Understanding Challenges: Intermittent Resources
Prior Studies and Real-World Examples

Both Real Challenges and Mental Challenges
CAISO’s Duck Curve

The duck curve shows steep ramping needs and overgeneration risk.

Sample Net Load – March 31, 2012

- 2012 (actual)
- 2013 (actual)
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020

ramp need
~13,000 MW
in three hours

overgeneration risk

(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

MW Production Over 24-Hours

CA Renewable Production
Imports to CA
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

Ireland All-Island Wind Penetration Duration Curve

Number of 15 min time periods with various levels of wind penetration
Based on Actual 2018 Data (29% wind) and Estimate of 70% wind in 2030
2018 Source Data: http://www.eirgridgroup.com/how-the-grid-works/renewables/

Challenges
1) Going from 65% to 100% instantaneous
2) What to do with energy above 100%

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%)
NREL Report: The Western Wind and Solar Integration Study (20%)
Break
Understanding Challenges: Intermittent Resources
Figure 6.47 Study Area Dispatch – Week of April 10th – 30% R Case
Could you predict the energy production for this wind park either day-ahead or 5 hours in advance?
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

Day-Ahead Single Point Prediction

Real-Time Production

3,180 MW Error
73% Forecast Error

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!**
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
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