



Electricity Generation in California

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Lecture Outline

- California's Energy Agencies
- California's Load Serving Entities
 - Investor Owned Utilities
 - Publically Owned Utilities
- California's Electric Grid: History of Central Generation
 - Historic Electricity Generation Policies
 - California Electric System Restructuring
 - California Energy Crisis – 2000
 - California's Electric System Today
- California's Electricity Generation Policies & Resources
- California's Climate-Energy Nexus
- California's Renewable Energy & Integration Challenges
- California's Electric Grid of Tomorrow



California Energy Commission

The California Energy Commission is the state's primary energy policy and planning agency. Created by the Legislature in 1974 and has eight basic responsibilities as it sets state energy policy:

- **Forecasting**: Forecasts future energy needs and maintains historical energy data
- **Permitting**: Permits thermal power plants 50 megawatts (MW) or larger
- **R&D**: Administers the Energy Research and Development programs, advancing science and technology in energy related fields
- **Energy Efficiency**: Promotes energy efficiency by setting the state's appliance and building standards
- **Renewable Energy**: Supports the development of renewables
- **Contingency Planning**: Plans for and directs the State's response to energy emergencies
- **Transportation**: Supports the deployment of alternative and renewable fuel sources and vehicle technologies
- **IEPR**: Publishes the Integrated Energy Policy Report (IEPR) – the State's energy policy document



California Energy Commission

Commissioners

Five Commission seats, appointed for five year, staggered terms.

Current Commissioners:

Chairman
Robert Weisenmiller



Scientist / Engineer

Commissioner
Janea Scott



Public Member

Commissioner
Andrew McAllister



Economist

Commissioner
David Hochschild



Environmental

Commissioner
Karen Douglas



Attorney



California Public Utilities Commission

In 1911, the California Public Utilities Commission (CPUC) was established by Constitutional Amendment as the Railroad Commission. In 1912, the Legislature passed the Public Utilities Act, expanding the CPUC's regulatory authority to include natural gas, electric, telephone, and water companies as well as railroads and marine transportation companies.

- **Energy Regulatory Authority Over Investor Owned Utilities (SCE, PG&E and SDG&E):**
 - **Sets electricity and natural gas retail rates by:**
 - Establishing each Investor Owned Utilities "fair" rate of return on infrastructure investments
 - Determines tariff language
 - **Promotes social, economic and environmental sustainability by:**
 - Mandating Investor Owned Utilities to implement the States renewable energy goals
 - Approving utility long term contracts with independent generators
 - Advancing climate strategies
 - **Promotes energy efficiency and demand response through the Investor Owned Utilities energy efficiency portfolio by:**
 - Setting energy saving targets
 - Evaluating, measuring and verifying energy savings
 - Rewarding Investor Owned Utilities with a risk/reward financial incentive based on evaluated energy savings
 - **Participates in transmission line planning and conducts environmental review/permitting for transmission projects**
 - **Ensures electric, natural gas, and propane gas system safety**



California Public Utilities Commission *Commissioners*

Five Commission seats, appointed for Six year, staggered terms.

Current Commissioners:

**President Michael
Peevey**



**Commissioner
Michel Florio**



**Commissioner
Catherine Sandoval**



**Commissioner
Carla Peterman**



**Commissioner
Michael Picker**



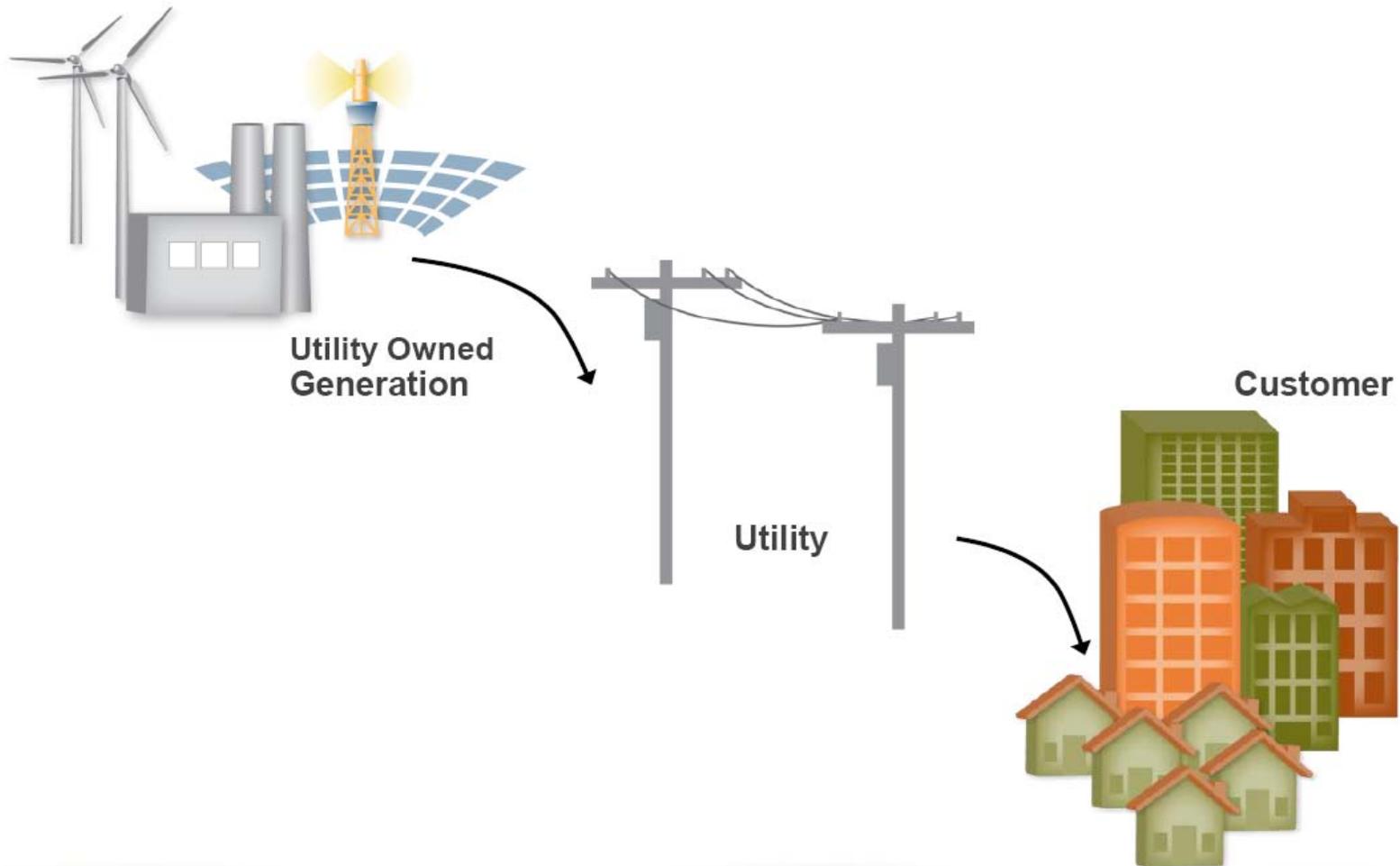


History of Electricity Generation in California



California's Electric Grid

A History of Central Generation





California's Load Serving Entities (LSE's)

- **LSE's Defined:** An entity that secures electric energy, transmission service, and related services to serve the demand of its customers.
- **Electric Utility Companies in California**
 - California is served by about 75 load-serving entities. These are broken down as:
 - Investor-Owned Utilities - 6
 - Publicly Owned Utilities - 48
 - Rural Electricity Cooperatives - 4
 - Native American Utilities - 3
 - Other Electricity Service Providers – 14



California's Five Largest Utilities

• Investor Owned Utilities

- Southern California Edison Company (SCE)
- Pacific Gas and Electric Company (PG&E)
- San Diego Gas & Electric (SDG&E)

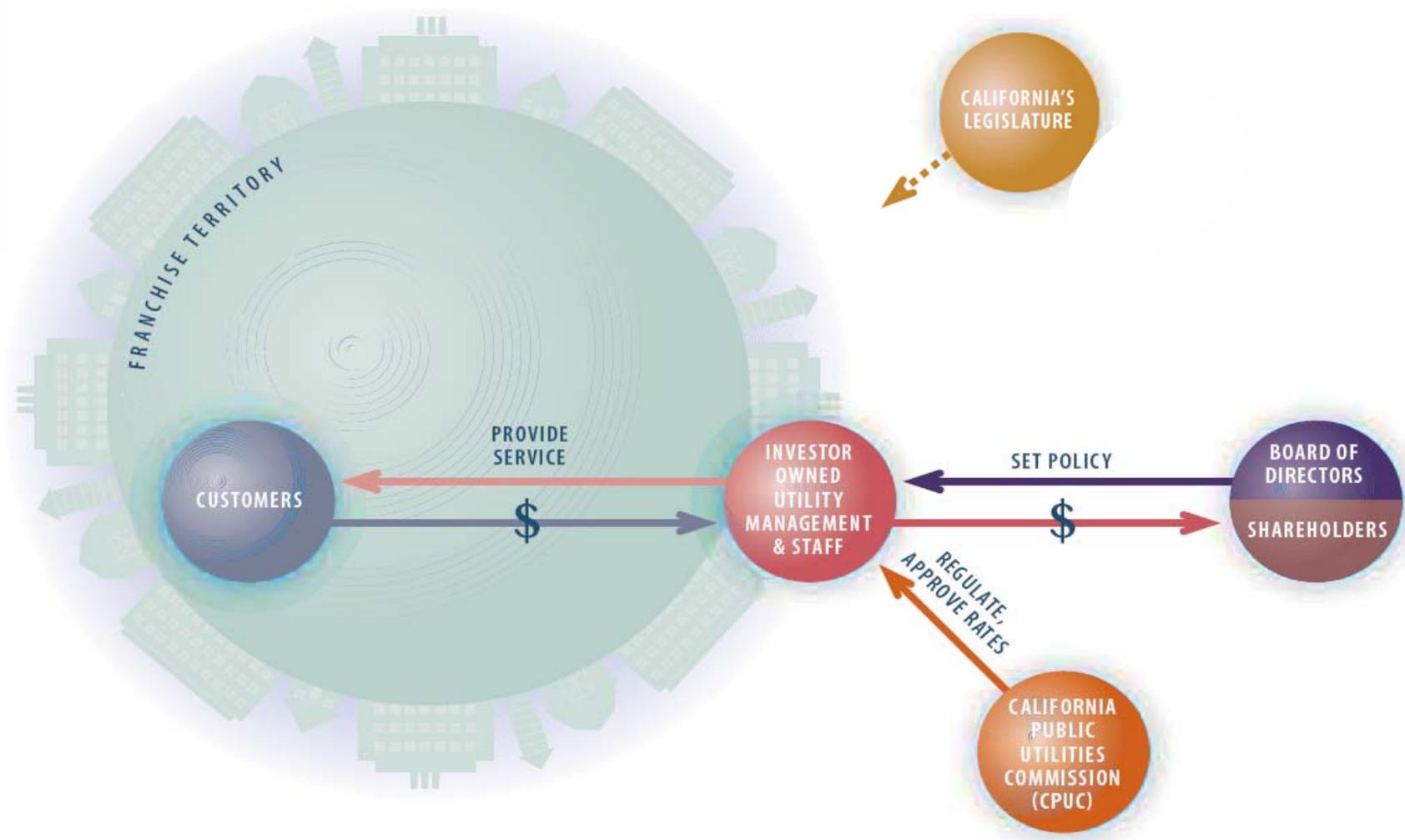
• Publically Owned Utilities

- Los Angeles Department of Water and Power (LADWP)
- Sacramento Municipal Utility District (SMUD)



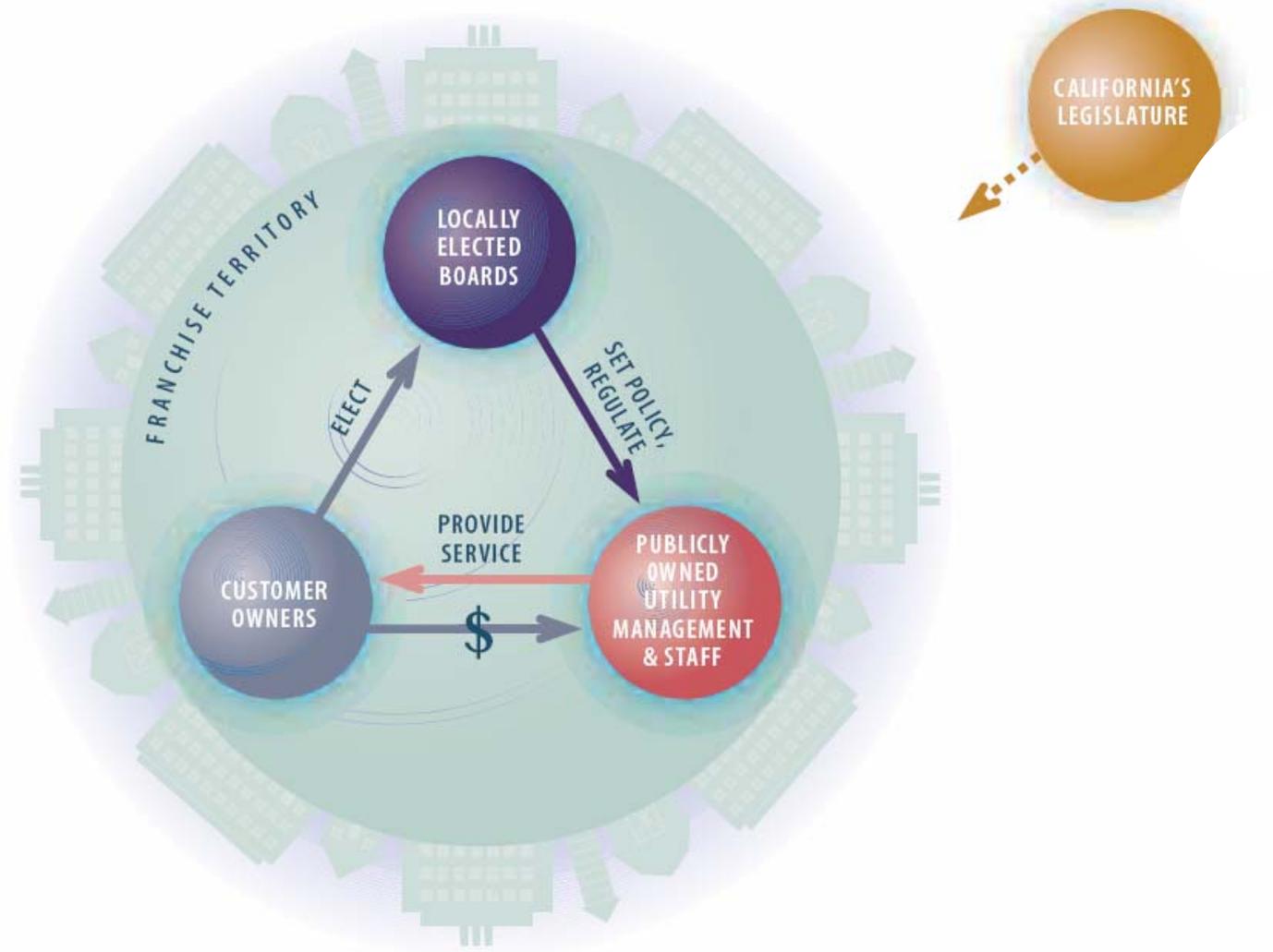


Investor Owned Utility *Structure & Management*





Publically Owned Utility *Structure & Management*





Electricity Generation Policies

- *The 1970's: Era of Federal Energy Policy*

- 1973 Arab Oil Embargo/Crisis brought the topic of energy supply and demand to the forefront of U.S. Policy.

- As a result:

- 1975 Energy Policy & Conservation Act
- 1977 Department of Energy Organization Act
- 1978 National Energy Act (comprised of 5 statutes)
 - 1978 Energy Tax Act
 - 1978 Natural Gas Policy Act
 - 1978 National Energy Conservation Policy Act
 - 1978 Power Plant & Industrial Fuel Use Act
 - 1978 Public Utility Regulatory Policies Act



Electricity Generation Policies

- *California Energy Policies - 1973 Arab Oil Embargo/Crisis*
 - Before and during the 1970's California's power plants were primarily fueled by Petroleum
 - In response to the 1973 Arab Oil Embargo/Crisis the State passed the Warren-Alquist Act in 1974 which Created the California Energy commission (CEC) to address the energy challenges facing the state
 - The CEC's original goal was to wean California's power plants off of unstable supplies of petroleum fuel and provided a one stop shop and transparent **public process** for power plant siting and environmental mitigation
- *California Energy Policies – Population Growth*
 - With a growing population and an increase in electricity demand, California's IOU's proposed building new Coal and Nuclear fueled power plants throughout California
 - Environmentalists, the CEC and the California Public Utilities Commission disapproved this proposal and determined it was more cost-effective to invest in energy efficiency, renewable energy and natural-gas power plants



California Electric System *Restructuring*

- **1990's: Time of Energy Deregulation/Restructuring**
 - The CPUC initially developed a framework to transition California's electric Investor Owned Utilities (IOUs: PG&E, SDG&E, SCE) from a vertically integrated monopolistic market to a competitive market which in theory would lead to cheaper electric prices and a more efficient electric system.
 - **In 1996 the State Legislature passed AB 1890 whereby:**
 - Created the State non-profit **California Power Exchange (CPX)** to manage the competitively priced bids between independent energy producers and the IOUs
 - Created the State non-profit **California Independent Systems Operator (ISO)** to coordinate, operate and manage the flow of electricity through California's transmission lines
 - Each IOU was required to divest powers plants to independent energy producers (except hydro-power and nuclear power facilities)
 - Each IOU would own transmission and distribution lines and would be responsible for retail electric sales
 - IOUs were required to purchase wholesale electricity from independent energy producers through the CPX on the day ahead market



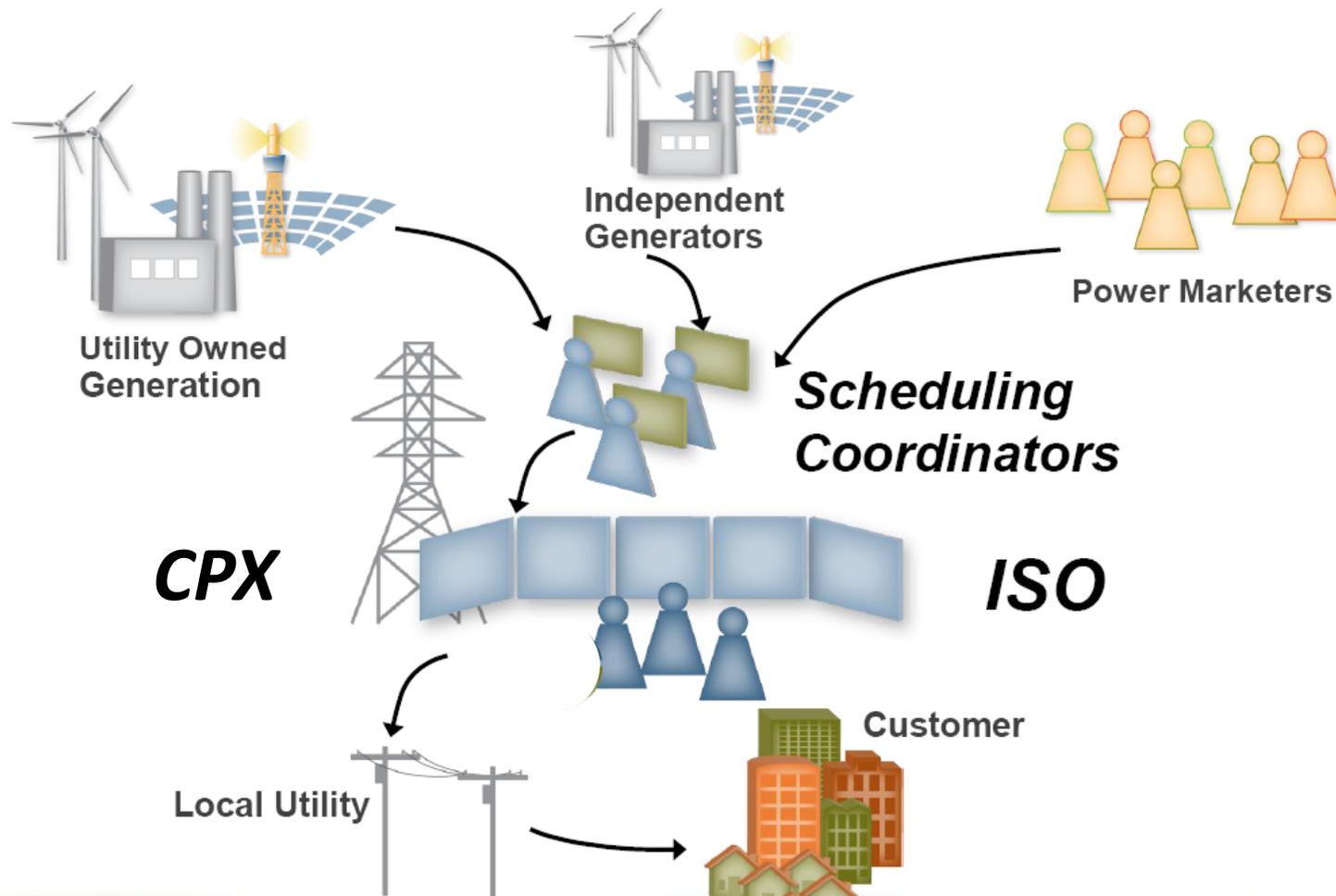
California Independent System Operator Territory & Transmission Lines





California's Electric System

Deregulation/Restructuring





California Energy Crisis

Lessons Learned

- 2000-2001 rolling blackouts in California
- Cited reasons for failure:
 - Gaming of system by independent energy providers
 - Competitive wholesale prices but frozen retail prices (partial deregulation)
 - Issue of recovering IOU stranded costs (high priced investments: nuclear facilities, renewable energy etc.)
 - Utilities unable to enter into Long-Term contracts with independent energy producers
 - Federal Energy Regulatory Commission (FERC) fails to set price cap on high electric prices



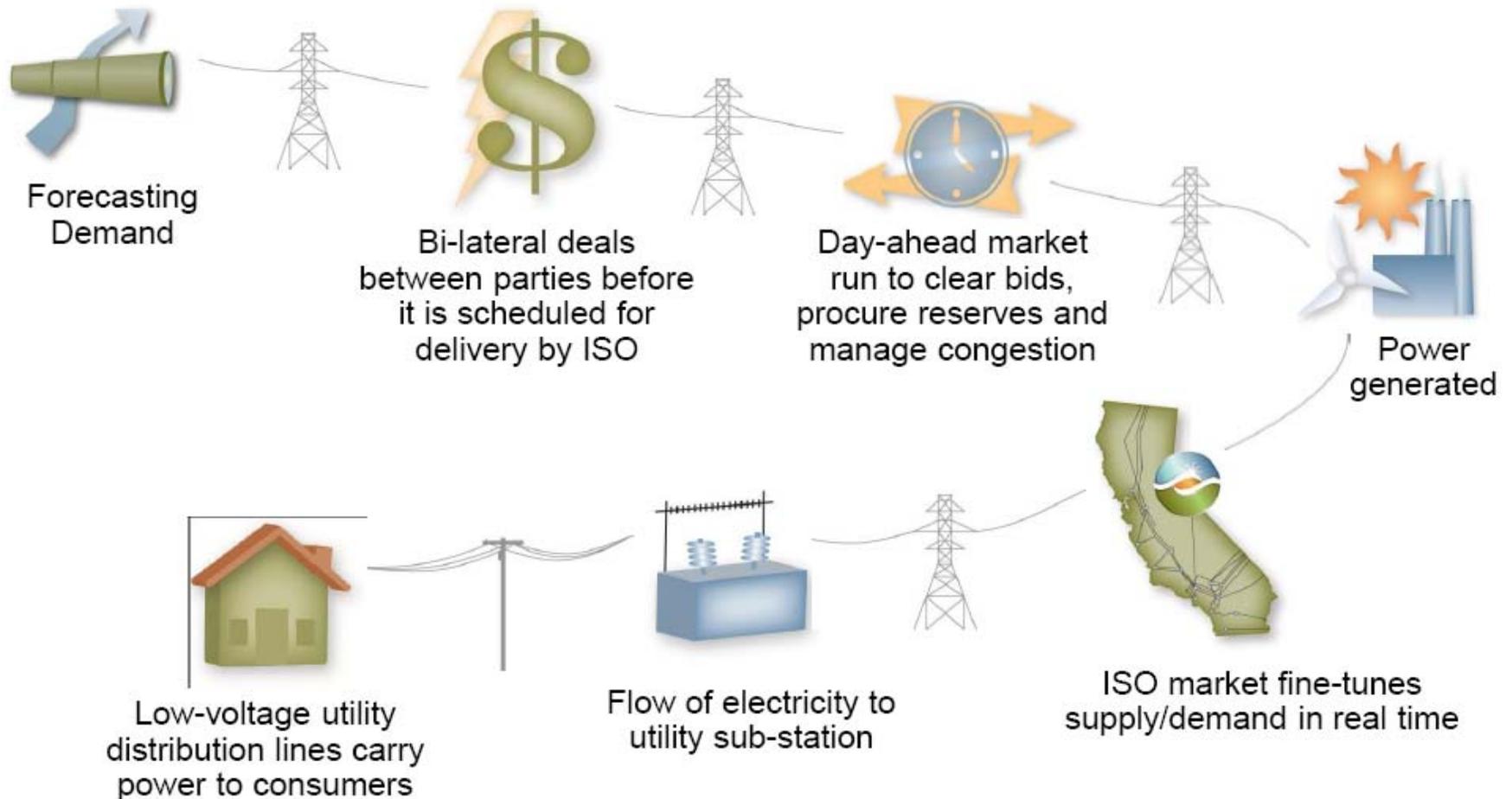
California Energy Crisis

Combating the Crisis

- State issues bonds through the Dept. of Water Resources to purchase electricity and stabilize wholesale electricity market
- CPX was dissolved and responsibilities were subsumed by ISO
- Flex Alerts issued throughout the State
- IOU's could enter into long term contracts with pre-approval from the CA Public Utilities Commission



Flow of Electricity Today





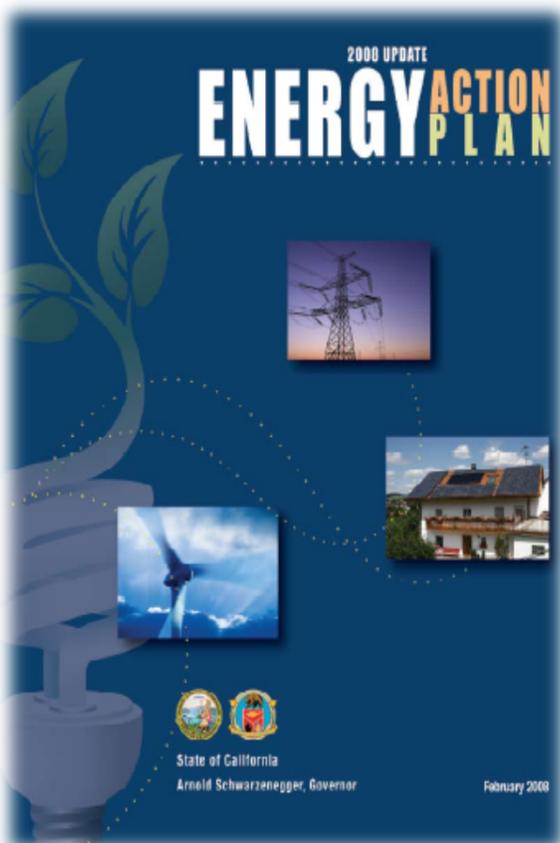
California's Electricity

Generation Policies & Resources



California's Energy Policy *Loading Order*

In 2003, California's *Energy Action Plan* defined a loading order to address the state's increasing electricity demand



1. Energy efficiency & Demand Response
2. Renewable Energy & Distributed Generation
3. Clean fossil-fueled sources & infrastructure improvements

This strategy benefits CA by reducing Greenhouse Gas emissions and diversifying energy resources.



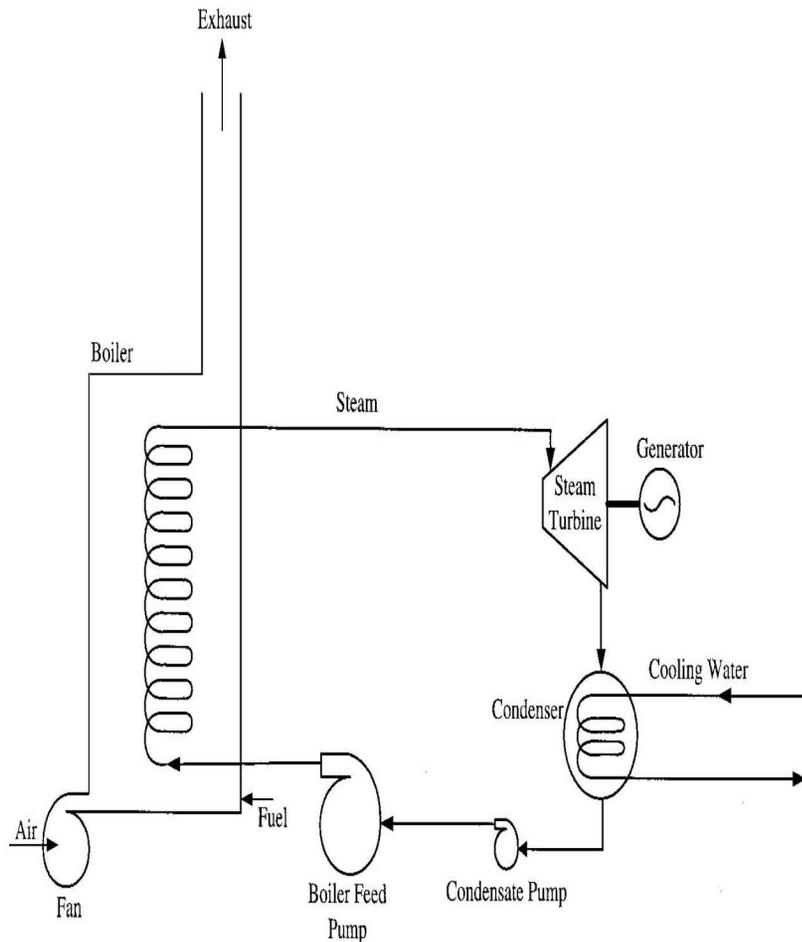
2012 Total Electric System Power *Fuel Sources*

2012 Total System Power in Gigawatt Hours

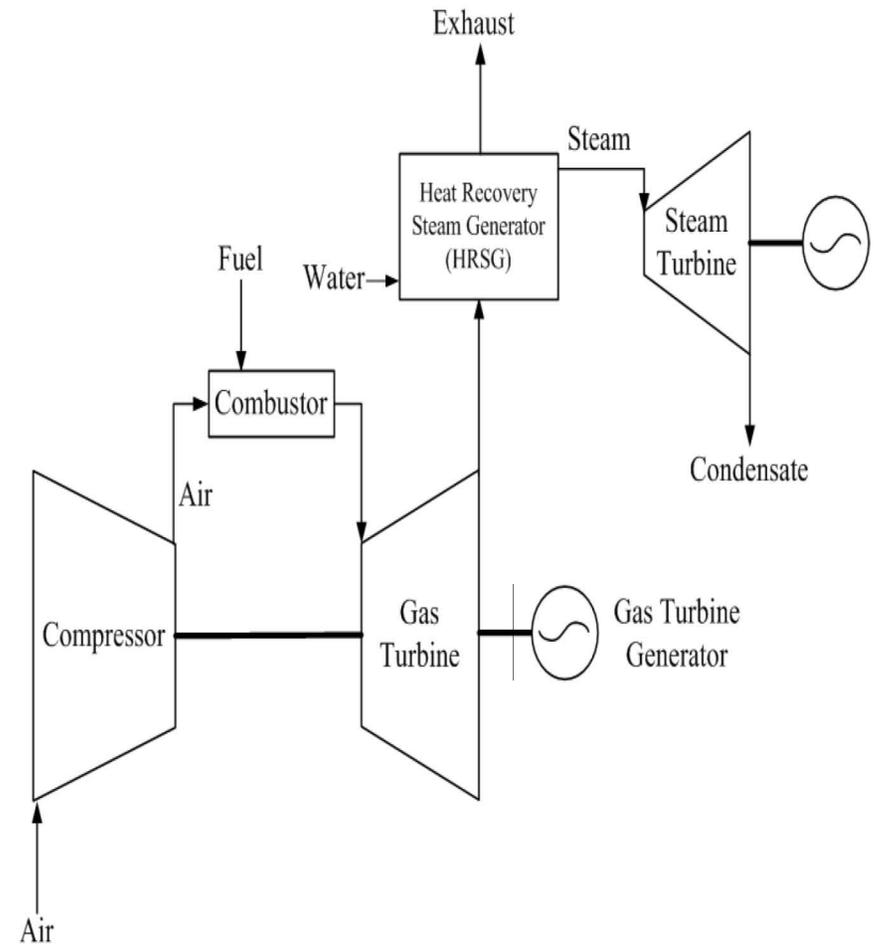
Fuel Type	California In-State Generation (GWh)	Percent of California In-State Generation	Northwest Imports (GWh)	Southwest Imports (GWh)	California Power Mix (GWh)	Percent California Power Mix
Coal	1,580	0.8%	561	20,545	22,686	7.5%
Large Hydro	23,202	11.7%	12	1,698	24,913	8.3%
Natural Gas	121,716	61.1%	37	9,242	130,995	43.4%
Nuclear	18,491	9.3%	-	8,763	27,254	9.0%
Oil	90	0.0%	-	-	90	0.0%
Other	14	0.0%	-	-	14	0.0%
Renewables	34,007	17.1%	9,484	3,024	46,515	15.4%
Biomass	6,031	3.0%	1,025	23	7,079	2.3%
Geothermal	12,733	6.4%	-	497	13,230	4.4%
Small Hydro	4,257	2.1%	204	-	4,461	1.5%
Solar	1,834	0.9%	-	775	2,609	0.9%
Wind	9,152	4.6%	8,254	1,729	19,135	6.3%
Unspecified Sources of Power	N/A	N/A	29,376	20,124	49,500	16.4%
Total	199,101	100.0%	39,470	63,396	301,966	100.0%



California's Natural Gas Power Plants



Simple Cycle



Combined Cycled

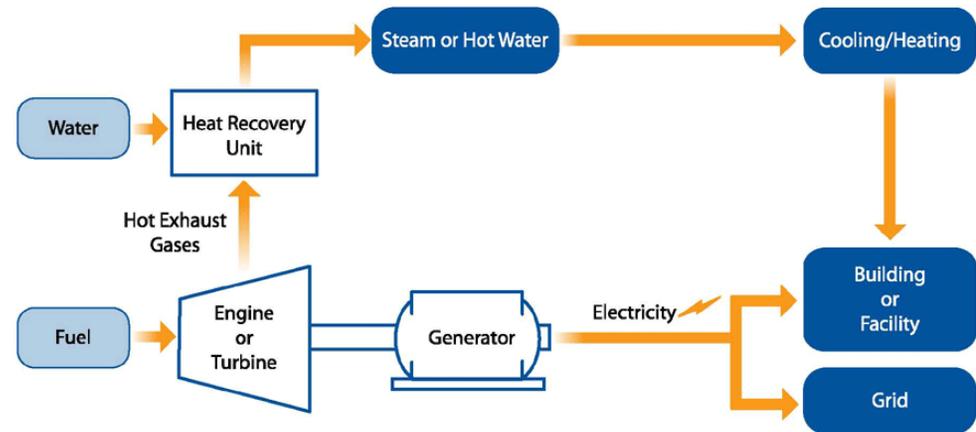


California's Natural Gas Power Plants

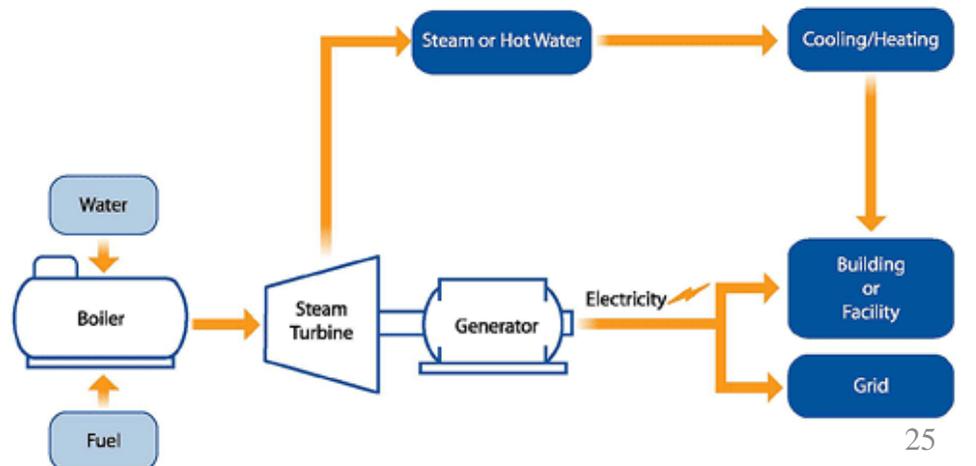
Combined Heat & Power (CHP)

- Roughly 8,700 MW of installed capacity in California
- *Defining CHP:* Simultaneous generation of electricity and useful heat from a single source of fuel

Topping Cycle CHP



Bottom Cycle CHP





Nuclear Generation in California



San Onofre Nuclear Generating Station



Diablo Canyon Nuclear Generating Station



San Onofre Nuclear Generating Station

Recent Outage & Near Future

- **January 31, 2012** Unit 3 had a small radiation leak and was shut down (Unit 2 was already down for routine maintenance)
- **March 2012** Nuclear Regulatory Commission (NRC) sent an Augmented Inspection Team to gather facts about SONGS and NRC issued Confirmatory Action Letter (CAL) describing actions SCE needed to take prior to returning Unit 2 and 3 to power generation
- **July 18, 2012** NRC issued the Augmented Inspection Team Report identifying 10 unresolved items that warranted additional follow-up
- **October 2012** SCE submitted to NRC their response to the CAL and filed their plan to restart Unit 2 at 70% for 5 months. CPUC opened proceeding on Order Instituting Investigation (OII) to investigate issues raised by the extended outages of Units 2 and 3 and the resulting effects on the provision of safe and reliable electric service
- **May 2013** Week long Evidentiary Hearings was held on Phase I of the OII
- **June 7, 2013** SCE announced decision to permanently retire SONGS. At the end of June, all fuel had been removed from Unit 3.
- **July 2013** All fuel removed from Unit 2. ALJ s Darling and Dudley issued memo clarifying scope of Phase 2: “the values of SONGS assets in rate base.”
- **October 2013** Week long Evidentiary Hearings held on Phase III of OII
- **May 13, 2014** CPUC will hold an Evidentiary Hearing on the Motion to Adopt settlement filed by Settling Parties in the consolidated SONGS OII proceedings.



Need a Variety of Energy Resources

Reliability & Demand

Type	Energy (MWs)	Contingency response	Voltage support (VARs)	Direct GHG emissions
Energy Efficiency	Yes ²	Yes ²	Yes ²	Low
Demand Response	Yes	Yes	No	Low
Combined Heat & Power	Yes	Maybe	Yes	High
Storage	Yes	Yes	Maybe	Medium 1
Rooftop Solar	Yes	No	No	Low
Synch Condenser and other voltage support devices	No	Yes	Yes	Medium 1
Gas Peaker/CT	Yes	Yes	Yes	High
Gas Combined Cycle	Yes	Yes	Yes	High
Transmission	Yes	Yes	Yes	Medium 1

[1] The GHG attributes of storage and synchronous condensers depend on the energy used from the grid

[2] Reduces overall load and requirements



Near Term Actions (2013 - 2018)

VARs	MW	VARs & MW
Permit Talega & San Onofre Mesa projects	Flex-Alert funding beyond 2014	Maintain capacity at Cabrillo II - COMPLETE
Extend Huntington Beach synchronous condensers	Permit construction of Sycamore-Penasquitos 230kv line	Timely action on Pio Pico - COMPLETE
Modify San Onofre voltage criteria (w/SCE) - COMPLETE	Authorize acceleration of EE, DR, DG, and storage procurement in target areas	Authorize procurement to replace Encina - COMPLETE
Timely decisions to convert San Onofre site to a synchronous condenser	Evaluate transmission alternatives	Timely decisions to license replacements for OTC capacity
	Develop & implement multi-year auction for DR and EE	Create contingency permitting process

 CPUC
 CEC
 ISO



Long-Term Actions (2019 & Beyond)

CPUC

- Authorize additional resources thru LTPP and other proceedings, including EE, DR, DG, storage
- Direct SDG&E and SCE to pursue contingency permits in Northern San Diego County and LA Basin that will be competitively bid to independent generation developers
- Address potential need for gas infrastructure in San Diego

CEC

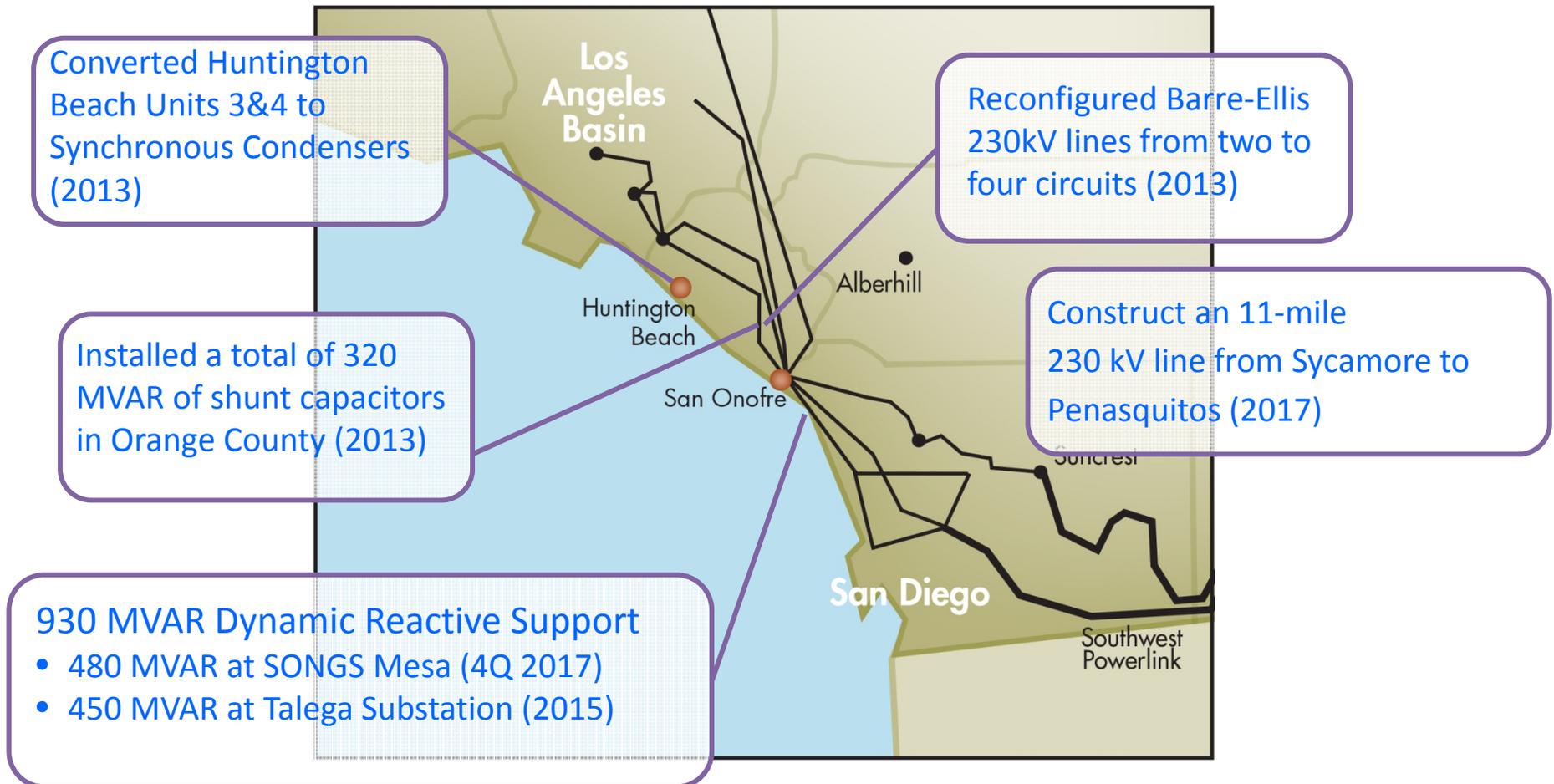
- Conduct siting review of contingency generation
- Establish contingency approach to OTC compliance deadlines in consultation with the State Water Resources Control Board

ISO

- Consider transmission alternatives - AC, DC, sub-marine cables
- Monitor system upgrades in collaboration with the CEC and CPUC
- Trigger contingency backups



Completed Transmission Upgrades and Future Projects Approved by the ISO Board of Governors





California's Climate-Energy Nexus

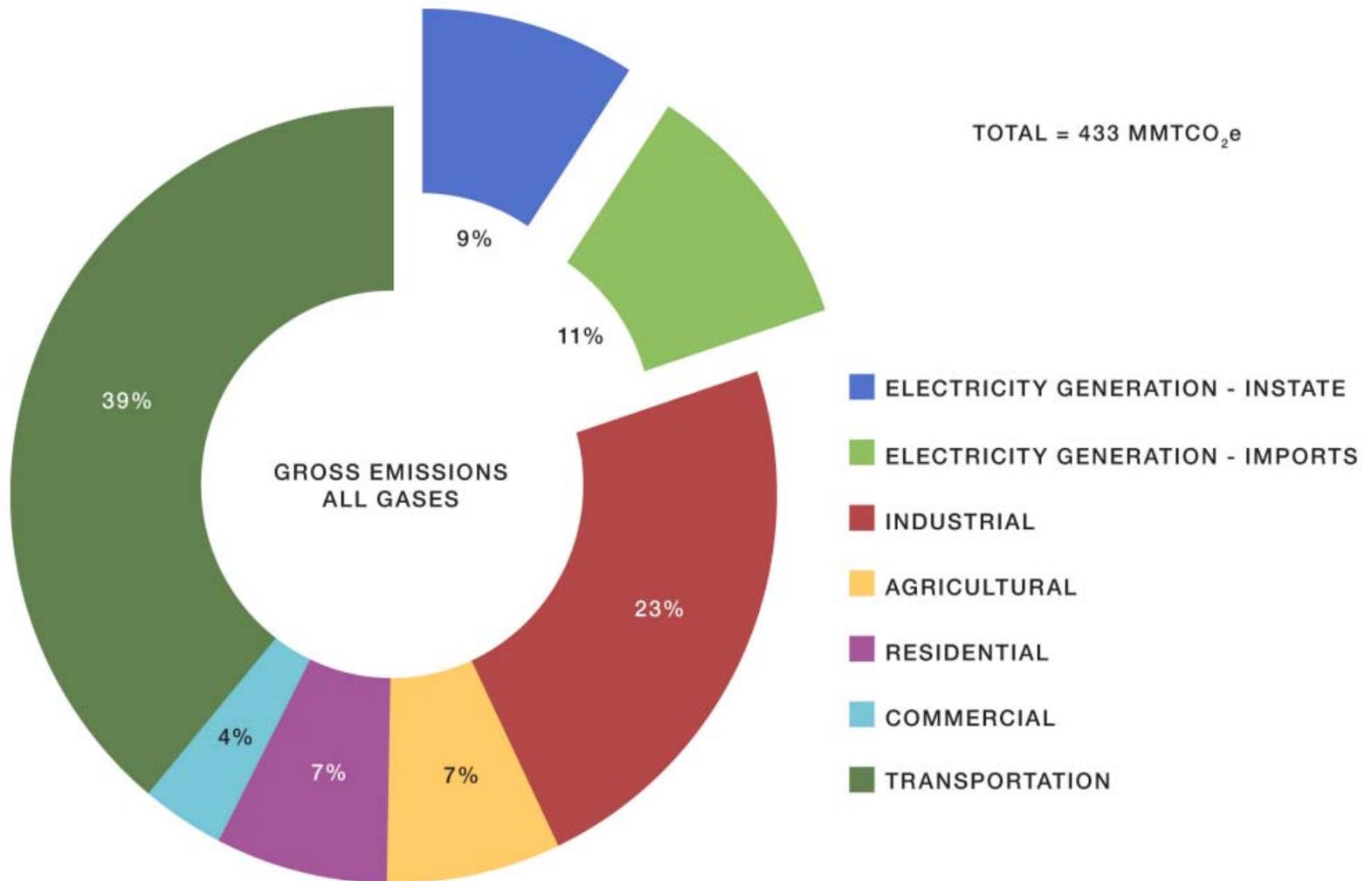


Assembly Bill 32: *The California Global Warming Solutions Act of 2006*

- AB 32 (2006) - landmark legislation requiring California to reduce its greenhouse gas (GHG) emissions to 1990 levels by 2020
- AB 32 directed the California Air Resources Board (ARB) to establish a comprehensive program of regulatory/market mechanisms to achieve real, quantifiable, cost-effective reductions of GHG. (Cap & Trade)
- In December 2008, ARB adopted the "Scoping Plan" -- California's policy blueprint containing the broad overview of programs, measures, and approaches to achieve the required GHG emission reductions.
- ARB has held 6 Cap & Trade Auctions since Nov. 14, 2012
 - **2014 Settlement Price Per Allowance: \$11.48**



California's 2011 Greenhouse Gas Emissions *By Sector*





Reducing Greenhouse Gas Emissions

Electricity Sector

2008 ARB 32 Scoping Plan

Recommended Actions for Electricity Sector

MEASURE	GHG REDUCTIONS (MMTCO ₂ E)
Energy Efficiency (32,000 GWh of Reduced Demand) <ul style="list-style-type: none"> • Increased Utility Energy Efficiency Programs • More Stringent Building & Appliance Standards • Additional Efficiency and Conservation Programs 	15.2
Combined Heat and Power Increase Combined Heat and Power Use by 30,000 GWh	6.7
Renewables Portfolio Standard Achieve a 33% renewables mix by 2020	21.3
Million Solar Roofs (Including California Solar Initiative, New Solar Homes Partnership, and solar programs of publicly owned utilities) <ul style="list-style-type: none"> • Target of 3,000 MW Total Installation by 2020 	2.1
TOTAL	45.3



Assembly Bill 32

Scoping Plan Update

- California is well on its way to meet the 2020 GHG target.....
- The *Update* covers a range of topics:
 - Latest scientific findings related to climate change and its impacts
 - A review of progress-to-date, including an update of Scoping Plan measures and other state, federal, and local efforts to reduce GHG emissions
 - Potential technologically feasible and cost-effective actions to further reduce GHG emissions by 2020.
 - Recommendations for establishing a mid-term emissions limit that aligns with the State's long-term goal of an emissions limit 80% below 1990 levels by 2050.
 - Sector-specific discussions covering issues, technologies, needs, and ongoing State activities to significantly reduce emissions throughout California's economy through 2050.



Renewable Energy in California & --- Integration Challenges



Solar Thermal in California

Centralized-Generation



Parabolic Troughs:

Solar Energy Generating Station
- SEGS I to IX 354 MW

**Power Tower: Ivanpah-
Brightsource, 370 MW**





Solar Photovoltaic in California

Centralized-Generation

California
Valley Solar
Ranch
(250 MW)



First Solar
Desert
Sunlight
Power Plant
(550 MW)



Wind Farms in California

Centralized-Generation



Tehachapi Wind Farm



Rio Vista Wind Farm



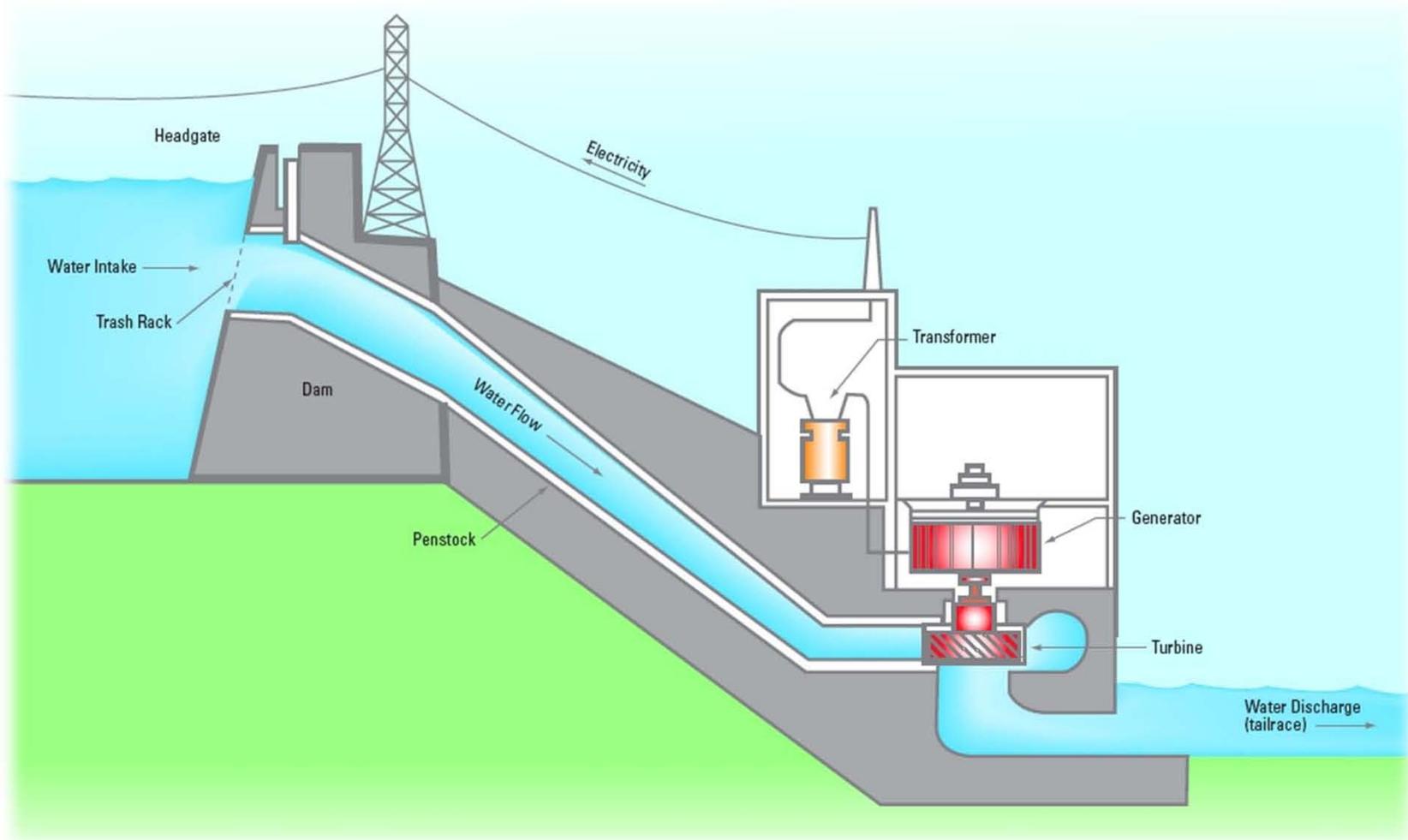
Altamont Pass Wind Farm

San Geronio Pass Wind Farm





Hydro-Electric Generation in California





Biomass Generation in California



**Mt. Poso Biomass
Plant (44 MW)**





Geothermal in California

The Geysers in the Mayacamas Mountains (835 MW)



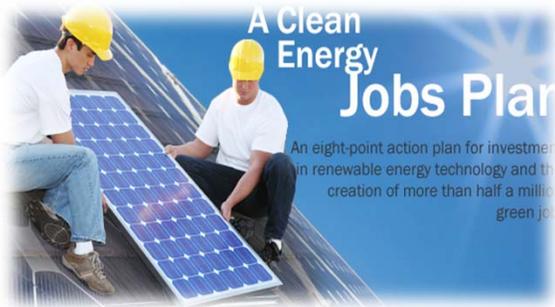


Transmission Lines to Meet 33% RPS by 2020



Transmission upgrade	Approval status		Online
	ISO	CPUC	
1 Carrizo-Midway	LGIA	NOC effective	energized
2 Sunrise Powerlink	Approved	Approved	energized
Suncrest dynamic reactive	Approved	Not needed	2017
3 Eldorado-Ivanpah	LGIA	Approved	energized
4 Valley-Colorado River	Approved	Approved [†]	energized
5 West of Devers	LGIA	Pending	2019
6 Tehachapi (segments 1, 2 & 3a of 11 completed)	Approved	Approved	2015
7 Cool Water-Lugo	LGIA	Pending	2018
8 South Contra Costa	LGIA	Not yet filed	2015
9 Borden-Gregg	LGIA	Not yet filed	2015
10 Imperial Valley C Station	Approved	Not needed	2014
11 Sycamore-Penasquitos	Approved	Not yet filed	2017
12 Lugo-Eldorado line reroute	Approved	Not yet filed	2020
13 Lugo-Eldorado and Lugo-Mohave series caps	Approved	Not needed	2016
14 Warnerville-Bellota recond.	Approved	Not yet filed	2017
15 Wilson-Le Grand recond	Approved	Not yet filed	2020

Source: CAISO



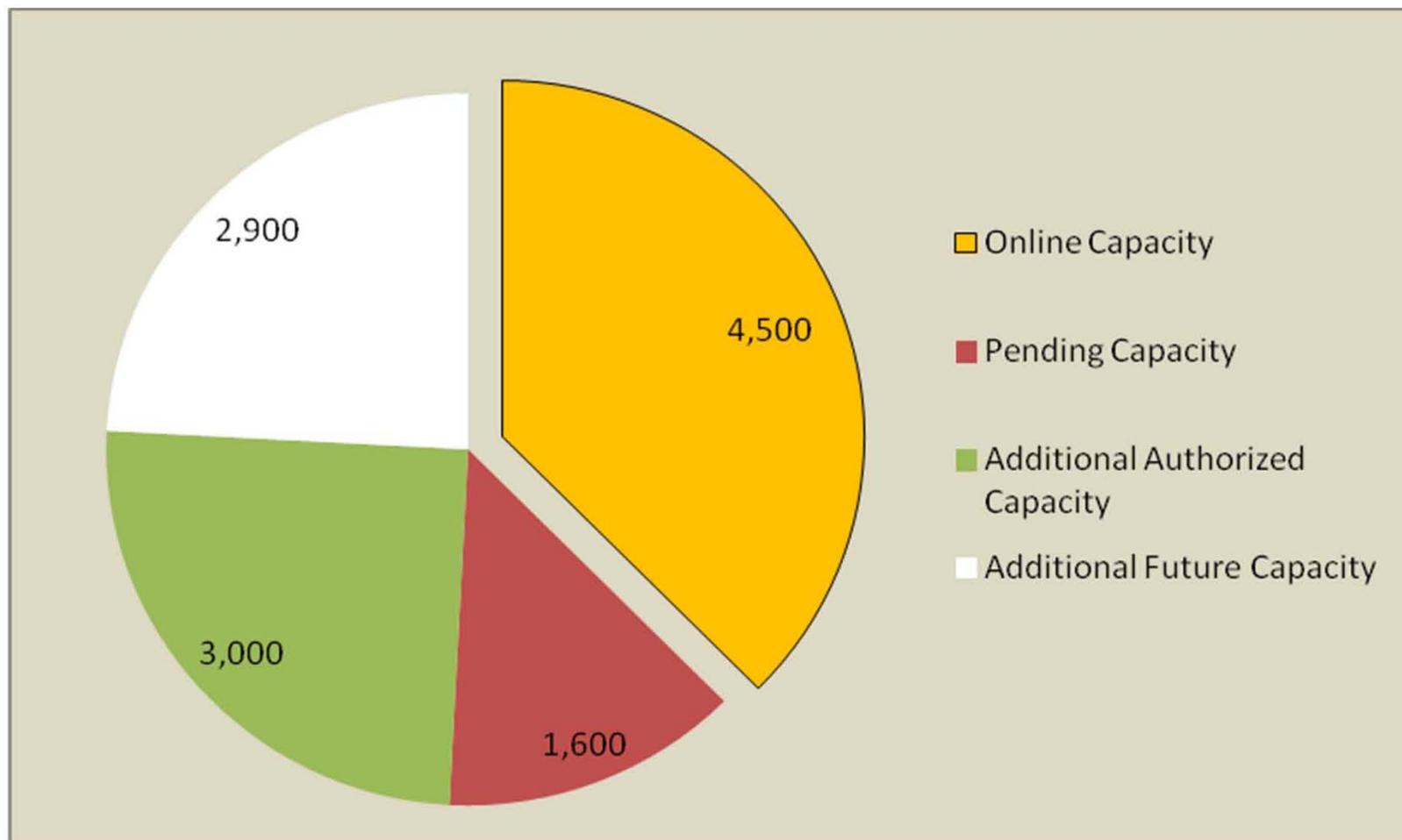
Renewable *Distributed Generation*

- Governor Brown's Clean Energy Jobs Plan Calls for:
 - 12,000 MW of “Distributed Generation”
- Defining “Distributed Generation”
 - Fuels and technologies accepted as renewable for purposes of Renewable Portfolio Standard
 - Sized up to 20 MW
 - Located within low-voltage distribution grid or supply power directly to consumer





Renewable Distributed Generation in California *20 MW or Smaller – Wholesale & Self-Generation*

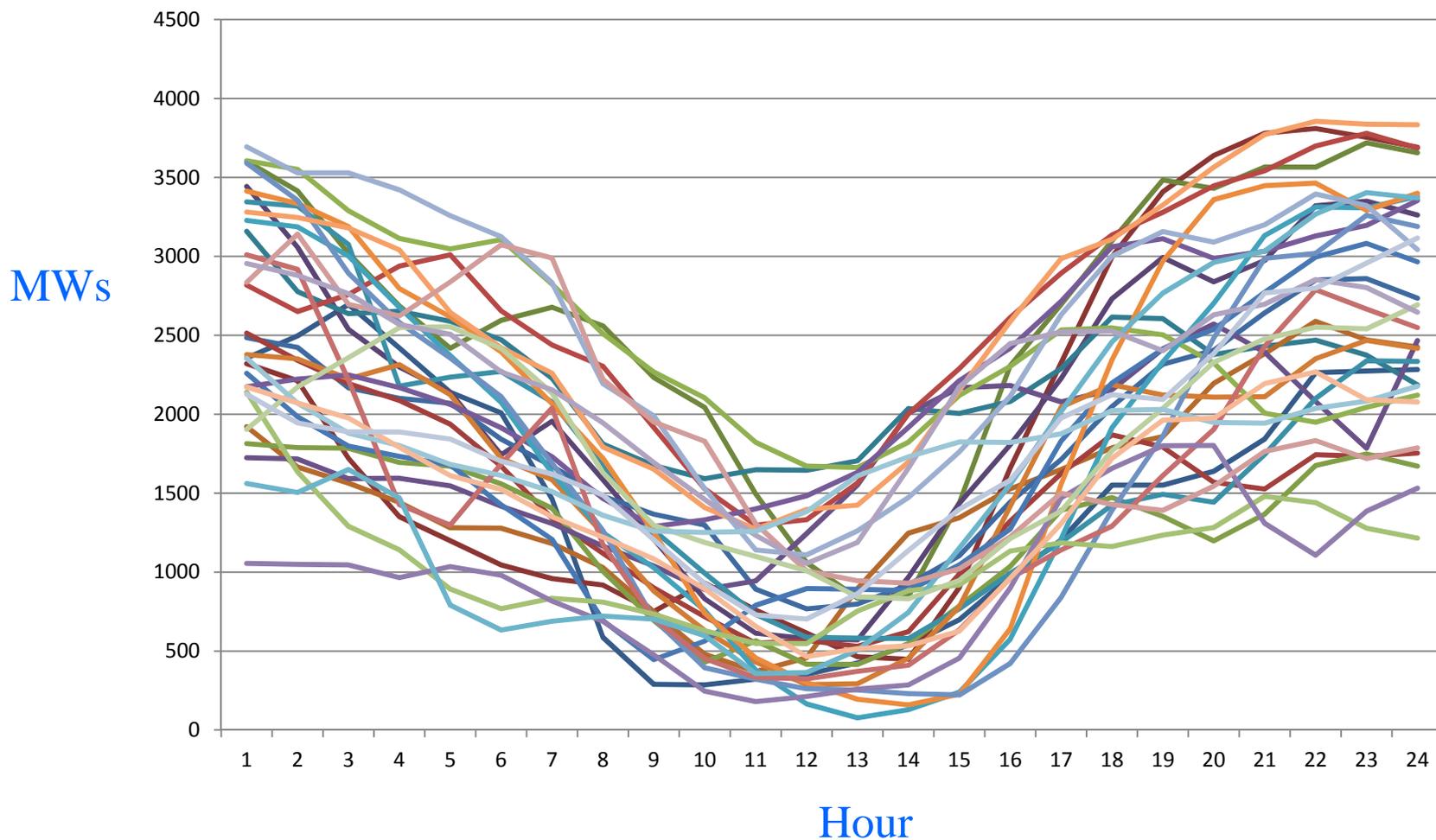




Example: Wind Generation

Differs Day to Day = Challenging to Forecast & Integrate

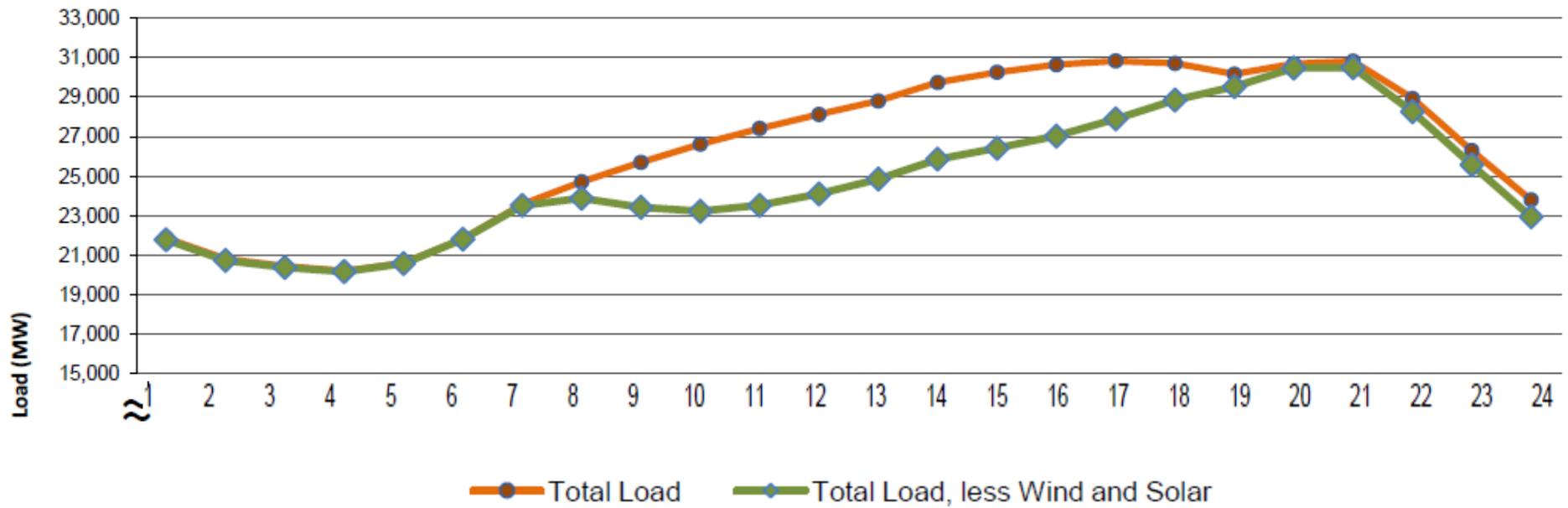
Daily Wind Managed by CAISO, July 2013





Demand Minus *Wind & Solar Generation*

Hourly Average Net Load





Integrating Renewable Energy: *California's Electricity Supply Portfolio*

- Combined-Cycle Natural-Gas Fired Power Plants (efficient & fast-ramping)
- Electricity Storage
- Demand Response
- Regional Coordination

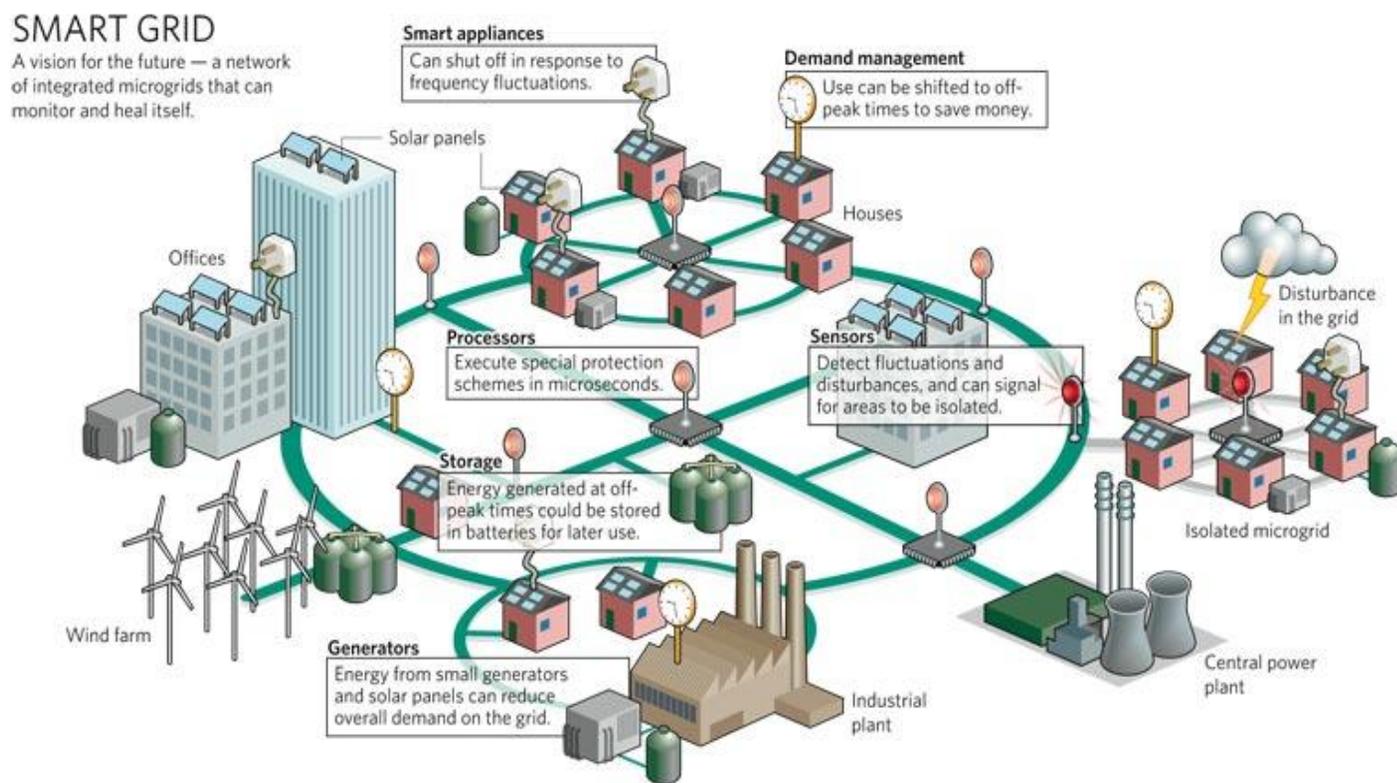


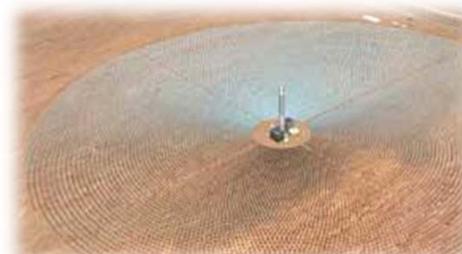


California's Electric System of Tomorrow

Smart Grid

- **Defining Smart Grid:** Modernizing our electric system with digital and two-way communication technologies for a cleaner, more efficient, secure and reliable electric system.





Any Questions?

Chair Robert Weisenmiller
California Energy Commission

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