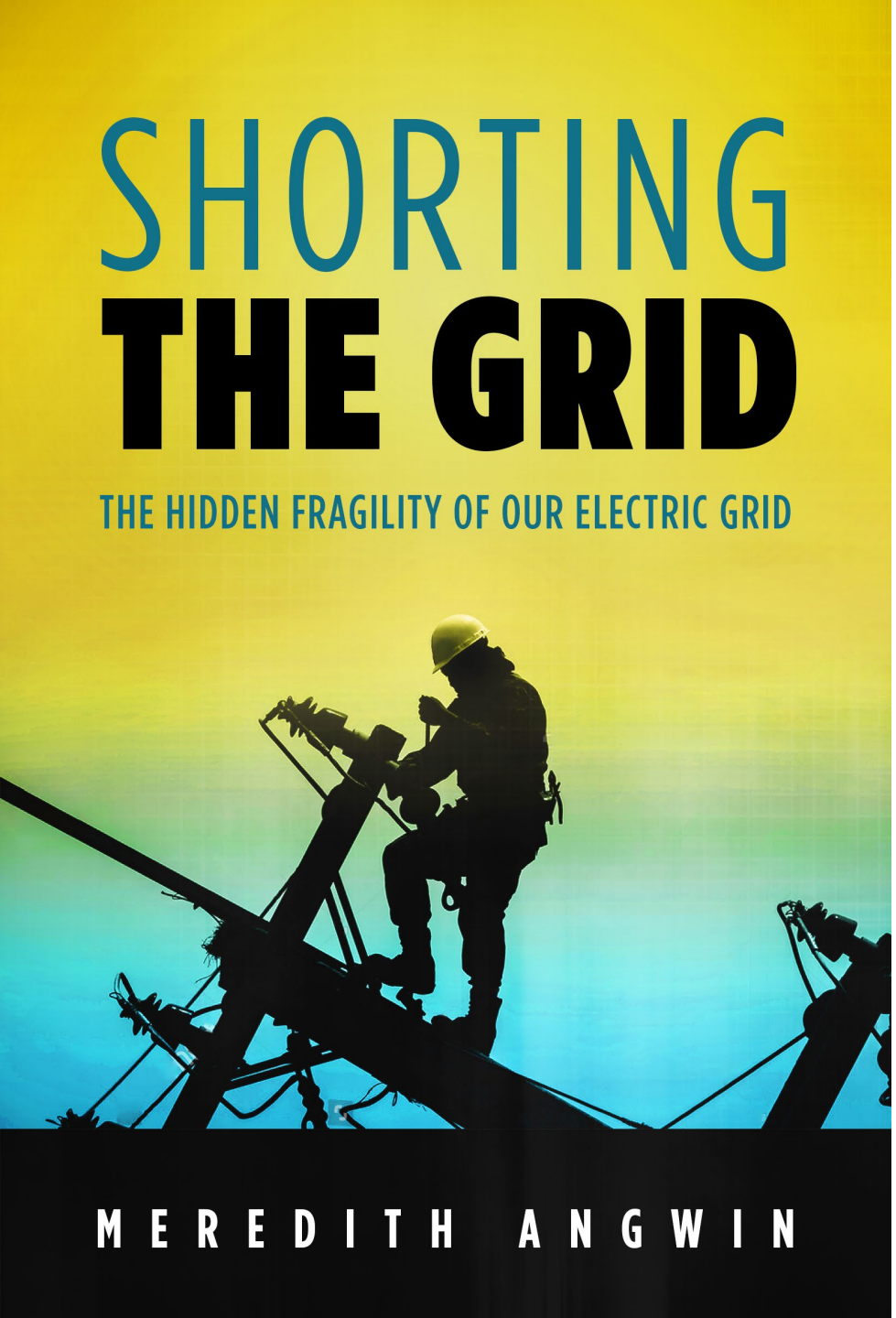
Nuclear and the Grid: A Northeastern Perspective

- NH Nuclear Study Commission
- December 12, 2022
- Presentation by Meredith Angwin



My background

- Master's degree in Physical Chemistry, University of Chicago
- Specialized in mineral chemistry in grad school
- Worked on issues facing electric utilities
  - As a contractor
  - At EPRI (Electric Power Research Institute)
- Research on pollution control and corrosion control for geothermal, gas-fired, coal-fired and nuclear plants
- Active in the Consumer Liaison Group of ISO-NE
- (And yeah, the book)

A Strong Grid is a Reliable Grid!

- **Reliable electricity**
- Relatively inexpensive electricity, so electricity can be used for health and happiness (and manufacturing)
- Electricity made with low levels of pollution and ecosystem disruption

Presentation outline

1. The Policy Grid and the Physical Grid
2. What is an RTO? How do the auctions work.
3. Winners and Losers in the Auctions
4. The Fatal Trifecta for a grid
5. Baseload Power
6. Nuclear Energy

1. Physical Grid and Policy Grid

The Two Grids: Physical and Policy

Physical:

- Transmission, distribution, substations, dispatchers, linemen, generators, end-users
- Mostly limited by physics laws, not regulations

Policy

- Net zero, net metering, Renewable Portfolios Standards
- Mostly about how the physical grid is paid

The Two Grids Confused

- Vermont Yankee contracts with Vermont utilities ended in 2012
- Vermont Yankee continued operations, selling into the auctions, till 2014
- In 2013, anti-nuclear people said: “We don’t need Vermont Yankee. We’re not even using it now!”
- Deliberate confusion or mistake? Either way, Vermont *was* using Vermont Yankee power in 2013
  - Changing a contract does not change the wires.

The Third Grid: The "Could" Grid

- The grid you hear about is usually the "could" grid.
  - For example: with battery breakthroughs we "could" use just wind and solar
  - For example: forget those old "legacy" plants because (whatever) is just around the corner.
- Research doesn't turn into deployment very quickly

2. About RTOs (Regional Transmission Organizations)

Major types of grid governance

Traditional vertically integrated utilities

- Utility is responsible for reliability
- Utility owns power plants and distribution systems
- It receives a “rate of return” set by regulators
- State Public Utility Commission (PUC) is major regulator

RTO area (sometimes called “deregulated”)

- Nobody is responsible for reliability
- Merchant generators supply power
- Distribution utilities buy that power at auctions run by RTOs
- Regulation is multi-level and easily “gamed”

The Energy Auctions: How RTOs work

- Run every five minutes
- ”Economic dispatch”
- Highest price plant needed sets price for all plants
  - Say that plant A bids at $20/MWh, plant B at $30/MWh, and plant C at $40/MWh
- Say they are all needed. All will receive the clearing price ($40/MWh) set by plant C

Incentives for the power plants in an RTO

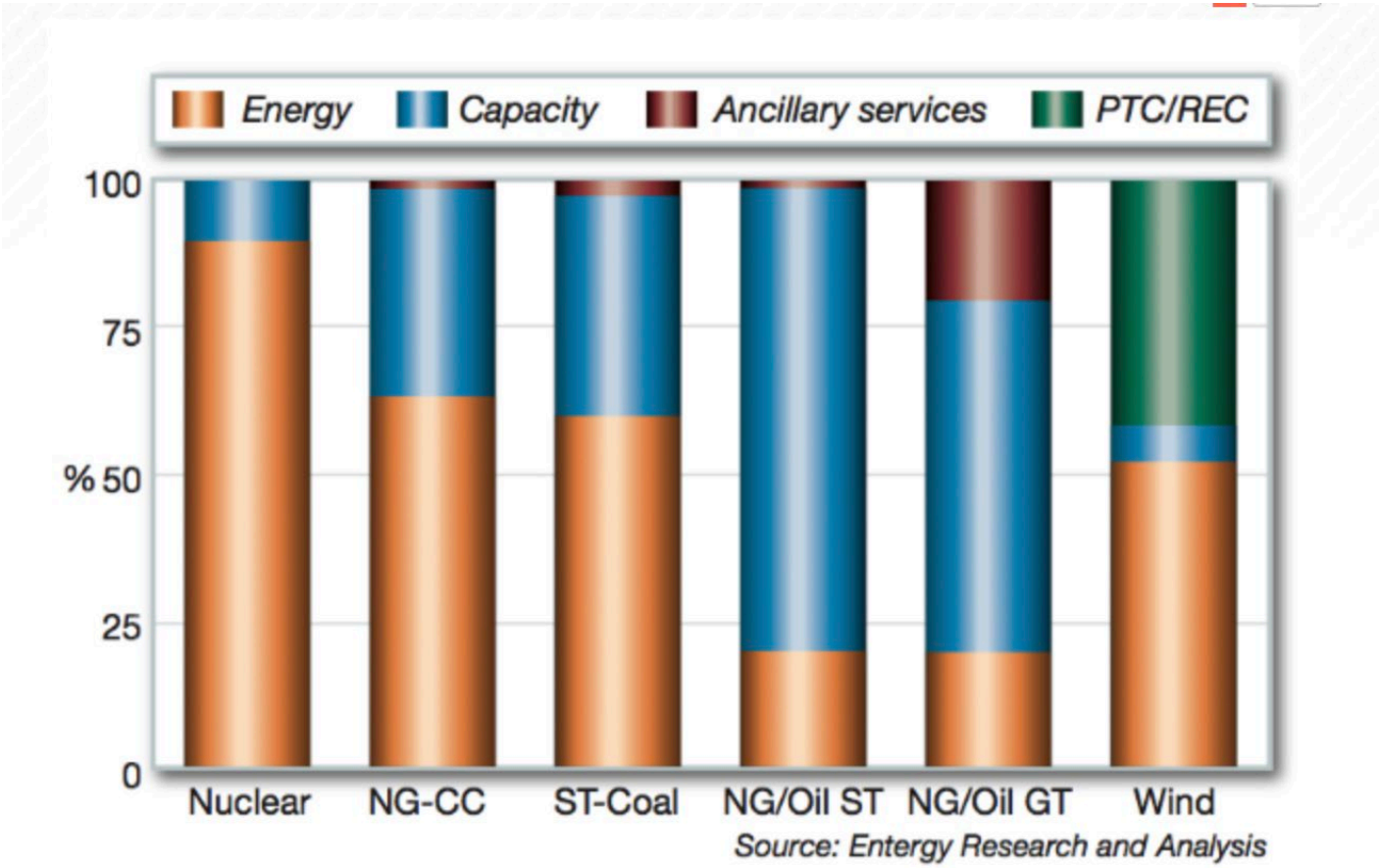
- Power plant owners want high clearing prices
- Reliability of the grid is “not their department”
- Rolling blackouts in California in 2001 partially because: Enron did game the market

Texas "Worked as Designed"

- After a winter storm in Texas earlier this month left the state's residents to contend with widespread power outages and skyrocketing electricity prices, **William W. Hogan**, the **architect of the state's energy market system** and a professor at the Harvard Kennedy School, said in an interview with The Crimson Wednesday that the state's **electricity market had "worked as designed"** given the conditions.
- (Quote from The Harvard Crimson, Feb 26, 2021. Emphasis added)

3. What Types of Plants Have Advantages in an Auction System?

Selling kWh is a losing game in an RTO



Source: [‘Pay for Performance’ and the US grid]

4. The Fatal Trifecta for a Grid

The fatal trifecta for a grid

1. **Overreliance on renewables** that start and stop on their own schedule, not the demand schedule
2. Backing up the renewables with **natural gas, delivered just-in-time** through pipelines
3. **Overdependence on the neighbors**, who are having the same weather as your own grid.

Fuel is key for winter reliability

Fuel stored on site: oil, coal, nuclear reactor fuel (in the reactor), water behind the dam

Or fuel replenished by delivery: oil, coal, LNG

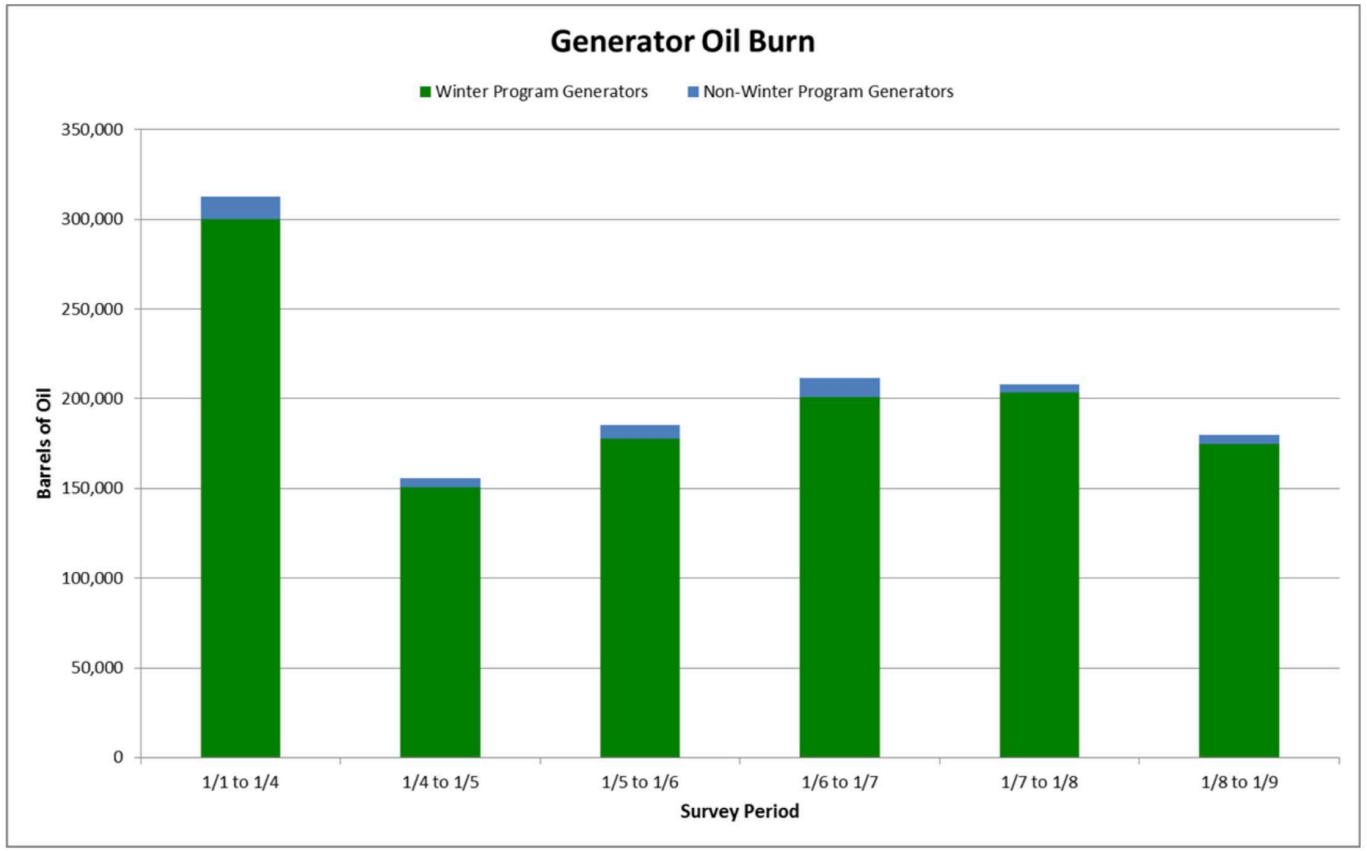
Natural Gas is Just-in-Time Delivery

- On an ordinary day, our grid runs about 50% natural gas fired
- In winter, power plants compete with homes for natural gas
- In cold snaps, people run space heaters, and electricity demand grows
- In cold snaps, natural gas is less available for power plants
- Oil to the rescue!

Winter Reliability Success

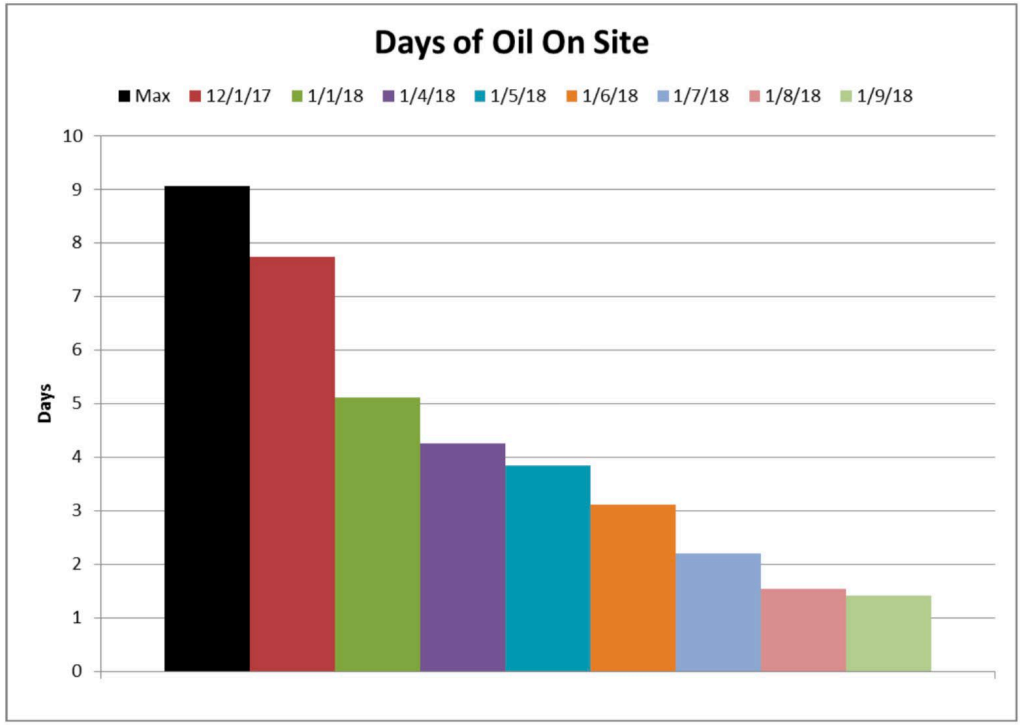
- From ISO-NE Cold Weather Operations report (December 2017 to January 2018)
- Author Vamsi Chadalavada

Generator Oil Burn – January 2018

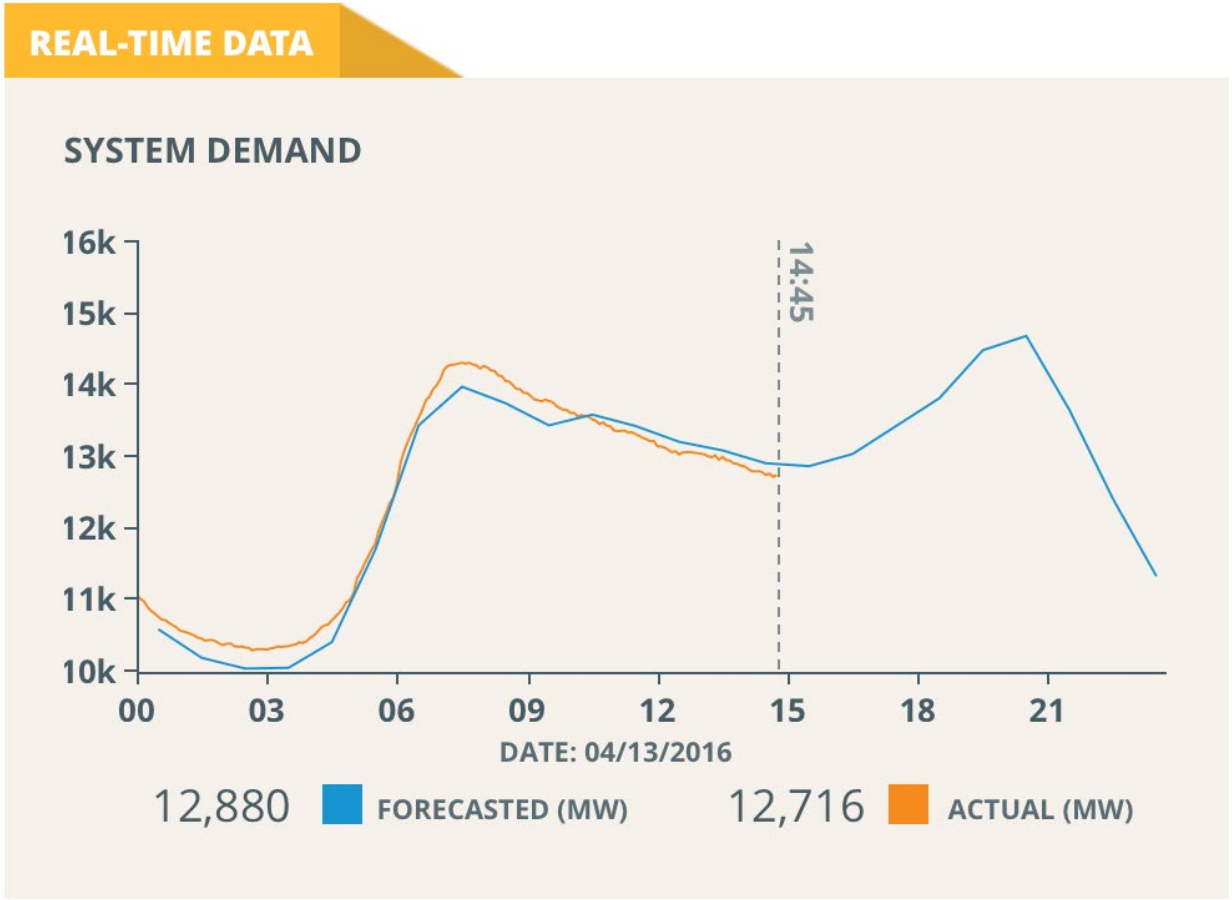


Winter Reliability Near Failure: only one day of fuel remained

Oil Depletion at a Specific Station – An Example



5. Does Baseload Power Exist?



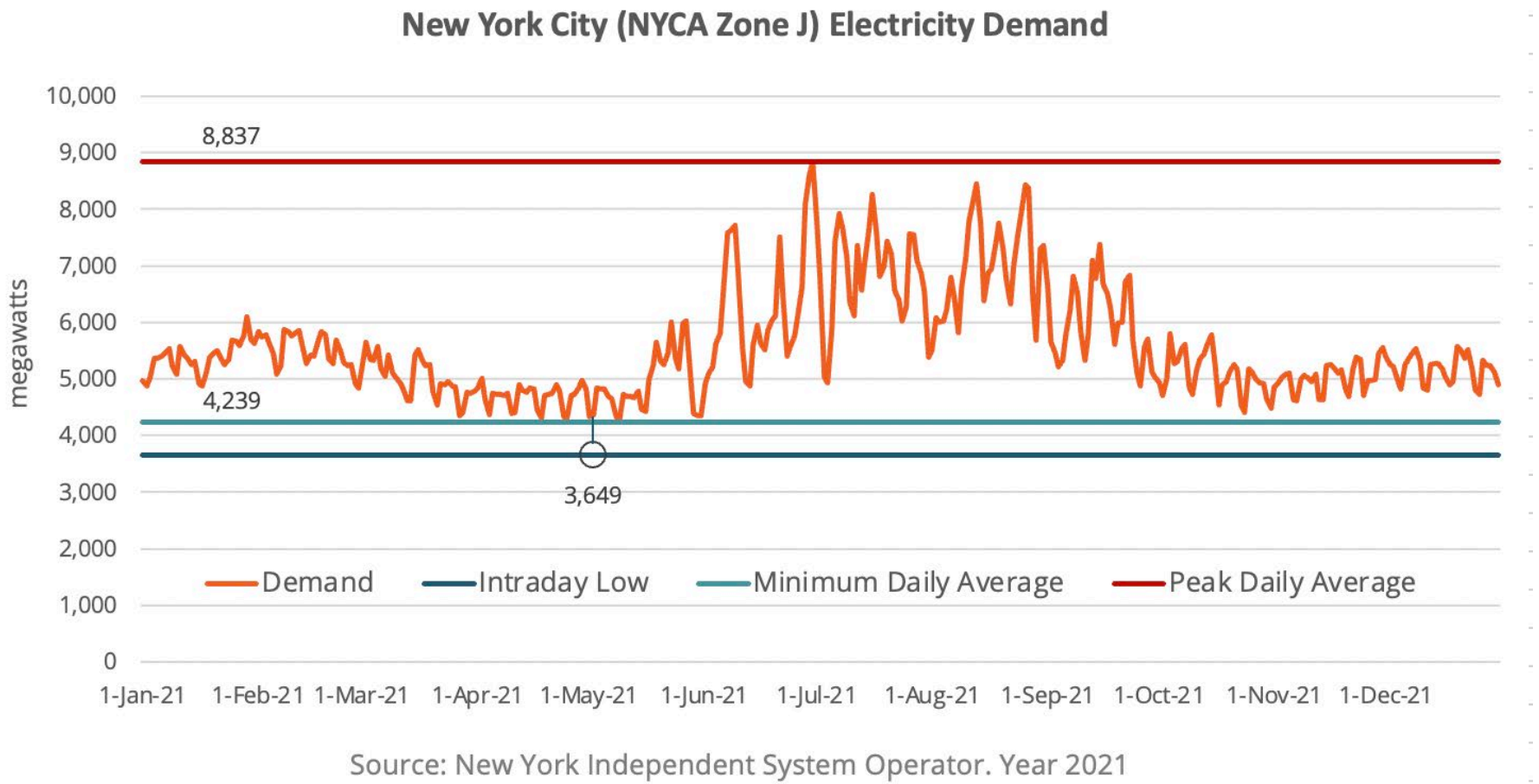
Varying Demand: Fundamental Issue for All Grids

Demand on the ISO-NE grid, April 13, 2016

New York and baseload power

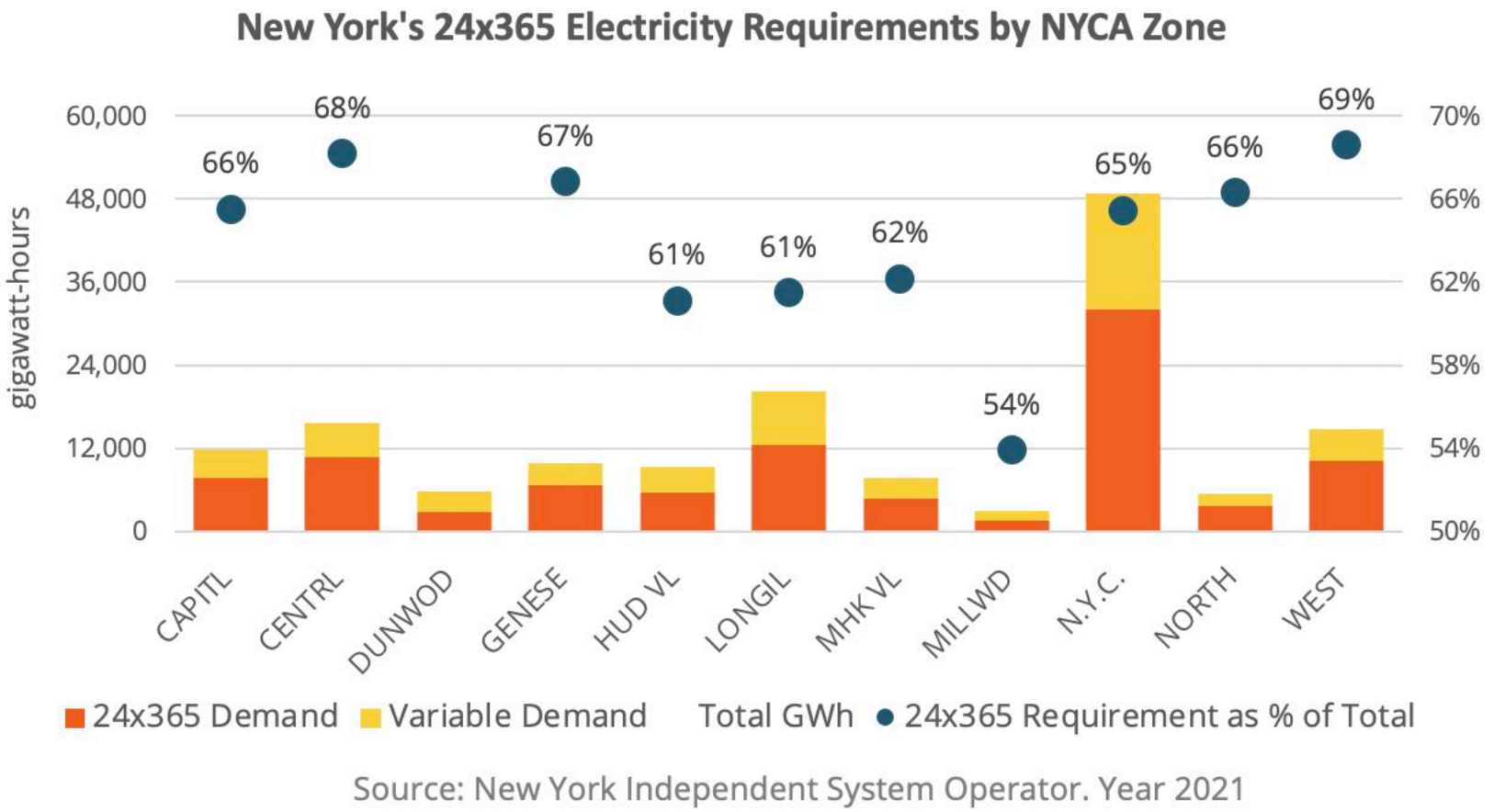
- Following are two slides about New York power
  1) MW required
  2) MWh used
- Note: Slides are courtesy of Isuru Seneviratne
  - Founder of Radiant Value Management
- These slides show the importance of baseload

Baseload, NYC in MW



Source: New York Independent System Operator. Year 2021

Baseload in New York State, MWh



Source: New York Independent System Operator. Year 2021

6. A few words about nuclear energy

Nuclear energy is good for a grid!

Three Ways Nuclear Energy Supports the Grid

Baseload power

Over a year of fuel stored on site

“Traditional” support for grid operations

Nuclear Support for Grid Operations

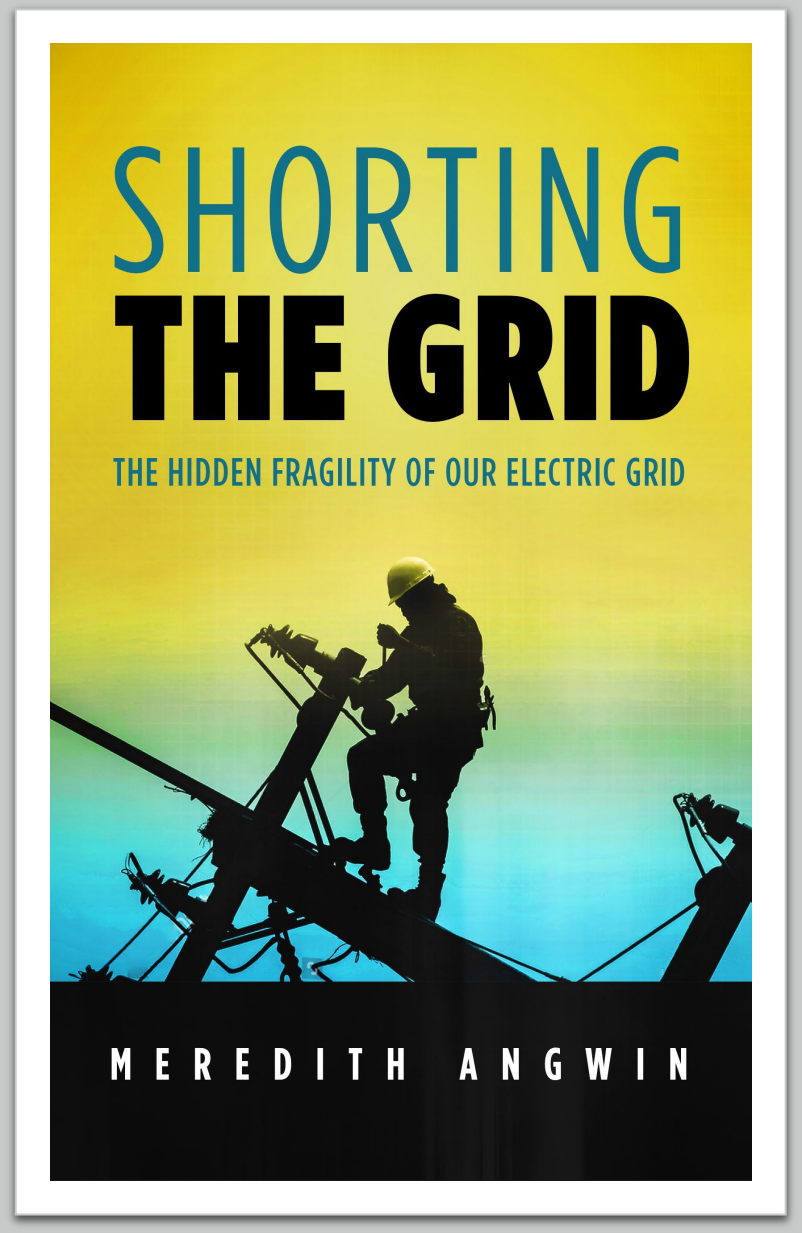
- Many renewables are inverter-based
- Nuclear is not inverter-based
- Nuclear can supply inertia
- Nuclear can support voltage and frequency

Other Advantages to Nuclear Energy

- Small footprint
- Weather resistant, not weather dependent
- Low environmental impact, including very low CO_2

A Good Citizen

- Conventional statements
  - A good citizen makes personal sacrifices
    - Meat? Warm houses? Travel? Lawn mowers? Plastic straws?
    - It's all up to ME!
- No! A citizen is a citizen, not a lone actor.
- A good citizen acts as a *citizen*
  - Realizes the death toll if anything happens to the grid
  - Supports a reliable grid
  - It's about choices, not sacrifices.
  - It's up to all of us!



Thank you!

- I am always happy to hear from you!
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- Plus, just for fun because everyone should know this site:
  - https://www.electricitymap.org