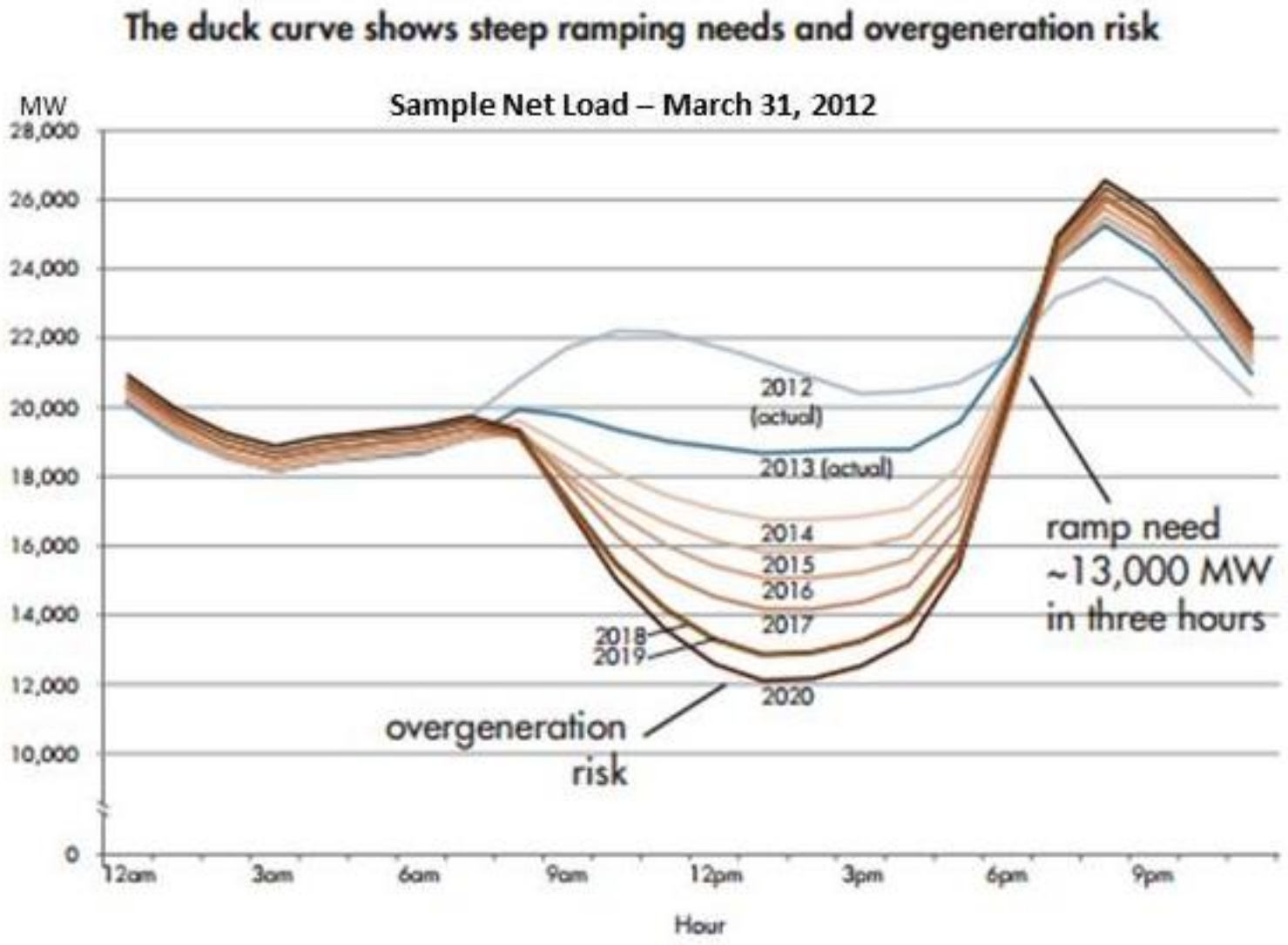
Understanding Challenges: Intermittent Resources

Prior Studies and Real-World Examples

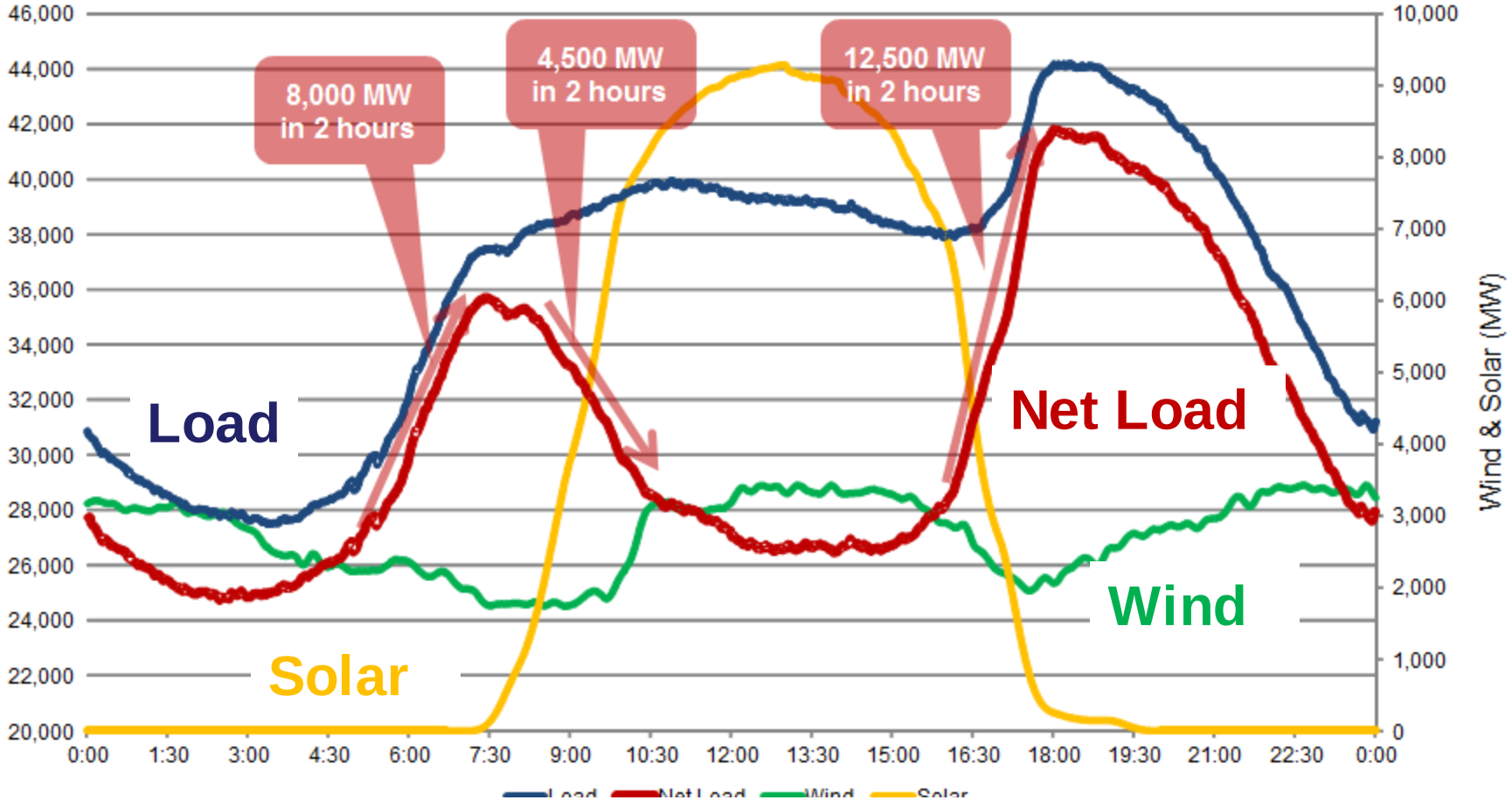
Both Real Challenges and Mental Challenges

CAISO's Duck Curve



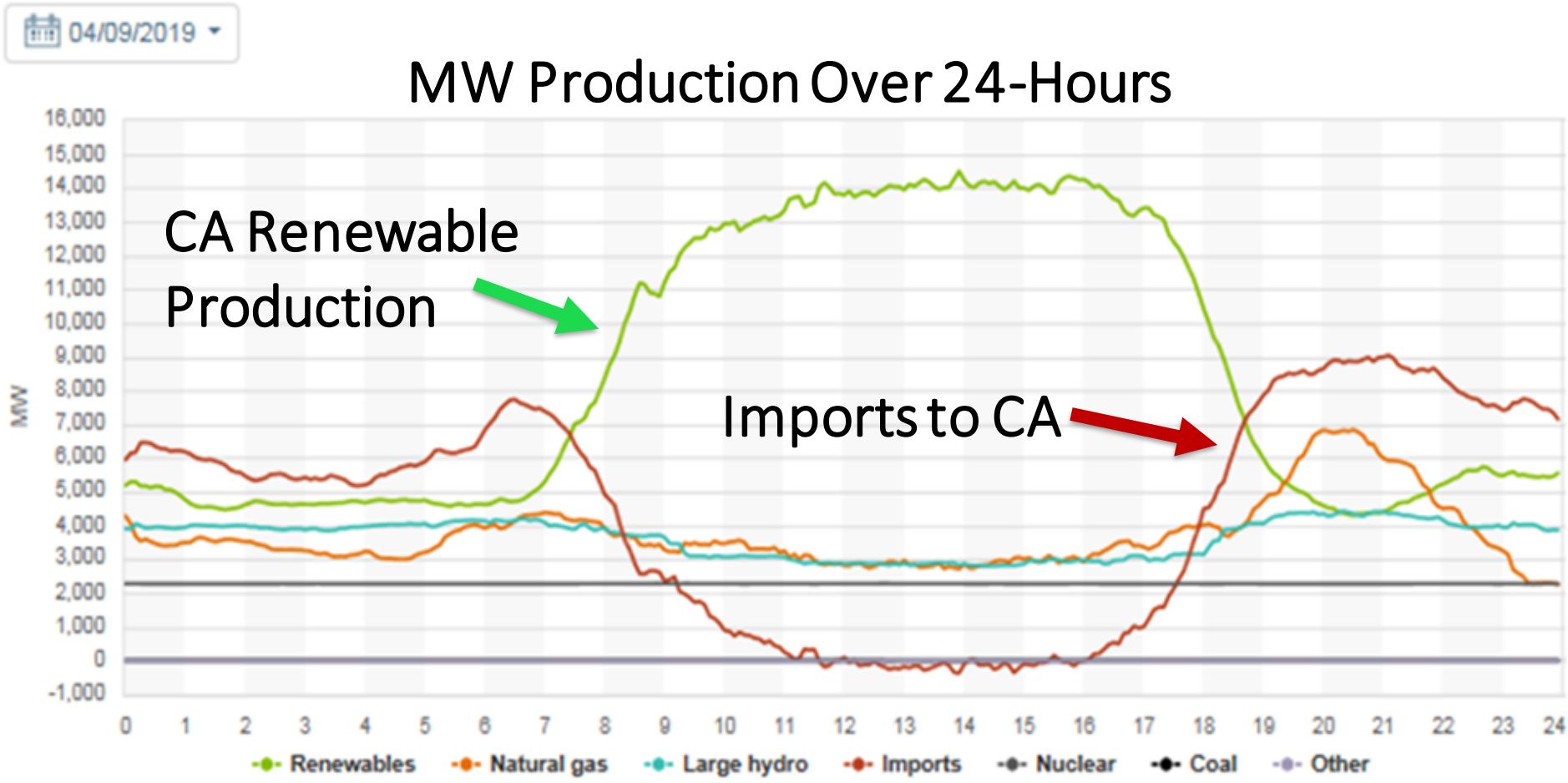
(from the California Independent System Operator)

Massive Ramping Required Predicted in California - 2020



Such ramping requirements alone are a challenge, let alone the locational requirements

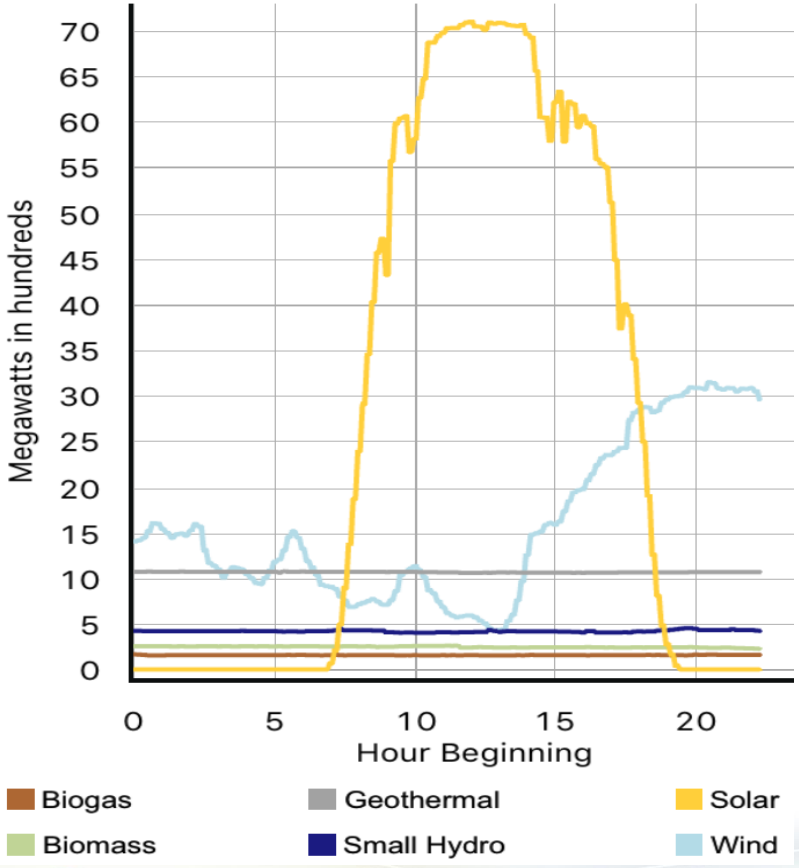
California: April 9, 2019
Net Imports: Providing Most of the Flexibility



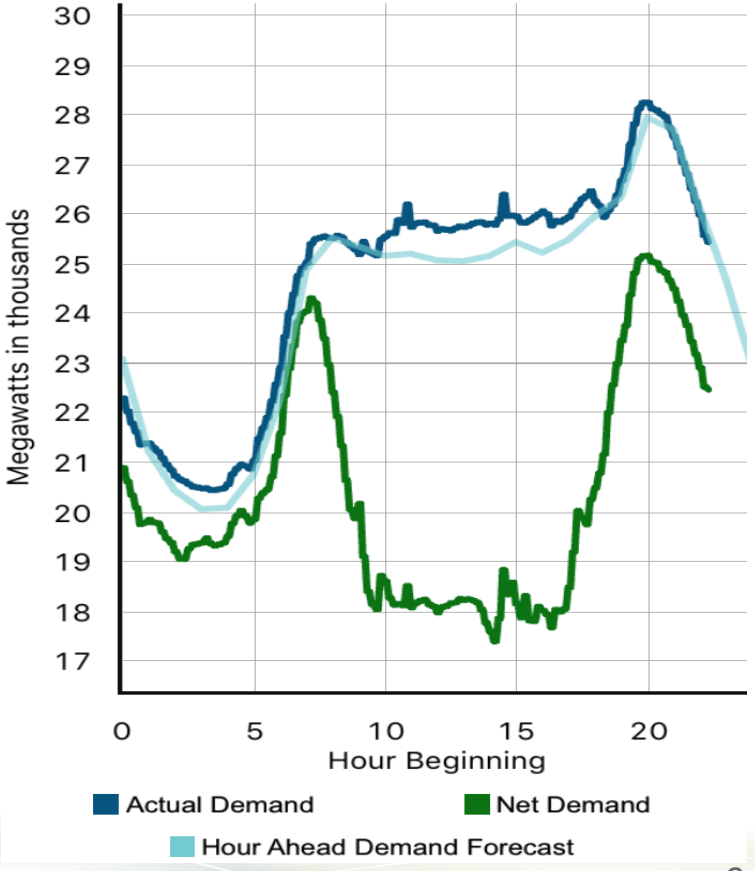
Changing resource mix leads to new needs for market products -- already seen in CAISO's net demand

(Source: "ISO Today" iPhone App, 3/24/2016)

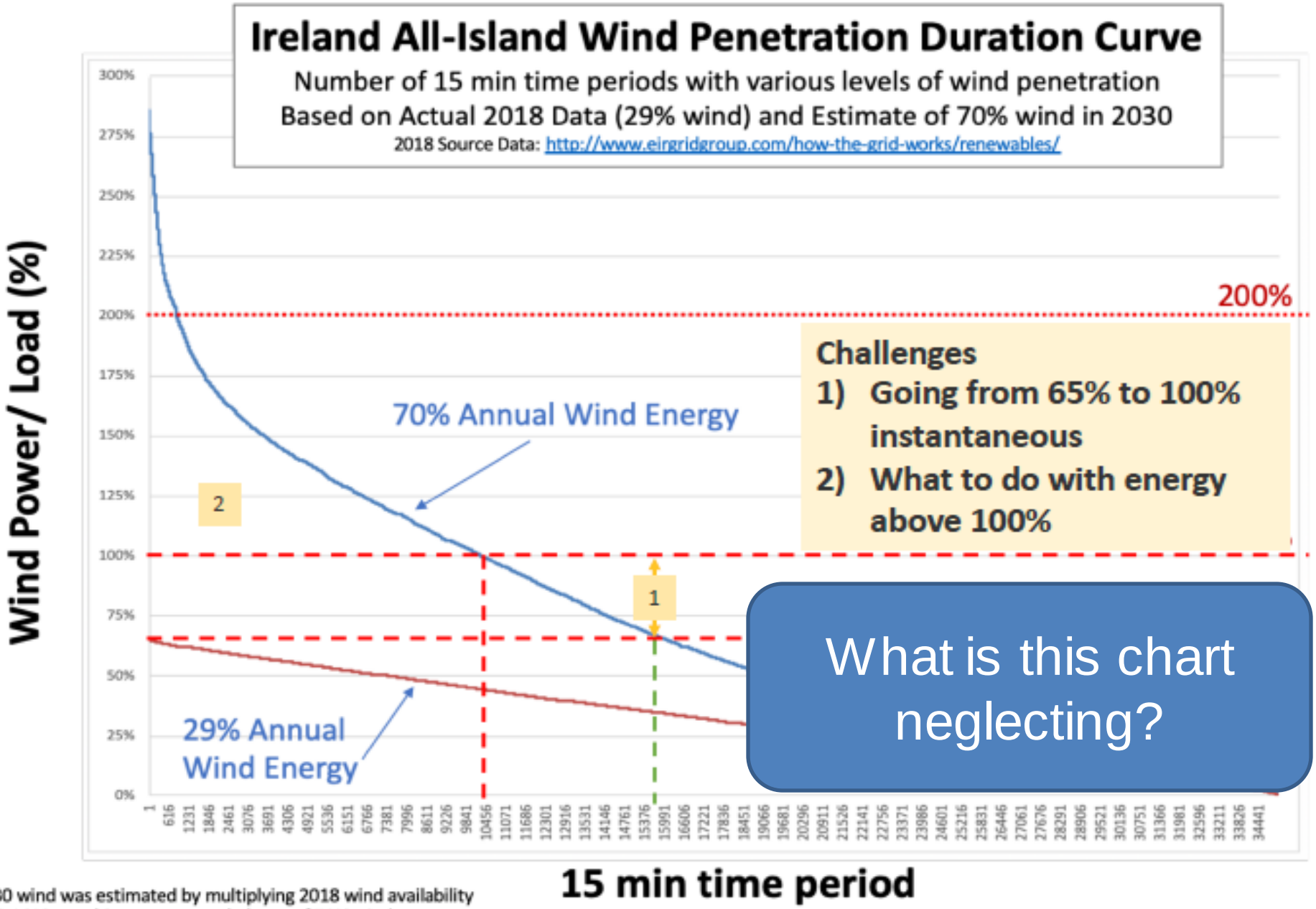
Renewable resources: July 2016 solar exceeds 8000 MW



Net demand has sharper peaks & more variability than gross demand



A closer look at 70% in Ireland



What is this chart neglecting?

2030 wind was estimated by multiplying 2018 wind availability by 2.1612 to achieve an energy balance of 70% wind.

National Renewable Energy Lab: The Western Wind & Solar Integration Study (10%)

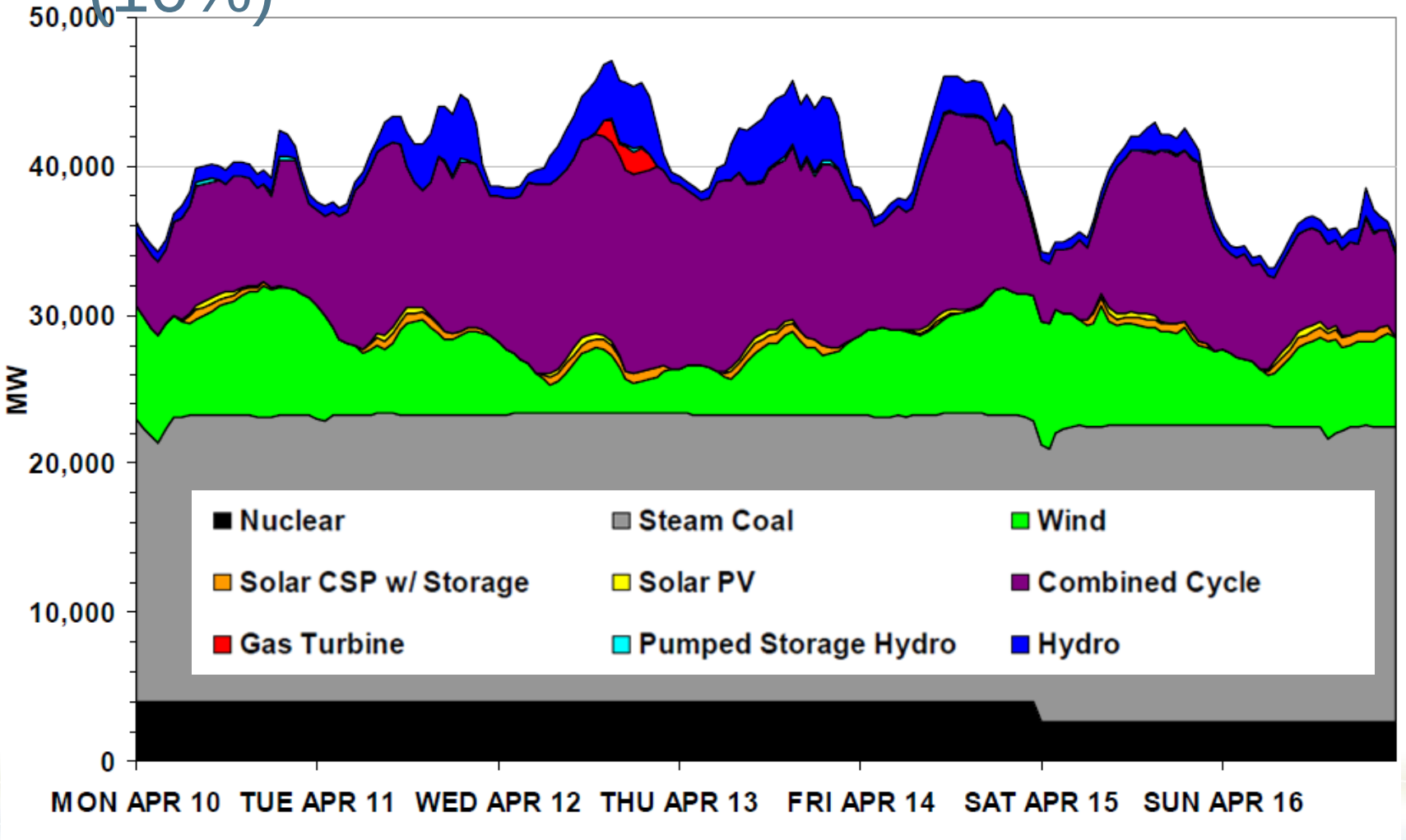


Figure 6.42 Study Area Dispatch – Week of April 10th – 10% R Case

NREL Report: The Western Wind and Solar Integration Study (20%)

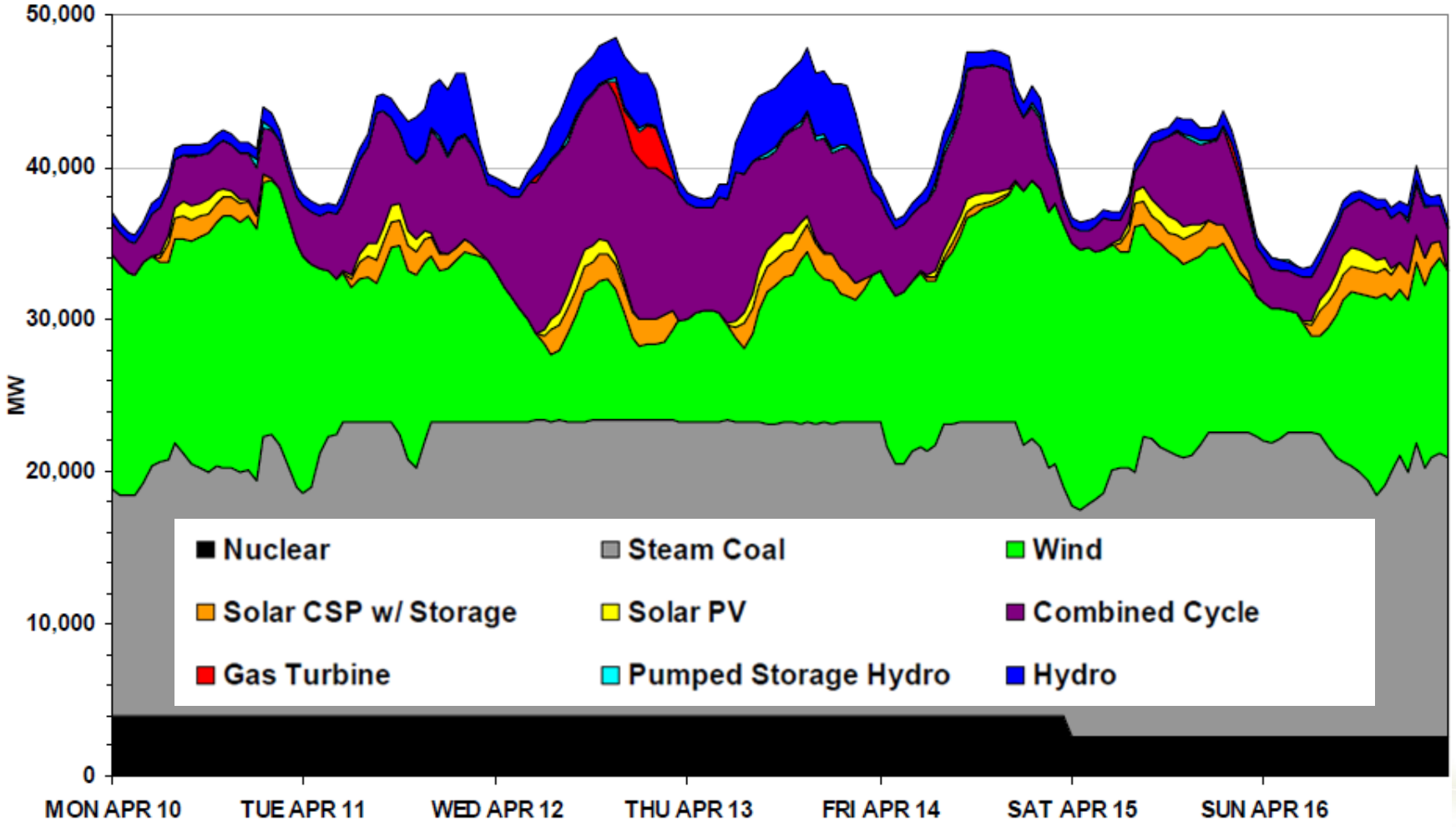


Figure 6.46 Study Area Dispatch – Week of April 10th – 20% R Case

NREL Report: The Western Wind and Solar Integration Study (30%)

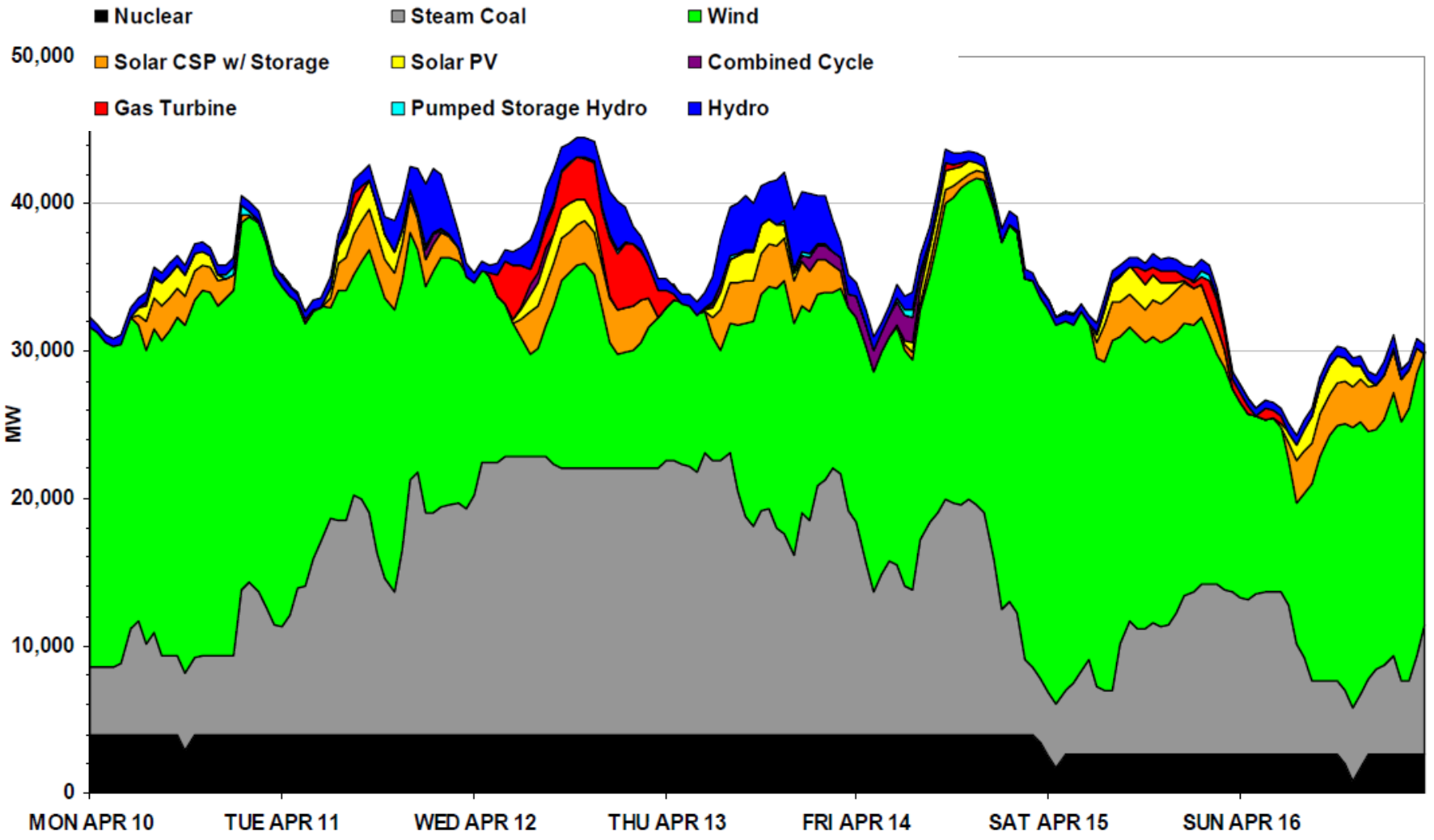


Figure 6.47 Study Area Dispatch – Week of April 10th – 30% R Case

Break

Understanding Challenges: Intermittent Resources

NREL Report: The Western Wind and Solar Integration Study (30%)

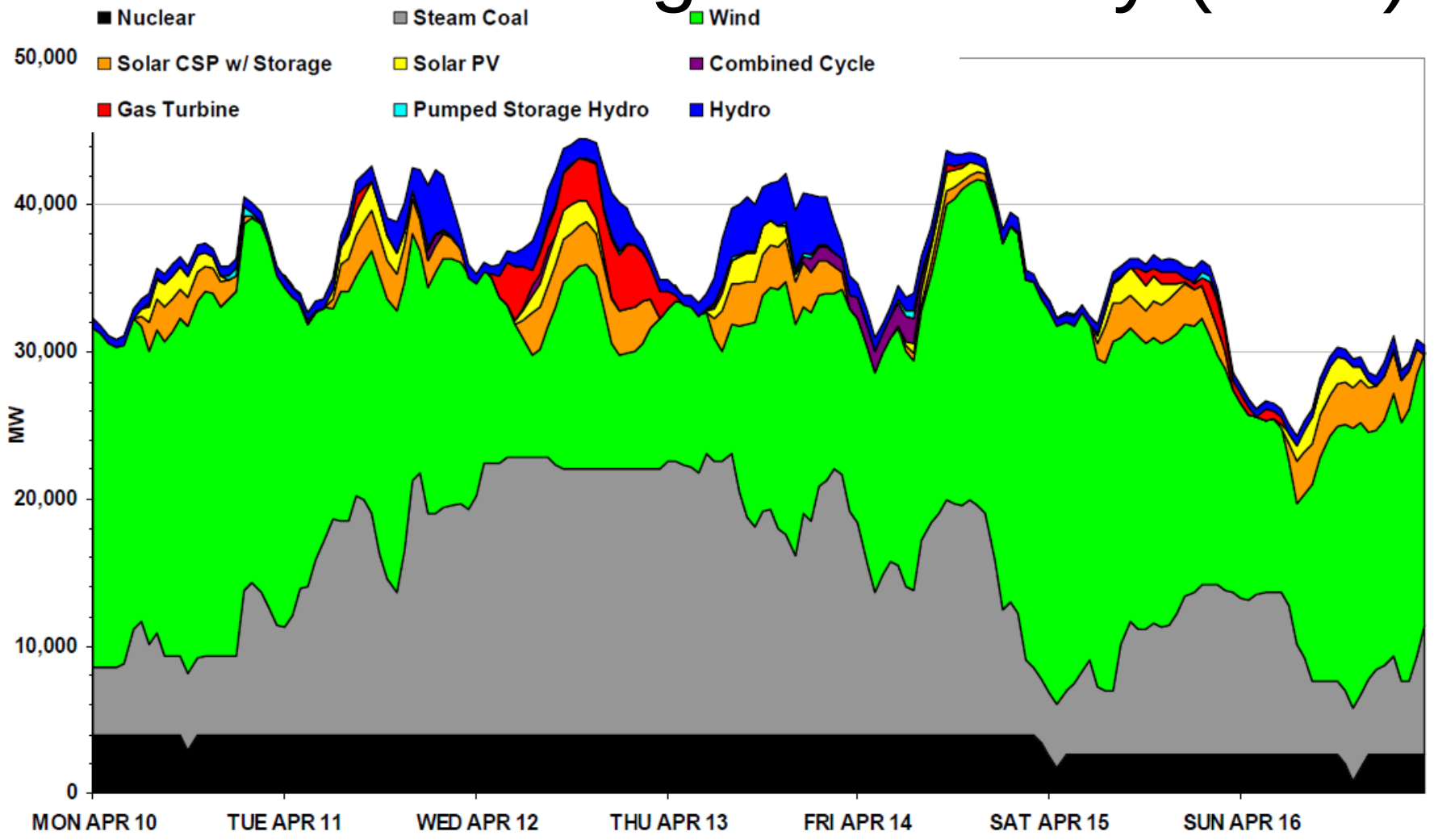
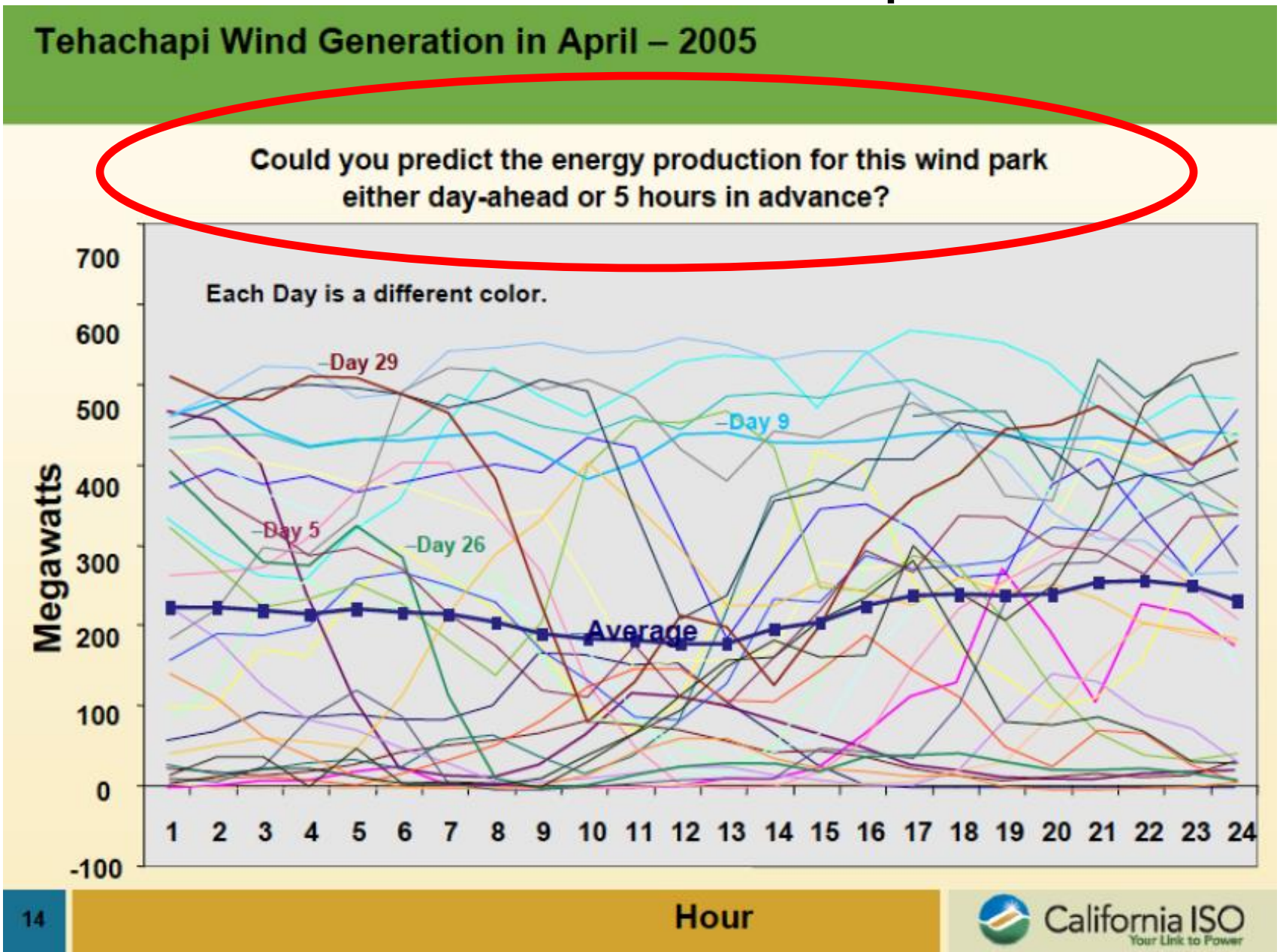


Figure 6.47 Study Area Dispatch – Week of April 10th – 30% R Case

Wind Production at Tehachapi Pass, CA



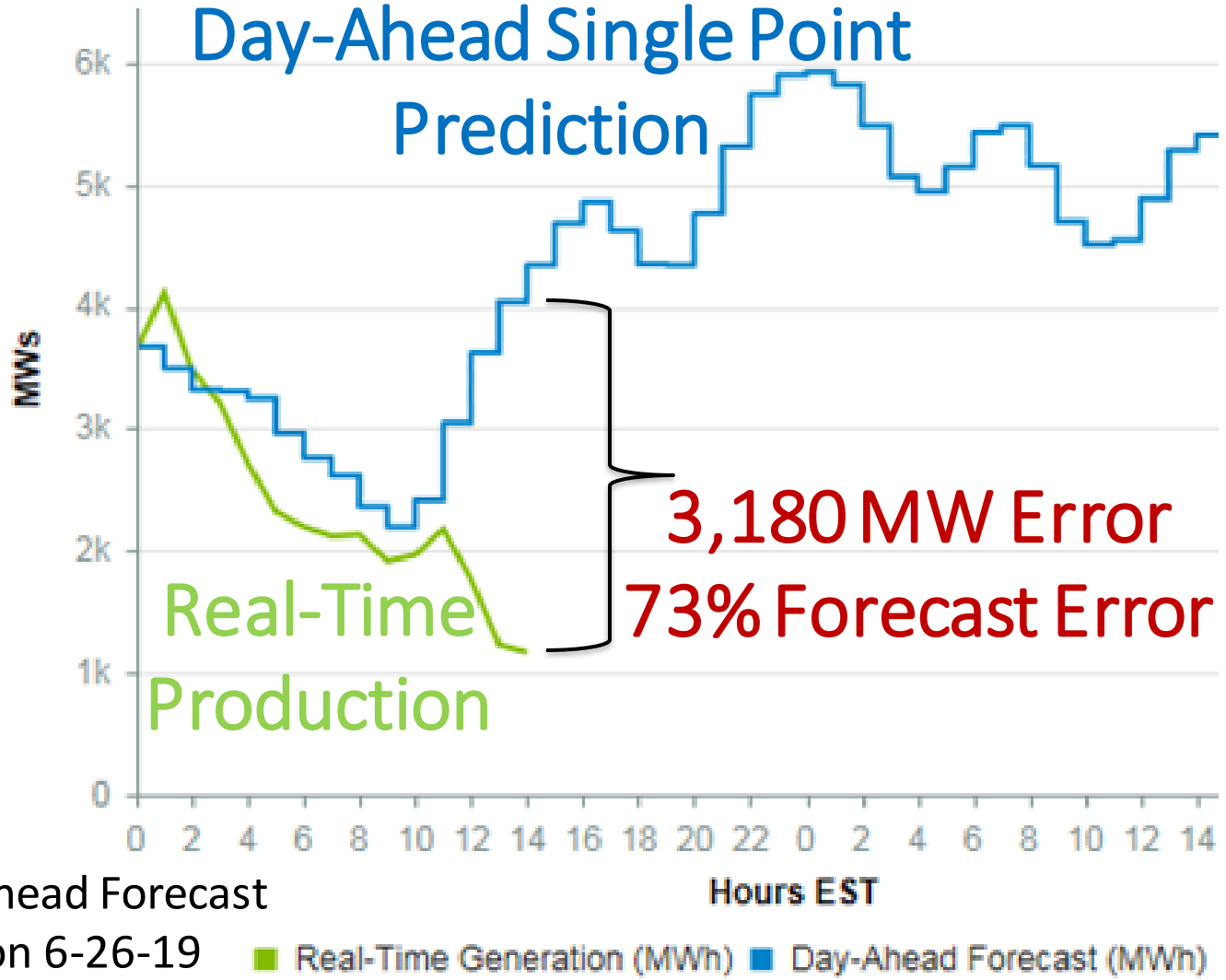
Variability versus Uncertainty

- Variability: indicates to what degree the resource is changing (but this does not ***necessarily*** describe the uncertainty associated to the resource)
- Uncertainty: describes that the resource is not fully known

Prior NREL report assumes perfect foresight of renewable production

Challenges Due to Renewable Resources: MISO Forecast Error

TODAY:
- Reliance on conventional generators
- Single point predictions



MISO Renewable Day-Ahead Forecast and Real-Time Production 6-26-19

Challenges Due to Renewable Resources: MISO Wind Events

- **July 29, 2018: 1MW** renewable power produce for one operational state
- **July 28, 2018: 128MW** renewable power produce over an hour
- 2018 MISO renewable capacity: **18GW!**
- MISO, "MISO 2018 Summer Assessment Report," pp. 4, Sept. 2018. Online. Available: https://cdn.misoenergy.org/2018%20Summer%20Assessment%20Report283263.pdf

One of the Grid Operators in the Northwest: Bonneville Power Administration (BPA)

- Grand Coulee Dam should have the following reserves due to the wind in Eastern Washington:
  - 850MW of up, 1050MW of down reserves
  - Substantially restricts their operating region
- Too much outflow at times, interfering with fish management
- Have been required to sell power for $0/MWh at times
  - 50,000MWh of energy released for free
- This is due to the ***uncertainty*** of wind, not knowing if it will drop off or spike in production
- http://integrating-renewables.org/integrating-renewables-case-study-bonneville-power-administration/

How can we address these challenges?

- Better forecasting
- More infrastructure (more fast backup generation, more transmission – but very expensive)
- Energy storage
- Demand response
  - Demand response has existed for decades but only recently are we moving towards really integrating demand response into all functions of our operations
- **Optimization**
  - Make better use of existing resources to reduce the cost of integrating intermittent resources
  - **Better deterministic reserve policies**
  - **Stochastic optimization**
- Harness flexible transmission (enhance deliverability)… grid enhancing tech as referenced in DE-FOA-0002740

How can geographical diversity of renewable resources help?

- Improves the chances the wind is blowing somewhere
- But deliverability of the resources and locational limitations are still a challenge (voltage, power quality, transmission limitations)
- What if traffic patterns were (more) random?
  - With transportation systems, you are late to work
  - With electric power, the result is a blackout