California ISO

Renewables 100 Policy Institute

H2@Scale: The Role of Storage and DER for California

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Angelina Galiteva: Member CAISO Board of Governors,
Founder Renewables 100 Policy Institute, November 2017

Electric industry in the midst of unprecedented change

- Driven by fast-growing mix of interrelated issues

Existing 50% goal

Federal Election Impacts

Gas Storage Challenges

NEW 100% goal

Community or Retail Choice

Grid Modernization

Regional Collaboration

Consumer-owned Power

Fossil Plant Retirements

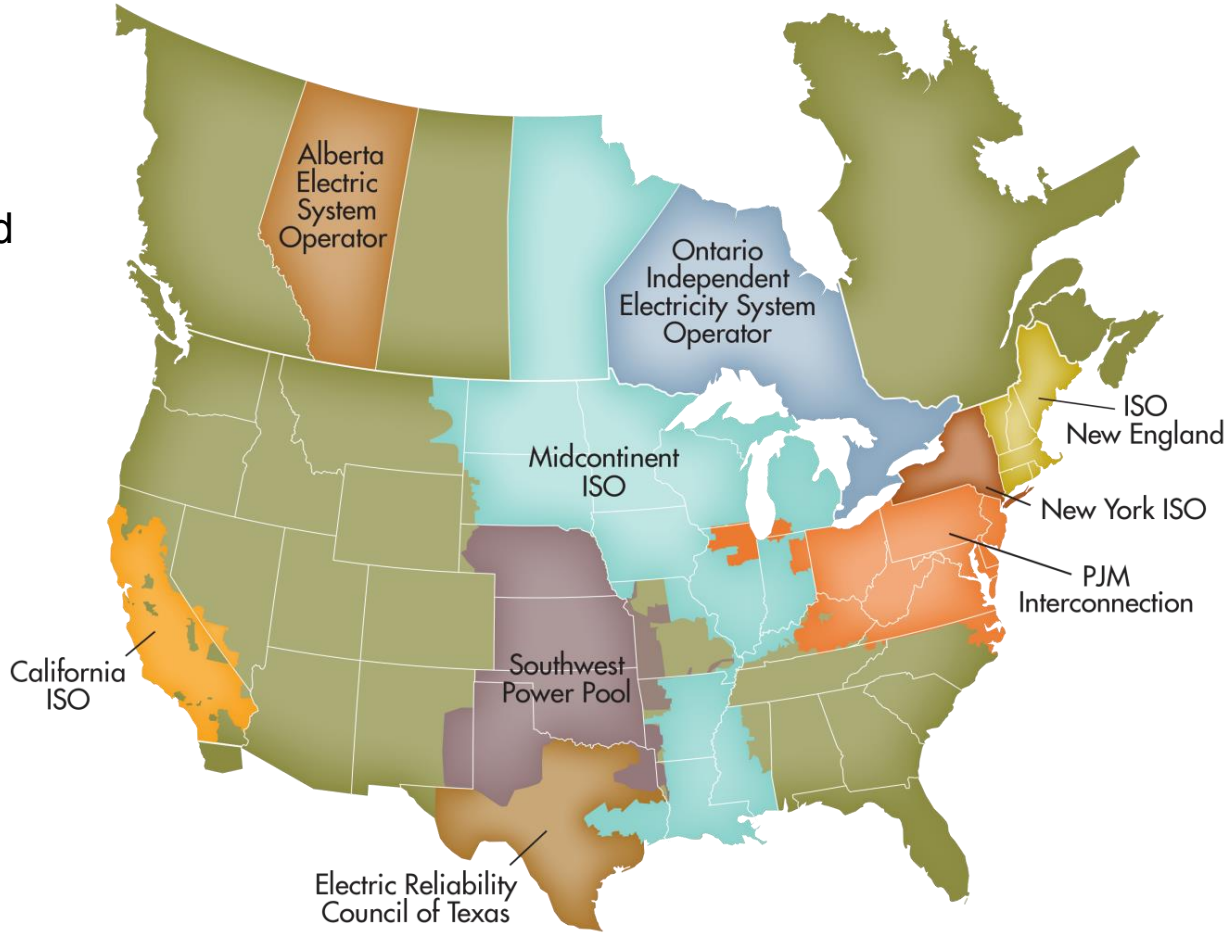
Transmission & Distribution Systems Interface

The California ISO

- Balance supply and demand…every 4 seconds
- Operate markets for wholesale electricity and reserves
- Manage new resource interconnections
- Plan grid expansions

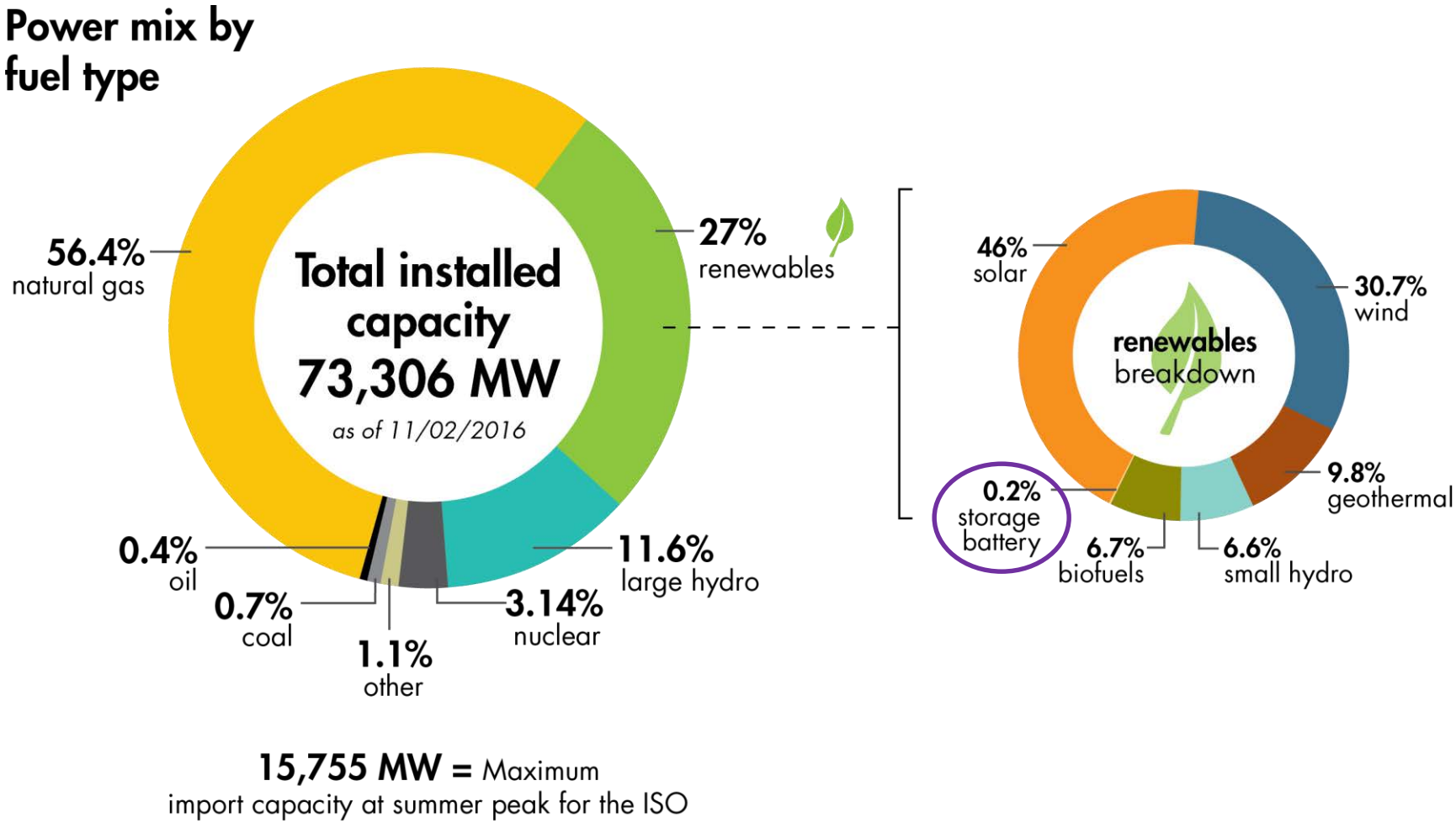
One of nine Grid Operators in the U.S.

- 2/3 of the U.S. is supported by an ISO
- ISO is one of 38 balancing authorities in the western interconnection

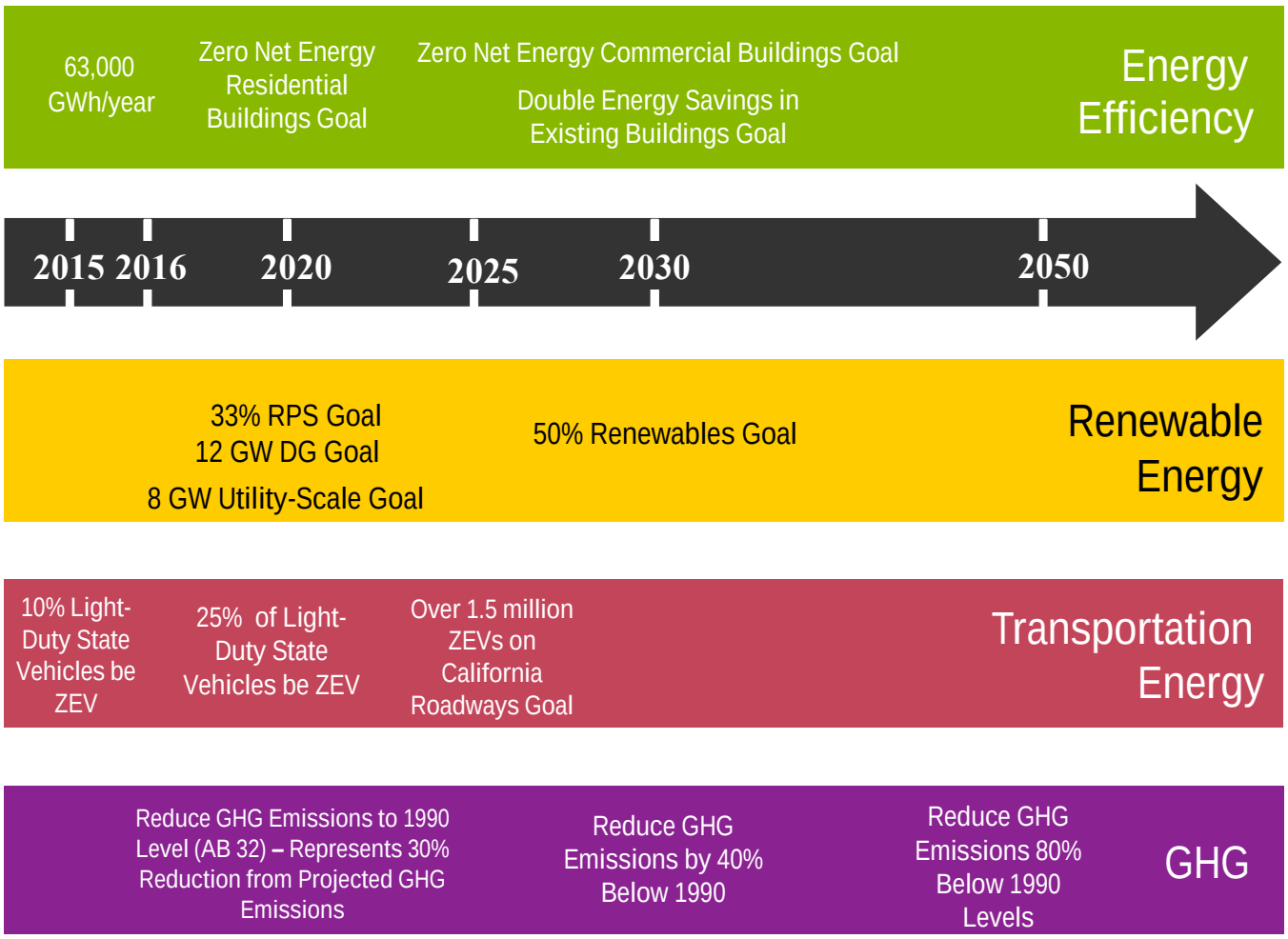


ISO Resource Mix

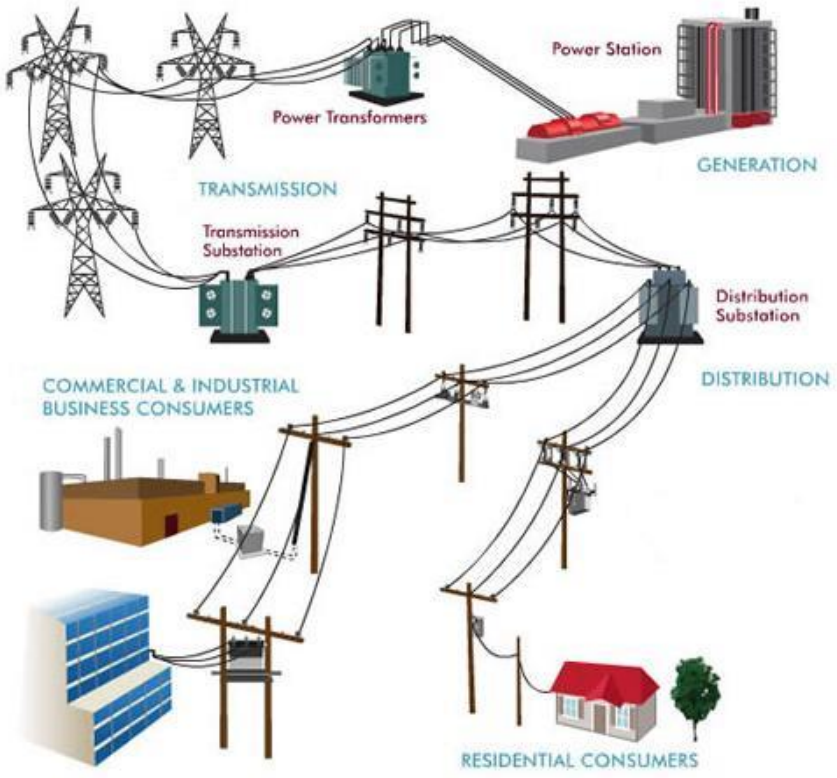
- Good progress toward State's goals

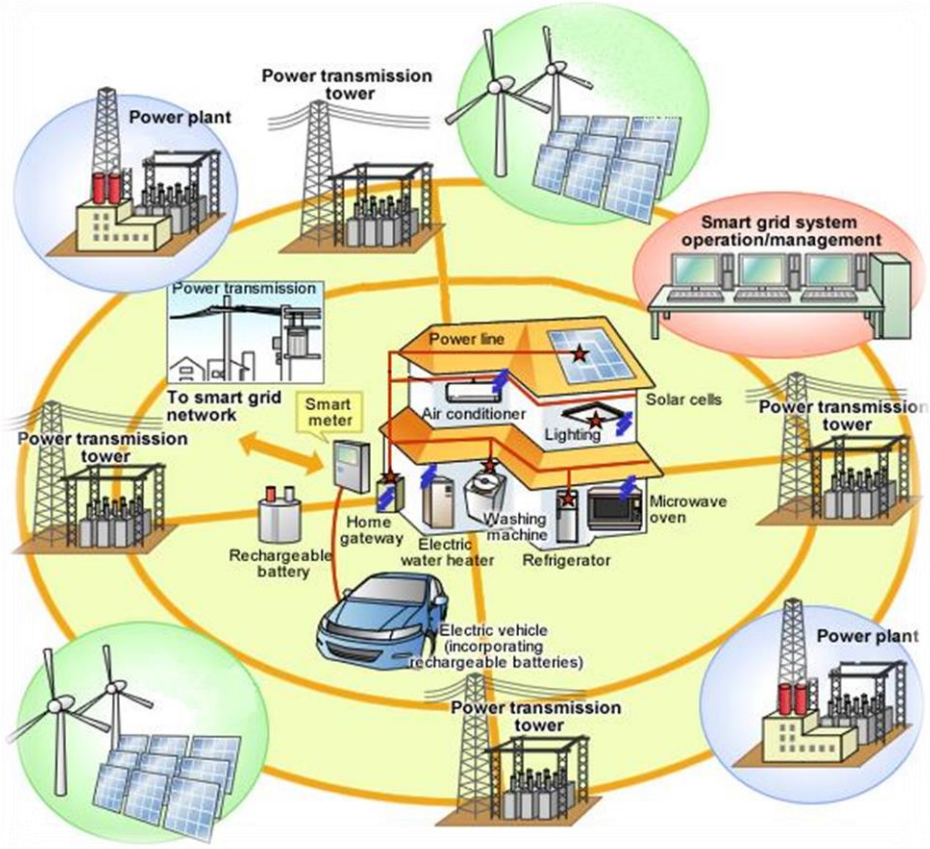


State Energy Policy Drives Energy RD&D Investments



Supporting Evolution of the Electricity Grid





Historical Grid → "Smart" Grid

The “State of the State” of Renewables

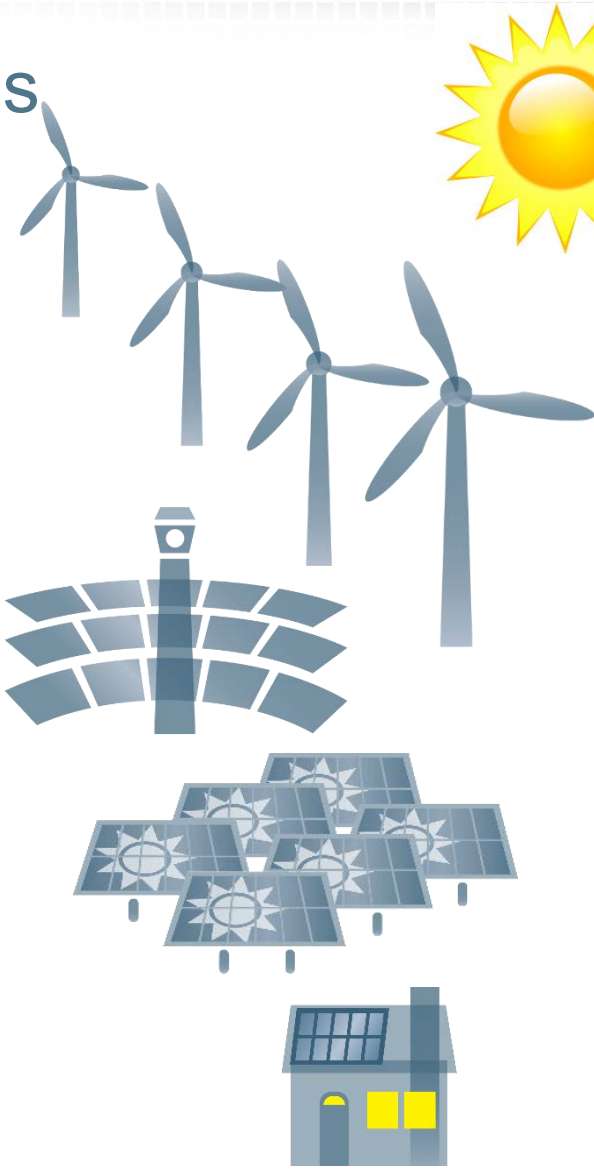
73,000 MW of installed capacity
- 30,000 load +/- in spring and fall

20,000 MW of utility scale renewables
- Solar peak 8,545 MW (Sept ‘16) – doubled in 2 years

Another 5,000 MW to meet 33%

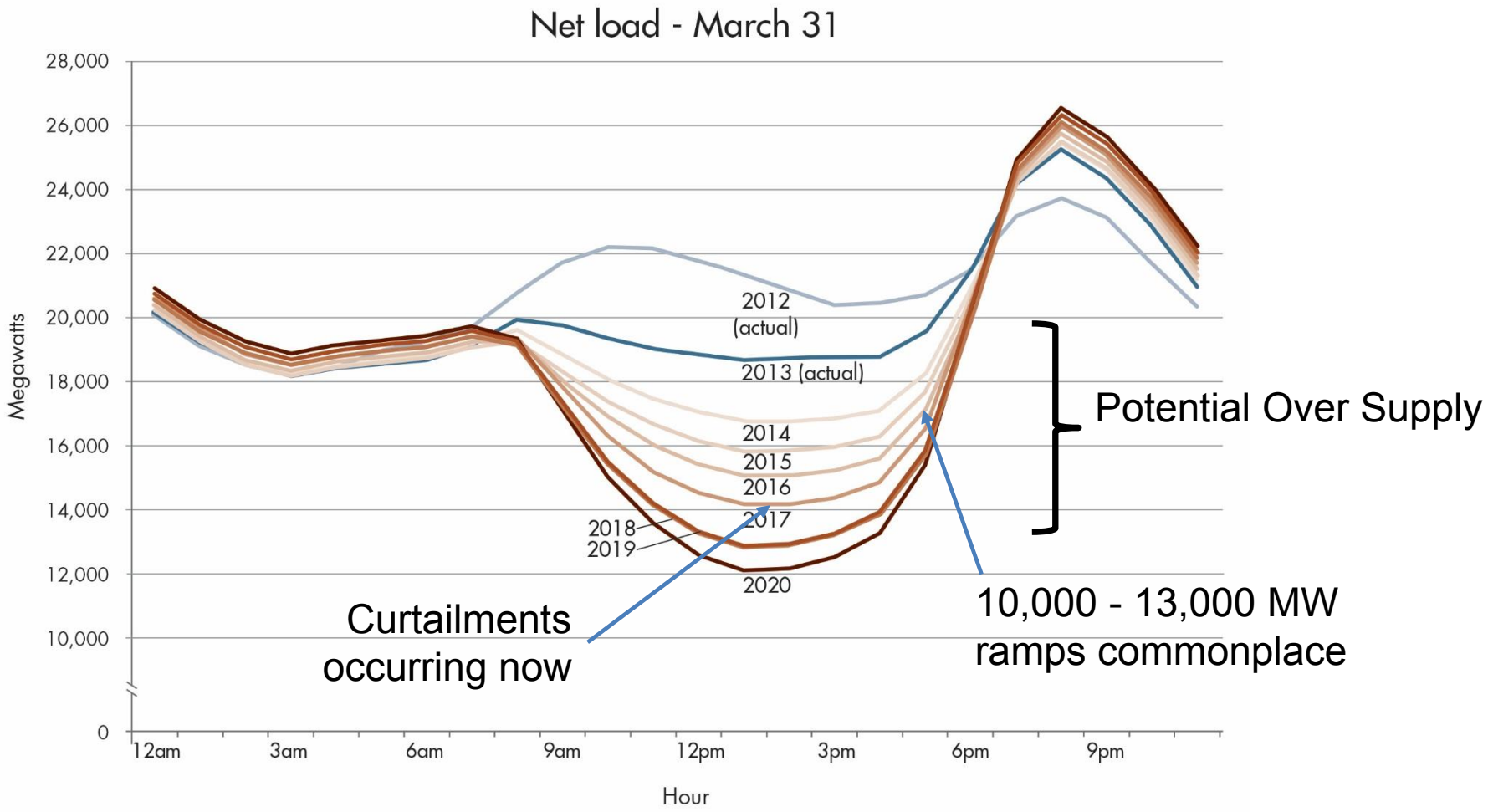
12,000-16,000 MW to meet 50%

4,500 MW of consumer rooftop solar
- 11,000 new/month; = 50-70 MW / mo.

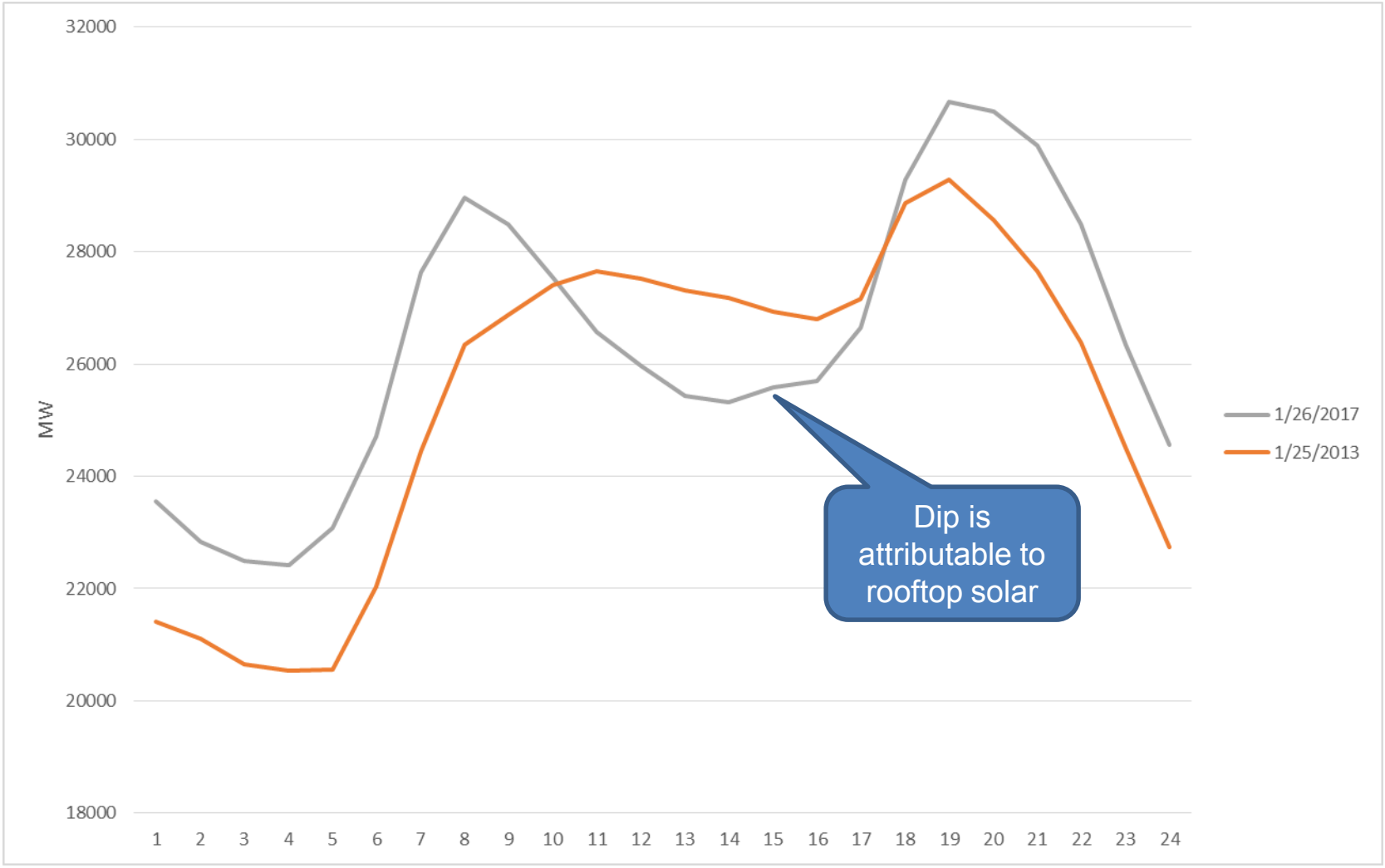


Clean, plentiful renewables…what's the problem?

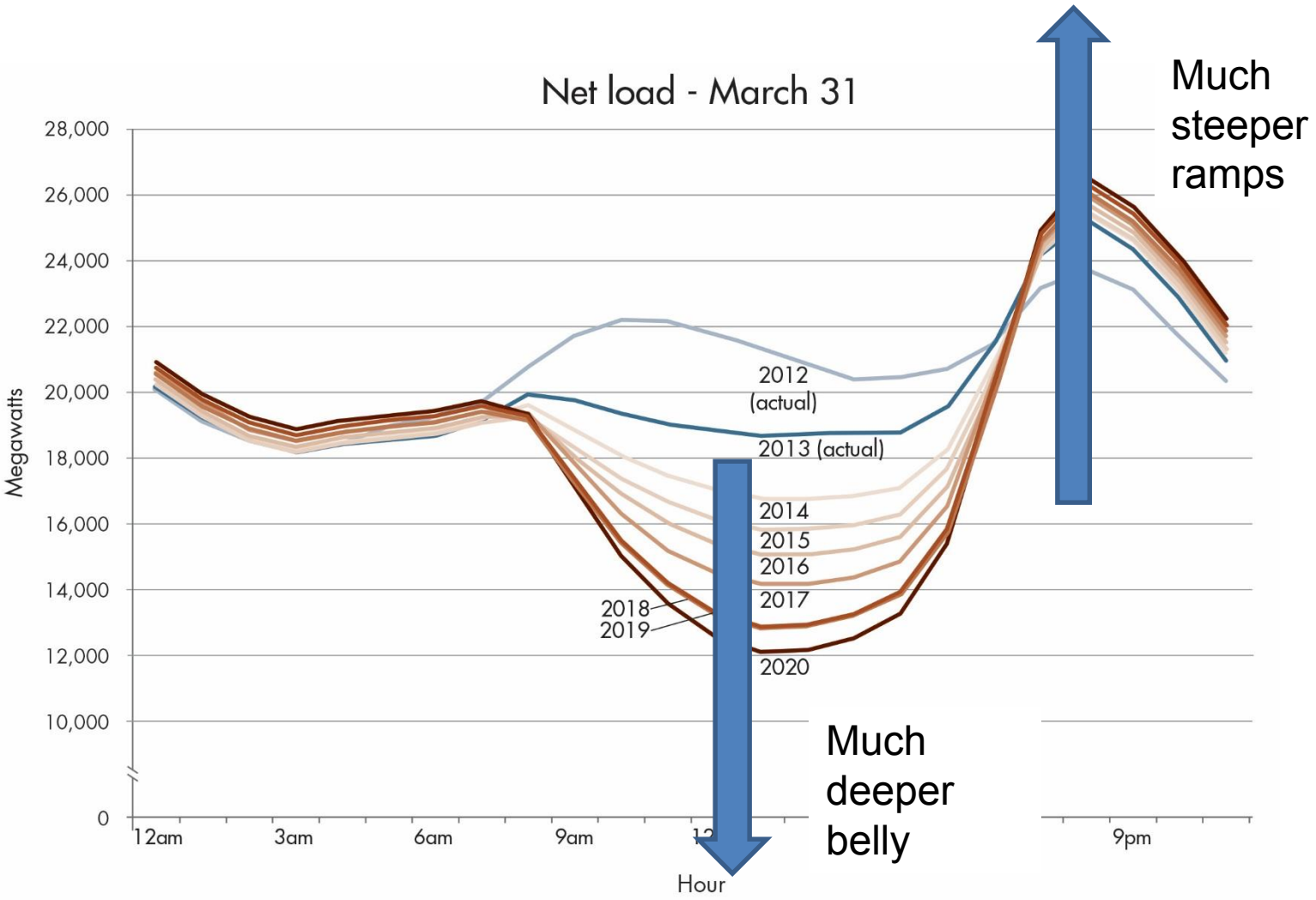
- *Oversupply and Steep Ramps*



NOT the Duck: ISO gross load curve is changing

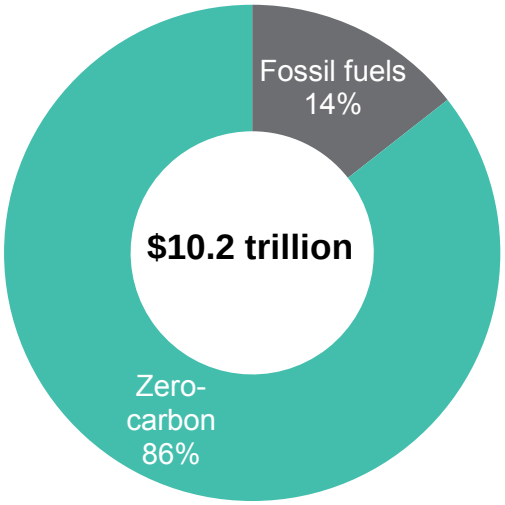


ISO working on a 50% duck curve



Solar and wind attract 60% of new investment in power generating capacity

Investment, by technology, 2017-2040



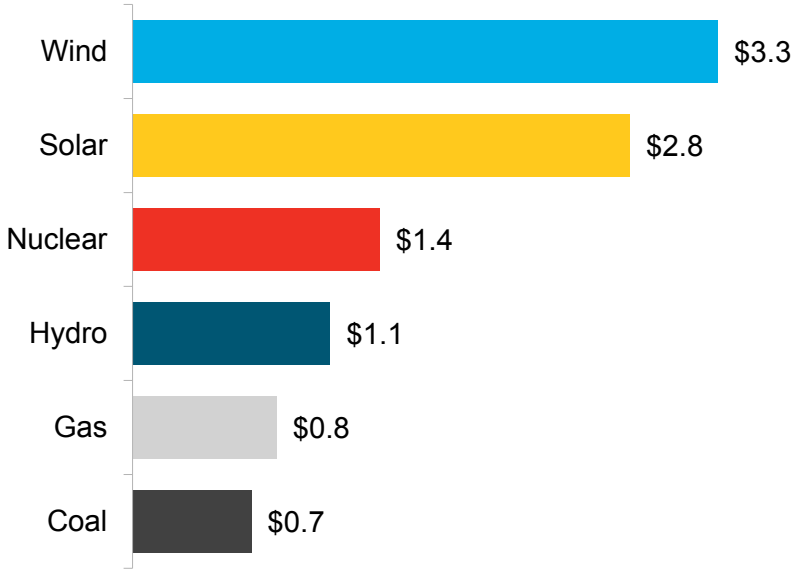
Source: Bloomberg New Energy Finance, NEO 2017

Source: Bloomberg New Energy Finance

Source: Bloomberg New Energy Finance

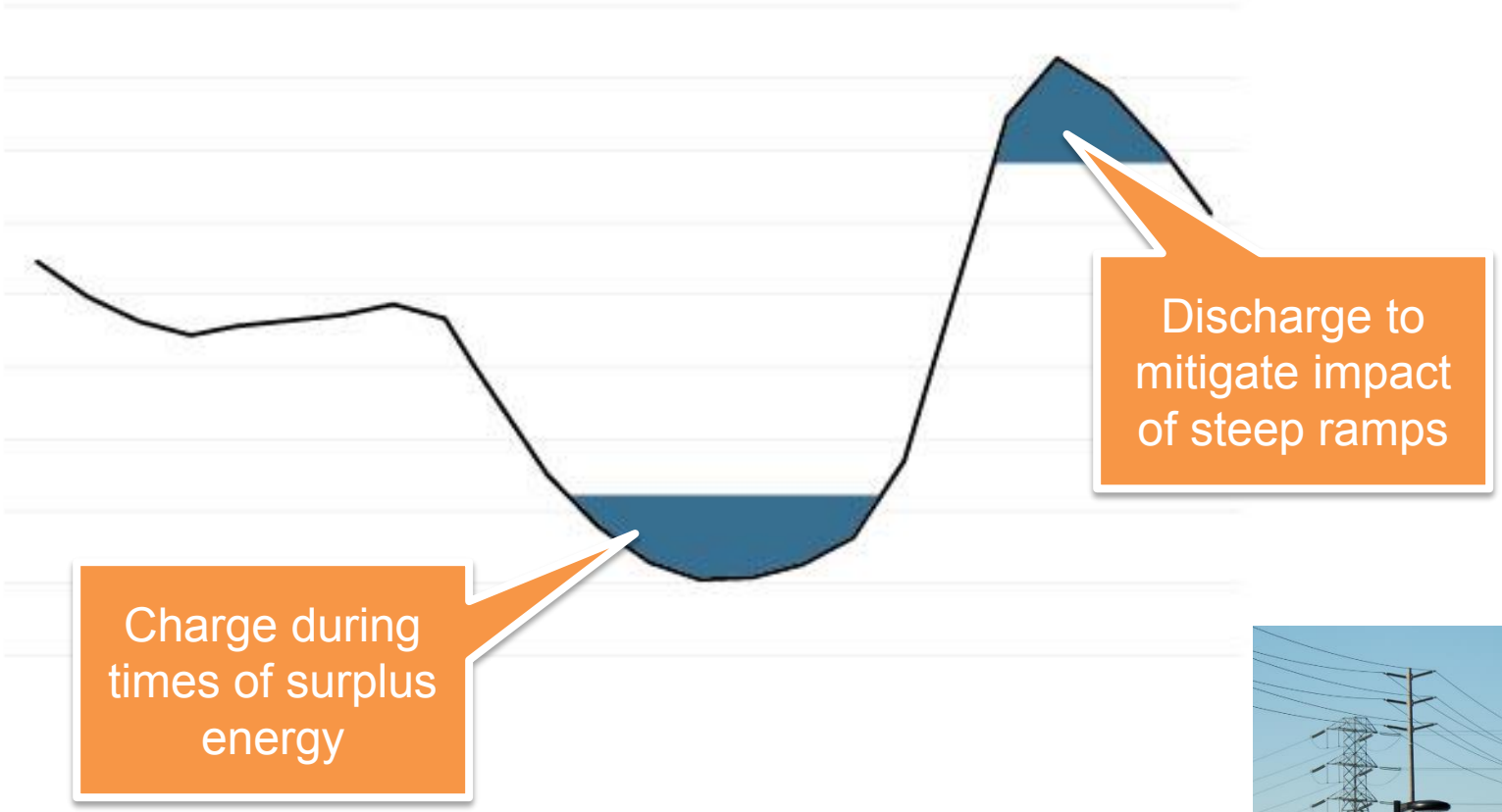
Investment, by technology, 2017-2040

($ trillion - 2016 real)

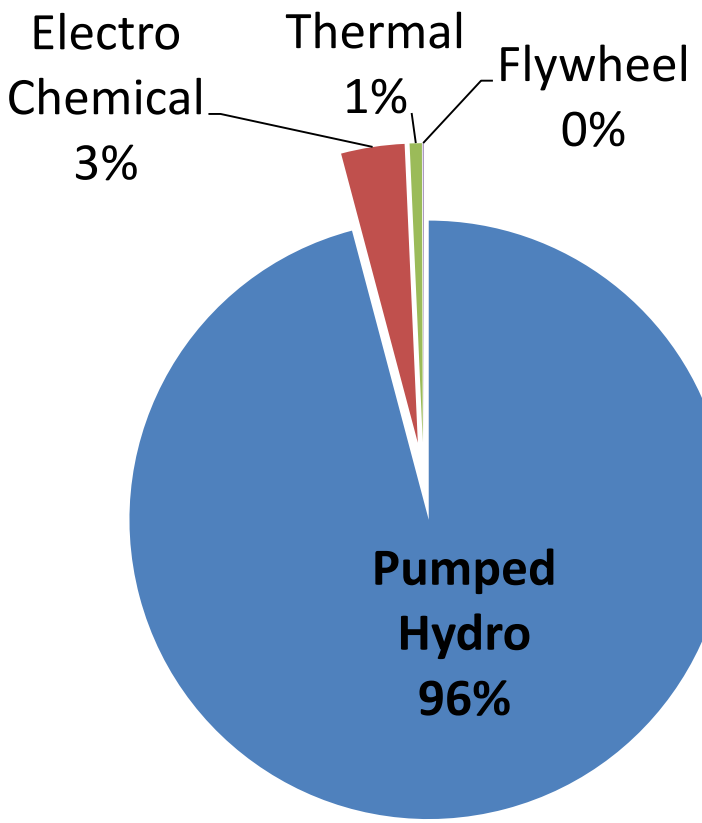


Source: Bloomberg New Energy Finance

Storage uniquely qualified to help mitigate operational issues



Existing Storage in California



Pumped Hydro:	4087 MW
Electro-chemical:	146 MW
Thermal:	28 MW
Flywheel:	2 MW

No Single Solution to Oversupply and Ramping

- *Need to **Decarbonize, Decentralize, Regionalize***

A comprehensive solutions set is needed
Energy storage — bulk, distribution-sited facilities, consumer owned
More customer demand response
Retrofit existing power plants — lower minimum operating level; gain flexibility
Enable economic dispatch of renewables – allow them to “bid-out” of the market
Decarbonize transportation fuels
Deepen regional coordination — big impact; make use of installed assets EIM
Consumer participation — align time-of-use rates w/ system conditions

Renewable Energy Integration Issues

- Variable resources / not highly predictable
- Generation Profile vs CA Load Profile
- Not Dispatchable
- Seasonal Issues
  (Over/Under generation)
- No Contribution to System Inertia, Frequency Control, Other Ancillary Services

ISO Programs Enable Participation

Energy Storage & Distributed Energy Resources (ESDER)

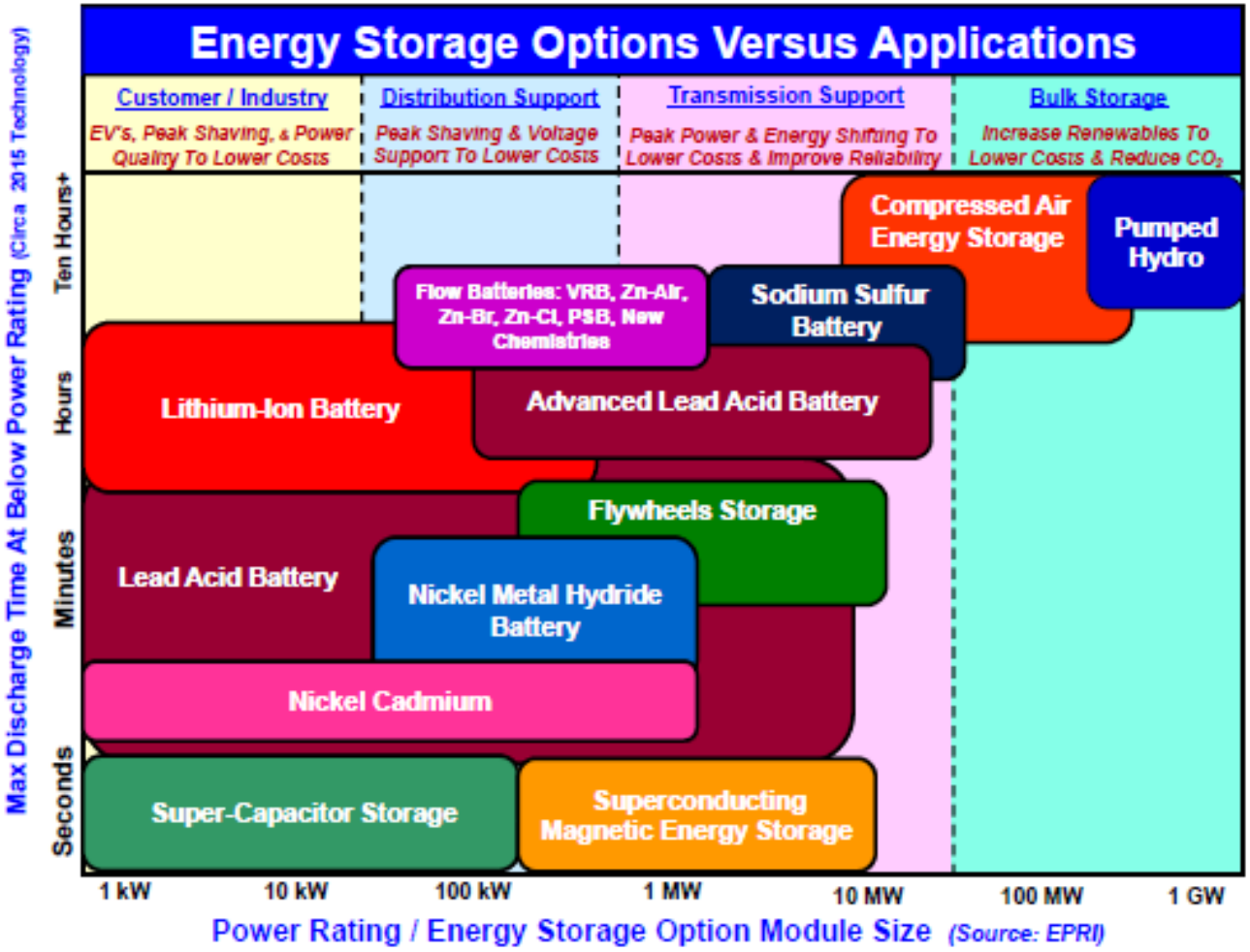
- Enable transmission-connected storage and distribution-connected resources to participate in ISO market (2016)

Distributed Energy Resource Provider (DERP)

- Pathway for distributed resources to bundle & participate

Bulk Storage	Behind the Meter	Distribution Connected

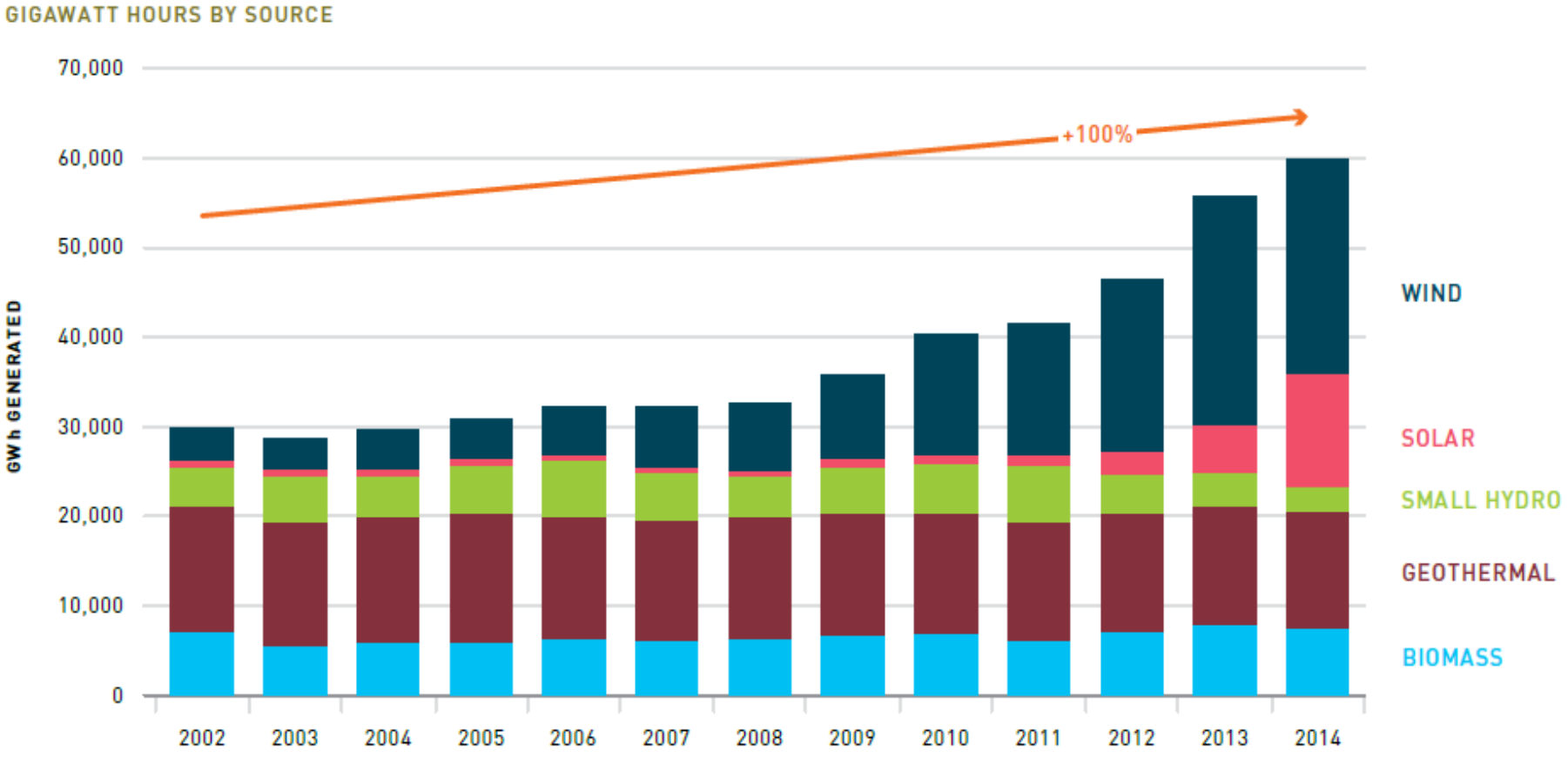
Energy Commission Research Supports Options and Applications



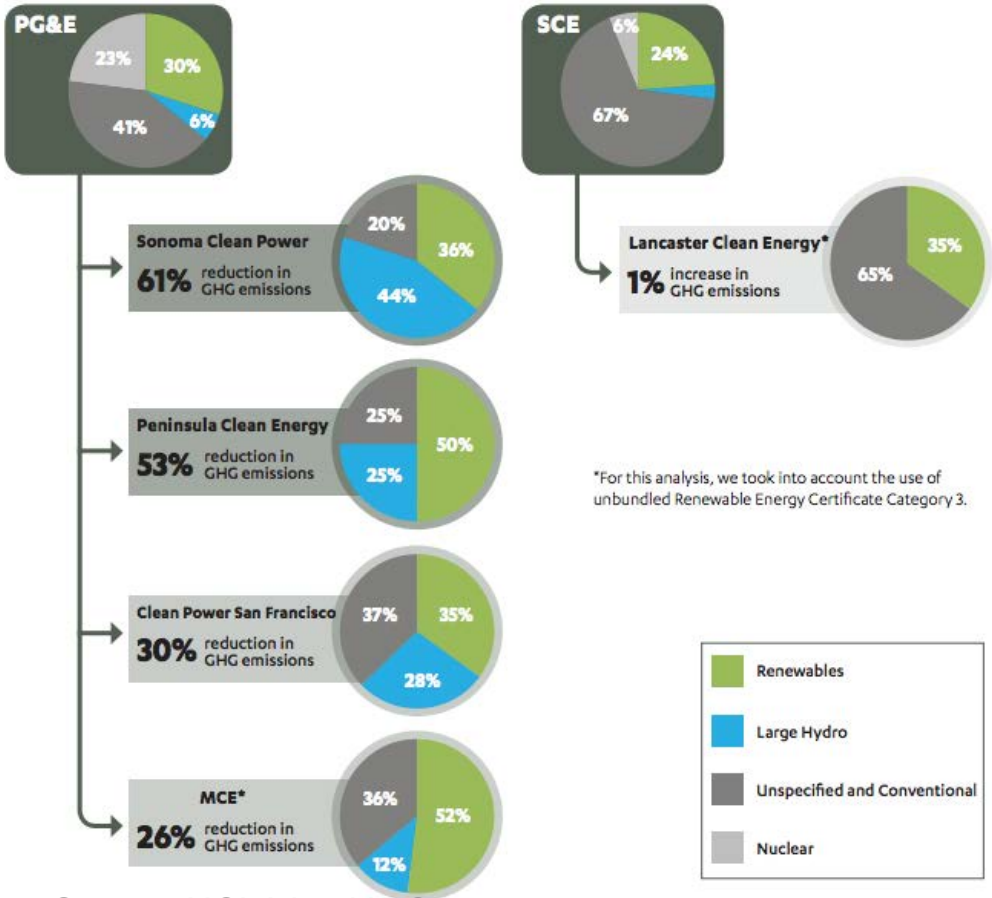
Energy Commission research:

- 3 CAES projects
- 6 flow batteries
- 2 zinc-air batteries
- 8 lithium-Ion batteries
- 4 electric vehicle solutions
- 2 sodium sulfur batteries
- 2 flywheels
- sodium nickel battery

Steady Growth for California Renewables



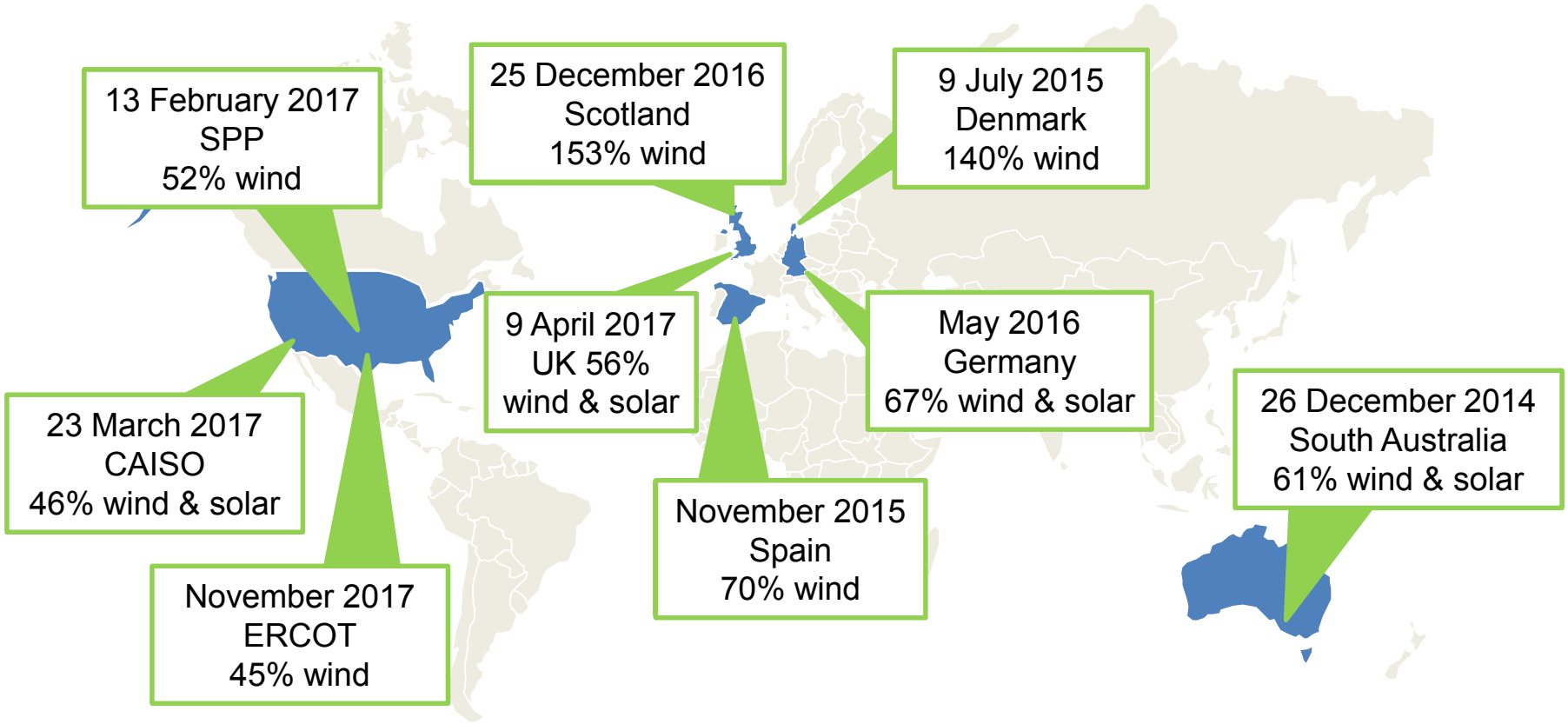
Success across California



Source: UCLA Luskin Center, 2017

Source: Clean Power Exchange

High Levels of Renewable Penetration

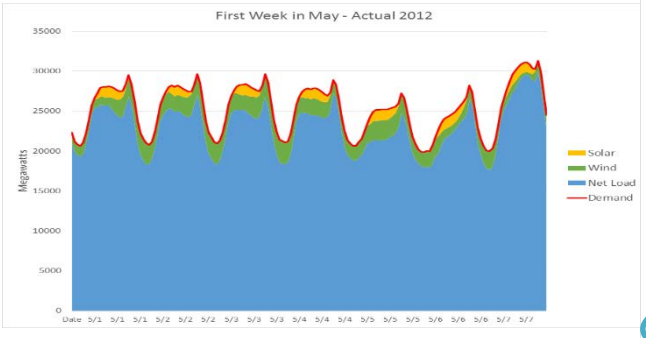


Source: Bloomberg New Energy Finance, various

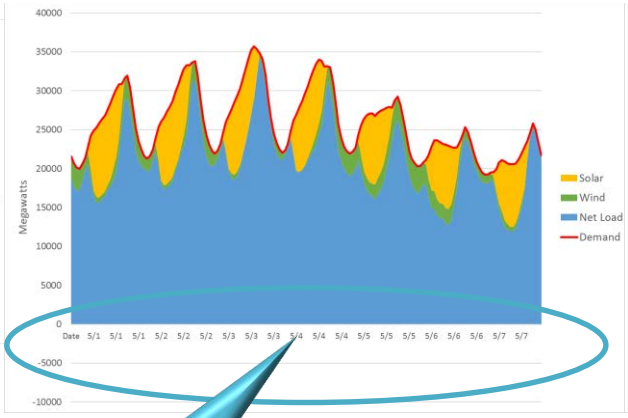
Evolving structure of power supply - California

Huge ramp rates up and down

First week of May 2012 (actual)



First week of May 2017 (actual)



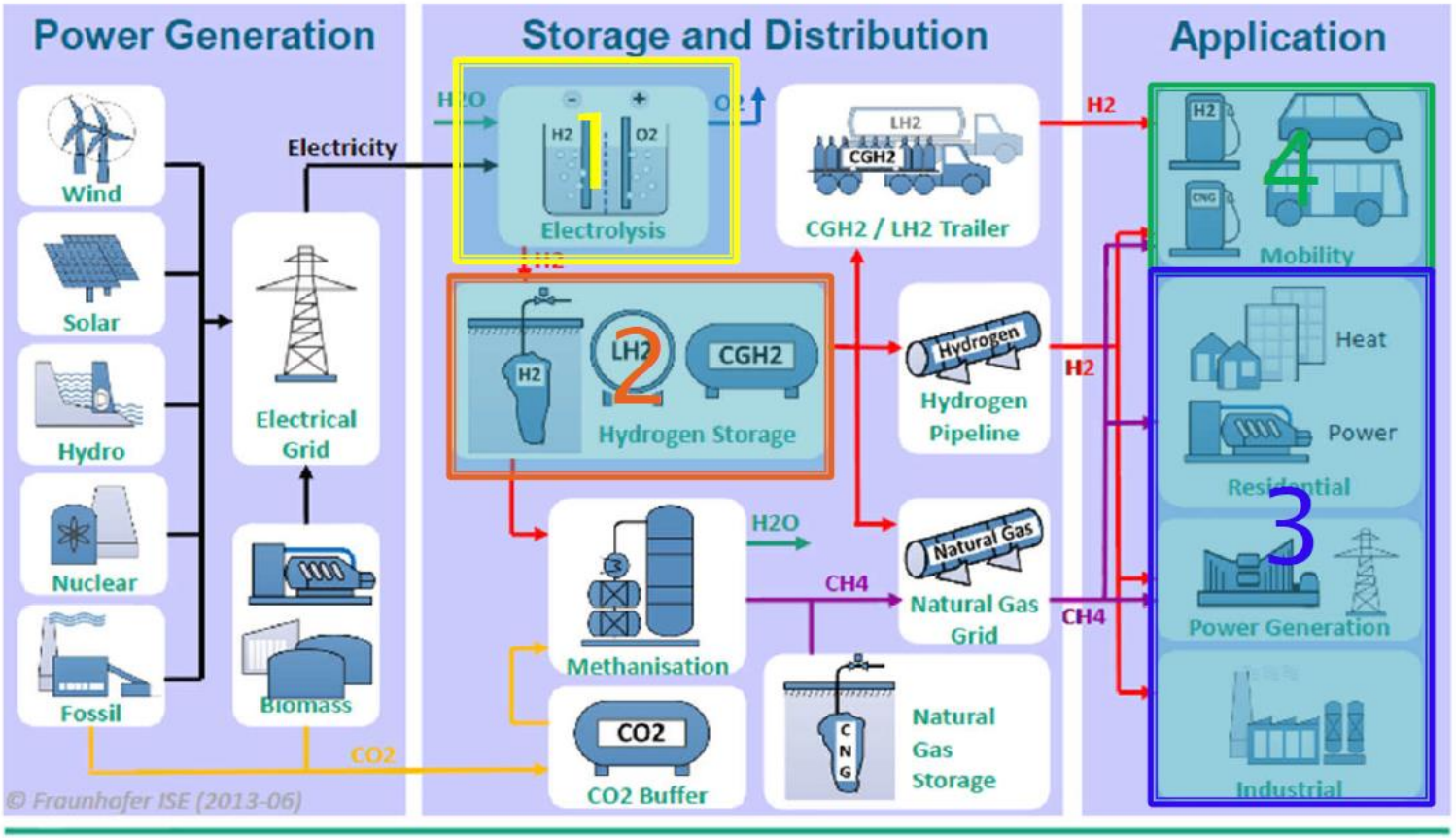
First week of May 2030 (modelled)

No more “baseload”

Lots of DR, storage and export - or curtailment

Source: CAISO OASIS; CEC proposed IRP; LM Power; CESA; Bloomberg New Energy Finance

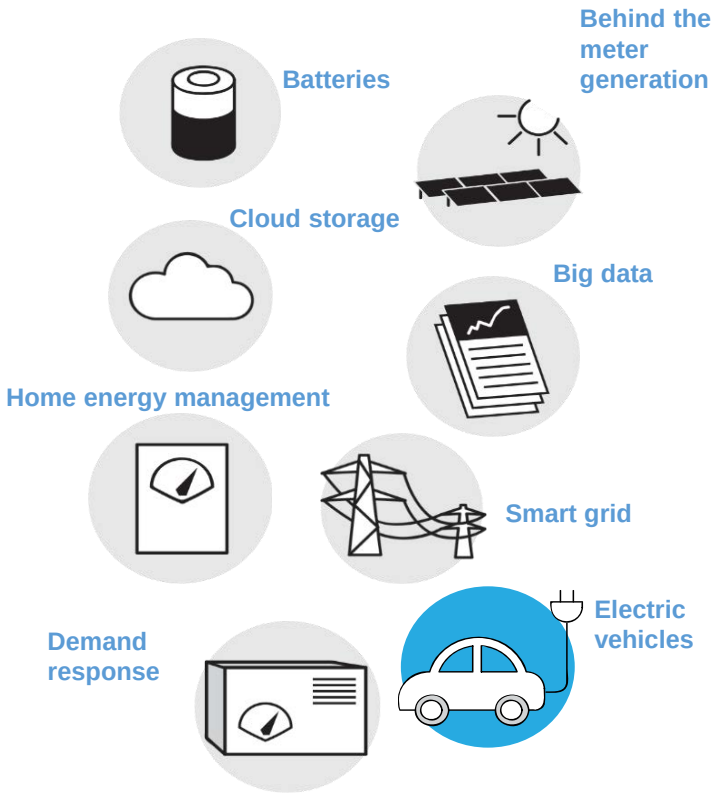
Hydrogen Pathway



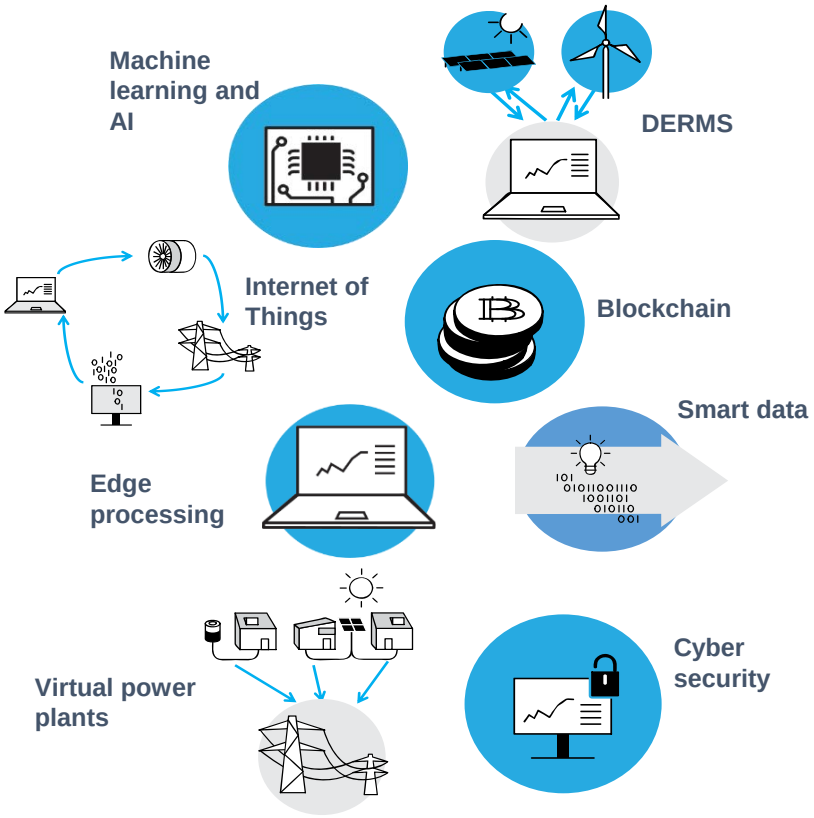
Source: "Water Electrolysis: Status and Potential for Development", Fuel Cells and Hydrogen 2014

Digitization technologies

Existing technologies driving digitization



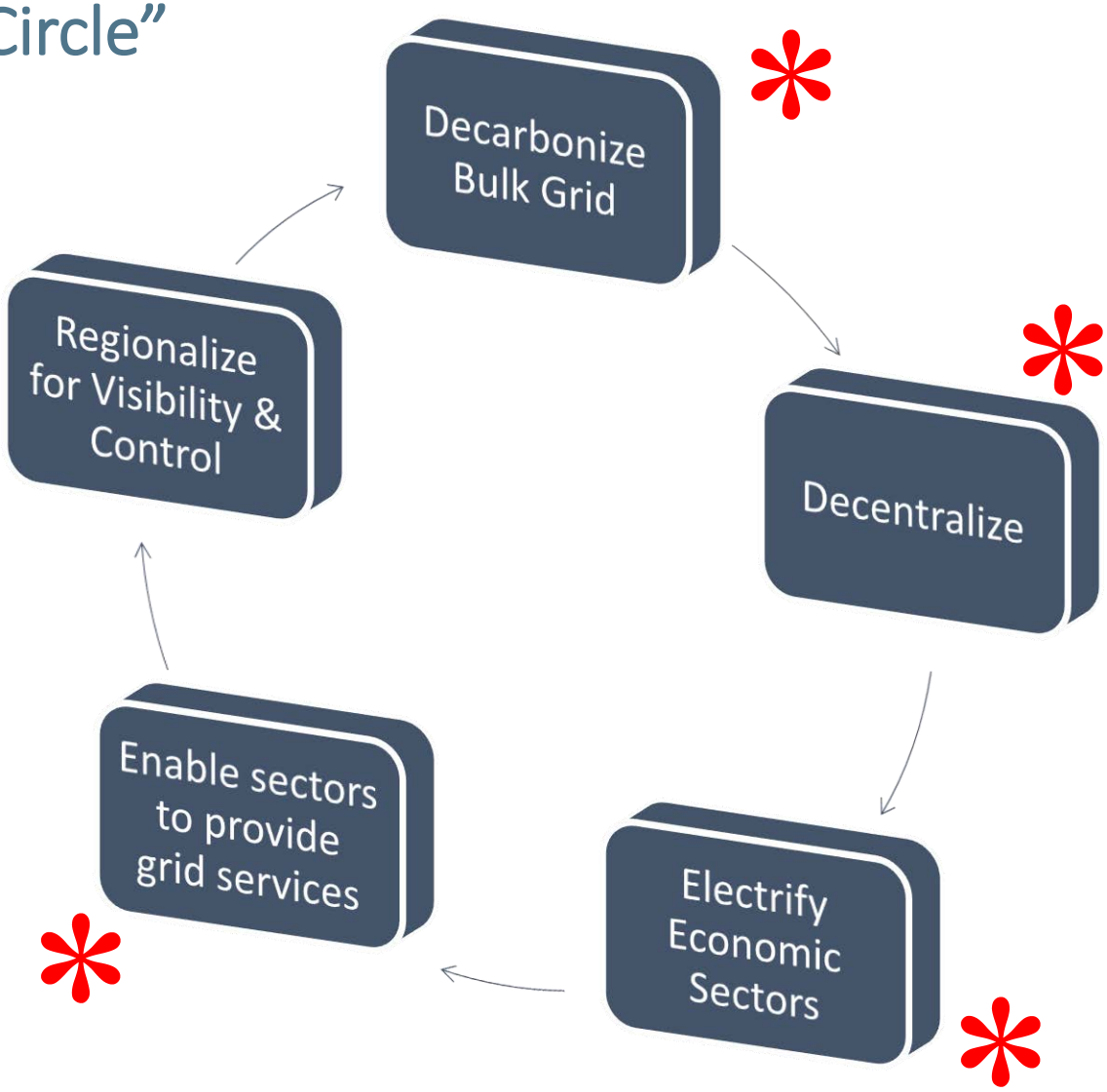
Emerging technologies driving digitization



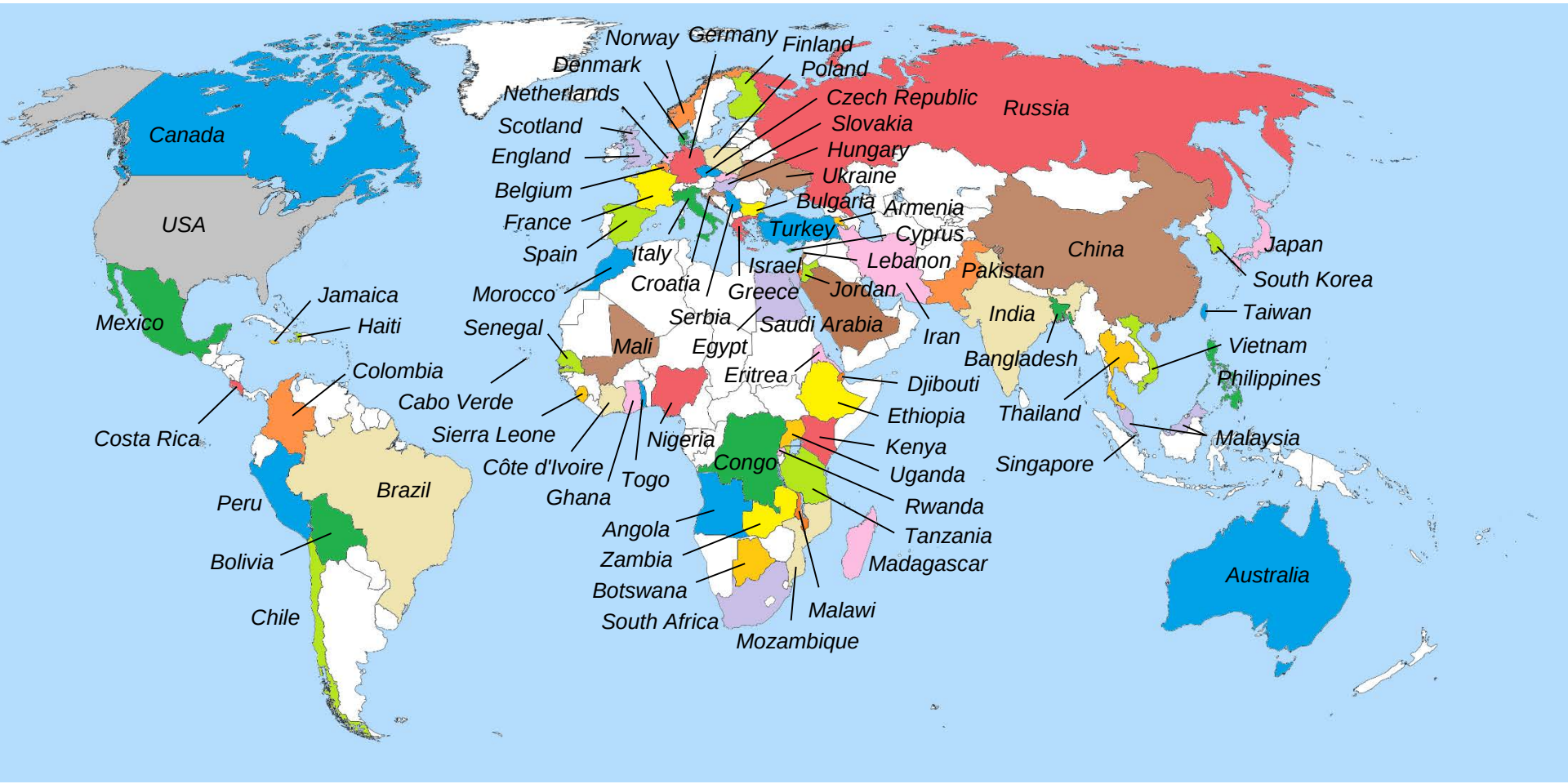
Source: Bloomberg New Energy Finance

A new “Low Carbon Circle”

= Opportunity for Storage



A global phenomenon: 77 Nations visited the CAISO in 2016



Thank you

Renewables 100 Policy Institute

Questions?

Angelina Galiteva

+1/310/ 735 3981

galiteva@AOL.com
or
a.galiteva@renewables100.org