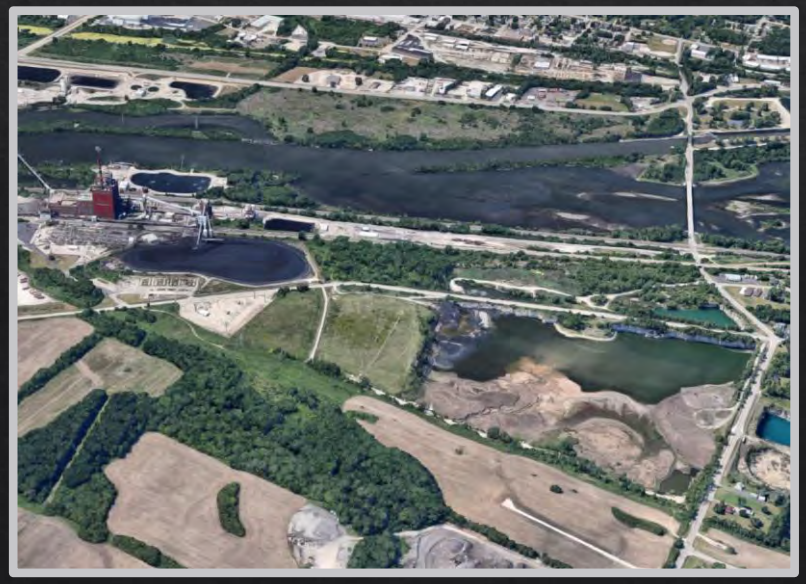
Coal Ash Remediation

Challenge for State PUCs



From Google Map

Introduction to Draft Whitepaper
Prepared for
NARUC under a grant by the Department of Energy

By Seidler Consulting

November 17, 2019

Main Takeaways

1. Coal Ash is an **environmental challenge**
2. EPA issued a **major rulemaking** on coal ash in 2015
3. The rule will require major **action by electric utilities**
4. The rule is very **complex and technical**
5. Rules are in a state of flux creating **uncertainty**
6. Coal ash has many commercial applications called **Beneficial Use**
7. Congress gave EPA **special enforcement authority** over coal ash in 2016
8. State **environmental policy** will dictate most of coal ash policy
9. PUCs will have the responsibility of determining **impact of costs**
10. North Carolina is a good case study of the **controversy of cost recovery**

1. Coal Ash

- Coal ash is what's left over after coal is burned for electric generation
- Mostly stored on generation site in ponds and landfills near waterways
- Environmental Challenges
  - Structural Integrity: Collapse Catastrophes
  - Water Quality: Leaching into Groundwater
- Beneficial Use
  - Traditional: cement, gypsum, road surfaces
  - Exotic: rare earth minerals, advanced R&D

2A. EPA Rulemaking (2015)

- Took a long time to issue rule
- RCRA: Is coal ash a hazardous waste?
- Bevill Amendment 1980
- RCRA Amended in 1991
  - Part C Hazardous
  - Part D Nonhazardous
- Catastrophes in 2010 and 2014
- Proposal in 2010; Final in 2015

2B. EPA Rulemaking (2015)

- Extensive evaluation of coal ash characteristics
  - 2009: EPA implemented Coal Ash Surface Impoundment Integrity Assessment Program
    - Multiple rounds of data requests to utilities
    - On-site inspections of the structural integrity
    - Assessed 676 surface impoundments at 240 generation stations
  - 2014: EPA published the detailed data rating units

- Efficacy of EPA's Assessment Program
  - Utilities began correcting structural instability issues
  - But EPA's "fair" assessment of pond at Duke Energy Dan River generation station raised questions as to assessments' usefulness after spill in 2014

3. Impact on Electric Utilities

- Over 1000 coal ash ponds and landfills
  - Complex Characterization
  - 307 plants disposed of coal ash on-site
  - 197 transporting to off-site landfills
- Combined total of 310 active landfills and 735 active surface impoundments
  - Average size of landfills was over 120 acres, or 90 football fields, with a depth of 40 feet; and
  - Average size of surface impoundments was 50 acres, with a depth of 20 feet
  - Most are over 25 years old; 56 units are older than 50 years
- Key Question: Closure and Timing
  - Cover in place
  - Excavate and haul
  - Storage
- Credit Rating

4A. Rule is Technical and Complex

- Rule established nationally applicable minimum criteria
  - safe disposal in new or extended units
  - designed to address risks posed by
    - groundwater contamination,
    - structural failures; and
    - fugitive dust emissions
- Technical Standards
  - Location Restrictions
  - Design Standards – Liners and Structural Integrity
  - Operating Standards
    - Fugitive Dust Control
    - Run-on/Run-off for Landfills
    - Hydrologic and Hydraulic Capacity Requirements

4B. Rule is Technical and Complex

- Monitoring, Inspections & Public Information
  - Groundwater Monitoring Program and Corrective Action
  - Inspections for Surface Impoundments and Landfills
  - Record Keeping and Internet Posting
- Closure and Post-Closure Care
- Beneficial Use

5A. State of Play is Uncertain

- DC Circuit: remanded rules back to EPA twice
- EPA: two new proposals pending
  - Universe of Units Covered
  - Timing of Requirements
- EPA: new enforcement power in WIIN Act
- State legislatures may get involved: 4 states have passed new laws
- North Carolina and Virginia more controversial than expected

5B. State of Play is Uncertain

- Utilities: evaluating options in uncertainty
  - Traditional option (close-in-place) increased resistance
  - But environmentally preferred option (excavate-and-haul): expensive and requires transport
- Environmental groups: evaluating groundwater data and reaching dramatic conclusions
- Magnitude of problem is unknowable: closures must be monitored for 30 years and action taken if ponds are leaching into groundwater
- Potential for future Beneficial Use is blunted by uncertainty of supply of coal ash

6A. Beneficial Use

- Coal Ash Commercial Applications
  - Called Beneficial Use or Coal Combustion Products
  - Exempt from final rule Beneficial Use is encouraged

- Coal Combustion Beneficial Use Markets
  - Increased dramatically over in last 25 years
    - For 2017, 71.8 million tons were recycled out of 111.3 million tons produced, a record 64% being recycled
    - Increase from 56% in coal ash utilization in 2016 while coal ash production only increased 4%
    - American Coal Ash Association reported that “concrete producers would have used more fly ash if they could get it; numerous key markets can be characterized as ‘under-supplied.’”

6B. Future Commercial CCP Use

- DOE: Request for Information in March 2019
  - New advancements in fossil fuel byproduct utilization, and
  - Pathways to produce value-added products from coal ash
- National Energy Technology Lab (NETL)
  - Maximize the value of coal as a feedstock and develop new high-value products derived from coal, initiated the Coal Beneficiation Program.
- Possible future uses from Advanced Research into the chemical and physical makeup of fly ash

6C. Future Commercial CCP Use

- DOD: Potential rare earth elements (REE)
  - Trade tensions between the U.S. and China
    - In 2018, China had 70% of global REE market
  - Vulnerability of U.S. defense industries and major economic sectors
    - cell phones, computers, engines
    - clean energy technologies
- Need domestic supply, including domestic processing and refinery facilities

7A. Enforcement of Coal Ash Rule

- EPA traditionally had no authority to enforce Part D guidelines under RCRA
- State Enforcement
  - Incorporated into the state's waste management regulations
  - Conditions under a state permit
- Individuals can bring a suit against a person operating a waste site in non-compliance of EPA's standards

7B. Enforcement of Coal Ash Rule

- Water Infrastructure Improvements for the Nation Act in 2016
- EPA Enforcement Actions only for coal ash
- EPA Permit Program if state action is inadequate
- State can establish exempt permit program
  - EPA must approve if as protective as EPA's rule
  - State coal ash permit, once approved, operates in lieu of EPA"s regulations
  - Pending EPA's approval EPA 's national minimum criteria governs

8A. The State Environmental Arena

- States have responsibility for approving plans
- States generally have well established agencies and procedures for the issuance of permits
- States can apply for exemptions under WIIN Act if state program is as protective as the EPA rule
- EPA issued guidance in August 2017 on state exemptions under WIIN Act
  - Oklahoma granted an exemption, but challenged
  - Georgia's proposal is pending

8B. The State Environmental Arena

- State Legislatures Enter the Arena
  - North Carolina in 2014 and 2016
  - Michigan in 2018
  - Virginia in 2019
  - Illinois in 2019
- Environmentalists engaging on water
- Very Political in VA, NC, TVA
- Possible Safety issues for cleanup workers

9A. State PUCs' Role

- State PUCs have the responsibility
  - Electric Utilities vs IPPs
  - Number of Units will matter
  - how much remediation costs can be recovered
  - which customers must pay for the costs
- Distinguish between costs for today's service and cost for past service
- Costs for units still in use less controversial
- Costs for inactive units more controversial
- Potential Conflict in Values

9B. State PUCs' Role

- Contrast with Nuclear Waste Fund and Offshore Wind
- Rubber Stamp Environmental Costs?
- Comparable Challenges
  - Environmental control technologies
  - Nuclear and Coal plant cancellations
- Early Warning Signs are that these are likely to be controversial

10A. North Carolina Case Study

- Duke Energy: Dan River Catastrophe 2014
  - State Legislation in 2014 and 2016
  - Legislature Prohibited Cost Recovery from Dan River Spill
  - Legislation required accelerated closure of all coal ash units
- Close in Place option met with hostility
  - DEQ requires Excavate and Haul
  - Duke estimates $5 billion in future costs
- Duke Rate Case 2018
  - First Major Rate Case over coal ash costs
  - NCUC Decision: Allowed $700 million with $100 million penalty
  - NC Supreme Court Pending: Attorney General sued
- Duke Filed New Rate Case in September 2019
- South Carolina disallowed Duke recovery on units outside of South Carolina

10B. Ratemaking Principles

- Just and Reasonable and Prudency
  - Utility's Historic Treatment of coal ash units
  - Current costs for compliance: battle of closure plans
- Most Recovery is for services to past customers
  - Used and Useful
  - Cost Causation
- Future Test Year: Known and Measurable vs Speculative
- Deferral Accounts
- Operating Costs vs Capital Expenses
  - Recovery of Costs vs Rate of Return on costs

Conclusions

- Significant new cost for electric utilities
  - Differential Impact on States: few or no units or IPPs
  - Long time frame
  - Rules and implementation are still uncertain
- Remediation expensive and controversial
  - Virginia and North Carolina
  - Environmentalists Focusing on Water Quality
- Coal Ash costs compete with other utility priorities

Conclusions

- Role of PUCs is both heightened and uncertain
  - Federal Rules in flux
  - State Permitting Agency
  - Legislature
  - Courts
- Fast Moving Target
  - Two EPA proposals pending
  - Supreme Court Case on Clean Water Act pending
  - NC Supreme Court Case on cost recovery pending
  - Environmentalists Engaging
  - Possible State Legislation

Questions

- Draft of Report completed early October
- Comments received by end of October
- Final Draft by December 1
- Webinars in January after Final Report

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RECENT CHANGES TO U.S. COAL PLANT OPERATIONS AND CURRENT COMPENSATION PRACTICES

NARUC Annual Meeting 2019

Subcommittee on Clean Coal

San Antonio, TX
November 17, 2019

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ABOUT ENERGY VENTURES ANALYSIS

Energy Ventures Analysis is an energy consulting firm located in Arlington, Virginia. Since 1981, EVA has been publishing supply, demand, and price forecasts as part of its FUELCAST subscription service for the electric power, coal, natural gas, petroleum, renewable, and environmental sectors.

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OUTLINE

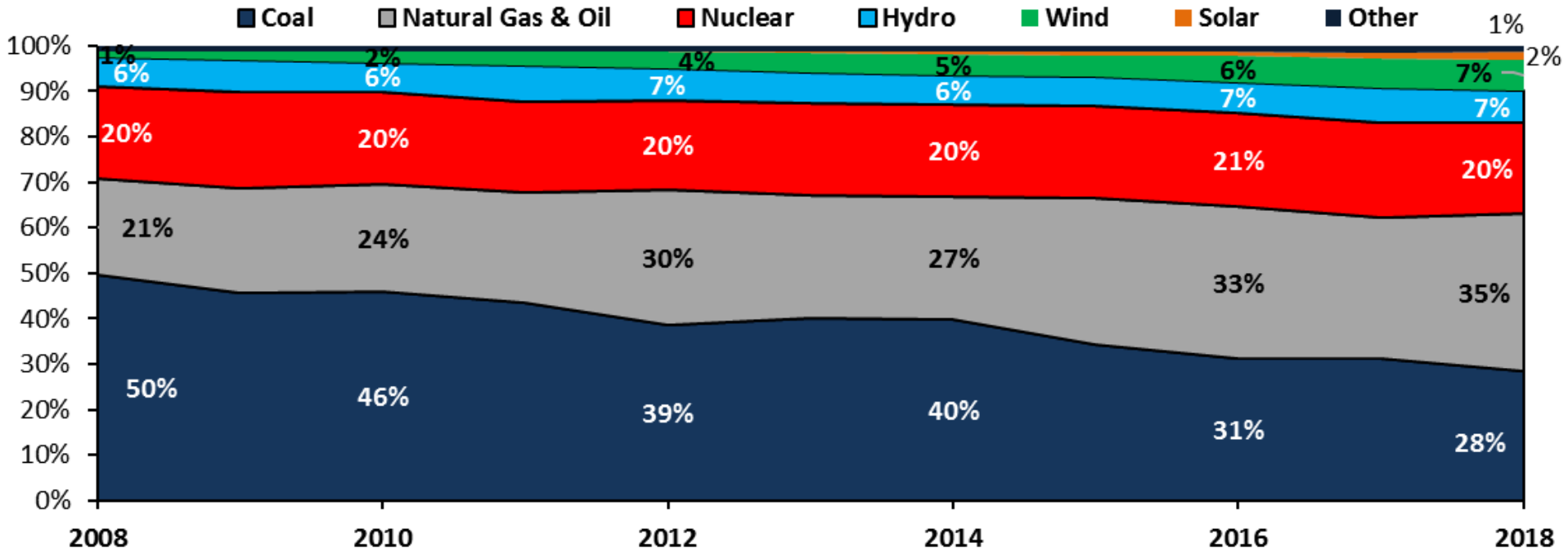
1. **Study Purpose**
2. **Study Results**
   a. Overview of the Changes in the U.S. Electric Power System over the Last Decade
   b. Operational Changes at Coal Plants between 2008 and 2018
   c. The Costs and Implications of Coal Plant Cycling
   d. Current Financial Compensation Practices for Plant Flexibility Operation
3. **Major Takeaways**

STUDY PURPOSE

- **Over the last decade, the U.S. electric power sector has gone through one of the most dramatic changes in its existence.**
- **Low natural gas prices as a result of the shale gas revolution and a substantial reduction in construction and operating costs for renewable resources supported by federal and state subsidies has resulted in a significant shift away from coal-fired generation and instead towards natural gas and renewable generation.**
- **With funding support from the DOE Office of Fossil Energy, NARUC hired EVA to develop a white paper on coal flexibility and reliability for state utility regulators.**
- **The paper focuses on operational changes experienced by U.S. coal-fired power plants as a result of high renewable penetration.**
- **The report also explores how fossil fuel plant flexibility is currently procured and compensated and presents options for states to consider to maintain flexible, reliable, and affordable electricity.**

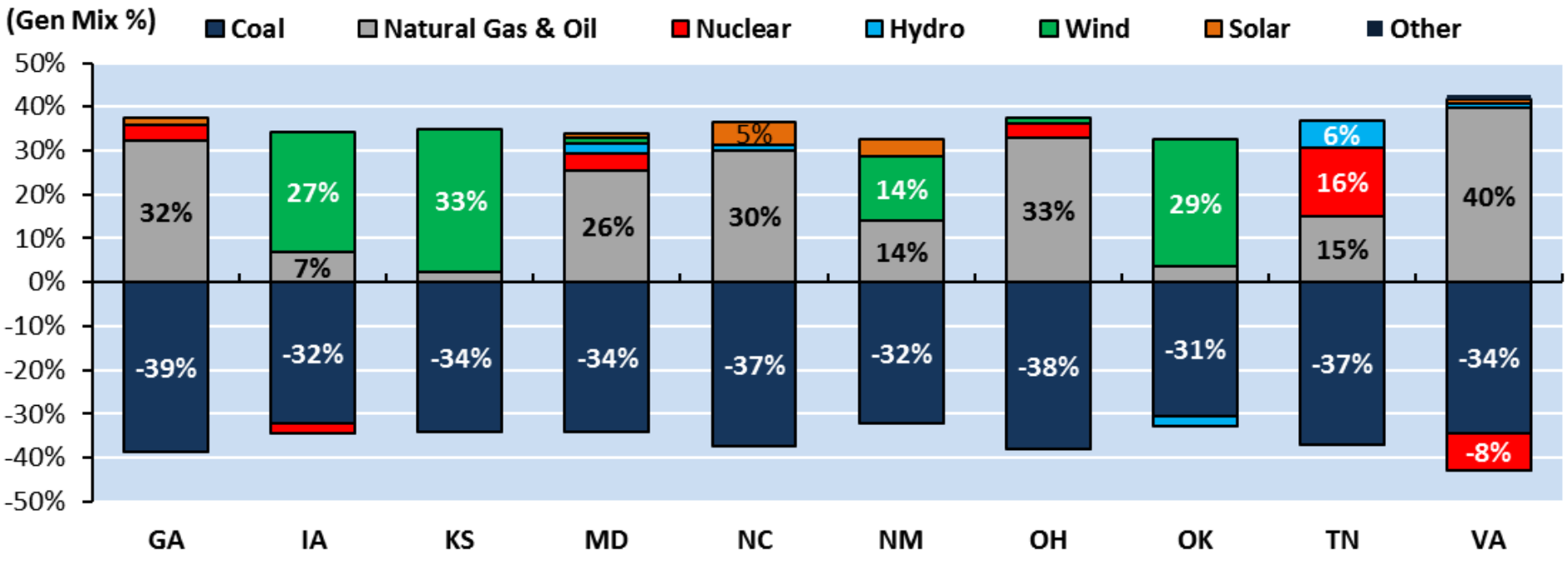
COAL GENERATION IS LOSING SHARE TO NATURAL GAS AND RENEWABLES

- **Coal generation dropped from 50% generation share in 2008 to just 28% in 2018**
- **Cheap natural gas prices made natural gas generation more competitive, increasing its share of baseload generation**
  - Utilization rates for coal plants dropped from 72% in 2008 to 54% in 2018
- **Public policy requirements, federal and state tax incentives, and drop in construction costs helped renewables gain significant market share over the last decade**



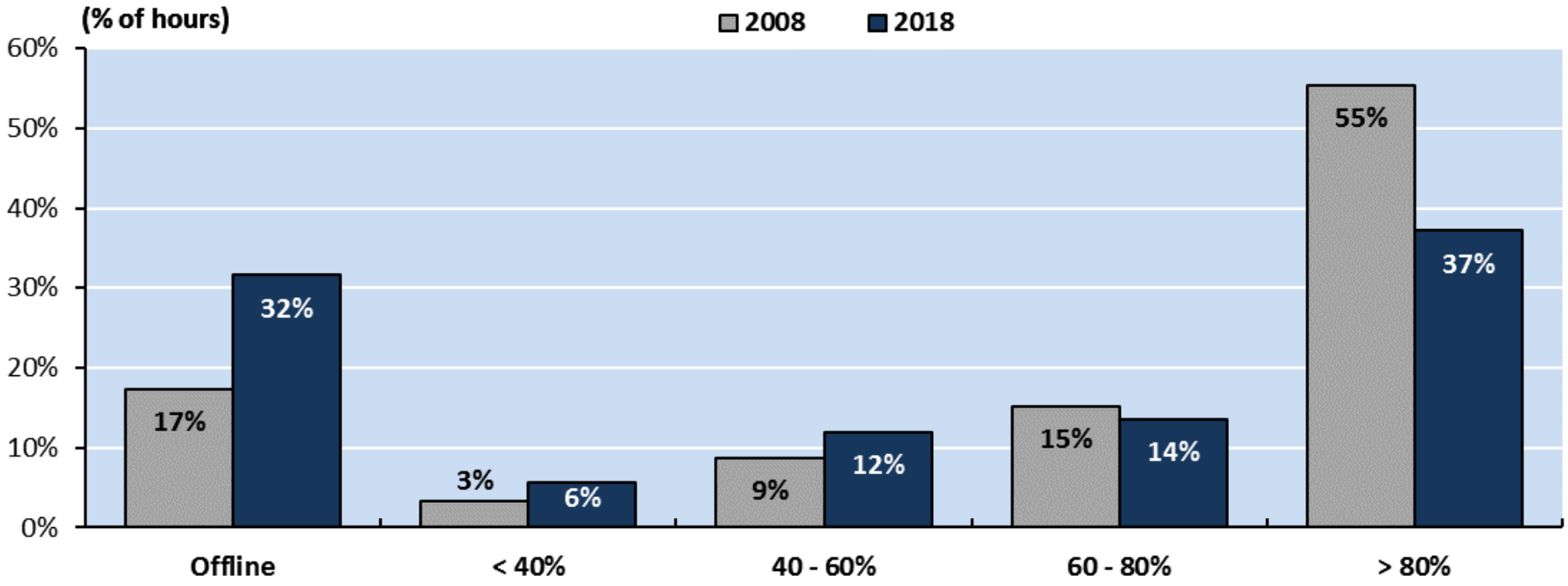
REPLACEMENT FUEL FOR COAL DEPENDS ON AVAILABLE RESOURCES

- **While coal generation has been falling in all states across the country, its replacement largely depends on the locally available resources and state policies**
- **States with access to cheap natural gas (e.g., Ohio) mainly replaced the decline in coal with new natural gas plants**
- **States with high wind resources (e.g., Kansas, Oklahoma, Texas and Iowa) primarily replaced coal with new wind farms**



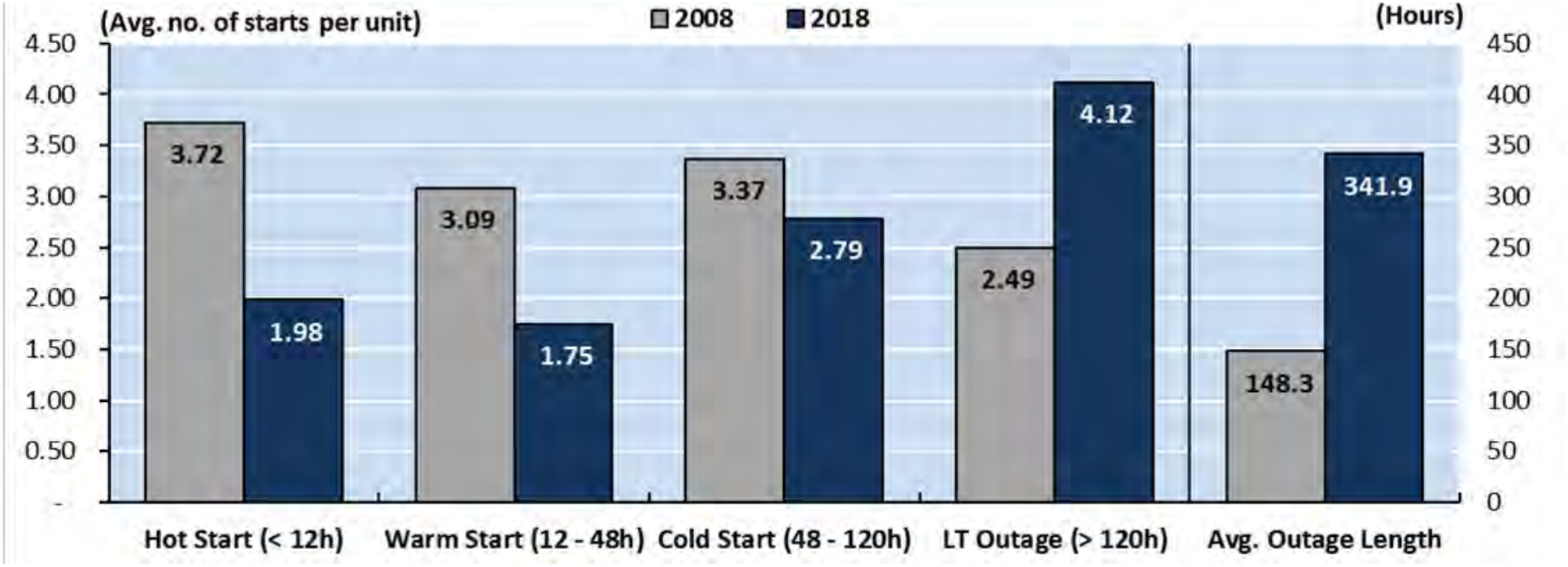
COAL PLANTS RUN LESS AND AT LOWER CAPACITY FACTORS

- With increased renewable generation and competition from natural gas-fired power plants, coal plants are operating at lower utilization rates, when they are operating at all
- In 2008, U.S. coal plants operated above an 80% capacity factor 55% of the time, while being offline only 17% of the time
- In 2018, coal plants were almost as often offline (32%) as they are operating at optimal capacity levels (>80% only 37% of the time)



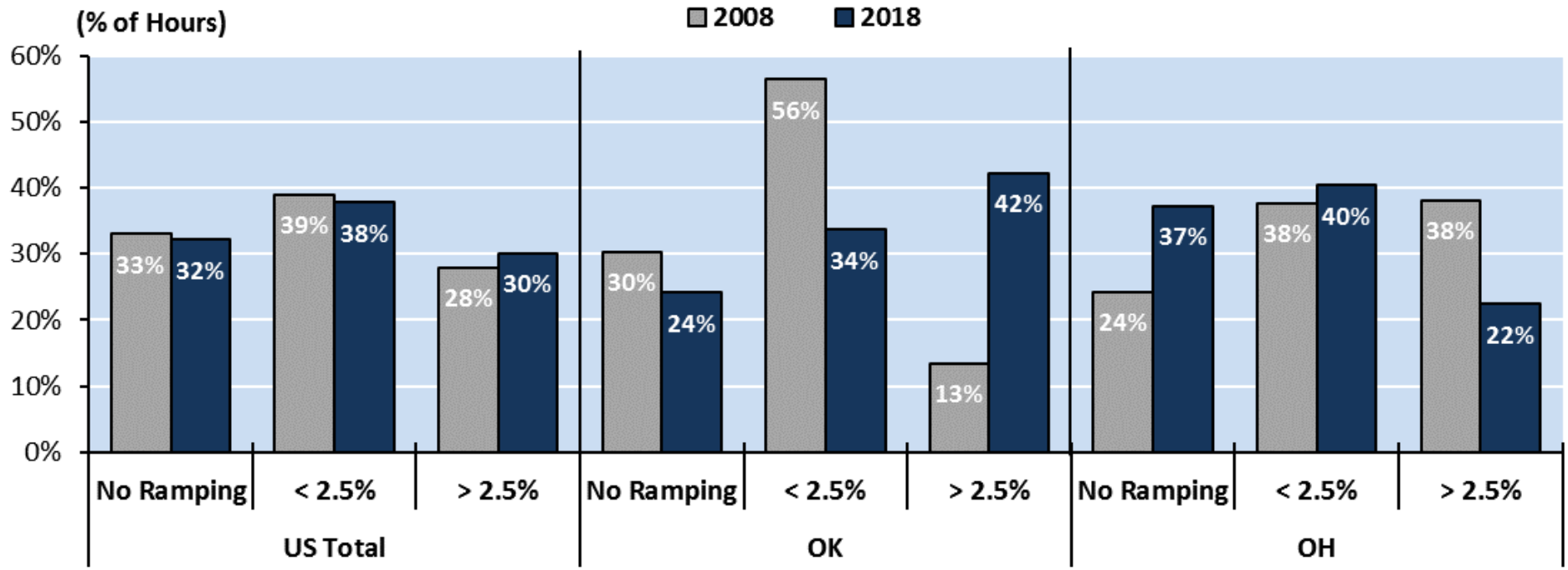
COAL PLANTS ARE OFFLINE FOR MUCH LONGER TIMES

- **Although the average number of starts has declined slightly from 2008 to 2018 (12.6 average number of starts in 2008 vs. 10.6 in 2018), the time between starts has increased significantly**
- **In 2008, the average outage length was roughly 6 days, while the average outage length in 2018 more than doubled to approx. 14 days**
- **Also, coal plants experience more starts at lower ambient boiler temperatures (i.e., cold starts), putting increased stress on plant equipment**



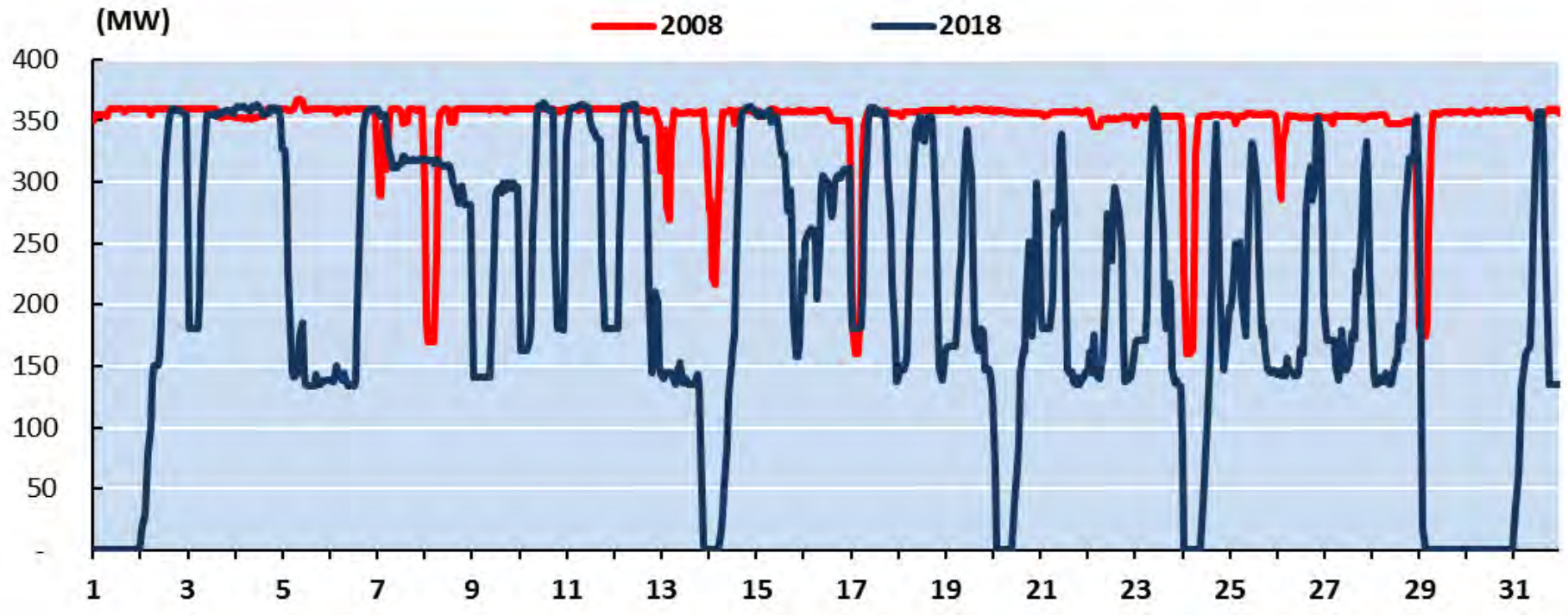
COAL PLANTS RAMP MORE OFTEN TO OFFSET LOSS IN RENEWABLE GENERATION

- **While ramp rates for the entire U.S. coal fleet are similar between 2008 and 2018, there are stark regional differences, most likely depending on the fuel that displaced coal generation**
- **In states where coal generation was mainly displaced by new more-efficient gas plants (e.g., Ohio), coal plants tend to experience fewer stark swings in load in 2018 compared to 2008**
- **However, in states with high wind penetration (e.g., Oklahoma), coal plants are ramping up and down much more frequently and at higher rates in 2018 than in 2008 to offset the variability in renewable generation**



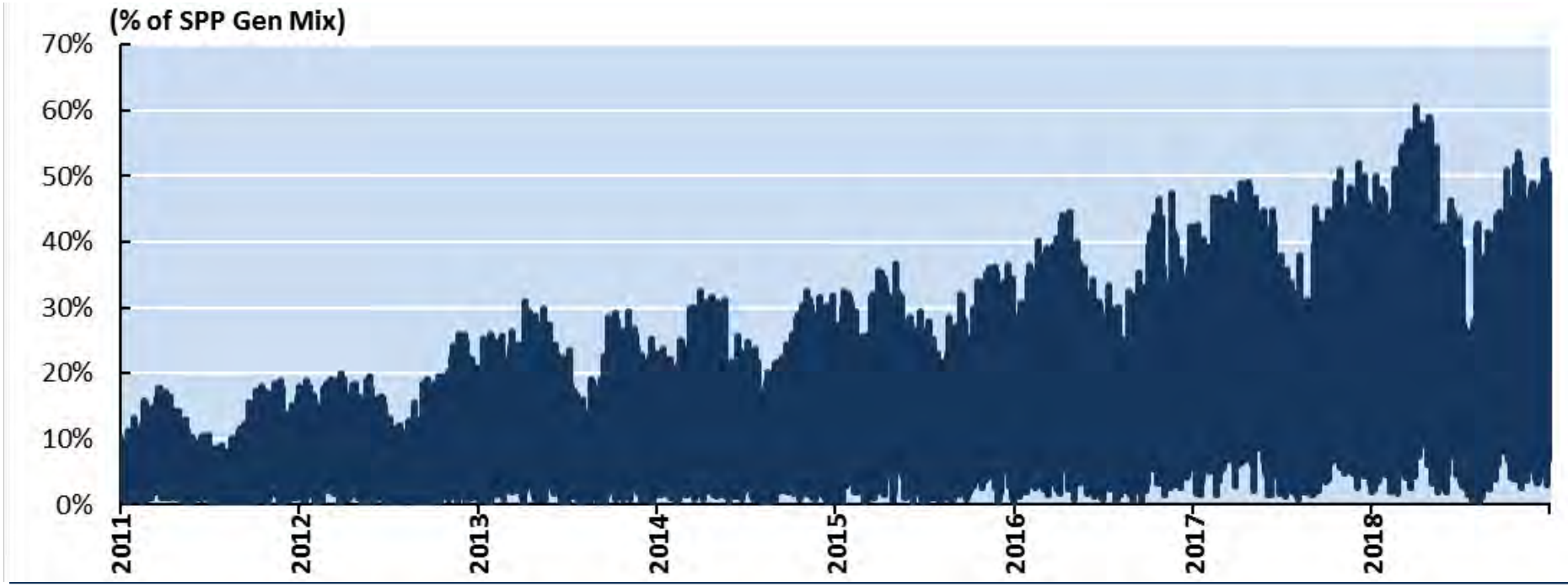
EXAMPLE OF CHANGING COAL PLANT OPERATIONS

- **The example below is Xcel Energy's Harrington 1 coal unit in Texas, which dispatches in SPP, and its hourly generation profile for the month of December in 2008 and 2018**
- **While it operated at or near maximum output for most of December 2008, its generation output in December 2018 was much more variable, with five starts and significant ramping between the minimum and maximum load**
  - Capacity factor in Dec 2008 - 94.7%; no. of starts – 0; avg. ramp rate – 1.1%
  - Capacity factor in Dec 2018 - 57.1%; no. of starts – 5; avg. ramp rate – 4.9%



COAL PLANTS ARE ESSENTIAL IN BALANCING THE GRID

- **As wind generation continues to increase in the Central U.S., so does the sudden loss of said generation**
  - For example, ERCOT real-time power prices reached its maximum of $9,000 per MWh during a heatwave in August 2019 when wind generation dropped over 80% in 12 hours
- **In SPP, wind generation accounted for over 60% of total generation at times in 2018, while also falling to 0% at other times**
- **Coal plants are more often used by grid operators to balance the sudden loss of wind generation to maintain grid reliability**



COSTS AND IMPLICATIONS OF COAL PLANT CYCLING

- **These operational changes and other factors associated with more flexible operation can have the following effects on coal-fired EGUs:**
  - Increased wear-and-tear on high-temperature and high-pressure plant components and associated costs
  - Increased wear-and-tear on balance-of-plant components and related costs
  - Shorter periods between maintenance time and more prolonged outages
  - Decreased thermal efficiency at high turndown levels
  - Increased fuel costs due to more frequent and inefficient unit starts
  - Difficulties in maintaining optimal steam chemistry leading to accelerated corrosion
  - Potential for catalyst fouling on NO_x control equipment
  - Long-term loss of critical equipment life

	Cost estimates ($/MW)		
	Expected	Low	High
Hot Start (1–23 h offline)	$ 225	$ 178	$ 291
Warm Start (24 - 120 h offline)	$ 277	$ 217	$ 351
Cold Start (> 120 h offline)	$ 417	$ 325	$ 465
Load follow down to 36% of Capacity	$ 32	$ 19	$ 50

CURRENT FINANCIAL COMPENSATIONS AND FUTURE POSSIBILITIES

- **Independent system operators start to notice that coal-fired power plants are integral to maintaining a balanced power grid and that recent market changes are forcing more plants into early retirement due to poor economics**
- **The two ISOs with the highest share of wind generation (ERCOT and SPP) do not compensate power plants for the capacity they provide (i.e., energy-only markets)**
- **The only revenue sources for coal plants in these markets are energy revenues from producing electricity and minimal revenues from providing emergency grid stability through voltage control and spinning reserves**
- **However, four major ISOs are in the process of revising current market structures to adequately compensate coal plants for their services:**
  - PJM: Price setting adjustments to minimize losses for baseload coal plants overnight
  - MISO: Multiday operating margin forecast allows plant operators to make scheduling decisions based on load requirements up to 7 days out
  - SPP & ERCOT: Develop compensation mechanisms or products to pay for capacity to cover uncertainties, such as the loss of any significant amount of generation during high demand times

MAJOR TAKEAWAYS AND THINGS TO CONSIDER

The Issue:

1. Coal plants have been losing significant market share to natural gas and renewables over the last decade
2. These generation mix changes have resulted in major operational changes for coal-fired power plants, such as lower utilization rates, more frequent cold starts, and higher load variations, especially in areas with high renewable penetration
3. Coal plants were not designed to be utilized as load-following or even peaking generating resources and, therefore, are incurring higher operating and maintenance costs

Possible Steps Going Forward:

1. Accurately assessing the actual cycling cost for each coal unit is essential to operate the system at its lowest cost
2. Investing in existing coal plants to increase their flexibility and minimizing O&M costs is often more economical than investing in new fossil generation
3. Creating new market mechanisms or products that appropriately compensate coal plants for the reliability and flexibility they provide during high demand and/or low renewable output periods

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OVERVIEW OF EDUCATION INITIATIVES

NARUC – San Antonio
November 17, 2019

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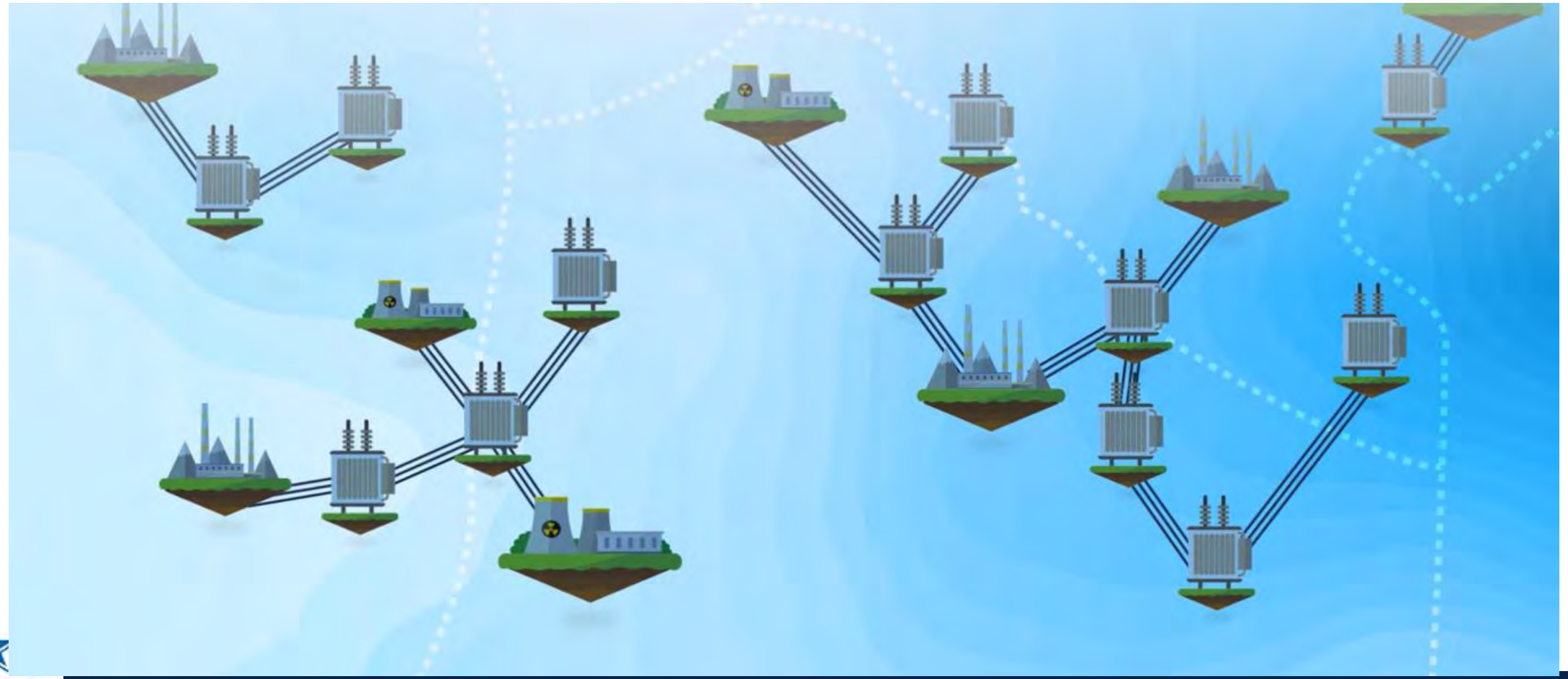
New Educational Series on Electricity Fundamentals:

How We Use Electricity

New Educational Series on Electricity Fundamentals:

The Electric Grid



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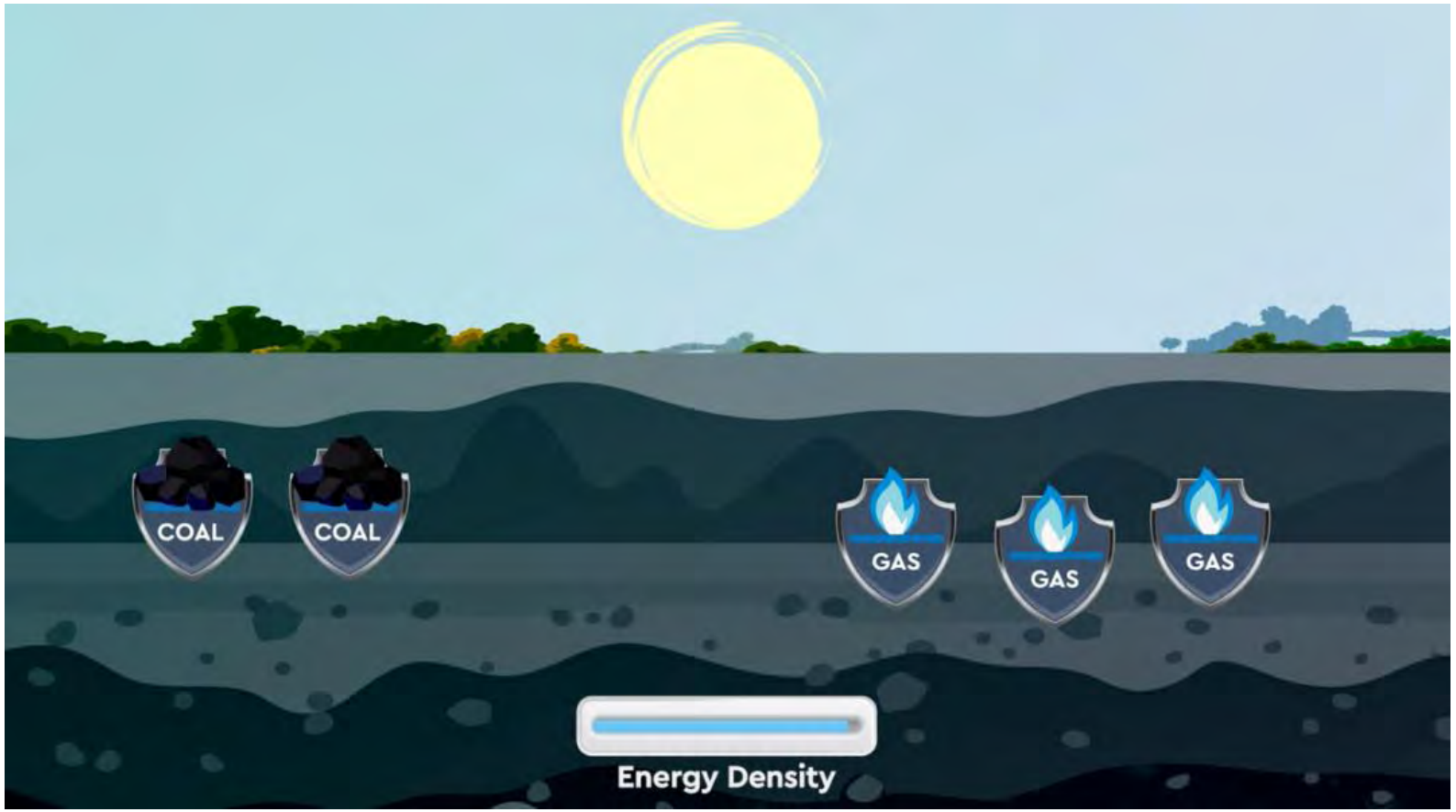
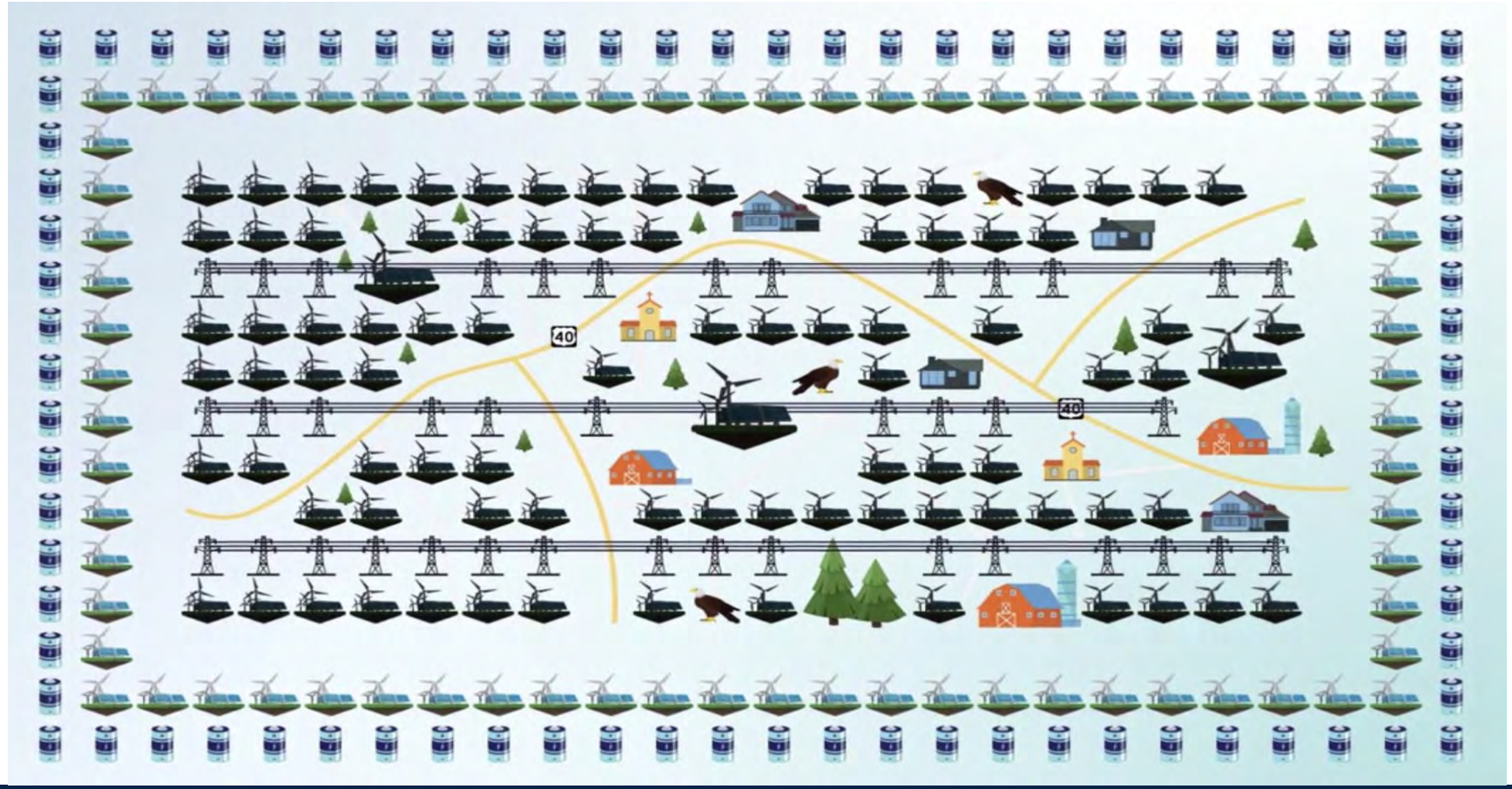
New Educational Series on Electricity Fundamentals

- Electric Grid Fuels:



New Educational Series on Electricity Fundamentals – Energy Density:



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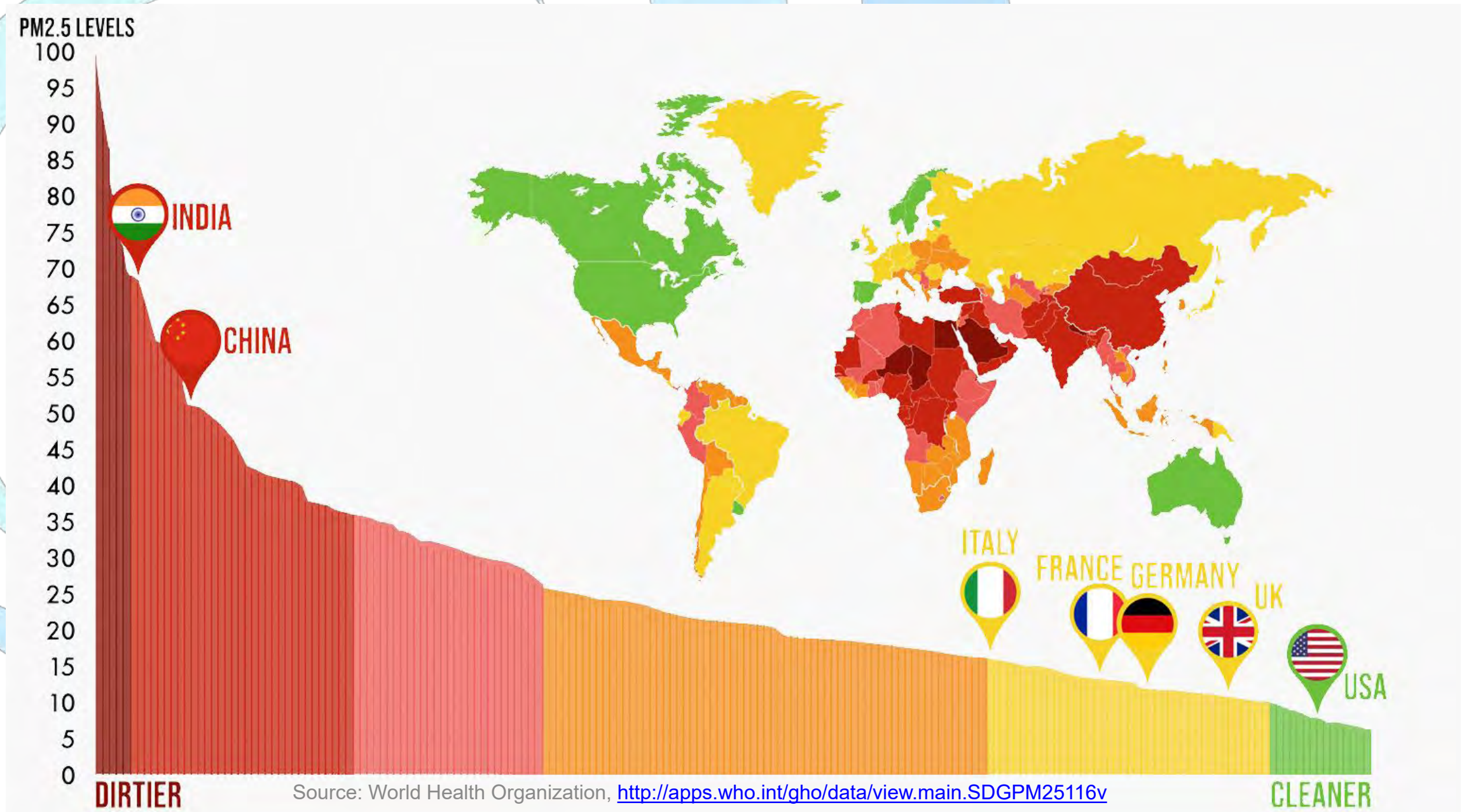

Source: World Health Organization, http://apps.who.int/gho/data/view.main.SDGPM25116v

"Energy Poverty" Video

https://www.youtube.com/watch?v=nEovKjVkUpc

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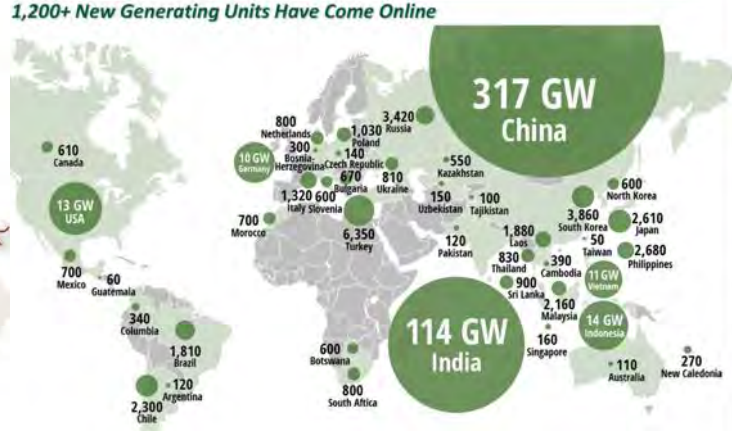

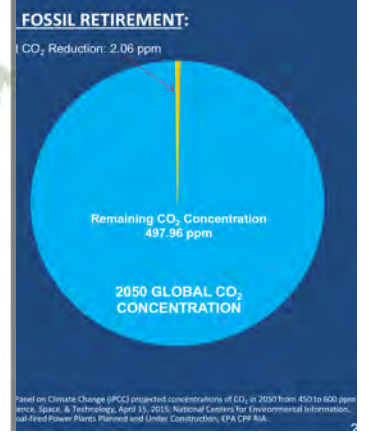

"Converting Carbon to a Commodity" Video

https://www.youtube.com/watch?v=TlXVvAoQBjc

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To reframe the national discussion about energy sources – including fossil fuels - on the importance of reliable, abundant, affordable energy to the American quality of life and the advancement of the human condition.

[“Billionaires Telling the Navajo What to Do” Video]

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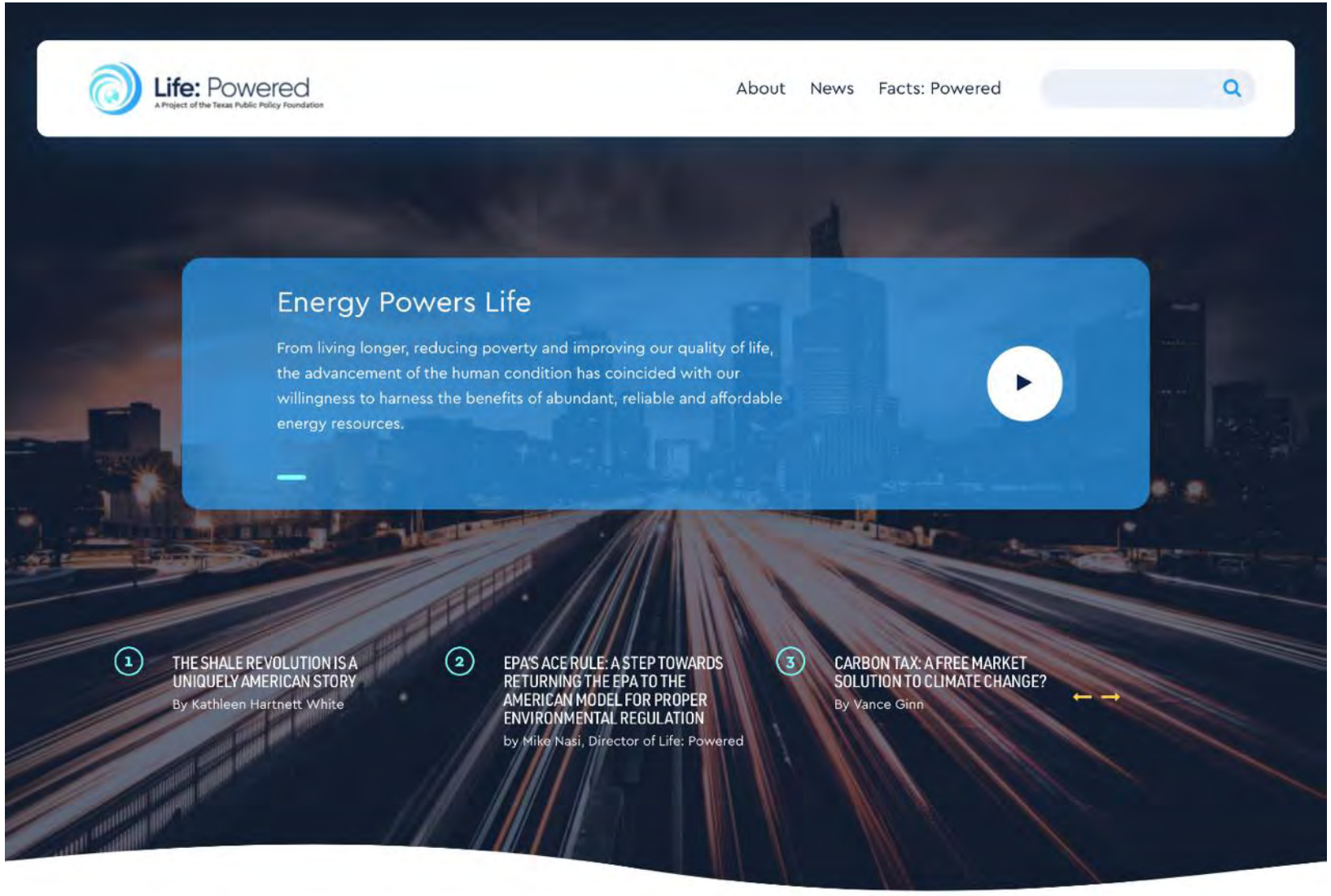

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