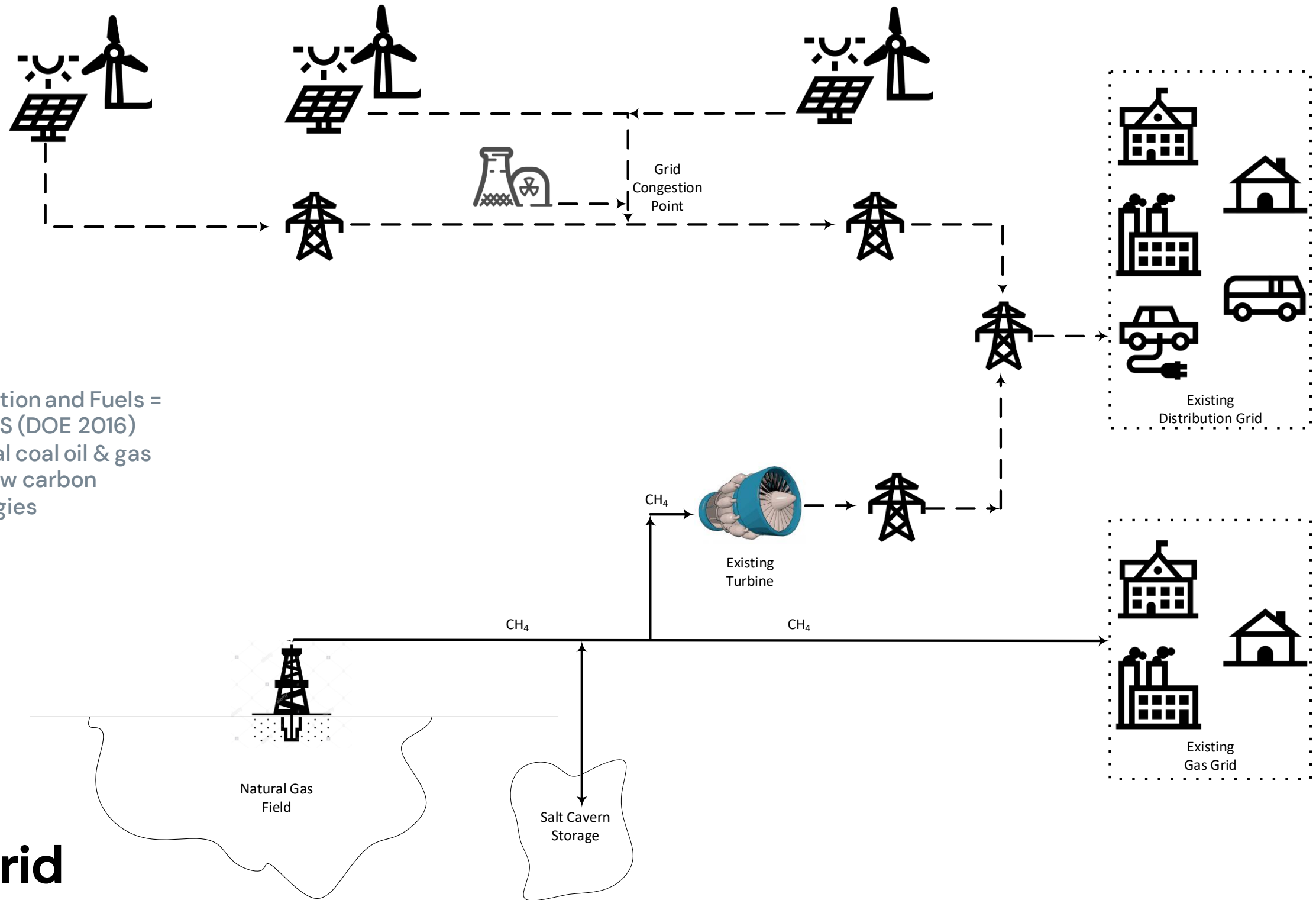




# NCSL Energy Supply Task Force 2022



Mike McCurdy, P.E.  
Managing Director – Fuels & Power  
Energy Advisory, ICF



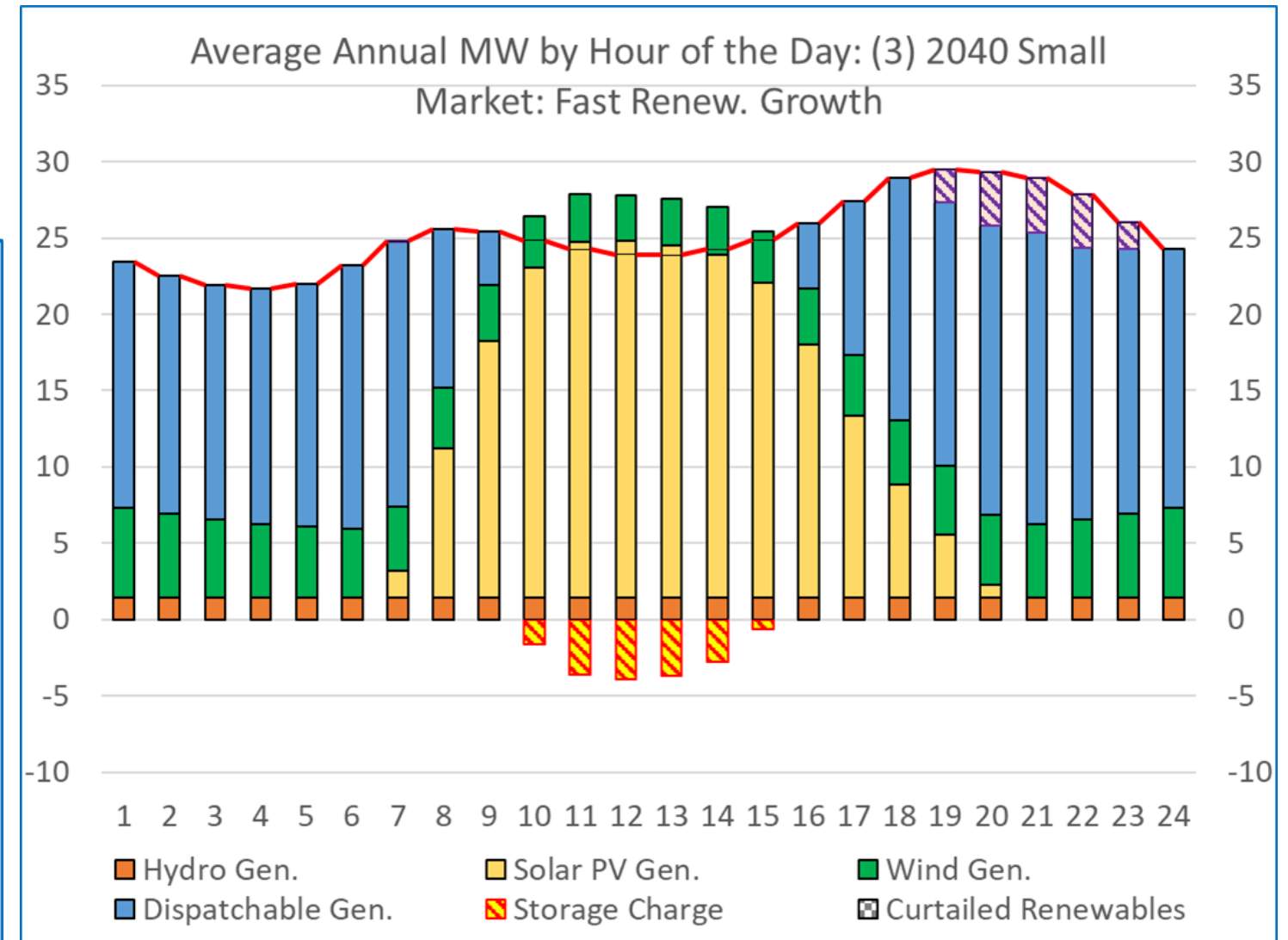
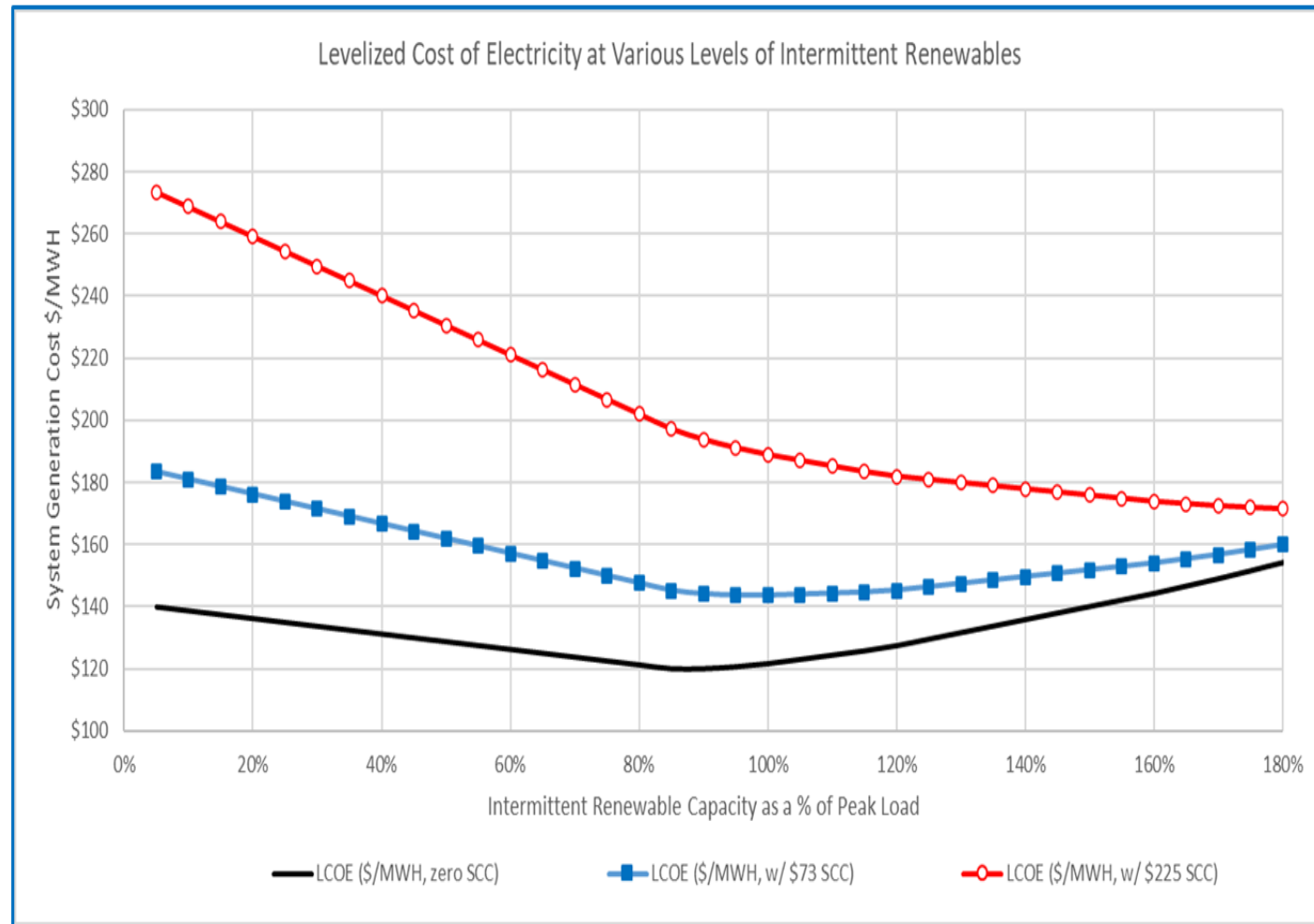
Electric Power Generation and Fuels = 1.9 million workers in US (DOE 2016)

- 1.1 million traditional coal oil & gas
- 800 thousand in low carbon emission technologies

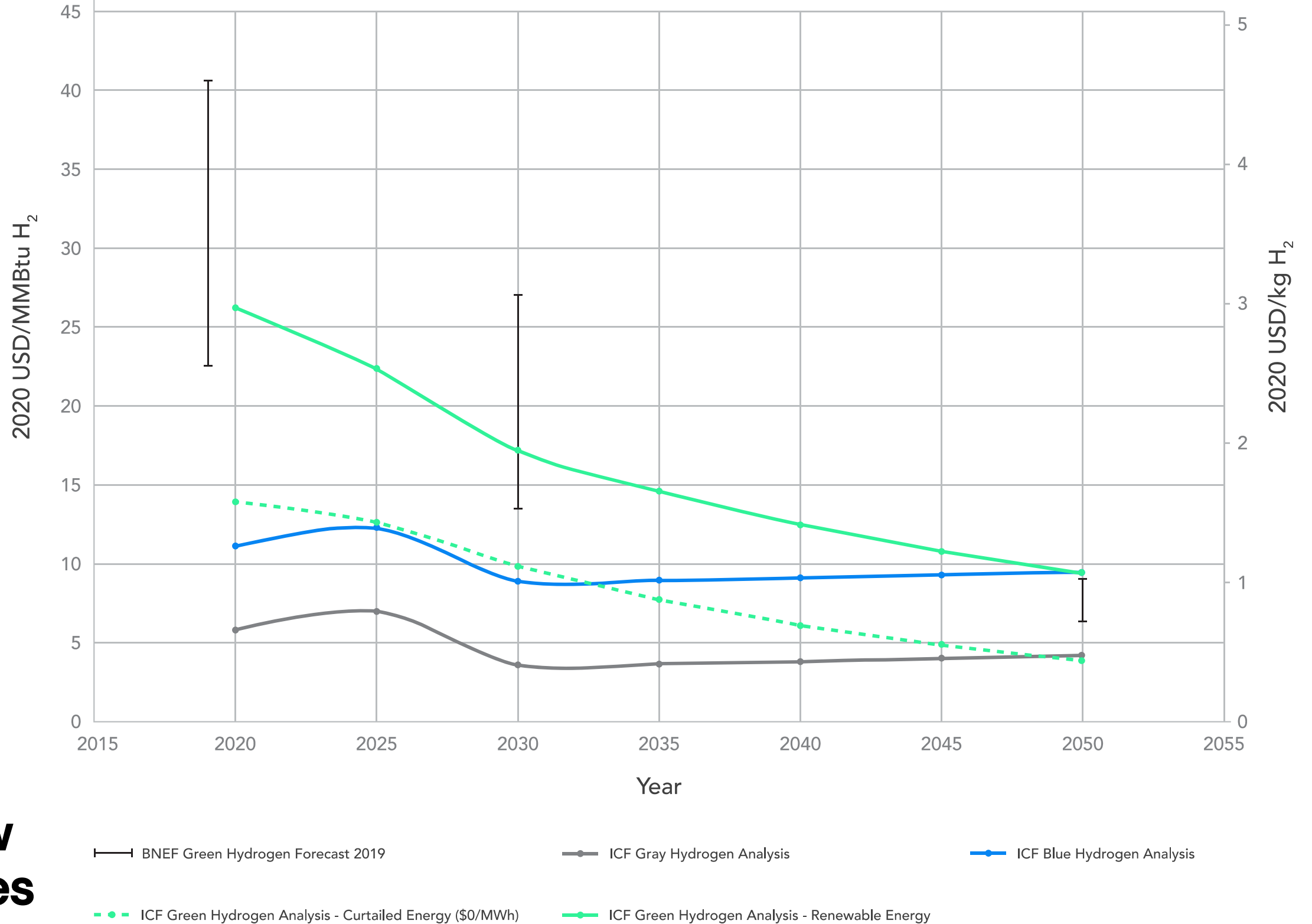
## → Existing Grid

# You Still Need Dispatchable Power, How to Do it GHG Free?

## Renewable Penetration in Isolated Island Grid



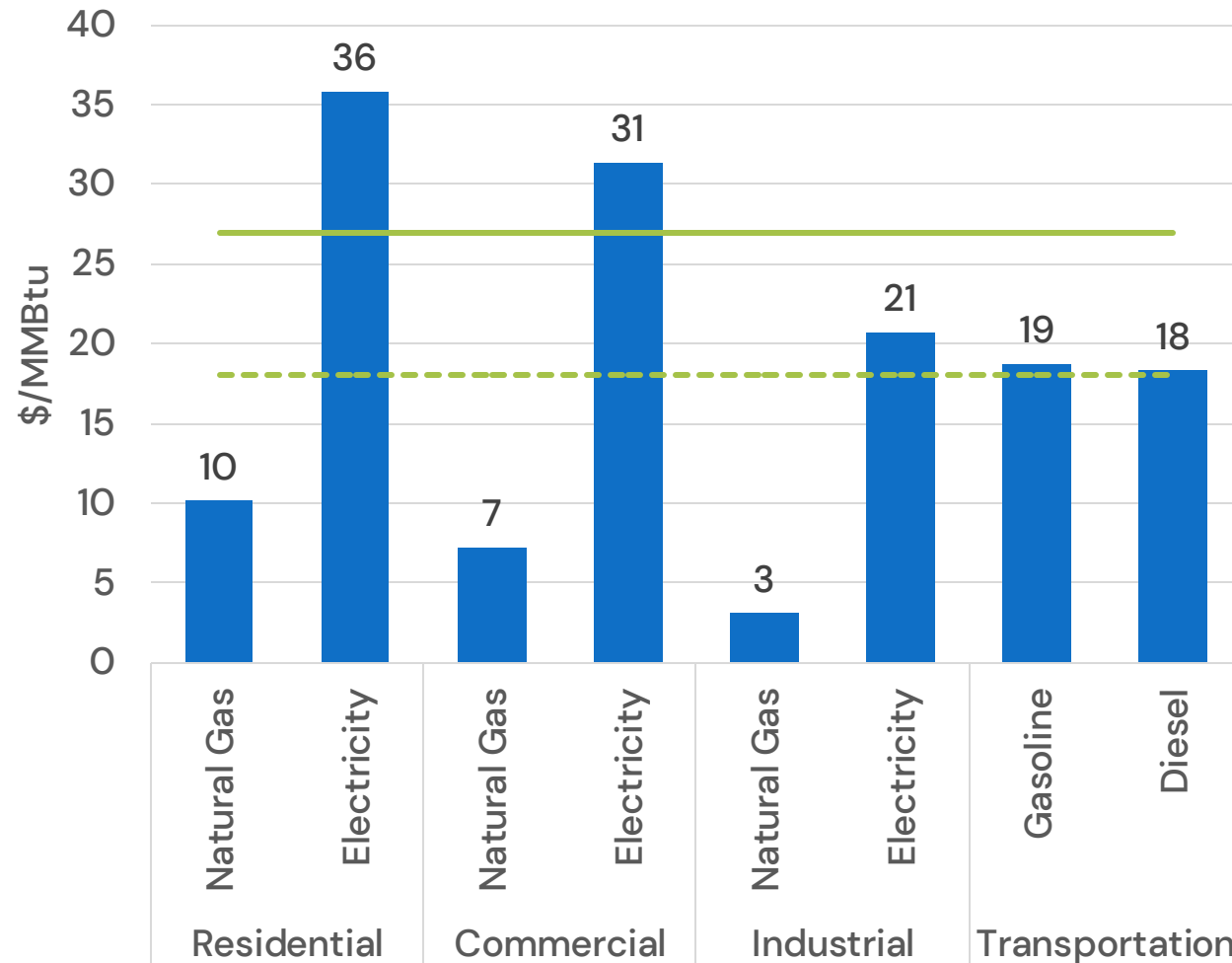
→ **Declining hydrogen production prices are opening new opportunities**



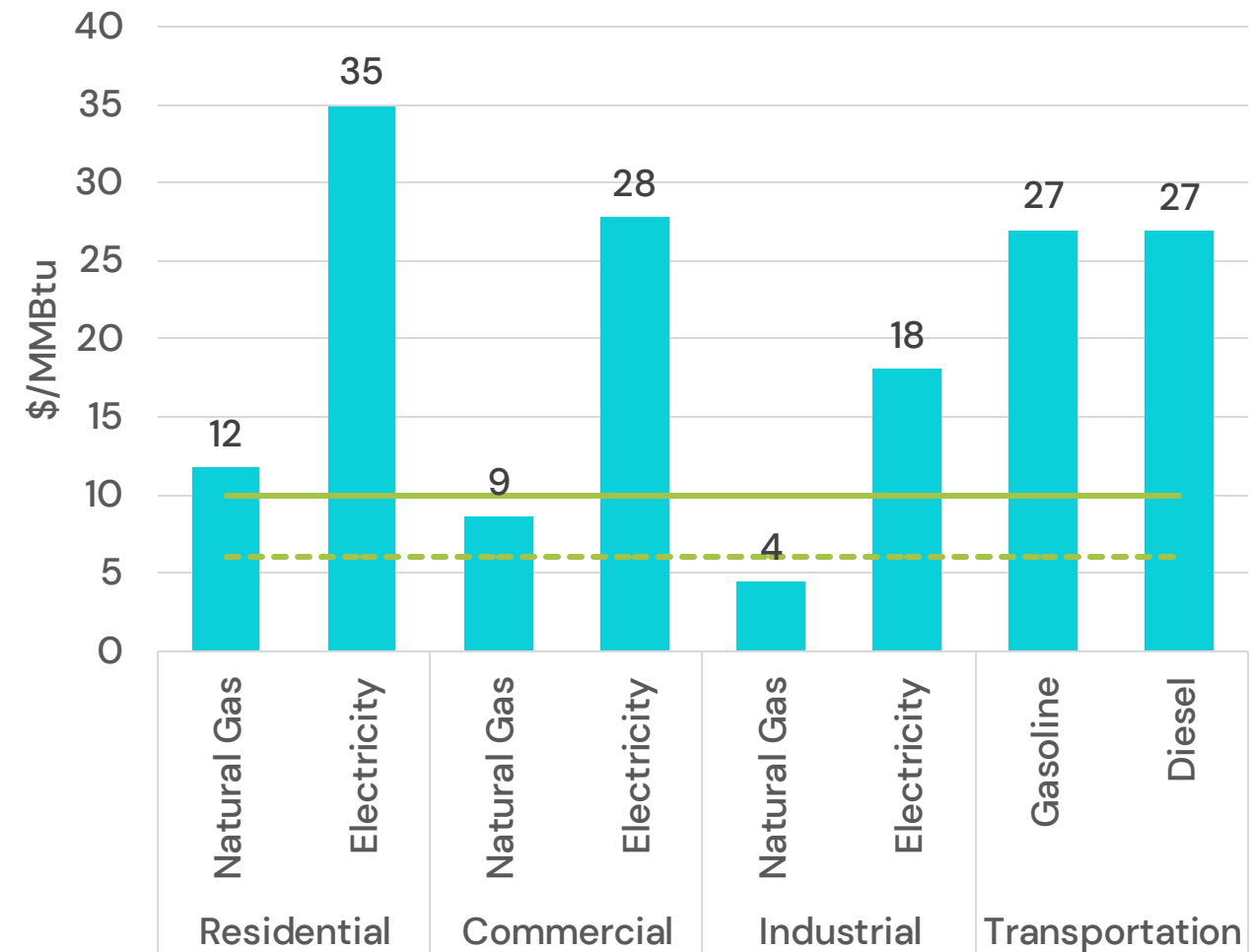
Source: ICF - Examining the current and future economics of hydrogen energy

# Hydrogen production costs in context of delivered energy prices

AEO Average Energy Prices for 2020



AEO Average Energy Prices for 2050



— Green H2 (Renewable Power)

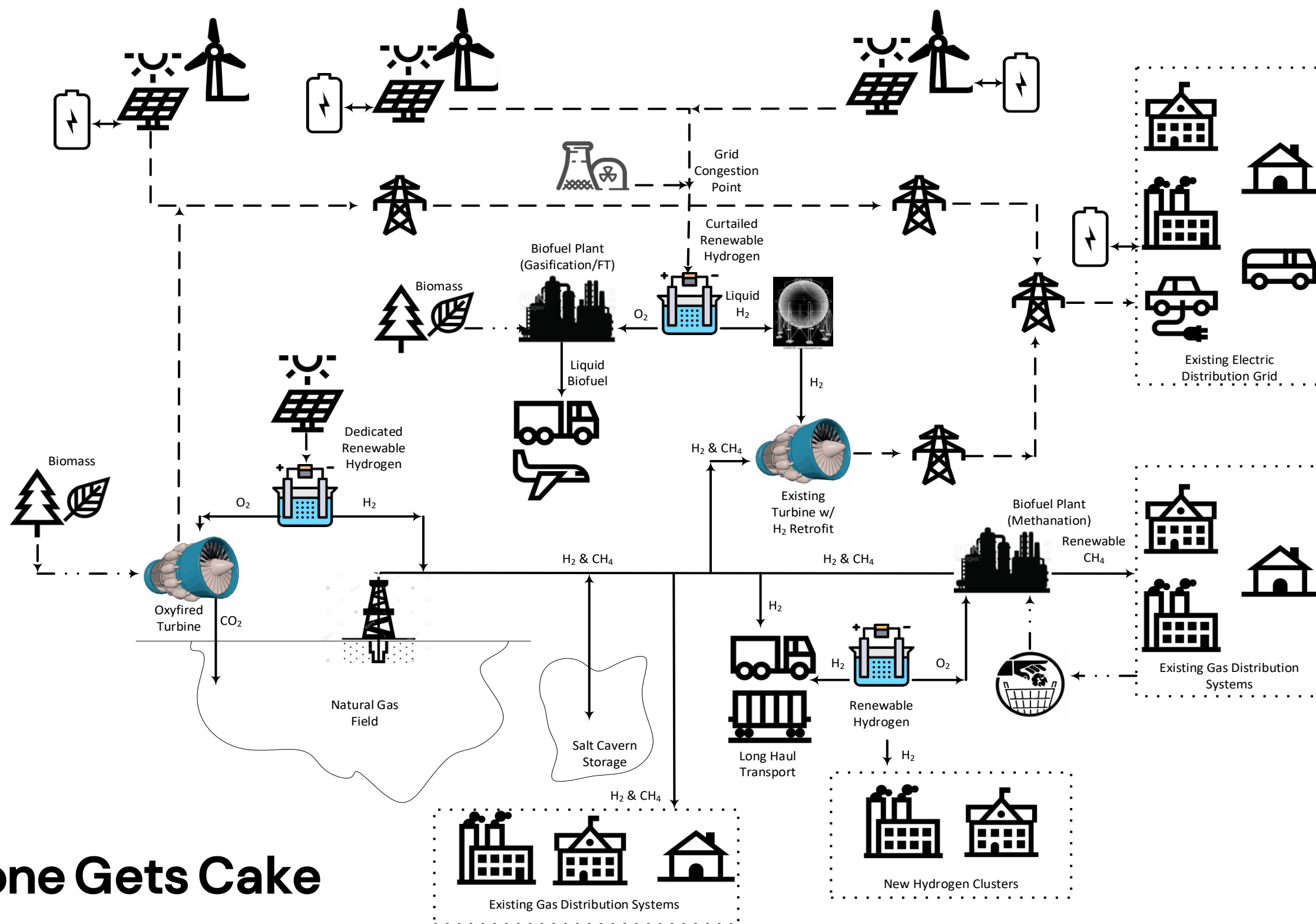
- - - Green H2 (Curtailed Power)

— Green H2 (Renewable Power)

- - - Green H2 (Curtailed Power)

**Notes:**

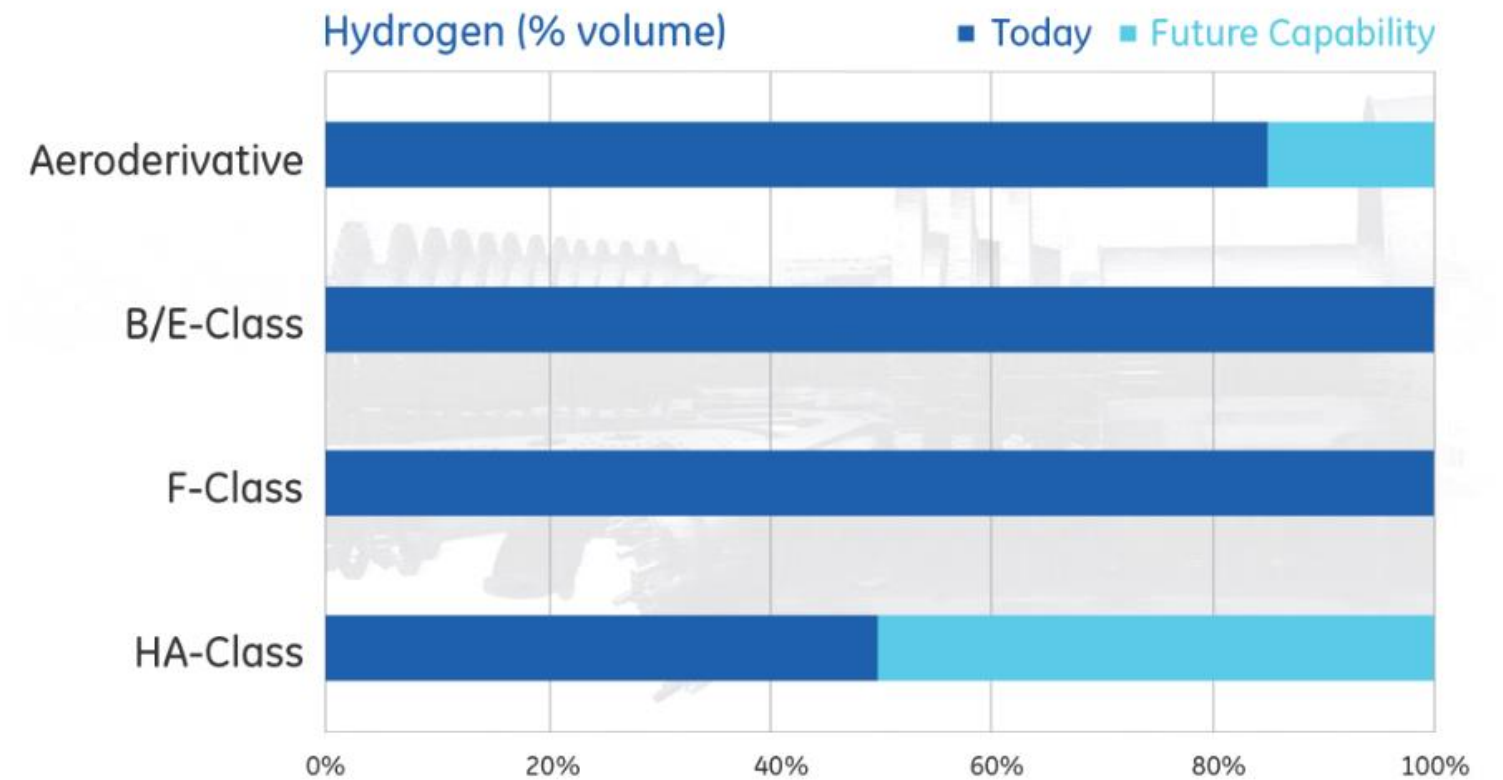
- Delivered energy prices/costs are national averages from EIA's 2021 Annual Energy Outlook (AEO)
- Hydrogen production costs are an ICF calculation for green hydrogen, based on assumptions on previous slide
- These bars do not account for relative efficiency of equipment using different fuel types



→ **Everyone Gets Cake**

# Hydrogen in Combined Cycle Service

- Existing GT's can be Retrofit for High Hydrogen Service
  - Hydrogen combustors
  - Larger fuel piping and valves
  - Safety sensors and flame detectors
  - Control system changes
- Major OEMs (GE, Mitsubishi, Siemens) Targeting 100% Hydrogen Compatibility between 2025 and 2030
- GE lists 75 turbines with 6MM+ operating hours, the Deasan Refinery 6B's in South Korea have been running on 70–95% hydrogen since 1997 (guaranteed at 95%)



Hydrogen (% volume, actual hydrogen levels may vary based on gas turbine model, combustion model, combustion system, and overall fuel composition)

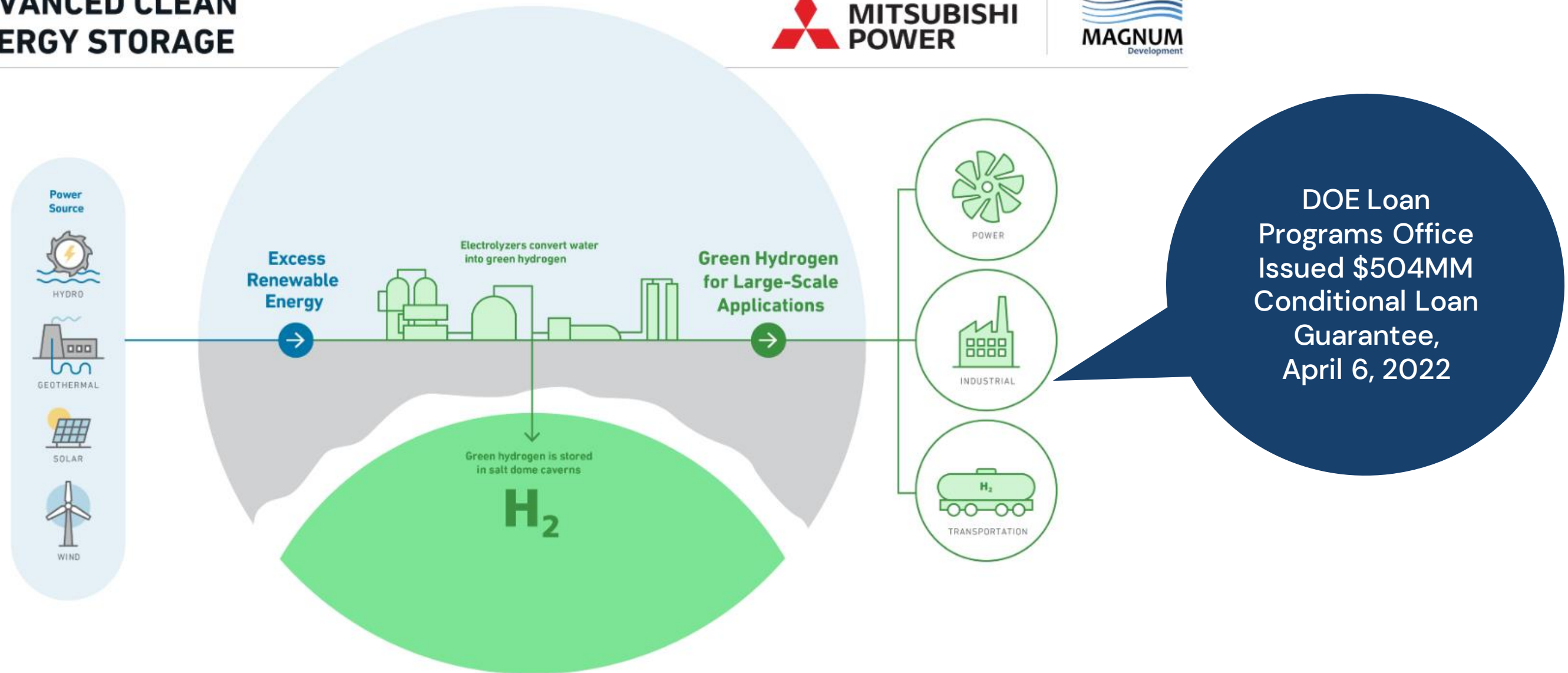
Source: <https://www.ge.com/gas-power/future-of-energy/hydrogen-fueled-gas-turbines>



6B.03

Source: <https://www.ge.com/power/gas/gas-turbines/6b-03>

# ADVANCED CLEAN ENERGY STORAGE



<https://power.mhi.com/regions/amer/news/20210511.html>

## → Long Duration Storage – Advanced Clean Energy Storage (Delta Utah)



ICF does produce thought pieces on hydrogen from time to time. Recent examples include;

- Exploring the Economic Potential of Hydrogen Energy (collaboration with Norton Rose)  
<https://www.icf.com/insights/energy/economic-potential-hydrogen>
- Examining the current and future economics of hydrogen energy  
<https://www.icf.com/insights/energy/economics-hydrogen-energy>
- Fueling the future of India's long-haul vehicles with hydrogen  
<https://www.icf.com/insights/energy/india-hydrogen-future-long-haul-vehicles>
- Exploring hydrogen as a versatile option for decarbonization  
<https://www.icf.com/insights/energy/hydrogen-versatile-option-decarbonization>
- The hydrogen value proposition  
<https://www.icf.com/insights/energy/hydrogen-value-proposition>
- Repurposing infrastructure for hydrogen in a net-zero future  
<https://www.icf.com/insights/energy/hydrogen-power-zero-carbon-future>
- Hydrogen's essential role in the decarbonization of aviation  
<https://www.icf.com/insights/transportation/hydrogen-role-decarbonization-aviation>
- Hydrogen energy insights page  
<https://www.icf.com/insights/hydrogen-energy>

## → Additional Resources



Get in touch with us:

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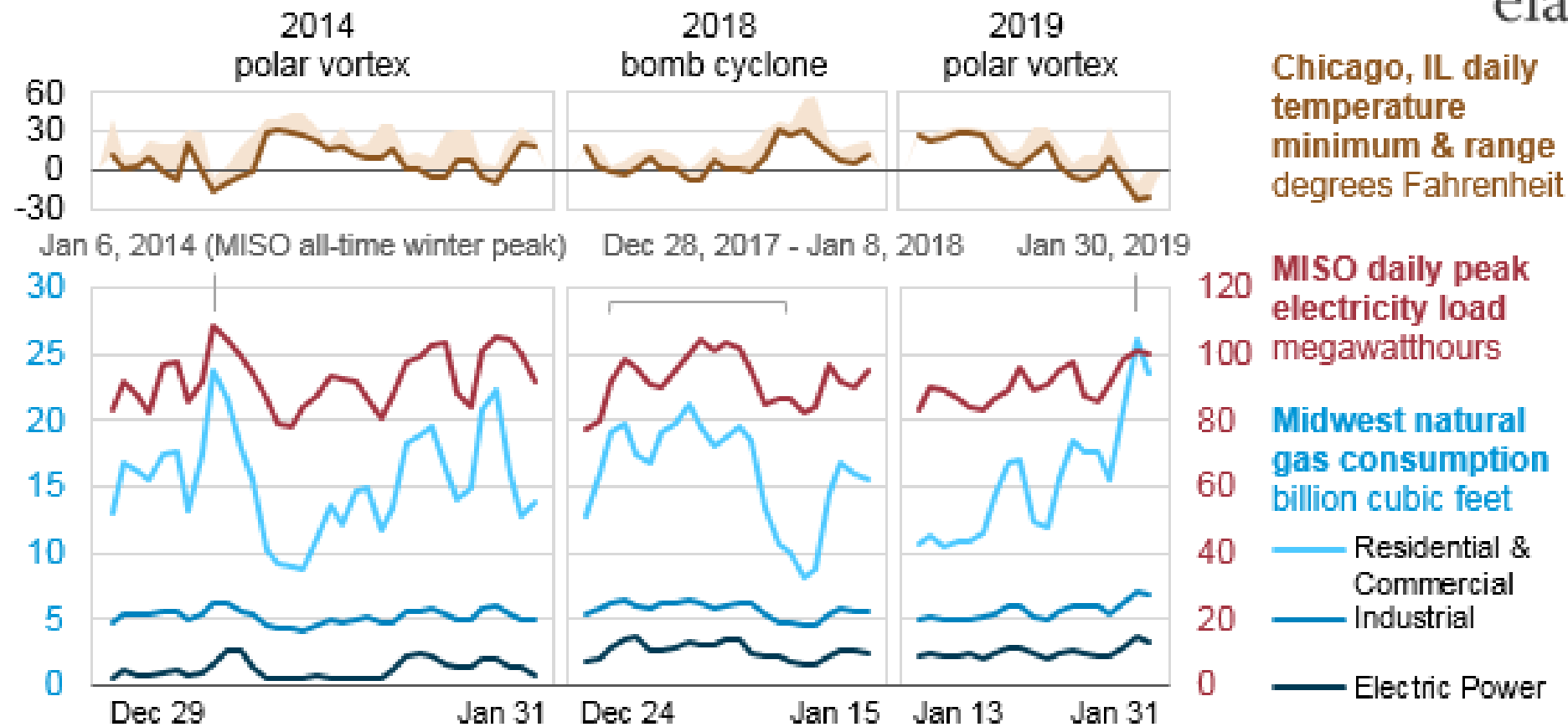
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#### About ICF

ICF (NASDAQ:ICFI) is a global consulting and digital services company with approximately 8,000 full- and part-time employees, but we are not your typical consultants. At ICF, business analysts and policy specialists work together with digital strategists, data scientists and creatives. We combine unmatched industry expertise with cutting-edge engagement capabilities to help organizations solve their most complex challenges. Since 1969, public and private sector clients have worked with ICF to navigate change and shape the future.

# Natural Gas System (Chemical Storage) Currently Provides Peaking and Long-Term Storage Capacity

Midcontinent ISO (MISO) region during recent cold weather events



<https://www.eia.gov/todayinenergy/detail.php?id=384>

72

- Demand can double or even treble in days, difficult for battery storage
- Battery storage economically viable for 4-8 hours
- ERCOT would have needed ~90 hours this spring