

# Electricity Generation in California

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# Outline

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- California's Energy Agencies
- California Load Serving Entities
  - Investor Owned Utilities
  - Publically Owned Utilities
- California's Electric Grid: History of Central Generation
- Historic Electricity Generation Policies
  - Federal Policies
  - State Policies
- California Electric System Restructuring
- California Energy Crisis – 2000
- California's Electric System Today
- California Electric Generation Fuel Sources
- California's Electric Grid of Tomorrow



# California Energy Commission

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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 Public Interest Energy Research (PIER) program, advancing science and technology in energy related fields
- **Energy Efficiency**: Promotes energy efficiency by setting the state's appliance and building standards (Title 20 & 24)
- **Renewable Energy**: Supports the development of renewables through incentives authorized by the Public Goods Charge
- **Contingency Planning**: Plans for and directs the State's response to energy emergencies
- **Transportation**: Supports the deployment of alternative and renewable fuel sources
- **IEPR**: Publishes the Integrated Energy Policy Report (IEPR) – the State's energy policy document



# California Energy Commission

## *Commissioners*

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Overseen by 5 commissioners who are appointed for staggered  
5 – year terms

### Current Commissioners\*:

**Chair Robert  
Weisenmiller**



**Scientist / Engineer**

**Commissioner  
Karen Douglas**



**Attorney**

**Commissioner  
Andrew McAllister**



**Economist**

\* Environmental & Public Member Commissioner positions are vacant pending Governor's Appointment



# California Public Utilities Commission

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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*

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Overseen by 5 commissioners who are appointed for staggered  
6 – year terms

### Current Commissioners:

**President Michael  
Peevey**



**Commissioner  
Michel Florio**



**Commissioner  
Catherine Sandoval**



**Commissioner  
Mark Ferron**



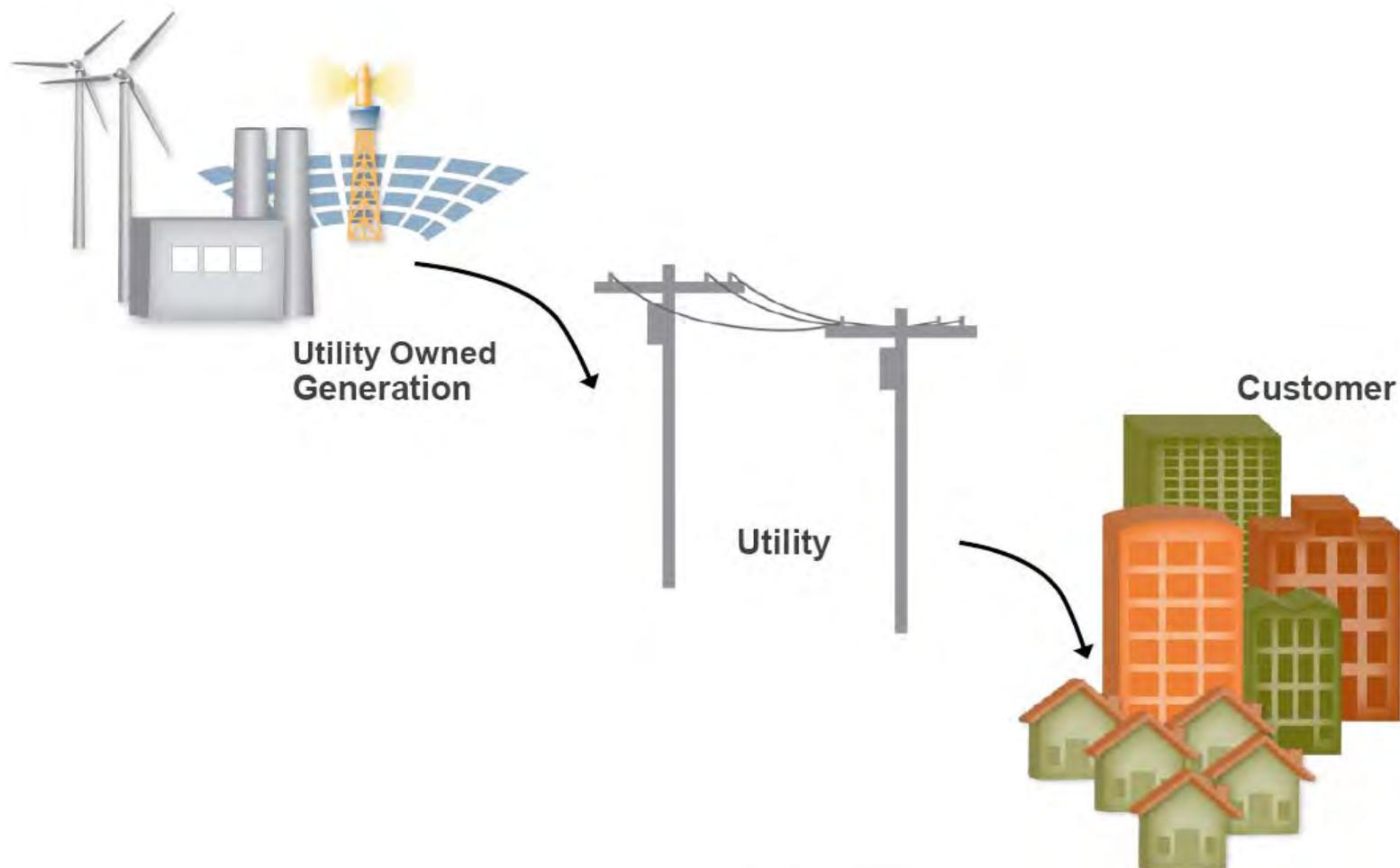
**Commissioner  
Carla Peterman**





# California's Electric Grid

## *A History of Central Generation*





# California's Load Serving Entities (LSE's)

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- **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)

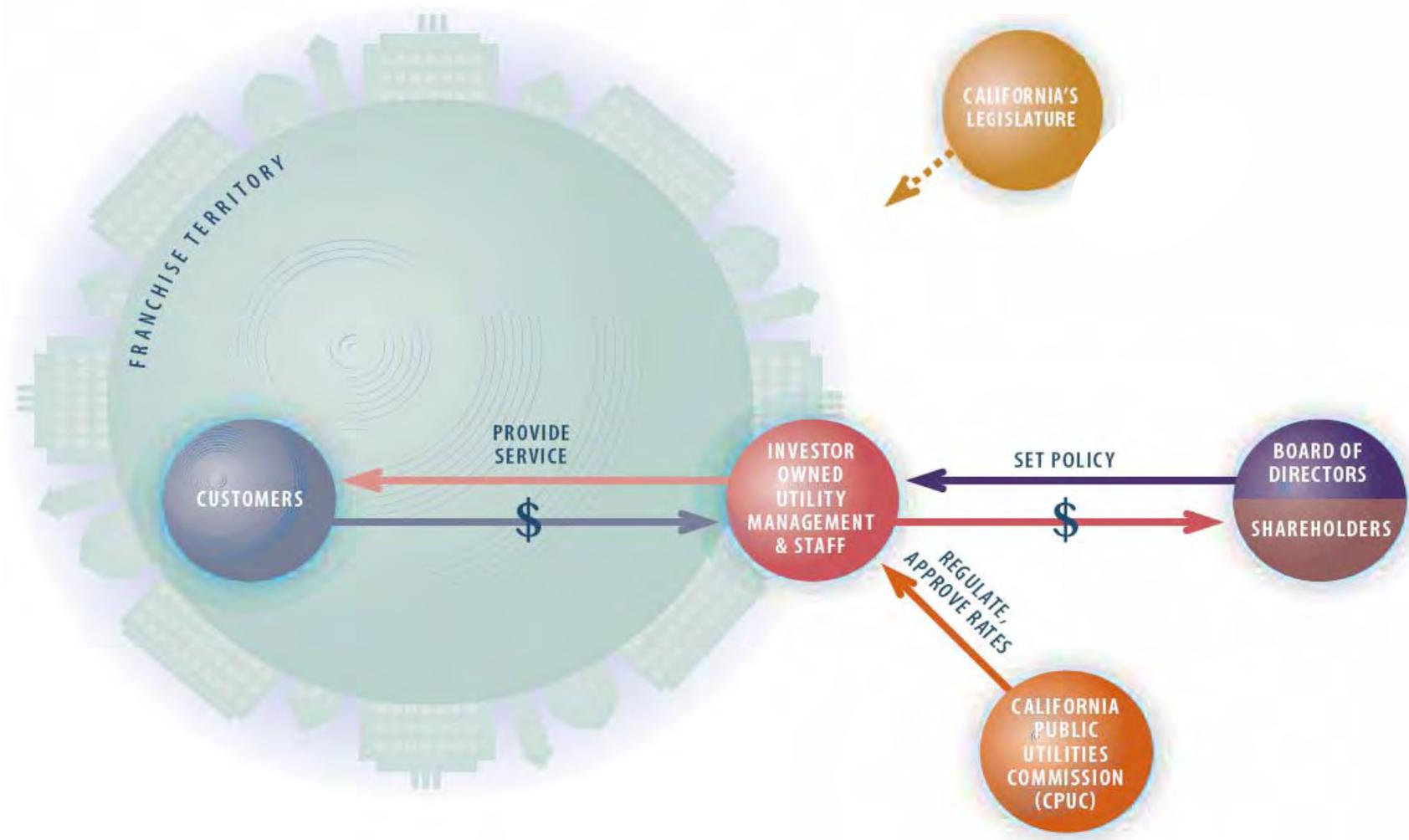
## • Publically Owned Utilities

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



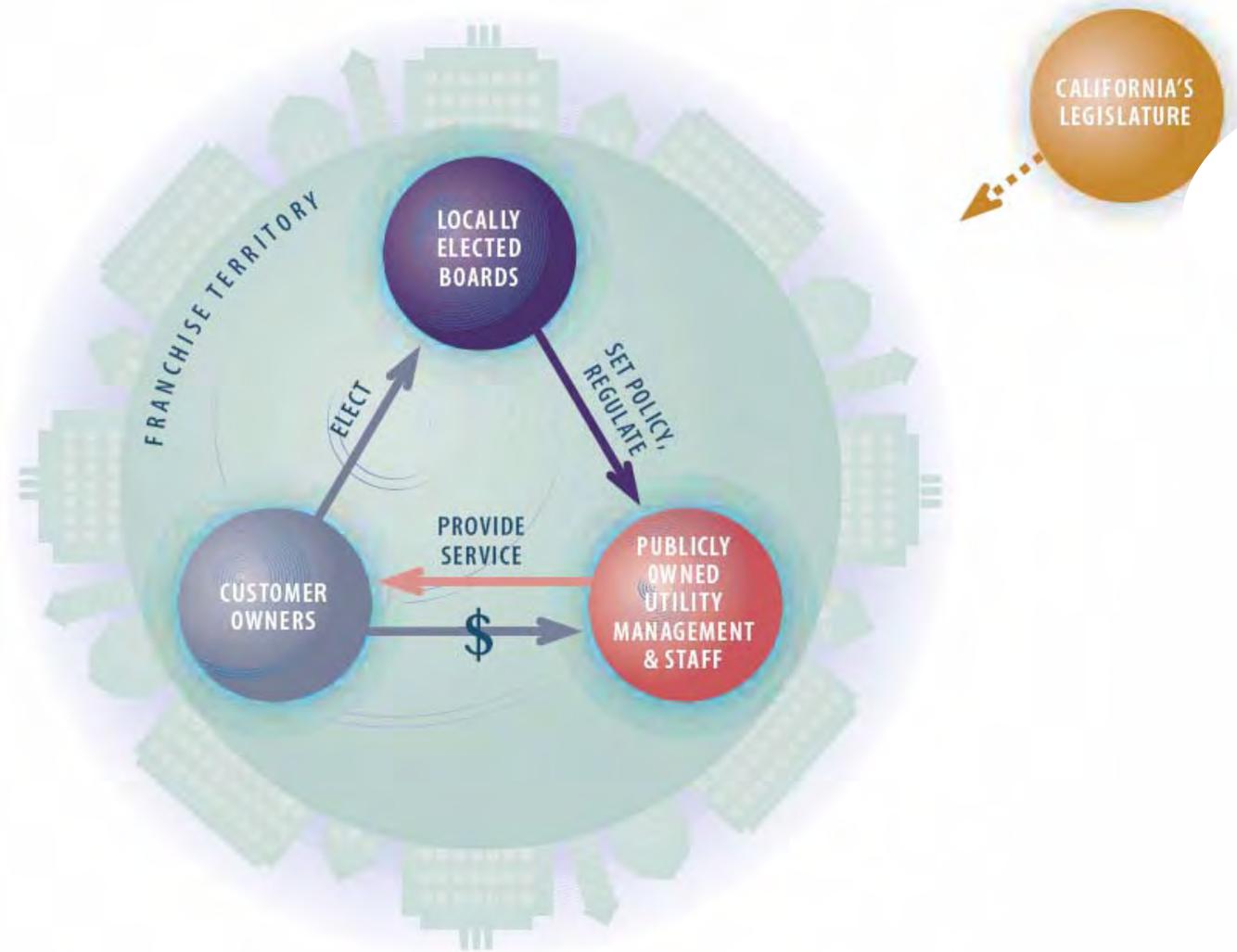


# Investor Owned Utility *Structure & Management*





# Publically Owned Utility *Structure & Management*





# Electricity Generation Policies

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- *The 1970's: Era of Federal Energy Policy*
  - 1973 Arab Oil Embargo/Crisis brought the topic of energy supply and use 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
      - 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

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- **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 provide 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
  - Environmentalist, 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*

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- **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 the Independent energy producers and the IOUs
    - Created the State non-profit **California Independent Systems Operator (ISO)** to coordinates, operates and manages 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



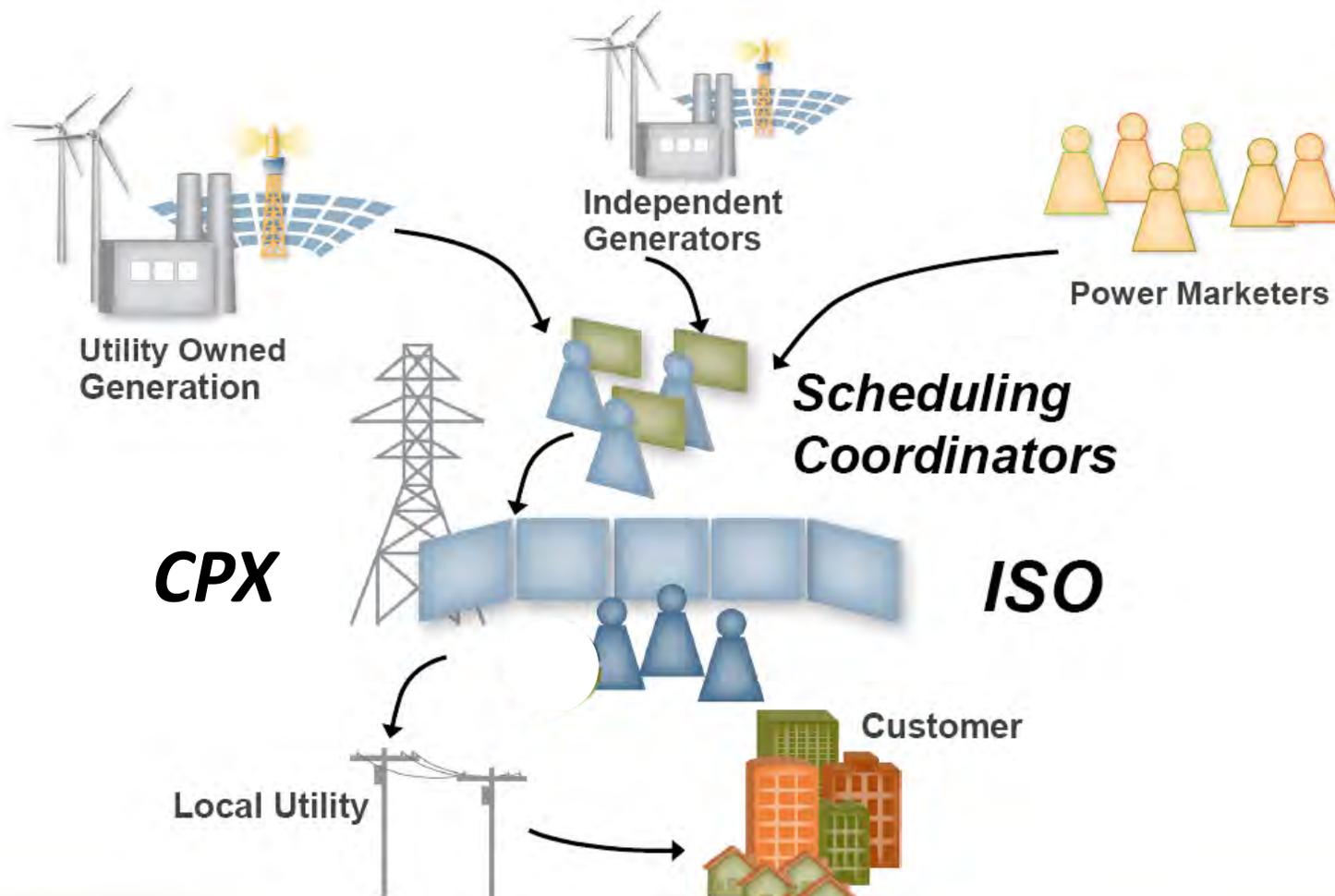
# California Independent Systems Operator Territory & Transmission Lines





# California's Electric System

## *Deregulation/Restructuring*





# California Energy Crisis

## *Lessons Learned*

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- 2000-2001 rolling blackouts in California
- 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

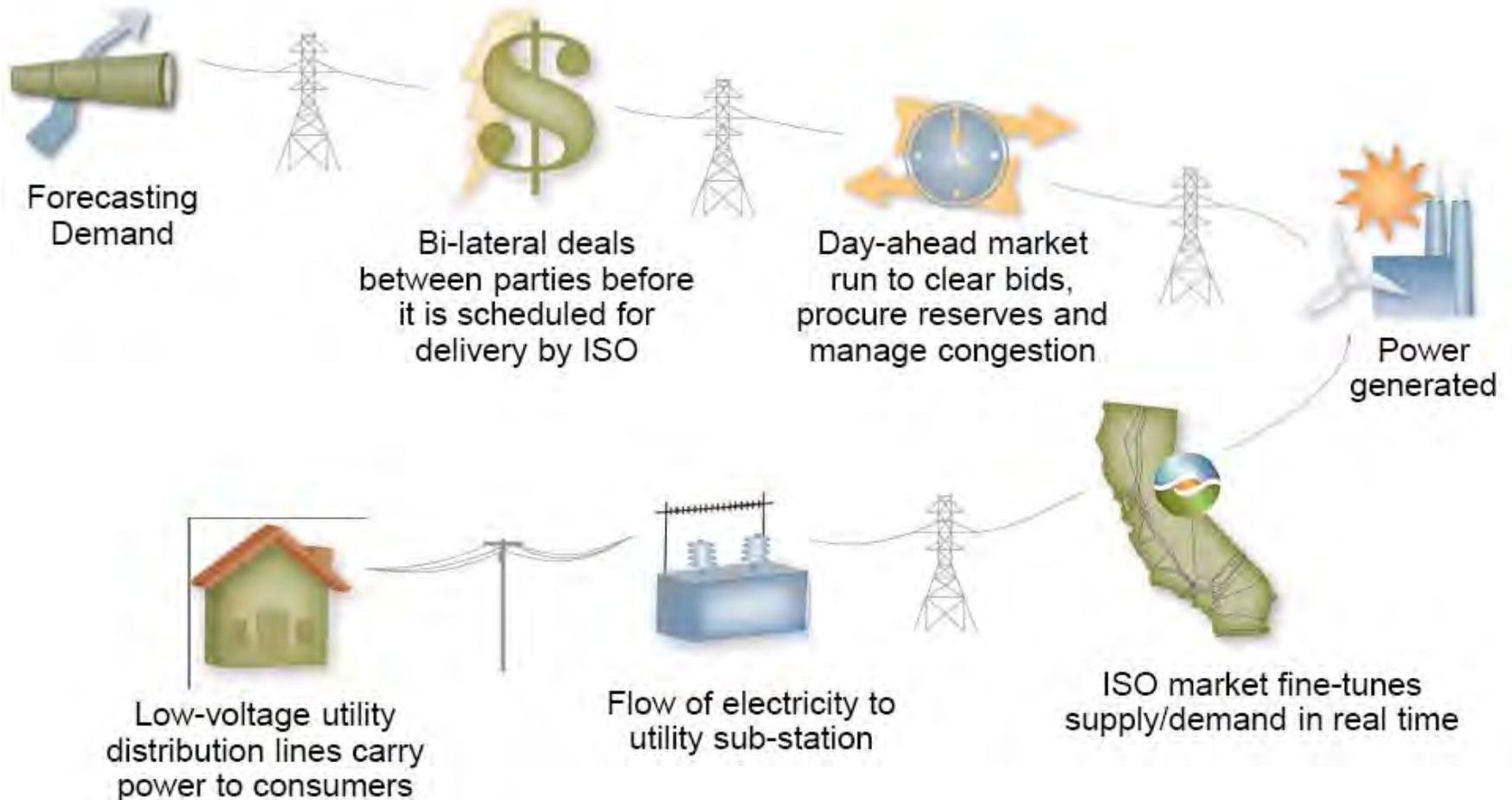
## *Combating the Crisis*

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- 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



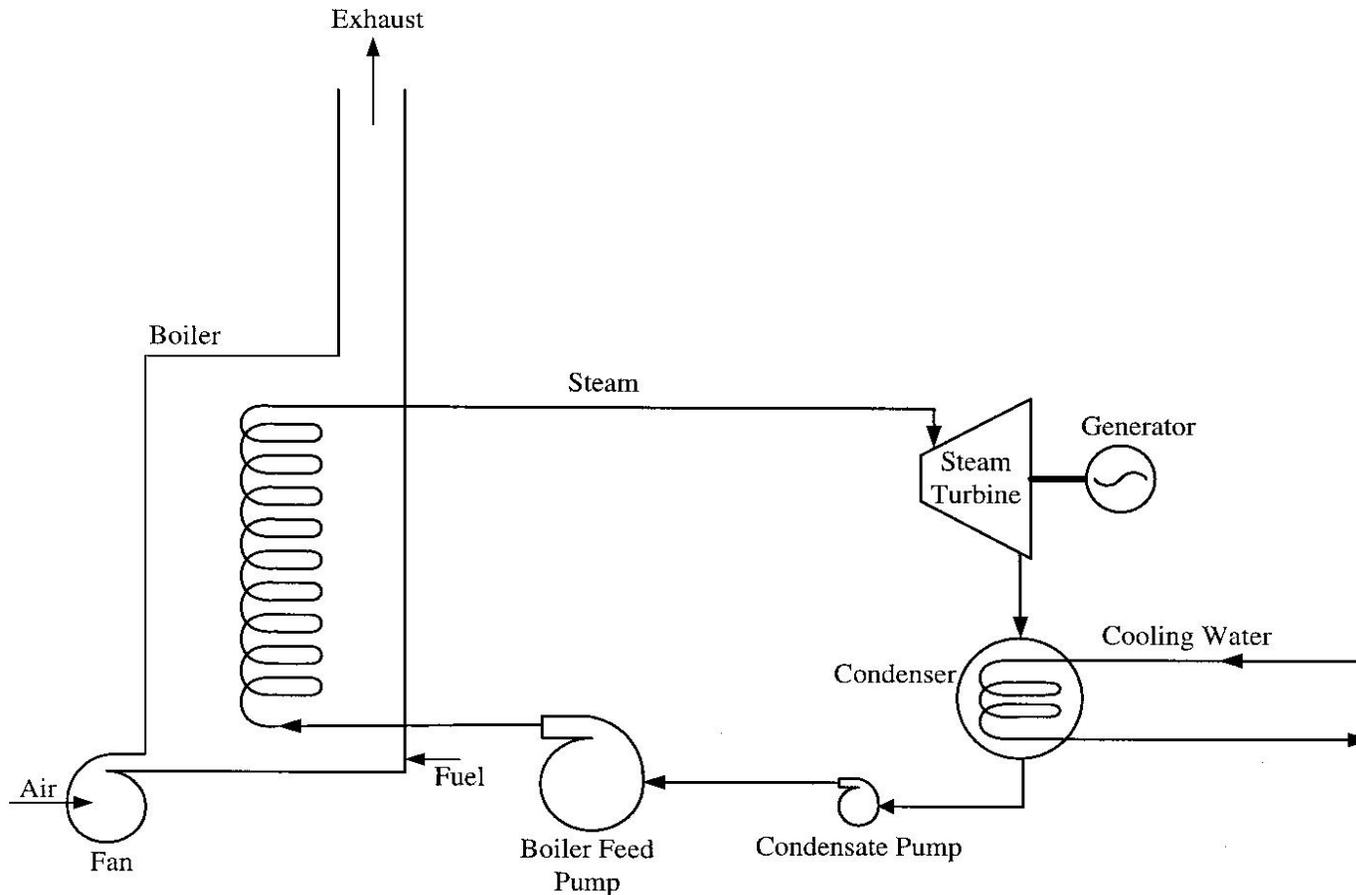


# 2011 Total Electric System Power *Fuel Sources*

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	3,120	1.6%	692	20,158	23,969	8.4%
Large Hydro	36,596	18.3%	74	1,430	38,101	13.4%
Natural Gas	90,751	45.3%	215	13,072	104,037	36.5%
Nuclear	36,666	18.3%	-	8,031	44,697	15.7%
Oil	36	0.0%	-	-	36	0.0%
Other	0	0.0%	-	-	0	0.0%
Renewables	33,244	16.6%	5,398	2,751	41,393	14.5%
Biomass	5,777	2.9%	419	-	6,195	2.2%
Geothermal	12,685	6.3%	-	574	13,259	4.7%
Small Hydro	6,130	3.1%	6	-	6,136	2.2%
Solar	1,058	0.5%	29	130	1,217	0.4%
Wind	7,594	3.8%	4,945	2,047	14,585	5.1%
Unspecified Sources of Power	N/A	N/A	21,339	11,381	32,719	11.5%
Total	200,414	100.0%	27,718	56,821	284,953	100.0%



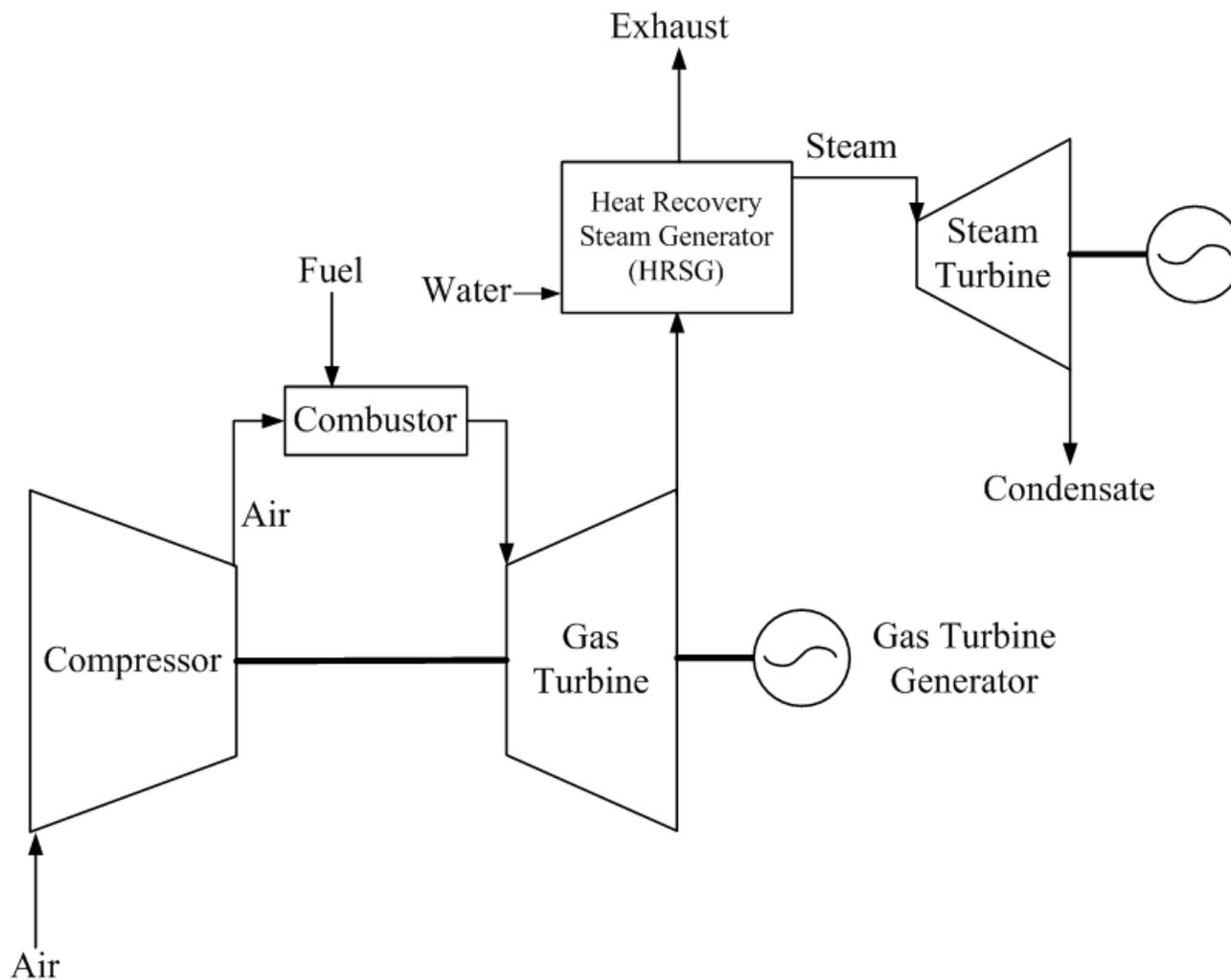
# Natural Gas Power Plants in California's *Simple Cycle*



**Rankine (Steam) Cycle**



# Natural Gas Power Plants in California's *Combined Cycle*

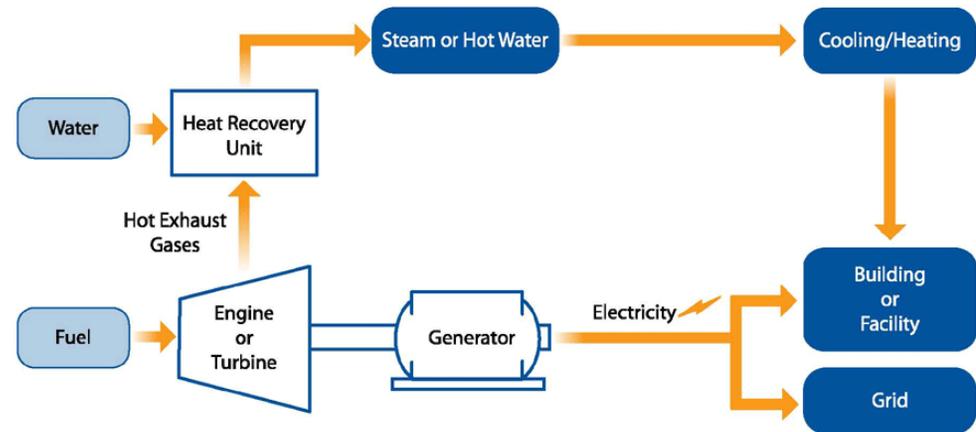




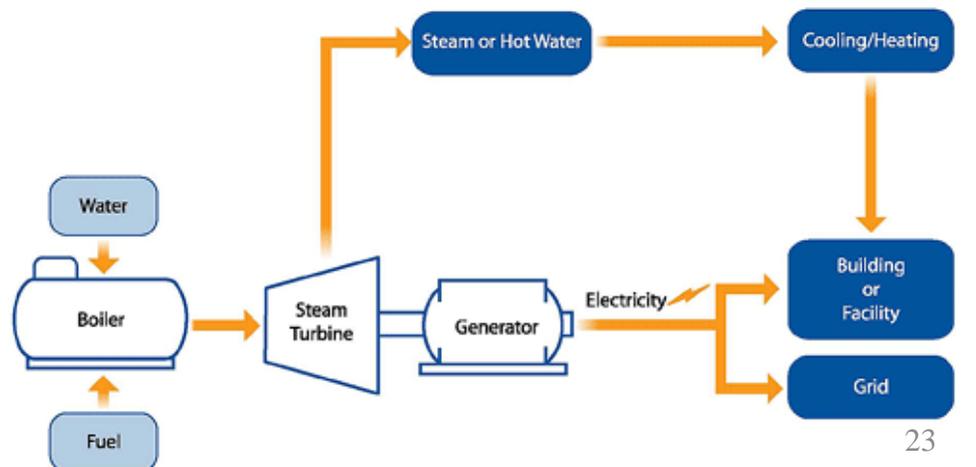
# Natural Gas Power Plants in California's *Combined Heat & Power (CHP)*

- Roughly 8,500 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

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San Onofre Nuclear Generating Station



Diablo Canyon Nuclear Generating Station



# San Onofre Nuclear Generating Station

## *Recent Outage & Near Future*

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- **January 31, 2012** Unit 3 had a small radiation leak and was shut down (Unit 2 was already down for routine maintenance)
- **March 19, 2012** Nuclear Regulatory Commission (NRC) sent an Augmented Inspection Team to gather facts about SONGS
- **March 27, 2012** 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 3, 2012** SCE submitted to NRC their response to the CAL and filed their plan to restart Unit 2 at 70% for 5 months
- **October 9, 2012** NRC public meeting in Dana Point to discuss the status of NRC oversight of SONGS
- **October 25, 2012** 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
  - Section 455.5 – determination whether to order the immediate removal of all cost related to SONGS from rates
- **December 26, 2012** NRC staff requested additional information (RAI) from SCE in order to complete their technical evaluation and Unit 2 CAL inspection report, which they expect in late February to early March
- **January 8, 2013** CPUC held prehearing conference (PHC) on SONGS OII to discuss the proceeding scope and schedule (4 phases) into 2014.



# 2012 Summer Peak Days

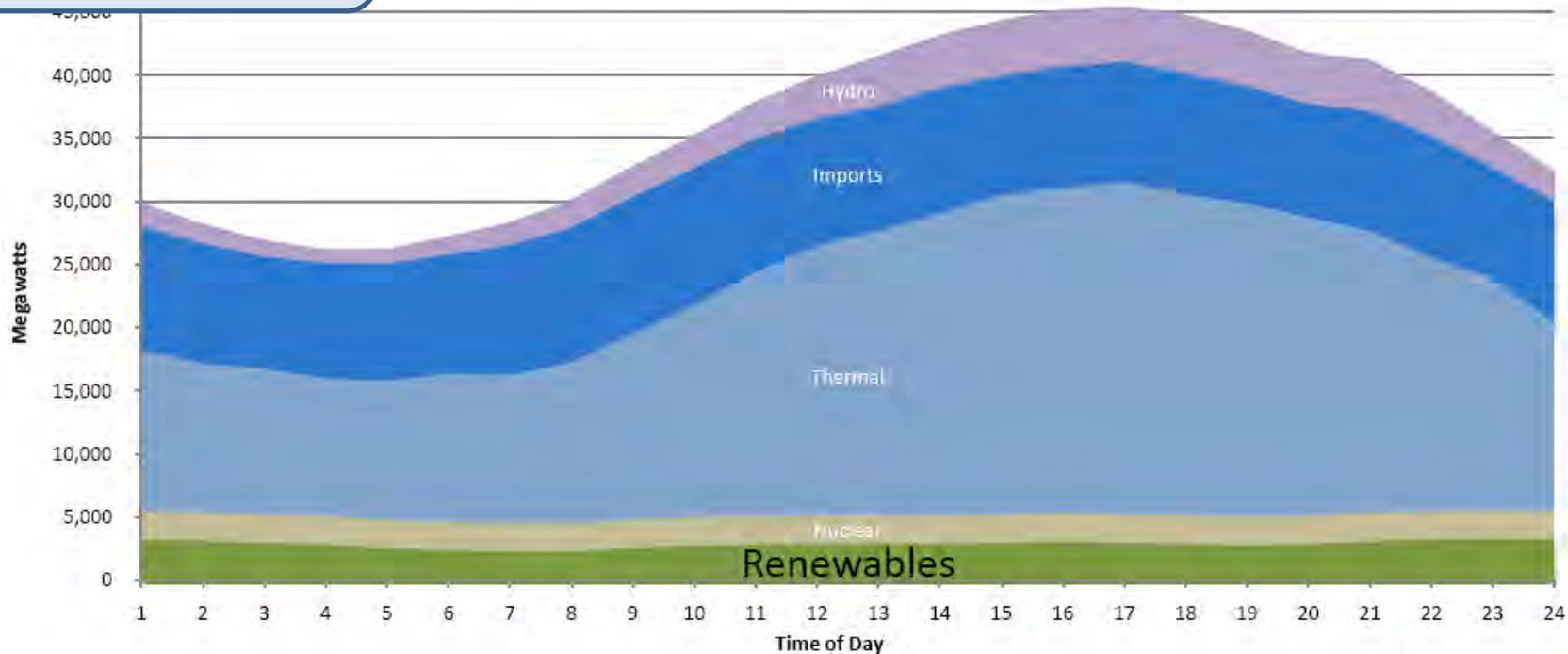
## Electricity Demand Curve in ISO Territory & Renewables

August 10<sup>th</sup>, 2012 – Flex Alert Day  
(Similar to August 14<sup>th</sup>, 2012)

Critical Peak Pricing Days

- SCE called 12 days for 48 hours
- SDG&E called 7 days for 56 hours

Hourly Breakdown of Total Production By Resource Type



This graph depicts the production of various generating resources across the day.

<http://www.aiso.com/market/Pages/ReportsBulletins/DailyRenewablesWatch.aspx>



# 2012 Summer Reliability Achievements

## *San Onofre Nuclear Generating Station Outage*

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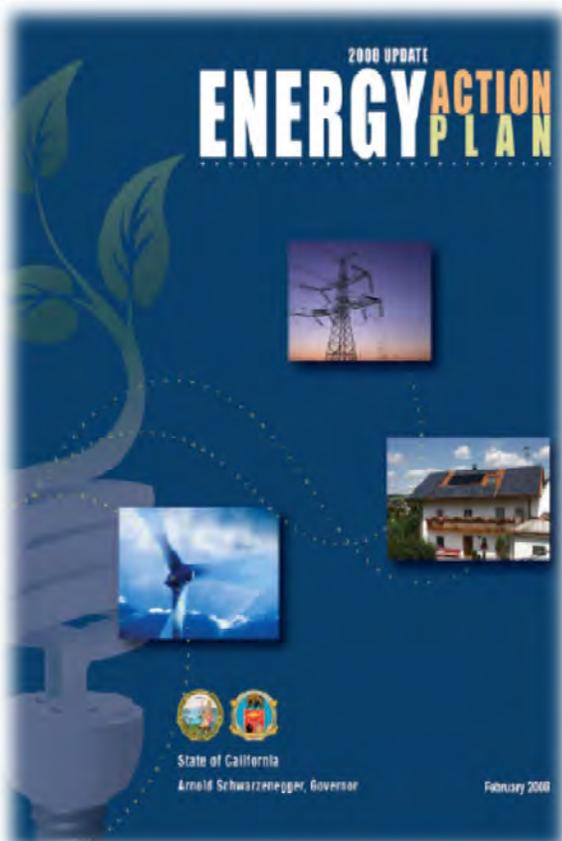
- Return Huntington Beach units 3 & 4 to service
- Accelerate Barre-Ellis transmission upgrade
- Completed Sunrise transmission line & related outage planning
- Fully funded Flex Alerts
- Fully utilized available demand response
- Sought additional military & public agency demand response
- Ensured that existing generation was well-maintained & available





# California's Energy Policy *Loading Order*

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



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 sources.



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

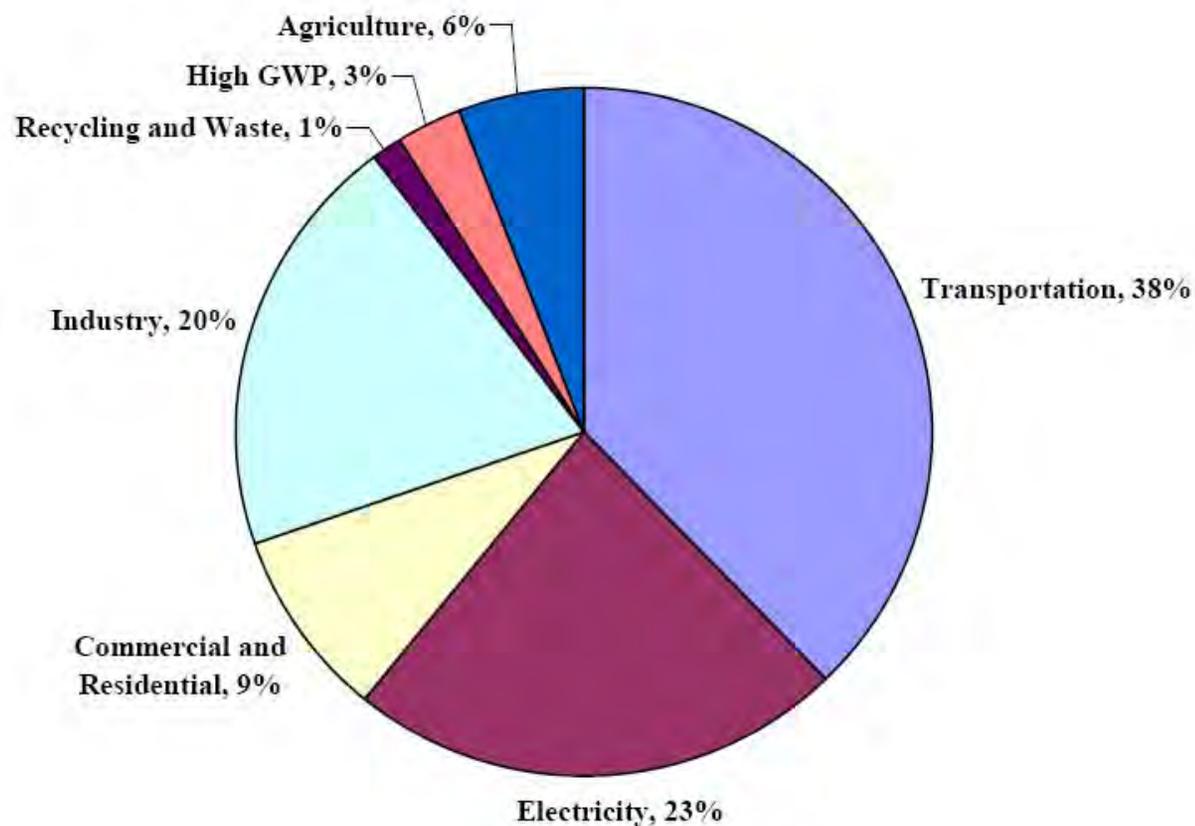
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- AB 32 (2006) - landmark legislation requiring California to reduce its greenhouse gas (GHG) emissions to 1990 levels by 2020
- AB 32 directed the California Air Resources Board (ARB) to establish a comprehensive program of regulatory/market mechanisms 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 held their first Cap & Trade Auction on Nov. 14<sup>th</sup>, 2012
  - **Allowances Sold at Auction:** 23,126,110
  - **Settlement Price Per Allowance:** \$10.09
- ARB working on updating AB 32 "Scoping Plan" which will contain information on progress made at reducing California's Greenhouse Gas emissions



# California Greenhouse Gas Emission *By Sector*

Figure 1: California's Greenhouse Gas Emissions  
(2002-2004 Average)<sup>14</sup>





# Reducing Greenhouse Gas Emissions

## *Electricity Sector*

ARB 32 Scoping Plan

### Recommended Actions for Electricity Sector

MEASURE	GHG REDUCTIONS (MMTCO2E)
<b>Energy Efficiency</b> (32,000 GWh of Reduced Demand) <ul style="list-style-type: none"> <li>Increased Utility Energy Efficiency Programs</li> <li>More Stringent Building &amp; Appliance Standards</li> <li>Additional Efficiency and Conservation Programs</li> </ul>	15.2
<b>Combined Heat and Power</b> Increase Combined Heat and Power Use by 30,000 GWh	6.7
<b>Renewables Portfolio Standard</b> Achieve a 33% renewables mix by 2020	21.3
<b>Million Solar Roofs</b> (Including California Solar Initiative, New Solar Homes Partnership, and solar programs of publicly owned utilities) <ul style="list-style-type: none"> <li>Target of 3,000 MW Total Installation by 2020</li> </ul>	2.1
<b>TOTAL</b>	<b>45.3</b>



# Transmission Lines to Meet 33% RPS by 2020



Transmission upgrade	Approval status		Renewable Potential		Online
	ISO	CPUC	MW	TWh/Yr	
1 Carrizo-Midway	Pending LGIA	Not yet filed	900	2.1	2012
2 Sunrise Powerlink	Approved	Approved	1,700	4.1	2012
3 Eldorado-Ivanpah	LGIA	Approved	1,400	3.6	2013
4 Pisgah-Lugo	LGIA	Not yet filed**	1,750	4.1	2017
5 Valley-Colorado River	Approved	Approved*	4,700	8.6	2013
6 West of Devers	LGIA	Not yet filed			2017
7 Tehachapi	Approved	Approved	4,500	15.2	2015
8 Tehachapi Wind/Solar Diversity	N/A	N/A	1,000	3.0	2015
9 Cool Water-Lugo	Pending LGIA	Not yet filed	600	1.4	2018
10 South Contra Costa	LGIA	Not yet filed	300	0.8	2015
11 Borden-Gregg	LGIA	Not yet filed	800	2.0	2015
12 Path 42	Pending approval	Not yet filed	1,400	3.5	2015
Other-Outside of ISO Grid	N/A	N/A	3,300	8.4	
<b>Total</b>			<b>22,350</b>	<b>56.8</b>	
<i>TWh/year needed in ISO area to meet 33% goal: 44</i>					

Source: CAISO



# Renewable Energy in California

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- Solar
  - Thermal
  - Photovoltaic
- Wind
- Small-Hydro
- Biomass
- Geothermal





# Solar Thermal in California

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## Parabolic Troughs:

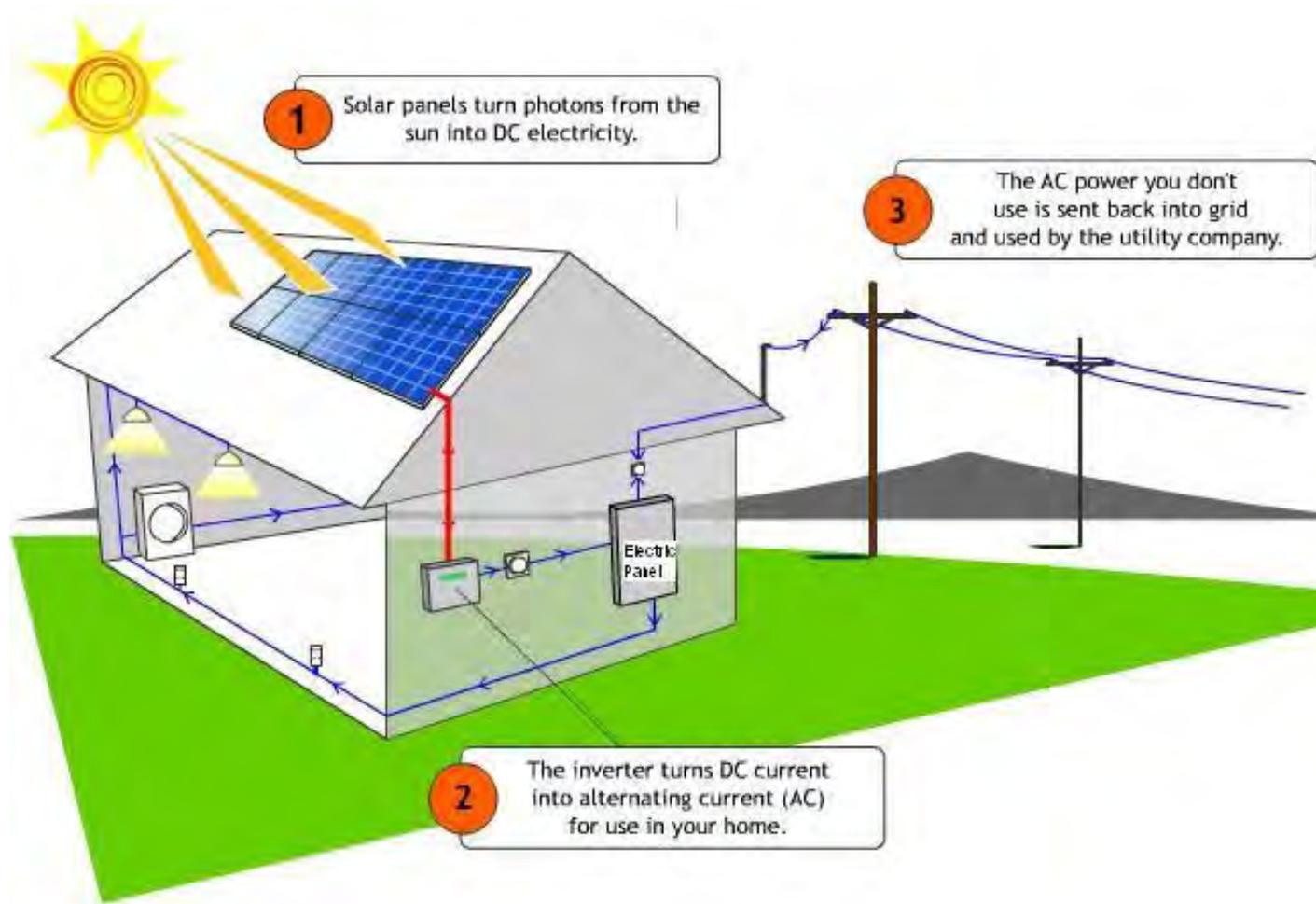
Solar Energy Generating Station -  
SEGS I to IX 354 MW

Power Tower: Ivanpah-Brightsource,  
370 MW





# Solar Photovoltaic Technology





# Existing Wind Farms in California

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**Tehachapi Wind Farm**



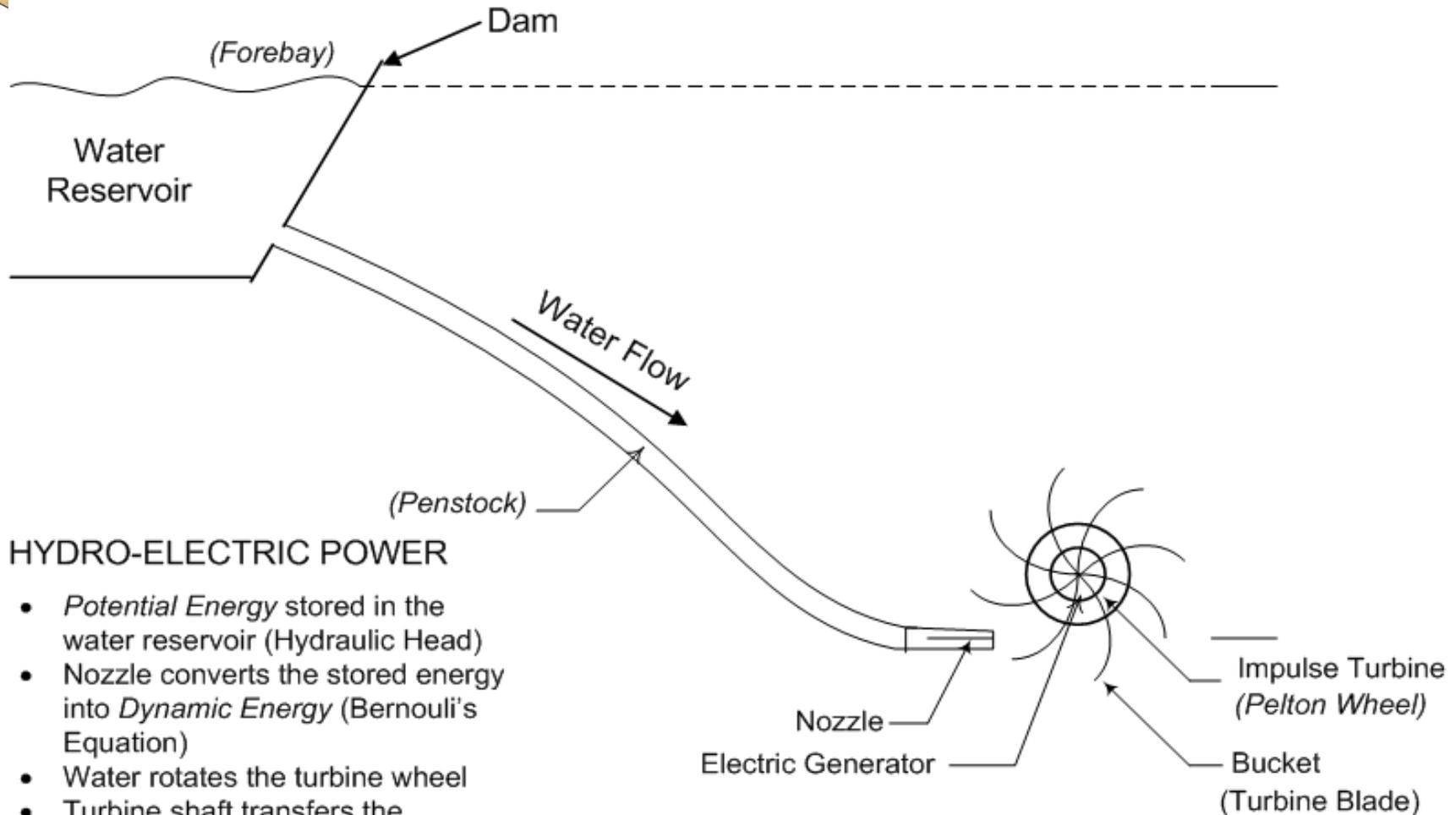
**Altamont Pass Wind Farm**

**San Geronio Pass Wind Farm**





# Hydro-Electric Technology



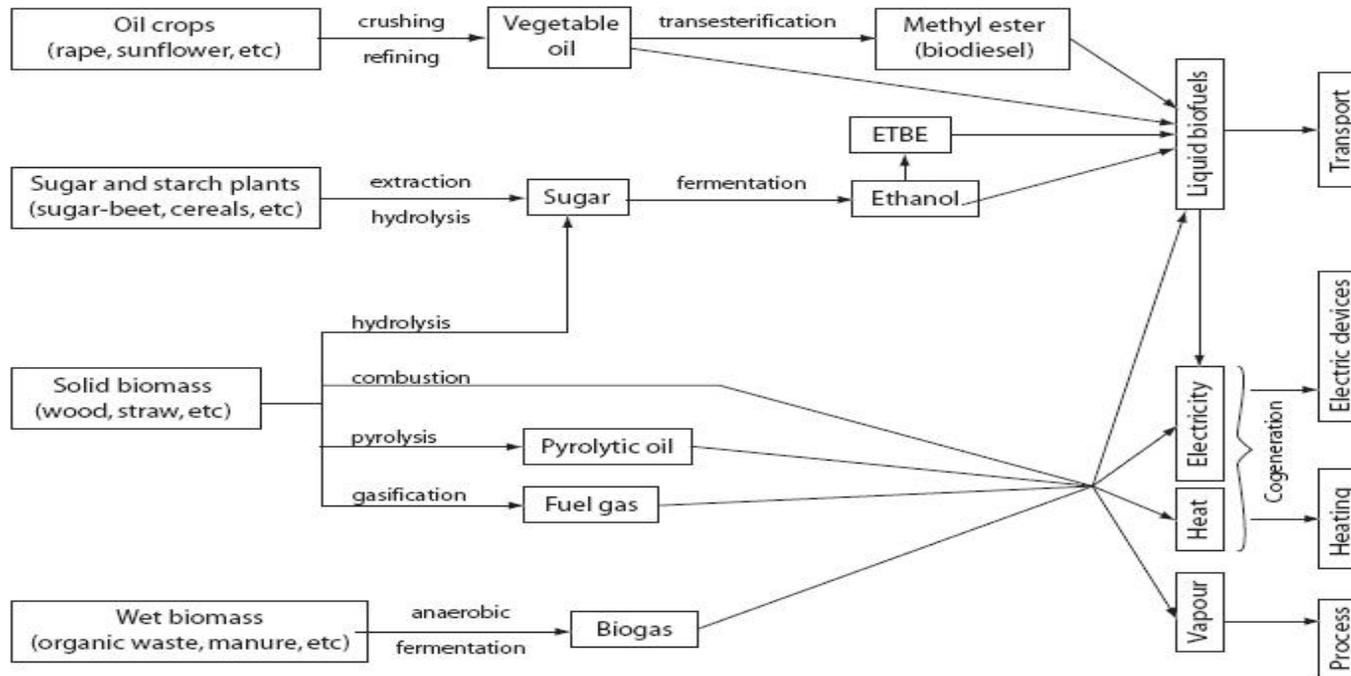
## HYDRO-ELECTRIC POWER

- *Potential Energy* stored in the water reservoir (Hydraulic Head)
- Nozzle converts the stored energy into *Dynamic Energy* (Bernoulli's Equation)
- Water rotates the turbine wheel
- Turbine shaft transfers the *Rotational Energy* to the Electric Generator



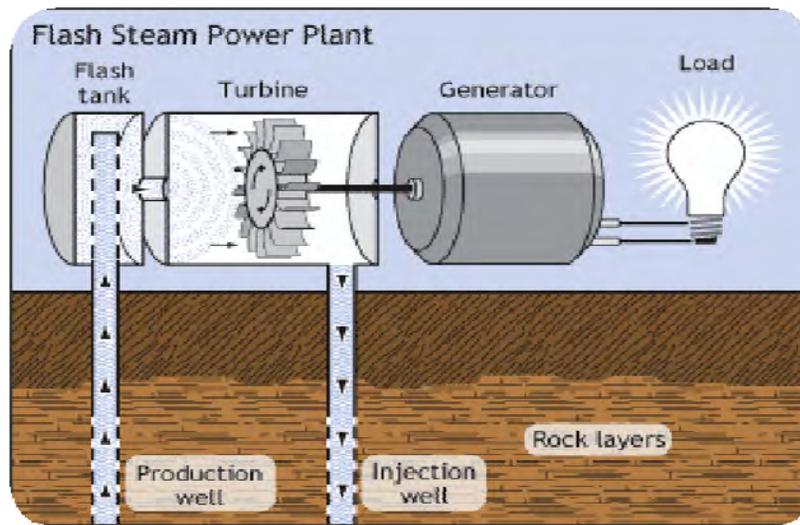
# Biomass in California

## Bioenergy routes





# Geothermal in California





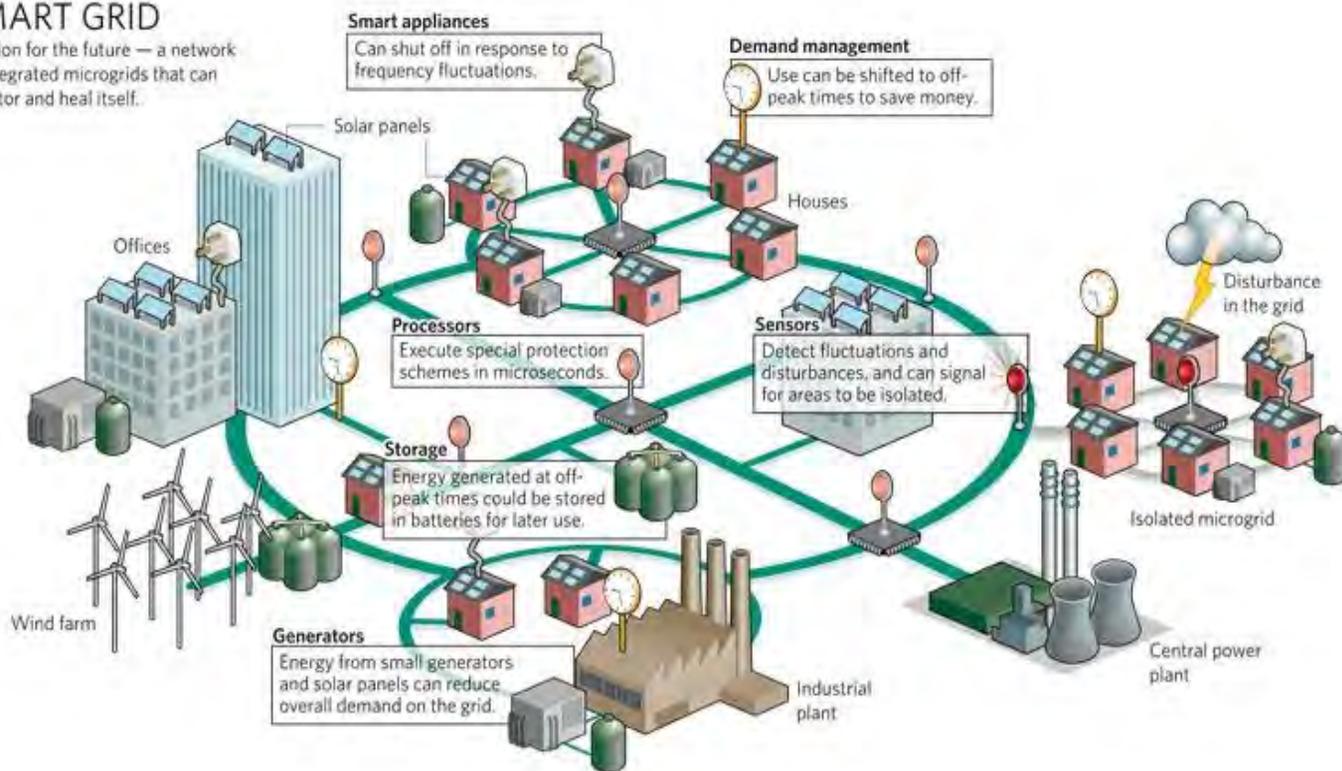
# California's Electric System of Tomorrow

## Smart Grid

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

### SMART GRID

A vision for the future — a network of integrated microgrids that can monitor and heal itself.





# California's Electric System of Tomorrow

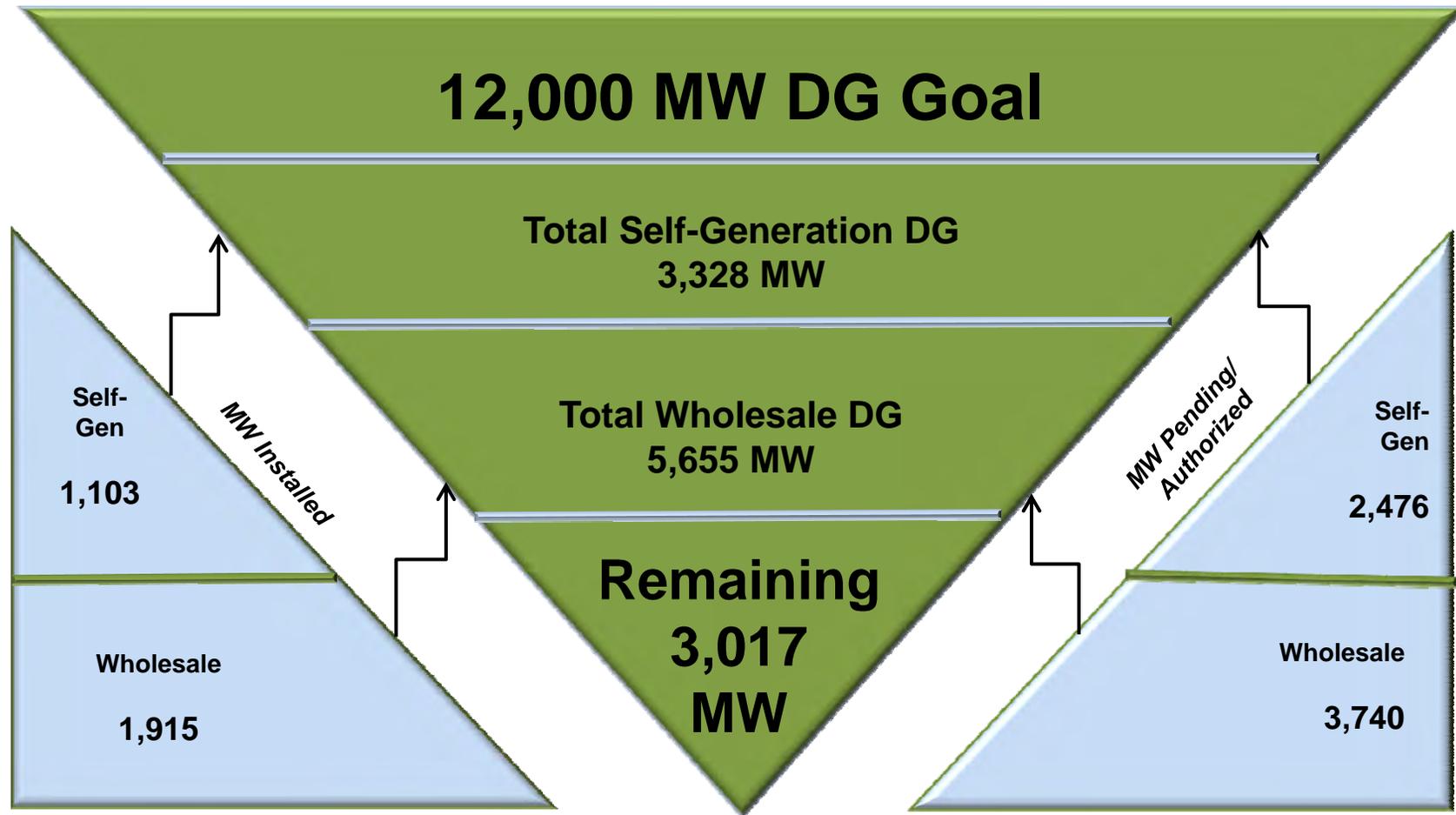
## *Distributed Generation*

- 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





# Progress Towards the 12,000 MW Distributed Generation Goal



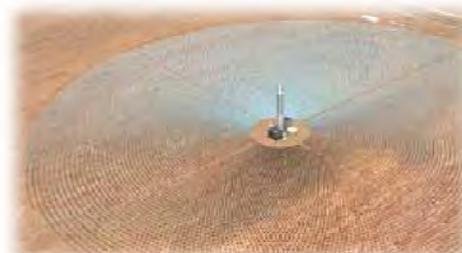


# California's Electric System of Tomorrow

## *Large Scale Renewable Energy*

- Utilities are procuring electricity from renewable fuel sources in order to meet the 33% Renewable Portfolio Standard by 2020





# Any Questions?

Chair Robert Weisenmiller  
California Energy Commission

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