California Energy Commission

STAFF FINAL REPORT

THE ELECTRIC PROGRAM INVESTMENT CHARGE:

PROPOSED 2012-14 TRIENNIAL INVESTMENT PLAN

CALIFORNIA
ENERGY COMMISSION

Edmund G. Brown, Jr., Governor

OCTOBER 2012

CEC-500-2012-082-SF

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ABSTRACT

The California Energy Commission has prepared this triennial investment plan (2012 – 2014) for the new Electric Program Investment Charge program in response to the California Public Utilities Commission's May 31, 2012, Phase 2 Decision 12-05-037. This decision established the Electric Program Investment Charge program to fund electric public interest investments in applied research and development, technology demonstration and deployment, and market facilitation for clean energy technologies.

The California Public Utilities Commission approved a total of $162 million annually for the program for the four administrators – the Energy Commission, Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company. The Energy Commission is administering 80 percent of the approved Electric Program Investment Charge research funds, or $127.8 million per year, which will be collected beginning on January 1, 2013. Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company are administering 20 percent of the funds, or $33.3 million. The remaining $0.8 million is allocated to the California Public Utilities Commission for program oversight.

This first Electric Program Investment Charge investment plan was developed through an open and transparent process that involved public workshops and consultation with key stakeholder groups. Input from these stakeholders is reflected in the recommended funding initiatives discussed in detail in the program plan in Chapters 3, 4, and 5.

The California Public Utilities Commission will conduct a formal proceeding beginning in November 2012 to consider this plan, with anticipated adoption in May 2013. Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company are developing their own investment plans to fund technology development and deployment initiatives, and the Energy Commission will coordinate with that effort.

Keywords: California Energy Commission, Electricity Program Investment Charge, applied research and development, technology demonstration and deployment, market facilitation, clean energy technologies, renewable energy, guiding principles, electricity value chain, energy innovation pipeline, energy efficiency, smart grid, clean generation

Please use the following citation for this report:

California Energy Commission, 2012. *The Electric Program Investment Charge: Proposed 2012-2014 Triennial Investment Plan*, Staff Report. Publication Number CEC-500-2012-082-SF.

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EXECUTIVE SUMMARY

The Electric Program Investment Charge program was established by the California Public Utilities Commission in May 2012 to provide funding for investments in applied research and development, technology demonstration and deployment, and market facilitation of clean energy technologies and approaches. Funding will be collected from California's three largest electric investor-owned utilities – Pacific Gas and Electric Company, San Diego Gas & Electric Company, and Southern California Edison Company – at the level of $162 million per year beginning January 1, 2013 and ending December 31, 2020. Collections for 2012 are slightly less at $143.4 million for the year. All funds will be administered under the oversight of the California Public Utilities Commission, with the investor-owned utilities and the California Energy Commission designated as the administrators of the program. Eighty percent of the funds will be administered by the Energy Commission and the rest by the utilities. The California Public Utilities Commission plans to hold a proceeding to consider investment plans from the four administrators and anticipates releasing a decision adopting or modifying the plans in May 2013.

This draft *Electric Program Investment Charge Proposed 2012-14 Triennial Investment Plan* was developed through a public process with extensive stakeholder input and reflects the following five guiding principles:

1. Allocate funding in consideration of California's "loading order" of meeting growing energy needs first with energy efficiency and demand response, then with renewable resources, distributed generation, and combined heat and power applications, and finally with clean and efficient fossil fuel-fired generation.
2. Accelerate "home-grown" technology innovations to reach the state's goals to reduce greenhouse gas emissions, promote energy efficiency, increase the use of renewable energy, transform and electrify the transportation sector, and develop a robust transmission and distribution grid with advanced communication abilities to support all of these goals.
3. Design the project selection process to avoid duplication with other public or private research activities, assert downward pressure on administrative costs, and maximize in-state investments.
4. Embody ratepayer benefits throughout the entire plan from selection of funded initiatives to criteria for project selection.
5. Build on lessons learned from the Energy Commission's past programs to create a new program that meets today's priorities.

Funding investments and amounts for the first three years of funding fall into three areas. First is applied research and development ($158.7 million, Energy Commission), which includes activities to support precommercial technologies and approaches intended to solve specific problems in the electricity sector, including addressing environmental and public health impacts, supporting building codes and appliance standards, and clean transportation that is

linked to electricity ratepayer benefits. Second is technology demonstration and deployment ($129.8 million, Energy Commission and $86.6 million, investor-owned utilities), which involves installation and operation of precommercial technologies or strategies at a scale that will reflect actual operating, performance, and financial characteristics and risks. Twenty percent of the Energy Commission's 2012 – 2014 investment plan funds in this category will be set aside for bioenergy projects or activities. Finally, market facilitation ($43.3 million, Energy Commission) includes a range of activities such as program tracking, market research, education and outreach, regulatory assistance and streamlining, and workforce development to support clean energy technology and strategy deployment. This category is not necessarily limited to renewables but may also include other clean energy technologies and/or approaches.

A fourth area not allocated funding in the CPUC decision is market support, defined as activities and programs that support commercially viable technologies that still need public support to achieve economies of scale and be competitive with other technologies. The Energy Commission's New Solar Homes Partnership fits into this category, and the California Public Utilities Commission decision stated that if a change in legislation allowed funds to be used for this program, it may consider adding $25 million per year to the Electric Program Investment Charge for New Solar Homes Partnership incentives.

Total EPIC funding for Energy Commission activities is summarized in Table E-1.

Table E-1: California Energy Commission EPIC Funding by Program Element 2012-2014 (millions)

Funding Element	2012	2013	2014	Total
Applied Research and Development	$48.7	$55.0	$55.0	$158.7
Technology Demonstration and Deployment	$39.8	$45.0	$45.0	$129.8
Market Facilitation	$13.3	$15.0	$15.0	$43.3
Program Administration	$11.3	$12.8	$12.8	$36.9
Sub Total	**$113.1**	**$127.8**	**$127.8**	**$368.7**
New Solar Homes Partnership Up to 10% ($2.5 million) of these funds may be used for administration of the NSHP.	$0.0	$25.0	$25.0	$50.0
Grand Total	**$113.1**	**$152.8**	**$152.8**	**$418.7**

The draft *Electric Program Investment Charge Proposed 2012-14 Triennial Investment Plan* includes a variety of strategic objectives for the three funding areas discussed above, under which proposed research initiatives are grouped. For the area of applied research and development, these include:

- **Developing energy efficiency technologies and strategies for the building sector:** Research initiatives under this objective focus on lighting systems; heating, ventilation, air-conditioning, and refrigeration systems; building envelope systems; understanding building occupant behavior; cost-effective building retrofit strategies; reducing energy use from plug

loads; improving indoor air quality in efficient buildings; and technologies and approaches to achieve zero-net-energy buildings.

- **Developing technologies and applications to enable cost-beneficial energy choices on the customer side of the meter:** Research initiatives under this objective include developing cost-effective metering and communication devices to allow demand response, distributed generation, plug-in electric vehicles, and energy storage to participate in California Independent System Operator markets; developing technologies and strategies to allow demand response customers to participate in ancillary services markets; demonstrating and evaluating distributed energy storage at the community scale; and developing technologies, strategies, and applications for customer-side energy storage.
- **Developing technologies, tools, and strategies to make distributed generation more affordable**: Research initiatives under this objective include developing combined heat and power technologies and deployment strategies; accelerating the commercialization of sustainable bioenergy systems; and developing advanced distributed photovoltaic systems.
- **Developing emerging utility-scale renewable generation technologies and strategies to improve power plant performance, reduce costs, and expand the renewable resource base:** Research initiatives under this objective focus on improving the performance of concentrating solar power; increasing performance and reliability of utility-scale renewable power plants; improving the cost-effectiveness of geothermal energy production; investigating barriers to offshore wind and wave energy technologies in California.
- **Reducing environmental and public health impacts of electricity generation and make the system less vulnerable to climate effects:** Research initiatives under this objective consist of air quality research to address environmental and public health effects of conventional and renewable electricity production; research on sensitive species and habitats to assist renewable energy planning and deployment; reducing energy stresses on aquatic resources and improve water-energy management; and tools and technologies to plan for and minimize the effects of climate change on the electric system.
- **Developing technologies, tools, and strategies to enable a 2020 "smart grid:"** Research initiatives under this objective include developing technologies to allow for two-way power flow through the transmission and distribution system; expanding distribution automation capabilities; developing operational practices and automation to make use of smart grid equipment; improving forecasting of renewable resource availability; and developing smart grid communication systems that interface with customer networks and distributed resources.
- **Developing tools, computer models, and simulations to improve grid resource planning:** Research initiatives under this objective include research on the characteristics of the generation fleet in 2020; cataloging distributed resources to improve operator dispatch and visibility; developing and running real-time scenarios to support grid operations; and developing interoperability test tools and procedures.

- **Integrating energy storage technologies and determine the best applications that provide locational benefits:** Research initiatives under this objective focus on optimizing grid-level energy storage by location, size, and type; and developing energy storage technologies that can improve integration of intermittent renewables and help meet peak electricity demand.
- **Advancing technologies and strategies that optimize the benefits of plug-in electric vehicles to the electricity system:** Research initiatives under this objective focus on charging technologies and approaches to integrate plug-in electric vehicles into the power grid; developing grid communication interfaces to support vehicle-to-grid services; advancing strategies for second-use electric vehicle battery storage; and developing recycling technologies and processes for recycling plug-in electric vehicle batteries.
- **Leveraging California's regional innovation clusters to accelerate deployment of clean energy technologies and companies:** Research initiatives under this objective consist of providing small grants to early-stage energy companies and entrepreneurs; supporting demonstration testing and verification centers to accelerate deployment of precommercial clean energy technologies; and using scenario assessments and gap analysis to develop or update research roadmaps.

For the area of technology demonstration and deployment, strategic objectives and research initiatives include:

- **Demonstrating and evaluating technical and economic performance of emerging energy efficiency and demand-side management technologies and strategies:** Research initiatives under this objective include identifying and demonstrating promising energy efficiency and demand response technologies suitable for commercialization and utility rebate programs and demonstrating integrated demand-side management programs to achieve targets identified in the California Energy Efficiency Strategic Plan.
- **Demonstrating and evaluate emerging clean energy generation technologies and deployment strategies.:** Research initiatives under this objective focus on demonstration and appraisal of operations and performance of precommercial biomass conversion technologies, generation systems, and development strategies and demonstration and deployment of precommercial combined heat and power applications.
- **Demonstrating integration of energy efficiency demand-side resources, distributed clean energy generation, and smart grid components to help develop energy-smart communities:** Research initiatives under this objective consist of demonstrations of zero-net-energy buildings and communities, renewable energy microgrids, advanced vehicle-to-grid energy storage technologies, and second-use vehicle battery applications.

For the area of market facilitation, strategic objectives and initiatives include:

- **Collaborating with local jurisdictions and stakeholders to enhance current regulatory assistance and permit streamlining efforts that help coordinate investments and promote widespread deployment of clean energy infrastructure:** Research initiatives under this

objective include conducting pilot demonstrations of localized energy resource markets; providing planning grants to cities and counties to incorporate clean energy planning and permitting processes into local planning and zoning efforts; conducting a needs assessment to identify regulatory gaps within local planning and zoning processes; working with local jurisdictions and industry to create model ordinances for clean energy technologies; funding to assist in development of general plan guidelines; and developing educational materials for local officials interested in clean energy.

- **Strengthening the clean energy workforce by creating tools and resources that connect the clean energy industry to the labor market:** The research initiative under this objective will provide grants to develop and enhance training and apprenticeship programs to support clean energy deployment programs in investor-owned utility territories.
- **Guide EPIC investments through effective market assessment, program evaluation, and stakeholder outreach:** Research initiatives under this objective include creating a Web portal to connect innovators, investors, educators, job seekers, and policy makers seeking to promote adoption of clean energy technologies; conducting forums to connect technology innovators with potential investors, job seekers, and policy makers; assessing progress in the clean energy industry and developing roadmaps for future investments; conducting a survey on end-use energy consumption and saturation characterization; conducting a market analysis of strategies to help clean energy storage, demand response, electric vehicles, and renewable energy; and conducting project and program evaluations.

An important aspect of the Electric Program Investment Charge Program investment plan is evaluating the investment plan's success over time. The Energy Commission intends to use a programwide approach to assess benefits that is integrated into solicitation planning, solicitation and agreement development, project management, and project closeout. Metrics that will be used to assess the program include job creation, economic and environmental benefits, barriers or issues that were overcome, effectiveness of information dissemination, adoption of technologies, strategies, or research data by other entities, and funding support from other entities for research funded through the program.

Once adopted by the Energy Commission, this investment plan will be submitted to the California Public Utilities Commission on November 1, 2012, for consideration along with the investment plans of the three investor-owned utilities. The California Public Utilities Commission's schedule anticipates considering the plans for approval in May 2013. In early 2014, the Energy Commission staff intends to hold scoping workshops for the second triennial investment plan covering the 2015-2017 funding cycle. The Energy Commission will also file annual reports to the California Public Utilities Commission starting in February 2014 and continuing through February 2020.

CHAPTER 1: Introduction

The California Energy Commission prepared this triennial investment plan for the Electric Program Investment Charge (EPIC) Program in response to the California Public Utilities Commission's (CPUC) May 31, 2012, Phase 2 Decision 12-05-037.[1] That decision established the EPIC Program for funding electric public interest investments. This triennial investment plan presents the Energy Commission's strategy for administering $368.8 million in EPIC funds for applied research and development, technology demonstration and deployment, and market facilitation from 2012 to 2014. The EPIC Program will provide public interest investments in clean energy technologies and approaches for the benefit of electricity ratepayers of California's three largest electric investor-owned utilities (IOUs): Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E), and Southern California Edison Company (SCE). The Phase 1 decision[2] authorized funding collections in 2012 of $143.4 million, and the Phase 2 decision authorized funding collections starting in January 2013 of $162 million per year, with 80 percent of those funds to be administered by the Energy Commission and 20 percent to be administered by the three IOUs. The Phase 2 decision also establishes ratepayer benefits as the mandatory guiding principle to guide investment decisions. All funds will be administered under the oversight of the CPUC, which will conduct triennial public proceedings to review coordinated investment plans by all four administrators.

The Energy Commission's development of the EPIC investment plan is being conducted in accordance with recent legislation, Senate Bill 1018 (Chapter 39, Statutes of 2012), and overlaps significantly with the Energy Commission's broad authority under Public Resources Code Sections 25216 (c) and 25401. SB 1018 establishes the Electric Program Investment Charge Fund in the State Treasury to receive EPIC Program funding to be administered by the Energy Commission and authorizes the Energy Commission to use this funding as authorized by the CPUC and appropriated by the Legislature. (Public Resources Code Section 25711)

Public Resources Code Section 25216, subdivision (c), provides that in addition to other duties specified in Division 15 of the Public Resources Code, the Energy Commission shall "…carry out, or cause to be carried out, under contract or other arrangements, research and development into alternative sources of energy, improvements in energy generation, transmission, and siting, fuel substitution, and other topics related to energy supply, demand, public safety, ecology, and conservation which are of particular statewide importance."

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1 California Public Utilities Commission, *Phase 2 Decision Establishing Purposes and Governance for Electric Program Investment Charge and Establishing Funding Collections for 2013-2020*, Rulemaking 11-10-003, May 31, 2012: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/167664.pdf.

2 California Public Utilities Commission, *Phase 1 Decision Establishing Interim Research, Development And Demonstration, And Renewables Programs Funding Levels*, Rulemaking 11-10-003, December 21, 2011.

Public Resources Code Section 25401 directs the Energy Commission to "… continuously carry out studies, research projects, data collection, and other activities required to assess the nature, extent, and distribution of energy resources to meet the needs of the state, including but not limited to, fossil fuels and solar, nuclear, and geothermal energy resources…" and also directs that it "…carry out studies, technical assessments, research projects, and data collection directed to reducing wasteful, inefficient, unnecessary, or uneconomic uses of energy …"

Energy Commission staff developed the *Electric Program Investment Charge Proposed 2012-14 Triennial Investment Plan* with input and guidance from Energy Commission Chair Robert B. Weisenmiller in his capacity as the lead commissioner on research, development, and demonstration matters and from Commissioner Carla Peterman in her capacity as lead commissioner on renewable energy matters.

Energy Commission staff held public workshops on August 2 and 3, 2012, in Sacramento, and on August 9 and 10, 2012, in Southern California to solicit input from experts, stakeholders, and the public on the development of the Energy Commission's EPIC investment plan. The input received as part of these workshops was then considered by staff in developing the staff draft *Electric Program Investment Charge Proposed 2012-14 Triennial Investment Plan.* On September 27, 2012, staff held a public workshop to solicit input and comments on the staff draft investment plan. Staff made additional changes to the investment plan based on input and comments received as part this workshop and comments submitted to the 12-EPIC-01 docket. These changes are reflected in the *Proposed Triennial Investment Plan*.

Workshop materials and public comments are available online at http://www.energy.ca.gov/research/epic/. Persons can also use this webpage to subscribe to the Energy Commission's EPIC e-mail ListServer.

The CPUC's Phase 2 decision indicated that the determination to appoint the Energy Commission as an administrator of EPIC funds was based on the Energy Commission's status as the state agency created to develop and support state energy policy, numerous continuing statutory obligations to provide analysis and programs to support clean energy goals, and a preference for public agency rather than private entity administration. The Energy Commission will administer the EPIC program with these considerations in mind.

The framework in this investment plan reflects five guideposts:

1) The investment plan enables cost-beneficial achievement of the California's clean energy goals. The funding allocations reflect the state's energy priorities as articulated in the "loading order." This investment plan portfolio emphasizes achieving greenhouse gas (GHG) emission reduction; all cost-effective energy efficiency; 33 percent renewables; the

transformation and electrification of the transportation sector; and a "smart grid" that can promote this transformation.[3]

2) The priorities in this plan will accelerate "homegrown" technology innovation and create the technologies, tools, and products needed to reach these goals.
3) The project selection process is designed to:
   - Select the most promising technology solutions that do not duplicate other ongoing public or private research activities.
   - Assert downward pressure on administrative costs.
   - Maximize in-state investments.
4) Ratepayer benefits are embodied in the entire plan from selection of funded initiatives to criteria for project selection.
5) The plan builds on lessons learned from the Energy Commission's programs and creates a new program that is updated to meet today's priorities and respond to guidance in the CPUC decision.

Chapter 2 discusses the directives of the EPIC Program, including the guiding principle of providing benefits to California's electric ratepayers and a number of complimentary benefits. Also outlined are the funding levels for each program research area, a discussion of the technology areas targeted for investment, the policy justifications for investments in energy research, development, and demonstration, and the energy innovation pipeline.

Chapters 3, 4, and 5 describe how the planned investments in the 2012-2014 time frame relate to grid operations, market design, generation, transmission, distribution, and demand-side management. Chapter 3 describes proposed strategic investment objectives in applied research and development (R&D). The objectives address gaps in the funding needed to help innovative energy technologies and approaches succeed. The chapter focuses on targeted investments in energy efficiency and demand response, clean generation, smart grid enabling clean energy, and cross-cutting technologies, which span two or more of these areas. Each objective includes a number of key research initiatives that will address the gaps in applied R&D funding for that technology area.

Chapter 4 maps out proposed strategic investment objectives in technology demonstration and deployment with a focus on providing key bridge funding to scale up efficiency, renewables, and clean transportation in a real-world environment.

3 The Energy Commission's vision of the smart grid is the thoughtful integration of intelligent technologies and innovative services that produce a more efficient, sustainable, economic, and secure electrical supply for California communities. Energy Commission website: http://www.energy.ca.gov/research/integration/smart_grid.html

Chapter 5 addresses funding for the market facilitation program area which aims to fill gaps in market processes for clean energy generation such as regulatory and permitting barriers, workforce development, outreach, and project tracking.

Chapter 6 identifies a need for funding for the New Solar Homes Partnership, which provides financial incentives for installing eligible solar energy systems on new homes as part of the California Solar Initiative.

Chapter 7 discusses program administration including the following key elements of the investment plan identified by the CPUC:

- The amount of funding to be devoted to each program area.
- Policy justification for the proposed funding allocation.
- The type of funding mechanisms (such as grants and contracts) to be used for each investment area.
- Project eligibility and selection criteria.
- Per project funding limits, including match funding requirements.
- Metrics for measuring benefits and success.
- Treatment of intellectual property rights.

Chapter 8 addresses the methods for assessing the program's benefits and success based on project and technology type, energy use sector, the project funded, and where it is in the energy innovation pipeline. These measurements of benefits and success are being incorporated into each phase of program development, including solicitation planning, project agreement development, project management, and project closeout.

CHAPTER 2: Program Directives

Investment Areas

The California Public Utilities Commission (CPUC) Phase 1 and 2 decisions stipulate funding investments and amounts in three defined areas:

- **Applied Research and Development** ($158.7 million; three-year funding to the Energy Commission): This area is defined as activities supporting precommercial technologies and approaches that are designed to solve specific problems in the electricity sector, including activities that address environmental and public health impacts of electricity-related activities, support building codes and appliance standards, and clean transportation with a linkage to electricity sector ratepayer benefits.
- **Technology Demonstration and Deployment** ($129.8 million; three-year funding to the Energy Commission and $86.6 million of three-year funding to the three large investor-owned utilities [IOUs]): This area is defined as the installation and operation of precommercial technologies or strategies at a scale sufficiently large and in conditions sufficiently reflective of anticipated actual operating environments to enable appraisal of the operational and performance characteristics and the financial risks. Twenty percent of the Energy Commission's 2012 – 2014 investment plan funds in this category will be set aside for bioenergy projects or activities.
- **Market Facilitation** ($43.3 million; three-year funding to the Energy Commission): This area is defined as a range of activities including program tracking, market research, education and outreach, regulatory assistance and streamlining, and workforce development to support clean energy technology and strategy deployment. The Phase 2 decision further clarifies that this category should not necessarily be limited to renewables but may also include any other clean energy technologies and/or approaches.

A fourth area, market support, was not allocated funding in the decision. As discussed below, the New Solar Homes Partnership (NSHP) fits within this category.

- **Market Support**: This area is defined as activities and programs that support commercially viable technologies that still need public support to achieve economies of scale and be competitive with other technologies. The CPUC decision stated that if a change in legislation allowed EPIC funds to be used for the NSHP, the CPUC may consider adding $25 million per year to EPIC for NSHP incentives.

Total EPIC funding for the Energy Commission activities is summarized in Table 2.

Table 2: California Energy Commission EPIC Funding by Program Element 2012-2014 (millions $)

Funding Element	2012	2013	2014	Total
Applied Research and Development	48.7	55.0	55.0	158.7
Technology Demonstration and Deployment	39.8	45.0	45.0	129.8
Market Facilitation	13.3	15.0	15.0	43.3
Program Administration	11.3	12.8	12.8	36.9
Sub Total	**113.1**	**127.8**	**127.8**	**368.7**
New Solar Homes Partnership Up to 10% ($2.5 million) of these funds may be used for administration of the NSHP.	0.0	25.0	25.0	50.0
Total	**113.1**	**152.8**	**152.8**	**418.7**

Source: California Energy Commission

Guiding Principles

The mandatory guiding principle of EPIC is to develop a new program that invests in clean energy technologies and approaches that provide benefits to electricity ratepayers by promoting greater reliability, lower costs, and increased safety. In addition, the following complementary guiding principles are adopted:

- Societal benefits.
- Greenhouse gas (GHG) emissions mitigation and adaptation in the electricity sector at the lowest possible cost.
- The loading order.
- Low-emission vehicles/transportation.
- Economic development.
- Efficient use of ratepayer monies.

Also, principles articulated in Public Utilities Code Sections 740.1 and 8360 – which govern utility expenditures in the areas of research, development, and demonstration (RD&D) and smart grid – serve as guidance. Section 740.1 states that, in evaluating RD&D projects, consideration will be given to:[4]

- Projects that provide reasonable probability of ratepayer benefits.
- Minimizing projects with a low probability of success.

4 Public Utilities Code § 740.1: http://www.leginfo.ca.gov/cgi-bin/displaycode?section=puc&group=00001-01000&file=727-758

- Projects consistent with the utility corporation's resource plan.
- Projects that do not duplicate previous or current research by other electrical or gas corporations or research organizations.
- Projects that support one or more of the following objectives:
  - Environmental improvement.
  - Public and employee safety.
  - Conservation by efficient resource use or by reducing or shifting system load.
  - Development of new resources and processes, particularly renewables resources and processes that further supply technologies.
  - Improve operating efficiency and reliability or otherwise reduce operating costs.

Section 8360 outlines the requirements for the state's electrical transmission and distribution (T&D) system to maintain safe, reliable, efficient, and secure electrical service to meet future growth and demand in achieving the following:[5]

- Increased use of cost-effective digital information and control technology to improve reliability, security, and efficiency of the electric grid.
- Dynamic optimization of grid operations and resources, including appropriate consideration for asset management and use of related grid operations and resources, with cost-effective full cybersecurity.
- Deployment and integration of cost-effective distributed resources and generation, including renewable resources.
- Development and incorporation of cost-effective demand response (DR), demand-side resources, and energy-efficient resources.
- Deployment of cost-effective smart technologies, including real-time, automated, and interactive technologies that improve the physical operation of appliances and consumer devices for metering, communications concerning grid operations and status, and distribution automation.
- Integration of cost-effective "smart" appliances and consumer devices.
- Deployment and integration of cost-effective advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.

5 Public Utilities Code § 8360: http://www.leginfo.ca.gov/cgi-bin/displaycode?section=puc&group=08001-09000&file=8360-8369.

- Provide consumers with timely information and control options.
- Develop standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.
- Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.

Chapters 3, 4, and 5 include matrices that identify the specific benefits (or guiding principles) targeted for each proposed initiative investment.

Electric System Value Chain

Phase 2 of the CPUC decision requires all investments to be mapped to the different elements of the electricity "value chain," which was characterized as consisting of grid operations/market design, generation, transmission, distribution, and demand-side management. Similar to the guiding principles listed above, each initiative in Chapters 3, 4, and 5 includes a matrix and is mapped to the electric system value chain.

EPIC Investment Strategy

California energy policy frames a vision for its electricity future that includes an aggressive transition from fossil generation to renewable sources, highly efficient homes and businesses, and electrification of portions of the transportation system. The role of the Energy Commission's EPIC Program is to provide the tools, technologies, and market assistance that accelerate achievement of this vision in IOU service territories at a reasonable cost and without sacrificing safety and reliability. To accomplish this, the Energy Commission staff proposes strategic improvements to help bridge gaps along the electric system value chain.

Homes and businesses need high-quality and cost-effective efficiency products and services. Renewable generation and electric transportation must be seamlessly integrated into the electric grid at all levels of interconnection ranging from small-scale home applications to large central-station power plants. The Energy Commission's *Integrated Energy Policy Report* and ongoing analysis at the California Independent System Operator (California ISO), the CPUC, the United States Department of Energy (U.S. DOE), and the United States Environmental Protection Agency (U.S. EPA) have identified key challenges to achieving this clean energy vision for California's IOU service territories. Each of the initiatives described in Chapters 3-5 addresses an important barrier and investment gap.

Vision That Drives EPIC Investments

California's future electricity system will consist of near zero net energy buildings, highly efficient businesses, low-carbon generation, sustainable bioenergy systems, more localized generation, and electrification of transportation, supported by a highly flexible and robust distribution and transmission infrastructure.

EPIC Program Mission

The Energy Commission through EPIC will fill critical funding gaps within the energy innovation pipeline to advance technologies, tools, and strategies that provide California's IOU ratepayers with clean, affordable, and reliable electricity and help enable the 21st century power grid.

California's Energy Policy

Imbedded in the directives outlined above, including the guiding principles, is the expectation that California will achieve the state's clean energy policy goals while promoting greater reliability, lower costs, and increased safety. California continues to lead the nation in promoting clean energy goals such as those directed at reducing GHG emissions and ensuring an aggressive portfolio of efficient and renewable energy sources. The Energy Commission's EPIC Program used these goals to guide the development of strategic objectives outlined in this plan.

Governor Brown's Clean Energy Jobs Plan

By 2020, California should produce 20,000 new megawatts (MW) of renewable electricity, accelerate the development of energy storage capacity, and strengthen energy efficiency measures. This includes installing 8,000 MW of renewable central station capacity and 12,000 MW of renewable distributed generation (DG). The plan also calls for adding 6,500 MW of combined heat and power (CHP) systems over the next 20 years.[6]

Integrated Energy Policy Report

Senate Bill 1389 (Bowen and Sher, Chapter 568, Statutes of 2002) requires the Energy Commission to: "[C]onduct assessments and forecasts of all aspects of energy industry supply, production, transportation, delivery and distribution, demand, and prices. The Energy Commission shall use these assessments and forecasts to develop energy policies that conserve resources, protect the environment, ensure energy reliability, enhance the state's economy, and protect public health and safety." (Public Resources Code Section 25301[a]).

6 Governor Brown's Clean Energy Jobs Plan, http://gov.ca.gov/docs/Clean_Energy_Plan.pdf
http://gov.ca.gov/docs/Clean_Energy_Plan.pdf

The *2011 Integrated Energy Policy Report* addressed, among other things, the development of energy efficiency, renewable electricity, DG, and CHP in California and recommended policies to foster the development of these areas in California.

Energy efficiency continues to be California's top priority for meeting new electricity needs and a key strategy for creating jobs and reducing GHG emissions from the electricity sector. The central policies that aim to increase energy efficiency in the state include achieving all cost-effective energy efficiency, reducing energy use in existing buildings, and making all new residential construction in California zero-net-energy by 2020 and all new commercial construction zero-net-energy by 2030.[7]

As part of the *2011 Integrated Energy Policy Report* proceeding, the Energy Commission issued the *Renewable Power in California: Status and Issues* report, which discussed challenges to developing renewables and achieving the goals in Governor Brown's Clean Energy Jobs Plan. The report identified five high-level strategies: prioritize geographic areas for development; evaluate costs and benefits of renewable projects; minimize interconnection costs and time; promote incentives for projects that create in-state benefits; and promote and coordinate existing financing and incentive programs for critical stages in the renewable development continuum. These strategies are the foundation for a more detailed Renewable Action Plan being developed as part of the *2012 Integrated Energy Policy Report Update.* The update will also include a summary of a recent assessment of CHP technical and market potential.

Assembly Bill 32 and Executive Order S-3-05

The California Global Warming Solutions Act of 2006 (Assembly Bill 32 [Núñez, Chapter 488, Statutes of 2006]) requires the state to reduce GHG emissions to at or below 1990 levels by 2020. Executive Order S-3-05 established a goal to reduce GHG emissions to 80 percent below 1990 levels by 2050.

The Loading Order

Since 2003, California's energy policy has defined a loading order of resource additions to meet the state's growing electricity needs: first, energy efficiency and DR; second, renewable energy and DG; and third, clean fossil-fueled sources and infrastructure improvements. This strategy has had the benefit of reducing carbon dioxide emissions and diversifying California's sources of energy.

Energy Efficiency

The CPUC's *Energy Efficiency Strategic Plan* and the Energy Commission's *Integrated Energy Policy Report* set zero net energy goals for new homes by 2020 and new commercial buildings by

7 California Energy Commission, *2011 Integrated Energy Policy Report*, http://www.energy.ca.gov/2011publications/CEC-100-2011-001/CEC-100-2011-001-CMF.pdf

2030.[8] The California Air Resources Board's *Climate Change Scoping Plan* sets a target of 32,000 gigawatt-hours of reduced energy consumption from energy efficiency improvements by 2020.[9]

Renewables Portfolio Standard

California's aggressive Renewables Portfolio Standard (RPS) requires all electricity retailers, including IOUs, to serve 33 percent of their retail sales with renewable energy procurement. The RPS is mandated under Public Resources Code 399.11.[10]

Transmission and Distribution

Senate Bill 17 (Padilla, Chapter 327, Statutes of 2009) mandates implementing and planning a smart grid, defined as an electric grid using computers and communications to gather, distribute, and act on information about the behavior of suppliers and consumers to improve efficiency, reliability, economics, and sustainability of electricity services.

To implement the RPS successfully, it will be necessary to upgrade existing transmission facilities and build new ones to connect remote, large-scale generation to load centers. Proactively assessing environmental and land-use challenges will greatly aid permitting to upgrade existing lines and build new ones to help meet the policy goals.

Assembly Bill 2514 (Skinner, Chapter 469, Statutes of 2010) requires the CPUC to open a proceeding by March 1, 2012, to determine appropriate targets, if any, for each load-serving entity to procure viable and cost-effective energy storage systems and, by October 1, 2013, to adopt an energy storage system procurement target, if determined to be appropriate, to be achieved by each load-serving entity by December 31, 2015, and a second target to be achieved by December 31, 2020.

Transportation

Senate Bill 626 (Kehoe, Chapter 355, Statutes of 2009) codified Public Utilities Code Section 740.2, which directs the CPUC to adopt rules to evaluate policies and develop infrastructure sufficient to overcome barriers to the widespread deployment and use of plug-in hybrid and electric vehicles.

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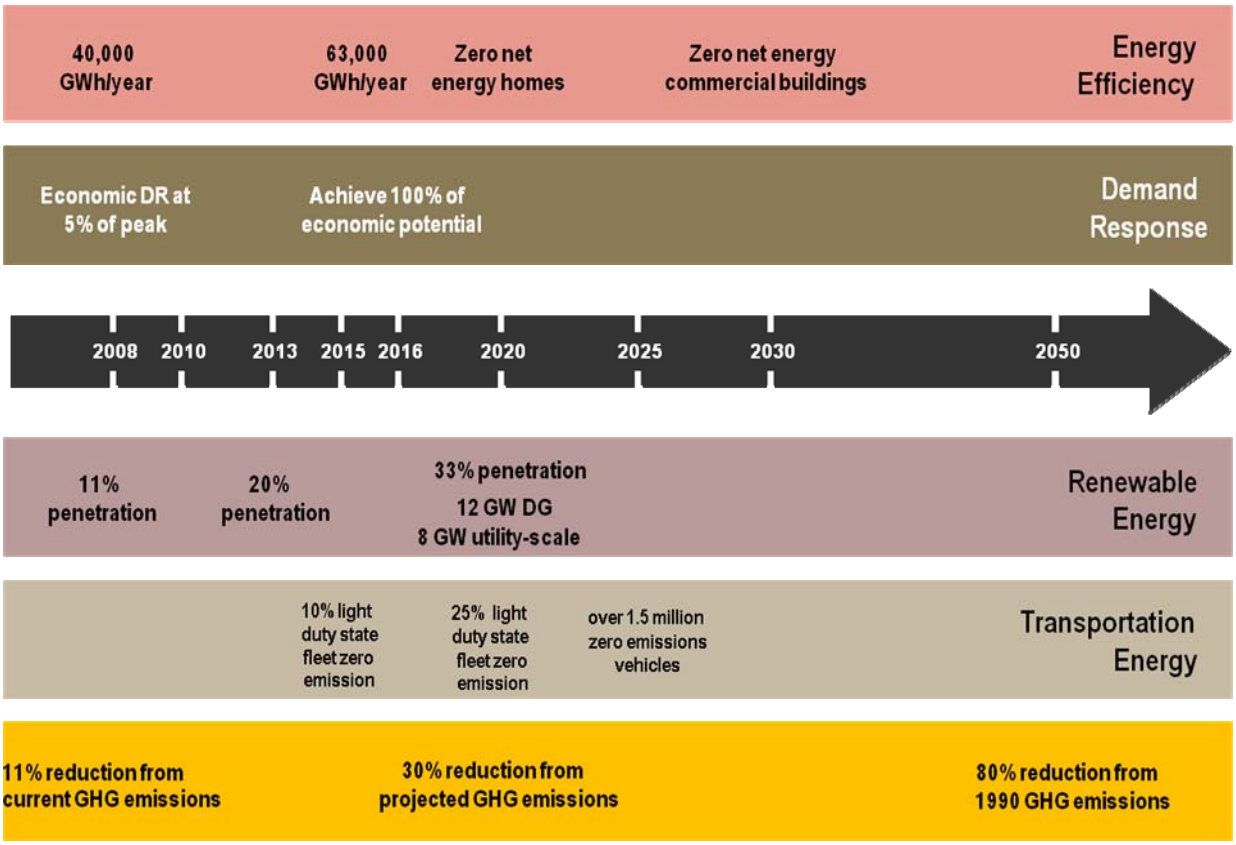
8 California Public Utilities Commission, *California Energy Efficiency Strategic Plan, January 2011* http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/

9 California Air Resources Board, *Climate Change Scoping Plan,* http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

10 The RPS was enacted by Senate Bill 1078 (Sher, Chapter 516, Statutes of 2002) and subsequently modified by Senate Bill 107 (Simitian, Chapter 464, Statutes of 2006). In 2011, the RPS goal was increased to 33 percent by 2020 under Senate Bill x1-2 (Simitian, Chapter 1, Statutes of 2011).

Governor Brown's Executive Order B-16-2012 establishes expectations for agencies to expedite the rapid commercialization of zero-emission vehicles (ZEV). The order was issued on March 23, 2012, directing California to "encourage the development and success of zero-emission vehicles to protect the environment, stimulate economic growth and improve the quality of life in the State." The Governor's Executive Order sets a long-term target of reaching 1.5 million ZEVs on California's roadways by 2025. The *2012 ZEV Action Plan* follows on the Governor's Executive Order by identifying specific strategies and actions that state agencies will take to meet the Executive Order. This action plan was released in draft form in September 2012 to solicit broad stakeholder input. Following that input, a final version of the action plan will be released later in 2012.

Figure 1: Overview of California Energy Policy Drivers



Source: California Energy Commission

Vision for the 2020 Electricity System and Beyond

A vision for 2020 and beyond underlies the strategic objectives and initiatives defined in this plan. The vision aligns the proposed research, demonstration, and deployment activities with the state's energy policies, and aligns with the major elements of the IOU's visions that are

defined in their SB-17 Smart Grid Deployment Plan filings. When developing the strategic objectives and initiatives, the following attributes were used:

Clean and Efficient Energy Future: The electric system and operational structure of the smart grid in 2020 and beyond will rely on more real-time and near-real-time communications and control. The IOU ratepayers will have access to more of their energy use information and have the ability to cater their energy use decisions to meet their individual needs. In addition to their smart meter, ratepayers will have the option of selecting from a variety of home area networks, which will help them manage their home energy use. The T&D system will operate in an environment where energy consumption data is available in real-time or near-real-time allowing smart energy decisions to be made or automated based on the needs of the power grid and the choices of the consumer. The energy innovation pipeline defined in this plan will be a key vehicle for providing customers with valuable energy choices while creating a more robust, reliable, safe, and secure electric grid that operates efficiently by optimizing assets and lowering costs.

Achieving Energy Savings in the Buildings, Agricultural, Industrial, and Water Sectors: Current research to increase energy efficiency in buildings through technology improvements, integrated demand-side management programs, and building and appliance energy efficiency standards will result in buildings using 50 percent less energy than those today, and, in many cases, also being zero net energy. Buildings will be highly efficient, comfortable, functional, and energy self-sufficient. These buildings will have fully-integrated controls that provide building occupants with instant feedback on energy use and cost, and they will correlate energy use patterns with occupant behavior to determine the best way to minimize energy use. Technologies and strategies considered novel and expensive today, such as zero net energy, advanced heating and cooling systems, and LED lighting, will be standard and commonplace. Though most existing buildings will not be zero net energy, many will use substantially less energy than today's buildings, thanks to technology breakthroughs resulting in lower capital and operating costs of these energy savings technologies. For the industrial and water sectors, current efforts strive to maximize energy and operational savings while addressing environmental concerns (for example, air pollution and water and waste disposal). By 2020, Energy Commission staff anticipates that 5-10 percent of the industries will adopt these advanced technologies with an estimated 10 percent reduction in energy use per industry. All these efforts will help California be the state with the lowest per capita energy use by 2020 while substantially contributing to the GHG reduction goals of AB 32.

Empowered "Smart" Customers: By 2020, it is envisioned that customers will be able to cost-effectively choose their power source and their homes and businesses will have less impact on the environment and be economical to operate. Achievement of this vision requires technological advancements in communications and control technologies and tools that allow the smart customer to have easy access to their energy use data. These technologies and tools could provide real time or near real time recommendations on how to conserve energy and manage customer energy demands. Many of these services will be provided for residential

customers with improved home area networks. According to the telecommunications industry more than half of all cell phone users now have smart phones. New smart phone applications will provide smart customer options that are not available today. Future automated demand response (AutoDR) capabilities will allow smart customers to preprogram their facilities to respond automatically to DR programs and other applicable tariffs, to conserve energy, lower their energy bills, and provide services to the grid that lower overall operating costs for the entire grid. Technology demonstrations and information sharing will help encourage all customers to use these new technologies and programs to manage their individual energy needs.

Clean Generation: By 2020, a minimum of 33 percent of California's electric supply will be generated by renewable sources. New thermal generation will be more efficient, produce fewer emissions and use less water than those operating in the past. Modifications to the thermal fleet will create more flexible operation and ramping capabilities and, along with improved tools to better forecast renewable supplies, will enable integration of intermittent renewable resources at lowest possible economic and environmental costs. Fuel choices will be more diverse and harvested in a manner that reduces harm to natural environments and vulnerable communities while greatly reducing waste streams. Smart environmental planning and up-front assessments will help locate generation in the most environmentally benign areas and that could help create jobs in rural communities. There will be less reliance on central station capacity and greater reliance on economically feasible distributed generation and energy storage options. Customers will have access to a wider variety of renewable energy options, including "plug-and-play" distributed generation technologies designed to streamline installation and interconnection. On-site distributed clean energy systems will be included in new developments as a standard feature to enable zero-net energy facilities and communities. California will be better poised to adapt to climate change effects to the electricity sector through strategies that predict water shortfalls, increased energy demand from extreme temperatures and built-in protections to energy infrastructure.

Increased Electrification of the Transportation System: By 2020, over 1 million plug-in electric vehicles will be deployed and integrated into California's electricity system. Real-time price signals and smart charging technologies will efficiently integrate PEV charging into the grid to maximize the economic and environmental benefits of these vehicles. Vehicle-to-grid and battery reuse strategies will improve the operation and efficiency of the electric grid; and provide revenues to PEV owners, reducing the upfront purchase costs of PEVs and making electric vehicles more economically viable alternative for California consumers. Advanced recycling processes in California will reduce the disposal impacts of PEV batteries in a safe, cost-effective, and environmentally sound manner, reduce California's reliance on imported lithium, and reduce the energy and material costs of in-state battery production.

Development and Prioritization of Proposed Funding Initiatives

The Energy Commission investment plan outlines a series of *strategic objectives* and *research initiatives* that incorporate the CPUC EPIC decision's defined program areas, guiding principles, electricity value chain, policy, and other ratepayer benefits. The strategic objectives and initiatives are based on current knowledge of state-of-the-art technologies and information, existing RD&D efforts, known barriers and knowledge gaps, and key factors driving clean energy development. Energy Commission staff developed the following framework to develop and prioritize the funding initiatives in this investment plan:

1. What are the policy goals, barriers to achieve them, and scale of the gaps?
2. What are funding opportunities to address these barriers?
3. Do the barriers require public funding to achieve these opportunities?
4. How big are the potential benefits, and at what cost?
5. Do the opportunities address needs unique to California?
6. Is the portfolio balanced in terms of risk, time frame, and the benefits to the residential, commercial, and industrial ratepayer sectors?

In developing and prioritizing the proposed funding initiatives, Energy Commission staff leveraged numerous resources including:

- **Energy Commission research roadmaps.** Research roadmaps are expert- and stakeholder-driven documents that provide strategic guidance on prioritizing research initiatives by summarizing current research, data gaps, connections to state policy, potential impact by cost, urgency and timeliness of outcomes, and potential partnerships with other funding entities. As part of the EPIC Investment Plan development process, the Energy Commission utilized the numerous research roadmaps developed to date as well as U.S. DOE roadmaps to identify gaps and funding opportunities. For example, the gaps analysis in the *Plug-in Hybrid Electric Vehicle Research Roadmap* (CEC-500-2010-039) found that there has been an abundance of basic chemical and battery formatting research conducted by battery manufacturers but minimal research into the second use of batteries after their primary vehicle application.

  To reduce program implementation costs, the Energy Commission will build on and update existing research roadmaps. Also, where needed, the Energy Commission will undertake new research roadmaps to further refine initiatives and funding priorities. Recognizing that funding decisions can be dynamic due to market, economic, and political changes, these roadmaps are also dynamic and will require periodic refinements or updates. Examples of roadmaps include:

  - *PIER Industrial, Agricultural, and Water Energy Efficiency Program RD&D Targets: Consolidated Roadmap* (http://www.energy.ca.gov/2011publications/CEC-500-2011-035/CEC-500-2011-035.pdf).

  - *Public Research on Advanced Generation Roadmap* (http://www.energy.ca.gov/2012publications/CEC-500-2012-079/CEC-500-2012-079.pdf).
  - *California Utility Vision and Roadmap for the Smart Grid of 2020* (http://www.energy.ca.gov/2011publications/CEC-500-2011-034/CEC-500-2011-034.pdf).
- **Institutional knowledge of Energy Commission staff.** The Energy Commission has extensive experience and expertise in administering programs to advance clean energy technologies. The Energy Commission's subject matter experts routinely conduct literature reviews, participate in state agency and utility collaborations, manage various R&D projects, attend Web forums, participate in technical/program advisory committees, and perform other activities and duties to stay informed about current issues and technologies. In addition, through the planning and management of past and current funding programs, the Energy Commission's subject matter experts have developed and sustained strategic but neutral partnerships with experts in industry, academia, government, and nongovernmental organizations that help avoid duplicative efforts, leverage investments, and build upon previous successful projects to ensure that the best technologies move forward. These partnerships have included enlisting businesses, utilities, researchers, advocacy groups, and institutions to provide input into various public planning processes and forums, serve on project technical advisory committees, and review project deliverables.
- **Expertise of the many stakeholders that provided comments during the investment plan proceeding.** California is home to many of the world's leading experts, companies, and institutions in the clean energy sector. To ensure the investment plan leveraged the expertise of these stakeholders, the Energy Commission conducted two two-day public workshops to solicit input on potential investment areas. These public workshops were held on August 2-3, 2012, in Sacramento and on August 9-10, 2012, in Los Angeles. Along with the oral comments provided at the workshops, the Energy Commission received more than 200 sets of written comments. The input and comments were used to shape and develop the proposed funding initiatives in a staff draft investment plan which was released to the public on September 21, 2012. On September 27, 2012, the Energy Commission conducted a public workshop to receive stakeholder comments on the staff draft investment plan. The comments provided at the public workshop, along with additional written comments submitted after the workshop, were used to further refine and prioritize the funding initiatives for the staff final investment plan.

Table 3: Stakeholder Workshop Schedule

Stakeholder Activity	Date and Location
Northern California scoping workshop	**August 2-3, 2012 in Sacramento**
Southern California scoping workshop	**August 9-10, 2012 in Los Angeles**
Staff draft investment plan posted	**September 21, 2012**
Public workshop to receive comments on staff draft investment plan	**September 27, 2012 in Sacramento**
Staff final investment plan posted	**October 22, 2012**

Source: California Energy Commission

Along with the decision's guiding principles, Energy Commission staff considered the following additional factors and criteria in developing and prioritizing proposed funding initiatives.

- **Policy Drivers.** California is at the forefront of energy policy and has developed some of the most aggressive clean energy goals in the world. Over the past several years, the state has developed a number of policy and planning documents to identify barriers, challenges, and strategies to achieve these goals. Energy Commission staff reviewed these documents to identify key policy drivers and barriers that need to be addressed to provide electric ratepayer benefits encompassed in state energy policy goals. These policy and planning documents include but were not limited to:
    - *Various Integrated Energy Policy Reports* (IEPR)
    - *California Energy Efficiency Strategic Plan* (CEESP)
    - *California Clean Energy Futures* (CCEF)
    - *AB 32 Climate Change Scoping Plan*
    - *Draft 2012 Zero Emission Vehicle (ZEV) Action Plan*

  Tables 4-7 provide examples of key policy drivers.

Table 4: Illustrative Energy Efficiency Initiative Policy Drivers

Efficiency

- "Lighting is the largest electrical load in both homes and businesses, accounting for 35 percent of commercial annual electricity use and 22 percent of residential annual use" - 2011 IEPR
- "California will need new, cost-effective technologies, strategies and innovations for existing and new buildings to reduce energy use, such as new building materials and fabrication techniques, and "smarter" building operating systems, such as visual displays of real-time energy use" - CEESP
- "New technologies and practices are needed in the industrial, agricultural and water sectors to maintain or increase productivity while reducing energy consumption and costs" - CEESP

Table 5: Illustrative Clean Energy Generation Initiative Policy Drivers

Clean Energy Generation

- "Energy Storage can provide a variety of integration services, but additional evaluation is needed"- 2011 IEPR
- "Distributed generation technologies will be deployed at significantly higher levels" - CCEF
- "Biomass electricity generation will be a major component of base-load generation in California" - CCEF

Table 6: Illustrative Smart Grid Initiative Policy Drivers

Smart Grid

- "The distribution systems need to use technologies that easily allow for two-way flow of electricity as well as improved communication technologies" - 2011 IEPR
- "Better model and simulation tools are needed to evaluate the operational requirements of the grid with a high penetration of distributed generation resources" - 2011 IEPR
- "Conduct demonstration projects to determine the value of used vehicle batteries as grid storage" - Draft ZEV Action Plan

Table 7: Illustrative Cross Cutting Initiative Policy Drivers

Cross Cutting

- "Establish an incubator program to acclerate the commercialization of the most promising technologies" - CEESP
- "As investment in the clean energy economy expands, there is increased need for a coordinated approach to workforce training that is closely alligned with labor demand" - 2011 IEPR
- "Advance the state's I-HUB Regional Innovation cluster program to support transfer of knowledge between national labs, academia and industry" - Draft ZEV Action Plan

- **Transformational Potential**. To ensure efficient use of ratepayer funds, it is important that the investment plan prioritize technologies and strategies with the potential for significant market penetration in California relative to business as usual as well as the potential to provide significant ratepayer benefits as described in the CPUC's EPIC decision. Energy Commission staff reviewed existing market and technology assessments, IEPR forecasts, and past research results to identify technologies and strategies that have the potential for large-scale deployment and adoption in California. For example, a study by ICF (CEC-500-2009-094-F) estimates California has more than 15 MW of additional CHP capacity, but under base case conditions, only about 3,000 MW will penetrate the market over the next 20 years.
- **Investment Scope.** There are a number of technologies that could provide ratepayer benefits but are beyond what EPIC investments are capable of funding. For example, emerging utility-scale renewable demonstration projects typically cost hundreds of millions of dollars.

Energy Commission staff has determined that projects of this size would not be an efficient use of ratepayer funds.

- **Potential Duplication With IOU EPIC Investment Plans.** The CPUC's EPIC decision requires the four administrators to file coordinated triennial investment plans. Throughout the investment plan process, Energy Commission staff worked collaboratively with the other three administrators (PG&E, SCE, and SDG&E), conducting conference calls, participating in each other's public workshops, and meeting periodically to coordinate investment plans and ensure funding initiatives were complementary and not duplicative. In furtherance of the guiding principles and goals of the EPIC energy RD&D program as set out by the CPUC, and in order to maximize the benefits of the program to electric utility ratepayers, the EPIC Administrators have agreed to pursue the following principles for cooperating and collaborating for EPIC-funded energy RD&D programs:
  - **Information Sharing and Coordinated Planning.** The EPIC Administrators will work together to address common goals, consistent with the State's energy and environmental policies and the guiding principles for energy RD&D as stated in the CPUC's EPIC Phase 2 decision. To this end, the EPIC Administrators will share information regarding their EPIC investment plans, programs and projects as much as practicable in order to maximize the efficient use of the funds and facilitate the dissemination of the results of the program efforts for the benefit of electric utility ratepayers.
  - **Leveraging Funding and Avoiding Duplication of Projects.** To the extent legally permissible, the EPIC administrators will work together to avoid unnecessary duplication of efforts, consistent with Public Utilities Code 740.1, and to leverage the EPIC funding for the benefit of electric utility ratepayers.
  - **Consistent Evaluation, Measurement and Verification of RD&D Results.** The EPIC administrators will work together to establish consistent and common evaluation, measurement and verification protocols for developing and reporting to the CPUC and stakeholders the performance and results of EPIC funded projects..
  - **Coordinated Input and Advice from Stakeholders.** The EPIC administrators will continue working together to schedule, solicit and respond to comments and advice from stakeholders on their respective proposed and on-going EPIC Plans and programs.
  - **Intellectual Property.** The EPIC administrators will work together and use best efforts to agree on common approaches to intellectual property rights to facilitate the dissemination and sharing of EPIC funded RD&D results for the benefit of electric utility ratepayers.

- **California Uniqueness.** It is also crucial that EPIC be nonduplicative and focus on California's uniqueness. The research needs in California are often different from those pursued by the federal government. The federal government typically spends far more research dollars on developing new technologies and materials to lower the component costs of the new or emerging technologies. Given this focus by the federal government, California can best use state funds addressing technology integration and demonstrations

closer to the end application. For example, over the last decade the U.S. DOE has spent billions on reducing the material and manufacturing costs of renewable technologies and research efforts in California focused on renewable integration, reducing barriers to expanding renewables on the grid, and demonstrating grid-scale and customer renewable technologies. However, in California DR is critical to the management of the high peak load on the grid, so California has invested heavily in implementing new DR technologies, policies, and automation. At the same time, the federal government has focused the majority of its efforts on national policy, rates, and tariffs rather than technology development or demonstration. In critical areas such as energy storage, microgrids, or distributed renewables, California often is a leader in fielding and demonstrating these technologies and can work actively with the federal government to jointly fund future efforts that are valuable to both missions. In some of these cases, California can be the test bed for the entire country. In other cases, the state has unique attributes such as a hot dry climate, so building and residential energy efficiency technologies that work well in California are not effective in the humid, moist areas of the North, East, and South. Also, with California's location on the Pacific's "ring of fire" and due to tectonic plate convergences, California contains the largest amount of geothermal generating capacity in the United States and leads the industry in converting these resources into useful baseload renewable generation.

Due to the increased penetrations of intermittent renewables and the demand for more to come on-line given the aggressive 33 percent RPS, California will need to be at the forefront of addressing renewable integration issues. Further, California has some of the most polluted air basins in the country and that, coupled with some of the most progressive and forward-thinking state and local air quality management organizations in the nation, is leading to electrification of the state's transportation fleet to help meet strict air quality requirements. System integration issues due to high penetration of electrical vehicles will also be an issue that California will have to explore. Lastly, policy goals in California push for a more distributed electricity supply chain, which will strain the state's aging T&D grids. Integration of a distributed electricity supply will present unique challenges to California that R&D dollars should target. Under EPIC, the Energy Commission will continue its approach of ensuring that California funds and federal funds are leveraged to the maximum extent possible while avoiding duplication of work being done by other entities, federal or otherwise.

Energy Innovation Pipeline

Ensuring a reliable, safe, clean, and diverse electricity system remains one of the most important elements toward securing economic, environmental, and state energy security. The need to expand and diversify California's energy sources from traditional fossil fuel sources is now well understood and embedded in state energy policy. However, major barriers remain, including higher costs of new technologies. Private sector investments in early-stage, untested

technologies often present financing risks for profit-minded business models. The maturation process for new technologies from early- to market-stage adoption requires several steps known as the energy innovation pipeline. The earliest phase of the energy innovation pipeline is basic or fundamental research. This is characterized as expansion of knowledge without a predefined commercial application or invention in mind. Basic research lays the foundation for applied science, and there is no obvious commercial value to the discoveries that result from basic research.[11] The EPIC Program excludes basic research. This category is typically supported by national labs and research universities.

The next phases of the energy innovation pipeline consist of early feasibility, such as lab or field research, bench- and pilot-scale testing, and full-scale demonstration and deployment. The latter two steps also require monitoring and validation studies to provide proven assurances to be fully embraced by private markets. Promising innovations often languish unless supported by public investments. Within the energy innovation pipeline, two critical stages of financing gaps have been recognized – the bridge to move beyond the applied research stage (for example, from lab to pilot-scale) and the bridge between demonstration and commercialization. These two economic barriers are described by Jenkins and Mansur (2011) as the "Technology Valley of Death" and the "Commercialization Valley of Death" and are considered the greatest barriers to innovative energy prototypes and innovative entrepreneurs entering the market place.[12]

In his 2006 article in *Innovations*, John P. Holdren of Harvard University outlined the acute need for investment and deployment on new energy technologies.[13]

> "In this context, the needed process of innovation in energy technology must be understood as not consisting only of research and development (R&D), but also of at least equal emphasis and resources devoted to demonstration at commercial scale and in diverse contexts of the technological improvements that R&D have made possible and to mechanisms to promote accelerated deployment of those demonstrated options that offer the greatest leverage for reducing important externalities and enhancing important public goods. The energy-technology-innovation 'pipeline' is full of potentially valuable—even potentially crucial—technologies at every stage of development, and it is no less important to push along toward full commercialization those that are already close to that threshold than to be doing the applied research and early development needed to move forward the more 'far out' possibilities."

11 http://www.lbl.gov/Education/ELSI/research-main.html.

12 Jenkins, J., & Mansur, S. (2011). Bridging the Clean Energy Valleys of Death: Helping American Entrepreneurs Meet the Nation's Energy Innovation Imperative. Breakthrough Institute. Retrieved from http://thebreakthrough.org/blog/Valleys_of_Death.pdf

13 http://www.policyinnovations.org/ideas/policy_library/data/energy_innovation

Holdren also acknowledged that private sector investments in research, development, and deployment are inadequate due to corporate environments that rely on short-term and high rates of return, which R&D is not likely to provide.

Within the energy innovation pipeline there are critical funding gaps not adequately addressed by the private sector due to market barriers. Private venture capital firms, while accustomed to making risky speculative bets on new technologies, avoid investing in early-stage technologies and instead opt to invest when a technology is only a few years from production.[14] Private funding is also rarely enough to fund energy technologies. Unlike software and other large technology industries, demonstrating and assessing precommercial energy technologies often require prohibitively large amounts of money over many years.

To illustrate the type of research the Energy Commission expects to fund in the EPIC Program, below are examples of projects that returned significant ratepayer benefits but likely would not have received initial private sector funding:

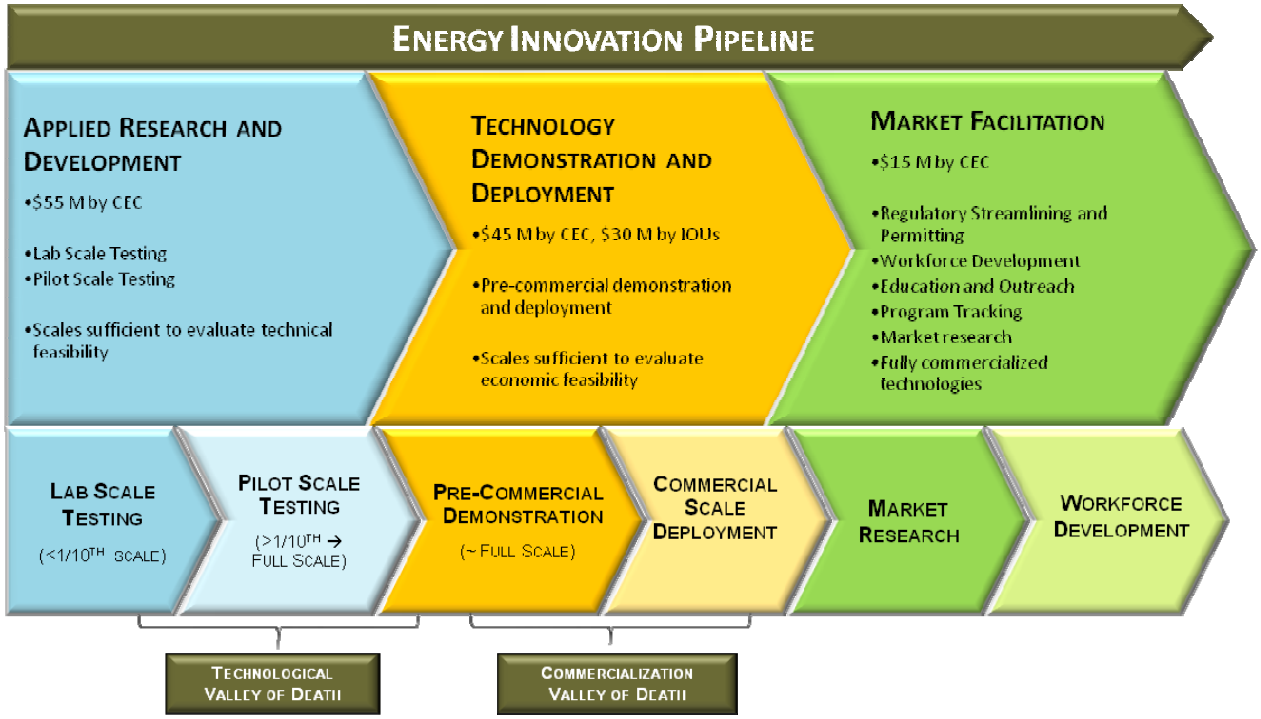
- Synchrophasor research was seed funded for a decade by the U.S. DOE and the Energy Commission and matched by several utilities. A synchrophasor is a piece of hardware that provides real-time information about the performance of electrical transmission systems. Synchrophasors, and associated analysis tools, provide a more precise indication of transmission stability and an early warning of possible problems. Wide deployment of synchrophasors in a smart grid will deliver power more reliably and efficiently and match load with intermittent renewable resources. It is unlikely that the private sector would have invested in the broad development of synchrophasor applications even though the advancements have resulted in multimillion-dollar benefits from improved grid reliability as well as enabling increased renewable energy integration. This technology is most effective when deployed widely over the Western Interconnection, making it cost-prohibitive for a single company to invest in and profit from its development.
- Since its inception, the Energy Commission has conducted research to develop some of the most aggressive statewide energy efficiency standards in the nation. More recently, the results of research incorporated into California's Appliance Efficiency and Building Standards will result in annual cost savings of more than $1 billion for California electric and natural gas ratepayers upon full implementation. The annual cost savings are based on six research measures adopted into the codes: external power supply, residential furnace fan efficiency, television energy use, roofs that reflect heat (known as *cool roofs*) for homes, residential attic/duct model, and battery chargers. It is unlikely that the private sector would have invested in such research.

14 Weiss, C., & Bonvillian, W. (2009). *Structuring an Energy Technology Revolution.* Cambridge Mass.: MIT Press. Pg. 20.

- A significant challenge in developing renewable energy projects is often the lack of data necessary to complete environmental permitting requirements. The Energy Commission's research aided environmental review and permitting of renewable energy facilities in California's deserts and is contributing to the Desert Renewable Energy Conservation Plan (DRECP). The goal of the desert research program is to remove barriers and delays in the siting of renewable energy generation and transmission lines in the desert by addressing critical data gaps that can hinder and lead to costly delays in environmental permitting. Though this research is just beginning, DRECP agencies and stakeholders are using results in current environmental planning, permitting, and analysis and in designing renewable energy facilities with fewer environmental impacts. It is unlikely that the private sector would have invested financially in such research. However, the research will benefit the state and ratepayers by advancing the state's RPS goal and ensuring that desert renewable energy projects provide clean energy and jobs while protecting the state's desert ecosystems.

The Energy Commission will focus EPIC investments on addressing conditions in which private investment is either unlikely to be invested at all or if invested would be inadequate to resolve barriers promptly. Investments will also be targeted to projects where publicly available data can reduce the cost of clean energy technologies to the ratepayers.

Figure 2: Energy Innovation Pipeline



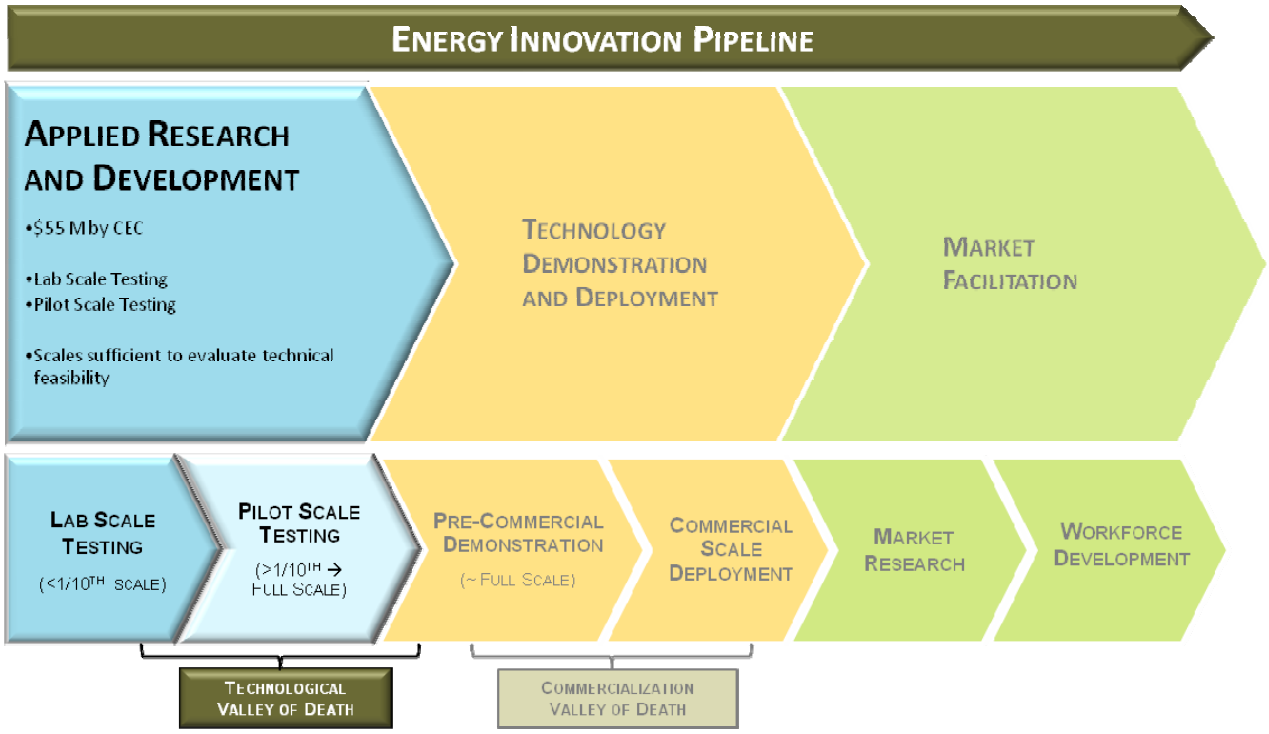
Source: California Energy Commission

The CPUC's approach to investments in clean energy research recognizes these market-driven scientific and financial barriers by allocating funding to three interconnected stages of development, as displayed in Figure 1. The Applied Research and Development program area will support precommercial technologies by providing funding needed to help bridge the technology valley of death. The Technology Demonstration and Deployment program area funding is devoted to installing and testing precommercial technologies or strategies at scales sufficient to evaluate operational performance and financial risk. Finally, the Market Facilitation program area funding is designed to support late-stage market barriers including monitoring, workforce development, public outreach and training, and regulatory assistance.

The Technology Demonstration and Deployment and Market Facilitation program areas will be crucial to bridge the commercialization valley of death. Through the EPIC Program, the Energy Commission will fill critical funding gaps to ensure an interconnected innovation pipeline for promising and innovative technologies with the greatest potential to provide benefits to IOU ratepayers.

Subsequent chapters of this report describe how the Energy Commission plans to bring new energy technologies to market through this first triennial investment plan's proposed funding initiatives. To make this investment plan easier to navigate, the strategic objectives in Chapters 3, 4, and 5 are color coded, matching the program area addressed to the program area's color from Figure 1. Figure 1 is reproduced at the beginning of each chapter as a visual reference.

CHAPTER 3:
Applied Research and Development



Through the Applied Research and Development program area, the Energy Commission will address gaps in the funding needed to help innovative energy technologies and approaches bridge the "Technological Valley of Death." For this three-year investment plan, the Energy Commission will provide $158.7 million for applied research and development (R&D) funding for development of new technologies, methods, and approaches from early bench-scale up to pilot-scale prototype demonstration. This will include activities that address environmental and public health impacts of electricity-related activities, support building and appliance standards, and promote clean transportation. Each strategic objective below outlines a set of initiatives focused on a particular area of proposed research. The strategic objectives are:

- **Energy Efficiency and Demand Response**
  - S1 Strategic Objective: Develop Next-Generation End-Use Energy Efficiency Technologies and Strategies for the Building Sector.

- S2 Strategic Objective: Develop New Technologies and Applications That Enable Cost-Beneficial Customer-Side-of-the-Meter Energy Choices.

- **Clean Generation**
  - S3 Strategic Objective: Develop Innovative Technologies, Tools, and Strategies to Improve the Affordability of Distributed Generation.
  - S4 Strategic Objective: Develop Emerging Utility-Scale Renewable Energy Generation Technologies and Strategies to Increase Power Plant Performance, Reduce Costs, and Expand the Resource Base.
  - S5 Strategic Objective: Reduce the Environmental and Public Health Impacts of Electricity Generation and Make the Electricity System Less Vulnerable to Climate Impacts.

- **Smart Grid-Enabling Clean Energy**
  - S6 Strategic Objective: Develop Technologies, Tools, and Strategies to Enable the Smart Grid of 2020.
  - S7 Strategic Objective: Develop Operational Tools, Models, and Simulations for Improved Planning of Grid Resources.
  - S8 Strategic Objective: Integrate Grid-Level Energy Storage Technologies and Determine Best-Use Applications to Provide Locational Benefits.
  - S9 Strategic Objective: Advance Technologies and Strategies That Optimize the Benefits of Plug-in Electric Vehicles to the Electricity System.

- **Cross-Cutting**
  - S10 Strategic Objective**:** Leverage California's Regional Innovation Clusters to Accelerate the Deployment of Early-Stage Clean Energy Technologies and Companies.
  - S11 Strategic Objective: Provide Cost Share for Federal Awards.

Table 8: Proposed Funding Allocation for the Applied Research and Development Program Area by Strategic Objective

Funding Area	Amount (Millions)
Energy Efficiency and Demand Response	**$64.7**
S1 Strategic Objective: Develop Next-Generation End-Use Efficiency Technologies and Strategies for the Building Sector.	$43.3
S2 Strategic Objective: Develop New Technologies and Applications That Enable Cost-Beneficial Customer-Side-of-the-Meter Energy Choices	$21.4
Clean Generation	**$44.0**
S3 Strategic Objective: Develop Innovative Technologies, Tools, and Strategies to Improve the Affordability of Distributed Generation	$19.5
S4 Strategic Objective: Develop Emerging Utility-Scale Renewable Generation Technologies and Strategies to Increase Power Plant Performance, Reduce Costs, and Expand the Resource Base	$9.5
S5 Strategic Objective: Reduce the Environmental and Public Health Impacts of Electricity Generation and Make the Electricity System Less Vulnerable to Climate Impacts	$15.0
Smart Grid Enabling Clean Energy	**$23.0**
S6 Strategic Objective: Develop Technologies, Tools, and Strategies to Enable the Smart Grid of 2020	$8.0
S7 Strategic Objective: Develop Operational Tools, Models, and Simulations for Improved Planning of Grid Resources	$5.0
S8 Strategic Objective: Integrate Grid-Level Energy Storage Technologies and Determine Best Use Applications to Provide Locational Benefits	$6.0
S9 Strategic Objective: Advance Technologies and Strategies That Optimize the Benefits of Plug-in Electric Vehicles to the Electricity System.	$4.0
Cross-Cutting	**$27.0**
S10 Strategic Objective: Leverage California's Regional Innovation Clusters to Accelerate the Deployment of Early-Stage Technologies and Companies	$27.0
S11 Strategic Objective: Provide Cost Share for Federal Awards*	$ -
Applied Research and Development Program Area Total	**$158.7**

*S11 funds are drawn from allocations in S1 – S10

The proposed funding allocations for the Applied Research and Development Program Area by Strategic Objective provided in Table 8 were developed based on the priorities defined in the CPUC EPIC decision and the expected level of effort of applied research and development needed to fully address each of the specific strategic objectives. These funding levels are estimates and may change based on the number of successful responses received from competitive solicitation awards and the amount of leveraging of the EPIC funds from other parties that can be obtained by strategic objective. For S11, *Provide Cost Share for Federal Awards,*

up to 10 percent of the funding allocated for the applied research and development strategic objectives can be applied to providing cost share for these types of competitive federal awards.

The following section describes each strategic objective under applied R&D and its associated planned research initiatives.

Energy Efficiency and Demand Response

S1 Strategic Objective: Develop Next-Generation End-Use Energy Efficiency Technologies and Strategies for the Building Sector

Table 9: Ratepayer Benefits Summary for Strategic Objective 1

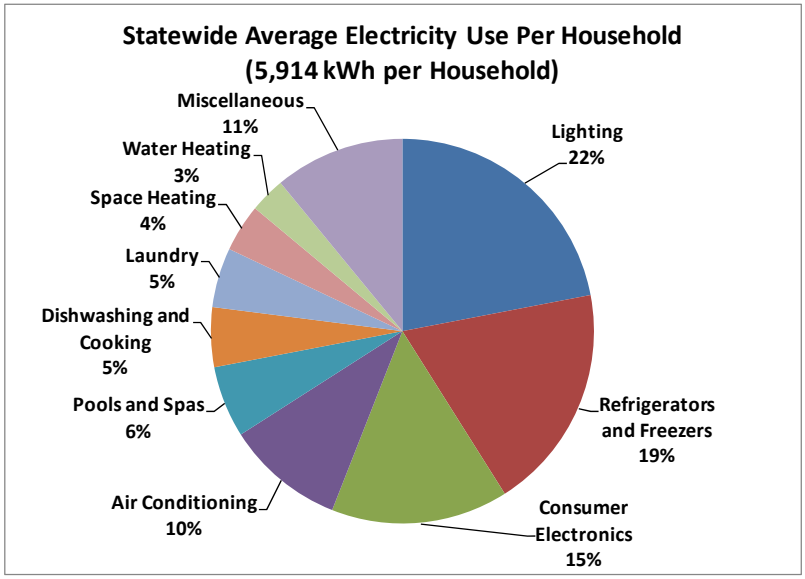
	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/ transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S1.1 Develop, Test, and Demonstrate Next-Generation Lighting Systems and Components.	X	X		X	X		X	X	
S1.2 Develop, Test, Demonstrate, and Integrate Equipment, Systems, and Components That Improve the Energy Efficiency Existing and Advanced Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.	X	X		X	X		X	X	
S1.3 Develop, Test, and Demonstrate Advanced Building Envelope Systems, Materials, and Components.	X	X		X	X		X	X	
S1.4 Investigate and Improve Understanding of Building Occupant Behavior and Related Consumer Choice Motivations to Increase and Sustain Energy Efficiency Improvements in Buildings	X	X		X	X			X	
S1.5 Develop Cost-Effective Retrofit Strategies to Achieve Greater Energy Efficiency in Existing Residential and Nonresidential Buildings.	X	X		X	X		X	X	
S1.6 Reduce the Energy Use of Plug-Load Devices Through the Development of Products, Systems, and Controls, and Evaluation of Consumer Behavior That Affects Energy Use.	X	X		X	X		X	X	
S1.7 Develop and Evaluate Ideal Strategies to Improve Indoor Air Quality in Energy-Efficient Buildings		X	X	X				X	
S1.8 Develop Cost-Effective Technologies and Approaches to Achieve California's Zero Net Energy Buildings Goal.	X	X		X	X		X	X	X

Source: California Energy Commission

Electricity use in residential and commercial buildings accounts for about 69 percent of electricity consumed in California. The Energy Commission and the California Public Utilities Commission (CPUC) have adopted a goal of achieving zero net energy building standards by 2020 for homes and by 2030 for commercial buildings. Achieving these goals cost-effectively will require development and adoption of advanced building energy efficiency technologies and strategies beyond what is currently commercially available.[15]

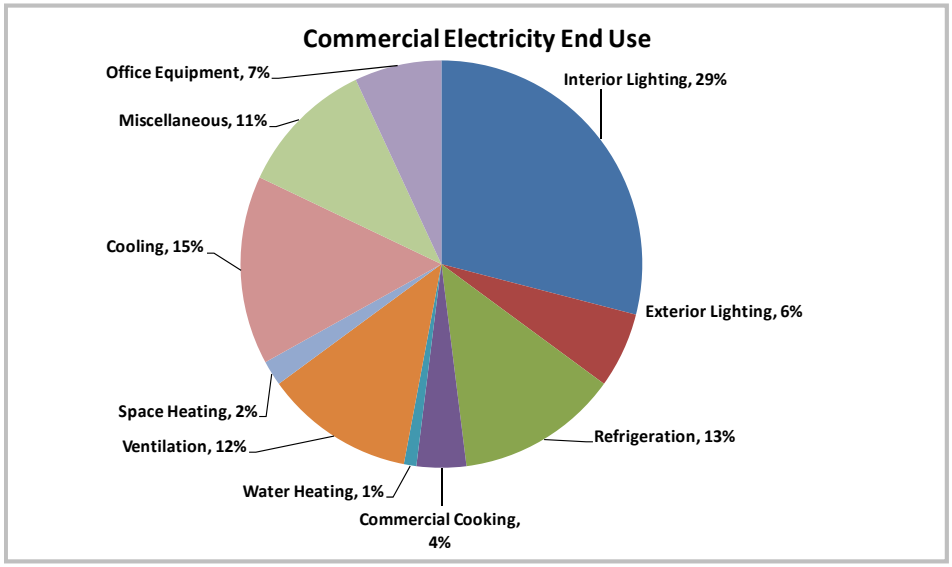
Most of the electricity used in residential and commercial buildings is for lighting, air conditioning, refrigerators, and consumer electronics.[16, 17] Significant strides have been made, but innovation is needed to increase the efficiency of lighting sources and their controls,

Figure 4: Statewide Average Residential Electricity Use



Source: *California Energy Efficiency Strategic Plan*, January 2011, page 10, http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/

Figure 3: Statewide Average Commercial Electricity Use



Source: California Commercial End Use Survey, March 2006, page 9, http://www.energy.ca.gov/2006publications/CEC-400-2006-005/CEC-400-2006-005.PDF

15 *California Energy Efficiency Strategic Plan.*

16 *California Residential Appliance Saturation Study,* 2010, www.energy.ca.gov/appliances/rass/.

17 *Commercial End Use Survey,* 2006.

cooling, ventilation, and refrigeration systems, and office electronics. This also includes integration of multiple technologies in whole buildings, due to the interactive effects that one technology can have on the other. For instance, reducing lighting load and improving the building envelope can affect air-conditioning and ventilation requirements. This comprehensive approach will be needed to achieve zero net energy use for new commercial buildings by 2030 and to achieve zero net energy or near zero net energy (with deep retrofits) for at least half of existing commercial buildings by 2030.[18]

Achieving the transformational goals for the residential and commercial sector contained in the *California Energy Efficiency Strategic Plan* will involve novel research that includes developing advanced energy efficiency technologies, services, and products; encouraging their use through utility incentive programs or building energy efficiency codes; and evaluating the behavior of energy users.

Applied research on energy efficiency technologies and strategies, as described in this section, can provide the foundational justification for future utility rebate and incentive programs. The Energy Commission's EPIC Program therefore plans to coordinate closely with the Emerging Technologies Coordinating Council (ETCC).[19] The ETCC will provide an opportunity for members to meet, collaborate, and exchange information on energy efficiency research and to provide a path for promising technologies to the marketplace. The ETCC focuses on identification, assessment, and rapid commercialization of energy-reducing technologies. The resulting products of the EPIC-funded applied research can help investor-owned utilities (IOUs) meet the energy efficiency goals set by the CPUC – namely that the IOU energy efficiency programs need to help California save 23 billion kilowatt hours (kWh) of electricity and 45 million therms of natural gas. This is the annualized equivalent of taking nearly 2 million cars off the road and lighting 3.4 million homes.[20] Ratepayers benefit with better, lower cost and more cost-efficient projects with validated savings.

Potential research initiatives that were removed from consideration were those that had undetermined energy efficiency research benefits in advancing science and technology, required regulatory rate changes to be cost-effective, or could be considered in the future based on results of current research, roadmapping, or other IOU/CPUC-related activities. Examples of initiatives that were eliminated include projects that emphasized bioenergy improvements with

18 *California Energy Efficiency Strategic Plan.*

19 Members of the ETCC include Pacific Gas and Electric, San Diego Gas & Electric, Southern California Gas, Southern California Edison, the Sacramento Municipal Utility District, the California Public Utilities Commission and the California Energy Commission.

20 Emerging Technology Coordinating Council, http://www.etcc-ca.com/about/11?task=view.

no energy efficiency benefits, peak load-reducing technologies such as thermal energy storage that required special rate structures, and graywater reuse technologies.

Much of the research in this strategic objective will help provide the analysis and pilot activities to demonstrate the technical and economic feasibility of the technologies. Once this can be demonstrated, companies have an easier time securing private venture capital and other funding to further develop and improve the technology. The research in this strategic objective can also be used in developing future energy efficiency codes and standards, which is not research typically conducted by the private sector since it provides limited monetary benefit. Without the baseline data, testing, and analysis of existing equipment use and the potential benefits from higher efficiency equipment that this research will provide, it will be difficult to justify the continual strengthening and expansion of the building and appliance codes identified as needed by the *California Energy Efficiency Strategic Plan.*

S1.1 Proposed Funding Initiative: Develop, Test, and Demonstrate Next-Generation Lighting Systems and Components.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X							**X**

Issue: Lighting represents nearly 25 percent of California's electricity use and costs Californians about $10 billion each year. Though significant improvements have been made in lighting efficiency, continued innovation in energy-efficient lighting technologies and lighting systems is necessary to meet the *California Energy Efficiency Strategic Plan* goal of 60 to 80 percent reduction in electrical lighting energy consumption by 2020.[21] Similarly, light-emitting diodes (LEDs) offer benefits over compact fluorescents and other lighting technologies due to their high efficiency and more diverse design options but need innovative improvements to reduce cost and improve light spectrum quality and fixture design. In addition, natural daylight is underused in most buildings due to nonoptimized building design and lack of control systems to seamlessly integrate natural lighting with electric lighting. Furthermore, despite automatic occupancy controls many lights in existing buildings remain uncontrolled and stay on when they are not needed.

21 http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf (see Chapter 13).

Purpose: This initiative will conduct research that promotes the development and implementation of new technologies and market applications to promote lighting systems and components with improved energy efficiency and performance. The focus will be to:

- Improve and develop whole lighting systems and components.
- Develop design and simulation tools that will encourage cost-effective daylighting,[22] as well as best retrofit strategies.
- Improve control systems to integrate electric lighting with natural lighting, coupled with optimal fixtures that lead to better overall light quality and consumer acceptance.
- Evaluate self-commissioning systems to compensate for installer inexperience, improve performance, and reduce installed costs.
- Conduct lab, bench-scale, and pilot programs to estimate energy savings and other benefits, identify technologies that are candidates for utility incentive programs, and inform future updates to building and appliance energy efficiency standards.
- Engage local experts and other stakeholders through public workshops to identify research priorities and needs associated with lighting-related R&D with the goal of providing cost-effective benefits to California ratepayers.

Stakeholders: Electric ratepayers who own and operate buildings and facilities, equipment manufacturers, lighting designers, researchers and utilities.

Background: Lighting offers significant opportunities for energy savings and peak demand reductions. Many new products that promise more efficient lighting, including LEDs, are beginning to enter the market, but additional work is needed to realize the full potential of these light sources. Increased interest, awareness, and emphasis on energy efficiency combined with rapid technological advances in LEDs and lighting controls systems could transform the lighting industry. This, in turn, will create opportunities for faster acceptance of new technologies that can accelerate reductions in energy consumption and greenhouse gas (GHG) emissions.

Lighting research focuses on advancing the Energy Commission and state energy policies by accelerating the development and commercialization of technologies through demonstration, outreach, education, and training. This initiative will complement past and current work on lighting and controls.

22 *Daylighting* is using natural light — for example, from direct sunlight or skylights — into a building to reduce electric lighting and saving energy.

S1.2 Proposed Funding Initiative: Develop, Test, Demonstrate, and Integrate Equipment, Systems, and Components That Improve the Energy Efficiency of Existing and Advanced Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Heating, ventilating, and air-conditioning (HVAC) and refrigeration systems consume nearly 33 percent of California's electricity in the residential buildings sector and 42 percent in the commercial buildings sector.[23] It is not only a huge draw on the electric system, but the HVAC load also occurs during the summer peak demand period. Finding ways to reduce HVAC and refrigeration loads will be critical to reducing electrical demand, saving ratepayer money, reducing the need to run peaking units, and improving system reliability. Efficiency gains will reduce energy consumption and are key to achieving the state's zero net energy building goals.

Few HVAC and refrigeration systems perform at their maximum efficiency due to improper equipment sizing, undercommissioning, lack of recommissioning, changes in design and operating conditions, undetected faults, degradation, lack of maintenance, and refrigerant issues. Recent renovations of retail space have resulted in the addition of refrigeration and freezer units into space never designed to be a grocery store. This has resulted in operating inefficiencies of the HVAC units and increased energy use.

Purpose: This initiative will focus on the following areas:

- Improve the efficiency of existing HVAC and refrigeration systems.
- Develop advanced energy-efficient equipment and systems that are optimized for California climates.
- Optimize integration of HVAC and refrigeration systems.
- Develop fault detection and diagnostic tools and test protocols, especially for package and split-system air conditioners and refrigeration equipment to ensure continued system performance and energy efficiency over time.

23 *California Energy Efficiency Strategic Plan*, January 2011 Update—see also Figure 3.

- Develop simulation models, performance modeling rule sets to promote utility incentives and compliance credit for innovative systems, test protocols to detect refrigerant issues (for example, leakage, contamination, and flow restrictions), and appropriate design guides.
- Develop and implement pilot programs for candidate technologies.
- Engage local experts and other stakeholders through public workshops to identify research priorities and needs associated with HVAC and refrigeration-related research and development with the goal of providing cost-effective benefits to California ratepayers.

The research in this initiative endeavors to address barriers that lead to inappropriate equipment sizing with an emphasis on whole system integration that considers all components while also ensuring continued system performance and energy efficiency over time. These efforts could be accomplished by developing fault detection and diagnostic tools, test protocols, and new approaches to detecting and reducing refrigerant leakage, a source of GHG emissions.

This initiative will be coordinated with other ongoing CPUC/IOU activities/studies. This will ensure that the research and work scope will a) benefit and inform CPUC/IOU efficiency policy and b) be consistent with energy, monitoring and verification frameworks, standards, and the *California Energy Efficiency Strategic Plan*'s *HVAC Action Plan*.[24]

Stakeholders: Electric ratepayers who own and operate buildings, HVAC equipment manufacturers and contractors, engineers, building designers, academia, researchers and utilities.

Background: HVAC and refrigeration systems are among the largest consumers of electricity in residential and commercial buildings and are therefore one of the primary targets for reducing energy consumption. Reductions in HVAC energy consumption have also been targeted by the CPUC in its 2010-12 and 2013-14 IOU energy efficiency portfolio and are a component of utility incentive programs.[25] [26] The IOUs, HVAC designers and contractors, and regulators also need better and simpler simulation tools to help design and evaluate high efficiency systems, justify incentive levels, and develop and improve energy efficiency standards.

Past research focused on advanced evaporative air conditioners, radiant floor cooling, and underfloor air-distribution systems. For instance, research to evaluate the benefits of radiant

24 HVAC Action Plan, http://www.cpuc.ca.gov/NR/rdonlyres/25B56CBE-7B79-41BC-B1C0-AE147F423B19/0/HVACActionPlan.pdf.

25 http://www.energy.ca.gov/2011_energypolicy/documents/2011-07-20_workshop/presentations/Cathy_Fogel_Current_Public_Goods_EE_Program_for_Existing_Buildings.pdf.

26 http://www.calmac.org/events/EE_and_MEO_2103-14_decision_166830.pdf.

cooling systems resulted in the adoption of this technology by several Wal-Mart stores located in hot, dry climates. A ceiling-mounted radiant cooling system for homes is under development. Additional work is required to move these technologies to the next level and potentially integrate them with other HVAC systems such as thermal energy storage. This initiative will further develop and pilot test these technologies, improve their performance and cost-effectiveness, and move them closer to wide-scale deployment and commercialization.

There has also been promising research on the development of automated tools for fault detection and diagnostics. These tools can help building operators detect and address operating problems promptly and automatically reduce energy cost and waste. However, additional research is needed to improve validation and standardization of these tools for broader adoption by the building industry. Research is also needed to ensure sufficient validated data collection for a variety of HVAC systems and system faults to increase confidence in diagnostic protocol evaluation. This tool will help HVAC contractors and facility managers make appropriate decisions to ensure energy-efficient operations of equipment.

The areas to be investigated in this initiative were identified through public workshops, internal deliberative discussions with the Energy Commission's Building and Appliance Energy Efficiency rulemaking staff, and public comments on the draft EPIC investment plan.[27]

S1.3 Proposed Funding Initiative: Develop, Test, and Demonstrate Advanced Building Envelope Systems, Materials, and Components.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Building energy efficiency, durability, and habitability are strongly influenced by the building envelope, which consists of the structure's outer shell. Elements of the building envelope include doors, windows, skylights, roofs, walls, foundations and their constituent materials, and the overall envelope design in which the elements reside. Across the United States, 38 percent of residential building energy use is related to heating and cooling, and a

27 August 2011 workshop: http://www.energy.ca.gov/research/notices/2011-08-31_workshop/presentations/ and February 2012 workshop: http://www.energy.ca.gov/research/notices/2012-02-23_workshop/presentations/ and comments on the EPIC plan: http://www.energy.ca.gov/research/epic/documents/2012-09-27_workshop/comments/

large fraction of this is related to the building envelope.[28] New materials, manufacturing techniques, and technologies for improving the performance of existing structures are becoming available.

These technologies and techniques show promise but often need further development and validation before they enter the market.[29] Simulation tools may lack the ability to model specific benefits of these new systems and will need enhancement to include characteristics of the new materials, components, and designs. For example, dynamic windows, which are electrically controllable to manage light transmittal, are now in an early stage of market deployment, but accurate simulation of the energy benefits of these windows will require further assessment of the window performance as well as further development of simulation tools.[30]

While lighting components are easily replaced and HVAC equipment is replaced every 20 years or so, envelope features and components often last for the life of the building. This makes these features disproportionately important in terms of energy use. Envelope features affect not only the energy consumption of a building, but the health and comfort of its occupants. Poorly placed windows can cause thermal discomfort and glare. Materials that emit air toxics can affect occupant health, with recent studies implicating building materials in air quality issues.[31] Even when buildings are well-designed and materials are carefully selected, improper construction methods can lead to air and water leakage that can affect occupant health and building efficiency and durability.[32]

More work is needed in this area because past research indicates that many new buildings do not perform as well as they could and often exhibit comfort, performance, and energy deficiencies from the first day.[33] Since the private sector will not do this research because there is generally no way of recouping the investment required, public investment is required.

Purpose: This initiative will conduct research to improve the performance of building envelope systems, materials, and components. The primary focus is to improve and develop cost-effective products, systems, and materials including whole-building designs, manufacturing techniques, and simulation tools to ease their successful entry into the market and to advise future building energy efficiency standards. The initiative will:

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28 http://www.c2es.org/technology/factsheet/BuildingEnvelope.

29 http://www1.eere.energy.gov/buildings/envelope_rd.html.

30 http://apps1.eere.energy.gov/buildings/energyplus/.

31 http://homes.lbl.gov/content/hazard-assessment-chemical-air-contaminants-measured-residences.

32 http://www.energy.ca.gov/2007publications/CEC-500-2007-036/CEC-500-2007-036.PDF.

33 *Efficiency Characteristics and Opportunities for New California Homes (ECO) - Final Project Report*, http://www.energy.ca.gov/publications/displayOneReport.php?pubNum=CEC-500-2012-062.

- Engage local experts and other stakeholders through public workshops to identify research priorities and needs associated with envelope-related R&D with the goal of providing cost-effective benefits to California ratepayers in the form of lower energy bills and healthier, more durable, and more comfortable residential and commercial structures.
- Identify needed improvements that can increase the energy efficiency of building envelope systems, materials, and components. This will be accomplished by using research and product developments discovered during assessments and targeting other ongoing complementary research.
- Evaluate new materials and components for building envelopes and evaluation of durability and energy performance. For example, infrared reflective pigments incorporated into wall paints may be able to reflect nearly half of the incident solar energy, potentially reducing cooling loads, but research is needed to validate their energy performance and durability.
- Assess the most effective ways to measure the performance of building envelopes and promote techniques that achieve high performance, including manufacturing processes.
- Develop and implement pilot programs for candidate technologies.

Managers in California IOU emerging technology programs have expressed support for this type of research and have proposed that some research activities be conducted in harsher climates in Southern California.

Stakeholders: Electric ratepayers who own and operate buildings and facilities, equipment manufacturers, engineers, building designers and developers, academia, and utilities.

Background: Research has been conducted to make buildings more efficient by promoting new envelope systems and other building components that are efficient, durable, and cost-effective. The results from past research were the basis for the initiatives in this section. Examples of past research include:

- Fenestration: Lawrence Berkeley National Laboratory's Windows and Facades test bed has looked at innovative ways to cut energy use in windows and window treatments. This has resulted in developing improved modeling and simulation tools. New types of windows that dramatically reduce infiltration are used in passive houses in Europe, but the high cost of these windows is a market barrier in the United States. Assessments of the benefit of these windows and development of manufacturing approaches to reduce their cost are needed to ease market entry.[34] Windows often allow water to leak inside walls, potentially leading to mold growth. Window improvements that eliminate this source of leakage need development and independent validation to enhance building durability and ensure that

34 http://buildings.lbl.gov/.

these products perform as claimed.[35] Further research is required to develop more robust daylight discomfort glare models to enable improvement in automated controls.[36] Interior shade products can reduce cooling loads and improve thermal comfort but are not as effective as exterior systems. Additional research is needed to promote integrated designs and create the demand for high-efficiency buildings.[37]

- Roofing and building envelope: Past research has resulted in developing innovative cool roof materials. New roofing materials include coatings that increase reflectivity and emissivity[38] and keep structures cooler during hot, sunny summer months. Efforts are also underway to integrate solar photovoltaic (PV) cells more effectively into roofing materials.[39] Other envelope improvements, such as insulation at the roof plane and sealed attics, are also being tested and need rigorous validation. Retrofit technologies like techniques for sealing existing building envelopes with adhesive mist show great promise, but research is needed to monitor and verify energy and cost savings.
- Building manufacturing: Improvements in manufacturing processes, such as use of in-shop manufacturing and quality control for entire wall sections, can reduce waste and construction defects that typically plague site-built structures. The benefits of these techniques need assessment and possible credit in building standards. All of these new building techniques, materials, and components require updated simulation tools to provide accurate information to designers, engineers, and standards developers.

S1.4 Proposed Funding Initiative: Investigate and Improve Understanding of Building Occupant Behavior and Related Consumer Choice Motivations to Increase and Sustain Energy Efficiency Improvements in Buildings

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X							**X**

35 http://www.energy.ca.gov/2007publications/CEC-500-2007-036/CEC-500-2007-036.PDF.

36 High Performance Building Façade Solutions: http://gaia.lbl.gov/btech/papers/4583.pdf.

37 Ibid.

38 Emissivity refers to a material's ability to release absorbed heat. In warm and sunny climates, highly emissive roof products can help reduce the cooling load on a building by releasing heat absorbed from the sun.

39 http://heatisland.lbl.gov/coolscience/cool-science-cool-roofs.

Issue: Energy used in buildings varies widely depending on occupant behavior. Energy use is also significantly affected by consumer purchasing decisions regarding appliances and electrical devices. Understanding building occupant attitudes, patterns, and motivations that affect energy use behaviors is critical to identifying and tailoring strategies that will result in persistent energy savings. Issues include:

- Types of technologies and information needed by particular individuals and groups that will address their needs, values, and motivations.
- How to effectively identify target customers for efficiency and demand response program participation and how to effectively develop marketing, incentive, and education programs for customer segments that will produce measurable energy savings.
- How to design technology to provide useful and actionable energy information.
- How to measure accurately the effects of these strategies with the goal of significantly affecting awareness, concerns, and actions related to energy use.
- How to quantify and correlate nonenergy benefits and their motivational effect on energy-related consumer choices.

Purpose: This initiative will conduct research to better understand the factors that motivate customers and tenants to make energy-efficient equipment purchases and operate buildings in the most energy-efficient manner. The research will address the role of consumer choice and operational behavior in influencing the way equipment is designed and operated. It will also address how privately and publicly supported energy efficiency programs can be tailored and improved to expand participation in target audiences. Potential research areas include:

- Determining the types of energy information that motivates different types of customers – using demographic, geographic, and other characteristics – to make energy-efficient choices with respect to purchasing devices and equipment and operating energy using appliances or devices in homes and workplaces.
- Answering key questions such as how, where, and when such information should be provided and/or displayed.
- Considering how the information should be framed and to what degree and in what situations energy efficiency should be automated versus controlled by end users.
- Analyzing smart technologies available on the market that can program and automate energy using devices such that energy use can be reliably predicted for planning public or utility program initiatives.

- Analyzing the persistence of the effects of behavioral energy efficiency programs and providing feedback and understanding of the real potential for behavior-based programs.[40]
- Testing and determining the most effective ways to measure responses to energy information.
- Determining how best to collect, disaggregate, and interpret energy data provided by building occupants and owners, smart meters and utility companies.
- Demonstrating technologies and promoting market education and adoption.
- Examining the effect of different information delivery channels or methods.
- Reviewing best practices in behavior change that could be applied to ratepayer funded clean energy training programs.

This initiative will be coordinated with other on-going behavior activities/studies by the CPUC, the California Air Resources Board (ARB), and the IOUs. This coordination will ensure that the research and work scope is not duplicative and will provide mutual benefits that will inform each respective group's efficiency policy. The coordination will also ensure consistency of energy monitoring and verification frameworks, standards, and other requirements.

Stakeholders: Electric ratepayers who own, operate or occupy buildings and facilities, equipment manufacturers, engineers, building designers and developers, academia, governmental agencies, and utilities.

Background: A 2008 study conducted by the National Buildings Institute on the energy performance of Leadership in Energy and Environments Design commercial buildings revealed that many of these buildings (built to similar specifications) have not performed to the energy efficiency targets that were expected. The study concluded that building energy performance is not determined solely by the technologies included in the design, and that tenant/occupant choices and general building operations can either substantially improve or degrade building energy performance. In the residential sector, some studies have shown that nearly identical housing units occupied by demographically similar families have reported large (for example, 200-300 percent) variations in energy use (Lutzenhiser 1993). There are also studies that show increased energy use after building energy retrofits, exactly the opposite of what one would expect (Andres and Loudermilk 2010).

The need and importance of operational behavior research associated with energy efficiency has been repeatedly raised at workshops and public meetings sponsored by the Energy

40 This research would support the CPUC's recent decision requiring IOUs to engage 5perecent of households in their service areas in energy efficiency programs.

Commission, including those for the EPIC Program. The general consensus is that energy-related operational behavior and consumer choices are areas with significant knowledge gaps that need to be addressed. Better understanding is needed to realize energy savings through providing energy information and feedback. These decisions affect how technology is designed to provide what information, how utility incentive and demand response programs are created, and how building designs incorporate automatic versus manual control in the energy-related systems. Additionally, energy-related tenant operational behavior and consumer motivations to consider energy when making purchases are the key subjects discussed at the annual Behavior Energy and Climate Change conference.[41] There is growing recognition of the importance of this topic as evidenced by the number of abstracts submitted for the conference each year.

Based on the early phase of a current study at Stanford University, "Large-Scale Energy Reduction Through Sensors, Feedback, and Information Technology," energy cost by itself is not a strong enough motivation to change behavior. Preliminary projections indicate that intervention strategies that create energy awareness can result in energy reductions ranging from 5 percent to 30 percent. However, the study duration period is not long enough to measure persistent effects, and in some cases sample sizes are small. Nonetheless, the research will provide valuable insights into what may be effective energy-conserving strategies with respect to technology, design, social and marketing incentives, identifying responsive utility customers, and information framing. The research is scheduled to be completed in October 2013.

Some utility companies and private sector consulting firms that are studying how to market and design utility incentive programs are doing small-scale energy behavioral research, but significant knowledge gaps remain about how to influence behaviors in ways that produce persistent savings and how to accurately measure those savings.

New technologies such as whole house power meters, smart appliances, and home area networks are coming on the market, but it is unclear how effective these technologies are in achieving continuing energy savings due to a lack of statistically significant studies that clearly establish the links between information, customs, habits, and the correct operation of devices. Funding for larger and longer duration studies is needed to determine with confidence what persistent energy-related behavior change is achieved using different intervention strategies. Review of the literature indicates that there are few such studies that have been done to date.

41 http://beccconference.org/.

S1.5 Proposed Funding Initiative: Develop Cost-Effective Retrofit Strategies to Achieve Greater Energy Efficiency in Existing Residential and Nonresidential Buildings.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Nearly 60 percent of California's housing stock (and a comparable percentage of the state's commercial building stock) was built before the establishment of California's first Building Energy Efficiency Standards in 1978.[42] Accordingly, substantial energy efficiency improvements are needed in most of California's existing buildings, particularly in multifamily residential and small and mid-size commercial buildings. However, many market and cost barriers prevent energy retrofits to residential and commercial buildings. Foremost are the economic payback of energy retrofits, longevity of home ownership, and the split incentives between renters and building owners (since in many cases renters pay utility bills and building owners do not). Additional barriers include:

- Lack of knowledge by building owners and financial decision makers of the attributes of energy-efficient buildings.
- Knowledge of how to obtain a higher performance building.
- Knowing what resources (tools, models, and entities) are available to help building owners.
- Knowing how to assess cost-effectiveness of building retrofits, and how to obtain low-cost financing for retrofits.

Purpose: This initiative will develop new technologies and approaches for cost-effective energy efficiency retrofits in existing buildings in IOU territories. Proposed research includes:

- Developing a roadmap for maximizing cost-effective energy efficiency retrofits in existing buildings. The roadmap will consider the Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009) Scoping Plan and subsequent action plans, including robust stakeholder input and the guiding principles established by the CPUC and Energy Commission.
- Identifying and piloting innovative technologies and approaches to bring energy efficiency retrofits solutions to low-income residential builders/owners and the multifamily market.

42 http://www.energy.ca.gov/ab758/documents/AB_758_Technical_Support_Contract_Scope_of_Work.pdf.

- Developing and demonstrating an integrated suite of cost-effective, advanced energy efficiency measures, tools, models, and strategies for enabling best practices in retrofit construction. This includes identifying the most cost-effective package of advanced heating, cooling, and ventilation, lighting, plug-load efficiency strategies, building envelopes, domestic hot water systems, building controls, and performance technologies for use in existing buildings in California climates. This includes use of simplified, low-cost tools that use satellite imaging rather than onsite audits, such as the Building Energy Asset Rating System (BEARS), to reduce the cost of assessments.
- Evaluating current issues that underlie the lack of available energy performance information for decision makers in the building retrofit marketplace.
- Investigating and collaborating with others to institute common data collection and sharing protocols that can be instituted in all public and ratepayer-funded RD&D and other incentive and evaluation programs, to provide this much-needed performance information to all market actors
- Investigating the role of consumer behavior, particularly in multifamily buildings, to develop technologies and approaches for cost-effective strategies in the retrofit market.

This initiative will coordinate with ongoing activities and studies by the CPUC, IOUs, and the Energy Commission related to AB 758 implementation and whole building retrofits.

Stakeholders: Electric ratepayers who own and operate buildings and facilities, equipment manufacturers, engineers, building designers, developers, contractors and consultants, academia, governmental agencies, utilities, national labs.

Background: Existing building retrofits have occurred haphazardly. Utility rebate programs have focused on specific energy technologies rather than whole-building approaches and participation in those programs is limited. Whole-building energy audit programs typically target specific sectors or to organizations with a desire to upgrade or renovate. Often, energy renovations require a champion to push for improvements and identify energy and nonenergy benefits (for example, improved employee or student performance). Split incentives can deter any energy improvements since building owners often do not pay utility bills or reap the benefits from retrofits.

S1.6 Proposed Funding Initiative: Reduce the Energy Use of Plug-Load Devices Through the Development of Products, Systems, and Controls, and Evaluation of Consumer Behavior That Affects Energy Use.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X							**X**

Issue: Plug loads, devices that plug into electrical outlets, are becoming an increasingly large share of residential and commercial building energy load. If not controlled, the current plug load trajectory could affect meeting the ZNE buildings goals in California by 2020 and is estimated to be about 40 percent of the energy use of a ZNE building.[43] [44] Current barriers include lack of controls, high energy use of plug load devices, low efficiency, and a wide range of products. As a result, more comprehensive and ambitious plug-load research, efficiency improvements, and policy action resulting in new Title 20 standards are needed. There are significant building design and operation issues with regard to plug loads. Behavior and occupancy are also a significant influence.[45]

Purpose: This initiative will advance the development and deployment of more efficient consumer and office electronics. Potential research includes:

- Improve and develop efficiency improvements in existing and future plug-load devices while also including the integration of smart controls.
- Advise future Title 20 appliance standards, as applicable.
- Address behavioral and other issues.
- Develop and implement pilot programs for candidate technologies.
- Engage local experts and other stakeholders through public workshops to identify research priorities and needs associated with plug load-related research and development with the goal of providing cost-effective benefits to California ratepayers.

43 http://calplug.uci.edu/index.php/7-main

44 Kaneda, Jacobson, Rumsey, "Plug Load Reduction: The Next Big Hurdle for Net Zero Energy Building Design," http://eec.ucdavis.edu/ACEEE/2010/data/papers/2196.pdf

45 Ibid

The efforts will complement and coordinate with other past and current research being undertaken by UC Irvine, national laboratories, and others. This research is anticipated to be supported by consumer/business equipment industry, utilities, and standard setting groups.

Stakeholders: Electric ratepayers who own and operate plug load devices, equipment manufacturers, engineers, building designers, developers, contractors and consultants, academia, governmental agencies, utilities, national labs and researchers.

Background: Plug loads are not traditional appliances and contain internal or external AC-DC power supplies. Energy use in the residential and commercial sectors in California for plug loads is one of the fastest growing energy loads. For instance, the average house that contained only four or five plug load devices 20 years ago now has as many as 50.[46] Current estimates indicate that plug loads are contributing about 15-20 percent of residential and 10-15 percent commercial electrical use, and this use could nearly double by 2030.[47] Recent estimates by the U.S. DOE have put residential plug load, without intervention, at 40 percent by 2035. At this pace, plug load energy use will prevent achievement of the state's zero net-zero energy building goals.[48]

Past research focused on external power supplies, office electronics, battery chargers, flat-screen televisions, home stereo/audio systems, 24/7 kiosks (for example, ATMs) and computers. The Energy Commission's plug load research to date has been very successful and is projected to result in annual savings of more than $1.2 billion through adoption of three Title 20 Standards.[49] The UC Irvine's CalPlug Center is performing research on set-top boxes due to the potential for large savings.[50] Preliminary estimates by UC Irvine show that California may be able to save about $400 million per year through set-top box improvements. This initiative will continue research into other plug load areas such as improving computer efficiency, improving the efficiency of small server rooms, understanding smart user controls, and how to create a personal user energy footprint based on the collection of data from a variety of plug-load end uses collected in smart meters.

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46 http://viewer.epaperflip.com/Viewer.aspx?docid=bfddb00c-6c9a-4169-befe-a06101208516#?page=16.

47 U.S. DOE Annual Energy Outlook, 2008.

48 Brown, Rittleman, Parker & Homan, "Appliances, Lighting, Electronics, and Miscellaneous Equipment Electricity Use in New Homes," 2006.

49 Battery charger:www.energy.ca.gov/appliances/battery_chargers/documents/2010-10-11_workshop/2010-10-11_Battery_Charger_Title_20_CASE_Report_v2-2-2.pdf. Televisions: www.energy.ca.gov/appliances/2008rulemaking/documents/2008-04-01_workshop/2008-04-04_Pacific_Gas_+_Electric_Televisions_CASE_study.pdf. External power supply: www.energy.ca.gov/appliances/2004rulemaking/documents/case_studies/CASE_Power_Supplies.pdf.

50 www.nrdc.org/energy/files/settopboxes.pdf.

S1.7 Proposed Funding Initiative: Develop and Evaluate Ideal Strategies to Improve Indoor Air Quality in Energy-Efficient Buildings

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Indoor air pollution in California – not including tobacco smoke – has been attributed to around $11 billion per year in adverse health impacts with another $9 billion attributed to lost productivity in office workers and teachers. The increased efficiency of new and existing buildings is resulting in tighter buildings that reduce air infiltration. As a result, indoor air quality is deteriorating**.** Use of new construction materials and products and increased use of recycled materials may result in increases of unknown emissions (such as semivolatile organic compounds). Research is needed to identify the resulting indoor air quality and public health consequences and develop cost-effective mitigation measures.

Purpose: This initiative will focus on research to characterize indoor air quality and develop cost- and energy-efficient air quality improvement methods.

Stakeholders: Electric ratepayers who own and operate buildings and facilities, engineers, building designers, developers, contractors and consultants, academia, governmental agencies, utilities, and national labs.

Background: To help meet AB 32 goals, the Energy Commission is working with the CPUC, the ARB, and various stakeholders to implement the *California Energy Efficiency Strategic Plan*. One of the goals in the plan is to strengthen and expand building and appliance codes and standards. The increased efficiency of new and existing buildings is resulting in tighter buildings that reduce air infiltration. Past research was guided by the *2002 Energy-Related Indoor Environmental Quality Research: A Priority Agenda* and has resulted in several landmark studies of indoor environmental quality and related factors in California. These include studies of new residential buildings, small and medium commercial buildings, and pollutant emissions from office equipment. Current studies are looking at retrofits of low-income apartments, exposure from unvented combustion appliances, and healthy zero-energy buildings. In addition, studies of building heating, ventilating, and air conditioning (HVAC) and air leakage that are pertinent to indoor environmental quality have been conducted. *Indoor Environmental Quality: Research Roadmap 2012-2030: Energy-Related Priorities* has been developed to guide future research. ARB sponsors research on indoor air quality covering topics such as indoor and personal exposure, indoor-outdoor relationships, and toxic air contaminants. ARB has funded large

indoor air quality field studies in homes and schools, as well as studies on emissions from indoor sources, building ventilation, and air cleaners.

The U.S. Environmental Protection Agency (U.S. EPA) Indoor Air Quality research focuses on improving techniques to measure and model emissions of indoor chemical contaminants present in a variety of structures such as schools, office buildings, and homes and investigates a variety of approaches to ameliorate mold problems in residences and office buildings. In the late 1990s, the U.S. EPA completed the landmark Building Assessment, Survey, and Evaluation (BASE) study to determine the typical concentration distributions of a number of chemicals found in a representative sample of office buildings in the United States to correlate these pollutant levels with building parameters and occupant activities and symptoms. The U.S. DOE's indoor air quality research and development focuses on developing new ventilation strategies that simultaneously improve indoor air quality and reduce the energy impact of increased ventilation.

S1.8 Proposed Funding Initiative: Develop Cost-Effective Technologies and Approaches to Achieve California's Zero Net Energy Buildings Goals

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Existing studies are underway by the IOUs to develop ZNE roadmaps that identify barriers and cost-effective strategies and technologies for the most promising building types. However, there has been little focus on ZNE building strategies for multifamily and small commercial buildings. Owners of these types of buildings have very little incentive to achieve ZNE when they do not pay utility bills. Because ZNE buildings have noticeably higher first costs than traditional building designs, marketing and consumer education has been unable to encourage widespread acceptance of ZNE as a high-priority goal despite subsidies, tax incentives, and other financial incentives.

On the technical side, there has been little analysis correlating climate zones and the most appropriate building types with the most potential for ZNE application. Some single or combined emerging technologies have potential to maximize energy efficiency and reduce overall building and life-cycle costs. Examples include dynamic windows, radiant heating and cooling, direct current lighting, and advanced innovative applications of thermal energy storage. However, these strategies need to be integrated into whole buildings and their performance measured on a pilot scale. Another technical barrier is that many existing newly

planned buildings are not suitable for onsite electricity generation or solar hot water systems due to orientation, shading, and other factors. To meet the energy needs of buildings with renewable energy, builders and designers must apply holistic design principles and take advantage of naturally occurring assets, such as passive solar orientation, natural ventilation, daylighting, thermal mass, and nighttime cooling along with maximizing energy efficiency. Climate-specific technologies and design practices also need to be developed to account for the wide variations in heating and cooling needs based on climate zone.

Purpose: This initiative will coordinate and complement existing studies by the CPUC and IOUs and activities to reach ZNE building goals cost-effectively. Potential research includes:

- An assessment and review of current and past ratepayer-funded studies, roadmaps, technical potential studies, and barriers identification studies to determine research gaps that still need analysis to support ZNE targets consistent with the *California Energy Efficiency Strategic Plan*. Once the assessment is completed, develop a solicitation to address these research gaps.
- A review of the technical potential of ZNE in both residential and nonresidential buildings in climate zones not currently being analyzed by IOUs and the appropriate cost-effective mix of measures. This activity will be coordinated with IOUs in order to be consistent in identifying energy use index targets for several building types.
- Evaluation of alternative business models and definitions for achieving ZNE or near-ZNE building goals. This can include an assessment of the economic breakpoints by climate zone and by different ZNE definitions to get to ZNE buildings. For instance, in some climate zones it may not be economically feasible to get entirely to ZNE, but it may be possible to achieve 80 percent of the potential.
- Integrating pilot-scale evaluation of measures most suitable for cost-effective deployment of ZNE buildings.

Stakeholders: Electric ratepayers who plan to build ZNE buildings, equipment manufacturers, engineers, building designers, developers, contractors and consultants, academia, governmental agencies, utilities and national labs.

Background: The *California Energy Efficiency Strategic Plan* and the Energy Commission's *Integrated Energy Policy Report* have established ZNE goals for residential and commercial new and retrofit construction.[51, 52] The CPUC has authorized several studies with Pacific Gas & Electric Company (PG&E) with the objective of establishing a framework for ZNE research that includes identifying technical potential, performing market assessments of drivers and barriers ,

51 *California Energy Efficiency Strategic Plan*, January 2011 Update, p. 11.

52 *2011 Integrated Energy Policy Report*, p. 8.

identifying research needs, and developing a roadmap for new construction.[53] This initiative will build on the results of this work and some of the work listed below to achieve the ZNE goals.

- San Diego County's research project "ZNE Affordable Multifamily Housing" demonstrated that, with motivated local agencies, progressive developers, and a combination low-income tax credits, state rebates, and additional debt leveraged from energy cost savings, developers can fully cover the first cost of constructing a ZNE building. Thus ZNE or near ZNE is achievable in low-income multifamily buildings. This project also demonstrated that per-unit cost premiums could be minimized by using innovative integrated design principles and establishing clear project goals. The two apartment complexes that were the focus of the project generated almost as much energy (90 percent or more) as they drew from the electric grid. More work is necessary to replicate these types of results and overcome barriers in different climate zones and local jurisdictions.
- In the project "Commercializing Zero Energy New Home Communities" (2010), the goals were to define innovative and cost-effective approaches in the areas of PV systems, energy efficiency product selection, and new home design and construction standards. Three homebuilders built more than 270 ZNE homes in four demonstration communities; one of the buildings was a 46-unit multifamily building. The single-family homes exceeded existing Title 24 energy efficiency standards by 35 percent, and energy costs were 60 percent to 70 percent lower than comparably built non-ZNE housing. According to the builder, the premium for the homes with ZNE was minimal, and the ZNE homes sold much faster than similar homes without PV systems.
- In a larger-scale energy efficiency project, *Energy-Efficient Community Development in California: Chula Vista* (2008), results of modeling 40 building types with various optimizations of energy-efficient technologies were combined with renewables and some multibuilding heating and cooling strategies. The project models demonstrated the potential to reduce energy use by up to 43 percent and peak demand by 45 percent as compared to the Title 24-compliant project/development in place at the time. The modeling to determine the best combination of market-feasible technologies indicates that these technologies are building-specific. Results of the financial, business, and policy analysis show that communities need new public and private sector management models to address barriers that currently impede adopting these building technologies and site features by the building industry. In-depth study and the development of solutions to these barriers are needed in future research.

53 www.pge.com/.../b2b/purchasing/bidopportunities/ZNE_Pilot_Program.doc.

- Habitat for Humanity has built several ZNE, or near ZNE, single-family homes that have demonstrated the potential to build affordable ZNE homes for low-income families. Monitoring persistence of savings to document benefits over time is needed.

Though there has been interest in ZNE building design, there is little information on the best approaches for meeting the ZNE goals of the different building sectors and types by climate zones. Due to this, very few designers, builders or contractors have the expertise or experience to construct ZNE buildings.

S2 Strategic Objective: Develop New Technologies and Applications That Enable Cost-Beneficial Customer-Side-of-the-Meter Energy Choices.

Table 10: Ratepayer Benefits Summary for Strategic Objective 2

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/ transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S2.1 Develop Cost-Effective Metering and Telemetry to Allow Customers with Demand Response, Distributed Generation, Plug In Electric Vehicles, and Energy Storage to Participate in California ISO Markets and/or Provide Grid Services.	x	x		x	x	x		x	x
S2.2 Develop Demand Response Technologies and Strategies to Allow Customers to Participate in Ancillary Service Markets and/or in Dynamic Price and Reliability-Based DR Programs and Market Transactions in Retail and Wholesale Markets.	x	x		x	x		x	x	x
S2.3 Demonstrate and Evaluate the Integration of Distributed Energy Resources, Including Storage and Demand Response, at the Community Scale and in Microgrids	x	x		x	x	x	x	x	x
S2.4 Develop and Test Novel Technologies, Strategies, and Applications That Improve the Business Case for Customer-Side Dispatchable Distributed Resources and/or Expansion of Demand Response Capabilities.	x	x		x		x	x	x	x

Source: California Energy Commission

Customer participation in dynamic pricing and other programs allows them to reduce their electricity demand and generate new income streams. Customer participation delivers value and cost savings in multiple ways. Customers who participate in these dynamic pricing programs are rewarded for being willing to reduce their individual energy demand on critical days and during times the utility grid is reaching its peak demand limitations. Additionally, customers who own distributed resources including demand response (DR), distributed storage, distributed generation (DG), and plug-in electric vehicles (PEVs) will have a new revenue stream by providing grid support such as ancillary services and voltage stability to address intermittent generation resources. In addition, greater customer participation in these programs will help utilities and grid operators reduce peak demand and integrate intermittent renewables while providing the benefits of a more reliable grid.

The following initiatives will address barriers and advance the technologies, applications, and strategies to enable and encourage customer-owned resources to participate in energy market programs that provide demand-side management.

S2.1 Proposed Funding Initiative: Develop Cost-Effective Metering and Telemetry to Allow Customers With Demand Response, Distributed Generation, Plug-in Electric Vehicles, and Energy Storage to Participate in California ISO Markets and/or Provide Grid Services.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X			X

Issue: This research addresses barriers to cost-effective metering and telemetry. Telemetry refers to automatic measurement and transmission of data by wire, radio, or other means from remote sources to a distant receiver for recording and analysis. The cost of telemetry is a major barrier to the expanded use of automated demand response, distributed renewables, combined heat and power (CHP) generation, electric vehicles and other distributed energy resources. This barrier makes it very difficult for these technologies to participate in California ISO programs for ancillary services, especially frequency regulation, because of the current need for the high fidelity metering systems. Lowering these costs will increase the integration of systems that can provide ancillary services.

Purpose: This initiative aims to reduce the cost of communication and telemetry technologies and improve automation to allow more electricity customers to participate in dynamic ancillary services markets. This will ease the addition of more renewable generation to the grid to help meet Renewables Portfolio Standard (RPS) goals and Governor Brown's Clean Energy Jobs Plan

goal of 6,500 MW of additional CHP by 2030. Other DG, such as biomass, energy storage and DR technologies, may be able to participate in dynamic ancillary services markets and/or provide grid services with cost-effective metering and telemetry.

Areas of research include:

- Developing less-expensive telemetry technologies.
- Researching best practices and data requirements for ancillary services markets used by other independent system operators.
- Exploring ways to reduce the cost of metering and telemetry for automated demand response, electric vehicles, small generators of renewable energy and CHP.
- Exploring ways to lower the costs of data verification, and determining timescales and granularity required by the distribution and transmission system to provide grid operators with transparency and visibility of customer-side-of the meter resources.

Based on staff's review of the initial drafts and the information provided at public workshops sponsored by the IOUs for the proposed EPIC investment plans, the utilities identified plans for demonstration and deployment activities making greater use of both utility owned and customer owned distributed energy resources (DER) to supply grid support and ancillary services. As an example San Diego Gas & Electric Company (SDG&E) proposes demonstrations of DER to provide services. PG&E is also proposing demonstrations of DER. Coordination of these IOU planned activities with the research under this initiative will enhance the results and ensure that activities are not duplicated.

Stakeholders: Ratepayers who have DER, system operators, and utilities.

Background: Alternative metering and telemetry systems protocols to the current systems required by the California ISO are developed, operating in other areas and are being enhanced through other stakeholder working groups and do not require EPIC funding. The commercial availability of the Open Automated Demand Response (OpenADR) and SEP 2.0 protocols will allow controls to make greater use of web-based internet connectivity. Web-based energy information systems have been demonstrated. These systems use the internet as an inexpensive communications platform to transfer secure data quickly and reliably. These systems can also track performance in DR events and help the customer see utility bill savings.

There has been excellent collaboration between control companies, utilities, and standards groups in adopting OpenADR and SEP 2.0. More research is needed to reduce telemetry costs. This research has drawn only limited funding from the U.S. DOE, but its role is growing.

The private sector has not developed lower-cost telemetry so far, as the California ISO requires essentially continuous two-way communications, especially for frequency regulation, and the market for this type of metering and telemetry is small.

S2.2 Proposed Funding Initiative: Develop Demand Response Technologies and Strategies to Allow Customers to Participate in Ancillary Service Markets and/or in Dynamic Price and Reliability-Based DR Programs and Market Transactions in Retail and Wholesale Markets

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X			X

Issue: As renewable generation adoption accelerates, resources with intermittent and variable output will affect grid stability and increase the need for ancillary services.

DR can provide support of the grid by both lowering the peak demand during critical times and also providing a variety of ancillary services to the grid operators. DR can be provided by residential, commercial and industrial customers. Energy storage can supply ancillary services much the same as traditional generation, but current energy storage systems are significantly more expensive than generation alternatives. Based on experience gained over the last decade on utility and third-party managed DR programs, DR services can provide many of the capabilities of energy storage, however, not as fast as classical energy storage systems. Vehicle-to-grid capabilities for plug-in electric vehicles (PEV) can function like energy storage, but it is limited in capacity. DR, when combined with either traditional energy storage or vehicle-to-grid, can provide cost-effective ancillary services. A set of tools is needed to help combine DR with other DER such as PEVs and other energy storage to enable customers to participate in ancillary services markets and/or in dynamic price and reliability-based DR Programs.

Purpose: Expanding the use of DR by developing a set of tools to help combine DR with other DER, such as PEVs and other energy storage, will enable customers with these resources to participate in ancillary services markets. This will also help residential, commercial and industrial customers to participate in future dynamic pricing programs for both peak load reduction and ancillary services. This research will enhance grid flexibility and cost-effectiveness and create new revenue streams for end-users through participation in IOU dynamic pricing programs and California ISO markets. Interoperable tools and information systems will allow residential, commercial, and industrial building owners and operators to understand DR technologies and to reduce their electric bills, enable greater use of renewables, and shift peak demand.

Possible activities under this initiative will:

- Develop benchmarking and simulation tools and analysis platforms for DR strategies.

- Allow information from DR and DER (storage and PEVs) to be aggregated and dispatched in larger consolidated systems like a grid-scale battery to provide ancillary services.
- Explore use of real-time energy measurement, cost analysis, and modeling to improve customer economics and minimize bills.
- Evaluate the economic and other benefits to electric ratepayers

Stakeholders: Ratepayers with DR, storage, PEVs or other DER; grid operators, and utilities.

Background: New technologies and operating practices are constantly developing on the distribution system in response to increasing penetration of renewable energy generation. There is a need for coordination and research to maximize end customer participation in utility dynamic rates and California ISO markets for ancillary services.

S2.3 Proposed Funding Initiative: Demonstrate and Evaluate the Integration of Distributed Energy Resources and Storage and Demand Response at the Community Scale and in Microgrids.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X			X

Issue: Renewable generation will be a key component of energy-smart communities. Renewable generation tends to be more variable and intermittent, and does not have the system inertia for grid stabilization provided by conventional generation. This has increased the need for ancillary services, such as providing reactive power and voltage and frequency regulation. Energy storage can provide these services for energy-smart communities to deploy more renewable generation and stabilize the grid. AutoDR can also provide services to these communities that are responsive, timely and cost effective.

The high cost of most distributed energy storage systems is a primary barrier to market adoption. In addition, the required characteristics of energy storage systems vary between clean energy resources when used for peak demand shifting. For example, peak generation from solar resources needs to be shifted only a few hours to coincide with peak demand times. Wind energy, however, typically peaks at night and must be shifted further in time to match peak demand. Energy storage and AutoDR may provide the technological solutions to provide peak shaving. Furthermore, energy storage can be strategically deployed in energy-smart communities to maximize system reliability and provide voltage and frequency regulation where needed.

Purpose: This initiative will develop and evaluate the integration of energy storage systems, AutoDR, and DG applications within energy-smart communities to mitigate intermittency, increase the value of distributed renewable energy generation, and offset peak demand. Promising electric, thermal, and mechanical energy storage designs will be evaluated for their potential to mitigate the intermittency impacts of renewable energy generation and provide additional ancillary services in distributed settings. AutoDR, CHP and other distributed resources will be evaluated for their potential to mitigate the intermittency impacts of renewable energy generation and provide additional ancillary services in distributed settings. These evaluations will include the advantages and disadvantages of distributed electric storage systems at different sizes, scales, and locations and configurations, the combination of AutoDR and energy storage as a lower costs system, the use of distributed generation systems such as CHP to stabilize the local grid, and other technology combinations to provide energy smart communities and microgrids the services they need.

EPIC investment will support the integration of electric storage technologies with other system components such as inverters, electric vehicle chargers, and other DER. This will improve DG performance and interoperability with smart grid components and will decrease energy storage costs.

This initiative will also advance thermal energy storage systems to increase the ability to cost-effectively shift the demand profile of buildings within energy-smart communities and maximize the economic benefits of onsite electricity generation.

Stakeholders: Ratepayers due to greater renewables on the distribution grid, including ratepayer-owned renewable generation; utilities, and distribution grid operators.

Background: The National Renewable Energy Laboratory recently developed a small commodity inverter for PV that can accommodate energy storage and has four-quadrant operational capability which allows it to supply reactive power to the grid. There is also a demonstration at Los Angeles Air Force Base of electric vehicle-to-grid storage that can participate in the California ISO ancillary services market. Automated demand response (AutoDR) has been gaining national acceptance through the NIST Smart Grid standards development process and the results of these national efforts are expected to improve the performance and lower the system costs of implementing AutoDR. These innovations can apply to different types of distributed energy storage and are examples of the type of technology that needs to be deployed and refined for the future grid.

Energy storage is an area with a wide variety of beneficial uses and has accordingly received significant funding from different sources, such as the U.S. DOE. Research is underway in California to evaluate the benefits of adding distributed energy storage in a high PV penetration residential community in several configurations.

S2.4 Proposed Funding Initiative: Develop and Test Novel Technologies, Strategies, and Applications That Improve the Business Case for Customer-Side Dispatchable Distributed Resources and/or Expansion of Demand Response Capabilities.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X	X					X	X

Issue: Current customer-side dispatchable distributed resources are limited primarily to energy storage and CHP. Energy storage is typically provided by batteries which are large, expensive, and have limited capacity. In addition, the life expectancy of current batteries is short and replacement is costly. AutoDR has recently entered the market place with many new options that have not been integrated with other customer-sided energy resource systems. Past R&D has primarily focused on demonstration projects using existing technologies as opposed to developing new technologies or improving existing technologies. New technologies and strategies are needed to demonstrate that these new integrated, multiple energy source systems, can reduce the cost of customer-side applications.

Purpose: This initiative will develop and test new technologies and applications to reduce the cost and improve the performance of customer-side storage and expand DR capabilities. This initiative will conduct applied R&D in the following areas:

- Develop and assess the business case for the expansion of demand response capabilities and the automation of demand response services.
- Develop new technologies, such as printed batteries using ink technology, into working prototypes for pilot demonstrations: The U.S. DOE has provided significant funding over the last few years for basic research into advanced storage technologies. The Energy Commission will look for opportunities to address critical funding gaps to develop storage technologies into working prototypes, and demonstrate and evaluate the prototypes in pilot-scale applications.
- Research emerging storage technologies and novel applications identified in CPUC energy storage proceedings.
- Demonstrate emerging or proven storage technologies in novel applications: There may be opportunities to reduce the costs of customer-side storage by integrating storage technologies with other technologies such as AutoDR to create novel applications and strategies. For example, the Southeastern Pennsylvania Transportation Authority is using the same kind of braking technology found in hybrid vehicles – regenerative braking – to

convert energy from braking trains into electricity and store it in a battery system for future use or for sale back to the grid in times of high demand. This initiative will investigate and demonstrate innovative applications and strategies that improve the business case for customer-side storage.

- Demonstrate other types of dispatchable distributed resources in novel applications

Stakeholders: Ratepayers who wish to deploy energy storage, AutoDR service and other customer side energy systems, and utilities.

Background: Customer-side energy storage, AutoDR, and distributed energy resources continue to remain a high priority for achieving the state's policy goals for the electricity sector. Over the past few years, the Energy Commission has provided more than $6 million in cost-share funds for various energy storage projects in California funded through the American Recovery and Reinvestment Act of 2009 (ARRA), along with $9 million to support several non-ARRA energy storage projects. Also, in 2011, the Energy Commission provided funding to install and integrate an advanced lithium-ion battery system at the Santa Rita jail in Alameda County. This storage system helps the jail reduce its electricity demand during summer peak to zero, allows the jail the potential to export energy, and provides congestion reduction and improved reliability to the local distribution grid. Additionally, the Energy Commission supported several ARRA funded field demonstrations of AutoDR to illustrate both the value and ease in which end customers can incorporate it into their operations.

Clean Generation

S3 Strategic Objective: Develop Innovative Technologies, Tools, and Strategies to Improve the Affordability of Distributed Generation.

Table 11: Ratepayer Benefits Summary for Strategic Objective 3

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/ transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S3.1 Develop Next Generation Combined Heat and Power Technologies and Deployment Strategies.	x	x		x	x		x	x	x
S3.2 Develop Innovative Technologies, Techniques, and Deployment Strategies to Accelerate the Commercialization of Sustainable Bioenergy Systems.		x		x	x		x	x	x
S3.3 Develop Advanced Distributed Photovoltaic Systems to Reduce the Cost of Energy, Increase Interoperability, and Advance Plug-and-Play Capabilities	x	x		x	x		x	x	x

Source: California Energy Commission

Distributed generation (DG) – small-scale power generation located close to electricity loads – can reduce or eliminate the need to build new utility-scale generators, transmission, and distribution infrastructure. It can also improve the efficiency of the electric system by avoiding transmission and distribution (T&D) losses that occur when electricity travels great distances over power lines to the distribution system. DG systems can also improve reliability by providing electricity and/or heat during grid outages. DG that delivers during peak demand periods can free up other generating capacity and ease transmission congestion.

The following initiatives aim to provide ratepayer benefits by reducing market barriers for DG systems, increasing the diversity of DG systems in the commercial market, and developing systems that provide direct benefits to electricity ratepayers. Furthermore, these initiatives will help advance the goals of Governor Brown's Clean Energy Jobs Plan, specifically the goals of adding 12,000 MW of distributed renewables by 2020 and 6,500 MW of CHP[54] capacity in the next 20 years to California's energy generation portfolio.

54 For the purposes of this objective, CHP includes combined cooling, heating, and power applications.

The Energy Commission will evaluate innovative ideas to increase performance over existing DG technologies in the lab and use results to guide the development of advanced bench-scale prototypes. Technologies and strategies that show promise will move to pilot-scale demonstrations to evaluate market potential. Further applied research will be conducted to evaluate where and how technologies should be deployed to maximize the benefits to California electricity ratepayers.

S3.1 Proposed Funding Initiative: Develop Next Generation Combined Heat and Power Technologies and Deployment Strategies.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X					**X**		**X**

Issues: In *Advanced Generation Roadmap Background Paper, 2009,* Navigant Consulting noted that "[t]echnology barriers have impeded full market deployment of industrial cogeneration systems. These barriers include system and component capital costs, emissions control, and fuel costs and flexibility. "[55] Upfront costs of installing CHP systems are a major barrier for many potential customers. Another major deterrent, particularly for reciprocating internal combustion engine systems, is the poor air emissions performance and inconsistent ability to cost-effectively achieve and sustain compliance with air emission standards. Advanced generation technologies such as microturbines and fuel cells emit fewer air pollutants but have other cost and operation-related barriers, some of which are discussed below.

CHP systems are also limited by the fact that they are sized for their thermal load, which sometimes results in excess electricity generation that does not provide additional value to the customer. The ability to match thermal load with potential end-use applications and customer-specific controls remains among the major technical issues. Other issues include the maintainability and durability of CHP systems, interconnection complexities (including telemetry requirements), and the flexibility to use alternative fuels and varying operational profiles. Compounding these issues are the perceived risk and uncertainty by potential customers about owning such a system, as well as a lack of technical expertise to conduct operation and maintenance.

55 Contreras, Jose Luis, David Walls, Erin Palermo, David Feliciano (Navigant Consulting, Inc.). *Advanced Generation Roadmap Background Paper, 2009*. California Energy Commission, PIER Program. CEC-500-2009-086. Page 64.

Navigant Consulting, Inc., noted the following challenges to widespread adoption of CHP technologies:[56]

- Fuel cells: unproven reliability, low stack life, and fuel reformer system design.
- Hybrid fuel cell-gas turbine technology: high front-end risk, cost of developing these systems, integration issues between fuel cell and turbine technologies, undemonstrated reliability.
- External combustion engines: lack of robust research and development, low efficiencies, unproven operational durability.
- Microturbines: unverified efficiency, emissions, and reliability claims; low electrical efficiency; and sensitivity to changes in ambient conditions.
- Small gas turbines: Require high-pressure gas or in-house gas compressor, poor efficiency at low loading, sensitive to changes in ambient conditions.
- Absorption chillers and inlet cooling systems, particularly fog intercooling, require additional research to identify ways to improve reliability, reduce corrosion and costs, and address other technical challenges.
- Recuperated gas turbine cycles: difficult to retrofit existing turbines.

Purpose: This initiative will solicit applied research and development to advance the technical, economic, and environmental performance of CHP systems – including combined cooling, heating, and power (CCHP) – that operate on renewable fuels, fossil fuels, or both. The goal of research in this area is to reduce technology costs and improve system components by addressing the challenges identified above through the following actions:

- Evaluate novel emission controls and strategies to meet air quality standards.
- Develop advanced technologies and strategies to improve prime mover performance and efficiency for emerging technologies. Applicants must demonstrate that the technologies they are developing will substantially improve performance and reliability and reduce costs over existing systems.
- Test and verify performance of fuel-flexible CHP/CCHP systems and innovative deployment strategies that expand California's CHP market potential.

56 Contreras, Jose Luis, David Walls, Erin Palermo, David Feliciano (Navigant Consulting, Inc.). *Advanced Generation Roadmap Background Paper, 2009*. California Energy Commission, PIER Program. CEC-500-2009-086.

To promote wide acceptance of CHP and realize its full benefits to ratepayers, this initiative will investigate technological improvements and cost-effective and environmentally sound strategies for advanced CHP systems and prime movers. Funding will be prioritized on addressing the challenges identified above. Expected outcomes of research include:

- Increase the total energy conversion efficiency and reliability of the system.
- Reduce overall system costs through design improvements and development strategies.
- Develop advanced gas turbine cycles to promote hybrid systems and the use of renewable fuels.
- CHP-enabling strategies that will address a range of fuel flexibility and technical and economic improvement for heat recovery technologies.

Stakeholders: Ratepayers in industrial, commercial, institutional facilities and multifamily residences; local air quality districts; energy-smart community developments; and CHP industry groups.

Background: CHP is an important energy generation technology that caters to all three priority actions under California's loading order. It is a proven technology for improving energy efficiency and when viewed as such, qualifies as first in the loading order. CHP represents about 12 percent of the on-line power generation capacity in California. A majority of this CHP capacity is powered by fossil fuels, with limited capacity from renewable resources. The many benefits provided by CHP systems include reduced energy costs, more efficient fuel use, fewer environmental impacts, improved reliability and power quality, locations near load centers, and support of utility T&D systems.

ICF International released a report that evaluates several scenarios for CHP deployment in California over 20 years. The analysis indicated that a 10 percent capital cost reduction is needed by 2030 to achieve the penetration modeled in the high-case scenario. Previous research examined the development of lower-cost, high-performance CHP systems. Current research projects will address the technical and operational requirements for integrating multiple DG and CHP technologies and enabling technologies and for DG/CHP systems with multiple fuel capabilities. Some specific areas targeted by current research include emerging approaches for reducing criteria pollutant emissions, expanding applications for use of exhaust heat for process heating and cooling support, application of other exhaust components such as carbon dioxide from internal combustion engines, and strategies for cofueling of natural gas and biogas. Additional research will build on these emerging, emission-reduction and technology integration strategies, expanded potential applications, and other key project results to further reduce costs and enable further deployment of CHP and CCHP systems in California.

S3.2 Proposed Funding Initiative: Develop Innovative Technologies, Techniques, and Deployment Strategies to Accelerate the Commercialization of Sustainable Bioenergy Systems.[57]

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X	X				X		X

Issues: Biomass conversion technologies include thermochemical, biochemical, and physicochemical conversion processes. Physicochemical processes are mainly associated with the development of transportation biofuels. Thermochemical and biochemical processes are the dominant route for biomass electricity generation (or biopower) and are the focus of this discussion. Thermochemical conversion processes are expensive due to the low energy conversion efficiencies and the lack of full-scale deployment and require more research to drive down the costs and improve efficiency.

To ensure biopower is ecologically sustainable, California's biomass use policy limits harvest to feedstock derived as a secondary waste product or harvested from sustainable energy crops. Not all agricultural crop or forest residues should be harvested as some residues are needed to maintain soil fertility and tilth, or for erosion control. [58] Additional research is needed to develop uniform sustainability standards for biomass harvests.

Because biomass wastes are dispersed throughout the state, the cost to collect and transport the material significantly limits the feasibility of utility-scale bioenergy facilities. As diesel prices rise, the effective maximum radius for biomass collection sites decreases. Without innovative biomass handling systems that reduce biomass volume and improve energy content such as densification and torrefaction, or biomass collection approaches such as centralized biomass

57 Initiative supported by comments from California Biomass Energy Alliance; The Nature Conservancy; Natural Resources Defense Council; Union of Concerned Scientists; The Schatz Energy Research Center; Waste Management and Wheelabrator Technologies Inc.

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

collection and distribution stations,[59] most new biopower systems will only be economically sustainable at sizes of smaller than 10 MW. [60]

At small scales, internal combustion engines have been the most reliable generation technology. However, the equipment needed to control air pollution emissions on these devices can be relatively expensive because cost does not scale down with system size. Other generation technologies, like microturbines and fuel cells, have lower emissions profiles but are more costly and can be more complicated to operate. Research is needed to develop and test low-cost pollution controls for small generators and develop simple off-the shelf low-emission generation technologies.

Purpose: Through this initiative, research will advance the development of state-of-the-art biomass conversion technologies, low-emission generation systems, and fuel handling and processing systems. It will also include studies on how to reduce environmental impacts from harvesting, ash disposal and the supply of fuels. The goal of this initiative is to advance innovative approaches that show the greatest potential to reduce system costs and increase energy conversion efficiency. This initiative will conduct applied R&D in the following areas:

- Advanced Biomass-to-Energy Conversion Technologies: Biomass conversion technologies funded through this initiative include thermochemical and biochemical conversion technologies and approaches that can decrease production costs and/or otherwise increase the value of biogas. Innovative, lab-proven biomass conversion technologies and approaches should continue development into next generation prototypes to verify technical potential. Anaerobic digestion technologies will be examined for opportunities to reduce costs by increasing energy conversion efficiency and biogas production. Similarly, promising thermochemical technologies such as gasification, plasma arc gasification, and pyrolysis will continue to be developed and evaluated for reliability, conversion efficiency, cost-effectiveness, and environmental performance at the pilot scale.
- Improved Performance of Electricity Generators: To increase market acceptance of new conversion technologies, low-emission generation systems (including advanced pollution controls) will be developed and tested at pilot scale. To avoid duplication, biopower systems will be evaluated in coordination with other initiatives in this plan. Emissions profiles will be developed and made public on technology pairings with recommendations for future demonstration projects.

59 JDMT Consulting. http://www.energy.ca.gov/bioenergy_action_plan/documents/2010-12-14_workshop/comments/JDMT_Comments_TN-59368.pdf.

60 Larger facilities may be developed at sites that can support ecologically sustainable harvest and collection of biomass from locally derived feedstocks. The California Biomass Energy Alliance notes in their October 1, 2012 comments that the optimal size is defined by site location and biomass feedstock density.

- Sustainable Biomass Harvesting, Processing, and Handling Systems: Through this initiative, research will investigate technologies and approaches to reduce the cost and environmental impacts of collecting and transporting biomass feedstocks over greater distances, and increase the technical and economical availability of biomass feedstock throughout the state. Additional research topics include development and testing of innovative strategies to reduce the cost of fuel processing and handling systems.
- Advance research on sustainability standards for harvesting biomass in forestry and agricultural settings to ensure that future bioenergy development is environmentally sustainable.

Stakeholders: Ratepayers in rural and urban communities, industrial and commercial food processing facilities, dairy and agriculture facilities, and wastewater treatment facilities; California Department of Food and Agriculture; local air quality districts; ARB; California Department of Forestry and Fire Protection; biomass industry groups; California Department of Resources Recycling and Recovery; waste management industry.

Background: This initiative will address challenges identified in the *2009 Integrated Energy Policy Report*, the *2011 Bioenergy Action Plan*, [61] and the *Renewable Energy in California: Status and Issues* report. This initiative also supports the biomass activities specifically identified in the EPIC decision.

Unlike variable renewable energy resources, bioenergy technologies can provide reliable and renewable baseload generation, meaning that electricity can be generated during scheduled times and at predetermined power levels. Some bioenergy technologies can also increase or decrease output based on the demand for power.

Biomass waste streams produced by California's commercial, agricultural, and industrial practices can be used as a fuel for combustion, or as a feedstock to produce biogas that can then be used to generate electricity. A number of emerging technologies and processes can be used to convert biomass into biogas (or producer gas), and each has its advantages and disadvantages. DG systems can then use the biogas to generate electricity. Bioenergy has many benefits compared to other forms of energy generation, including displacing fossil fuel power plants with a reliable renewable resource; generating distributed energy near demand; reducing GHG emissions, providing jobs in rural communities; providing agriculture, industry, and forestry

61 California has adopted numerous policies to promote bioenergy, but significant barriers to its development remain. The *2011 Bioenergy Action Plan* identifies those barriers and recommends actions to address them, so that the state can meet its clean energy, waste reduction and climate protection goals. The *2012 Bioenergy Action Plan* reflects an update to the actions in the 2011 Plan, but does not update the challenges. For more information on California's Bioenergy Action Plan, please go to: http://www.energy.ca.gov/bioenergy_action_plan.

with an effective disposal option for biomass residues; and reducing wildfire severity and the use of landfills.

Biomass harvesting, handling, and processing systems include strategies and approaches to reduce the overall delivered cost of biomass to end users. This can include, but is not limited to, innovative approaches to collecting and harvesting biomass, technologies and strategies to increase the biomass energy density, and innovative collection systems such as strategically placed distributed biomass fuel yards.

Through the Alternative and Renewable Fuel and Vehicle Technology Program and under Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007), the Energy Commission is required to "establish sustainability goals to ensure that alternative and renewable fuel and vehicle projects . . . will not adversely impact natural resources, especially state and federal lands."[62]

Sustainability research should build on and complement the research that has been undertaken by various agency and conservancy organizations throughout California.

The U.S. DOE is funding thermochemical research projects to develop conversion and upgrading technologies, focusing on the low temperature pyrolysis to bio-oil pathway. Current projects focus on enabling biorefineries to efficiently convert woody biomass into biofuels at demonstration and commercial scales.[63] The conversion technology research funded through this effort will apply to biopower systems.

Recent research efforts in California include preliminary evaluations of forest biomass conversion and the tradeoffs between power generation and biofuels production; economic and environmental analysis of dairy digester technologies; air quality implications of various conversion pathways and DG technologies; and low-emission technologies to enable CHP production from biogas and landfill gas. EPIC investments will advance this knowledge base and build on recent project results, with particular focus on strategies to enable sustainable forest biomass collection and conversion, increase energy generation from agricultural waste streams, and develop low-cost emission control and advanced generation technologies to enable increased use of biomass in small-scale applications.

62 Baroody, Leslie, Charles Smith, Michael A. Smith, Charles Mizutani. 2010. 2*010-2011 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program Commission Report.* California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2010-001-CMF. Page 101.

63 http://www1.eere.energy.gov/biomass/thermochemical_conversion.html.

S3.3 Proposed Funding Initiative: Develop Advanced Distributed Photovoltaic Systems to Reduce the Cost of Energy, Increase Interoperability, and Advance Plug-and-Play Capabilities.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		X

Issues: Current incentives for PV technologies are unsustainable over the long term, and further cost reductions are necessary for PV to become cost-competitive with conventional generation in California. While the cost of PV cells has decreased in recent years, the cost of other system components, such as inverters and racking systems, has not fallen quite as fast. Integrated, low-cost, off-the-shelf systems need to be developed and brought to market to increase plug-and-play capabilities and interoperability of distributed PV systems with other DER.

The focus of the CPUC's California Solar Initiative (CSI) RD&D plan includes a narrow set of investment areas including production technologies, grid integration, and business, development, and deployment.[64] This leaves a research gap on advanced system components and other strategies to further reduce nonhardware costs of PV energy generation.

As the penetration of distributed PV continues to increase, so does its impact on distribution feeders in California, and a number of integration issues arise for utilities and grid operators. Several European countries require all inverter-based PV to autonomously support volt-VAR and frequency management functions.[65] Currently, IEEE 1547 and California Rule 21[66] do not allow for the interconnection of these advanced inverter technologies. Further research is required to verify the reliable performance of PV systems with advanced inverter functionality and advise standards for the development of such systems.

Purpose: This initiative will develop next generation, low-cost distributed PV system hardware components and power electronics designed to work in concert with other DERs and to enable communications between inverters and customer premise networks (CPNs), as discussed in

64 CPUC. 2007. *The Adopted California Solar Initiative Research, Development, and Demonstration Plan*. http://www.calsolarresearch.org/images/stories/documents/csi_rdd_adopted_plan_73189.pdf

65 http://www.energy.ca.gov/2011_energypolicy/documents/2011-06-22_workshop/presentations/06%20Frances%20Cleveland%20-Xanthus%206-20-Advanced%20Inverter-based%20DER%20Functions%20-%20CEC%20Panel%20v2.pdf.

66 http://www.cpuc.ca.gov/PUC/energy/Procurement/LTPP/rule21.htm.

initiative S6.5*: Develop Smart Grid Communication Systems That Interface With Customer Premise Networks and Distributed Energy Resources*. This initiative will also support the development and evaluation of comprehensive approaches to reducing the cost of energy for PV, and investigating strategies and business models to ensure that commercial PV systems are readily available and provide the functionality needed for customers and the utility grid. The Energy Commission will evaluate PV systems that are easily and quickly deployable as well as technology advances and strategies to increase the value of distributed PV systems in energy-smart communities. This initiative will conduct applied R&D to improve the economic performance of distributed PV, including, but not limited to:

- Advanced concentrating PV technologies and designs: To reduce costs and increase PV system performance, this initiative will develop and evaluate innovative concentrating PV systems, including concentrator designs, low-cost and high accuracy advanced tracker systems, system integrated inverters with advanced functionality, and strategies to use heat generated as a by-product of concentrating sunlight to increase system efficiencies. Concentrating PV systems use optical concentrators to focus incident radiation onto a small PV cell, generating heat. Typically, this heat is dissipated into the surrounding environment as waste, but there are several technologies that look to use this waste heat in useful CHP applications, thereby increasing the overall system efficiency.
- Low-cost building-integrated PV materials: This initiative will further reduce costs by developing building-integrated PV and hybrid solar systems that are fully integrated into building designs, including roofing surfaces, window materials, and/or other building elements. These systems should work in concert with other energy components within the building to advance California's ZNE buildings goals. Applied research activities will also inform standards for the integration of PV systems into new residential and commercial buildings.
- Advanced PV inverter functionality and interoperability: This initiative will develop and evaluate smart PV inverter technologies that can autonomously monitor local grid conditions and respond accordingly. Inverter functionalities will include volt-VAR control, dynamic grid support during low-voltage ride through, remote communications, and power curtailment. Advanced inverter technologies and smart grid components will be developed and integrated into packaged PV systems to increase interoperability with other co-located DER including energy storage, electric vehicle chargers, and other smart grid resources enabling the development of energy-smart communities and local microgrids. This initiative will support research to develop the abilities of PV systems to communicate with Local Area Networks to securely provide real-time system performance information to customers and utilities.
- Strategies to reduce nonhardware costs of PV: This initiative will develop and evaluate strategies to reduce the nonhardware costs for distributed PV across the entire value chain –

including manufacturing, distribution, installation, operations, and end-of-life system considerations. The Energy Commission will identify any untapped opportunities for nonhardware cost reduction and investigate strategies to strengthen the business case for distributed PV systems in California.

- Hardware technologies for self identification of DER equipment such as communication chips embedded in the DER systems, to automatically identify distributed energy resources as they interconnect to the utility's grid. This initiative will develop and evaluate embedded hardware to limit the safety risks associated with otherwise undetected DER installations. The utilities have related but separate pilot demonstrations of "auto registration" of DER equipment using their smart meter data to see changes in their energy use profile from the installation of DER equipment. This initiative will research embedded hardware that will provide direct communication of device information to increase the visibility of the individual DER equipment.

Stakeholders: Ratepayers in residential, commercial and industrial facilities; California ISO; IOUs; CPUC; energy-smart community developments; distributed PV installers; solar industry groups.

Background: The CPUC administers the CSI RD&D program. Through this program, $50 million of the CSI funds are directed to research, development, demonstration, and deployment projects. The RD&D program runs through 2016, and is funded by the electric ratepayers of California's three largest IOUs, PG&E, Southern California Edison Company (SCE), and SDG&E as described in Decision 06-12-033.[67]

Although solar is one of California's most promising renewable resources, it is not yet cost-competitive with other forms of conventional electricity generation. Particularly over the long term, as PV subsidies expire, it will be important to continue to investigate opportunities to further reduce costs (both technology and "soft" costs) to continue advancing California's PV industry. CSI RD&D will invest up to $50 million by 2016 pursuant to Public Utilities Code Section 2851.[68] Through this proposed initiative for EPIC applied research, the Energy Commission will seek opportunities to complement the advances made by the CSI RD&D program and avoid duplicative efforts.

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67 CPUC. 2007. *The Adopted California Solar Initiative Research, Development, and Demonstration Plan*. http://www.calsolarresearch.org/images/stories/documents/csi_rdd_adopted_plan_73189.pdf.

68 Public Utilities Code Section 2851 (c)(1) establishes a CSI R&D funding cap of $50 million. It provides in pertinent part: "In implementing the California Solar Initiative, the commission [CPUC] shall not allocate more than fifty million dollars ($50,000,000) to research, development, and demonstration that explores solar technologies and other distributed generation technologies that employ or could employ solar energy for generation or storage of electricity or to offset natural gas usage…"

A significant research effort is underway at the federal level with the U.S. DOE's SunShot Initiative, which aims to reduce the cost of solar energy 75 percent by 2020. As part of this effort, the U.S. DOE launched the Rooftop Solar Challenge to reduce nonhardware PV costs and improve market conditions for PV projects. This nationwide effort engages diverse teams of local and state governments along with utilities, installers, nongovernmental organizations, and others to make solar energy more accessible and affordable.[69] The SunShot initiative presents a significant opportunity for California to leverage U.S. DOE funding while maintaining the state's track record of innovation and early adoption.

In recent years, several research projects have focused on ways to advance distributed PV technologies and California's PV industry as a whole. For example, SolarTech has looked at comprehensive ways to reduce the cost of solar energy through permitting, installation, and other "soft cost" reductions. Other projects have sought to reduce costs with innovative technology designs and low-cost installation strategies. While promising advances were made in these projects, further cost reduction opportunities exist that are essential to the long-term viability of distributed PV in California.

The proposed IEEE 1547.8 update should allow higher penetrations of inverter-based DER, including PV, but it is still under development. The purpose of the update is to provide more flexibility in determining the design and processes used in expanding implementation strategies for interconnecting distributed resources with electric power systems.[70] Developing and deploying advanced inverter technologies will improve power system efficiency, delay the need for distribution upgrades, and help avoid grid outages. Inverter manufacturers are already including advanced functions for the European market, and lessons learned could be leveraged to develop optimized upgrades for California's environment. Results of applied research in this area could be used to advise any updates to California's Rule 21.

69 http://www.eere.energy.gov/solarchallenge/.

70 http://www.4thintegrationconference.com/downloads/Distribution%20Grid%20Codes%20Tutorial_PPL%20Electric_Bassett.pdf.

S4 Strategic Objective: Develop Emerging Utility-Scale Renewable Energy Generation Technologies and Strategies to Increase Power Plant Performance, Reduce Costs, and Expand the Resource Base.

Table 12: Ratepayer Benefits Summary for Strategic Objective 4

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/ transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S4.1 Develop Advanced Utility-Scale Thermal Energy Storage Technologies to Improve Performance of Concentrating Solar Power.	x	x		x	x			x	x
S4.2 Develop Innovative Tools and Strategies to Increase Utility-Scale Renewable Energy Power Plant Performance and Reliability.	x	x		x	x			x	x
S4.3 Develop Advanced Technologies and Strategies to Improve the Cost-Effectiveness of Geothermal Energy Production.	x	x		x	x			x	x
S4.4 Investigate the Economic, Environmental and Technical Barriers to Offshore Wind in California.	x	x		x	x			x	x
S4.5 Investigate the Economic, Environmental and Technical Barriers to Wave Energy Conversion Technologies in California.	x	x		x	x			x	x

In response to the adoption of the 33 percent RPS and Governor Brown's Clean Energy Jobs Plan goal of deploying 8,000 MW of large-scale renewable energy systems by 2020, California has aggressively pursued greater reliance on renewable energy sources. As a result, the state leads the nation in electricity generation from nonhydroelectric renewable energy sources, including solar, wind, geothermal, and biopower generation. While gas-fired generation and nuclear power continue to play significant roles in the state's electricity system, the focus is on protecting the environment and creating jobs through developing and integrating renewable energy sources. R&D initiatives identified in this objective will focus on utility-scale renewable energy sources, specifically solar PV and concentrating solar thermal, geothermal energy, and emerging offshore renewable technology opportunities.

The Energy Commission will fund research to improve the cost and performance of existing utility-scale clean energy generation, which is defined as a standalone generation facility that is

directly connected to the grid and is 20 MW or greater in capacity. Research on clean energy generation will also be targeted at filling knowledge gaps and technology needs to deploy and integrate emerging utility-scale renewable energy technologies in a stable, secure, and environmentally friendly way. Research initiatives focus on system engineering in addition to developing data, technologies, and tools for planning and operating large renewable energy power plants that work with state, regional, and local transmission resources. Incremental improvements in technology, as well as innovative breakthroughs, will be sought through applied research in bench- and pilot-scale developments.

Additionally, developing utility-scale clean energy technologies and pre-commercial applications need investment. Two such emerging energy technologies that may be able to contribute to California's RPS goals are offshore wind and marine renewable energy. California has considerable electricity generation potential located in offshore resource areas but has yet to analyze comprehensively the technical economic barriers facing the development of these resources.

S4.1 Proposed Funding Initiative: Develop Advanced Utility-Scale Thermal Energy Storage Technologies to Improve Performance of Concentrating Solar Power.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		X

Issue: Integrating thermal energy storage (TES), a means of storing thermal energy for later use, with concentrating solar power (CSP) plants allows energy to be generated during off-peak periods and used when needed, reducing system variability and evening peak demand. The use of storage may increase annual capacity factors as well: the National Renewable Energy Laboratory [71] estimates that the use of TES may allow CSP plants to achieve annual capacity factors of up to 70 percent or more, a significant increase over plants without thermal storage. CSP plants integrated with TES can provide not only firm capacity but high-value ancillary services such as spinning reserves.

There are several drawbacks to the use of TES systems, including additional costs and the need to oversize the solar field. Further research is needed to reduce the cost of TES and improve the properties of heat transfer fluids to maximize CSP plant performance.

71 NREL website: http://www.nrel.gov/csp/troughnet/thermal_energy_storage.html. Accessed August 23, 2012.

Purpose: This initiative will support research to improve TES for CSP applications. This initiative will also seek research on storage media with improved thermal and physical properties and advanced heat transfer fluids for CSP plants, such as organic salts and molten metals. Research on heat transfer fluids for direct use in solar plant operation may be coupled with research under this initiative.

Stakeholders: Utilities, ratepayers, California ISO, independent energy developers, the U.S. DOE and operators, energy academia, and renewable energy industry groups.

Background: A variety of different heat transfer fluids, which are used to transport heat to the power block, have also been used to assess energy storage potential in CSP plant operations.TES has been demonstrated with a number of alternative heat transfer materials, such as petroleum-based products and molten salt. TES using molten salt storage seems to hold the greatest promise of economic commercialization. Molten salt systems, usually a mixture of 60 percent sodium nitrate and 40 percent potassium nitrate, allow the solar field to operate at higher temperatures relative to other fluids or storage media, returning as much as 93 percent of the energy sent into storage. Storage capacities from 3-12 equivalent full load hours have so far been evaluated.

The U.S. DOE has funded research on thermal energy storage through the SunShot Initiative. In 2008, the U.S. DOE SunShot Initiative funded 15 projects looking at advanced heat transfer fluids and novel thermal storage concepts for concentrating solar power generation for around $67.6 million. TES topics addressed by these projects included the use of molten salt carbon nanotubes, the use of liquid CO_2 as the heat transfer fluid, and using solid ceramics for the energy storage vessels. In August 2012, the U.S. DOE announced new investments totaling $10 million for two university-led projects to advance innovative CSP system technologies. One of these awards was for a collaborative research team including University of California, Los Angeles, and University of California, Berkeley, to investigate liquid metals as potential heat transfer fluids with the ability to withstand higher temperatures.

KEMA is researching thermodynamic modeling of different solar generation-thermal storage configurations to identify optimal approaches for dispatch applications. In 2011, KEMA began to evaluate the economic potential of CSP plants integrated with TES and develop models to examine the relative performance of a variety of TES technologies for CSP plant applications. Future Energy Commission work should expand this effort to include emerging TES technologies and configurations.

S4.2 Proposed Funding Initiative: Develop Innovative Tools and Strategies to Increase Utility-Scale Renewable Energy Power Plant Performance and Reliability.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		X

Issue: Both solar PV and CSP technologies present challenges to operation of the power system due to the variability and the relative uncertainty of their generation output. Specific technical concerns related to intermittency involve grid stability, voltage regulation, and power quality (voltage rises, sags, flickers, and frequency fluctuations).

As there is a relatively small amount of installed solar capacity, the characteristics of solar technology (PV and CSP) power output are not well established. Initial experience with PV indicates that output can vary more rapidly than wind unless aggregated over a large area. There is also a need for modeling to smooth regional variations in generation, reducing the need for highly accurate forecasts. To facilitate utility-scale solar generation integration into the grid, there is a need to improve forecasts that inform grid operators of upcoming variability and to smooth regional generation variability.

Purpose: This initiative will support research solutions to improve intermittent renewable energy integration into the state's electrical grid through developing improved forecasting and modeling tools. To enable the integration of increasing amounts of utility-scale solar generation into the grid, research under this initiative will develop and evaluate improved forecasting techniques and tools to inform grid operators of expected power plant performance on minutes-ahead, hours-ahead, and days-ahead time scales.

Expanding on past efforts, the suite of existing solar forecasting tools and models should be integrated and developed into a best-mix forecast tool for grid operators to incorporate into planning processes and dynamic operation of the grid. This initiative will also develop advanced modeling techniques and real-time resource assessments to smooth regional variation in generation, reducing the need for increasingly accurate forecasts.

Stakeholders: Utilities, ratepayers, California ISO, independent energy developers, the U.S. DOE and operators, energy academia, and renewable energy industry groups.

Background: Research has been conducted to develop solar energy forecasting and monitoring tools for a spectrum of time scales, from minutes ahead to hours ahead to days ahead. There are several distinct forecasting techniques that each provides more accurate forecasts within certain timeframes, including total sky imagers for minutes ahead, satellite-based cloud vector analysis

for hours ahead, and numerical weather prediction models for days ahead. Recent research is evaluating the feasibility of integrating these three tools into one seamless forecasting tool. Future research activities should build from these efforts and support the pilot demonstration of an integrated forecasting tool in the California ISO planning, such as the one described below. The California ISO[72] calls for improved day-ahead forecasting through numerical weather models with a focus on marine layer clouds. This can be achieved through developing advanced algorithms to ingest satellite and ground measurements to model for cloud cover as well as developing tools to select forecast models based on meteorological conditions.

The University of California, San Diego, has performed extensive R&D in this area, particularly using shorter-time frame forecasting techniques and predicting the onset of localized weather events such as marine layers. The National Oceanic and Atmospheric Administration (NOAA) recently completed a two-year project with the U.S. DOE to improve forecasts of turbine-level (or boundary layer) winds using high-resolution numerical models. Other private entities, such as Clean Power Research and AWS Truepower, have performed Energy Commission-sponsored forecasting research in collaboration with the California ISO. Further research is needed to integrate each approach into a best-mix tool that provides accurate forecasts of solar plant output across each time scale.

The U.S. DOE SunShot Initiative and CSI RD&D program have both supported research into forecasting for solar generation. EPIC investments will be coordinated with these and other programs to avoid duplication and leverage project results from these programs.

S4.3 Proposed Funding Initiative: Develop Advanced Technologies and Strategies to Improve the Cost-Effectiveness of Geothermal Energy Production.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X					X		X

Issues: Challenges to increased geothermal development stem from the fact that exploration and resource characterization activities are expensive and time consuming, and therefore, necessitate long lead times for project development. Permitting and environmental considerations, such as emission of toxic air pollutants and possible impacts to water resources, are also major barriers. Exploration, drilling, and resource development can account for roughly

72 California ISO Research Topic Area Comment on EPIC Investment Plan TN-66713. Submitted August 16, 2012.

half of the capital costs associated with construction and operation of a geothermal power plant. Consequently, improvements in exploration and drilling technologies and resource assessment capabilities may hold the greatest potential for geothermal power plant cost reductions.

Purpose: This initiative will research improvements to geothermal resource characterization and development tools and analytical techniques to help reduce risks associated with development of a variety of geothermal systems, including hydrothermal, enhanced, and geopressurized systems. An area for advancement includes developing exploration and characterization tools to locate and characterize low- and moderate-temperature hydrothermal systems before drilling, thereby reducing well field costs. Research activities will also address downhole, high-temperature tools and electronics to improve geothermal subsurface operations, as well as improved drilling mechanisms, such as steering technologies. Ensuring reservoir productivity is also a priority, so the initiative will also research refinements to the techniques and modeling tools needed to quantify production and injection impacts on geothermal reservoirs. Alternative working fluids for hot, dry rock resources, such as CO_2, will also be addressed. Lastly, the initiative will address research to improve existing geothermal plant efficiency, reduce corrosion and scaling, recover useable metals from spent geothermal brine, and improve cooling technology.

Stakeholders: Utilities, ratepayers, geothermal energy developers and operators, resource exploration and characterization companies, the U.S. DOE, and geothermal industry groups.

Background: The U.S. DOE's Geothermal Technologies Program conducts in-house research on exploration, characterization, and development tools for enhanced geothermal systems, including high-temperature tools and sensors, advanced drilling systems for enhanced geothermal systems, resource characterization and validation studies, and research on geothermal water use. Forty-six research projects have been funded in California through different U.S. DOE solicitations. EPIC geothermal research can use and build upon these federally supported research efforts to help improve and support California-specific geothermal research.

The Energy Commission also administers geothermal R&D funds under the Geothermal Grant and Loan Program, which is funded by the state's Geothermal Resources Development Account. The objective of the Geothermal Grant and Loan Program is to promote planning and development of new or existing geothermal resources and technologies in California; however, certain research activities are not eligible for funding under this program. EPIC funding will be used to complement California's existing geothermal research projects and leverage geothermal development funding opportunities from the U.S. DOE.

S4.4 Proposed Funding Initiative: Investigate the Economic, Environmental, and Technical Barriers to Offshore Wind in California.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	

Issues: There are number of remaining barriers that need to be further investigated before offshore wind can be developed in California. The average water depth on the West Coast increases far more rapidly than most other coastal regions in the United States, which means that the highest quality wind resources are located in deep water. While shallow water offshore wind technologies are being developed rapidly in Europe, additional research is needed to address concerns of offshore wind in California's unique marine environment.

Environmental concerns are potentially a major barrier to offshore wind energy development. For example, good potential offshore wind resources may be in the migration path of sea mammals and birds, increasing the risk of collision with turbine blades. Noise and vibration from construction and operation of the wind turbine may also disrupt marine species' behavior.

Some of the technology advancements needed for deepwater offshore wind include larger capacity turbines and innovative integrated turbine configurations (rotor, drivetrain, tower, controls) to counterbalance their additional capital cost. To increase wind turbine capacity, weight needs to be reduced by developing innovative blade designs and lighter weight composite materials. Construction and operation costs can be reduced by simplifying installation and reducing maintenance requirements. Further analysis is needed to evaluate economic and technical feasibility and any additional technology advancements that will be needed.

The U.S. military may have concerns with locations of offshore wind plants and their interference with defense testing. Issues such as these may limit deployment along the California coast. Oregon has addressed this by developing a comprehensive marine spatial plan that incorporates the needs of marine renewables.

Purpose: This initiative will evaluate the costs, environmental concerns, and technology needs for offshore wind energy systems in California, including the underwater transmission infrastructure necessary to connect with California's electricity grid. Research activities will identify the specific benefits, disadvantages, and trade-offs of offshore wind technologies, which could lead to future demonstrations in California.

Potential applied research topics include, but are not limited to:

- Evaluating societal impacts under various deployment scenarios
- Evaluating deep-water foundations and innovative component designs to baseline technology platforms, evaluating cost-effectiveness, and identifying lowest cost options.
- Identification of priority locations and siting constraints for offshore wind installations.
- Developing modeling tools to evaluate installation configurations.
- Evaluating grid integration impacts of offshore wind energy.

Environmental research on offshore wind development is also discussed in S5.3: *Develop Analytical Tools and Technologies to Reduce Energy Stresses on Aquatic Resources and Improve Water-Energy Management.*

Stakeholders: Utilities, ratepayers, coastal communities, U.S. Bureau of Ocean Management, Regulation and Enforcement Ocean Protection Council, offshore wind developers, and the U.S. DOE.

Background: The U.S. DOE's National Renewable Energy Laboratory has been conducting in-house research on offshore wind for nearly a decade. The program is focused on improved resource characterization, grid integration, and standards development. The U.S. DOE also funded $20 million of research in 2011 to explore technology development and removing market barriers. More recently, funding opportunities were announced to demonstrate emerging offshore wind energy systems in United States waters, including the U.S. DOE *Offshore Wind: Advanced Technology Demonstration Projects*.[73] This grant opportunity provides funding for two topics: pilot-scale deployment and assessment of commercial viability. Multiple proposals were submitted for demonstration projects in California, but awards have yet to be announced. While no offshore wind projects have been demonstrated in California, interest in developing these resources has recently increased.

73 http://www1.eere.energy.gov/wind/financial_opps_detail.html?sol_id=473.

S4.5 Proposed Funding Initiative: Investigate the Economic, Environmental, and Technical Barriers to Wave Energy Conversion Technologies in California.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	

Issues: Currently, the estimated costs to purchase, install, maintain, and operate wave energy converter systems in California and the underwater transmission infrastructure necessary to connect them to the grid far exceed those of fossil fuel generation and other renewable resources. Compounding the cost issue are concerns about the effects that marine renewable energy technologies may have on marine animals and benthic (sea bed) ecosystems.

The potential environmental impacts of marine renewable energy include dangers to marine life from working fluid leakage, electromagnetic fields, sounds and vibrations produced during electricity generation, and the impacts of erosion and sediment flows on natural coastal processes. These environmental compliance issues require significant attention before a demonstration project is possible in California.

Purpose: This initiative will investigate the environmental, economic, and technical issues with marine renewable energy technologies, including underwater transmission and substations. Technologies will be evaluated for their cost, reliability, and environmental performance in California's waters. Integration issues surrounding deployment of these marine energy technologies will be addressed along with the research to scope the potential environmental barriers to wave energy deployment.

Extreme events (typically 50- or 100-year return events) are important design considerations when evaluating the structural loads on marine energy installations. Such loads are induced by winds, currents, waves, tsunamis, and seismic activities. These events need to be properly characterized using existing data to form the design basis for marine energy installation in California.

Stakeholders: IOUs, ratepayers, coastal communities, U.S. Bureau of Ocean Management, Regulation and Enforcement Ocean Protection Council, offshore wind developers, and the U.S. DOE.

Background: A large variety of wave energy converter technologies have been tested and demonstrated in other states and in Europe with varying degrees of success. Attenuators, point

absorbers (power buoys), oscillating water columns, and multipoint absorbers are just a few of the wave energy converter technology types that have emerged over the last several years.

Previously, PG&E had proposed several wave energy demonstration projects off the Northern and Central California coasts with its WaveConnect program. These demonstration projects would have included four different wave energy technologies and generated 5 MW of grid connected electricity. PG&E opted to discontinue the project due to development and operation costs beyond what they were willing to spend on unproven technologies.

The U.S. DOE Wind and Water Power Program supports R&D on a wide range of advanced marine renewable energy technologies, with the objective of better understanding their potential for energy generation, and identifying and addressing the technical and nontechnical barriers to their application and deployment, through programs such as the Marine and Hydrokinetic Technology Readiness Advancement initiative.[74] Specific activities addressed by the U.S. DOE in recent years have included component and device development, device testing, national marine renewable energy testing centers, array design, development, modeling and testing, and technology evaluation. This broad range of activities has resulted in a number of R&D funding opportunities that have not yet been fully leveraged by California's R&D funding agencies, including the Energy Commission.

Most recently, Ocean Power Technologies, a wave energy device developer, announced that it has received approval from the U.S. Federal Energy Regulatory Commission (FERC) for a planned 1.5 MW wave energy installation off the coast of Oregon. This is the first FERC license for a commercial wave power facility issued in the United States. The license provides a regulatory approval for the deployment of up to 10 wave energy converter devices.

74 https://www.fedconnect.net/FedConnect/?doc=DE-FOA-0000293&agency=DOE.

S5 Strategic Objective: Reduce the Environmental and Public Health Impacts of Electricity Generation and Make the Electricity System Less Vulnerable to Climate Impacts.

Table 13: Ratepayer Benefits Summary for Strategic Objective 5

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S5.1 Conduct Air Quality Research to Address Environmental and Public Health Effects of Conventional and Renewable Energy and to Facilitate Renewable Energy Deployment.			x	x					
S5.2 Research on Sensitive Species and Habitats to Inform Renewable Energy Planning and Deployment.		x	x	x			x		
S5.3 Develop Analytical Tools and Technologies to Reduce Energy Stresses on Aquatic Resources Water and Improve Water-Energy Management.	x		x	x					
S5.4 Develop Analytical Tools and Technologies to Plan for and Minimize the Impacts of Climate Change on the Electricity System.	x		x	x					

As California moves toward achieving a 33 percent RPS and the GHG reduction goals of the Global Warming Solutions Act, the state must balance the need for renewable energy development with appropriate levels of environmental protection. Lack of suitable information and tools has emerged as a major source of uncertainty and delay in the permitting and deployment of renewable energy projects. This impacts the cost of achieving the RPS and the cost is borne by the ratepayer. This is readily apparent in the Southern California desert where traditional approaches to avoiding and mitigating environmental impacts of proposed solar projects have proved inadequate. Furthermore, the state's existing electricity system continues to contribute to the overall degradation of land, air, and water resources while adversely affecting public health.

The environmental costs and benefits of renewable energy policies, conventional and emerging energy technologies, and system performance in achieving the state's RPS and GHG emission goals must be understood to give decision makers the tools and information they need to

balance environmental protection and energy development. This translates to achievement of goals at a lower cost to the ratepayer, both in terms on dollar cost and environmental impact.

The initiatives under this strategic objective address research on air quality, habitat protection, and water resources associated with the existing electricity generation systems, including fossil fuel and renewable energy sources. Most public health research will be addressed under the air quality research initiative. Research under this initiative will also assess environmental issues associated with emerging renewable energy technologies, the interaction of climate change with the electricity system, and the electricity system's future evolution.

S5.1 Strategic Initiative: Conduct Air Quality Research to Address Environmental and Public Health Effects of Conventional and Renewable Energy and to Facilitate Renewable Energy Deployment.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X					**X**		

Issue: The emphasis on adding renewable generation to the California energy mix has not replaced the requirement for new natural gas power plants. There is a need to understand how the new electricity system will function and affect air quality. Also, there is a need to identify new sources of air pollution offset credits because credit scarcity is affecting the ability to site new plants where they are needed. This in turn may impact customer reliability. It will also be critical to understand the potential air quality impacts of new generation technologies and fuels – as well as control technologies and mitigation strategies – as the state strives to meet its renewable energy and GHG emission reduction goals. This challenge is especially true for biopower, which faces major siting and permitting challenges due its potential air quality impacts. At the same time, the electrification of some energy services (for example, transportation and water heating) can be a tool to improve air quality conditions in California. Emissions inventories and assessments of the spatial distribution of emissions from biopower generation are needed to evaluate potential air quality benefits/impacts.

The *2012 Bioenergy Action Plan* identifies the need for additional R&D to ensure that energy production is environmentally and economically sustainable. Because biopower produces air pollution emissions of ozone precursors and particulate matter in each phase of development – from feedstock collection, transportation, and processing to generation – compliance with air quality standards may be a major factor in bioenergy siting. Emission factors for certain

technologies and feedstocks are incomplete and need further research. Bioenergy gasification presents another area in need of research because emissions from bioenergy gasification and combustion vary significantly based on the feedstock source and the gasification technology.

Purpose: This initiative will evaluate air quality impacts of the current IOU electricity system, which is predominantly natural gas-fired generation, including how to address the shortage of pollutant offsets for new generation. Air quality research will also focus on new generation technologies and fuels for electricity generation. This research, which will be closely coordinated with the ARB and air quality districts, will inform improved emissions estimates for generation technologies and fuels and improved mitigation strategies.

Public health research will focus on short-term dispersion modeling to inform understanding of pollution exposure in disadvantaged communities located near electricity generating facilities. Air quality research will also investigate the formation, composition, measurement, and population exposure to particulate matter, particularly ultrafine particulate matter (less than 100 nanometers in size).

Stakeholders: Ratepayers, utilities, research institutions, non government organizations (NGOs), ARB, U.S. Environmental Protection Agency (U.S. EPA), Air Quality Management Districts.

Background: Since 1971, the ARB has sponsored more than 245 research projects on public health effects of air quality and sources, controls, and inventories of air pollutants. Recent ARB bioenergy research has focused on developing transportation fuels. In recent years, research funding has totaled slightly more than $5 million in each of the annual research plans. Research identified in the plans has been heavily focused on transportation-related issues. For example, ARB's Fiscal Year 2012-2013 Research Plan[75] identifies about $5.65 million in air quality research entirely focused on the transportation sector.

Coordinating with the ARB, local air districts, and stakeholders, the Energy Commission has focused on developing new test methods, instruments, and tools capable of measuring emissions from small and large generation sources and predicting both local and regional air quality impacts. It is supporting research on the air quality issues related to biogas from anaerobic digestion of food waste, the air quality impacts of implementing the RPS, and economically and environmentally viable strategies for conversion of bioresources to power. Other organizations such as the U.S. EPA and the New York State Energy Research and Development Authority have conducted similar research on ozone and particulate matter health effects, but additional California utility-specific research is needed.

75 California Air Resources Board, Fiscal Year 2012 – 2013 research Plan. June 2012. http://www.arb.ca.gov/research/apr/plan/fy12-13/2012-13_arb_annual_research_plan.pdf

S5.2 Proposed Funding Initiative: Research on Sensitive Species and Habitats to Inform Renewable Energy Planning and Deployment.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X					**X**		

Issues: Increasing renewable energy production can yield numerous environmental and societal benefits by reducing GHG emissions and dependence on fossil fuels; however, developers must carefully identify locations for energy projects to avoid unnecessary damage to California's vulnerable species and habitats. Utility-scale renewable energy offers significant challenges to balancing environmental protection with energy development due to the large land footprint of such projects.

A lack of baseline data, tools, and methodologies to assess and mitigate the interactions of species and habitats with renewable energy projects creates uncertainty and delays and increases the costs of permitting. A lack of shared information on the effects of renewable energy siting and deployment on wildlife species has created significant challenges for utility-scale solar development in southeastern California. Resource assessment and impact determination are difficult due to the lack of experience, information regarding how to adequately assess species distribution over square miles of desert, knowledge on population dynamics, and knowledge of species sensitivity to disturbance. This problem is exacerbated by a lack of proven mitigation measures and strategies. This issue, however, is not unique to large scale solar projects, but also applies to other large scale renewable energy sources such as wind farms, transmission lines, and forest biomass harvesting. Species and habitat considerations have also been major barriers to siting and deployment of other renewable energy technologies, including biomass and geothermal energy. There is a need for information and tools to not only to make the permitting process easier for these renewable energy technologies, but also to ensure environmental protection through developing, enhancing, and validating mitigation measures.

Bird, bat, and other animal deaths from collisions with power lines and wind turbines are an ongoing environmental issue, affecting wind energy and electricity development, and are a major challenge for siting wind energy projects throughout the state. A greater understanding of the status and movement patterns of birds and bats will allow for the development of appropriate and viable mitigation for the take of species at wind facilities. An example of this is the lack of information regarding the population status and viability of the golden eagle has led

to a cessation of take permits necessary for project development in the Desert Renewable Energy Conservation Plan (DRECP).

Large-scale biomass cultivation and harvesting in agricultural and forested areas may adversely affect wildlife species. Agricultural areas within the state support sensitive species, such as the Swainson's hawk, may be displaced if new agricultural crops for biomass production are introduced. Wildlife responses to forest biomass harvesting vary from species to species, but more information is needed to understand how each species will respond to different harvesting techniques and how to conduct harvesting sustainably.

Purpose: The intent of this initiative is to develop tools, technologies, and information that will help reduce, resolve, and anticipate environmental barriers to renewable energy deployment in California. Research on fossil fuel generation will also be addressed under this initiative. This initiative will emphasize resolving scientific data gaps and developing analytical tools related to sensitive terrestrial species and habitats to reduce delay and uncertainty in the siting process for energy facilities. Potential research topics include developing and testing innovative species mitigation strategies, building habitat suitability models and planning/management tools, and improving impact assessment protocols and scientific baselines. Under this initiative, tools to minimize environmental impacts can be tested and demonstrated through the pilot-scale stage.

Research under this initiative will also inform planning efforts, such as the Desert Renewable Energy Plan, to ensure environmental barriers to future energy deployment are proactively addressed and land-use conflicts minimized. Ratepayers benefit by achieving RPS goals with lower environmental impact, with mitigation focused on effective habitat strategies.

Stakeholders: Ratepayers, utilities, research institutions, NGOs, U.S. EPA, renewable energy developers.

Background: While a significant amount of research on the state's biological resources has been conducted, very little of this work has focused on applied research to address the environmental effects of electricity generation. Examples of research to inform the permitting process for energy development in California include efforts by the California Wind Energy Association, the U.S. Forest Service, and others to address avian and bat interactions with wind turbines; the U.S. Forest Service is addressing the effects of collecting forest biomass on song birds and small mammals; and the University of Redlands is developing a decision support tool for assessing and mitigating impacts to desert tortoises.

Nine current projects are addressing research to facilitate renewable energy siting and planning in the DRECP, as identified in the *2009 Integrated Energy Policy Report*. The DRECP will guide renewable energy siting and conservation in the Mojave Desert and Colorado Desert of California and is being developed by the Renewable Energy Action Team made up of the Energy Commission, California Department of Fish and Game (DFG), the U.S. Fish and Wildlife Service, and the U.S. Bureau of Land Management. These agencies, along with universities and

other environmental stakeholders such as the Nature Conservancy, have recently invested in targeted research to facilitate the DRECP. For example, in 2011 at least $1 million in federal funding was provided to the DFG for endangered species research related to the DRECP.

S5.3 Proposed Funding Initiative: Develop Analytical Tools and Technologies to Reduce Energy Stresses on Aquatic Resources and Improve Water-Energy Management.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X					X		

Issues: Water is closely intertwined with the state's electricity system. Not only is electricity used to pump, treat, use, and dispose of water, but water is also used in electricity generation . Hydropower, of course, uses water; electric power plants use water for evaporative cooling as well.

As California's electricity system evolves to meet the state's renewable energy and GHG emission goals, it is important to reduce electricity's demand for water. Scarce freshwater resources may be a barrier to greater penetration of certain renewable energy technologies like CSP, geothermal, and biomass.

Opportunities for construction of new hydroelectric plants are extremely limited in California. Most economically viable sites have already been taken, and development of remaining suitable sites faces significant barriers. Because hydropower plays a significant role in the state's electricity system, there are significant opportunities from improved forecasting and decision support tools as well as an improved understanding of meteorological processes, such as atmospheric rivers that affect the amount and distribution of precipitation, runoff patterns, and hydropower generation.

As identified in the *2005 Integrated Energy Policy Report*, there is a need for research to reduce the effects of hydropower generation on California's aquatic ecosystems. California's inland fish populations have suffered a steep decline, in part due to hydropower generation. As existing nonfederal hydropower facilities are relicensed by FERC, there is a need for research to inform this permitting process.

Environmental concerns may also pose significant permitting issues for emerging marine renewable energy technologies such as wave energy devices or offshore wind. Wave energy devices may change near-shore sediment transport, adversely affecting near-shore benthic (sea bottom) communities. Fish are anticipated to use wave energy conversion installations as

artificial habitat, so sound and electromagnetic fields from the technology may affect their behavior. Large arrays of wave energy devices may block migratory marine mammal migration routes. Offshore wind anchoring devices may also block migrating marine mammals and cause bird and bat collisions with the wind turbines. It is important that these environmental effects be assessed and, where needed, be avoided, resolved, or reduced prior to commercial deployment of these emerging technologies.

Purpose: This initiative will develop tools, technologies, and information to inform the permitting and deployment process to help improve water and energy management. For example, there is a need to improve understanding of meteorological processes to increase the ability to forecast precipitation and runoff for hydropower generation. There is also a need to develop innovative forecasting techniques for high elevation hydropower, which represents about a third of California's hydropower capacity. For example, the Hydrologic Research Center has demonstrated the usefulness of probabilistic runoff forecasts at five low-elevation reservoirs in Northern California. This initiative would support application of probabilistic forecasting to other hydropower projects.

This initiative will also support research to help reduce the impacts of electricity generation, especially hydropower generation, on aquatic species and habitats as well. Three thousand MW of nonfederal hydropower generation in the state will be up for relicensing by FERC within the next 10 years. Since these licenses last 30 to 50 years, it is critical that the necessary tools and information be developed to inform this permitting process.

This initiative will also support research to reduce water demands from the electricity-generating sector. A major source of water consumption from fossil fuel and renewable generation is the water used for steam condensation, commonly referred to as power plant cooling. While there is water conserving cooling technologies available, such as an air-cooled condenser, which reduces water demand for cooling to zero, there are cost and performance penalties associated with their use. There is also a need for research to inform future renewable energy siting for offshore wind and wave technologies. Under this initiative, ecological information, tools, and methodologies will be developed to proactively determine potential environmental impacts prior to full-scale deployment of offshore wind or wave energy conversion technologies.

Stakeholders: Ratepayers, research institutions, NGOs, IOUs, Department of Water Resources, water management districts.

Background: The U.S. DOE, the Electric Power Research Institute, and others have researched ways to reduce water demand from electricity generation, specifically through the use of air-cooled condensers or the use of water sources not suitable for agricultural or municipal uses. Research on air-cooled condensers has sought ways to reduce the heat and wind effects on condensers while degraded water research addressed the challenges of using such water from different sources in power plant cooling towers. Research by John Maulbetsch and the

University of California, Davis, is assessing the best use of wind barriers to reduce wind effects on air-cooled condensers.

The University of California, Davis, the U.S. Forest Service, Garcia and Associates, and others researched the effects of hydropower ramping flows on aquatic ecosystems. H.T. Harvey and Associates has conducted an environmental knowledge gap analysis for wave energy development in California.

Research conducted by NOAA's Office of Atmospheric Research, the California Department of Water Resources, and the California Energy Commission has delineated the importance of atmospheric rivers, a weather phenomenon that delivers a significant portion of the precipitation and runoff that occurs in California.

S5.4 Proposed Funding Initiative: Develop Analytical Tools and Technologies to Plan for and Minimize the Impacts of Climate Change on the Electricity System.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X					**X**		

Issues: Recent research has shown that over the next few decades the electricity system will be highly vulnerable to climate change and extreme events. The information generated so far, however, has been designed to estimate the seriousness of the impacts and has looked mostly at what would happen by the second half of this century. The rapid evolution of the energy system must also be taken into account given the ambitious GHG reduction goals adopted in California. This evolution should be guided with information that facilitates the creation of a more climate-resilient energy system. It is unlikely that programs other than EPIC would be able to generate the scientific and engineering information needed to create a more resilient electricity system for ratepayers in California.

Purpose: This initiative will produce practical information on GHG mitigation, impacts, and adaptation to inform policy deliberations at the CPUC, Energy Commission, and other jurisdictions. The main focus will be on mitigation, impacts, and adaptation options for the next few decades since that is the time frame used to develop energy policy.

To better assess potential climate change effects on the state's electricity system, this initiative will improve climate change projections for California. Current climate change projections focus on temperature and precipitation with a very crude treatment of important variables such as wind and solar radiation. The proposed new research will improve the simulation of wind,

ground-level solar radiation, relative humidity, and other parameters of importance to the electricity sector and will refine projections of temperatures and precipitation that still contain significant uncertainties, especially on local-to-regional scales specific to IOU electricity systems in California.

This initiative will also improve the depiction of high-elevation hydropower units in water models under different climate scenarios. Current simulations address only low-elevation hydropower units. Including high-elevation hydropower units is essential because research shows that climate change would cause high levels of spillage from high-elevation reservoirs during the late part of the winter season, creating water management problems for low-elevation reservoirs and their associated hydropower units.

This initiative will also address the energy implications of adaptation measures. California has begun to identify and implement adaptation measures that may substantially affect energy generation and demand. For example, water agencies are investigating the use of natural groundwater reservoirs to store water during wet years and to lessen the effects of expected snowpack decline in the Sierra Nevada. The energy demand implications of pumping water from these groundwater reservoirs is unknown. Research to identify the energy consumption implications of different adaptation options under consideration now and in the future is also needed.

This initiative will also research the potential evolution of the electricity system to identify how the IOU electricity system will need to change to drastically reduce GHG emissions while avoiding or minimizing environmental impacts.

This initiative will use a practical approach by delving into engineering design issues for concrete steps that could be taken by electricity system managers. The research focus is on practical engineering applications that produce actionable products but will also look at economic issues, including econometric and economic experiments, as needed to fully evaluate mitigation and adaptation opportunities. For example, Pacific Institute research has shown that with sea level rise some coastal power plants will be in danger of coastal flooding. What is needed now are engineering studies to identify when the problem would materialize, what specific actions should be taken at these power plants, and what alternatives are available. The same can be said about effects of climate change on high-elevation hydropower units. Researchers have developed models that can adequately identify overall system impacts but are unable to generate practical local information that can be used to implement actionable adaptation measures at specific hydropower units.

Stakeholders: Ratepayers, research institutions, Air Quality Management Districts, ARB, CPUC, and IOUs.

Background: California leads the nation on climate change research. While there are national research efforts by different federal agencies, including the U.S. DOE and the National

Academy of Sciences, they will not specifically address California and the unique challenges that climate change will present to the state. Nongovernmental organizations have also expressed strong support for the spirit of this initiative in comments submitted to the CPUC by The Nature Conservancy, the Natural Resources Defense Council, the Union of Concerned Scientists, the Sierra Club, the Environmental Defense Fund, and others during the deliberations that culminated with the creation of EPIC.

Smart Grid Enabling Clean Energy

S6 Strategic Objective: Develop Technologies, Tools, and Strategies to Enable the Smart Grid of 2020.

Table 14: Ratepayer Benefits Summary for Strategic Objective 6

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S6.1 Develop Equipment and Technologies to Enable Power Flow Control and Bi-Directional Power Flow Through the Transmission and Distribution System.	x		x					x	x
S6.2 Develop Controls and Equipment to Expand Distribution Automation Capabilities.	x	x	x			x		x	x
S6.3 Develop Automation and Operational Practices to Make Use of Smart Grid Equipment.	x		x	x				x	x
S6.4 Develop Grid Operation Practices and Applications that Use Renewable Availability Data.	x		x					x	x
S6.5 Develop Smart Grid Communication Systems that Interface with Customer Premise Networks and Distributed Energy Resources.	x	x	x	x			x	x	x

Today's electricity grid was designed for centralized generation in which power flows in one direction from baseload power plants through the T&D systems and finally to the customer. As new technologies such as intermittent renewable resources, energy storage, DG, and PEVs are deployed into the system at higher levels, California's electricity grid will become more decentralized and complex. To manage this more complex system, electric grid operators will need improvements in grid communications, automation of T&D systems, standards and protocols, and other related areas to optimally integrate these technologies into a reliable, efficient, and flexible smart grid.

The California Legislature recognized the need for a smart grid and in 2009 passed the first statewide smart grid bill in the country. Senate Bill 17 (Padilla, Chapter 327, Statutes of 2009) directed the CPUC to set requirements for IOU smart grid deployment plans.

This objective will conduct R&D activities to help facilitate the successful implementation of these preliminary smart grid deployment plans by developing, testing and evaluating new and advanced technologies, tools, and strategies that can be further demonstrated and deployed by the IOUs.

Since 2003, the Energy Commission has collaborated with IOUs and the California ISO in the form of a standing research committee in the Transmission Research Program. This committee identified the highest priority issues for research within the California grid. An example of an identified research topic is synchrophasor research. This research has attained a high degree of success. A similar committee was formed for distribution system research. Today these committees are combined and provide advice and guidance on smart grid research activities. The Energy Commission has also held numerous public workshops on technologies considered for research.

Activities in the research initiatives under this objective will be closely coordinated with the IOUs to ensure no duplication of efforts, and to provide a path to market for the research products of these initiatives. The market for smart grid technologies is very dynamic with research continuing across the nation and vendors continuing to develop product offerings. Coordinating the activities of the EPIC administrators and sharing information on recent developments in the research areas under this objective will inform and enhance the projects and their results.

Transmission and Distribution Upgrades for Smart Grid

To meet the Governor's goal of 20 gigawatts of renewable generation by 2020, the existing T&D system must be upgraded to handle high penetrations of distributed and renewable energy resources, increase grid reliability, and shorten the downtime when outages do occur. The existing T&D system lacks the infrastructure and technical sophistication to support this goal while maintaining high grid reliability. With limited capacity for two-way power flows and

without control and communication at the point of use, California's existing distribution system is not equipped to fully realize the benefits of DG. Upgrades will include modernizing T&D equipment, enhancing automated distribution systems, and improving control over DER.

Smart Grid Communications Systems

Utilities can improve electric service if they have a better understanding of the generators and loads behind the meter. This task becomes more difficult and complicated as more DG and electric vehicles are added because the net power from local generation and loads is combined together within a distribution circuit.

Incorporating local generator and load data from CPNs into smart grid communications systems will help operators address potential problem areas in the distribution system and respond with the appropriate operational modifications, helping to relieve grid congestion. Smart grid communications systems that are properly integrated with communications on the customer side of the meter will allow California electric ratepayers to have secure access to more information and options for electric services to lower their electricity costs.

In forming the initiatives to meet Strategic Objective S6, the Energy Commission reviewed the preliminary IOU smart grid deployment plans. The Energy Commission also considered the results from smart grid roadmaps prepared from the utility and industry perspectives. The gaps identified in these preliminary deployment plans and roadmaps were discussed with stakeholders through advisory board meetings for strategic-level advice on future research. A technical working group on smart infrastructure provided advice at the program level. Energy Commission staff facilitated workshops with stakeholders identified in the CPUC decision. These stakeholders identified the objectives and initiatives contained in this investment plan. Through this process, the Energy Commission developed smart grid initiatives that are not being adequately addressed in the competitive or regulated marketplace. These initiatives fit into the role of the CPUC and the Energy Commission. An example of an initiative outside the role of the CPUC and the Energy Commission was a recommended initiative for testing flame retardant clothing. This recommended initiative was considered but excluded for EPIC funding. Testing of safety equipment is best left to the federal government, the Occupational Safety and Health Administration, and other agencies that have that role. Other initiatives not considered for funding were initiatives dealing with standards development. In the U.S., there are many stakeholder-funded organizations such as IEEE, SAE, NEMA, and ANSI through whom standards are developed. While these initiatives were proposed, they were removed from this Investment Plan as there are already stakeholder funded groups developing standards.

S6.1 Proposed Funding Initiative: Develop Equipment and Technologies to Enable Power Flow Control and Bi-Directional Power Flow Through the Transmission and Distribution System.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X	X	X	

Issue: Existing T&D equipment cannot handle the two-way power flow that occurs with DG connected at all levels in the electric system, from utility-scale storage down to a residential solar roof. The traditional design of the protection and control systems also prevents integrating high penetrations of DER at various connection points throughout the system. Recently developed and deployed smart grid-enabled devices need to be coordinated into a single system that can easily assimilate new smart devices over time.

Purpose: This initiative will advance the development and deployment of new technologies to modernize the electrical T&D system for an adaptable and controllable smart grid. Examples of proposed research topics include:

- Developing synchrophasor technology for the distribution system.
- Developing new products such as flexible, alternating current transmission system devices and other direct control power flow devices.
- Developing equipment and technologies to increase T&D circuit capacities.
- Developing new or improving existing equipment to react quickly enough to adapt to variable behavior of renewable generators and loads.

Stakeholders: Ratepayers who wish to install renewable energy generation, utilities, and electric vehicle owners.

Background: Past research on synchrophasors developed phasor measurement units to measure and transmit data about the transmission system to the California ISO. Early stage research on four-quadrant smart inverters, fault current controllers, and smart transformers is of interest to utilities. Existing distribution equipment such as switches, protective relays, capacitor banks, and voltage regulators cannot handle two-way power flow and will need to operate more frequently as more variable renewable generation, distributed energy storage, and electric vehicles are added to the grid. Inadequate T&D equipment is a critical barrier to renewable integration that must be overcome.

S6.2 Proposed Funding Initiative: Develop Controls and Equipment to Expand Distribution Automation Capabilities.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X						X	

Issue: Existing distribution monitoring and control systems are not designed to manage high penetrations of distributed and renewable energy resources and cannot be used to control energy-smart communities and microgrids. In addition to addressing data resolution and communication issues, more information on the behavior of variable renewable resources is needed for monitoring and control systems. Renewable energy exhibits nontypical generator behavior that makes it difficult for grid operators to manage. At the same time, the increasing load of PEVs introduces more uncertainty for electric supply and demand.

Purpose: This initiative will enhance distribution automation to integrate DER and improve grid reliability. This research will develop new emerging technologies to increase the amount of renewables that can be connected at the distribution level and provide greater control over the operation of DER. Research will include methods to aggregate and control loads and DG, including PEVs, to improve grid reliability. Grid operators will have a greater level of confidence in providing reliable electric service with high penetrations of renewable and DG.

Examples of proposed research topics include:

- Developing synchrophasors for use in distribution systems.
- Developing technologies and strategies for T&D systems to handle renewable generation issues such as intermittency and voltage regulation.
- Investigating other functions of DG and distributed storage, individually or in combinations.
- Developing controls capable of controlling all of the functions within energy-smart communities and microgrids.
- Coordinating DG control between operators and energy aggregators.
- Determining the optimal aggregation of various types of DG, including PEVs.

- The utilities in their investment plans and their preliminary smart grid deployment plans have identified activities in the area of distribution automation. The activities in this initiative will research and develop new technologies or applications not addressed in the utility plans such as synchrophasors for use on the distribution system. Activities in this initiative will be coordinated with the utilities to avoid duplication, and provide a path to market. Coordination of these activities with the utilities under this initiative will enhance the results of the research as it moves from applied research to demonstration and deployment.

Stakeholders: Ratepayers who operate microgrids, grid operators, utilities, and third-party aggregators.

Background: Utilities already have distribution management systems, but they lack the capability to respond fast enough to changes resulting from variable renewable generation at multiple connection points, including dispatching energy storage. Past research on synchrophasors on the transmission system successfully provided higher resolution data to the California ISO; therefore, the question for research is whether synchrophasor technology can be used to obtain detailed information about the distribution system. Other related barriers to enhancing distribution automation include managing large volumes of data and a lack of analysis tools to implement automated system changes.

One of the barriers to having a flexible grid is the inability to control DER and loads at the grid level. Multiple stakeholders must be involved in coordinating DG control to maximize grid capacity and flexibility. There has been limited research on methods to aggregate and control loads and DG, including PEVs, to improve grid reliability. However, schemes using intelligent software agents to aggregate load and generation and also wide-area management systems have undergone testing. Since 1996, various schemes for combining loads and electric vehicles have been proposed; however, none were implemented due to market barriers.

S6.3 Proposed Funding Initiative: Develop Automation and Operational Practices to Make Use of Smart Grid Equipment.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X	X	X	

Issue: Grid operators lack the proper procedures for handling high penetrations of renewable resources because they do not know what to expect. The variety of characteristics of different

types of renewable energy resources increases the complexity of operating the grid, especially as additional resources are connected. It is critical to have a comprehensive understanding of the changes in grid operations needed as penetration of renewable generation increases over time.

Purpose: This initiative will develop automation and operational practices, including those for outage management, low system inertia, congestion mitigation, and infrastructure protection, to make use of smart grid equipment. Examples of proposed research topics include:

- Determining effects on transmission systems from operational changes in the distribution system associated with distributed energy resource integration.
- Enabling dynamic thermal ratings for transmission lines to increase load-carrying capacity.
- Establishing thresholds for system inertia and frequency response and methods for maintaining those thresholds.
- Investigating methods for sharing multiple resources, such as energy storage, between balancing authorities (California ISO and Bonneville Power Authority).

Stakeholders: Ratepayers, due to increased grid reliability and greater availability of renewable energy, and grid operators.

Background: Past research has attempted to characterize grid reliability issues such as instability and renewable intermittency, and further research is needed to understand their impacts on the grid. However, there appears to be less research on how to modify grid operations to handle these issues. The traditional approach is to build more infrastructure such as new generators, circuits, and wires, but this approach is no longer sufficient for an observable, controllable, and adaptable grid with high penetrations of renewables.

Energy Commission staff held Technical Advisory Committee (TAC) meetings with the IOUs and the California ISO over the past several years to discuss T&D research needs. TAC members have identified this research gap, which needs to be addressed to integrate high penetrations of renewable and DG on the grid. Another barrier to renewable integration is transmission congestion. Research on understanding which transmission lines would most benefit from dynamic thermal line ratings could help increase transmission capacity for renewable generation and under extreme conditions.

The California ISO identified a specific research barrier regarding real-time monitoring. Grid operators want to incorporate frequency response and inertia limits into their generation commitment and dispatch procedures, but they do not know what these limits are for maintaining grid reliability.

S6.4 Proposed Funding Initiative: Develop Grid Operation Practices and Applications That Use Renewable Availability Data.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X			

Issue: Weather events can dramatically affect the power output of renewable wind and solar generation. The resulting fast ramping strains the grid infrastructure, and the ability of grid operators to reliably anticipate and react appropriately or automatically to these events does not yet exist.

Determining the availability of renewable resources using existing demand forecasting methods has forced operators to make many assumptions. Automated monitoring of the electrical system and increased use of smart metering has made it easier to collect large amounts of system data. The merging of internal utility data and all publicly available data can help utilities better understand the operations of the electric system and better meet customer needs. Developing ways to integrate forecast data, including weather events and demand forecasts, into automated operation systems is necessary to streamline grid operations. Modern analysis using data analytics has not been applied for grid operation of renewables. There is a need to define data applications, assemble the analytics, and produce data visualizations and operation protocols for utilities.

Purpose: This initiative will develop the best practices and applications in data analytics and select specific examples to demonstrate with the utilities and the California ISO. These best practices could be in better outage management, DER management, renewable integration, or customer load management.

Stakeholders: Ratepayers who own renewable generation, utilities, grid operators, and renewable energy providers.

Background: Utilities have been collecting monitoring data in databases for many years. Other large databases exist in the public domain (for example, weather, traffic, and earthquakes). Much of this data is not used because it cannot be easily merged. Recently, industry has ramped up efforts to use this data. These activities are known as "data analytics" and apply to a wide variety of industries. A certain subset of the available data would be relevant to utilities for the purposes of weather forecasting and demand forecasting. There are also several vendors

making available products that can perform data analytics without significant custom programming.

Data analytics in the context of grid operation and demand forecasting is new and not suited to full-scale demonstrations in the near term. R&D activities under this initiative would allow all California utilities to leverage the best practices and develop the best applications. The long period for the deployment of these best practices and applications fits with the EPIC program's time frame and mandate.

S6.5 Proposed Funding Initiative: Develop Smart Grid Communication Systems That Interface With Customer Premise Networks and Distributed Energy Resources.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X						X	X

Issue: Utilities are concerned about protecting the distribution system, particularly when dealing with increasing amounts of two-way power flow from DERs and large varying loads. Microgrids and other off-the-grid sources may create a sudden overload on the distribution system if these sources malfunction due to equipment failure, local faults, or a temporary shortage of resources such that they cannot meet their demand and need power from the grid. Utilities need enough real-time information about customer electricity usage to address these issues.

Various technologies and smart devices/appliances can provide electricity usage data; however, research is needed to determine a secure and reliable interface between customer-side-of-meter systems, such as CPNs and local energy storage, and the distribution system that is compatible with utility systems for more efficient power delivery based on customer demand.

Purpose: This initiative will develop smart grid communications systems that use CPN data, especially DER data. This information will give utilities a better understanding of actions "behind-the-meter" such as DG profiles and varying loads that may affect distribution operations. Monitoring the appropriate information from distribution-level renewable resources and loads will allow proper integration into the smart grid. Improving the smart grid communications system will also encourage aggregators to participate in California ISO markets. Examples of proposed research topics include:

- Developing and demonstrating communication interfaces between CPNs and the distribution system.

- Determining what distribution operations to modify and how to modify them based on information received from CPNs.
- Detecting low-level faults and other system anomalies.
- Reducing metering and telemetry costs of participants in California ISO markets.
- Filtering CPN and microgrid data and identifying pertinent information for grid operators.
- Designing control system to monitor and control DERs including energy storage.
- Disaggregate DG from loads.
- This initiative will develop the communications between inverters and CPNs to support the PV system hardware components and power electronics as discussed in initiative S3.3*: Develop Advanced Distributed Photovoltaic Systems to Reduce the Cost of Energy, Increase Interoperability, and Advance Plug-and-Play Capabilities.*

Stakeholders: Ratepayers who operate microgrids or otherwise have equipment that interoperates with their utility for sharing resources, utilities, grid operators, and third-party aggregators.

Background: Research in DR programs has resulted in the OpenADR protocol, which is now completed and commercially available. The research included interfacing with CPNs for industrial and commercial customers. This research by Lawrence Berkeley National Laboratory may be applicable for other programs to encourage participation in California ISO markets. Other protocols suitable for communications include SEP 2.0 and IEC 61850.

Past research on microgrids provides information on community-scale local generation and communications. The microgrid at the University of California, San Diego, is an example of a multibuilding system with local generation, energy storage, electric vehicle charging, combined heat and power, and various renewable technologies all integrated through one master controller.

S7 Strategic Objective: Develop Operational Tools, Models, and Simulations for Improved Planning of Grid Resources.

Table 15: Ratepayer Benefits Summary for Strategic Objective 7

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S7.1 Determine the Characteristics of the Generation Fleet of 2020 for Grid Operators and Planners.	x	x			x		x	x	x
S7.2 Catalog Distributed Energy Resources to Improve Operator Dispatch and Visibility.	x	x			x			x	x
S7.3 Develop and Run Real-Time Scenarios to Support Operations, Including Energy Storage Utilization.	x	x			x	x	x	x	x
S7.4 Develop Interoperability Test Tools and Procedures to Validate New Subsystem Integration into the Grid.	x	x	x	x	x		x	x	x

To enable increasing penetrations of intermittent renewable energy into California's grid while maintaining reliability, a number of grid-operation tools, planning enhancements, and simulation tools need to be developed and implemented. Better models and tools are needed to evaluate the needs and characteristics of potential future energy fleets and incorporate them into future planning processes. Most scenarios will likely include increasing amounts of DER, including variable renewables. Increasing the visibility and dispatchability of these distributed resources will enable grid operators to more accurately predict resource availability and more efficiently operate the grid. Development and evaluation of real-time scenarios can further support efficient grid operations. Finally, it is essential to understand the operating characteristics of emerging energy resources before they can be integrated into the grid and incorporated into grid planning.

In light of California's stated clean energy goals, the composition of the 2020 grid will likely be greatly different from its current state. To understand what tools, technologies, and resources

will be needed to ensure grid reliability, it will be essential to characterize California's potential energy fleet for a number of future development scenarios. Better characterization of grid resources will enhance system visibility and allow for better modeling of the electricity generation fleet to create greater operational stability and robustness. This characterization will increase reliability and lower the costs of operation for utilities and ratepayers in California.

Providing grid operators with the ability to run real-time scenarios to support grid operations, including energy storage use, will allow grid operators to use the capabilities of smart grid equipment more effectively in everyday operation and thus improve the return on investments in smart grid infrastructure. Allowing operators to anticipate and react to disruptive events more effectively will also improve the resilience and reliability of smart grid operation. These advantages provide economic benefits to utility ratepayers by decreasing the costs resulting from fewer emergency response costs.

Developing interoperability test tools, models, and procedures to validate new subsystems into the grid will ensure the security, safety, and interoperability of grid equipment. This will result in fewer disruptive events and safety hazards, improving public confidence in and the cost-effectiveness of grid operations. Minimizing the deployment of proprietary, noncompatible subsystems will allow more companies to develop innovative grid infrastructure. A safe, interoperable, and secure infrastructure accelerates the adoption of renewable electrical generation.

In forming initiatives to meet Strategic Objective S7, the Energy Commission met with stakeholders through advisory board meetings and technical working group on smart grid research needs. Energy Commission staff also incorporated comments from the workshops held on its draft investment plan. Through this process, the Energy Commission developed smart grid initiatives that are not being adequately addressed in the competitive or regulated marketplace.

Since 2003, the Energy Commission has collaborated with IOUs and the California ISO in the form of a standing research committee on transmission and distribution issues facing utilities and grid operators. This committee provides advice and guidance on planning of grid resources.

S7.1 Proposed Funding Initiative: Determine the Characteristics of the Generation Fleet of 2020 for Grid Operators and Planners.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X	X		

Issue: With the increasing adoption of variable and intermittent renewable generation, the operating characteristics of the grid have changed fundamentally. These characteristics are unknown and need research. The current fleet of generation equipment is a combination of legacy units and new additions with greatly varying characteristics of output capacity, fixed and variable costs of operation, geographical locations, load following capability, and dispatchability. There would be value in characterizing an optimal path for additions and alterations to the generating equipment fleet in California. California's ISO and utilities cannot determine the most cost-effective evolutions of California's generation fleet until a generation fleet model that accounts for interconnection and other factors is created.

Purpose: This initiative is for research to determine the characteristics of a cost-effective and robust generation fleet. A baseline and an "ideal" objective for the optimal evolution of the generation fleet needs to be established. Detailed models of present and possible future generation configurations will allow better evaluation of additions, modifications, and decommissioning activities as the generation fleet evolves.

Stakeholders: Grid operators, utilities, and ratepayers due to increased reliability and more cost-effective grid operations.

Background: Models currently provide information on different facets of grid operation and economics. They vary in the time scales, subsystems, and variables under investigation. Current models for renewables are simplistic and based on limited knowledge of the resources. These models must be augmented for a wider variety of applications and validated for use in generation fleet planning. They should take into account the impacts of current and projected fuel costs, plant commissioning and decommissioning activities, increasing renewable penetration, and energy storage including PEVs.

Allowing build-out, modification, and decommissioning decisions to proceed from a cost and operational standpoint will result in lower costs for utilities and ratepayers. New modeling capabilities will inform decisions for changes in the generation fleet, thereby supporting stable grid operation and robustness to benefit California's economy.

The Energy Commission is geared to administer research projects under this initiative because this initiative's objectives fit with the mandate and time frame of the EPIC Program. Generation fleet characterization is a California-wide activity covering multiple utility service territories, and it will be cost-beneficial and equitable for a nonutility entity to perform the fleet characterization activities.

S7.2 Proposed Funding Initiative: Catalog Distributed Energy Resources to Improve Operator Dispatch and Visibility.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X		X	X

Issue: Many distributed energy generation resources are aggregated with loads on the customer side of the meter. This presents a problem for grid operators because the DG is often solar PV or wind that ramps up and down dramatically within seconds or minutes in response to weather events. The inability of operators to see proportions of load and generation on the distribution level greatly limits their flexibility and situational awareness. Operators need higher granularity of the DER to maintain service reliability.

Purpose: This initiative is for cataloguing characteristics of DER in California to allow utilities and the California ISO to operate with far more visibility. This requires cataloguing the location, size, and type of DG equipment and developing new tools using the database. The increased visibility of DG will improve operating characteristics and provide greater confidence in advanced planning for weather and demand events.

Stakeholders: Ratepayers due to increased service reliability, grid operators, and utilities.

Background: Probabilistic and historical decision support tools are used to plan generation dispatching, but these same tools could be used to greater effect if grid visibility is improved by cataloguing DER and disaggregating generation from load. The need to disaggregate generation from load is critical at this time as the penetration of fast-ramping DG such as solar PV is expanding. The uncertainty surrounding the minute-to-minute output of these generation sources would be reduced if they sources were accurately catalogued and matched to regional weather patterns.

Utilities will proceed with deploying their own grid modeling and operational tools in the future. These tools will be more effective once the utilities are furnished with data that accurately maps the locations and types of DER. Developing the methods to gather and compile this data is itself an activity that requires effort; therefore, it would be duplicative if each utility

mapped the DG in its own territory. It is more efficient and equitable for a statewide entity such as the Energy Commission to perform the generation mapping activities that the utilities will then leverage for grid operations.

S7.3 Proposed Funding Initiative: Develop and Run Real-Time Scenarios to Support Operations, Including Energy Storage Utilization.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X			

Issue: Utilities have limited visibility and control of grid system resources, including energy storage of various types, as well as distributed renewable generation. The inability of utilities to see and model various smart grid resources in real time, as well as the proportions of load and generation on the distribution level, greatly limits flexibility and situational awareness and degrades the robustness of the electric grid.

Purpose: This initiative will develop models and tools with real-time and automation capability to improve smart grid operations. These tools will provide grid operators with real-time assessments of the condition of the grid and a greater amount of control of T&D level resources. A possible research project under this initiative is to determine the "point of diminishing returns" for the granularity of grid visibility and control to ensure cost-effectiveness.

Stakeholders: Ratepayers due to more cost-effective grid operations and greater reliability, and grid operators due to having real-time assessments.

Background: Recent improvements in supervisory control and data acquisition, advanced metering infrastructure, geographic information systems, and computation can improve existing distribution models. This ability can tie together many data inputs in grid operation and enable distribution simulation and analytics. These models could very quickly run scenarios to show the effects of system planning or forecast weather to aid in real-time operation. The models can also be useful for future renewable and electric vehicle integration studies.

Significant effort will be expended in developing these models and tools, which California utilities will later use in planning and real-time operations. If each utility were to develop its own models and tools, there would be significant duplication of effort, and it would be inequitable if one utility were to develop models and tools that would then be applicable throughout California. Therefore, the Energy Commission, with continuous stakeholder input,

is equipped to administer research activities to create and improve models and tools for grid operations, including energy storage use.

S7.4 Proposed Funding Initiative: Develop Interoperability Test Tools and Procedures to Validate New Subsystem Integration Into the Grid.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand – side Management
X				X		X	X

Issue: New smart grid hardware is being developed and deployed for customer-side applications and for the distribution and transmission levels. Smart grid hardware provides the foundational capabilities for integrating large amounts of variable renewable generation by making resources such as energy storage and demand-side programs available. However, the smart grid paradigm makes the electric grid significantly more complex and increases the number and variety of potential failures. It is critical to ensure that every smart grid subsystem is safe, interoperable, forward-compatible and, when applicable, equipped with cost-effective security. These measures will reduce disruptive events in the complex grid system, improve safety, and increase customer confidence in the smart grid infrastructure.

Purpose: This initiative will develop test tools, simulation models, and procedures to validate the safety, interoperability, and security features of new grid-connected equipment. These tools will validate the wide array of emerging customer-side equipment, including energy storage and vehicle-to-grid interconnection technologies, as well as distribution- and transmission-level infrastructure.

Stakeholders: Ratepayers who operate microgrids or otherwise have equipment that interoperates with their utility for sharing resources, utilities, and grid operators.

Background: Standards for certain grid subsystems have been developed, but new capabilities and operating paradigms are appearing that do not fit neatly into existing standards and certifications. Without a more coherent and comprehensive set of interoperability standards and test procedures, some new smart grid equipment will not be capable of operating in certain contexts or systems. This would adversely affect customers' adoption of smart grid equipment due to the impaired economics stemming from restricted equipment choices and capabilities. With greater equipment interoperability, customers would have greater access to a larger number of smart grid subsystems applicable to their needs.

Currently, utilities leverage nationally adopted standards and protocols for the delivery of information to authorized third parties and for the transmission of information among customer and third-party devices and utility-smart devices. All procedures and practices must meet local, state, and federal requirements, and to reduce duplication of effort, it is efficient for a statewide entity such as the Energy Commission to develop the interoperability test tools and procedures. To provide vendors and utilities with tools and procedures that are easy to use and most applicable to their needs, stakeholder input will be a continuous and integral part of activities in this initiative.

S8 Strategic Objective: Integrate Grid-Level Energy Storage Technologies and Determine Best Use Applications to Provide Locational Benefits.

Table 16: Ratepayer Benefits Summary for Strategic Objective 8

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S8.1 Optimize Grid-Level Energy Storage Deployment With Respect to Location, Size, and Type.	X	X		X	X	X	X	X	X
S8.2 Develop Innovative Utility-Scale and Generation Energy Storage Technologies and Applications to Mitigate Intermittent Renewables and Meet Peak Demand.	X		X			X	X	X	X

Grid-level energy storage is a key strategy to improving the operation and performance of the electric system. Grid-level storage can store excess energy, such as that produced by wind turbines at night, for later use at peak demand times. This will reduce the costs of integrating high levels of intermittent renewable generation into the grid by providing "time shifting" to compensate for its intermittent nature. Grid-level energy storage also allows for "peak shaving" by tapping into stored energy at times of peak electrical demand, offsetting the need for expensive and inefficient “peaker” natural gas plants to provide reserve capacity and load-following capability. In addition, Governor Brown’s Clean Energy Jobs Plan estimates that 8,500 permanent jobs would be created if utilities procure storage equivalent to five percent of their peak load demand.

Despite the benefits of grid-level storage, there are a number of barriers to its commercial adoption. Utilities recognize certain energy storage technologies as immature technologies and

cited a lack of commercial operating experience as a barrier in their comments to CPUC rulemaking 10-12-007 proposed decision under AB2514.

Many energy storage technologies are yet to be used on a commercial scale. The Department of Ratepayer Advocates has noted that "The nascent nature of some storage technologies and the lack of detailed information about application-specific costs ... present barriers to more widespread understanding of storage systems." There is consensus that this barrier will diminish over time, when utilities gain more experience with energy storage.

Support has been proposed for the development of emerging technologies through pilot systems and R&D programs. PG&E has recommended that the CPUC support pilot projects and fund feasibility studies for long lead-time storage technologies to enable implementations options if and when future resources needs and cost-effectiveness are determined. Utility investment policies mandate that the benefits of projects must exceed costs, a condition that will be satisfied once more cost-effective energy storage technologies are developed and their optimal deployment is determined by research activities under the EPIC program.

This objective will conduct R&D activities to help optimize the successful integration of grid-level energy storage by developing, testing, and evaluating new and advanced technologies and applications that can be further demonstrated and deployed by the IOUs. Sharing information on recent developments in the research areas under this objective will inform and enhance the projects and their results.

In forming initiatives to meet Strategic Objective S8, the Energy Commission met with stakeholders through advisory board meetings and technical working group on smart grid research needs. Energy Commission staff also incorporated comments from the workshops held on its draft investment plan. Through this process, the Energy Commission developed smart grid initiatives that are not being adequately addressed in the competitive or regulated marketplace.

S8.1 Proposed Funding Initiative: Optimize Grid-Level Energy Storage Deployment With Respect to Location, Size, and Type.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X				**X**		**X**	

Issue: As energy storage technologies are adopted, their affects on grid operation and flexibility due to discharge duration, inertia, location, and availability are more noticeable. For instance, a

large cluster of grid-level energy storage located at the wrong side of a choke point in the transmission infrastructure will not be able to benefit the grid to the extent it might have if it had been sited more thoughtfully. Metrics and decision-support tools should be developed to optimize the placement and types of energy storage.

Additionally, utilities and other planners do not and will not have significant control over the placement of distributed small-scale energy storage resources such as PEVs.

Purpose: Developing methods and tools to strategically optimize grid-level energy storage with respect to location, size, and type will allow the electric grid to function more cost-effectively and with greater reliability. Research under this initiative will consider many factors including the consequences of the lack of control over the deployment of some small-scale distributed energy storage, such as PEVs.

PG&E has indicated an interest in performing a demonstration on its system of storage to capture the locational benefits. The research under this initiative will benefit in its final analysis from actual deployment data from this demonstration. These activities will be coordinated to provide enhanced results and ratepayer benefits.

Stakeholders: Ratepayers due to cost-effective placement of energy storage, utilities due to lowered costs for storage deployment, and renewable energy providers including residential ratepayers due to energy storage increasing the renewable energy capacity of the distribution system.

Background: Various energy storage technologies are being developed and refined. Two examples are presented here. Flywheels are evolving exclusively from power devices, which have the capability to discharge over a period of minutes, into load-shifting devices that have higher energy capacities and can discharge over a period of hours. This capability increases their usefulness and range of functions for grid energy storage. Ultracapacitors have fallen dramatically in price over the past decade, and this makes them newly cost-effective as high-power storage for renewable output stabilization. These new developments and capabilities change the nature of grid-level energy storage and call for refinements in the ways they are planned and deployed.

Utilities recognize certain types of energy storage technologies as immature technologies, and their investment policies mandate that the benefits of projects must exceed costs. As research activities improve energy storage technologies, this condition that will be satisfied more often, and energy storage will expand and more deeply affect grid operation and flexibility. A statewide effort under the EPIC Program to develop methods and tools to optimize grid-level storage deployment will be an efficient and equitable way to maximize the benefits of energy storage in California.

S8.2 Proposed Funding Initiative: Develop Innovative Utility-Scale and Generation Energy Storage Technologies and Applications to Mitigate Intermittent Renewables and Meet Peak Demand.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	

Issue: The reliability of California's energy system depends on the ability to meet peak power demand. The electric utilities on hot summer afternoons use many "peaker" natural gas plants that run for just a few hours a year. To satisfy peak demand, very high prices are paid on the spot market to these plants that pollute more and are less efficient than other power plants. Renewable power, such as solar and wind, is often intermittent and is available a limited number of hours every day. As a result, renewable energy can be difficult to integrate into the base load of the overall energy delivery system. At present, most long-term storage applications, such as lithium-ion batteries, are far too costly and are not a substitute for transmission upgrades. Higher capacity storage technologies such as pumped hydro and compressed air energy storage have special site requirements.

Purpose: The Energy Commission will fund applied research and development activities to develop innovative utility-scale and generation energy storage technologies and applications to mitigate intermittent utility-scale renewable energy generation. Potential applied R&D activities include the development of advanced thermal energy storage systems that can be coupled with utility-scale concentrating solar plants to alleviate short-term intermittency effects and provide additional ancillary services to the grid, including regulation services and reserve capacity.

Electric energy storage, such as batteries of various chemistries, will be evaluated and developed for their ability to be coupled with utility-scale wind and solar power plants to smooth short term ramping events and allow electricity generated by these installations to be stored and dispatched when it is needed most, at times of peak demand. Other forms of mechanical energy storage, such as pumped hydro installations and compressed air energy storage, will be evaluated for their potential applications at utility-scale renewable energy plants, and ultimately deployed wherever found to be cost-effective. Additional research may focus on required changes to existing energy storage systems to help balance generation and load second-by-second, minute-by-minute, and over the long term.

Stakeholders: Ratepayers due to the benefits of increased renewable energy availability, grid operators, and renewable energy providers.

Background: The California ISO has identified energy storage as an important tool to enable integration of renewable energy at increasing penetration levels, along with DR and flexible natural gas-fired power plants. Energy storage and fast-ramping power plants allow electricity supply to more smoothly match the increasingly unpredictable minute-to-minute electricity demand. The California ISO will require advanced renewable resource prediction models and operational tools to incorporate into its planning processes.

Utilities recognize certain energy storage technologies as immature technologies. Utility investment policies mandate that the benefits of projects must exceed costs, a condition that will be satisfied more often once plant-level energy storage technologies are developed further by statewide research activities under the EPIC Program.

Furthermore, Governor Brown's Clean Energy Jobs Plan encourages the development of energy storage systems, which could lead to 8,500 permanent new jobs if the utilities procure storage equivalent of 5 percent of their peak load demand.

S9 Strategic Objective: Advance Technologies and Strategies That Optimize the Benefits of Plug-in Electric Vehicles to the Electricity System..

Table 17: Ratepayer Benefits Summary for Strategic Objective 9

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S9.1 Investigate Smart and Efficient Charging Technologies and Approaches to Integrate Plug-In Electric Vehicles into the Power Grid.	X	X	X	X	X	X		X	X
S9.2 Develop Grid Communication Interfaces for Plug-In Electric Vehicle Charging to Support Vehicle-to-Grid Services.	X	X		X	X	X		X	X
S9.3 Advance the Economics and Business Case of Distributed Storage through the Development of Second-Use EV Battery Storage Applications.	X	X	X	X	X	X		X	X
S9.4 Develop Advanced Recycling Technologies and Processes for Recycling Plug-In Electric Vehicle Batteries.			X	X					

PEVs and other electric transportation technologies such as electric rail offer a promising and potentially revolutionary alternative for meeting the state's transportation needs. PEVs include light-, medium-, and heavy-duty plug-in hybrid electric vehicles and full electric vehicles. These vehicles offer a number of benefits over conventional vehicles including lower fueling costs, reduced air pollutants, and reduced greenhouse gas emissions. Furthermore, PEVs can provide a number of benefits to the electricity grid when integrated with smart charging technologies and other strategies. The R&D initiatives in this objective will advance technologies and strategies that provide optimal benefits to both the electricity system and the PEV market.

In forming initiatives to meet Strategic Objective S9, the Energy Commission met with stakeholders through advisory board meetings and technical working group on smart grid and electric vehicle infrastructure research needs. Energy Commission staff also incorporated comments from the workshops held on its draft investment plan. Through this process, the Energy Commission developed smart grid initiatives that are not being adequately addressed in the competitive or regulated marketplace.

S9.1 Proposed Funding Initiative: Investigate Smart and Efficient Charging Technologies and Approaches to Integrate Plug-In Electric Vehicles Into the Power Grid.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X							X

Issue: Depending on how, when, and where they are charged, PEVs affect the electricity system in various ways. Unmanaged PEV charging could lead to increases in peak demand while technologies and strategies to encourage off-peak charging, especially during times when grid demand is low and renewable wind resources are abundant, could provide significant ratepayer benefits by further utilizing the existing infrastructure, reducing cases of "over generation," and significantly reducing air pollutants and GHG emissions. In addition to the potential peak demand issues, wireless PEV charging could negatively impact ratepayers. Wireless charging technologies are significantly less efficient than their plug-in counterparts, losing roughly 10 to 20 percent of their electricity during charging.

Purpose: This initiative will investigate and pilot technologies, tools, and strategies to advance demand-side management of PEV charging. Research and development will be conducted in two topics:

- Smart Charging: This topic will investigate smart charging technologies and other strategies including time-of-use rates for shifting PEV charging to off-peak times while still meeting

consumer needs. This topic will also develop and validate methods to better predict the charging behavior of PEV drivers and the impact of PEVs on the grid. In addition, this topic will explore and pilot methods to better utilize smart chargers to integrate PEVs into the grid. This topic will support the following strategies identified in the draft *2012 Zero Emission Vehicles (ZEV) Action Plan*:

  - Plan for and integrate peak vehicle demand for electricity into the state's energy grid.
  - Evaluate the need to revise utility time of use electricity rates for PEVs, based on PEV charging data, to incentivize off-peak charging.

- Wireless PEV Charging: This topic will investigate and analyze the benefits and downside of wireless PEV charging technologies. As mentioned previously, wireless charging technologies are less energy-efficient, but they also offer benefits to consumers, including improved convenience and safety. In addition, wireless charging can help address barriers to PEV ownership for disabled populations. This initiative will conduct research to analyze potential trade-offs for wireless charging technologies and inform potential standards.

Stakeholders: Ratepayers, utilities, electric vehicle owners, and third-party aggregators.

Background: The UC Davis Plug-in Hybrid & Electric Vehicle Research Center is conducting research analyzing the usability and functionality of a charging interface that helps inform the electric vehicle user of the tariffs associated with on-peak charging. The results and findings from this work are pending completion of the project. There are ongoing efforts to test and analyze methods of leveraging smart grid communications technology to enable DR applications through advanced PEV charging technologies. .

For wireless PEV charging, the U.S. DOE has a funding opportunity announcement to research and develop a production-feasible wireless charging system, integrate the system into a production-intent vehicle, and demonstrate the technology's readiness to deliver the benefits of wireless charging to drivers of light-duty PEVs.

S9.2 Proposed Funding Initiative: Develop Grid Communication Interfaces for Plug-In Electric Vehicle Charging to Support Vehicle-to-Grid Services.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X		X	X

Issue: Electric vehicle charging and its effects on the grid are not well understood, including how PEVs can provide additional energy to the grid when not in use. These issues are particularly critical if the PEVs are concentrated in one regional area on the distribution system. There may be specific elements to the PEV charging profile that impact the distribution system that may be obtained by analyzing CPN data. Security issues regarding electricity pricing signals, data privacy, and system integrity may impede full adoption of this technology if it is not cost-effective to implement these elements reliably.

Purpose: This initiative will develop grid communication interfaces for PEV charging to support vehicle-to-grid services. Monitoring electric vehicle charging will provide useful information on how to optimize grid connections wherever the vehicles are located and their effects on those particular distribution circuits. Data from CPNs can provide critical information on PEV charging characteristics and customer usage to avoid major problems in distribution system operations and support vehicle-to-grid connections. Examples of proposed research topics include:

- Developing and demonstrating that communication methods for CPNs and PEV charging systems are compatible with utility operations.
- Sharing CPN data across utility service areas.
- Coordinating PEV electricity use in clusters and across multiple utility territories.
- Developing PEV infrastructure for remote control and data communications for utilities and third-party aggregators.
- Demonstrating new vehicle-to-grid technologies with utilities, the California ISO, and third-party aggregators.

Stakeholders: Ratepayers who own electric vehicles, utilities, and third-party aggregators.

Background: San Diego Gas & Electric Company is designing and assembling a PEV simulator that can be used to test typical distribution grid feeder arrangements. This testing will measure

the actual effects of charging vehicle batteries and provide data that can be transferred to computational models. This project will also demonstrate PEV charging that integrates renewable generation, energy storage, and smart charging to show that grid performance, reliability, and power quality can be maintained even with the introduction of a substantial PEV charging load.

The U.S. DOD also has a project to convert all nontactical base vehicles at the Los Angeles Air Force Base to PEVs. These medium- and heavy-duty PEVs will demonstrate vehicle-to-grid services by participating in the California ISO ancillary services market.

Major utility and customer stakeholders are interested in vehicle-to-grid services but do not know how this technology and the communications with the California ISO can be implemented in an efficient, cost-effective manner.

S9.3 Proposed Funding Initiative: Advance the Economics and Business Case of Distributed Storage Through the Development of Second-Use EV Battery Storage Applications.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X							**X**

Issue: The high cost of lithium-ion batteries is a significant barrier to deploying distributed storage and the primary barrier to the commercial success of PEVs. One potential strategy to reduce battery costs is to reuse the lithium-ion batteries – after they are no longer usable in the vehicle – in distributed energy storage devices. The revenues generated from these "second-life" energy storage applications could potentially offset the high costs of the battery packs, lowering both the costs and risks to auto manufacturers and PEV consumers. However, a number of issues need to be addressed before a viable market for second-life battery energy storage applications can develop.

The primary barrier to developing a second-life battery market is demonstrating the economic viability of second-life applications to convince potential customers that their use is more cost-effective than purchasing new batteries, which could include low-cost lead-acid batteries. Establishing a business case for second-use applications will require information regarding the performance, cycle life, and price of new PEV batteries and the likely condition of the batteries when they are removed from the vehicle at end of life after at least 5-10 years of service. The second-use company will need sufficient information to be able to set a reliable warranty for the batteries. In addition, they would need a good indication of the size of the markets they would be involved with. The end result would have to be a price for the reused batteries that would foster both the markets for the PEVs and the second-use batteries.

Purpose: This initiative will continue to advance the development of second-use applications to reduce the upfront costs of both distributed storage and PEVs. This will include research and development to:

- Conduct pilot-scale demonstrations of second-life batteries in smart grid storage applications. These demonstrations will provide data to help establish the optimal technical requirements and potential revenue streams for second-use applications. The UC Davis Plug-in Hybrid and Electric Vehicle Research Center is investigating the potential for second-use batteries to be used in industrial sites, shopping malls, microgrid applications, commercial buildings, and DG applications. This initiative will build upon these and ongoing efforts to pilot second-use battery demonstrations for the most promising smart grid storage applications.
- Conduct baseline testing for the next generation of PEV batteries. Previous research conducted baseline testing of current PEV lithium-ion batteries to determine for which grid storage applications they could meet the technical requirements. As auto manufacturers deploy PEVs with improved batteries, this initiative will conduct research to determine if these next-generation batteries can be reused in more profitable storage applications.
- Investigate technologies and strategies to facilitate the repurposing of PEV batteries into second-life storage devices. Scenario analysis conducted by the UC Berkeley Transportation Sustainability Research Center estimates that repurposing a used PEV battery into a second-life storage will cost approximately $1,150 and $1,780 for a Chevy Volt battery pack and Nissan Leaf battery pack respectively. This study suggested that it would be useful for each battery to have integrated in its management system a "health meter" that would track a few key battery history parameters to reduce testing costs for repurposed batteries. This study also identified the need for battery leasing strategies to help facilitate battery reuse. This initiative will investigate technologies and strategies, include conducting analysis to estimate the technical and economic feasibility on integrating "health meters" into battery management systems; as well as potential leasing strategies.

Stakeholders: Residential and commercial ratepayers who can benefit from on-site energy storage, electric vehicle owners, auto manufacturers, battery manufacturers, and utilities.

Background: In 2011, the Energy Commission funded the first ever study on second-life storage applications for lithium-ion vehicle batteries. Advanced simulation tools used in the study determined that the most suitable and profitable storage applications for used vehicle batteries are "area regulation" and "load following." Testing to determine if used vehicle batteries could meet real-world requirements for "area regulation" and "load following" was performed on various battery packs and modules from different battery manufacturers and found that the majority of vehicle batteries performed exceptionally well in the simulated conditions. The National Renewable Energy Laboratory provided an additional $660,000 to this effort to conduct long-term field testing of second-life applications at the UC San Diego campus. This long-term testing, which began in February 2012, will more fully advise key aspects of the potential second-life market for used PEV battery packs.

S9.4 Proposed Funding Initiative: Develop Advanced Technologies and Processes for Recycling Lithium-ion Batteries used in Distributed Storage and Plug-In Electric Vehicles.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X						X	X

Issue: Despite the energy and emission benefits of distributed battery storage and PEV use, the "cradle-to-grave" benefits are less certain due to battery production and disposal impacts. Recent studies estimate that battery production accounts for roughly 20 percent of a PEV's carbon footprint and 20 percent of its sulfur oxide emissions. Battery disposal could also have significant land use impacts if batteries are sent to landfills instead of recycled; and although lithium is 100 percent recyclable, producing battery-grade lithium from current recycling processes is about five times more costly than production from virgin materials.

Purpose: This initiative will further develop and evaluate advanced technologies and methods for the safe and efficient recycling of battery backs from PEVs. In addition, this initiative will develop the data and tools needed to inform the development of a recycling infrastructure for PEV batteries in California.

Stakeholders: Residential and commercial ratepayers who use EV batteries for on-site energy storage, electric vehicle owners, and other owners of EV batteries.

Background: A Frost and Sullivan report estimates that the market for recycling PEV batteries will be worth more than $2 billion by 2022, with more than half a million end-of-life EV battery packs available for recycling through the waste stream. Argonne National Laboratory and the U.S. Environmental Protection Agency have commissioned studies with battery manufacturers to examine the life-cycle impacts of automotive lithium-ion batteries. Argonne National Laboratory found that recycling lithium-ion battery materials potentially reduces the material production energy by 50 percent; and advanced recycling processes that recover battery-grade materials have the potential for even greater energy savings.

Cross-Cutting

S10 Strategic Objective: Leverage California's Regional Innovation Clusters to Accelerate the Deployment of Early-Stage Clean Energy Technologies and Companies.

Table 18: Ratepayer Benefits Summary for Strategic Objective 10

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S10.1 Provide Small Grants to Early-Stage Energy Companies and Entrepreneurs Through Regional Innovation Clusters.		X		X			X	X	X
S10.2 Support Demonstration Testing and Verification Centers to Accelerate the Deployment of Pre-Commercial Clean Energy Technologies.		X		X				X	X
S10.3 Conduct Scenario Assessments and Gaps Analyses That Will Be Used to Develop or Update Research Roadmaps.		X		X				X	X

California's research institutions, small businesses, and entrepreneurs – along with the U.S. Department of Energy's National Labs – are teeming with new energy technologies that if commercialized could provide significant benefits to ratepayers. The state's regional innovation clusters may be ideally suited to connect these technologies to the market needs. EPIC provides an opportunity to develop new initiatives that do not reside in the prior programs.

S10.1 Proposed Funding Initiative: Provide Small Grants to Early-Stage Energy Companies and Entrepreneurs Through Regional Innovation Clusters.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	X

Issue: Emerging energy companies and entrepreneurs with bench-validated technologies must overcome a number of obstacles to turn innovations into successful businesses. These early-stage companies often have management teams heavily weighted with researchers possessing little business experience, which increases the private sector's perception of investment risk. Furthermore, technology innovation is often disconnected from the regional economic resources and private capital needed to develop sound business models.

Purpose: This initiative will work with regional innovation clusters to provide small grants to entrepreneurs that have developed and verified innovative clean energy products at the bench-scale, but do not have the expertise, resources, or market connection to create a commercialized offering. Grant funding will be awarded in tandem with capital from private investors to leverage public-private partnerships and increase the likelihood of promising clean energy innovations developing into competitive commercial products. Grants awarded through regional innovation clusters will:

- Reduce capital cost barriers for early-stage clean energy companies.
- Establish business connections based on mutual interests.
- Demonstrate a high-level of due diligence to alleviate any concerns private investors may have with the technology or innovation.
- Help promising innovations overcome the commercialization valley of death.

Funding amounts will be dependent on the nature of the innovation and the level of risk associated with developing the product. Grants will be awarded for targeted hardware and software innovations in all of the major EPIC funding categories, including:

- Energy efficiency and DR technologies and measures.
- Clean energy generation systems and deployment strategies.
- T&D hardware.
- Grid operations and systems management.

- Integration of transportation electrification.
- Integrated demand-side resources optimized for smart grid applications.

Stakeholders: Electricity ratepayers in general, early-stage energy companies, local economies, energy-related academics, private investment groups, renewable energy industry groups.

Background: Regional cleantech groups provide a venue to strengthen local economies, while bringing promising clean energy products to the marketplace. A number of regional cleantech groups exist in California, each with differing models and priorities based on regional technological and economic priorities. Through EPIC, the Energy Commission plans to leverage the capacity of these regional cleantech innovation groups to accelerate the development and commercialization of promising energy innovations to strengthen California's clean energy economy.

S10.2 Proposed Funding Initiative: Support Demonstration Testing and Verification Centers to Accelerate the Deployment of Pre-Commercial Clean Energy Technologies.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				x	x	x	x

Issue: Early-stage emerging energy technologies face numerous obstacles before products can be commercialized and business models can become profitable. Due to these issues, many promising clean energy ventures fail to reach full commercialization. Testing centers can increase the rate and level of commercial success for advanced clean energy technologies. By performing rigorous due diligence on the performance, safety and economics of energy components and systems, testing centers can help to address private investor concerns and remove barriers to the commercialization of innovative energy technologies.

Purpose: This initiative will provide funding for the development and operation of regional testing and verification centers in California. These centers will provide the facilities, permitting, and equipment to enable companies to test and verify their pilot-scale technologies in controlled lab environments that approximate real-world conditions. These testing and verification centers will work with potential early-adopter end-users to develop specifications that meet the customers' needs. This initiative will develop clean energy generation testing centers to validate the environmental performance and cost-competitiveness of emerging clean energy generation components and technologies at the pilot-scale. These testing centers will

leverage public-private partnerships to accelerate the commercialization of next-generation clean energy technologies, and may include the following:

- Biomass-to-energy systems.
- CHP systems.
- High-efficiency PV systems.
- Low-cost wind energy components.
- Advanced hydrokinetic turbines.

Testing centers will provide a variety of functions to support the incubation of promising energy technologies and strengthen California's clean energy economy. Clean energy testing centers will provide a number of functions, including, but not limited to:

- Start-up assistance to demonstrate emerging energy technologies at the pilot scale
- Access to pre-permitted demonstration facilities and equipment for environmental compliance testing.
- On-site technology installation and engineering support.
- Business consultation services to evaluate business cases for technology types.
- Connection to market commercialization and industrial partners. Recommendations for potential technology integration opportunities.
- Evaluations of additional applied research activities to reduce technology costs, improve performance, or achieve economic feasibility at various scales.
- Advising technology codes, standards, and safety certifications.
- Working with local universities to train engineers, collaborate with academia, and advance renewable energy education.

Stakeholders: Electricity ratepayers in general, energy technology inventors, local economies, energy-related academics, U.S. DOD, U.S. DOE, IOUs, renewable energy industry groups.

Background: California's IOUs currently have a number of test centers to evaluate a electricity technologies in simulated scenarios. One such test center is PG&E's Applied Technology Services test center in San Ramon, which is primarily focused on advanced transmission, distribution, and power electronics technologies. Additionally, SDG&E and SCE both have test centers devoted to evaluating and showcasing cutting-edge energy efficiency technologies. Emerging renewable energy technologies could benefit from a similar model and leverage California's regional engineering and technical experts to streamline commercialization of the most promising products and provide localized economic benefits.

The 2007 National Defense Authorization Act required that the U.S. DOD produce or procure 25 percent of all energy from renewable sources by 2025.[76] To support this effort, U.S. DOD has funded the operation of multiple energy technology testing centers across the United States. One such testing center, the Technikon Renewable Energy Testing Center at McClellan Air Force Base in California, provides third-party analysis of promising waste-to-energy technologies. Similar testing centers could be developed for a number of other clean energy technologies.

S10.3 Proposed Funding Initiative: Conduct Scenario Assessments and Gaps Analyses That Will Be Used to Develop or Update Research Roadmaps.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				x	x	x	x

Issue: Future funding opportunities and priorities for EPIC may change as new state energy policies are implemented and emerging technologies are developed and deployed into the state's evolving electricity system. To ensure efficient use of ratepayer funds in this dynamic and ever-changing environment, research is needed to develop gap analyses, scenario assessments, and other decision-making tools to ensure that EPIC funds are optimally directed towards technologies and barriers that provide the greatest benefits to IOU ratepayers.

Purpose: This initiative will develop advanced methods, tools, information and data to develop and analyze future scenarios for the state's electricity system, and identify critical research gaps that must be addressed. Results of the analyses will be used to strategically target future EPIC investments in a manner that provides optimal benefits to IOU ratepayers, and maximizes the use of public research and development investments. Activities funded under this initiative will include:

- Developing advanced methods to analyze integrated scenarios for the future electricity system.
- Identifying critical current and future research funding gaps to achieve IOU ratepayer benefits encompassed in state policy goals.

76 United States Code, Title 10, Section 2911, as amended by Section 2852 of Public Law 109–364, 109th Congress, ,http://www.gpo.gov/fdsys/pkg/PLAW-109publ364/pdf/PLAW-109publ364.pdf.

- Prioritizing potential research activities based on near-term, mid-term, and long-term needs; potential to benefit ratepayers; investment risk; and other criteria to maximize IOU ratepayer benefits for each dollar invested.

To prioritize research activities future investment plans, scenario assessments and gap analyses are planned for the following research topics:

- Industrial, Agricultural and Waste Energy Efficiency
  - Data centers.
  - Petroleum refineries.
  - Electronics industry.
  - Food processing.
  - Industrial (e.g., cement, pharmaceutical, glass, etc.).
  - Water/wastewater (coordinated with Water Research Foundation roadmapping effort).
  - Food processing.
  - Pre-harvest agriculture (such as irrigation and sensors).
- Building Energy Efficiency
  - Lighting.
  - HVAC.
  - Envelopes.
  - Plug Loads (coordinated with CalPlug roadmapping effort).
  - ZNE buildings (coordinated with PGE roadmapping effort).
  - Existing buildings (coordinated with IOU roadmapping effort).
- Clean Energy Generation
  - Distributed renewable energy systems.
  - Biopower.
  - Strategies to increase utility scale power plant performance.
  - Offshore renewable energy.
  - Reducing environmental barriers to renewable energy permitting and Deployment (including water, habitats and species, and air quality).
  - ZNE communities (coordinated with energy efficiency efforts).

Stakeholders: Energy researchers, CPUC, IOUs, California ISO, ARB, U.S. DOE, U.S. DOD, Ocean Protection Council, other federal agencies, energy industry groups.

Background: In the past, the Energy Commission has funded gap analyses and other assessments to identify R&D activities needing public interest funding support. These assessments have been critical to identifying and prioritizing funding opportunities in research roadmaps, budget plans, and other R&D planning documents. Existing Energy Commission research roadmaps contain gap analyses to identify critical barriers and R&D opportunities that

are not covered by other private or public funding sources, however many of these roadmaps need to be updated to reflect current technology advances and market trends.

In addition to gap analyses, scenario assessments can also help direct EPIC investments to technologies that will provide the greatest ratepayer benefits.

S11 Strategic Objective: Provide Cost Share for Federal Awards

Table 19: Ratepayer Benefits Summary for Strategic Objective 11

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S11.1 Provide Cost Share for Federal Awards.		X		X			X		

Historically, California entities (entrepreneurs, small businesses, and research institutions) have not fared as well as expected when competing with other states for federal funding on clean energy initiatives. When these entities have been able to request cost share and support from the Energy Commission, there is usually a higher probability of winning a competitive federal award. When Energy Commission staff have talked with federal agency representatives about the value of these Energy Commission co-funding and support letters of intent that are submitted with a proposal, these federal representatives indicated that this element is always perceived as a positive action and in many cases increases the proposer's competitive score. The end result of this is additional federal funding coming into California resulting in market growth, expansion and jobs for these California entities. Normally, to ensure the commercial entity continues to have a commitment to the project, the Energy Commission contribution to the match is limited to no more than half of the federal required match. As a result, the state ends up receiving a high leverage of these funds that is routinely 5 to 15 times the Energy Commission commitment (when you account for the industrial match and federal funding).

S11.1 Proposed Funding Initiative: Provide Cost Share for Federal Awards.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
X				X	X	X	X

Issue: There may be opportunities for the Energy Commission to use EPIC funds as cost share to leverage future federal investments that provide significant benefits to the state's IOU ratepayers. Because these future cost share opportunities are released through other federal agencies (for example, U.S. DOE, U.S. DOD, U.S. Department of Labor), the timing and scope of the proposed cost share opportunity cannot be pre-defined or pre-approved in the investment plan. Without a specific process to provide for federal cost share, the Energy Commission may not be able to use EPIC funds as effectively to attract significant federal investments into California.

Purpose: This initiative will provide EPIC funds as cost share to leverage federal investments for projects that (a) meet the guiding principles of the decision; and (b) cannot use funding from other proposed initiatives in the investment plan as cost share due to timing or scope constraints. Examples of federal cost share opportunities include:

- Co-funding projects in IOU territories with federal agencies including the U.S. DOE, U.S. DOD and others as appropriate.
- Providing cost-share funding for California entities that receive funding from the U.S. DOE, the U.S. DOD, and others as appropriate.
- Continuing to provide match funding for the WESTCARB program that is funded by the U.S. DOE and has been managed by the Energy Commission since 2003.

Stakeholders: Research Institutions, companies, U.S. DOE, U.S. DOD, nongovernmental organizations.

Background: Over the past few years, the Energy Commission has been able to leverage significant federal funding for California. For example, the Energy Commission provided cost share to California entities that received ARRA awards. As a result of this cost share, California was able to leverage more than $500 million in ARRA funds with a contribution of only around $20 million of state funds. Without this state cost share, many of the projects would not have been selected by the U.S. DOE for funding and California would have lost the benefits of the tax

revenues, jobs, and California-based manufacturing capabilities that these ARRA projects provided.

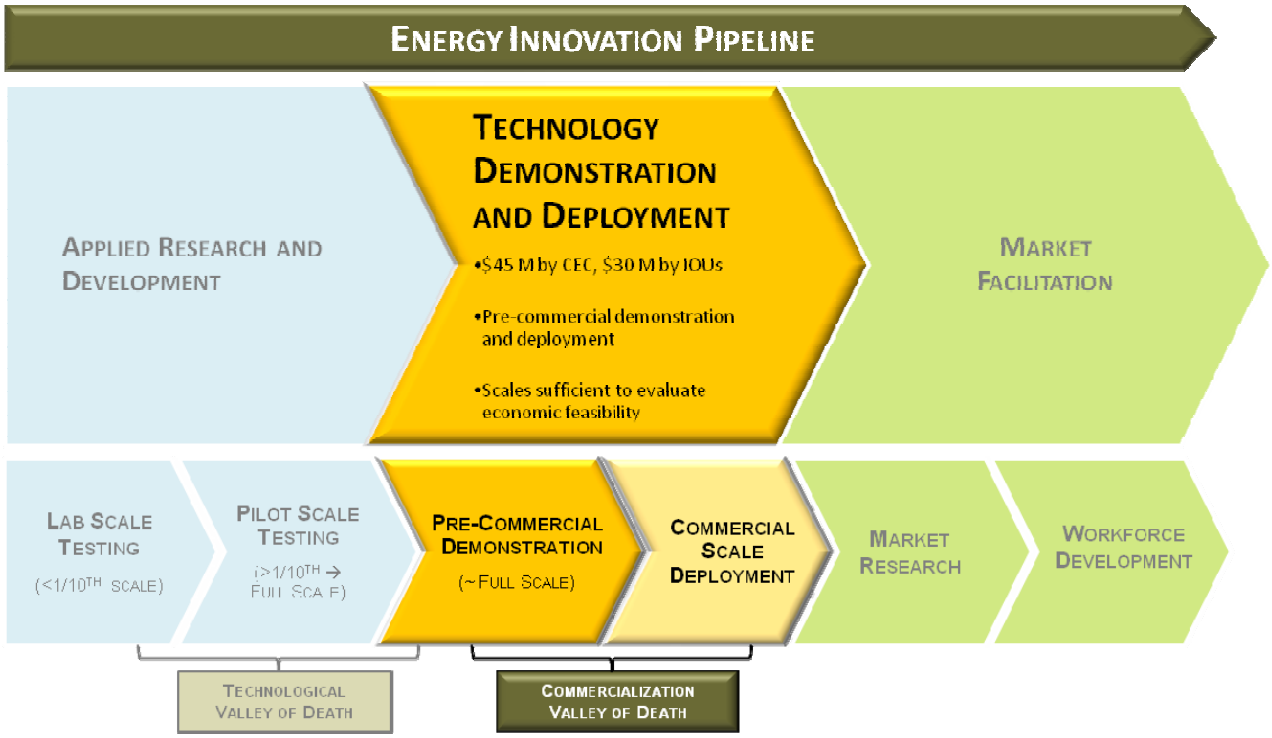
In another example, the Energy Commission is the overall project leader for the multistate WESTCARB program that is funded by the U.S. DOE. In addition to directly supporting California's emission reduction policies, the WESTCARB grant has leveraged substantial federal and industrial cost-share funding directly into the California economy. To date, the WESTCARB research effort includes more than $20 million in federal funds and more than $5 million in industry match funds — all leveraged at a cost of less than $6 million in California's research funds. Although six other states also participate in the WESTCARB partnership, more than 75 percent of the federal funds and industrial funds have been utilized in California to generate jobs and create future opportunities for California businesses.

The Commission envisions continuing this partnership in the future and requesting additional U.S. DOE funds. For the three-year period, it is expected that the WESTCARB grant will require $3 million to $6 million in EPIC funds to match $10 million to $30 million in federal U.S. DOE and industry cost share funding. The funding will be used to help California utilities meet future emission reduction goals. One area of specific interest is the demonstration of carbon dioxide (CO2) capture, transmission, utilization and storage from an IOU operated natural gas combined cycle power plant. Phase one of this effort is currently underway and the next phase is expected to start in the next one to three years. One unique element of this WESTCARB grant team is that to obtain the grant from U.S. DOE, the Energy Commission must select a team of partners including industry partners when submitting the grant. This grant is competitively reviewed and scored by U.S. DOE and if awarded, normally some of the contracts that are used to execute the grant are sole source contracts with commercial contractors.

The U.S. DOD is currently pursuing the most aggressive clean energy goals of any federal or state agency in converting its state-side bases to high levels of renewable penetration (50 percent), aggressively installing new energy efficiency technologies (for both existing and new facilities), and the transition of its nontactical vehicle fleet from fossil-fuel based to all electric. There are more than 30 U.S. DOD locations in California and the opportunity for co-funding and cost share projects is significant. For example, the U.S. DOD is currently planning its first regional roll out of electric vehicle transition at several California bases over the next few years. This creates a strong opportunity to cost share the research, deployment and implementation of this critical technology. Additionally, California companies that can become part of the regional roll out in California will have business opportunities throughout the nation and the world as the U.S. DOD completes its system-wide transition to electric vehicles.

Funding Strategy: Rather than set aside a specific amount of funding for federal cost share, the EPIC program will allow applied research strategic objectives to apply up to 10% of the funding to support federal cost share opportunities.

CHAPTER 4: Technology Demonstration and Deployment



The applied research and development stage develops novel clean energy technologies and strategies, evaluates technical performance, and tests promising prototypes. The next step, technology demonstration and development, aims to evaluate the performance and cost-effectiveness of these technologies at or near commercial scale.

Through the Technology Demonstration and Deployment program area, the Energy Commission will provide funding for activities to test scalability and preliminary operating issues, bringing promising "pre-commercial" technologies and strategies closer to market. Pre-commercial refers to technologies and strategies that have not reached commercial maturity or deployed at scales sufficiently large and in conditions sufficiently reflective of anticipated actual operating environments to enable appraisal of the operational and performance characteristics and the financial risks. For this three-year investment plan, the Energy Commission will provide $129.9 million for technology demonstration and deployment funding to test new technologies in conditions that approximate real-world applications. A minimum of $27 million will be targeted specifically to bioenergy technology demonstration and deployment projects.

Building on the Applied Research and Development initiatives, the Technology Demonstration and Deployment program will also facilitate the achievement of the states' energy policy priorities, including the "loading order." Demonstration projects funded in this category will also serve as a test bed to explore opportunities to make the whole better than the sum of individual parts through a holistic approach to integrating efficiency, renewables, and clean transportation. The potential benefits are improved customer choice, lower costs achievement of energy goals, and a better interface with the "smart grid."

Demonstration and deployment activities will typically be conducted in investor-owned utility (IOU) service territories. However, projects located outside IOU service territories may be considered, if there is a strong case that the project demonstrates IOU electricity ratepayer benefits. The demonstration and deployment strategic objectives discussed below outline a set of initiatives focused on a particular proposal area. The strategic objectives are:

- S12 Strategic Objective: Demonstrate and Evaluate the Technical and Economic Performance of Emerging Efficiency and Demand-Side Management Technologies and Strategies in Major End-Use Sectors.
- S13 Strategic Objective: Demonstrate and Evaluate Emerging Clean Energy Generation Technologies and Deployment Strategies.
- S14 Strategic Objective: Demonstrate the Reliable Integration of Energy Efficient Demand-side Resources, Distributed Clean Energy Generation, and Smart Grid Components to Enable Energy-smart Community Development.
- S15 Strategic Objective: Provide Cost Share for Federal Awards.

Table 20: Proposed Funding Allocation for the Technology Demonstration and Deployment Program Area by Strategic Objective

Funding Area	Amount (Millions)
S12 Strategic Objective: Demonstrate and Evaluate the Technical and Economic Performance of Emerging Efficiency and Demand-Side Management Technologies and Strategies in Major End-Use Sectors	$37.3
S13 Strategic Objective: Demonstrate and Evaluate Clean Energy Generation Technologies and Deployment Strategies	$48.0
S14 Strategic Objective: Demonstrate the Reliable Integration of Energy Efficient Demand-side Resources, Distributed Clean Energy Generation, and Smart Grid Components to Enable Energy-Smart Community Development	$44.4
S15 Strategic Objective: Provide Cost Share for Federal Awards	$ -
Technology Demonstration and Deployment Program Area Total	**$129.8**

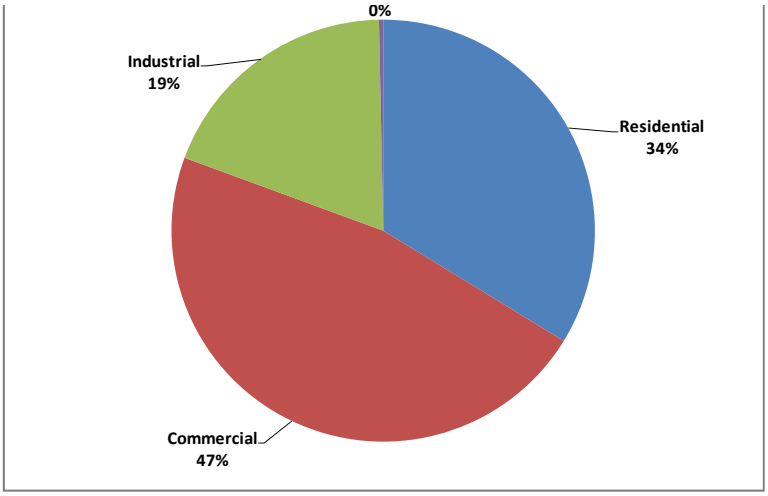
The proposed funding allocations for the technology demonstration and deployment program area provided in Table 20 were developed based on the priorities defined in the CPUC EPIC decision and the expected level of effort needed to fully address each of the specific strategic objectives. These funding levels are estimates and may change based on the number of successful responses received from competitive solicitation awards and the amount of leveraging of the EPIC funds from other parties that can be obtained by strategic objective. For S15, *Provide Cost Share for Federal Awards*, up to 10 percent of the funding allocated for the technology demonstration and deployment strategic objectives can be applied to providing cost share for these types of competitive federal awards.

S12 Strategic Objective: Demonstrate and Evaluate the Technical and Economic Performance of Emerging Efficiency and Demand-Side Management Technologies and Strategies in Major End-Use Sectors.

Table 21: Ratepayer Benefits Summary for Strategic Objective 12

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/ transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S12.1 Identify and Demonstrate Promising Energy Efficiency and Demand Response Technologies Suitable for Commercialization And Utility Rebate Programs.	X	X		X	X		X	X	X
S12.2 Demonstrate Integrated Demand Side Management Programs – Using Emerging Efficiency, Demand Response, Distributed, Metering and Other Grid-Related Technologies – For the Residential, Commercial, Industrial and Agriculture Sectors	X	X		X	X		X	X	X

Figure 5: California's Electricity Consumption by Sector (total 258,000 million kWh/yr)



Source: United States Energy Information Administration (EIA), 2010

The State of California has recognized energy efficiency as a primary strategy to reduce the state's energy use and costs, as well as greenhouse gas (GHG) emissions. Electricity used in homes, commercial buildings, industrial and agricultural processes, and water and wastewater activities consume nearly 258 billion kWh/year in annual electricity use.

Figure 6 shows the energy intensity of the industrial, agricultural and water sectors.

Once technologies have been successfully demonstrated in bench scale systems, and meet pre-defined performance targets, they must be fully demonstrated in commercial settings at an appropriate

scale "real-world" conditions to validate energy, water and cost savings, environmental parameters, overall economics (including operational and maintenance costs) and other criterions necessary to commercialize the technology/strategy and gain public acceptance. In addition to energy savings, some customers, especially industries, are highly sensitive to the reliability and quality of electric power. Therefore, in addition to improving energy efficiency, these demonstrations must also address power quality, supply and reliability issues as they improve energy efficiency or energy demand.

The focus of the initiatives in this section are to demonstrate emerging technologies that will result in electricity and cost savings, and economic and environmental benefits to California through peak load reduction and/or reduced energy consumption. These demonstrations will address specific California Energy Efficiency Strategic Plan goals of maximizing energy efficiency in existing facilities and processes. Facilities can include buildings and associated structures, industrial, agriculture and water processes.

The research initiatives in this section were developed based on the following:

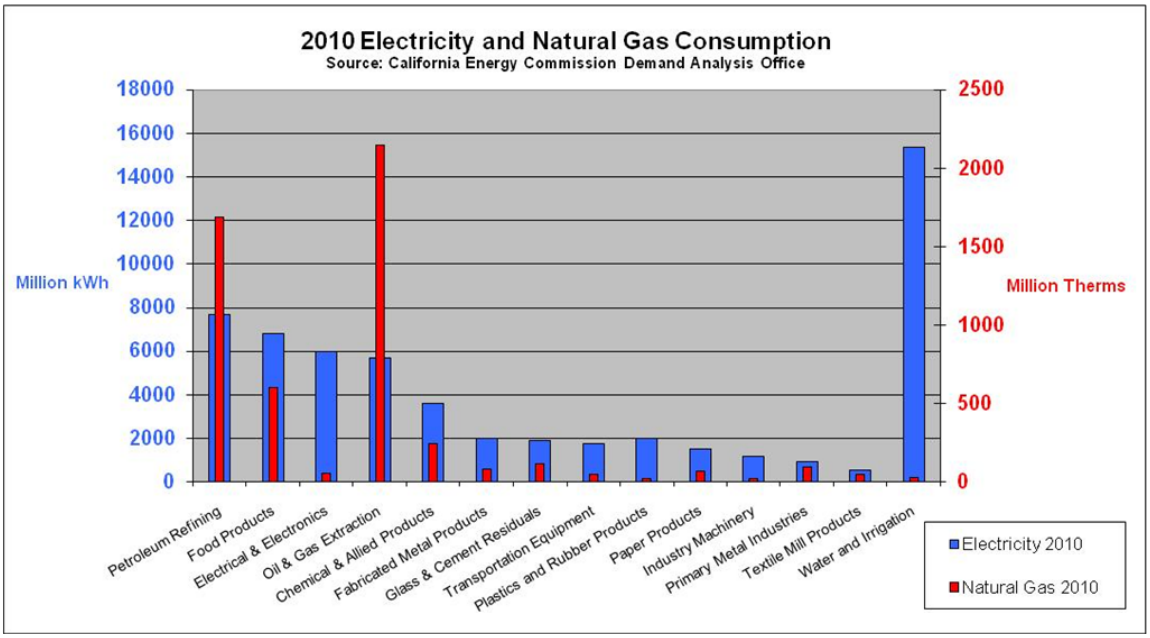
- Evolution of past research activities and results that indicate demonstration beyond pilot scale is needed to further the technology into the marketplace.
- Strong energy policy connection and industry support.
- Discussions with the research community as a result of public workshops, project and technical advisory committee meetings.
- Public comments received regarding the September 27, 2012 triennial investment plan.
- Deliberative input from state agencies.

Initiatives that were dropped and not considered were those that had undetermined energy efficiency research benefits, such as projects that emphasized energy generation only, or projects with direct overlap with existing IOU and California Public Utilities Commission (CPUC) activities. Examples of the latter include developing and evaluating pilot programs for innovative financing mechanisms for whole building retrofits.

Additionally, S 12.2 has been expanded to include integrated demand-side management using emerging energy efficiency, demand response (DR), distributed generation (DG), metering and other grid related technologies across multiple sectors and will be coordinated with IOU/CPUC efforts to maximize synergies and minimize duplication.

The private and industrial sectors are diverse, very risk averse, require high rate of return and some may have environmental barriers to overcome. As a result, demonstrations are needed with independent monitored and verified data to show the energy saving benefits and cost-effectiveness of emerging technologies.

Figure 6: 2010 Selected Industrial Energy Consumption Data



Source: California Energy Commission Demand Analysis Office

S12.1 Proposed Funding Initiative: Identify and Demonstrate Promising Energy Efficiency and Demand Response Technologies Suitable for Commercialization and Utility Rebate Programs.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
	X	X					X

Issue: There are emerging technologies that can help California's end-use electricity sectors reduce their energy consumption, emissions, and/or water use, in environmentally sustainable ways, while maintaining productivity and safety. However, a significant portion of these emerging technologies have yet to be proven (demonstrated) at commercial or industrial scales in "real-world" conditions. They are in need of an independent assessment of their performance, overall economics, reliability, life-cycle cost and energy savings. Without an independent assessment of their technical and economic viability, these technologies do not make it past the "commercialization valley of death." Additionally, demonstrations are needed to overcome the barriers associated with any new technology—such as technical feasibility, reliability, environmental considerations, regulatory and permitting, economic feasibility, such

as cost and operating considerations and benefits, market awareness and long term viability and persistence of benefits.

Purpose: This initiative will demonstrate emerging technologies that are past the "proof-of-concept" stage in building, industrial, agricultural, water or wastewater plant settings. These demonstrations will be partially funded by EPIC and the applicants will need to provide a required level of matching funds. The objective is to produce proven technical and economic performance data, which could make the technologies eligible to participate in the utilities' energy efficiency rebate programs and could facilitate the successful deployment of the technologies into the marketplace. Utility rebates can expedite customer acceptance and market development for the demonstrated technologies. Examples of technologies include the following:

- Buildings. Examples include: lighting, heating and cooling systems and controls, including, but not limited to those resulting from Strategic Objective S1.
- Industrial, agricultural, water or wastewater sectors. Example technologies include: industrial energy efficiency processes (foundries, boilers, burners), water energy efficiency (pumps, efficient canal technologies), post-harvest agricultural processes (vegetable cleaning, peeling); data center improvements (air conditioning, high efficiency chipsets), with additional targets towards the most energy intensive industries, such as glass, cement, pharmaceuticals, petroleum, and reducing peak load through DR industrial technologies.

Stakeholders: Electric ratepayers who own and operate buildings, facilities and industrial, agricultural and water operations, equipment manufacturers, engineers, contractors and consultants, academia, governmental agencies, utilities and national labs.

Background: This initiative will build and expand upon energy efficiency research efforts to demonstrate advanced technologies:

- Buildings related: The Energy Commission's past successes with demonstration activities include the State Partnership for Energy Efficient Demonstrations (SPEED), which focused primarily on demonstrations with public university and State of California buildings. The SPEED program has resulted in widespread application and installation of emerging technologies, especially lighting improvements and HVAC controls, in several University of California and state buildings and has saved an estimated 61 million kWh/year and 4.2 million therms/year, resulting in $12 million per year in savings.[77] Additionally, other efforts also resulted in demonstrations of whole building energy efficiency concepts in limited residential and commercial buildings in a few climate zones. This initiative will expand these commercial demonstrations and emphasize large scale demonstration and deployment of advanced technologies to private and other publicly owned buildings.

77 2012 State Partnership for Energy Efficient Program, Draft final report.

- Industrial, Agriculture and Water: The targeted demonstration areas will affect the major energy using sectors, such as food processing, electrical and electronics, chemical industry, and water and irrigation. These areas were identified through extensive Energy Commission staff research, roadmaps, interactions with industry stakeholders and utilities and past research conducted in the Emerging Technology Demonstration Grant Program which focused primarily on industrial, agriculture and water processes.[78] From 2003 to 2009, the California Energy Commission staff engaged stakeholders from various industries to guide the development of research, development, and demonstration (RD&D) roadmaps to guide funding priorities. Over the course of these efforts, the IAW program produced the following roadmaps:
    - Industrial Agriculture & Water Energy Efficiency RD&D Program Overview Technology for Reducing Natural Gas Use in California Industry.
    - Energy Efficiency Roadmap for Petroleum Refineries in California.
    - Data Center Energy Research & Deployment Roadmap.
    - RD&D Plan and Roadmap for Enhancing Energy Efficiency and Supply Reliability for California's Electronics Industry.
    - Energy Efficiency Roadmap for the California Food Processing & Beverage Industry.
    - Energy Efficiency in California's Food Industry.
    - PIER Water-Energy Strategic Plan and Technology Roadmap.
    - Water and Wastewater Industry Energy Efficiency: A Research Roadmap.

In addition, stakeholder workshops have been held to further identify specific research needs and emerging technologies ready for demonstration at a commercial/industrial scale. Stakeholders include industrial operators such as foundries, metal recyclers, glass and cement manufacturers, the oil and gas industries, and agriculture and water agencies. The IOUs are stakeholders and their input has been received through participation in the Emerging Technology Coordinating Council (ETCC) and other venues such as the Emerging Technologies Summit. Both of these venues have heavy participation by the IOUs and the Sacramento Municipal Utility District.

Initiatives that are not being considered in this initiative are those that are exclusively renewable energy or combined heat and power (CHP) projects since these are covered mainly by S13. Though these types of projects could be associated with industrial and agricultural processes (e.g., diary digesters or wastewater treatment operations), they do not result in any energy efficiency benefit and is more appropriately handled in the other initiatives.

There is a need for public funding for demonstrations of emerging technologies to bridge the "commercialization valley of death." The private sector, for the most part, does not conduct basic research and is risk averse regarding new, unproven technologies, often lacking the

78 http://www.energy.ca.gov/publications/displayOneReport.php?pubNum=CEC-500-2011-035.

resources to analyze and evaluate various technologies. New technologies often are developed in academic communities which do not have the funding for large scale demonstrations, only bench scale. Typically, the private sector only offers funding after a successful field demonstration.

The focus will be on large-scale demonstrations and deployment and will involve multiple industrial players, such as IOUs, major manufacturers and industrial customers, regulators and leading nonprofit research institutions. These larger scale activities can result in quicker market adoption of the technology.

S12.2 Proposed Funding Initiative: Demonstrate Integrated Demand Side Management Programs – Using Emerging Efficiency, Demand Response, Distributed Generation, Metering and Other Grid-Related Technologies – For the Residential, Commercial, Industrial and Agriculture Sectors

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X					X

Issue: Demand side management (DSM) options have been "siloed" within regulatory bodies, utilities, and other organizations. [79] The result is mass delivery and promotion of individual products and measures that do not maximize energy savings nor minimize the costs of program delivery. This can present a barrier to implementation of any energy efficiency measure as energy users are confronted with too many energy saving options and become confused on which to implement first. There's also a lack of new technologies and systems that enable multiple DSM options that can provide synergies across DSM program types.[80]

Facility owners need to see actual, verified savings and benefits of installing integrated solutions before they will commit to finance energy and cost saving measures. They also need to understand system installation and commissioning practices for new systems before savings are achieved. Without that knowledge, facility owners will hesitate to install integrated solutions that can include advanced energy efficiency, DR, metering and distributed technologies. A lack of centralized information that allows facility owners and professionals to be educated on cost-effective integrated DSM measures and programs, results in a knowledge gap. Currently, the

79 *California Energy Efficiency Strategic Plan*, 2011, Chapter 8.

80 Ibid.

responsibility lies with the facility owner or energy consultant to seek out the necessary technology and financing avenues. Without an implementation mechanism that can demonstrate and verify savings, and provide the necessary funding and marketing, there is little incentive for facility operators to retrofit their facilities in an integrated manner.

Purpose: This initiative will coordinate and complement existing CPUC/IOU activities associated with integrated DSM options and whole building retrofits with the goal of supporting the objectives of the *California Energy Efficiency Strategic Plan.* Potential research includes:

- Integrated DSM demonstrations in residential, commercial, industrial and agriculture sectors: These demonstrations will apply lessons from pilots developed through the CPUC/IOU programs to full scale demonstration and include integration of advanced energy efficiency measures, energy management controls, customer side generation, DR , storage, grid related technologies and other technologies to enable integration. These demonstrations will provide quantifiable data that would measure the energy and cost savings, emission reductions and other benefits associated with integration.
- Development and demonstration of new technologies and systems that enable multiple DSM options that can provide synergies across DSM program types.
- Create an information repository/hub for facility owners, design professionals and trades to share integrated DSM information and experiences based on demonstration and deployment results. This repository/hub will take into account existing online activities, such as the "Home Builder" blog.

This initiative will coordinate with on-going and planned CPUC/IOU activities related to integrated DSM pilots and whole building retrofits to ensure synergies and avoid duplication.

Stakeholders: Electric ratepayers who own and operate buildings, facilities and industrial and agricultural operations, equipment manufacturers, engineers, contractors and consultants, academia, governmental agencies, utilities, and national labs.

Background: The *California Energy Efficiency Strategic Plan* emphasizes a goal to deliver integrated DSM options that include efficiency, DR, energy management and other measures through coordinated marketing and regulatory integration. The result would be increased energy savings at lower cost through the implementation of a menu of DSM options.

In decision 07-10-032, the CPUC required the IOUs to "integrate customer demand-side programs, such as energy efficiency, self-generation, advanced metering, and DR in a coherent and efficient manner."[81] The intent was to achieve maximum savings while avoiding

81 http://www.calmac.org/events/EE_and_MEO_2103-14_decision_166830.pdf.

duplication of efforts, reducing transaction costs, and diminishing customer confusion.[82] In this same decision, the IOUs were directed to fund pilot projects to achieve integrated DSM and the results would be independently evaluated by the CPUC staff in late 2012.
The *California Energy Efficiency Strategic Plan* also sets retrofit targets for reduction of energy consumption in existing building stock. In its Decision 12-05-015 on May 10, 2012, the CPUC stated that "these goals will require immediate action to drastically increase the uptake and scale of deep retrofit projects across the building sector."[83] The IOU 2010-2012 portfolios made notable steps towards this undertaking, but more needs to be done to expand deep retrofit programs in multifamily and nonresidential buildings and address cost-effectiveness issues, and incorporate financing into retrofit project transactions.[84]

This initiative will coordinate with on-going and planned CPUC/IOU activities associated with both integrated DSM and deep retrofits of residential and commercial buildings and complement the work undertaken through the Energy Upgrade California Program, other Energy Commission building efficiency retrofit programs and AB 758, (Skinner, Chapter 470, Statutes of 2009). The Energy Upgrade California Program is a collaboration between the California Energy Commission, the CPUC, utilities, local governments, nongovernmental organizations and the private sector to promote and finance energy efficiency and renewable energy projects for homes and businesses. Other Energy Commission building efficiency retrofit programs include the Bright Schools Program, Energy Partnership Program and low interest loan program. The focus on these programs is the use of conventional technologies and not emerging technologies. AB 758 requires the Energy Commission to develop and implement a comprehensive program to achieve greater energy savings in the state's existing residential and nonresidential building stock. The program is comprised of a complimentary portfolio of techniques, applications, and practices that will achieve greater energy efficiency in existing residential and nonresidential structures, especially those that fall significantly below the efficiency required by the current California Building Energy Efficiency Standards (Title 24, Part 6). The proposed comprehensive program includes meaningful and reliable building energy assessments, energy benchmarks, building energy use ratings and labels, cost-effective energy efficiency improvements, public and private sector energy efficiency financing, public outreach and education and green workforce training. The bill directs the Energy Commission to consider these components when developing the program, as well as other factors and strategies that the Energy Commission deems appropriate. These improvements will result in major energy savings that are important to California's economy and environment, particularly due to the air quality and water resource impacts of power plants, energy bill impacts of

82 Ibid

83 http://www.calmac.org/events/EE_and_MEO_2103-14_decision_166830.pdf

84 Ibid

unnecessary electricity and natural gas use, and California's efforts to mitigate climate change through GHG emission reductions.

S13 Strategic Objective: Demonstrate and Evaluate Emerging Clean Energy Generation Technologies and Deployment Strategies.

Table 22: Ratepayer Benefits Summary for Strategic Objective 13

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S13.1 Demonstrate and Appraise the Operational and Performance Characteristics of Pre-Commercial Biomass Conversion Technologies, Generation Systems, and Development Strategies.	x	x	x	x	x		x	x	x
S13.2 Demonstrate and Deploy Pre-Commercial Technologies and Strategies for Combined Heat and Power Applications.	x	x	x	x	x		x	x	x
S13.3 Demonstrate Technologies and Strategies to Facilitate the Integration of Intermittent Renewable Energy.	x	x		x	x		x	x	x

As mentioned in Chapter 3, renewable energy and CHP can provide numerous benefits to ratepayers. However, current market offerings for renewables and CHP are typically more expensive than conventional generation. A number of innovative technologies and strategies are currently being developed that can increase the market viability of clean generation. These technologies need to be proven at or near commercial scales in real-world conditions to reduce their perceived risk to potential investors and customers.

As directed by the CPUC EPIC decision, a minimum of twenty percent of the technology demonstration and deployment funds will be allocated to biomass-to-electricity projects. Most of the solicitations in this area will fall within the scope of initiative S13.1.

S13.1 Proposed Funding Initiative: Demonstrate and Appraise the Operational and Performance Characteristics of Pre-Commercial Biomass Conversion Technologies, Generation Systems, and Development Strategies.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X			X		

Issue: Biopower technologies, as described in chapter 3, have a variety of challenges limiting full-scale commercial deployment. The Energy Commission has held a number of public workshops to identify and address these challenges through the Bioenergy Action Plan. [85] [86] This initiative will not address every challenge facing the industry; rather, support will focus on demonstration and deployment activities that address the highest priority issues as identified by stakeholders. A summary of the issues that will be addressed through this initiative include:

- Air quality standards within the San Joaquin and South Coast air districts necessitate the demonstration and deployment of advanced pollution control equipment and low-emission generators that have demonstrated the ability to meet air quality standards at pilot scale. In addition, cost-effective compliance technologies and mitigation measures are needed to commercially deploy bioenergy systems.[87] The U.S. Environmental Protection Agency's (U.S. EPA) rule for toxic and hazardous air pollution may pose a challenge for existing solid-fuel biomass facilities, particularly with respect to hydrogen chloride emissions. [88]
- Biomass feedstock costs are directly correlated to the transportation distance, which necessitates size constraints for new facilities. To harness the economies of scale that larger

85 For a detailed list of the challenges limiting bioenergy development, please see O'Neill, Garry, John Nuffer. 2011. *2011 Bioenergy Action Plan*. California Energy Commission, Efficiency and Renewables Division. Publication number: CEC-300-2011-001-CTF.

86 O'Neill, Garry. 2012. *2012 Bioenergy Action Plan*. California Energy Commission, Efficiency and Renewables Division.

87 Economic Feasibility of Dairy Manure and Co-Digester Facilities in the Central Valley of California. May 2011. Prepared for the California Regional Water Quality Control Board, Central Valley Region by Environmental Science Associates.

88 California has higher than average chloride concentrations compared to the rest of the US. Reasons include proximity to high concentrations of chloride in the ocean and irrigated regions with high salinity. Chloride that is absorbed by vegetation can be transformed to HCl during combustion.

projects can provide, new fuel handling systems or technologies that reduce the transportation costs of biomass feedstocks must be demonstrated at market scales.

- Within the dairy industry, the dairy market and the perceived technical risk of on-farm biopower systems have made financing and development of pre-commercial systems difficult and expensive.[89]
- Challenges specific to thermochemical conversion technologies and generation systems include high capital cost, and the need for demonstration facilities to assess air emissions, cost, and reliability of downstream gas treatment and catalyst systems.[90]

Purpose: This initiative will advance pre-commercial technology demonstration and early-stage deployment of biopower and biogas technologies and systems, including technologies, processes, and strategies successfully demonstrated at pilot scale. The types of demonstration and deployment projects that the Energy Commission will consider in this initiative include community-scale bioenergy facilities in agricultural, forest or wildland, and urban regions, and low-emission or zero emission DG technologies including CHP, combined cooling heating and power (CCHP), and other integrated systems. The overall goal of this initiative is to address issues limiting full-scale deployment and develop publicly available data on the operational characteristics of these technologies and best practices to reduce the overall cost of generation.

For the purposes of this investment plan, "community-scale" biogas and biopower demonstration projects are technologies and strategies sized to sustainably utilize locally available biomass resources and provide benefits to local communities in addition to ratepayer benefits. Criteria for project selection includes: integration/reliability services, net local air quality benefits, reduction in the amount of biomass that goes to landfills, GHG emission reductions, and/or reduced risk of forest fires.

Technology demonstration and deployment projects in this area will need substantial funding to overcome the challenges we have identified. Therefore, to maximize the effect of EPIC investments in this area, this initiative will focus on the following areas:

- Agricultural-based and community-scale bioenergy technologies and systems, such as anaerobic digesters, thermochemical conversion, advanced pollution controls, and ultra low emission generation technologies capable of meeting local air quality standards. This

89 *Economic Feasibility of Dairy Manure and Co-Digester Facilities in the Central Valley of California*. May 2011. Prepared for the California Regional Water Quality Control Board, Central Valley Region by Environmental Science Associates.

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

initiative may fund the demonstration of new ownership models for on-farm energy generators including multifarm cooperatives or third-party ownership.[91]

- For systems near urban and wildland interface regions, the focus will be on demonstrating community-scale "pre-commercial" biopower systems and low-emission generation systems that will use locally sourced biomass, primarily from fire prevention activities.
- Demonstration of advanced pollution controls and ultra low emission generation technologies capable of meeting local air quality standards at new or existing facilities.
- Demonstrate advanced biomass fuel handling and delivery systems or strategies that have been successfully evaluated through "applied research" and are ready for full-scale demonstration.
- Demonstration of pre-commercial integrated systems that combine biopower technologies with other processes (including waste management, composting, and recycling) into a single location. Demonstration of co-digestion systems will also be considered in this initiative.

Where appropriate, demonstration and deployment projects on state lands within an IOU service territory may be given preference during funding solicitations. The Energy Commission will work with California Department of Forestry and Fire Protection (CalFire) and other state agencies to indentify appropriate locations and projects.

Stakeholders: Ratepayers in rural and urban communities, industrial and commercial food processing facilities, dairy and agriculture facilities, and wastewater treatment facilities; California Department of Food and Agriculture; local air quality districts; California Air Resources Board (ARB); CalFire; California Department of Resources Recycling and Recovery; Department of Transportation; U.S. Department of Agriculture (USDA); U.S. EPA; bioenergy developers; bioenergy and waste management industry groups. **Background:** Although many of the core digester technologies have been established on a global scale, these systems have not reached commercial maturity for use in agricultural and urban waste settings (with the exception of wastewater applications) in California. Technology demonstrations that could dramatically improve future on-farm bioenergy adoption include cost-effective low-emission internal combustion engines, micro-turbines or fuel cells, inexpensive emissions control technologies, or efficient biogas upgrading systems with low-pressure pipeline injection.[92] [93]

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91 Cooperative Approaches for Implementation of Dairy Manure Digesters. http://www.rurdev.usda.gov/rbs/pub/RR217.pdf.

92 *Economic Feasibility of Dairy Manure and Co-Digester Facilities in the Central Valley of California*. May 2011. Prepared for the California Regional Water Quality Control Board, Central Valley Region by Environmental Science Associates.

93 *Advanced Technology to Meet California's Climate Goals: Opportunities, Barriers & Policy Solutions.* ETAAC Advanced Technology Sub-Group. December 14, 2009. Pages 4-11.

Recently, a federal grant was provided to assess the feasibility of a centralized dairy digester model. This study advances this conceptual model and lays the foundation for development of centralized dairy digester projects in California.[94] The feasibility study is scheduled for completion by the second quarter of 2013.

The Energy Commission has provided funding to develop many biopower projects, including demonstration and testing of advanced biological and thermochemical conversion technologies at a variety of settings in California. These projects have shown that additional demonstrations and early stage deployment projects are needed to bring down the development costs and improve environmental compliance of these technologies.

One particular program provided a key insight in future biopower demonstration projects. The Dairy Power Production Program primarily focused on demonstrating on-farm dairy digester projects in the San Joaquin Valley. Projects funded by this program encountered a changing regulatory environment, including increasingly stringent air emissions standards. Unaware that emissions standards were under review by the local air district, projects purchased generation equipment based on emissions limits that would no longer be in effect when installed two years later. A key lesson learned from the implementation of this program is that demonstration solicitations should require the involvement of local regulatory agencies at an early stage to ensure that projects are designed to meet regulations in effect when the project begins operating. [95] [96]

On December 15, 2010, the Energy Commission adopted a memorandum of understanding (MOU) between the Energy Commission and the Departments of General Services, Corrections and Rehabilitation, Transportation, Water Resources, and Fish and Game "to facilitate the development of renewable energy projects on state buildings, properties, and rights-of-way." Under this MOU, the agencies, among other things, will collaboratively study, plan, and develop electricity infrastructure and to develop statewide request-for-proposals to make these properties available to interested developers. "These agencies have the experience and resources necessary to perform the additional evaluations and environmental screening needed to determine which state-owned buildings, lands, and rights-of-way are most appropriate for renewable development going forward. The aim is to develop renewable resources on state property through existing programs and at no net increase in cost to the state." Energy Commission staff recommends that the state install 2,500 MW of renewable energy on state-

94 http://www.calepa.ca.gov/Digester/Documents/CentDigStudy.pdf.

95 http://www.calepa.ca.gov/digester/History.htm.

96 *Dairy Power Production Program Dairy Methane Digester System Program Evaluation Report*. Western United Resource Development, Inc. February 2009. CEC-500-2009-009.

owned property by 2020. EPIC funds can further this cause through targeting demonstration and deployment projects on pre-screened public lands.[97]

There are a number of other grant opportunities for the demonstration of biomass to energy systems, including:

- USDA Rural Business Opportunity Grants (RBOG): The primary objective of the RBOG program is to promote sustainable economic development in rural communities with exceptional needs. On-farm bioenergy is eligible for grants under this program. EPIC funding can leverage additional federal funding in this category.
- USDA Rural Energy for America Program (REAP): This program assists agricultural producers and rural small businesses to complete a variety of projects. Offering both loan guarantees and grants, the REAP program helps eligible applicants install renewable energy systems such as solar panels or anaerobic digesters, make energy efficiency improvements such as installing irrigation pumps or replacing ventilation systems, and conduct energy audits and feasibility studies. EPIC funding can leverage additional federal funding in this category.
- Biomass Research and Development Initiative (BRDI)—a joint program through USDA and the U.S. DOE—will help develop economically and environmentally sustainable sources of renewable biomass. The focus of this funding program is on development of transportation biofuels. However, funding in this program for feedstock development activities may overlap some EPIC funded projects. EPIC staff will monitor this program for opportunities to leverage funds.

S13.2 Proposed Funding Initiative: Demonstrate and Deploy Pre-Commercial Technologies and Strategies for Combined Heat and Power Applications.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	**Full-scale Demo**	**Early Deployment**	**Market Facilitation**	**Grid Operations / Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
	X	X			X		X

Issues: Upfront purchase and installation costs and other barriers have limited the market penetration for CHP technologies despite their system-wide benefits. CHP systems have an estimated total technical potential of more than 18,000 MW in California, yet an Energy Commission-funded study estimates only 2,988 MW will be installed by 2029 under a base case

97 Barker, Kevin, Jim Bartridge, Heather Raitt. 2011. *Developing Renewable Generation on State Property*, California Energy Commission. Publication number: CEC-150-2011-001.

scenario. New technological innovations are emerging that could significantly increase the market penetration of CHP. However, these technologies have not been deployed at sufficient scales to prove their commercial viability and acceptance, and drive down installation and maintenance costs. More demonstration and early deployment projects are needed to further increase their market competitiveness.

Purpose: Through this initiative, funding will be provided to demonstrate new technologies and approaches to advance the economic and environmental performance of CHP systems using both renewable and fossil fuel sources. There are significant opportunities to demonstrate and deploy promising CHP/CCHP systems customized for industrial and institutional settings such as food processing plants, manufacturing facilities, hotels, hospitals and wastewater treatment plants. EPIC investments should be used to demonstrate and evaluate the value that CHP and CCHP systems such as these can provide to customers and California as a whole.

This initiative will focus on the following demonstration activities:

- Demonstration of low-emission or zero emission prime mover technologies or emission control equipment. This will be coordinated with other similar demonstration projects to avoid duplication.
- Demonstrate and evaluate the economic and environmental performance of fuel-flexible CHP/CCHP systems and deployment strategies in real-world applications.
- Demonstration of advanced CHP/CCHP technologies on state property.
- Deploy innovative CHP technologies at utility scale, assess the installation costs, and develop strategies to address.

Stakeholders: Ratepayers in industrial, commercial, institutional facilities and multifamily residences; local air quality districts, and energy-smart community developments, IOUs, CHP developers, CHP industry groups.

Background: There are a number of funding opportunities for CHP systems, including incentives, grants, and feed-in tariff pricing mechanisms. Funding in this initiative will be used to fill identified gaps in funding for demonstration projects in California without duplicating in-state incentive programs such as the Self Generation Incentive Program.

Current funding programs:

- Self Generation Incentive Program, administered by the IOUs, provides incentives for qualifying distributed energy systems installed on the customer's side of the utility meter. Qualifying technologies include wind turbines, waste heat to power technologies, pressure

reduction turbines, internal combustion engines, microturbines, gas turbines, fuel cells, and advanced energy storage systems.[98]

- Feed-in Tariffs for Highly Efficient CHP: This FIT provides standard offer contracts for purchase of excess electricity from eligible CHP systems by an electrical corporation under Assembly Bill 1613. A standard contract will be available to all eligible CHP systems up to 20 MW and a simplified contract will be available to CHP systems that export no more than 5 MW.[99]

Financial Funding Assistance for Small Business Innovation Research and Small Business Technology Transfer for U.S. DOE:[100] A step-by-step grant program that is covering multiple types of renewable energy.[101] CA companies have been successful in the past entering the program. Restrictions on the type of eligible projects limit effectiveness of the program for developing innovative ideas.

S13.3 Proposed Funding Initiative: Demonstrate Technologies and Strategies to Facilitate the Integration of Intermittent Renewable Energy.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X		X	X		X

Issues: The intermittent nature of renewable resources, such as wind and solar, results in variable and sometimes unpredictable electricity generation. High intermittency can cause major problems for grid operators, including potentially costly outages. Complementary technologies, such as energy storage, demand response (DR) and flexible natural gas-fired generation can provide options for rapid response to variable output from intermittent renewables.[102] However, pre-commercial storage technologies have not been demonstrated and deployed at scales sufficient to establish a business case for these technologies. DR applications

98 http://www.cpuc.ca.gov/PUC/energy/DistGen/sgip/

99 http://www.cpuc.ca.gov/PUC/energy/Climate+Change/chpfeedin.htm

100 http://science.energy.gov/sbir/about/

101 http://science.doe.gov/grants/pdf/SC_FOA_0000628.pdf (example from 2012 that wanted to possibly sponsor offshore wind mooring technology)

102 2011 Integrated Energy Policy Report (IEPR). CEC-100-2011-001-CMF. Page 39.

have so far been limited in scope to pilot demonstrations, and require full-scale field demonstrations to evaluate the overall value that DR can provide to renewables integration. Furthermore, while natural gas power plants are able to provide a number of services to support the integration of renewables, there is room to improve ramping ability to enable greater penetration of renewable energy into the grid.

Purpose: This initiative will demonstrate and evaluate technologies and approaches to advance the integration of intermittent renewable energy into California's grid. Focus will be placed on demonstrations to evaluate technologies and strategies that can improve natural gas power plant ramp rates in order to rapidly respond to variations in renewable energy output and enable the integration of increasing levels of intermittent renewables. In addition, the Energy Commission will coordinate storage and DR efforts in this initiative with the IOUs to address potential funding gaps not covered in the IOU investment plans.

Stakeholders: Ratepayers due to the benefits of increased renewable energy availability, grid operators, and renewable energy providers.

Background: The ability of the electricity grid to handle high levels of intermittent renewable energy is of key importance to achieving California's energy policy goals. California ISO outlines a three-fold approach to cost-effectively integrate renewables into the grid.[103] The three strategies include energy storage, demand response, and fast-ramping natural gas fired generation. While the investor owned utilities' proposed investment plans appear to sufficiently cover demonstration or deployment activities related to demand response and energy storage, they do not include any initiatives that look to demonstrate or deploy energy generation technologies.

Technologies and strategies for improving the operational capabilities of gas fired generators exist. General Electric offers a line of retrofit products called OpFlex that allows their gas turbines units to lower turndown levels and improve ramp rates, both of which would help the CAISO integrate more renewable energy. The General Electric 7FA combustion turbine units are the most common in California, with 33 installed statewide. In addition, there are other gas turbines in use in California that may benefit from retrofits using other emerging products. Technologies and software solutions such as the above need to be demonstrated in California's IOU service territories to evaluate economic and operational viability.

[103] 2012 IEPR Workshop Presentation. http://www.energy.ca.gov/2012_energypolicy/documents/2012-06-11_workshop/presentations/00_Korosec_6-11-12_for_posting.pdf. Slide 11.

S14 Strategic Objective: Demonstrate the Reliable Integration of Energy Efficient Demand-Side Resources, Distributed Clean Energy Generation, and Smart Grid Components to Enable Energy-Smart Community Development.

Table 23: Ratepayer Benefits Summary for Strategic Objective 14

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S14.1 Demonstrate Zero-Net Energy Buildings and Communities.	X	X		X		X	X		
S14.2 Demonstrate Renewable Energy-Based Microgrids Capable Of Sharing Resources Across the Larger Power Grid.	X	X	X	X		X	X		
S14.3 Demonstrate Advanced Vehicle-to-Grid Energy Storage Technologies and Second-Use Vehicle Battery Applications.	X			X	X	X			

Energy-smart communities are state-of-the-art communities in which energy is supplied primarily from locally-available renewable energy resources, with the possibility of providing excess energy back to the grid. These communities also include near-zero or zero-net energy (ZNE) buildings, local clean energy generation systems and the integration of electric transportation infrastructure, thereby providing economic and environmental benefits to local ratepayers. Furthermore, energy-smart communities can potentially offer an additional value to electricity utilities by providing localized power generation and management of local community demand.

To achieve California's ambitious renewable energy and GHG reduction goals, a coordinated effort will be required at local and regional levels. These initiatives will serve as community showcases of cutting edge technologies, system components, and integration strategies. Energy smart community demonstrations will involve advanced and emerging energy technologies across the electricity value chain, including efficiency, renewables, energy storage, advanced communications, and intelligent grid-operation technologies to evaluate technical potential and economic performance in real-world community environments. Potential systems designs, deployment strategies and ownership models will be evaluated for their cost-effectiveness and ability to be replicated throughout California.

Successful demonstration of projects funded under this objective would increase consumer, industry, and utility confidence in energy smart community strategies and serve as a showcase for similar business parks, neighborhoods, and facilities across IOU territories. These demonstrations will help develop innovative partnerships, business models, and permitting processes that accelerate achievement of our clean energy policy goals through energy smart communities. The primary goal of the following initiatives is to determine how to best design, build and integrate ZNE buildings and community in the most cost-beneficial manner that also will be adopted in the marketplace.

The research initiatives in this section were developed based on the following:

- Evolution of past research activities and results that indicate demonstration beyond pilot scale is needed to further the technology into the marketplace.
- Strong energy policy connection and industry support.
- Discussions with the research community as a result of public workshops, project and technical advisory committee meetings.
- Comments received concerning the September 27, 2012 triennial investment plan.
- Deliberative input from state regulatory and other agencies.

Initiative S14.1 includes joint planning and coordination with IOU/CPUC related activities to build on program synergies and results and minimize duplication,

Full scale demonstrations are needed to provide the independent analysis , and measurement and verification of technical and economic feasibility of technologies. Though the demonstration partners will provide some match funds, the risk is limited and controlled. Additionally, by aligning the project with a government program, all results are available to the public and this information can be disseminated to others in the industry.

S14.1 Proposed Funding Initiative: Demonstrate Zero-Net Energy Buildings and Communities.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X		X	X	X	X

Issue: The primary barrier to ZNE buildings and communities is the cost of required technologies and components. Also, the deployment of distributed renewables, such as wind and solar, results in a variable local energy generation profile and increases the need for local

ancillary services. Current building-scale ZNE solutions may not take advantage of the full range of benefits offered by community energy systems. While ZNE communities are technically possible at this time, previous demonstration attempts have encountered a number of issues that hinder their success.

The inadequate supply of builders and developers that have the skills and experience to create ZNE buildings and communities is a barrier. Many design challenges and site-specific considerations are required to efficiently meet the energy needs of a building and the surrounding community. Designers must apply holistic design principles and take advantage of the free, naturally occurring assets available, such as passive solar orientation, natural ventilation, daylighting, thermal mass, and nighttime cooling. Without properly trained builders and developers to create ZNE buildings and communities, new technologies will never reach market maturation due to the lack of exposure or poor performance related to incorrect designs and installations.

Lack of a long-term financing mechanism, such as the Property Assessed Clean Energy (PACE) program in California, which allowed current building owners to pass forward loan payments for energy retrofits to new owners when homes are sold, can be a barrier to the goal of ZNE buildings. Financing opportunities are especially critical to low-income qualified buildings, which make up a large percentage of multiunit dwellings. The limited availability of financing and incentive options prohibit builders from realizing any payback from new building or retrofitting a building.

Purpose: This initiative will demonstrate and verify designs and approaches for the cost-effective integration of localized energy generation, efficiency, and systems technologies into community environments to enable ZNE buildings and communities. This initiative can include demonstrations of ZNE buildings, communities or a combination of both. Verified models and tools can then be utilized by local developers to minimize energy costs and maximize ratepayer benefits realized by deploying ZNE systems.

Potential activities include:

- Demonstrate advanced energy efficiency technologies, strategies and controls to reduce building and/or community level electricity use and demand.
- Design, implement, monitor and verify advanced clean energy generation and efficiency components, systems and integration system performance and benefits.
- Examine integration strategies across residential, industrial, commercial, institutional, and governmental facilities and buildings to enable economically-viable, fully-operational net-zero energy business parks, shopping centers, institutional facilities and communities.
- Demonstrate novel approaches to achieve high penetration deployment of DG technologies, smart grid technologies, distributed energy storage, and electric transportation

infrastructure in industrial, commercial, residential and mixed-use community developments.

- Develop and evaluate innovative financing mechanisms for ZNE buildings and communities.
- Increase knowledge, skills and experience by builders and designers to create ZNE buildings or communities.
- Increase knowledge of the human behavior characteristics associated with ZNE buildings and communities, and what barriers must be overcome for widespread adoption based on post monitoring of ZNE buildings or community demonstrations.
- Analyze and evaluate the potential of a "phased approach" to ZNE buildings or communities, such as assessing and establishing intermediate ZNE goals (for example, 50 percent, 75 percent, 100 percent and evaluating technical/economic feasibility).
- Provide empirical data information in a common taxonomy for use by stakeholders, policymakers, consumers, and local governments through available software such as HERS and BEARS compatible with other energy/asset rating software systems. This is critically important to allow various ZNE case studies to be compared with common metrics.

This initiative will coordinate and complement existing CPUC/IOU studies and activities associated with ZNE buildings and communities to support the objectives of the *California Energy Efficiency Strategic Plan* and to ensure consistent and coordinated definitions of ZNE buildings and communities in the marketplace.

Stakeholders: Ratepayers in existing commercial and residential buildings, IOUs, CPUC, energy-smart community developers, future homeowners, universities, ARB, U.S. DOE, renewable energy industry groups.

Background: The CPUC's Long Term Energy Efficiency Strategic Plan has established big bold initiatives to achieve residential and commercial ZNE in new construction by 2020 and 2030 respectively. ZNE buildings have been demonstrated in a limited scale in both commercial and residential buildings in California. In addition, early adopter institutions, facilities, and neighborhoods in California are implementing zero- or near-zero energy approaches at the community scale. San Diego Gas & Electric (SDG&E) currently operates an energy smart community demonstrating state-of-the-art technologies at Borrego Springs. The UC Davis West Village is the largest planned ZNE community in the United States. However, the technical feasibility of ZNE buildings and communities is still in the early stages of demonstration. "Significant additional resources will be required to scale these efforts up for full-scale production at affordable prices"[104]

104 *California Energy Efficiency Strategic Plan.*

S14.2 Proposed Funding Initiative: Demonstrate Renewable Energy-Based Microgrids Capable of Sharing Resources Across the Larger Power Grid.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X		X	X	X	X

Issue: Microgrids have emerged as a powerful infrastructure for a customer, or aggregation of customers, to integrate renewable resources and demand management strategies in a controlled environment, and when necessary, safely island and reconnect to the larger power grid. Renewable energy microgrids with decentralized management and control offer the benefits of increasing grid reliability, stability, and resiliency in the face of power outages.[105] However, utilities and the California ISO lack the ability to monitor the operation of microgrids and coordinate the sharing of resources from one microgrid to another. Microgrid controllers are new and unproven. Many resources within a microgrid have yet to be operated as part of an integrated system. Plug-in electric vehicles (PEVs) have yet to be integrated as a resource within microgrids. Additionally, sharing resources across microgrids has never been demonstrated. Interest by the U.S. Department of Defense (U.S. DOD) and others is high due to the benefits that shared resources can offer.

Purpose: The Energy Commission will fund microgrid demonstration projects to evaluate the potential of technology solutions and deployment strategies to minimize energy costs and provide electricity customer ratepayer benefits. EPIC-sponsored microgrid research will include activities to demonstrate and evaluate:

- Advanced microgrid control and operation techniques.
- Strategies for the coordination and sharing of resources of multiple regionally-separated microgrids.
- The interoperability of microgrid component technologies.
- The impacts and benefits of microgrid deployment on grid planning and operations.

Stakeholders: Ratepayers in secure facilities, prisons, hospitals, police stations, and military bases; U.S. DOD, U.S. DOE, California ISO, IOUs, microgrid developers, renewable energy industry groups.

105 EPRI, 1/30/2006. "Sustainable Communities—Business Opportunities for the Electric Utility Industry," http://my.epri.com/portal/server.pt?.

Background: Microgrids are ideal for applications that **r**equire secure and uninterrupted energy supply, such as military installations, universities, hospitals, and prisons, and can help enable energy smart communities. Microgrids require the deployment and integration of a variety of onsite clean energy technologies to reliably and securely meet local energy demand. Additionally, microgrids need the ability to "island" or operate independently from the grid when needed. Switches are needed that can seamlessly transition from islanded mode to grid-synchronized operation on very short notice.

The Energy Commission has previously funded several microgrid demonstration efforts throughout California, including Santa Rita Jail[106] in Alameda, Borrego Springs in SDG&E territory, and the University of California, San Diego. The Energy Commission will continue to work with the U.S. DOD to develop microgrids for defense department facilities in California that will be capable of sharing resources. The intent is to lessen the impacts of these facilities on California's grid while helping the U.S. DOD meet its renewable energy goal of 25 percent penetration by 2025.

S14.3 Proposed Funding Initiative: Demonstrate Advanced Vehicle-to-Grid Energy Storage Technologies and Second-Use Vehicle Battery Applications.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X		X		X	X

Issue: Vehicle-to-grid and second-life storage application systems require integrating numerous components including the vehicle itself, communication software, and utility and ISO signals. Demonstrations are needed to test that all the components are appropriately integrated and to address issues that may have an effect on distribution and transmission levels. Currently, this integration has not been demonstrated at a sufficient scale to encourage fleet and facility operators to consider deploying vehicle-to-grid and second-life storage applications. Additionally, vehicle Original Equipment Manufacturers (OEMs) are concerned with potential implications of V2G on the vehicle battery pack and battery charging components.

Purpose: This initiative will demonstrate V2G and battery-second use applications at facilities located in IOU territories. Demonstrations of V2G and energy storage from stationary batteries (secondary use) are needed to test that all the components are successfully integrated, and to address issues that may exist at the distribution level and transmission level. This initiative will

106 http://www.energy.ca.gov/2010publications/CEC-500-2010-FS/CEC-500-2010-FS-005.PDF.

support demonstration efforts in various locations and fleet applications (commercial vehicle fleets as well as light-duty fleets), including, but not limited to, ports, school bus facilities, utility facility yards, corporate distribution headquarters, post offices, military bases, and airports. The demonstrations will include methods to evaluate and address concerns regarding the application of V2G on battery packs and vehicle charging components. Furthermore, these demonstrations could help establish a business case for not only vehicle-to-grid and battery second-use applications, but also increased purchase of PEVs by fleet operators.

Stakeholders: Auto manufacturers, battery manufacturers, fleet operators, PEV consumers, CPUC, ARB, California ISO, U.S. DOD, facility operators.

Background: There have been a few small scale demonstrations of V2G and second-life storage applications. For V2G, the Energy Commission is co-funding a project at LA Air Force base to demonstrate using medium-duty PEVs to provide ancillary grid services with the California Independent System Operator (California ISO). Additionally, work is currently underway within the U.S. DOD to conduct demonstrations at the microgrid level at military installations in Hawaii and Colorado. Work is also underway within PJM Interconnect, BMW and the University of Delaware to demonstrate use of V2G. For battery-second use applications, the University of California, San Diego is currently conducting long-term testing of vehicle battery packs to better determine their suitability for grid applications. The University of California, Davis is demonstrating the feasibility of a second-use device at the household level to provide demand-side management.

S15 Strategic Objective: Provide Cost Share for Federal Awards

Table 24: Ratepayer Benefits Summary for Strategic Objective 15

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S15.1 Provide Cost Share for Federal Awards.		X		X			X		

As explained in Strategic Objective S11 in the Applied Research and Development chapter, California entities (entrepreneurs, small businesses, and research institutions) have historically not fared as well as expected when competing with other states for federal funding on clean energy initiatives. When these entities have been able to request cost sharing and support from the Energy Commission, there has usually been a higher probability of winning a competitive federal award. When Energy Commission staff have talked with federal agency representatives

about the value of these Energy Commission co-funding and support letters of intent that are submitted with a proposal, federal representatives indicated that this element is always perceived as a positive and in many cases increases the proposer's competitive score. This is especially true for critical demonstration and deployment activities. Many actual field demonstrations and deployments funded by the U.S. DOE and the U.S. DOD routinely require a higher level of cost sharing or co-funding than applied research and development projects. Applicants normally select a maximum funding limit in addition to the requirement for the requesting entity to fund at least half of the project co-funding with their own match or co-funding resources. For example, the Energy Commission funded over 20 separate projects under the American Recovery and Reinvestment Act (ARRA). Some of the projects were very large (in excess of $100 million). In those cases, the Energy Commission agreed to fund up to half of the co-funding requirement, not to exceed $1 million per project. This allowed the state to provide substantial support without having to expend all available resources on a single project. It is envisioned that in EPIC, a similar maximum cap will be selected based on the availability of funds, priority of the proposed effort and the importance of the effort to California ratepayers.

S15.1 Proposed Funding Initiative: Provide Cost Share for Federal Awards.

Technology Pipeline Stage				Electricity System Value Chain			
Applied R&D and Pilot-scale Testing	Full-scale Demo	Early Deployment	Market Facilitation	Grid Operations / Market Design	Generation	Transmission / Distribution	Demand – side Management
	X	X		X	X	X	X

Issue: There may be opportunities for the Energy Commission to use EPIC funds as cost share to leverage future federal investments that provide significant benefits to the state's IOU ratepayers. Because these future cost share opportunities are released through other federal agencies (for example, U.S. DOE, U.S. DOD, Department of Labor [DOL]), the timing and scope of the proposed cost share opportunity cannot be pre-defined or pre-approved in this investment plan. Without a specific process to provide for federal cost share, the Energy Commission may not be able to use EPIC funds as effectively to attract significant federal investments to California.

Purpose: This initiative will provide EPIC funds as cost share to leverage federal investments for projects that (a) meet the guiding principles of the decision; and (b) cannot use funding from other proposed initiatives in the investment plan as cost share due to timing or scope constraints. Examples of federal cost share opportunities include:

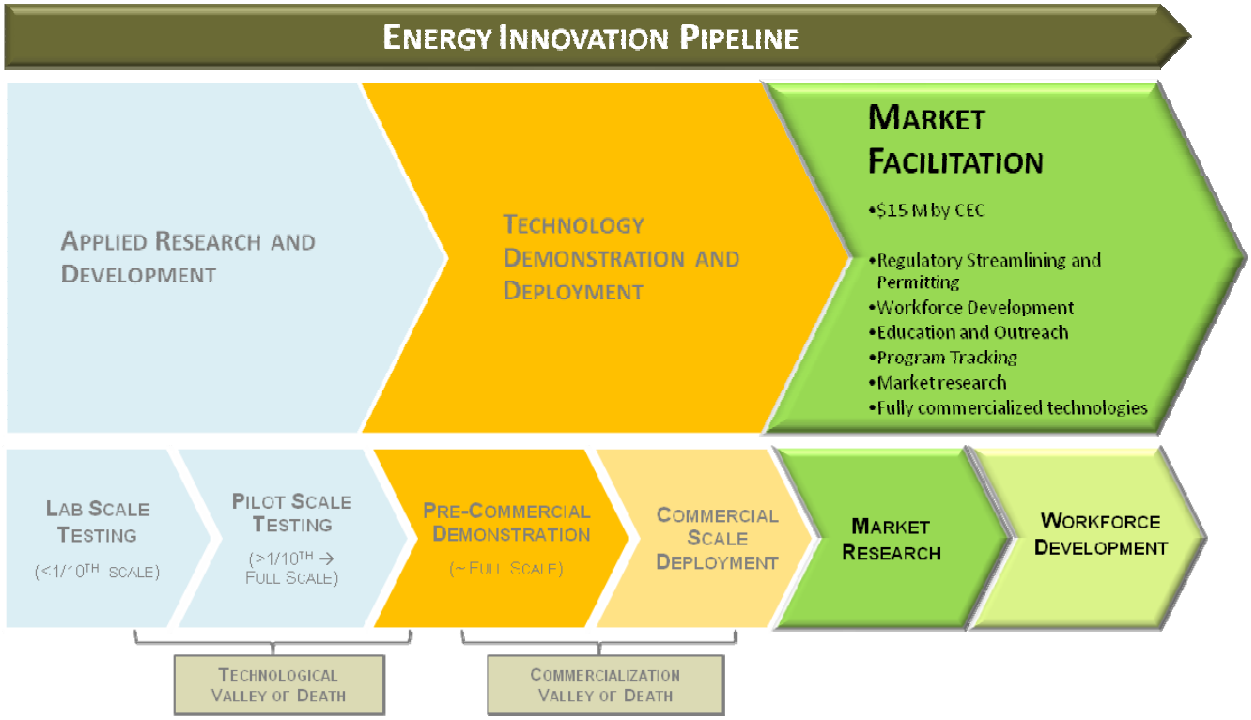
- Co-funding technology demonstration and deployment projects in IOU territories with federal agencies including the U.S. DOE, U.S. DOD and others as appropriate.
- Providing cost-share funding for California entities that receive funding from the U.S. DOE, the U.S. DOD, and others as appropriate for technology demonstration & deployment projects.

Stakeholders: Research Institutions, companies, U.S. DOE, U.S. DOD, nongovernmental organizations.

Background: Over the past few years, the Energy Commission has been able to leverage its own funds to bring significant federal funding to California. For example, the Energy Commission provided cost share to California entities that received ARRA awards. As a result of this cost share, California was able to leverage more than $500 million in ARRA funds with a contribution of only around $20 million of state funds. Without this state cost share, many of the projects would not have been selected by the U.S. DOE for funding and California would have lost the benefits of the tax revenues, jobs, and California-based manufacturing capabilities that these projects provided. Several of these projects included technology demonstration and deployment phases in their projects.

Funding Strategy: Rather than set aside a specific amount of funding for federal cost share, the EPIC program will allow specific Technology Demonstration and Deployment projects to apply up to 10% of their approved funding to support federal cost share opportunities. This allows the separate elements of the program to specifically address unique opportunities when they occur while at the same time not holding valuable funds in reserve for an opportunity that may not occur.

CHAPTER 5: Market Facilitation



Through the Market Facilitation program area, the Energy Commission will address funding gaps in market processes that drive clean energy investment within investor-owned utility (IOU) service territories. For this three-year investment plan, the Energy Commission will provide $15 million annually for market facilitation funding initiatives that streamline regulatory processes and project permitting, help develop the state's clean energy workforce, fund education and outreach programs, and fund program tracking activities. Specifically, the Energy Commission proposes the following areas of funding:

- Regulatory assistance: Offer a combination of direct and indirect investments in IOU territories that facilitate clean energy development.
- Workforce development and education: Provide direct investments that strengthen the wide variety of workforce development efforts in targeted communities.
- Program tracking: Monitor progress and major changes within the clean energy industry to inform solicitation and project selection decisions for future EPIC investment plans.
- Market Research: Develop analytics on the clean energy market that include policy impact and policy opportunity assessments.

Each strategic objective below outlines a set of initiatives focused on a particular area of the proposed funding. The strategic objectives are:

- S16 Strategic Objective: Collaborate with local jurisdictions and stakeholder groups in IOU territories to establish strategies for enhancing current regulatory assistance and permit streamlining efforts that facilitate coordinated investments and widespread deployment of clean energy infrastructure.
- S17 Strategic Objective: Strengthen the clean energy workforce by creating tools and resources that connect the clean energy industry to the labor market.
- S18 Strategic Objective: Guide EPIC investments through effective market assessment, program evaluation, and stakeholder outreach.

Table 25: Proposed Funding Allocation for the Market Facilitation Program Area by Strategic Objective

Funding Area	Amount (Millions)
S16 Strategic Objective: Collaborate with local jurisdictions and stakeholder groups in IOU territories to establish strategies for enhancing current regulatory assistance and permit streamlining efforts that facilitate coordinated investments and widespread deployment of clean energy infrastructure	$23.3
S17 Strategic Objective: Strengthen the clean energy workforce by creating tools and resources that connect the clean energy industry to the labor market	$4.5
S18 Strategic Objective: Guide EPIC investments through effective market assessment, program evaluation, and stakeholder outreach.	$15.5
Market Facilitation Program Area Total	**$43.3**

The proposed funding allocations for the market facilitation program area provided in Table 25 were developed based on the priorities defined in the CPUC EPIC decision and the expected level of effort of market facilitation program area needed to fully address each of the specific strategic objectives. These funding levels are estimates and may change based on the number of successful responses received from competitive solicitation awards and the amount of leveraging of the EPIC funds from other parties that can be obtained by strategic objective.

S16 Strategic Objective: Collaborate with Local Jurisdictions and Stakeholder Groups in IOU Territories to Establish Strategies for Enhancing Current Regulatory Assistance and Permit Streamlining Efforts that Facilitate Coordinated Investments and Wide-Spread Deployment of Clean Energy Infrastructure

Table 26: Ratepayer Benefits Summary for Strategic Objective 16

	Promoter Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/ transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S16.1 Conduct Pilot Demonstrations of Localized Energy Resource Markets.	x	x		x	x	x		x	x
S16.2 Provide Planning Grants to Cities and Counties to Incorporate Clean Energy Technology Planning and Permitting Processes into Local Government Land Use Planning	x	x		x	x			x	x
S16.3 Conduct a Local Government Needs Assessment Study That Identifies Regulatory Gaps Within Local Planning and Zoning Processes.	x	x		x	x			x	x
S16.4 Collaborate with Local Jurisdictions and Industry Stakeholders to Create Model Ordinances for Emerging Clean Energy Technologies.	x	x	x	x	x			x	x
S16.5 Provide Funding to Assist in the Development of the General Plan Guidelines.		x	x	x	x		x	x	x
S16.6 Develop Consensus Based Educational Materials for Local Officials Interested in Facilitating Clean Energy Market Growth.		x	x	x	x		x	x	x

Source: California Energy Commission

The initiatives included in this objective invest in overcoming regulatory and permitting challenges at the local level. Local governments play an important role in achieving California's short- and long-term energy and climate goals. As the California Air Resources Board (ARB) explains in its Assembly Bill 32 *Climate Change Scoping Plan*, "Local governments are essential partners in achieving California's greenhouse gas (GHG) reduction goals. They have broad influence and, in some cases, exclusive authority over significant emission sources through their planning and permitting processes, local ordinances, outreach and education efforts, and municipal operations."

Investments in local governments are integral to the success of commercializing clean energy innovations.[107] Local government development policies that facilitate the appropriate deployment of clean energy technologies will help promote future grid reliability by creating a more predictable and certain development environment for a variety of clean energy technologies. Moreover, investments in the distribution grid must be made to accommodate localized energy resources (LER). Demonstrations are needed to show how local government clean energy goals can be achieved by coordinating land use planning with distribution infrastructure information.

Most local government comprehensive plans do not include clean energy land uses. Many cities and counties are processing development applications for renewable energy projects outside of the traditional comprehensive planning process, which adds uncertainty to project development. This uncertainty can hamper grid reliability, increase development costs, and increase health and safety risks to IOU ratepayers. Establishing uniform standards will provide more certainty while also keeping costs low and protecting the health and safety of ratepayers.

S16.1 Proposed Funding Initiative: Conduct Pilot Demonstrations of Localized Energy Resource Markets

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
X	X		X	X	X	X	X

Issue: The Center for Law, Energy, and the Environment (CLEE) reports that high penetrations of LER markets require coordination to address financial, regulatory, and technical barriers.[108] In CLEE's assessment, technical barriers refer to the constraints of the electric grid under high LER penetration and regulatory barriers relate to the planning difficulties that local governments face as LER penetration increases. Southern California Edison submitted

107 During the initial public workshops concerning the EPIC investment plan, the Energy Commission heard from several stakeholders that EPIC should invest in developing and allocating resources to local governments. Additionally, the Energy Commission received written comments supporting regulatory assistance from the following parties: Defenders of Wildlife, Communities Allied for Distributed Energy Resources, Pacific Forest Trust, Los Angeles Regional Collaborative for Climate Action and Sustainability, CALSTART, Joint Comment Letter from California ReLeaf, California Urban Forests Council, Planning and Conservation League, Trust for Public Land, and the California Chapter of the American Planning Association, and the California Center for Sustainable Energy.

108 http://www.law.berkeley.edu/files/ccelp/CA_Transition_to_Local_Renewable_Energy.pdf.

comments to the *2011 Integrated Energy Policy Report* proceeding recommending that utilities should help identify locations for LER to minimize system impacts and upgrade costs.[109]

Purpose: Pilot projects will demonstrate improved coordination of IOU distribution infrastructure, land-use planning and policies, existing state policies, clean energy incentives, and procurement markets in three locations, one in each IOU service territory. This initiative will demonstrate innovative strategies to achieve high penetrations of clean energy investment in locations that minimize system impacts and upgrade costs.

To achieve high penetrations of LER in the pilot projects, local government land use goals and utility infrastructure will leverage state and local policies with procurement programs and incentives to target areas where local governments and utilities prefer to locate renewable generators.

Through a competitive grant process, this initiative will solicit grant requests from regional consortiums of cities and counties to develop LER markets and assess the technical LER potential for all clean energy technologies. Based on the technical review, the Energy Commission and the IOUs will work with consortium grantees to communicate ideal interconnection points for LER generation.

The Energy Commission will also work with IOUs to include planned necessary grid upgrades in technical potential scenarios. Each consortium of cities and counties will compare IOU distribution infrastructure with existing and future land uses. The comparison should serve as a basis for selecting sites and implementing actions (including, but not limited to, general plan amendment, zoning change, variances, ordinances, and map overlays) to facilitate a high penetration of LER on sites that integrate with the distribution grid and meet the needs of communities.

In each pilot project, the EPIC program administrators will work with consortium grantees to identify policies and incentives to use to develop clean energy markets that support high LER investment. In future years, the scope of the pilot demonstrations may include collaboration with the Energy Commission, the CPUC, the California Independent System Operator (California ISO), IOUs, distributed energy developers, and local governments to demonstrate interconnection processes that reduce developers' costs and address interconnection challenges,. These collaborations will build on the results of EPIC applied research awards addressing interconnection challenges.[110]

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109 See Southern California Edison written comments to *2011 IEPR* proceeding at: http://www.energy.ca.gov/2011_energypolicy/documents/comments_draft_iepr/SCEs_Comments_TN-63209.pdf.

110 See comments received following the September 27, 2012 public workshop from the Joint Bioenergy Parties (TN# 67459).

Stakeholders: Local governments, utilities, and developers of clean energy technologies.

Background: Electric utilities, including California IOUs, consistently express concern that high penetrations of distributed generation will reduce grid reliability. Governor Brown's goal of installing 12,000 megawatts (MW) of LER will require significant investments in the distribution grid. As CLEE reports, integrating large amounts of distributed generation (DG) into the distribution grid requires collaboration particularly between distribution grid operators and local governments. Through their climate action plans and other consensus-based plans, local governments have expressed a desire to increase renewable DG within their communities. These local governments have set capacity targets for different renewable technologies. Also, they have indicated the land use and building types on which they prefer to see these technologies installed. However, these local governments have not coordinated identification of these areas and building types with the local electric distribution system.

S16.2 Proposed Funding Initiative: Provide Planning Grants to Cities and Counties to Incorporate Clean Energy Technology Planning and Permitting Processes into Local Government Land Use Planning.

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
X	X			X	X	X	

Issue: The Governor's Office of Planning and Research (OPR) reports that a majority "of jurisdictions do not have policies, programs, or ordinances that facilitate the development of renewable energy facilities."[111] At the local government level, clean energy policies, programs, and ordinances are needed to achieve high penetrations of clean energy investment into cities and counties. In the clean energy market, local governments have exclusive authority over a variety of technologies through their land use power. To date, several proactive local governments across California have taken steps to create regulatory frameworks that facilitate the development of a variety of clean energy technologies. Most of these local efforts help with deployment of distributed solar photovoltaic (PV) systems; some facilitate the deployment of utility-scale renewable energy systems. However, as the California County Planning Directors Association (CCPDA) reports, many local governments are resource constrained and face significant barriers to updating their regulatory frameworks to meet the rapidly changing clean energy market. [112]

111 See Figure 43, page 28 of the Annual Planning Survey: http://www.opr.ca.gov/docs/2012_APSR.pdf.

112 See slide 33 in the "2012 AEP Presentation on Streamlining Solar PV Strategies": http://www.ccpda.org/en/resources/docsandreports/cat_view/81-solar-issues?orderby=dmdate_published

Various issues regarding renewable energy on state property exist. As noted in a 2011 Energy Commission staff report exploring opportunities for renewable energy on state property, state agencies often need to ensure projects are consistent with local requirements even though local governments do not determine permits for renewable energy facilities on state property. Renewable energy projects on state property may also include facilities located on private property that falls under local government jurisdiction for permitting.[113] The complexities of permitting renewable energy projects on state property can create an insurmountable barrier to the competitiveness of innovative strategies for renewable energy. Greater coordination among state agencies and local governments in IOU service territories can help overcome this barrier and allow IOU ratepayers to capture the benefits of locating renewable energy on state property.

Purpose: This initiative will upgrade city and county comprehensive plans, regulations, and codes to promote deployment of clean energy technologies and balance development impacts. By investing in comprehensive planning and appropriate permitting processes at the local level, the Energy Commission will further the goals of EPIC and continue to create partnerships between state and local governments.

Through competitive grant solicitations, the grant program will invest in the planning and permitting activities of local governments in IOU service territories in California and will vary its roles in facilitating clean energy infrastructure based on the structure of local governments and local conditions across the state.

The Energy Commission will work closely with OPR to design applicant and project eligibility criteria. Also, the Energy Commission will include OPR in the scoring and ranking of grant applications. The Energy Commission expects that eligible applicants will include all cities and counties within the IOU service territories; however, proposals will not duplicate projects that are awarded funds under Public Resources Code Section 25619.[114] To the extent practicable, the Energy Commission will encourage neighboring cities and counties to submit regional consortium applications. However, the terms and agreements of grant applications will be made with individual cities and counties.

The Energy Commission will place an emphasis on awarding funds to grant proposals that address multiple technologies and leverage existing efforts such as the CCPDA Model Solar PV

113 Barker, Kevin, Jim Bartridge, Heather Raitt. 2011. *Developing Renewable Generation on State Property*, California Energy Commission. Publication number: CEC-150-2011-001.

114 Public Resources Code Section 25619 states: "The commission shall provide up to seven million dollars ($7,000,000) in grants to qualified counties for the development or revision of rules and policies, including, but not limited to, general plan elements, zoning ordinances, and a natural community conservation plan as a plan participant, that facilitate the development of eligible renewable energy resources, and their associated electric transmission facilities, and the processing of permits for eligible renewable energy resources."

Ordinance and OPR's Solar Permitting Guidebook. The Energy Commission will give preference to applicants who demonstrate innovative strategies to achieve land conservation, such as preserving productive farmland and protecting land with high biological value.[115] Also, the Energy Commission will consider grant proposals that provide regulatory assistance to coordinate permitting activities related to renewable energy projects on state lands.

The Energy Commission will ensure that EPIC investments do not duplicate existing efforts, such as the United States Department of Energy (U.S. DOE) SunShot Initiative, and other public investments to upgrade regulatory frameworks at the local government level. To maximize ratepayer return on investment, the Energy Commission will establish a preference for regional grant proposals that take advantage of economies of scale and create regional standardization. To ensure that ratepayer investments awarded to grant recipients return benefits to ratepayers, the Energy Commission will require grant applicants to quantify ratepayer benefits in grant applications and during grant monitoring.

Stakeholders: Ratepayers who will be purchasing clean energy technologies, local governments, environmental organizations, agricultural organizations, and developers of clean energy technologies.

Background: The state has taken little action to invest in upgrading local comprehensive plans that facilitate clean energy development. Regulatory assistance and permit streamlining is needed to ensure that local governments are prepared and informed on how best to facilitate market adoption of clean energy technologies.

Through its Planning Grants Program, the Strategic Growth Council (SGC) invests in local and regional comprehensive planning. The Planning Grants Program awards Proposition 84 funding on a competitive basis to cities, counties, and regional governments that propose planning projects that will result in sustainable community plans and natural resource conservation. However, these projects do not usually focus on clean energy. Most of the funding for SGC's Planning Grants Program has been awarded.[116]

In the current environment of limited public resources, local government budgets are constrained and must be prioritized to deliver services that meet the basic needs of their communities. Typically, planning is not considered a service that meets basic needs, and in resource constrained communities planning becomes an afterthought. Nevertheless, several stakeholders recognize the importance of modernizing local government planning and

115 See comments received following the September 27, 2012 public workshop from Defenders of Wildlife and Sierra Club (TN# 67458); California Farm Bureau Federation (TN# 67486); Distributed Wind Energy Association (TN# 67456); Solar Energy Industries Association, Vote Solar Initiative, and California Building Industries Association (TN# 67500).

116 For more information on SGC's Planning Grants Program: http://www.sgc.ca.gov/planning_grants.html.

permitting for clean energy technologies and, given limited financial alternatives at the local level, recommend using EPIC to fund this initiative.[117] Ratepayer-funded grants to fill voids in local government budgets for clean energy planning and permitting will advance the development of a clean energy electric grid that returns greater benefits to ratepayers.

S16.3 Proposed Funding Initiative: Conduct a Local Government Needs Assessment Study that Identifies Regulatory Gaps Within Local Planning and Zoning Processes.

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
X		X	X	X	X	X	

Issue: To date there have been only limited efforts to understand planning and zoning gaps for renewable technologies at the local level. These efforts have focused mostly on distributed solar PV, though local governments have authority over a wide range of clean energy technologies. As EPIC begins to invest in innovative strategies to streamline deployment of clean energy technologies, the program administrators will need to collect updated local government planning and zoning information. This updated information will assist the program administrators with designing future EPIC investment initiatives as well as measuring benefits to ensure efficient use of EPIC ratepayer funds.

Purpose: This initiative will review existing planning and zoning documents to assess the current regulatory environment at the local government level and track changes in specific planning and zoning gaps that impede clean energy deployment. The Energy Commission will use findings to track EPIC investment performance and to inform and revise scope and eligibility criteria of future grants and award programs through EPIC. The Energy Commission and OPR will coordinate with state and local regulators to identify regulatory barriers that prevent or delay implementation of clean energy projects. The assessment will focus on local governments that are within IOU service territories.

Through a competitive request for proposal process, this initiative will select an entity that can assess the current planning and zoning policy environment governing clean energy technologies at the city and county level. The chosen entity will provide an assessment that identifies planning and zoning gaps for each clean energy technology in cities and counties that include IOU service territories. Identified gaps will serve as the basis for prioritizing public funds targeted to local government in future EPIC funding opportunities. On a regular basis,

117 See comments received following the September 27, 2012 public workshop from Defenders of Wildlife and Sierra Club (TN# 67458); California Farm Bureau Federation (TN# 67486); Center for Energy Efficiency and Renewable Technologies (TN# 67469).

this work will update the analysis of planning and zoning gaps. This will contribute to an ongoing assessment of program performance and benefits to ratepayers. This work will also generate independent recommendations on regulatory assistance program design and investment strategies.

Stakeholders: Environmental groups, utilities, local government, clean transportation industry, agricultural organizations, and developers of clean energy technologies.

Background: Energy Commission staff is aware of some efforts being taken to assess the clean energy regulatory environment. Current assessments are limited to distributed solar PV, and include:

- In May 2012, the California County Planning Directors Association (CCPDA) presented responses to the Energy Commission from a survey of 22 county planning directors.[118] Of the 22 responses, only one county has developed a renewable energy overlay zone, though most expressed a need to develop overlay zones. Over 98 percent of the responses expressed a need for public funds to complete overlay zones.
- OPR's 2012 annual planning survey (previously known as the Planners' Book of Lists) is an important assessment of local planning policy within California. In the last few years, OPR has included assessments of energy and clean energy planning at the local level, mostly related to distributed solar and wind energy. In 2012, OPR received responses from 87 percent of local governments and found that nearly 65 percent "of jurisdictions do not have policies, programs, or ordinances that facilitate the development of renewable energy facilities."
- U.S. DOE funds SolarTech's Solar 3.0 program, which is a process innovation initiative to standardize the regulatory environment of distributed solar PV to reduce nonhardware costs. Solar 3.0 ranks 753 cities across the United States according to their "solar market readiness." Solar 3.0's survey is voluntary and uses ranking criteria such as population, solar insolation, electricity prices and other economic indicators. To date, Solar 3.0 ranks 490 California cities, 79 of which are in the top 200 cities in the United States.[119]

An up-to-date assessment of all technologies in the EPIC clean energy value chain is needed to inform the Energy Commission of priority investment areas.[120]

118 http://energy.ca.gov/2012_energypolicy/documents/2012-05-10_workshop/presentations/Snellings_Tim_CCPDA_05-10-12.pdf

119 http://solar30.org/communities/baseline-comparison/

120 This issue was discussed during the Energy Commission's August 2-3, 2012, workshop in Sacramento, CA, and also in the August 9-10, 2012, workshop in Los Angeles, CA.

S16.4 Proposed Funding Initiative: Collaborate with Local Jurisdictions and Industry Stakeholders to Create Model Ordinances for Emerging Clean Energy Technologies

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
X		X	X	X	X	X	X

Issue: As new clean energy technologies become commercially-viable, local governments will need ordinances in place that accommodate the incorporation of such technologies within their communities.

Purpose: Through a competitive request for proposal process, this initiative will help local governments establish the appropriate ordinances in advance of new technologies becoming fully deployable in markets. These efforts will serve to mitigate any issues that may result from the delayed adoption of ordinances related to the planning and permitting of clean energy technologies.

Stakeholders: Ratepayers who will be purchasing clean energy technologies, environmental groups, utilities, local government, agricultural organizations, and developers of clean energy technologies.

Background: Commercialized technologies, like distributed solar PV are receiving investment to create best practices and model standards to regulate solar PV at the local level. In California, these investments include two collaborative stakeholder practices driven by the California County Planning Directors Association (CCPDA) and the Governor's Office of Planning and Research (OPR).[121] At the federal level, U.S. DOE sponsored the Solar America Board for Codes and Standards (Solar ABCs) to provide information to local permitting agencies on best practices for permitting small solar PV systems.[122] Additionally, some trade groups, including the Distributed Wind Energy Association (DWEA), have created model practices for permitting small scale wind energy systems; though as DWEA indicates there is significant opportunity to improve these resources and institutionalize these model practices.[123]

121 CCPDA developed a model ordinance, which includes a streamlined tiered permitting process for solar PV facilities developed on 30 acres and less. http://www.ccpda.org/solar
OPR developed a permitting guide for small solar PV systems, adapting principles from the Solar ABC's with common interpretations of state code regulating small solar PV installations.
http://opr.ca.gov/docs/California_Solar_Permitting_Guidebook.pdf
122 http://www.solarabcs.org/
123 See comments received following the September 27, 2012 public workshop from the Distributed Wind Energy Association (TN# 67456).

The U.S. DOE is also challenging local agencies to improve solar PV permitting standards at regional scales by funding the Rooftop Solar Challenge.[124] Existing investments to develop resources for local governments regulating distributed solar PV are helping fully commercialize solar PV technologies and do not require further public investment in developing resources and information. However, local governments need additional information to prepare for the portfolio of other clean energy technologies, including current pre-commercial clean energy technologies. For example, pre-commercial anaerobic digestion bioenergy and utility-scale nonthermal power systems will depend on local regulatory agencies for permitting.

S16.5 Proposed Funding Initiative: Provide Funding to Assist in the Development of the General Plan Guidelines.

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X			X	X	X	X	

Issue: The regulatory environment governing clean energy development differs greatly across markets and develops at different rates across jurisdictions. Cities and counties are at the forefront of facilitating clean energy deployment, yet many do not recognize clean energy technologies in their comprehensive plan. With varying and often absent development standards, developers and local governments are uncertain how to develop clean energy projects. Development uncertainty adds costs for developers and can increase development impacts on communities. Some clean energy investments provide resources to cities and counties to update comprehensive plans, help minimize development risks, and mitigate development impacts. However, cities and counties lack traditional and authoritative guidance for including clean energy in the comprehensive planning process.

Purpose: For this initiative, the Energy Commission would hold a competitive request for proposal process to select a contractor to work with OPR. The contractor will work with OPR to include clean energy technologies in the general plan guidelines and ensure local governments have the tools to implement the guidelines in IOU territories.

Stakeholders: Environmental groups, utilities, local government, agricultural organizations, and developers of clean energy technologies.

Background: The current General Plan Guidelines need to be updated to reflect plans for significant deployment of clean energy technologies in IOU service territories.

124 http://www.eere.energy.gov/solarchallenge/

Government Code Section 65040.2 directs OPR to adopt and periodically revise guidelines for the preparation and content of local general plans. The last update was in 2003. OPR is revising the guidelines to include issues and guidance for renewable energy and other sustainable strategies related to energy. Cities and counties use the guidelines prepared by OPR to update their own comprehensive planning. OPR is also contemplating the development of a web-based tool to assist cities and counties with updating local comprehensive plans.[125]

In 2012, the California County Planning Directors Association (CCPDA) completed a model ordinance, which includes a streamlined tiered permitting process for solar PV facilities developed on 30 acres or less. While the CCPDA model ordinance provides the type of policy guidance that local governments depend on for clean energy, it only applies to solar PV generators that are roughly 7 MW or less. The General Plan Guidelines should include regulatory policies for all clean energy technologies. This initiative will provide planning information specific to projects interconnecting in IOU service territories.

S16.6 Proposed Funding Initiative: Develop Consensus Based Educational Materials for Local Officials Interested in Facilitating Clean Energy Market Growth.

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	**Workforce Development**	**Program Tracking**	**Market Research**	**Grid Operations/ Market Design**	**Generation**	**Transmission / Distribution**	**Demand – side Management**
X			**X**	**X**	**X**	**X**	

Issue: Through their land-use powers, local governments have regulatory authority over the development of most clean energy technologies. Most local governments in California are resource constrained and have little experience with planning for the land use impacts of emerging clean energy technologies. This can impede deployment of clean energy technologies in the latter stages of the technology maturation curve.

Purpose: This initiative will develop and disseminate clean energy planning and permitting information for local governments in IOU service territories. The Energy Commission will partner with the Institute for Local Government (ILG) to select an awardee via competitive solicitation to construct a suite of planning and permitting resources for projects interconnecting in IOU service territories. The resources will be promoted through ILG. For example, the resources developed by the awardee could be promoted through expanding ILG's Beacon Award to recognize local governments that display a commitment to fostering the deployment of clean energy technologies. [126]

125 http://opr.ca.gov/docs/GPG_2013_One_Pager.pdf

126 The Beacon Award: Local Leadership Toward Solving Climate Change, sponsored by the Institute for Local Government and the Statewide Energy Efficiency Collaborative, is a statewide program

This initiative will complement ILG's ongoing efforts to provide local governments with information related to sustainable planning initiatives that require local government implementation.

Developing the clean energy informational resources will require participation from a wide variety of stakeholders, including but not limited to, local governments, state agencies, clean energy developers, and clean energy trade associations. Through a collaborative process, driven by ILG, the awardee will work with these stakeholders to develop planning and permitting resources for a portfolio of clean energy technologies, focusing on interconnection processes in IOU service territories. Once developed, ILG will use their existing outreach efforts to make this clean energy planning and permitting information available.

Information dissemination to local governments for the planning and permitting of clean energy technologies is important to ensure that clean energy technologies achieve market potential. Providing local governments with planning and permitting information, including best practices, related to pre-commercial clean energy technologies helps ensure that local governments can balance community impacts and clean energy deployment without placing over-burdensome regulations on the clean energy industry.

The Energy Commission recognizes that this initiative is similar to initiatives S16.4 and S16.5, yet there are distinct differences between these initiatives. Initiative S16.4 focuses on developing model regulatory codes for permitting clean energy technologies. Initiative S16.5 supports developing state general plan guidelines, which will provide policy guidelines for renewable energy. Initiative S16.6 invests in strategies that facilitate a transition at the local government level for incorporating products developed under S16.4 and S16.5.

Stakeholders: Ratepayers who will be purchasing clean energy technologies, environmental groups, utilities, local government, agricultural organizations, and developers of clean energy technologies.

Background: Commercialized technologies, like distributed solar PV are receiving investment to create best practices and model standards to regulate PV at the local level. In California, these investments include two collaborative stakeholder practices driven by the California County Planning Directors Association (CCPDA) and the Governor's Office of Planning and Research (OPR).[127] At the federal level, U.S. DOE sponsored the Solar America Board for Codes and

recognizing California cities and counties that are working to reduce greenhouse gas emissions, save energy and adopt policies and programs that promote sustainability. For more information see Beacon Award resources from ILG: http://www.ca-ilg.org/BeaconAward.

127 CCPDA developed a model ordinance, which includes a streamlined tiered permitting process for solar PV facilities developed on 30 acres and less. http://www.ccpda.org/solar.

Standards (Solar ABCs) to provide information to local permitting agencies on best practices for permitting small solar PV systems.[128] The U.S. DOE is also challenging local agencies to improve solar PV permitting standards at regional scales by funding the Rooftop Solar Challenge.[129]

Existing investments to develop resources for local governments regulating distributed solar PV are helping to commercialize solar PV technologies and do not require further public investment in developing resources and information. However, local governments need additional information to help prepare the way for the portfolio of pre-commercial clean energy technologies moving through the energy innovation pipeline.

Developing and disseminating clean energy information related to local planning and zoning is part of the Energy Commission's larger strategy to invest EPIC funding on initiatives that help facilitate market growth of clean energy investments.

S17 Strategic Objective: Strengthen the Clean Energy Workforce by Creating Tools and Resources that Connect the Clean Energy Industry to the Labor Market

Table 27: Ratepayer Benefits Summary for Strategic Objective 17

	Promoter Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S17.1 Provide Grants to Develop and Enhance Training and Apprenticeship Programs to Support Clean Energy Deployment Programs in IOU Service Territories	X	X	X	X			X	X	X

Developing a well-trained clean energy workforce will increase the quality of clean energy infrastructure. The clean energy industry currently lacks sufficient tools and resources to align workforce training with labor demand. EPIC addresses this issue by prioritizing activities to

OPR developed a permitting guide for small solar PV systems, adapting principles from the Solar ABC's with common interpretations of state code regulating small solar PV installations. http://opr.ca.gov/docs/California_Solar_Permitting_Guidebook.pdf.

128 http://www.solarabcs.org/ .

129 http://www.eere.energy.gov/solarchallenge/ .

assist in bridging the gaps between job seekers and employers. This activity will provide grants to develop and enhance training and apprenticeship programs.

S17.1 Proposed Funding Initiative: Provide Grants for to Develop and Enhance Training and Apprenticeship Programs to Support Clean Energy Deployment Programs in IOU Service Territories

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
	X			X	X	X	X

Issue: As the U.S. economy recovers, the housing market improves, and labor demand increases, the rapidly growing clean energy industry will expand. The presence of a quickly deployable and well-trained workforce will be instrumental in furthering California's clean energy goals. This initiative will help ensure that there is a continual feed into the clean energy workforce, with trained job seekers available to meet future labor demand. In the past there have been numerous efforts throughout the state to provide training to the displaced workforce, but the number of trained workers exceeded jobs available in the emerging clean energy technology sector.

Purpose: In partnership with Division of Apprenticeship Standards (DAS), its registered apprenticeship program sponsors, other state agencies, labor organizations, and industry partners, this initiative will provide competitive grant funding to support new clean energy curriculum development, train-the-trainer initiatives, and appropriate certifications for energy-related apprenticeships. Certifications will assist employers in easily identifying desirable skill sets for employees. This initiative will focus on apprenticeships for communities in California's IOU service territories.

The Energy Commission will seek input from California Workforce Investment Board, Employment Training Panel, Green Collar Jobs Council, California Community Colleges Chancellor's Office, clean energy industries, labor unions, and other stakeholders. The Energy Commission recognizes the importance of collaborating with other parties to ensure that apprenticeship certifications reflect industry needs.

Several parties expressed general support for workforce development activities; some also identified specific target audiences for such efforts (for example veterans, students, and disadvantaged community members).[130] The Energy Commission will encourage applicants seeking to establish programs for targeted audiences to apply for funding.

130 The Energy Commission received written comments in support of workforce development efforts on the behalf of the following parties: Division of Apprenticeship Standards, UC Berkeley, Donald Vial

Stakeholders: Ratepayers pursuing clean energy technology training and job opportunities, California workforce agencies, utilities, state universities, community colleges, community organizations, and developers of clean energy technologies.

Background: This initiative will build on lessons learned from previous training programs, including:

- The California Clean Energy Workforce Training Program, funded through the American Recovery and Reinvestment Act (ARRA), provided grants to community college districts, counties, and cities.
- The Clean Energy Workforce Training Program (CEWTP), provided millions of dollars to support workforce training programs at community colleges, workforce investment boards and partnership academies in high schools throughout California. The CEWTP was designed to target unemployed workers, especially those from the construction sector, low wage-workers and those preparing to enter the workforce for jobs in energy efficiency, water efficiency, renewable energy and clean transportation. The program was funded through a combination of money from the federal American Recovery and Reinvestment Act (ARRA), public-private partnerships, and state and local programs. During the development of the CEWTP, and throughout the grant process, the Energy Commission created partnerships with numerous workforce entities. Although the CEWTP program is winding down, these partnerships are still in place and will provide a benefit as we move forward with this initiative.
- The Los Angeles Trade Technical College Clean Energy Pre-Apprenticeship (CEPA) Program. This is a partnership between Los Angeles area community colleges, Workforce Investment Boards, and employers.
- The Kern, Inyo, Mono Consortium Green Building Pre-Apprenticeship Program is a similar effort.[131]

Other efforts to advance clean energy jobs may be in place. In the event that a grant applicant is requesting funds to enhance their current program, the applicant will be required to provide a detailed description of what the supplement funds will be used for, and how such additions will improve the program.

Center on the Green Economy, La Cooperativa Campesina California, Department of Veteran Affairs, California Community Colleges Chancellor's Office, Larry McLaughlin of College of the Desert, California Conservation Corps, Taft College, California Construction Industry Labor Management Cooperation Trust, FORMA, Los Angeles California Conservation Corps, and Sacramento Regional Conservation Corps.

131 See http://www.energy.ca.gov/cleanenergyjobs/pre_LAtrade.html and http://www.energy.ca.gov/cleanenergyjobs/pre_kern.html for more information on the CEPA program and the Kern, Inyo, Mono Consortium Green Building Pre-Apprenticeship Program.

By working closely with industry and existing apprenticeship programs, this initiative will help workers update their skill set to better match the opportunities created by emerging clean energy technologies.

S18 Strategic Objective: Guide EPIC Investments through Effective Market Assessment, Program Evaluation, and Stakeholder Outreach.

Table 28: Ratepayer Benefits Summary for Strategic Objective 18

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S18.1 Create a Web Portal that Connects Innovators, Investors, Educators, Job Seekers, and Policy Makers to Facilitate Wide-Spread Adoption of New Clean Energy Technologies within Communities Statewide.	x	x	x	x	x		x	x	x
S18.2 Conduct Technology Forums to Connect Innovators of Clean Energy Technologies with Potential Investors, Customers, Job Seekers, and Policymakers	x	x	x	x	x	x	x	x	x
S18.3 Conduct Technology and Environmental Assessments to Track Progress in the Clean Energy Industry and Identify Future Needs	x	x	x	x	x	x	x	x	x
S18.4 Conduct the California End-use Energy Consumption and Saturation Characterization Survey		x		x				x	x
S18.5 Conduct Market Analysis of Innovative Strategies to Facilitate Clean Energy Storage, Demand Response, Electric Vehicles, and Renewable Energy	x	x	x	x	x	x	x	x	x
S18.6 Conduct Project and Program Evaluation	x	x		x	x			x	x

EPIC should track progress in key aspects of the clean energy industry to ensure that investments and policies to promote the advancement of emerging technologies in the industry. This strategy broadly covers the program tracking and market research elements of EPIC, while

connecting all of the stakeholders involved at various points along the technology innovation pipeline.

Including these initiatives in EPIC will benefit ratepayers by streamlining the integration of new clean energy technologies. This will ultimately be realized as ratepayer benefits in the form of decreased costs to consumers, improved energy infrastructure, and increased deployment of clean energy technologies (which will in turn lower GHG emissions and bolster economic development). Tracking the progress of new products as they flow through the energy innovation pipeline will also assist the Energy Commission in working with local jurisdictions to project the timeline and resource need for developing ordinances catered to the upcoming technologies.

S18.1 Proposed Funding Initiative: Create a Web Portal That Connects Innovators, Investors, Educators, Job Seekers, and Policy Makers to Facilitate Wide Spread Adoption of New Clean Energy Technologies Within Communities Statewide.

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission/ Distribution	Demand –side Management
X	X	X	X	X	X	X	

Issue: There are no existing efforts that comprehensively guide emerging clean energy technologies through the energy innovation pipeline and into full commercialization. The web portal will strengthen the clean energy industry by bringing together information on EPIC project results for emerging technology innovators, educators, policy makers, and local governments.[132]

The web portal will contain information that will make it possible to monitor industry progress, paying particular attention to financing/investment opportunities. Information gathered through this web portal will track progress of EPIC-funded technologies and strategies as they move through the energy innovation pipeline.

132 This issue was discussed during the Energy Commission's August 2-3, 2012, workshop in Sacramento, CA, and in the August 9-10, 2012, workshop in Los Angeles. Many panelists and stakeholders participating in these workshops expressed interest in using EPIC funds to develop a workforce clearinghouse. Energy Commission staff have expanded this concept to incorporate several other elements of the EPIC that were discussed during the workshops and/or in written comments.

Purpose: The objective of the web portal is to build on the successful partnerships the Energy Commission has developed with other California state agencies, IOUs, renewable energy associations, building trade unions, community colleges, state universities, workforce development providers, regulators, clean energy industry, and local governments to ensure that EPIC targets industry needs and opportunities.

The Energy Commission will hold a competitive solicitation for development of a web portal that may include information relating to the following areas:

- **Workforce Development and Education**: A repository on clean energy technology training programs, apprenticeship programs, best practices and models for clean energy training programs, and course syllabi and curricula. This section of the web portal will provide links to workforce agencies and IOU Energy Training Centers.
- **Market Research**: Compile and disseminate EPIC-funded project information.
- **Communication**: Contain a social media function to engage industry stakeholders and interested parties in the progress of EPIC-funded projects.
- **Information Dissemination:** Provide information specific to innovators, investors, and local governments that would assist in further developing emerging technologies. Some examples include:
    - For innovators:
        - Warranty development: assisting small companies with developing appropriate warranties.
        - Certifications: education and outreach on required/suggested certifications or safety listings for particular technologies.
        - Provide small businesses information on intellectual property and how to protect their innovations.
        - List of showcase sites: Provide a listing of potential demonstration sites to connect innovators with potential host sites.
        - List of innovation clusters to connect innovators with others in their region.
        - List of investors participating in clean energy space that may be interested in funding new technologies.
    - For Investors:
        - List of businesses looking for venture capital investments (include business name and clean energy technology).
        - Information on emerging clean technology breakthroughs/new products developed.
        - List of research grants.
    - For Local Government:

  - Model ordinances and permitting guides.
  - Opportunities for available funding.

- **Emerging Technology Tracker**: Allow stakeholders to track the progress of emerging clean energy technologies via a searchable database of EPIC projects. This will help agencies and researchers avoid duplication of activities and allow them to tap into on-going efforts, rather than wait for project conclusions and final reports. This will also assist local governments and jurisdictions with developing appropriate ordinances in advance of new technologies becoming fully deployable in markets. In addition, this will assist educators with developing new curriculum to prepare the workforce for new opportunities. Finally, monitoring the status and progress of the industry will enable the Energy Commission to continually improve the effectiveness of EPIC programs and projects.

Stakeholders: Ratepayers pursuing clean energy technology training and job opportunities, California workforce agencies, utilities, state universities, community colleges, community organizations, and developers of clean energy technologies.

Background: Commercialized technologies, like distributed solar PV are receiving investment to create best practices and model standards to regulate solar PV at the local level. In California, these investments include two collaborative stakeholder practices driven by the California County Planning Directors Association (CCPDA) and the Governor's Office of Planning and Research (OPR).[133] At the federal level, U.S. DOE sponsored the Solar America Board for Codes and Standards (Solar ABCs) to provide information to local permitting agencies on best practices for permitting small solar PV systems.[134] The U.S. DOE is also challenging local agencies to improve solar PV permitting standards at regional scales by funding the Rooftop Solar Challenge.[135] Existing investments to develop resources for local governments regulating distributed solar PV are helping fully commercialize solar PV technologies and do not require further public investment in developing resources and information. However, local governments need additional information to help prepare for the portfolio of pre-commercial clean energy technologies moving through the energy innovation pipeline.

133 CCPDA developed a model ordinance, which includes a streamlined tiered permitting process for solar PV facilities developed on 30 acres and less. http://www.ccpda.org/solar. OPR developed a permitting guide for small solar PV systems, adapting principles from the Solar ABC's with common interpretations of state code regulating small solar PV installations. http://opr.ca.gov/docs/California_Solar_Permitting_Guidebook.pdf.
134 http://www.solarabcs.org/.
135 http://www.eere.energy.gov/solarchallenge/.

S18.2 Proposed Funding Initiative: Conduct Technology Forums to Connect Innovators of Clean Energy Technologies with Potential Investors, Customers, Job Seekers, and Policymakers

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
X	X	X	X		X		X

Issue: Without coordination across clean energy stakeholder groups, new technologies face significant barriers at several steps on the path to market entry and full commercialization. Innovators must find customers to purchase their product, investors who can provide funds to scale-up production to a commercial level, employees, and policymakers to support the technology and work to create accommodating laws and ordinances to facilitate integration of the technology on the local, state, and federal levels.

Purpose: Conducting technology forums encourages communication between the various stakeholder groups involved with the deployment and commercialization of new clean energy technologies and strategies will help innovators cross the technological and commercialization "valleys of death." Forums provide innovators with valuable face-to-face networking opportunities with other stakeholder groups. These forums will also function as a means for disseminating information and status updates about various EPIC projects to the public.

Stakeholders: Ratepayers looking for investment opportunities and developers of clean energy technologies.

Background: The interaction between stakeholder groups is vital to understanding all of the elements related to increasing the presence of clean energy technologies. Current process silos each of the elements into its own section, and few opportunities for collaboration exist. Dates of the forums will be available on the Clean Energy web portal, and distributed to the Energy Commission and EPIC listserves. As suggested by stakeholders, the Energy Commission will work with other parties to plan the forums so that different stakeholder groups can host and lead the discussions, selecting relevant topics. Forums will take place periodically throughout the state, and will feature varying discussion topics related to the clean energy industry.

S18.3 Proposed Funding Initiative: Conduct Technology and Environmental Assessments to Track Progress in the Clean Energy Industry and Identify Future Needs

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
X	X	X	X	X	X	X	X

Issue: As the state's electricity system evolves in response to changing market and policy drivers, critical information gaps will need to be addressed to guide future EPIC investments. Technology and environmental assessments will be needed to determine the status and costs of various clean energy technologies entering the marketplace, identify any unforeseen barriers or environmental issues related to the deployment of new products, and identify market sectors where new innovations are needed.

Purpose: This initiative will build upon the more detailed applied research roadmapping initiative S10.3: *Conduct Scenario Assessments and Gaps Analyses that will be used to Develop or Update Research Roadmaps.* By tracking the progress of emerging clean energy technologies and identifying potential environmental effects of emerging clean energy innovations, the Energy Commission will be better positioned to facilitate successful IOU market deployment of technologies. Moreover, the CPUC EPIC decision clearly identifies the need for metrics to evaluate the effectiveness of EPIC programs. Conducting technology status and cost assessments in addition to environmental assessments will help the Energy Commission measure the success of EPIC-funded projects by providing a basis for measuring improvement and growth within the industries. Information gathered through this process will inform the Energy Commission of opportunities for new strategies or investments to consider in EPIC Investment Plans for subsequent years.[136]

Stakeholders: Ratepayers who are measuring the direct benefits of the EPIC programs, utilities, and developers of clean energy technologies.

136 This issue was discussed during the Energy Commission's August 2-3, 2012, workshop in Sacramento, CA, and also in the August 9-10, 2012, workshop in Los Angeles. Panelists and stakeholders participating in these workshops were supportive of efforts to assess the current energy markets for various technologies. The Energy Commission also received written comments in support of similar activities from the following parties: UCLA; Michele Rodriguez; CCSE; Kristin Skierka of Energy Initiatives; California Wind Energy Association; Terra Gen Operating Company; Audubon California; and the Lawrence Berkeley National Laboratory.

Background: The U.S. DOE's Energy Efficiency and Renewable Energy department issues annual market reports for solar, wind, and fuel cell technologies.[137] This initiative would establish similar tracking reports for new and pre-commercial technologies, but should not duplicate existing efforts for commercialized technologies. Reports produced through this initiative would be available via the Clean Energy web portal.

S18.4 Proposed Funding Initiative: Conduct the California End-use Energy Consumption and Saturation Characterization Survey

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
			X	X	X	X	X

Issue: California's detailed end-use energy consumption and saturation data is outdated. This has multiple negative effects; it inhibits development of future reasonable and defensible demand forecasts, negatively influences CPUC long term procurement planning (LTPP) activities, obscures understanding of baseline California energy consumption, prevents strategic development and evaluation of efficiency programs, prevents quantification of efficiency and demand response (DR) reductions and policies, inhibits assessment of shifting demand growth impacts on transmission, and prevents regular energy demand trend measurements. And, most significantly in the EPIC context, it hampers solid and defensible information on the current end-use baseline, from which progress will be measured.

Purpose: The collection of detailed end-use data not only helps in development of standards, but more importantly it is used in evaluating how effective those standards have been in changing consumption patterns and lowering amounts of energy used. End-use surveys tell us who, when, where, why and how much California's residents, businesses, and industries use energy. There is no other substitute for gathering this information. End-use values are used to develop detailed demand energy demand forecasts, efficiency market potential studies, to efficiently develop focused energy related policies, and to aid in the development of standards.

The CPUC uses Energy Commission statewide demand forecasts in their LTPP activities. LTPP sets procurement directions for utilities and the forecast helps them set the amounts of various kinds of resources needed in keeping with the loading order; cost recovery and rates are set in General Rate Cases. Potential studies support the strategic development of efficiency programs. A representative characterization of end-uses facilitates monitoring, and development of metrics for monitoring of, EPIC activities through appropriate benchmarking. The California Independent System Operator (California ISO) supports transparent and adequate metrics

137 http://www.eere.energy.gov/topics/renewable_energy.html

conforming to the utility value chain model predicated upon detailed knowledge of energy consumption, technology adoption, and market potentials. California utilities' require this information for forecasting and planning activities.

Title 20 data collection requirements state that surveys for residential, commercial, and industrial sectors are to be performed every four years. Surveys are designed to fully characterize residential, commercial, and industrial sectors. Over the past two decades, surveys have been performed sporadically due to resource and participation constraints. However, in 2009 the Energy Commission funded a residential survey to capture end-use appliance saturations and energy consumption. The last commercial end-use survey performed was completed in 2006. Given significant changes in the market, the Energy Commission is currently exploring opportunities to fund a commercial survey in the near future.

Stakeholders: Ratepayers who are measuring the electric use of residents, businesses and industries, the California ISO, and the utilities.

Background: Prior surveys, successfully managed by Energy Commission staff, have led to important and widely referenced sources of data. Unfortunately, these surveys have not been regularly implemented due to the lack of funding. Historically these surveys were funded through CPUC energy efficiency funds. The Energy Commission was able to partially fund some survey activities through a Budget Change Proposal with contract funding, but this annual appropriation was removed in 2010-2011 given current resource constraints and budgetary issues.

CPUC evaluation measurement and verification (EM&V) program collects data but emphasizes specific technologies and is not intended to represent California energy demand. Consequently, the CPUC data collected does not provide the detail needed for forecasting. Additionally, CPUC funded activities typically do not include publicly owned utilities (POU) which need to be captured within any statewide survey. In the past, the Energy Commission or the publicly owned utilities have provided additional funding to collect data from their service territories. Energy Commission staff will either obtain additional funding for the POU territories or only survey the IOU territories.

These surveys will focus on appropriately characterizing markets, providing baseline energy usage data, and providing baseline technology saturation data. The intent of the survey is to characterize the most important Californian end-uses in enough detail to allow forecasting, policy effectiveness evaluation, and policy development.

Recent discussions with CPUC EM&V regarding funding have been unsuccessful because priorities for the 2010-2012 three-year funding cycle are already defined; the CPUC is conducting market tracking studies that are valuable for efficiency program development purposes, but not forecasting. The CPUC is currently defining research priorities for the 2013-2014 two-year Energy Efficiency EM&V funding cycle. The Energy Commission is collaborating with the CPUC on research priorities to leverage EPIC funding.

End-use surveys and the associated analytical work performed in the past continue to provide benefits to ratepayers by providing important data to ongoing analyses. Energy Commission staff continue to respond to data requests and provide data in published reports which are utilized for energy efficiency potential studies, end-use demand analyses, and energy policy development. One important function of the end-use data is to develop demand forecasts for the CPUC's LTPP activities. This ensures only needed resources are procured thereby directly benefiting ratepayers. The Energy Commission's ability to analyze and forecast energy demand is essential to its energy-monitoring functions. These monitoring functions serve as an early-warning system on whether trends are consistent with state policies, helping policy-makers maintain the long-term functioning and stability of the market. Data on energy consumption, load research and end-user characteristics are the building blocks of the Energy Commission's ability to provide this service.

Public Utilities Code Section 8360 sets out the state's policy to support the development of a smart grid. End-use survey and saturation study activities further smart grid development by providing data and analyses useful for strategic deployment of appliances and technologies. The survey activity will also aid with the identification of current appliance distributions and help identify where opportunities exist for further action. In addition to market opportunities, a statewide end-use demand and saturation characterization would assist with identification of barriers and issues with technology and service deployment within California.

S18.5 Proposed Funding Initiative: Conduct Market Analysis of Innovative Strategies to Facilitate Clean Energy Storage, Demand Response, Electric Vehicles, and Renewable Energy

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
			X	X	X	X	X

Issue: The California ISO, CPUC, and IOUs are in the process of identifying new tariffs, innovative strategies, and market design changes to advance the state's goals for clean energy, including strategies for clean energy storage,[138] DR,[139] and electric vehicles-to-grid implementation.[140] These strategies are intended to help integrate high penetrations of

138 For more information on the CPUC's energy storage proceeding: http://www.cpuc.ca.gov/PUC/energy/electric/storage.htm

139For more information on the California ISO's demand response initiative: http://www.caiso.com/1893/1893e350393b0.html

140For more information on CPUC activities related to electric vehicle charging infrastructure: http://www.cpuc.ca.gov/PUC/hottopics/1Energy/090814_ev.htm

renewable energy generation into California's electricity system.[141] Market analysis and behavioral research is needed to inform development of proposed strategies and identify gaps that could be addressed through additional innovative strategies for clean energy, or even more fundamental market design changes.[142]

Purpose: This funding initiative will provide competitive solicitations for clean energy market analysis. The purpose of the market analyses is to help identify and respond to gaps in assessments of the ratepayer price, cost, and impact of new tariffs and strategies to facilitate clean energy storage, DR, and renewable energy. The Energy Commission will work closely with the California ISO, CPUC, and IOUs to develop the scope for each competitive solicitation and identify the pathway for results to inform the development and deployment of new tariffs, innovative clean energy strategies, and market design changes.

Stakeholders: Ratepayers who are concerned with the impact of tariffs, California ISO, utilities, and the CPUC.

Background: In the past, the Energy Commission has conducted market analysis and behavioral research to inform development of tariffs and strategies to advance the utilization of DR in California's electricity system. Similar analysis for tariffs and strategies is currently under consideration.

In addition, analysis is needed to identify whether changing market conditions are creating a need to revise tariffs and market design elements to better capture emerging opportunities to facilitate clean energy strategies.

141For more information on recent activities related to renewable integration: http://www.energy.ca.gov/2012_energypolicy/documents/2012-04-12_workshop/comments/PGE_Comments_on_Evaluating_and_Capturing_the_Benefits_of_Renewable_Energy_for_California_2012-04-20_TN-64860.pdf

142 The Energy Commission received written comments in support of similar activities from the following parties: UC Davis, A Better Place, Coulumb Technologies, California ISO, CALSTART, and Grant Management Associates.

S18.6 Proposed Funding Initiative: Conduct Project and Program Evaluation

Market Facilitation				Electricity System Value Chain			
Regulatory Assistance/ Permit Streamlining	Workforce Development	Program Tracking	Market Research	Grid Operations/ Market Design	Generation	Transmission / Distribution	Demand – side Management
		X	X	X	X	X	X

Issue: Periodic evaluation of projects and program elements will provide the feedback necessary to maximize ratepayer benefits.

Purpose: This initiative will provide routine reviews and evaluations of individual research projects and the program elements improve program design and implementation, and to focus research on the highest value needs to maximize value to the end users.

The evaluation could include how the EPIC funded project affected, or is expected to affect, the market place or the policy environment (an example of policy environment is how local governments plan for clean technology). Performance indicators may be chosen and evaluated based on stated project goals and milestones. For example, an evaluation of success of a regulatory assistance and streamlining project could test to what extent local government planning process suggestions and model ordinances were developed, were well received, were applied, and reduced the time needed for clean technology projects to reach fruition. Impact evaluation results will affect the direction of later EPIC funded projects. Process evaluation may also be conducted to evaluated and improve contract development, selection, and management processes.

Stakeholders: EPIC program administrators, grant recipients, and ratepayers.

Background: Evaluation and verification are key monitors to help gauge the success of the program and make necessary adjustments to ensure compliance with the program's guiding principles. Once a contract is closed it is very difficult to track progress and path to market successes. Efforts to continue tracking and follow-up on closed out contracts will allow the Energy Commission to better understand how well the program is meeting its goals to, for example, reduce costs, understand the volume of market penetration, or remove barriers to further implementation of technologies or policy goals. This type of information will also enable the CPUC and ratepayers to understand and evaluate the value of the program.

CHAPTER 6: New Solar Homes Partnership

The New Solar Homes Partnership (NSHP) provides a one-time, upfront incentive for eligible solar projects. The incentive is an Expected Performance-Based Incentive that encourages quality installation of solar energy systems. There are two incentive structures, one for market rate housing and affordable housing common areas, and another for affordable housing residential projects. The market rate housing incentive structure is further broken down into two incentive levels: Tier 1 and Tier 2. The Tier 1 incentive is for buildings that exceed the energy efficiency requirements of the current Title 24 Building Standards by at least 15 percent. The Tier 2 incentive is for buildings that exceed the energy efficiency requirements of the current Title 24 Building Standards by at least 30 percent. The current incentives level for Tier 1 and Tier 2 market rate housing are $2.00 and $2.25 per watt respectively. The incentive level for affordable housing residential units is $2.90 per watt. The incentive levels are scheduled to drop as specified capacity target are reached. Additional detail on the incentive levels and their decline schedule can be found in Chapter 3 of the *New Solar Homes Partnership Guidebook*[143].

To be eligible for NSHP, an applicant must be an electric customer of Pacific Gas & Electric Company (PG&E), Southern California Edison Company (SCE), San Diego Gas and Electric Company (SDG&E), or Bear Valley Electric Service. The solar energy system must use new equipment, and major system components must be listed on the Senate Bill 1 Eligible Equipment Lists.[144] The solar energy system must serve new residential construction projects. The buildings in the project must exceed the energy efficiency requirements of the current Title 24 Building Standards by at least 15 percent. These eligibility criteria are described in Chapter 2 of the *New Solar Homes Partnership Guidebook*.

To prevent overpayment of funds and discourage oversized systems, the NSHP has funding limitations. Program incentives are limited to the first 7.5 kW of a system for residential units. In addition to the system size cap, affordable housing residential unit incentives are limited to no more than 75 percent of the total system cost and market-rate housing incentives are limited to no more than 50 percent of the total system cost. Applicants may not receive incentives from both the NSHP and another California Solar Initiative (CSI) program. If the applicant receives an incentive from another incentive program that is not part of CSI, then a minimum of 5 percent of that amount will be subtracted from the NSHP incentive amount. (*New Solar Homes Partnership Guidebook*)

143 http://www.energy.ca.gov/renewables/06-NSHP-1/documents/index.html

144 http://www.gosolarcalifornia.ca.gov/links/equipment_links.php

The *New Solar Homes Partnership Guidebook* lists additional eligibility criteria relating to energy efficiency, building foundation, transient housing, system equipment and installation, and lease and power purchase agreements.

Proposed Budget Allocation

The NSHP is currently underfunded. Although it was established by SB1 as a $400 million program under the CSI, the law did not create a vehicle for adequately funding the NSHP.[145] Instead, the law relied on moneys in the Renewable Resource Trust Fund (RRTF) that were allocated to the Energy Commission's Emerging Renewables Program, and supported by the public goods charge (PGC) collections under Public Utilities Code Section 399.8, to fund the NSHP.[146] These PGC collections ended on December 31, 2011. The sum of RRTF moneys allocated to the Emerging Renewables Program and NSHP through 2011 totals approximately $282 million. This is far short of the $400 million identified in SB1 for NSHP purposes alone, and does not take into consideration money borrowed from the RRTF to support the state's General Fund.

The CPUC EPIC Phase 2 Decision addresses funding for the NSHP. The decision references a February 10, 2012 CPUC staff proposal and states "Commission staff estimate that prior annual PGC collections were approximately $146 million, with an additional approximately $40 million per year or more being authorized in various proceedings allowing utility cost recovery for RD&D projects. $162 million, plus an anticipated approximately $25 million for the NSHP program, achieves the same approximate total as in the past. Should the Legislature not authorize additional EPIC funding for NSHP, the Commission may choose to reevaluate whether to increase the EPIC total budget, and for what purposes, in the future."[147] In order to fully fund the NSHP, the Energy Commission supports an increase to the EPIC total budget to collect $25 million annually for the NSHP, beginning in 2013, with up to ten percent of this total for administration. Such an increase would raise the EPIC total budget to be consistent with the combined level of funding provided through the PGC collections and the utilities' cost recovery RD&D projects prior to EPIC.

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145 Senate Bill 1 (Murray, Stats. 2006, Ch. 132, Sec. 7), as codified in former Public Utilities Code Section 2851 (e), provided in pertinent part "… The financial components of the California Solar Initiative shall consist of . . . (3) Programs for the installation of solar energy systems on new construction, administered by the State Energy Resources Conservation and Development Commission … and funded by nonbypassable charges in the amount of four hundred million dollars ($400,000,000), collected from customers of San Diego Gas and Electric Company, Southern California Edison Company, and Pacific Gas and Electric Company pursuant to Article 15 (commencing with Section 399)." Section 2851 (e) has subsequently been amended by Senate Bill 1018 (Stats. 2012, Ch. 39, Sec. 111).

146 Public Resources Code Section 25744.5

147 California Public Utilities Commission Phase 2 decision, p. 87.

Moneys borrowed from the RRTF for the state's General Fund are currently scheduled to be repaid over the next two years for use in the NSHP. These funds amount to approximately $95 million, with the majority due to be repaid by June 30, 2013. However, under a best case scenario where all loans are repaid, the NSHP will still fall $130 to $150 million short of its $400 million budget. Assuming the loans are repaid, EPIC funds may not be needed for the NSHP for several years. Funding for NSHP should be collected at a level of $25 million per year. If EPIC funds are not needed for the NSHP in any given year, due to repayments to the RRTF or lower than expected program demand, the funds should be retained by the investor-owned utilities (IOUs) and carried forward to future years. Based on comments from the building industry and solar retailers, NSHP activity is likely to exceed $25 million per year, especially in the later years of the program, and carrying forward these funds for use in later years would help meet the NSHP goals. This level of NSHP funding is consistent with the recommendations in the Phase 2 decision.[148]

The Energy Commission's annual EPIC reporting to the CPUC will include a recommendation on whether EPIC funds need to be transferred to fund the NSHP in a given year; the level of total funds that have been collected and made available for NSHP applications (combined PGC and EPIC funds); and the balance of funds still available for new reservations. A determination on the need to transfer EPIC funds to the NSHP and the amount expected to be transferred in any given year will be based on the annual update on NSHP. Further adjustments to the EPIC funding can be made, if necessary, to ensure total funding for NSHP does not exceed the $400 million total program budget.[149] The amount of EPIC funds necessary for administration of the NSHP will be identified in the state annual budget process, and will be no more than the 10 percent cap established in the Phase 2 decision. These funds should be transferred to the Energy Commission in the same manner as other administration funds.

Policy Justification

The NSHP follows the state's "loading order" which identifies an order for guiding energy decisions: electricity needs should first be addressed by increased energy efficiency and demand response, second by renewable resources, and third by clean fossil fuel generation. The NSHP requires that all projects exceed the energy efficiency requirements of the current Title 24 Building Standards by at least 15 percent. This decreases the customer's electricity demand and ensures properly sized systems. By encouraging the installation of residential solar systems, NSHP also supports the goals of Senate Bill 626 (Chapter 355, Statutes of 2009), Assembly Bill 32, and Executive Order S-3-05. SB 626 seeks to overcome barriers to the deployment and use of plug-in hybrid and electric vehicles. Although the peak for solar generation does not occur at night, which is when a plug-in vehicle is most likely to be charged, due to the net metering

148 California Public Utilities Commission Phase 2 decision, p. 57.

149 California Public Utilities Code Section 2851 (e)(3).

arrangements a customer can still use the solar energy system to offset the cost of charging a vehicle. Assembly Bill 32 and Executive Order S-3-05 seek to reduce greenhouse gas (GHG) emissions.

The Phase 2 decision recommended continued funding for the NSHP, but stated that NSHP could not be funded through EPIC without affecting the total SB 1 funding cap under Public Utilities Code Section 2851 (e). The decision agreed with continuing NSHP "...as a matter of policy, because it is a vital piece of the CSI program targeting builders of new homes." (p. 54) The decision also stated that NSHP supports the "…goal of construction of all zero net energy new homes in California by 2020" as identified in the 2008 *California Energy Efficiency Strategic Plan*. (p. 56) The decision urged the Legislature to amend existing law to either increase the total CSI funding cap or modify the funding source for the NSHP to allow the CPUC to fund the NSHP without reducing the budget for the CSI program. At the end of June 2012, the law was amended for this purpose by Senate Bill 1018 (Chapter 39, Statutes of 2012, Section 111), which modifies Public Utilities Code Section 2851 (e) and permits EPIC moneys to be used to fund the NSHP without affecting the total CSI funding cap.

The Energy Commission supports increasing the EPIC total budget to collect $25 million annually to fund NSHP. Since 2007, the NSHP has issued incentive reservations at an average rate of $24.8 million per year. In 2011, incentive reservations totaling $32 million were issued; as of September 2012, nearly $40 million in reservations was issued and there was roughly $10 million available for additional NSHP incentive reservations.

During the Energy Commission's EPIC workshop on August 2, 2012, the California Building Industry Association (CBIA) commented that the remaining NSHP funds are likely to be claimed quickly. CBIA indicated that many large new homebuilders are considering including solar as a standard in their new developments, but these plans are contingent on NSHP funding availability. A summary of stakeholder comments and responses is included in the appendix.

Staff also recommends keeping the program eligibility criteria and requirements as described in the NSHP guidebook. The NSHP was designed with input from an advisory committee consisting of key stakeholders, and the program guidebook has evolved over the past five years based on stakeholder feedback received at staff workshops. Stakeholders are now familiar with the program requirements and processes. To remove the NSHP guidebook and begin the development of new program rules halfway through the program would create stakeholder frustration and discourage program participation.

The NSHP provides many ratepayer and societal benefits. The NSHP supports self-generation of electricity, which reduces demand for electricity from the utility. Much of the demand reduction occurs during hours of peak demand. This benefits ratepayers in a number of ways. The reduced demand on the electric grid decreases the need for the IOUs to purchase electricity from nonrenewable sources. This lowers overall costs to ratepayers by reducing the need for additional infrastructure to be built and helps the utilities avoid the higher generation costs

from entering into costly contracts for reserve electricity supplies. This also reduces the GHG emissions that would be generated from nonrenewable sources.

Additional environmental and safety benefits come from increased grid stability, which reduces the potential for power outages that could affect critical health or emergency services.

The NSHP incentive reduces the system cost, thereby reducing the payback period and offering customers an affordable alternative to reduce their electric bills. In addition, the NSHP helps spur investment in solar energy in California, which provides economic benefits: according to a 2009 report by the Center for American Progress (*The Economic Benefits of Investing in Clean Energy*), every $1 million spent on solar creates 9.8 direct and indirect jobs.

The effectiveness of the NSHP can be evaluated not just by the number of installations funded but by the economic and environmental benefits it promotes. By requiring eligible projects be highly energy efficient new construction, applicants can incorporate solar energy systems into their home design before the home is built. This allows any location constraints to be addressed prior to the solar energy system installation, allowing for a properly sized system, and reducing overall project costs. NSHP also removes the financing barriers that often prevent homeowners and builders from installing solar energy systems. Builders receiving NSHP incentives for a development are often able to take advantage of economies of scale further driving down the final cost to the homeowner.

Energy Commission staff is developing an online tool called PV Check to allow customers to track the daily output of their solar energy system and make sure it is working as expected. The NSHP will use this information to help fulfill auditing requirements. Another Energy Commission online tool already in use is the Solar Advantage Value Estimator (SAVE) calculator. The SAVE calculator educates contractors, realtors, appraisers, and lenders on the potential value of a solar energy system by calculating the added value of a solar energy system for a new or existing building.

The U.S. DOE's SunShot Initiative aims to decrease the total costs of solar energy systems. A decrease in total system costs will remove some of the financial barriers that potential applicants face and increase program participation. With system costs expected to decrease and participation from the programs mentioned above expected to increase, NSHP will take steps to ensure that the provided incentives do not exceed the total system costs.

NSHP currently collects information on equipment costs, installation costs, and permitting costs. Much of the data collected to date is shared with various research groups and is available to the public through the NSHP online application tool. This information can be used to monitor trends in system costs and help identify the distinct cost components that may be preventing total system prices from decreasing. This information can also be used by Energy Commission staff in coordination with data from other programs such as the CSI's average

system cost caps to develop strategies to ensure that the NSHP incentive levels are set appropriately.

The NSHP's energy efficiency requirements complement the energy efficiency requirements of the IOUs' California Advanced Homes Programs, which offer energy efficiency incentives for new residential construction. The synergy between the two programs allows for some streamlining in the NSHP, reducing administrative costs.

Public Utilities Code Section 740.1 identifies the following principles to be used in evaluating programs: provides reasonable probability of providing benefits to ratepayers, consistent with the resource plan, nonduplicative of other efforts, support environmental improvement, public and employee safety, conservation by efficient resource use or reducing or shifting system load, development of new resources and processes, and improve operating efficiency and reliability. Public Utilities Code Section 8360 seeks to modernize the state's electrical transmission and distribution system to maintain safe, reliable, efficient, and secure electrical service.

The NSHP program addresses the principles in the Public Utilities Code Sections 740.1 and 8360 by providing market support and promoting the purchase and installation of solar energy systems, and encouraging the development and improvement of new and existing solar technologies. The NSHP is the only program in IOU service territories that provides incentives for installing solar photovoltaic systems on new residential construction. The incentives do not cover the full system costs, maximizing the use of ratepayer funds and ensuring that funds are spent efficiently. The incentive offsets solar energy system costs, making solar energy systems cost-competitive with conventional forms of electricity and affordable for more consumers.

Funding for the NSHP through public goods charge collections is continuously appropriated, allowing funds released from prior incentive reservation to be used for new applications, regardless of the amount of elapsed time. However, EPIC-funded NSHP projects will be limited to a one-year encumbrance period and a two-year liquidation period unless the legislature takes action to provide a longer or continuous appropriation period. This means that the maximum reservation period for incentives under the NSHP will need to be shortened from three years to two years or less. In addition, funds released from a prior incentive reservation will not be returned for use by the NSHP unless re-authorized by the Legislature.

Based on historical activity and industry comments, funds currently available for the NSHP (as of October 2012) are expected to be reserved in the near future. The Energy Commission strongly supports the collection of additional funds though EPIC to support the NSHP. However, because no funds are currently being collected for the NSHP and the CPUC is not scheduled to adopt the EPIC investment plans until May 2013, it may be necessary for the CPUC to expedite the collection of these additional EPIC funds, if so approved, to ensure the NSHP is not adversely affected by a funding gap.

CHAPTER 7: Program Administration

This chapter discusses the procedures and processes the Energy Commission will follow for selecting and funding projects and programs, managing the funded projects and programs, and conducting program outreach efforts. The chapter starts with a discussion of how stakeholders can participate then continues with a discussion of how projects will be selected and awarded. The award process section covers the types of funding mechanisms that will be used, eligibility criteria, and funding limitations. The project management section discusses oversight and monitoring of funded projects to ensure they meet their stated objectives. The chapter concludes with an overview of outreach strategies that will be used to disseminate results and the Energy Commission's approach to intellectual property within the Electric Program Investment Charge (EPIC) program framework.

Stakeholder Participation

Investment Plan Development

The Energy Commission held the first stakeholder workshops on August 2-3, 2012, in Northern California and on August 9-10, 2012, in Southern California. The purpose of the workshops was to gain stakeholder input prior to the development of the draft Investment Plan. A third workshop was held on September 27, 2012 to provide an overview and solicit public comment on the draft Investment Plan.

Public comments received as a result of the workshops are summarized in the appendix.

The Energy Commission has created a website (http://energy.ca.gov/research/epic/) that provides information and activities associated with EPIC funding, including information on past workshops, public comments, upcoming events, how to sign up for the list serve (http://www.energy.ca.gov/research/epic/), and all the latest documents associated with the program.

Investment Plan Implementation

Energy Commission staff will hold public meetings in order for any interested individuals or entities (stakeholders) to provide input on the implementation of the investment plan, including seeking advice on project implementation, identifying synergy with other projects, solicit end-user needs and path to market opportunities, and facilitate a faster and more effective sharing of program results. These informal stakeholder meetings will not create a formal decision-making body and will not usurp the California Public Utilities Commission (CPUC) authority. They will, however, serve to provide transparency and accountability for investments, coordinate research to avoid duplication, seek opportunities to leverage funds, and ensure research is targeting ratepayer benefits. The stakeholder meetings will be conducted in a public

forum at least twice each year to provide program updates and gain valuable insight on progress and direction.

The Energy Commission will target, at a minimum, the following stakeholders for participation:

- Members of the Legislature, to the extent their participation is not incompatible with their legislative positions.
- Government, including state and local agency representatives.
- Utilities.
- Investors in energy technologies.
- California Independent System Operator (California ISO).
- Consumer groups.
- Environmental organizations.
- Agricultural organizations.
- Academics.
- Business community.
- Energy efficiency community.
- Clean energy industry and/or associations.
- Other industry associations.

Members of the public will be invited to participate in these meetings.

Annual Reporting Requirements

The Energy Commission will submit annual reports to the CPUC by February of each year beginning in 2014. As articulated in the CPUC Phase 2 decision, annual reports will provide a program status update, including all successful and unsuccessful applications for EPIC funding awarded during the previous year.

An independent third-party evaluation of the EPIC program overseen by the CPUC will be conducted at the completion of each triennial term. The purpose of this evaluation is to assess the effectiveness of the program and provide recommendations for program improvement.

Competitive Award Preference for EPIC Funds

The vast majority of initiatives included in this investment plan will be implemented through the Energy Commission's competitive solicitation process to ensure a fair, open, and transparent opportunity for interested parties. The competitive process is outlined later in this chapter. However, noncompetitive awards could occur with public agencies and private entities. For example, there may be a follow-on agreement to a successful project that would not be conducive to a competitive process, or there could be match funding to a federal grant. These instances of noncompetitive awards cannot be specified at this time and the Energy Commission will notify the CPUC in the annual report upon those rare instances when there is

no competitive bid. Noncompetitive awards will follow the state contracting manual procedures.

The Energy Commission's preference for a competitive selection process in EPIC will apply to public and private entities. The procedures for competitive solicitations will follow applicable requirements from the State Contracting Manual, State Public Contracts Code, Public Resources Code, and other laws and regulations, such as civil service restrictions, prevailing wages, and the California Environmental Quality Act.

Administrative Cost Containment

The Energy Commission will monitor its administrative costs to manage the EPIC program within the 10 percent cap established in the CPUC's EPIC decision. Administrative cost will also be part of the competitive proposal evaluation process, as discussed later in this section. The Energy Commission has established an electronic template that EPIC applicants will complete, which calculates administrative costs in a comparable manner.

Foster Investments in California

EPIC investments will maximize funds spent in-state to foster and grow California-based businesses and institutions. This will have direct and indirect economic benefits to state-wide and regional economies, as discussed further in the project selection criteria section.

Coordination with Other Research, Demonstration and Deployment Efforts

The Energy Commission will stay abreast of both in-state and national research, demonstration, and deployment activities. Agencies with energy-related activities such as the United States Department of Energy (U.S. DOE), the United States Department of Defense (U.S. DOD), the CPUC, and the Air Resources Board (ARB) will provide key input into the EPIC gap analysis and road mapping activities. In the past, Energy Commission staff has participated in U.S. DOE's research planning, project scoring, and/or program evaluation activities. This coordination is an invaluable tool both to avoid duplication and to leverage related efforts. The U.S. DOE and California's energy agencies (the CPUC, the ARB, the California ISO, and the Energy Commission) have initiated a high-level dialogue to facilitate improved collaboration.

At the request of Energy Commission Chair Robert Weisenmiller, the Energy Commission's Energy Research and Development Division is collaborating with the U.S. DOE to leverage public research dollars in California. As part of this effort, the Energy Commission initiated an informal partnership with U.S. DOE's Advanced Research Projects Agency – Energy (ARPA-E) program to maximize coordination of funding opportunities. ARPA-E funds the development and deployment of transformational energy technologies and systems. Consistent consultation and coordination between the Energy Commission and U.S. DOE will improve current funding

processes, provide greater cost-share opportunities to potential awardees and maximize the public/ratepayer benefits associated with innovative energy technologies.

California's national labs and academic institutions are leaders in clean energy research innovations and the Energy Commission will encourage broad participation across the state in EPIC implementation.

The Energy Commission is committed to on-going collaboration with the three utility administrators at least twice a year. Coordination meetings have been valuable in the development of this investment plan to identify each administrator's area of focus, as well as to suggest synergistic opportunities to collaborate. On-going collaboration will be a cornerstone of the program to assure EPIC activities return the highest benefit to the ratepayers that pay for the investments. The EPIC administrators have agreed to five principles of collaboration and these are articulated in chapter 2, page 25

Competitive Solicitation Process

Prior to releasing a solicitation, staff will identify the specific research, demonstration, or deployment objectives for the solicitation. Solicitation objectives will be designed to remove specific clean energy deployment barriers and will be mapped to achieve specific clean energy goals. These objectives are typically derived from a roadmap or through stakeholder workshops. Roadmaps are documents prepared for specific program areas that identify high priority research initiatives needed to meet state policy, industry, and private sector goals.

The solicitation process will begin with posting a funding opportunity announcement on the Energy Commission's website that contains all the information needed by interested parties to participate in the solicitation. The Energy Commission will notify interested parties of the funding opportunity through a number of available list servers.[150] All funding opportunity announcements will indicate the topic or topics addressed in the solicitation, the amount of funding available, and project and applicant eligibility requirements.

The posted opportunity notices on the Energy Commission website will contain all the materials, including electronic files, needed for a successful submission. These documents will include the application manual, required templates, and all instructions. The application manual will identify the solicitation purpose and objectives, the funding levels for research topics, project and applicant eligibility requirements, screening and/or scoring criteria, match funding requirements, selection and award process, grounds for submittal rejection and the solicitation schedule. The application manual will also included standardized templates for

150 To register for the EPIC List Serve: http://www.energy.ca.gov/research/epic/.

preparing work statements and budgets. Also included will be the Energy Commission's award terms and conditions that each applicant must agree to comply with. The appendix contains a draft Program Opportunity Notice (PON) template.

Shortly after a solicitation has been posted, Energy Commission staff will hold a publicly noticed workshop to review the solicitation purpose, requirements, eligibility, and research topics with interested parties. The public workshop will provide an opportunity for potential applicants to ask questions on the solicitation and the application process. There will also be an opportunity for interested parties to submit written questions about the solicitation. The staff's responses to questions will be posted on the Energy Commission website to ensure that all potential applicants have access to the same information. Any revisions, corrections, and clarifications on the solicitation will also be posted on the Energy Commission website. An estimation of a typical solicitation schedule is shown in Table 29.

Table 29: Solicitation Timeline

Estimated Solicitation Schedule	Approximate Timeline (calendar days)
PON Release	Day 0
Pre-Application Workshop	Day 14
Deadline to Submit Questions	Day 16
Post Questions, Answers and Addenda	Day 26
Deadline to Submit Applications	Day 56
Notice of Proposed Award Posting Date	Day 120
Business Meeting Date	Day 300
Agreement Start Date	Day 360

Project Award Requirements in the Three Funding Areas

The CPUC's EPIC decision outlined three funding areas for the Energy Commission administered program: Applied Research and Development, Technology Demonstration and Deployment, and Market Facilitation. Additionally, rather than set aside a specific amount of funding for federal cost share (with U.S. DOE, U.S. DOD and other federal appropriate entities), the EPIC program will allow applied research and development and technology demonstration and deployment strategic objectives to apply up to 10 percent of their approved funding to support federal cost share opportunities. The purpose is to help California companies and research entities secure federal funds that will benefit California ratepayers and the state's economy. This will be discussed further in a later section of this report.

The following describes the award process for funding opportunities with a single-stage proposal process.

Applied Research and Development Award Requirements

Projects in the Applied Research and Development investment area will focus on new technologies, methods, and approaches from early bench-scale up to pilot-scale prototype demonstrations that seek to solve identified problems in the electricity system "value chain." Nontechnology approaches are also included, such as strategies and methods to enhance adoption of clean energy technologies and research and development (R&D) that addresses electricity-related environmental and public health impacts, clean energy transportation, and building and appliance codes and standards. Awards in this area will help remove barriers and advance state energy goals for renewable energy, energy efficiency, the smart grid, and electric transportation.

Staff will evaluate the technical feasibility and practicality of proposed solutions, strategies, or technologies. At this phase in the energy innovation pipeline, projects that are awarded funding will likely not have a clear business case for deployment of private capital, meaning that the amount of match funding in most cases will be low, if any. Therefore, match funding is typically not required for research proposals in this program area. However, bidders that provide match funding can receive higher scores during the proposal evaluation process. This criterion is clearly spelled out in the application manual. Proposals will be initially screened by Energy Commission staff to ensure that they meet minimum administrative requirements such as those shown in Table 30. Failure in any one criterion could result in rejection of the entire proposal.

All proposals passing the initial screening will then be scored by a committee consisting of Energy Commission staff, possibly aided by technical reviewers expert in certain areas, by applying a scoring scale (for example, Table 31) to a set of technical criteria (for example, Table 32). Specific evaluation criteria will differ from solicitation to solicitation, depending on the specific solicitation objectives and expected products.

Table 30: Example Administrative Evaluation Criteria

Proposal Screening Criteria (Pass/Fail)
Proposal contains cover page, executive summary, project narratives, statement of work, budget and schedule of products and due dates
Proposal includes a cover page containing required information
Executive summary- limited to the maximum number of pages defined in each individual solicitation and discusses tasks and overall project management
Proposal narrative- limited to the maximum number of pages defined in each individual solicitation
Statement of Work and Budget-completed according to provided templates
Schedule of products and due dates completed according to provided templates
Minimum grant funds to be spent in California as specified in the solicitation
Other requirements unique to the solicitation
Proposer agrees to State terms and conditions
Proposal does not contain confidential information

Table 31: Example Scoring Scale

% of Possible Points	Interpretation	Explanation for Percentage Points
0%	Not Responsive	Response does not include or fails to address the requirements being scored. The omission(s), flaw(s), or defect(s) are significant and unacceptable.
25%	Minimally Responsive	Response minimally addresses the requirements being scored. The omission(s), flaw(s), or defect(s) are significant and unacceptable.
50%	Inadequate	Response addresses the requirements being scored, but there are one or more omissions, flaws, or defects or the requirements are addressed in such a limited way that it results in a low degree of confidence in the proposed solution.
70%	Adequate	Response adequately addresses the requirements being scored. Any omission(s), flaw(s), or defect(s) are inconsequential and acceptable.
80%	Good	Response fully addresses the requirements being scored with a good degree of confidence in the Applicant's response or proposed solution. No identified omission(s), flaw(s), or defect(s). Any identified weaknesses are minimal, inconsequential, and acceptable.
90%	Excellent	Response fully addresses the requirements being scored with a high degree of confidence in the Applicant's response or proposed solution. Applicant offers one or more enhancing features, methods, or approaches exceeding basic expectations.
100%	Exceptional	All requirements are addressed with the highest degree of confidence in the Applicant's response or proposed solution. The response exceeds the requirements in providing multiple enhancing features, a creative approach, or an exceptional solution.

Table 32: Example Scoring Criteria and Weighing Factors – Applied Research

Approx Weight	Scoring Criteria
30%	Impacts and Benefits to California Ratepayers and Funds Spent in California. [151] • Public benefit to California utility ratepayers- residential, academic, commercial, institutional and/or industrial. • Public benefits include lower costs for electricity, more secure and reliable electric supply, and reduced peak demand for electricity. • Anticipated benefits are consistent with the cost, technological and market goals, and the commercialization path. • Supports California energy policies and policy report recommendations, provides a basis for informing future energy policy. • More than 60 percent of funds spent in California will receive a higher score, based on a sliding scale.
15%	Technical Merit and Need • Clear and concise description of goals, objectives, technological advancement and innovation and responsive to targeted research areas. • Explains how the project is unique, critically needed, and not duplicative of other efforts. • Adequate discussion of how the proposed research addresses current barriers and knowledge gaps. • Provide letters of support and/or commitment that demonstrate a benefit to the project. • Past and current work in subject technology performed by the project team, including success and failures, are described. • Justify the need for funds, explaining why it is not adequately supported by competitive or regulated/private markets. • Clearly stated, achievable, and technically and economically feasible. •
15%	Technical Approach • Identify major tasks, sub-tasks, and deliverables in a logical order. • Thorough understanding of science, engineering, and manufacturing. • Detailed plan explaining how the various tasks will be executed and coordinated with various participants and team members. • Plan to address critical success factors, risks, barriers, and limitations. • Project cost is consistent with the work to be performed and is fully justified. • Scope of Work prepared completely and accurately.

151 All of the scoring criteria will evaluate benefits to ratepayers. For example, technical approach and team experience will lead to higher probability of success while cost criteria ensures ratepayer value at lower costs.

Approx Weight	Scoring Criteria
10%	Team Qualifications • Experience, skills, and connections to the marketplace and industry partners to help ensure the successful market transfer of the technology, product, and knowledge. • Identifies key members of the project team including major subcontractors and other partners, with their roles and responsibilities. • Collaboration with utilities, industries, and/or other stakeholders who can help deploy results into the market. • Qualifications, experience, capabilities and credentials of key team members. • Project manager will successfully manage the project, control cost, maintain the schedule, and effectively report results and accomplishments.
10%	Overhead and General and Administrative Costs • Portions of the budget dedicated to research, development, and demonstration and market transfer actions are significantly greater than the costs for overhead, including general & administrative. • Detailed justification of project overhead, fringe benefits, and general & administrative costs.
10%	Match Funding • Provides match funds by the team, subcontractors, and/or partners. • Proposed match funds are secure based on the team's history and/or letters of commitment by other contributing entities. • Strategy for replacing match funding if the proposed match funds are significantly reduced or lost.
10%	Project Budget and Cost-Effectiveness • Cost is consistent with proposed work and deliverables. • Personnel rates, operating expenses, and overhead costs are reasonable for the proposed work and are consistent with scope of work. • Justify the reasonableness of funds relative to the benefits to California.

For applied research there is no match requirement. However, projects with match funding could be awarded on a sliding scale (for example, 0% = 7 points; 21-50%= 8 points; and over 50% = 10 points) or through a formula, as delineated in the solicitation.

Table 33 shows an example of how the points and weights could be applied to determine the score for the proposal. Passing proposals are typically those that achieve at least 70 percent of all points.

Table 33: Calculating the Proposal Score

Company A

Criteria	A Points (1-10)	B Weight	A x B Total points
Benefits to CA Ratepayers	9	3.0	17
Technical merit	9	1.5	13.5
Technical approach	9	1.5	13.5
Team qualifications	9	1.0	9
Overhead and G&A Costs	8	1.0	8
Match funding	7	1.0	7
Project Budget	8	1.0	8
Total		**10**	**86**

All proposals will be ranked and a Notice of Proposed Award will be released showing the rank of each proposal based on overall proposal score, applicant name, funds requested and staff funding amount recommended, match funding and score status. Funding will first be awarded to the top ranked proposal and then to the next ranked until all funds have been expended. A sample Notice of Proposed Award (NOPA) is shown in Table 34. All proposals recommended for funding will be considered at an Energy Commission business meeting.

Table 34: Sample Notice of Proposed Award

Name of Bidder/Applicant	Funds Requested	Funds Awarded	Match Amount	Score	Status
A Company	$1,000,000	$1,000,000	$200,000	86	Awardee
B Company	$500,000	$500,000	$5,000	85	Awardee
C Company	$3,000,000	$3,000,000	$200,000	80	Awardee
D Company	$2,000,000	$2,000.000	$10,000	77	Awardee
E Company	$2,000,000	$1,500,000	$100,000	71	*
F Company	$500,000	$500,000	$5,000	65	Did not pass
G Company	$2,000,000	$2,000,000	$20,000	50	Did not pass
Total	**$11,000,000**	**$6,500,000**	**$415,000**		

* To be awarded only if additional funds are available.

Table 35 provides a summary of the three-year funding for applied R&D, the estimated project award per recipient, match fund requirement, and amount of funding set aside to match federal grants. Each solicitation would have a minimum and maximum proposal funding level, along with match requirements, tailored to the individual solicitation.

Table 35: Summary of Three Year Funding for Applied Research and Development

3-Year Funding for Applied Research and Development	$158.7 million
Estimated Minimum/Maximum Project Award Per Recipient	$250,000 to $3 million*
Match Funding Requirement	None but those providing match will receive higher scores during proposal evaluation
Estimated Funding to Match Federal program investments (3 years)	EPIC program will allow applied research and development strategic objectives to apply up to 10 percent of the funding to support federal cost share opportunities

* Individual projects vary due to broad spectrum of projects under applied research from a simple component project to a pilot scale test. Pilots will generally not exceed $3 million of EPIC funds though the Energy Commission retains the option for larger pilot-scale demonstrations with higher matching funds.

**Set aside funding to leverage federal program investments to promote federal economic investments in California.

Technology Demonstration and Deployment Award Requirements

Projects under the technology demonstration and deployment (TD&D) investment area will focus on technologies, methods, and approaches that are beyond the "proof-of-concept" stage. These projects must have completed field, lab, bench-scale and/or pilot-scale work with verified performance data to warrant precommercial/commercial scale-up.

The overall goal for projects funded under the TD&D are is to demonstrate innovative technologies at an appropriate scale, at an appropriate host-site (that is, demonstrated in the intended market of the technology), under real-world conditions, and to validate energy, water and cost savings, air quality and electric transportation sector improvements, overall economics (including operation and maintenance costs), reliability, life-cycle cost assessment, and other criteria necessary to commercialize the technology/strategy and gain public acceptance. EPIC TD&D projects will be expected to have a clearly articulated path to market that will then be specified in the project scope of work.

When appropriate, the EPIC program will coordinate with the IOUs to provide research results and technologies that can be incorporated into utility-sponsored incentive/rebate programs to accelerate wider market adoption and deployment. Additionally, there may be opportunities to collaborate on projects to maximize the synergistic effect of both utility and Energy Commission EPIC programs. The EPIC program will also strive to partner with private companies in the industrial, agriculture, and renewable energy sectors and in the residential and commercial building industries, as well as with automotive manufacturers and entrepreneurs in clean energy markets. Projects that receive awards should demonstrate a clear link to business and commercialization with a plan to manufacture and market successful technologies within five years after successful demonstration.

Since TD&D projects have higher levels of private benefits and are near to commercialization, match funding will be required for TD&D projects. At a minimum, 20 percent of requested EPIC funds must be pledged as match funds. The solicitation application manual may require contingency plans to replace lost match funds, or specify stricter requirements on the level of matching funds and define what may be counted as matching funds.

The Energy Commission's three-year funding amount for TD&D is $129.8 million. Of this amount, a minimum of 20 percent or about $26 million will be set aside for bioenergy, as indicated in the CPUC EPIC decision.

Similar to applied research, proposals will be initially screened to ensure compliance with minimum requirements, such as using the criteria in Table 30. Proposals that pass this initial screening will then be evaluated by a technical scoring committee using a scoring scale, such as the one shown in Table 31 and applying criteria such as shown in Table 36. The technical scoring committee will typically consist of technology experts from the Energy Commission staff, who can receive assistance from external reviewers when needed.

Table 36: Example Scoring Criteria for Demonstration Projects-Demonstrations

Approx Weight	Scoring Criteria
30%	Impacts and Benefits to California Ratepayers and Funds Spent in California • Project benefits to ratepayers (energy and cost savings). • Impact to specific market segments in California and how California will benefit from the proposed technology demonstration. • Potential benefits to California using justifiable estimates of mature market penetration rates and applicable market segments. • Potential for cost-effective replication of the demonstrated technologies. • Possible job creation impacts from the construction process and materials used. • Qualitative or nontangible benefits, such as comfort, lighting quality, environmental, or durability improvements for California ratepayers. • More than 60 percent of the funds spent in California will receive higher scores based on a sliding scale. • Supports California energy policies and policy report recommendations, provides a basis for informing future energy policy.
20%	Technical Merit and Need • Clear and concise description of goals, objectives, technological advancement and innovation and responsive to targeted research areas. • Results from bench scale/pilot scale project performance to justify commercial/industrial scale demonstration. • Advance science and technology. • Overcome existing barriers to clean energy deployment. • Measurement and verification plan of project performance. • Demonstration will improve, supplement, and/or replace the current available technologies.
10%	Technical Approach • Identify major tasks in a logical order. • Project plan and timeline explaining how the various tasks will be executed and coordinated with various participants and team members. • Prepare and complete a scope of work, budget workbook, and schedule of products. • Meets a well defined market need applicable to California. • Appropriate plans to initiate and sustain transfer of the technology results into the marketplace. • Clearly identifies responsible parties to perform each task and explicitly details project management activities.
10%	Overhead and General Administrative Costs • Portions of the budget dedicated to research, development, and demonstration and market transfer actions are significantly greater than the costs for overhead, including general & administrative. • Detailed justification of project overhead, fringe benefits, and general & administrative costs.
10%	Project budget and Cost-Effectiveness • Explain and justify the cost relative to the scope of work and the potential benefits to California. • Reasonable cost for personnel, subcontractors, equipment, technology/product warrants, technology operational and maintenance costs, etc. • Describes the estimated economics of the technology if successful and calculates the projected life cycle cost and savings, including all assumptions on equipment. • Funds requested are reasonable relative to the goals and objectives of the project.

Approx Weight	Scoring Criteria
10%	Match Funding • Match funds provided by the team, subcontractors, and/or partners in excess of 20 percent. • Proposed match funds are secure based on the team's history and/or letters of commitment by other contributing entities. • Strategy for replacing match funding if the proposed match funds are significantly reduced or lost.
10%	Team Qualifications • Project manager has proven track record for managing technology demonstration projects successfully, including the capability to control cost, maintain the project schedule and budget, providing quality control of products produced by the team, and effectively communicating project results. • Clear roles and responsibilities defined among team members. • Past success in taking research, development, and technology demonstration products to market level. • Includes California-based companies and employees. • Identify other key members of the work team including major subcontractors, and other partners with their roles and responsibilities. • Collaboration with utilities, industries, and/or other stakeholders who can help achieve the project goals, overcome barriers, create market acceptance, and deploy the work results. • Qualifications, experience, capabilities and credentials of the key team members.

Each solicitation will state a proposal minimum and maximum, along with minimum match requirement of 20 percent. Points awarded for match funding could be based on a sliding scale (for example, 20% = 7 points; 21-50%= 8 points; and over 50% = 10 points) or through development of a formula, as determined in the solicitation.

Points are assigned to each criterion based on the scoring scale and technical criteria (Table 31 and Table 36). Proposal scores are calculated as shown in Table 37. Passing proposals are those that achieve a minimum score, typically at least 70 percent of all points. All proposals are ranked and a NOPA is released, similar to Table 34. All passing proposals are ranked and funding is awarded to the top ranked proposal and then to the next ranked until all funds have been expended. All proposals recommended for funding are considered at an Energy Commission business meeting.

Table 37: Calculating the Proposal Score

Company A

Criteria	A Points (1-10)	B Weight	A x B Total points
Benefits to CA Ratepayers	7	3.0	21
Technical merit and need	7	1.5	11
Technical approach	7	1.5	11
Overhead and G&A Costs	7	1.0	7
Project Budget and cost-effectiveness	7	1.0	7
Match funding	7	1.0	7
Team qualifications	7	1.0	7
Total		**10**	**71**

Table 38 summarizes the three year funding for technology demonstration and deployment including the minimum 20 percent set aside for bioenergy. Each solicitation would state a proposal minimum and maximum, along with minimum match.

Table 38: Summary of Three Year Funding for Technology Demonstration and Deployment

3-Year Funding for Technology Demonstration and Deployment	Up to $129.8 million ($27 million for bioenergy)
Estimated Minimum/Maximum Project Award Per Recipient	$1 million to $5 million ($100,000 to $5 million for bioenergy projects)*
Match Funding Requirement	20 percent of the requested EPIC funds. Those providing match funds in excess of 20 percent will receive higher scores during proposal evaluation
Estimated Funding to Match Federal program investments (3 years)	EPIC program will allow technology demonstration and deployment strategic objectives to apply up to 10 percent of the funding to support federal cost share opportunities

* The Energy Commission reserves the right to release technology demonstration and deployments with a minimum award less than $1 million ($100,000 for bioenergy) if deemed necessary for advancing clean energy technologies or strategies.

**Set aside funding to leverage federal program investments to promote continued national economic investments in California.

Market Facilitation Award Requirements

Projects under the market facilitation investment area will address funding gaps in market processes and includes a wide range of activities such as:

- Program tracking.
- Market research.
- Education and outreach.
- Regulatory assistance/streamlining.

- Workforce development or support clean energy technology deployment.
- Evaluation.

The overall goal is to help ensure that products or strategies make it all the way through the technology development cycle and are delivering benefits to consumers.

Market facilitation efforts support clean energy technology and strategy deployment. Though they can lead to more widespread application of technologies and strategies, there is not a clear business case for deployment of private capital, meaning that the amount of match funding in most cases will be low, if any. Match funding is typically not required for projects in this program area; however, bidders that provide match funding can receive higher scores during the proposal evaluation process. The following table provides a summary of the three-year funding for market facilitation, the estimated project award per recipient and match fund requirement.

Similar to applied research, proposals will be initially screened to ensure compliance with the minimum administrative requirements (Table 32). The proposals will then be evaluated using a scoring scale, such as the one shown in Table 31, and then evaluated against criteria like those shown in Table 39. Specific evaluation criteria will differ in each solicitation, depending on the solicitation objective and expected products.

Table 39: Common Scoring Criteria and Weighing Factors –Market Facilitation

Approx Weight	Scoring Criteria
30%	Impacts and Benefits to California Ratepayers and Funds Spent in CA • Public benefit to California utility ratepayers- residential, academic, commercial, institutional and/or industrial. • Public benefits include lower costs for electricity, more secure and reliable electric supply, and/or reduced peak demand for electricity. • Anticipated benefits are consistent with the cost, technological and market goals, and the commercialization path. • Supports California energy policies and policy report recommendations, provides a basis for informing future energy policy. • More than 60 percent of funds spent in California will be awarded a higher score, based on a sliding scale.

Approx Weight	Scoring Criteria
15%	Technical Merit and Need • Clear and concise description of goals, objectives, and innovation and responsive to targeted areas. • Explains how the project is unique, critically needed, and not duplicative of other efforts. • Adequate discussion of how the proposed project addresses current barriers and knowledge gaps. • Provide letters of support and/or commitment that demonstrate a benefit to the project. • Past and current work in subject area performed by the project team, including success and failures, are described. • Justify the need for funds, explaining why it is not adequately supported by competitive or regulated markets. • Clearly stated, achievable, and technically and economically feasible.
15%	Technical Approach • Identify major tasks, sub-tasks, and deliverables in a logical order. • Thorough understanding of the subject area. • Detailed plan explaining how the various tasks will be executed and coordinated with various participants and team members. • Plan to address critical success factors, risks, barriers, and limitations. • Project cost is consistent with the work to be performed and is fully justified. • Scope of Work prepared completely and accurately.
10%	Team Qualifications • Experience, skills, and connections to the marketplace and industry partners to help ensure the successful market transfer of the project results. • Identifies key members of the project team including major subcontractors and other partners, with their roles and responsibilities. • Collaboration with utilities, industries, and/or other stakeholders to help deploy results. • Qualifications, experience, capabilities and credentials of key team members. • Project manager will successfully manage the project, control cost, maintain the schedule, and effectively report results and accomplishments . • Provide letters of support and/or commitment that demonstrate a benefit to the project.
10%	Overhead and General and Administrative Costs • Portions of the budget dedicated to performing the work are significantly greater than the costs for overhead, including general & administrative. • Detailed justification of project overhead, fringe benefits, and general & administrative costs.
10%	Match Funding • Provides match funds by the team, subcontractors, and/or partners. • Proposed match funds are secure based on the team's history and/or letters of commitment by other contributing entities. • Strategy for replacing match funding if the proposed match funds are significantly reduced or lost.
10%	Project Budget and Cost-Effectiveness • Cost is consistent with proposed work and deliverables. • Personnel rates, operating expenses, and overhead costs are reasonable for the proposed work and are consistent with scope of work. • Reasonableness of requested funds relative to the benefits to California. • Project cost is consistent with the work to be performed and is fully justified

For market facilitation there is no match requirement. However, projects with match funding could be awarded points based on a sliding scale or formula as determined in the solicitation. Points are assigned based on a scoring scale in (for example, Table 31) and technical criteria (for example, Table 39). The points and weights will be applied to determine the score for the proposal, such as those indicated in Table 40. Passing proposals are those that achieve a minimum score, typically at least 70 percent of all points. All proposals will be ranked and a NOPA will be released, similar to Table 34. Funding will be awarded to the top ranked proposal and then to the next ranked until all funds have been expended. All proposals recommended for funding will be considered at an Energy Commission business meeting.

Table 40: Calculating the Proposal Score

Company A

Criteria	A Points (1-10)	B Weight	A x B Total points
Benefits to CA Ratepayers	7	3.0	21
Technical merit	7	1.5	11
Technical approach	7	1.5	11
Team qualifications	7	1.0	7
Overhead and G&A Costs	7	1.0	7
Match funding	7	1.0	7
Team qualifications	7	1.0	7
Total		10	71

Table 41 summarizes the three year funding for market facilitation. Each solicitation would state a proposal minimum and maximum, tailored to the individual solicitation.

Table 41: Summary of Three-Year Funding for Market Facilitation

3-Year Funding for Market Facilitation	$43.3 million
Estimated Minimum/Maximum Project Award Per Recipient	$25,000 to $3 million
Match Funding Requirement	None. Those providing match funds will receive higher scores during proposal evaluation

Two Phase Application Process

Some solicitations may use a two-phase selection process. The first phase involves preparation of a brief abstract to determine technical merit. The abstract will be evaluated on a pass/fail basis according to specific criteria, such as those listed in Table 42. The proposal must pass all criteria to proceed to the next phase. If the proposal passes this first phase, the applicant will be invited to progress to the second phase and submit a full proposal. The full proposal will be evaluated according to the requirements stated in the previous sections for Applied R&D, TD&D, and Market Facilitation.

Match Funds for Federal Awards

A portion of EPIC funds will be set aside to leverage federal funds and boost research investments and economic benefits to California. The following criteria will be used to evaluate potential requests to provide cost share to match federal funds from the U.S. DOE and others:

- The research projects goals/objectives are aligned with those in this investment plan.
- The potential recipient is a California-based applicant.
- The EPIC funds will be spent in California to benefit electric ratepayers.
- The potential recipient receives a federal award.

This will be similar to the approach the Energy Commission took with American Recovery and Reinvestment Act funding. Under the American Recovery and Reinvestment Act of 2009, the Energy Commission successfully leveraged more than $500 million in federal stimulus funding while providing $21 million in match funding for projects that are consistent with the Energy Commission's research program and state's policy goals. Depending on the research goals and work scope, the EPIC funds to match the federal grant may come from Applied R&D or the TD&D funding areas as indicated in separate Research Initiatives. EPIC match funds will be capped at no more than half the required match in the federal award. It is anticipated that the selection and evaluation of proposed bidders requesting EPIC funds to match federal awards will be through a competitive process similar to that described in this investment plan but emphasizing the criteria described in this section. Refer to initiatives S11 and S15.

Table 42: Example Scoring Criteria for Evaluation of Stage One Proposals for Two Phase Application Processes

Pass/Fail	Scoring Criteria
Pass/Fail	Technical Merit of Project Summary • Clearly describes the proposed technology and its current stage of development. • Clearly states the purpose and scope of the proposed technology/project; outlines the issues the project will address and the need for the project. • Summarizes technical approach and principal tasks required to accomplish the project. • Discuss barriers and resulting solutions to be addressed to accomplish stated goals. • Clearly explain why the project is unique and the benefits to Californians. • Describes industry, utility and other market support/need for the technology.
Pass/Fail	Match Funding • Must meet the minimum amount of requested match funding. • Provide letter committing project team to minimum (or more) match funding requirements.
Pass/Fail	For demonstrations, • Provide proof that technology is ready for scale up demonstration. • Provide proof of demonstration site (letter from site). • Justify that demonstration is of sufficient scale to provide meaningful data to facilitate commercialization of the technology in its intended market.
Pass/Fail	Economic Investment in California • At least 60 percent of the funds must be spent in California.

Integrating Source(s) of Funding in a Solicitation

The typical solicitation will be EPIC funding only. However, the Energy Commission recommends allowing a combination of funding sources in the same solicitation when it adds value to the ratepayers. For example, some barriers and solutions may benefit from an integrated electricity and natural gas approach. It could be beneficial to include EPIC funding and natural gas funding together in the same solicitation because some initiatives (for example, HVAC or building envelope) can have both electric and natural gas savings. Having a joint solicitation will capture the synergy associated with both fuel savings. Any such use of multiple funding sources will be clearly identified in the funding opportunity notice and all proposals will be required to demonstrate how the proposed project will provide benefits to both electric and natural gas ratepayers.

As an example, one of the proposed initiatives in this plan is to develop, test, and demonstrate advanced building envelope systems, materials, and components to improve building efficiency. This initiative could result in technologies that could affect both air conditioning and heating in buildings. Since most buildings in California use electricity for air conditioning and natural gas for heating, this research could result in envelope systems that could reduce demand for both energy sources. In this case, the project could be funded with both EPIC and

natural gas funds. Gas and electric funds, as well as benefits, would be tracked and reported separately.

Bidder Eligibility

EPIC solicitations will be open to all public and private entities and individuals interested in electricity-related applied R&D, TD&D, and market facilitation; however, some solicitations may target one or the other. Eligibility for receiving EPIC funding through the competitive process is based on the specific screening and scoring criteria set forth in the solicitation application manual as explained in the following sections.

Proposal Scoring and Preparation

Each proposal submitted in response to an EPIC solicitation will be screened and scored according to criteria described earlier in this chapter. Proposal scores will be based upon a series of technical criteria to ensure that the proposed project has merit, is feasible, and does not duplicate other efforts, the team is qualified, and the budget is reasonable (see Table 32, Table 36, and Table 39). At a minimum, proposals must be organized in a way that facilitates scoring of the proposal, such as:

- Incorporating the scoring criteria within the proposal project narrative.
- Discussing the project in sufficient detail.
- Identifying and quantifying rate-payer benefits from the project with clear justification on all assumptions.
- Discussing the projects market connection and the market size.
- Identifying and discussing the match funding and the source.
- Outlining project risks and measures to mitigate risk.
- Discussing project team qualifications and structure.
- Providing a detailed project scope of work, budget and schedule.
- Discussing private partnerships and plans for technology transfer.

After the scoring is completed, a NOPA will be released by the Energy Commission that identifies recipients for which EPIC funding is proposed (see Table 34). For each recipient receiving funding, a grant agreement or contract will be developed and approved by the Energy Commission. For recipients not awarded funding, there will be a specified debriefing process as described in each solicitation.

Other Solicitation Criteria

California Based Businesses, Suppliers and Jobs

The Energy Commission under the EPIC program will strive to maximize research funds spent in California by providing scoring criteria in proposals that clearly illustrate the most direct economic benefits to ratepayers. This includes prime contractors and subcontractors using

researchers, manufacturers, suppliers, and other labor forces located in California. Proposals with fewer funds and direct benefits going to California ratepayers will receive lower scores.

Loaded Rates

Another area of emphasis in EPIC solicitations will be ensuring reasonable overhead and general administrative costs. The Energy Commission staff has evaluated different methods for evaluating loaded rates and project cost for use in current solicitations (refer also to the draft PON template in the appendix). Two methods include:

- Compare the proposal costs relative to the lowest cost proposal.
- Compare the average loaded and unloaded hourly rates for each proposal team (including prime and subcontractors).

Loaded rates include direct labor, fringe benefits, overhead, general and administrative costs, and profit. Budget templates are being developed and this method is currently being evaluated for use in the EPIC solicitations.

Contracting

The Energy Commission will use either grant agreements or contracts to establish agreements with recipients receiving funding under the EPIC Program. Both grants and contracts will identify the task requirements, schedule, and budget for the funded effort.

The mechanism for awarding most contracts or grants will be a competitive process. Noncompetitive awards may be granted in selective circumstances as discussed in a later section. All procedures will follow applicable requirements of the State Contracting Manual, State Public Contracts Code, and Public Resources Code.

Agreement Terms and Conditions

Each solicitation will identify the terms and conditions to be used in the solicitation. These will apply to private entities, private universities, nonprofit organizations, the University of California (UC), California State University Foundations, the U.S. Department of Energy National Laboratories, and others. All recipients must agree to the terms and conditions prior to entering into an agreement.

Each grant agreement or contract also includes terms and conditions which set forth the recipient's rights and responsibilities. When the funding recipient is the UC or the U.S. DOE, the terms and conditions will be those that have been specifically negotiated by the Energy Commission or the Department of General Services for these agencies.

Research Centers (University of California and National Laboratories)

Under EPIC, the Energy Commission plans to establish a competitive process for investments in research centers. The Energy Commission previously funded research centers via interagency agreements to target research on technologies and analyses most needed to advance evolving energy policies, public interest research not addressed elsewhere, and as a cost-beneficial method to bring together researchers, industry, manufacturing and policy experts, universities and national laboratories. These centers have been very effective at turning innovative technologies into products that become supported by California markets or advancing science to support decisions by policy makers. Additionally, centers located at universities provided teaching laboratories for students, thus educating the future workforce. Many of the centers leveraged state funding and secured private and federal funding.

An example of a research center funded with RD&D funds is the California Lighting Technology Center (CLTC). The CLTC at the University of California, Davis, has accelerated the development and commercialization of energy-efficient lighting technologies by connecting private industry, state regulatory agencies, and utility emerging technology programs.

One of the technologies developed through previous research funding was adaptive smart lighting. This technology involves the integration of energy efficient light sources (for example, light emitting diodes [LED], induction, fluorescent) with smart controls that turn lights on and off depending on occupancy and/or daylighting. The initial research helped develop the technology and provided monitoring and verification to demonstrate the actual energy savings that can be achieved and convince building owners/operators of the benefits of such systems. As a result, the technology was used in utility emerging technology/incentive programs and has now progressed to being included in codes and standards. Without initial public research investment, this technology would not have been able to complete the innovation cycle in this time frame, if at all. Building owners and operators that use these technologies can anticipate reduced energy costs for lighting. This technology has been deployed in many buildings located in the IOU service territory, including UC campuses in Santa Barbara, Irvine, and Davis.

Some of the strategic objectives outlined in Chapters 3-5 may be best implemented through a solicitation targeted to research centers. Under EPIC, the Energy Commission will pursue opportunities to advance these highly cost-effective technological and analytical innovative incubators. Research centers, however, will still be required to compete for funding. Solicitations will be developed to provide multiyear funding for research centers that meet a specific set of criteria depending on targeted outcomes. Examples of criteria that could be included in a solicitation are:

- Unique research that addresses a major energy using/technological area with fast changing and evolving technology.

- Proven track record of providing explicit California electric ratepayer benefits. This can include developing technologies and strategies that have had an impact on reducing energy costs, improving public health, increasing energy reliability, creating jobs and other benefits to California ratepayers.
- Successfully using state research funds to leverage other private and public funding, such as from industry, manufacturers, utilities, and the U.S. DOE. The preference is not to have EPIC funds be the only source for the center.
- Strong private, industrial, manufacturing, and utility partnerships with demonstrated need for goods and services.
- Demonstrated successful "path to market," such as market penetration of goods and services or significant analyses that inform policy. One of the best ways to make certain that the products and services developed are needed and used, is to ensure that there is a partner who will use the results. This will help guarantee resulting research will not languish but will actually be used or commercialized.
- Portions of the budget dedicated to performing the work are significantly greater than the costs for overhead.

Noncompetitive Awards

Noncompetitive awards could occur with public agencies and with private entities. For public agencies, the State Contracting Manual allows contracts directly with the UC, California State University, national laboratories, and other public agencies without competition.[152] As a result, the Energy Commission anticipates some limited circumstances where interagency agreements or sole source agreements will be justified although those cannot be specified at this time. For example, a competitive process may not be conducive to a follow-on agreement to a successful project. Other examples would be an interagency agreement with another state agency to implement a specific program or project, or match funding to a federal grant as stated earlier in the chapter.

Project Management

A project agreement establishes a business relationship between the Energy Commission project manager and the recipient of EPIC funds. The EPIC project management process will include checkpoints for reviewing the progress of the project. Standard template language for all contracts and grants will require awardees to participate in kick-off meetings to establish

152 State Contracting Manual, Chapter 3, Sections 3.03 and 3.06, http://www.dgs.ca.gov/ols/Resources/StateContractManual.aspx

deliverable expectations, roles and responsibilities, accounting procedures, and reporting requirements; monthly or quarterly progress reports to ensure the contractor is complying with the task schedules specified in the contractual agreement; regular critical project reviews to monitor progress and make necessary corrections to ensure project success; and final documentation in the form of data, engineering plans, final construction and operation of facilities, or final reports documenting research results and other contractual deliverables.

Energy Commission Project Manager

Each project that is funded will be assigned a single Energy Commission project manager. The project manager will be responsible for coordinating with funding recipients, providing project oversight, and serving as the Energy Commission's point of contact for stakeholders interested in receiving more information about the project.

Critical Project Reviews

Research agreements will typically include critical project reviews at predesignated milestones in which the Energy Commission agreement manager will review the progress to date and determine whether progress to date justifies proceeding to the next project phase. This is an important management tool for research projects that do not always meet their initial goals and decisions need to be made whether to terminate or rescope a project based on research findings.

Technical Advisory Committee and Project Advisory Committee

EPIC research projects will typically include technical or project advisory committees. These committees will be composed of diverse professionals and can provide valuable perspective as the project matures. The number and composition of the committee members can vary depending on potential interest and time availability. The committee members serve at the discretion of the Commission Project Manager.

The committee may be composed of qualified professionals in the following disciplines:

- Researchers knowledgeable about the project subject matter.
- Members of the trades who will apply the results of the project (for example, designers, engineers, architects, contractors, and trade representatives).
- Public interest market transformation implementers.
- Product developers relevant to project subject matter.
- U.S. DOE, academia, and other governmental research managers.
- Public interest environmental groups.
- Utility representatives.
- Members of relevant technical society committees.

The role of the advisory committee will be to:

- Provide guidance in research direction. The guidance may include reviewing scope of research, research methodologies, timing, and coordination with other research to maximize synergy and avoid duplication. Guidance may be based on:
  - Technical area expertise.
  - Knowledge of market applications.
  - Links between the agreement work and past, present, or future research (both public and private sectors) in a particular area.
- Review deliverables and provide specific suggestions and recommendations for needed adjustments, refinements, or enhancement.
- Review and evaluate tangible benefits to California of the research and provide recommendations as needed.
- Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the research products.

Outreach

The Energy Commission is committed to ensuring that information regarding EPIC-funded projects and activities is available to stakeholders. The Energy Commission will employ a variety of techniques to disseminate information tailored to the audience. The predominant media techniques are described below. The Energy Commission will use professional industry networks and forums to share project highlights and significant findings. Technical Advisory Committees and Project Advisory Committees will provide recommendations for information dissemination and technical transfer priorities that are specific to each project and their industry. The Energy Commission will use these expert recommendations to maximize the strategic and meaningful distribution of project findings.

Scientific Journals and Trade Publications

EPIC projects that are of interest to the scientific community will be featured in scientific journals or trade publications. While these feature articles are not guaranteed, the Energy Commission will seek every opportunity to highlight EPIC-funded projects to drive industry forward and extend the reach of research and development efforts. These articles will provide more depth and project detail than fact sheets and describe the project's influence on policy development or industry momentum.

Project Fact Sheets

The Energy Commission will develop fact sheets for each project funded through EPIC. Fact sheets will be posted on the Energy Commission website and provide the public, stakeholders, and decision makers with current information on projects funded through EPIC. Projects can take several years from start to conclusion. The fact sheet, a one- to two-page summary, is a useful tool to keep all interested parties informed. For longer-term projects or those that are of particular interest to the general public or industry stakeholders, the Energy Commission will update fact sheets to reflect interim and final research findings. For non-research projects, like local government planning and permitting and workforce development activities, project fact sheets will describe project outcomes and identify lessons learned as well as best practices.

Reports

Projects funded through EPIC will include a final technical report that thoroughly describes the issue or problem addressed by the research, the approach and analysis, any findings, and recommendations for follow-up activities. In some of the longer-term or higher-profile projects, interim reports will be required to describe analysis and results to date.

Innovation Forums

The Energy Commission will periodically host technology/innovation forums to showcase and share project results. All program administrators will be invited to participate.

Energy Commission Website

Project fact sheets, final reports, and other documents related to, or supported by, EPIC funds will be publicly accessible on the Energy Commission website to maximize transparency and increase value for the program and its projects. The Energy Commission website will also serve as a resource for Energy Commission proceedings related to the development of the triennial EPIC investment plan. On the website, interested stakeholders will be able to navigate to EPIC policy documents, past workshop presentations, funding solicitations, annual EPIC reports, and other resources that will facilitate active participation in the program. In the future, there are plans to develop a searchable database for all EPIC funded projects. The EPIC website is: http://www.energy.ca.gov/research/epic/.

Intellectual Property

Intellectual property (IP) refers to products of the mind protected by law such as copyrights, trademarks, and patents. The treatment of IP rights under an RD&D program will affect its success. Correct handling of IP rights encourages participants in RD&D programs and advances the commercialization of new technologies, while incorrect handling can have the opposite effect. To ensure EPIC is successful in this regard, IP rights under EPIC RD&D should result in the following:

1) Provide tangible benefits to the ratepayers who pay for the RD&D.

2) Foster and not hinder the commercialization of new technologies, including advances in existing technologies.
3) Advance the collective knowledge of energy RD&D.

One of the basic benchmarks of any RD&D program is whether it results in new, commercially successful technology. IP rights play a significant role in commercialization. For example, IP rights that inappropriately share ownership or make proprietary information public would prevent the commercialization of new technologies. An entity would no longer have a competitive advantage, and thus no longer have the impetus for developing new technology.

Although it is important that IP rights lead to the commercialization of new technologies, IP rights must also allow the sharing of new scientific knowledge which fosters further advances and prevents duplication of efforts by others, which in turn preserves RD&D funds for new efforts.

IP Rights Under EPIC

The IP rights under EPIC will be structured as follows:

1) Each EPIC RD&D project needs to identify the IP that it will create in the form of new technology, advances in existing technology, or advances in scientific knowledge, and how the new IP will benefit the contributing ratepayers.
2) In general, the rights of IP developed under EPIC should be held by the entity developing it. Such entities are usually in the best position to commercialize the new technology, and it is not the state's role to create programs that compete with private companies. However, the state may retain a license to use the IP to protect ratepayer benefits.
3) The EPIC Program should have march-in rights to take IP that entities who accept EPIC funds develop but do not use. This will protect the ratepayers' investment in the IP and ensure that the benefits from the developed IP are received.
4) IP derived from general energy research that is geared towards new knowledge rather than product development should be put in the public domain, made publically available, or if kept by the entity, used such that the results are made public (for example, the University of California or national labs might keep the copyright to research papers, but then publish the results to make them known and available). This advances science and prevents other entities from performing duplicate research.
5) Royalties will not be collected unless statutory changes are made to allow it. The Energy Commission collects royalties under its Public Interest Research Program (PIER) due to the authority granted by Public Resources Code Section 25620.4. This authority,

however, is specific to PIER and the Energy Commission does not have the legal authority to collect royalties under EPIC.

CHAPTER 8: Program Benefits Assessment

Assessment Process

The California Public Utilities Commission (CPUC) Phase 2 decision requires that the Energy Commission include metrics against which the investment plan's success should be judged, including at least the following:

- Potential energy and cost savings.
- Job creation.
- Economic benefits.
- Environmental benefits.
- Identification of barriers or issues resolved that prevented widespread deployment of technology or strategy.
- Effectiveness of information dissemination.
- Adoption of technology, strategy, and research data by others.
- Funding support from other entities for EPIC-funded research on technologies or strategies.
- Other benefits.

The Energy Commission will determine which of the above benefits will be measured as applicable based on the type of project and technology, energy use sector, and the specific project funded, as well as its stage in the energy innovation pipeline.

Table 43 shows samples of how the targeted benefits of proposed funding initiatives under each chapter's strategic objectives will be shown using S1.1 and S13.2 as examples. Each table displays the following targeted benefits for each initiative:

- Promote greater reliability.
- Lower costs.
- Increased safety.
- Societal benefits.
- Greenhouse gas (GHG) emissions mitigation and adaptation.
- Economic benefit.
- Public Utilities Code Section 740.1.
- Public Utilities Code Section 8360.

Table 43: Examples of Proposed Funding Initiative Benefits Tables

S1 Strategic Objective: Develop Next-Generation End-Use Energy Efficiency Technologies and Strategies for the Building Sector

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/ transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S1.1 Develop, Test, and Demonstrate Next-Generation Lighting Systems and Components.	X	X		X	X		X	X	
S1.2 Develop, Test, Demonstrate, and Integrate Equipment, Systems, and Components That Improve the Energy Efficiency Existing and Advanced Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.	X	X		X	X		X	X	
S1.3 Develop, Test, and Demonstrate Advanced Building Envelope Systems, Materials, and Components.	X	X		X	X		X	X	
S1.4 Investigate and Improve Understanding of Building Occupant Behavior and Related Consumer Choice Motivations to Increase and Sustain Energy Efficiency Improvements in Buildings	X	X		X	X			X	
S1.5 Develop Cost-Effective Retrofit Strategies to Achieve Greater Energy Efficiency in Existing Residential and Nonresidential Buildings.	X	X		X	X		X	X	
S1.6 Reduce the Energy Use of Plug-Load Devices Through the Development of Products, Systems, and Controls, and Evaluation of Consumer Behavior That Affects Energy Use.	X	X		X	X		X	X	
S1.7 Develop and Evaluate Ideal Strategies to Improve Indoor Air Quality in Energy-Efficient Buildings		X	X	X				X	
S1.8 Develop Cost-Effective Technologies and Approaches to Achieve California's Zero Net Energy Buildings Goal.	X	X		X	X		X	X	X

S13 Strategic Objective: Demonstrate and Evaluate Emerging Clean Energy Generation Technologies, and Deployment Strategies.

	Promote Greater Reliability	Lower Costs	Increased Safety	Societal Benefits	GHG emissions mitigation and adaptation	Lower emission vehicles/transportation	Economic Development	Public Utilities Code Section 740.1	Public Utilities Code Section 8360
S13.1 Demonstrate and Appraise the Operational and Performance Characteristics of Pre-Commercial Biomass Conversion Technologies, Generation Systems, and Development Strategies.	X	X	X	X	X		X	X	X
S13.2 Demonstrate and Deploy Pre-Commercial Technologies and Strategies for Combined Heat and Power Applications.	X	X	X	X	X		X	X	X
S13.3 Demonstrate Technologies and Strategies to Facilitate the Integration of Intermittent Renewable Energy.	X	X		X	X		X	X	X

Source: California Energy Commission

Under initiative S1.1: *Develop, Test and Demonstrate Next-Generation Lighting Systems and Components*, the targeted benefits for advanced lighting systems research would be to improve the reliability and performance of the lighting systems, lower the system costs, and provide societal benefits such as reducing the glare in an office and/or providing improved lighting to contribute to increased worker productivity. Additional targeted benefits under the Public Utilities Code would be to support environmental improvements by reducing GHGs from reduced energy use and increase the probability of ratepayer benefits by using the experience of the Energy Commission staff to plan research using gap analyses, road maps and collaboration with key stakeholders.

For initiative S13.2: *Demonstrate and Deploy Pre-Commercial Technologies and Strategies for Combined Heat and Power (CHP) Applications,* targeted benefits for CHP applications would be to increase the safety and reliability of the CHP system, lower the system costs, and reduce GHG emissions. Other targeted benefits under Public Utilities Code would be to conserve and/or more efficiently use resources and improve operating efficiency and reliability by reducing operating costs.

Program/Project Benefits Assessment

The Energy Commission will use a program-wide approach to benefits assessment, which will include integrating benefit and cost assessment elements into solicitation planning, implementation, and project evaluation. The Energy Commission will implement prospective

and retrospective benefits assessment. Prospective assessments are integral to the planning and project assessment process and will estimate potential benefits based on size of the sector, magnitude of the barrier, and solutions that are targeted. Retrospective assessments will be conducted at project closeout to capture actual achieved benefits. More specifically, the Energy Commission will integrate benefits assessment into the following program phases:

- Solicitation Planning.
- Solicitation and Agreement Development.
- Project Management.
- Project Closeout.

More details of the benefits assessment activities in each program phase are described below.

Solicitation Planning

In the solicitation-planning phase, the Energy Commission will define the problem and solutions targeted for each competitive solicitation. Solicitations will identify specific potential benefits and explicit targets within a particular energy use sector. Potential benefits evaluation will be part of the selection criteria. The following quantitative and qualitative benefits are the metrics against which a bidder's potential success may be measured:

- **Quantitative Benefits**
  - Potential energy and cost savings.
  - Job creation and net jobs.
  - Economic benefits.
  - Funding support from other entities (for example, match).
  - Adoption of technology, strategy, and research data by others.
  - Other benefits.

- **Qualitative Benefits**
  - Effectiveness of information dissemination.
  - Environmental benefits.
  - Identification of barriers or issues resolved that prevented widespread deployment of technology or strategy.
  - Enhanced grid performance in terms of reliability, safety and security.
  - Meeting and informing policy goals (i.e., RPS, AB 32, Loading Order, others).
  - Public health and safety.
  - Other benefits.

Solicitation/Agreement Development

Solicitations instructions will require bidders to provide data to support potential quantitative and qualitative benefits including information on the location of the research or project and the geography of the expected benefits.

Where applicable, the bidder will be required to submit a proposal that includes an estimate of the potential benefits of the research if adopted by the market in terms of energy savings and cost savings. The bidder will also be required to present the basis of or assumptions used in the energy or cost savings calculations, including projections of market penetration of the technology and the size of the market. In the case of environmental or market research, bidders will typically provide qualitative prospective benefits evaluations that explain the need for the research, including which policy and regulatory drivers they are addressing and how the research will fill knowledge gaps or facilitate adoption of clean energy technologies.

To provide the attribution of benefits to EPIC funding – specifically public funding from EPIC rather than private sector funding – a bidder must discuss why the desired research or project outcome would not occur without EPIC funding or why it might not occur as quickly or in a manner beneficial to California ratepayers without EPIC funding.

The Energy Commission will evaluate and score potential awards based on a bidder's reasonable probability of achieving California ratepayer benefits, as well as other factors such as match/leveraged funds, research or market facilitation activities conducted in California, administrative/financial capability, and so on.

In the agreement development phase, the Energy Commission will incorporate the benefits to be measured in the proposed scope of work. Where applicable, the agreement will include some or all of the following information to measure benefits during the project management and closeout phases:

- Quantitative and qualitative benefits.
- Methods to measure benefits.
- Issues or barriers to be resolved.
- Test results.
- Critical project review (see chapter 7).
- Specific deliverables to document the benefits:
  - Fact sheets.
  - Project Interim reports.
  - Sharing technology information via workshops/conferences.
  - Project Final reports.
  - Post-program follow-up data sharing.

- Other information.

Project Management

The Energy Commission will hire and retain staff with the appropriate engineering, scientific, and related skill sets to effectively manage technical energy projects. During the project management phase, the Energy Commission will use its knowledge and experience from other Energy Commission programs to manage EPIC program agreements. This phase will begin with the assignment of the project to an agreement manager who will be responsible for overseeing the project. The Energy Commission will hold a kickoff meeting to reinforce the contractor's responsibility to measure benefits and communicate those benefits to the Energy Commission. The agreement manager will visit the project site, review all reports, and be in regular communication with the contractor to actively follow and shape the project to a successful conclusion. The Energy Commission will work closely with the researcher or award recipient to verify and capture, where applicable, potential benefits. The Energy Commission will also work with the researcher or award recipient to prepare a fact sheet that identifies the energy issue(s)/barriers that are preventing deployment, the planned research or investment initiative, and the potential benefits for information sharing with the public through the Energy Commission's website.

Energy Commission staff will oversee projects and evaluate benefit assessments, as needed, through regular communications, critical project review meetings, monthly or quarterly reports, and final reports. In cases where the contractors are not meeting the projected benefits, the Energy Commission will advise on an appropriate course of action. The agreement manager will draw on internal and external experts to review project results during critical phases. Through the life of the agreement, the Energy Commission will work with the researcher or award recipient to assess and report benefits through project interim reports and stakeholder workshops or conferences. Finally, the Energy Commission will work with the researcher or award recipient to publish a final project report that includes the research and/or project results, including the quantitative/qualitative benefits, methods used to measure the benefits and the issues/barriers resolved.

Achieving benefits will be aided by consultation with other industry and agency experts. As the Energy Commission continues to administer the EPIC Program, it will consult with interested stakeholders to vet research initiatives and market facilitation activities and seek feedback to ensure that the research and activities continue to provide clear electricity ratepayer benefits.

Project Closeout

During the project closeout phase, the Energy Commission will capture achieved research results, along with the targeted market potential. For a portion of projects, the Energy Commission will conduct in-depth post-project benefits assessment audits. Due to resource constraints, the Energy Commission will not do detailed analysis of all the EPIC-funded projects, but will instead strategically focus on a sample of closed projects that merit

consideration for follow-up interviews to determine represented quantitative and qualitative benefits. Additionally, the Energy Commission will validate the researcher's or award recipient's method(s) to measure benefits. The Energy Commission will share the benefits information in published project fact sheets, project final reports, annual reports to the CPUC, and through other avenues such as published technology brochures and trade journals.

Standard Practices

In all cases, the Energy Commission will document the steps of benefits assessment and transparently present the uncertainties in the benefits calculations. Additionally, peer review of benefits calculations will also be a central practice in the Energy Commission's benefits assessment. Moreover, the Energy Commission will evaluate the EPIC program benefits assessment processes by working with other benefits assessment practitioners, including government and other research organizations, to continually evaluate and improve the EPIC program benefits assessment process.

Next Steps

Through public workshops held in August 2012 and September 2012, the Energy Commission gained valuable stakeholder input for this first triennial Investment Plan. Public comments received during the workshops have helped to shape the investment initiatives presented in this proposed final investment plan. The Energy Commission plans to consider adopting a revised draft investment plan at the October 31, 2012 Business Meeting. The schedule calls for submitting a proposed investment plan to the CPUC on November 1, 2012. Consistent with the CPUC's Phase 2 decision, the CPUC will consider the Energy Commission's Plan, along with the Investment Plans of the three investor-owned utilities. The Phase 2 decision schedule calls for CPUC approval of the Investment Plan in May 2013. Staff plans to hold scoping workshops for the second triennial Investment Plan in early 2014, covering the 2015-2017 funding cycle.

After plan approval, the Energy Commission will prepare and issue solicitations to fund the initiatives outlined in this plan. The four administrators, including the Energy Commission and the three utilities, will file annual reports to the CPUC, starting in February 2014 and through February 2020, for review and oversight by the CPUC.

The Energy Commission looks forward to implementing the EPIC program and seeing these projects come to fruition for the benefit of customers that fund this program.

APPENDICES

Appendix A: Summary of Stakeholder Comments and Energy Commission Staff Responses on the August 2-3 and August 9-10 Workshops

Appendix B: Summary of Stakeholder Comments and Energy Commission Staff Responses on *The Electric Program Investment Charge Proposed 2012-14 Triennial Investment Plan*

Appendix C: Summary of Stakeholder Comments Presented During the September 27, 2012 Workshop on the *The Electric Program Investment Charge Proposed 2012-14 Triennial Investment Plan*

Appendix D: Tentative Implementation Schedule for the 2012-14 Electric Program Investment Charge Investment Plan

Appendix E: Sample Program Opportunity Notice Template

These appendices are available as a separate volume, publication number:

CEC-500-2012-082-SF-AP