Stranded Fossil Fuel Infrastructure

HOW BIG IS THE STRANDED ASSET PROBLEM, AND WHAT SHOULD WE DO ABOUT IT?

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FERC Regulatory Committee

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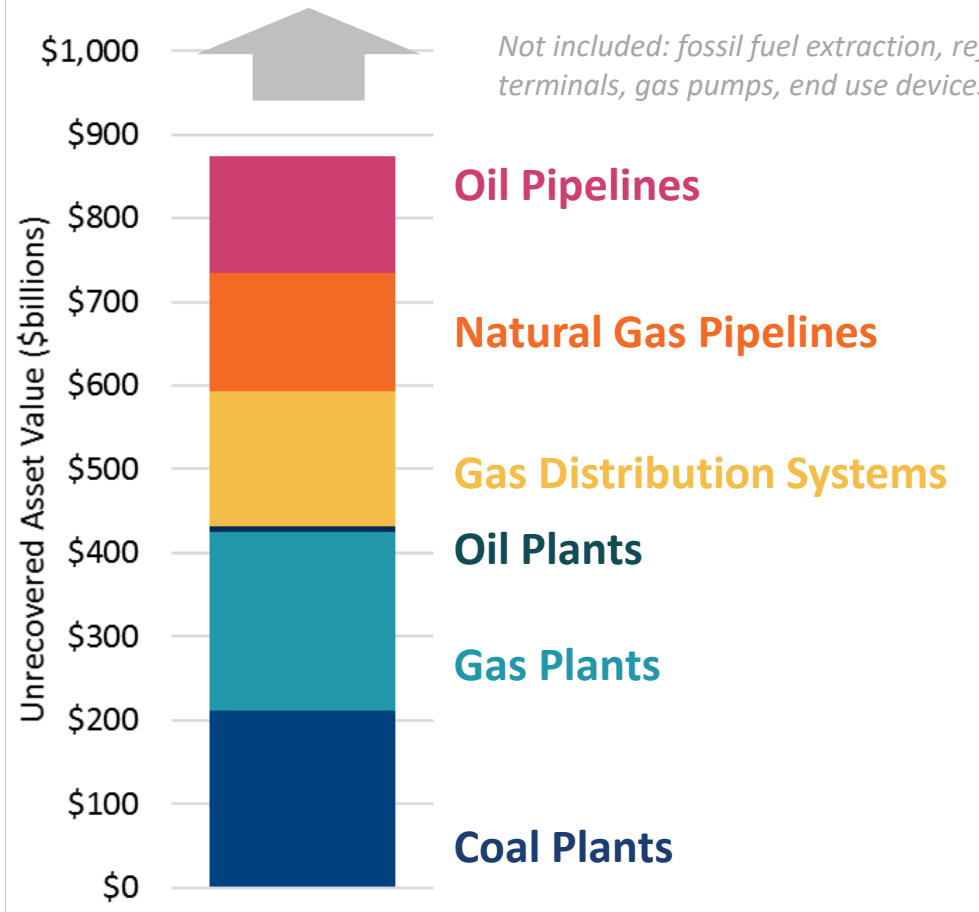
Brattle

How big could the stranded asset problem be?

Thought Experiment:
Some $900 billion in US major fossil fuel infrastructure investments have not yet recovered investment costs

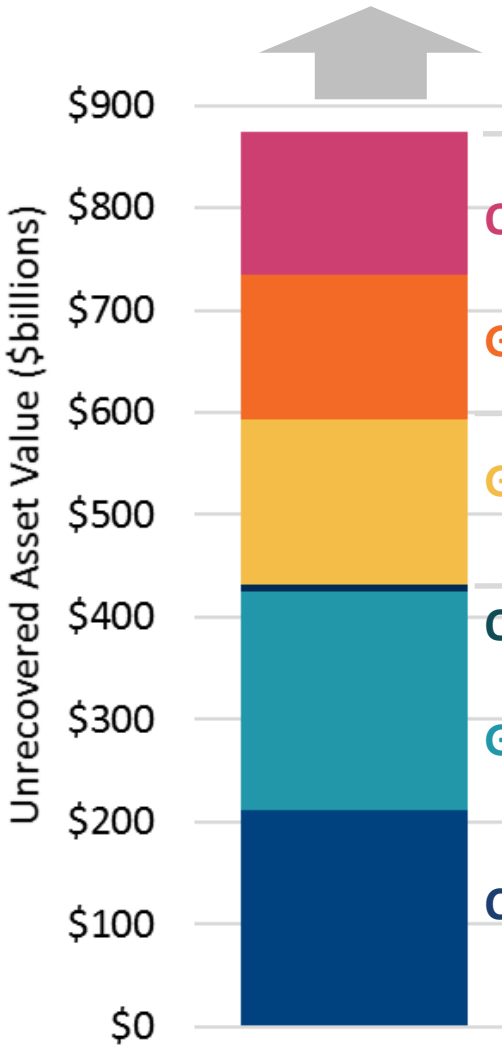
What happens when the US *really* moves on a green economy?

Approximate Unrecovered Investment Costs In Fossil Fuel Infrastructure



Sources and Notes: Rough approximation of unrecovered asset value, gas LDC rate base from SNL rate cases; pipeline rate base from FERC Form 6; approximate generator unrecovered asset value based on analysis of FERC Form 1 and approximate plant costs and remaining life.

And what happens when fossil infrastructure becomes stranded?

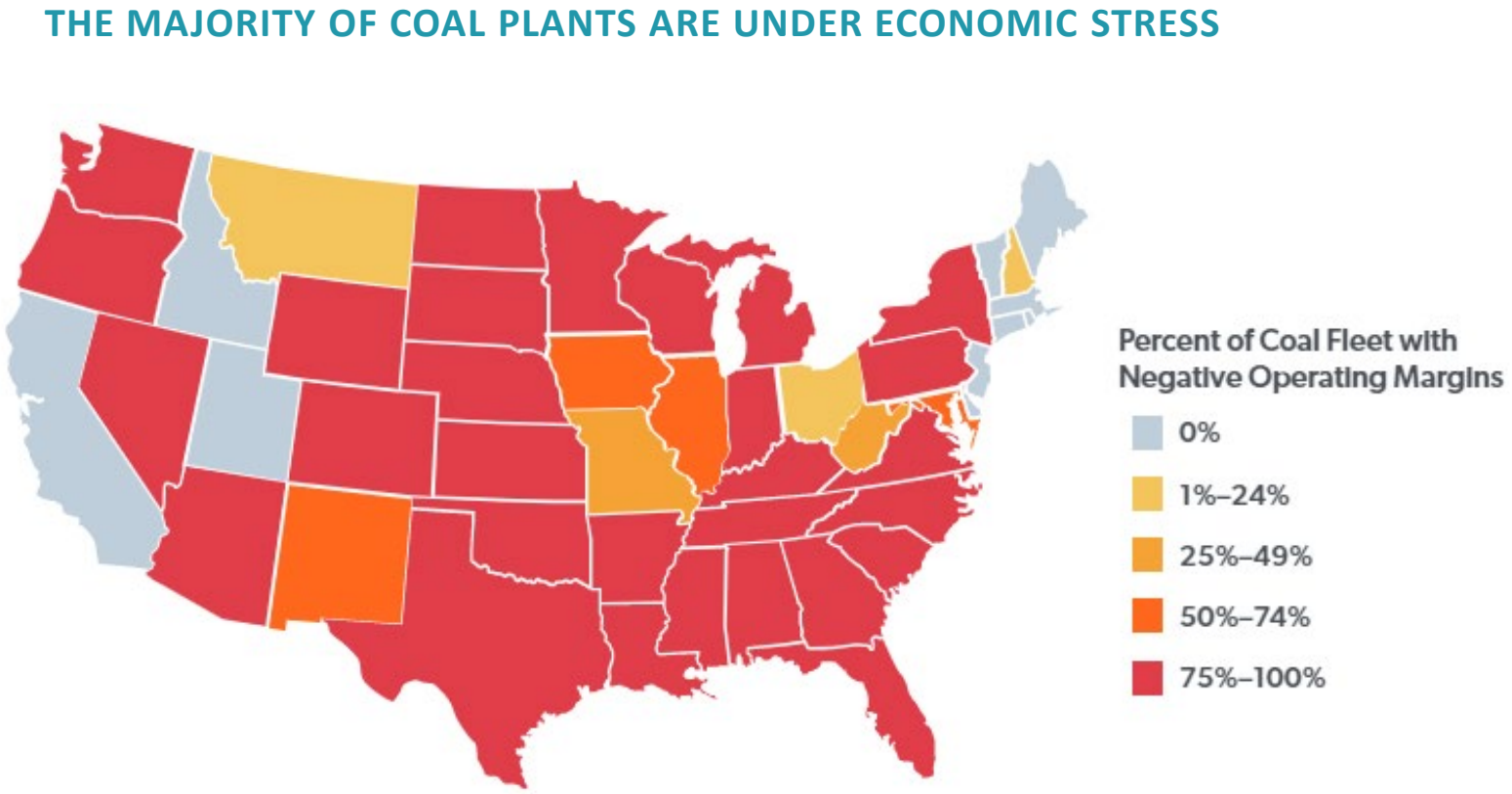


Fossil Infrastructure	Who pays?	What's to be done about it?
	Investors	Reposition for the green economy (or go out of business)
Oil Pipelines Gas Pipelines	**Pipeline Owners & Shippers**	Up to a point: Re-negotiate or file for higher rates, cut operating costs When shipping volumes drop too low: shutter pipelines & investors absorb remaining costs
Gas Distribution	**Notionally: Gas Ratepayers** *(But this is not sustainable as the only answer…)*	New policy framework is badly needed
Oil Plants Gas Plants	**Regulated Assets: Electricity Ratepayers**	Limit going-forward spend on potentially stranded assets (existing and new). New cost recovery strategies for accelerated retirements
Coal Plants	**Merchant Assets: Investors**	Investors: Reposition for the green economy Markets: Catch up to policy & customer demand for green energy

Power Plants

40% of the coal fleet is already retiring

- Many coal assets are more costly to maintain/retrofit than building new renewables or gas
- Since 2011, 87 GW of coal has already retired, and another 33 GW is announced to retire by 2025



See: Managing Coal Plant Retirements for an Orderly Transition to Decarbonization, Celebi, Graves, Mudge, Lam. The Brattle Group, 2021.

Emerging treatment of stranded coal assets is emerging

Addressing massive stranded coal asset problem is well underway…

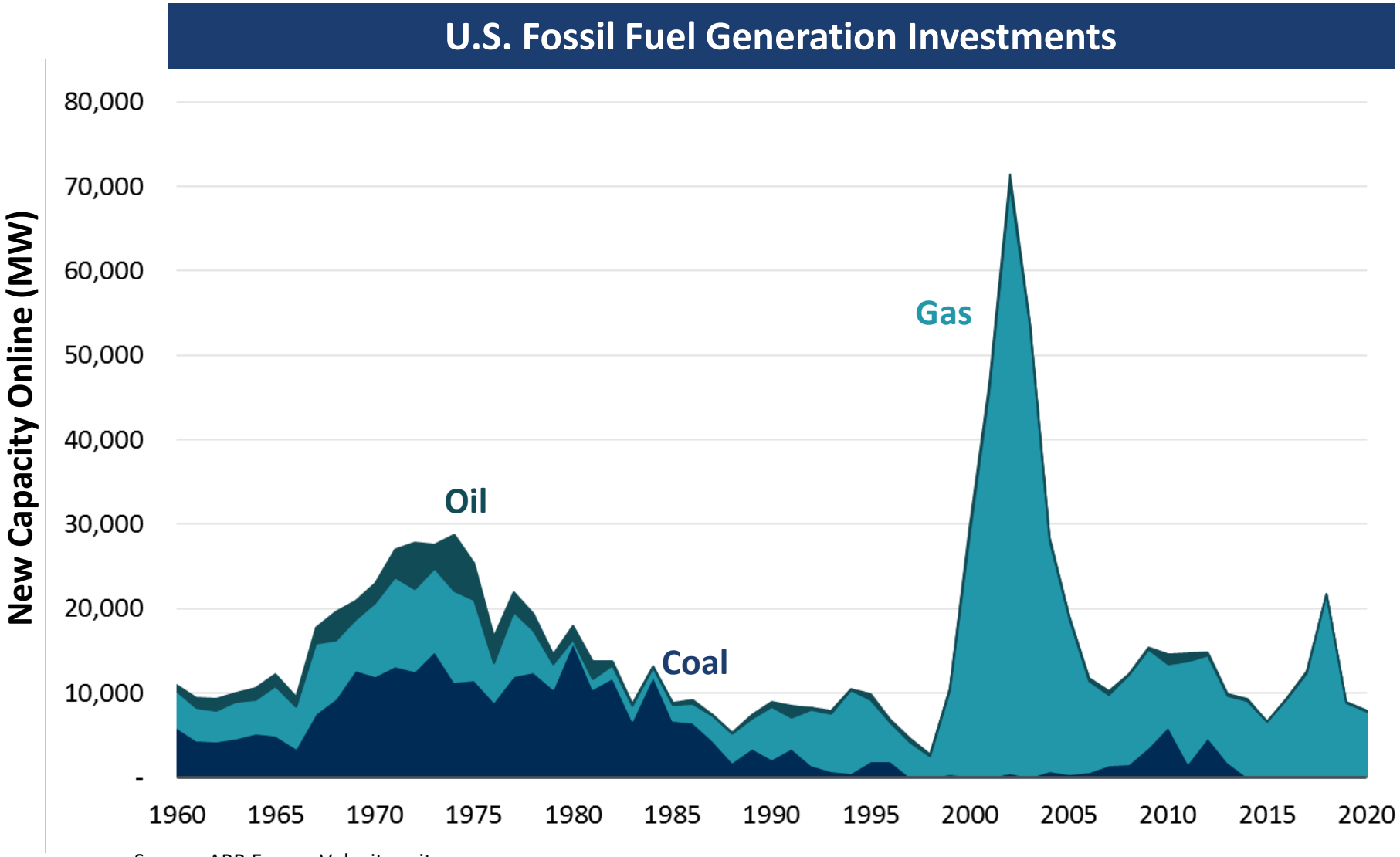
- **Regulated Coal Plants:** Customers pay the stranded asset costs (but costs are partly mitigated by early retirement)
- **Merchant Coal Plants:** Investors must absorb cost and reposition themselves

PRIMARY REGULATORY TREATMENT OF UNDEPRECIATED COAL ASSETS

Treatment	Description	No. of cases, 2010-2020	
Regulatory asset	Plant is retired, and utility continues to receive return on and of investment; takes effect upon retirement	20	Rate based
Accelerated depreciation	Plant's depreciation schedule is changed to match the period until retirement; put in place in anticipation of retirement	7	
Securitization	Recovery of stranded assets through ratepayer-backed bonds with low interest rates	3	Not rate based
Partial Disallowance	Part of the undepreciated cost or return on that balance is removed	2	

Compiled by Dr. Metin Celebi, The Brattle Group.

…but what if the gas plants become uneconomic?



Source: ABB Energy Velocity suite.

Merchant markets and planning continue to drive gas plant investments (in conflict with states' environmental policy)

Several RTO regions are facing a sharp divide in a "markets vs. policy" debate

- FERC and States (PJM, ISO-NE, NY) have been at odds over the Minimum Offer Price Rule (MOPR) that excluded state-supported resources from capacity markets (now likely to be eliminated)
- New solutions like the NJ/Brattle Integrated Clean Capacity Market (ICCM) may redirect investment incentives away from gas and toward new clean resources
- But… many recent gas plant investments may prove uneconomic

Case Study: This Month's PJM Capacity Auction

CAPACITY PRICES ($/MW-DAY)

Rest of RTO	MAAC
$50.00	$95.79

Compare to CC Net CONE
About **$100-150/MW-day** depending on location

NEW GAS PLANT INVESTMENTS (ICAP MW)

Delivery Year	CT/GT	Combined Cycle
2015/2016	1,382.5	5,914.5
2016/2017	171.1	4,994.5
2017/2018	131.0	5,010.0
2018/2019	1,032.5	2,352.3
2019/2020	167.0	6,145.0
2020/2021		2,410.0
2021/2022		
2022/2023	14.0	5,626.8

Source: PJM 2022/23 BRA results & parameters.

LDC Systems

How should policymakers address LDC system costs in states aiming to cut gas consumption by 80%?

Federal and some state policies are focused on electrification as the least-cost decarbonization pathway. Poses several challenges:

- ~80% of LDC capital expenditure is for safety and reliability
- Obligation to serve for public health & safety
- ~30% of gas demand lacks cost-effective electrification options
- Cost recovery over smaller sales volumes becomes unsustainable at some point. The last 20% of gas customers cannot be asked to pay all of these costs, especially if the last remaining gas customers are low-income. Cost recovery may have to be partially funded through public investment and/or electricity rates

STATES & CITIES RETHINKING GAS

	STATE-WIDE	CITY			
	Proceeding on Future Role of Natural Gas	Proposed Gas Bans	Enacted Gas Bans	Implemented Moratoriums	Electrification "Reach" Codes
California	✓		✓		✓
Oregon	✓	✓	✓		
Washington	✓	✓	✓		
New York	✓	✓		✓ (Partially Lifted)	✓
Massachusetts	✓	✓	✓		
Colorado	✓	✓			✓
Washington D.C.	✓				
Vermont					✓

NY GAS PLANNING PROCEEDING – STAFF PROPOSAL

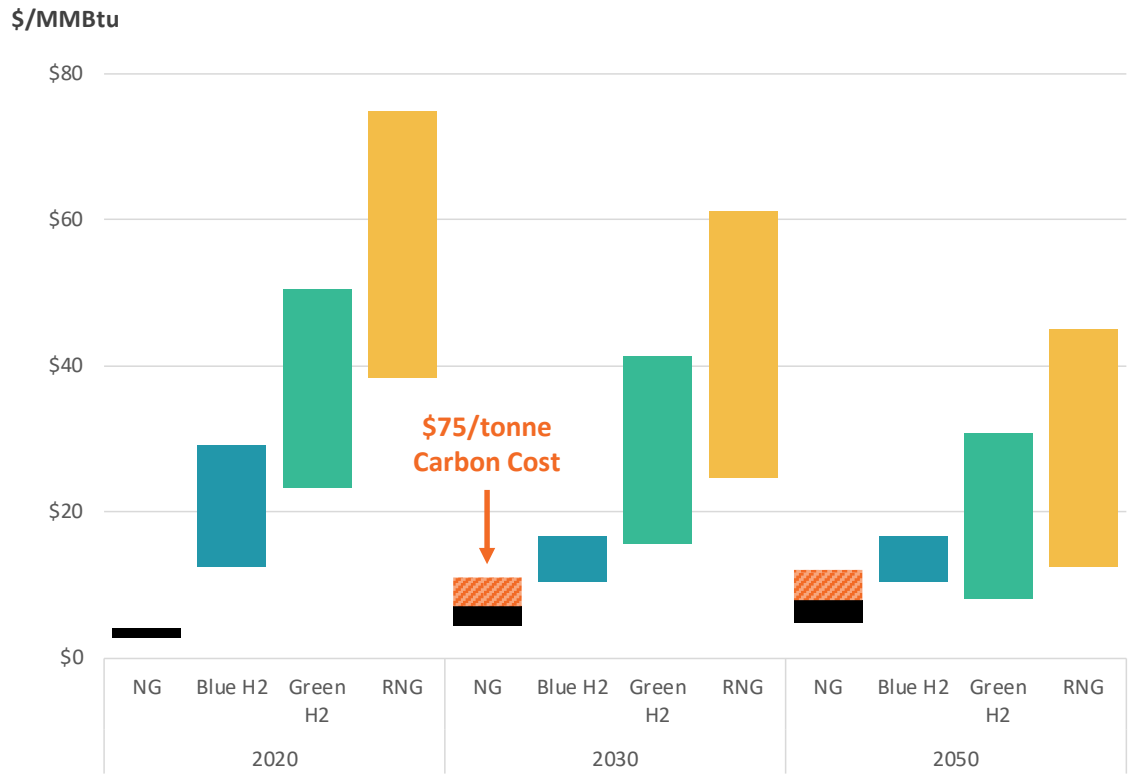
- Utilities must incorporate demand-side solutions into their long-term planning to **manage or reduce gas demand**.
- LDC's must **identify opportunities to avoid replacing leak prone pipe** and instead deploy "Non-Pipeline Alternative" investments.

Decarbonizing the gas distribution system

Competing (or possibly complementary) pathway is decarbonizing fuel supply

- Clean fuels are not yet cost-effective, requiring R&D and industry advances
- Utility pilot programs (e.g. localized use, fuel blending) needed to gain experience and maintain gas system decarbonization as an option
- Long-term, reliable fuel stocks need to be identified, including delivery options
- Modernized utility incentives need to align with policy goals to achieve carbon reductions cost effectively, and enable some risk-taking with early-stage technologies

FUEL COST FORECASTS FOR FOSSIL NG, RNG, AND GREEN H_2

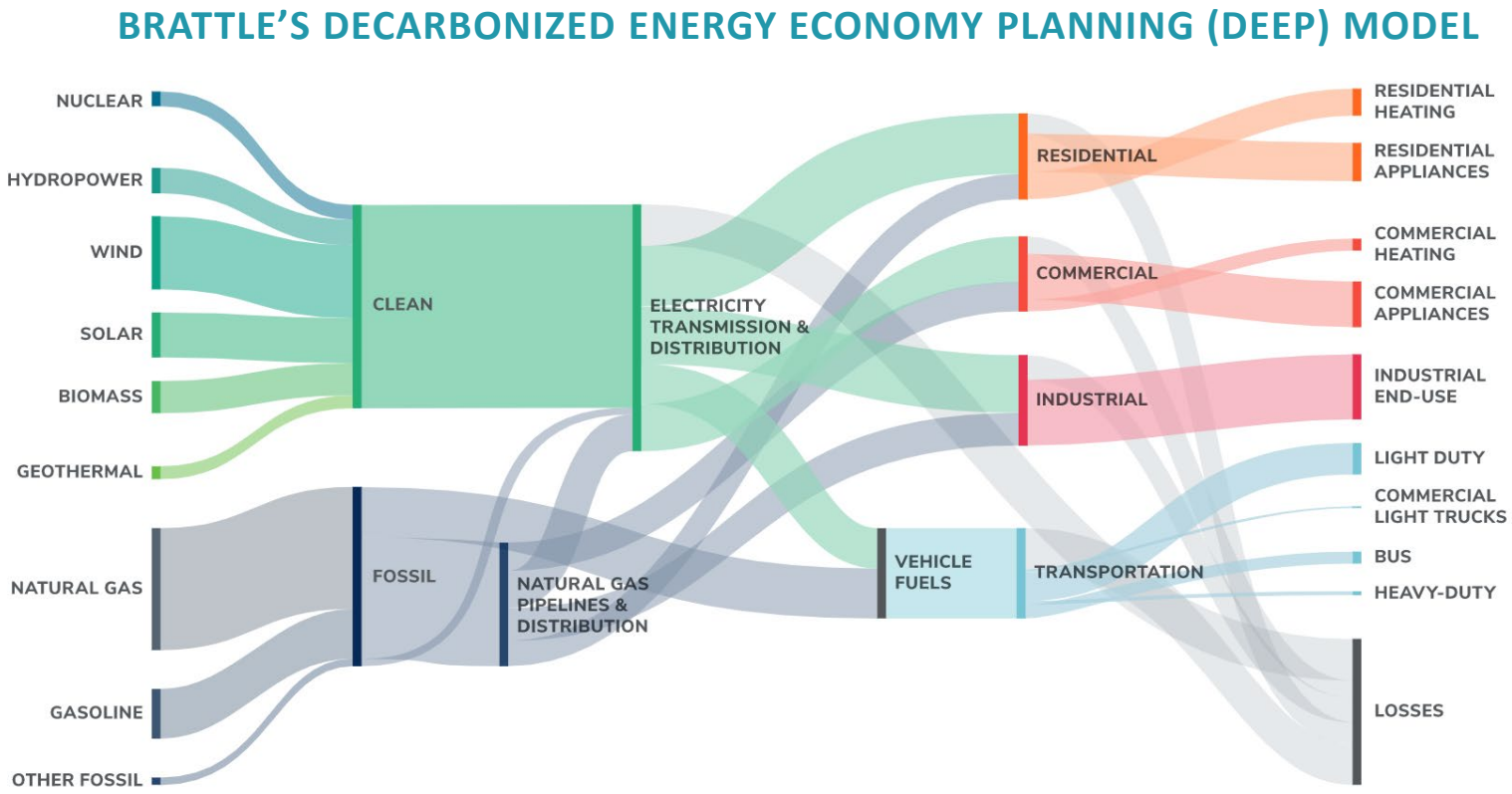


Note: Forecasts are generated by Brattle's clean fuel forecasting tool.

Most economic policy pathway should be grounded by a holistic view of the energy economy

New phase of integrated planning needed to manage policy pathway and contain costs, considering:

- Integrated planning across efficiency, electrification, and gas system considering emissions, safety, costs & equity
- Review total costs and emissions across electrification, fuel decarbonization, and mixed pathways
- Examine appropriate rate structures to equitably apportion the costs of clean energy transition

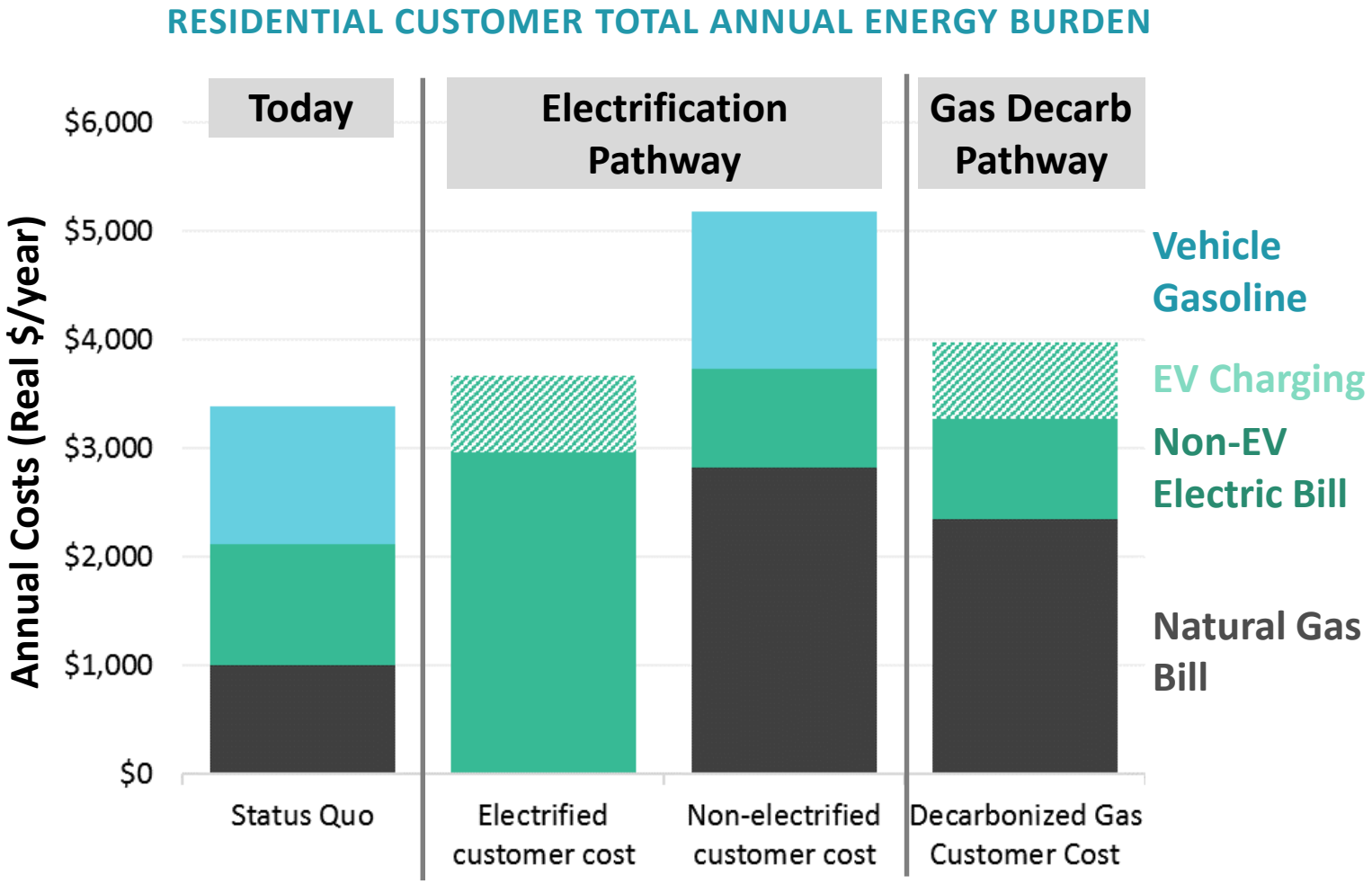


Notes: Brattle DEEP model represents flows of primary energy supply to customer energy demand across end uses and sectors, to examine cost and quantity of economy-wide carbon abatement opportunity, resulting electrification-driven demand growth, and (if relevant) multi-sector carbon market prices.

Gas rates in consideration of total energy burden

Total annual costs over the year (across all major uses) may increasingly be a critical component of policymaking and rates

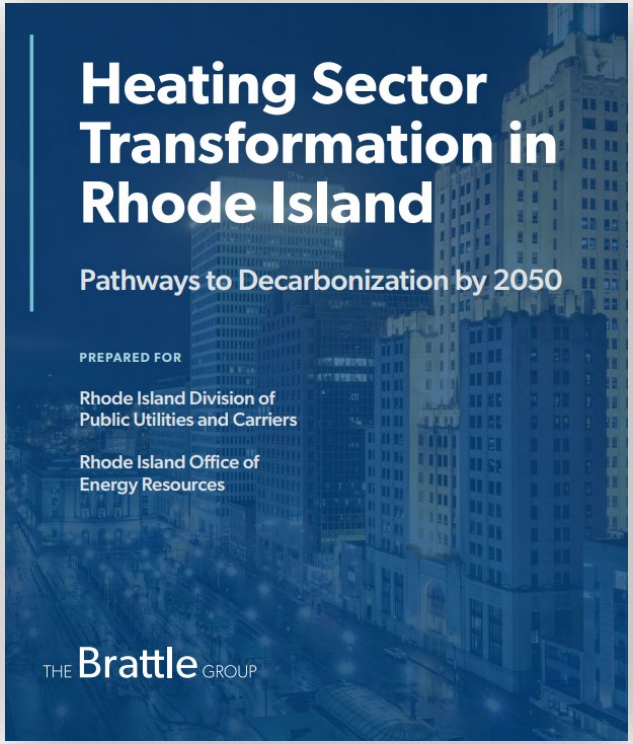
As of now, there is too much uncertainty to determine if electrification or gas decarbonization will prove more cost effective



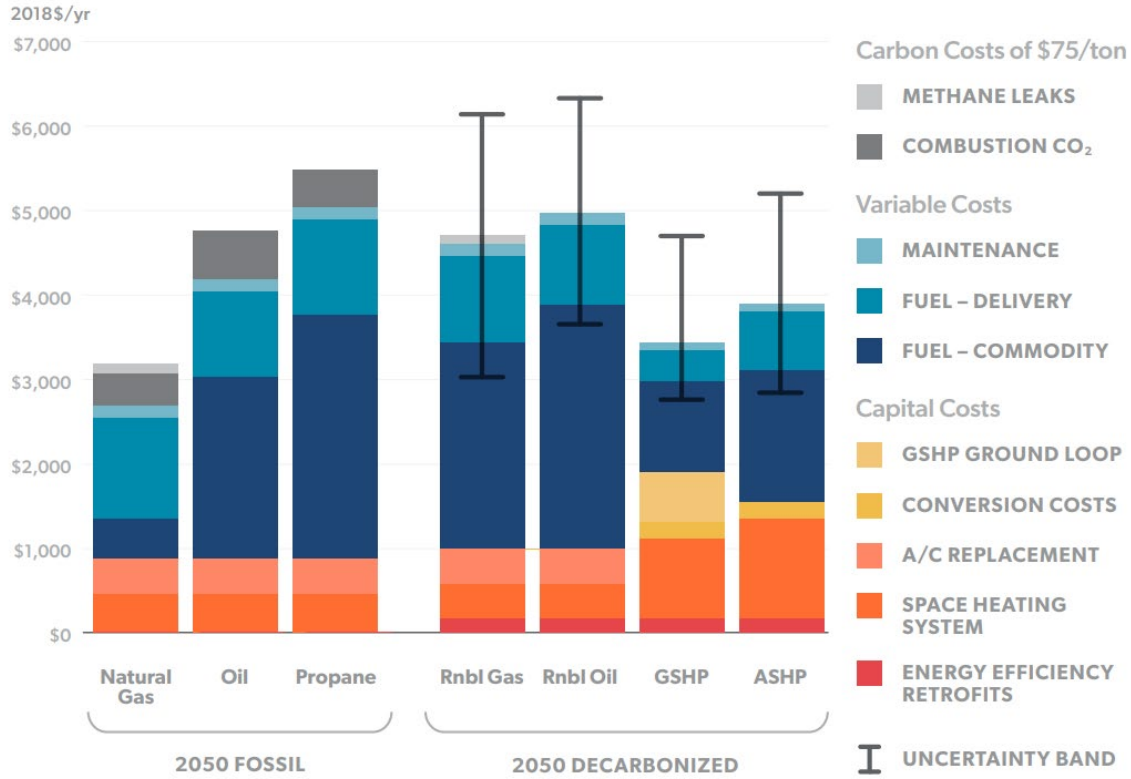
Notes: Illustrative, simplified assumptions. One-car residential customer. Approximate real 2050 costs.

Example: Rhode Island heating decarbonization study

Findings: Decarbonization would increase gas consumer costs relative to no-policy. As of now, there is too much uncertainty to determine whether electrification or gas decarbonization will prove more cost effective



ANNUALIZED COST OF SPACE HEATING IN 2050, REPRESENTATIVE SINGLE-FAMILY HOME



Source: Murphy, Weiss, The Brattle Group. Heating Sector Transformation in Rhode Island: Pathways to Decarbonization by 2050.

Pipelines

Thoughts on Interstate Natural Gas Pipeline Volume and Contract Declines: Who Bears the Risk? (Obligations are contract driven)

- **Newer P/Ls and Extension/Expansion Projects:** P/L bears unsubscribed capacity risk
  - For certain P/Ls, eventual roll-in into system-wide COS serves to mitigate P/L risk
- **Older Pipelines (>20 years):**
  - "Small" undersubscription: P/L bears shortfall 'til rate case; Max tariff customers bear justified "discounts" & throughput declines in post-rate-case rates
  - Exception: Negotiated rate shortfall borne by P/L unless tariff provision allowing shift
  - "Large" undersubscription: FERC expects P/Ls and shippers to "settle" on risk sharing
  - Not aware of FERC explicitly assigning large shortfall to P/L
- **Headroom:**
  - Historically, North America its own NG market. Supply booms pushed down commodity prices, providing "headroom" for P/Ls and LDCs to recover costs and still keep delivered rates low.
  - LNG export projects are slowly changing that dynamic: North America will gravitate toward world prices, reducing headroom for stranded cost recovery. Too early to determine severity.

Thoughts on Interstate Natural Gas Pipeline Volume and Contract Declines: Pricing Flexibility

- **P/L - charge market prices for short term firm and IT (e.g., TCPL)**
- **P/L - charge premium for hourly flexibility (EPNG)**
- **P/L - charge peak/off-peak prices:** Notion - twelve equal monthly demand charges is an arbitrary construct
- **Depreciation schedules tied to market, not basin:**
  - Traditionally, depreciation tied to basin – 35-, 40-, 50-year cost recovery.
  - Newer projects conditioned on market – e.g., 20 years.
- **Maximize max tariff customers under system-wide COS**
  - Easiest way to move costs around
- **Special-purpose Surcharges if P/L is underrecovering?**
  - Less successful when P/L already overrecovering

Thoughts on Interstate Natural Gas Pipeline Volume and Contract Declines: Operational Flexibility

- **Pipeline Integrity and Cybersecurity create cost pressure in wrong direction**
- **But, P/Ls with severely declining throughput are able to reduce cost structure:**
  - Mothballing or retiring compressors
  - Retiring uneconomic lines
  - Reducing staff through automation and shared services companies
- **P/Ls very successful in converting / reversing/ redeploying P/L assets**
  - Major Midstream Companies engaged in NA continent-wide arbitrage
  - Oil to gas, gas to oil, oil/gas to other products (CO2, ethane)
  - Would LDCs support limited conversion to renewable natural gas?

What’s Next?

Thoughts on next steps:

- **Private investments:** Reposition for the green economy
- **Policy changes for rate-regulated assets:**
  - Align utility incentives to manage spending on assets that may become stranded (acknowledge investments are essential to maintain public safety)
  - Enable risk-taking and innovation to drive clean energy transition
  - Address decarbonization pathway from a whole-of-economy cost and planning perspective
  - Rethink cost recovery for gas distribution systems considering equity and total energy burden, may require shifting some cost recovery to public sector or electricity ratepayers
- **Power markets:** Reflect consumer and policymaker demand for clean energy transition into wholesale markets (carbon pricing, competitive clean energy markets)

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