

# Negotiating the Clean Energy Transition: California's Experiment-in-Progress

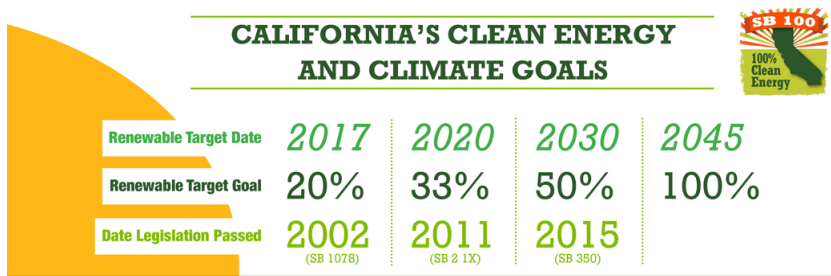
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UC Berkeley and NBER

3rd Annual Workshop on the Economics of Electricity Policy and Markets  
Ivey Energy Policy and Management Centre

October 22, 2019

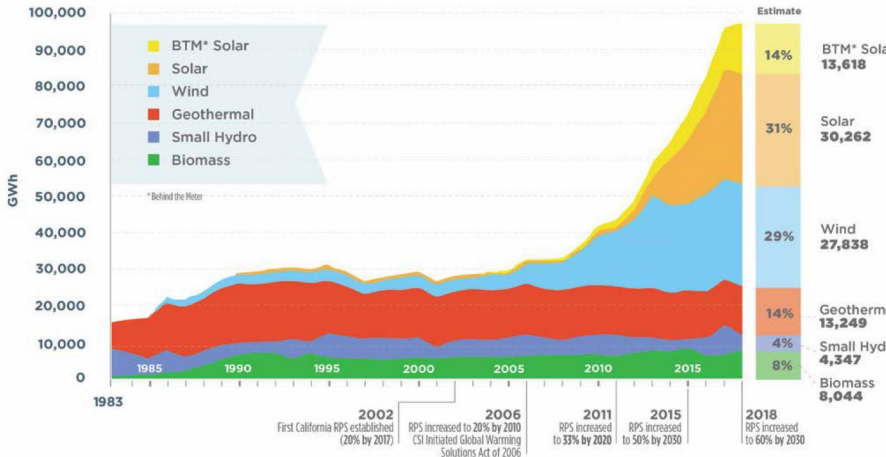
# How will the power sector adapt to this changing technological landscape?

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California is on the bleeding edge of this question.

# A Remarkable Real-World Experiment



Source: California Energy Commission, staff analysis November 2018

In 2018, California got over 30% of its electricity from renewable sources (not including distributed generation or large hydro)

# The Crucible that is California

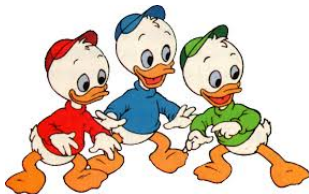
- Rapid acceleration of distributed and utility-scale renewable energy investments is transforming/disrupting many aspects of California's power sector.
- Some impacts expected or intended.
- Other chain reactions were unanticipated.



## Overview

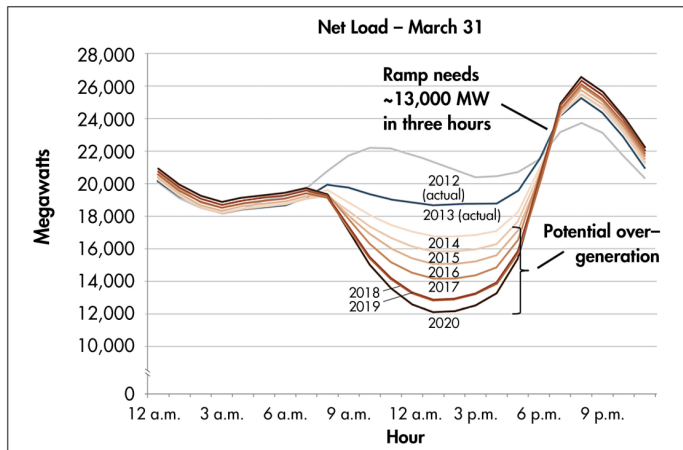
1. **Impacts to date:** How has an accelerated deployment of wind and solar impacted electricity market outcomes?
2. **How did we get here?** Technology mandates and distributed generation incentives.
3. **Challenges ahead:** Accelerated renewable energy integration, resource adequacy, and regionalization.

**How has the accelerated deployment of wind and solar impacted California's electricity market outcomes?**



# Expected Impacts: The Net Load Duck

Figure 1: Net load on the CAISO system

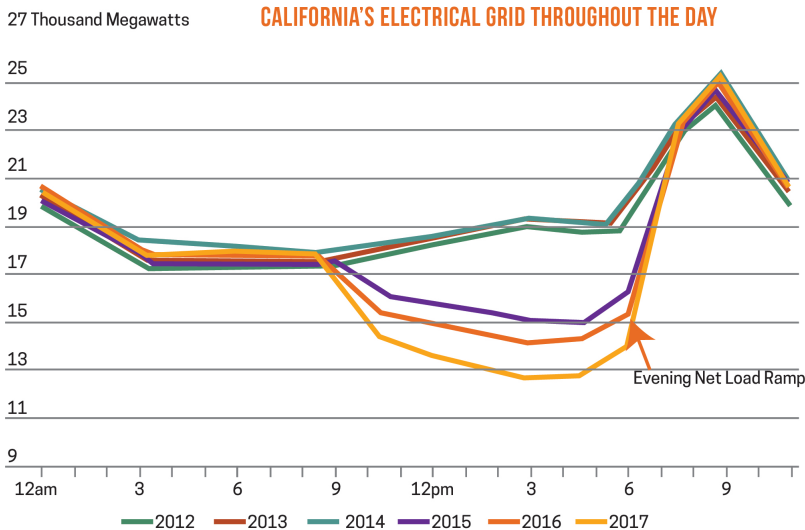


Source: CAISO

*Projected* impacts (circa 2013) on electricity demand net of renewable generation.

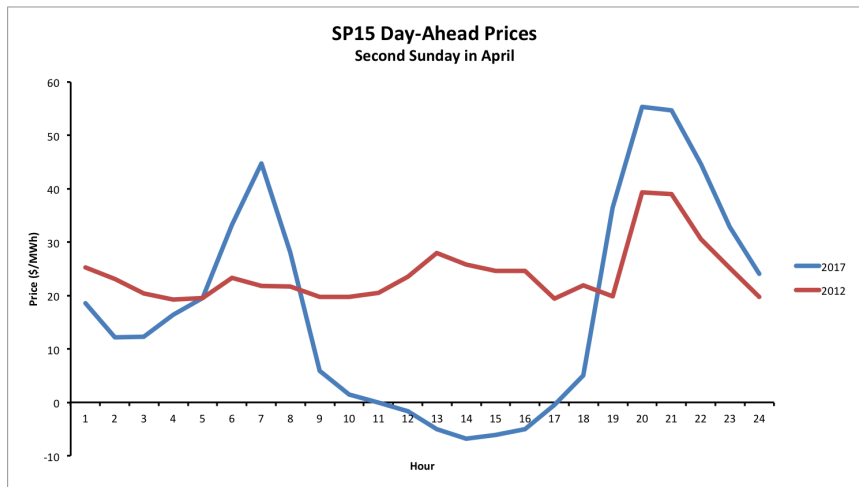


# How's the duck shaping up?



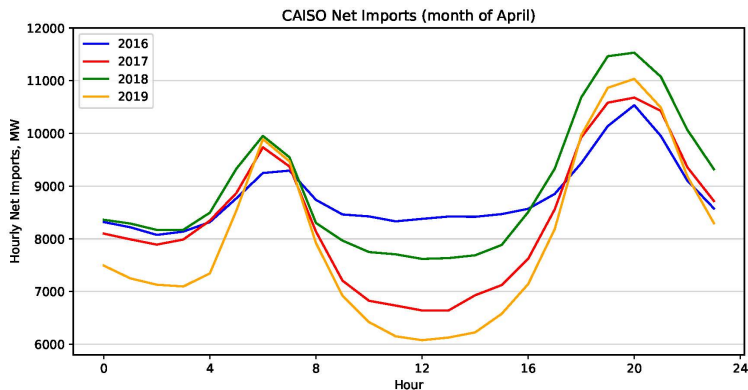
Source: [cpowerenergymanagement.com](http://cpowerenergymanagement.com)

# Realized Impacts: Wholesale Price Response Duck



Source: Wolfram, Catherine. "Is the Duck Sinking?", Energy Institute Blog, UC Berkeley, April 24, 2017.

## Realized Impacts: Net Trade Duck



Source: Fowlie, Meredith. "The Little Energy Market That Could", Energy Institute Blog, UC Berkeley, October 7, 2019.

## How did California accelerate wind and solar capacity investment so fast?



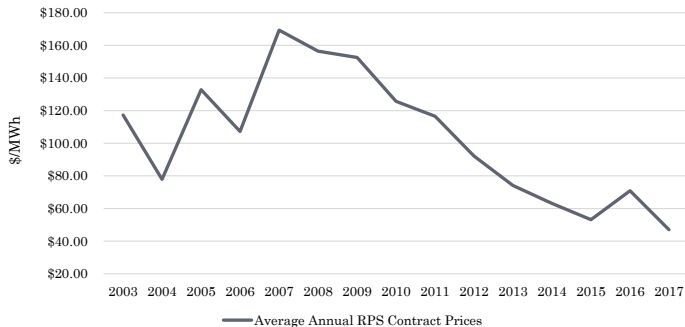
*The intended and unintended impacts of California's renewable energy policies.*

## Renewable Portfolio Standards (RPS) in California

- Mandatory RPS targets: 33% by 2020; 60% by 2030 (SB100); 100% by 2045.
- All load serving entities are required to comply with these RPS standards.
- Since 2002, California's investor owned utilities have been instrumental in delivering RPS capacity additions...

## Utilities lock into long run (>10 year) contracts

### Average Annual RPS Contract Prices (2018 Real Dollars - CPI Adjusted)



Data Source: 2018 Annual Report on Costs and Cost Savings for the RPS Program (Padilla Report)<sup>37</sup>

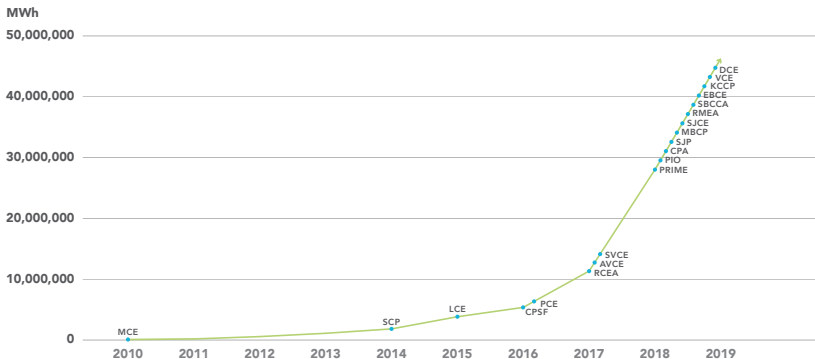
- Early contract prices reflect depreciated small hydro.
- Contracts for new solar and wind dominate since 2007.

## An unexpected RPS ripple effect....

- AB 117 (also introduced in 2002) allows local governments to take a more active role in energy procurement *and authorized default customer enrollment!*
- 'Community Choice Aggregators' (CCAs) are authorized to aggregate load and act as load serving entities for their community/city/county.
- CCAs have recently started taking advantage of low RE technology costs and low wholesale market prices .....

# CCAs now serve over 25% of retail load (wow!)

**FIG 1** CCA Load Growth Over Time<sup>3</sup>

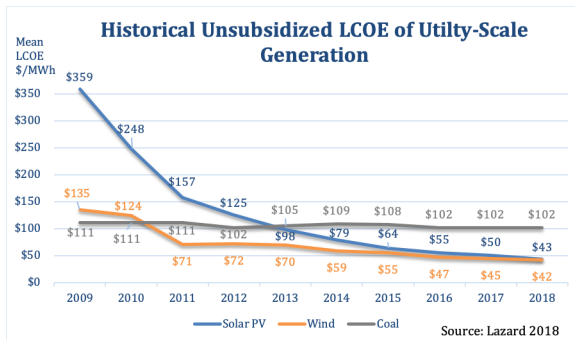


Source: UCLA Luskin Center for Innovation (2018)

CPUC projects that up to 85% of load could defect to CCAs / direct access by 2030.



# How can CCAs compete for market share?



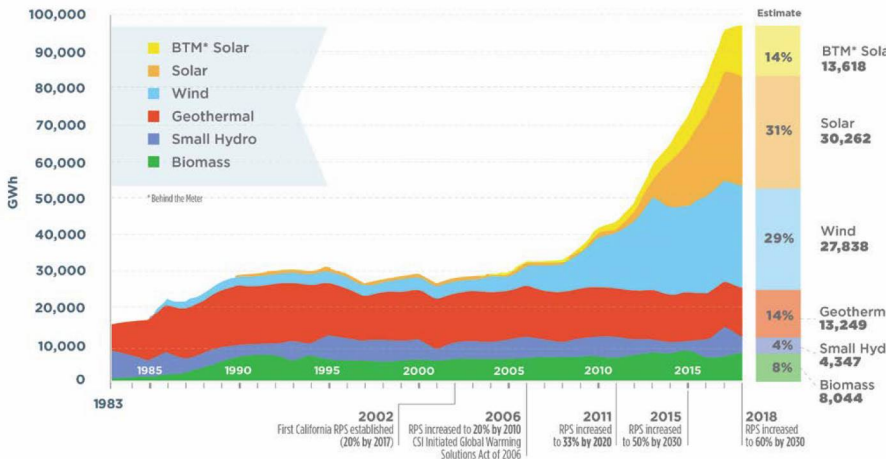
- While IOUs are locked into expensive long-term contracts, relatively unburdened CCAs are taking advantage of low wind and solar prices (note power charge indifference adjustment).
- CCAs are relying on short-term PPAs (and low wholesale market prices) versus long term contracts (this will change with SB 350 in 2021).

## RPS has catalyzed more than technological change..

- California's RPS policies have accelerated:
  1. The penetration of wind and solar generation (intended)
  2. The 'fragmentation' of retail procurement (unintended!)
- As Community Choice Aggregators take market share and influence from the incumbent investor owned utilities, coordinating resource adequacy becomes more complicated....



## Meanwhile, behind the meter...



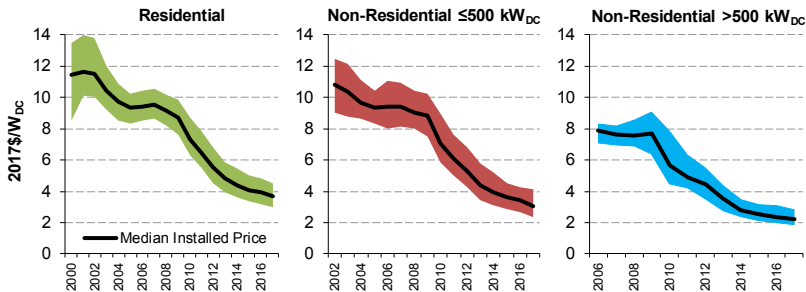
Source: California Energy Commission, staff analysis November 2018

In 2018, California got over 30% of its electricity from renewable sources (not including distributed generation or large hydro)

## Meanwhile, behind the meter...

Distributed generation costs also falling (although economies of scale remain significant).

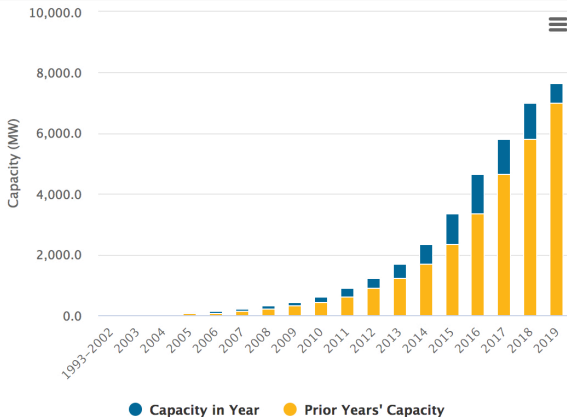
### National Median Installed Prices: 2000-2017



Notes: Solid lines represent median prices, while shaded areas show 20<sup>th</sup>-to-80<sup>th</sup> percentile range. Summary statistics shown only if at least 20 observations are available for a given year and customer segment.

Source: Tracking the Sun 2019 (Lawrence Berkeley National Laboratory).

# The rise of distributed PV in California has been policy-driven



Source: <https://www.californiadgstats.ca.gov>

California has the most distributed PV generation in the U.S.  
(much thanks to net metering).

## Net metering *over*-subsidizes distributed solar PV

- Under net metering, households and firms are credited for every kWh of solar electricity generated **at the retail price**.
- This retail (per kWh) price reflects variable costs of supply **and fixed and sunk infrastructure costs**.
- The majority of fixed costs aren't avoided when a California household installs solar panels!

*But households should get credit for accelerating the transition to clean energy! Yes, but...*

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*But households should get credit for accelerating the transition to clean energy! Yes, but...*

- Average retail rates (@ \$0.20/kWh and rising) exceed variable operating costs (e.g. wholesale electricity price @ \$0.05/kWh) by a significant margin.
- Retail price per kWh exceeds social marginal cost.

## Unintended distributional consequences of net metering

- **Problem:** Fixed supply costs are reallocated from adopters (wealthier on average) to non-adopters (less affluent on average).
- **Equity matters!** As retail electricity prices rise - and the state mandates solar PV on all new homes!- distributional concerns loom large.





## Some Take-Aways..

### RPS

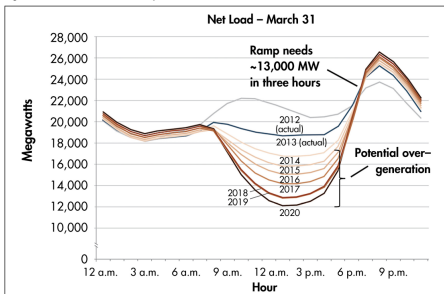
- Using technology mandates - versus an emissions price- to accelerate clean tech investments is a relatively crude way to incentivize GHG reductions.
- All qualifying renewables receive the same incentive per kWh regardless of value generated (problematic implications for wholesale prices.)

### Net metering

- Net metering has exacerbated inefficiencies associated with rate structures that aren't well aligned with costs.
- The equity/distributional implications of 'sloppy' rate design are reaching a breaking point.

## Rising to the renewable resource integration challenge.

Figure 1: Net load on the CAISO system



Source: CAISO

*Ducks revisited*

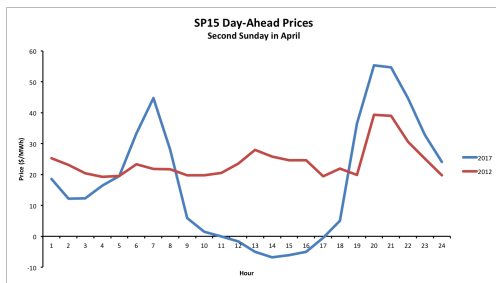
## Rising to the renewable resource integration challenge...

Integrating more and more intermittent renewable energy resources will require some combination of:

- Flexible and nimble generation
- Demand response
- Storage
- Integrated and optimized grid operations.

Are existing market/policy incentives up to the task of efficiently coordinating the deployment of these strategies?

## Flexible ramping resources?



- Low wholesale prices are posing serious challenges for many incumbent (and flexible) generators (e.g. natural gas plants).
- Growing concern that existing market incentives do not adequately reward availability/flexibility/dependability.

# California Resource Adequacy 1.0

**Resource Adequacy** requirements are imposed on all retail Load Serving Entities (LSEs).

- **Objective:** Maintain physical generating capacity and electrical demand response adequate to meet load requirements.
- **Requirements:** LSEs are required to own or contract with sufficient resources to meet their share of the CAISO systems peak demand, plus a reserve margin of 15%.

**Load ‘fragmentation’ means a larger and more heterogeneous group of entities is responsible for delivering adequate procurement.**

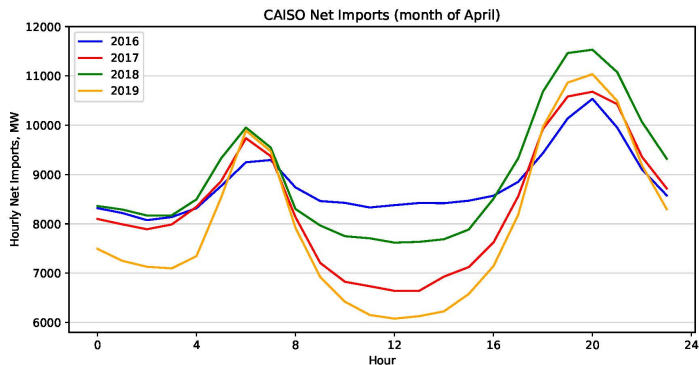
## How to reform resource adequacy (RA)?

**Up for debate:** How to make sure that a growing number of retail players share the responsibility for procuring the resources needed to keep the grid operating efficiently?

- If RA value is not fully reflected in market incentives, who will pick up the slack?
- Local versus system-wide resource investment optimization?

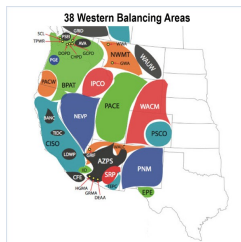
Retail market fragmentation seems to be pushing us towards a more centralized integrated resource planning process.

# We are not an island!



Regional market integration has an important role to play in renewable resource integration.

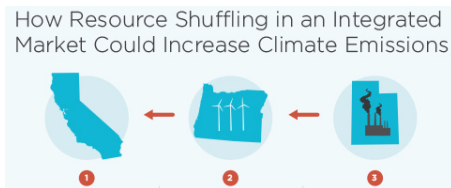
## Unexploited gains from trade?



- Frictions between 38 fragmented areas that balance electricity supply and demand across the west means there are gains from trade were not accessing
- A more integrated western electricity market could lower renewable resource integration costs (e.g reduced curtailment, more coordinated investments in flexible ramping capacity).



## What's not to like about regional integration?



Source: Sierra Club

- California has tried in the past to integrate Western power markets (RIP AB 813).
- **An important sticking point:** A more integrated market increases potential for emissions leakage and resource shuffling.
- Fears that proposed regionalization would undermine California's ability to determine its own power sector policies.



## A development worth watching...

- There is a movement to build on the success of the Western EIM and expand to the day ahead market (EDAM).
- Coordinated, market-based day-ahead trading at state-borders under mutually agreed upon terms could deliver significant efficiency gains.
- Crafting terms that respect and accommodate different GHG regulations of different jurisdictions non-trivial!
- Stay tuned!

## In summary

New renewable energy investments will fall short of their full potential if they are plugged into an electricity market that is not designed to absorb them

### **Some challenges ahead:**

1. Designing policy and market incentives to align cost allocation more effectively with cost causation.
2. Retail rate reform to address mounting efficiency and distributional concerns.
3. Striking a balance between seamlessly integrating markets and ensuring GHG accounting integrity across jurisdictions with different levels of climate mitigation ambition.

Thank you!

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