Phased approach to 100% carbon-free power

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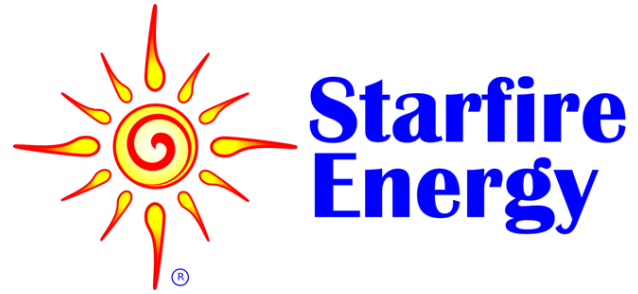
Working together to accelerate our low-carbon future



Overview

- Background and value proposition
- Phase 1: hydrogen-methane blend
- Phase 2: hydrogen-ammonia blend

US Gas Industry & Infrastructure

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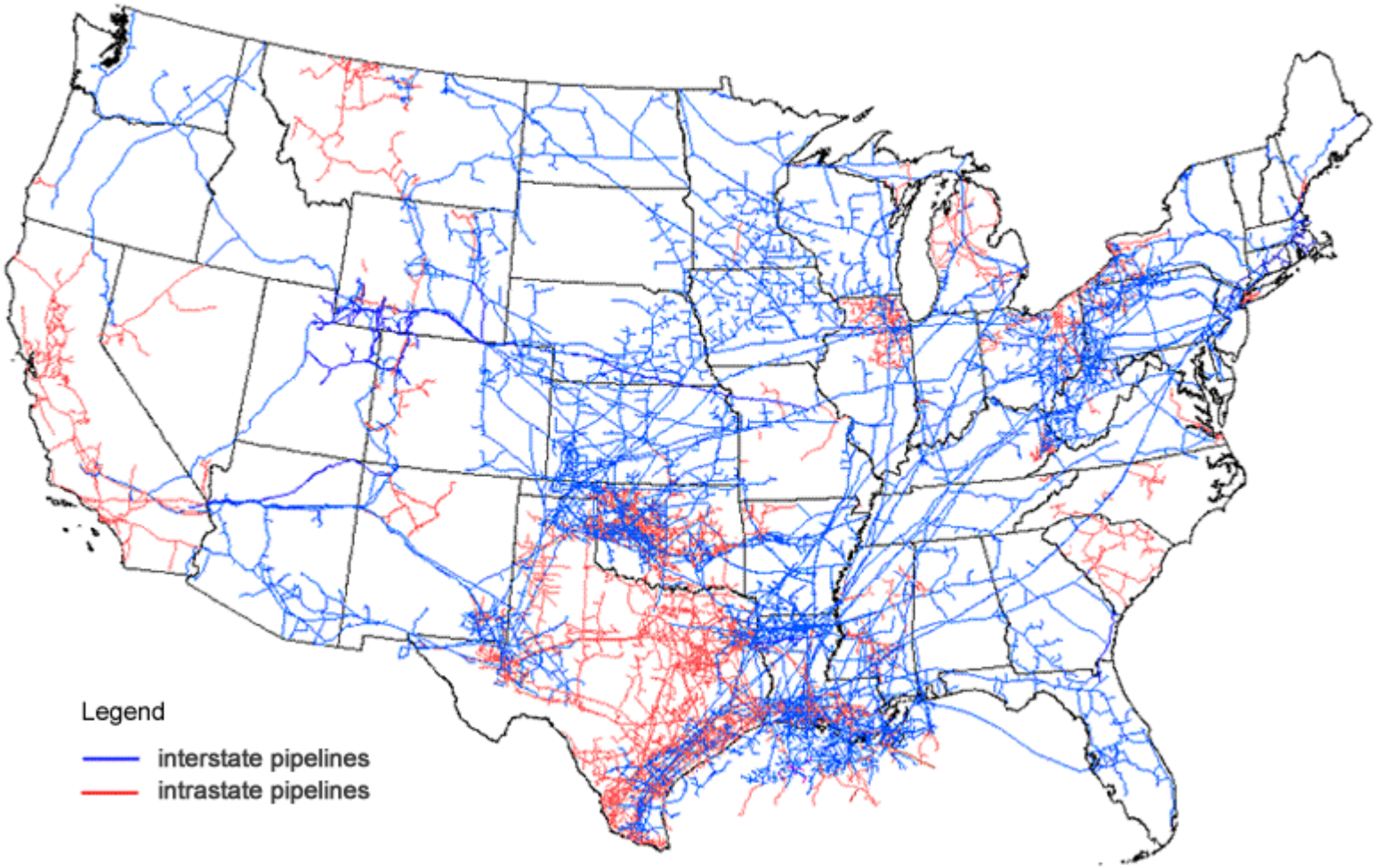
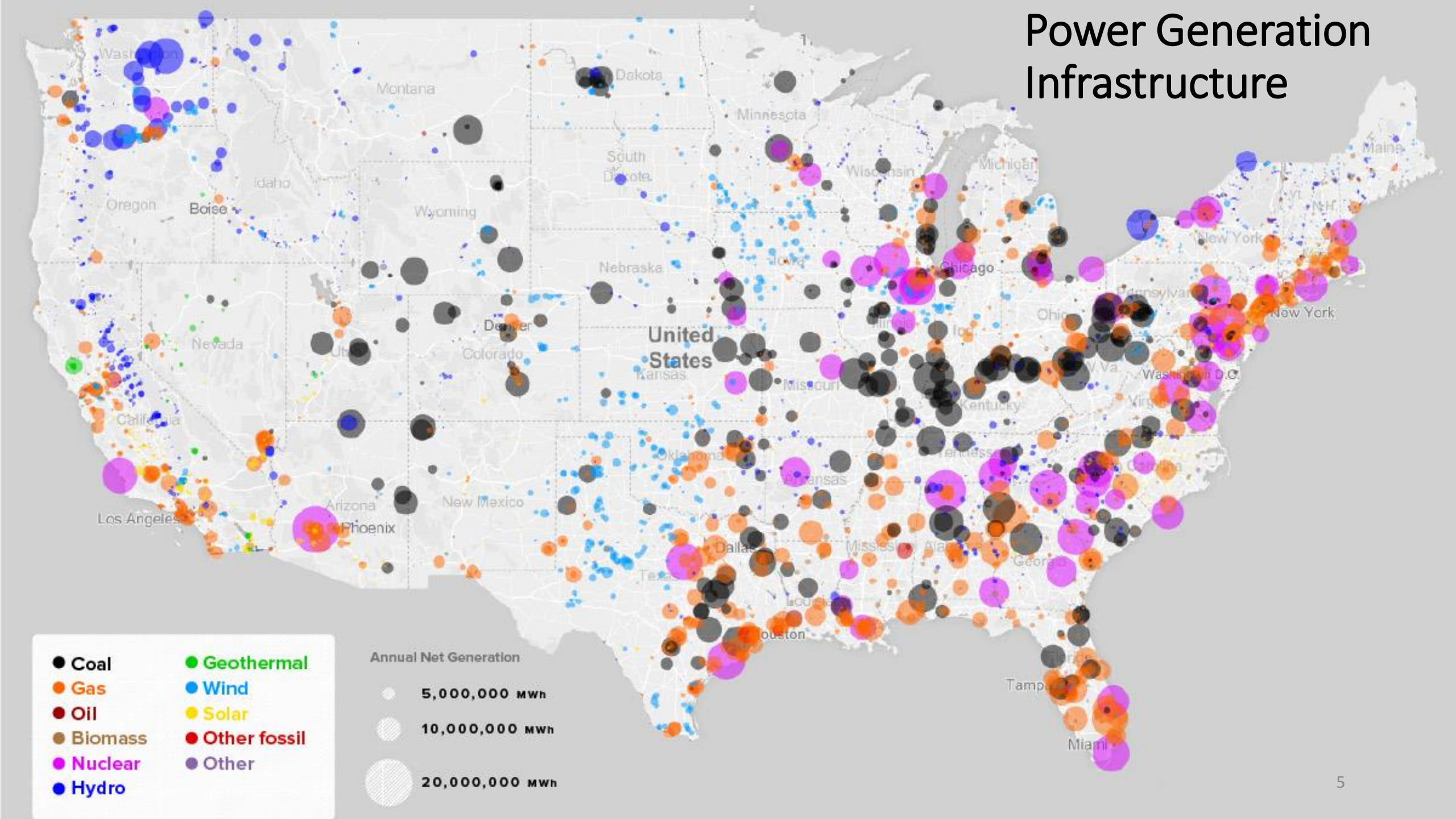
Map of U.S. interstate and intrastate natural gas pipelines



Source: U.S. Energy Information Administration, *About U.S. Natural Gas Pipelines*

- >$400,000,000,000 in annual revenue
- $187,900,000,000 in assets
- 3,400,000 jobs
- Represents about 2.5% of economic activity in US

Power Generation Infrastructure



Fossil Power Plants

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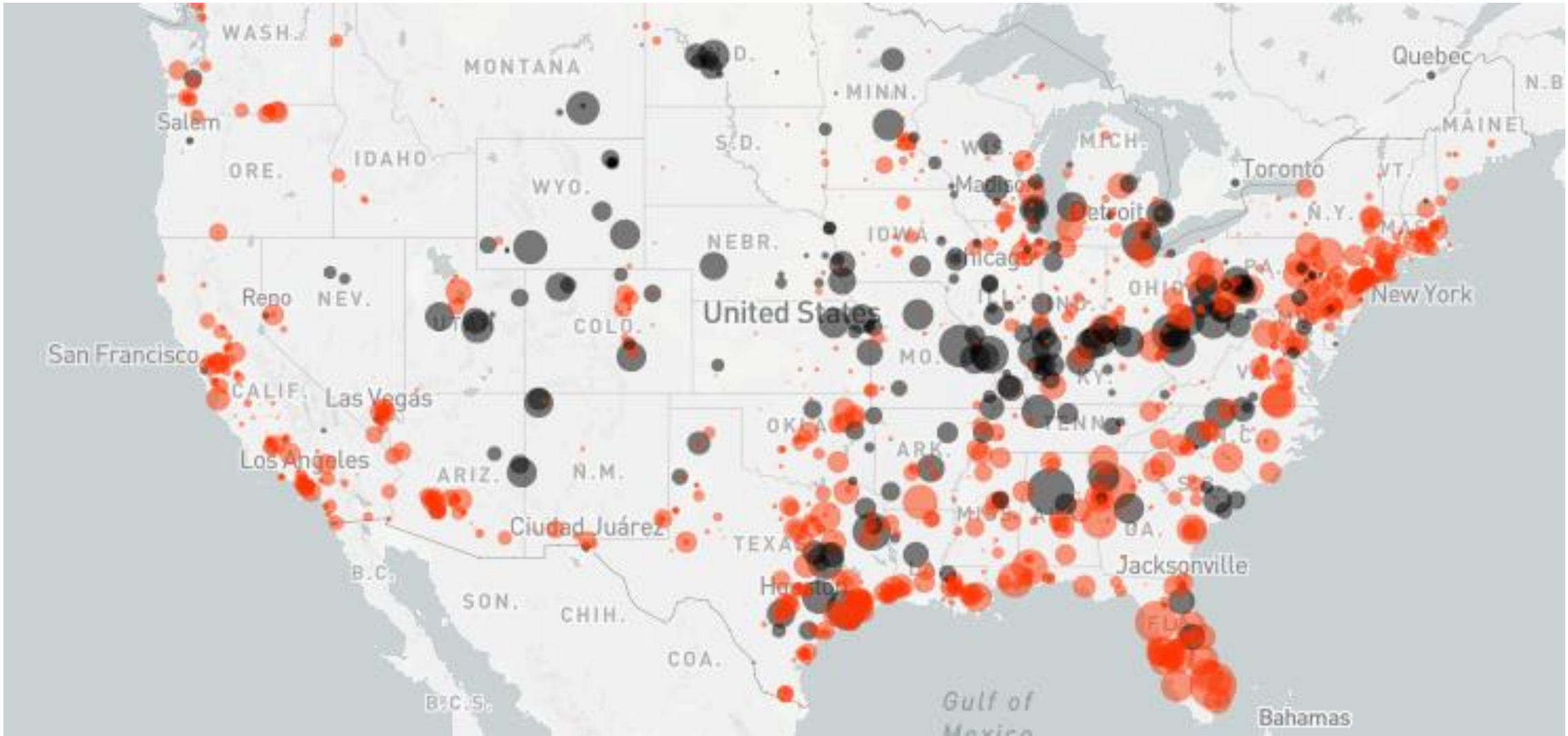
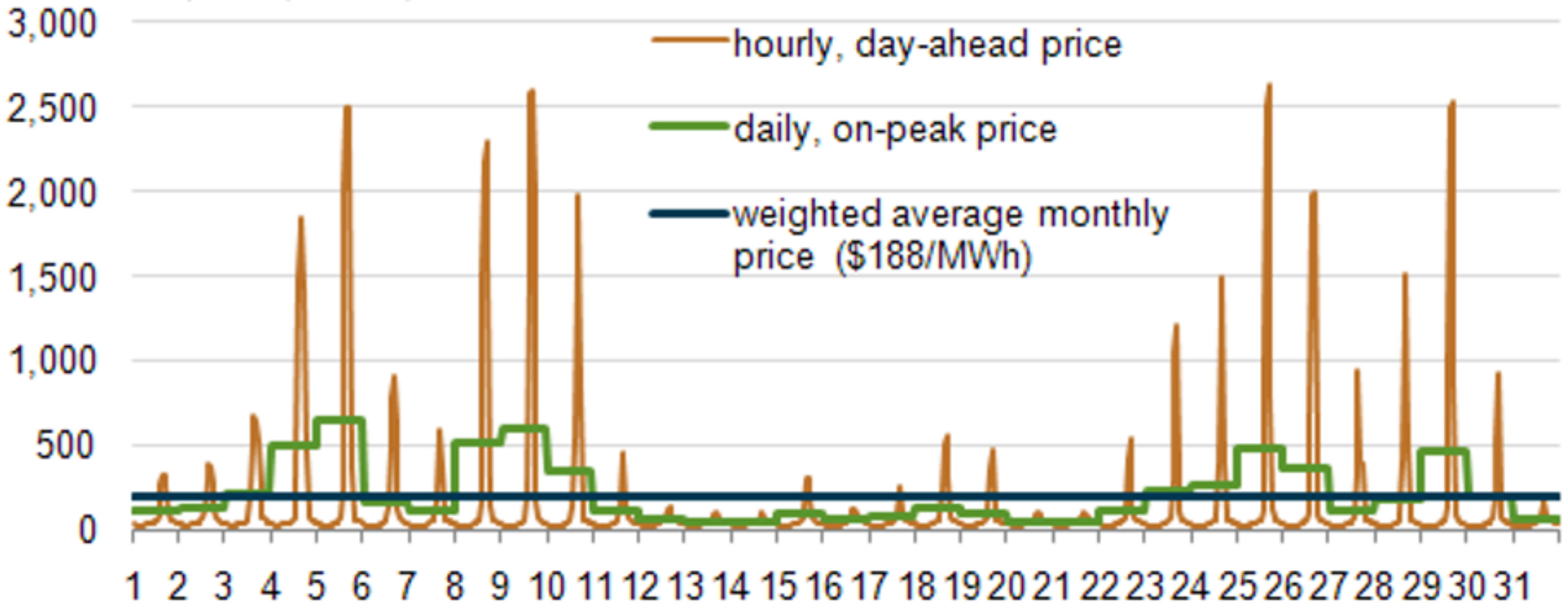


Wholesale Electricity Pricing

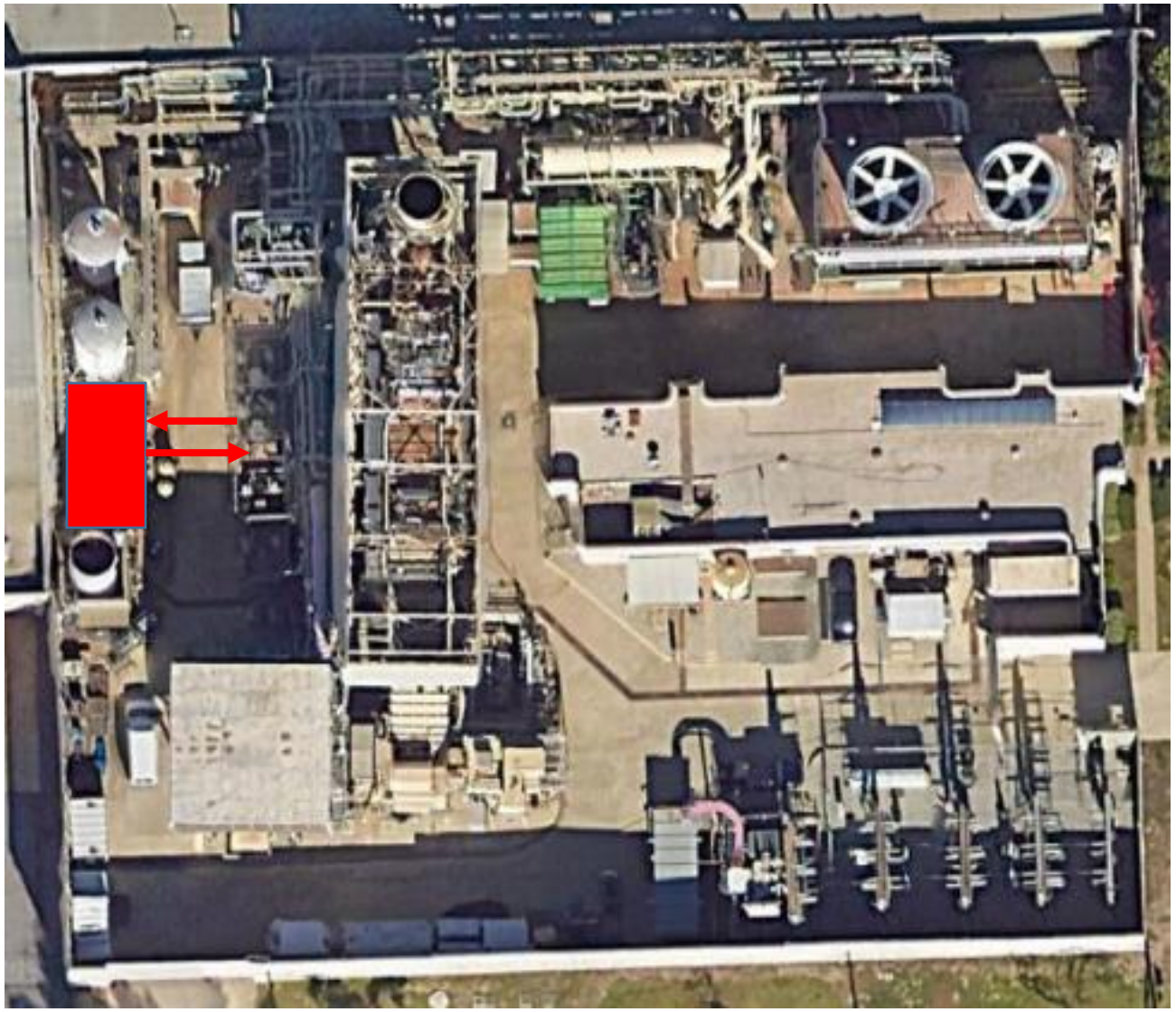


Courtesy of eia.gov, data from ERCOT North Zone August 1-30, 2022, hourly day-ahead, daily on-peak, and monthly weighted average wholesale price, $/MWh

Natural gas power plant

- Can be turned on and ramped up very quickly
- Thousands deployed worldwide
- nameplate 45 MW – 20,000 homes
- Fuel cost: $50-75/MWh

Interlock Pyrolysis Modification



- Hydrogen produced on demand; no storage
- Uses existing natural gas delivery
- Ties into existing plant fuel system with minimal piping
- Small footprint: <1000 SF
- Waste heat integration option
- Fuel system tie-in
- 40% more natural gas usage
- 2MW heat input required
- Solid carbon is byproduct

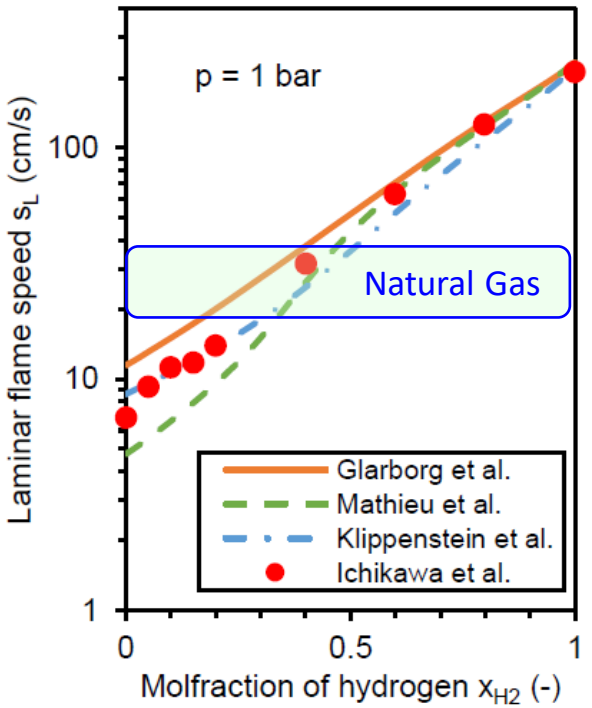
Phase 1: 30% Hydrogen

Annual run hours	1000
Annual MWh	40,000
Cost per MWh to run 100% natural gas	$52
Cost per MWh to run 30% hydrogen, 70% natural gas	$75

Phase 2: 30% Hydrogen, 70% ammonia

- Flame speed
- Flame temperature
- Prevent equipment damage

Ammonia Hydrogen blends to replace hydrocarbon fuels



Methane flame

Ammonia/Hydrogen flame

Courtesy of Dr. Colin Wolden of CSM and Blaze Energy

Ammonia production - Land Use

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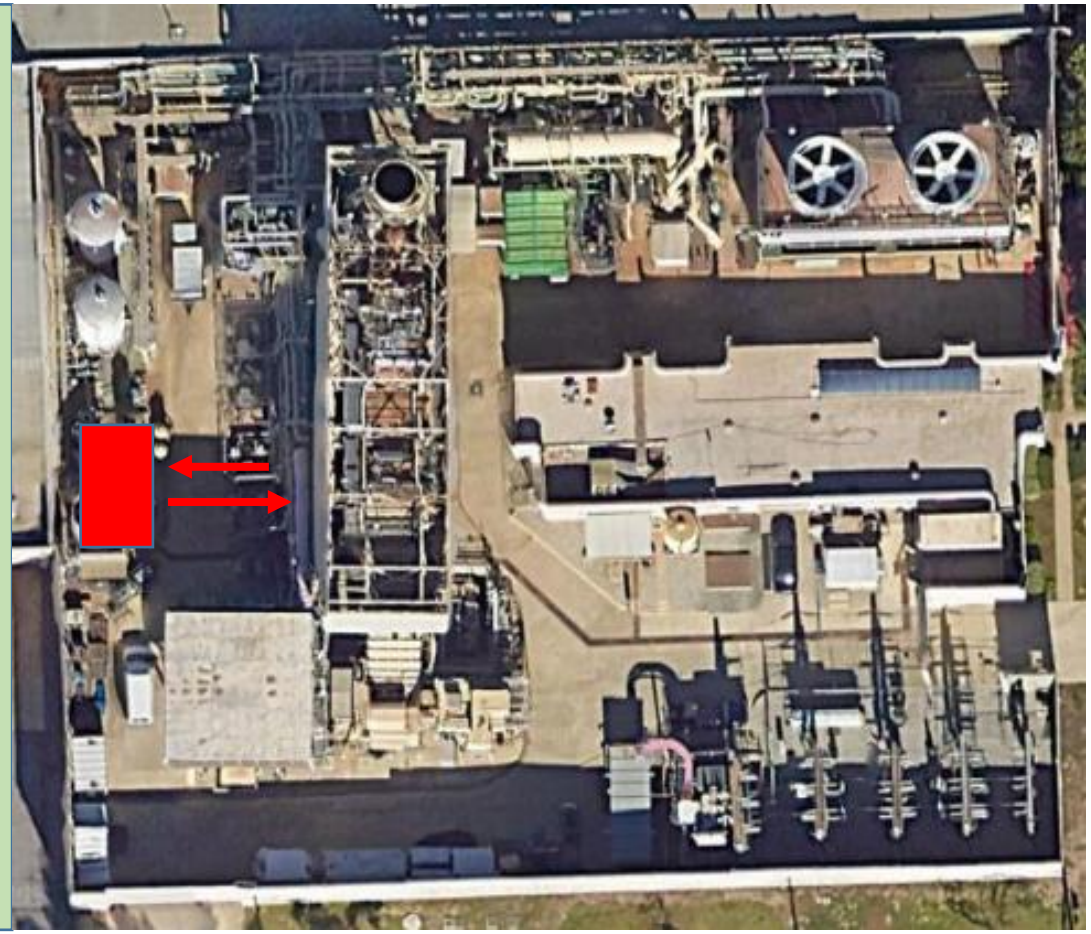
Modular Ammonia Production and Storage



Combustion Turbine Operational Profile

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Annual run hours	1000
Annual MWh	40,000
Baseline: Cost per MWh to run 100% natural gas	$52
Phase 1: Cost per MWh to run 30% hydrogen, 70% natural gas	$75
Phase 2: Cost per MWh to run on 30% hydrogen, 70% ammonia	$250

Customer #1: Phased approach to phase 1

Questions?

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Assumptions, inputs and sources

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Parameter	Value	reference
Estimated minimum cost to replace firm generation capacity currently provided by coal and gas	$1000/kW	Interlock's conservative estimate based on utility integrated resource plan (see slide 21)
Lower heating value of ammonia	5.2 MWh thermal per ton	https://www.sciencedirect.com/science/article/pii/S2542435120301732#:~:text=Recognizing%20that%20the%20lower%20heating,energy%20efficiency%20of%20only%2065%25.
Aeroderivative gas turbine service hours per year	969	Average of 10 combined cycle units on a power grid impacted much more by solar than wind
Aeroderivative gas turbine efficiency	32.6%	Calculated from averaged operational data of 10 units
MWh of production per year	36,605	Calculated from averaged operational data of 10 units
Fuel usage in MMBTU/year	382,900	Calculated from averaged operational data of 10 units
Natural gas pricing	$5.30/MMBTU	Average 2023 Hedge Price in the US, US Energy Information Administration https://www.eia.gov/naturalgas/weekly/#:~:text=The%20price%20of%20the%2012,12.2%20cents%20to%20%245.302%2FMMBtu.

Assumptions, inputs and sources

INTERLOCK ENERGY

Parameter	Value	reference
Cost estimate for hydrogen	Under NDA	Interlock internal estimate based on implementation planning for first customer
Cost estimate for ammonia	Under NDA	Developed via OEM discussions
Total number of US jobs in 2018	128.57 million	Statista.com https://www.statista.com/statistics/192356/number-of-full-time-employees-in-the-usa-since-1990/
Number of natural gas jobs in the US in 2018	3.4 million	S&P Global https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/natural-gas-use-supports-3-4-million-us-jobs-408b-in-gdp-industry-report-says-59380000
% of US workers in natural gas	2.4%	Calculated
2018 US GDP	$20.53T	Data Commons https://datacommons.org/place/country/USA?utm_medium=explore&mprop=amount&popt=EconomicActivity&cpv=activitySource%2CGrossDomesticProduction&hl=en
% of US GDP from natural gas	2%	Calculated

Assumptions, inputs and sources

INTERLOCK ENERGY

Parameter	Value	reference
Ammonia demand	20 tons per hour	Calculated from thermal demand of 10 reference natural gas plants, and 70% by volume
Hydrogen demand	0.4 tons per hour	Calculated from thermal demand of 10 reference natural gas plants, and 30% by volume
Utility Scale Coal Generation capacity	~200 GW	https://www.eia.gov/todayinenergy/detail.php?id=506586
Utility Scale natural gas power generation capacity	~500 GW	https://www.eia.gov/todayinenergy/detail.php?id=5043
Estimated minimum cost of replacement power generation capacity	$1000/kW	See utility integrated resource planning slide
Power plant capacity maps		Weber State University department of Physics and Astronomy
Data source for power plant capacity maps		US Energy Information administration

Assumptions, inputs and sources

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Parameter	Value	reference
US natural gas pipeline map		US Energy Information Administration: https://www.eia.gov/energyexplained/natural-gas/natural-gas-pipelines.php
US natural gas wells, processing plants, pipelines, storage, and LNG facilities		https://www.energy.gov/sites/prod/files/2015/06/f22/Appendix%20B-%20Natural%20Gas_1.pdf
Fuel Mixtures for Clean Combustion		Efficient Generation of H2/NH3 fuel mixtures for clean combustion by Rok Sitar, Javishk Shah, J. Douglas Way, and Colin A. Wolden

TABLE 2-4. LIST OF FUTURE GENERATION RESOURCE OPTIONS AND ASSOCIATED COSTS

FUTURE GENERATION RESOURCE OPTIONS	CAPTIAL COSTS ($/KW)
NUCLEAR	
AP1000 Hybrid	$6,830
Small Modular Reactor (SMR)	$5,605
NATURAL GAS (Hydrogen Capable)	
Large-Frame Combustion Turbine	$652
Aeroderivative Gas Turbine	$1,512
Combined Cycle	$994
MICROGRID	
Gensets	$946
GRID-SCALE SOLAR	
Thin Film Solar PV - Single Axis Utility	$1,160
Thin Film Solar PV - Fixed Utility	$1,084
Solar PV + Battery Energy Storage System (PVS)	$2,385
Solar Thermal Tower with Storage	$7,107
ROOFTOP SOLAR	
Thin Film Solar PV - Fixed Commercial	$1,260
Thin Film Solar PV - Fixed Residential	$2,687
ENERGY STORAGE	
Battery Energy Storage System (Li-ion)	$1,225
Compressed Air Energy Storage (CAES)	$3,878
Pumped Storage Hydro	$3,546
Flow Battery	$1,570
OTHER RENEWABLE ENERGY SOURCES	
Arizona / New Mexico Wind	$1,343
Geothermal	$3,034
Biomass	$4,666

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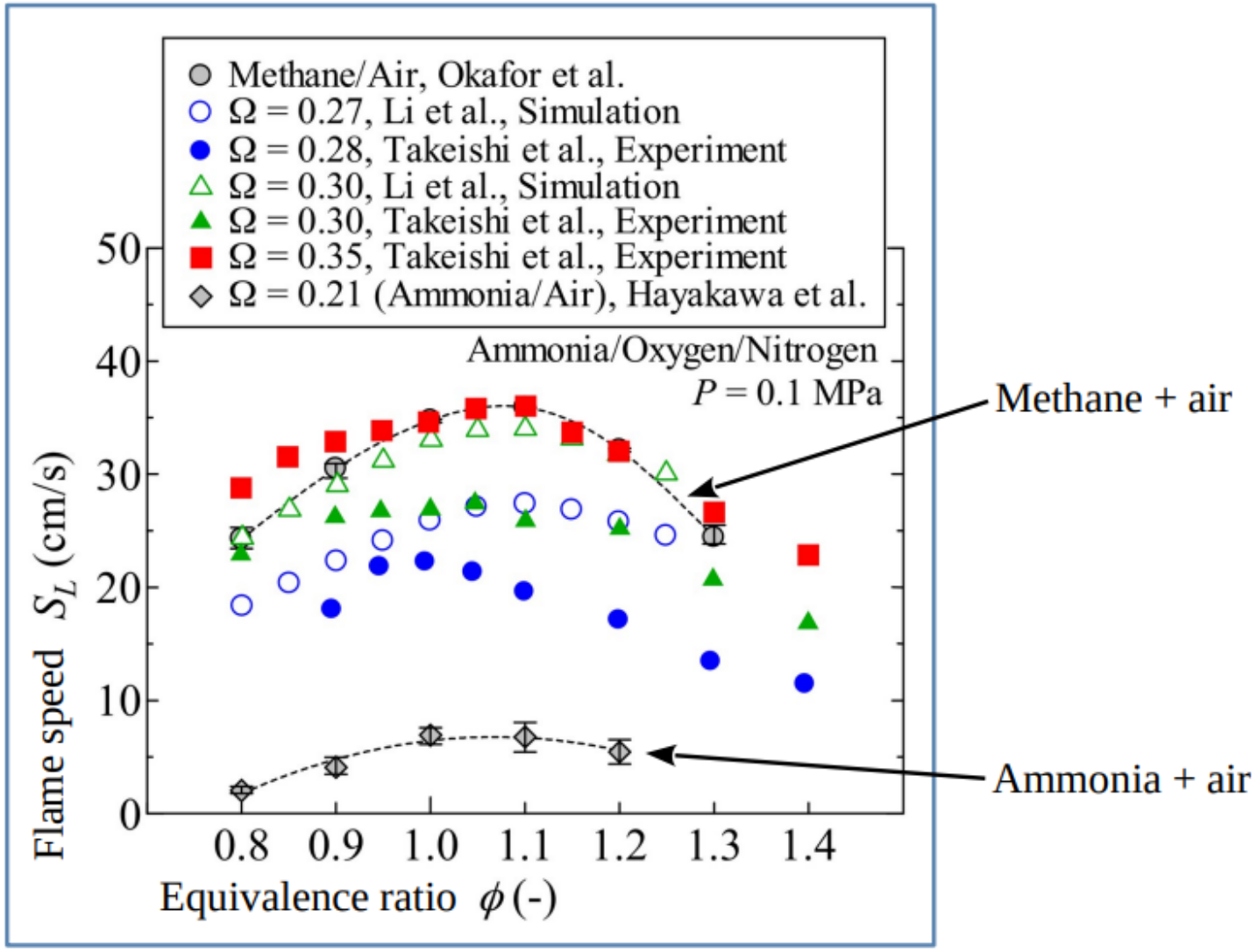
Ammonia Tank Storage

- Tank size is 20,000 tons – a size already deployed in agriculture
- Interesting future option for long-duration storage; vastly lower self-discharge rate than lithium-ion batteries
- Lithium ion batteries: $50-100 to store 1 MWh one time ($20 worth of energy, if it came from a solar farm you bought)
- Ammonia has a low RTE and high production cost, but this is overcome by the low self-discharge rate

Oxygen enrichment may solve cold start



- Ammonia with air enriched to 30-35% oxygen has laminar flame speed similar to methane in air
- 30-35% oxygen enrichment is common in industrial burners
- Possibly start burner with oxygen enrichment, switch to cracking when hot

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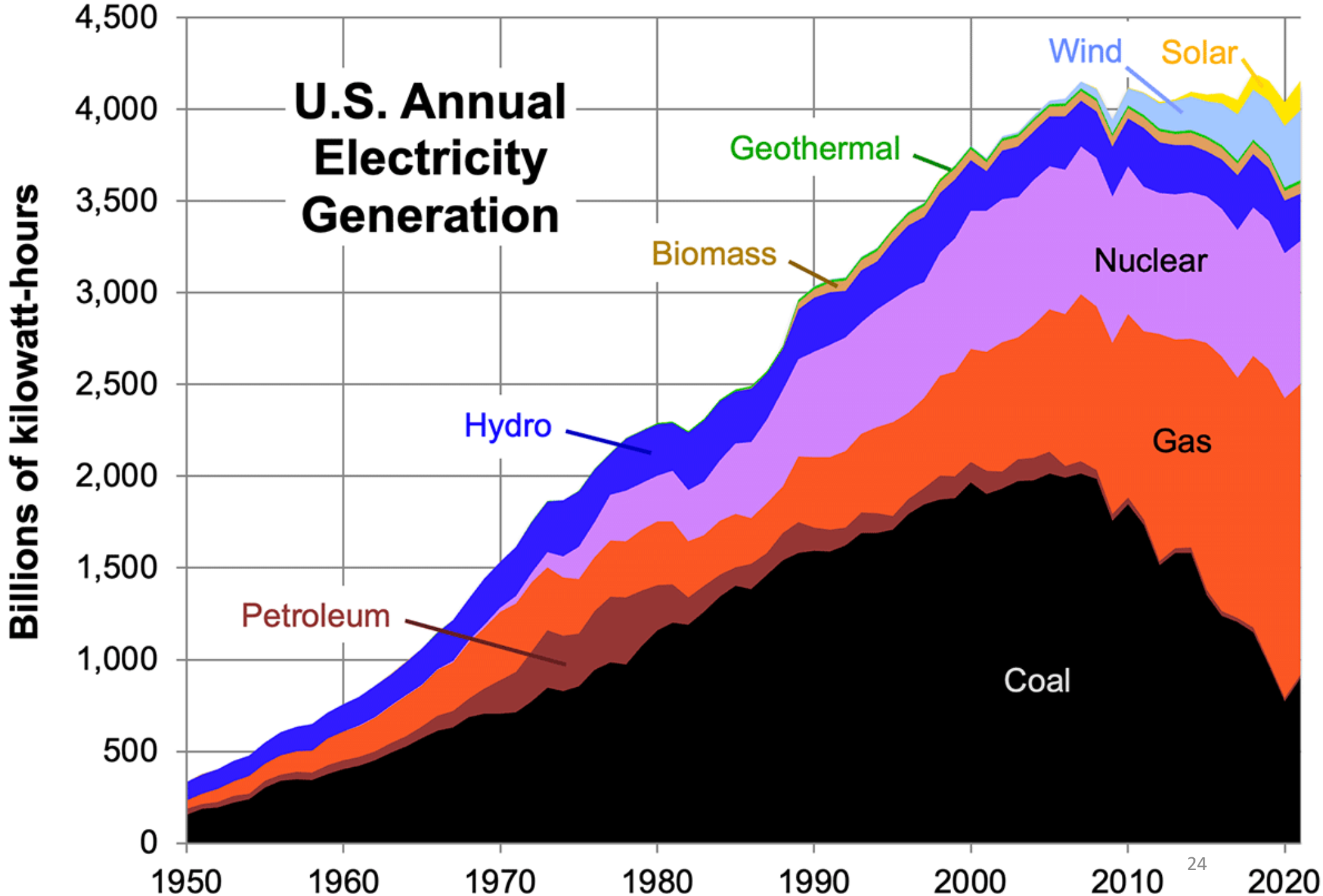
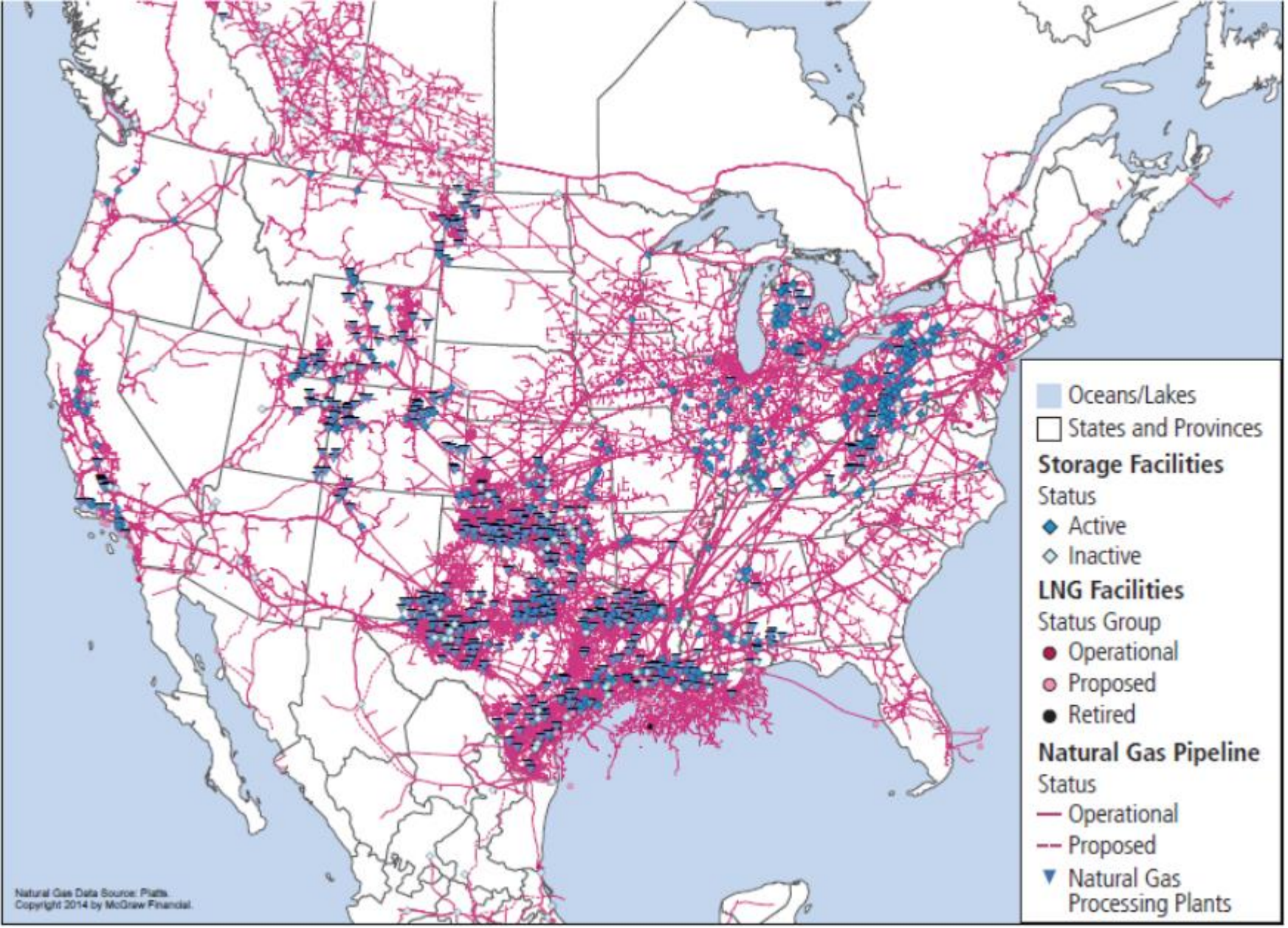

U.S. Annual Electricity Generation
Billions of kilowatt-hours
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1950
1960
1970
1980
1990
2000
2010
2020
Wind
Solar
Geothermal
Biomass
Nuclear
Hydro
Gas
Petroleum
Coal



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- three million miles of natural gas pipeline in the US alone

1. https://www.energy.gov/sites/prod/files/2015/06/f22/Appendix%20B-%20Natural%20Gas_1.pdf
2. https://www.eia.gov/energyexplained/natural-gas/natural-gas-pipelines.php