ENERGY SOLUTIONS CENTER

Track: Natural Gas Basics
Unit 3: Natural Gas Supply, Consumption, Production, Operations, and Pricing

Eric Burgis, Energy Solutions Center

Presentation Outline

- Supply
- Distribution
- Natural Gas Consumption
- Production
- Pipeline Operation
- Pricing
- Metering
- LNG Exports

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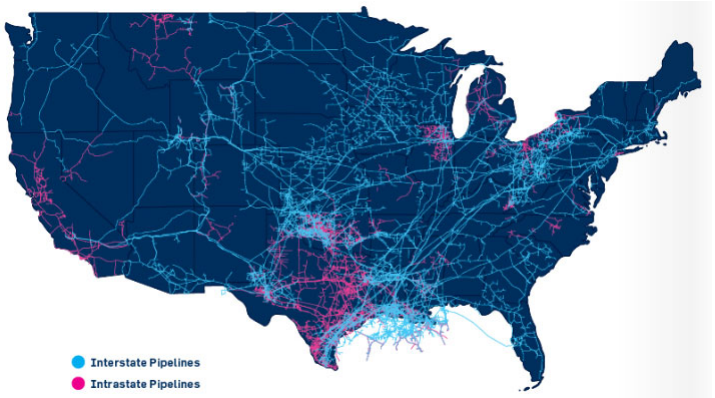
Natural Gas Supply

Interstate Pipeline Network



- 2.6 million mile underground system
- ~2.2 million LDC, ~300,000 Transmission

Source: AGA Playbook

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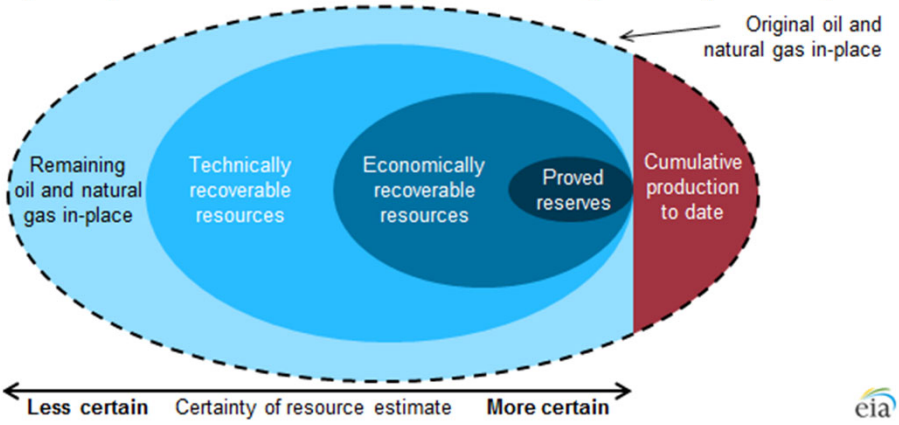
Resources & Certainty

Stylized representation of oil and natural gas resource categorizations (not to scale)



https://www.eia.gov/todayinenergy/detail.php?id=17151

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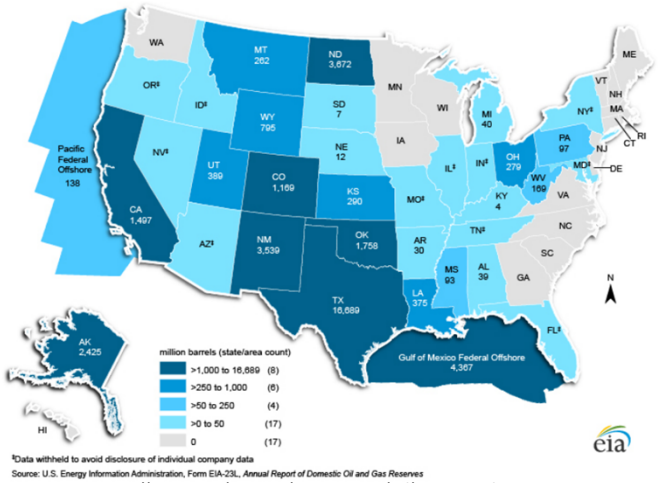
U.S. Proved Reserves

Figure 14. Proved reserves of U.S. crude oil and lease condensate by state/area, 2020

2020 U.S. proved reserves of crude oil and lease condensate: 38,212 million barrels



¹Data withheld to avoid disclosure of individual company data

Source: U.S. Energy Information Administration, Form EIA-23L, *Annual Report of Domestic Oil and Gas Reserves*

https://www.eia.gov/naturalgas/crudeoilreserves/pdf/usreserves.pdf

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U.S. Production, Imports & Exports (Million Cubic Feet)

	U.S. Gas Imports or Production	U.S. Gas Exports
Pipeline Canada	2,784,438	937,124
Pipeline Mexico	1,718	2,154,457
LNG Total	21,587	3,560,818
CNG Canada	217	211
U.S. Gross Withdrawals & Production	41,666,118	

https://www.eia.gov/dnav/ng/ng_move_expc_s1_a.htm

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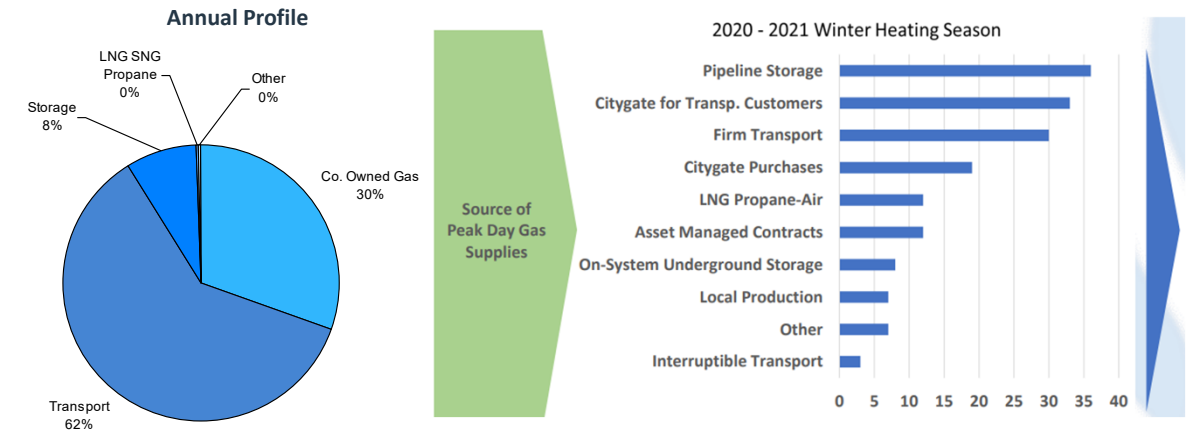
Typical LDC Gas Supply Management



Source: Energy Information Administration, AGA Survey

https://www.aga.org/wp-content/uploads/2023/01/WHS-2020-2021-Jan-23-Presentation.pdf

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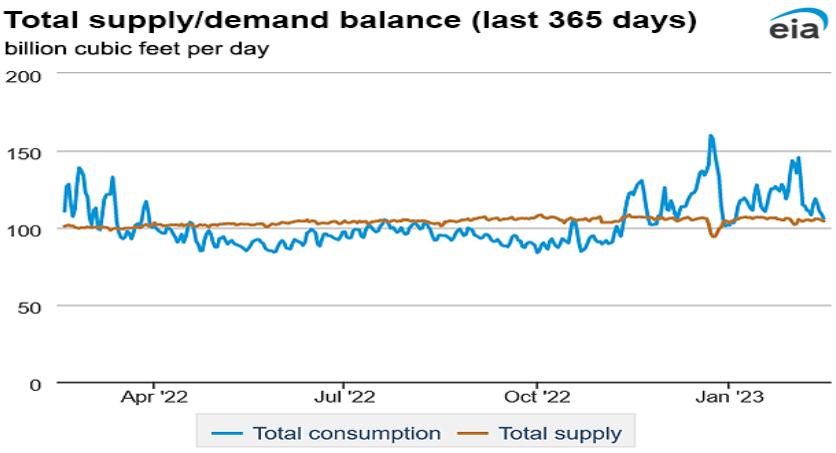
Gas Supply & Demand



Data source: S&P Global Commodity Insights

EIA: Natural Gas Weekly

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Gas Supply Management

- Gas Supplier Options
  - Intrastate pipeline
  - Producer
  - Marketer
  - Company-owned production
- Gas Contract Options
  - Length
  - Pricing
    - Indexed (monthly, weekly)
    - Fixed
    - Spot
    - Hedged (NYMEX)

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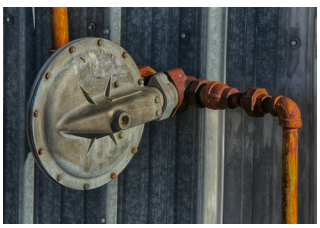
Distribution Operations

Distribution Operations

- Supply Management
- Gate Stations
  - Odorant
  - Pressure reduction
- Construction



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Supply Management

- Represents how the industry works – the supply chain for natural gas from the identification of resources to the end user
- System must be redundant
  - Redundancy within the US natural gas supply chain enables critical components to continue to operate in case of disruptions to the system
- Resiliency of the system
  - The redundancy of components and the resiliency of the system design inhibit traditional chokepoints in the natural gas supply chain

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Gate Stations

- The "city gate" station is the place where the long-distance pipeline connects with the gas utility's own delivery system
- Before distribution the gas pressure is lowered so gas can travel safely through the distribution mains
- The utility will add Mercaptan – a non-toxic odor (similar to rotten eggs) so it's easy to smell a natural gas leak
- The local gas utility delivers natural gas through a system of underground pipelines "mains" that are the pipes that carry gas from the city gate station to the customer

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Construction

- Utilities study their gas pipeline system to be sure it meets service & security expectations
- Except for gas service lines, the pipe used in natural gas pipeline systems can range in size from 2 inches to 42 inches in diameter
- Natural gas distribution systems have been constructed from many different materials including cast iron, steel, copper, and plastic pipe
- Plastic pipe is most commonly installed today for gas distribution systems

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Construction

- Much of the main line construction is bid out to contractors when the work involves new installation or replacement/retrofit of the piping network

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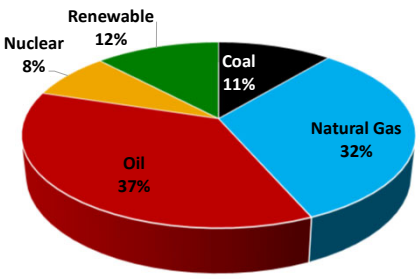
Natural Gas Consumption

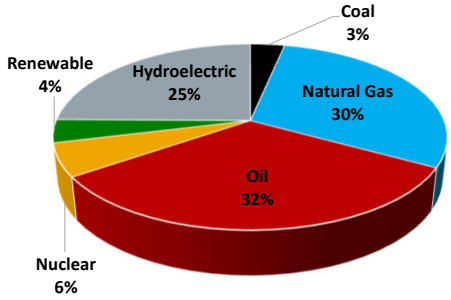
Total Energy Consumption

- Natural Gas accounts for almost 1/3rd of U.S. & Canadian primary energy consumption.

U.S. Primary Energy Consumption



Canada Primary Energy Consumption



Electricity that is generated using fossil fuels is a secondary source of energy

Source: Dept. of Energy, Energy Information Administration & Statista.com

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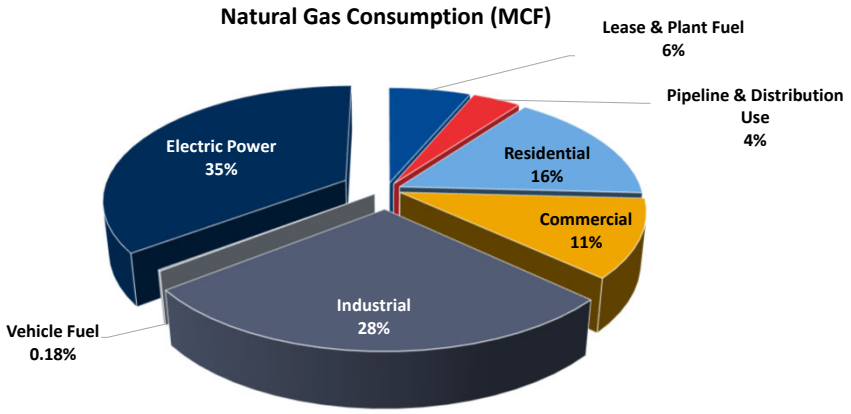
Natural Gas Consumption – U.S.



http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm

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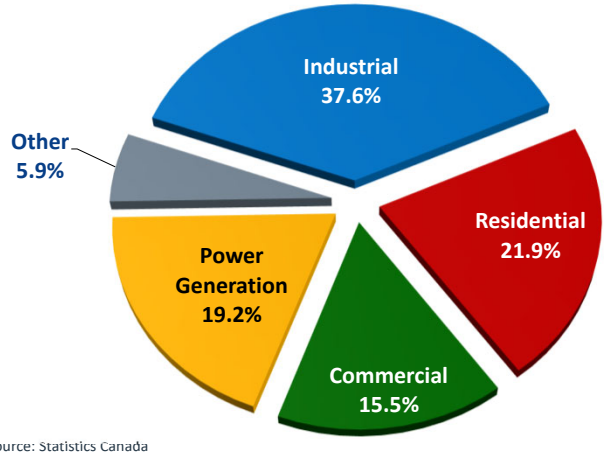
Natural Gas Consumption - Canada



Source: Statistics Canada

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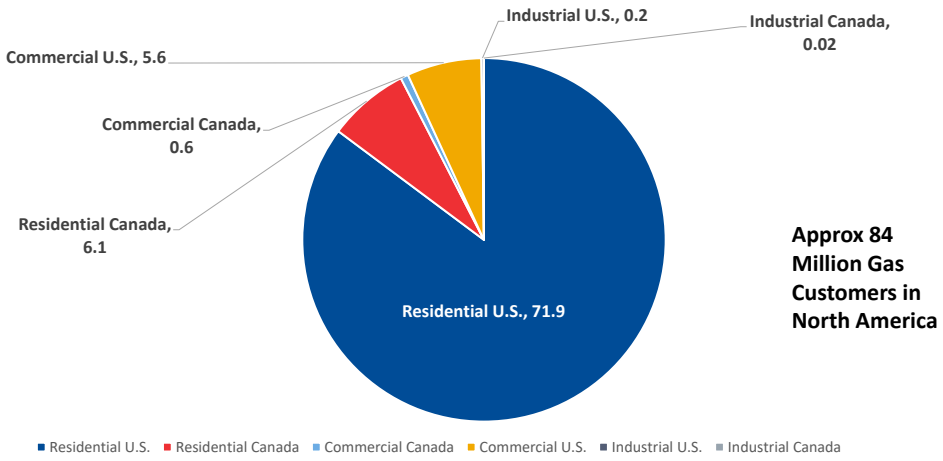
Number of U.S. & Canadian Consumers (Millions)



Approx 84 Million Gas Customers in North America

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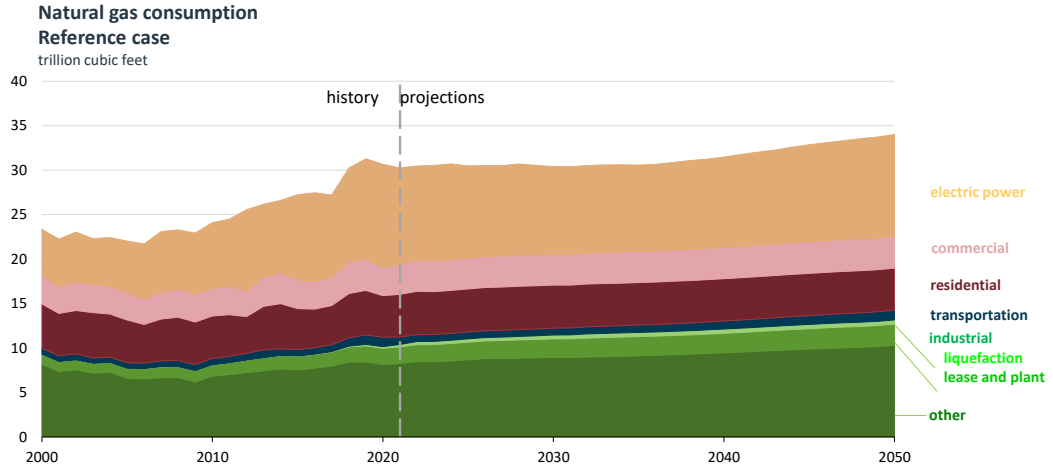
Natural Gas Consumption Growth



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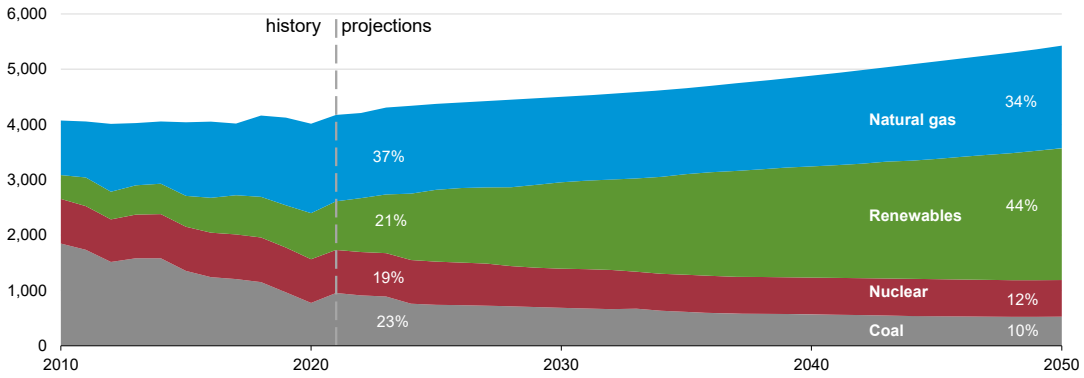
Electric Generation Shifted from Coal to Gas & Renewables

U.S. electricity generation from selected fuels
AEO Reference case
billion kilowatthours



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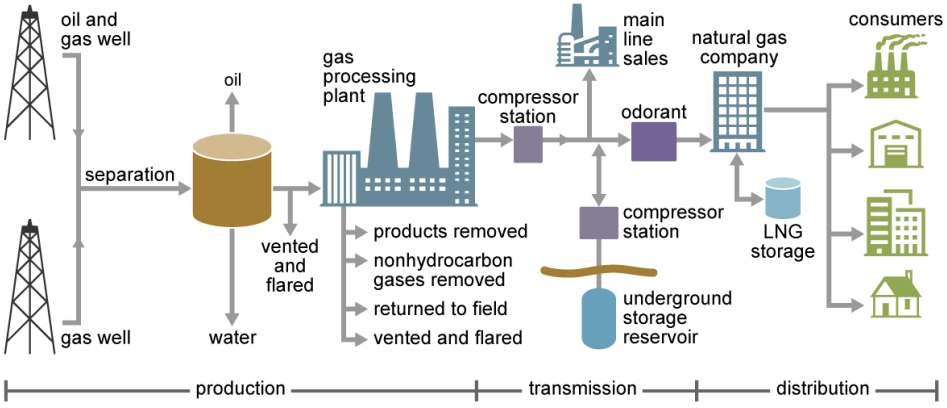
Gas Production

Natural Gas Production & Delivery



Source: U.S. Energy Information Administration

https://www.eia.gov/energyexplained/natural-gas/

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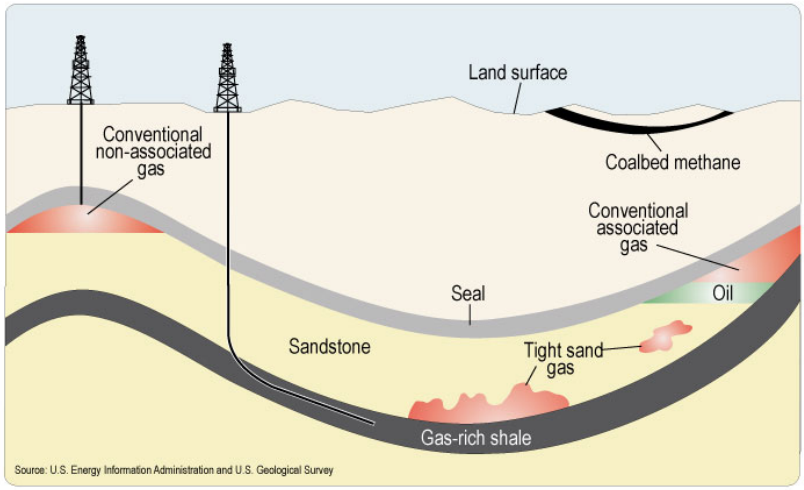
Marketed Natural Gas Production



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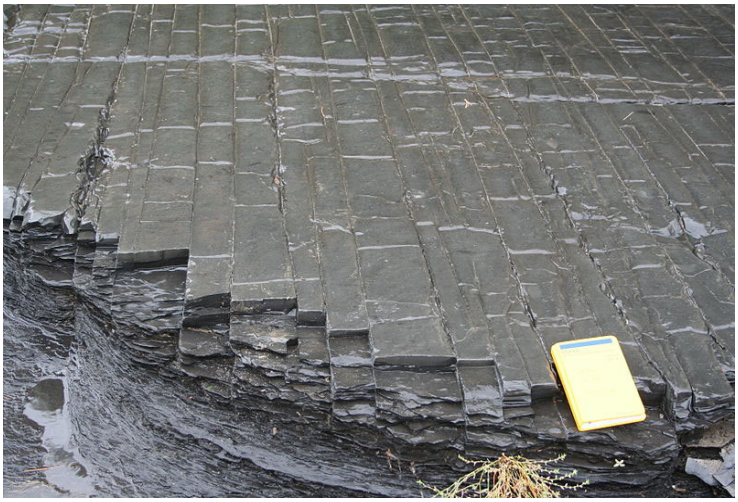
Outcrop – Utica Shale



Source: www.wikipedia.org/wiki/Utica_Shale.

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Domestic Abundance

Source: Energy Information Administration based on data from various posted studies

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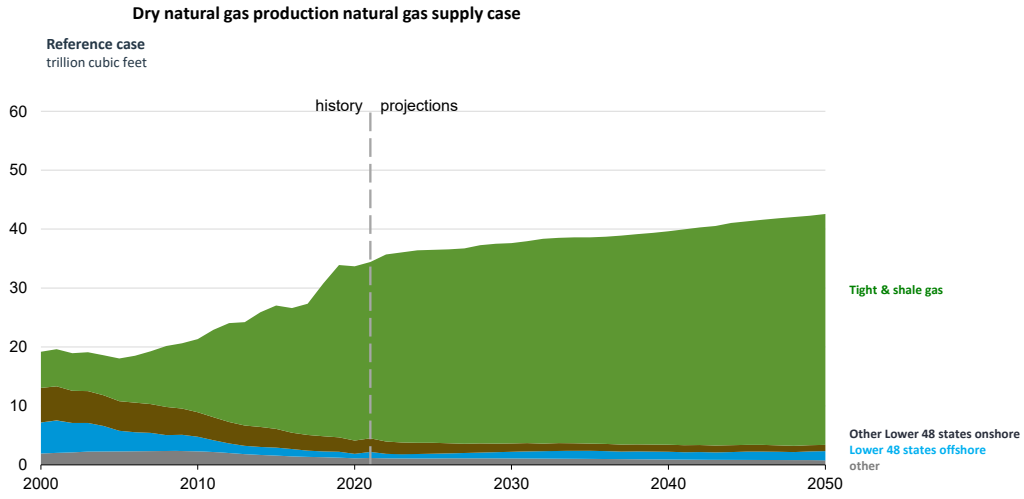
U.S. Natural Gas Production, 2000-2050



Note: *Tight and shale* gas includes tight gas, shale gas, and natural gas from tight oil formations.

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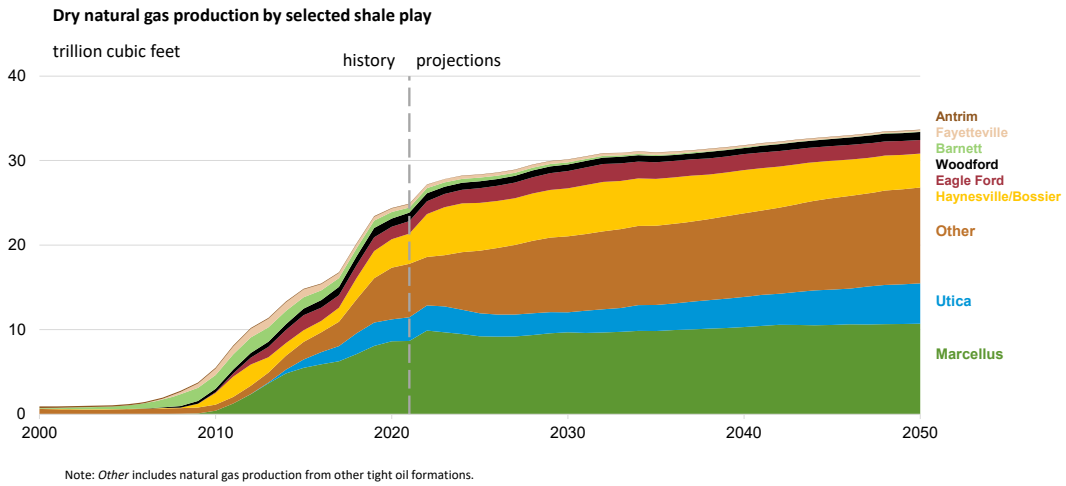
Shale Gas Production



Note: *Other* includes natural gas production from other tight oil formations.

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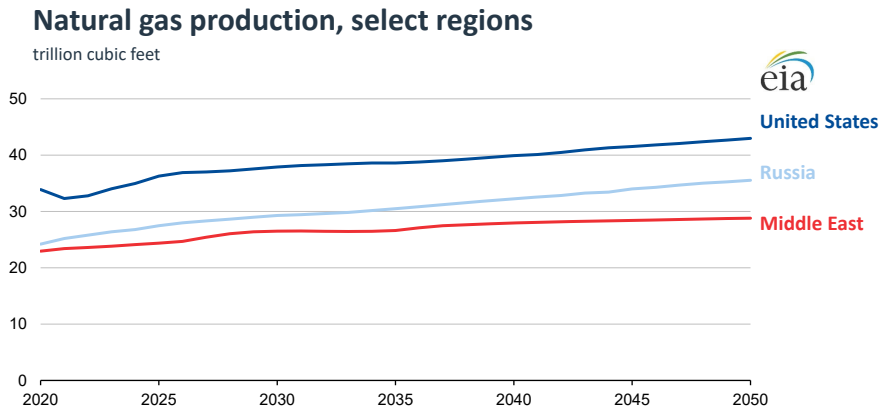
Worldwide Natural Gas Production



Source: U.S. Energy Information Administration, International Energy Outlook 2021 (IEO2021) Reference case

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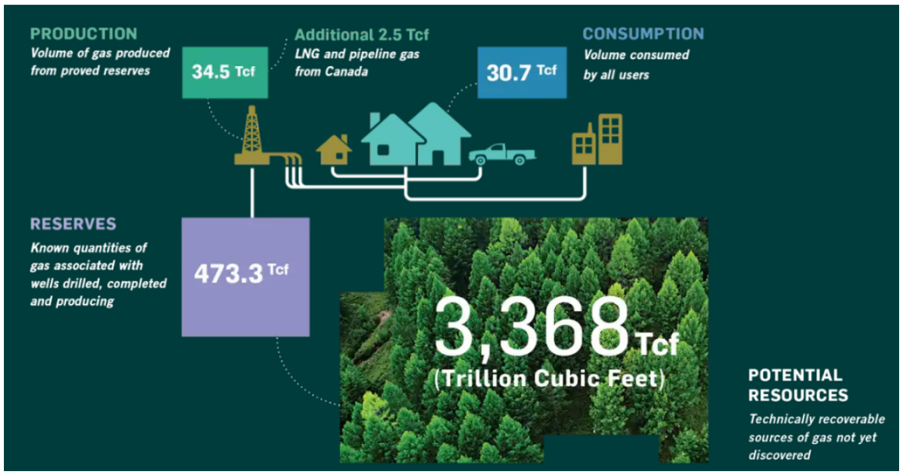
More than 100 Years of Supply



2023 AGA Playbook, https://playbook.aga.org/natural-gas-data

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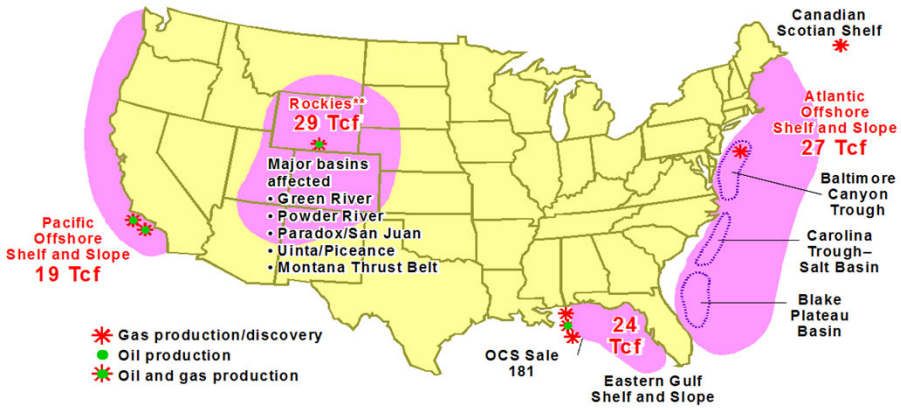
Undiscovered Gas



Source: Cambridge Energy Research Associates
Note: 207 Tcf have restrictions or are off limits
99 Tcf are off limits for exploration and development
An additional 108 Tcf of the Rockies gas resources are available with restrictions

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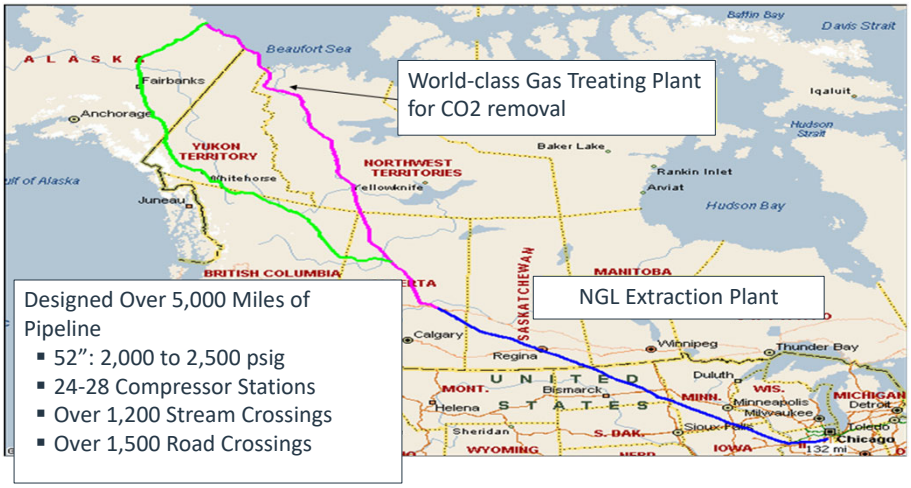
Alaskan Potential



Proposed 4.5 BCF/D pipeline adds 35-40 TCF of reserve immediately

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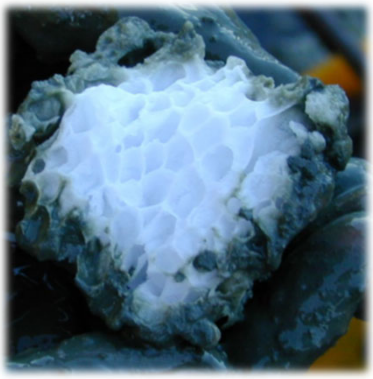
Methane Hydrates

- 10,000 TCF U.S. alone
- The DOE/NETL program has a project portfolio that includes field and laboratory efforts aligned with the research areas described above. Current projects are designed to fill remaining gaps in the program, while pushing methane hydrate R&D to the next level.



Gas hydrate piece, from the subduction zone off Oregon

Source: DOE NETL R&D Program 2020, https://www.netl.doe.gov/sites/default/files/2020-02/NETL-Methane-Hydrate-Program-2000-2020.pdf

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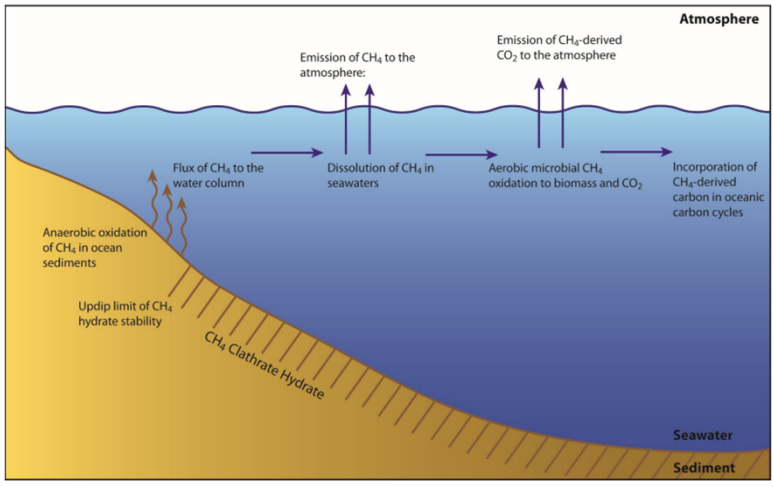
Methane Hydrates



Source: DOE NETL R&D Program 2020, https://www.netl.doe.gov/sites/default/files/2020-02/NETL-Methane-Hydrate-Program-2000-2020.pdf

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Natural Gas Pipeline Operation

Operations

- Pipeline Operations
  - Compression
  - Maintenance
  - Underground Storage
- Distribution Operations
  - Gate Stations
  - Mains and Services
  - Metering

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Gas Compressor Station

- Compressor stations are facilities that assists the transportation process of natural gas from one location to another
- Natural gas, transported through a gas pipeline, needs to be re-pressurized at intervals of about 40 to 100 miles

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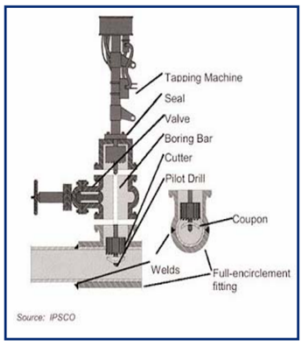
Pipeline Maintenance

- Hot taps reduce Methane Emissions
  - A new branch connection can be added to existing gas line while the pipeline remains in service.
  - Attaches a branch connection and valve to the main pipeline.
  - Cut-out a section of the main pipeline wall through the valve to connect the branch to the main pipeline.



Source: Williamson Industries Inc.

https://www.epa.gov/sites/default/files/2017-07/documents/june-charlotte-pipeline.pdf

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Pipeline Maintenance ….continued

- Composite Wraps
  - Can be performed without taking pipeline out of service
  - Repair is quick and less costly than replacement or sleeve options
  - Eliminates venting associated with replacement
- Cast Iron Joint Sealing Robots
- Robotic system inserted into live 15 to 31 cm diameter cast iron distribution lines to seal leaking joints with an anaerobic sealant.
- No service disruption and minimal excavation

Source: Armor Plate

Source: ConEdison

https://www.epa.gov/sites/default/files/2017-07/documents/june-charlotte-pipeline.pdf

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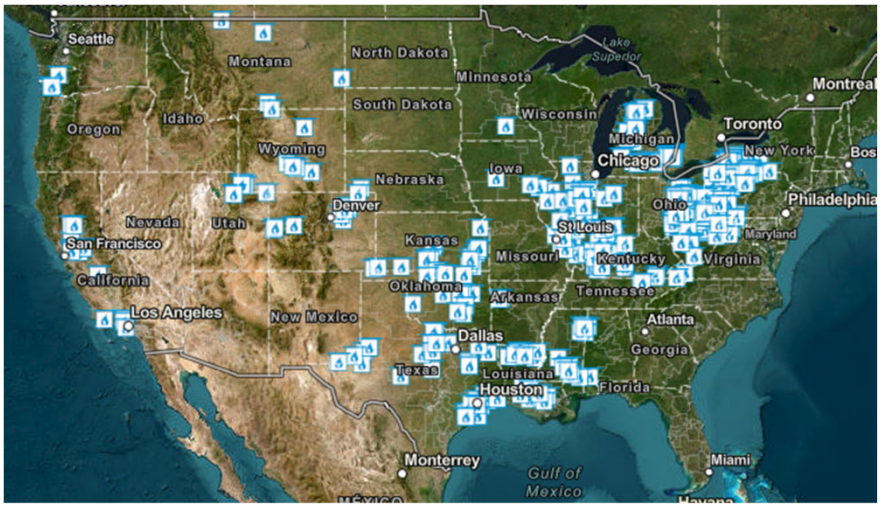
Natural Gas Underground Storage



https://atlas.eia.gov/apps/all-energy-infrastructure-and-resources/explore

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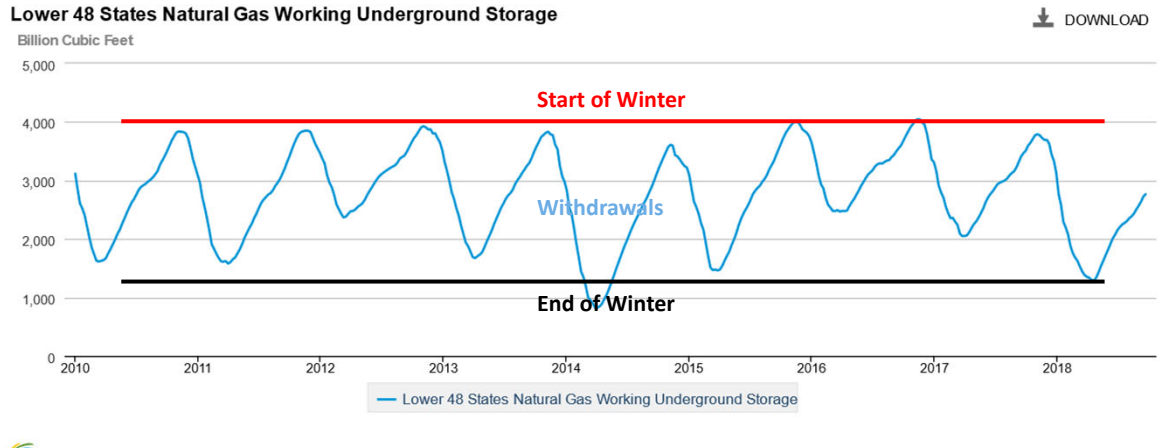
Natural Gas in Underground Storage



Source: U.S. Energy Information Administration

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Gate Stations

- Facility typically is owned and operated by a municipality or local gas utility and interconnects the long-distance interstate pipeline with a local distribution network
- City gate stations are composed of valves, pipes, and pressure reduction devices to allow gas to be delivered safely to customers
- Odorant is often added at the City gate Station

northshoregasdelivery.com

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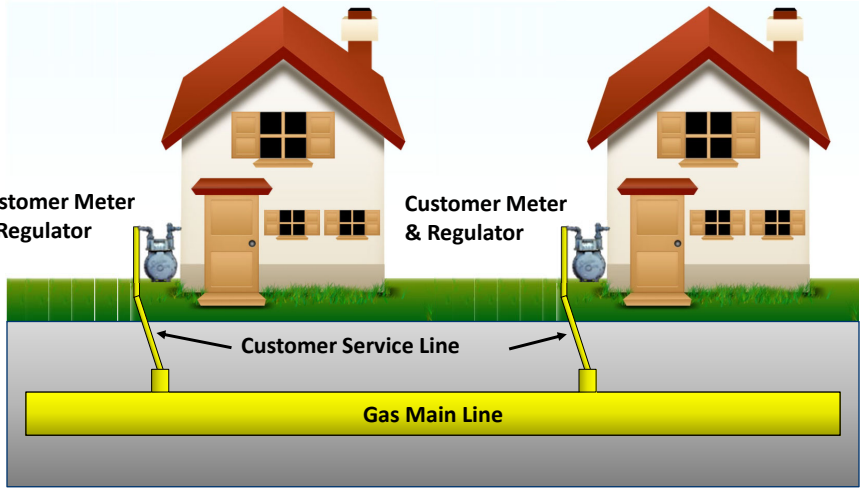
Mains and Services



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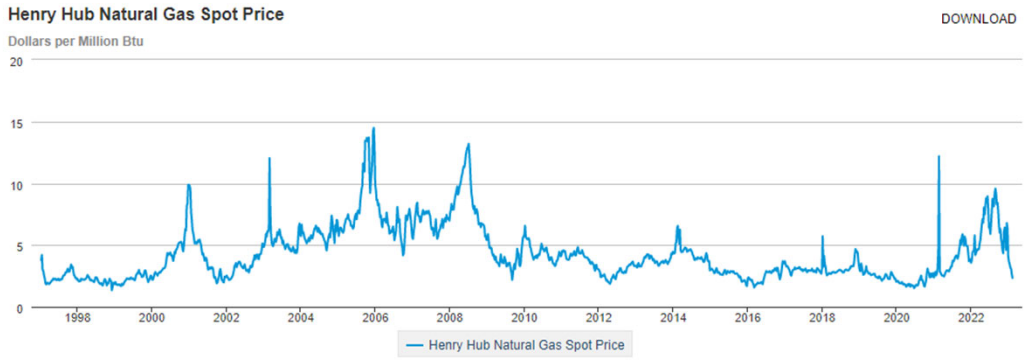
Natural Gas Pricing

Historical Pricing

Henry Hub Natural Gas Spot Price
Dollars per Million Btu



http://www.eia.gov/dnav/ng/hist/rngwhhdd.htm

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Pricing to LDC

- Rate of return regulated by FERC
  - Traditional contracts with set rates
  - Capacity release market
- Types of contracts/services
  - Firm
  - Interruptible
  - Transportation
  - Other
- Factors impacting returns
  - Demand - weather
  - Competition from other pipelines
  - New construction
  - Conservation

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Pricing to Consumer

- Regulated pricing (supply and transportation)
  - Firm
  - Interruptible
- Deregulated pricing (transportation only)
  - Firm
  - Interruptible

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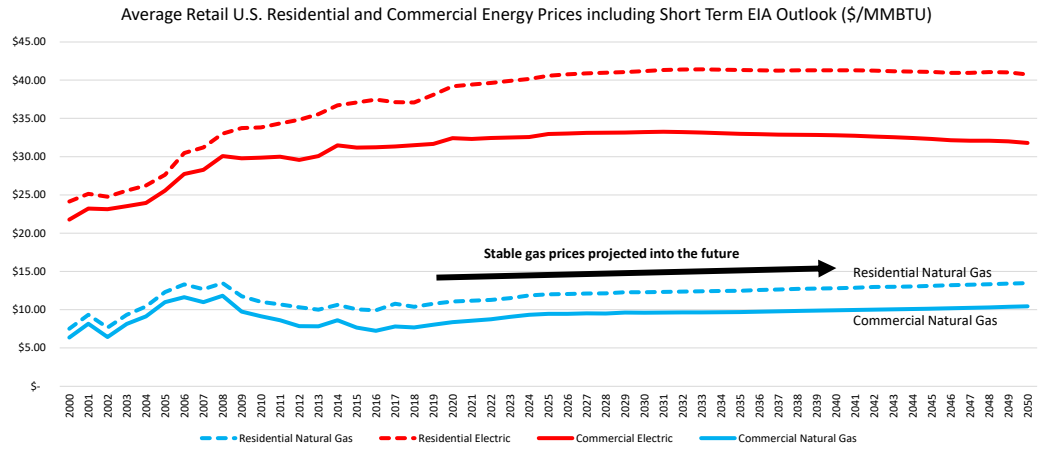
Market Stability



EIA STEO

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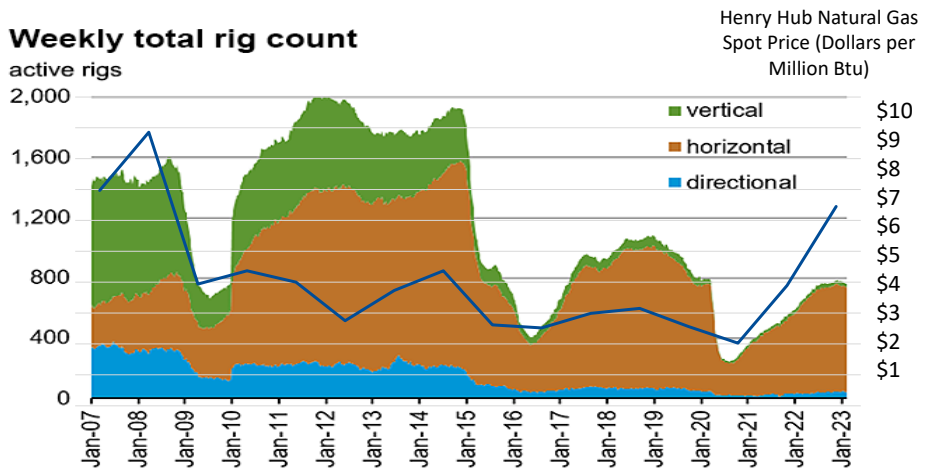
Rig Count Versus Spot Price



Data source: Baker Hughes Company

https://www.eia.gov/naturalgas/weekly/

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Metering

Meter Types

- Diaphragm/bellows meters
- Rotary meters
- Turbine meters
- Orifice meters
- Ultrasonic flow meters

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Diaphragm/Bellows Meter

- Most common type of positive displacement gas meter used for residential and small commercial installations
- Meter has two or more chambers formed by movable diaphragms

American Meter Company

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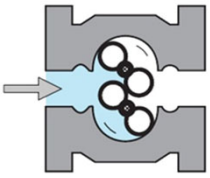
Rotary Meter

- Highly machined precision instrument capable of handling higher volumes and pressures than diaphragm meters
- Within the meter, two figure "8" shaped lobes, the rotors (also known as impellers or pistons) spin in precise alignment
- With each turn, they move a specific quantity of gas through the meter



https://dresserutility.com/dresser-measurement/rotary-meters-2/

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Turbine Meter

- Turbine gas meters infer gas volume by determining the speed of the gas moving through the meter
- Because the volume of gas is inferred by the flow, it is important to have good flow conditions

https://sensus.com/products/mark-ii/

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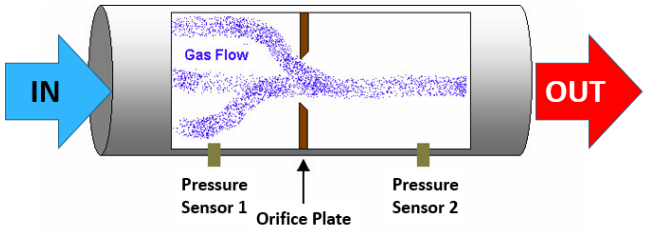
Orifice Meter

- Orifice gas meters consist of a straight length of pipe inside which a precisely known orifice creates a pressure drop, thereby affecting flow
- These are a type of differential meter, all of which infer the rate of gas flow by measuring the pressure difference across a deliberately designed and installed flow disturbance



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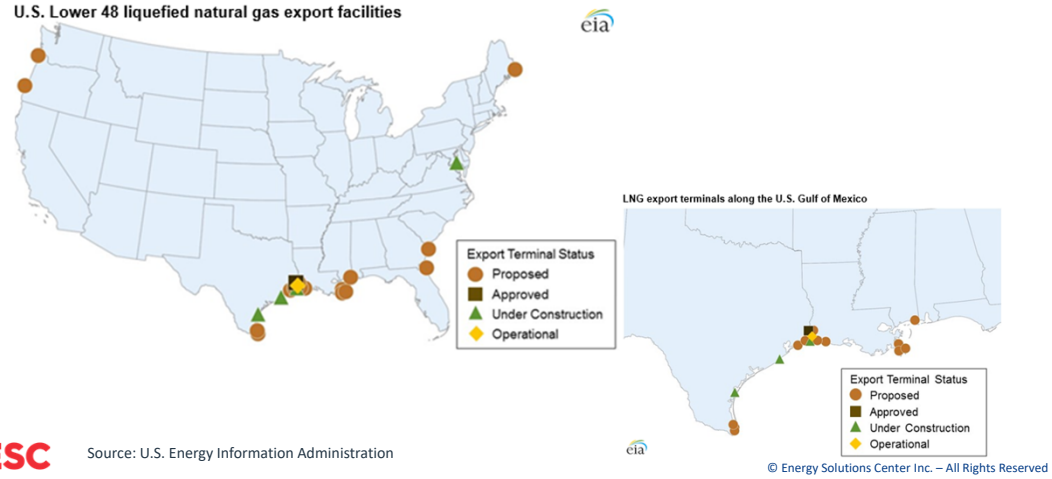
LNG Exports

LNG Exports

U.S. LNG Export Terminals Proposed, Approved, Under Construction, and Operational



Source: U.S. Energy Information Administration

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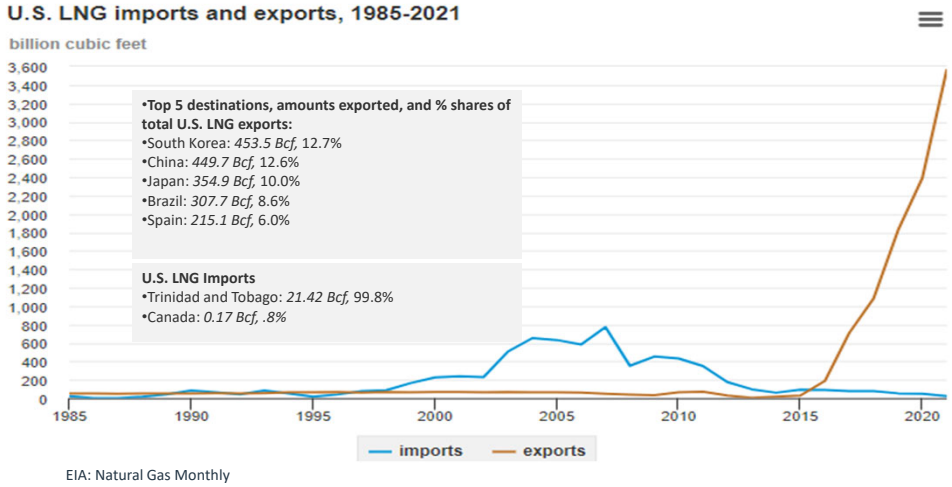
U.S. Natural Gas Imports & Exports



EIA: Natural Gas Monthly

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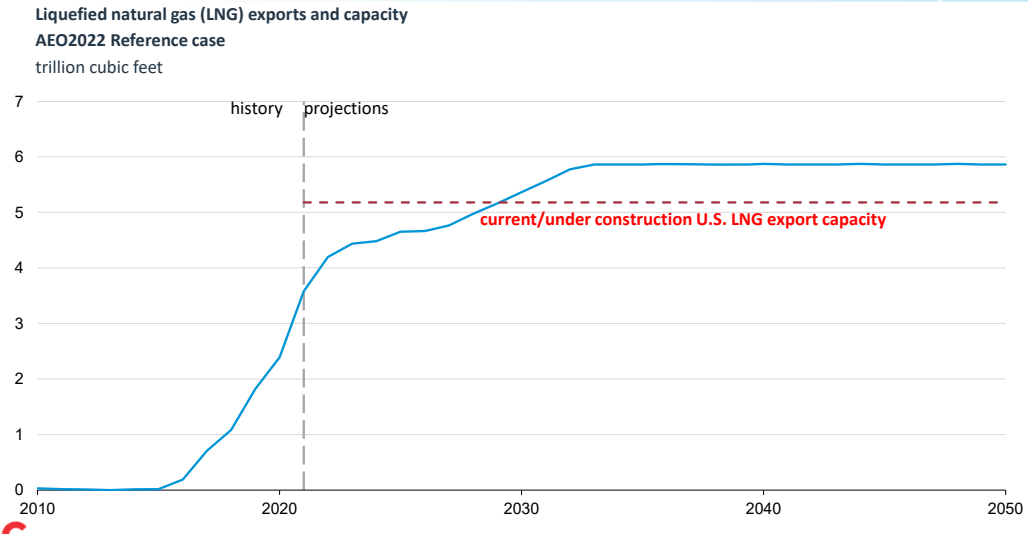
U.S. LNG Exports & Capacity



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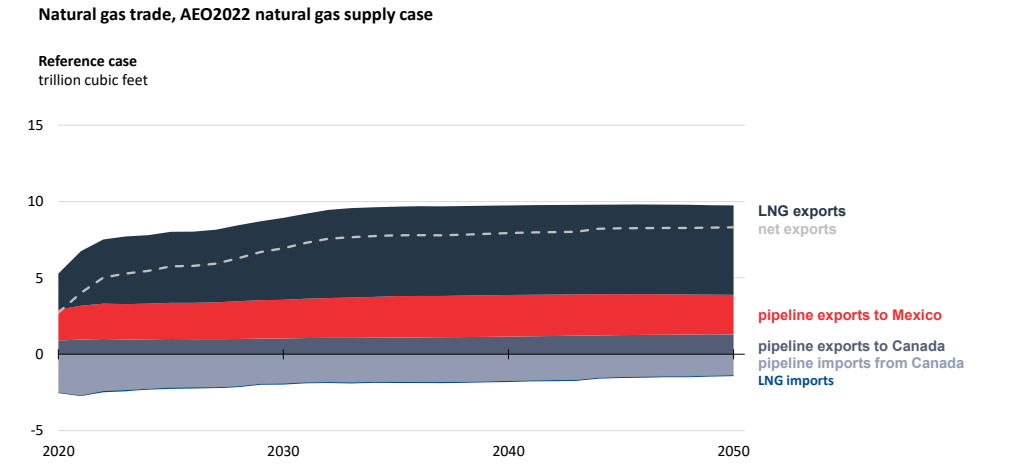
U.S. Imports and Exports



EIA's Annual Energy Outlook

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