Case Study: The Impact of Solar Energy Policies in California and Lessons Learned

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THE Brattle GROUP

An intensive policy drive set the pace for renewable development

Goals

Distributed Generation & Utility-Scale:

- 2003 – Loading Order and Preferred Resources
- 2011 – Zero Net Energy Goals (CA Energy Efficiency Strategic Plan)

Codes & Standards

Distributed Generation:

- 2018 – Building Energy Efficiency Standards

Distributed Generation & Utility-Scale:

- 2002 – Renewables Portfolio Standard

Rebates & Tax Incentives

Distributed Generation:

- 1998 – Emerging Renewables Program
- 2001 – Self-Generation Incentive Program
- 2006 – California Solar Initiative
- 2006 – New Solar Homes Partnership

Distributed Generation & Utility-Scale:

- 2006 – Federal Solar Investment Tax Credit
- 2011 – Federal SunShot Initiative

Rate Design

Distributed Generation:

- 1996 – Net Energy Metering 1.0
- 2016 – Net Energy Metering 2.0
- 2015 – Green Tariff/Shared Renewables Program
- 2019 – Net Energy Metering 3.0 (in progress)

Note: Dates represent the year of initial implementation.

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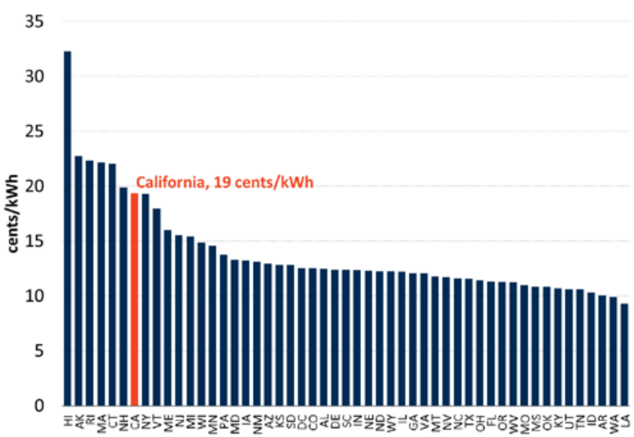
Solar is economically attractive in California

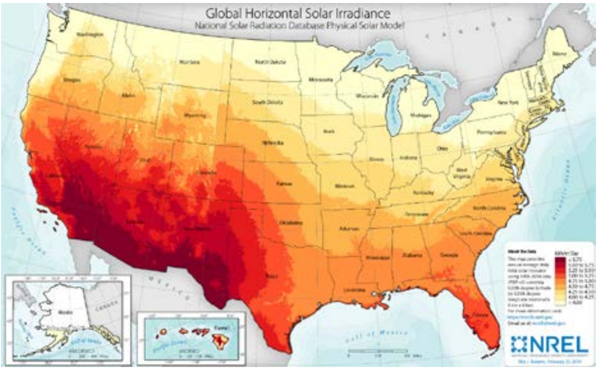
Solar power has expanded in California because electricity rates are relatively expensive, the region has high solar irradiance, and the state prioritized renewables with an intensive policy drive over the last 20 years.

Expensive Retail Rates



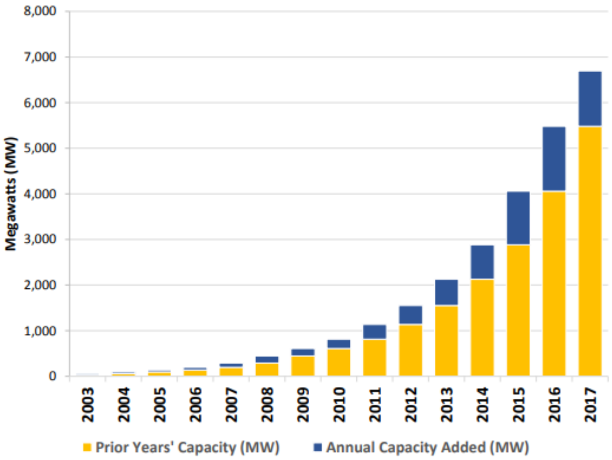
Source: U.S. Energy Information Administration.

High Solar Irradiance



Source: National Renewable Energy Lab, available here: https://www.nrel.gov/gis/images/solar/solar_ghi_2018_usa_scale_01.jpg.

Expansive Policy Drive

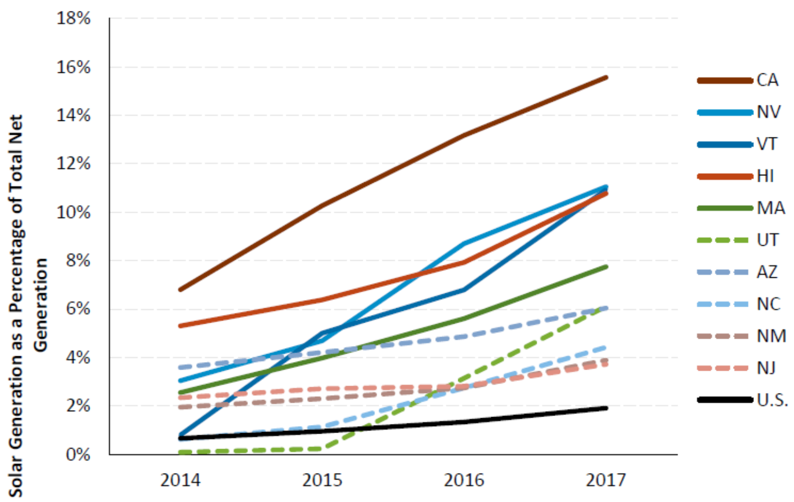


Sources and notes: Total and incremental BTM solar capacity in CA. California Energy Commission, Tracking Progress July 2018, Figure 10, p.19.

California is the national leader in solar energy

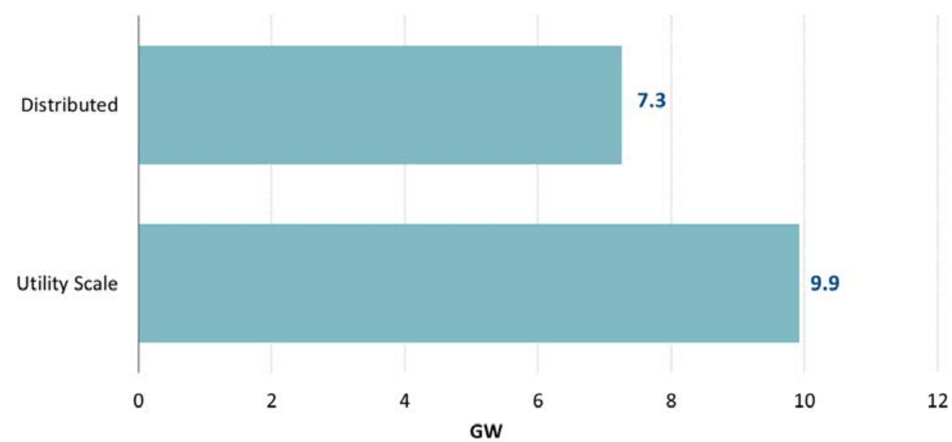
- Approx. **20% (17 GW)** of total installed generating capacity in California
- **38%** of total U.S. solar capacity is from California in Q2 2018
- **17%** of California's in-state electricity generation came from solar generation as of Q2 2018

Solar Generation as a Percentage of Total Generation, 2014-2017



Source: Q4 2017/Q1 2018 Solar Industry Update, National Renewable Energy Lab, NREL/PR-6A20-71493, May 2018., p. 30: https://www.nrel.gov/docs/fy18osti/71493.pdf.

Net Solar Capacity in California (GW)



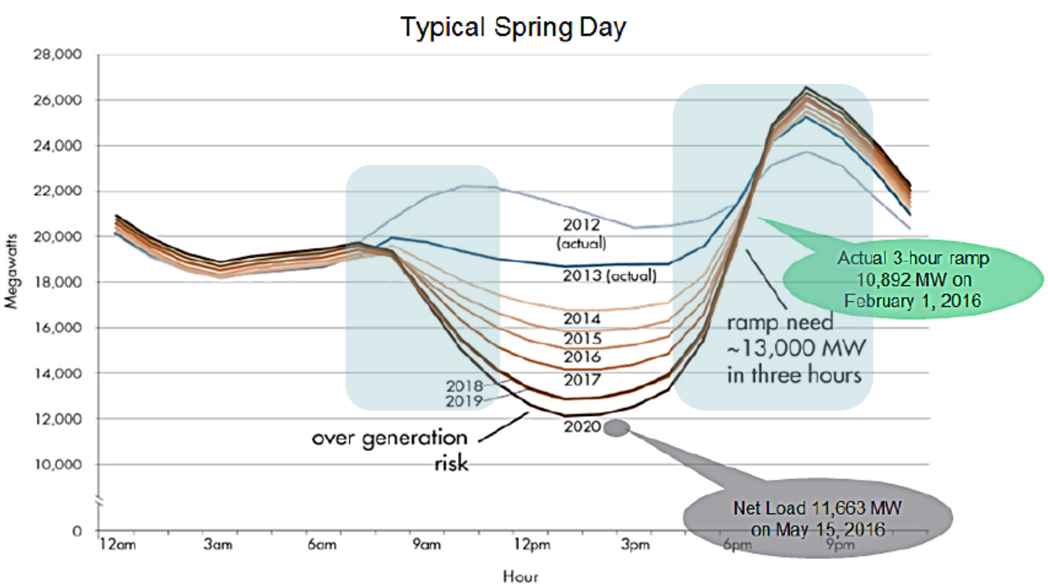
Source: Net summer capacity from the U.S. Energy Information Administration's (EIA) Electric Power Monthly Report released August 2018, Table 6.2.B.

Source: U.S. Energy Information Administration and California Energy Commission.

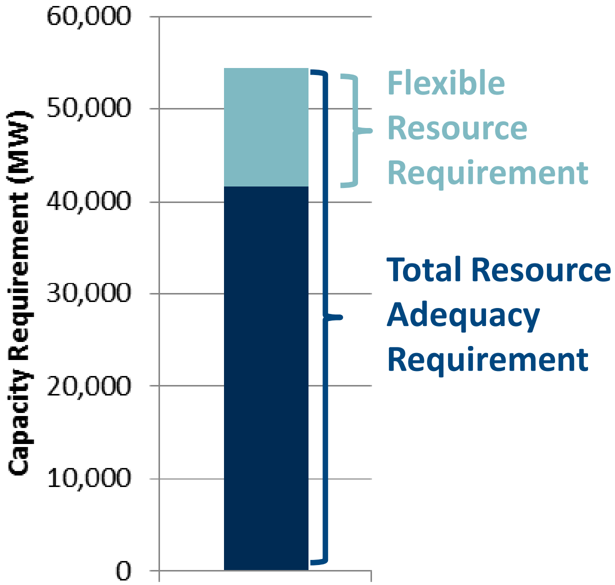
Challenges due to high solar penetration in California

Responding to steeper ramps

CAISO introduced a flexible resource capacity requirement and Flexible Ramping Product.



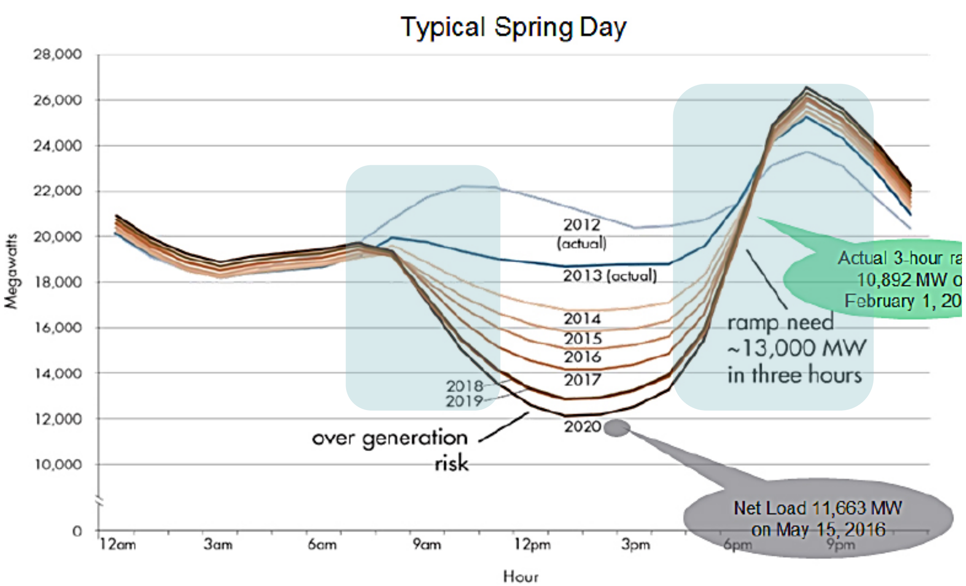
Source: Modified from CAISO Flexible Resources Fact Sheet 2016, Figure 2.



Sources and Notes: California Public Utility Commission, Tracking progress, Resource Flexibility, December 15, 2016. Flexibility requirements are comprised of three sub-types, but all reflect a 3-hour ramping capability.

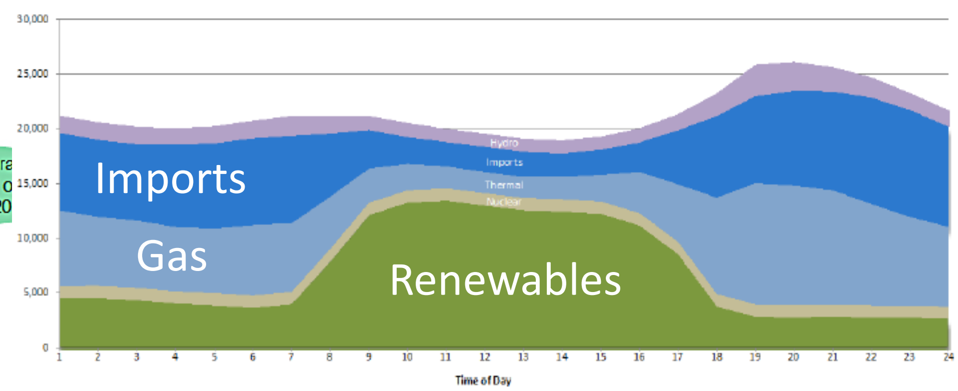
Responding to increased variability

Balancing of renewable resources is conducted using imports from outside of the state.



Source: Modified from CAISO Flexible Resources Fact Sheet 2016, Figure 2.

Hourly Average Breakdown of Total Production by Resource Type (MW)

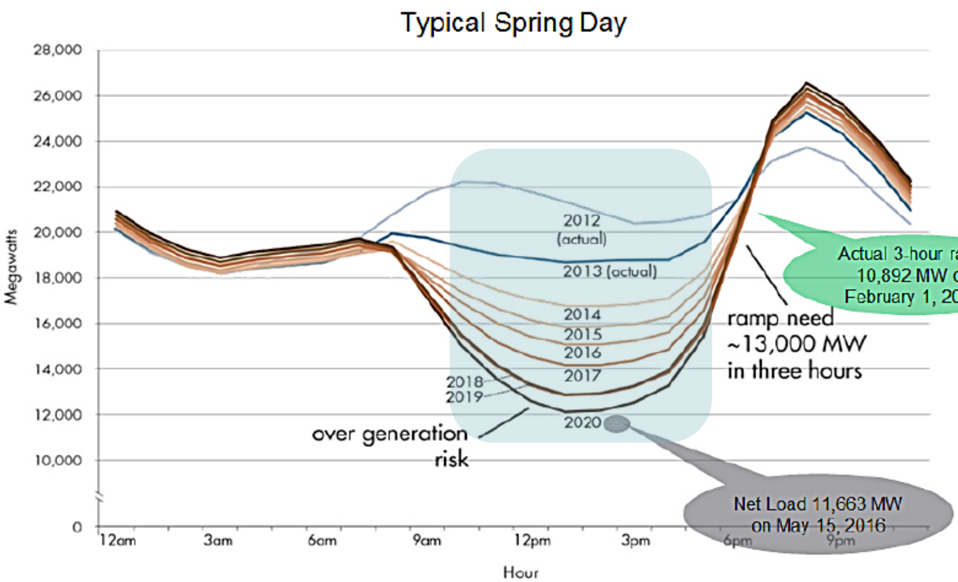


Source: Modified from Q4 2017/Q1 2018 Solar Industry Update, National Renewable Energy Lab, NREL/PR-6A20-71493, May 2018., p. 30: https://www.nrel.gov/docs/fy18osti/71493.pdf.

GENERATION AND TRANSMISSION PLANNING

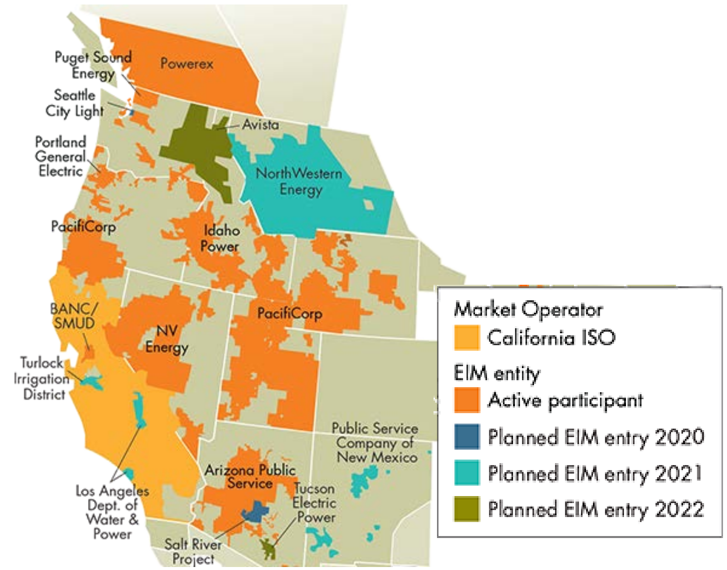
Responding to overgeneration

Power plants with higher shutdown or restart costs maintain minimum generation and compete with cheaper renewables, resulting in curtailed electricity and negative wholesale prices.



Source: Modified from CAISO Flexible Resources Fact Sheet 2016, Figure 2.

Western Energy Imbalance Market (EIM)



Source: Source: Briefing on western energy imbalance market and benefits, CAISO, http://www.caiso.com/Documents/WesternEnergyImbalanceMarket-BenefitsUpdate-Mar2019.pdf.

Additional proposed solutions:

- Potentially expanding CAISO's geographic service area
- Shifting load with demand response or time-of-use rates
- Improving storage capabilities

Potential infrastructure challenges

Moving toward a fully integrated distribution-transmission system

- Benefits of generating closer to loads
  - Congestion relief
  - Reduced system losses

Premature replacement of grid components

- Equipment wear and tear
- Distribution voltage
- Reverse power flow

Grid modernization is necessary

- Hosting capacity is key
- Advanced inverters
- Battery storage

Benefits of DER should be appropriately compensated

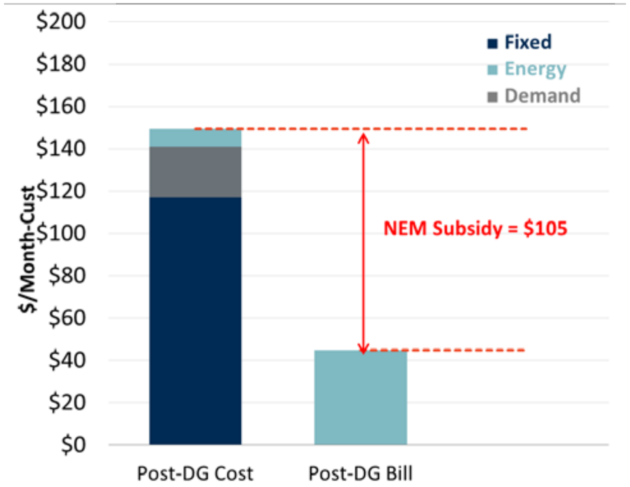
Net Energy Metering creates incentives but shifts cost recovery to non-DG customers

- Exacerbated by 2019 Building Codes requiring all new homes to install rooftop solar

Excess generation should be compensated based on forward-looking avoided costs

- Alternative compensation structures
  - Net billing (Arizona, Hawaii)
  - Value stack tariff (New York)
  - Buy-all, sell-all (Maine)

2018 Estimated NEM Subsidy for PG&E DG Customers



Aligning revenue incentives with utility operations

DG is changing how customers rely on the grid

- Moving away from centralized generation
- Reducing customer net load

Regulatory responses to new business risks

- Revenue decoupling
- Incentivizing penetration of renewables
- Incentivizing non-wires alternatives
- Revising utility business model

Utilities are using different strategies to respond to threats related to DG solar

Table 3. Strategies to Address Concerns about the Utility Financial Impacts of DPV

Strategies	Stakeholder Concerns Addressed		
	Increased Retail Electricity Rates and Cost-Shifting	**Reduced Utility Shareholder ROE**	**Reduced Utility Earnings Opportunities**
Reduce compensation to DPV customers Key examples: NEM and retail rate reforms, community solar	✓	✓	✓
Facilitate higher-value DPV deployment Key examples: time-varying, locational, or unbundled attribute pricing; enhanced utility system planning, utility ownership and financing of DPV, shared solar, distribution network operators, ESUs	✓	✓	
Broaden customer access to solar Key examples: utility ownership and financing of DPV, community solar	✓		
Align utility profits and earnings with DPV Key examples: Decoupling and other ratemaking reforms to reduce regulatory lag, utility ownership and financing of DPV, performance-based incentives, distribution network operators, ESUs		✓	✓

Source: Utility Regulatory and Business Model Reforms for Addressing the Financial Impacts of Distributed Solar on Utilities, NREL, NREL/TP-6A20-65670, May 2016, p. 62

Challenges due to high solar penetration in California

Build an adequate policy framework

- Evaluate the economics of solar generation for the region
- Design an incentive framework

Anticipate potential infrastructure challenges

- Identify resource mix flexibility
- Strengthen integration of transmission and distribution systems
- Measure hosting capacity
- Evaluate potential for grid modernization

Target incentives toward more cost-effective solutions

- Analyze cost effectiveness of different solar development options
- Design incentives to provide adequate price signals
- Introduce cost-reflective tariffs

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