

# 113<sup>th</sup> Meeting of the Lyncean Group of San Diego

2 August 2017



# Today's talk

**A fast, precise, flexible and coordinated control technology for the electric grid of the future**

Speaker: Patrick Lee

Vice President, Infrastructure and Technology  
Sempra Infrastructure, LLC

President, PXiSE Energy Solutions, LLC

# Background information

Electrical grid basics

# Recent news related to today's talk

- July 2017: National Academies Press (NAP), pre-publication, “*Enhancing the resilience of the nation’s electricity supply*”  
<https://www.nap.edu/catalog/24836/enhancing-the-resilience-of-the-nations-electricity-system>
- 3 March 2017, U.S. Energy Information Administration (EIA), “*California imports about a quarter of its electricity on average*”  
<https://www.eia.gov/todayinenergy/detail.php?id=30192>
- 20 July 2017: San Diego Union-Tribune, “*Hydro, wind, solar big factors in power grid,*” (driven by Renewable Portfolio Std.)  
<http://www.sandiegouniontribune.com/business/sd-fi-california-electricgeneration-20170719-story.html>
- 14 June 2017: EIA, “*Wind & solar in March accounted for 10% of U.S. electricity generation for the first time,*” (in 2007 it was 1%)  
<https://www.eia.gov/todayinenergy/detail.php?id=31632#>

# Recent news (continued)

- 25 July 2017: EIA, “*Electric Power Monthly – Data for May 2017,*” (capacity factors for utility-scale generators)

[https://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.php?t=epmt\\_6\\_07\\_b](https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b)

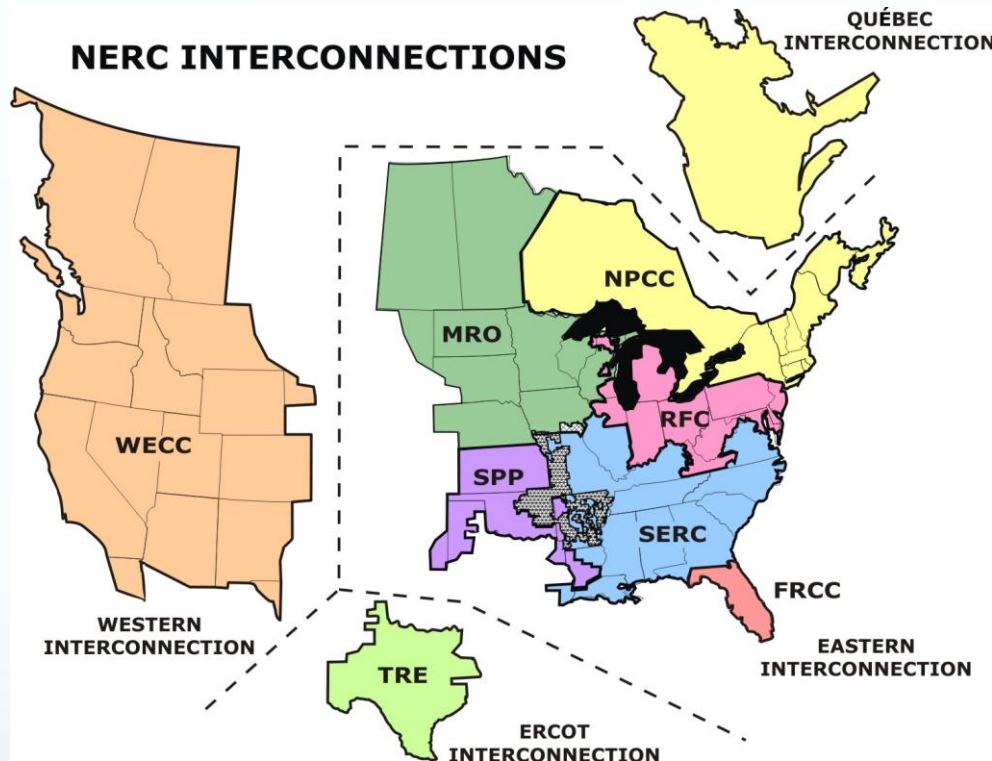
- 28 February 2017: “*SDG&E unveils world’s largest lithium ion battery storage facility,*” (SDG&E, Escondido, 30 MW/120 MWh; driven by California’s energy storage mandate)

<http://sdgenews.com/battery-storage/sdge-unveils-world’s-largest-lithium-ion-battery-storage-facility>

- 31 July 2017: San Diego Union-Tribune, “*Pump it up: Water officials looking for offers to build a hydro storage plant at the San Vicente Reservoir,*” (up to 500 MW/4,000 MWh)

<http://www.sandiegouniontribune.com/business/sd-fi-sanvicente-pumped-20170726-story.html>

# The N. American electrical grid



For more information:

FERC (electricity markets): <https://www.ferc.gov/market-oversight/mkt-electric/overview.asp>

NERC: <http://www.nerc.com/Pages/default.aspx>

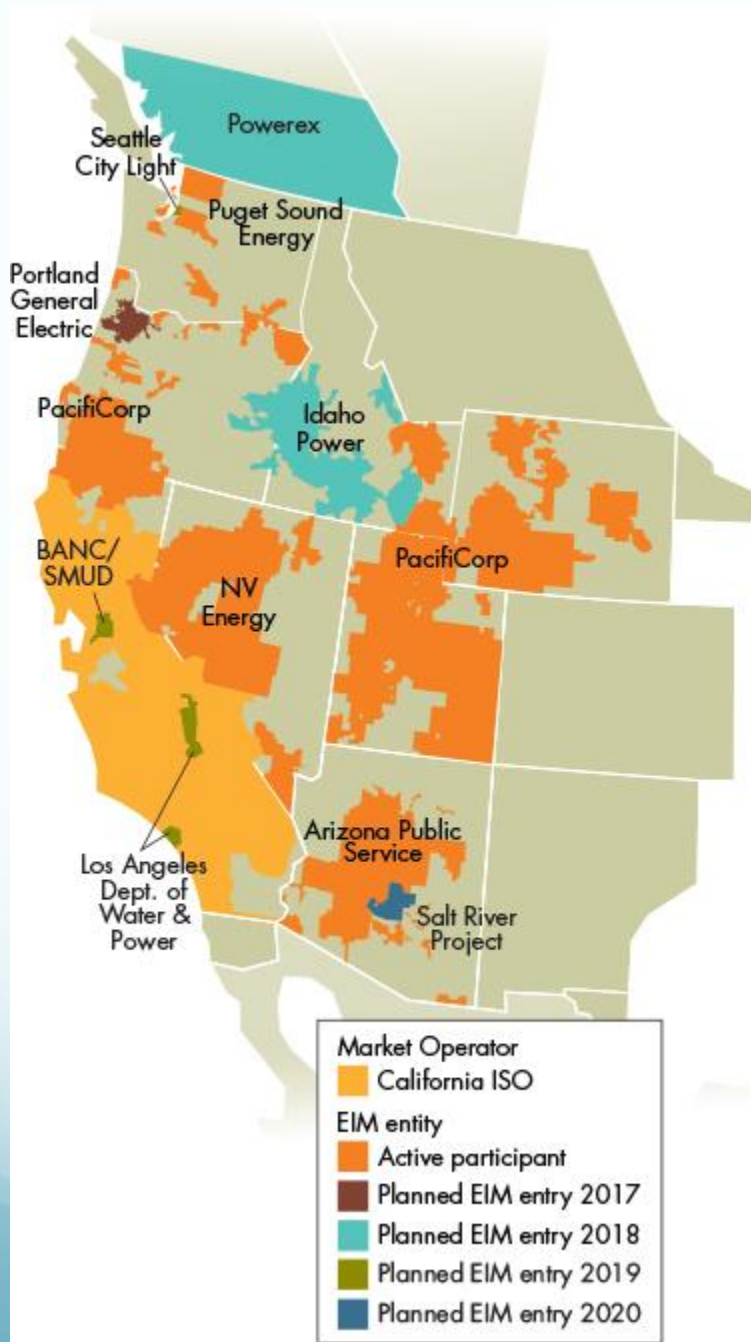
WECC: <https://www.wecc.biz/epubs/StateOfTheInterconnection/>

California ISO: <http://www.aiso.com/Pages/default.aspx>

- Federal Energy Regulatory Commission (FERC) has broad responsibilities for regulating electricity, natural gas and oil in inter-state commerce.
- North American Electricity Reliability Corporation (NERC) is responsible for ensuring the reliability and security of the bulk power system (transmission network) in N. America.
- Regional entities are delegated responsibility to assure reliability across their assigned interconnection. Southern CA is in that area governed by the Western Electricity Coordinating Council (WECC).
- Grid operation is managed at a lower level. San Diego is in the area managed by the California Independent System Operator (CAISO).
- Three large investor-owned utilities (IOUs) provide  $\frac{3}{4}$  of the generating capacity in CAISO. San Diego Gas and Electric (SDG&E) is one of these IOUs.

# Western Energy Imbalance Market (EIM)

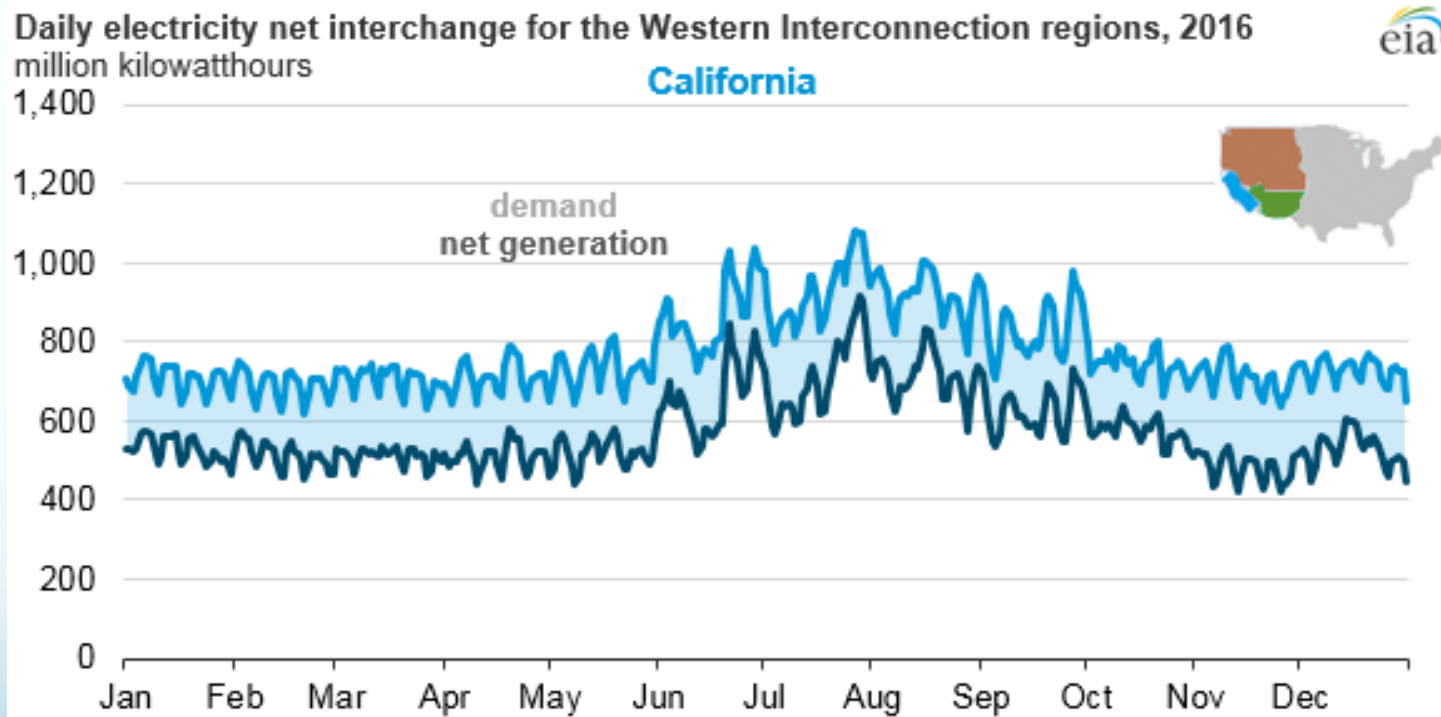
- Established in 2014 by the California Independent System Operator (CAISO) as a real-time bulk power trading market within WECC.
- Intended to better integrate variable renewable energy sources (the wind is always blowing somewhere in the West) and find a cost-effective mix of power generators from across a wide geographic region to meet real-time demands.



Source: Western EIM,  
<https://www.westerneim.com/Pages/About/default.aspx>

# California imported 26% of its electricity in 2016

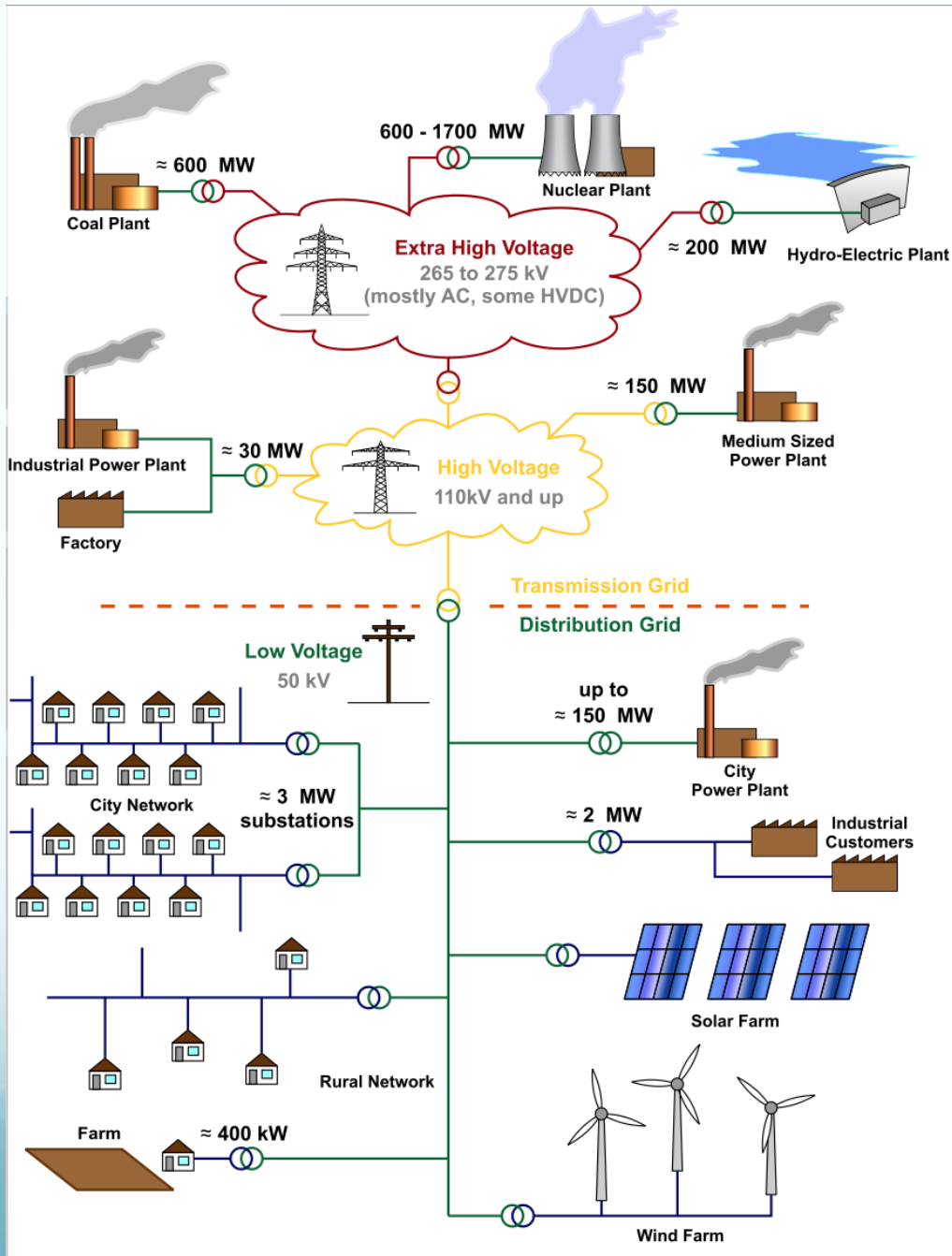
CAISO's 2016 average daily import demand: 201,000 megawatt-hours; about 2/3 from the southwest, and 1/3 from the northwest



Source: EIA, 3 March 2017,  
<https://www.eia.gov/todayinenergy/detail.php?id=30192>



# Today's electrical grid architecture

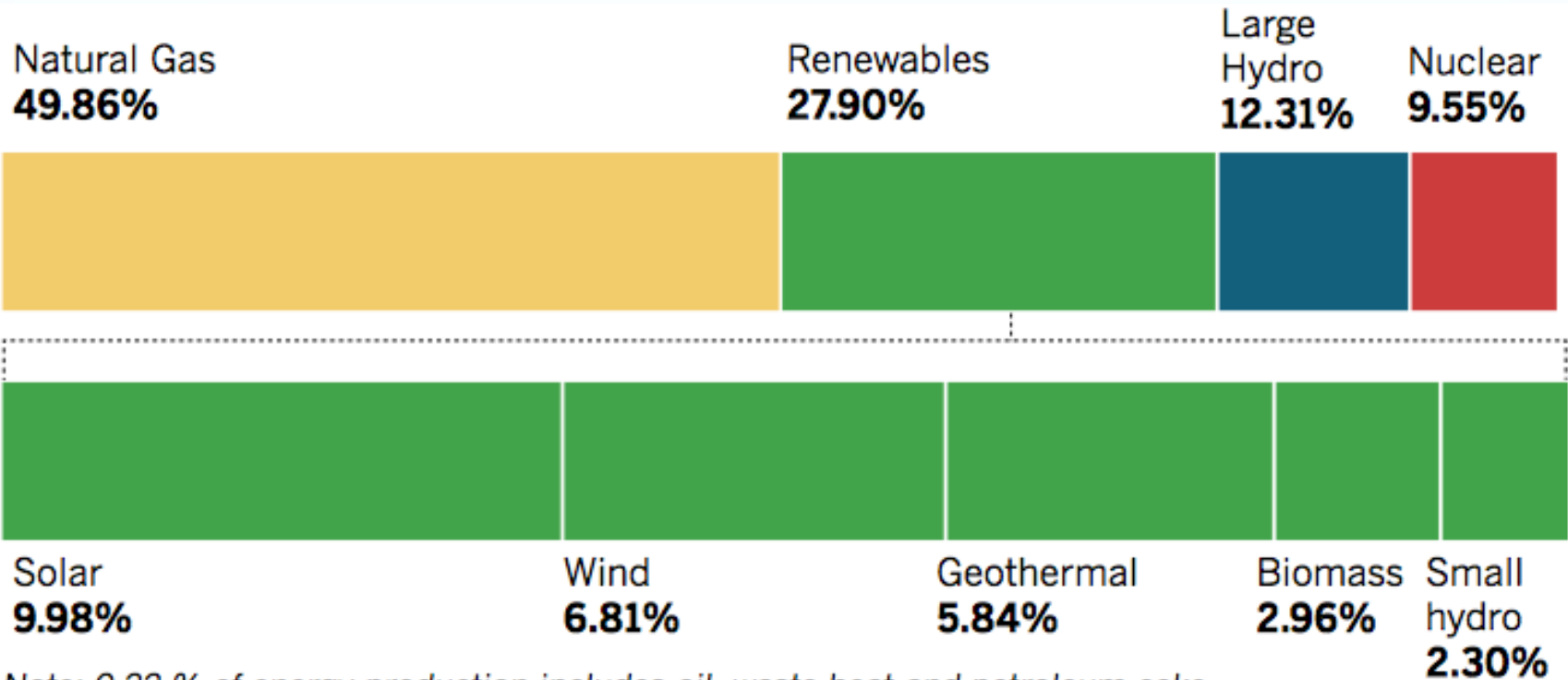


- Regional transmission grids are interconnected to establish the national grid.
- Each regional transmission grid feeds multiple distribution grids within its region

# California's "Renewables Portfolio Standard" (RPS)

- Targets for IOUs, electric service providers and community choice aggregators:
  - Deliver 33% of retail electricity from “eligible” renewable sources by 2020, increasing to 50% by 2030
- Eligible sources: Wind, solar (photovoltaic & thermal), geothermal, small hydro, biogas & biomass
- You can get more information on RPS here:
  - Program details from California PUC:  
[http://www.cpuc.ca.gov/RPS\\_Homepage/](http://www.cpuc.ca.gov/RPS_Homepage/)
  - Fact sheet from Union of Concerned Scientists:  
<http://www.ucsusa.org/sites/default/files/attach/2016/07/california-renewables-portfolio-standard-program.pdf>

# California's 2016 electrical generation breakdown



Note: 0.22 % of energy production includes oil, waste heat and petroleum coke

Source: California Energy Commission

DANIEL WHEATON U-T

Read the full 20 July 2017 San Diego U-T article at: <http://www.sandiegouniontribune.com/business/sd-fi-california-electricgeneration-20170719-story.html>

# 2016 annual average generation capacity factors

- Nuclear: 92.5%
- Coal: 52.7%
- Natural gas: 56%  
(combined cycle)
- Conventional (large) hydro: 38%
- Wind: 34.7%
- Solar voltaic: 27.2%
- Solar thermal: 22.2%
- Landfill gas and municipal solid waste: 70.7%
- Other biomass, including wood: 46.7%
- Geothermal: 74.2%

Sources:

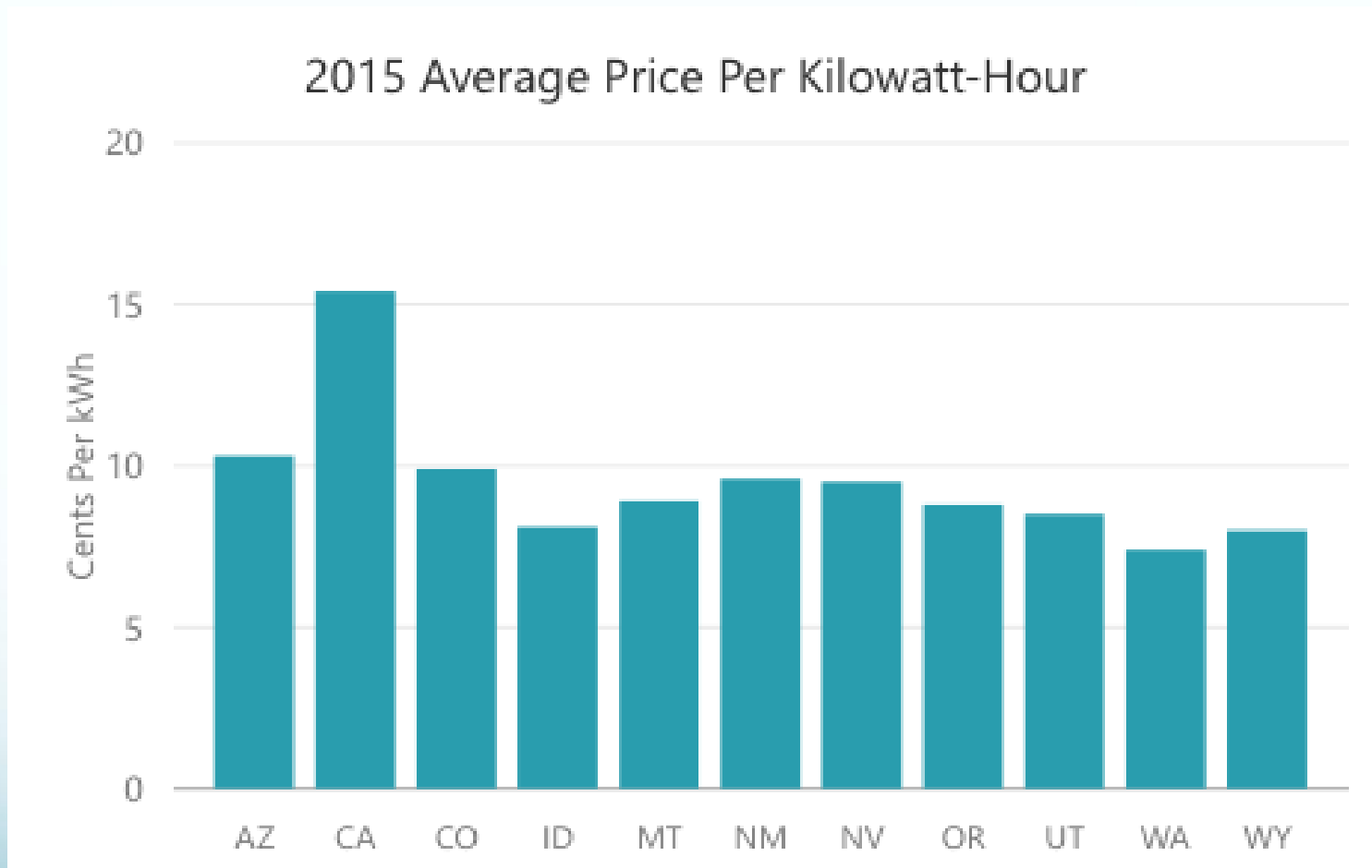
EIA, non-fossil: [https://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.php?t=epmt\\_6\\_07\\_b](https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b)

EIA, fossil: [https://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.php?t=epmt\\_6\\_07\\_a](https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_a)

# California's energy storage mandate

- California had the first, and now, has the most robust mandate in the nation for investor-owned utilities (IOUs) to implement energy storage devices.
- Needed primarily to help balance the grid to compensate for intermittent wind and solar generation.
- Statewide target: 1,325 MW procured by 2020 & online by 2024
  - SCE: 580 MW
  - PGE: 580 MW
  - SDG&E: 165 MW
- Typical energy storage capacity provides 4 – 6 hours at rated power
- You can get more information here:
  - California ISO Energy Storage Roadmap  
<https://www.caiso.com/informed/Pages/CleanGrid/EnergyStorageRoadmap.aspx>
  - California Public Utility Commission (PUC), “Decision on Track 2 energy storage issues,” (finalizes CA energy storage target, 27 April 2017)  
<http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M184/K630/184630306.PDF>
  - 22 November 2016, Renewable Energy World, “At the halfway point, the effect of California’s energy storage mandate”

# Impact on electricity price



Source: WECC

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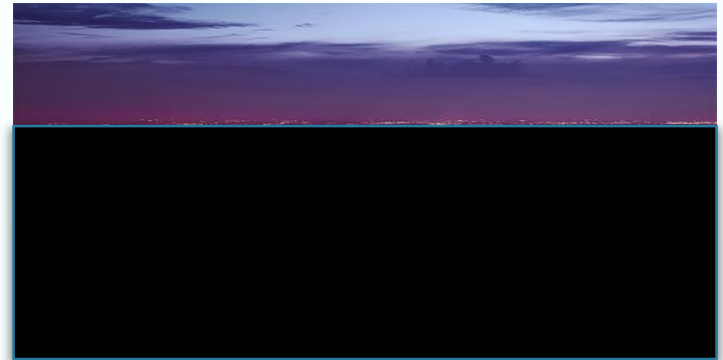
Vice President, Infrastructure and Technology  
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# Great blackout of 2011

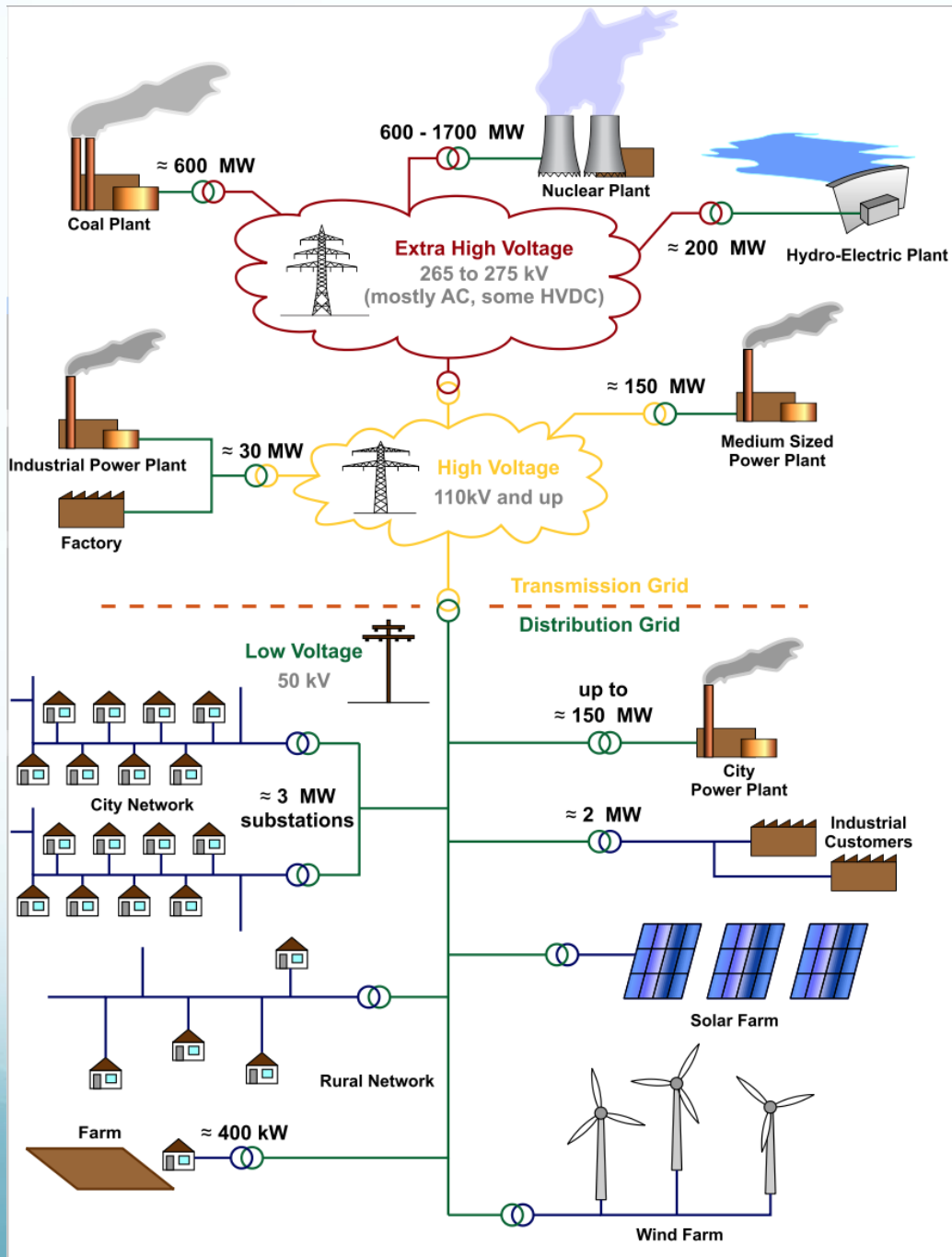


September 8, 2011, 3:38 PDT

11 hour duration, 694,000 customers affected

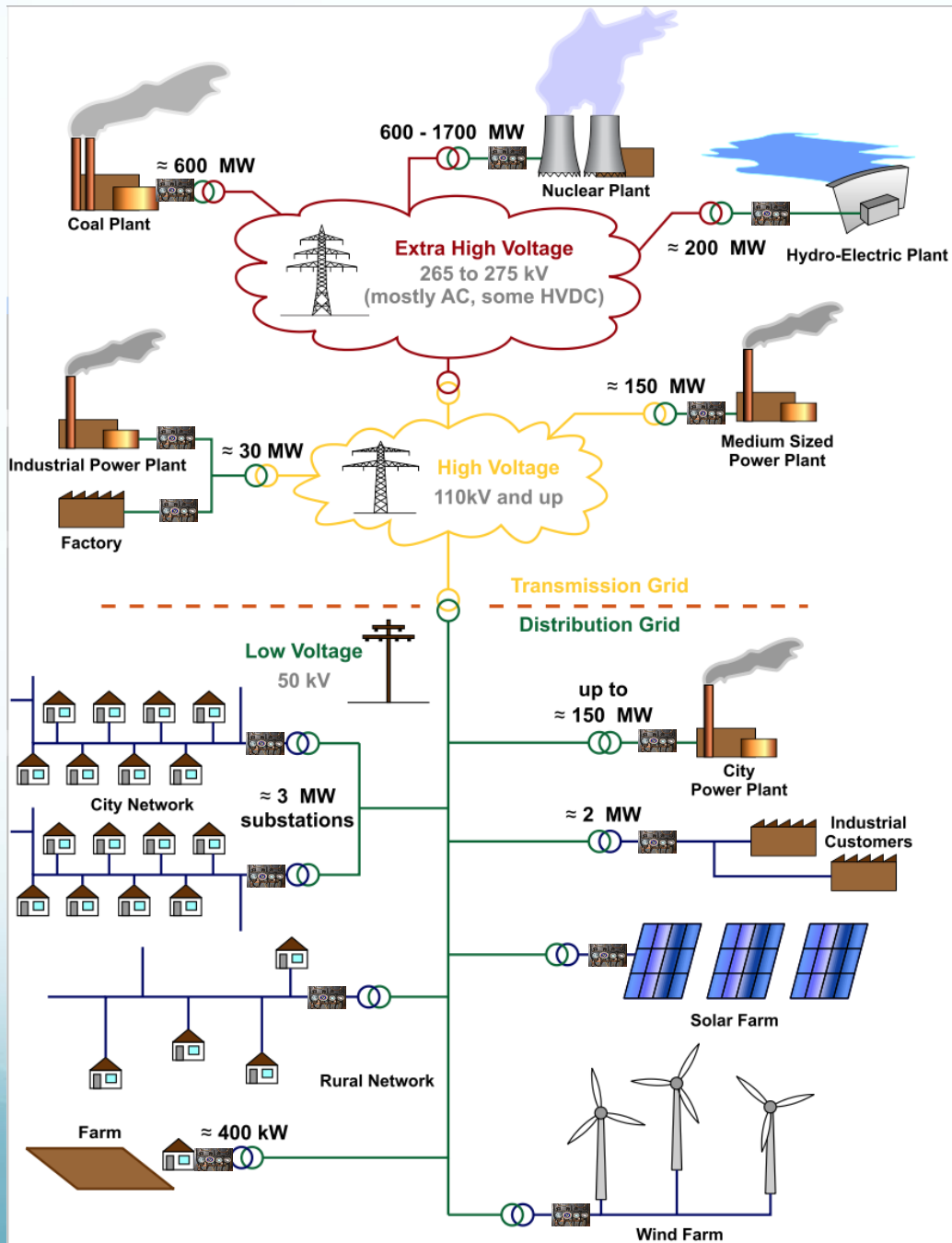
Largest power outage in California history

# Today's electrical grid

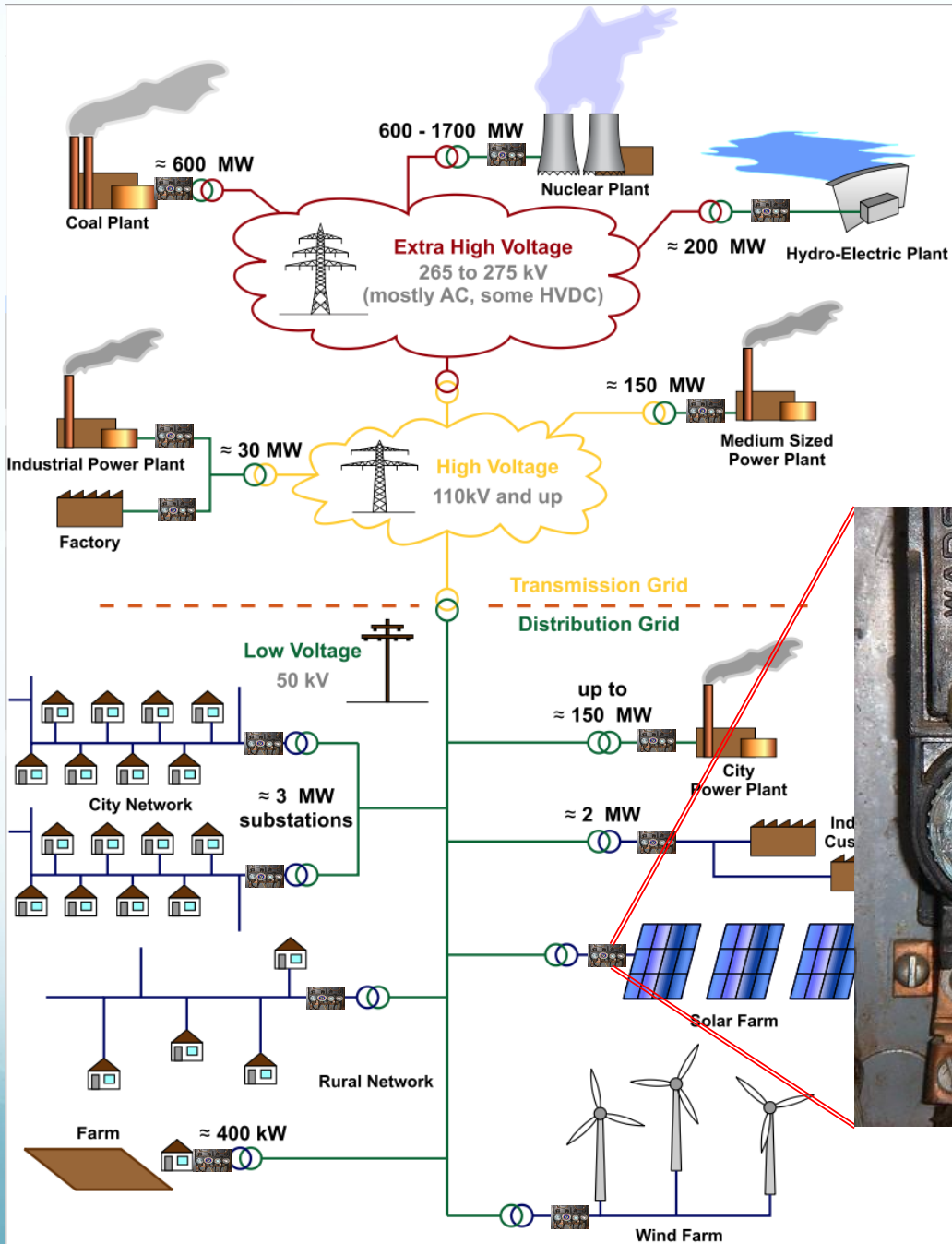


Limited ability to recover rapidly from a significant fault.

# Modified grid with rapid recovery feature



# How the rapid recovery feature works



Patent pending

Adapted from Wikipedia



# Upcoming talks

## **John Glass**

9/13/17     *Professor & Group Leader*     Engineering Life Using CRISPRs and Synthetic  
*Synthetic Biology & Bioenergy Group*     Biology  
*J. Craig Venter Institute*

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## **Ray Ashley**

10/25/17     *President and CEO of the San Diego*     Replicating the *San Salvador*, the ship in which  
*Maritime Museum*     Juan Cabrillo sailed to San Diego

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## **Andreas Bratt-Leal**

12/6/17     *Director of Research & Develop-*     Patient-specific cell therapy for Parkinson's  
*ment, Summit for Stem Cell Foundation*     disease

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## **Alex Cannara**

1/17/18     *Engineering and Environmental Consul-*     Ocean Acidification  
*tant*