NREL
NATIONAL RENEWABLE ENERGY LABORATORY

10 Minute Intro to Grid Operations and Flexibility

Jennie Jorgenson

Energy Systems Engineer, NREL

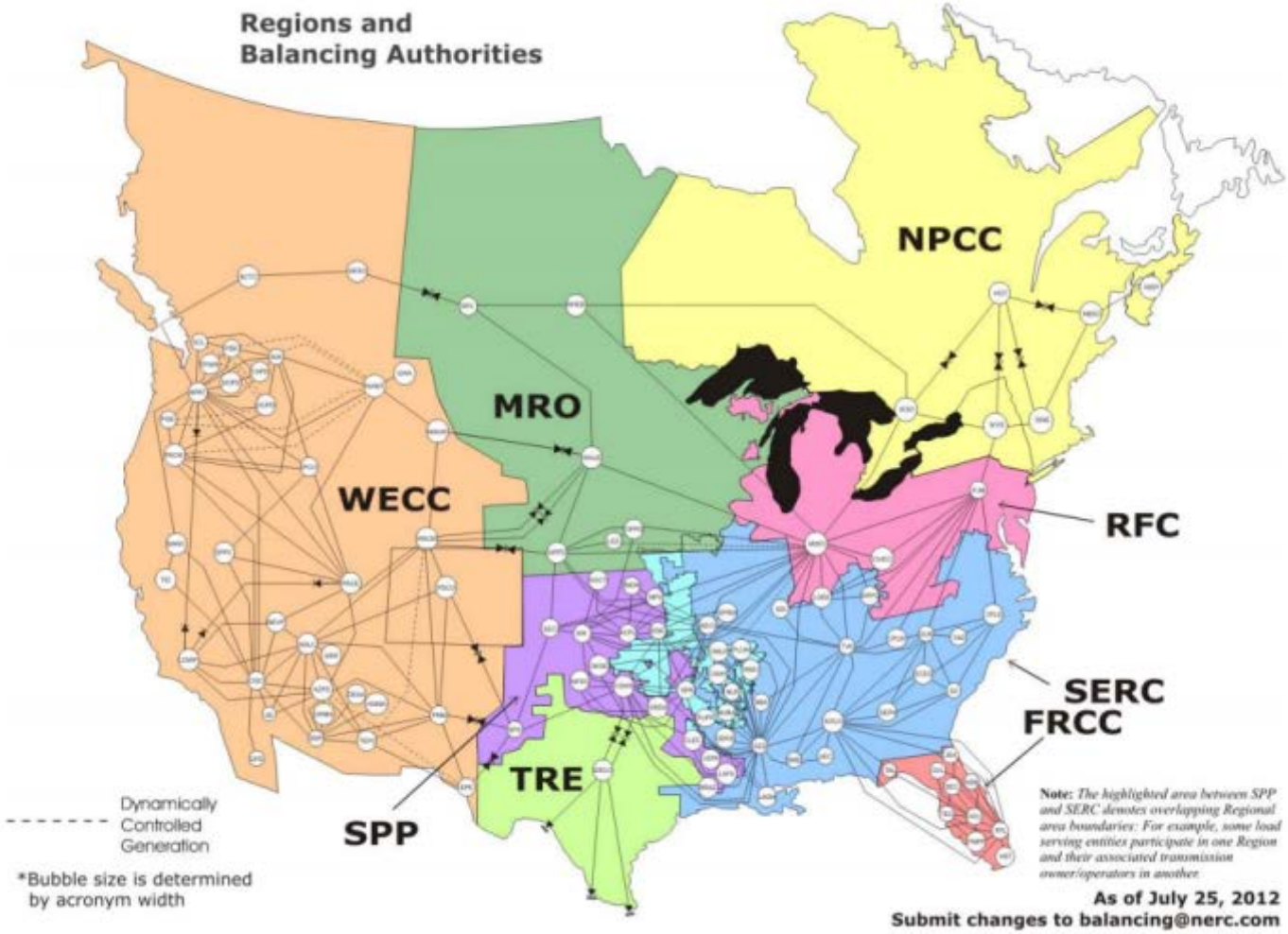
June 9th, 2016

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

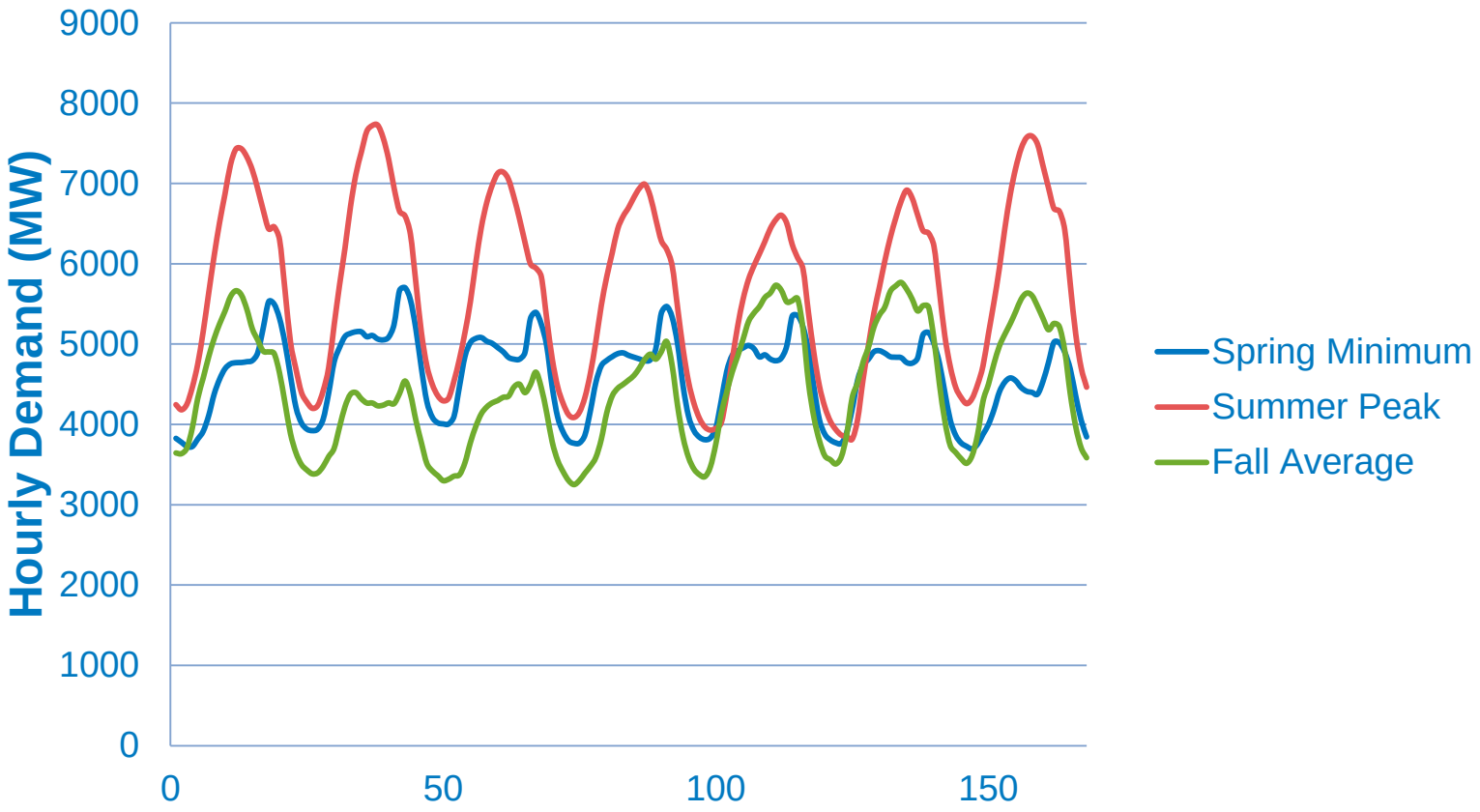
The Electric Power Grid

- A very large rotating machine spinning at 60 Hz (here in the US)
- Rules:
  - Supply must equal demand
  - Demand changes every instant (supply might too!)
  - Must maintain system reliability (or, be prepared for bad things to happen)
- How does that possibly work?

Balancing Authorities Match Supply and Demand

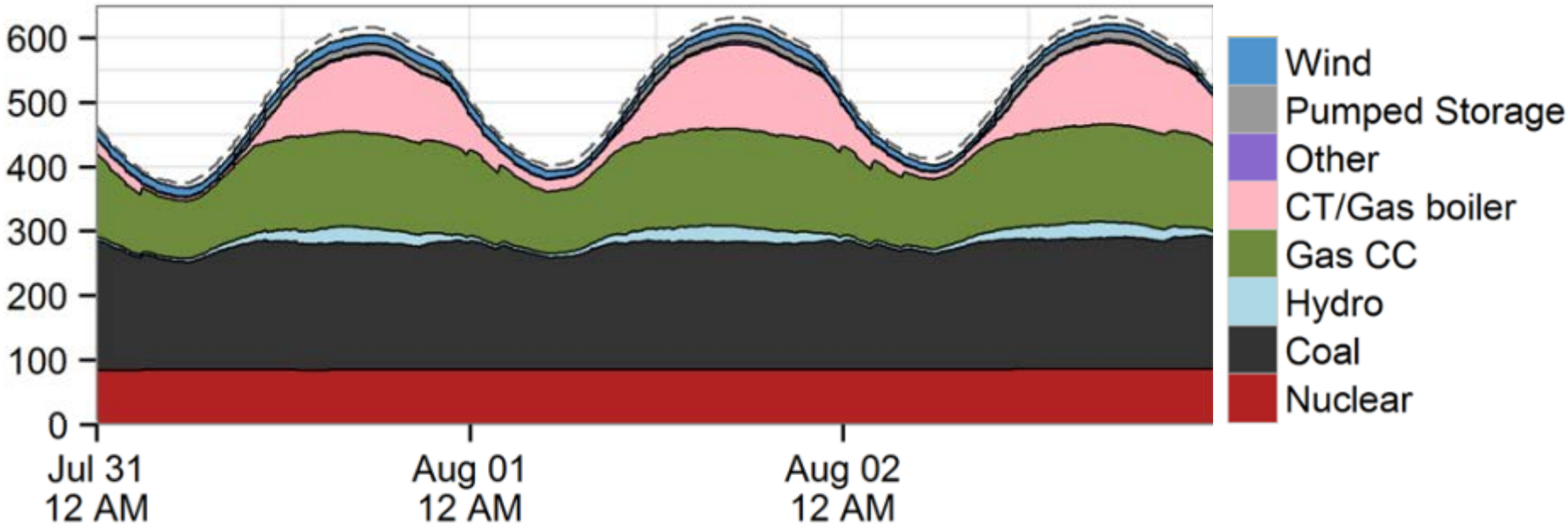


The Electric Power Grid



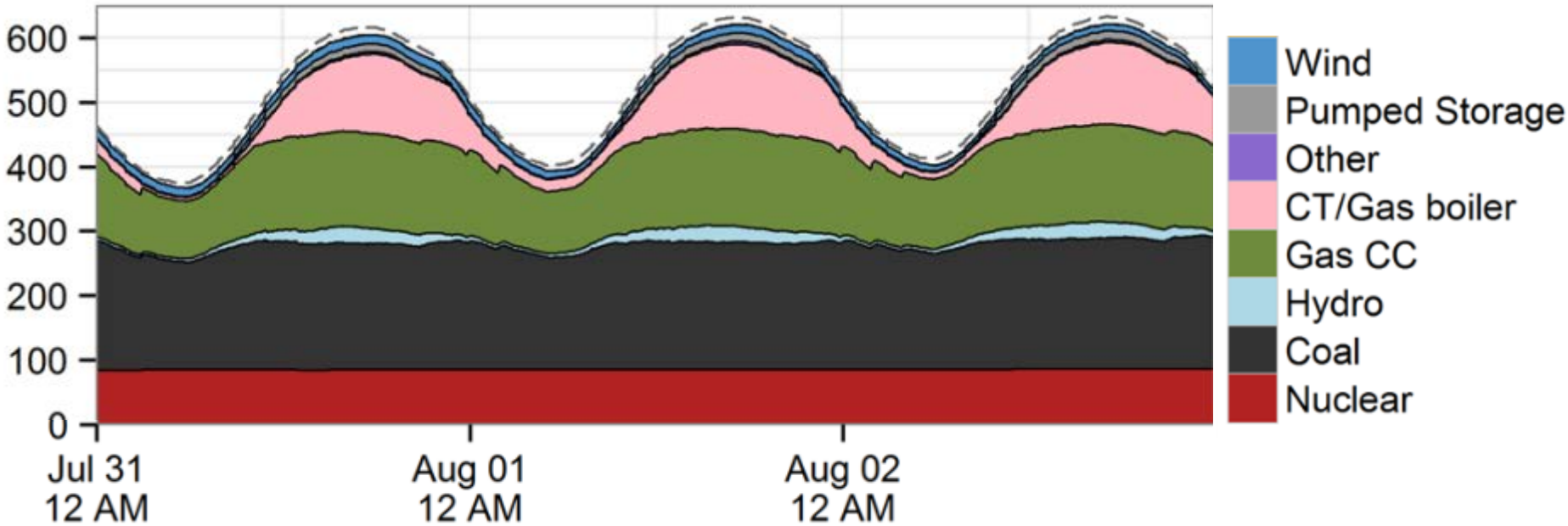
3 weeks from the Public Service of Colorado in 2006

The Electric Power Grid



Variations in demand traditionally balanced by conventional thermal generation, or hydro

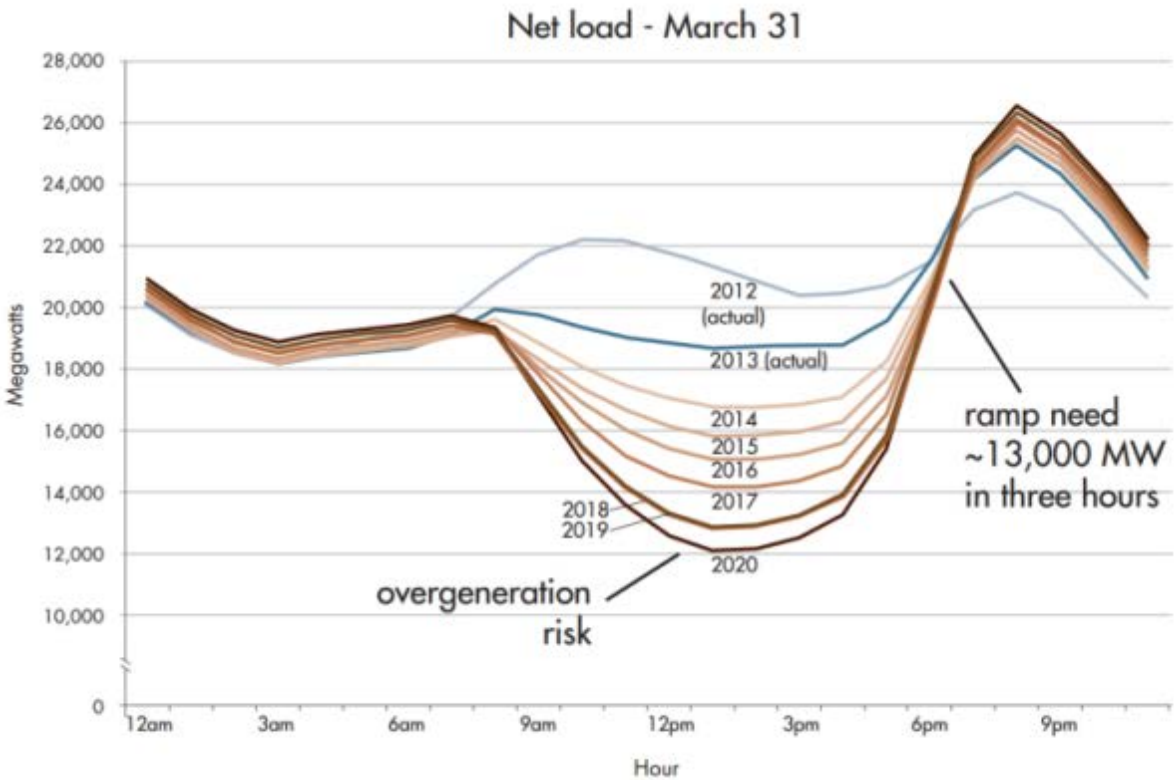
The Electric Power Grid



Variations in demand traditionally balanced by conventional thermal generation, or hydro

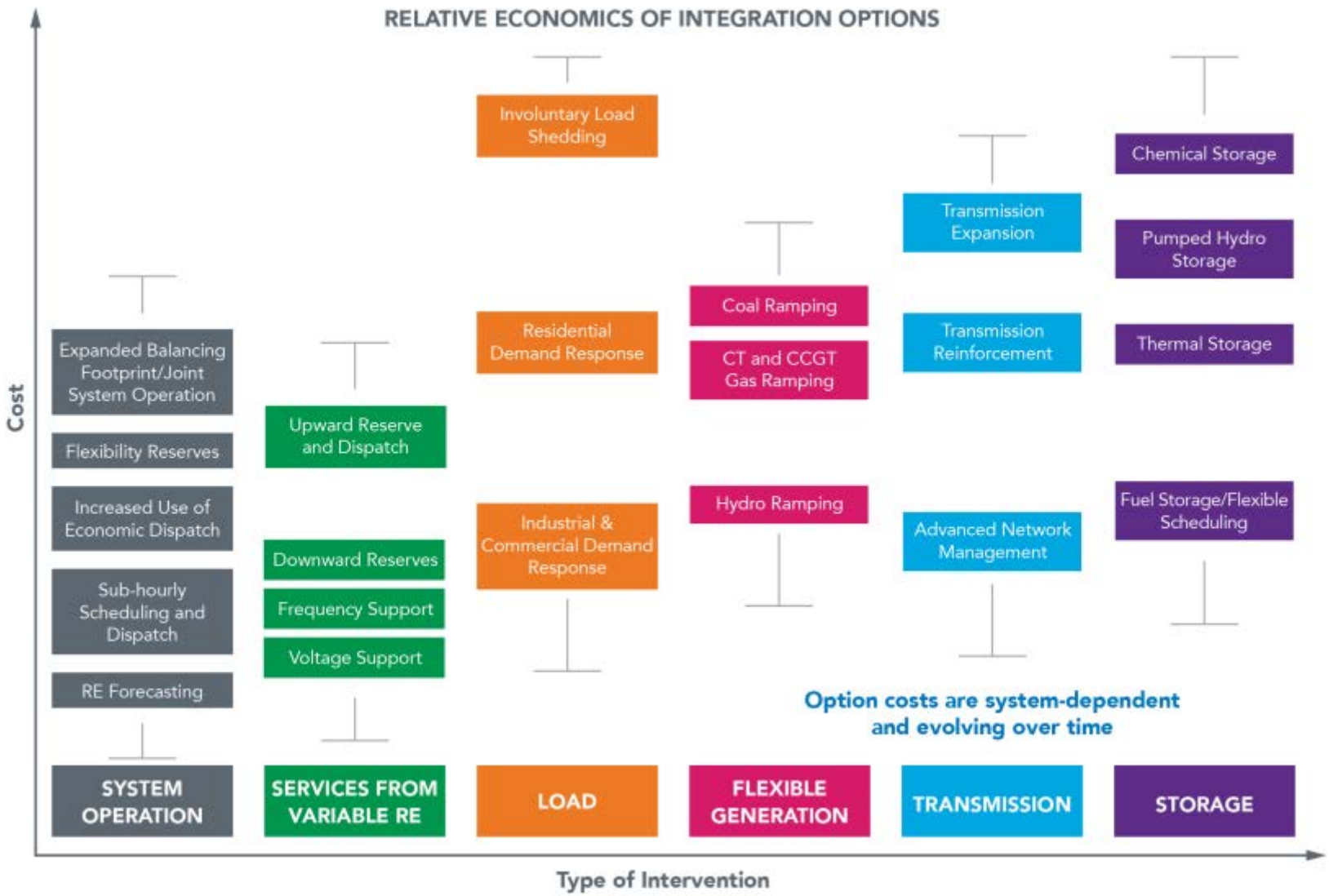
Renewables complicate the traditional paradigm

Effect of Renewable Energy On the Grid

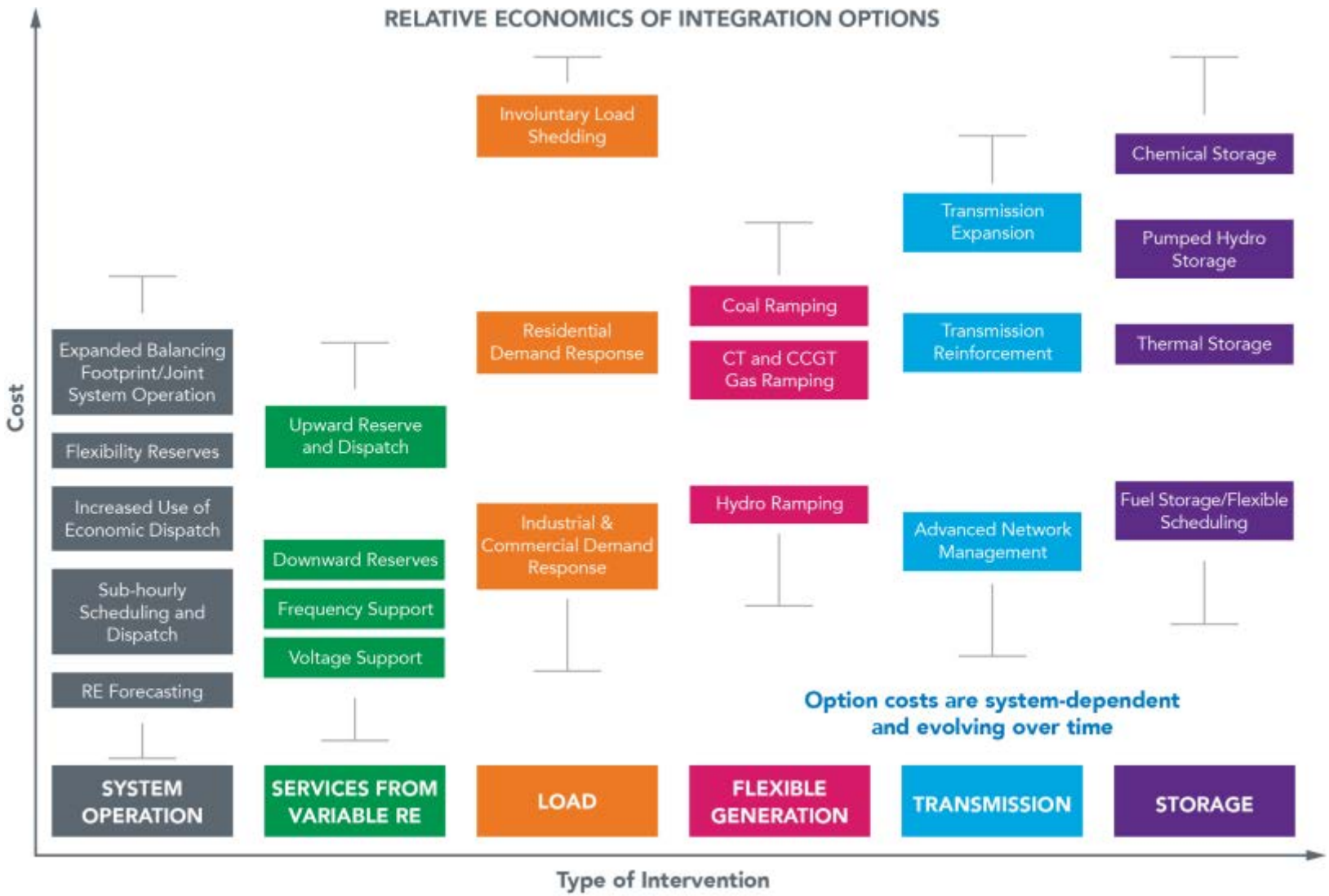


- Increased uncertainty in net load
  - More operating reserves to compensate for another 'unknown'
- Greater variation in net load
- Increased ramp (speed and range)
- More requirements for **grid flexibility**

The Electric Power Grid



The Electric Power Grid



Institutional ⟷ Technical

Why is grid flexibility important?

- Maintain grid reliability (even in a grid with more ‘unknowns’)
- Cost effective operation
- More cost effective renewables

www.nrel.gov

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.