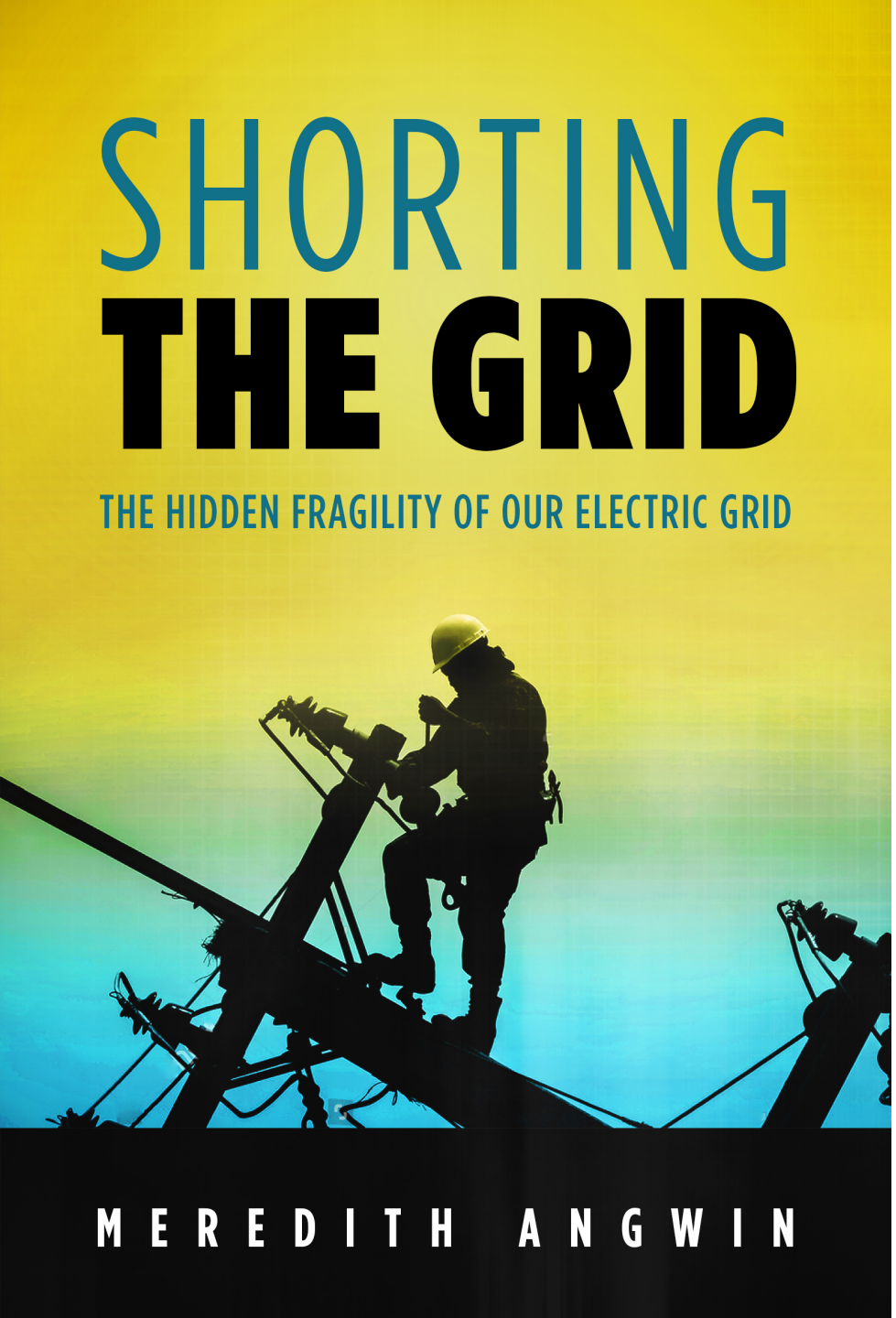
Shorting the Grid

- Tom Nelson Podcast
- June 2023
- Presentation by Meredith Angwin

About me, and about the grid.

- Starting with me



My background

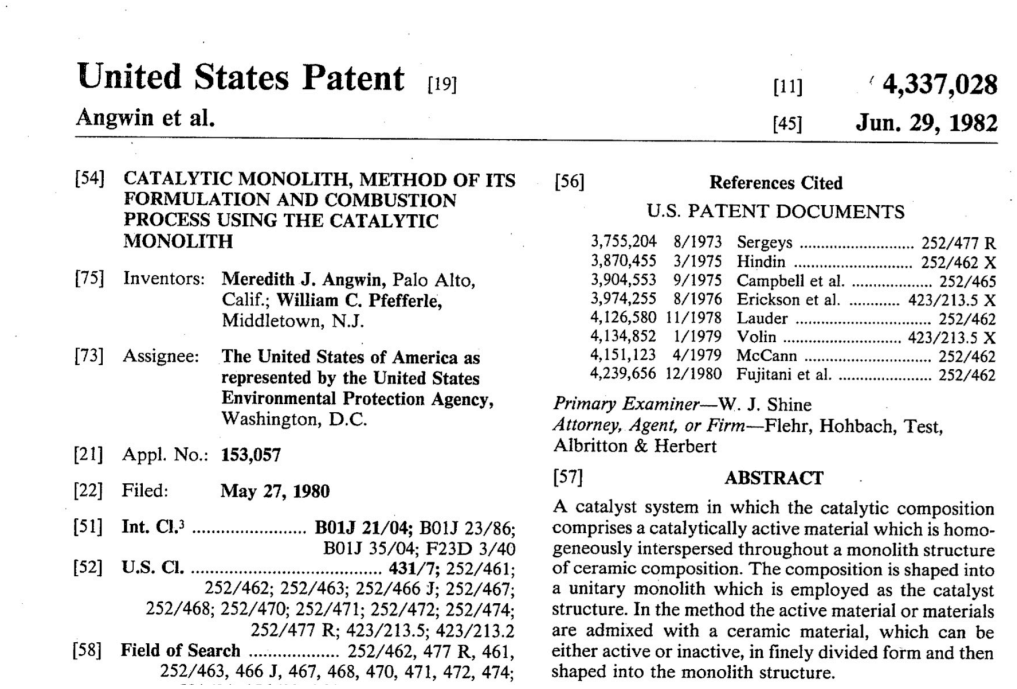
- Master's degree in Physical Chemistry, University of Chicago
- Specialized in mineral chemistry in grad school
- Worked on issues facing electric utilities
  - As a contractor
  - At EPRI (Electric Power Research Institute)
- Research on pollution control and corrosion control for geothermal, gas-fired,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

The geothermal and combustion years

- Mineral chemistry and an interest in energy meant--geothermal
- First contracts were reviewing other people's work in geothermal
- NOx first

NOx and SOx (mostly NOx)

- Controlling NOx with combustion catalysts
- Platinum evaporates at high temperature
- No platinum
- I am principal inventor on patents for catalysts that are transition metals in alumina matrices



United States Patent [19]

Angwin et al.

[11] **4,337,028**

[45] **Jun. 29, 1982**

[54] **CATALYTIC MONOLITH, METHOD OF ITS FORMULATION AND COMBUSTION PROCESS USING THE CATALYTIC MONOLITH**

[75] Inventors: **Meredith J. Angwin**, Palo Alto, Calif.; **William C. Pfefferle**, Middletown, N.J.

[73] Assignee: **The United States of America as represented by the United States Environmental Protection Agency**, Washington, D.C.

[21] Appl. No.: **153,057**

[22] Filed: **May 27, 1980**

[51] **Int. Cl.**[3] **B01J 21/04**; B01J 23/86; B01J 35/04; F23D 3/40

[52] **U.S. Cl.** ..... **431/7**; 252/461; 252/462; 252/463; 252/466 J; 252/467; 252/468; 252/470; 252/471; 252/472; 252/474; 252/477 R; 423/213.5; 423/213.2

[58] **Field of Search** ..... 252/462, 477 R, 461, 252/463, 466 J, 467, 468, 470, 471, 472, 474;

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,755,204	8/1973	Sergeys	252/477 R
3,870,455	3/1975	Hindin	252/462 X
3,904,553	9/1975	Campbell et al.	252/465
3,974,255	8/1976	Erickson et al.	423/213.5 X
4,126,580	11/1978	Lauder	252/462
4,134,852	1/1979	Volin	423/213.5 X
4,151,123	4/1979	McCann	252/462
4,239,656	12/1980	Fujitani et al.	252/462

Primary Examiner—W. J. Shine
Attorney, Agent, or Firm—Flehr, Hohbach, Test, Albritton & Herbert

[57] **ABSTRACT**

A catalyst system in which the catalytic composition comprises a catalytically active material which is homogeneously interspersed throughout a monolith structure of ceramic composition. The composition is shaped into a unitary monolith which is employed as the catalyst structure. In the method the active material or materials are admixed with a ceramic material, which can be either active or inactive, in finely divided form and then shaped into the monolith structure.

Geothermal finally

- As a chemist—mostly corrosion
- Geysers
- Heber
- Hot Dry Rock
- Geopressured Zone

Seawater Underground and in Nuclear!

- 3X geothermal waters (X is seawater)
- Bye bye Debye-Huckel
- Steam Generator Project Office
- A tube sheet crevice--3X again

Nuclear:
Practical and theoretical

- Model boilers
- Big thermodynamics programs
- Simple semi-solutions: better alloys and cleaner water
- Eventually, my own company on nuclear corrosion

My own company: Personal growth

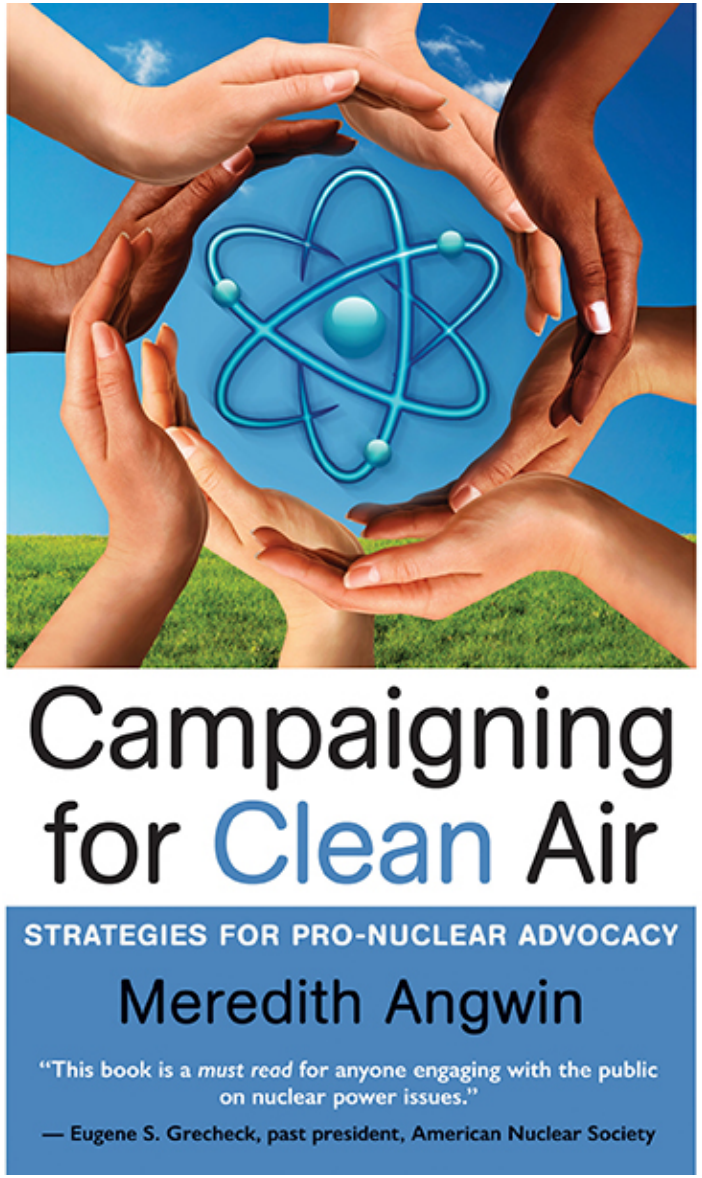
- Responsible for projects
- Responsible for payroll
- Foreign travel (South Africa, Japan, Europe)
- “Great Books of Management”

The great shakeup and a new start

- Around 2000, utilities were in a state of turmoil
- Became a tech writer in several firms (Hyperion, TIBCO)
- Later, moved to Vermont to be closer to family

Trying to save Vermont Yankee

- Blog “Yes Vermont Yankee”
- Book *Campaigning for Clean Air*
- Learning about the grid
- Consumer Liaison Group of ISO-NE



About me, and about the grid.

- About the grid

Presentation outline

1. What is a Strong Grid?
2. Physical Grid and Policy Grid
3. What is an RTO?
4. Questions
5. RTOs and Auctions
6. The Fatal Trifecta for a grid
7. Conquering the Fatal Trifecta
8. Questions

1.What is a Strong Grid?

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

2. Physical Grid and Policy Grid

The Two Grids: Physical and Policy

Physical:

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

Policy

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

The Two Grids Confused

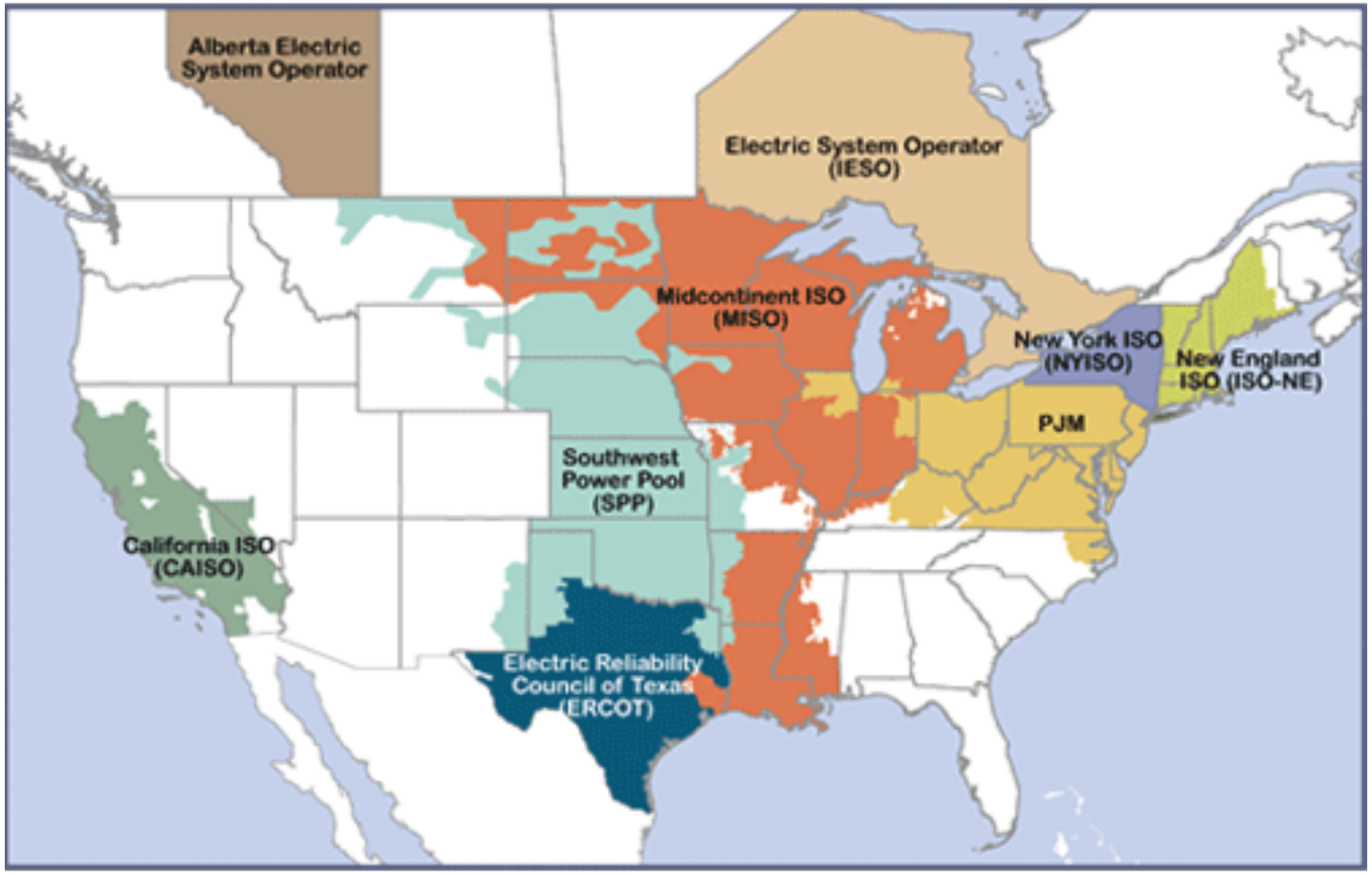
- Vermont Yankee contracts with Vermont utilities ended in 2012
- Vermont Yankee continued operations, selling into the auctions, till 2014
- In 2013, anti-nuclear people said: “We don’t need Vermont Yankee. We’re not even using it now!”
- Deliberate confusion or mistake? Either way, Vermont *was* using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

3. About RTOs (Regional Transmission Organizations)

RTOs Regional Transmission Organizations



Major types of grid governance

Traditional vertically integrated utilities

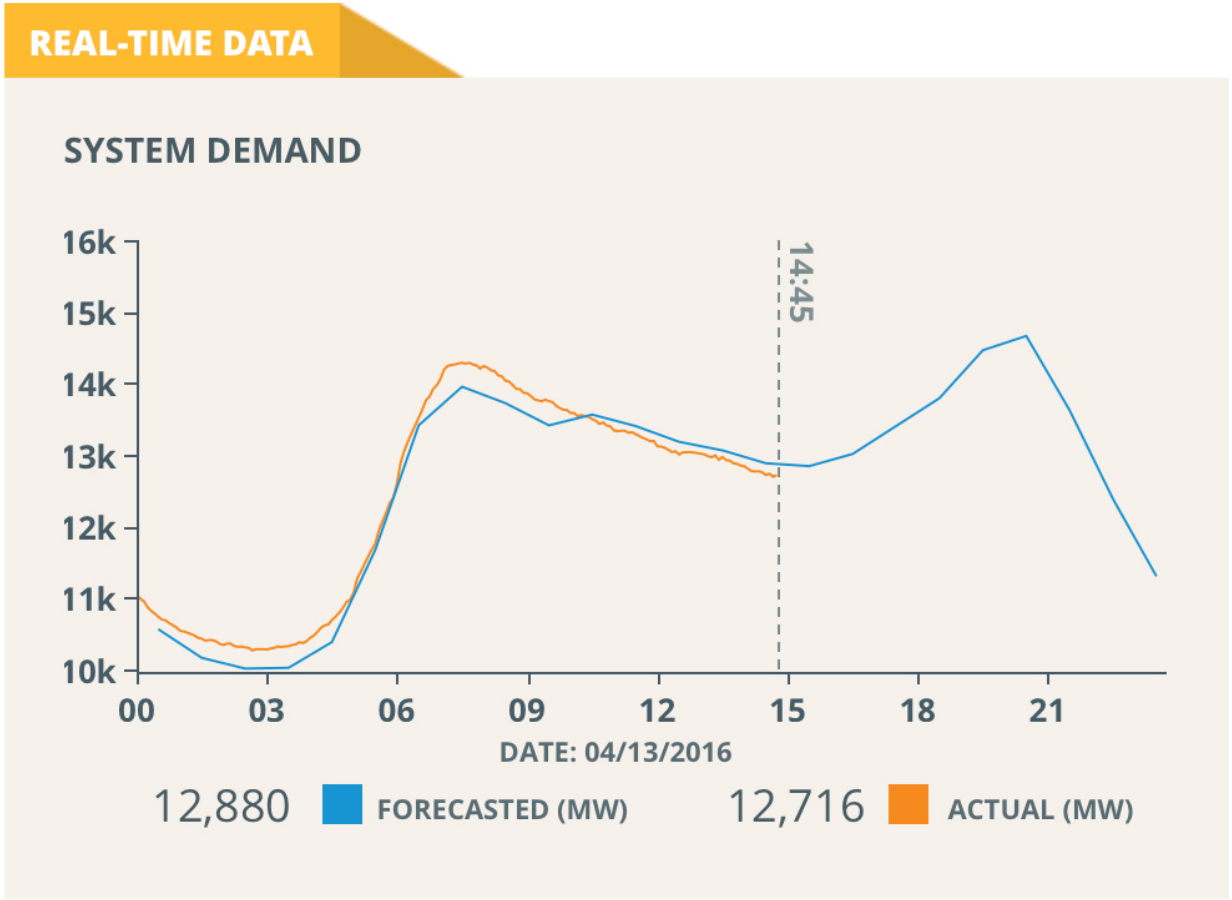
- Utility is responsible for reliability
- Utility owns power plants and distribution systems
- It receives a “rate of return” set by regulators
- State Public Utility Commission (PUC) is major regulator

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”

Control Room at ISO-NE

- The Balancing Authority
- Keeping the demand (amount of electricity used) and the supply (amount of electricity produced) in balance.
- Several desks, feeds from TV (local news), LNG tanker tracking, gas pipelines.



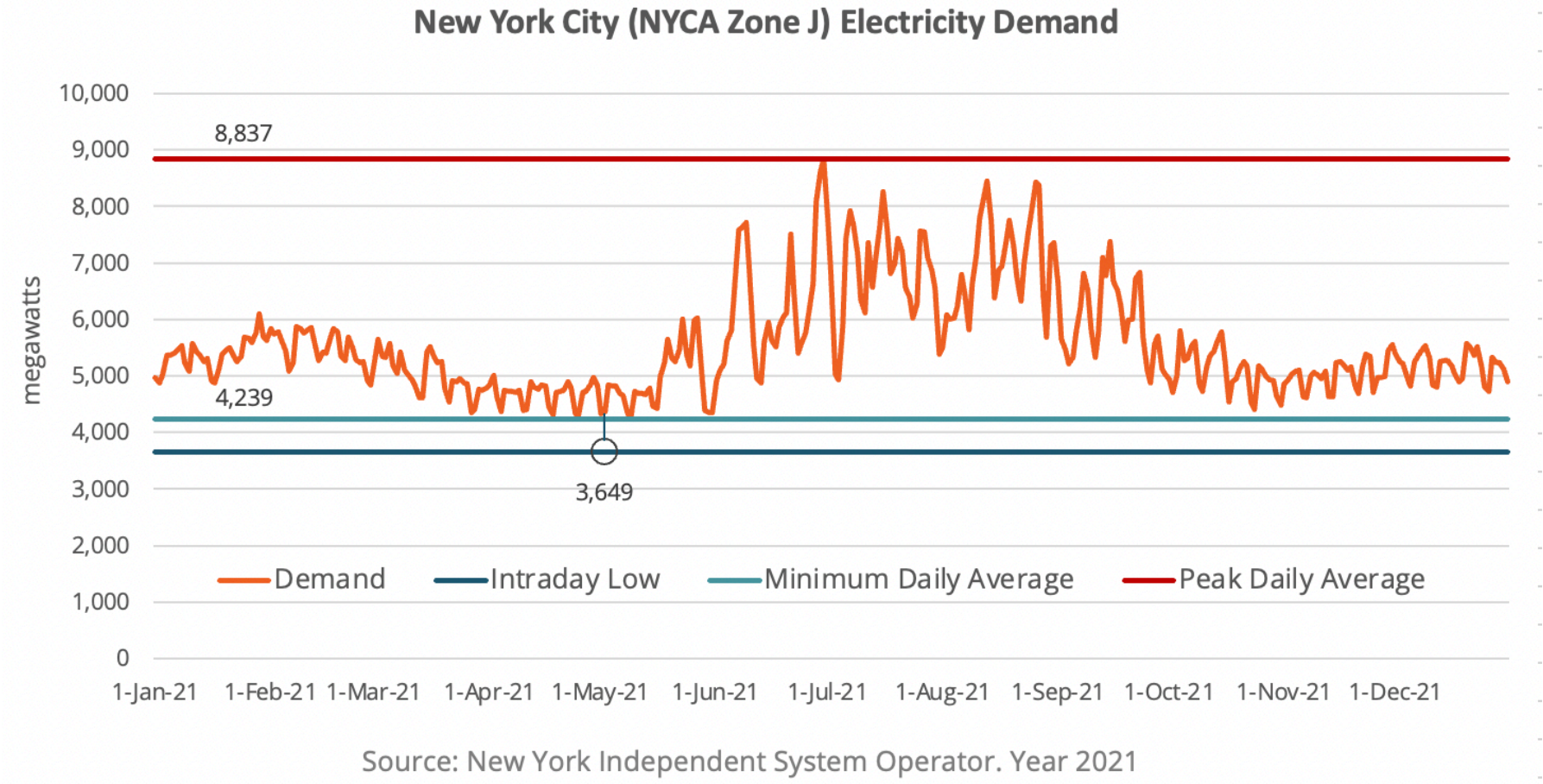
Varying Demand: Fundamental Issue for All Grids

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

New York and baseload power

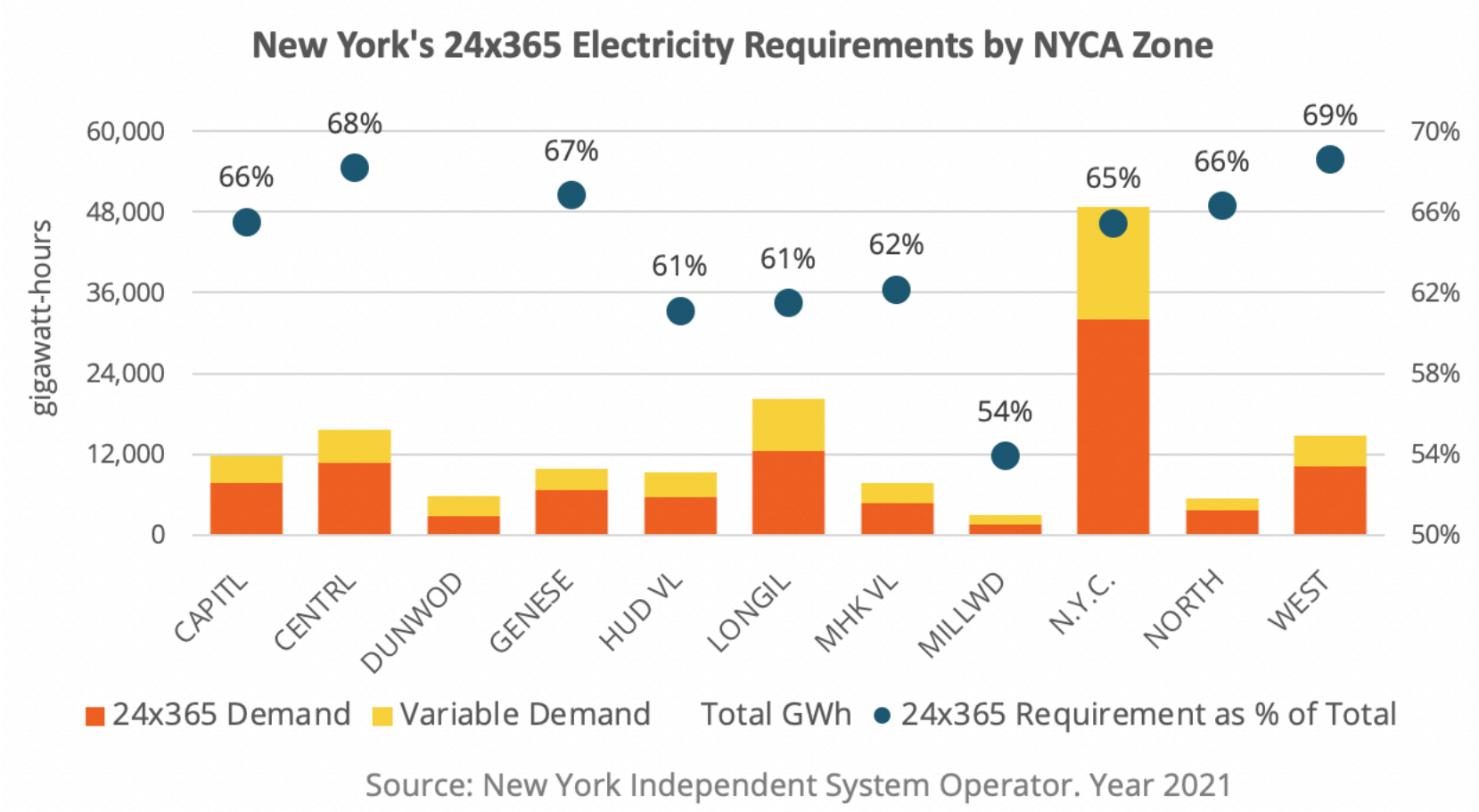
- Following are two slides about New York power
  1) MW required
  2) MWh used
- Note: Slides are courtesy of Isuru Seneviratne
  - Founder of Radiant Value Management
- These slides show the importance of baseload

Baseload, NYC in MW



Source: New York Independent System Operator. Year 2021

Baseload in New York State, MWh

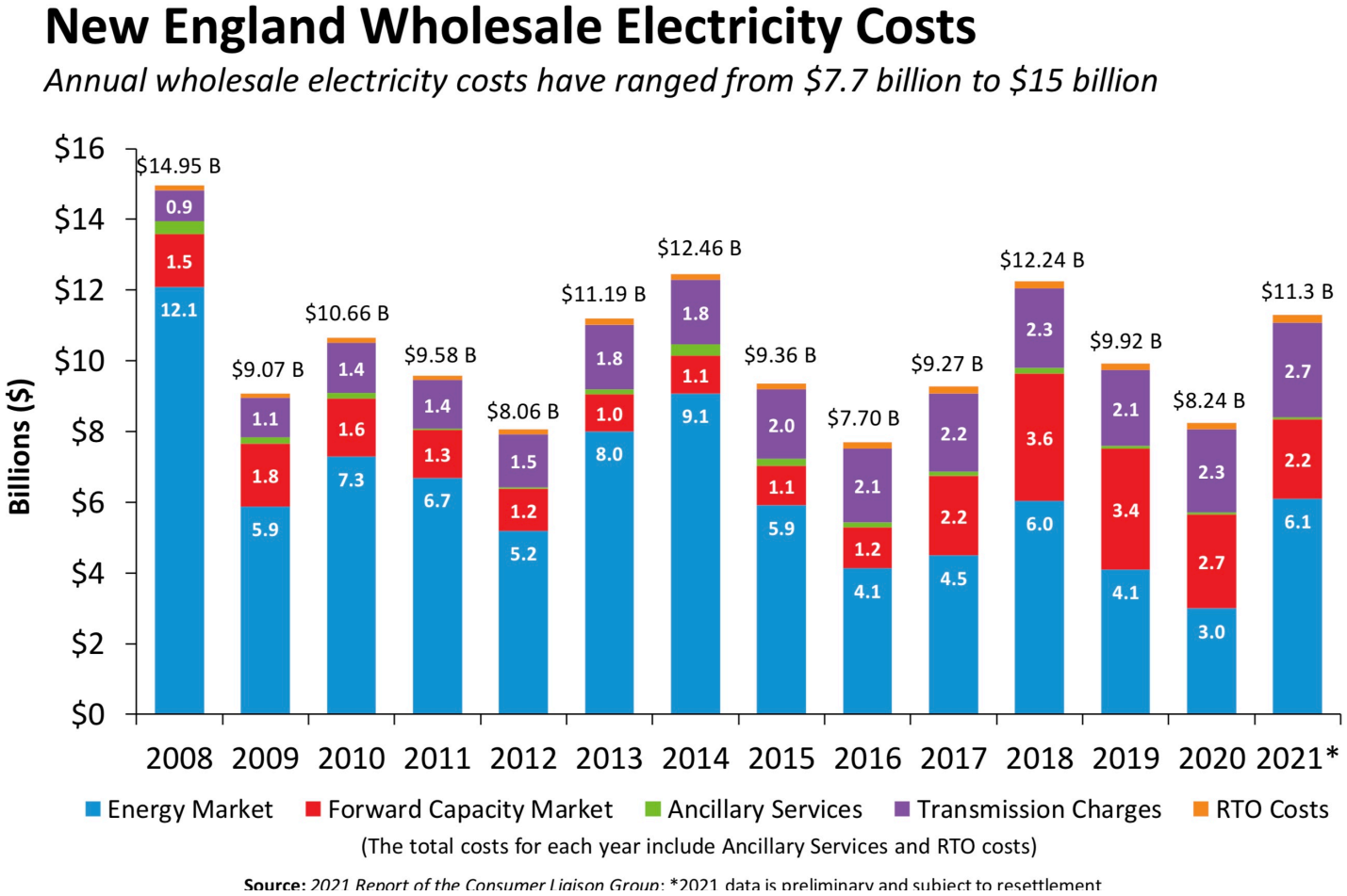


Questions?

4. RTOs and the Auctions

RTO is not just a Balancing Authority

- Also runs the auctions
- Several auctions (most RTOs).
  - Energy
  - Capacity
  - Ancillary services
- “Economic Dispatch.” Least expensive dispatched (allowed on the grid) first



Energy, Capacity, Ancillary, and Transmission

https://www.iso-ne.com/static-assets/documents/2022/11/clg_meeting_george_iso_new_england_update_presentation_nov_30_2022.pdf

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

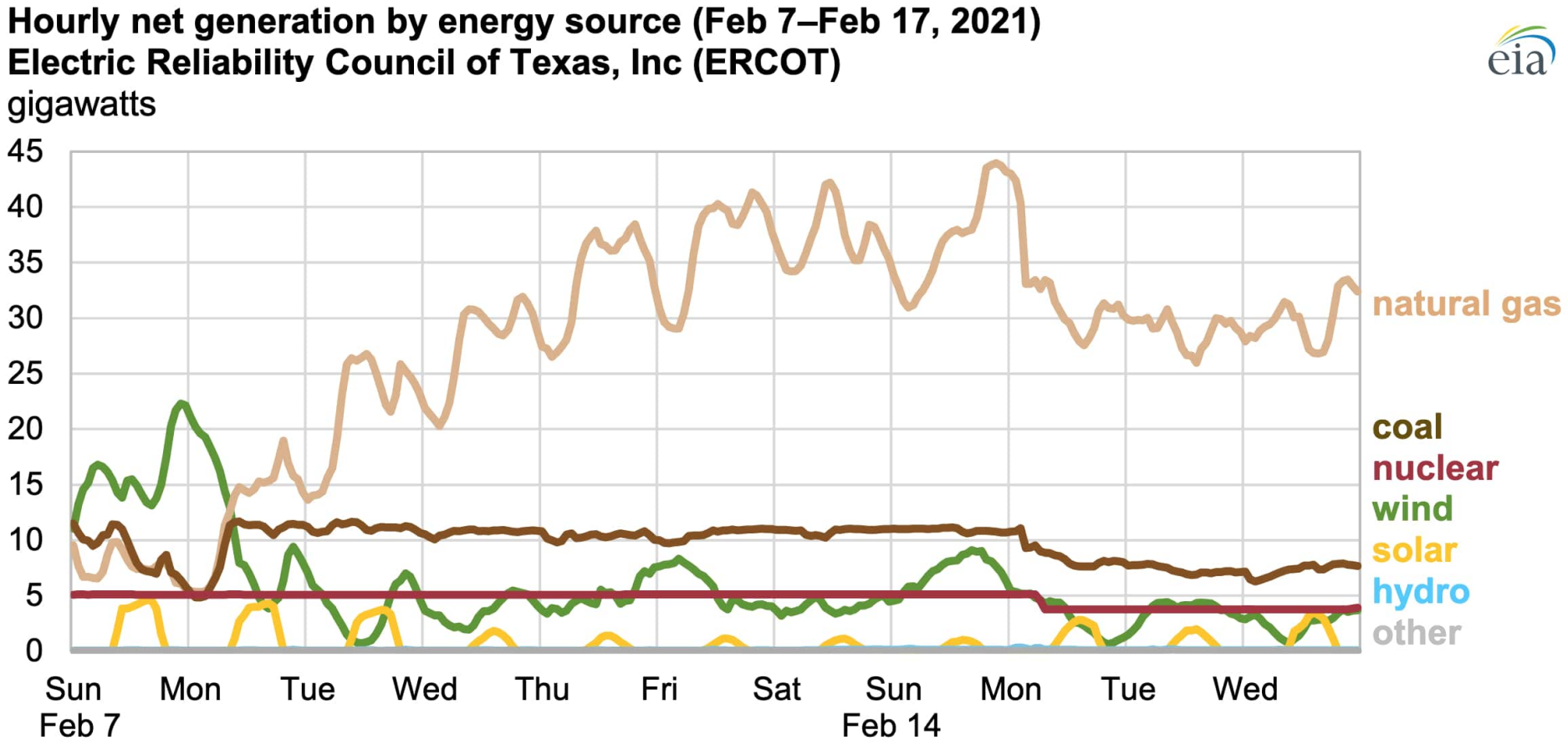
Incentives for the power plants in an RTO

- 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)

Texas Crisis from the EIA



5.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.

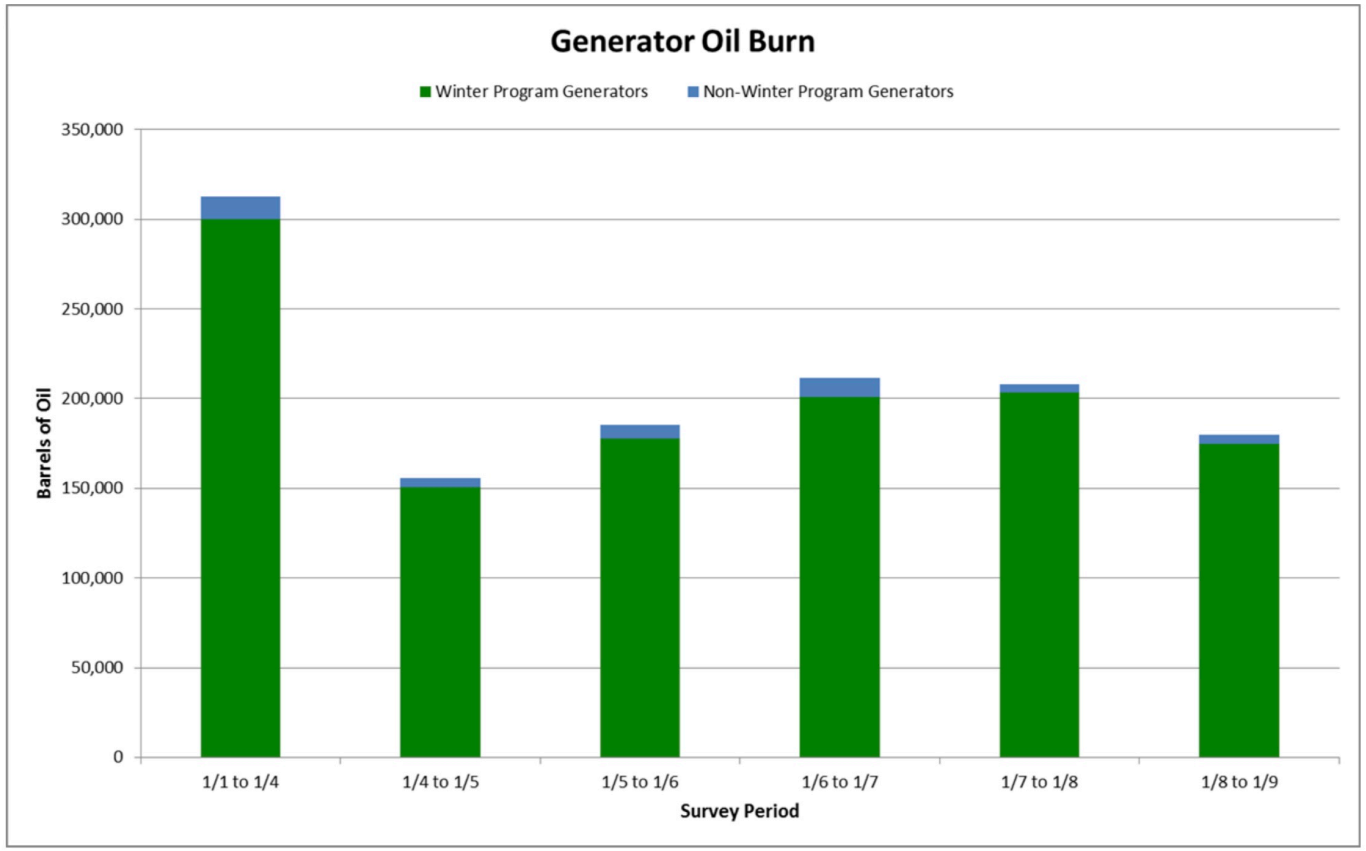
Natural Gas is Just-in-Time Delivery

- 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



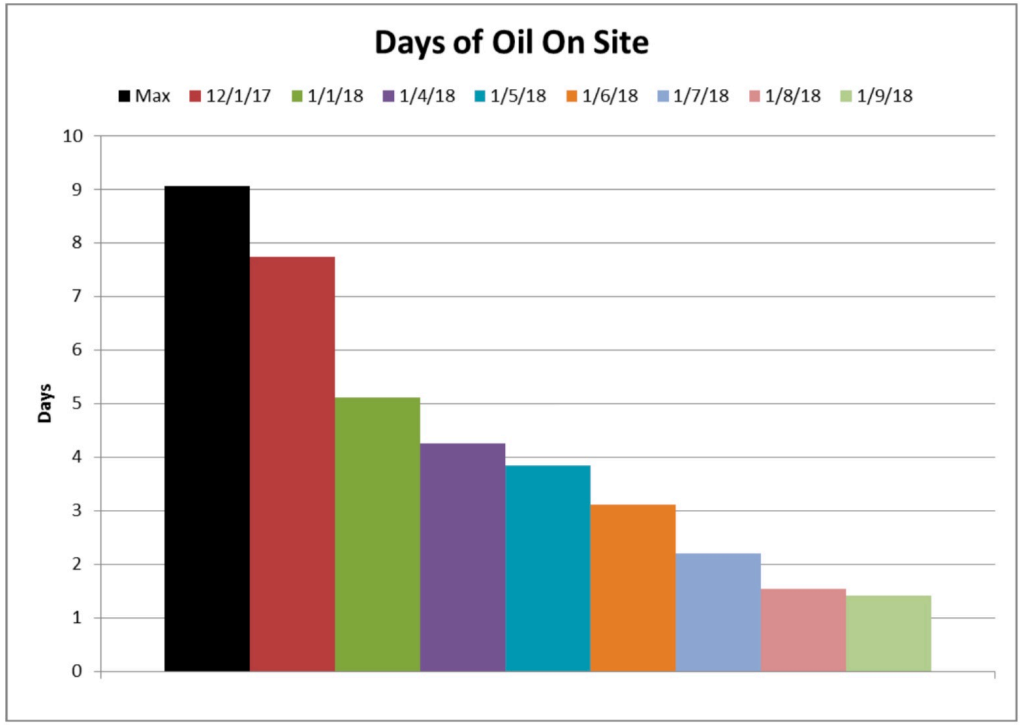
Fuel is key for winter reliability

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

Or fuel replenished by delivery: oil, coal, LNG

Winter Reliability Near Failure: only one day of fuel remained

Oil Depletion at a Specific Station – An Example



6.Conquering the Fatal Trifecta

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

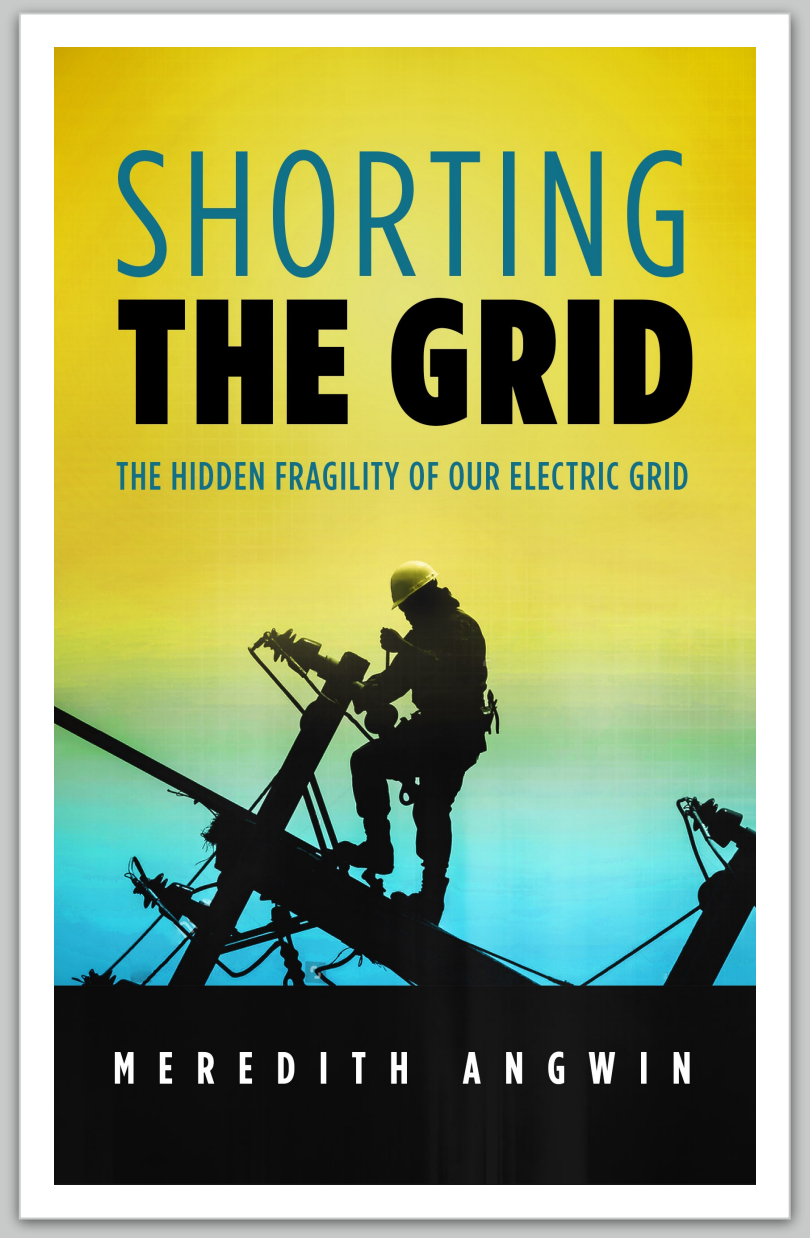
8. Looking Forward

Fuel stored on site, and flexibility

- Base load: Nuclear
- Intermediate load: mixture of nuclear, solar and gas
- Peaking load: gas, batteries

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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- @meredithangwin

- Plus, just for fun because everyone should know this site:
  - https://www.electricitymap.org