. The remainder of the ownership on the line includes Western (8.33 percent), Startrans (6.25 percent) and Modesto Irrigation District, City of Santa Clara and City of Redding (M-S-R 17.5 percent).

212 Amirali, Ali, Starwood Energy Group, transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues, May 7, 2013, p. 118, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

213 Ibid, p. 119.

214 Ibid, p. 118.

and not build it than it is to try and catch up."[215] TWE made similar comments requesting an analysis about how out-of-state transmission projects would be incorporated into a system, and does it make sense to incorporate them. TWE's request to the Energy Commission was for consideration about how out-of-state projects could fit into a broader transmission plan.[216] Startrans requested that in meeting the state's energy policy goals the Energy Commission develop a means to submit these projects into the California ISO, and help the California ISO in defining the policy projects and getting ahead of the curve.[217] Clean Line Energy Partners sent letters to the Energy Commission[218] and CPUC[219] requesting support at the California ISO for their recommendation of including out of state transmission in the GIDAP that would benefit the Centennial West Clean Line Transmission Project and other out of state transmission projects. Both agencies found no compelling reason to support Clean Line's recommendation since investor-owned utilities have reached 20 percent renewables and have contracted to meet 33 percent renewables even with some degree of contract failure by 2020. In addition, Chair Weisenmiller identified more pressing policy issues dealing with the reliability of the transmission and distribution system. Some of these issues include:

- Reliability of transmission in Orange County and the San Diego regions with the recent shutdown of San Onofre.
- Increasing the utilization and efficiency of the existing transmission with an energy imbalance market in the West.
- California ISO interconnection queue management.
- The need for a more coordinated effort for environmental and land-use planning of transmission lines identified in the California ISO's Transmission Planning Process.

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215 Gates, Jeff, Duke American Transmission Company, transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues, May 7, 2013, p. 132, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

216 Smith, David, representing TransWest Express, *transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues*, p.138, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

217 Amirali, Ali, Starwood Energy Group, *transcripts from Lead Commissioner Workshop on California and Western States Transmission Planning and Permitting Issues*, May 7, 2013, p. 120, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_afternoon.pdf.

218 Weisenmiller, Robert B., California Energy Commission, Letter to Ms. Jayshree Desai dated January 9, 2013, Clean Line Energy Partners, LLC, Docket No. 13-IEP-1E, TN 71925, August 29, 2013.

219 Florio, Michel P., California Public Utilities Commission, Letter to Ms. Jayshree Desai dated January 18, 2013, Clean Line Energy Partners, LLC, Docket No. 13-IEP-1E, TN 71926, August 29, 2013.

Both agencies encouraged Clean Line Energy Partners to participate in the California ISO's generator interconnection procedures stakeholder process, which is the proper venue for vetting their recommendation.

NV Energy Acquisition by MidAmerican Energy

On May 29, 2013, MidAmerican Energy Holdings, a Berkshire Hathaway subsidiary, acquired NV Energy in Nevada. MidAmerican Energy Holdings' other acquisitions include PacifiCorp, Nevada Power, and Rocky Mountain Power. NV Energy is working with the California ISO in developing joint transmission projects between Nevada and California. Also, PacifiCorp, Nevada Power, and Rocky Mountain Power will be participating in the EIM being developed by the California ISO. In addition, MidAmerican Energy Holdings is developing transmission and renewable projects in the West. The company's Energy Gateway Transmission Project is under construction and proposes to connect PacifiCorp's wind and gas assets in Wyoming with its Rocky Mountain Power subsidiary in Utah and its Pacific Power unit in Oregon.

Westlands Solar Park

Westlands Water District (WWD) is proposing to establish the Westlands Solar Park Master Plan and Related Facilities (WSP). Located in west-central Kings County, the area affected is almost entirely cultivated agricultural land. The WWD issued a Notice of Preparation for a draft EIR in April 2013 for potential conversion of 24,000 acres from farmland into a solar park. Over a 12-year period, WWD expects to build a utility-scale solar energy generation facility capable of producing about 2,400 MW.[220]

The proposed WSP area would lead to major changes on existing transmission lines in the area: construction of a new 230 kV transmission line running parallel and adjacent to the existing 230 kV Henrietta-Gates transmission line; potential upgrade to Path 15, the major north-south high-voltage transmission line between northern and southern California between the Gates and Los Banos Substations; and construction of a new Helm-Gregg transmission line that interconnects the Helm Substation (not to be confused with the Helms Pumped Storage Facility in the Sierras) with the Gregg Substation.[221] An alternative that could be explored is to study the use of lower voltage (69 kV and 115 kV) collection lines and interconnect into existing substations.

Supporters of using previously disturbed agricultural land that is no longer productive for development of renewable energy resources include the Defenders of Wildlife[222] and the Natural Resources Defense Council.[223]

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220 https://cs.westlandswater.org/resources/resources_files/misc/environmental_docs/WWD-WSP-NOP-Final_3-13-2013.pdf

221 https://cs.westlandswater.org/resources/resources_files/misc/environmental_docs/WWD-WSP-NOP-Final_3-13-2013.pdf, p. 2-3.

222 https://www.defenders.org/sites/default/files/publications/smartfromthestartreport12_print.pdf.

223 http://switchboard.nrdc.org/blogs/czichella/growing_a_solar_park_in_califo.html

Emerging Trends in the Western Interconnection

Restructuring the Western Electricity Coordinating Council

Regional oversight of the operation of the high-voltage transmission system in the Western Interconnection is the responsibility of the Western Electricity Coordinating Council (WECC). Its primary mission is to "maintain a reliable electric power system in the Western Interconnection that supports efficient, competitive power markets." WECC functions under a delegation agreement with the North American Electric Reliability Corporation (NERC), the electricity reliability organization for the United States. Under this agreement, WECC is responsible for implementing and enforcing compliance with the mandatory reliability standards put in place by FERC. WECC is funded through provisions of Section 215 of the Federal Power Act, as approved by FERC. WECC also has contractual arrangements with the governments of British Columbia, Alberta, and Baja Norte Mexico to assist those governments in assuring that entities in their territories with electric system planning and operating responsibilities in the Western Interconnection meet comparable reliability requirements.

Since its formation in 2002, WECC has been governed by a large "hybrid" board of directors, composed of a combination of 26 stakeholder directors and 7 independent directors. The seven member classes include large transmission owners, small transmission owners, other electric lines of business entities (generators/marketers), states/provinces, consumers, Canadian members, and "other." Key functions WECC undertakes include enforcing continent-wide reliability standards; developing and enforcing additional reliability requirements for the Western Interconnection; performing interconnection reliability coordination and interchange authority responsibilities; establishing flow ratings for transmission paths, including capacity ratings for proposed transmission projects and seasonally updated operating path ratings, taking into account actual changes in Western Interconnection topology; conducting interconnection-wide transmission expansion planning; housing the Western Renewable Energy Generation Information System (WREGIS); and providing annual assessments of resource adequacy to NERC for inclusion in national adequacy assessments.

An important new initiative in the West, led by the WECC Board of Directors at the behest of NERC and FERC commissioners, is the restructuring of WECC. This proposal could, if approved by the membership of WECC, lead to bifurcation and changes in governance of WECC, among other changes. The following subsections briefly describe the proposal, the schedule and status of the proposal, and potential implications for states.

Proposed Restructuring

The most significant elements of the proposal are related to structure, governance, and funding. With respect to structure, the WECC Board has approved splitting WECC into two entities: a new reliability coordination company (RCCo) and the existing reliability entity that would be WECC. The goal is to separate the responsibility for real-time reliability operation from the regulatory oversight functions of standards development and compliance enforcement. Each entity would be incorporated independently and would have separate boards of directors (described below).

For governance, significant changes would be made. Specifically, there would no longer be a hybrid or stakeholder board that governs decisions. Instead, there would be complete independence required of all board members, with no affiliation with WECC members. The RCCo would be governed by a seven-member independent board and the RE by a nine-member independent board. To address membership concerns, each board would be advised by a strong member advisory committee, consisting of three members from each of five classes: large transmission owners, small transmission owners, end users, other electric lines of business entities, and states.

With respect to funding, FERC has been petitioned to approve Section 215 funding for all functions of both entities.

Status and Potential Implications

All major decisions have been made by the board and the membership has approved bylaw revisions needed to implement bifurcation. On June 27, 2013, the WECC Board of Directors approved bifurcation of the company into a Regional Entity (WECC) and a reliability coordination company (RCCo). Two new member advisory committees have been formed with elected representatives. Candidates for independent board of director positions will likely be nominated in late summer 2013 with elections held in the fall. It is possible that the new RCCo will go live in January 2014.

The process has not been without opposition, and some members of the large and small transmission owner classes have raised substantial objections to the governance and bylaw changes. Key entities in California have raised concerns, including the California ISO, SDG&E, the Western Area Power Authority, and others. Successful implementation will depend on cooperation of affected parties and could be deterred by potential litigation. Final approval will rest with the NERC in approving a revised delegation agreement and by FERC in approving funding and all reliability-related matters for jurisdictional entities.

Potential implications of restructuring moving forward include the following:

- WECC members, including states, lose direct representation with an independent board.
- Eastern United States directors may become more prominent than on the current board because of the requirement for all directors to be nonaffiliated with western entities.
- An independent board may be more inclined toward regional transmission operator-like functions that have not traditionally been pursued in the Western Interconnection.
- Contingency reserve requirements and other standards essential to reliable operations may change.
- Continuing location and funding of WREGIS and interconnection-wide transmission planning could face increased scrutiny.
- Consensus support for one interconnection-wide reliability coordinator or regional entity function may be eroded.

Observations

WECC is important to California and the western states and provinces because it performs functions that are essential to the electricity industry. Key among these are establishing and maintaining path ratings for major transmission paths, studying safe operations, and undertaking systematic examinations of disturbances to learn from them and continuously improve reliable operations. Under the delegation agreement, WECC enforces compliance with reliability standards whose implementation costs are significant and paid for by all consumers and the state economy. Violations of standards anywhere in the 1.8 million-mile Western Interconnection territory can cause hugely disruptive cascading outages that result in substantial economic damage. With the largest load centers in the Western Interconnection, California can bear the brunt of cascading outages, such as those that occurred in the mid 1990s and again in September 2011. It is thus important that California closely monitor implementation of changes at WECC as approved by the membership.

Presidential Memorandum on Improved Transmission Siting, Permitting, and Review

On June 7, 2013, the White House issued a presidential memorandum titled *Transforming Our Nation's Electric Grid Through Improved Siting, Permitting, and Review*.[224] The memorandum builds on the work of the administration's Rapid Response Team for Transmission (RRTT) aimed at improving the performance of federal siting, permitting, and review for infrastructure development.[225] In particular, the memorandum builds upon the work of the RRTT related to transmission projects, noting that a transmission project may cross multiple jurisdictions over hundreds of miles, thereby requiring robust coordination among federal, state, local, and tribal governments. The memorandum notes that an important avenue for improving these processes is the designation of corridors on federal land because the designation of such corridors can help expedite siting, permitting, and review for projects within such corridors and improve the predictability and transparency of these processes.

The memorandum also builds upon previous corridors designated under to Section 368 of EPAct-05. In January 2009, the Secretaries of the Interior and Agriculture designated energy corridors in the 11 contiguous Western states.[226] In July 2009 environmental groups sued various agencies of the federal government, challenging their compliance with EPAct-05 and the National Environmental Policy Act, and challenged several Records of Decisions and some

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224 Available at http://www.whitehouse.gov/the-press-office/2013/06/07/presidential-memorandum-transforming-our-nations-electric-grid-through-i.

225 The Rapid Response for Transmission Team (RRTT) aims to improve the overall quality and timeliness of electric transmission infrastructure permitting, review, and consultation by the Federal government on both Federal and nonfederal lands. The RRTT is focusing initially on seven pilot project transmission lines, one of which is the TransWest Express Transmission Project, discussed earlier in the chapter. For more information on the Rapid Response Team for Transmission, see http://www.whitehouse.gov/administration/eop/ceq/initiatives/interagency-rapid-response-team-for-transmission.

226 For more information, see the Westwide Energy Corridor Programmatic EIS Information Center website at: http://corridoreis.anl.gov/.

requirements of the Endangered Species Act. On July 3, 2012, the parties filed a settlement agreement that required the completion of a new memorandum of understanding among the parties within 12 months and, that once signed, "the agencies will commence a periodic review of section 368 corridors, with recommendations due twelve months thereafter."[227] According to the Wilderness Society, "Through the settlement, the designations will be reevaluated and revised to better: avoid environmentally sensitive areas, diminish proliferation of dispersed right-of-ways (ROWs), and facilitate development of renewable energy projects."[228]

The Energy Commission believes the tasks outlined in the presidential memorandum are timely, appropriate, and consistent with the state's transmission corridor designation process established by SB 1059. In particular, the Energy Commission agrees with the "Principles for Establishing Energy Corridors" in section 1 of the memorandum. These include facilitation of renewable resources; collaboration with state, local, and tribal governments to ensure that energy corridors can connect effectively between federal lands; and designing energy corridors to minimize environmental and cultural resource impacts to the extent practicable, including impacts that may occur outside the boundaries of federal lands. The Energy Commission also supports the memorandum's encouragement of the use of designated federal corridors and the steps to be taken to consider additions, deletions, and revisions to those corridors as outlined in Section 2 of the memorandum "Energy Corridors for the Western States." Finally, the Commission appreciates the focus of Section 4 "Improved Transmission Siting, Permitting, and Review Processes" and supports the creation of an integrated, interagency preapplication process for significant transmission projects requiring federal approval.

Recommendations

- **Encourage participation in the energy imbalance market.** To take advantage of the benefits of real-time balancing of load and resources and the regional diversity in renewable resources, the state should encourage entities both within and outside California to join the California ISO's energy imbalance market.
- **Identify long-term transmission solutions and ways to reduce transmission permitting timelines.** The energy agencies should continue to work together to analyze and recommend the long-term potential transmission solutions to address reliability concerns associated with the recent shutdown of San Onofre. The energy agencies should continue to explore ways to achieve the Governor's goals on reducing the permitting time for transmission projects in California.
- **Evaluate deliverability requirements.** The cost-effectiveness, prudency, and alternatives for requiring full deliverability for future renewable generation that is procured to meet RPS requirements should be evaluated by California's energy agencies in the overall context of long-term planning for meeting RPS and greenhouse gas emission reduction goals.

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227 For more information, see the settlement agreement at http://corridoreis.anl.gov/documents/docs/Settlement_Agreement_Package.pdf.

228 http://www.npca.org/assets/pdf/Settlement_Facts_West_Wide_Energy_Corridors.pdf, p. 1.

- **Identify transmission corridors.** From a timing perspective, it makes sense to identify and designate, where appropriate, transmission corridors in advance of future generation development so that needed transmission projects can be permitted and built in an effective, environmentally responsible manner, contemporaneous with the generation development. The Energy Commission will work with the utilities; federal, state, and local agencies; and stakeholders to identify transmission line corridors that are a high priority for designation such as those corridors that would ease the development of renewable energy resources. Appropriate corridors could be identified as a result of the Desert Renewable Energy Conservation Plan effort, future examination of opportunities and needs in the Central Valley, and the ongoing San Onofre transmission alternatives under consideration.

CHAPTER 6:
Nuclear Power Plants

In 2011, nuclear power played a significant role in California's energy mix, providing roughly 18 percent of California's in-state electricity generation. This generation came from three plants: the Diablo Canyon Power Plant (Diablo Canyon) and the San Onofre Nuclear Generating Station (San Onofre) in California, and the Palo Verde nuclear power plant in Arizona. Given the importance of California's nuclear facilities to the state's electricity supply, in 2006 Assembly Bill 1632 (Blakeslee, Chapter 722, Statutes of 2006) directed the Energy Commission to evaluate major issues related to the future role of these plants in the state's energy portfolio. The Energy Commission issued the *Assessment of California's Nuclear Power Plants: AB 1632 Report* as part of the *2008 Integrated Energy Policy Report Update*, which included a detailed list of recommendations on issues such as seismic events, plant aging, and potential effects of plant disruption on reliability, public safety, and the economy.

In 2011, the disaster at the Fukushima Daiichi nuclear plant in Japan heightened concerns about safety issues for California's coastal nuclear plants. The Nuclear Regulatory Commission (NRC) established a task force to evaluate what lessons might apply to the safety of United States reactors and instructed NRC plant inspectors to conduct immediate, independent assessments of each plant's level of emergency preparedness. In 2011, the NRC's Near-Term Task Force (NTTF)[229] issued post-Fukushima recommendations for enhancing reactor safety and a priority list of actions and, following up on the AB 1632 report, the *2011 IEPR* called for utilities to report on their progress to implement report recommendations related to seismic and tsunami hazard studies and emergency response planning.

On June 7, 2013, Southern California Edison (SCE) announced it was permanently closing San Onofre because of economic considerations and continued regulatory uncertainty related to plans to restart Unit 2 at reduced power. Both Units 2 and 3 had been shutdown since January 2012 due to damaged steam generator tubes. While the San Onofre closure has made some of the *2011 IEPR* recommendations obsolete, concerns remain about the storage of spent nuclear fuel onsite and plans for decommissioning.

This chapter discusses progress toward implementing recommendations made in the *AB 1632 Report* and the *2011 IEPR*, and by the NRC's Near-Term Task Force. It also summarizes recent federal efforts on nuclear waste transport, storage, and disposal; pending legislative proposals on nuclear issues; and events related to the shutdown of the San Onofre Units 2 and 3 that ultimately led to SCE's announcement to permanently close the plant.

229 The Near-Term Task Force was established in response to NRC direction to conduct a systematic and methodical review of U.S. NRC processes and regulations to determine whether the agency should make additional improvements to its regulatory system and to make recommendations to the NRC for its policy direction, in light of the accident at the Fukushima Daiichi Nuclear Power Plant.

Background

In 2006, AB 1632 directed the Energy Commission to assess the potential vulnerability of "large baseload generation facilities of 1,700 megawatts or greater" to a major disruption due to a seismic event or plant age-related issues. In response to AB 1632 and as part of the *2008 IEPR Update*, the Energy Commission developed *An Assessment of California's Nuclear Power Plants: AB 1632 Report.*[230] The *AB 1632 Report* addressed seismic and tsunami hazards, reliability concerns, and specific vulnerabilities of Diablo Canyon[231] and San Onofre [232] and made policy recommendations that were incorporated into the *2008 IEPR Update*. Beginning with the *2009 IEPR*, Pacific Gas and Electric Company (PG&E) and Southern California Edison (SCE) have reported every two years on their progress in implementing the *AB 1632 Report* recommendations. Several policy recommendations from the *2011 IEPR* also call for updates and progress reports from PG&E and SCE.

Since the March 2011 Fukushima Daiichi nuclear disaster,[233] the NRC has been working to understand the events in Japan and relay important information to U.S. nuclear power plants. In July 2011, the NRC's NTTF provided recommendations to enhance U.S. reactor safety[234] and these became the foundation for the NRC's post-Fukushima activities. The NRC has since created the Japan Lessons Learned Project Directorate in the Office of Nuclear Reactor Regulation to implement those recommendations.

The U.S. Department of Energy (U.S. DOE) has for decades worked toward resolving issues associated with the safe transport, storage, and permanent disposal of nuclear waste. In January 2013, the U.S. DOE issued the *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*[235] as a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel

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230 California Energy Commission, *An Assessment of California's Nuclear Power Plants: AB 1632 Report*, October 2008, CEC-100-2008-009-CMF, available at http://www.energy.ca.gov/2008publications/CEC-100-2008-009/CEC-100-2008-009-CMF.PDF

231 Diablo Canyon is located north of Avila Beach in San Luis Obispo County and is owned by Pacific Gas and Electric Company.

232 San Onofre is located south of San Clemente in San Diego County and is co-owned by Southern California Edison, San Diego Gas & Electric, and Riverside Public Utilities.

233 On March 11, 2011, a 9.0-magnitude earthquake struck Japan and was soon followed by a tsunami, estimated to have exceeded 45 feet (14 meters) in height, resulting in extensive damage to the six nuclear power reactors at the Fukushima Daiichi site.

234 Recommendations for Enhancing Reactor Safety in the 21st Century, July 12, 2011 http://pbadupws.nrc.gov/docs/ML1118/ML111861807.pdf

235 http://energy.gov/sites/prod/files/Strategy%20for%20the%20Management%20and%20Disposal%20of%20Used%20Nuclear%20Fuel%20and%20High%20Level%20Radioactive%20Waste.pdf

and high-level radioactive waste from civilian nuclear power generation, defense, national security, and other activities.

The NRC's Waste Confidence Decision and Rule represent the generic determination by the NRC that spent nuclear fuel can be stored safely and without significant environmental effects for a period of time after the end of the licensed life of a nuclear power plant. However, on June 8, 2012, the U.S. Court of Appeals for the District of Columbia Circuit found that some aspects of the NRC's 2010 Decision did not satisfy the NRC's National Environmental Policy Act (NEPA)[236] obligations and vacated the decision and rule. The court indicated that the NRC needed to add discussions concerning the consequences of failing to secure permanent disposal for spent nuclear fuel and the effects of certain aspects of potential spent fuel pool leaks and spent fuel pool fires. On August 7, 2012, the NRC suspended all final licensing activities that rely on the decision[237] and created a Waste Confidence Directorate within the Office of Nuclear Material Safety and Safeguards to oversee the drafting of a new Waste Confidence Generic Environmental Impact Statement (GEIS) and Rule.

In 2012, the percentage of nuclear generation in California's power mix dropped by half to about 9 percent[238] because of the total loss of generation from the outage at San Onofre.[239] Beginning in January 2012, San Onofre was taken offline due to unexpected degradation of the newly installed steam generator tubes in both Units 2 and 3. Damage to Unit 3 was extensive, and the fuel was removed in late 2012. After many months of uncertainty regarding the possibility of restarting Unit 2, on June 7, 2013, SCE announced plans to permanently retire San Onofre Units 2 and 3.[240]

Implementing AB 1632 Report and *2011 IEPR* Recommendations

The *AB 1632 Report* made recommendations that required the utilities to report biennially on topics such as seismic vulnerability, plant aging-related degradation, impacts of a major disruption, economic and environmental policy issues, nuclear waste accumulation, and licensing renewal issues. The *2011 IEPR* included recommendations on seismic issues, the spent

236 Signed into law on January 1, 1970, NEPA was the first major environmental law in the United States. NEPA requires federal agencies to assess the environmental effects of their proposed actions before making decisions.

237 http://pbadupws.nrc.gov/docs/ML1222/ML12220A100.pdf

238 Percentage excludes imported electricity. Source: Installed Capacity Tracking Progress, Table 2: In-State Electric Generation by Fuel Type from Power Plants Larger than 1 MW, pg. 4.

http://www.energy.ca.gov/renewables/tracking_progress/documents/installed_capacity.pdf

239 San Onofre Units 2 and 3 have been offline since January 2012 due to unexpected degradation of tubes in the newly installed steam generators; see http://www.nrc.gov/info-finder/reactor/songs/tube-degradation.html

240 http://www.songscommunity.com/news2013/news060713.asp

fuel pool and Independent Spent Fuel Storage Installation (ISFSI), station blackout, liability coverage, Fukushima lessons learned, and plant safety.

Much of the reporting from utilities on these topics covers activities that are taking place concurrently or are ongoing. Some of the activities involve processes that will take many years to complete. This section discusses progress made on activities that are new or continuing (see Appendix I for a Summary and Status of all *2011 IEPR* Nuclear Policy Recommendations).

Diablo Canyon

Seismic and Tsunami Hazards

The *AB 1632 Report* recommended that PG&E report on the overall status of ongoing efforts to understand seismic hazards affecting the Diablo Canyon site through its Long Term Seismic Program (LTSP) and the results of the research. NRC NTTF recommendation 2.1 requires nuclear power plants to conduct seismic hazard and risk evaluations in conformance with the Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 process as outlined in the NRC's NUREG-2117, *Practical Implementation Guidelines for SSHAC Level 3 and 4 Hazard Studies.*[241] Risk evaluations are required for plants where the hazard exceeds the design basis of the plant. Based on the information from the seismic hazard and risk evaluations, the NRC will determine appropriate regulatory actions (such as issuing orders for upgrades to the plant).

A seismic hazard update is underway for the Diablo Canyon site that will use an updated Seismic Source Characterization (SSC) and updated Ground Motion Characterization (GMC) as basic inputs to a site-specific probabilistic seismic hazard analysis (PSHA). The SSC describes the future earthquake potential (that is, magnitudes, locations, and rates) for the region surrounding the Diablo Canyon site, and the GMC describes the distribution of the ground motion as a function of magnitude, style-of-faulting, source-to-site geometry, and site condition.

The Diablo Canyon SSHAC Level 3 study started in April 2011. The project was designed as a combined SSC and GMC study. In June 2012, the study was divided into two SSHAC Level 3 studies – a site-specific SSC project for the Diablo Canyon site region and a regional GMC study that would be applicable to the Southwest United States (SWUS). The new project structure and organization of the SWUS GMC included SCE and Arizona Public Services. Workshop 2 for the SSHAC SSC study was held in November 2012 with the primary goal of interactively using the "Proponent Experts"[242] to explore the center, body, and range of technical defensible interpretations for the SSC for the Diablo Canyon region, with a focus on those parameters most significant to the seismic hazard.

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241 http://pbadupws.nrc.gov/docs/ML1211/ML12118A445.pdf

242 A proponent expert advocates a particular hypothesis or technical position. Examples of proponent experts include representatives from federal agencies (for example, U.S. Geological Survey), educational institutions, organizations representing the scientific community (such as the Southern California Earthquake Center), and specialized consultants.

The SWUS GMC Workshop 2 is planned for October 2013. Workshop 3, "Preliminary Model and Hazard Feedback," is scheduled for the first quarter of 2014 for both the SSC and SWUS GMC SSHAC studies. The completion of the study is on track for March 2015, with an updated site-specific PSHA and new ground motion response spectra.

One outstanding issue related to the seismic hazards affecting Diablo Canyon is the evaluation of seismic hazards against the plant's licensed design basis. Two elements of the design basis, the Design Earthquake[243] (DE) and the Double Design Earthquake[244] (DDE), include more conservative assumptions about seismic hazards than the third element, the Hosgri Evaluation, which was the basis for the Diablo Canyon's LTSP ground motion response spectra. In August 2011, the NRC noted,[245] that "Region IV was unable to confirm the licensee's statements that new seismic information was only required to be evaluated under the LTSP. Although the LTSP margin analysis demonstrated that the new Shoreline Fault Zone information was bounded by the [Hosgri Evaluation[246]], the licensee didn't evaluate the new seismic information against the other two design basis earthquakes, the DE and DDE."

The NRC concluded that the Hosgri Evaluation was not by itself bounding for Diablo Canyon seismic qualification. New seismic information developed by PG&E must be evaluated against all three of the seismic design basis earthquakes and the assumptions used in the supporting safety analysis; comparison to the LTSP by itself is not sufficient.

In November 2011, PG&E reported on the implications of this issue in its quarterly report to the Securities Exchange Commission:[247] "the NRC found that a report submitted by the Utility to the NRC on January 7, 2011 to provide updated seismological information did not conform to the requirements of the current Diablo Canyon operating license. On October 21, 2011, the Utility filed a request that the NRC amend the operating license to address this issue. If the NRC does not approve the request the Utility could be required to perform additional analyses of Diablo Canyon's seismic design which could indicate that modifications to Diablo Canyon

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243 Design Earthquake (0.2g) – The amount of vibratory ground motion for which those plant features necessary for continued operation remain functional without undue risk to the health and safety of the public.

244 Double Design Earthquake (0.4g) – The evaluation of the maximum earthquake potential (producing the maximum vibratory ground motion) for which structures, systems, and components needed to prevent or mitigate an accident will remain functional, allowing for some plastic deformation of structural material.

245 Task Interface Agreement, Concurrence on Diablo Canyon Seismic Qualification Current Licensing and Design Basis (TIA 2011-010) http://pbadupws.nrc.gov/docs/ML1121/ML112130655.pdf

246 Hosgri Event (0.75g) – A postulated 7.5 M earthquake (unique to Diablo Canyon) assumed to occur on the Hosgri Fault line. Only equipment credited in the alternate Hosgri Event shutdown path is required to remain functional following a Hosgri design basis earthquake.

247 Form 10-Q Quarterly Report Pursuant to Section 13 OR 15(d) of the Securities Exchange Act of 1934 , Period ended September 30, 2011
http://www.sec.gov/Archives/edgar/data/75488/000119312511295273/d234790d10q.htm.

would be required to address seismic design issues. The NRC could order the Utility to cease operations until the modifications were made or the Utility could voluntarily cease operations if it determined that the modifications were not economical or feasible."

PG&E withdrew the proposed license amendment after NRC staff allowed it to delay the DDE test until completion of its post-Fukushima seismic evaluation (that is, the current SSHAC process) in 2015. This action by the NRC resulted in assertions by the Alliance for Nuclear Responsibility[248] that Diablo Canyon is operating in violation of its licensing conditions and that NRC staff, by electing to waive enforcement of the DDE criteria for operability determinations against the new seismic information associated with the Shoreline Fault, the San Luis Bay Fault, and the Los Osos Fault, has in effect approved a "*de facto*" license amendment.[249]

The NRC has indicated that for Diablo Canyon, the probabilistic hazard analysis will likely exceed the DDE, and plant risk evaluations will be needed.[250] Plant risk evaluations include an expedited and a complete plant risk evaluation. PG&E has already performed a seismic probabilistic risk assessment (PRA) but will need to update it to account for new, reevaluated ground motion levels that will be coming out of the SSHAC process.

The *AB 1632 Report* also included a recommendation that PG&E use three-dimensional geophysical seismic reflection mapping and other advanced techniques to explore fault zones near Diablo Canyon. In November 2012, PG&E's plans to conduct the recommended 3-D, high-energy seismic surveys offshore of Diablo Canyon were denied by the California Coastal Commission,[251] partly because of potentially significant environmental impacts.[252] As a result, no high-energy marine seismic surveys have been conducted. However, PG&E still plans to conduct a number of other surveys and studies, such as low-energy two-dimensional and 3D, (which the Diablo Canyon Independent Peer Review Panel[253] will continue to review), in

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248 The Alliance for Nuclear Responsibility identifies itself as a non-profit organization that works to educate and protect the citizens of the State of California and future generations from the dangers of radioactive contamination. http://a4nr.org.

249 Prepared Rebuttal Testimony of John Geesman on Behalf of the Alliance for Nuclear Responsibility Before the California Public Utilities Commission, June 28, 2013, http://a4nr.org/wp-content/uploads/2013/06/A-12-11-009-Rebuttal-Testimony-_-Apend.pdf.

250 Cliff Munson, US NRC, Lead Commissioner Workshop on California Nuclear Power Plant Issues, June 19, 2013.

251 The California Coastal Commission also objected to PG&E's certification of the proposed project's consistency with California's approved coastal zone management program because the proposed project did not meet the first test of Coastal Act Section 30260 (the Coastal Act's coastal-dependent industrial development "override" policy). http://www.coastal.ca.gov/fedcd/cach3.pdf

252 California Coastal Commission Staff Report and Addendum, November 13, 2012. http://documents.coastal.ca.gov/reports/2012/11/W13b-11-2012.pdf.

253 The Diablo Canyon Independent Peer Review Panel is a multi-agency panel of seismic hazard specialists who work under the auspices of the CPUC to provide independent review of PG&E's plans and analyses of enhanced seismic studies. Established by CPUC Decision 10-08-003

addition to seismic hazard reevaluations being performed as required by NRC NTTF recommendations.

Vulnerabilities

PG&E completed a tsunami hazard study titled "Pacific Gas & Electric Company, Methodology for Probabilistic Tsunami Hazard Analysis: Trial Application for the Diablo Canyon Power Plant Site" on April 9, 2010.[254] PG&E found no new hazards that warrant inclusion into the Diablo Canyon design and license basis. The NRC's 50.54(f) request for information[255] regarding NTTF Recommendation 2.1 directed all licensees to perform a flood hazard reevaluation of all appropriate external flooding sources, including the effects from local intense precipitation on the site, probable maximum flood on stream and rivers, storm surges, seiches,[256] tsunami, and dam failures. The flood hazard reevaluation serves to collect information for the NRC to determine if there is a need to update the design basis and systems, structures, and components important to safety to protect against updated hazards at operating reactor sites. In response to this request, PG&E agreed to perform a flood hazard reevaluation and provide a final report documenting results, as well as pertinent site information and detailed analysis by March 12, 2015.[257] Along with this flood hazard reevaluation, PG&E will consider new and significant information and research conducted since the 2010 Probabilistic Tsunami Hazard Analysis draft was completed (such as sea level rise and extreme wave characteristics).

The inventory of the Diablo Canyon spent fuel pools as of June 2013 was 2,112 spent nuclear fuel assemblies, including 1,060 assemblies from Unit 1 and 1,052 assemblies from Unit 2.[258] PG&E's *2011 IEPR* response indicated that the spent fuel pool inventory was 2,164 assemblies and that the ISFSI contained 16 storage casks, each containing 32 spent fuel assemblies. In 2012,

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(http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/122059.pdf), its members include representatives from the California Geological Survey, California Coastal Commission, California Emergency Management Agency, California Energy Commission, California Seismic Safety Commission, California Public Utilities Commission, and the County of San Louis Obispo. IPRP reports are available on the CPUC's website on nuclear power: http://www.cpuc.ca.gov/PUC/energy/nuclear.htm.

254 https://www.pge.com/regulation/DiabloLicenseRenewal/Other-Docs/PGE/2011/DiabloLicenseRenewal_Other-Doc_PGE_20110201Atch01_205921.pdf.

255 http://pbadupws.nrc.gov/docs/ML1205/ML12054A735.pdf.

256 A *seiche* is a wave that oscillates in lakes, bays, or gulfs from a few minutes to a few hours as a result of seismic or atmospheric disturbances.

257 http://pbadupws.nrc.gov/docs/ML1233/ML12333A145.pdf.

258 *2013 Integrated Energy Policy Report*: Pacific Gas and Electric Company Supplemental Response to Nuclear Data Request, June 18, 2013. http://www.energy.ca.gov/2013_energypolicy/documents/nuclear_responses/PGandE_Response_TN-70883_Files/PGandE_Supplemental_Nuclear_Data_Response.pdf.

PG&E loaded an additional 7 casks, bringing the number of storage casks to 23. PG&E plans to load an additional 6 casks during the summer of 2013.

Although PG&E has made progress in moving used fuel assemblies from wet to dry storage, the density in the spent fuel pools is still roughly four times the design capacity of the original spent fuel racks. Furthermore, if relicensed, PG&E intends to store the spent fuel generated during the 20-year relicensing period in the spent fuel pools at close to the existing density.

In July 2010, the NRC issued Requests for Additional Information (RAIs) for PG&E structures aging management programs (AMPs) reviewed during the AMP audit.[259] RAI B2.1.32-4 requested further information in response to reports from Diablo Canyon personnel that the spent fuel pool has had a persistent minor leak for many years. It was unclear to staff if leakage of the borated water has degraded either the concrete or embedded steel reinforcement that is inaccessible for inspection. PG&E's response indicated that the Unit 2 spent fuel pool has had persistent minor leakage varying from 50 to 975 milliliters (ml) per week, with a typical range of 300 to 500 ml per week, and that the evaluations to date have not been able to conclusively identify the root cause of the leakage.[260] The path of the leakage is through the liner to the spent fuel pool leak chase monitoring location.[261] Structures that could be potentially affected by the presence of the borated water are the SFP concrete and structural steel. PG&E concluded that, based on evaluation of industry experience on spent fuel pool leakage,[262] the amount of leakage being experienced was acceptable as there is a negligible adverse effect on the concrete and reinforcing steel. However, the extent of damage to the Unit 2 spent fuel pool concrete and embedded steel reinforcement remains unknown in inaccessible areas.

PG&E's current and planned wet storage practices at Diablo Canyon comply with NRC license requirements,[263] the safety of which is supported by a July 2013 consequence study conducted by the NRC.[264] The study sought to examine if faster removal of older, colder spent reactor fuel from pools to dry cask storage significantly reduces risks to public health and safety. This study compared potential accident consequences from a pool nearly filled with spent fuel and a pool

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259 http://pbadupws.nrc.gov/docs/ML1025/ML102530542.pdf.

260 http://pbadupws.nrc.gov/docs/ML1025/ML102530195.pdf.

261 A leak chase is a channel that collects water leaking through the liner of spent fuel pool. The leak chase monitoring location is where the amount of water leakage can be measured.

262 *Repair and Replacement Applications Center: Boric Acid Attack of Concrete and Reinforcing Steel in PWR Fuel Handling Buildings*. EPRI, Palo Alto, CA: 2009. 1019168, Final Report, June 2009.

263 The NRC approved Diablo Canyon's 1985 license amendment request (LAR-85-13) allowing expansion of the spent fuel pool storage capacity for each spent fuel pool from the original 270 to 1324 spent fuel assembly spaces.

264 Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a U.S. Mark I Boiling Water Reactor, https://www.federalregister.gov/articles/2013/07/02/2013-15840/consequence-study-of-a-beyond-design-basis-earthquake-affecting-the-spent-fuel-pool-for-a-us-mark-i.

in which fuel that had cooled sufficiently had been removed. The regulatory analysis for the NRC study indicates that expediting movement of spent fuel from the pool does not provide a substantial safety enhancement for the reference plant.

However, the NRC study does not appear to be supported by National Academy of Sciences conclusions from the report *Safety and Security of Commercial Spent Nuclear Fuel Storage: Public Report (2006)*[265] that dry-cask storage offers several advantages over pool storage. Dry-cask storage is a passive system that relies on natural air circulation for cooling, rather than requiring water to be continually pumped into cooling pools to replace water lost to evaporation caused by the hot spent fuel. Also, dry-cask storage divides the inventory of spent fuel among a large number of discrete, robust containers, rather than concentrating it in a relatively small number of pools. The NAS report also concluded that while successful attacks on spent fuel pools are difficult, they are a possibility and could lead to the release of large amounts of radioactive material.

In 1980, the NRC adopted fire protection regulations intended to reduce the chance of disabling fires at nuclear power plants. In the late 1990s, NRC inspectors discovered that many nuclear plants did not conform to these regulations. In 2004, the NRC adopted an alternative set of fire protection regulations,[266] and plant owners had the option of complying with either the 1980 or 2004 regulations. Diablo Canyon notified the NRC of the intention to comply with the 2004 regulations. Compliance with the 2004 regulations involves extensive modifications to the plant and its procedures to obtain necessary protection against fire hazards. On October 10, 2012, an NRC Event Notification Report[267] identified three unanalyzed fire protection deficiencies. The report noted that Diablo Canyon staff identified fire areas that neither conformed to 10 CFR 50.48(b)[268] requirements nor had established, proceduralized, and practiced compensatory measures in place. The issues were identified in the Diablo Canyon corrective action program, and compensatory measures were established in accordance with Diablo Canyon fire protection program requirements. Roving fire watches are serving as interim fire protection (compensatory) measures for the three deficiencies until permanent corrective measures are determined and implemented.

In 2011, in its Twenty-first Annual Report on the Safety of Diablo Canyon Nuclear Power Plant Operations,[269] the Diablo Canyon Independent Safety Committee,[270] in response to the Energy

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265 http://www.nap.edu/openbook.php?isbn=0309096472.

266Alternate Fire Protection Rule [10 CFR 50.48(c), National Fire Protection Association (NFPA) 805], http://www.nrc.gov/reactors/operating/ops-experience/fire-protection/protection-rule.html.

267 Event Notification Report for October 10, 2012, Event Number: 48395, http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2012/20121010en.html.

268 Code of Federal Regulations (CFR) § 50.48 Fire Protection, http://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0048.html.

269 Diablo Canyon Independent Safety Committee Twenty-first Annual Report on the Safety of Diablo Canyon Nuclear Power Plant Operations. July 1, 2010–June 30, 2011. http://www.dcisc.org/21st-pdf.pdf

Commission's *2009 IEPR* recommendation, reported on their evaluation of reactor pressure vessel integrity for Diablo Canyon over a 20-year license extension period in the context of any change to seismic hazard at the site. In their evaluation of pressurized thermal shock[271] and seismic interactions at Diablo Canyon, the Diablo Canyon Independent Safety Committee concluded that there is no direct relationship between having earthquakes, even very large earthquakes, and pressurized thermal shock issues associated with neutron embrittlement[272] of the reactor vessel.

In a separate issue related to the Unit 2 Pressurizer nozzles, in March 2013, PG&E submitted a request to the NRC for relief from certain American Society of Mechanical Engineers (ASME) Code requirements for pressure vessels. The request for relief was on the basis that complying with the ASME Code requirement to remove laminar indications (flaws) on pre-emptive structural weld overlays would result in hardship or unusual difficulty without a compensating increase in the level of quality or safety. The weld overlays were originally inspected in March 2008 using ultrasonic testing, and again in 2009. In February 2013, using more advanced ultrasonic testing techniques, several flaws were discovered that were outside the ASME Code allowable screening size. PG&E plans to initiate an evaluation to determine the root cause(s) of the flaws, to understand why they were not detected originally, and to identify any required corrective actions. On August 28, 2013, the NRC determined that PG&E's proposed alternative (to permit the unacceptable laminar flaws to remain in service) provides reasonable assurance of structural integrity and leak tightness and authorized use of the proposed alternative for one cycle of operation (approximately 18 months).[273]

Emergency Response Planning

Following the Fukushima Daiichi nuclear disaster, the NRC initiated lessons-learned evaluations for U.S. nuclear plants. The NRC established the NTTF to develop a comprehensive set of recommendations using defense-in-depth concepts of prevention, mitigation, and emergency preparedness. These recommendations were prioritized into three tiers. The first tier

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270 The Diablo Canyon Independent Safety Committee was created by the CPUC in 1988 (D.88_12_083) to assess safety of DCPP operations and makes recommendations for the plant's safe operation. The Energy Commission Chair appoints one of three members; in 2012, Dr. Peter Lam was reappointed for a three-year term beginning July 1, 2012, through June 30, 2015.

271 PTS is a phenomenon which may occur due to an accident condition of some kind wherein cold water is injected into a reactor vessel, thereby causing an area of the vessel to go through a transition from ductile to brittle and whereby preexisting small flaws in the metal vessel could propagate and cause failure of the reactor vessel.

272 Neutron embrittlement can be caused by the presence of significant amounts of copper in metal used in existing reactors (some steel that was used in existing reactors came from recycled materials that may have contained copper). Thus, new reactor vessels do not use steel or weld materials containing significant amounts of copper.

273 http://pbadupws.nrc.gov/docs/ML1323/ML13232A308.pdf

consists of those recommendations that the NRC determined should be started without unnecessary delay.

Seismic and flooding walkdowns (detailed inspections) of accessible components of Diablo Canyon Units 1 and 2 were completed in November 2012, and the results were provided to the NRC on November 27, 2012.[274] None of the walkdown findings were determined to have any adverse effect on the performance of any required safety function; there are no planned or newly installed changes to Unit 1. Unit 2 seismic walkdowns of inaccessible components[275] were completed in April 2013. Unit 1 walkdowns of inaccessible components have not yet been completed.

An overall integrated plan providing Diablo Canyon's approach for providing mitigation strategies for beyond-design-basis external events[276] in accordance with NTTF Recommendations was developed and submitted to the NRC on February 27, 2013.[277] These strategies rely on installed plant equipment as well as onsite and offsite portable equipment. These strategies will be implemented by October 30, 2015 for Unit 1 and May 31, 2016, for Unit 2.

The Diablo Canyon phase 1 staffing study was completed in March 2013. The results of this study found 1) the minimum on-shift staffing is sufficient to support the implementation of current Diablo Canyon procedures simultaneously for Units 1 and 2 with no collateral duties; 2) Diablo Canyon has the staffing needed to support an expanded response capability for a beyond-design-basis external event; and 3) procedures will need to be enhanced to integrate the expanded response and transportation capabilities.

An assessment of Diablo Canyon's capability for emergency preparedness communications systems to perform their intended function during a large-scale loss of alternating current power event was submitted to the NRC in October 2012. Based on this assessment, enhancements will be implemented, which include additional phones, radios, radio console, and communications trailers. These enhancements will be implemented in two phases. The satellite phone "footballs" and communication trailers will be implemented by December 31, 2013. The remaining enhancements will be implemented by October 27, 2015.

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274 http://pbadupws.nrc.gov/docs/ML1233/ML12333A270.pdf.

275 Inaccessible areas are areas that cannot reasonably be inspected due to significant personnel safety hazard. Very High Radiation Areas, major equipment disassembly, or no reasonable means of access (for example, buried). Items classified as "inaccessible" require the utility to justify that there is reasonable assurance that the feature is available and will perform the protection or mitigation function for the full duration of the seismic and/or flood condition.

276 External events (e.g., earthquakes and tsunamis) that exceed what a nuclear facility was designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety.

277 http://pbadupws.nrc.gov/docs/ML1305/ML13059A501.pdf.

Updated evacuation time estimates (ETE)[278] for Diablo Canyon were completed in November 2012. According to Table 7-2, Time to Clear the Indicated Area of 100 Percent of the Affected Population, the longest evacuation time scenario would be more than 19 hours during a summer special event (such as fireworks shows at Avila Beach, Pismo Beach, and Morro Bay Harbor). However, evacuation time estimates do not include a time estimate for a seismic event. PG&E reports that additional evacuation time estimate analyses for seismic events are being developed as part of a supplemental report that PG&E expects to issue by December 2013.[279]

Economic Considerations

In June 2013, PG&E released a study titled *Economic Benefits of Diablo Canyon Power Plant: An Economic Impact Study*.[280] For 2011, the study estimates a beneficial economic impact of $919.8 million to San Luis Obispo and Northern Santa Barbara counties. The indirect and induced impacts[281] totaled $244.3 million and included positive influences on many local businesses such as restaurants, real estate, wholesale trade, retail shops, financial institutions, and health care. With 11 and 12 years remaining on the current licenses for the Diablo Canyon units, it is expected that PG&E would continue to operate Diablo Canyon for the duration of those licenses and that the plant would continue to generate economic benefits similar to those that exist today. When the study area is expanded to include all of California, the economic impacts increase significantly primarily because of two factors: larger expenditures for goods and services, and larger multipliers. The study further estimates the total output impact for Diablo Canyon nationally is $1.969 billion.

PG&E purchases the maximum limit of nuclear liability coverage ($375 million) from American Nuclear Insurers through the Facility Form Policy, which is purchased by all commercial nuclear power plant operators in the United States and satisfies the Price-Anderson Act[282] requirement for primary financial protection. In addition, the Secondary Financial Protection (SFP) Policy provides coverage for losses that exceed the primary limit. Diablo Canyon Units 1

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278 Diablo Canyon Power Plant Development of Evacuation Time Estimates, November 2012, http://pbadupws.nrc.gov/docs/ML1236/ML12363A209.pdf.

279 http://www.energy.ca.gov/2013_energypolicy/documents/nuclear_responses/PGandE_Response_TN-70883_Files/PGandE_Supplemental_Nuclear_Data_Response.pdf.

280 http://www.pge.com/includes/docs/pdfs/shared/edusafety/systemworks/dcpp/PGE_Economic_Impact_Report_Final.pdf.

281 For example, a dollar spent at a grocery store is divided between the suppliers of the grocery store, the workers at the grocery store, the landlord of the grocery store, and the owner of the grocery store business. Any dollar spent at the grocery store is parceled out and "respent" by the store's suppliers and landlord (the "indirect effect"), and the employee's households (the "induced effect"). The "multiplier" effect of the original dollar spent combines the indirect and induced effects, often referred to as the indirect effect.

282 The Price-Anderson Act, enacted in 1957, was designed to ensure adequate funds would be available for public liability claims for personal injury and property damage in the event of a nuclear accident at a commercial nuclear power plant. The limit of liability for a nuclear accident is now more than $12 billion.

and 2 each has a certificate to the SFP program. The total protection amount for nuclear claims at Diablo Canyon is equal to the primary and SFP program for a total of roughly $12.6 billion.

However, some preliminary cost estimates for the 2011 Fukushima accident range from $250 billion[283] to $500 billion,[284] and a recent study conducted by the the French Institute for Radiological Protection and Nuclear Safety[285] estimated the cost of a major nuclear accident in France to be $580 billion.[286] The *2011 IEPR* recommended that PG&E provide a comprehensive study on the adequacy of Price-Anderson liability coverage for a severe event at Diablo Canyon resulting in a large offsite release of radioactive materials. Such a study could provide valuable new information on the potential economic costs associated with a severe nuclear event. PG&E has not completed such a study and reports that it has no plan at this time to perform the study.[287]

San Onofre Nuclear Generating Station

Seismic and Tsunami Hazards

With the closure of San Onofre and a new focus on the decommissioning process, many of the *AB 1632 Report* and *2011 IEPR* recommendations may no longer be applicable. SCE officials are consulting with NRC staff to understand how the regulatory requirements for the SSHAC process apply to San Onofre as they transition into decommissioning the plant. Seismic hazard analyses for SSC study Workshop 2 were held in August 2013. However, seismic activities are under review and likely will be terminated.[288]

In a letter to the CPUC dated August 5, 2013, SCE stated that it is evaluating the scope of San Onofre seismic activities, and is planning to reduce the scope to only those activities that are required to fulfill NRC 50.54(f) requirements or are research projects that have already been initiated and are nearing completion. SCE indicated that AB 1632 recommendations to conduct high-energy two-dimensional/three-dimensional marine acoustic surveys are no longer

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283 http://newsonjapan.com/html/newsdesk/article/89987.php.

284 Massive Radiological Releases Profoundly Differ From Controlled Releases, February 2013, http://www.irsn.fr/FR/Actualites_presse/Actualites/Documents/EN_Eurosafe-2012_Massive-releases-vs-controlled-releases_Cost_IRSN-Momal.pdf.

285 The French Institute for Radiological Protection and Nuclear Safety (IRSN) is the national public expert in nuclear and radiological risks, http://www.irsn.fr/EN/Presentation/about_us/Pages/who_are_we.aspx

286 http://www.reuters.com/article/2013/02/07/us-france-nuclear-disaster-cost-idUSBRE91603X20130207

287 PG&E Supplemental Nuclear Data Response, June 18, 2013, http://www.energy.ca.gov/2013_energypolicy/documents/nuclear_responses/PGandE_Response_TN-70883_Files/PGandE_Supplemental_Nuclear_Data_Response.pdf.

288 Mark Nelson, SCE, Lead Commissioner Workshop on California Nuclear Power Plant Issues, June 19, 2013, http://www.energy.ca.gov/2013_energypolicy/documents/2013-06-19_workshop/presentations/02_Nelson_2013_Nuclear_IEPR_SONGS_Retirement.pdf.

required since San Onofre is not an operational plant and thus, SCE does not plan to complete them. The San Onofre Independent Peer Review Group[289] will continue to review and report on ongoing seismic studies.

SCE is performing an evaluation of external flooding sources, including the effects of tsunamis, using guidance and methods consistent with the NRC's 10 CFR 50.54(f) request for information. This information is due to the NRC by March 2015.[290] Previously completed tsunami analysis demonstrated no additional protection was warranted for San Onofre, however, updated tsunami hazard evaluations are not complete. Upon review of the evaluation results, SCE and the NRC staff will determine whether additional actions are necessary (for example, updating the design basis) to provide additional protection against tsunami hazards.

Vulnerabilities

San Onofre has 2,346 spent fuel assemblies in wet storage and 792 assemblies in dry cask storage. SCE reports that the size of ISFSI at San Onofre will have to be tripled to move all spent fuel assemblies out of wet storage.[291] The ISFSI is located in the area formerly occupied by Unit 1 (now decommissioned), and sufficient space exists there to store all the spent fuel assemblies.[292] Movement of used fuel from pools to dry cask storage is estimated to occur over the next 7 to 12 years after the assemblies have cooled enough to be moved to dry casks. Dry casks are concrete and metal containers that are filled with inert gas and then placed on concrete pads or in large concrete silos at the reactor site. Unlike cooling pools that require mechanically driven water circulation (which is estimated to use between 200,000 to 500,000 gallons of water per minute at San Onofre[293]), dry casks employ "passive" cooling: air enters an opening at the bottom of the cask, absorbs heat from the spent fuel, then rises and exits through an opening at the top, creating a "chimney effect" that pulls more air into the bottom of the cask.

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289 The San Onofre Independent Peer Review Group (IPRG) is a multi-agency panel of seismic hazard specialists who work under the auspices of the CPUC to provide independent review of SCE's plans and analyses of enhanced seismic studies. Established by CPUC Decision 12-05-004 (http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/166519.PDF), its members include representatives from the California Geological Survey, California Coastal Commission, California Emergency Management Agency, California Energy Commission, California Seismic Safety Commission, and the California Public Utilities Commission. IPRG reports are available on the CPUC's website on nuclear power. http://www.cpuc.ca.gov/PUC/energy/nuclear.htm.

290 Plant-Specific Actions in Response to the Japan Nuclear Accident: San Onofre Nuclear Generating Station, http://www.nrc.gov/reactors/operating/ops-experience/japan/plants/sano2.html

291 Mark Nelson, SCE, Lead Commissioner Workshop on California Nuclear Power Plant Issues, June 19, 2013.

292 Caroline McAndrews, SCE, Lead Commissioner Workshop on California Nuclear Power Plant Issues, June 19, 2013.

293 June 10, 2013 telephone conversation. Kathy Yhip of SCE and Joan Walter, Energy Commission.

Passive cooling makes dry casks less likely to lose their cooling capacity than "active" systems like cooling pools, which are vulnerable to mechanical failure, technical or human error, terrorist attack, and natural disasters.

Figure 11: Spent Fuel Pools Versus Dry Cask Storage

Spent Fuel Pool | Dry Cask Storage

Source: Nuclear Regulatory Commission

Emergency Response Planning

SCE submitted updated Emergency Planning Zone evacuation time estimates (ETE)[294] to the NRC on December 19, 2012. This study was developed using the area, infrastructure, and population described by the San Onofre Emergency Plan and off-site response organization emergency response plans. As indicated in a letter dated April 16, 2013,[295] from the NRC to the Federal Emergency Management Agency (FEMA), SCE's ETE report was reviewed by the NRC, found generally consistent with the guidance in NUREG/CR-7002, and found to be complete in accordance with 10 CFR Part 50, Appendix E.IV.3. Table 7-2, Time to Clear the Indicated Area of 100 Percent of the Affected Population, indicates the longest evacuation time to be more than 20 hours during a summer earthquake.

Economic Considerations

The NRC requires operators of nuclear power plants to put aside funds for decommissioning while the plant is operating. The money is collected from customers and invested in dedicated trusts. The cost to decommission San Onofre Units 2 and 3 is estimated to be $4.1 billion. SCE's share is $3 billion, of which $2.7 billion had been collected through March 31, 2013. Other

294 San Onofre Nuclear Generating Station Development of Evacuation Time Estimates, November 2012, http://pbadupws.nrc.gov/docs/ML1236/ML123630620.pdf.

295 Quarterly Report of Activity Related to Updated Evacuation Time Estimates, April 16, 2013, http://pbadupws.nrc.gov/docs/ML1310/ML13105A417.pdf.

owners of San Onofre [296] have collected more than $927 million through December 2012. On July 22, 2013, SCE submitted updated plans and decommissioning cost estimates to the CPUC as part of the 2012 Nuclear Decommissioning Cost Triennial Proceeding (A.12-12-013) to reflect the permanent shutdown of San Onofre.[297] SCE completed the transfer of fuel from the Unit 2 reactor to the spent fuel pool on July 18, 2013, and sent a letter to the NRC on July 23, 2013, certifying that the fuel was removed from the Unit 2 reactor. Once the NRC certifies the Unit 2 defueling, the nuclear plant will have a possession-only[298] license rather than an operating license, and will no longer be authorized to place fuel in the reactor vessel. Within two years of permanently ceasing operations, SCE must submit to the NRC and state officials a detailed plan (known as a Post-Shutdown Decommissioning Activities Report) that spells out specific decommissioning activities and schedules, cost estimates, and potential environmental impacts.[299] SCE currently anticipates Units 2 and 3 decommissioning activities to commence in mid-2015.

Japan Lessons Learned - NRC Near-Term Task Force Recommendations

After the Fukushima Daiichi nuclear accident, a task force of senior NRC staff reviewed the circumstances of the event to determine what lessons could be learned. In July 2011, the task force provided recommendations to enhance U.S. reactor safety, and these became the foundation of the NRC's post-Fukushima activities. At Fukushima, flooding from the tsunami disabled internal electrical power systems after the earthquake had cut off external power sources, leaving the plants with only a few hours' worth of battery power. Nuclear power plants need electrical power 24 hours a day, even when the nuclear reactors are shut down, to run equipment that cools the reactor core and spent nuclear fuel. The NRC approved a three-tiered prioritization of recommendations;[300] Tier 1 recommendations are activities to be implemented without unnecessary delay, Tier 2 recommendations are those that cannot be initiated in the near term due to resource or critical skill set limitations, and Tier 3 recommendations require further staff study to determine if regulatory action is necessary.

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296 San Onofre is co-owned by Southern California Edison, San Diego Gas & Electric, and Riverside Public Utilities.

297 Testimony of Edward Randolph, CPUC Energy Division Director, California State Senate Committee on Energy, Utilities, and Communications Informational Hearing (Padilla), Life after San Onofre: The Decommissioning Process, August 13, 2013. http://seuc.senate.ca.gov/20132014informationalhearings/#August132013

298 A possession-only license authorizes the licensee to possess specific nuclear material but does not authorize its use or the operation of a nuclear facility.

299 http://pbadupws.nrc.gov/docs/ML0037/ML003701163.pdf.

300 http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard/priorities.html#tier-02.

Tier 1 Activities

Tier 1 activities include orders, requests for additional information (RAIs), and rulemakings. The NRC issued three orders in March 2012 to implement Tier 1 recommendations from the Japan Lessons Learned. Two orders apply to every U.S. commercial reactor, while the third order applies only to reactors with designs similar to the Fukushima plant (which Diablo Canyon and San Onofre do not have).

The first order includes mitigation strategies requiring plants to obtain and protect additional post-9/11 equipment to support all reactors at a given site simultaneously. The mitigation strategies are expected to use a combination of currently installed equipment (such as steam-powered pumps), additional portable equipment that is stored on-site, and equipment that can be flown or trucked in from support centers. Seismic and flooding reevaluations for Diablo Canyon and San Onofre are due March 2015.[301]

The second order requires all U.S. nuclear power plants to install enhanced equipment for monitoring water levels in each plant's spent fuel pool. During the accident at Fukushima, the plants lost their ability to cool the spent fuel pools. Plant operators couldn't determine how much water was in the pools during the accident, which was a problem because if enough water boiled away or was otherwise lost, the spent fuel rods could emerge from the receding water and potentially release significant amounts of radiation. The NRC issued the order requiring plants to install water-level instrumentation in their spent fuel pools to remotely report at least three distinct water levels: 1) normal level; 2) low level but still enough to shield workers above the pools from radiation; and 3) a level near the top of the spent fuel rods where more water should be added without delay.

The third order applies to boiling-water reactors with hardened containment vents. These reactors must improve or install emergency venting systems that can relieve pressure in the event of a serious accident. The order for ensuring reliable hardened containment vents does not apply to Diablo Canyon or San Onofre because they are pressurized water reactors. Every U.S. plant must comply with the relevant orders by December 31, 2016.

RAIs address reevaluation of seismic and flooding hazards and staffing needs and communications capabilities to respond effectively to an emergency event affecting multiple reactors at a site. Longer-term rulemaking activities will address station blackout/mitigation strategies (2016), onsite emergency response (2016), and filtering and confinement strategies[302] (2017).

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301 In light of SCE's recent decision to permanently cease operation of San Onofre Units 2 and 3, the NRC will discuss with the licensee the need for completing actions related to lessons learned from the Fukushima accident.

302 Applicable only to boiling-water reactors; does not apply to Diablo Canyon or San Onofre because they are pressurized water reactors.

Tier 2 and 3 Activities

Tier 2 activities address spent fuel pool makeup capability (to provide a reliable means of adding extra water to spent fuel pools) and emergency preparedness for multireactor and loss of power events (including training and exercises, equipment and facilities, and multiunit dose assessment capability[303]). Tier 3 activities evaluate the need for additional enhancements in a number of areas related to reactor oversight. The NRC plans to address these activities through long-term evaluation and planned rulemaking. See Appendix H for a complete list of NRC Post-Fukushima Activities.

Federal Efforts on Nuclear Waste Transport, Storage, and Disposal

United States Department of Energy

The U.S. DOE has broad authority under the Atomic Energy Act of 1954,[304] as amended, to regulate all aspects of activities involving radioactive materials that are undertaken by U.S. DOE or on its behalf, including the transportation of spent nuclear fuel (SNF). The U.S. DOE uses this authority to manage certain SNF shipments that usually involve special circumstances, such as SNF from foreign research reactors, U.S. DOE-owned research and defense reactors, and nuclear powered U.S. Navy ships to U.S. DOE storage facilities. In addition, the U.S. DOE manages the shipment of SNF from NRC-licensed nonpower reactors to U.S. DOE facilities for interim storage because of the lack of a permanent disposal facility for SNF.

In January 2012, the Blue Ribbon Commission on America's Nuclear Future identified removal of stranded used nuclear fuel at shutdown sites as a priority so that these sites may be completely decommissioned and put to other beneficial uses.[305] In April 2013, the U.S. DOE Office of Nuclear Energy, as part of the Used Fuel Disposition Campaign, released a preliminary evaluation of removing used nuclear fuel from nine shutdown sites,[306] including Humboldt Bay Nuclear Power Plant[307] and Rancho Seco Nuclear Generating Station.[308]

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303 The capability of assessing radiation doses from multiple sources (for example, more than one reactor, a spent fuel pool, and so forth).

304 The Atomic Energy Act of 1954, 42 U.S.C. § 2011 et seq., is the fundamental U.S. law on both the civilian and the military uses of nuclear materials. It covers laws for the development, regulation, and disposal of nuclear materials and facilities in the United States. http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/v1/sr0980v1.pdf.

305 Transportation and Storage Subcommittee Report to the Full Commission, January 2012, http://cybercemetery.unt.edu/archive/brc/20120620215746/http://brc.gov/sites/default/files/documents/final_updated_ts_report_012612.pdf.

306 Preliminary Evaluation of Removing Used Nuclear Fuel From Nine Shutdown Sites (FCRD-NFST-2012-000613), April 30, 2013 (see http://curie.ornl.gov/).

307 Humboldt Bay Nuclear Power Plant operated from 1963 to 1976 and is being decommissioned. It is located just south of Eureka in Humboldt County and is owned by PG&E.

Objectives of the study will be to characterize the actions necessary to remove used nuclear fuel from the shutdown sites and develop a plan and schedule for key program activities.

United States Nuclear Regulatory Commission

The NRC regulates commercial nuclear power plants that generate electricity under the Atomic Energy Act of 1954. The Waste Confidence Decision and Rule represent the generic determination by the NRC that spent nuclear fuel can be stored safely and without significant environmental impacts for a period of time after the end of the licensed life of a nuclear power plant. Historically, this generic analysis has been incorporated into the Commission's NEPA reviews for new reactor licenses, license renewals, and ISFSI licenses through the Waste Confidence Rule. The Waste Confidence Decision and Rule satisfy the NRC's obligations under NEPA, with respect to post licensed-life storage of spent nuclear fuel.

In June 2012, the District of Columbia Circuit Court found that some aspects of the NRC's 2010 Waste Confidence Decision and Rule (2010 Decision and Rule) did not satisfy the NRC's National NEPA obligations and vacated the 2010 Decision and Rule.[309] The Court identified three specific deficiencies in the analysis: 1) it did not evaluate the environmental effects of failing to secure permanent disposal; 2) it failed to properly examine the risk of spent fuel pool leaks in a forward-looking fashion; and, 3) it failed to properly examine the consequences of spent fuel pool fires.

In response to the Court's decision, the NRC ordered that no final decisions on issuing licenses that rely on the 2010 Decision and Rule will be made until the court's remand was appropriately addressed.[310] The NRC created a Waste Confidence Directorate to oversee the drafting of a new Waste Confidence Environmental Impact Statement (EIS) and Rule and instructed the Directorate to issue the final EIS and Rule by no later than September 2014. The NRC published the draft GEIS[311] for public comment on September 13, 2013. During the 75-day comment period, the NRC will hold several public meetings around the country to present the proposed rule and draft GEIS and receive comments. Two of these meetings will be held in Southern and Central California.

On August 13, 2013, the U.S. Court of Appeals for the District of Columbia issued an order[312] granting a writ of mandamus directing the NRC to "promptly continue the legally mandated

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308 Rancho Seco Nuclear Generating Station was commissioned in 1975 and decommissioning was completed in 2009. It is located in Herald in Sacramento County and is managed by Sacramento Municipal Utility District.

309 (New York v. NRC, 681 F.3d 471 (D.C. Cir. 2012).

310 NRC Memorandum and Order, CLI-12-16, August 7, 2012, http://pbadupws.nrc.gov/docs/ML1222/ML12220A100.pdf.

311 *Waste Confidence Generic Environmental Impact Statement*, Expected Publish Date August 2013, http://pbadupws.nrc.gov/docs/ML1315/ML13150A347.pdf.

312 http://www.atg.wa.gov/uploadedFiles/Home/About_the_Office/Cases/Yucca/Opinion.pdf

licensing process" for Yucca Mountain. The Court's order became effective on September 3, 2013. On August 30, 2013, the NRC requested input from participants in the adjudicatory proceeding to offer views to the NRC on how to restart the Yucca Mountain licensing process.[313] This input, which the NRC accepted during a 30-day comment period ending September 30, 2013, will help the NRC ensure the most efficient and productive use of the approximately $11 million the agency has left to resume the licensing process (which had previously been suspended in September 2011). The NRC has directed its staff to gather pertinent budgeting information during the 30-day comment period. The Commission will review the comments submitted by the parties as well as the information it receives from the NRC staff and decide the path forward in the licensing process.

Nuclear Waste Administration Act of 2013

In June 2013, Senators Dianne Feinstein (D-California) and Lamar Alexander (R-Tennessee) – the leaders of the Senate Appropriations Subcommittee on Energy and Water Development – and Energy and Natural Resources Committee Chairman Ron Wyden (D-Oregon) and Ranking Member Lisa Murkowski (R-Alaska) introduced the Nuclear Waste Administration Act of 2013 (S. 1240).[314] This bill is intended to implement the recommendations of the Blue Ribbon Commission on America's Nuclear Future[315] to establish a nuclear waste administration and create a consent-based process for siting nuclear waste facilities. The bill would enable the federal government to fulfill its commitment to managing nuclear waste, ending the costly liability the government bears for its failure to dispose of commercial spent fuel. The integrated storage and repository system established by this legislation would expand opportunities for nuclear power to supply carbon-free energy, provide long-term protection of public health and safety for both commercial and defense high-level waste, and ensure adequate funding for managing nuclear waste.[316] The proposed bill includes the following key components:

- Establishes a new federal agency, headed by a single administrator, appointed by the President by and with the advice and consent of the Senate, to manage the nuclear waste program in place of U.S. DOE.
- Directs the new agency to build a pilot spent fuel storage facility to store spent fuel from decommissioned nuclear power plants and emergency shipments from operating plants.

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313 http://www.nrc.gov/reading-rm/doc-collections/news/2013/13-070.pdf

314 http://www.feinstein.senate.gov/public/index.cfm/files/serve/?File_id=a7095770-9cab-41bb-a5a3-152fdb51adfa.

315 *Blue Ribbon Commission on America's Nuclear Future Report to the Secretary of Energy*, January 2012, http://cybercemetery.unt.edu/archive/brc/20120620220235/http://brc.gov/sites/default/files/documents/brc_finalreport_jan2012.pdf.

316 Source: Summary of the Nuclear Waste Administration Act of 2013 Discussion Draft, http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=e10c815a-4baf-4eb3-a55a-be05fe0f88e4.

- Directs the new agency to build one or more consolidated storage facilities to store nonpriority spent fuel for utilities or defense wastes for DOE temporarily.
- Establishes a new siting process, applicable to both repositories and storage facilities, that requires the new nuclear waste agency to 1) establish technical siting guidelines to evaluate sites, 2) solicit states and communities to volunteer sites, 3) obtain state and local consent to study sites, 4) hold multiple public hearings before studying or selecting sites, 5) obtain state and local consent to site a repository or storage facility, 6) obtain congressional ratification of any consent agreement for a site, and 7) obtain a license from the NRC to construct and operate a repository or storage facility.
- Authorizes the administrator to begin siting consolidated storage facilities immediately, and does not set waste volume restrictions on storage.
- Proposes a requirement that, while constructing and operating the storage facility, the Administrator is required to continue making progress on siting and constructing a repository as measured against its own mission plan.
- Establishes a new Working Capital Fund in the Treasury, into which the fees collected from the utilities (currently about $765 million per year) would be deposited. These funds would be available to the Administration without further appropriation. Fees already collected (about $28.2 billion as of January 2013) remain in the Nuclear Waste Fund, where they will continue to be subject to appropriation.

The proposed bill updates an April draft after consideration of more than 2,500 public comments on the measure. The Energy and Natural Resources Committee held a hearing on the bill in July 2013.

Permanent Closure of San Onofre Nuclear Generating Station

Steam Generator Tube Degradation

On January 31, 2012, SCE, the operator of San Onofre, began a precautionary shutdown of Unit 3 after readings from highly sensitive instruments detected a reactor coolant leak in one of the unit's steam generator tubes. Although the leak rate was small, it increased enough in a short period for SCE to perform a rapid shutdown when the estimated leak rate exceeded 75 gallons per day. Unit 2 was already offline for a planned maintenance, refueling, and technology upgrade. SCE began extensive testing to understand fully the cause of the leak and discovered unexpected wear in both steam generators, including significant tube-to-tube wear in the free span areas of more than 100 tubes. Testing results from Unit 2 also revealed unexpected tube wear at the retainer bars, and additional analysis and testing identified two tubes with tube-to-tube wear similar to what was observed in Unit 3. For both Units 2 and 3, this was the first cycle of operation with new replacement steam generators. SCE had replaced the Unit 2 steam generators in January 2010 and Unit 3 steam generators in January 2011.

NRC Confirmatory Action Letter Process

On March 27, 2012, the NRC issued a Confirmatory Action Letter (CAL) to SCE, to confirm the actions that SCE committed to take before returning Units 2 and 3 to power operation. The CAL

specified that before restarting either unit, SCE would identify the cause(s) of the excessive tube wear and take corrective actions to ensure that steam generator tube integrity could be maintained. The CAL also specified that SCE would provide in writing to the NRC its protocol of inspections and/or operational limits for the planned operating interval and the basis for SCE's conclusion that there was reasonable assurance that the units will operate safely. Neither unit would be allowed to resume operations until SCE responded to the items in the CAL, and the NRC had completed a thorough review of those actions and wrote that it was satisfied the plant could operate without undue risk to public health and safety.

Unit 2 Restart Plan

On October 3, 2012, SCE submitted its CAL response and return-to-service report for Unit 2. SCE stated it had determined the causes of tube-to-tube interactions that resulted in steam generator tube wear in Unit 3, implemented actions to prevent loss of tube integrity due to these causes in the Unit 2 steam generators, and established a protocol of inspections and operational limits, including plans for a midcycle shutdown. SCE's return-to-service plan included operating Unit 2 at reduced power for an initial five-month period, followed by more inspection.

The NRC indicated that months of NRC inspection and analysis would precede any decision on whether to restart the reactor. Over the next eight months, NRC staff reviewed SCE's CAL responses and issued more than 72 requests for additional information (RAIs). RAI 32 addressed Unit 2 technical specifications that require steam generator structural integrity to be maintained over the full range of normal operating conditions (that is, 100 percent power). To address this issue, on April 5, 2013, SCE submitted a license amendment request proposing to lower permissible operating levels from 100 percent to 70 percent. SCE asserted that the license amendment request was a technical change only that posed no significant hazards. However, this request increased mounting concerns about the safety of restarting Unit 2; several challenges to the NRC CAL process were already underway. On May 13, 2013, the NRC's Atomic Safety and Licensing Board issued an order[317] in response to one of these challenges, concluding that the CAL process for San Onofre Units 2 and 3 constituted a de facto license amendment proceeding subject to a hearing opportunity under the Atomic Energy Act. By some estimates, a full adjudicatory hearing process would take a year or more to complete.

CPUC Order Instituting Investigation

On October 25, 2012, the CPUC voted unanimously to open a proceeding on a new Order Instituting Investigation (OII)[318] to obtain information on the outages and investigate the causes, the future of the San Onofre units, and the resulting effect on the provision of safe and reliable electric service at just and reasonable rates. The order states that all revenues collected in recovery of costs on and after January 1, 2012 related to San Onofre Generating Station Units 2

317 http://libcloud.s3.amazonaws.com/93/8f/0/2930/13-05-13_MEMO_AND_ORDER_Resolving_Issues_Referred_in_CLI_12_20_LBP_13_07.pdf.

318 I.12-10-013 http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M032/K192/32192692.pdf.

and 3 are subject to refund and all Steam Generator Replacement Program costs, and rates collected in recovery of those costs, are subject to reasonableness review and refund.

In January 2013, the CPUC held the prehearing conference to consider the schedule for issues raised by the extended outages. The proceeding was divided into four phases with a preliminary schedule indicating that phase 1 rulings could be expected mid-2013, and Phase 2 and Phase 3 rulings could be expected in mid-2014.[319] The CPUC held Phase 1 evidentiary hearings in August 2013 to address the method for calculating the cost of replacement power during 2012 due to the San Onofre outage. The scope of Phase 2 evidentiary hearings,[320] scheduled for October 2013, will include determining the value(s) of San Onofre assets in rate base, and which of these assets should be removed from rate base pursuant to Public Utilities Code Section 455.5.[321] A Phase 2 decision is anticipated in February 2014.

The CPUC OII will ultimately determine who is responsible for paying the costs associated with the outage at San Onofre, including among other costs, the cost of the steam generator replacement project, substitute market power costs, capital expenditures, operation and maintenance costs, and seismic study costs. According to SCE, these costs are estimated to be more than two billion dollars.[322]

Permanent Closure and Decommissioning

On June 7, 2013, SCE announced it had decided to permanently retire San Onofre Units 2 and 3. Economic reasons were cited as the basis of the decision, as well as the need to eliminate continued uncertainty about San Onofre to assist with orderly planning for California's energy future. On June 13, 2013, SCE formally notified the NRC[323] that it had permanently ceased operation of San Onofre nuclear plant Units 2 and 3. The notification, called a Certification of Permanent Cessation of Power Operations, was the formal administrative step following SCE's announcement to retire San Onofre that sets the stage for SCE to begin preparations for decommissioning. Decommissioning is a well-defined NRC process[324] that involves transferring the used fuel into safe storage, followed by the removal and disposal of radioactive components and materials. Within two years of shutdown, SCE must submit to the NRC and state officials a detailed plan that spells out specific decommissioning activities and schedules, cost estimates, and potential environmental impacts. SCE has indicated it intends to file a decommissioning

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319 http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M042/K157/42157052.PDF

320 http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M073/K768/73768014.PDF

321 http://www.leginfo.ca.gov/cgi-bin/displaycode?section=puc&group=00001-01000&file=451-467

322 SCE 2013 SEC Filing, Second Quarter 10Q; Note 9. Permanent Retirement of San Onofre, Pgs. 29-33. http://www.edison.com/images/cms_images/c8156_EIX_2013_Q2_AS_FILED_3043.pdf

323 http://pbadupws.nrc.gov/docs/ML1316/ML131640201.pdf.

324 http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/decommissioning.html.

plan by the end of 2014.[325] SCE estimates that movement of used fuel from pools to dry cask storage will occur over a period of 7 to 12 years, which would put completion of those activities between 2020 to 2025.

Recommendations

Diablo Canyon Power Plant

- **Complete and make available *AB 1632 Report* recommended studies.** PG&E should continue to provide updates on its progress in completing the *AB 1632 Report*-recommended studies to the Energy Commission and make its findings and conclusions available to the Energy Commission, the California Public Utilities Commission (CPUC), and the Nuclear Regulatory Commission during their reviews of the Diablo Canyon license renewal application.
- **Update evacuation time estimates**. PG&E should provide updated evacuation time estimates, including an evacuation scenario following a seismic event.
- **Assess liability coverage adequacy**. Based on mounting clean-up costs for the 2011 Fukushima accident, prior to reactivating the Diablo Canyon license renewal application with the Nuclear Regulatory Commission, PG&E should provide to the Energy Commission and CPUC a comprehensive study on whether the Price-Anderson liability coverage for a severe event at Diablo Canyon would be adequate to cover liabilities resulting from a large offsite release of radioactive materials in San Luis Obispo County, and if not, identify and quantify other funding sources that would be necessary to cover any shortfall. The CPUC should consider requiring P&GE to complete such a study as a condition of License Renewal funding approval.
- **Evaluate seismic hazard analysis against the licensed design.** To help ensure plant reliability and minimize costs to ratepayers, prior to reactivating the Diablo Canyon license renewal application with the Nuclear Regulatory Commission[326], PG&E should evaluate all seismic hazard analyses for Diablo Canyon against the licensed design basis elements for the Design Earthquake and the Double Design Earthquake, in addition to the Hosgri earthquake element.

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325 Testimony of Stephen Pickett, SCE Executive Vice-President of External Relations, California State Senate Committee on Energy, Utilities and Communications Informational Hearing (Padilla), Life After SONGS: The Decommissioning Process, August 13, 2013. http://seuc.senate.ca.gov/20132014informationalhearings/#August132013

326 On April 10, 2011, PG&E requested that the NRC defer issuance of renewed operating licenses until updated seismic studies were completed (see http://pbadupws.nrc.gov/docs/ML1110/ML111020618.pdf). The NRC responded on May 31, 2011 (see http://pbadupws.nrc.gov/docs/ML1113/ML11138A315.pdf) by revising the remaining review schedule for the license renewal application to "To Be Determined" and instructing PG&E to update the NRC on the schedule of completion of the 3-D seismic studies and estimated receipt of a coastal consistency certification.

- **Comply with applicable fire protection regulations.** PG&E should, as expeditiously as possible, bring Diablo Canyon into compliance with the applicable 2004 National Fire Protection Agency fire protection regulations and report to the Energy Commission on their progress until full compliance is achieved.
- **Evaluate long term impacts and costs of spent fuel storage options.** PG&E should evaluate the potential long term impacts and projected costs of spent fuel storage in pools versus dry cask storage of higher burn-up fuels[327] in densely packed pools, and the potential degradation of fuels and package integrity during long-term wet and dry storage and transportation offsite and submit the findings to the Energy Commission and CPUC.
- **Evaluate the structural integrity of the spent fuel pools.** To help ensure plant reliability and minimize costs to ratepayers, prior to reactivating the Diablo Canyon license renewal application with the Nuclear Regulatory Commission, PG&E should provide to the Energy Commission and CPUC an evaluation of the structural integrity of the concrete and reinforcing steel in the spent fuel pools, including any increased vulnerability to damage resulting from a seismic event.
- **Evaluate the annual capability of moving spent fuel bundles to dry cask storage.** PG&E should perform, and report to the Energy Commission and CPUC as part of the 2014 *IEPR Update*, an evaluation of the inventory of the spent fuel pools to determine the maximum number of spent fuel bundles it can move on a per year basis from the spent fuel pools into dry cask storage, taking into consideration the following constraints:
    - Thermal limits of the dry casks imposing a minimum threshold on the age of the spent fuels;
    - Federal requirements on older spent fuels surrounding newer spent fuels;
    - Availability of dry casks;
    - Building schedule(s) of dry cask storage pads;
    - Coordination of refueling outages and dry casks loading schedules; and
    - Availability of plant staff and contractors for dry cask loadings.
- **Transfer spent fuel to dry casks as expeditiously as possible.** To reduce the volume of spent fuel packed into Diablo Canyon's storage pools (and consequently the radioactive material available for dispersal in the event of an accident or sabotage), PG&E should, as soon as practicable, transfer spent fuel from the pools into dry casks, while maintaining compliance with Nuclear Regulatory Commission spent fuel cask and pool storage requirements and report to the Energy Commission on its progress until the pools have been returned to open racking arrangements.[328]

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327 I.e., Average assembly burnups exceeding 45 gigawatt days per metric ton of uranium (GWd/MTU).

328 Open racking arrangements would reduce the density of spent fuel assemblies stored in the pools to levels consistent with their original design capacity (prior to re-racking).

- **Complete the evaluation of laminar flaws on Unit 2 pressurizer nozzles.** The Diablo Canyon Independent Safety Committee should monitor PG&E's progress in completing the root cause evaluation of laminar flaws on the Unit 2 pressurizer nozzles and identification of required corrective actions over the next cycle of operation, and follow the issue until it is resolved.

San Onofre Nuclear Generating Station

- **Complete and make available *AB 1632 Report* recommended studies on security of spent fuel.** SCE should continue to complete *AB 1632 Report*-recommended studies as they apply to the security of spent fuel storage facilities at San Onofre and provide updates to the Energy Commission and CPUC on its progress.
- **Expand timely and safe transfer of spent fuel to dry casks.** SCE should, as soon as practicable, expand the Independent Spent Fuel Storage Installation and transfer spent fuel from pools into dry casks, while maintaining compliance with Nuclear Regulatory Commission spent fuel cask and pool storage requirements and report to the Energy Commission on its progress until all spent fuel is transferred to dry cask storage.
- **Develop and implement a decommissioning plan as quickly as possible.** SCE should submit a decommissioning plan to the Nuclear Regulatory Commission as soon as possible and proceed with decommissioning of San Onofre swiftly, providing progress updates to the Energy Commission until decommissioning of the site is completed.

Nuclear Waste

- **Represent California's interests in federal nuclear waste management program activities.** The Energy Commission will continue to monitor federal nuclear waste management program activities and represent California in the reactivated Yucca Mountain licensing proceeding to ensure that California's interests are protected regarding potential groundwater and spent fuel transportation impacts in California.

CHAPTER 7: Natural Gas

Natural gas is used in California for everything from generating electricity to cooking and space heating to an alternative transportation fuel. Because natural gas continues to represent a large percentage of California's energy mix, it is important to ensure reliable supplies through forecasts of future natural gas demand, supply, prices, and infrastructure needs. In turn, forecasting requires an understanding of future issues and trends that could affect natural gas markets and disruptions in supply.

Issues and trends that affect gas supply and demand include population growth, pipeline capacity, economic outlook, weather, national and global markets, environmental concerns, and the effects of energy policies. Supply and demand, in turn, affect natural gas prices. California and the rest of the United States are experiencing the lowest natural gas prices in the last decade because of a combination of technological advances related to shale gas and upgrades to the pipelines that bring natural gas to consumers.

This chapter presents the results of the Energy Commission's 2013 preliminary forecasts of natural gas supply, demand, infrastructure issues, and prices. Energy Commission staff produced a range of forecasts based upon reasonable and transparent assumptions to give planners and decision makers the information needed to determine near- and long-term procurement needs and contingency planning. Results are preliminary because inputs on natural gas demand for residential, industrial, commercial, and transportation needs are still being modeled. Those inputs will be incorporated into the forecasts with results provided in a final report expected to be released in October 2013.

This chapter also briefly discusses the most influential issues affecting natural gas supply and demand in California, including development of shale deposits in North America, pipeline safety, factors affecting increases and decreases in natural gas-powered generation, and natural gas infrastructure.

End-User Natural Gas Demand Forecast

As part of each *IEPR* cycle, staff forecasts end-user natural gas demand in a process that parallels the electricity demand forecast described in Chapter 4—with a suite of end-use and econometric models organized along utility planning area boundaries. The forecast results presented in this section do not include natural gas used by utilities or others for electric generation, but do include projections for residential, industrial, commercial, and light-duty natural gas vehicle fuel use. More detailed results and a description of inputs and methodologies is available as part of the *California Energy Demand 2014-2024 Preliminary Forecast* (CED 2013).[329]

329 http://www.energy.ca.gov/2013publications/CEC-200-2013-004/CEC-200-2013-004-SD-V1.pdf

Table 11 compares three demand scenarios for end-user natural gas consumption at the statewide level for selected years. California natural gas consumption was lower in 2012 than predicted in the *CED 2011* mid case forecast[330] and grows at a slower rate in all three scenarios from 2012 – 2022. By 2022, the mid case natural gas demand is projected to be around nine percent lower compared to the *CED 2011* mid case. Key factors include slower projected population growth in the *CED 2013* mid and low cases, new efficiency initiatives, higher projected natural gas rates, and the introduction of climate change impacts in the mid and high cases. By 2024, climate change is projected to reduce end-user natural gas demand statewide by around 250 million therms in the mid case and by roughly 640 million therms in the high case.

Table 11: Statewide End-User Natural Gas Forecast Comparison (MMTherms)

	CED 2013 Preliminary High Energy Demand	*CED 2013 Preliminary Mid Energy Demand*	*CED 2013 Preliminary Low Energy Demand*
1990	12,893	12,893	12,893
2000	13,913	13,913	13,913
2012	12,686	12,686	12,686
2015	12,613	12,631	12,353
2020	12,722	12,789	12,649
2024	12,779	12,804	12,719
Average Annual Growth Rates			
1990-2000	0.76%	0.76%	0.76%
2000-2012	-0.77%	-0.77%	-0.77%
2012-2015	-0.19%	-0.15%	-0.88%
2012-2022	0.05%	0.08%	-0.01%
2012-2024	0.06%	0.08%	0.02%

Source: California Energy Commission, Demand Analysis Office, 2013

The three scenarios for the preliminary forecast are fairly close as climate change impacts reduce consumption in the mid and high cases and resource extraction[331] output is lower in the high demand case. The difference in resource extraction gas consumption is enough to push the high demand case below the mid case by 2024. In general, growth rates for total natural gas consumption are lower compared to electricity, reflecting a historical trend for gas demand that is flat or declining for most of the previous decade, an indication of the effectiveness of building codes and standards.

330 http://www.energy.ca.gov/2012publications/CEC-200-2012-001/CEC-200-2012-001-SF-V1.pdf.

331 Resource extraction consists almost entirely of natural gas burned for enhanced oil recovery.

Natural Gas Outlook

Staff developed natural gas price and cost cases around trends that represent three possible future scenarios -a business as usual or reference case, a high-energy demand/low-price case, and a low-energy demand/high-price case. These three "common cases" illustrate trends in the natural gas market, with different assumptions about market and regulatory trends in each case. Assumptions include economic growth, technology improvements, renewable portfolio and combined heat and power targets, amount of megawatts historically provided by coal, once-through cooling and nuclear power plants that will be replaced with natural gas power plants, natural gas supply and demand, and costs (Table 12).

Table 12: Assumptions for Common Cases

Assumptions	Reference Case	Low Demand/ High Price Case	High Demand/Low Price Case
GDP Growth Rate	2.50%	3.00%	2.00%
Natural Gas Technology Improvement Rate	1%	1%	2.50%
CHP Demand (Bcf)/Capacity (MW) for CA in 2024[a]	82/1614	133/3273	13/210
Total US Natural Gas Demand (Tcf/yr)			
2014	24.5	24.1	24.4
2019	28.4	27.9	27.2
2024	30.5	29.9	28.3
Maximum RPS Target			
CA Meets Target	On time	10 year delay	On time
WECC Meets Target	On time	10 year delay	On time
Other States Meet	5 year delay	10 year delay	On time
Additional US Coal Generation Converts to Natural Gas Starting in 2014 (GW)	61	80	31
LNG Capacity Additions	No	Yes	No
Grow or Shrink Natural Gas Resource Available (US)	N/A	Shrink by 5.5%	Grow by 5.5%
Additional Environmental Mitigation Cost (2010$/Mcf)	N/A	$0.40/Mcf Shale $0.20/Mcf Conventional	N/A
Cost Environment[b]	Mid (P50)	High (P10)	Low (P90)

a) Percent of total from Fossil/Nuclear/Hydro/Renewable Generation
b) Each scenario is a function of the sustained cost environment and reserve estimates. A P50 assessment means there is a 50 percent probability, meaning there is an equal chance that the cost or reserve estimate will fall above or below the mean value. These cost and reserve estimates are established by the Potential Gas Committee. The reference case is the function of a P50 sustained cost environment and a P50 reserve estimate. The low demand high price case assumes a P10 sustained cost environment, while assuming the adjusted lower bound of the P50 reserve estimate. The high demand low price case is the combination of a P90 sustained cost environment and the adjusted upper bound of the P50 reserve estimate.
c) Refers to the assessment of the quantities of recoverable gas resources. By industry convention, the P50 assessments mean there is a 50 percent probability that at least this much gas is recoverable from that play using current technology. To increase the spread of resulting gas prices, additional cases were run assuming higher probability but lower resource amounts (a P90 case) and lower probability but higher resource amounts (a P10 case).

Source: California Energy Commission

Figure 12 shows the forecasted price for natural gas from 2013 to 2025 for the three common cases. The NAMGas model used in this analysis is an annual average model and does not account for operational fluctuations that occur in the natural gas market on a daily basis. To account for inherent uncertainty in natural gas markets, staff used past natural gas forecast results generated by the Energy Commission to produce error bounds around price results of the three common cases. Percent differences from Energy Commission forecasts to actual natural gas market prices were determined and used to develop regression trend line equations that were applied to the current Reference Case price results. The error bands capture a much wider price range of price uncertainty then seen in price deferential of the common cases.

In 2013, prices drop in all three cases. Effects of the recent recession cause demand to be stagnant, which explains the initial reduction in the price of natural gas, but as the economy and demand for natural gas recovers, prices for natural gas rise in all three cases, starting in 2014. After 2015, natural gas prices for all three cases remain fairly flat and increase gradually over the forecast period. By 2025, prices are approaching $7.00/MM British thermal units (BTU) for the Low-Energy-Demand/High-Price Case; roughly $5.50/MMBTU for the Reference Case; and about $4.50/MMBTU for the High-Energy Demand/Low-Price Case. The additional natural gas supply from shale plays development allows for more natural gas to be available at lower costs when compared to years past. As shown in Figure 13, this results in a longer supply curve for natural gas supply basins in North America. As a result, a narrow range of natural gas prices can be seen for the common cases.

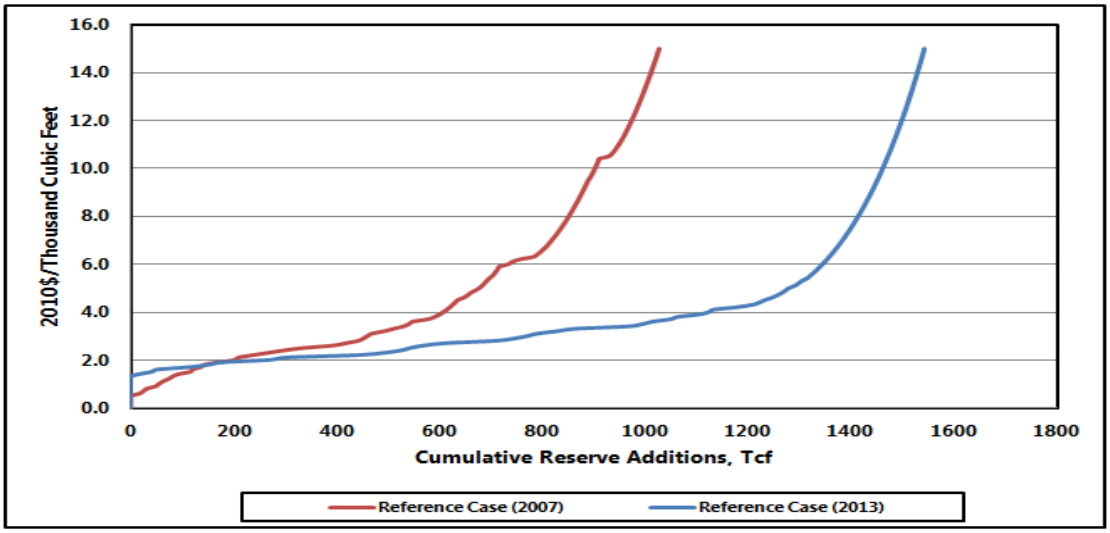
Figure 12: Common Case Price Forecasts with Adjusted Error Bands

Source: California Energy Commission

Natural Gas from Shale Formations

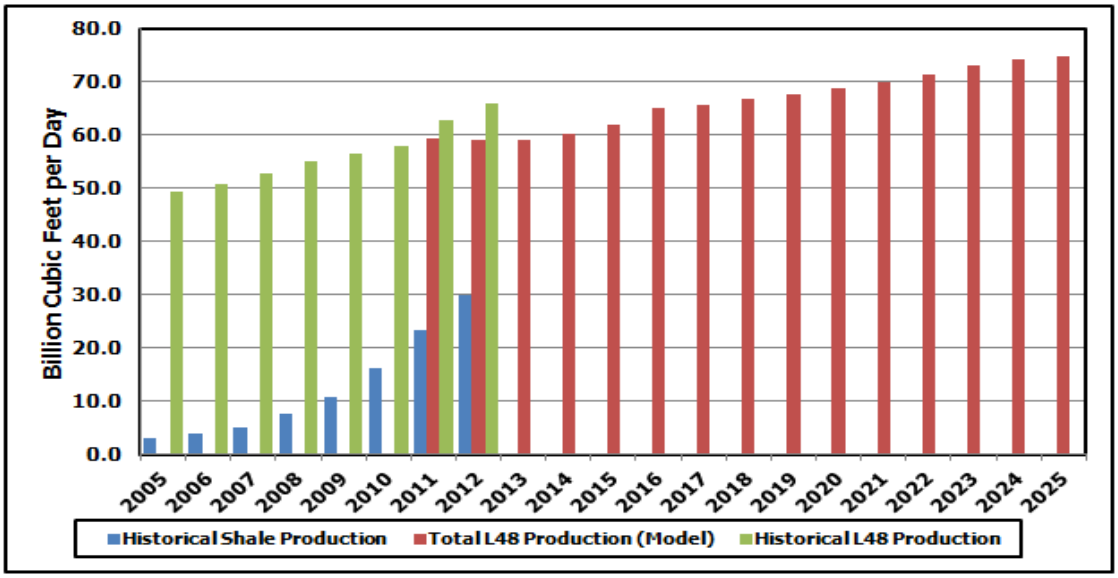
As a result of technological innovations, some natural gas-bearing formations such as shale reservoirs, once inaccessible, are now producing (or will be producing) in 31 states in the Lower 48 states. Figure 13 shows the greater abundance of natural gas available at much lower costs from 2007 to 2013. Figure 14 shows the increasing share of shale gas production in proportion to the total production of natural gas in the Lower 48.

Figure 13: Cumulative Supply Cost Curves



Source: Rice World Gas Trade Model

Figure 14: Lower 48 Natural Gas Production



Source: California Energy Commission, Lippman Consulting

The surge in Lower 48 production has now extended into Canada where similar development activities are generating comparable results. However, in both the Lower 48 and Canada, producers are shifting their investment dollars to shale "plays" with higher liquid content motivated by higher oil and liquid prices (per MMBTU) relative to natural gas prices.

Hydraulic fracturing used by the industry to unlock oil and natural gas from geologic formations such as shale has raised health and environmental concerns. The potential for groundwater contamination, the possibility of increased seismic activity, the diversion of fresh water used in hydraulic fracturing, and the possibility of increased methane emissions have all

pushed decision makers to reexamine policy related to the development of shale resources. Some jurisdictions such as New York have delayed the development of their shale resources, while others have instituted environmental mitigation fees. Others such as California are proposing tighter regulations on hydraulic fracturing.

The United States Environmental Protection Agency is investigating hydraulic fracturing and is considering new regulations. In May 2012, the United States Bureau of Land Management released regulations on hydraulic fracturing of wells on federal lands. In California, the Legislature is considering Senate Bill 4 (Pavley), that if passed will require increased well testing, community notification, and the disclosure of chemicals used in the subsurface technique. In December 2012, the California Department of Conservation released draft regulation concerning hydraulic fracturing. The Department expects to issue a rulemaking by end of summer 2013 to formally consider new rules and anticipates that the process will be completed by the end of summer 2014.

Energy Commission staff developed and analyzed 16 cases to assess price and supply impacts of the development of shale formations. The analysis concluded that the abundance of natural gas from shale formations and the proliferation of technological innovation limited the impact on prices and supply, while environmental policies such as mitigation fees or production constraints can alter development and production outcomes.

Natural Gas and Electricity Generation Industry Interface

As the use of natural gas for power generation increases nationwide, natural gas and electricity industries have become increasingly interdependent and there is a need to better coordinate pipeline delivery of natural gas and electric system reliability. Issues with matching natural gas supply with electricity generation-driven demand differ regionally throughout the United States. Regions that have until recently relied on coal-fired generation for electricity production are now switching generation sources because the price of natural gas is now competitive with coal, although some regions lack the necessary infrastructure to do so. California will be able to avoid many of the challenges associated with converting from coal-fired generation to natural gas-fired generation because only a minimal amount of its in-state power generation comes from coal.[332] The rest of the Western Electricity Coordinating Council (WECC) area has about 37 GW of coal-fired generation capacity, but it is uncertain how much of this capacity is subject to retirement.

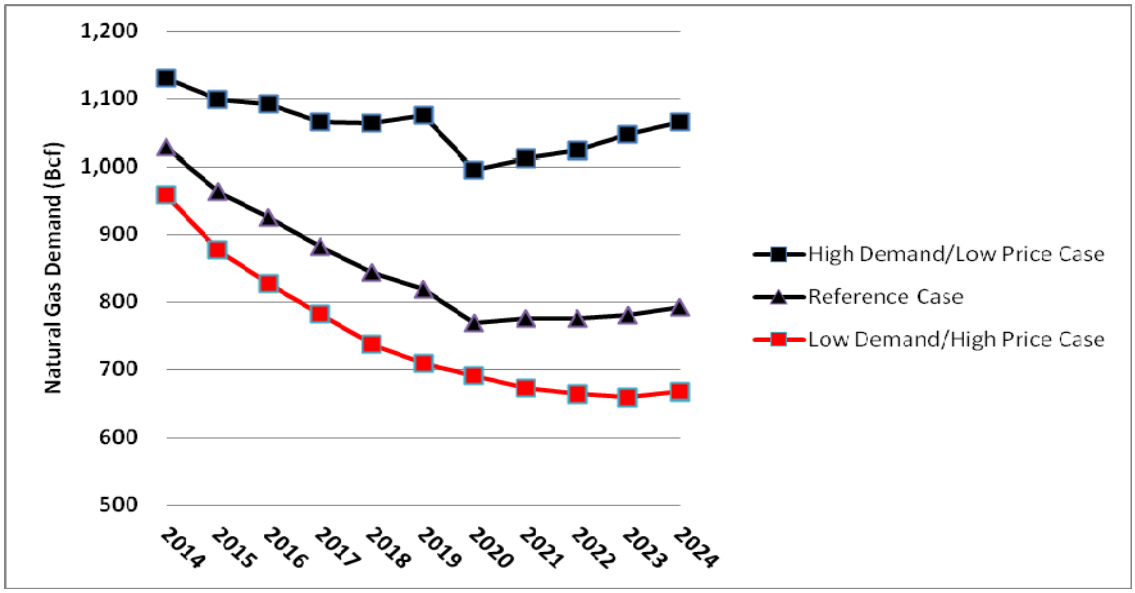
California's Renewables Portfolio Standard (RPS) mandate of 33 percent renewables by 2020 is leading to a build out of renewable generating capacity that is producing energy that likely would have been met by natural-gas fired generating units. However, because of the intermittent nature of renewable generation, natural gas-fired units may be needed to fill in short-term mismatches between supply and demand. Going forward, it is important that the natural gas system has the flexibility to accommodate the short-term ramps up and down of

332 Roughly 400 MW in 2012 and 200 MW in 2013 (California Energy Commission's Electricity Analysis Office data)

natural gas units that will be required to integrate renewables. Additionally, increasing spare pipeline and storage capacity will help natural gas provide a more flexible and reliable source of power generation for the state. As referred to in Chapters 4 and 5, the California Independent System Operator has announced the creation of a real-time energy imbalance market aimed at making greater use of renewables, which will involve more efficient use of the West's natural gas fleet.

Energy Commission staff used the preliminary demand forecast to populate an electricity dispatch model to estimate natural gas demand for power generation in the WECC for each of the outlook scenarios, and then used the resulting outputs as inputs to the North American Market Gas-Trade model. Results show a decline in demand for natural gas in the power generation sector in California over the next decade, but an increase in demand over the entire WECC (Figures 15 and 16).

Figure 15: California Natural Gas Demand for Power Generation



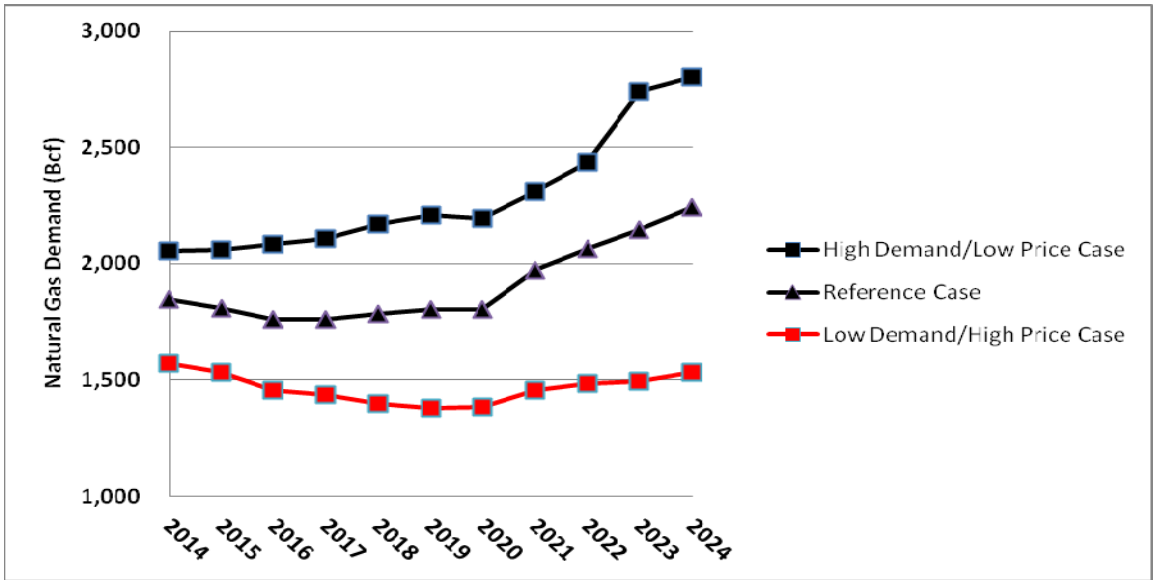
Source: California Energy Commission

Despite the overall decline in natural gas for power generation in California, a significant amount of this gas could be redirected to generate electricity for California's industry and commercial sectors. Governor Brown's Clean Energy Jobs Plan includes a target of 6,500 MW of additional installed combined heat and power capacity over the next 20 years.[333] While future CHP will be both commercial (for example, big box retail and restaurants) and industrial (such as food processing and water treatment) sectors, Energy Commission staff analysis allocated the market shift in natural gas demand from the power generation sector to generation for CHP in the industrial sector. Figure 17 shows the net additional natural gas demand shifted to CHP to

333 ICF 2012. *Combined Heat and Power Policy Analysis and 2011-2030 Market Assessment*. CEC-200-2012-002.

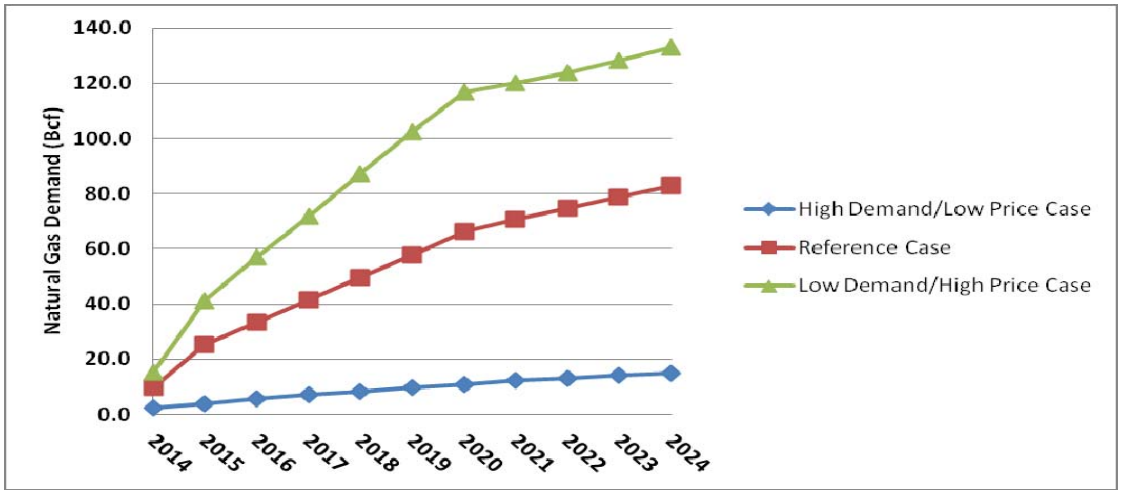
generate electricity for industrial sector customers in each of the Energy Commission staff's forecast scenarios showing positive average annual growth in both the reference and low demand/high price cases. The high demand/low price case assumes minimal CHP addition in the industrial sector. The section on "Other Natural Gas Issues" later in this chapter provides more information about CHP.

Figure 16: WECC Natural Gas Demand for Power Generation



Source: California Energy Commission

Figure 17: California Natural Gas Demand for CHP to Generate Electricity for Industrial and Commercial Sector Customers



Source: California Energy Commission

Natural Gas Pipeline Safety

Pipeline safety, in the wake of the San Bruno pipeline explosion in 2010, remains a critical concern of the Energy Commission, the California Public Utilities Commission (CPUC) and the legislature. The CPUC ordered pressure reductions until the gas utilities verified important pipeline features to set pipeline maximum allowable operating pressures (MAOP), and directed that segments without acceptable records either be subject to hydrostatic or other strength testing, or be replaced.

The gas utilities were also required to submit pipeline safety enhancement plans. In December 2012, the CPUC approved Pacific Gas and Electric Company's (PG&E's) 2012–2014 Pipeline Safety Implementation Plan, which spelled out criteria and a timetable as to how PG&E would upgrade its gas system, including the addition of remote or automatic valves and making more of its system able to use in-line inspection techniques. The CPUC authorized rate recovery for $299 million of the associated expenditures, which are estimated by PG&E to increase its rate for residential core service by 1.5 percent.[334]

Southern California Gas, likewise, has filed with the CPUC its Pipeline Safety Enhancement Plan,[335] which is a multi-year pipeline testing and replacement effort that will target upgrading, replacing or adding approximately 487 valves on their system with remote control capability. Phase 1 of the Plan is estimated to cost $2.5 billion over ten years. In April of 2013, the CPUC released its updated Natural Gas Safety Action Plan,[336] which focuses on setting, monitoring, and enforcing rules for regulated utilities based on risk assessment and risk management, while also tracking implementation of improvements responsive to recommendations made by the Independent Review Panel and the National Transportation Safety Board in response to the tragic PG&E San Bruno pipeline explosion. Specifically, the plan aims to ensure the safety of the existing gas system, upgrade and replace the gas system to make it safer, reform the CPUC to make safety its first priority, and instill a Safety Culture in Gas Operators.

While the gas utility and CPUC safety plans are appropriate and necessary steps toward safer natural gas pipelines, remnants of the issues that led to the pipeline explosion in the City of San Bruno still exist. On July 3, 2013, PG&E filed an "Errata to Pacific Gas and Electric Company's Supporting Documentation for Lifting Operating Pressure Restrictions on Line 101 and 147," pipelines, which are located in the greater San Francisco area. The errata explains that the supporting information it filed in October of 2011 in support of its request to lift operating pressure restrictions on these pipelines was erroneous. That information contained PG&E records – developed as part of the pipeline records validation process ordered by the CPUC after the San Bruno explosions – showing that these pipelines contained double submerged arc

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334 CPUC, "CPUC Approves Pipeline Safety Plan for PG&E; Increases Whistleblower Protections," press release, December 20, 2012, http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M040/K531/40531580.PDF

335 Southern California Gas Company (U 904 G) Natural Gas System Operator Safety Plan: http://www.socalgas.com/regulatory/documents/r-11-02-019/SCG-Cover%20Filing-6.29.12.pdf

336 http://www.cpuc.ca.gov/PUC/safety/Pipeline/Natural_Gas_Safety_Action_PlanApril2013.htm

welds or were seamless and had joint efficiency factors of 1.0. This justified an MAOP of 365 pounds per square inch gauge (psig). Based on this representation by PG&E, the CPUC granted permission to raise the MAOP's of the lines to no more than 365 psig in December of 2011.

The errata filed on July 3, 2013 revealed that PG&E had learned upon repair resulting from a routine leak inspection that as many as six segments of Line 147 actually have single submerged arc welds, implying a joint efficiency factor of 0.8, which effectively reduces the pipeline's MAOPs to 330 psig from the approved 365 psig. The implications from a pipeline safety perspective are clear. Due to PG&E's admitted error, the pipelines received approval to operate at pressures that are higher than the recommended MAOP. PG&E noted in the errata that it has reduced the operating pressures to safe levels, but both the length of time it took PG&E to file the errata – 18 months – and the fact that the information contained in the errata was substantive, led the CPUC to order PG&E to appear at a hearing and show cause why it shouldn't be sanctioned for violating Rule 1.1 of the Commission's Rules of Practice and Procedure. Rule 1.1 states that any person who transacts business with the CPUC agrees to "never mislead the Commission or its staff by an artifice or false statement of law or fact."[337] The Show Cause Order also asks PG&E to show why all of the CPUC orders approving PG&E requests to restore operating pressures arising out of the post-San Bruno effort to verify pipeline features and maximum allowable operating pressures should not be rescinded until "competent demonstration that PG&E's natural gas system records are reliable."

Notably, PG&E indicated at the Show Cause hearing that significant curtailments of natural gas service to power plants, noncore customers on the San Francisco Peninsula, and core customers in San Francisco's Financial District would be triggered at cold temperatures expected to occur once in every ten years. In addition, PG&E, in late September, reduced operating pressures on Line 300, the backbone transmission line that comes from the interstate pipeline connections at the California-Arizona state line and feeds the southern Bay Area and Peninsula, as well as the San Joaquin Valley. The reduced operating pressures again reduce the maximum throughput capability of this important high pressure transmission line. PG&E has not yet indicated whether this additional pressure reduction, needed for safety purposes, will expose Californians to reliability issues.

In response to California's continued focus on pipeline safety, the Energy Commission continues to provide research, development and deployment funding to projects that explore new technologies to monitor and address pipeline safety. The Energy Commission is also closely monitoring the effective capacity reductions imposed as PG&E reduces operating pressures.

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337 CPUC Rules of Practice & Procedure: http://docs.cpuc.ca.gov/WORD_PDF/AGENDA_DECISION/143256.PDF, Page 1

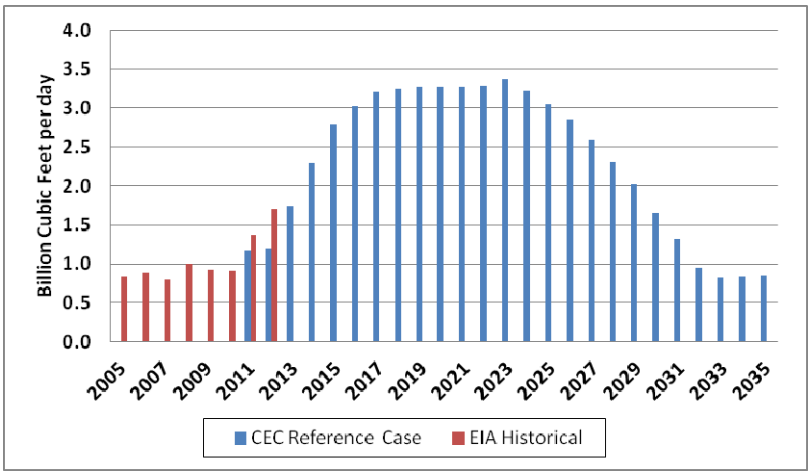
Natural Gas Infrastructure

Energy Commission staff has identified four areas of potential natural gas infrastructure changes: exports to Mexico, exports of liquefied natural gas, pipeline development in the Lower 48 states, and natural gas storage in California.

Exports to Mexico

In 2012, Mexico imported an average of 1.7 billion cubic feet per day (Bcf/d) of natural gas from the United States. By 2018, U.S. exports to Mexico are expected to increase more than 100 percent based on a report by Bentek Energy (3.6 Bcf/d)[338] and on the Energy Commission staff's reference case forecast (3.3 Bcf/d, Figure 18). Most of the increase comes from increased gas demand for power generation. To meet this demand, pipeline developers have announced seven new projects that will increase the export capacity from the United States to Mexico by 4.3 Bcf/day.

Figure 18: Historical and Forecasted Lower 48 Exports to Mexico



Source: Energy Commission staff forecast, Energy Information Administration

Liquefied Natural Gas Exports

The boom in U.S. shale gas production has led to increased interest in exporting liquefied natural gas (LNG). There are nine LNG import terminals in the Lower 48 plus about a dozen planned import/export terminals that have filed with the U.S. Department of Energy (U.S. DOE) for approval of non- Free Trade Agreement licenses to export LNG to foreign countries, mostly in Asia, with two approved within the last three years. U.S. DOE has been cautious about approving these types of licenses because of concerns that high levels of LNG imports might cause U.S. gas shortages and price increases. Prospective export terminals also face billions of dollars in costs to convert to import/export capability and two to four years of construction time. In that time frame, the foreign market for U.S. LNG could be met by other sources closer

338 Canonica, Rocco, Ellen Nelson, Darrell Proctor, and Tricia Bulson. Growing Mexican Gas Market Creates Southwest Price Premiums. Energy Market Fundamentals Report. Bentek Energy, Platts, May 2013, pg. 17.

to demand, such as Australia or Qatar. Of approved export terminals, only the Sabine Pass LNG terminal in Louisiana has begun construction. Nonetheless, the prospects for California to be an exporter are extremely low as the state is neither a big producer nor net exporter of natural gas.

Lower 48 Pipeline Development

The U.S. pipeline system is facing a period of instability because of changing supply and demand dynamics from the abundance of shale gas, expected increases in natural gas-fired electricity generation as coal generation is retired, and expiration of contracts by 2015 that is causing pipeline companies to look for ways to replace lost revenue. In the Northeast, Pennsylvania's Marcellus shale has brought gas supply much closer to demand. Long-haul Tennessee and REX pipelines, which carry gas from the Gulf to the Northeast and the Rocky Mountain Basin to the Northeast, respectively, are considering reversing or enabling bidirectional pipeline flow to deliver gas out of the Marcellus shale and fill their excess capacity. In the southwest, the El Paso Natural Gas pipeline from Texas to Southern California has unsubscribed capacity. Although the pipeline owner explored two plans to increase revenue – first, by abandoning some compressor stations to lower the capacity and operating costs, and second, by converting a segment of the pipeline from gas transmission to oil – both plans were eventually dropped.

To accommodate expected replacement of coal plants with natural gas, an Interstate Natural Gas Association of America study projects a need for 25 Bcf of new pipeline capacity.[339] An Aspen Environmental Group study of a worst-case scenario in which all existing coal generation is replaced with gas indicates that gas demand would rise by 14.1 Tcf (61 percent) and require 70 Bcf of new pipeline capacity.[340]

For most of California, there is ample pipeline capacity to meet demand, and there are no anticipated supply issues. In southern California, however, there could be supply constraints because of greater demand from the closing of San Onofre and ramping requirements needed to integrate renewable generation.

The Energy Commission does not expect any significant pipeline disruptions due to unsafe or aging infrastructure, given the active attention that PG&E and other California gas utilities have given to pipeline safety following the San Bruno pipeline explosion in 2010. The Energy Commission continues to provide research, development, and deployment funding to projects that explore new technologies to monitor and address pipeline safety.

Natural Gas Storage in California

Storage of excess natural gas in the late spring/early summer and in the fall/early winter provides sufficient gas for late summer power generation demand related to cooling loads and for winter heating demands. California has 13 underground natural gas storage facilities with a

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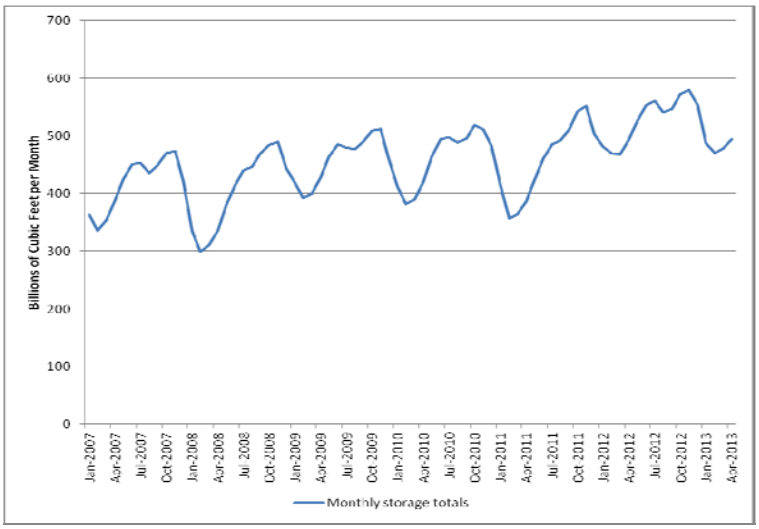
339 ICF International. *Natural Gas Pipeline and Storage Infrastructure Projections Through 2030*. Washington D.C.: The INGAA Foundation, October 2009. http://www.ingaa.org/File.aspx?id=10509.

340 Elder, Catherine. *Implications of Greater Reliance on Natural Gas for Electricity Generation*. Prepared for the American Public Power Association. Aspen Environmental Group, July 2010.

total working gas inventory of 335 Bcf as of 2011. As shown in Figure 19, storage capacities in 2012 rose in the winter and spring by up to 24 percent compared to 2011 on the heels of a warmer-than-usual winter and lower than usual demand. This trend has continued in 2013 with storage totals through April 2013 staying relatively even. Overall, the trend has been increased storage totals each year over the past six years as working storage capacity has increased and as demand is expected to grow with improving economic conditions.

Figure 19: California Monthly Natural Gas Storage Totals (Total Inventory Including Working Gas)



Source: Energy Information Administration

Other Natural Gas Issues

Biomethane

As discussed in Chapter 3, pipeline-quality biomethane can be a renewable, low-carbon substitute for natural gas. However, Assembly Bill 4037 (Hayden, Chapter 932, Statutes of 1988) added language to the California Health and Safety Code prohibiting injection of biomethane from landfills into gas utility pipelines from instate sources because of concerns with vinyl chloride concentrations, even if the gas is treated to meet health and safety standards.[341]

To help meet California's RPS, utilities began securing contracts from out-of-state sources of biogas. However, the RPS eligibility of generation from a natural gas power plant that uses pipeline biomethane gas from a distant source is unclear because, once injected into the intrastate pipeline, the gas may not actually be physically delivered to and used by that power plant to generate electricity. Because of concerns regarding consistency with the RPS, the Energy Commission suspended eligibility credits for pipeline biomethane in March 2012.

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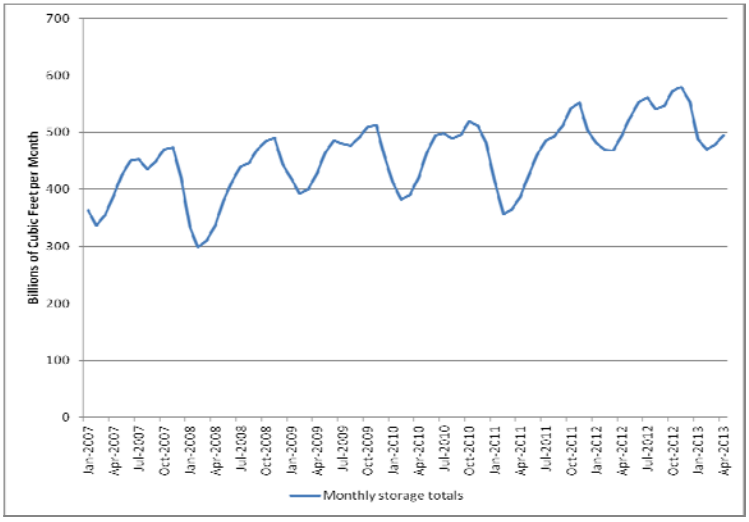
341 California Health and Safety Code, Section 25421(a): "No gas corporation shall knowingly purchase landfill gas, if that gas contains vinyl chloride in a concentration that exceeds the operative no significant risk level set forth in Article 7 (commencing with Section 12701) of Chapter 3 of Division 2 of Title 22 of the California Code of Regulations."

Figure 20: California Monthly Natural Gas Storage Totals (Total Inventory Including Working Gas)



Source: Energy Information Administration

To address these issues, Assembly Bill 1900 (Gatto, Chapter 602, Statutes of 2012) in 2012 requires the California Public Utilities Commission to develop standards for constituents in biogas to protect human health and pipeline integrity and safety. The statute also requires the Energy Commission "to determine, for new certifications, whether a source of biomethane results in new displacement of fossil fuels and directly achieves air quality improvements in an air basin in or affecting California." While the bill is intended to ease restrictions, some stakeholders have expressed concern that it could create new barriers by expanding the scope of standards beyond vinyl chloride to include any compounds that may create health and safety hazards, damage pipeline facilities, or inhibit the marketability of the gas.

Combined Heat and Power

CHP, also known as cogeneration, is an integrated system that generates both electricity and thermal energy using a single fuel source such as natural gas, biogas, biomass, coal, waste heat, or oil. Less fuel is consumed in a typical CHP system than would be required to obtain electricity and thermal energy separately. Since less fuel is consumed, CHP systems offer greenhouse gas (GHG) reduction benefits over the conventional method of obtaining heat from a boiler and power from the electric grid.

California policy supports the use of CHP as a GHG emissions reduction measure and to support California's industrial economy. The California Air Resources Board's AB 32 *Climate Change Scoping Plan* includes a target of 6.7 million metric tons of carbon dioxide equivalent (CO2e) reductions from new and existing CHP resources,[342] and Governor Brown's Clean Energy Jobs Plan sets a goal of 6,500 MW of new CHP capacity by 2030.[343]

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342 California Air Resources Board. *Climate Change Scoping Plan: A Framework for Change*. 2008. http://arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm, pp. 42 – 43.

343 "Brown Announces Clean Energy Jobs Plan," at http://www.jerrybrown.org/Clean_Energy.

California has several programs to support these policies and promote clean and efficient CHP systems. These include the Self-Generation Incentive Program,[344] the Waste Heat and Carbon Emissions Reduction Act[345] (also known by its founding legislation Assembly Bill 1613), and a program for competitively bid CHP resources established by the Qualifying Facility and Combined Heat and Power Settlement Agreement [346]

In 2011 the Energy Commission contracted with ICF Consulting to identify existing CHP capacity and quantify the long-term market potential for CHP in California and the degree to which CHP can reduce potential GHG emissions over the next 20 years. The resulting *Combined Heat and Power: 2011-2030 Market Assessment* identified 8,518 MW of installed CHP at the end of 2011 and indicated that cumulative market penetration for new CHP in 2030 varies between 1,888 MW and 6,108 MW.[347] Existing capacity has decreased by roughly 330 MW with the closure of some CHP facilities that used coal or petroleum coke, as well as the economic closure of the Campbell's Soup plant in Sacramento.

With very few exceptions, CHP generation uses natural gas or biofuel. The three exceptions are ACE Cogeneration, Argus Cogeneration, and Wilmington Calciner. ACE Cogeneration has announced intention to convert its 108 MW facility to natural gas by 2017. Argus Cogeneration generates 55 MW of electricity and Wilmington Calciner generates 36 MW of electricity.[348] It is unknown if these two facilities will convert to an alternate source of fuel or cease operation.

Some applications of CHP are a natural fit for the use of onsite digester biogas. These include wastewater treatment facilities and dairy processing facilities. The creation and use of biogas at these facilities offset the need for natural gas or electricity from the grid. A 2009 Energy Commission study, *Combined Heat and Power Potential at California's Wastewater Treatment Plants*,[349] estimates the market potential for additional capacity at wastewater treatment plants as 100 MW. However, the capacity could be increased to 450 MW by adding biodegradable

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344 CPUC Decision 01-03-073 implementing Assembly Bill 970 (Ducheny, Chapter 329, Statues of 2000), later amended by Assembly Bill 1685 (Leno, Chapter 894, Statutes of 2003), Assembly Bill 2778 (Lieber, Chapter 617, Statutes of 2006), Senate Bill 412 (Kehoe, Chapter 182, Statutes of 2009), and Assembly Bill 1150 (Pérez, Chapter 310, Statutes of 2011).

345 Assembly Bill 1613 (Blakeslee, Chapter 713, Statutes of 2007), later amended by Assembly Bill 2791 (Blakeslee, Chapter 253, Statutes of 2008).

346 California Public Utilities Commission. 2010. *Decision Adopting Proposed Settlement.* Decision 10-12-035, at http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/128624.PDF.

347 Hedman, Bruce, Ken Darrow, Eric Wong, Anne Hampson. ICF International, Inc. 2012. *Combined Heat and Power: 2011-2030 Market Assessment.* California Energy Commission. CEC-200-2012-002.

348 Quarterly Fuels and Energy Reports submitted to the Energy Commission in 2011 and 2012 and available at http://energyalmanac.ca.gov/electricity/web_qfer/.

349 Kulkarni, Pramod, 2009, *Combined Heat and Power Potential at the California Wastewater Treatment Plants*. California Energy Commission. Publication# CEC-200-2009-014-SD.

waste from California dairies and food processing plants, and restaurant oil and grease to the sludge in the anaerobic digesters.

The main economic driver for CHP development is the difference between the price of natural gas and the price of avoided electricity, more commonly known as the "spark spread." For example, extended forecasts of low natural gas prices coupled with forecasts for increased electricity and electrical infrastructure costs result in an even greater spark spread, which should result in increasing the numbers of CHP projects that are financially feasible.

While increased CHP generation will add to the amount of natural gas used on site, it will cause a net decrease in the amount of natural gas to meet both the electrical and thermal needs of the facility. This calculation becomes more complex as renewable resources are added to the electric grid. The RPS requires utilities to procure one-third of their electricity from renewable resources by 2020. Electricity produced by CHP facilities and sold to the local utility counts toward utility procurement of natural gas resources and does not reduce the need for procurement of renewable generation. Electricity produced by CHP facilities that is used on site is not counted toward utility natural gas procurement and effectively reduces the amount of renewable generation the local utility has to procure. It is in this fashion that CHP may increase the demand for natural gas.

Recommendations

- **Continue to monitor changes in the natural gas and electricity generation interface.** As the use of natural gas for power generation increases nationwide, and the need for quick ramping gas-fired generation to integrate intermittent renewable resources has grown, natural gas and electricity industries have become increasingly interdependent. To ensure continuity of both wholesale and retail supply as wholesale reliance on natural gas increases, there is need for better coordination of pipeline delivery of natural gas with electric system reliability needs, particularly in the San Diego region. Monitor Southern California Gas proposals at the California Public Utilities Commission to either increase gas deliveries to Ehrenberg or build new infrastructure to connect their northern and southern pipeline systems.
- **Monitor and evaluate interest in exporting liquefied natural gas.** Monitor the current national interest in exporting liquefied natural gas and the analyze implications of this for California's natural gas supply needs.
- **Monitor changing revenue dynamics for natural gas.** Monitor changing natural gas revenue dynamics in an era marked by shale abundance, generation shifts away from coal, and expiring pipeline contracts and their implications for maintaining necessary supply flows into California.

CHAPTER 8: Transportation Energy

The transportation sector is a major user of energy and is essential to California's economy. Movement of people and goods by vehicles, rail, airplanes, and other transportation modes account for about 40 percent of all energy consumed within the state[350] and produces roughly 38 percent of the state's GHG greenhouse gas (GHG) emissions.[351] There are more than 27 million registered vehicles in California and those vehicles consume nearly 19 billion gallons of fuel each year. Petroleum comprises 92 percent of California's transportation energy sources, but technology advances, market trends, consumer behavior, and government policies could lead to significant changes in the fuel mix by 2020. In fact, over the last decade, California has initiated several actions and put in place policies, rules, and regulations to improve vehicle efficiency, increase the development and use of alternative fuels, reduce air pollutants and GHG emissions from the transportation sector, and reduce vehicle miles traveled. These California trends have initially shown modest progress but new circumstances are poised to push significant advances. California needs a fuller understanding of the impact of these potential changes and assurances that transportation and infrastructure options will continue to provide reliable mobility for people and businesses. This chapter describes a series of investments that California is making to transform the transportation sector and then identifies emerging transportation energy trends.

Alternative and Renewable Fuel and Vehicle Technology Program

California's investment in transforming the transportation sector. Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) in 2007 and authorized the Energy Commission to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain California's climate change policies. The ARFVTP is authorized at up to $100 million per year in funding to develop and deploy technology and alternative and renewable fuels in the marketplace, without adopting any one preferred fuel or technology. Since the program's inception, the Energy Commission has invested more than $400 million into some 233 fuel, vehicle, and infrastructure projects across the state. This investment supports the State's energy, clean air, and climate goals. In September 2013, the California legislature reauthorized this program with AB 8 (Perea, not yet chaptered, Statutes of 2013), extending the ARFVTP funding through January 1, 2024.

Developing a plan that invests in a broad transportation portfolio. The Energy Commission uses a portfolio approach that balances near- and long-term technologies to reduce criteria, particulate and carbon emissions from the multiple vehicle types, users, and market

350 U.S. Energy Information Administration, http://www.eia.gov/state/?sid=CA#tabs-2.

351 California Air Resources Board, Green House Gas Inventory, http://www.arb.ca.gov/cc/inventory/data/data.htm.

applications that typify California's large and diverse vehicle fleets of 26 million passenger vehicles and one million trucks. This portfolio approach is specified by the legislature and has been supported and recommended in multiple publications including: the *2007 State Alternative Fuels Plan*;[352] the Low Carbon Fuel Standard (LCFS) planning documents prepared by UC Berkeley and UC Davis; [353] and more recently in the draft *2050 Vision for Clean Air* released by the California Air Resources Board (ARB) and South Coast Air Quality Management District.[354]

The Energy Commission has developed and adopted five investment plans since 2008, with $548.7 million in technology development and deployment investments for the first six fiscal years of the ARFVT Program. Program funding for each annual cycle is determined by the Energy Commission through updates to the annual *Investment Plan* based on a public process that features a multi-stakeholder 20 plus member Advisory Committee and multiple public workshops. The Advisory Committee includes representatives from industry trade associations; academic institutes; non-governmental environmental; public health and alternative energy organizations; labor; and energy and environmental agencies. The Energy Commission uses the data, experiences, and expertise gathered during this important public process in addition to its knowledge, analyses, and expertise to inform and help shape the *Investment Plan*.

As of June 30, 2013, the Energy Commission has funded 233 projects totaling $409.6 million since the initial round of solicitations were released in 2009 and 2010. Table 13 and Figure 21 summarize the $409.6 million in funding awards by fuel category and specific technology application and show the distribution of ARFVTP awards across the portfolio by primary fuel and program categories. To date, the ARFVTP has:

- Invested approximately one third of total ARFVTP investments into **electric drive** technologies (including the manufacturing category). These include light-duty passenger vehicle chargers, components, voucher support, and planning grants, as well as medium- and heavy-duty advanced technology truck grants.
- Dedicated another third ($127.6 million) of the total program funding to **biofuel production and development**. Currently, more than $100 million is being used to fund 36 fuel production projects. This portfolio of biogas, ethanol and cellulosic ethanol, and biodiesel and renewable diesel projects features very low carbon intensity values that are generally 75 percent lower than gasoline and diesel. This portfolio also includes waste-based biomass feedstocks from municipal waste streams, dairies and feedlots, and other agricultural residues, as well as alternative feedstocks such as sweet sorghum and sugar beets.

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352 *State Alternative Fuels Plan,* California Energy Commission, Publication No. 600-2007-011-CMF, 2007.

353 Farrell, Alexander and Sperling, Daniel, "A Low Carbon Fuel Standard for California, Part 1: Technical Analysis," UC Berkeley and UC Davis, August 2007.

354 "Vision for Clean Air: A Framework for Air Quality and Climate Planning," California Air Resources Board, San Joaquin Valley Air Quality Management District, South Coast Air Quality Management District, June 2012.

Table 13: Detailed Accounting of ARFVTP Award Categories through June 30, 2013

Fuel Type	Funding Activity	Amount ($ millions)	No. of Awards	Total ($ millions)
Electric Drive	Charging Infrastructure	$24.8	27	$87.1
	Vehicle Deployment Incentives *	$24.1	4	
	Medium- and Heavy-Duty Advanced Vehicle Demonstration	$36.2	21	
	PEV Regional Readiness	$2.0	10	
Hydrogen	Hydrogen Fueling Infrastructure	$36.8	8	$43.2
	Fuel Standards Development	$4.0	1	
	Fuel Cell Bus Demonstration	$2.4	1	
Natural Gas	Vehicle Deployment Incentives	$33.5	3	$55.5
	Medium- and Heavy-Duty Advanced Vehicle Demonstration	$6.3	4	
	Fueling Infrastructure	$15.7	42	
Propane	Vehicle Deployment Incentives	$7.3	2	$7.3
Biofuels	Biomethane Production	$49.9	13	$127.6
	Diesel Substitutes Production	$26.0	12	
	Gasoline Substitutes Production	$26.4	11	
	Sustainability Research	$2.1	2	
	E85 Fueling Stations	$16.5	4	
	Upstream Diesel Substitutes Infrastructure	$4.0	4	
	Medium- and Heavy-Duty Advanced Vehicle Demonstration	$2.7	1	
Manufacturing	Manufacturing Facilities and Equipment	$48.3	18	$48.3
Workforce Training/Dev.	Workforce Training and Development	$23.3	30	$23.3
Program Support	Technical Assistance and Analysis	$17.3	15	$17.3
Total		**$409.6**	**233**	**$409.6**

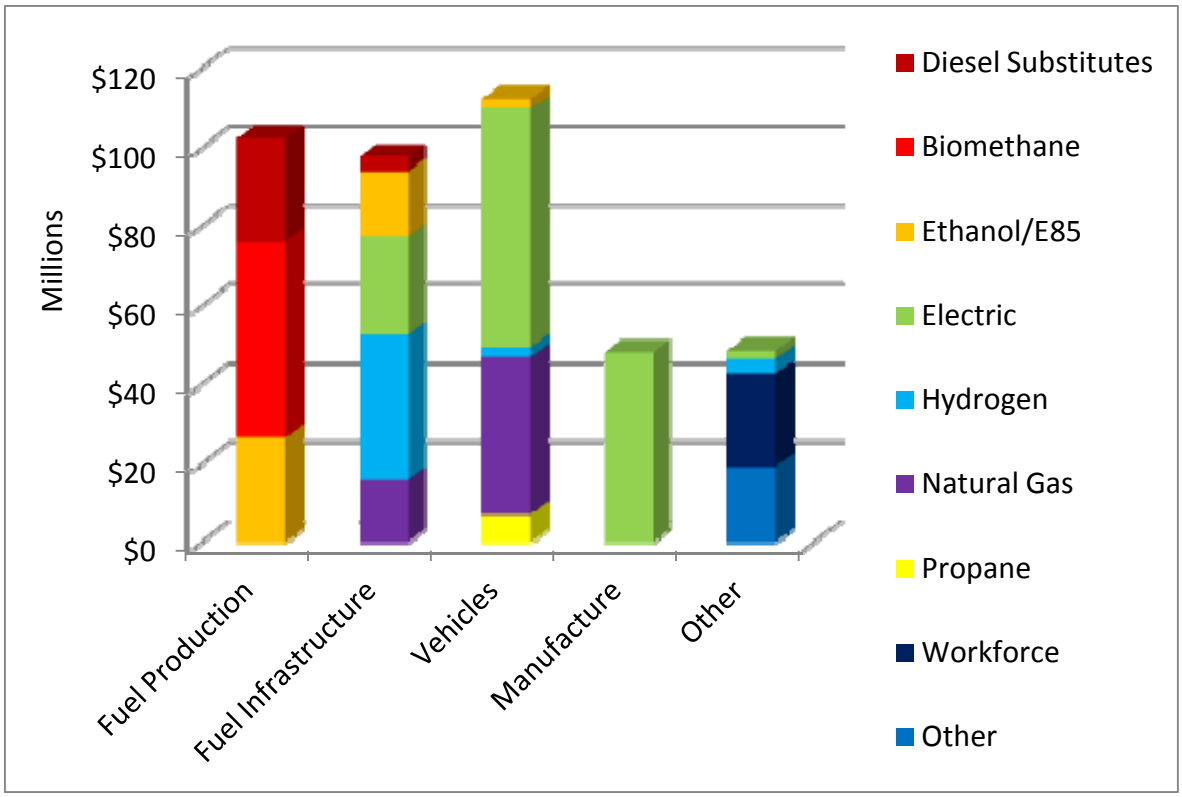
*Table 13 shows ARFVTP funding awards to the end of June 2013, which is the end of the state fiscal year. Assembly Bill 101 will transfer another $24.55 million from ARFVTP to the ARB's Clean Vehicle Rebate Project.

Source: California Energy Commission

- Incentivized and accelerated a transition from older higher polluting vehicles, to new less polluting vehicles. The Energy Commission's investments in **natural gas trucks and fueling infrastructure** total more than $55 million, and include funding for nearly 1,400 natural gas vehicles, a series of natural gas engine development projects, and 50 new natural gas fueling stations throughout California.

- Distributed awards widely throughout the state. As shown in Table 14, about 25 percent of Program funding has gone to the South Coast region, while the Bay Area region received about 18 percent of funds and the San Joaquin Valley region received about 13 percent.

Figure 21: Cumulative 2009-13 Program Investments by Fuel Type and Supply Phase



Source: California Energy Commission

- Allocated about 64 percent of program investments to commercial deployment and production projects; 26 percent to pre-commercial demonstration, research and development; and 10 percent to clean transportation workforce development.
- Leveraged $1.80 of private sector or other public sector funding for each $1 invested. Private sector and additional public sector matching contributions to the 233 projects funded total nearly $740 million. To date, the largest public funds leveraged by the ARFVT Program have been federal monies made available through the American Reinvestment and Recovery Act of 2009.

Making Progress on Zero Emission Vehicles. California leads the nation in market adoption and policy support for alternative fuels and vehicles. Reducing carbon from the transportation sector; reducing petroleum fuel use; reducing criteria, particulate, and toxic emissions; and promoting zero emission vehicle (ZEV) technologies are core policy goals for Governor Brown and the Legislature. These policy goals are articulated in legislation, executive orders, and program regulations. These policy goals are supported with incentive funding from ARFVTP and Air Quality Improvement Program, totaling $548 million and $227 million to date for each program, respectively. The eight-year reauthorization will enable up to $1.12 billion in additional incentive funding through 2023.

Table 14: Geographic Distribution of ARFVTP Awards

Air District	Funding Amount ($ millions)	Percent of Total (%)	Number of Awards
Bay Area	73.6	18.0	42
Monterey	2.7	0.7	2
Sacramento	17.4	4.3	16
Santa Barbara	1.9	0.5	6
San Diego	15.7	3.8	15
San Joaquin	54.0	13.2	28
South Coast	103.2	25.2	68
Ventura	11.3	2.7	3
Yolo-Solano	10.5	2.5	6
Other Nor Cal Districts	5.1	1.2	9
Other So Cal Districts	2.1	0.5	6
Statewide	112.1	27.4	32
Total	**409.6**	**100**	**233**

Source: California Energy Commission

Assembly Bill 101, (Committee on Budget, Chapter 354, Statutes of 2013), Section 27, transfers an additional $24.55 million from the Alternative and Renewable Fuel and Vehicle Technology Fund to the Air Quality Improvement Fund. These funds were previously loaned to the General Fund and likely will not affect funding levels for the 2014-15 *Investment Plan*. This transfer is an additional contribution to the ARB's Clean Vehicle Rebate Project. This additional funding will support roughly 12,400 additional vehicle rebates.

The Energy Commission's Role. The Energy Commission's investments in light-duty electric vehicle deployment in California total $90.8 million, or 20 percent of grant agreements to date. This includes nearly $25 million for more than 7,200 electric chargers, $23.5 million for 9,063 vehicle purchase vouchers under the via the ARB's Air Quality Improvement Program,[355] $2 million for regional readiness planning, and $40.3 million for 11 component, battery, and vehicle development grants through manufacturing solicitations.

For ZEV truck funding, the Energy Commission has invested a total of $60 million in demonstration and deployment projects. This includes $36.2 million for 21 demonstration projects for all-electric, plug-in electric, and hybrid electric drive trucks that range from Class 8 electric drayage trucks to Class 3 and 4 electric shuttle vans, to initial funding for a demonstration of an overhead wire catenary-electric trolley truck configuration for the Interstate 710 corridor near the ports of Los Angeles and Long Beach. The $60 million investment also includes 7 grants from the manufacturing category to support new electric

355 ARFVTP transfers to AQIP: 8,903 light duty electric vehicle vouchers totaling $19.5 million and 160 electric truck vouchers totaling $4 million.

truck assembly plants in California from companies such as Electric Vehicles International, Transpower and Boulder Electric.

The Energy Commission has also invested more than $43 million in hydrogen fuel station development for 24 new and refurbished vehicle fueling stations, a fuel cell bus fueling station and bus demonstration, and development of retail fueling dispensing standards and regulations through the California Division of Weights and Measures.

The Zero Emission Vehicle Regulation. The ARB first adopted the ZEV requirement in 1990 as part of the Low Emission Vehicle regulation. The ZEV Program is designed to achieve the state's long-term emission reduction goals by requiring manufacturers to offer for sale specific numbers of the very cleanest cars available. Since 1990, not only have partial ZEVs and advanced technology become commercially viable, but ZEV and ZEV-enabling technologies are coming to market.

The ZEV Program remains an important regulation for meeting California's air quality and GHG reduction goals and has spurred many new technologies that are being driven on California's roads today. The goal of the regulation is to have zero emission technologies available on a commercial scale as quickly as possible so that future fleet average standards can count on ZEVs and the entire fleet can approach zero emission levels. These ZEV program technologies, which include battery electric, fuel cell, and plug-in hybrid electric vehicles, are just beginning to enter the marketplace.

The 2012 amendments increase requirements of ZEVs and plug-in hybrid electric vehicles to over 15 percent of the new vehicle sales by 2025. This will ensure ZEV volumes are at a level sufficient to reduce the incremental ZEV costs and reach commercialization. Cumulative ZEV sales under the new requirements should reach 1.4 million by 2025.

Executive Order B-16-12 and the Governor's ZEV Action Plan. On March 23, 2012, Governor Brown signed Executive Order B-16-12[356] directing state government to help accelerate the market for ZEVs in California and support the ZEV regulation. The Executive Order established several milestones on a path toward widespread infrastructure to support 1.0 million ZEVs by 2020 and cumulative ZEV sales of 1.5 million by the year 2025. The Executive Order also sets a longer term target of reducing transportation-related GHG emissions by 80 percent below 1990 levels by 2050, augmenting the original Executive Order S-3-5 that established an economy-wide 80 percent target.[357] In addition, the Governor published a *Zero Emission Vehicle Action Plan* which specifies clear action items to promote the building of fueling infrastructure, increase vehicle adoption, and the development of ZEV-related California jobs.[358]

356 http://gov.ca.gov/news.php?id=17472 .

357 http://gov.ca.gov/news.php?id=17463.

358 http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf.

Program Impacts and Changes to California's Alternative Fueling Infrastructure, Vehicle Fleets and Biofuels Industry: 2008-2013

As articulated in the ARFVT Program investment plans, the Energy Commission's strategic program goals for allocating the ARFVT Program's funding has been to:

- Establish the foundation for a ZEV and near-ZEV transportation future by focusing on battery electric, hydrogen, natural gas, E85 (a blend of 85 percent ethanol and 15 percent gasoline) retail fueling stations, and biodiesel wholesale fueling terminals. Early establishment of alternative fueling networks signals California's commitment to the long-term transition to alternative fueled and powered vehicles, which should in turn boost early market sales of alternative vehicles in California.
- Accelerate shifts in medium and heavy duty truck fleets from diesel to natural gas to capture early carbon reduction benefits and begin investments in ZEV truck technologies to meet long-term carbon and criteria emissions reduction goals. While diesel-fueled trucks are a small percentage of the State's total vehicle fleet (3.3 percent), they are responsible for a disproportionately large amount of fuel consumption and vehicle emissions due to their large engine sizes, low fuel mileage, and high levels of vehicle-miles-traveled. In fact, these trucks account for about 23 percent[359] of the total on-road emissions in California. Program investments in this relatively small sector have the potential to achieve large reductions in petroleum fuel consumption and associated carbon and criteria emission pollutants, and are being used to shift California trucking fleets away from their dependence on diesel and gasoline.
- Provide funding for feasibility studies, demonstrations, and commercial production of advanced technology biofuels in California that avoid the use of food crops and prime agricultural soils for feedstock production by focusing on waste-based resources and alternative feedstocks that can be developed on degraded agricultural lands or in industrial facilities.

While the percentage increases in alternative technology vehicle and fueling systems shown below are important, they still represent small fractions of the total fleet of over 26 million vehicles and 10,000 retail gasoline fueling stations in California. The growth of key alternative fuel, vehicle, and infrastructure sectors is an early indicator that California's fuel and vehicle markets are beginning the shift towards alternative and renewable fuels and advanced vehicle technologies. California now has the largest network of electric vehicle charging systems and hydrogen fueling stations in the country. As shown in Table 15, the ARFVT Program is playing an important role in accelerating this transition by meeting some of the initial strategic program goals discussed above.

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359 California Air Resources Board, California Greenhouse Gas Inventory for 2000-2011 — by Category as Defined in the 2008 Scoping Plan, calculated as emissions from heavy duty trucks as a percentage of on-road transportation greenhouse gases, http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_scopingplan_00-11_2013-08-01.pdf

Table 15: Alternative and Renewable Fuel and Vehicle Technology Program and Air Quality Improvement Program Funding Impact on Infrastructure and Vehicle Deployment in California

(Through June 30, 2013)

	Fuel Area	Existing 2009-2010 Baseline Levels	Additions from ARFVT or AQIP Program Funding	Percent Increase
Alternative Fueling Infrastructure	Electric	1,270 charging stations	7,200 charging stations (public, fleet and workplace)	566
	E85	39 fueling stations	205 fueling stations	525
	Natural Gas	443 fueling stations	50 stations	11
	Hydrogen	6 public fueling stations *(plus 5 more under construction)*	24 fueling stations	218
Alternative Fuel Vehicles	Electric Cars (ARB Vouchers)	13,268 (mostly neighborhood electric vehicles)	26,331*	198
	Electric Trucks	1,409	160	11
	Natural Gas Trucks	13,995	1,375	10

* The Energy Commission has provided funding for 8,903 of these vouchers, about 33 percent of the total Clean Vehicle Rebate Project vouchers.

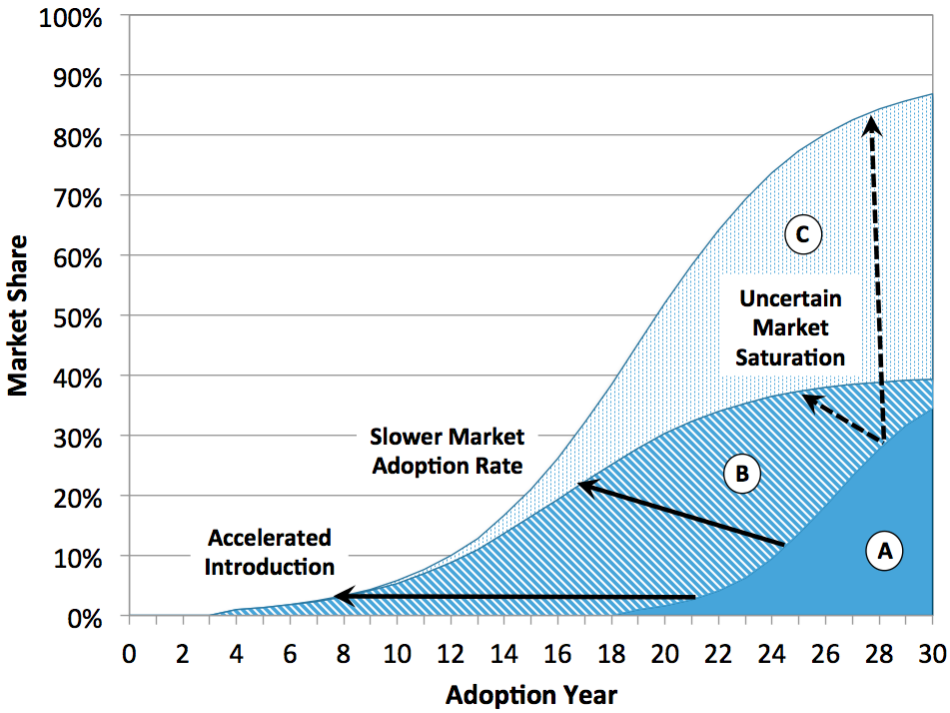
Source: Extrapolated from 2009 Department of Motor Vehicle data, plus actual deployment data. Electric truck and natural gas trucks extrapolated from 2009 data.

Market Transformation Challenges for Sustainable Vehicles and Fuels

To achieve significant market growth, alternative renewable fuels and vehicles need to overcome barriers such as cost, lack of manufacturing scale, and lack of infrastructure development. Support from government agencies and industry initiatives is justified based upon the social and environmental benefits accrued as a result of GHG emission reductions, increased energy security from reduced reliance on petroleum-based fuels, reductions in criteria air emissions, savings to consumers on fuel costs, and resulting direct or indirect contributions to California's regional economy.

Figure 22 depicts a "transitional" view of market transformation dynamics with a new technology only achieving significant market share after market conditions become favorable over time, shown as area "A." Examples for this delayed adoption could be battery electric vehicles or fuel cell electric vehicles becoming favorable when both petroleum prices remain consistently high and technology costs decline through slow and steady improvements (Greene 2013). For transitional market transformation support, the introduction of the technology could occur much earlier as a result of policy support mechanisms, such as ARFVTP, shown as area "B." Alternatively, if market conditions become favorable more quickly (for example, petroleum prices climb, or robust carbon policies are implemented), the new technology could attain a higher level of market saturation, as shown in area "C." The ultimate market saturation level is dependent upon a large number of uncertain and interdependent factors, including levels of government policy and financial support and market conditions.

Figure 22: Market Share Shifts for Transitional Market Transformations (Derived From Geller and Nadel 1994)



Source: National Renewable Energy Laboratory Benefits Guidance Report

Benefits of the ARFVT Program

In 2008, the legislature passed AB 109 (Núñez, Chapter 313, Statutes of 2008), which amended AB 118 to require the Energy Commission to include an evaluation of projects funded by the ARFVTP in the biennial *Integrated Energy Policy Report* (*IEPR*), including their expected benefits and contribution toward improving air quality, reducing petroleum use and GHG emissions, and transitioning to a diverse portfolio of clean, alternative transportation fuels. The Energy Commission has contracted with the National Renewable Energy Laboratory[360] (NREL) to develop a methodology to calculate expected benefits from ARFVTP to 2025.[361] The Energy Commission and NREL will estimate benefits in terms of petroleum reduction, carbon reduction, criteria emissions and particulate matter reduction, public health, and job creation. Additionally, NREL is providing guidance on estimating social, environmental, and market transformation benefits associated with projects supported by the Commission's ARFVT

360 CEC Agreement Number 600-11-002.

361 Melaina, Marc, George Mitchell, Ethan Warner, Aaron Brooker, Garvin Heath, (National Renewable Energy Laboratory). 2013. Program Benefits Guidance: Analysis of benefits associated with projects and technologies supported by the Alternative and Renewable Fuel and Vehicle Technology Program. California Energy Commission. Publication pending.

Program. For this draft of the *IEPR*, the Commission provides information on the methods and approach NREL is developing to estimate programmatic-level benefits through 2025 in Appendix E. Actual benefit estimates will be provided in a final *IEPR* and as a stand-alone Energy Commission Contractor Report. Commission staff will calculate job creation benefits, and the U.S. Environmental Protection Agency Region 9 will assist in the calculation of public health benefits from reduced petroleum fuel use.

Transportation Energy Trends

Trends show continuing declines in gasoline consumption. Since 2008, trends in California and the rest of North America show a sustained decline of gasoline consumption. Previous Energy Commission staff analysis from the 2009 and 2011 *IEPRs* identified this trend, showing a 6 percent decline in gasoline consumption reflecting the effect of the national economic downturn and vehicle efficiency improvements. The Energy Commission and other experts expect this decline in gasoline consumption to continue for another decade because national vehicle economy standards (Corporate Average Fuel Economy or CAFÉ) require automobile and light truck manufacturers to increase average miles per gallon performance from 27.5 to 35.5 in 2016 and to 54.5 in 2025. As a consequence of improved vehicle efficiency, California should experience a 2 billion gallon decline in gasoline consumption from 14.6 billion gallons per year in 2012 to 12.7 billion gallons per year by 2022. This change could affect production levels of some of the 20 existing crude oil refineries in California, 13 of which produce gasoline and diesel fuel for California vehicles.

Trends show increases in other transportation fuels. Since 2011, trends in California and the rest of North America show increases in crude oil and natural gas production. By 2012, North America experienced an upsurge in crude oil and natural gas production because horizontal drilling and hydraulic fracturing technology advances lowered exploration, drilling, and recovery costs. The 2009 and 2011 *IEPRs* noted diesel fuel consumption demand growing at a rate of 1to 2 percent per year for twenty years. The economic recession interrupted this trend for four years, but the growth has been restored in 2012. Most of this change reflects growth in fuel consumption from the transport of freight in trucks. Natural gas trucks may also offer an option to address goods movement growth. By 2014, up to 20 new diesel models of passenger vehicles and light trucks should be available in North America, possibly accelerating a transition to diesel fuel from gasoline and providing another market for biodiesel and renewable diesel. Also, although initially small, significant future growth is expected for electric and hydrogen vehicles.

Displacement of Petroleum and Potential Growth of Alternative Fuels in California

Alternative fuels include liquid and gaseous fuels and electricity used in cars, trucks, and buses. Liquid biofuels are blended with gasoline or diesel, or in some instances, replace gasoline (E85) or diesel (B100 or 100 percent biodiesel and renewable diesel). Biofuels are produced through several methods and technologies and are derived from dozens of purpose grown crops (corn, sugar cane, and grain sorghum) and agriculture, forest, and urban waste residue. Natural gas fuel is also used in all types of vehicles as compressed natural gas (CNG) or liquefied natural gas (LNG), and electric and hydrogen vehicles have been introduced with expectations for

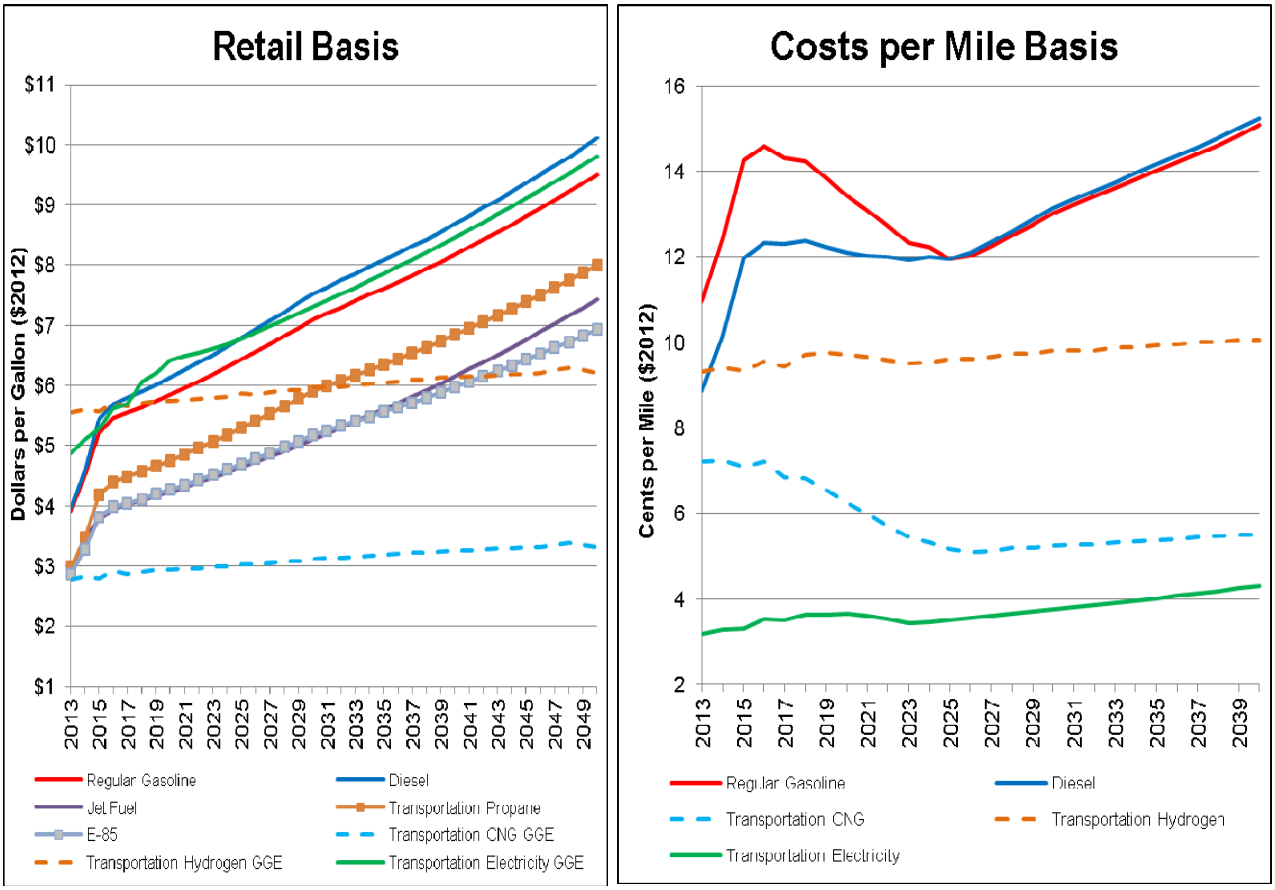
significant growth. As discussed in Chapter 3, biomethane or biogas is another form of natural gas, and electricity is produced from multiple sources including hydroelectricity, natural gas, nuclear, coal, and renewable resources (solar, wind, geothermal, and biomass).

By 2012, California experienced modest but notable increases in the use of alternative fuels. During the period from 2003 to 2012, alternative fuel market penetration grew to 7.3 percent of on road transportation fuel consumption. This growth is mainly due to an increase in ethanol blends in gasoline from 5.7 percent to 10 percent in 2008 and modest growth in natural gas and biodiesel fuel use in trucks and buses compared to a very small 2003 baseline. Several industry experts conclude that multiple factors increase the plausibility of alternative fuel growth within the next ten years in North America and particularly in California.

Fuel Price Forecasts – Gasoline, Diesel and Alternative Fuels

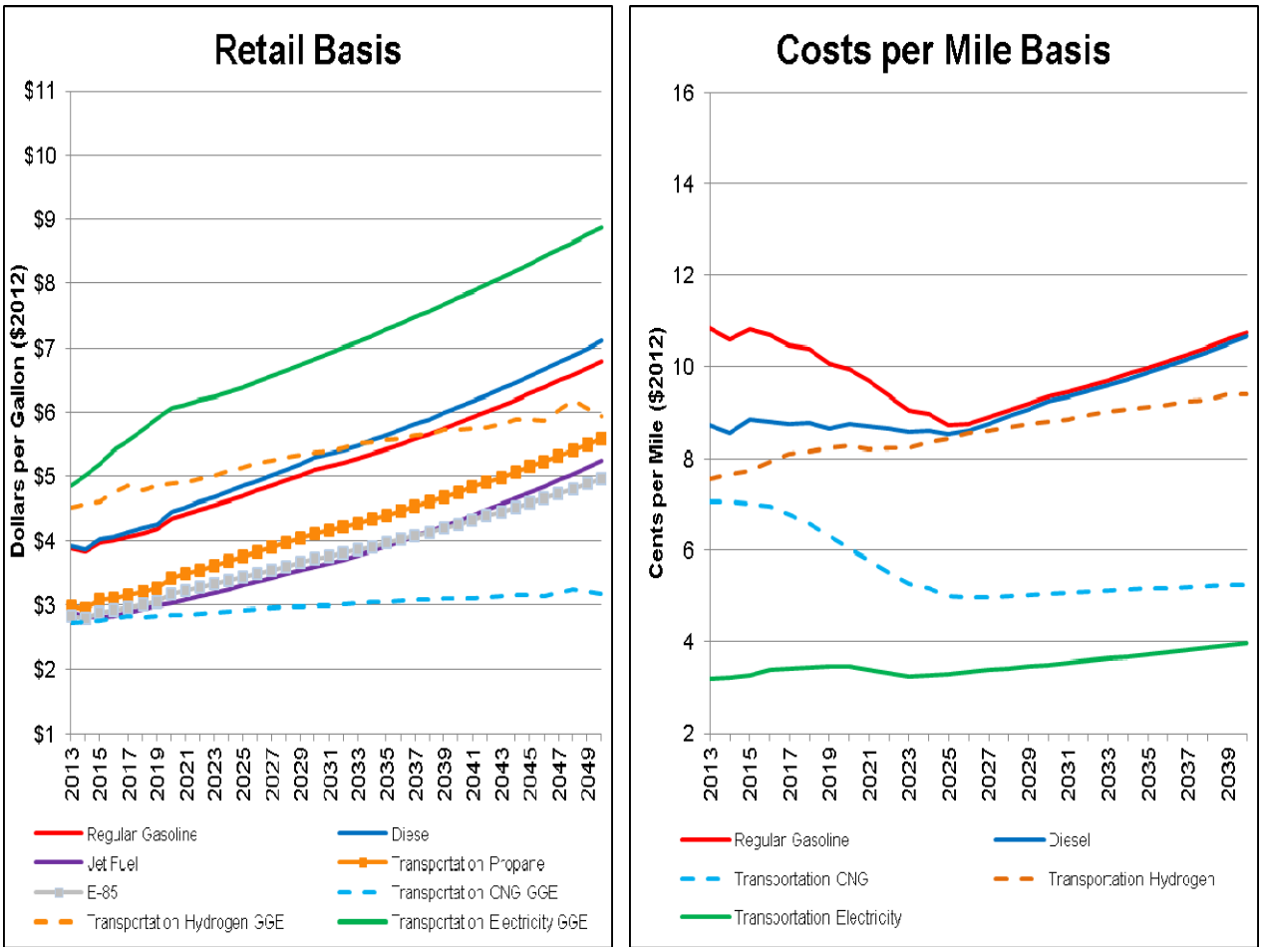
For most of the U.S. Department of Energy's fuel price forecasts, natural gas, electricity, hydrogen, and some biofuels used in vehicles offer a cost advantage over petroleum fuels (Figures 23, 24, and 25).

Figure 23: High Energy Price Common Case



Source: California Energy Commission

Figure 24: Reference Common Case



Source: California Energy Commission

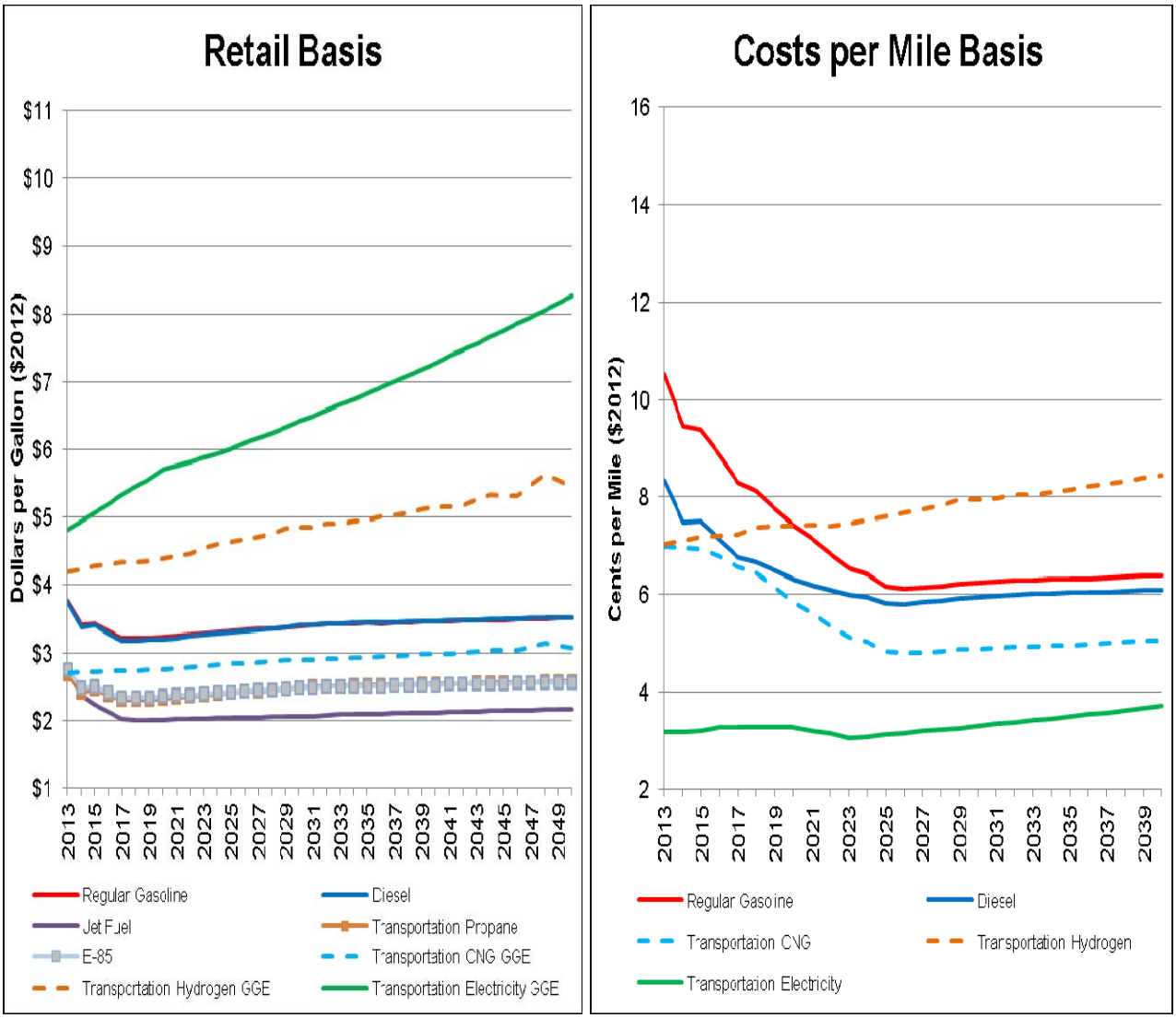
Current natural gas prices of approximately $3.60 per million British thermal unit (BTU) are $1.00 to $1.50 per gallon (gasoline per gallon equivalent – gge) below diesel and gasoline and U.S. Department of Energy's natural gas price forecast scenarios over the next 7 to 10 years are all lower than its lowest gasoline and diesel price projections.[362] Natural gas prices are projected to stabilize near $4.00 per million BTU over the next 7 to 10 years and this stabilization in price could trigger investment in a shift to this transportation fuel. The impact of directional and horizontal drilling and hydraulic fracturing of natural gas shale structures led to substantial increases in natural gas supplies in North America.

As a consequence, natural gas prices dropped, leading power plants in the Midwest and eastern states to switch from coal to natural gas fuels and creating opportunities for natural gas use in vehicles. Because natural gas pricing varies by continent and has not yet evolved to

362 U.S. Department of Energy, http://www.eia.gov/forecasts/aeo/chapter, 2013.

international commodity pricing, natural gas should remain moderately priced in North America for up to 10 years.

Figure 25: Low Energy Price Common Case



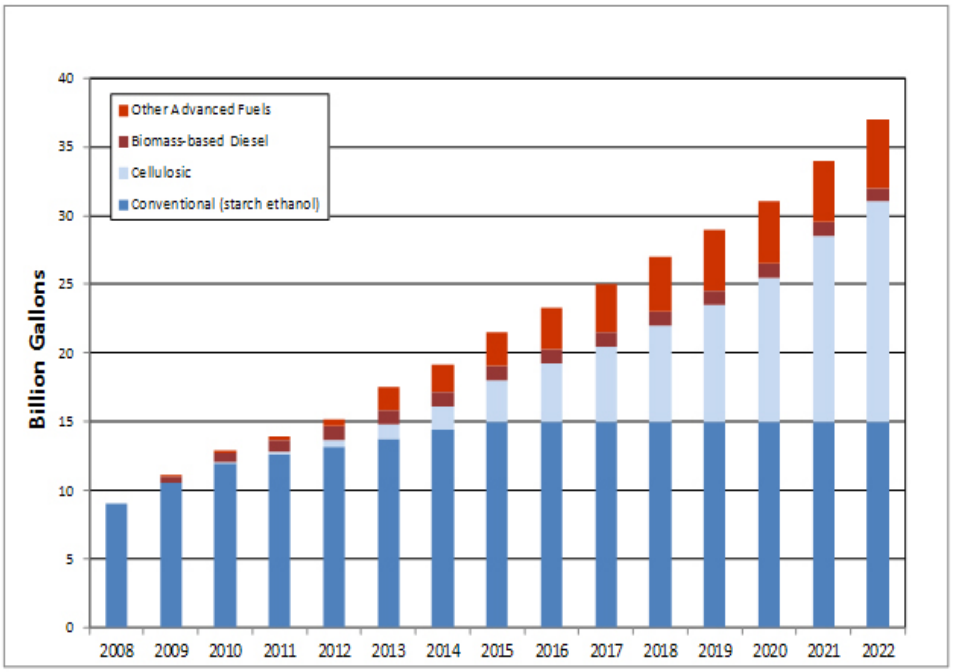
Source: California Energy Commission

Federal Regulations and Incentives

Renewable Fuels Standard: The federal Renewable Fuels Standard (RFS) requires fuel producers and marketers (obligated parties) to increase the use of renewable fuels to displace gasoline and diesel in the transportation sector. Biofuels eligible for RFS compliance include advanced biofuels, ethanol produced from corn and sugar-cane, biodiesel and renewable diesel produced from soy, used cooking oil, tallow, and corn oil. Biomethane is also eligible as a renewable fuel for RFS compliance. The RFS also requires obligated parties to use low-carbon-

intensity advanced biofuels at increasing levels each year (Figure 26). Obligated parties can produce or acquire renewable fuels themselves or buy credits from others who make renewable fuels available through renewable identification numbers (RINs). These RIN credits have monetary value and can be packaged with compliance obligations or separated and sold or traded. For more information on RIN credits, please see Appendix F.

Figure 26: Renewable Fuel Standard Volumes by Year



Source: California Energy Commission

The Clean Air Act: An additional federal regulation, the National Ambient Air Quality Standards, administered by the U.S. Environmental Protection Agency, will require regions designated as nonattainment for the air quality standards to reduce emissions until the standards are met. The South Coast Air Quality Management District[363] concluded that to comply with this rule, the on-road vehicle fleet would have to be dominated by zero-emission vehicles displacing combustion fuels, such as gasoline, diesel, and natural gas. This conclusion has inspired and accelerated new research and early demonstrations of hybrid electric and all-electric drayage trucks for ports and other transport technologies.

Federal incentives continue to spur the development and use of alternative fuels. Furthermore, federal tax credits provide additional incentives for biodiesel and renewable diesel ($1.00 per gallon blender's credit through 2013), natural gas vehicles, and electric vehicles ($7,500 tax credit for up to 200,000 of each vehicle model sold in the country).

California Policies, Incentives and Regulations

363 Greenwald, Peter, "The Need for Zero Emission Technologies – SCAQMD Zero Emission Transportation Technology Forum and Roundtable Discussion," April 20, 2011.

California laws, regulations, and executive orders increase the potential for alternative fuel growth. Beginning in 2003 with the passage of the Petroleum Reduction and Alternative Fuels Act, California government transformed transportation energy policy from purpose singular focus on reducing smog-forming tailpipe air emissions, to more complex policies emphasizing multiple objectives. The Energy Commission and the ARB adopted goals to reduce petroleum consumption and increase alternative fuel use. Table 16 highlights a few of these key transportation energy initiatives and the rest of this section features two of these initiatives: (1) the LCFS and (2) the ZEV Mandate.

Table 16: California's Transportation Energy Initiatives

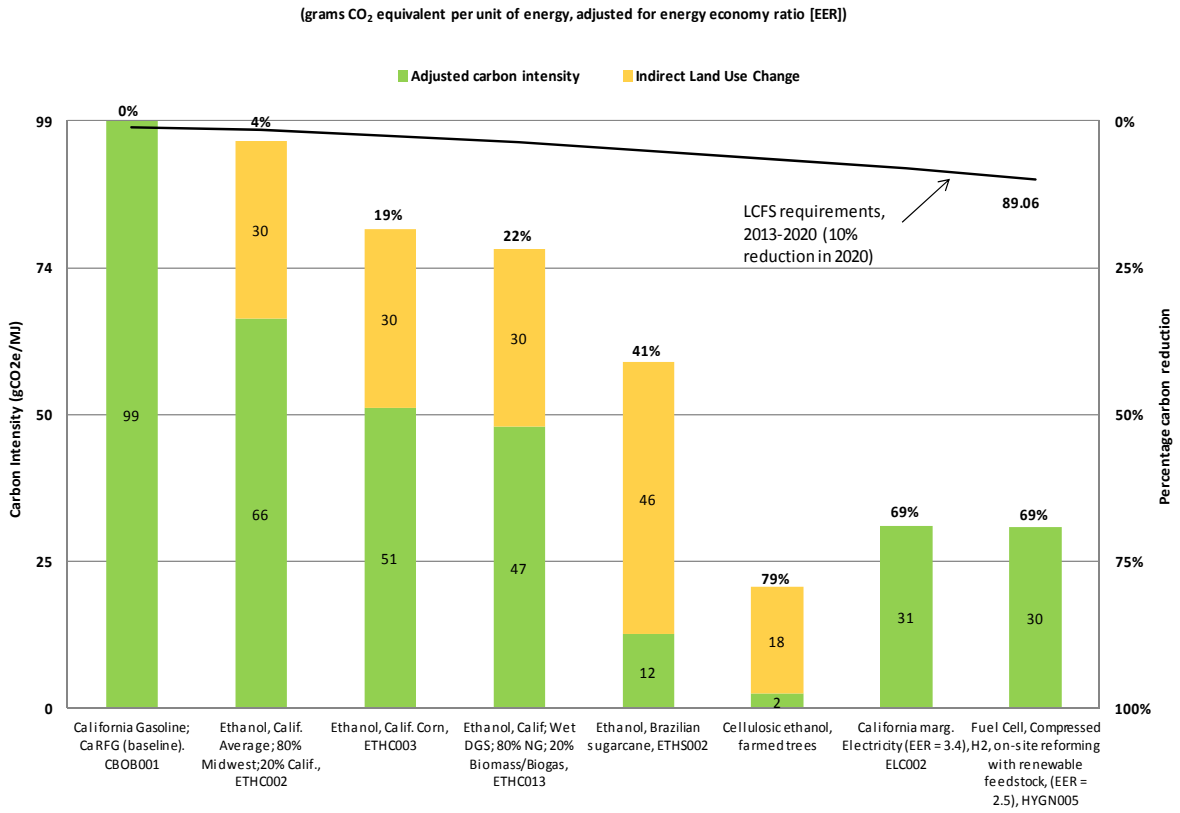
Policy/Law/Regulation	Quantified Objectives
Global Warming Act(2006)	Reduce GHG emissions to 1990 levels by 2020 and 80 percent below 1990 levels by 2050.
Petroleum Reduction and Alternative Fuel Goals (2003) and Alternative Fuels Plan (2007)	Reduce petroleum fuel use to 15 percent below 2003 levels by 2020. Increase alternative fuel use to 9 percent of California's fuel consumption by 2012, 11 percent by 2017, and 26 percent by 2022.
Bioenergy Action Plan (2006)	Produce 20 percent of biofuels used in California from in-state sources by 2010, 40% by 2020, and 75 percent by 2050.
Low Carbon Fuel Standard (2009)	Reduce carbon intensity of transportation fuels sold in California by 10% by 2020.
Zero Emission Vehicle Mandate (2012)	Establish requirements for automakers to provide electric and hydrogen vehicles for sale in California by 2020 (regulation).
ZEV Executive Order (2012)	Ensure California has infrastructure to support 1 million ZEVs by 2020 and 1.5 million by 2025 (Executive Order).
AB 118, Carl Moyer, and Proposition 1B Incentives (2003, 2005 and 2007)	Energy Commission, ARB, and local air districts provide financial incentives to fund vehicles, infrastructure, and fuel production projects that reduce GHG emissions and air pollutants and increase the use of alternative fuels.

Source: California Energy Commission

The ARB adopted a LCFS regulation in 2009, requiring fuel producers to lower the carbon intensity of fuel sold in California by at least 10 percent in 2020. The LCFS has separate requirements to reduce the carbon intensity values of gasoline and diesel and the requirements are increased incrementally each year to achieve the total 10 percent reduction by 2020. Petroleum fuel producers can comply with the standard by reducing carbon intensity of petroleum fuels by several methods. Alternative fuels have carbon intensity values lower than petroleum fuels and are sources of carbon reduction that generate credits to help fulfill LCFS compliance. As a consequence, the LCFS provides an incentive to develop and use alternative

fuels. Figures 27 and 28 illustrate carbon intensity reductions of various alternative fuels compared to gasoline and diesel fuels.

Figure 27: Carbon Intensity for Gasoline and Substitutes



Source: California Energy Commission

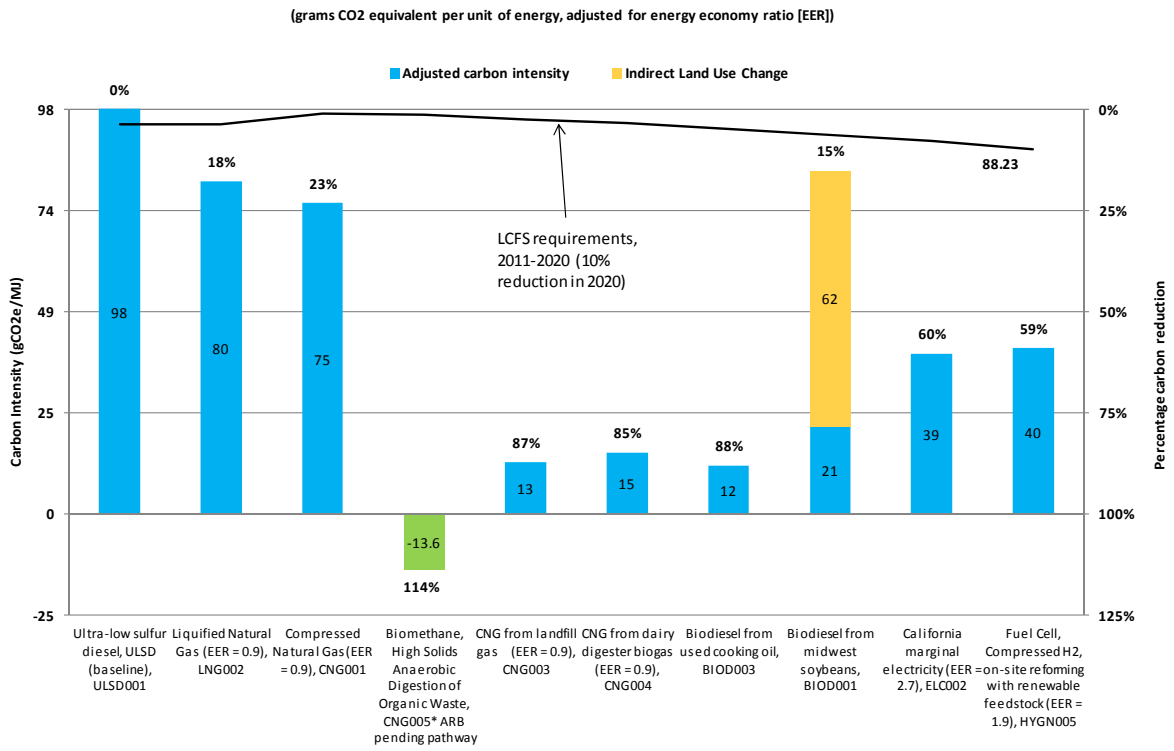
The Governor's ZEV Executive Order provides guidance to ensure that California has infrastructure in place to support one million ZEVs in 2020 and 1.5 million ZEVs in 2025. This Executive Order milestone supports the requirements in ARB's ZEV regulation. Figure 29 illustrates the expected annual ZEV sales to meet the requirements.

Transportation Energy Scenarios

The Energy Commission conducted a joint IEPR and Lead Transportation Commissioner workshop on July 31, 2013 to obtain insights on transportation energy scenarios from fuel developers, automakers, truck and bus experts, fueling infrastructure developers and owners, utilities, public interest groups, and industry associations. The participants provided growth projections to at least 2020 for all of the alternative fuels and diesel vehicles, presented key factors substantiating the growth, identified challenges that might impede growth, and recommended government actions needed to achieve the transportation energy goals. Energy Commission staff evaluated the information provided by the participants and summarized the

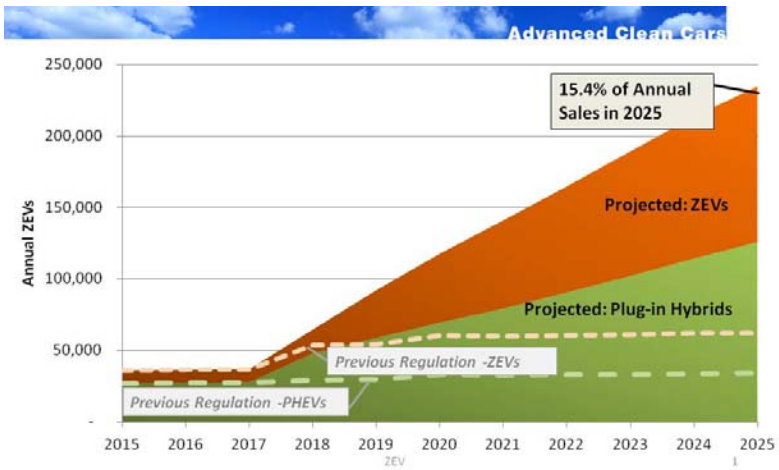
scenarios in Table 17. The information is listed in common units (gasoline gallons equivalent) for each option and reflect vehicle efficiency differences (energy efficiency ratios).

Figure 28: Carbon Intensity for Diesel and Substitutes



Source: California Energy Commission

Figure 29: 2015-2025 ZEV Requirements



Source: ARB, staff presentation at the January, 2012 Board hearing.

To achieve California's 2020 goals noted in Table 16 to reduce GHG emissions, increase alternative fuel and vehicle use, and displace petroleum, aggressive market penetration of alternative fuels is needed compared to California's 2012 baseline. Table 17 represents the Energy Commission's current estimates of plausible growth for several low carbon alternative fuel options. Existing government incentives and regulations combined with alternative fuel price advantages, expected economy of sale vehicle manufacturing, and technology advances could lead to at least three-fold increase in alternative fuel growth by 2020. If this happens, California will achieve goals for petroleum displacement, in-stage biofuel production, and LCFS compliance. Key highlights and conclusions of the scenario projections are described below.

Biofuel Gasoline Substitutes

Existing gasoline-based substitutes are predominantly comprised of ethanol produced from Midwest corn and Brazilian sugar cane. There are also several emerging low-carbon biofuel technologies on the horizon, most notably cellulosic ethanol, which can be made from agricultural, forest, and urban waste materials. The first wave of commercial-scale cellulosic facilities in the U.S. began producing in late 2012, and nationwide production of cellulosic ethanol is expected to increase from 20,000 gallons in 2012 to 5 million gallons in 2013. Biofuel producers are also developing other low-carbon ethanol sources from grain sorghum, sugar beets, and sweet sorghum. Ethanol is typically used as an oxygenate in gasoline to reduce exhaust tailpipe emissions from vehicles. In most areas in the U.S., gasoline is blended with 10 percent ethanol by volume (E10). Ethanol is also used in a fuel commonly known as E85 which can be used in flexible fuel vehicles. There are approximately 500,000 flexible fuel vehicles operating in California today.

California uses approximately 1.5 billion gallons of ethanol per year of which nearly 150 million gallons per year are produced in California and the remainder is imported corn ethanol from the Midwest. The combination of RFS requirements for obligated parties, substantial RIN credit values, availability of sufficient biofuel resources, and California's LCFS will compel the development of low-carbon biofuel projects in the state and a shift of low-carbon biofuels to California. Increased Brazilian sugar cane ethanol is the largest near-term contributor because it has a lower carbon intensity value compared to most corn ethanol and will displace 250 to 400 million gallons per year of corn ethanol imports. Three operating corn ethanol plants in California have already begun a shift to lower-carbon ethanol by using grain sorghum in 2013, and a fourth plant, currently idle, could begin operating and using low carbon biofuel feedstocks.

The Energy Commission has invested over $150 million in several California advanced biofuel production plants using sweet sorghum, sugar beets, and agricultural and forest waste residue. These projects are expected to proceed to commercial scale development in 2016 and 2017. The moderate scenario also assumes that at least one developer will successfully produce ethanol from a combination of sugar cane and other purpose-grown crops with high fuel conversion and low carbon intensity values in the Imperial Valley. In addition, it is anticipated that at least one cellulosic ethanol plant will be built in California by 2020.

Table 17: Alternative Fuel Growth Estimates

Fuel Type	Fuel Production/Calif. Consumption (Millions of Gallons - GGE and EER Factors)			
	2013	2015	2017	2020
Gasoline Substitutes				
Corn Ethanol Imports	1,150	1005	708	593
CA Corn/Grain Sorghum	150	180	220	220
CA Advanced Biofuels	2	63	100	180
CA Sugar Cane/Energy Cane			50	50
Brazilian Sugar Cane Imports	200	250	400	400
Cellulosic	1	5	25	60
Subtotal	1,503	1,503	1,503	1,503
Diesel Substitutes				
Palm Oil Imports	0	0	0	0
Soy Imports/CA Production	5	5	5	5
UCO/Corn Oil/Tallow	27	88	150	188
Renewable Diesel	103	157	310	310
Purpose Grown Crops (Camelina, Jatropha)			10	80
Algae			10	100
Cellulosic	1	5	25	60
Subtotal	136	255	510	743
Natural Gas				
CNG/LNG	150	300	500	900
Biomethane		1	2	4
Subtotal	150	301	502	904
Transportation Electric				
Light and Heavy Rail	44	45	45	45
Transit/Trolley	5	5	5	5
PEVs and Hydrogen FCVs	5	40	80	120
Subtotal	54	90	130	170
Propane	20	20	20	20
TOTAL	**1,863**	**2,169**	**2,665**	**3,340**

Source: California Energy Commission

Diesel Substitutes (Biodiesel and Renewable Diesel)

Diesel substitutes generally include biodiesel and renewable diesel. Historically, biodiesel was produced primarily from Midwest soybeans; however, because of LCFS requirements, biodiesel use in California has shifted to lower-carbon sources. California companies are producing greater volumes of biodiesel from used cooking oil, tallow, and corn oil which are mostly waste products with very low carbon intensities. California biodiesel plants have the capacity to

produce approximately 50 million gallons per year of biodiesel, but current production is about half of the capacity. California's diesel consumption totaled approximately 3.3 billion gallons in 2012 for on-road vehicles and another 500 million for off-road farm and construction vehicles. Diesel fuel is used in 70 percent of California's 1 million trucks and buses and biodiesel is generally splash-blended[364] at diesel fuel distribution centers.

Renewable diesel can be produced from the same feedstocks as biodiesel but the conversion process is different. Renewable diesel is chemically equivalent to diesel fuel and does not require separate blending infrastructure. In 2013, California received the first shipment of renewable diesel from Singapore and expects to see future growth. The Energy Commission expects at least a six-fold increase in biodiesel production to 188 million gallons per year and renewable diesel production and delivery to over 300 million gallons per in California by 2020.

The RFS mandate, RIN credits, and the LCFS drive a major growth trend in the production of biodiesel and renewable diesel. Both can be derived from the same resources, but use different technologies and conversion methods. Used cooking oil, tallow, and corn oil offer significant near-term growth contributions because they have lower carbon intensities than soy biodiesel and will displace the use of soy imports. The federal blender's tax credit will exist through 2013, providing an added incentive to develop biodiesel and renewable diesel fuels. These combined factors could push a four-fold increase in biodiesel and renewable diesel fuels by 2020.

A potential constraint is securing enough low-carbon-intensity feedstock to produce biodiesel and renewable diesel. Estimated potential for used cooking oil, tallow, and corn oil from within California is 100 million gallons of biodiesel or renewable diesel. The bulk of the renewable diesel is produced in Singapore and shipped to California. California will also attract imports of biodiesel produced from low-carbon feedstocks in other states. Resource constraints have triggered research and demonstration of purpose-grown crops such as jatropha, canola, and camelina to produce biodiesel, and several companies have developed pilot projects to produce renewable diesel from algae.

Biodiesel can be safely used at various 5 percent blend levels, and a new ARB alternative diesel fuel regulation being developed will guide the use of this fuel in California. Renewable diesel's makeup is undistinguishable from conventional diesel, so it can be used in a variety of blends with diesel with no restrictions. Because automakers will introduce 20 new diesel passenger cars and pickup trucks over the next year, growth of biodiesel and renewable diesel fuel will not be limited to medium and heavy-duty trucks.

Natural Gas Transportation

Natural gas has matured as a transportation fuel and is commonly used as CNG and liquefied natural gas in transit buses, trucks, waste haulers, and passenger cars. Several thousand natural gas vehicles operate in California and over 500 dispensing stations are operating in public access and fleet home base fueling centers. Because of the fuel cost advantage natural gas

364 "Splash-blended" refers to pumping biodiesel into storage tanks followed by diesel fuel.

currently enjoys compared to diesel and gasoline, high mileage vehicle owners have begun a shift to natural gas in long-haul trucks and taxis. The higher differential cost of natural gas engines and vehicles compared to diesel and gasoline vehicles can be offset by the lower cost of fuel if the natural gas trucks travel more than 80,000 miles per year and taxis more than 50,000 miles per year. The Energy Commission's natural gas rebate buydown program offers a mechanism to offset this cost and to increase market adoption of vehicles that do not have high mileage annual use. Scale economy manufacturing of natural gas engines and vehicles should also have an impact on lowering the vehicle cost by 2020 or sooner.

One automaker in the U.S. produces a dedicated natural gas passenger vehicle, but four others have developed dual-fueled gasoline/natural gas concept cars and may bring them to market in limited production within the next three years. Nearly 80 percent of transit buses in California have converted to natural gas fuels with funding from the U.S. Department of Transportation. A growth scenario representing a six-fold increase in natural gas vehicles and natural gas consumption from 2012 levels by 2020 is very possible. More aggressive growth may depend on the availability of more engines and vehicle models. California has installed over 500 natural gas fueling stations, and developers have constructed natural gas fueling stations along highway corridors to enhance the use of LNG trucks. The LCFS is expected to help incentivize this growth because of the value of LCFS credits derived from natural gas used in transportation.

Electric Transportation

Virtually every automaker produces an all-electric or plug-in hybrid-electric vehicle for sale or lease in California. As of mid 2013, 32,000 plug-in electric vehicles, and an additional 14,000 neighborhood electric vehicles are on the roads.[365] More than 8,000 electric vehicle chargers have been installed. Electric vehicles are 3.4 times more efficient than gasoline internal combustion engines. The Governor's ZEV Executive Order and the ARB's ZEV mandate, combined with a federal tax credit and incentives for electric vehicle rebates and electric charger installations, are advancing the electric vehicle market penetration in California. The Executive Order calls for California to ensure infrastructure is developed to support 1 million zero-emission vehicles by 2020 and 1.4 million by 2025. The Executive Order also reflects a 2050 goal to reduce transportation-related greenhouse gas emissions by 80 percent below 1990 levels by 2050 and concludes that electric and hydrogen fuel cell vehicles comprising greater than 80 percent of all passenger vehicles in 2050 will achieve that objective. The $7,500 federal tax credit expires when each electric vehicle model exceeds 200,000 cumulative sales. California also provides up to $2,500 under the California Vehicle Rebate Project for eligible electric vehicles. Electric vehicles offer a significant reduction in GHG emissions compared to gasoline or diesel-fueled vehicles, particularly if renewable electricity is the source of vehicle charging. As a result, the Energy Commission expects exponential growth in the development and use of electric passenger vehicles.

365 http://www.energy.ca.gov/renewables/tracking_progress/documents/electric_vehicle.pdf

Plug-in electric passenger vehicles represent the largest contributor to electric transportation, but other modes (transit, trucks, rail, and port electrification) are emerging as important electric transportation options. For example, the California High-Speed Rail project will connect Northern California to Los Angeles and eventually San Diego, will use renewable electricity, and is anticipated to displace a significant share of intrastate air travel. Electrification of the equipment used at ports is another example. Port electrification involves shifting from petroleum fuels to electricity sources to operate crane, yard tractors, onboard energy for vessels in ports and some container trucks, electric transit and trolleys, truck stop electrification, and shifting refrigerated trucks from diesel to electric power adds up to a significant contribution.

Hydrogen Fuel Cell Vehicles

Although a few hundred hydrogen fuel cell vehicles operate in California and new infrastructure is needed to fuel the vehicles, this option has tremendous potential because hydrogen and electric vehicles offer two of the best options to achieve the 2050 GHG emission reduction goals. Hydrogen is derived from natural gas reforming or electrolysis and the carbon intensity of the fuel is reduced because the vehicle is 2 to 3 times more efficient than gasoline or diesel vehicles. In addition, all hydrogen fuel sold from publicly-funded stations must contain at least one third renewable hydrogen, as required by SB 1505, which reduces the carbon footprint to a level equivalent to plug-in electric vehicles. Initial sales of hydrogen fuel cell vehicle are expected to occur in cluster areas in the San Francisco Bay Area and Southern California – establishing these as priority areas for fueling infrastructure. The California Fuel Cell Partnership Roadmap, the preeminent study on hydrogen fueling for California, shows that an initial set of about 68 stations are needed by 2015-2017 to provide fueling infrastructure for 20,000[366] hydrogen fuel cell vehicles expected from automakers by this timeframe. To help ensure a successful transformation of the transportation sector to ZEVs, the ARFVTP is providing incentives to help fund this initial set of hydrogen fueling stations.

Public incentives will be needed in the initial years of advanced vehicle deployment until they gain a sustainable foothold in the market. As specified in the new ARFVTP and AQIP reauthorization statute, the ARB and Energy Commission will assess the continuing need for hydrogen fueling station public incentives, the appropriate level of those incentives, and when an advanced technology has penetrated the market where incentives are no longer needed. The legislative goal as articulated in AB 8 is for the state to help develop a 100-station network. A National Academy of Sciences study projects that hydrogen and electric vehicles will be less expensive than internal combustion engine vehicles after that point. Furthermore, increased hydrogen fuel sales is the key factor for fueling stations to cover operation costs and profit margin for fueling infrastructure to achieve market maturity and diminish the need for government incentives.

366 The California Air Resources Board is in process of re-surveying the automakers on production and rollout plans of hydrogen fuel cell vehicles. Hydrogen fuel cell vehicle production numbers will be updated when available.

Transit, forklifts, and stationary fuel cell applications are growing markets for fuel cell uses and can provide complementary business models to accelerate hydrogen fuel cell technology improvements and increase hydrogen fuel sales leading to scale economy manufacturing, reduced vehicle and infrastructure capital costs, and successful business practices.

Transportation Demand Forecast and Supply Demand Balance

The Energy Commission staff has prepared forecasts of transportation fuel demand to 2050 using demand forecasting models for commercial light-duty vehicle travel, urban and intercity travel (including public transit), freight movement, and passenger and freight aviation. Some of the key findings in the demand models that helped to inform the transportation fuel forecast are:[367]

- Light-duty vehicle travel: Vehicle attributes are expected to change over the next 30 years, assuming significant increases in fuel economy, full implementation of ARB's ZEV mandate, and an increase in passenger vehicle and light truck stock from 27 million to between 42 and 47 million vehicles in 2050.
- Urban Travel: Urban travel, trips of less than 50 miles, comprises 72 percent of the passenger miles traveled in California and the number of passenger trips taken in light-duty vehicles is projected to increase from 17.8 billion to between 23.8 billion and 26.5 billion. Vehicle miles traveled are projected to increase from 136 billion miles in 2011 to between 182 and 202 billion miles in 2050. Transit miles are also expected to increase from 396 million in 2011 to between 653 and 727 million miles in 2050.
- Intercity Travel: Intercity travel, trips of more than 50 miles, currently comprises about 28 percent of all passenger travel in California. Intercity passenger trips are expected to increase from 750 million in 2011 to 1.7-2.0 billion in 2050.
- Freight Movement: There are nearly one million trucks on California's road with approximately 70 percent fueled by diesel, 29 percent by gasoline, and the remainder by alternative fuels. Trucking moves the majority of interstate freight *from* California *to* other states. Rail and intermodal move the majority of freight *from* other states *to* California.

These demand models are behavioral models that respond to changes in economic and demographic variables, and to changes in vehicle attributes and fuel prices. These models use projected inputs from a number of sources to develop fuel demand forecasts. Estimating future transportation fuel demand requires staff to contend with uncertainties in future economic and market conditions, human behavior, and the regulatory and policy environment; therefore, the forecasts must be viewed in this context. Staff has developed multiple scenarios to allow for many of these uncertainties.

367 Please see Appendix G for further information about the low, medium, and high cases and other detail on these assumptions.

There are uncertainties in the projections of crude oil and transportation fuel prices, economic growth, and demographic and technological trends that are used in developing fuel demand forecasts. Moreover, many of the events that shape energy markets in the short-term cannot be anticipated, including weather, geopolitical disruptions, and labor strikes. Nor can longer-term developments in transportation technologies, demographics, and resources markets be foreseen with certainty. Staff has developed scenarios that address key uncertainties in crude oil and transportation fuel prices, economic growth patterns, and federal and State regulations for current *IEPR* projections.

In addition to uncertainties inherent in the data and specifications used in estimating any forecasting model, there are also uncertainties associated with the public and private sector projections used as inputs to these models. Changes in consumer preferences, the regulatory environment, land-use patterns, and fuel and vehicle technology, as well as crude oil and transportation fuel price fluctuations, also add to the uncertainties of fuel demand forecasts in an increasingly globalized economy.

Fuel Price Forecast

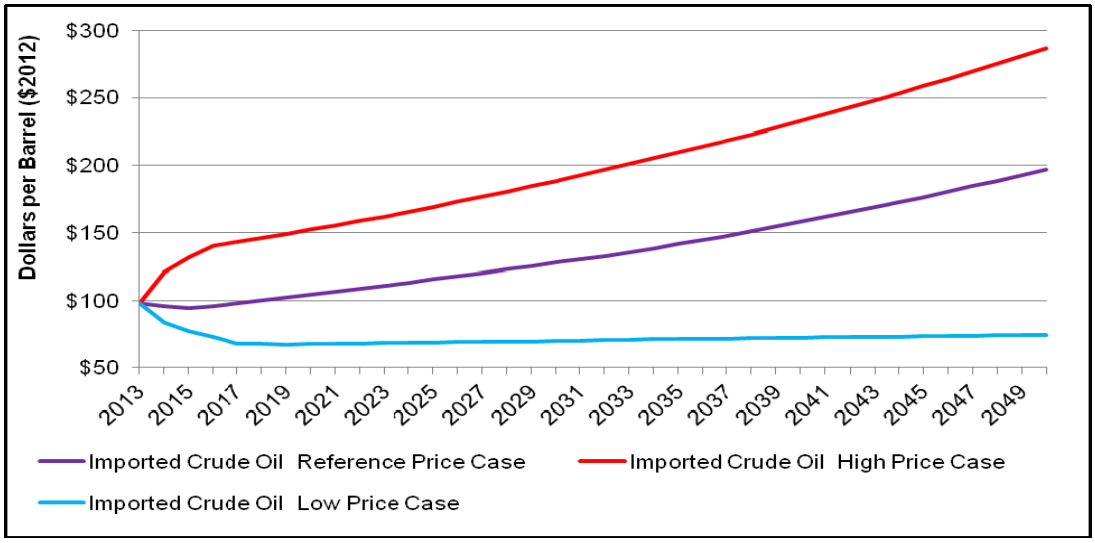
For the *2013 IEPR*, staff has developed California-specific Reference, High, and Low price cases for gasoline, diesel, and other petroleum price cases based on Refiner Acquisition Cost (RAC) projections for U.S. refiners. RAC of imported crude oil, as defined and measured by the Energy Information Administration (EIA), is the weighted-average cost to refiners for obtaining an imported barrel of crude oil and is commonly used as a proxy for world crude oil prices. This index is historically roughly $3 to $10 per barrel less than the average for higher-quality light sweet oil, such as West Texas Intermediate (WTI), and has traditionally been a better predictor of crude oil prices for the California market then other benchmarks. For all three cases, staff obtained values for RAC from the 2013 Annual Energy Outlook (AEO) produced by the EIA. The AEO cases used by the Energy Commission were the Reference Case, High Oil Price Case, and Low Oil Price Case. Figure 30 displays the three RAC price cases in inflation adjusted 2012 dollars.

Consistent EIA documentation, these cases have included the incorporation of the California LCFS and AB 32's cap-and-trade program.[368] In all of these cases, West Coast production of crude oil (for which California is the largest producer) remains in decline, with it declining the most in the Low Price Case (-1.6 percent a year) and the least in the High Price Case (-0.3 percent a year).

By 2040, in all cases, tight oil production forms a third of all U.S. production of crude oil, half of that production coming from on-shore sources. Only in the Low Price Case does crude oil production in the U.S. decline.

368 http://www.eia.gov/forecasts/aeo/chapter_changes.cfm

Figure 30: Crude Oil Price Cases

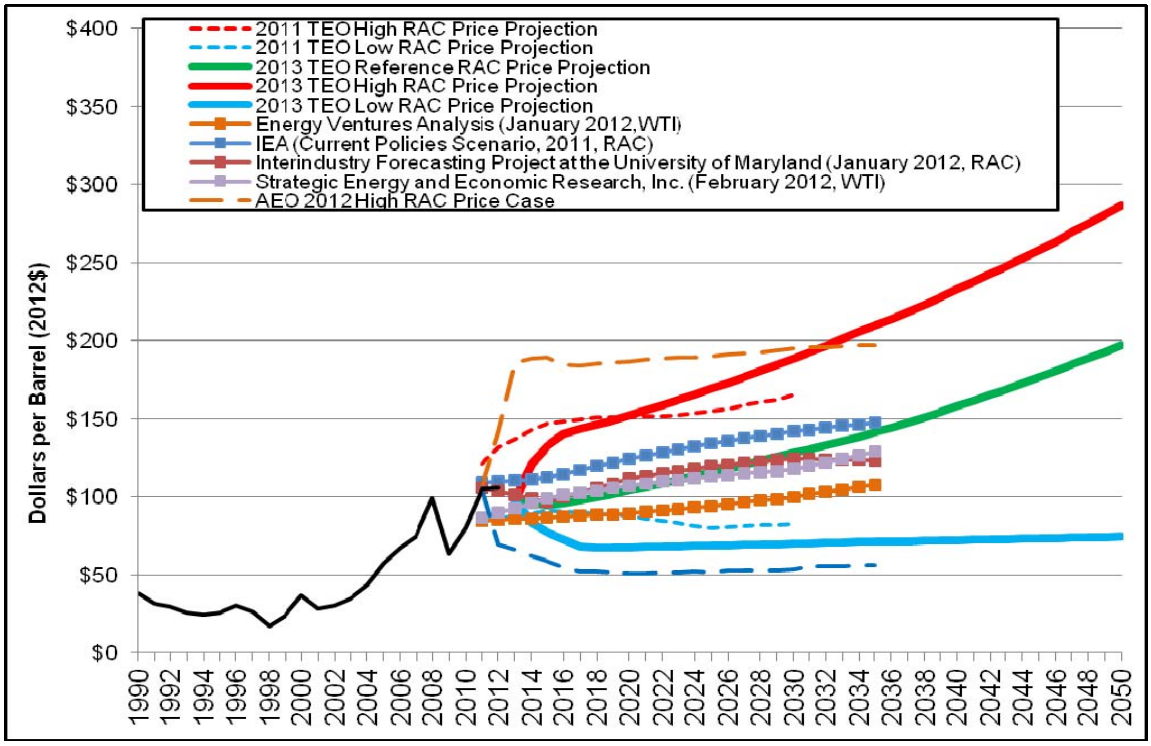


Source: California Energy Commission and the U.S. Energy Information Administration

Upon comparison of these projections and similar ones produced by other crude oil analysis firms, as seen in Figure 31, the Reference Case projection used by staff and the EIA is in the center of the largest clump of projections and represents a lowering of the average crude oil price in the near term before rising to its final price of roughly $200 a barrel in 2050. The Low Case falls to roughly $75 a barrel of oil and then maintains that price point. While not the lowest price on the chart, it is the second lowest with only the previous year's AEO being lower. The High Case has a sharp near-term increase in prices followed by a lower rate increase past 2016 with a final 2050 price of roughly $290 a barrel. This forecast is on the upper end of the presented projections and represents a continued growth in prices similar to the 2002 to 2008 time period.

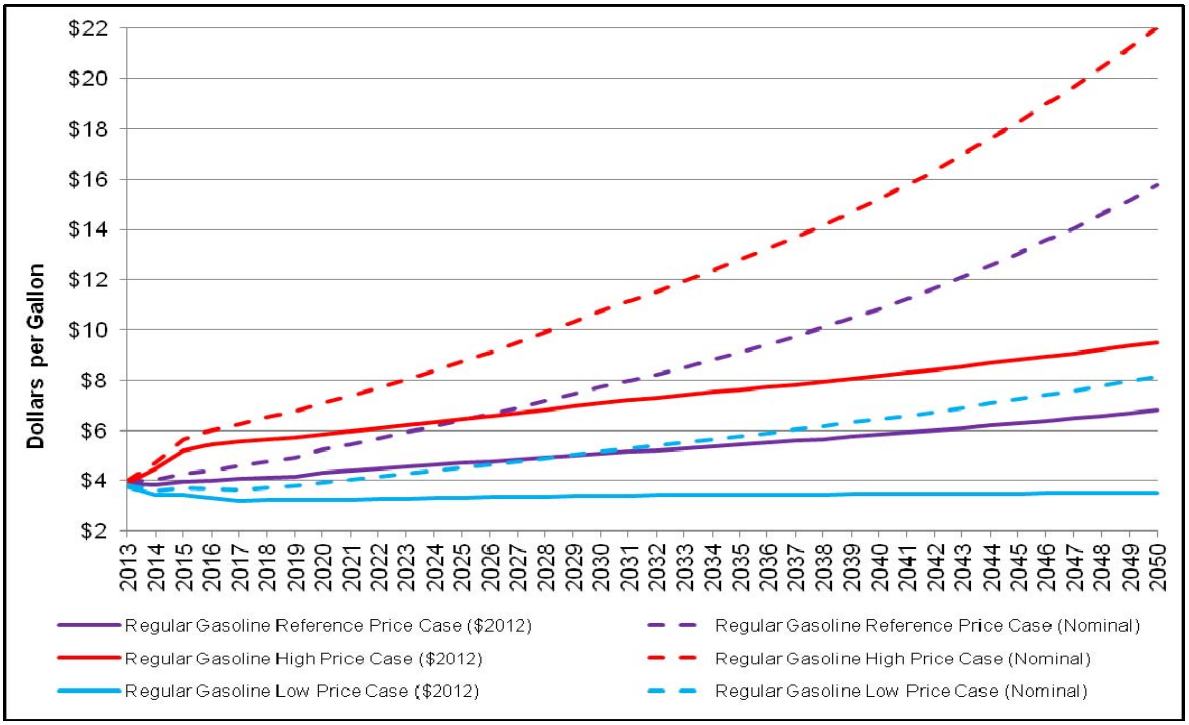
Figure 32 and Figure 33 show the California regular retail gasoline and retail diesel fuel price cases in 2012 dollars per gallon, as well as the common carrier price for jet fuel cases. These price cases are generated by adding the price margins and the corresponding tax estimates for each fuel type to the corresponding imported crude oil price cases. All prices included common-case assumptions regarding carbon prices used within both the natural gas and electricity market price and demand projections. In the inflation-adjusted price patterns, like the crude oil cases, deviation in the retail prices occurs in the near-term of the projections with steady rises in the later portions of the projections. Once future price inflation is accounted for, in all cases actual prices likely seen by consumers will rise, with a doubling of the gasoline price occurring by 2025 in the High Case.

Figure 31: Recent Crude Oil Price Forecasts from Leading Energy Price Analysis Firms



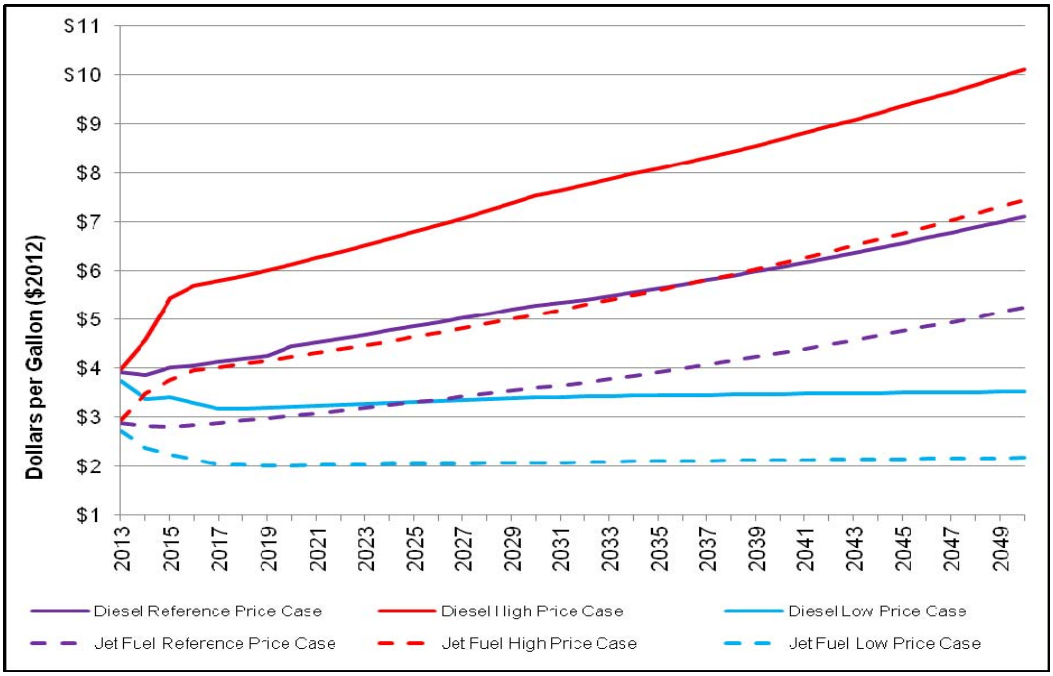
Source: California Energy Commission and the U.S. Energy Information Administration

Figure 32: *IEPR* 2013 Regular Gasoline Price Cases



Source: California Energy Commission

Figure 33: *IEPR* 2013 Diesel and Jet Fuel Price Cases (2012$s)



Source: California Energy Commission

Challenges to Achieve Alternative Fuel Growth Potential and Ensure an Adequate Transportation Energy System

Potential changes in the regulatory landscape. Potential changes to regulations that require increases in alternative or low carbon fuels, like the U.S. Environmental Protection Agency's Renewable Fuel Standard or the ARB's LCFS, can impact demand. To the extent that investments in biofuel production and infrastructure are based on current regulations, investment may be affected by the real or perceived risks that may be caused by uncertainty in those regulations.

More storage may be needed to accommodate higher volumes of imported fuels. As volumes of sugar cane ethanol increase to 250 million gallons a year or more, transport is more cost effective by marine vessel shipment directly to California ports compared to shipments to Houston and transferring the fuel by rail cars to California. However, fuel terminal storage is limited in the California ports. Following the growth scenarios presented in Table 17, if no additional storage capacity is built, then limited storage could impede delivery of large amounts of this low-carbon fuel.

Demand is outpacing availability of incentives. California incentives have spurred the growth of alternative fuels, and the increased growth depends on continuing incentives. However, the demand has begun to exceed the amount of government funds available in existing pools of state government funds. The alternative fuels industry is still in start-up phases with uncertain timeframes to achieve technology and market maturity and develop sustainable business models. Incentives can help address and offset the real and perceived risks that private

investors may see. Incentives can also help speed the transition to new alternative technologies and fuels by bringing their costs closer to those of established technologies and fuels, helping California to meet its climate, clean air, and energy security goals.

Integrating the transportation system into the electric grid. Electric transportation growth requires increased attention to balance multiple objectives associated with that growth. These objectives include: (1) ensuring electric grid and local distribution system safety, (2) maximizing renewable electricity use in electric vehicle charging and other transportation uses, balanced with electricity system load management, (3) enhancing community and utility readiness for vehicle charging and electricity system infrastructure for the growth of electric transportation, and (4) providing affordable electricity for household and business use of electric transportation. To help advance smart charging consistent with grid conditions, the California ISO is leading the development of a vehicle to grid roadmap that is expected to be completed by the end of the year.

Limited number of natural gas vehicle models. Even though natural gas enjoys a significant fuel price advantage compared to diesel and gasoline to help offset the higher vehicle cost, only one major engine manufacturer produces a natural gas engine for trucks and buses and one automaker provides a dedicated natural gas passenger vehicle. Industry growth is dependent on expansion to multiple vehicle and component manufacturers.

Scaling up infrastructure and vehicles for hydrogen. Automakers need greater certainty about the commitment to install hydrogen fueling stations near early adopter hydrogen fuel cell vehicle customers and station owners need assurances that vehicle owners will use their fueling stations. Numerous automakers, including Honda, Toyota, General Motors, Daimler, Hyundai and Nissan state that they are planning to bring hydrogen fuel cell vehicles to market in the 2015-2017 timeframe. Currently nine hydrogen fueling stations are operational and open to the public, and the Energy Commission has provided funding for 24 more new and upgraded stations. The Energy Commission facilitates the initial development of this industry by providing co-funding for the hydrogen fueling stations to offset investment risk until enough vehicle owners purchase hydrogen fuel at these stations to cover operating costs.

Changing trends in gasoline, diesel, and aviation fuel consumption. The decline in domestic and statewide gasoline consumption and the increase in diesel and aviation fuel demand may present challenges to some California refineries that would need to make investments to re-configure their refineries. This situation could lead to refinery throughput reductions, possible closures, or consolidation to fewer refinery owners, perhaps increasing the state's vulnerability to supply disruptions and gasoline and diesel price spikes, although the state's diversified fuel mix – electricity, hydrogen, natural gas, and liquid biofuels – would certainly lessen that impact. [369]

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369 Ogden, Joan, Yang, Christopher and Parker, Nathan, "Transition Scenarios for the U.S. Light-Duty Sector: Chapter 9, Sustainable Transportation Energy Pathways, "UC Davis Institute of Transportation Studies, 2011.

Challenges tracking and evaluating alternative fuel growth. The hallmarks of alternative fuel growth trends include technology advances, vehicle cost reductions, scale economy manufacturing, commercial-scale fuel production and infrastructure projects, and competitive fuel pricing. Although the Energy Commission has authority to collect confidential information from the California petroleum industry, it has limitations to gather information on the alternative fuels industry. The ARB has authority for information gathering under the ZEV mandate, the LCFS, and other regulations, but lacks some details outside their regulatory jurisdiction. Although data limitations diminish capabilities to track the fast growth of alternative fuels and to evaluate the continued need, level, and appropriate mechanisms for economic incentives, continued cooperation between the Energy Commission and ARB is essential for gaining an overall understanding of the alternative fuels market.

Recommendations

To address challenges, the Energy Commission recommends initiatives and policy actions that will lead to measurable change, including recommendations to:

- **Help implement the *2013 Zero Emission Vehicle Action Plan* and California's high-speed rail.** Provide guidance to implement the *2013 Zero Emission Vehicle Action Plan* and use electricity and alternative fuels in the California High-Speed Rail Project.
- **Support national Renewable Fuel Standard Goals.** Confer with the U.S. Department of Energy, U.S. Environmental Protection Agency, and Congress to advocate for a balance of stricter adherence by obligated parties to advanced, low-carbon, Renewable Fuels Standard goals and sustained federal government incentives that phase out as conversion technologies and commercial projects mature.
- **Evaluate fuel storage needs for low-carbon biofuels.** Investigate the need for investment, development, and permit approval of fuel storage terminals for imported and California-produced, low-carbon biofuels.
- **Develop a multi-year strategy to fund electric, hydrogen, and natural gas vehicle rebates.** The Energy Commission and California Air Resources Board should jointly prepare a multi-year strategy to estimate the need, the amount of multi-year government funds required, and revenue source options to fund electric, hydrogen, and natural gas vehicle rebates and incentives for related infrastructure.
- **Optimize incentives for alternative fuel production and fueling infrastructure.** The Energy Commission, in conjunction with the California State Treasurer's Office and California Infrastructure and Economic Development Bank, should evaluate and recommend to the Governor and Legislature options to use State, federal, or other mechanisms to optimally configure existing incentives and explore strategies to leverage the value of carbon credits to increase private sector project financing of commercial-scale alternative fuel production plants and fueling and charging infrastructure.

- **Advance multiple objectives of transportation electrification.** The Energy Commission, California Independent System Operator, and California Public Utilities Commission (CPUC) should jointly confer with investor-owned, publicly owned utilities, and other public and private stakeholders to balance multiple objectives associated with the growth of transportation electrification and electric vehicle charging.
- **Evaluate factors affecting California's crude oil production and refining.** The Energy Commission shall consult with the California Environmental Protection Agency and California Department of Conservation to evaluate several factors that might reduce international imports of crude oil and change California's production and refining of crude oil and refining of crude oil from other states. The findings should be reported to the Governor and Legislature and include:
    - The Energy Commission shall consult with the California Environmental Protection Agency and California Department of Conservation to evaluate the magnitude, cost, and environmental impacts of producing crude oil from the Monterey shale formation and existing heavy oil fields in the San Joaquin Valley.
    - The Energy Commission should evaluate demand from other states and other countries for crude oil and petroleum products developed in California.
    - The Energy Commission should evaluate potential oil refinery industry and retail consolidation stimulated by a decline in gasoline consumption and increase in diesel and aviation fuel consumption.
    - The Energy Commission and California Environmental Protection Agency should evaluate reconfiguration of energy security goals to fuel diversity objectives if the trend continues toward a greater percentage of crude oil produced from domestic sources.
- **Expand joint data collection authority.** Expand existing authority for the Energy Commission and the California Air Resources Board to jointly gather annual information and data on alternative fuels, vehicles, and infrastructure from automakers and truck, bus, and engine manufacturers; wholesalers and marketers; and commercial infrastructure providers.

CHAPTER 9: Climate Change

In Governor Brown's talk at Tsinghua University in China, he said: "Shifting from the easy burning of fossil fuel to a leaner and more elegant energy production will cost money. It will take collaboration, it will take brain power, it will take research, and I'm very happy to say that California is in the forefront in many respects."[370] California remains a world leader in its efforts to address climate change by reducing greenhouse gas (GHG) emissions and identifying ways to prepare for and adapt to climate change impacts. Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006), the Global Warming Solutions Act of 2006, caps economy wide California GHG emissions at 1990 levels by no later than 2020. This aggressive goal represents around an 11 percent reduction from current emissions levels and a nearly 30 percent reduction from projections of business-as-usual levels in 2020.

California's strategies to reduce GHG emissions in the energy sector include improving the energy efficiency of buildings and appliances, reducing greenhouse gas emissions from the electricity sector by increasing the use of renewable resources, and developing low-carbon renewable and alternative transportation fuels and vehicles. However, the energy sector will also be significantly affected by changes in climate. Atmospheric warming will increase electricity demand, decrease the efficiency of thermal power plants, and potentially change the availability of hydropower. Electricity reliability could also be affected by increased risk of wildfires that could damage power lines and by potential flooding in coastal power plants due to sea-level rise.

As part of the 2012 and 2013 *Integrated Energy Policy Report* (*IEPR*) proceedings, the Energy Commission held workshops to explore the effects of climate change on the California energy system and potential adaptation strategies. Energy Commission staff prepared a white paper based on information gathered through these and other climate-related workshops, three climate change assessments done in California since 2006, and state-sponsored climate change research. The white paper, scheduled for release in fall 2013, focuses on the vulnerability of California's energy supply and demand infrastructure to the effects of climate change, research needed going forward to better understand those effects, adaptation options, and key policy issues.

This chapter discusses the Climate Consensus Document, climate change research and projections relevant to California's energy sector, potential impacts on energy supply and demand, climate readiness strategies, and future research needed to continue to support California's GHG reduction and readiness strategies. Also, to help support planning for the 2050 GHG reduction target, this chapter discusses how the Energy Commission staff is

370 Governor Brown's remarks at Tsinghua University, Beijing China; China-California dialogue entitled "Our Shared Path toward Energy Innovation and Low Carbon Development." April 11, 2013; http://gov.ca.gov/news.php?id=17992.

beginning efforts to evaluate changes needed to California's electricity system by 2030. The chapter concludes with recommendations for future work.

Climate Change Consensus Document

In May 2013, the Governor joined more than 500 world-renowned researchers and scientists in releasing a groundbreaking call to action[371] on climate change and other global threats to humanity. The 20-page consensus statement, produced at the Governor's urging and signed by scientists from over 44 countries, translates key scientific findings from disparate fields into one unified message. The document aims to improve the nexus between scientific research and political action on climate change.

According to the consensus statement, "climate disruption, extinction, ecosystem loss, pollution, and population growth are serious threats to humanity's well-being and societal stability." By the year 2100, carbon emissions trends will likely cause average global temperature to rise between 4.3 - 11.5 degrees Fahrenheit. These trends would have devastating impacts. The impacts highlighted by the consensus statement include the following:

- By 2050, human quality of life will suffer substantial degradation if we continue down our current path.
- By 2100, the 1-in-20 year hottest day is likely to become a 1-in-2 year event.
- Cities would experience the extent of damage caused by superstorm Sandy on a more frequent basis.
- Decreasing snowpack and slow spring melt will adversely impact cities and farmland that rely on the seasonal accumulation of snowpack.
- Damage to coastal areas, flooding of ports, water shortages, adverse weather and shifts in crop-growing areas, creation of new shipping lanes, and competition for newly accessible arctic resources will all cost billions of dollars.

Relying on the science, the consensus statement concludes that the negative trends in climate disruption require scaling up carbon-neutral energy production. To stabilize atmospheric concentrations of carbon and potentially prevent global temperatures from rising more than 2 percent, the world would have to decrease emissions by 5.1 percent per year for the next 38 years. This will require government policies that increase innovation and "realign the economic landscape for energy production."

California can be an important part of the solution, but that California cannot do it alone. As Governor Brown said,"What's beautiful and exciting about climate change is no one group can

371 Scientific Consensus on Maintaining Humanity's Life Support Systems in the 21st Century: Information for Policy Makers. May 21, 2013, http://mahb.stanford.edu/consensus-statement-from-global-scientists .

solve the problem. Not the United States, not California, not Japan, not China. We all have to do it."[372]

Climate Change Research and Projections

State-sponsored research and assessments of climate change continue to advance the understanding of the potential effects of climate change on California, including effects on the energy sector. Since 2006, the state has sponsored a series of climate change assessments. The first showed that climate change is a function of global emissions of GHGs and that lowering emissions can reduce climate change effects. The second, released in 2009, concluded that adaptation to climate change is a necessary and urgent complement to reducing emissions. The third assessment, released in 2012, explored local and statewide vulnerabilities to climate change and highlighted concrete actions to reduce climate change impacts. A fourth assessment is in the planning stages.

The Energy Commission staff white paper prepared for the *2013 IEPR* synthesizes the results of the three climate change assessments, climate change reports and research through the Energy Commission's Public Interest Energy Research Program, *IEPR* workshops held in April 2012 and June 2013, and a California Climate Extremes Workshop held in December 2011 at the Scripps Institution of Oceanography. The white paper sets the stage for the energy component of the fourth Climate Change Assessment and is part of a comprehensive, integrated California climate change policy that includes an evolving suite of policy documents such as the 2008 AB 32 *Climate Change Scoping Plan*, the 2009 *Climate Adaptation Strategy*, and forthcoming major climate change documents such as the 2013 Update to the AB 32 *Climate Change Scoping Plan*.[373]

Analysis of historical data provides evidence of increasing temperatures in California and changes in the spring snowpack in the Sierra Nevada that are likely caused primarily by increased concentrations of GHGs in the atmosphere. Nighttime minimum temperatures in particular have been increasing in recent decades. Climate projections suggest that heat waves will be more frequent, last longer, start earlier in the year and end later, and be hotter than historical records. Precipitation in California is highly variable, and this high variability will continue to be a feature of the state climate in the future. Projections imply a potential for more frequent inland flooding in the future. As sea level rises, the frequency and magnitude of extremes would increase markedly, with high sea-level surges that used to occur very infrequently in the historical period becoming very common by the end of this century and lasting for extended periods.

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372 Governor Brown's remarks at Tsinghua University, Beijing China; China-California dialogue entitled "Our Shared Path toward Energy Innovation and Low Carbon Development." April 11, 2013; http://gov.ca.gov/news.php?id=17992.

373 California Air Resources Board. *Climate Change Scoping Plan: A Framework for Change*. 2008. http://arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm.

Impacts of Climate Change on Energy Supply

Climate change is likely to compromise electricity supplies, particularly during temperature spikes when demand for air conditioning will be high. The main effects on energy supply include less electricity output from thermal power plants, reduced capacity of the transmission and distribution infrastructure to deliver electricity, damage to energy infrastructure from extreme events like weather and wildfires, and changes in the availability and timing of renewable energy resources such as hydroelectric power.

A study conducted by the Lawrence Berkeley National Laboratory (LBNL) for the *2012 California Climate Change Vulnerability and Adaptation Study*[374] found that higher temperatures would decrease the capacity of thermal power plants (for example, natural gas, solar thermal, nuclear, and geothermal) to generate electricity during particularly hot periods. At higher temperatures, power plant cooling is less efficient, which in turn reduces the plant's efficiency and how much energy it can generate. California's gas-fired generating plants have a nameplate capacity of about 44,000 megawatts (MW), which by the end of the century could be reduced by around 10,000 MW on hot days. The LBNL study indicates that by the end of the century, energy supplies would need to increase by nearly 40 percent to meet increased demand from climate change and offset lower capacity of thermal generating plants and substations, assuming no technology advancements or population changes.

The energy system will also be increasingly vulnerable to extreme weather events such as wildfires and coastal flooding.[375] As many as 25 coastal power plants and 86 substations face the risk of flooding or partial flooding because of sea level rise, and in some scenarios, the probability of wildfires occurring near large transmission lines is expected to increase dramatically in parts of California by the end of the century. The LBNL study found a 40 percent increased likelihood of wildfires near certain transmission lines, including the line that brings hydropower generation from the Pacific Northwest to California during periods of peak demand.

Climate change could also affect the amount and timing of energy generation from renewable resources over time.[376] Solar photovoltaic and wind energy are probably less vulnerable than conventional power plants, but the effects of future climate on wind and solar energy generation in California need to be investigated further.[377]

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374 Sathaye, J.A., et al. 2013. Estimating impacts of warming temperatures on California's electricity system. *Global Environ. Change*, in press, http://dx.doi.org/10.1016/j.gloenvcha.2012.12.005.

375 Sathaye, Jayant, Larry Dale, Peter Larsen, Gary Fitts, Kevin Koy, Sarah Lewis, and Andre Lucena. 2012. *Estimating Risk to California Energy Infrastructure From Projected Climate Change*. California Energy Commission. Publication Number: CEC-500-2012-057.

376 Vine, Edward. 2012. Adaptation of California's electricity sector to climate change. Climatic Change 111:75–99.

377 Ibid.

Hydropower contributes about 15 percent of California's in-state generation on average and provides low-cost, low-carbon power in the hottest months of the year when electricity demand is at its highest. Higher temperatures will mean that more precipitation falls as rain instead of snow, with remaining snowpack melting and running off earlier in the year. The system may not be able to store sufficient water for release in high-demand periods.[378] Many climate projections show a drier climate by late-century, although some suggest increased precipitation, especially in northern California.

Most research has focused on climate change effects on electricity infrastructure. Assessments will need to be expanded to include the vulnerability of California's transportation fuel supply infrastructure – including refineries, pipelines, marine terminals, underground storage tanks, and fueling stations – to extreme weather events such as flooding, fire, and storms and to other potential climate effects like sea level rise, coastal erosion, and rising temperatures.

Impacts of Climate Change on Energy Demand

Increasingly hot and longer summers are likely to increase demand for air conditioning, while warmer winters will decrease demand for heating in the cooler season. California's residential sector uses relatively little electricity for heating, but the overall demand for electricity will increase with more frequent operation of existing air conditioners and as more air conditioners are installed in areas of the state, such as the coastal regions, where there are currently few. Although technological advances could offset some of this increased demand, higher temperatures in the next decade could increase demand by as much as 1 gigawatt during hot summer months. Also, a 10 percent increase in peak demand is projected by the middle of the century.[379] This peak demand will occur at the hottest time of day when thermal power plants may not be able to deliver at full capacity.

To better understand the effects potential of climate change on peak energy demand, in 2011 the Energy Commission began factoring climate change into its electricity and natural gas demand forecast. This year, along with an updated peak demand analysis, the *2013 IEPR* preliminary demand forecast incorporates estimates of climate change impacts on electricity and natural gas consumption.

Climate Readiness Strategies

The energy sector is taking steps to increase its preparedness for potential climate change effects. First, energy generation resources are being diversified to reduce negative climate effects on any particular resource. California permitted more than 19,000 MW of renewable generating facilities from 2010-2012, and state incentive programs for customers who generate

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378 Guegan M., K. Madani, and C. B. Uvo. 2012. *Climate Change Effects on the High-Elevation Hydropower System with Consideration of Warming Impacts on Electricity Demand and Pricing.* California Energy Commission. Publication number: CEC-500-2012-020.

379 Sathaye, J.A., et al. 2013. "Estimating impacts of warming temperatures on California's electricity system". *Global Environ. Change*, in press, http://dx.doi.org/10.1016/j.gloenvcha.2012.12.005.

their own electricity have led to installation of nearly 4,000 MW of solar photovoltaic systems, small fuel cells, and small wind turbines that began operation between 2010 and 2012. Another 2,200 MW of new renewable generation is under construction.

Second, studies are being done to assess vulnerability and risk for energy infrastructure and to evaluate technological alternatives to adapt to extreme weather conditions. The Third Climate Change Assessment looked at vulnerability to increased temperatures, sea level rise, and increased risk of wildfire,[380] while new projects being funded by the Public Interest Energy Research Program are examining potential risks from flooding and sea level rise in the Sacramento-San Joaquin Delta on energy infrastructure. Utilities are also assessing their vulnerability and incorporating climate change into their planning processes.

Third, evaluations of climate change effects are being incorporated into power plant siting and licensing processes by considering future risks of proposed sites to extreme events as well as cumulative impacts of development and climate change on species of concern and other environmental factors. The state is developing new guidelines under the California Environmental Quality Act on how climate change impacts such as sea level rise and flooding are to be assessed, and permit review processes will incorporate these guidelines once they are approved. Research is also looking at how to assess the effects of new energy infrastructure in the context of a changing climate, since climate change will affect habitat conditions and migration patterns. Finally, decision support tools such as probabilistic forecasts are being developed to potentially reduce negative effects of climate change on California's energy water systems by more effective management of reservoirs and hydropower units.

Future Climate Change Research Needs

California has developed an unmatched legacy of state-level research on climate change and its impacts. Nevertheless, new data, knowledge, and analytical capabilities dictate the need for continuing research to help the state achieve its existing and future policy goals. Energy Commission staff has identified several areas where research is needed.

Fourth Climate Change Assessment

A partial list of research areas the Fourth Climate Change Assessment may address includes advances in fine-scaled probabilistic climate change projections; vulnerability to extreme events; economic impacts and costs of adaptation; modeling and analysis of sectors and systems; funding mechanisms for adaptation; how public and private sectors can implement climate considerations in their day-to-day activities; overcoming regulatory and legal barriers; supporting sustainable renewable generation; and evaluations of regions of the state not previously targeted for studies, such as the Central Valley and the desert/inland areas of southern California.

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380 Sathaye, Jayant, Larry Dale, Peter Larsen, Gary Fitts, Kevin Koy, Sarah Lewis, and Andre Lucena. 2012. *Estimating Risk to California Energy Infrastructure From Projected Climate Change*. California Energy Commission. Publication Number: CEC-500-2012-057.

Effects of Extreme Events on the Energy Sector

In December 2011, Governor Brown hosted an invitation-only conference in San Francisco focusing on the impacts of extreme climate events and how best to protect California from those impacts. The conference included experts from research, business, public health, local government, agriculture, energy, water and other sectors. Specific research needs in this area include improved assessments to identify targeted readiness options; development and testing of supply and demand forecasting methods; and innovative engineering design studies to identify when problems will materialize, what actions should be taken, and what alternatives are available.

Effects on Renewable Energy Goals

Research is needed to improve simulation of wind, solar radiation, relative humidity, cloud cover, and other variables that affect the amount of renewable generation that must be installed to meet state renewable goals. Also, effects of future climate conditions on wind and solar energy generation need to be further investigated. Further research is also needed on how to make up potential losses in hydropower generation.

Improve and Update Climate Change Indicators

Research is needed to improve indicators of climate change, which help the state track, evaluate, and report on the outcomes of its efforts to reduce climate change effects. There are opportunities to improve current indicators and develop new ones to track the resilience and vulnerability of the energy sector. For example, wildfires are an important source of power interruptions in California, but additional data are needed on wildfire events prior to 2002 to better understand the effects of such events.

Evolution of the Energy System

California's energy system must change drastically over the next few decades in response to policy goals to reduce GHG emissions and increase the amount of renewable energy in the electricity mix. This evolution will require information that helps create a more climate-resilient energy system. The Public Interest Energy Research Program is funding a project to enhance a newly developed model of the electricity system known as SWITCH (a loose acronym for Solar, Wind, Hydro, and Conventional Generation and Transmission Investment model). Energy scenarios developed with SWITCH will provide insight on strategies to achieve California's long-term GHG emission reduction goals for 2050 at minimum cost, and will also help decision makers anticipate negative environmental impacts and develop mitigation strategies in advance. To meet these long term goals, interim goals for 2030 are needed.

California's 2030 Electricity System

Research and planning are both needed to help increase the resiliency of the energy system while also transforming it to dramatically reduce greenhouse gas emissions. California's energy sector contributes about 85 percent of the state's GHG emissions on a yearly basis, roughly 25 percent of which comes from the electricity sector, the remainder comes from natural gas systems, transportation services, and fuel infrastructure. Transportation represents the largest share, about 40 percent of the state's GHG emissions, meaning that transforming the

transportation sector is an essential part of meeting the state's GHG goals.[381] Realizing California's 2050 goal of reducing economy-wide GHG emissions to 20 percent of 1990 levels will require substantial decarbonization of the electricity sector and electrification of the transportation sector. Because there is so much uncertainty about planning for a 2050 goal, the state must evaluate interim goals in for 2030.

Decarbonization of California's electricity system must occur as demand from population and economic growth increases, combined with the necessary electrification of the industrial and transportation sectors to reduce their GHG emissions which is expected to more than offset future improvements in energy efficiency. The effects of climate change will further complicate efforts to reduce greenhouse gas emissions.

An 80 percent reduction of GHG emissions by the electricity sector would limit 2050 emissions to 21.6 million metric tons of carbon dioxide equivalents (MMT CO_2-e)[382] and require roughly a 70 percent reduction in electricity generation using fossil fuels.[383] By 2030, California utilities will have divested themselves of coal-fired generation, and have met a RPS of 33 percent or more; replacing 21,000 GWh of coal-fired generation with renewable energy would yield a GHG emission reduction of 20 MMT.

The pathway to 2050 is all but certain to include the development of technologies now in their infancy, including fossil-fueled generation with carbon capture, use, and sequestration and advanced biofuels. Because widespread deployment of such technologies by 2030 cannot be assumed, however, California needs to consider how to meet interim GHG emission reduction and renewable resource development goals with existing and mature technologies.

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381 Energy Commission staff analysis. Data accessed on 06/07/2013 from http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_scopingplan_00-10_2013-02-19.pdf (Scoping Plan Category) and http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_ipcc_00-10_all_2013-02-19.pdf (IPCC Category).

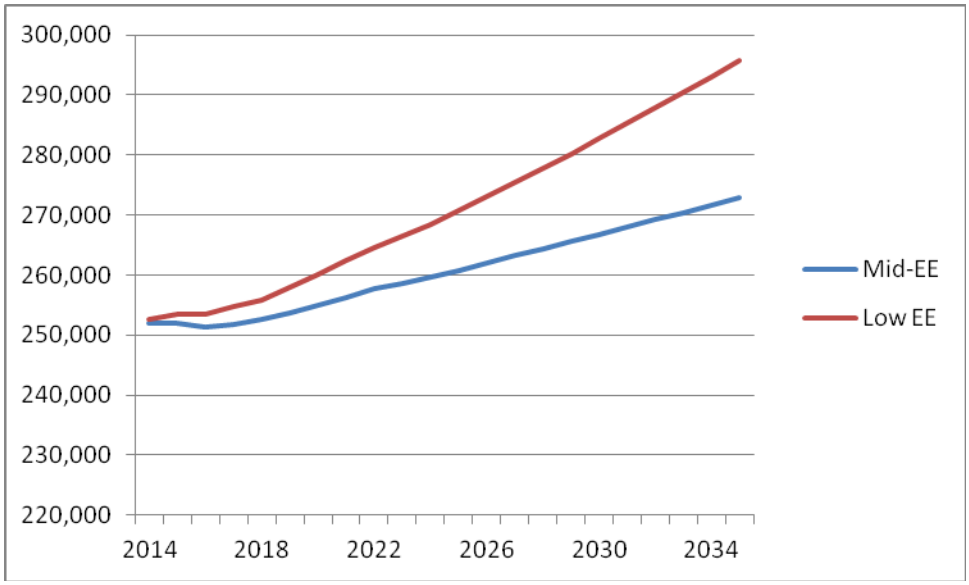
382 This value would be higher to the extent that offsets were used to meet GHG emission reduction goals. The cap-and-trade program developed by the California Air Resources Board allows for up to 8 percent of required emission reductions to be met with offsets. It is not expected that offsets will be used to the full extent allowed; see Elizabeth M. Bailey, Severin Borenstein, James Bushnell, Frank A. Wolak and Matthew Zaragoza-Watkins, *Forecasting Supply and Demand Balance in California's Greenhouse Gas Cap and Trade Market*, March 12, 2013.

383 Assuming no sequestration of GHG emissions and an average heat rate of 7,400 Btu/kWh, 21.6 MMT CO_2-e would be emitted by 55,000 GWh of natural-gas fired generation, about half of the electricity generated in California today using natural gas. California also meets part of its 300,000 GWh demand for electricity with 21,000 GWh of coal-fired generation from neighboring states (20 MMT CO_2-e), 13,000 GWh of imported gas-fired generation (7 MMT) and more than 30,000 GWh of imported power from unspecified sources (13 MMT CO_2-e attributed). See http://energyalmanac.ca.gov/electricity/electricity_generation.html, California Energy Commission, Total System Power Reports, 2010 and 2011, available at http://energyalmanac.ca.gov/electricity/total_system_power.html, and California Air Resource s Board, Greenhouse Gas Inventory Data, 2010, available at http://www.arb.ca.gov/cc/inventory/data/data.htm.

Electricity Demand in 2030

The Energy Commission's 2013 preliminary demand forecast for the next 10 years is substantially lower than the 2011 forecast because of substantial reductions in projected population growth. Figure 34 illustrates the mid-case forecast for RPS-eligible retail sales with the mid- and low cases for achievable energy efficiency and extrapolates it to 2035 based on 2018 – 2024 growth rates, showing that growth in RPS-eligible retail sales from 2020 to 2035 will depend greatly on the extent to which energy efficiency savings are realized.

Figure 34: California Energy Demand 2013 RPS-Eligible Retail Sales Forecast



Source: California Energy Commission

Simply extending electricity demand for 2025 – 2030 based on forecasted trend growth from 2020 to 2024 may be misleading because of uncertainty about the effects of various factors during the preceding decade. Several of these uncertainties relate to the magnitude of possible reductions in electricity demand:

- Development of new energy efficiency technologies, increased expenditures on utility efficiency programs, and increased adoption of efficiency measures because of higher electricity prices could lead to greater energy efficiency savings during the next two decades. While there is substantial technical potential for energy efficiency savings through 2030, the extent to which these savings will be realized is uncertain.
- Zero-net-energy requirements for new residential construction are expected to result from the 2020 building efficiency standards. The extent of savings by 2030 will depend on compliance rates and the extent to which the zero-net-energy target is met by energy efficiency savings rather than onsite solar photovoltaic generation. While the change in grid-supplied energy is unaffected by the latter consideration, the daily ramps that central-station generation, demand response programs, and storage must meet are altered.

- While a million new homes may be built during 2020 – 2030, energy efficiency savings of the magnitude needed to meet long run GHG emission reduction goals will require substantially reduced energy use in many more existing buildings, including rented and leased space.
- Development of efficient combined heat and power (CHP), a component of both the *Climate Change Scoping Plan* from Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006) and the Governor's Clean Energy Jobs Plan, could reduce the demand for grid-provided energy. Although estimates of economic potential are substantial,[384] the CPUC's assumption in its 2012 LTPP proceeding – that there will be no incremental CHP development through 2022 – reflects the numerous obstacles that CHP developers currently face. The return of cogenerators to utility service would increase the demand for electricity from utility-owned and merchant generators.

Other uncertainties related to possible increases in electricity demand include the following:

- The Energy Commission's 2013 preliminary demand forecast assumes increased deployment of full electric and plug-in hybrid electric vehicles, with more than 2 million vehicles by 2024 consuming 6,113 GWh. Although costs are expected to fall and performance characteristics improve, deployment through 2030 remains uncertain. In addition, demand may increase with the development of high-speed rail and zero-energy vehicles for use in ports and goods transport.
- Electrification of the industrial sector to meet long-term GHG emission reduction goals is expected to accelerate as carbon prices rise and will at least partially offset any efficiency improvements. The extent to which this will occur by 2030 is uncertain, as is the role that non-utility supply – solar process heating and combined heat and power – will play in meeting increased demand.
- Growth in demand from other sources such as plug loads and potential new sources such as desalination may markedly increase the demand growth rate.
- The effect of climate change on electricity demand will increase from 2025 – 2030, with higher average temperatures and more frequent extreme heat events increasing average and peak electricity demand, respectively.[385]

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384 *Combined Heat and Power: Policy Analysis and 2011-2030 Market Assessment*, ICF International, CEC-200-2012-002, February 2012. The mid-case presented by ICF indicates a potential 13,730 GWh reduction in retail sales in 2030, the result of 3,443 MW of CHP generating at an 80 percent capacity factor with slightly more than 50 percent of the generation being consumed on site.

385 The Energy Commission's 2013 preliminary forecast projects an increase in cooling degree days over 2012 – 2024 that is not offset by a smaller reduction in heating degree days and a 0.7 – 1.1 degree increase in expected peak temperatures. This leads to a 1,283 GWh increase in demand and a peak demand increase of 1,061 MW by 2024.

Electricity Supply Through the Early 2020s

If electricity demand grows as slowly over 2024 – 2030 as indicated in Figure 34, the likely generation portfolio in 2024 provides an informative starting point for envisioning the system in 2030. This requires consideration of the renewable portfolio that is expected to meet the 33 percent RPS in the early 2020s, the nonrenewable resources to be added to provide reliable service given the retirement of San Onofre and OTC facilities in southern California, and any additional resources needed to integrate intermittent renewable generation

Renewable Development through the Early 2020s

Table 18 shows California's RPS-eligible renewable portfolio as of the beginning of 2013. Slightly more than 20 percent of this energy, 11,600 GWh, comes from resources that came on-line in 2012.

Based on the Energy Commission's 2013 preliminary demand forecast, the projected energy required to meet the 33 percent RPS in 2024 will require an additional 27,100 GWh to 31,400 GWh of renewable energy.[386] The forecast projects that these resources will be accompanied by the development of an additional 3,000 MW solar photovoltaic on the customer side of the meter, bringing the statewide total to an estimated 4,730 MW that will generate about 7,920 GWh of energy.

Table 18: California's RPS Portfolio, December 2012

Technology	Projected Annual Energy (GWh)			Nameplate Capacity (MW)
	In-State	Out-of-State	Total	
Solar	3,453	1,166	4,620	2,149
Wind	13,215	8,449	21,664	7,404
Geothermal	13,522	1,392	14,914	2,891
Biofuels	6,460	1,559	8,019	1,128
Small Hydro	5,184	40	5,224	1,612
Total	**41,834**	**12,606**	**54,441**	**15,184**

Source: California Energy Commission. The figures do not include customer-side-of-the-meter solar photovoltaics (PV), installed as part of the California Solar Initiative and publicly-owned utility programs, estimated to be 1,596 MW, (http://www.californiasolarstatistics.ca.gov/, June 30, 2013) providing 2,420 GWh of energy (assuming a 17.1 percent capacity factor).

The CPUC and the Energy Commission have jointly developed renewable resource portfolios intended to reflect both environmental and land-use constraints and likely or potential development to satisfy the RPS during the current 10-year planning horizon. Under a May 2010,

386 *California Energy Demand 2013 draft forecast*. The demand forecast coupled with the mid-case for additional energy efficiency yields an incremental need for renewable energy of 31,400 GWh. The development of 3,250 MW of new combined heat and power resources beyond the small amount assumed in the forecast, assumed to operate at an 80 percent capacity factor and use slightly more than half the energy produced on site, reduces the renewable net short- the amount of renewable energy that remains to be procured to meet the RPS- to 27,100 GWh.

Memorandum of Understanding, the agencies developed "commercial interest," "environmental," and "high distributed generation" portfolios, presented to stakeholders at a joint agency workshop in December 2012 for consideration in the California ISO's 2013/2014 TPP.[387] A majority of the renewable resources needed to meet the 33 percent RPS in 2020 have already been procured by the state's utilities and are under construction or about to begin. Others are likely – and assumed by planners – to be built, given CPUC-approved power purchase agreements with utilities and targets for such programs as the Renewable Auction Mechanism. The portfolio developed for use in Track 2 of the CPUC's 2012 LTPP proceeding is summarized in Table 19. This portfolio, like others developed for the CPUC's LTPP and Resource Adequacy proceedings and the California ISO's TPP, assumes development of a large amount of intermittent resources, especially solar.

Table 19: Projected Renewable Portfolio for California, 2022

Technology	Projected Annual Energy (GWh)			Nameplate Capacity (MW)
	In-State	Out-of-State	Total	
Solar	18,843	1,633	20,476	9,115
Wind	4,481	1,496	5,977	2,149
Geothermal	3,766	1,200	4,965	688
Biofuels	1,377	0	1,377	193
Small Hydro	0	0	0	0
Total	**28,468**	**4,328**	**32,796**	**12,144**

Source: California Energy Commission.

Nonrenewable Generation Development through the Early 2020s

Several studies are underway that will provide information for estimates of the need for nonrenewable generation resources in the California ISO balancing authority area through 2022.

The California ISO's 2012 LTPP Track 2 Studies estimate operational flexibility needs in 2022 given the expected portfolio of renewable resource additions. Expected to be completed in fall 2013, the studies will indicate the potential need for incremental operational flexibility given the retirements of San Onofre (2,246 MW) and OTC plants in both Northern and Southern California that have compliance deadlines through 2020[388] (11,524 MW) as well as expected

387 For a discussion of the development of these portfolios, see the letter from CPUC President Michael R. Peevey, Energy Commission Chair Robert B. Weisenmiller, and CPUC Commissioner Michael P. Florio to California ISO President and CEO Steve Berberich, February 7, 2013, available at http://www.caiso.com/Documents/2013-2014RenewablePortfoliosTransmittalLetter.pdf.

388 The SWRCB OTC policy allows for delays in compliance cum retirement of resources to preserve electricity system reliability. Given the need to replace most of the OTC capacity in the Los Angeles Basin in the absence of San Onofre, it appears increasingly possible that retirement and replacement will have to be staggered beyond 2020.

retirements of other facilities in these areas before 2022.[389] Building on this effort, the Energy Commission, CPUC, and California ISO staffs, in collaboration with Southern California Edison, South Coast Air Quality Management District (SCAQMD), San Diego Gas & Electric, the State Water Resources Control Board (SWRCB), and the California Air Resources Board, prepared a "Preliminary Reliability Plan for LA Basin and San Diego." The purpose of the plan is to ensure reliability in Southern California in light of the closure of San Onofre, the expected closure of 5,068 MW of gas-fired generation that uses OTC, and load growth. Recommendations from the preliminary plan were presented by staff to the leaders of the state energy agencies, the California ISO, and SCAQMD during a workshop on September 9, 2013. Public comment will be taken and the plan will be revised as needed before it is submitted to the Governor.

The California ISO's 2012 LTPP Track 4 study, due in August 2013, is assessing local capacity needs in the Los Angeles and San Diego local capacity areas as a result of the retirement of San Onofre. This study will affect the decision whether to authorize the procurement of dispatchable resources beyond the 1,200 MW to 1,800 MW in the Los Angeles Basin already authorized.[390]

Supply filings submitted as part of the *2013 IEPR* proceeding by POUs in California's other balancing authority areas indicate that new natural gas-fired resource development by these entities is expected to be minimal through 2020. The only major activity expected involves a change in the date of the Los Angeles Department of Water and Power's (LADWP) divestiture of its Navajo entitlement (477 MW of coal) to the end of 2015.[391] The utility's filing indicates that it expects to replace Navajo with a 300 MW combined-cycle facility.[392]

While these studies are not completed, it is likely that they will indicate that a substantial share of the capacity to be retired in the Los Angeles Basin and San Diego through 2020, perhaps 5,000 MW to 6,000 MW, will have to be replaced with flexible, dispatchable generation to meet local reliability needs.

Need for Operational Flexibility

The California ISO's Track 2 study of operational flexibility needs in 2022 indicates that the expected amount of new solar generation on both the customer- and utility-side of the meter will create early-evening ramps of substantial size from November to March. This will result in

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389 These include 238 MW of generation capacity in San Diego and 1,645 MW of aging gas-fired capacity in the Los Angeles Basin.

390 D.13-02-015 (February 13, 2013) authorized 1,000 – 1,200 MW of conventional gas-fired resources, and 150 -600 MW of preferred resources including storage. In addition 215 – 290 MW was authorized in the Moorpark subarea of Big Creek/Ventura. In addition, D.13-03-029 (March 21, 2013) authorized San Diego Gas& Electric to procure 298 MW of local capacity for 2018.

391 http://www.ladwpnews.com/go/doc/1475/1727379/LADWP-Takes-Historic-Action-Toward-Clean-Energy-Future-for-Los-Angeles.

392 LADWP's filing does not indicate whether this resource would be developed or purchased, or whether it would be located in or outside California.

up to 14,000 MW of load having to be met by dispatchable resources when solar output falls during late afternoon and early evening hours.[393] The study also indicates the potential need to export energy during mid-morning hours in low-load months – months in which the Pacific Northwest has surplus hydroelectricity and the Southwest is meeting demand with coal resources, which cannot be turned off or ramped down. In addition, the "net load peak" – the point at which the need for dispatchable generation is greatest – is pushed back in summer months to 8:00 p.m. (an hour when very little solar generation is available), indicating that additional solar development, absent storage, would not markedly reduce the need for dispatchable capacity.

The CPUC and the California ISO are jointly developing ways to quantify the operational flexibility of generation and other resources such as demand response and storage, and to estimate the combined monthly system need for flexible resources, as well as resource adequacy protocols that will ensure California ISO control over the required amount of capacity. In the fall of 2014, the California ISO will inaugurate an energy imbalance market (EIM) that includes resources from both the California ISO and PacifiCorp balancing authorities. Resources bidding into this market will be scheduled on a 5-minute basis, which will increase the quantity and flexibility of resources the California ISO can draw on in real time to manage intrahour and longer ramps. The potential contribution of this market to meeting ramping requirements needs to be assessed to accurately estimate the amount of flexible generation available to California from out-of-state resources. Over the long term, technology advances and other factors will promote increased participation by demand response and energy storage resources in this and other markets (such as ancillary service markets), allowing for reduced need for gas-fired resources to balance the system.

Potential Supply Development From 2024 Through 2030

If electricity demand grows as slowly from 2024 – 2030 as indicated by the midcase for energy efficiency shown in Figure 34, incremental capacity from nonrenewable sources to meet system wide and zonal reserve margins, local capacity requirements, and reliability needs will be driven as much by resource retirements as by changes in peak demand. The latter indicates an annual growth rate in electricity demand of 0.4 percent.

There are three major sets of retirements to be considered in the post-2020 period:

1. If Diablo Canyon is not relicensed in 2024 and 2025, the zero-carbon energy from 2,240 MW of generation capacity and an unknown share of the capacity itself will require replacement. The equivalent annual output of 17,300 GWh from an efficient fast-start, gas-fired, combined-cycle plant emits nearly 7 MMT CO_2-e.
2. LADWP and five smaller southern California POUs will have to replace the energy from their shares (1,777 MW) of the coal-fired Intermountain Generating Station in the late 2020s

393 See *2012 LTPP Track 2* Study, Shucheng Liu, California ISO, June 17, 2013. Ramps are higher in nonsummer months as the sun sets earlier and peak demand occurs in the early evening; thus solar output is lower at 5:30 p.m. while demand at 8:00 p.m. has not fallen from late afternoon levels.

because of California's Emission Performance Standard. The utilities hope to accelerate the divestiture of their purchase obligations by two years: from 2027 to 2025, replacing a share of the energy with output from a natural gas plant that would replace all or part of the existing facility. The GHG emissions associated with California's share of the resource equal roughly 11 MMT CO_2-e; those associated with the replacement energy from the gas plant would be significantly smaller.[394]

3. LADWP OTC units will have to comply with the SWRCB policy. Scattergood 1-2 (358 MW, end of 2024), Haynes 1-2 (444 MW, end of 2029), and the Harbor combined-cycle (215 MW, end of 2029) will likely be replaced with a comparable amount of efficient, flexible capacity onsite due to local reliability needs and the difficulties and costs associated with major transmission upgrades within the Los Angeles area that would allow for retirement without replacement.

Potential for Development of Nonrenewable Zero- and Low-Carbon Technologies

Studies of pathways to a decarbonized electricity sector point to several generation technologies that may be relied upon to provide zero- or low-carbon electricity by 2050. These include coal and natural gas-fired generation using carbon capture, utilization, and sequestration (CCUS); nuclear generation, immature renewable technologies (offshore wind, tidal generation), and advanced biofuels, in addition to the mature technologies that make up the state's current renewable portfolio.[395]

While advancement of immature technologies is all but certain by 2050, the pace at which it will occur is uncertain. The rate at which coal- and natural gas-fired generation with CCUS and generation with advanced biofuels are developed will likely be influenced by the presence or absence of a national carbon policy, which would accelerate private sector research and development. But even if reductions in cost and improvements in CO_2 emitted per MWh (for CCUS technologies) allow for a technology's widespread deployment by 2030, it still may face public opposition.

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394 Average annual GHG emissions attributed to California utility shares of Intermountain over 2007 – 2010 were 10.86 MMT CO2 according to the California Greenhouse Gas Emissions Inventory. Replacement of 50 percent of the energy from Intermountain with gas-fired generation and 50 percent with renewable energy would reduce the GHG emissions to 3.1 MMT.

395 In its study of potential resource portfolios for meeting 2050 GHG reduction goals, Energy and Environmental Economics, Inc. (E^3) presented various portfolios that relied upon renewable energy (74 percent of total energy), nuclear energy (55 percent), and fossil generation (natural gas and coal) with carbon capture and sequestration (CCS; 47 percent). See *Meeting California's Long-Tem Greenhouse Gas Reduction Goals*, Energy and Environmental Economics, Inc., November 2009. The California Council on Science and Technology develops similar portfolios in *California's Energy Future: The View to* 2050, California Council on Science and Technology, May 2011.

Large-scale coal-fired generation with CCUS is at the pilot stage of development.[396] It is unlikely that existing coal plants, many of which will be 50 years old or more in 2030, will be economic candidates for retrofitting with gasification/sequestration technology. Even if coal-fired generation with CCUS is cost-competitive with renewable resources by 2030, it is more likely that (1) such resources will be developed in neighboring states by local utilities in support of local loads, and (2) be supercritical and ultra-supercritical facilities that, due to engineering constraints, will have limited ability to cycle up and down in support of California's intermittent generation.[397] Public opposition to "clean coal" in California may hamper its procurement. It is not unreasonable to imagine a future in which coal-fired generation with CCUS, while competitive with renewable generation with storage, is developed by out-of-state entities to exploit an indigenous resource but is largely rejected as an alternative by California because of incremental bulk transmission needs, questions regarding the integrity of sequestration, the desire to reduce the environmental impact and profitability of mining a fossil resource that is a candidate for export abroad, and a preference for renewable resources.

Natural gas-fired generation with CCUS is arguably a more likely candidate for widespread development in California by 2030. Estimates of the levelized cost of energy from such plants are 37 to 57 percent higher than the cost of conventional gas plants, requiring that a carbon price be well above current levels to incentivize development.[398] CCUS costs are expected to fall, however, and a combination of high carbon prices and lower costs could lead to marked instate development by 2030. The farther CCUS development and operating costs decline, the lower the carbon price needed to encourage gas-with-CCUS development, and the lower the post-deployment carbon price will become.

Nuclear development in California is precluded by legislation, although California utilities can invest in out-of-state facilities. Public acceptance of nuclear generation in California is very low in the post-Fukushima era, and time lags for permitting and construction are very long, making development of nuclear resources by 2030 very unlikely. As noted above, the retirement of Diablo Canyon - whether due to operational concerns or a decision not to relicense it in 2024-2025 – is a risk that must be managed.

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396 The only utility-scale plant under construction in the United States is the Kemper County facility in Kemper County, Mississippi, which will produce 582- MW (524 MW gasified coal, 58 MW natural gas) when it comes on-line in 2014, at a cost of $6700/kW. The facility will capture and use 65 percent of its CO2 emissions for enhanced oil recovery (EOR). Hydrogen Energy of California (HECA) is seeking certification for a 400 MW (288 MW net) facility to be built at an estimated cost of $4.03 billion ($10,000/kW).

397 *Impact of Cycling on Coal-Fired Power Generating Assets*, Steve Hesler, Electric Power Research Institute, April 2011, available at http://web.mit.edu/mitei/intermittent-renewables/papers/CoalImpacts.pdf.

398 Rubin, Edward S. and Haibo Zhai, *The Cost of CCE for Natural Gas-Fired Power Plants*, presentation to the 10th Annual Conference on Carbon Capture and Storage, May 3, 2011.

Given the uncertainties associated with the deployment of fossil-fueled generation with CCUS and nuclear generation, further reductions in GHG emissions from 2024 to 2030 may have to come from the renewable technologies relied upon today.

Renewable Development from 2024 – 2030

When extrapolated to 2030, the Energy Commission's 2013 preliminary demand forecast mid-case forecast and achievable energy efficiency scenarios jointly yield estimates of renewable energy needs in 2030 under a 33 percent RPS that are only slightly higher than in 2020 (Table 20; the values in parentheses represent the incremental renewable energy needed during the post-2020 period to meet different RPSs in 2030 and 2040).

The incremental renewable energy needed to maintain a 33 percent RPS during 2020 – 2030 is small because load growth is projected to be low due to a combination of slower population growth, the development of customer-side distributed generation, and energy efficiency savings. The incremental renewable energy needed to reach a 40 percent RPS, roughly 25,000 GWh, is not substantial compared to the procurement of renewable energy over the past several years. Table 21 provides the MW of capacity that would be needed to provide 25,000 GWh of energy from various renewable technologies.

Table 20: Renewable Energy Needs in 2030 by RPS Percentage, GWh

Year/RPS Target	Mid EE Case (GWhs)	Low EE Case (GWhs)
2020 / 33%	84,125	85,819
2030 / 33%	88,044 (3,919)	93,287 (7,468)
2030 / 40%	106,720 (22,595)	113,074 (27,265)
2030 / 50%	133,400 (49,275)	141,343 (55,524)

Source: California Energy Commission. Numbers in parentheses represent estimated incremental renewable energy needs compared to 2020/33%.

Table 21: Capacity Needed to Provide 25,000 GWh of Energy, Selected Renewable Technologies

Technology	Capacity Factor	Required MW
Distributed Solar	24%	11,891
Central Station Solar	28%	10,192
Wind	32%	8,918
Geothermal	80%	3,567
Biomass/Biomethane	85%	3,358

Source: California Energy Commission

While the amount of incremental renewable energy procured in the course of going from a 33 percent RPS in 2020 to a 40 percent RPS in 2030 is not large, acquiring a significant share of this energy from solar resources will exacerbate the operational concerns hinted at in the California ISO Track 2 Study. Developing such resources on the utility side of the meter will be in addition to customer-side distributed solar projected assumed to be developed in the 2013 preliminary demand forecast and capacity expected to be added as a result of zero-net-energy regulations

arising out of 2020 standards for new home construction. It is questionable whether this level of development can occur without developing significant amounts of complementary resources, the most effective of which will be energy storage that is capable of absorbing energy during other hours, including the morning down-ramp, for use during the net peak hours of the early- and mid-evening.

Primary Research Topics for 2030 Analysis

Electricity system needs in 2030 are likely to resemble those of today. In the absence of technological advances that would allow for the widespread deployment of such zero- and low-carbon generation technologies as coal-fired generation with CCUS, nuclear, and advanced biofuel generation until 2030 and beyond, increasing amounts of "conventional" renewable generation will likely be relied upon to achieve interim GHG emission reductions from the electricity sector. To the extent that these resources are predominantly intermittent, they will increasingly need to be accompanied by gas-fired generation with CCUS, energy storage, or demand response to minimize the development and use of high GHG-emitting resources.

Uncertainties point to the importance of the following analyses to assess more accurately possible resource needs through 2030, given increased deployment of intermittent generation resources:

- Development of reasonable bounding estimates for load growth over 2025 – 2030, including scenarios for the impact of zero-net-energy regulations arising from 2020 building standards for new home construction, specifically the extent to which energy use will be reduced though 2030 by energy efficiency measures as opposed to being offset by onsite generation, as these have different implications for complementary resource needs. Development of similar estimates for energy efficiency savings associated with existing buildings is needed; potential savings based on the number of existing buildings are much larger than for new construction, but more difficult to realize.
- Estimation of changes in the net load shape[399] as solar is increasingly deployed over time, and its implication for the following:
    - The quantity of complementary resources needed to meet morning and afternoon ramping requirements.
    - Surplus generation.
    - Hourly wholesale electricity prices and the value of specific energy efficiency programs, for example lighting, that would reduce demand in higher-priced and higher-ramp hours.
- Estimation of gas-fired generation capacity that will be built to replace San Onofre, retiring OTC facilities, and other generation expected to retire through 2030.

399 "Net load shape" here refers to the hourly profile of electricity demand that remains to be met after all intermittent generation- solar and wind energy- has been used to satisfy a portion of it.

- Assessment of the potential for dispatchable resources in other California balancing authority areas and neighboring states to provide load-following services to the California ISO through an energy imbalance market during periods of the year and times of day in which they are most needed. The contributions of gas-fired generation in the Southwest during early evening hours, for example, may obviate the need for new capacity in California solely for the integration of intermittent renewable resources until sufficient energy storage can be developed. This assessment consists of evaluating both the surplus capacity in neighboring states that is likely to be available to participate in California markets and the need for internal generation and limits on imports into California during high-ramp hours. Similarly, increased renewable resource development in the remainder of the West can assist in balancing the California system with zero-carbon resources, to the extent that out-of-state resources have an output profile that compliments that of renewable resources in California.
- The ability of neighboring states to absorb any excess energy that California may generate.

Recommendations

The Energy Commission supports the Governor's Climate Change Consensus Document[400] and recommends the following actions to help reduce the effects of climate change to California's energy infrastructure:

- **Sponsor research on regional climate projections, energy sector vulnerability, and adaptation strategies.** Continue to sponsor climate change research on regional climate projections, the vulnerability of the energy sector, and adaptation strategies.
- **Fund research, development, and demonstration for technologies that reduce greenhouse gas emissions.** Continue funding research, development, and demonstration on technologies that reduce greenhouse gas emissions and that need public support in California.
- **Support actions that provide climate change mitigation and adaptation benefits**. California should emphasize climate mitigation actions to reduce greenhouse gas emissions that also make the energy system more resilient, reliable, and efficient in the face of climate change.
- **Expand support for Cal-Adapt and CalLEAP, tools that assist local planning efforts.** Sustain and expand Cal-Adapt (a web-based interactive visualization tool developed to convey the risks of climate change to local decision makers and Californians who live in affected communities) and CaLEAP (a program that local governments use in preparing plans to ensure that key assets are resilient to disaster events that impact energy). These tools have proven to be valuable aids to local communities in planning for climate change.
- **Assess the vulnerability of transportation fuel infrastructure to climate change.** The Energy Commission will assess the vulnerability of the transportation fuel infrastructure

400 http://mahb.stanford.edu/consensus-statement-from-global-scientists.

such as refineries, pipelines, marine terminals, underground storage tanks, and fueling stations to extreme weather events and other climate impacts.

- **Continue to coordinate climate change research by California agencies.** The Energy Commission will continue to provide coordination support to climate change research sponsored by state agencies in California via the Climate Action Team Research Working Group.
- **Support development of greenhouse gas reduction targets for 2030 and metrics to track progress.** The Energy Commission will work with the California Air Resources Board to develop potential greenhouse gas reduction strategies and goals for 2030 as part of the *Climate Change Scoping Plan First Update* development process. The agencies will also jointly develop metrics to track progress against the *Scoping Plan*.

ACRONYMS

AQMD	—	air quality management district
ARB	—	California Air Resources Board
ARFVTP	—	Alternative and Renewable Fuel and Vehicle Technology Program
ARRA	—	American Recovery and Reinvestment Act
ASME	—	American Society of Mechanical Engineers
BAMx	—	Bay Area Municipal Transmission Group
BLM	—	Bureau of Land Management
BTU	—	British thermal unit
CAL	—	Confirmatory Action Letter
CaLEAP	—	California Local Energy Assurance Planning
California ISO	—	California Independent System Operator
CBD	—	Center for Biological Diversity
CCUS	—	carbon capture, utilization, and sequestration
CEQA	—	California Environmental Quality Act
CHP	—	combined heat and power
CMUA	—	California Municipal Utilities Association
CPUC	—	California Public Utilities Commission
DATC	—	Duke-American Transmission Company
DAWG	—	Demand Analysis Working Group
DE	—	design earthquake
DDE	—	double design earthquake
DFA	—	Development Focus Area
DOE	—	Department of Energy
DRECP	—	Desert Renewable Energy Conservation Plan
DRRC	—	Demand Response Research Center
EIM	—	energy imbalance market
EIR	—	Environmental Impact Report
EIS	—	Environmental Impact Statement
EM&V	—	evaluation, measurement, and verification
EPA	—	Environmental Protection Agency
ERC	—	emission reduction credit
FERC	—	Federal Energy Regulatory Commission
FIT	—	feed-in tariff
GEIS	—	Generic Environmental Impact Statement
GGE	—	gasoline gallon equivalents
GHG	—	greenhouse gas

GHP	—	geothermal heat pump
GIDAP	—	Generator Interconnection and Deliverability Allocation Procedures
GMC	—	ground motion characterization
GWh	—	gigawatt hour(s)
HERS	—	Home Energy Rating System
HVAC	—	heating, ventilation, and air conditioning
HVDC	—	high-voltage direct current
IDSM	—	Integrated Demand Side Management
IEPR	—	*Integrated Energy Policy Report*
IID	—	Imperial Irrigation District
IOU	—	investor owned utility
IPRG	—	Independent Peer Review Group
ISFSI	—	Independent Spent Fuel Storage Installation
LADWP	—	Los Angeles Department of Water and Power
LCFS	—	Low Carbon Fuel Standard
LCOE	—	Levelized Cost of Energy
LNG	—	liquefied natural gas
LTPP	—	Long Term Procurement Plan
LTSP	—	Long Term Seismic Program
MM	—	Million
MMth	—	million therms
MW	—	megawatt(s)
NAS	—	National Academy of Sciences
NEPA	—	National Environmental Policy Act
NERC	—	National Electricity Reliability Council
NRC	—	Nuclear Regulatory Commission
NTTF	—	Near-Term Task Force
OII	—	Order Instituting Investigation
OIR	—	Order Instituting Rulemaking
OTC	—	once-through cooling
PGC	—	public goods charge
PG&E	—	Pacific Gas and Electric
POU	—	publicly owned utility
PPA	—	power purchase agreement
PV	—	Photovoltaic
PSHA	—	probabilistic seismic hazard analysis
RAI	—	request for additional information
RAM	—	Renewable Auction Mechanism

RCCo	—	reliability coordination company
RE	—	reliability entity
REAT	—	Renewable Energy Action Team
ReMAT	—	Renewable Market Adjusting-Tariff
RFS	—	Renewable Fuels Standard
RIN	—	Renewable Identification Numbers
RPS	—	Renewables Portfolio Standard
RRTT	—	Rapid Response Team for Transmission
SCAQMD	—	South Coast Air Quality Management District
SCE	—	Southern California Edison Company
SDG&E	—	San Diego Gas & Electric Company
SFP	—	Secondary Financial Protection
SMUD	—	Sacramento Municipal Utility District
SNF	—	spent nuclear fuel
SSC	—	seismic source characterization
SSCs	—	systems, structure, and components
SSHAC	—	Senior Seismic Hazard Analysis Committee
SWRCB	—	State Water Resources Control Board
SWUS	—	Southwest United States
TDV	—	Time Dependent Valuation
TPP	—	Transmission Planning Process
TRTP	—	Tehachapi Renewable Transmission Project
TTG	—	Transmission Technical Group
TWE	—	TransWest Express Transmission Project
U.S. EPA	—	United States Environmental Protection Agency
VEA	—	Valley Electric Association
WECC	—	Western Electricity Coordinating Council
WREGIS	—	Western Renewable Energy Generation Information System
WSP	—	Westlands Solar Park Master Plan
WWD	—	Westlands Water District
ZEV	—	zero-emission vehicle
ZNE	—	zero-net-energy

GLOSSARY

Ancillary services market	The market for services needed to maintain system reliability
AutoDR	Short for automated demand response, refers to reducing or shutting down loads automatically through use of technology, rather than manual switching operations
Benchmarking	A measurement of the quality of an organization's policies, programs, or strategies, and their comparison with standard measurements or similar measurements of its peers
Building commissioning	The process of verifying, in new construction, all of the subsystems achieve the owner's project requirements as intended by the building owner and as designed by architects and engineers
Closed-loop geothermal system	System that continually circulates the same water and antifreeze solution through a closed loop
Cost-effectiveness protocols	Method to measure the cost-effectiveness of demand response programs, intended for evaluations of programs which provide long-term resource value
Direct load control	Activities that can interrupt load at the time of peak by interrupting power supply on consumer premises, usually applied to residential customers
Flexible resources	Resources that generate cost in proportion to the amount used
Load impact protocols	Protocols the California Public Utilities Commission uses to provide input on determining demand response cost-effectiveness and to assist in resource planning and long-term forecasting
Local capacity area requirements	Minimum quantity of local capacity necessary to meet the local capacity requirement criteria
Megajoule	Unit of energy expended in applying a force of one newton through a distance of one metre
Once-through cooling	Water that is withdrawn from the ocean or other water body is passed through a steam condenser one time, then returned to the water body some distance from the intake

OpenADR	Short for open automated demand response, this research and standards development effort for energy management is typically used to send information and signals to cause electrical power-using devices to be turned off during periods of high demand
Open-loop geothermal system	System that uses well or surface body water as the heat exchange fluid, returning it to the ground once it has circulated through the system
Port electrification	The process of transforming the port's power sources from internal combustion to electricity
Reach standards	Standards in addition to efficiency levels that should be installed in any building project striving to be considered a "green" building
Rule 21	Formal language outlining the requirements for interconnection at the Distribution System level that applies to electric utilities in California that are under the jurisdiction of the California Public Utilities Commission
Rule 1315	South Coast Air Quality Management District rule that enables the district to replenish the District Account by allowing them to harvest as needed the 0.2 of the 1:2:1 offset ratio imposes by Rule 1303 on all offsets surrendered
Standard Capacity Product	Provides a mechanism that offers an incentive or disincentive to a resource based on resource availability, reflecting whether it is providing the capacity value that it was procured for
Synchronous condenser	A specialized synchronous motor whose shaft is not attached to anything, but spins freely, and whose purpose is to adjust conditions on the electric power transmission grid
Telemetry requirements	Requirements for automatic measurement and transmission of data by wire, radio, or other means from remote sources to receiving stations for recording and analysis
Time dependent valuation	An alternative to source energy as the currency for evaluating building energy performance, time dependent valuation accounts for when energy is used.
Time value of service	The value electricity customers place on the electricity used at a given time

Truck stop electrification	The process of transforming the truck stop's power sources from internal combustion to electricity
Use-limited resources	Resources that have operational or environmental restrictions that limit production hours but can operate for a minimum set of consecutive trading hours

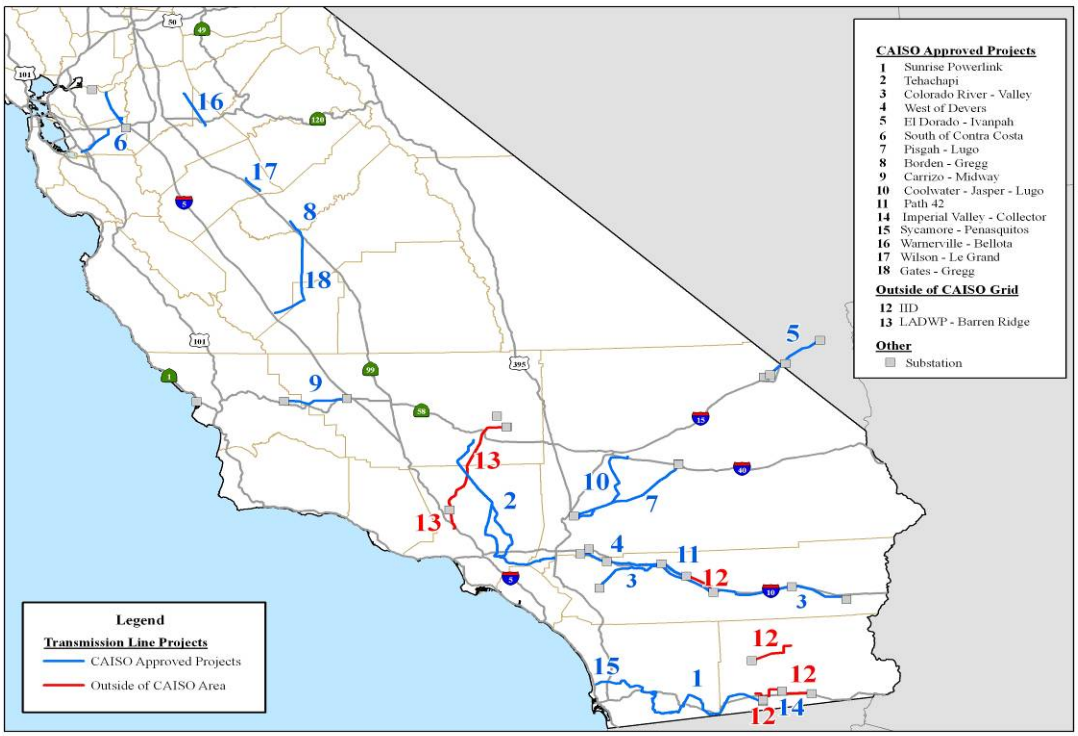
APPENDIX A:
Detailed Description of Approved Transmission Line Projects

As noted in Chapter 5, the California Independent System Operator (California ISO), the Imperial Irrigation District (IID) and the Los Angeles Department of Water and Power (LADWP) have identified and approved 18 transmission projects[401] for the integration of renewable resources that will enable California to meet its 33 percent Renewables Portfolio Standard (RPS) goal by 2020. The status of these transmission projects are posted on the Energy Commission website.[402] Below are detailed descriptions of each project and key dates throughout the approval process. The projects are in presented in the same order as the spreadsheet posted on the website. The map below shows the approximate location of each transmission project.

401 The California ISO in collaboration with SCE will reevaluate the need for the Pisgah-Lugo transmission project in light of K Road, LLC filing a request with the Energy Commission to withdraw and terminate the Energy Commission license for the 850 MW Calico Solar Project on June 20, 2013.

402 The status of each transmission project is posted on the Renewables/Tracking Progress/Transmission Expansion page of the Energy Commission website at: http://www.energy.ca.gov/renewables/tracking_progress/.

Figure A-1: Map of California ISO, IID and LADWP Approved Transmission Projects



Source: California Energy Commission

Sunrise Powerlink (1)

Description

On June 17, 2012, SDG&E completed construction and energized the 117-mile 500 kV Sunrise Powerlink transmission line that increases the import capability into San Diego from the renewable energy-rich Imperial Valley. Sunrise Powerlink combined with the Imperial Valley (IV) Collector Station and IV-Collector transmission line and Sycamore-Peñasquitos projects (discussed below), will increase the import capability by an additional 1,000 MW for a total of 1,700 MW. As of June 7, 2013, the California ISO Interconnection Queue[403] includes 2,045 MW of active renewable generation projects in Imperial County that can interconnect to the Sunrise Powerlink and provide power to SDG&E and the rest of California. More than 7,000 MW of renewable generation projects in Imperial County have withdrawn from the California ISO's queue. The Imperial Irrigation District's interconnection queue consists of 17 projects with proposed generation of 1,099 MW that could also use the Sunrise Powerlink.[404]

403 California ISO Interconnection Queue is located on the California website at: http://www.caiso.com/planning/Pages/GeneratorInterconnection/Default.aspx.

404 Asbury, Jamie, Imperial Irrigation District, comments on *2013 IEPR – Transmission Planning and Permitting Issues*, Docket No. 13-IEP-1E, May 21, 2013, p. 1,

Key Dates

August 3, 2006: California ISO Board of Governors approved project.
August 4, 2006: SDG&E filed application with CPUC for a CPCN.
December 18, 2008: CPUC issued Decision 08-12-058[405] approving project.
January 20, 2009: BLM issued Record of Decision[406] approving project.
July 13, 2010: USFS issued Record of Decision[407] approving project.
December 9, 2010: SDG&E started construction.
June 17, 2012: In-service date.

Imperial Valley (IV) Collector Station and IV-Collector Line (14)

Description

In coordination with IID, the California ISO identified a policy-driven project with capital costs under $50 million for the Imperial Valley Area in the board-approved *2012-2013 Transmission Plan*.[408] The project was identified to help resolve transmission development and permitting issues, as well as commercial concerns of generators who desire to interconnect directly to the California ISO grid.[409] The elements of the project include an Imperial Valley 230 kV Collector station and a 230 kV transmission line, about one mile, which will connect the Collector Station to the existing Imperial Valley Substation. The Collector station and transmission line will provide an efficient means by which generation in the California ISO queue located in Imperial Valley can move forward to commercial operation. The project is contingent upon IID upgrading the IV-El Centro line (S line) and looping it into the new Collector Station. The IID

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http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Imperial_Irrigation_District_Comments_re_Transmission_Planning_and_Permitting_Issues_2013-05-21_TN-70922.pdf.

405 The CPUC Decision 08-12-058 approving the Sunrise Powerlink project can be found on the CPUC website at: http://www.cpuc.ca.gov/environment/info/aspen/sunrise/D08-12-058.pdf.

406 BLM Record of Decision approving Sunrise Powerlink can be found on CPUC website at: http://www.cpuc.ca.gov/environment/info/aspen/sunrise/rod.pdf.

407 USFS Record of Decision approving Sunrise Powerlink can be found on USFS website at: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5320675.pdf.

408 California ISO Board approved 2012-2013 Transmission Plan, p. 12, http://www.caiso.com/Documents/BoardApproved2012-2013TransmissionPlan.pdf.

409 Asbury, Jamie, Imperial Irrigation District, comments on *2013 IEPR* – Transmission Planning and Permitting Issues, Docket No. 13-IEP-1E, May 21, 2013, p. 2, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Imperial_Irrigation_District_Comments_re_Transmission_Planning_and_Permitting_Issues_2013-05-21_TN-70922.pdf.

upgrade will enhance its ownership rights at the IV substation. The Imperial Valley Collector Station and transmission line qualify for the competitive solicitation process.

Phase 3 of the California ISO's transmission planning process includes a competitive solicitation process for policy-driven and economically driven transmission projects, as well as for reliability-driven projects that provide additional policy and economic benefits. The bid window, where project sponsors can submit proposals to finance, construct, and own the IV Collector Station and IV-Collector line, was open from December 19, 2012, through February 19, 2013. On February 25, 2013, the California ISO posted the list of project sponsors that submitted proposals.[410] On July 11, 2013, the California ISO selected the Imperial Irrigation District as the approved project sponsor and accepted IID's offer of a cost cap of $14.3 million to construct the project.[411] The selected project sponsor will submit applications to state and federal regulatory agencies requesting project approval. California ISO's expected in-service date is no later than 2015.

Key Dates

December 14, 2012: California ISO management approved the project following a briefing to the California ISO Board of Governors.[412]
December 19, 2012 through February 19, 2013: Competitive solicitation bid window open.
February 25, 2013: California ISO posted the list of project sponsors that submitted proposals.
July 11, 2013: California ISO selected IID as the project sponsor.
No later than 2015: Expected in-service date.

Sycamore-Peñasquitos (15)

Description

The California ISO identified a policy-driven need for a 230 kV transmission line between SDG&E-owned Sycamore and Peñasquitos substations in its recently board-approved *2012-2013 Transmission Plan.*[413] The policy-driven line will ensure delivery of generation needed to meet

410 The list of project sponsors that submitted proposals for the IV Collector Station and IV-Collector line project can be found on the California ISO website at: http://www.caiso.com/planning/Pages/TransmissionPlanning/2012-2013TransmissionPlanningProcess.aspx.

411 The California ISO's *Imperial Valley Policy Element Project Sponsor Selection Report* can be found on the California ISO website at: http://www.caiso.com/Documents/ImperialValleyPolicyElement-ProjectSponsorSelectionReport_Jul11_2013.pdf.

412 The California ISO management briefing to the Board of Governors on the Imperial Valley Area policy driven transmission elements can be found on California ISO website at: http://www.caiso.com/Documents/BriefingImperialValleyAreaPolicy-DrivenTransmissionElementsUnder50Million-Presentation-Dec2012.pdf.

413 California ISO Board approved *2012-2013 Transmission Plan*, pp. 296 and 374, http://www.caiso.com/Documents/BoardApproved2012-2013TransmissionPlan.pdf.

the 33 percent RPS as well as reliability benefits to the San Diego area. As part of the 2012-2013 Transmission Planning Process, the California ISO examined the reliability impact without the Diablo Canyon Power Plant (Diablo Canyon) and San Onofre Nuclear Generating Station (San Onofre). The Nuclear Generation Back Up Plan study identified several transmission system upgrades that, in addition to generation replacement and mitigation measures already underway, would help manage future unplanned extended outages to the San Onofre plant. The upgrades included the installation of 650 MVAR of dynamic reactive support in the vicinity of San Onofre and the Sycamore-Peñasquitos project. Construction of this project becomes more important in light of SCE's June 7, 2013, announcement of its decision to permanently retire San Onofre Units 2 and 3.[414] The project is eligible for competitive solicitation.

Phase 3 of the California ISO's transmission planning process includes a competitive solicitation process for policy-driven and economically driven transmission projects, as well as for reliability-driven projects that provide additional policy and economic benefits. The bid window, where project sponsors can submit proposals to finance, construct, and own the Sycamore-Peñasquitos 230 kV line is open from April 1, 2013 through June 3, 2013. On June 6, 2013, the California ISO posted the list of project sponsors that submitted proposals for the Sycamore-Peñasquitos project.[415] The selected project sponsor will submit applications to state and federal regulatory agencies requesting project approval. California ISO's expected in-service date is 2017.

Key Dates

March 20, 2013: California ISO Board of Governor approved the *2012-2013 Transmission Plan.*
April 1, 2013, through June 3, 2013: Competitive solicitation bid window open.
June 6, 2013: California ISO posted the list of project sponsors that submitted proposals.
2017: Expected in-service date.

Tehachapi Renewable Transmission Project (2)

Description

SCE's Tehachapi Renewable Transmission Project (TRTP) will provide the electrical facilities necessary to integrate 4,500 MW of wind generation in Eastern Kern County to the Los Angeles Basin and accommodate planned or future solar and geothermal projects. TRTP addresses reliability needs of the California ISO-controlled grid due to projected load growth in the Antelope Valley and the South of Lugo transmission constraints in Hesperia, California. TRTP is being built in 11 segments and includes more than 300 miles of new and upgraded 220 kV and 500 kV transmission lines and substations. SCE submitted two applications to the CPUC for

414 SCE's news release can be found on SCE website at: http://edison.com/pressroom/pr.asp?id=8143.

415 The list of project sponsors that submitted proposals for the Sycamore-Peñasquitos project can be found on the California ISO website at: http://www.caiso.com/Documents/List-ProjectSponsorProposalsReceived-SycamoreCanyon_Penasquitos230kVLineProposedPolicyDrivenElement.pdf.

authorization to construct segments 1-3 (formerly known as Antelope-Pardee Transmission Project) and segments 4-11.

On October 17, 2011, SCE filed a Petition for Modification of Decision 09-12-044[416] to address the Federal Aviations Administration's (FAA) recommendations near Chino airport for segment 8, Phase 3. On April 11, 2013, the CPUC and U.S. Forest Service prepared a Draft Supplemental Environmental Impact Report/Environmental Impact Statement (Draft SEIR/SEIS)[417] for the proposed changes to the TRTP requested in SCE's Petition for Modification of Decision 09-12-044.

On November 10, 2011, the CPUC issued Decision 11-11-020[418] granting a construction stay for Segment 8A within Chino Hills, as modified on July 12, 2012 by the Decision 12-03-050.[419] The ruling of the Assigned Commissioner will continue until the CPUC makes a final determination on undergrounding options. Segment 8A undergrounding options are not the subject of the SEIR/SEIS. In April 2013, the Segment 8A undergrounding evidentiary hearings at the CPUC concluded. On June 11, 2013, CPUC Administrative Law Judge (ALJ) Jean Vieth issued Proposed Decision[420] denying the City of Chino Hills' petition for modification of Decision 09-12-044 regarding Segment 8A of TRTP finding that while the undergrounding of a transmission line is feasible, the cost is prohibitive and should not be borne by ratepayers. At the same time, President Michael Peevey issued an Alternate Proposed Decision[421] granting the City of Chino Hills' petition and ordering SCE to construct an underground, single circuit, cross-linked polyethylene (XLPE) system, UG5, in Segment 8A. On July 11, 2013, the CPUC voted in favor of President Peevey's Alternate Proposed Decision and released the construction stay. The decision requires SCE to underground Segment 8A, a 3.5-mile 500 kV transmission line, and

416 SCE's Petition for Modification of Decision 09-12-044 can be found on the CPUC website at: ftp://ftp.cpuc.ca.gov/gopher-data/environ/tehachapi_renewables/PetForMod_2.pdf.

417 SCE and USFS Draft SEIR/SEIS can be found on the CPUC website at: ftp://ftp.cpuc.ca.gov/gopher-data/environ/tehachapi_renewables/DSEIRS/Index.htm.

418 CPUC Decision 11-11-020 can be found on the CPUC website at: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/151130.pdf.

419 CPUC Decision 12-03-050 can be found on the CPUC website at: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/162534.pdf.

420 CPUC ALJ Vieth's Proposed Decision can be found on the CPUC website at: http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M066/K068/66068597.PDF.

421 CPUC President Peevey's Alternate Proposed Decision can be found on the CPUC website at: http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M065/K706/65706074.PDF.

remove the previously installed towers.[422] The original expected in-service date of 2015 may be adjusted depending on the outcome of the hearings.[423]

Key Dates

Segments 1-3

December 9, 2004: SCE filed application with CPUC for a CPCN.
January 11, 2005: SCE filed special use application with U.S. Forest Service.
March 1, 2007: CPUC issued Decision 07-03-012[424] approving the project.
August 23, 2007: USFS issued a Record of Decision[425] approving project.
2008: SCE started construction.
December 2009: Segments 1, 2, and 3A in-service.
Spring 2012: Construction started on 3B.
Fall 2012: Segment 3B in-service.

Segments 4-11

January 24, 2007: California ISO Board of Governors approved project.
June 29, 2007: SCE filed application with CPUC for a CPCN.
June 29, 2007: SCE filed special use application with U.S. Forest Service.
December 17, 2009: CPUC issued Decision 09-12-044 approving the project.
April 2010: SCE started construction.
October 4, 2010: USFS issued a Record of Decision approving project.
October 17, 2011: SCE filed a Petition for Modification of Decision 09-12-044 to address the FAA's recommendations near Chino airport for segment 8, Phase 3.
November 10, 2011: CPUC issued Decision 11-11-020 granting a construction stay for Segment 8A within the City of Chino Hills.
Spring 2012: Segments 4 and 10 in-service.
July 12, 2012: CPUC issued a Decision 12-03-050 modifying Decision 11-11-020.
Winter 2012: Segment 5 in-service.

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422 CPUC Decision on TRTP Segment 8A can be found on CPUC website at: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M071/K423/71423831.PDF.

423 Alvarez, Manuel, Southern California Edison, comments on *California Energy Commission Docket No. 13-IEP-1E Transmission Planning and Permitting Issues*, May 21, 2013, pp. 5-6, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Southern_California_Edison_Comments_re_Transmission_Planning_and_Permitting_Issues_2013-05-21_TN-70920.pdf.

424 CPUC Decision 07-03-012 can be found on the CPUC website at: http://docs.cpuc.ca.gov/published/FINAL_DECISION/65273.htm.

425 USFS Record of Decision can be found on the CPUC website at: http://www.cpuc.ca.gov/environment/info/aspen/antelopepardee/record_of_decision.pdf.

April 11, 2013: CPUC and USFS prepared a Draft Supplemental EIR/EIS based on SCE's proposed modifications.
June 3, 2013: Public comments period ends on draft Supplemental EIR/EIS.
June 11, 2013: CPUC ALJ Vieth Proposed Decision denying Chino Hills' petition for modification of Decision 09-12-044.
June 11, 2013: CPUC President Peevey Alternate Proposed Decision granting Chino Hills' petition for modification of Decision 09-12-044.
July 11, 2013: CPUC Decision favors President Peevey's Alternate Proposed Decision Chino Hills.
2015: Expected in-service date for remaining segments.

Colorado River-Valley (and Red Bluff Substation) (3)

Description

SCE's Colorado River-Valley 500 kV transmission project includes the Colorado River to Devers project, also referred to as the California side of the Devers-Palo Verde 2 (DPV2) project, consisting of the following main components:

- New 500/220 kV Colorado River Substation near Blythe
- New Red Bluff Substation west of the Colorado River Substation
- 111-mile Devers-Colorado River 500 kV transmission line between Devers Substation and the Colorado River Substation that will parallel the existing Devers-Palo Verde transmission line
- 42-mile Devers-Valley No. 2 500 kV transmission line between Devers Substation and Valley Substation in Menifee that will parallel the existing Devers-Valley transmission line

The project will allow generators in eastern Riverside County to connect with the Devers Substation in Southern California. This project, along with the West of Devers upgrade (discussed below), will allow for delivery of about 4,000 MW from Riverside County.

Construction of all facilities are nearing completion, but the June 2013 target completion date will likely not be met because a timeline for mitigation measures for nesting birds has not been established, which could delay construction. On May 22, 2013, SCE completed construction on the Red Bluff Substation, ahead of SCE's target in-service date of July 2013.[426] On September 29, 2013, SCE completed and energized the Colorado River-Valley project.

426 Alvarez, Manuel, Southern California Edison, comments on *California Energy Commission Docket No. 13-IEP-1E Transmission Planning and Permitting Issues*, May 21, 2013, p. 5, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Southern_California_Edison_Comments_re_Transmission_Planning_and_Permitting_Issues_2013-05-21_TN-70920.pdf.

Key Dates

February 24, 2005: California ISO Board of Governors approved the original Devers-Palo Verde 2 (DPV2) project. No further Board approval required for the Colorado River-Valley project.
April 11, 2005: SCE filed an application with CPUC for a CPCN.
January 25, 2007: CPUC issued Decision 07-01-040[427] approving DPV2.
July 14, 2011: CPUC issued Decision 11-07-011[428] approving construction of the expanded Colorado River Substation.
May 14, 2008: SCE filed a Petition for Modification (PFM) of Decision 07-01-040 requesting the CPUC authorize SCE to construct only the California portion of the DPV2 facilities.
November 20, 2009: CPUC issued Decision 09-11-007[429] approving the PFM.
July 19, 2011: BLM issued Record of Decision[430] approving the project.
September 2011: SCE started construction on Colorado River and Red Bluff Substations.
January 2012: SCE started transmission line construction.
May 22, 2013: Red Bluff Substation completed.
September 29, 2013: In-service date.

West of Devers (4)

Description

The California ISO's Generator Interconnection Procedures identified SCE's West of Devers transmission lines as delivery network upgrades for the Blythe, Genesis, and Palen solar generating projects in Riverside County. The West of Devers project consists of removing and replacing nearly 48 miles of existing 220 kV transmission lines with new double-circuit 220 kV transmission lines between the existing Devers Substation (near Palm Springs), Vista Substation (in Grand Terrace), and San Bernardino Substation. SCE received approval from the Federal Energy Regulatory Commission (FERC) and the California ISO through acceptance of the nonconforming Large Generator Interconnection Agreement (LGIA) for the Blythe, Genesis, and Palen solar generating projects.

SCE is developing routes and gathering the environmental information needed to apply for required state and federal permits. Without the West of Devers upgrades, most of the renewable generation proposed in eastern Riverside County will be unable to meet the deliverability requirements in their power purchase agreements. SCE will file a Proponent's Environmental

427 CPUC Decision 07-01-040 can be found on the CPUC website at: http://docs.cpuc.ca.gov/published//FINAL_DECISION/64017.htm.

428 CPUC Decision 11-07-011 can be found on the CPUC website at: http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/139770.htm.

429 CPUC Decision 09-11-007 can be found on the CPUC website at: http://docs.cpuc.ca.gov/published/FINAL_DECISION/110360.htm.

430 BLM Record of Decision can be found on the CPUC website at: http://www.cpuc.ca.gov/Environment/info/aspen/dpv2/record_of_decision_071911.pdf.

Assessment (PEA) with the CPUC in October 2013. If approved, construction will begin in 2016 with an expected in-service date of 2019.[431]

Key Dates

September 15, 2010: Energy Commission Decision[432] on Blythe Application for Certification (AFC).
September 29, 2010: Energy Commission Decision[433] on Genesis AFC.
December 15, 2010: Energy Commission Decision[434] on Palen AFC.
February 4, 2011: FERC Order[435] accepting Blythe LGIA.
February 17, 2011: FERC Order[436] accepting Palen LGIA.
October 20, 2011: FERC Order[437] accepting Genesis LGIA.
2011-2013: SCE in project planning and public outreach activities.
October 2013: SCE to file PEA with the CPUC requesting project approval.
2019: Expected in-service date.

Eldorado-Ivanpah (5)

Description

The California ISO's Generator Interconnection Procedures identified SCE's Eldorado-Ivanpah transmission project as delivery network upgrades for the Ivanpah Solar Electric Generating System. The Eldorado-Ivanpah project will provide the electrical facilities necessary to integrate

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431 Alvarez, Manual, Southern California Edison, comments on *California Energy Commission Docket No. 13-IEP-1E Transmission Planning and Permitting Issues*, May 21, 2013, p. 5, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Southern_California_Edison_Comments_re_Transmission_Planning_and_Permitting_Issues_2013-05-21_TN-70920.pdf.

432 Energy Commission Decision on Blythe AFC can be found on Energy Commission website at: http://www.energy.ca.gov/2010publications/CEC-800-2010-009/CEC-800-2010-009-CMF.PDF.

433 Energy Commission Decision on Genesis AFC can be found on Energy Commission website at: http://www.energy.ca.gov/2010publications/CEC-800-2010-011/CEC-800-2010-011-CMF.PDF.

434 Energy Commission Decision on Palen AFC can be found on Energy Commission website at: http://www.energy.ca.gov/2010publications/CEC-800-2010-010/CEC-800-2010-010-CMF.PDF.

435 FERC Order accepting Blythe LGIA can be found on California ISO website at: http://www.caiso.com/Documents/Feb4_2011Orderconditionallyacceptingnon-conformingLGIAsanddenyingmotions-consolidate_docketER11-2329_etal_.pdf.

436 FERC Order accepting Palen LGIA can be found on California ISO website at: http://www.caiso.com/Documents/February17_2011Orderconditionallyacceptingnon-conformingLGIAs_denyingmots_-consolidateindocketno_ER11-2451.pdf.

437 FERC Order accepting Genesis LGIA can be found on California ISO website at: http://www.caiso.com/Documents/2011-10-20_ER11-4512_GenMcCoyLGIAorder.pdf.

1,400 MW of new solar energy generation in the Ivanpah Dry Lake area. The project's major components include:

- New Ivanpah Substation in San Bernardino County.
- Replacement of a portion of an existing 115 kV transmission line with a 35-mile double-circuit, 220 kV transmission line between the new Ivanpah Substation and the existing Eldorado Substation near Boulder City, Nevada.
- Installation of associated telecommunication infrastructure.

On July 1, 2013, SCE completed and energized the Eldorado-Ivanpah project.

Key Dates

May 28, 2009: SCE filed an application with CPUC for a CPCN.
September 22, 2010: Energy Commission Decision[438] on Ivanpah AFC.
March 15, 2011: FERC Order[439] accepting amendments to original 2010 Ivanpah LGIAs.
December 16, 2010: CPUC issued Decision 10-12-052[440] approving project.
May 25, 2011: BLM issued Record of Decision[441] approving the project.
March 2012: SCE started construction.
July 1, 2013: In-service date

South of Contra Costa (6)

Description

The California ISO's Generator Interconnection Procedures identified PG&E's South of Contra Costa reconductoring project as needed to deliver 300 MW of new wind generation in Solano County. The South of Contra Costa project includes reconductoring the following transmission lines:

- 18.3 miles of the Contra Costa Power Plant-Delta Pumps 230 kV transmission line
- 21 miles of the Las Positas-Newark 230 kV transmission line

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438 Energy Commission Decision on Ivanpah AFC can be found on Energy Commission website at: http://www.energy.ca.gov/2010publications/CEC-800-2010-004/CEC-800-2010-004-CMF.PDF.

439 FERC Order accepting amendments to original Ivanpah LGIA can be found on California ISO website at: http://www.caiso.com/Documents/March15_2011LetterorderacceptingLGIAsbetweenISO_SCE__SolarPartnersindocketnos_ER11-2885_ER11-2899.pdf.

440 CPUC Decision 10-12-052 can be found on CPUC website at: http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/128873.htm.

441 BLM Record of Decision can be found on the BLM website at: http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/needles/lands_solar.Par.91949.File.dat/EITP_ROD.pdf.

- 8 mile of the Kelso-Tesla 230 kV transmission line

Without reconductoring these lines, none of the renewable generation proposed in the Solano County area will be considered deliverable. The Kelso-Tesla 230 kV reconductoring was completed in November 2012. PG&E is in the engineering phase for the Contra Costa Power Plant-Delta Pumps and Las Positas-Newark 230 kV transmission lines is and has not yet filed applications to state and federal regulatory agencies requesting approval. PG&E's expected in-service date for these remaining projects is 2017.

Key Dates

July 6, 2012: PG&E submitted Advice Letter 4083-E[442] to CPUC for Kelso-Tesla line.
August 5, 2012: CPUC approved Advice Letter 4083-E.
November 2012: In-service date for Kelso-Tesla transmission line.
2017: PG&E's expected in-service date for remaining projects.

Pisgah-Lugo (7)

Description

Due to multiple generator withdrawals in the Mojave Desert, including the 850 MW K Road Calico Solar Project,[443] the California ISO and SCE are reassessing the scope and need for the Pisgah-Lugo Renewable Transmission Project.[444]

The need for the project was originally identified in the California ISO's Generator Interconnection Procedures to interconnect and deliver power generated by the Calico Solar Project and other generators near Newberry Springs in the Mojave Desert. If the project does move forward, it would consist of a new 500/220 kV Pisgah vicinity substation near SCE's existing Lugo Substation, and roughly 60 to 70 miles of new 500 kV transmission line from the new Pisgah substation to SCE's Lugo Substation. About 50-55 miles of the new 500 kV line would replace the existing Pisgah-Lugo No. 2 220 kV line using the existing transmission corridor. The existing corridor between Lucerne Valley area and the Lugo Substation would not

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442 PG&E Advice Letter 4083-E can be found on PG&E website at http://www.pge.com/nots/rates/tariffs/tm2/pdf/ELEC_4083-E.pdf.

443 On June 20, 2013 K Road, LLC filed a request with the Energy Commission to terminate the Energy Commission license for the Calico Solar Project, http://www.energy.ca.gov/sitingcases/calicosolar/compliance_2012/notices/2013-06-24_Notice_of_Receipt_of_Request_to_Terminate_License_TN-71374.pdf.

444 See status of Pisgah-Lugo project on SCE website at https://www.sce.com/wps/portal/home/about-us/reliability/upgrading-transmission/lugo/!ut/p/b1/hc9BC4IwHAXwj7Rnm1rHDWP7CyniItsldpBYpHaIPn8TPAXpuz34vcNjjnXMjf4T7v4dptE_5-6yW7LX0lAL0mcrQapQiTkRaplHcI0AfyKxtb8w90OsSCPZ5Vwr4lan66AosQGEWMBB42jKegYNB_EGVSslB7IFrLyozDT07DV0CPQQX-pmKtI!/dl4/d5/L2dBISEvZ0FBIS9nQSEh/?from=lugopisgah.

be wide enough to accommodate the remainder of the new 500 kV line, and SCE would explore the need for a new transmission corridor to construct the remainder of the line. The Pisgah-Lugo project would provide access to 1,400 MW of renewable capacity in the Mojave Desert.

Key Dates

December 1, 2010: Energy Commission Revised Decision[445] on Calico AFC.
December 6, 2010: FERC Order[446] accepting Calico LGIA.
June 20, 2013: K Road, LLC filed request with the Energy Commission to terminate Calico Solar Project.

Borden-Gregg (8)

Description

The California ISO's Generator Interconnection Procedures identified PG&E's Borden-Gregg 230 kV transmission line reconductoring project as a delivery network upgrade as needed for the delivery of 800 MW of new solar generation proposed in the Fresno area, specifically the Westlands area. According to PG&E, the project is on hold. Once the project moves forward, PG&E will submit applications to state and federal regulatory agencies requesting approval. PG&E's expected in-service date is 2016.

Carrizo-Midway (9)

Description

The California ISO's Generator Interconnection Procedures identified PG&E's Carrizo-Midway transmission project as a delivery network upgrade identified as needed for the delivery of 900 MW of solar generation in the Carrizo Plain area. On May 5, 2011, PG&E submitted a notice of exempt construction, Advice Letter 3842-E[447], to the CPUC for transmission facilities that would interconnect renewable generators in the Carrizo Plain. San Luis Obispo County issued permits for the switching stations as part of the Conditional Use Permits granted for two PV projects: the California Valley Solar Ranch Project (250 MW) and the Topaz Solar Farm Project (550 MW). The proposed project consists of the Caliente Switching Station in San Luis Obispo County; and the Solar Switching Station in San Luis Obispo County associated with the two solar PV projects and reconductoring roughly 35 miles of the existing Morro Bay-Midway double-circuit 230 kV transmission line. On September 14, 2011, the CPUC issued Resolution E-4434 approving

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445 Energy Commission Revised Decision on Calico AFC can be found on Energy Commission website at: http://www.energy.ca.gov/sitingcases/calicosolar/notices/2010-12-01_Commission_Adoption_Order.pdf.

446 FERC Order accepting Calico LGIA can be found on FERC website at: http://www.ferc.gov/eventcalendar/Files/20101206170004-ER10-796-001.pdf.

447 PG&E Advice Letter 3842-E can be found on PG&E's website at: http://www.pge.com/nots/rates/tariffs/tm2/pdf/ELEC_3842-E.pdf.

PG&E's Advice Letter 3842-E. On March 20, 2013, PG&E completed reconductoring and energized the Morro Bay-Midway transmission line.

Key Dates

May 5, 2011: PG&E submitted Advice Letter 3842-E to the CPUC.
September 14, 2011: CPUC issued Resolution E-4434 approving Advice Letter 3842-E.
March 20, 2013: In-service date.

Cool Water-Jasper-Lugo (10)

Description

The California ISO's Generator Interconnection Procedures identified SCE's Coolwater-Jasper-Lugo transmission project as a delivery network upgrade needed for the Abengoa Mojave Solar Project. The project will provide an additional 1,000 MW transmission capacity needed in the Kramer Junction and Lucerne Valley areas to support large-scale renewable generation development and to ensure system reliability. The project includes:

- 35 miles of a 220 kV double-circuit transmission line from SCE's Coolwater Substation to the proposed Jasper Substation on a new right-of-way.
- Removal of 28 miles of existing Pisgah-Lugo No. 1 220 kV transmission line from Jasper Substation to Lugo Substation on an existing right-of-way and replace with
    - 12 miles of 220 kV double-circuit transmission line.
    - 16 miles of 500 kV single-circuit transmission line initially energized at 220 kV.
- Site for future Desert View Substation east of Apple Valley.
- Installation of a 3rd high-voltage transformer bank at SCE's Lugo Substation.

SCE plans file a PEA to the CPUC and BLM in August 2013. Depending on the timing of project approval by the two agencies, construction could begin in 2016. SCE's expected in-service date is 2018.[448]

Key Dates

September 8, 2010: Energy Commission Decision[449] on Abengoa AFC.
January 28, 2011: FERC Order[450] accepting Abengoa LGIA.

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448 Alvarez, Manuel, Southern California Edison, comments on *California Energy Commission Docket No. 13-IEP-1E Transmission Planning and Permitting Issues*, May 21, 2013, p. 6, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Southern_California_Edison_Comments_re_Transmission_Planning_and_Permitting_Issues_2013-05-21_TN-70920.pdf.

449 Energy Commission Decision on Ivanpah AFC can be found on Energy Commission website at: http://www.energy.ca.gov/2010publications/CEC-800-2010-008/CEC-800-2010-008-CMF.PDF.

August 28, 2013: SCE filed a PEA with the CPUC and BLM requesting project approval.
2018: Expected in-service date.

SCE/IID Joint Path 42 (11/12)

Description

The SCE/IID Joint Path 42 project is a successful collaboration among the California ISO, SCE, and IID. The SCE/IID Joint Path 42 project will increase the transfer capacity from 600 MW to 1,500 MW of renewable energy from IID to SCE's portion of the California ISO's controlled grid.[451] Upgrading Path 42 requires improvements to facilities under the control of SCE and the California ISO, as well as facilities under IID control. On May 18, 2011, SCE's portion of the upgrade received California ISO Board of Governors approval as a policy-driven upgrade upon adoption of the *2010-2011 Transmission Plan*.[452] SCE's upgrade includes a 15-mile, double-circuit, 230 kV transmission lines between SCE's Devers and Mirage Substations.

On August 16, 2011, the IID Board of Directors approved its portion of the Path 42 upgrade.[453] The upgrade consists of replacing 20 miles of a double-circuit 230 kV transmission line (one conductor per phase) with a bundle of two conductors per phase conductors between SCE's Mirage and IID's Coachella Valley and Ramon Substations. On August 20, 2013, IID and SCE filed with BLM a Draft Mitigated Negative Declaration and Environmental Assessment/Initial Study for public review and comment. IID is the CEQA lead for the project.[454] The parties have

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450 FERC Order accepting amendments to original Abengoa LGIA can be found on California ISO website at: http://www.caiso.com/Documents/January28_2011Orderconditionallyacceptingnon-conformingLGIAs_denyingmots_-consolidateindocketno_ER11-2368.pdf.

451 Asbury, Jamie, Imperial Irrigation District, comments on *2013 IEPR – Transmission Planning and Permitting Issues*, Docket No. 13-IEP-1E, May 21, 2013, p. 2, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Imperial_Irrigation_District_Comments_re_Transmission_Planning_and_Permitting_Issues_2013-05-21_TN-70922.pdf.

452 California ISO Board approved *2010-2011 Transmission Plan*, p. 524, http://www.caiso.com/Documents/Board-approvedISO2010-2011TransmissionPlan.pdf.

453 IID Board of Directors Regular Meeting, August 16, 2011, p. 2, http://www.iid.com/Modules/ShowDocument.aspx?documentid=4970.

454 Alvarez, Manuel, Southern California Edison, comments on *California Energy Commission Docket No. 13-IEP-1E Transmission Planning and Permitting Issues*, May 21, 2013, p. 6, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Southern_California_Edison_Comments_re_Transmission_Planning_and_Permitting_Issues_2013-05-21_TN-70920.pdf.

been working with the BLM on remaining permitting issues. IID anticipates construction will commence October 1, 2013 with an expected in-service date of April 30, 2014.[455]

Key Dates

May 18, 2011: California ISO Board of Governor approved the *2010-2011 Transmission Plan.*
August 16, 2011: IID Board of Directors initial approval of Path 42 upgrade.
August 23, 2012: IID Board of Directors reaffirmed approval of Path 42 upgrade.[456]
August 20, 2013: IID and SCE filed with BLM a Draft Mitigated Negative Declaration and Environmental Assessment/Initial Study
October 1, 2013: Construction to commence.
April 30, 2014: SCE and IID expected in-service date.

IID: Additional upgrades (12)

IID identified three additional upgrades needed for the interconnection of generating resources in its Transitional Cluster. The upgrades include El Centro-Highline, El Centro-Imperial Valley (S line), and Midway-Bannister. The El Centro-to-Highline project replaces existing 161 kV and 92 kV lines with a double-circuit 230 kV transmission line. The El Centro-Imperial Valley project, S line, replaces an existing 230 kV line with a double-circuit 230 kV transmission line between jointly owned IID/SDG&E Imperial Valley Substation to IID's El Centro Switching Station. The Midway-Bannister project consists of nearly 8 miles of a new 230 kV transmission line between IID's Midway Substation and the proposed Bannister Substation. Depending upon developer need, IID would expect to commence the required upgrades by 2014.

LADWP: Barren Ridge (13)

Description

LADWP's Barren Ridge Renewable Transmission Project consists of:

- About 75 miles of two new 230 kV transmission lines from the Barren Ridge Switching Station to the proposed Haskell Canyon Switching Station located north of Santa Clarita.
- 12-mile, 230 kV transmission line on existing structures from Haskell Canyon to the Castaic Power Plant, a pumped-storage generating facility, where renewable energy can be stored until needed to meet utility customer power needs.

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455 Asbury, Jamie, Imperial Irrigation District, comments on *2013 IEPR – Transmission Planning and Permitting Issues*, Docket No. 13-IEP-1E, May 21, 2013, p. 2, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Imperial_Irrigation_District_Comments_re_Transmission_Planning_and_Permitting_Issues_2013-05-21_TN-70922.pdf.

456 See IID news release at: http://www.iid.com/index.aspx?page=30&recordid=236&returnURL=%2Findex.aspx.

The project will provide additional transmission capacity to access 1,000 MW of wind, solar, and other renewable resources. LADWP's expected in-service date is 2016.

Key Dates

September 19, 2012: LADWP Board of Water and Power Commissioners approved final Environmental Impact Report.[457]
September 24, 2012: BLM issued Record of Decision[458] approving the project.
2013: LADWP to begin construction.
2016: Expected in-service date.

Warnerville-Bellota (16)

Description

The California ISO identified a policy-driven need for reconductoring the 230 kV transmission line between PG&E's Warnerville and Bellota substations in its recently board-approved *2012-2013 Transmission Plan*.[459] The policy-driven upgrade will allow for the delivery of renewable generation in the Greater Fresno, Central Valley North, Merced and Westlands zones needed to meet the 33 percent RPS. The Warnerville-Bellota, Wilson-Le Grand, and Gates-Gregg projects will allow for the delivery of roughly 700 MW renewable generation. PG&E will submit applications to state and federal regulatory agencies requesting project approval. California ISO's expected in-service date is 2017.

Key Dates

March 20, 2013: California ISO Board of Governor approved the *2012-2013 Transmission Plan.*
2017: Expected in-service date.

Wilson-Le Grand (17)

Description

The California ISO identified a policy-driven need for reconductoring the 115 kV transmission line between PG&E's Wilson and Le Grand substations in its recently board-approved *2012-2013 Transmission Plan*.[460] The policy-driven upgrade will allow for the delivery of renewable generation in the Greater Fresno, Merced, and Westlands zones needed to meet the 33 percent

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457 See LADWP news release at: http://www.ladwpnews.com/go/doc/1475/1547235/.

458 BLM Record of Decision can be found on BLM website at: http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/ridgecrest/barren_ridge.Par.25255.File.dat/BRRTP_ROD_Final.pdf.

459 California ISO Board approved 2012-2013 Transmission Plan, pp. 263 and 374, http://www.caiso.com/Documents/BoardApproved2012-2013TransmissionPlan.pdf.

460 California ISO Board approved 2012-2013 Transmission Plan, pp. 263 and 374, http://www.caiso.com/Documents/BoardApproved2012-2013TransmissionPlan.pdf.

RPS. The Wilson-Le Grand, Warnerville-Bellota, and Gates-Gregg transmission projects will allow for the delivery of roughly 700 MW renewable generation. PG&E will submit applications to state and federal regulatory agencies requesting project approval. California ISO's expected in-service date is 2020.

Key Dates

March 20, 2013: California ISO Board of Governor approved the *2012-2013 Transmission Plan.*
2020: Expected in-service date.

Gates-Gregg (18)

Description

The California ISO identified the need for a 230 kV transmission line between PG&E's Gates and Gregg Substations as a reliability-driven project with policy-driven benefits in its board-approved *2012-2013 Transmission Plan*.[461] The transmission line will be constructed as a double–circuit, 230 kV line with one side strung, facilitating future development requirements to supply load or integrate renewable generation while minimizing future right-of-way requirements. The Gates-Gregg, Wilson-Le Grand, and Warnerville-Bellota projects will allow for the delivery of nearly 700 MW renewable generation. The project is eligible for competitive solicitation.

Phase 3 of the California ISO's transmission planning process includes a competitive solicitation process for policy-driven and economically driven transmission projects, as well as for reliability-driven projects that provide additional policy and economic benefits. The bid window, where project sponsors can submit proposals to finance, construct, and own the Gates-Gregg 230 kV line is open from April 1, 2013, through June 3, 2013. On June 6, 2013, the California ISO posted the list of project sponsors that submitted proposals for the Gates-Gregg project.[462] Selected project sponsor will submit applications to state and federal regulatory agencies requesting project approval. California ISO's expected in-service date is 2022.

Key Dates

March 20, 2013: California ISO Board of Governors approved the *2012-2013 Transmission Plan.*
April 1, 2013, through June 3, 2013: Competitive solicitation bid window open.
June 6, 2013: California ISO posted the list of project sponsors that submitted proposals.
2022: Expected in-service date.

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461 California ISO Board approved *2012-2013 Transmission Plan*, pp. 149 and 376, http://www.caiso.com/Documents/BoardApproved2012-2013TransmissionPlan.pdf.

462 The list of project sponsors that submitted proposals for the Gates-Gregg project can be found on the California ISO website at http://www.caiso.com/Documents/List-ProjectSponsorProposalsReceived-Gates_Gregg230kVLineProposedPolicyDrivenElement.pdf.

APPENDIX B:
Strategic Transmission Investment Plan Workshop Summaries

In light of the transmission-related recommendations from the *2012 IEPR Update* and emerging issues and opportunities since that report was published, the Energy Commission held two workshops to introduce and develop these issues with input from stakeholders and create recommendations consistent with the legislative mandate to produce a biennial *Strategic Transmission Investment Plan*. The IEPR and Siting lead commissioners conducted a workshop on the morning of May 7, 2013 on the consideration of environmental and land-use factors in renewable scenarios for transmission planning and renewable energy project database issues.[463] The IEPR lead commissioner then held a workshop on transmission planning and permitting issues on the afternoon of May 7, 2013.[464]

May 7, 2013 (Morning) Joint IEPR/Siting Lead Commissioner Workshop

This workshop addressed Recommendation #9 in the Renewable Action Plan (Chapter 5 of the *2012 Integrated Energy Policy Report Update*), which directs the Energy Commission to ensure that environmental and land-use information developed through relevant sources is incorporated into renewable resource scenarios used in the California Public Utilities Commission (CPUC) Long-Term Procurement Plan (LTPP)proceeding and the California Independent System Operator (California ISO) Transmission Planning Process (TPP). Recommendation #9 also directs the Energy Commission to continue to develop its in-state and out-of-state renewable project databases via a public, transparent process that provides opportunities for stakeholder involvement. The purpose of this workshop was to discuss the goals and scope of this effort, data needs, possible sources of publicly available data, gaps in available information, data collection issues, and possible options.

Formal presentations at this workshop included a CPUC staff update on the CPUC's LTPP portfolio/scenario development process; an Energy Commission staff update on the Energy Commission's existing renewable energy project database and the environmental scoring method for LTPP renewable scenarios; and a CPUC staff presentation that provided background on the CPUC's RPS Calculator and consideration of long-term environmental/land-use data needs. Following the formal presentations, Energy Commission staff moderated a roundtable discussion on environmental/land-use data for scenario planning and renewable energy project database issues. Panelists included representatives from Energy Commission

463 See the complete workshop record at:
http://www.energy.ca.gov/2013_energypolicy/documents/#05072013-am

464 See the complete workshop record at:
http://www.energy.ca.gov/2013_energypolicy/documents/#05072013-pm

staff, CPUC staff, California Department of Fish and Wildlife, U.S. Bureau of Land Management, Los Angeles County, Western Electricity Coordinating Council, Natural Resources Defense Council, The Nature Conservancy, and SunPower Corporation. Four parties made public comments at the workshop. These included representatives for the Power Company of Wyoming, Large-Scale Solar Association, Pathfinder Renewable Wind Energy/Zephyr Power Transmission, LLC, and Defenders of Wildlife. Following the workshop, the Energy Commission received written comments on the workshop topics from the following organizations: Bay Area Municipal Transmission Group, Joint comments by The Nature Conservancy/Defenders of Wildlife/Sierra Club/Natural Resources Defense Council, supplemental comments by Natural Resources Defense Council, PG&E, Pathfinder Renewable Wind Energy/Zephyr Power Transmission, LLC, Power Company of Wyoming, and supplemental comments by The Nature Conservancy.

Two key issues emerged from the discussion, comments, and presentations of this workshop. The first issue that several participants articulated is a concern with the current environmental weighting in planning and/or the desire for placing greater weight on the environmental portfolio in the LTPP process and environmental impact in the TPP process.[465] The workshop generated several informative discussions and comments related to the types of environmental (and other) data that should be considered for use in the environmental scoring of projects. However, it appears any efforts to revise environmental scoring methodology itself or incorporate other datasets would have little effect on the transmission planning outcome because environmental score carries only a 10 percent weight in the commercial interest portfolio, which has been selected in past years and used in the main modeling for the LTPP at

465 Brand, Erica, The Nature Conservancy; Long, Noah, Natural Resources Defense Council; Friedman, Sarah, Sierra Club; Delfino, and Kimberley, Defenders of Wildlife, *California Energy Commission Docket No. 13-IEP-1E Joint Lead Commissioner Workshop on Environmental and Land-Use Factors in Renewable Scenarios and Database Development.* May 21, 2013, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/comments/Joint_Comments_to_the_Joint_Lead_Commissioner_Workshop_May_7_AM_2013-05-21_TN-70929.pdf; Flynn, Barry and Wagle, Pushkar, Bay Area Municipal Transmission Group, *California Energy Commission Docket No. 13-IEP-1E Lead Commissioner Workshop on Transmission Planning and Permitting Issues,* May 21, 2013, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_transmission_workshop/comments/Bay_Area_Municipal_Transmission_Group_Comments_2013-05-21_TN-70932.pdf; and Smith, David, Power Company of Wyoming, LLC, *California Energy Commission Docket No. 13-IEP-1E Joint Lead Commissioner Workshop on Environmental and Land-Use Factors in Renewable Scenarios and Database Development,* May 21, 2013, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/comments/Power_Company_of_Wyoming_LLC_Comments_re_the_Consideration_of_Environmental_and_Land_Use_Factors_2013-05-21_TN-70928.pdf.

present.[466] This issue of environmental score weighting remains a barrier to a more robust consideration of environmental data in the CPUC and California ISO planning processes.

CPUC staff reported their ongoing study and "back testing" of past environmental scoring and methods, and possibly reevaluating the weighting, to determine relevancy to renewable energy projects and the LTPP process.[467] Staffs of the CPUC and Energy Commission will collaborate as results from this CPUC study become available, and CPUC plans to hold a public stakeholder process if a new method is developed. Energy Commission staff would participate in that process and other opportunities to revisit environmental score weighting. CPUC anticipated this process of potential new scoring method development and stakeholder vetting to be completed by late 2013 or early 2014. In addition, Commissioner Andrew McAllister mentioned his ongoing collaboration with the CPUC regarding resources needed and data collection, which are related to advancing issues related to both transmission planning and energy efficiency.[468]

To address the issue of environmental weighting in transmission planning, Recommendation #1, item 2 recommends that the energy agencies (Energy Commission, CPUC, and California ISO) evaluate the environmental weighting process and policies associated with the LTPP and TPP processes. If attempts to significantly increase the weight on environmental scores are successful, many of the detailed data and methodology-related comments arising from this workshop could have more of an effect on planning outcomes and processes.

Renewable project database maintenance and improvement were the second main focus of the morning joint lead commissioner workshop. Energy Commission staff presented a summary of Energy Commission renewable data collection: (1) the Strategic Transmission Planning Office's siting-related tracking in the renewable energy project database (Renewable Energy Action Team [REAT] renewable generation database) and (2) the Renewable Energy Office's RPS Program-related tracking of verification, certification, and other data. Workshop participants provided feedback on the data fields of most interest to them and important characteristics of a

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466 Strauss, Robert, CPUC, Transcript of the May 7, 2013 *Joint Lead Commissioner Workshop on Environmental and Land-Use Factors in Renewable Scenarios and Database Development,* p. 20, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_morning.pdf.

467 Velasquez, Carlos, CPUC. Transcript of the May 7, 2013 *Joint Lead Commissioner Workshop on Environmental and Land-Use Factors in Renewable Scenarios and Database Development,* pp. 46-47, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_morning.pdf.

468 McAllister, Andrew, Transcript of the May 7, 2013 *Joint Lead Commissioner Workshop on Environmental and Land-Use Factors in Renewable Scenarios and Database Development,* p. 68, California Energy Commission, Sacramento, California, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/2013-05-07_transcript_morning.pdf.

publicly accessible database. The data fields of particular stakeholder interest that are already tracked by staff include geospatial linking data, capacity, acreage, technology type, status (project phase), facility on-line date, date of last project information update, and location.[469] Most participants provided recommendations regarding potential expansions to the scope of data tracking, including incorporation of other datasets for California and out-of-state resources. Some participants (for example, the Nature Conservancy and PG&E) noted difficulties in consolidating various online data sources and supported creation of a centralized renewable energy data clearinghouse, which is the subject of a separate, albeit relevant, recommendation under the Energy Commission's Renewable Energy Action Plan (RAP).[470] The Energy Commission's Electricity Supply Analysis Division staff is implementing RAP Recommendation 14 through participation in CPUC's Order Instituting Rulemaking (OIR)[471] and reported the scope of that OIR appears sufficiently broad to incorporate siting-related renewable project data useful for transmission planning. Staff agrees with PG&E's caution regarding the significant effort required to consolidate and maintain existing data and that "a new clearinghouse would provide little value if it duplicates data that already exist elsewhere."[472] The Energy Commission will continue to maintain the Renewable Energy Action Team renewable generation database on the Energy Commission web page and keep it updated quarterly to the extent possible. The Energy Commission will consider integrating some of the information from the other data sources mentioned (as feasible).

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469 Brand, Erica, The Nature Conservancy; Long, Noah, Natural Resources Defense Council; Friedman, Sarah, Sierra Club; Delfino, Kimberley, Defenders of Wildlife, *California Energy Commission Docket No. 13-IEP-1E Joint Lead Commissioner Workshop on Environmental and Land-Use Factors in Renewable Scenarios and Database Development.* May 21, 2013, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/comments/Joint_Comments_to_the_Joint_Lead_Commissioner_Workshop_May_7_AM_2013-05-21_TN-70929.pdf; and Zichella, Carl, Natural Resources Defense Council, *California Energy Commission Docket No. 13-IEP-1E Joint Lead Commissioner Workshop on Environmental and Land-Use Factors in Renewable Scenarios and Database Development*, May 21, 2013, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/comments/NRDC_Combined_Comments_TN-70973_TN-70974_TN-70975.pdf.

470 See Recommendation 14 in the *2012 IEPR Update*, Chapter 5 (Renewable Action Plan).

471 See http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M031/K744/31744124.PDF for scoping memo and decision and ftp://ftp.cpuc.ca.gov/13011516_EgyDataWorkshop for the latest posted workshop information.

472 Plummer, Matthew, PG&E, *California Energy Commission Docket No. 13-IEP-1E Joint Lead Commissioner Workshop on Environmental and Land-Use Factors in Renewable Scenarios and Database Development.* May 21, 2013, http://www.energy.ca.gov/2013_energypolicy/documents/2013-05-07_siting_workshop/comments/PG_and_E_Comments_on_the_May_7_Joint_Lead_Commissioner_Workshop_2013-05-21_TN-70921.pdf

May 7, 2013, (Afternoon) IEPR Lead Commissioner Workshop

The IEPR lead commissioner then held a workshop on transmission planning and permitting issues on the afternoon of May 7, 2013. This workshop contributes to development of the Energy Commission's 2013 IEPR proceeding. In particular, the workshop responded to the 2013 IEPR Scoping Order, dated March 7, 2013, which directs the Energy Commission to prepare a *Strategic Transmission Investment Plan* as required by Senate Bill 1565 (Bowen, Chapter 692, Statutes of 2004.) In addition, the workshop addressed implementation of Recommendation #10 (Monitor Status of California ISO-approved Transmission Projects to Ensure Timely Completion) and #11 (Streamline Transmission Permitting in California) in the Renewable Action Plan (Chapter 5 of the *2012 Integrated Energy Policy Report Update*). Major workshop topics included: western states transmission issues, status of approved transmission projects to meet the 33 percent Renewables Portfolio Standard, and synchronization of generation and transmission permitting to achieve renewable policy goals.

Presentations at this workshop included an Energy Commission staff presentation on Western Electricity Coordinating Council restructuring, a California ISO staff presentation on the California ISO Energy Imbalance Market Design Straw Proposal, a California ISO staff update on transmission planning to support the 33 Percent RPS mandate, and a presentation by Southern California Edison staff on Development Focus Area[473] Suitability and Transmission Planning. Following the formal presentations, Energy Commission staff moderated a roundtable discussion on synchronization of generation and transmission permitting to achieve renewable policy goals. Panelists included representatives from BrightSource Energy, Paul Hastings, LLP, for Abengoa Solar, Mangano Homes Inc. for Westlands Solar Park, SunPower Corporation, Southern California Edison, PG&E, California Municipal Utilities Association, CPUC staff, California ISO staff, Startrans IO, LLC, and Natural Resources Defense Council. Following the workshop, the Energy Commission received written comments from the Bay Area Municipal Transmission Group, Joint comments by California Consumer Alliance/Clean Coalition, Imperial Irrigation District, Large-Scale Solar Association, Wyoming Infrastructure Authority, Natural Resources Defense Council, PG&E, Pathfinder Renewable Wind Energy/Zephyr Power Transmission, LLC, Southern California Edison, and TransWest Express LLC.

473 Development Focus Areas represent the areas within which permitting of renewable energy development would be streamlined under the Desert Renewable Energy Conservation Plan.

APPENDIX C:
California Independent System Operator *Demand Response and Energy Efficiency Roadmap*

The California ISO's *Demand Response and Energy Efficiency Roadmap* sets out a plan for how DR and energy efficiency will become integral, dependable, and familiar resources that support a reliable transition to an environmentally sustainable electric power system. The California ISO envisions that the strategies contained in this roadmap will form the core of an ongoing dialogue and interagency collaboration that will result in the optimal availability of these resources to help shape load, bolster resource sufficiency, and promote efficient and economical grid operations.

The roadmap is composed of four parallel and roughly concurrent paths that run from 2013 through 2020. The roadmap highlights specific areas where coordination and communication will build new market opportunities for DR and energy efficiency solutions to meet the needs of both end-use customers and the power system as a whole.

The **load reshaping path** focuses on the demand side of the balance equation to create a flatter system load shape. This path emphasizes programs and incentive mechanisms such as retail tariff structures that change consumer behavior and favorably alter the load shape, by making it more expensive to consume energy when demand is high, and less expensive to consume energy when demand is low. This path also highlights activities for incorporating "load-modifying" DR programs into the demand forecast, such as providing locational and time-varying market signals to end users to elicit demand-side responses that align with system conditions. Such energy efficiency and DR programs could offset the need for new generating plants and could help in planning transmission upgrades and in determining future resource requirements. The California ISO is working with the Energy Commission, CPUC, and IOUs to clarify and standardize the terminology for classifying DR programs and resources so that all existing DR programs will be classified for the IEPR demand forecast.

The **resource sufficiency path** focuses on the supply side of the balance equation to ensure that sufficient resources with the needed operational characteristics are available in the right places at the right times. This path emphasizes the development of policies to guide and ease procurement of the needed DR resources through the procedures of each relevant agency and its jurisdictional load-serving entities. The California ISO will develop a catalog of DR resource types that includes typical DR operational attributes and capabilities and offers initial indications of which configurations could effectively offset or at least defer the need for a transmission upgrade. This information will inform the 2013-2014 transmission planning cycle and could provide study support for local resource procurement decisions in the 2014 LTPP proceeding. It will also form the basis for further ISO, CPUC, and Energy Commission coordinated efforts to arrive at consistent DR and energy efficiency assumptions to be used in future LTPP cycles. In addition, the California ISO will develop policy to replace the existing

backstop procurement mechanism (Capacity Payment Mechanism) that expires on March 31, 2015, with a market-based mechanism that would provide revenue certainty and price transparency for fast developing resources as well as support investments in upgrades to existing resources.[474]

The **operations path** takes the perspective of the grid operator responsible for continuous system balancing and focuses on making the best use of the resources that are made available through resource sufficiency path activities. This path would change some existing policies, modify or develop new market products to expand market participation in DR, and address relevant technical and process requirements. Such policies, markets, and technologies include:

- *Rule 24*: Enables existing utility DR programs as well as third-party aggregators to fully participate fully in the California ISO's wholesale market and is set for completion by 2014. SCE has indicated that the implementation of Rule 24 with Reliability DR Resource (required for emergency DR to bid and be dispatched through the California ISO's market) should bring 1,100 MW of DR capacity into the California ISO market in the summer of 2014.
- *Participating load model*: Enables DR to participate in the California ISO markets by increasing and decreasing consumption. The nongenerating resource model, which enables energy storage to participate by either increasing load (charging) or providing power to the system (discharging), can be adapted through a stakeholder process to enable participating load to be a dispatchable demand resource to support the ability of participants to more fully reflect operating capabilities to the California ISO market.
- *Must-offer obligation*: Obliges DR resources to submit economic bids into the California ISO day-ahead and real-time markets. Ensures the ISO can access DR resources for normal or emergency operations. A stakeholder process to define the must-offer obligation for flexible resources including use-limited resources will begin in 2013 to support the recent CPUC decision for the IOUs to report RA showing for 2015 compliance.
- *Standard capacity product for DR*: Provides a mechanism that offers an incentive or disincentive to a resource based on resource availability, reflecting whether it is providing the capacity value that it was procured for.
- *DR market participation guide*: Includes the California ISO participation steps for DR aggregators who intend to get RA credit and therefore must participate in the ISO market. The California ISO also will streamline the current process for assigning resource IDs as well as registering the customer accounts to provide the basis to define requirements and develop an automated interface for supplying registration data to the ISO.

474 The new capacity procurement mechanism procures capacity that is not already designated as resource adequacy capacity and is obligated to be available to the California ISO for scheduling and dispatch comparable to the obligations of resource adequacy capacity.

The **monitoring path** provides an essential feedback loop to the other three paths. This path ensures that from the beginning there are mechanisms in place for monitoring progress and outcomes and for providing feedback to the people and organizations responsible for the initiatives outlined in this roadmap. The goal of this path is that, with each stage of activity, this roadmap will foster a deeper understanding of the operational capabilities of DR resources, the effectiveness of DR and energy efficiency procurement programs in aligning with systemwide and locational needs, and the impacts of energy efficiency and other load-modifying programs to reshape the system demand curve. This path is a collaborative stakeholder process to assess the resource performance needs of the California ISO system in concert with the needs of consumers that will provide DR resources and cooperatively develop energy efficiency and DR programs and incentives that meet both sets of needs. By 2014, the California ISO, Energy Commission, and CPUC should reach consensus on a process to track the development of DR and energy efficiency programs, which will help ensure that DR and energy efficiency resources will be in service as alternatives to transmission upgrades.

APPENDIX D:
California Public Utilities Commission Staff Comments on the Draft Demand Response and Energy Efficiency Roadmap

The CPUC overall agrees that the four paths laid out in California ISO's draft roadmap provide a clear mechanism to allow the California ISO and the CPUC to address the supply-side and demand-side demand response (DR) and energy efficiency issues effectively. However, the CPUC's DR goals will involve developing DR under two frameworks: 1) as a supply-side resource, which focuses on a reliable and flexible DR that meets system planning and operational requirements; and 2) as a demand-side resource, which focuses on sustainable customer participation and rates. (See Table D-1 for a comparison of the two plans.)

The CPUC's discussion of DR as a **supply-side resource** is covered in its comments of the California ISO's Resource Sufficiency and Operations paths. The CPUC notes that only supply-side DR would be counted for resource adequacy (RA) as a supply-side resource and that the CPUC DR Rulemaking would be the likely venue to determine classification of DR resources. The CPUC suggests that implementing the corresponding RA counting rules would be best suited for the 2015 RA proceeding, which will also address the must-offer obligation for flexible, use-limited resources. In addition, the CPUC staff agrees that recognition and acceptance of the differences between DR and conventional generation are important so that California ISO operators and DR providers are proceeding with common expectations about resource performance. Finally, the CPUC staff agrees that the California ISO needs to develop a Standard Capacity Product (SCP) for DR with transparent rules and penalties for performance consistent with RA rules for conventional generation resources. The CPUC and California ISO will need to coordinate closely in setting the appropriate RA rules during the transition period and determine whether the must-offer obligation should be required in absence of SCP for DR.

The CPUC's discussion of DR as a **demand-side resource** is covered in its comments of the California ISO's load reshaping path. The CPUC has adopted timelines for the three large IOUs to phase-in default critical peak pricing for most nonresidential customers by 2016 and is therefore on a path to have a significant portion of IOU load on rates well-aligned with grid conditions. In addition, the CPUC is considering what types of rates should be offered to residential customers and on what basis (opt-in, opt-out, and so forth). The CPUC recognizes that it needs to find ways to make more economically efficient rate designs acceptable and attractive to the public, and it states that new legislative changes are needed to reform rates.

In response to the monitory path, the CPUC staff agrees that monitoring of DR and energy efficiency resources is important to ensure that the initiatives described in the draft roadmap accomplish their objectives and to make appropriate modifications as needed. One additional question the CPUC and California ISO need to resolve is determining which agency will be

responsible for determining the load impacts of third-party DR programs that bid into California ISO wholesale markets.

To summarize, the CPUC describes four main policy goals in its comments:

1. Integration of DR into wholesale market
2. Increased use of time-based rates and AMI-enabled devices
3. Increased Customer Participation
4. Improved DR metrics and goals

Finally, its procedural roadmap for DR is as follows:

- Finalize Rule 24 by Fall 2013
- Open New DR Rulemaking by September 2013. This involves:
  - Interagency coordination with California ISO and the Energy Commission to develop DR strategic plans.
  - DR evaluation and cost-effectiveness reform.
  - DR delivery model and cost recovery.
  - Bridge funding year for 2015.
  - Guidance for future DR program design.
- 2015 RA: Flexible Capacity Framework for DR by June 2014

Table D-1: Mapping of California ISO Four Paths and CPUC Vision

	California ISO Draft DR/EE Roadmap	**CPUC Vision for DR (June 17 Presentation at CEC IEPR Workshop)**	**How it will be accounted for in RA**
1	Load Reshaping Path	<u>Customer-Focused Programs and Rates:</u> • Load modifiers, e.g., dynamic rates, DR supporting programs, non-dispatchable DR	Resources will be reflected in the Energy Commission's load forecast
2	Resource Sufficiency Path	<u>Supply-Side Resources:</u> • Dispatchable DR o IOU Programs o 3rd Party Programs	Resources will qualify for RA/LTPP/TPP
3	Operations Path		
4	Monitoring Path	Evaluation, Monitoring, & Verification (EM&V): • Supply-Side Resources • Customer-Focused Programs and Rates	

Source: CPUC comments on the CAISO Roadmap, http://www.energy.ca.gov/2013_energypolicy/documents/2013-06-17_workshop/comments_to_caiso_dr_ee_roadmap/California_Public_Utilities_Commission_Comments_2013-07-24_TN-71704.pdf

APPENDIX E:
Approach to Estimating Alternative and Renewable Fuel and Vehicle Program Benefits

The Energy Commission has contracted with the National Renewable Energy Laboratory (NREL) for assistance in estimating the environmental, public health and economic benefits from the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP). NREL has developed the methodology described in this appendix, and quantitative benefit estimates will be finalized later in 2013. NREL recommends using the characterization of distinct types of benefits, which in general fall into two categories: *Demonstrated Benefits* and *Expected Benefits*. These two general categories include various sub-categories:

Demonstrated Benefits

These benefits accrue as advanced technology vehicles are driven and alternative fuels are consumed. Two distinct types of Demonstrated Benefits are quantified:

- **Demonstrated Program Benefits:** The result from the deployment and use of vehicles or fuels that have received direct monetary support from ARFVTP.
- **Demonstrated Baseline Benefits:** These result from the deployment and use of vehicles or fuels that have not received direct monetary support from ARFVTP.

Expected Benefits

These benefits are more hypothetical in nature than *Demonstrated Benefits*, primarily because they are more uncertain and difficult to measure. There are two general categories:

- **Market Transformation Benefits:** These benefits are realized through efforts that help reduce market entry barriers for new technology companies, increase consumer awareness, and remove consumer choice barriers associated with limited refueling availability. Examples of Market Transformation Benefits resulting from ARFVTP investments include market changes in electric drive cars and trucks, hydrogen fuel cell cars, and natural gas or renewable natural gas fueling and vehicle systems.
- **Market Growth Benefits:** These benefits are estimated quantitatively with high and low market adoption projections for vehicles and fuels. For ARFVTP-funded projects, Market Growth Benefits would accrue when a demonstration or pilot-scale project is constructed at commercial scale.

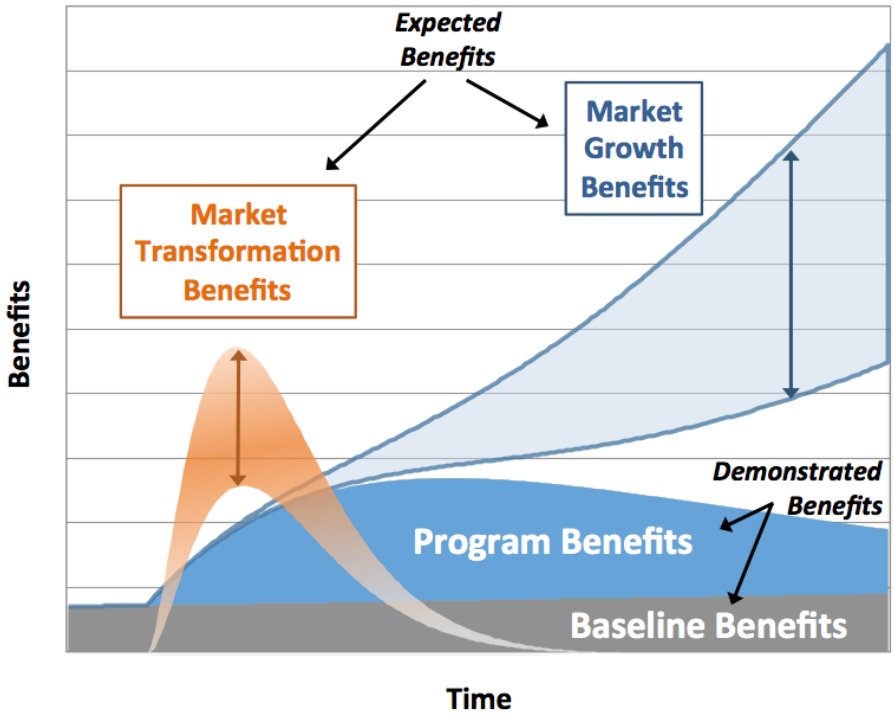
Several projects supported by ARFVTP will result in additional expected benefits, such as outreach, education, standards development, and policy support. Although these additional expected benefits may be substantial, they are difficult to quantify due to unclear relationships

between cause and effect. No attempt is made to estimate these other expected benefits at present.

Benefits Over Time

Figure E-1 is a schematic of the general relationships between these various benefit types as they might be realized over time.

Figure E-1: General Types of Benefits as a Function of Time



Source: National Renewable Energy Laboratory Benefits Guidance Report

The schematic is not intended to represent any particular vehicle-fuel combination. *Demonstrated Baseline Benefits* are shown as increasing slowly and linearly across the bottom of the figure, and are realized due to market growth likely to occur in the absence of ARFVTP or other state or federal programs. *Demonstrated Program Benefits* are indicated as a rapid increase in total benefits as new vehicles and fuels are introduced into the market. These benefits would decline over time as market success is achieved and additional funding is no longer required; vehicles funded directly would be used less often as they aged and eventually would be replaced, and fuel systems funded directly would be upgraded through new market-driven investments and eventually retired. These two types of Demonstrated Benefits can be estimated quantitatively, and are indicated as additive benefits in Figure E-1.

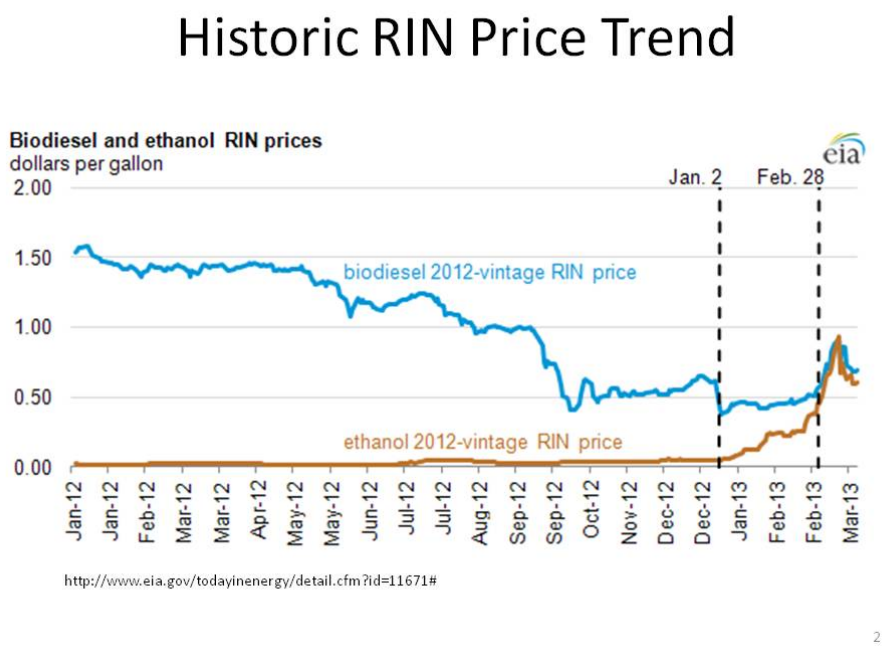
Through the success of ARFVTP projects and other efforts, sustained market growth is an enduring benefit, achieved as advanced and renewable fuels and vehicles successfully compete in the market without substantial monetary government support. These Market Growth Benefits are indicated as a range of high and low market projection trends that increase as total Demonstrated Program Benefits decline.

Finally, Market Transformation Benefits are achieved during the early phases of ARFVTP and early market growth, especially by increasing fueling availability for early niche markets. As demand increases, new investments in fueling infrastructure are market-driven and fueling availability becomes less of a market barrier for consumers.

APPENDIX F:
Renewable Identification Numbers Under the Renewable Fuels Standard

Figure F-1 illustrates fluctuations in Renewable Identification Number (RIN) credits, which reflect recent market conditions. RINS have different values for renewable fuels, advanced fuels, biodiesel and renewable diesel depending on the extent obligated parties can comply with annual RFS requirements, levels set or modified for each category, and the availability of credits generated by commercial sales of renewable fuels.

Figure F-1: Historical RIN Price Trend



Appendix G: Transportation Demand Forecast and Supply/Demand Balance

Light Duty Vehicles

The 2013 demand forecast for passenger vehicles and light trucks has been developed from surveys of consumers and commercial businesses. The Energy Commission staff used projected changes in vehicle attribute characteristics over the next 30 years to help estimate the forecast. Vehicle attribute changes included vehicle cost (manufacturer suggested retail price), fuel economy, vehicle miles traveled, income and other factors. Vehicle information was gathered from a recent National Academy of Sciences (NAS) study, which showed that significant increases in fuel economy will occur in all cars and light trucks between 2011 and 2030. The study also concluded that internal combustion vehicles will increase in cost, but alternative fuel vehicles will see reduced costs over the same period. Table G-1 summarizes the NAS expected changes.

Table G-1: Forecasted Fuel Economy and Manufacturer Suggested Retail Price (2011-2030) (NAS Reference Case)

Vehicle Type		Fuel Economy Improvement	(MSRP) Increase>/Decrease<
Internal Combustion Engine	Car	61%	> 7%
	Light Truck	55%	> 6%
Compressed Natural Gas	Car	61%	NA
	Light Truck	55%	NA
Hybrid Electric	Car	49%	< 4%
	Light Truck	41%	< 4%
Plug In Electric	Car	61%	< 8%
	Light Truck	60%	< 10%
Battery Electric	Car	21%	< 24%
	Light Truck	16%	< 25%
Hydrogen Fuel Cell	Car	24%	< 13%
	Light Truck	20%	< 13%

Source: California Energy Commission and Sierra Research

Vehicle attribute assumptions include full implementation of California Air Resources Board's (ARB's) zero emission vehicle mandate reflecting the expected market penetration of electric and hydrogen electric vehicles associated with the ARB program.

The passenger vehicle and light truck stock is expected to grow from 27 million vehicles in 2012 to a range of 42 million to 47 million vehicles in 2050 depending on petroleum fuel costs. Of the existing California light duty vehicle stock in 2012, the top five vehicle classes of total vehicles on the road include midsize, compact, and subcompact cars and standard and compact pick up trucks. Standard pick up trucks and midsize cars represent 38 percent, making them the two largest categories of commercial vehicles.

Medium and Heavy Duty Trucks

Nearly one million trucks operate on California's roads, with approximately 70 percent using diesel fuel, 29 percent using gasoline and the remainder representing alternative fuels. Trucks are categorized by weight and driving operations. Long haul trucks that carry cargo primarily along major highways with mileage exceeding 100,000 miles per year are classified as class 7 and 8 trucks – most use diesel fuel with options to use biodiesel or renewable diesel blended with diesel. Natural gas (LNG) trucks have begun to replace some of the diesel trucks in these categories because of the lower natural gas fuel price compared to diesel costs. Refuse trucks, package and beverage delivery trucks, shuttle vans and utility trucks are examples of other categories with different operation characteristics and varying annual mileage.

Freight movement

Freight movement data covering 1997 to 2011 from the Federal Highway Administration shows a modest increase in goods movement within California from other states but a 50 percent increase in goods moved from California to other states. The same freight movement in ton-miles indicates domestic freight reflects the movement of lower value but massive goods, including lumber, minerals and stone. California typically imports goods of higher value and lower mass.

Trucking moves the majority of interstate freight from California to other states. Rail and intermodal move the majority of freight from other states to California. The energy consumed by trucks to move a large volume of freight is significantly greater than the energy consumed moving the same volume by rail. For this reason, opportunities to shift freight from truck to rail can result in lower energy consumption.

California trucks moving within the state cover nearly two-thirds of the truck miles, with the remainder covered by interstate trucks. A larger share of the California trucks moving within the state are the smaller weight classes, while the interstate trucks tend to be the largest classes. Somewhat more of interstate truck movement is by trucks based in other states than trucks based in California.

The travel time index measures traffic congestion on average as the actual time required to make urban trips divided by the time required to make the same trips at times with no traffic

congestion. The general increase in traffic congestion from the early 1980s to about 2007 was broken by the recession starting in 2008.

Urban and Intercity

Travel demand in California is forecasted by our Urban and Intercity models. The Urban model is used to forecast passenger trips less than 50 miles, while the Intercity model is used to forecast passenger trips greater than 50 miles. Population and income growth are the main drivers of travel demand in the state. Although population growth rates have declined, California will add 350,000 new people every year and urban traffic congestion has not abated. This is a significant factor because vehicle trips average 3.5 times per day for households, daily travel average 35 miles per person and vehicle occupancy shows no signs of decreasing. Congestion remains high in California's urban areas. Population growth means that more fuels will be needed, but consumption is offset by vehicle efficiency.

Urban Travel

Urban travel comprises 72 percent of passenger miles traveled in California and urban trips average 1.5 passengers per vehicle. The number of passenger trips taken in light duty vehicles is projected to increase from 17.8 billion to 26.5 billion during the forecast period in the High Case, and 17.8 billion to 23.8 billion in the Low Case. The number of transit passenger trips is projected to increase from 529 million to 967 million during the forecast period in the High Case, and 529 million to 869 million in the Low Case.

Urban passenger miles follow a similar trend. Passenger miles in light duty vehicles are expected to increase from 204 billion in 2011 to 304 billion in 2050 in the High Case, and increase from 204 billion in 2011 to 272 billion in 2050. An increase in transit passenger miles is also anticipated, with an increase from 8.7 billion in 2011 to 15.9 billion in the High Case, and 8.7 billion to 14.3 billion in the Low Case.

As expected, urban vehicle miles also experience a substantial increase. In the High Case forecast, light duty vehicle miles increase from 136 billion in 2011 to 202 billion in 2050. In the Low Case, vehicle miles increase from 136 billion in 2011 to 182 billion in 2050. A significant increase in transit vehicle miles is expected in the High Case, with the number of miles almost doubling during the forecast period, from 396 million in 2011 to 727 million in 2050. In the Low Case, transit miles are forecasted to increase from 396 million in 2011 to 653 million in 2050.

Intercity Travel

Intercity travel currently comprises about 28 percent of all passenger travel in California. Automobile, air, bus, conventional rail, and high-speed rail represent the possible options for intercity travel. It should be noted that auto trips average 1.9 passengers per vehicle.[475]

Intercity passenger trips are expected to increase from 750 million in 2011 to almost 2 billion in 2050 in the High Case. In the Low Case, passenger trips are expected to increase from 750

475 California Household Travel Survey, California Department of Transportation, June 2013.

million in 2011 to 1.7 billion in 2050. In both the high and low projections, the number of intercity passenger trips more than double.

Likewise, intercity passenger miles more than double during the forecast period in the high case, as passenger miles are projected to reach 219 billion in 2050, increasing from 84 billion in 2011. In the Low Case, passenger miles are expected to rise from 84 billion in 2011 to 189 billion in 2050.

Future Direction of Urban and Intercity Travel

Transportation accounts for about 38 percent of greenhouse gas emissions in California, with cars and trucks accounting for almost three-quarters of those emissions. The primary intent of Senate Bill 375 (Steinberg, Chapter 728, Statutes of 2008) is to reduce pollution by improving land-use patterns and establishing a collaborative process between regional and State agencies to set regional targets for reducing greenhouse gas emissions.

California High-Speed Rail will provide an environmentally friendly interregional transportation system and help reduce greenhouse gas emissions as well as deliver other environmental benefits. The initial section, between Merced and San Fernando, is expected to be operating by 2022. The corridor between San Francisco and Los Angeles will be completed by 2029.

In the San Francisco Bay Area, Caltrain plans to convert its diesel trains to electricity beginning in 2019 and to share a corridor with the high speed rail system by 2029.

Based on diesel fuel consumption of over four million gallons in 2011,[476] electrification of rail systems would remove between 6.9 million and 7.7 million gallons of diesel fuel in 2050 if ridership growth is proportional to projected statewide population and income growth in the same time frame.

476 Transit Agency Survey, California Energy Commission, 2012.

APPENDIX H:
NRC Post-Fukushima Activities

Table H-1: NRC Post-Fukushima Activities

TIER 1 ACTIVITIES	DESCRIPTION	NRC ACTION
Mitigation Strategies	To enhance the capability to maintain plant safety during a prolonged loss of electrical power.	Order
Containment Venting System	To provide a reliable hardened containment vent system for boiling water reactors (BWRs) with Mark I or Mark II containment designs.	Order
Spent Fuel Pool Instrumentation	To provide a reliable wide-range indication of water level in spent fuel storage pools.	Order
Seismic Reevaluations	To reanalyze potential seismic effects using present-day information to determine if safety upgrades are needed.	Request for Information
Flooding Hazard Reevaluations	To reanalyze potential flooding effects using present-day information to determine if safety upgrades are needed.	Request for Information
Seismic and Flooding Walkdowns	To inspect existing plant protection features against seismic and flooding events, and correct any degraded conditions	Request for Information
Emergency Preparedness – Staffing and Communications	To assess staffing needs and communications capabilities to effectively respond to an event affecting multiple reactors at a site.	Request for Information
Station Blackout Mitigation Strategies	To enhance the capability to maintain plant safety during a prolonged loss of electrical power.	Rulemaking
Onsite Emergency Response Capabilities	To strengthen and integrate different types of emergency procedures and capabilities at plants.	Rulemaking
Filtration and Confinement Strategies	To evaluate potential strategies that may further confine or filter radioactive material if core damage occurs	Rulemaking
TIER 2 ACTIVITIES		
Spent Fuel Pool Makeup Capability	To provide a reliable means of adding extra water to spent fuel pools	Order (consolidated into Mitigation Strategies)
Emergency	To address three aspects of Emergency Preparedness	Order (1 and 2

Preparedness	for multi-reactor and loss of power events: 1. Training and exercises (drills) 2. Equipment, facilities, and related resources 3. Multi-unit dose assessment capability	consolidated into Mitigation Strategies) NRC-endorsed industry initiative (to address 3)
"Other" External Hazard Reevaluations	To reanalyze the potential effects of external hazards other than seismic and flooding events (which are being addressed under Tier 1).	Request for Information [planned]
TIER 3 ACTIVITIES		
Periodic Confirmation of External Hazards	To ensure external hazards, such as seismic and flooding effects, are periodically reanalyzed during the lifetime of a plant.	Rulemaking (planned)
Seismically-Induced Fires and Floods	To evaluate potential enhancements to the capability to prevent or mitigate seismically-induced fires and floods.	Longer-term evaluation
Venting Systems for Other Containment Designs	To evaluate the need for enhancements to venting systems in containment designs other than Mark I and II (which are addressed under Tier 1).	Longer-term evaluation
Hydrogen Control	To evaluate the need for enhancements to hydrogen control and mitigation measures inside containment or other plant buildings.	Longer-term evaluation
Emergency Preparedness	To evaluate additional enhancements to Emergency Preparedness (EP) programs that go beyond the Tier 1 and Tier 2 EP-related activities.	Longer-term evaluation
Emergency Response Data System (ERDS) Capability	To enhance the capabilities of the Emergency Response Data System (ERDS)	Longer-term evaluation
Decision-making, Radiation Monitoring, and Public Education	To evaluate the need for enhancements to Emergency Preparedness programs in the areas of decision-making, radiation monitoring, and education.	Longer-term evaluation
Reactor Oversight Process (ROP) Updates	To modify the Reactor Oversight Process to reflect any changes to the NRC's regulatory framework (which is being pursued under a separate activity).	Dependent on Regulatory Framework activity
Training on Severe Accidents	To enhance training of NRC staff on severe accidents and related procedures.	Dependent on outcome of Onsite Emergency Response Capabilities (Tier 1)
Emergency Planning Zone	To evaluate whether the basis for the size of the emergency planning zone needs to be modified.	Longer-term evaluation
Potassium Iodide (KI)	To evaluate the need to modify existing programs for the pre-staging of potassium iodide.	Longer-term evaluation
Expedited Transfer of	To evaluate the merits of expediting the transfer of	Longer-term evaluation

Spent Fuel to Dry Cask Storage	spent nuclear fuel from storage pools to dry cask storage.	
Reactor and Containment Instrumentation	To evaluate potential enhancements for instrumentation in the reactor and containment that can withstand severe accident conditions.	Longer-term evaluation

Source: Nuclear Regulatory Commission, http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard/priorities.html

APPENDIX I:
Summary and Status of 2011 IEPR Nuclear Policy Recommendations

Table I-1: Summary and Status of 2011 IEPR Nuclear Policy Recommendations

Seismic Issues			**Status**
2011-1	PG&E CPUC IPRP	PG&E should provide in a timely manner to the Energy Commission, the CPUC, and the Independent Peer Review Panel (IPRP) the technical details and any significant updates of their proposed seismic hazard study plans and findings for Diablo Canyon.	IPRP review of PG&E's seismic studies on-going. Report #6 issued 8/12/13.
2011-2	PG&E ASLB CPUC	PG&E should submit to the Atomic Safety and Licensing Board (ASLB), as part of PG&E's final seismic report to the ASLB in the Diablo Canyon license renewal proceeding, the findings and recommendations from the California IPRP on PG&E's seismic studies. These studies include PG&E's onshore and offshore seismic studies funded by CPUC Decision 10-08-003.	PG&E's AB 1632 seismic studies on-going; NRC SSHAC analysis on-going and scheduled for completion March 2015.
2011-3	SCE CPUC CAISO NRC	The CPUC should establish a San Onofre IPRP, comparable to Diablo Canyon's IPRP, to review San Onofre's seismic hazard study plans and findings as recommended in the *2008 IEPR Update*. SCE should provide in a timely manner to the Energy Commission, the CPUC, and the IPRP the technical details and any significant updates to their proposed seismic hazard study plans and findings for San Onofre. SCE should include the IPRP's evaluations, findings, and recommendations in its seismic hazard analyses and submittals to the NRC. California's IPRPs for PG&E's and SCE's seismic studies for Diablo Canyon and San Onofre should coordinate their seismic hazard evaluations.	San Onofre IPRG established 5/15/2012. IPRG review of SCE's seismic studies on-going. Report #2 issued 7/17/13.
2011-4	CPUC CAISO	SCE should include greater representation on its San Onofre's Seismic Advisory Board of independent seismic experts with no current or prior professional affiliation with utilities, including SCE or PG&E, or their consultants. The composition of SCE's San Onofre's Seismic Advisory Board of independent seismic experts should exclude those with a continuing affiliation with SCE.	On 7/7/2013, SCE announced plans to permanently retire San Onofre Units 2 & 3. SSHAC process has replaced Seismic Advisory Board efforts.
2011-5	PG&E SCE	PG&E and SCE should provide updates on their progress in completing the AB 1632 Report-recommended seismic studies to the Energy Commission as part of the *2012 IEPR Update*.	Utilities' AB 1632 progress reporting in 2013 IEPR.
Spent Fuel Pool and Independent Spent Fuel Storage Installation			
2011-6	PG&E SCE	PG&E and SCE should investigate adding safety-related instrumentation (capable of withstanding design basis natural phenomena) to monitor in the control room key spent fuel pool parameters, for example, water level, temperature, and radiation levels, during a severe accident in which radiation levels within the spent fuel pool building are unsafe.	Action needed.

2011-7	PG&E SCE	To reduce the volume of spent fuel packed into storage pools, and consequently the radioactive material available for dispersal in the event of an accident or sabotage, PG&E and SCE should, as soon as practicable, transfer spent fuel from pools into dry casks, while maintaining compliance with NRC spent fuel cask and pool storage requirements and report to the Energy Commission in the *2012 IEPR Update* on their progress.	Action needed; no net change in storage density from transfers completed to date.
2011-8	PG&E SCE	PG&E and SCE should evaluate, as part of the *2012 IEPR Update*, the potential long-term impacts and projected costs of spent fuel storage in pools versus dry cask storage of higher burn-up fuels in densely packed pools, and the potential degradation of fuels and package integrity during long-term wet and dry storage and transportation offsite.	Action needed.
Station Blackout			
2011-9	PG&E SCE	SCE and PG&E should report to the Energy Commission, as part of the *2012 IEPR Update*, on progress made in addressing the lessons learned from the station blackout at Fukushima and how well-equipped their plants are to withstand safely a station blackout lasting longer than seven days. This includes reporting on any significant changes, including estimated costs, associated with NRC requirements to address station blackout. It also includes arrangements for accessing emergency backup generation and fuel, responding to multiple unit events, seismically and flooding protected equipment, and addressing the lessons learned from Fukushima.	Efforts reported in 2013 IEPR Data Requests Responses/ 2013 IEPR Workshop.
2011-10	PG&E SCE	PG&E and SCE should report to the Energy Commission on the adequacy of trained people, equipment, and external support, including written agreements, for providing emergency power equipment and fuel for handling an extended station blackout.	Efforts reported in 2013 IEPR Data Requests Responses/ 2013 IEPR Workshop.
Nuclear Plant Liability Coverage			
2011-11	PG&E SCE	Based on the Fukushima experiences, PG&E and SCE should provide a comprehensive study to the Energy Commission, as part of the *2012 IEPR Update*, on the adequacy of Price-Anderson Act liability coverage for a severe event at Diablo Canyon or San Onofre resulting in large offsite releases of radioactive materials.	Action needed.
Replacement Power and Reliability			
2011-12	CAISO PG&E SCE CPUC	To support long-term energy and contingency planning, the California ISO (with support from PG&E, SCE, and planning staff of the CPUC and CEC) should report to the Energy Commission as part of its *2013 IEPR* and the CPUC as part of its 2013 Long-Term Procurement Plan on what new generation and/or transmission facilities would be needed to maintain system and/or local reliability in the event of a long-term outage at Diablo Canyon, San Onofre, or Palo Verde. The utilities should report to the CPUC on the estimated costs of these facilities.	On-going.
2011-13	CAISO PG&E SCE CPUC	As a contingency in the event that Diablo Canyon and San Onofre experience a long-term outage following a major seismic or other event, California ISO with input from the Energy Commission and CPUC, in cooperation with PG&E and SCE, should further evaluate: (1) the uncertainties of a long-term loss of electricity from these plants, (2) the extent to which existing resources have an energy supply capability beyond that used in normal market conditions, and (3) the need for new resources or different types of resources to satisfy any remaining energy gap. If necessary, the long-term planning and procurement process at the CPUC should be modified to ensure that any replacement resources found necessary through these studies are acquired in a timely manner.	On-going.

Emergency Response Planning			
2011-14	CPUC CAL OES	The CPUC should approve funding for Cal EMA or the affected counties to evaluate the adequacy of current evacuation and emergency response plans, emergency planning zones, and training for Diablo Canyon and San Onofre, given the Fukushima accident and NRC's recommended 50-mile evacuation zone for U.S. citizens in Japan. This review should include the adequacy of plans for dealing with prolonged station blackouts (for example, powering communications equipment), multiple or multiunit events at one site, increased population densities and traffic flow configurations near the plants, and the possible loss of access roads and evacuation routes in a major event, such as an earthquake or flooding.	Action needed.
2011-15	DPH	The California Department of Public Health should evaluate the adequacy of equipment, staffing, aerial plume monitoring, and models for dealing with two-unit events at the Diablo Canyon or San Onofre sites involving radioactive releases.	Action needed.
Fukushima Lessons Learned			
2011-16	PG&E SCE	PG&E and SCE should report to the Energy Commission, as part of the *2012 IEPR Update*, and the CPUC on their progress and estimated costs in carrying out the recommendations of the *NRC Near-Term Fukushima Task Force Report*.	Efforts reported in 2013 IEPR Data Requests Responses/ 2013 IEPR Workshop.
2011-17	PG&E SCE	PG&E and SCE should report to the Energy Commission, as part of the *2012 IEPR Update*, on the adequacy of resources, training, and equipment to cope with severe plant events including a station blackout combined with natural or manmade events (earthquake, flooding, fires, or terrorist attack); for example, the availability of (1) seismically robust and flood protected essential safety systems and equipment; (2) suitably shielded, ventilated, and well-equipped facilities needed for the workers to manage the accident; (3) ability to respond to multiple events and multiple-unit events, and (4) trained onsite and offsite responders for a long-term station blackout or loss of all heat sinks.	Efforts reported in 2013 IEPR Data Requests Responses/ 2013 IEPR Workshop.
2011-18	NRC	The NRC should expeditiously move forward on the Post-Fukushima Task Force recommendations, particularly the urgent recommendations.	On-going.
Relicensing			
2011-19	PG&E SCE	To help ensure plant reliability and minimize costs, PG&E and SCE should complete the remaining AB 1632 Report-recommended seismic studies and make their findings available for consideration by the Energy Commission, CPUC, California Coastal Commission, and the NRC during their reviews of PG&E's (and SCE's, if they apply) license renewal application(s) and related certificates. SCE should not file a license renewal application with the NRC without prior approval from the CPUC.	On-going.
2011-20	NRC PG&E SCE CPUC	Since the regulatory changes and requirements recommended by the NRC Near-Term Task Force on Fukushima could result in higher costs, for example, seismic retrofits, PG&E and SCE should provide cost estimates to the CPUC for complying with NRC's requirements and the costs of potential replacement power in the event of an extended outage. The CPUC should consider these additional costs during its license renewal evaluations for Diablo Canyon (and San Onofre, if SCE applies for license renewal).	Action needed.
2011-21	NRC	The NRC should delay its decisions on license renewal applications pending completion of the post-Fukushima lessons learned studies. NRC's license renewal review for Diablo Canyon and San Onofre (if SCE applies for license	On April 10, 2011, PG&E requested that the NRC defer

		renewal) should examine updated site-specific information on seismic and tsunami hazards, emergency preparedness and evacuation timeliness, lessons learned from Fukushima, spent fuel storage options, and plant security. NRC should delay license renewal reviews to allow for consideration of findings from Fukushima studies.	issuance of renewed operating licenses until updated seismic studies were completed.
Plant Safety			
2011-22	PG&E SCE	PG&E and SCE should report, as part of the *2012 IEPR Update*, on their efforts to improve the safety culture at Diablo Canyon and San Onofre and on the NRC's evaluation of these efforts and overall plant performance.	Efforts reported in 2013 IEPR Data Requests Responses/ 2013 IEPR Workshop.
2011-23	CPUC	The CPUC should consider establishing a San Onofre Independent Safety Committee, modeled after the Diablo Canyon Independent Safety Committee, to provide an independent review of San Onofre safety, performance, and follow-up to the lessons learned from the Fukushima Daiichi plant accident.	On 7/7/2013, SCE announced plans to permanently retire San Onofre Units 2 & 3.
Continuing Activities			
2011-24	CEC	The Energy Commission will continue to monitor reviews of Diablo Canyon and San Onofre by the NRC and the Institute of Nuclear Power Operations; in particular, the Energy Commission will monitor plant performance and safety culture at both plants.	On-going.
2011-25	CEC	The Energy Commission will continue to monitor the federal waste management program and represent California in the Yucca Mountain licensing proceeding (in the event this proceeding resumes) to protect California's interests regarding potential groundwater and spent fuel transportation impacts to the state.	On-going.
2011-26	CEC	The Energy Commission will continue to participate in United States Department of Energy and state regional planning activities for nuclear waste transportation.	On-going.
2011-27	CEC	The Energy Commission will continue to update information on the comprehensive, "cradle-to-grave" or life-cycle economic and environmental impacts of nuclear energy generation compared with alternatives. These include impacts from uranium mining, reactor construction, fuel fabrication, reactor operation, maintenance and repair; reactor component replacement and disposal; spent fuel storage, transport and disposal; decommissioning; and "beyond design basis" accidents including an extended station blackout lasting longer than assumed.	Action needed.

Source: California Energy Commission