

The Future Of Energy

 | **OUTLOOK**[®] CONFERENCE



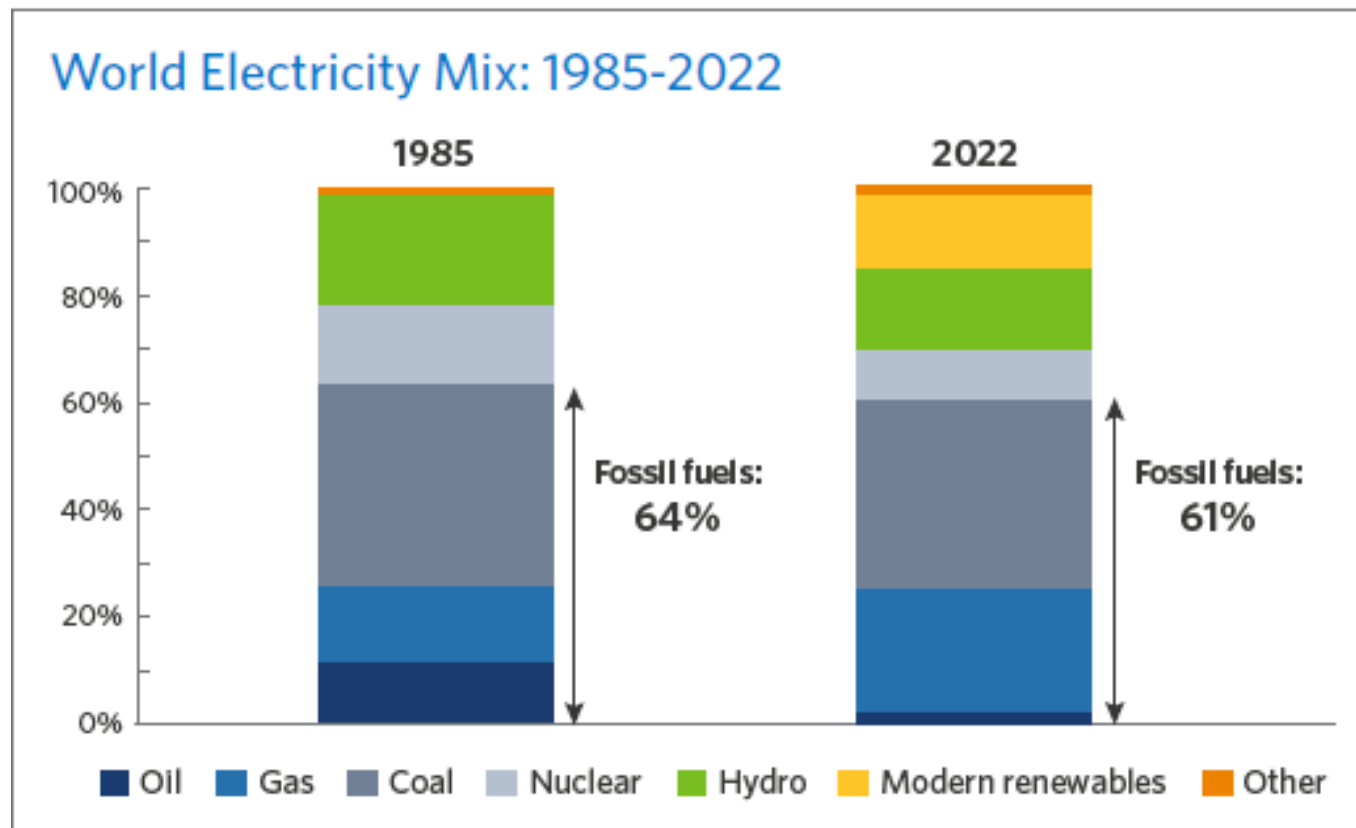
The Future of Energy

**IF MONEY ISN'T THE
ANSWER, ASK THE
QUESTION AGAIN**

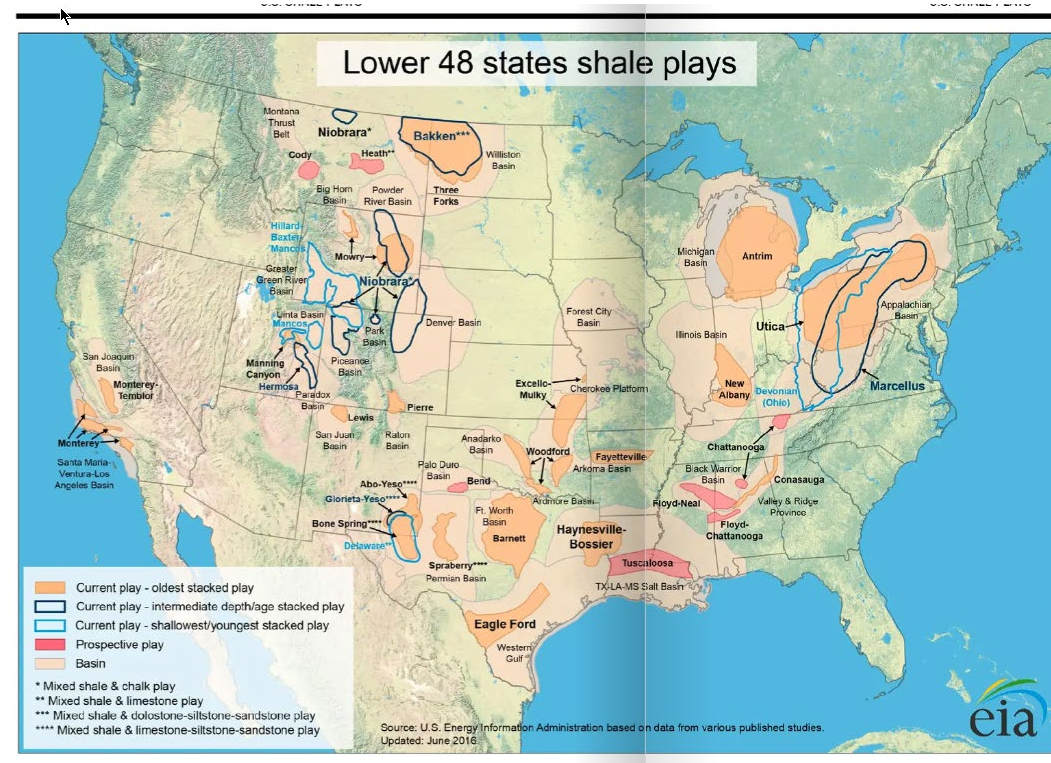
**“Political Science needs to catch up with Real
Science”**

“We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology.” Carl Sagan

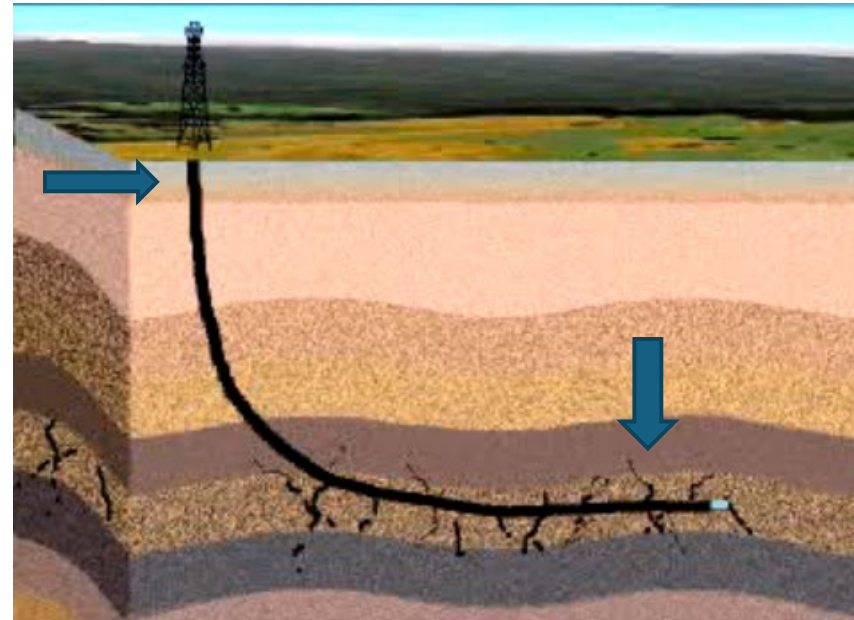
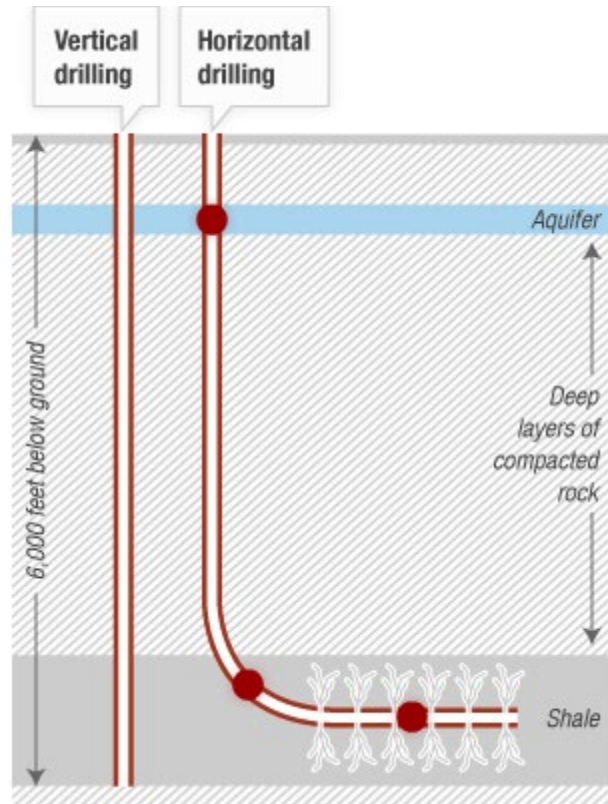
The Energy Mix Isn't Changing



Highest Oil and Nat Gas Production EVER!



Horizontal Drilling



Laterals were 1200 feet but now go to 30,000 feet

15,000 psi 6 MM gallons 2 MM lb. sand

CO₂ emissions

- **One ton of coal produces over 3 tons of CO₂**
- **20 MMBtus of natural gas produces one ton of CO₂**

GHG emissions are the drivers of change

- **Power generation 30%**
- **Buildings 30%**
- **Agriculture 20%**
- **Cars and trucks 10%**

Energy Sources Today and in the Future

- **Global carbon emissions from fossil fuel combustion and industrial processes are about 36 billion metric tons of CO₂ per year.**
- **4.5 tons per person (much greater in developed nations)**

Historically we made decisions through cost, now political favoritism in the way

- **The financial problems of wind and solar power, renewable natural gas and biofuels along with the rising cost with SMR nuclear plants will not be worked out in the natural marketplace where the best technology should prevail without political favoritism**
- **The distortion of subsidies, tax breaks, limitations of liability, mandated use and loan guarantees warp markets and add costs to consumers.**
- **The process ignores progress done naturally for centuries as technology became available and as economic conditions justified.**

Rate Increases Are Coming

- **Duke estimates that construction costs for new projects would hike average monthly energy bills for residential customers at Duke Energy Carolinas by 73% more per month by 2030.**
- **In 2023, US investor-owned utilities sought rate increases totaling \$18.13 billion.**
- **The surge in rate requests is driven by significant capital expenditure plans, including upgrades to transmission and distribution systems, renewable generation installations, and infrastructure modernization.**

Domestic Shale Natural Gas

- **Average cost to drill and complete a Marcellus well is about \$5 million**
- **Average Marcellus nat gas well produces about 5 million dekatherms (MMBtu)per day**
- **Cost to consumer is about \$3-4 per MMBtu**

Renewable Natural Gas RNG

- **Processed animal manure generally requires \$12 million to develop 400 dekatherms (MMBtu) per day**
- **Operating cost is \$9/MMBtu**
- **Consumers pay \$25/MMBtu**
- **Federal and State subsidies can exceed \$50/MMBtu**

RSG and Certified Natural Gas

- **The US oil and gas industry is the environmentally cleanest on earth**
- **Responsibly Sourced Gas has methane loss at levels below ½ of 1%**
- **Additional cost to consumers is about 10 cents per MMBtu and gets you 30-50% on the way to CO2 neutral**

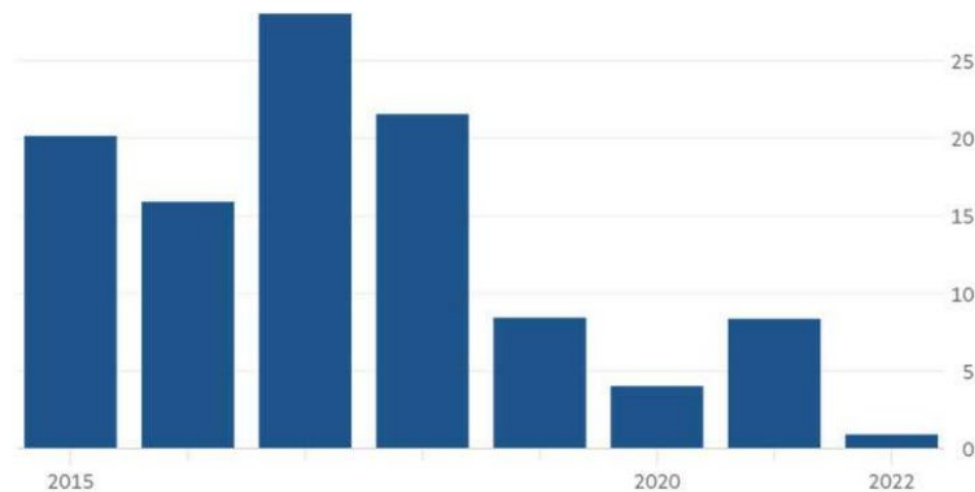
We Need Nat Gas Infrastructure

Added Interstate Capacity is Rock Bottom



US pipeline construction was at record lows in 2022

Added interstate capacity (bn cu ft/d)



Source: US Energy Information Administration

© FT

**Need trillions of dollars
in electric and nat gas
infrastructure**

Power Shortage Looms

- **The need for more nat gas pipelines is a nationwide problem. Before 2015, the US had 283 GW of coal-fired plants.**
- **62% of the coal generation in 2015 will be closed by 2035, with 70% by 2050.**
- **Most of the US and Canada are expected to face power supply challenges over the next decade.**
- **Power demand will exceed power generation capacity over the next 10 years.**
- **Too many voices without a genuine understanding of our energy systems are setting policies that will lead to reduced reliability and higher prices.**

Data Centers

- Data Centers can use 200 Mw of power
- Equivalent to 4 modern steel mills or 8 automobile assembly plants
- Which option provides the most benefits for communities?

Natural Gas Power Plants

- \$1.5 to \$2 million per MW to build
- \$30-\$40 per Mwh
- 24/7 availability

Coal Power plants

- \$2 million per MW to build
- \$50 per Mwh
- 24/7 availability

Small Modular Reactors SMR

- **SMR's there are about 70 designs, with six or seven far enough along to be working with regulators.**
- **New designs are focused on improved safety, alternative coolants that can reach higher temperatures, which can allow reactors to run more efficiently.**
- **Molten salt is one leading contender for alternative coolants.**
- **Developers are also looking to liquid metals, helium and other gases used to reach higher temperatures than water-cooled systems.**
- **Nuclear Regulatory Commission works too slowly.**
- **Estimates for building SMR range from \$5-\$10 million per MW**

Existing SMR's

- **There are only two small modular reactors (SMRs) in commercial operation**
- **In Siberia, a floating nuclear power plant with five 35 MW units and operates on a 30- to 36-month refueling cycle. The deployment process started in 1998 and was completed in 2020.**
- **In China, a capacity 250 MW. The project began in 1992, and in service 2021.**
- **According to the World Nuclear Industry Status Report 2023, both have operated at low-capacity factors, raising concerns about their effectiveness. Additionally, the construction of these reactors did not meet expectations of shortened timelines and lower costs, indicating challenges in commercializing SMRs.**

Utility Scale Battery Research

- Installed cost per Megawatt is \$2-\$6 million per Mw for 1-4 hour storage, unknown cost for longer term storage
- Much research is ongoing and necessary
- Hot Rocks

EV's

- Toyota's chairman, Akio Toyoda, dismisses the idea that electric will dominate
- **Nearly a billion people globally lack electricity.**
- Cold temperatures reduce their range by up to 12%, and charging times increase in low temperatures.
- Fast charging stations require immense infrastructure growth. **Five fast chargers require a megawatt of power, or enough to power 700 homes.**
- Flow battery technology may be a viable EV alternative. The range is touted to be up to 1,200 miles between refills. Charging and recharging nano particles in fluid with 10,000 or more recharges.

Wind Turbines

- GE, Vesta, Orsted all have problems with large wind turbines onshore and offshore
- Recycling blades is a problem
- \$2 million per megawatt onshore
- \$6 million per megawatt offshore
- Transmission lines add significantly to cost
- Less than 50% efficient

Solar

- On average, one-megawatt solar energy farm typically requires between 4 to 5 acres of land
- Inverters
- Recycling: Early stage but promising
- \$2-\$3 million per megawatt
- Transmission lines add to cost
- About 30% efficient

Green Hydrogen

- Hydrogen Fuel cells cost about \$3 million per megawatt
- Power from a Green Hydrogen fuel cell cost about \$380 per Mwh

Reality is setting in!

European example of the need to extend coal and nuclear plants will spill over to the US

With one person in five in the US already unable to pay power and gas bill, will we subsidize them at the expense of others?

Pushback from Membership COOP's

Pushback from PUC's

Pushback at elected officials

Thank You



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