Electricity Markets

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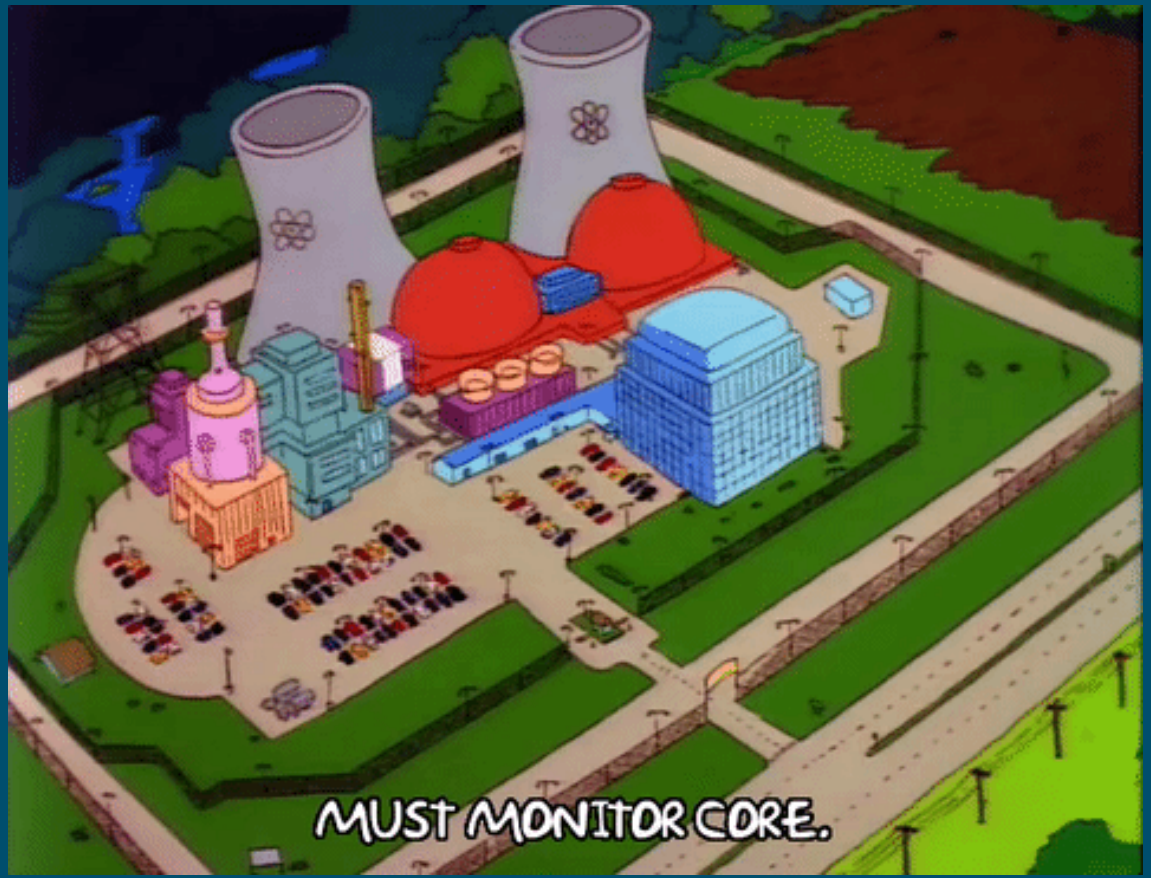
NUCLEAR ENERGY INSTITUTE

What is Nuclear Power?



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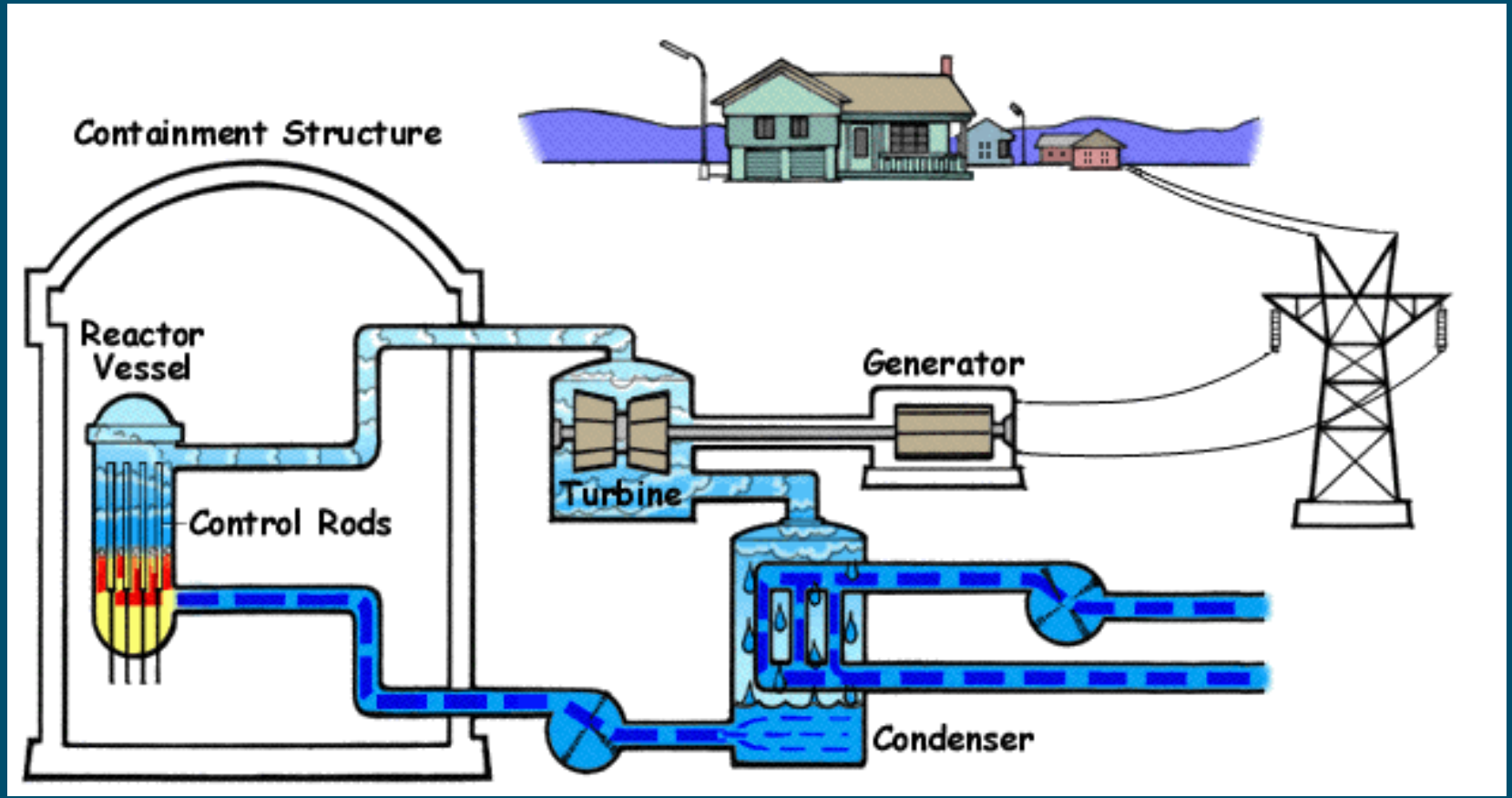
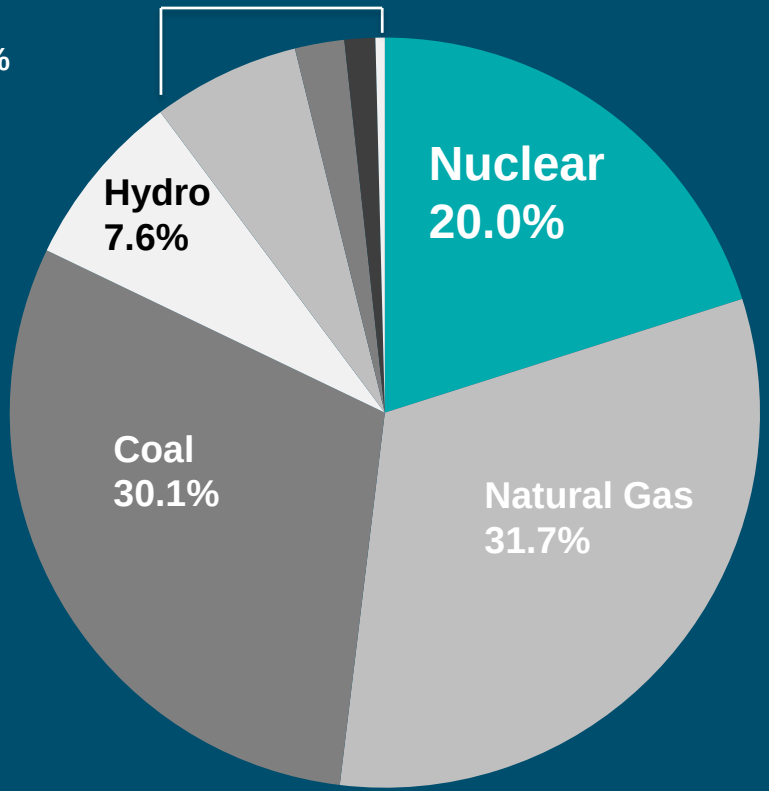


U.S. Electricity Generation Fuel Shares



- 20% of the U.S. energy generation comes from nuclear
- 99,635 MWe of baseload capacity in 2017
- 804.9 billion kWh generated
- 92.2% capacity factor

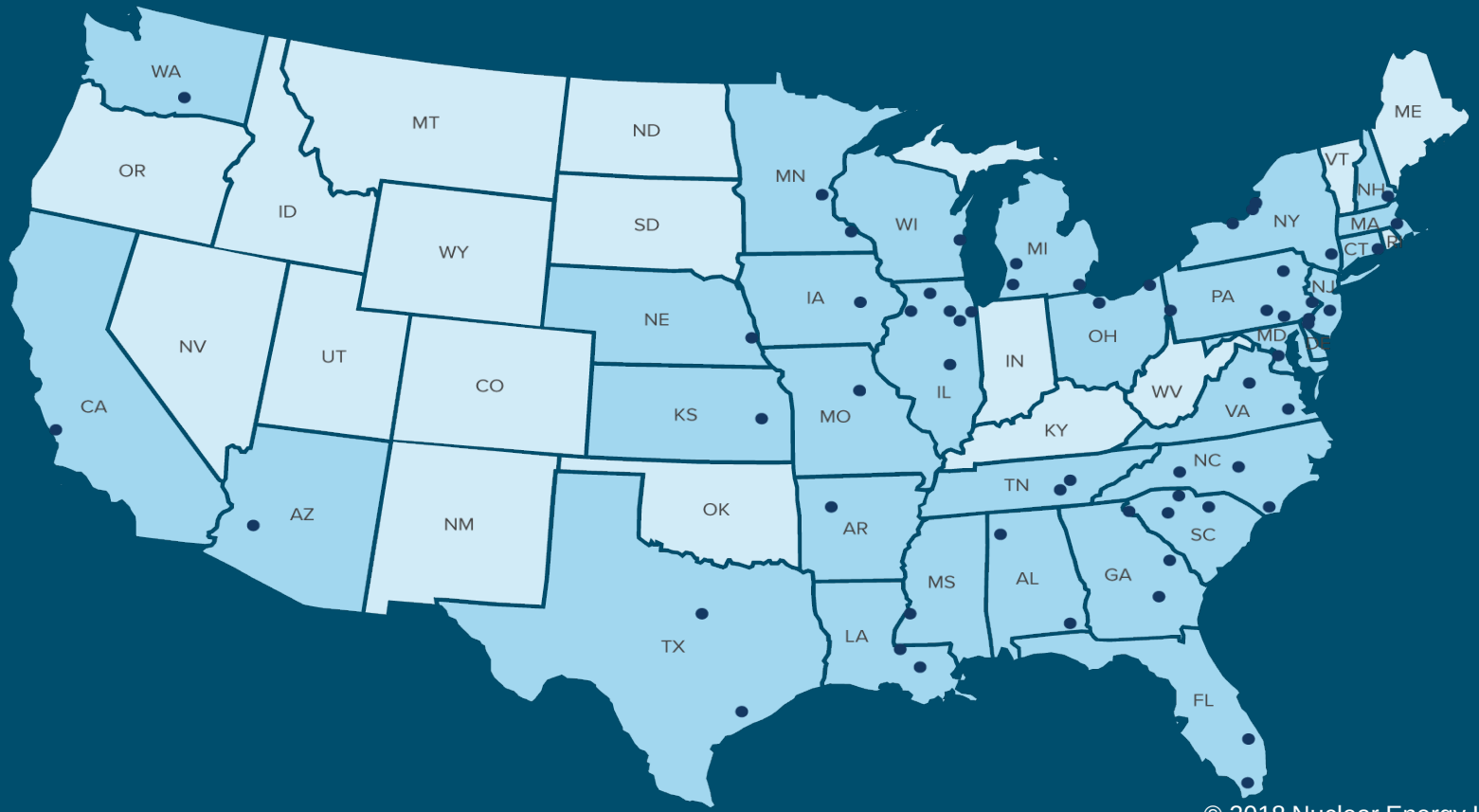
Source: U.S. Energy Information Administration
Updated: March 2018

Nuclear Power in the U.S.

- 97 reactors at 58 sites, in 30 states
- 99,010 MWe of baseload capacity

Source: U.S. Energy Information Administration
Updated: September 2018

NUCLEAR ENERGY IN THE U.S.



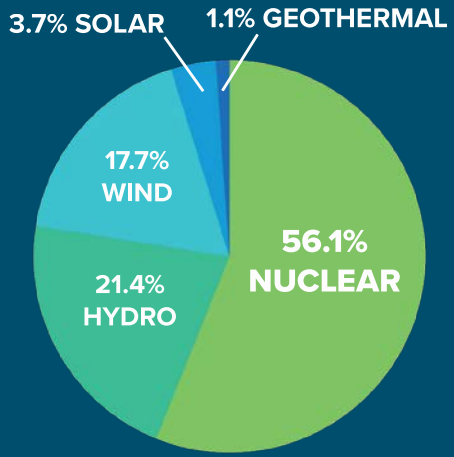
NUCLEAR CONTRIBUTIONS

AVOIDS **547.5 MILLION** METRIC TONS OF **CARBON EMISSIONS** EACH YEAR

+

PREVENTS **315,000 SHORT TONS** OF **NOx** AND **374,000 SHORT TONS** OF **SO2** EMISSIONS

AVERAGE **CAP FACTOR >90% SINCE 1999**

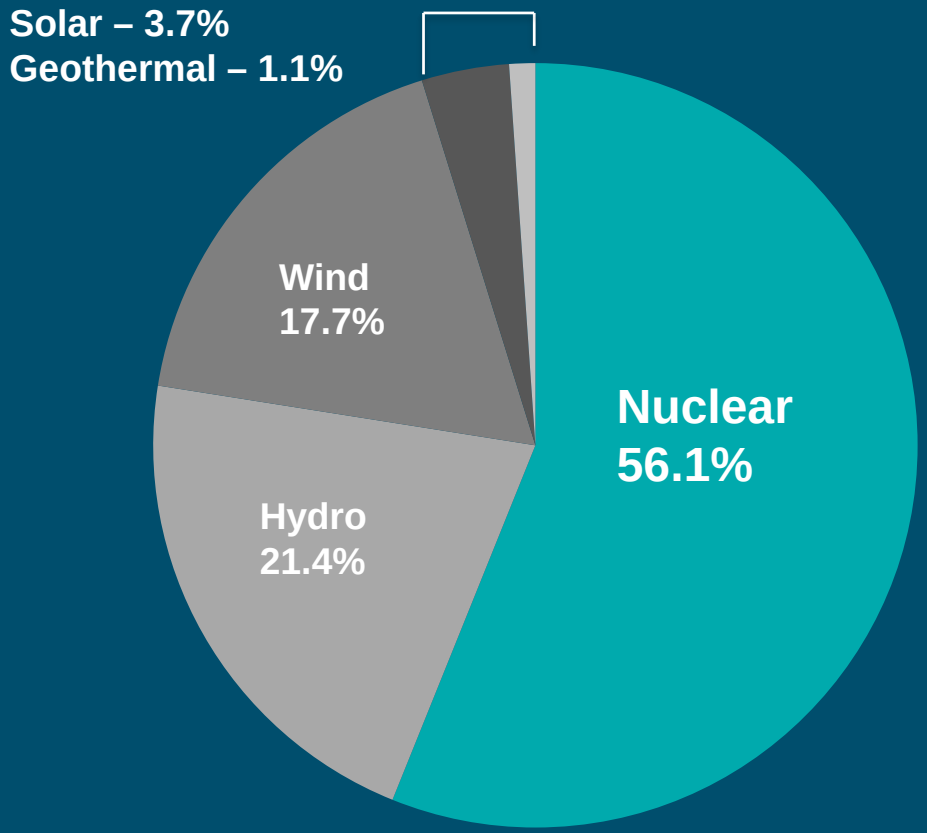


SUPPORTS **475,000** JOBS

SAVES CONSUMERS AN AVERAGE OF **6%** ON ELECTRICITY BILLS

ADDS **$60 BILLION** TO THE COUNTRY'S **GDP**

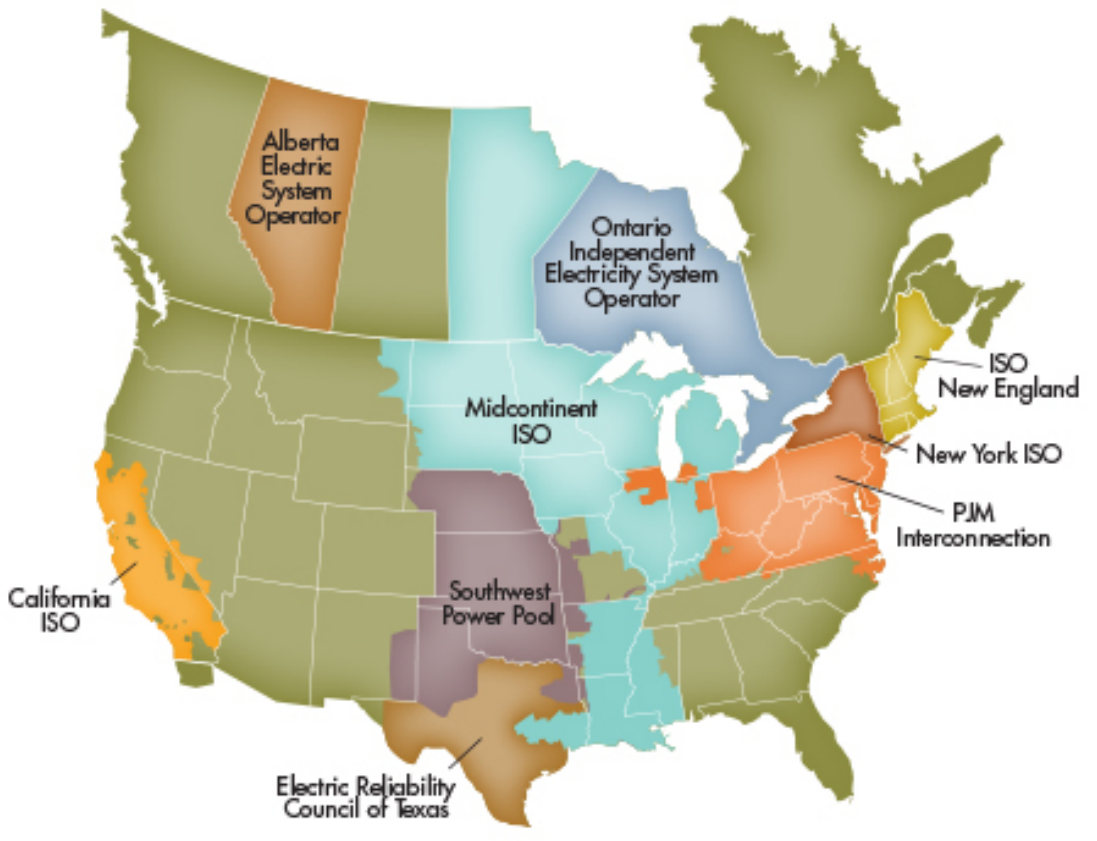
U.S. Emissions-Free Fuel Shares



Over 55% of the U.S. Clean Energy Comes from Nuclear

Source: U.S. Energy Information Administration
Updated: March 2018

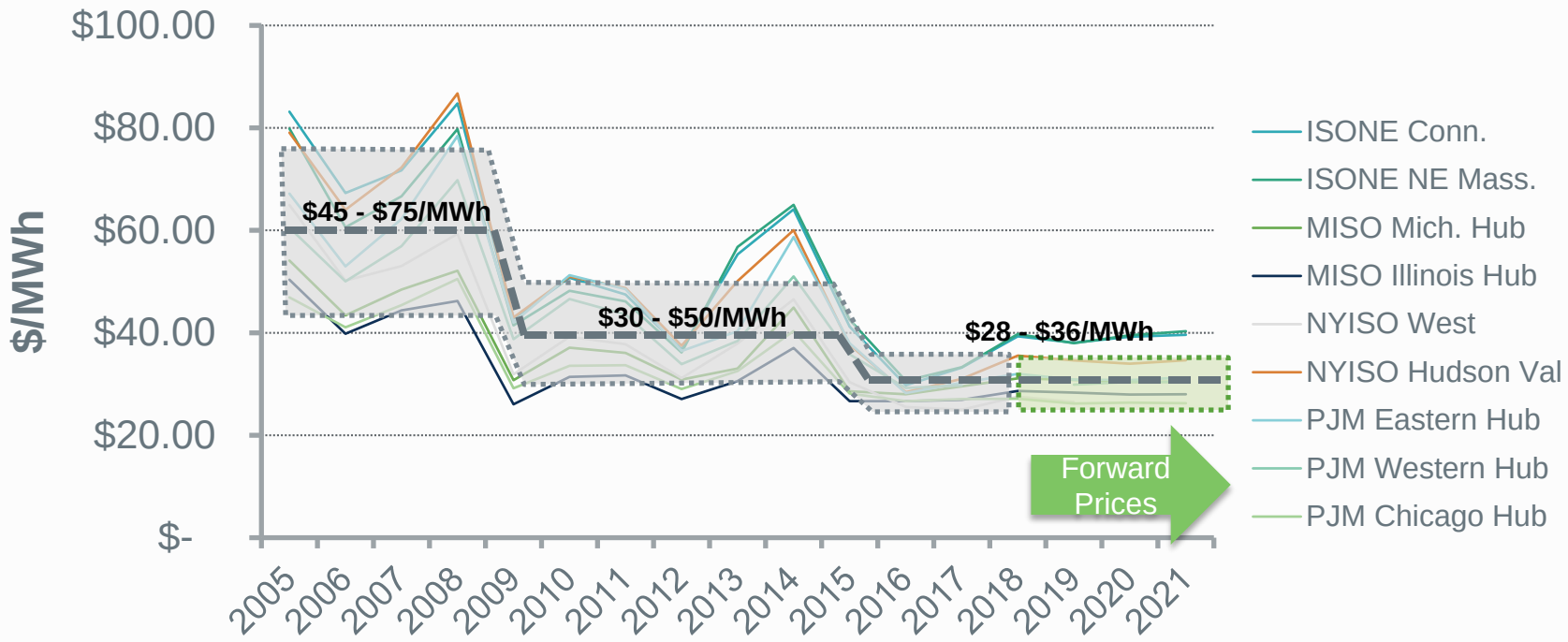
Electricity Markets



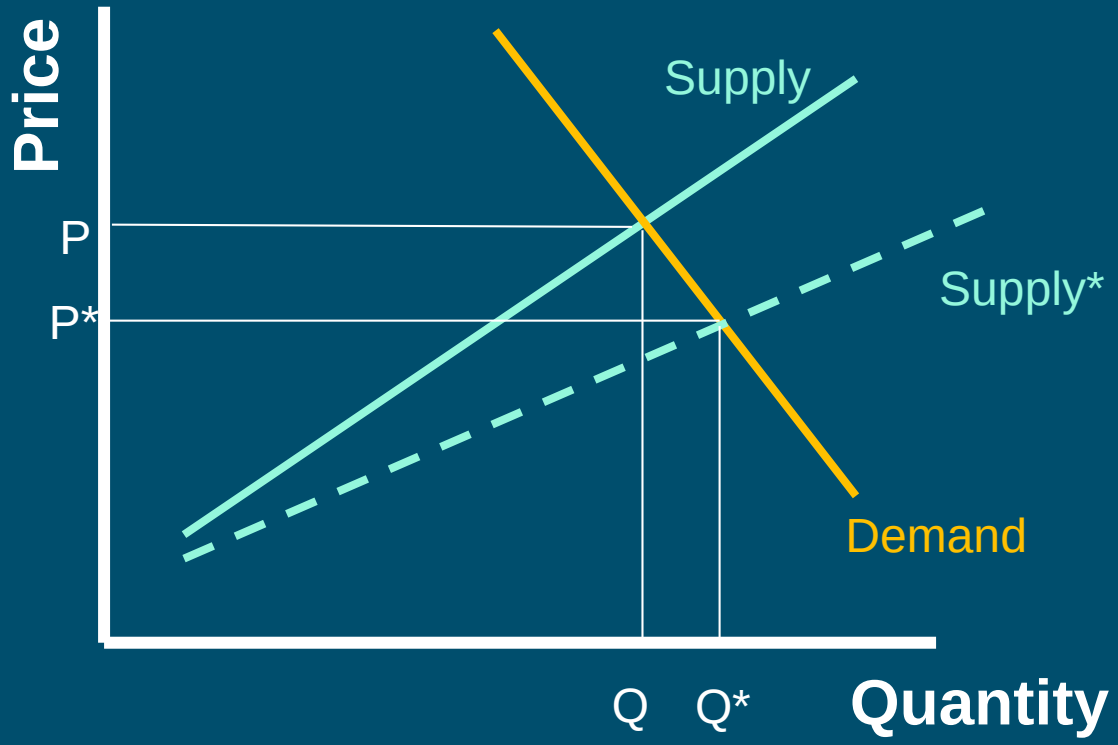
Challenges

- Continuing surge in supply of low-cost shale gas
- Low growth in electricity demand
- Failure of markets to recognize environmental attributes
  - Fuel/technology diversity is undervalued
  - State and federal policies that promote only renewables
- Transmission constraints
- Market design issues

Declining Electricity Prices



Electricity Markets Economics 101



Power plant owners bid to provide power in markets

Grid Operator

“Power plant operators, I am going to need more electricity in Washington, DC today at 5:30pm due to REMI Conference happy hour.

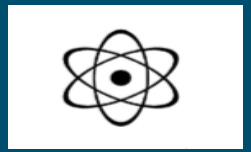
How much do you need to be paid?”

Power Plant Operator

"How Much Extra Would It Cost Me to Run the Plant?"

"I need to buy more coal and bring in a couple of workers. ***$25 per MWh*** *is worth it for me to generate power."*

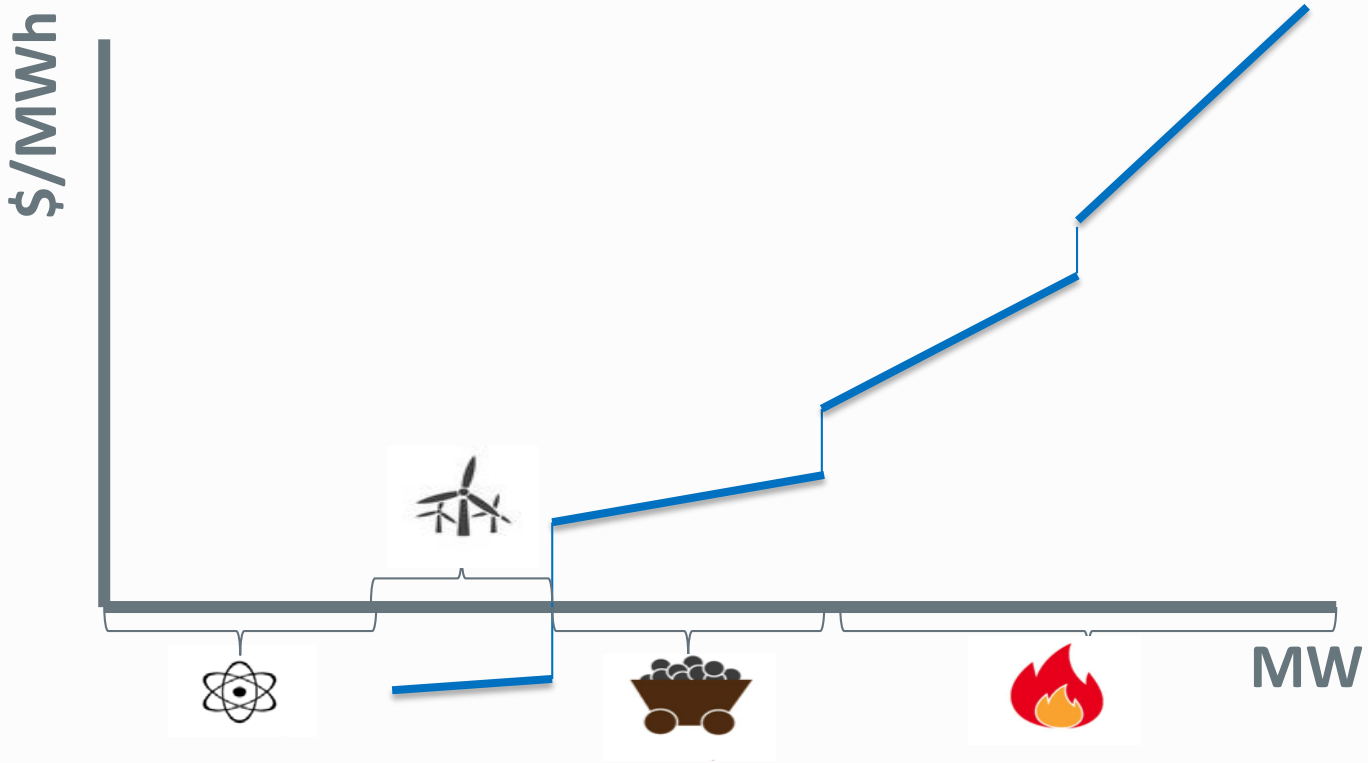
"I can buy natural gas at $4/mmBTU. I'm not the most efficient plant, but I'm pretty good. I can cover my costs at ***$32 per MWh****."*



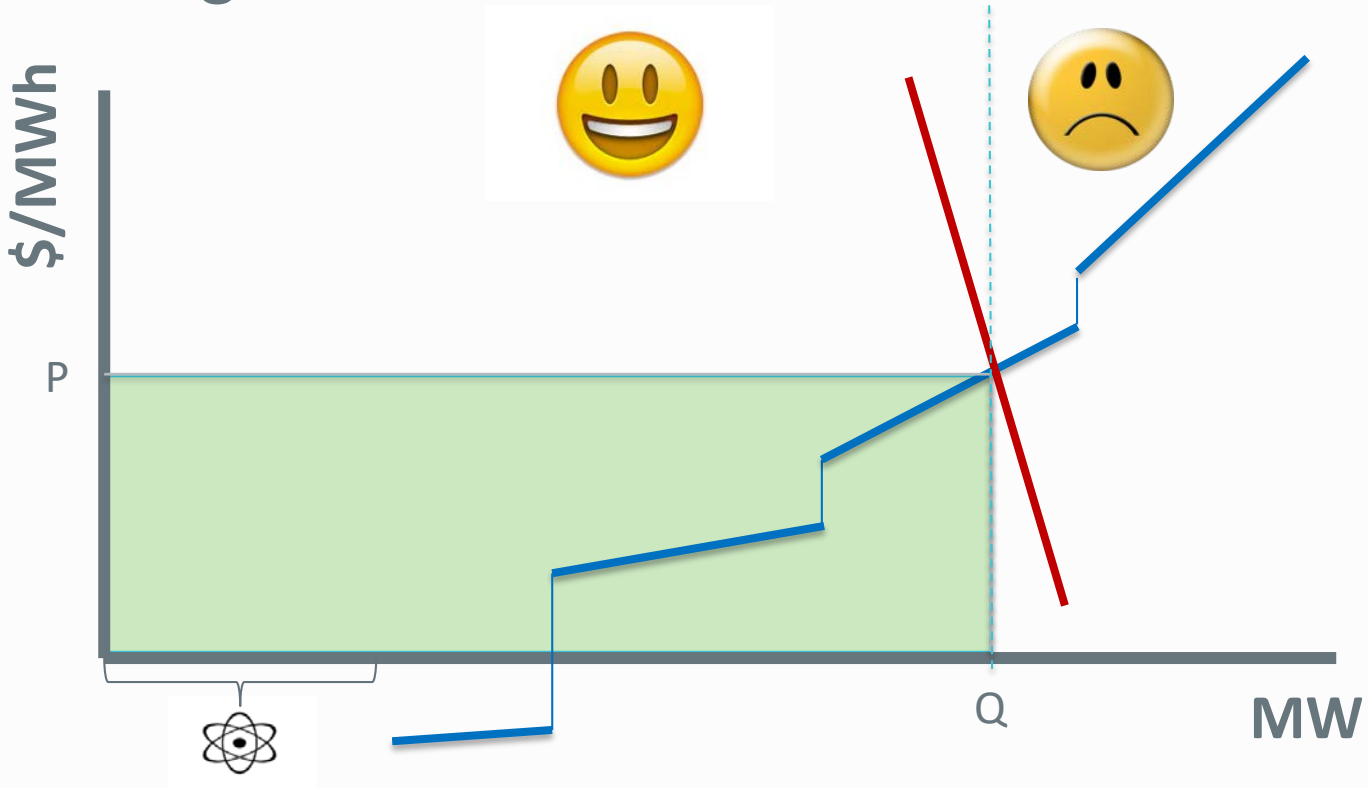
"I am running at 100% no matter what. Let the other generators set the market. I am a price taker."

"I get a tax credit as long as I sell my generation. I can bid ***negative $20 per MWh*** *(pay you) and still make profit."*

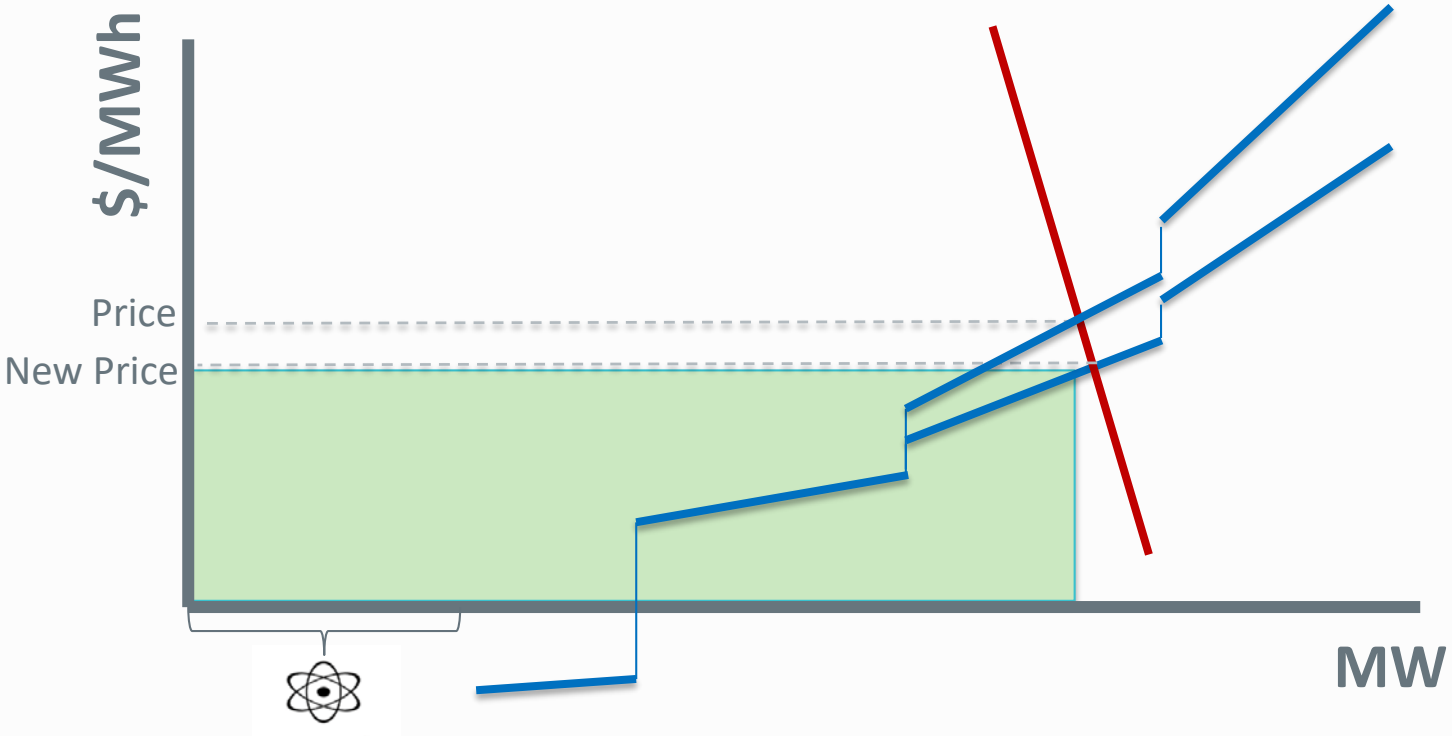
Building a Supply Curve



Finding a Price



Falling Natural Gas Prices

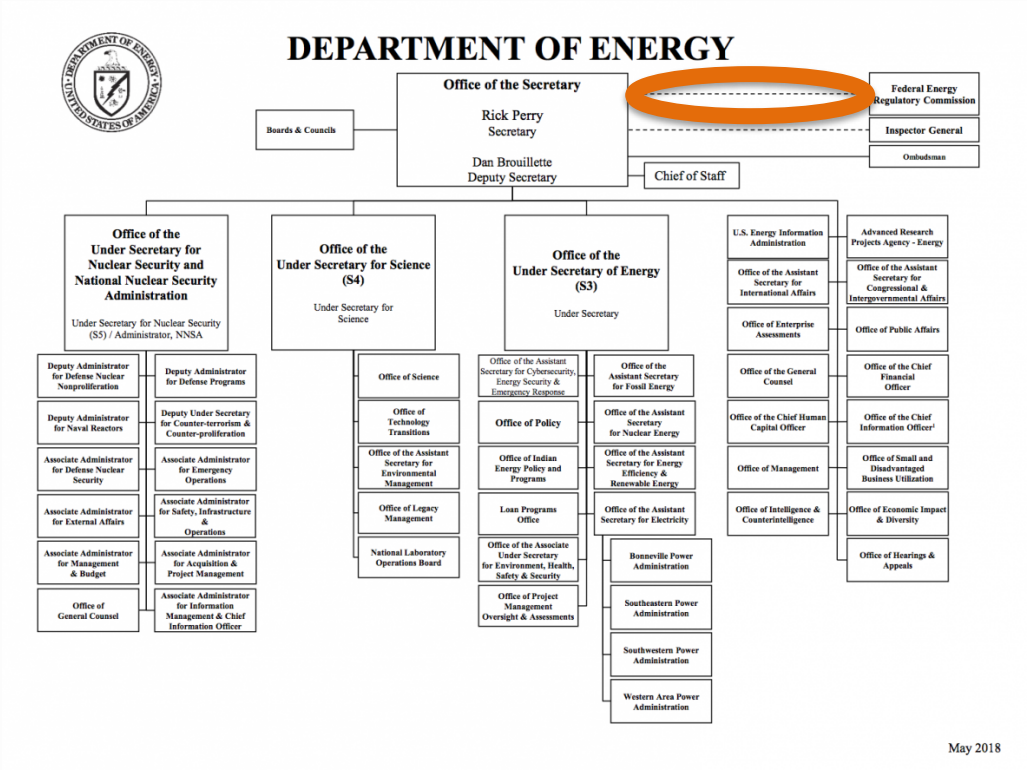


White House Direction

- President Trump directed Sec. Perry to address issue
  - “take immediate steps to stop the loss of these resources”
- DOE considering authorities
  - Emergency action to prevent closure – FPA 202(c)
  - Defense Production Act to prioritize national security procurements

Executive Branch

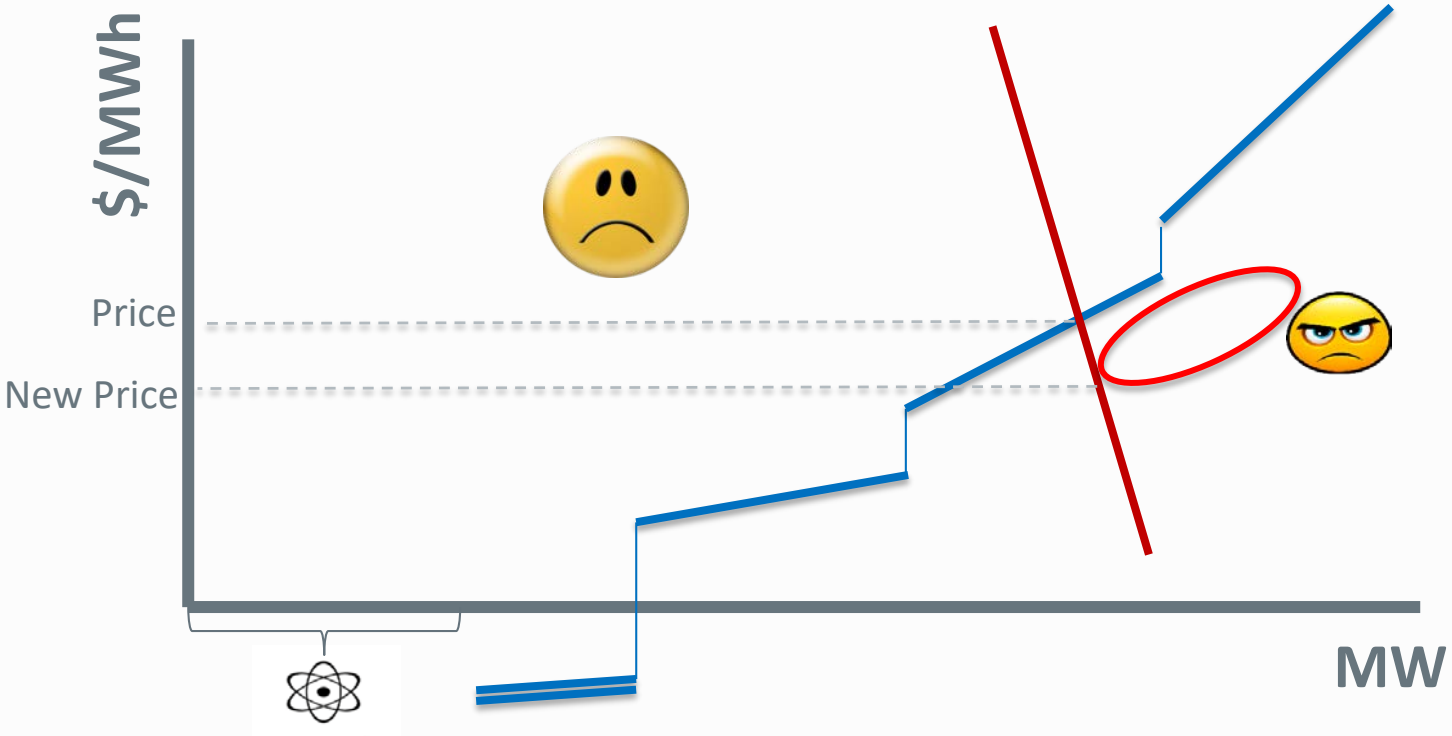
- Department of Energy Organization Act (1975)
- Federal Energy Regulatory Commission
  - Independent
  - Secretary has special standing



DOE NOPR to FERC (2017)

- Secretary Perry proposed rule to FERC
- Require rules that allow fuel-secure generation units to recover costs
  - 90 days of fuel on-site
  - Provides reliability services
- FERC declined to implement proposed rule
  - Longer-term effort on resilience

Policies to Promote Renewables



Grid Operators on Resilience

- ISO New England – We have a problem
  - Relying on natural gas, unable to ensure supply

    “the constrained gas-fuel infrastructure is unable to supply all of the region’s increasing number of fuel generators”

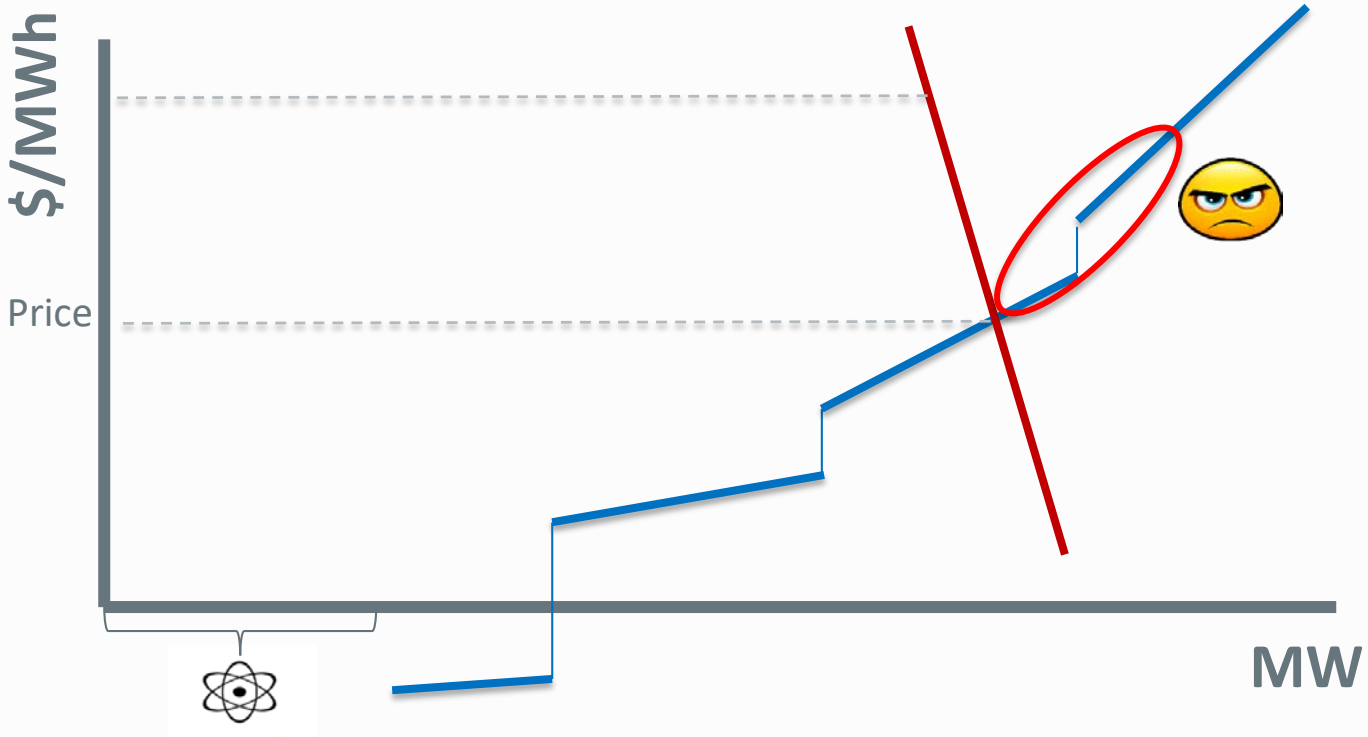
- PJM – We need to look into this
  - Natural gas coordination is difficult
  - Should reform how we set prices to better recognize resilient sources
  - Nuclear and coal closures would risk loss of load in winters

Role of States

- Federal Power Act – Regulation of electric resource adequacy left to states

- State policies to preserve nuclear plants
  - New York
  - Illinois
  - New Jersey
  - Connecticut
  - Others?

Policies to Preserve Nuclear



State Policies and Markets

- Are Zero Emission Credits legal?
  - So far, yes – Affirmed at circuit and appellate courts
  - Awaiting Supreme Court
- Can Zero Emission Credits work with market rules?
  - PJM said yes, FERC said no
  - Can plants opt out from the capacity market?
  - Still uncertain

Nuclear Plants Saved from Premature Closures

Plant	State	Capacity (MWe)	Projected Closure Year	Electricity Generated (billion kWh in 2018)	CO_2 Emissions Avoided (Million tons per in 2018)
Clinton	Illinois	1,060	2017	8.3	8.1
Fitzpatrick	New York	851	2017	6.5	3.1
Ginna	New York	582	2017	4.7	2.2
Hope Creek	New Jersey	1,172	~2020	9.5	6.6
Millstone 2 & 3	Connecticut	2,088	~2020	16.9	7.6
Nine Mile Point 1 & 2	New York	1,916	2017-2018	15.4	7.2
Quad Cities 1 & 2	Illinois	1,819	2018	15.5	10.6
Salem 1 & 2	New Jersey	2,328	~2020-2021	18.9	13.0
TOTAL		**11,816**		**95.8**	**58.3**

11,816 MWe baseload capacity

More than 7,400 direct jobs saved

More electricity generation than all U.S. utility solar in 2018

58.3 million metric tons of CO_2 avoided

Source: Emissions avoided are calculated using regional and national fossil fuel emissions rates from the **U.S. Environmental Protection Agency** and latest plant generation data from the **U.S. Energy Information Administration**. Updated: March 2019.

Policies to Price Carbon