

GAS/ELECTRIC PARTNERSHIP CONFERENCE XXVIII  
FEBRUARY 5, 2020

***LNG Facility Applications for the 21<sup>st</sup> Century  
LNG Peak Shaving, LNG as Commodity, LNG as Energy  
Storage***



Presented by



**New Energy  
Development Company**  
STRATEGY | PROJECT DEVELOPMENT | CAPITAL

Tom Quine, Partner  
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We deliver to midstream companies, local distribution companies, utilities, and other sponsors completely optimized, commercially operating LNG, natural gas, sustainability, and storage solutions stemming from our comprehensive capabilities:

1. Strategic market assessment and commercial structuring,
2. Complete project development and
3. Institutional co-investment

3. INSTITUTIONAL CO-INVESTMENT

# Meet the New Energy Development Leaders



*Hap Elliot*

Alexander “Hap” Ellis III, Managing Member, New Energy Development Company provides project development, strategic and advisory services in LNG, natural gas, and sustainable investments relating to his extensive experience in project development, corporate and industry strategy, commercial structuring and negotiations, risk management and corporate finance.

Mr. Ellis has served for 18 years as General Partner at RockPort Capital Partners (\$845 million AUM), a multi-stage venture capital firm that invests in alternative and traditional energy, mobility, and sustainability. He has over 40 years of executive experience originating, developing, funding and serving as executive in leading independent power companies and sustainable energy firms. Mr. Ellis is the chairman of The George and Barbara Bush Foundation Board of Directors as well as the Old Westbury Funds (\$34 billion AUM) Board of Directors. He is a graduate of Colorado College with a BA in Political Science and earned an MPPM from the Yale School of Management.



*Thomas Quine*

Thomas G. Quine, Partner, New Energy Development Company provides project development, strategic and engineering advisory services in LNG, natural gas, and energy relating to his more than forty years of experience in LNG and natural gas project development, company leadership, complex LNG plant operations, systems design and mechanical engineering, and project planning and control.

Mr. Quine was recently Founder, CEO, and Chairman of Northstar Industries LLC, a prominent and respected LNG and natural gas engineering and construction business. Mr. Quine grew Northstar over 24 years, successfully developing and leading many high-profile LNG and energy projects, revolutionizing the small and medium-scale LNG and natural gas midstream industry, including by means of modular liquefaction designs and other patented systems. Mr. Quine graduated with a BS in Electrical Engineering from Wentworth Institute of Technology and a BA in Legal Studies from the University of Massachusetts, Amherst.



*Scott Shields*

Mr. Shields, Partner, New Energy Development Company provides project development, strategic and advisory services in LNG, natural gas, energy and sustainable investments relating to his extensive experience in project development, corporate and industry strategy, commercial structuring and negotiations, trading, risk management and corporate finance. He most recently provided strategic consultancy services through Morgan Shields Energy LLC, a company he founded 10 years ago.

Scott Shields brings 25 years of executive experience from Repsol LNG, Exxon Corporation, and Enron Capital & Trade, combined with integrated start up consulting from many LNG projects and energy companies over 10 years at Morgan Shields Energy LLC. He is a military veteran and served as co-founder & board member at Oasis Bank SSB before its merger and subsequent IPO at nearly \$1 billion in valuation (NASDAQ: STXB). Mr. Shields is FINRA-licensed Series 79, 82, and 63, graduated with an MBA from the University of Chicago Booth School of Business, and a BS in Finance from the Pennsylvania State University.

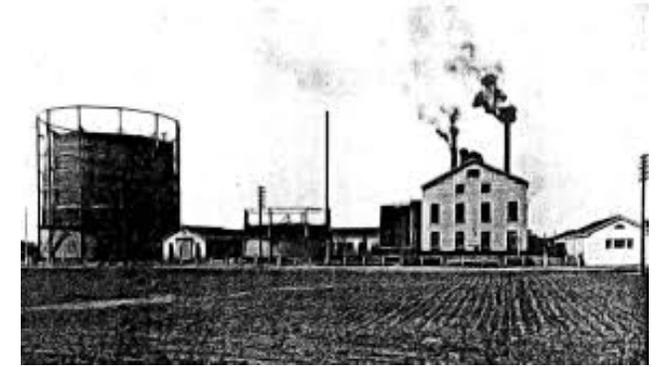
# AGENDA FOR PRESENTATION

- **US Gas History:** Manufactured Gas, Natural Gas Pipelines, LDC's Gas Storage, LNG, LPG/Air
- **Regulatory Milestones:** 1938-Present
- **Overview of Supply Chain:** Emphasis on LNG
- **21<sup>st</sup> Century Applications – Welcome to The Future**
- **Closing Thoughts, Q&A,**
- **Appendix Technical Items: (As Time Permits)**
  - LNG Plant Design Site layouts, Process Flow Plant Systems
  - Siting Requirements: Thermals and Vapors
  - Jurisdiction: 49 CFR 193/FERC/NFPA 59 A for Other
  - Stage Gate Project Development Cycle and Low Risk Schedules

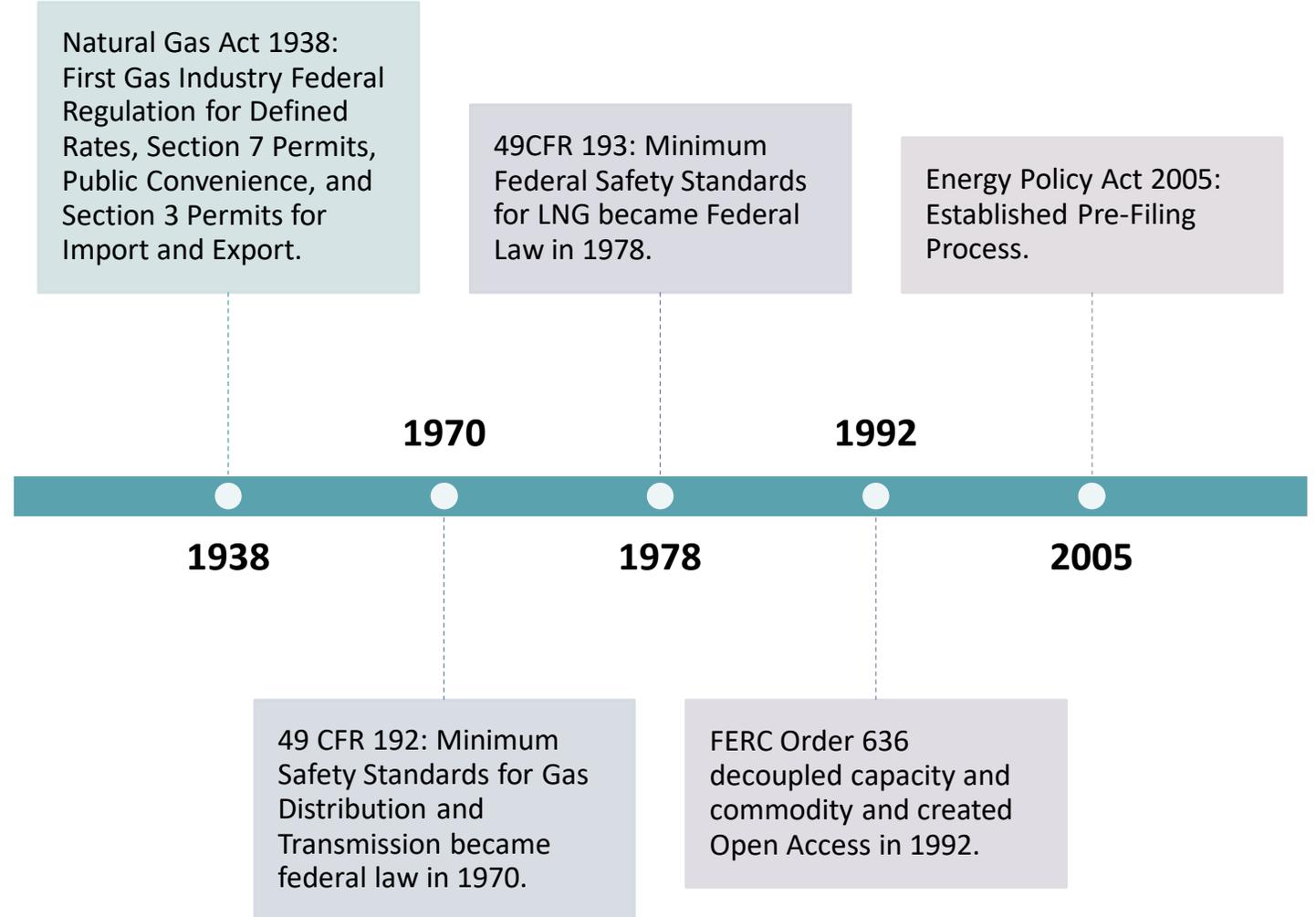


# Manufactured Gas & Nat Gas by Decade

- Mid-1800 : 500 BTU/CF Manufactured Coal Gas was being utilized in major US cities by the Civil War
  - Numerous Municipal gas lighting and
  - Then heavy industrial applications
- 1950: Natural Gas Transmission arrived in NE
  - Complete Appliance Conversion was Required
  - 1000 BTU/CF Fuel
- 1960: Propane Air was quickly identified as a peak shaving Fuel
- 1960-70: LNG and NY/PA midstream gas storage were developed in parallel
- 1999: LNG Import peaked at 800 BCF/Y
- 21<sup>st</sup> Century Fracking Technology Shale plays make importing LNG unattractive
- Current: Abundant supply of natural gas lowers prices and creates LNG commodity market



## Key Regulatory Milestones



# US Gas Supply Summary

- US LARGEST NG PRODUCER IN WORLD: 30 TCF/Y
- US consumes 40 Quads/year as oil; half of it is imported
- Oil is about twice the cost of NG yet we import 20 Quads/Year
- ~110 LNG Facilities in US
- ~120 BCF of LNG storage in US
- 38 LNG plants located in Northeast
- ~4 TCF of underground storage in US
- ~400 gas storage fields in US
- Gas costs \$2.60/dekatherm or MMBTU
- In a 100 Quadrillion BTU/Year US Economy oil/gas/coal/renewables are converging at a quickening PACE.

[www.NewEnergyDev.com](http://www.NewEnergyDev.com)

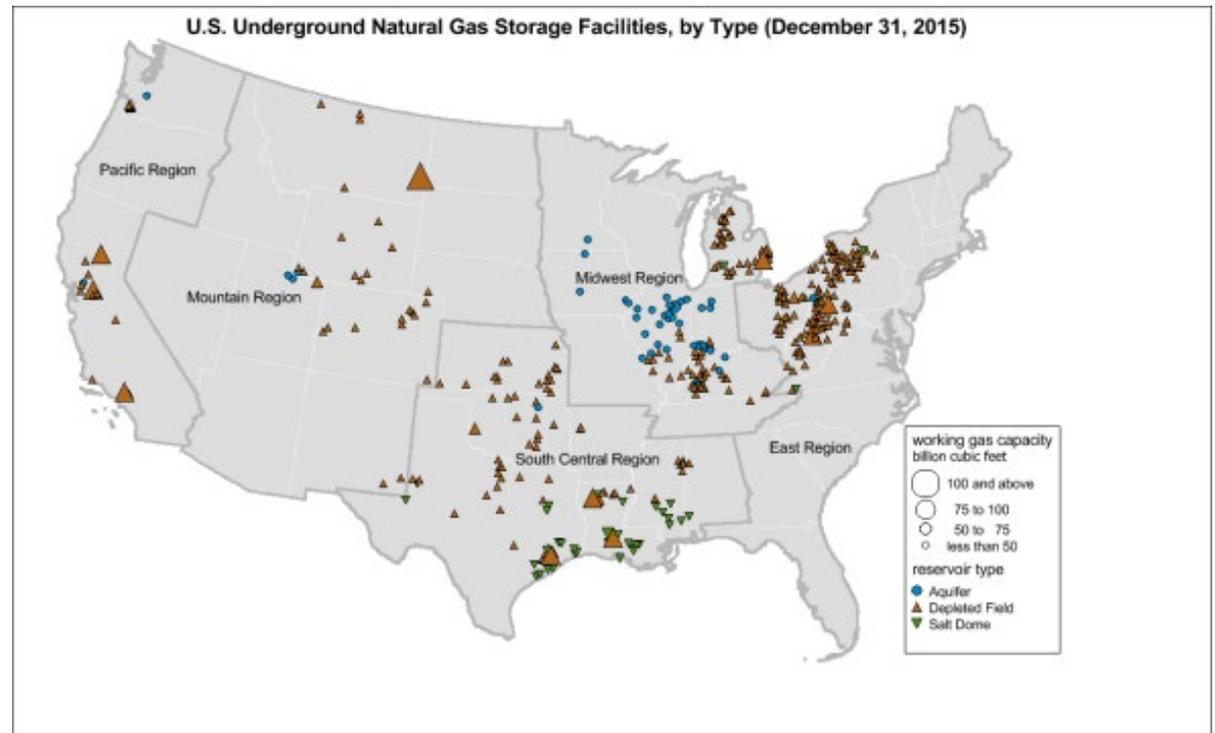


# Pipelines, Underground Storage, LNG

- 2.25 MM Miles of Gas Distribution and 250,000 Miles Gas Transmission
- 110 LNG Plants with 100 BCF of Storage



- 400 Natural Gas Storage Fields in US with 30 TCF Storage



## 1. Geological Underground Nat Gas Storage

20 BCF (20,000,000 DT) Underground Gas Storage facility: US \$250 MM or \$12.5/Dt

## 2. Liquefied Nat Gas

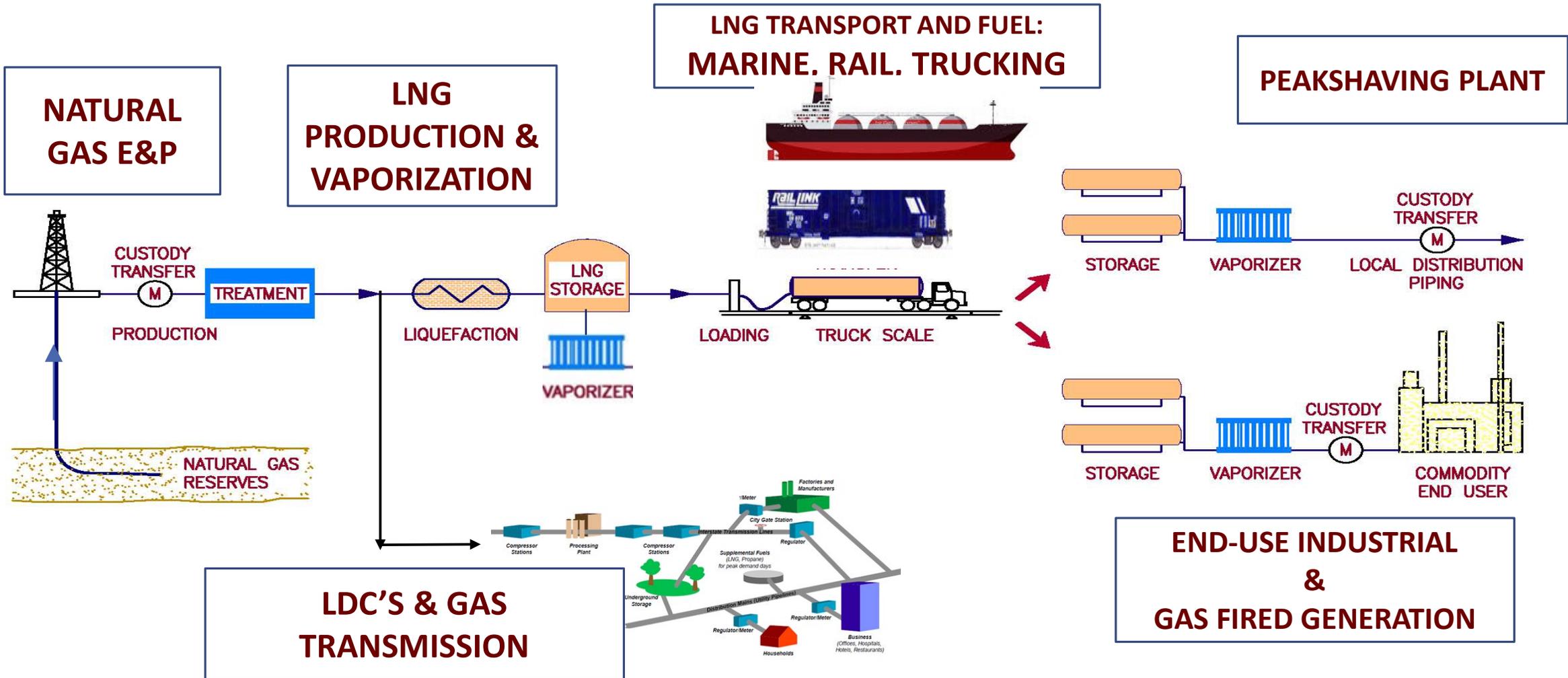
2 BCF (2,000,000 Dt) LNG facility: USD \$250 MM or \$125/Dt

## 3. Compressed Nat Gas - Gas Cylinders

.2 BCF (200,000 Dt) CNG cylinder Storage: USD \$250 MM or US \$1,250/Dt

\*as defined in 1998 DOE/NYSERDA Northstar Industries Commissioned Study

# LNG Supply Chain in the 21<sup>st</sup> Century

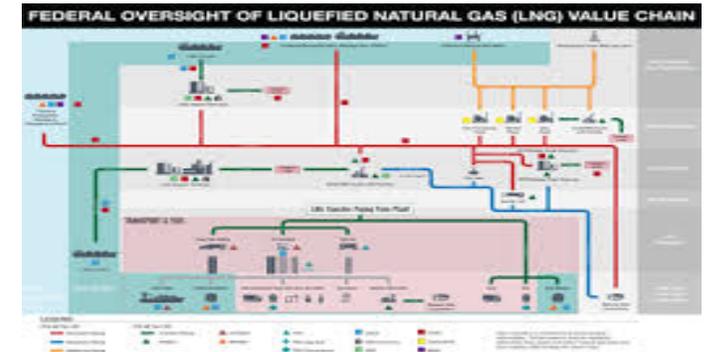


LNG facilities that provide LNG vaporization into pipelines or distribution systems regulated by 49 CFR Part 192 are subject to regulation by 49 CFR Part 193. There are approximately 100 LNG facilities in the USA, which fall under the jurisdiction of 49 CFR Part 193. Some are defined as Interstate and also FERC regulated. Some are Intrastate.

**INTERSTATE /FERC Regulated Facilities** are LNG Facilities Supplying Interstate Pipelines or LNG Marine Terminals for import and export.

**Intrastate DOT 49 CFR 193 Regulated Facilities** are LNG Facilities Supplying Intrastate Pipelines or Distribution Systems. Some states have their own LNG regulations for intrastate and Private facilities.

**Private LNG facilities** not subject to 49 CFR 193. Other LNG facilities that are not associated with jurisdiction pipes or LDC's would need to determine the local and state authorities having jurisdiction. In some case NFPA-59A would dictate standards. In others not.



# Why LNG Makes Sense for Energy Storage



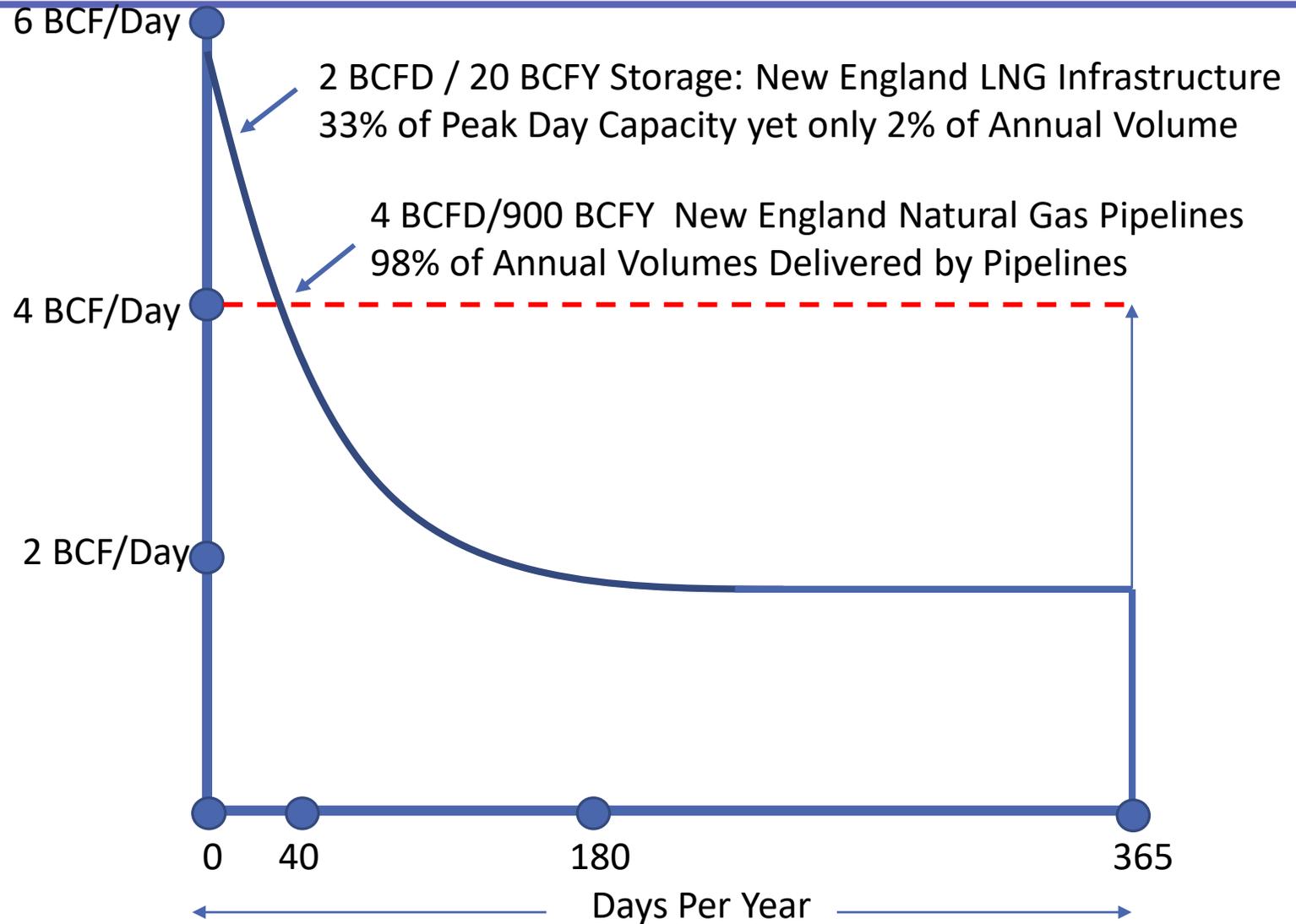
- **LNG IS VERY HIGH-DENSITY ENERGY STORAGE (beachball to ping pong ball)**
- **LNG AVOIDS PIPELINE CAPACITY:** For LDC's and End Users: New Capacity is US \$72MMY– US \$ 150 MMY each 100,000 DT/D
- **LNG AS COMMODITY SUPPLY INSTEAD OF OIL:** Market For Transportation and Industrials 25 Quadrillion BTU's/Y
- **LNG AS HEDGE FOR HIGH NG SPOT PRICES OVER US \$10/DT:** For LDC's and End Users paying \$140/DT.
- **LNG AS NATURAL GAS LOAD FOLLOWING FOR ELECTRIC GENERATION:** To Fill in for Intermittent Renewable Solar/Wind
- **TO AVOID REGIONAL PENALTIES FOR MISSING GENERATION CALL:** \$50 MM /Day for 500 MW Electric Gen Facility in NE

# Example of Economic LNG Use

## Potential LNG Peaking Facilities

- Typically consist of 33-50% of Peak Day
- Complement existing pipeline capacity
- Provide domestic supply and local solution
- Needed peak-day/peak-hour support
- High % of Peak Day/Low % of Annual Volumes

- ❖ 100,000 Dt/D of capacity costs US \$72MM/Y
- ❖ 2BCF/D of LNG Capacity is worth about \$1.5 B in demand charges alone

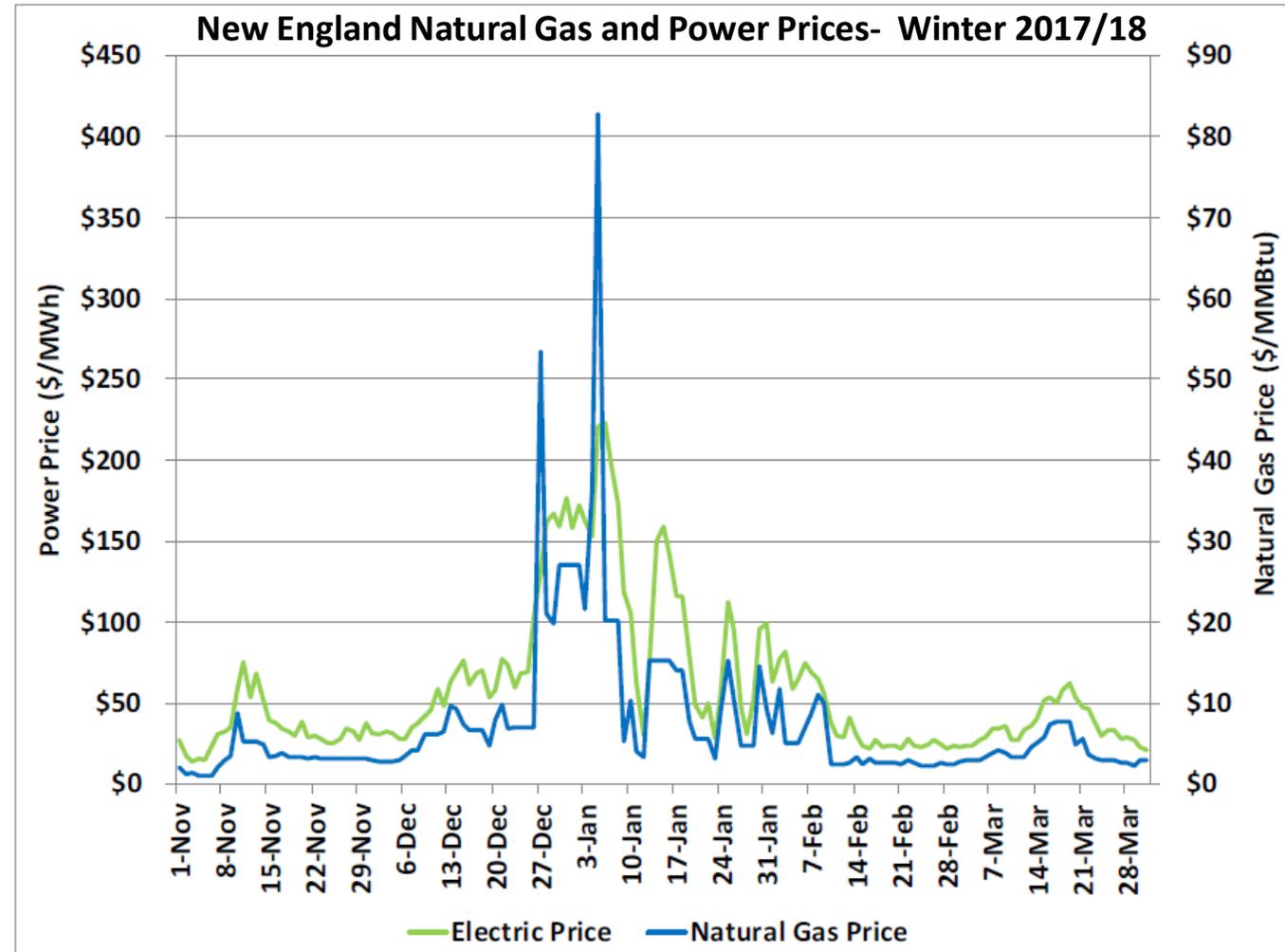


\*REGIONAL LOAD DURATION/GAS SUPPLY CURVE AT CAPACITY FOR 2020

# Economic Hedge Against Extreme Winter Weather

Supplemental natural gas supply and LNG storage refill during short term peak hour/day or multiday cold snaps

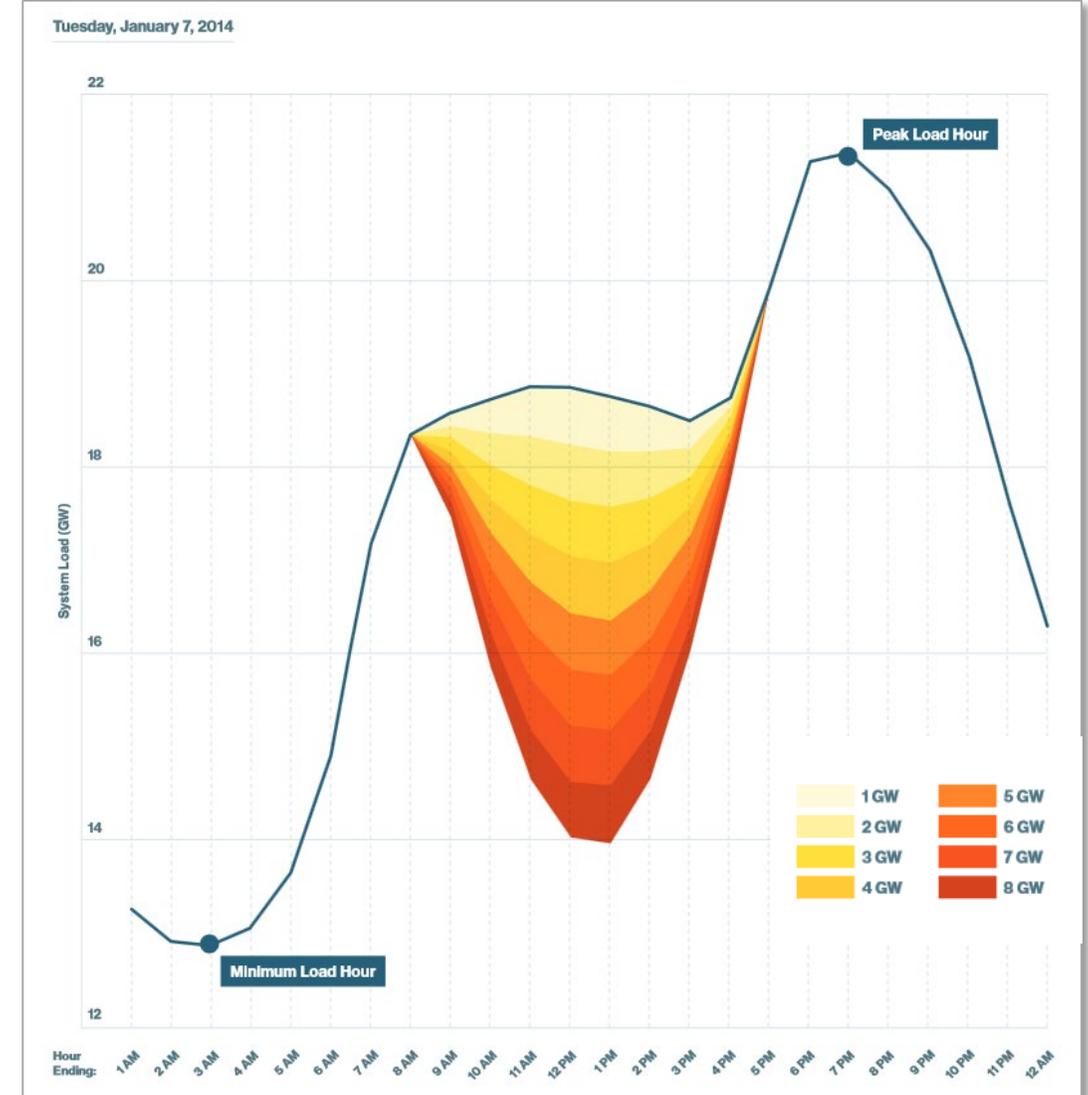
- During cold snap of late 2017/early 2018, natural **gas prices** rose to historical levels for a short period of time.
- Cold weather occurred **early** in the heating season. LDCs must maintain LNG storage inventory for mid and late winter cold snaps.
- February 15-28 AGT Citygates natural gas spot price averaged only \$2.50 per dth.
- Additional LNG:
  - Storage and vaporization can provide supplemental peak period supply at an economically attractive price
  - Liquefaction can provide LNG refill for remaining winter period needs as temperature and demand moderates



Source: Concentric Energy Advisors, Mass Coalition for Sustainable Energy

# Load Following as Energy Storage For Renewables

- Increased reliance on intermittent renewable energy adds more pronounced peaks and valleys (volatility) during the electric day
- Renewables (solar, wind) are used as **baseload supply** source and displace natural gas and coal-fired generation
- Regional increases in reliance on natural gas for load following and peaking, not baseload generation. This could impede new, large scale pipeline construction particularly in markets without vertically integrated electric market structure.



ISO-NE 2017 Regional Electricity Outlook

- NUMEROUS SMALL/MIDSCALE LNG FACILITIES FOR DOMESTIC USE:
  - Peak shaving, Liquid Supply, Commodity Blowout Hedge, Point of Use Fuel, and Energy Storage,
  - \$US 30 MM- \$500MM
- LNG FOR TRANSPORTATION FUEL: VEHICLES, RAIL, MARINE
- LNG CO-LOCATED ELECTRIC GENERATION, GAS STORAGE FACILITIES
- LNG CO-LOCATED WITH H2 PRODUCTION AND RENEWABLE ENERGY
- LNG CO-LOCATED WITH RNG FACILITIES





# CLOSING THOUGHTS

The gas industry began in the 19<sup>th</sup> Century with manufactured coal gas plants in every major US City.

In the 20<sup>th</sup> Century it morphed into the natural gas supply chain: pipes, UG storage, LNG, LDC's

Oil use created 200,000 gasoline stations, and trade deficit imports of Oil.

In the 21<sup>st</sup> century the US became the largest producer of NG and oil in the world.

*In the 21<sup>st</sup> Century, expect an integrated energy infrastructure with decarbonization and renewable energy supply.*

*Natural Gas, H2, RNG, Energy Storage, Renewable Electric Generation, Cleaner Base Load.*

# Q&A AND OPEN DISCUSSION



## LNG | Natural Gas | Storage Sustainable Investments

*ESTABLISHED TECHNOLOGY, NEW APPLICATIONS*

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# PROJECT DEVELOPMENT PROCESS DEFINED

- Establish business case and credit
- Perform Preliminary Engineering
- Site Selection and Options in Friendly Places
- Meet or Exceed Siting Requirements
- Execute Precedent Agreements
- Procure Equipment and Professional Services
- Seismic, Geotech, Fire Studies
- HAZID/HAZOP
- Complete Engineering Design
- Adjudicate Permits and Approvals
- Prefabricate Components/Buildings
- Conduct Field Construction,
- NDT Testing
- Commissioning, Training, Documentation
- Commercial Operations

# KEYS TO SUCCESSFUL STAGE GATE PROJECT DEVELOPMENT PLAN

## 6 Month Phase 1:

- Perform Conceptual Engineering To Define Technical Design Basis and Commercial Services
- Define business case offerings and engage customers
- Execute Precedent Agreements
- **Go/No-Go**

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## 18 Month Phase 2:

- Perform Preliminary Engineering
- Site Selection and Options in Friendly Places
- Define & Engage Stakeholders, Including First Responders
- Perform Open Season and Finalize Design Baseline and Customers.
- Conduct Public Hearings and Agency Contacts.
- Meet or Exceed Siting Requirements
- Procure/Engage Engineering, Equipment Engineering Support and Other Professional Services
- Seismic, Geotech, Fire Studies
- HAZID/HAZOP
- Complete Engineering Design
- Adjudicate Permits and Approvals
- **Go/No Go**

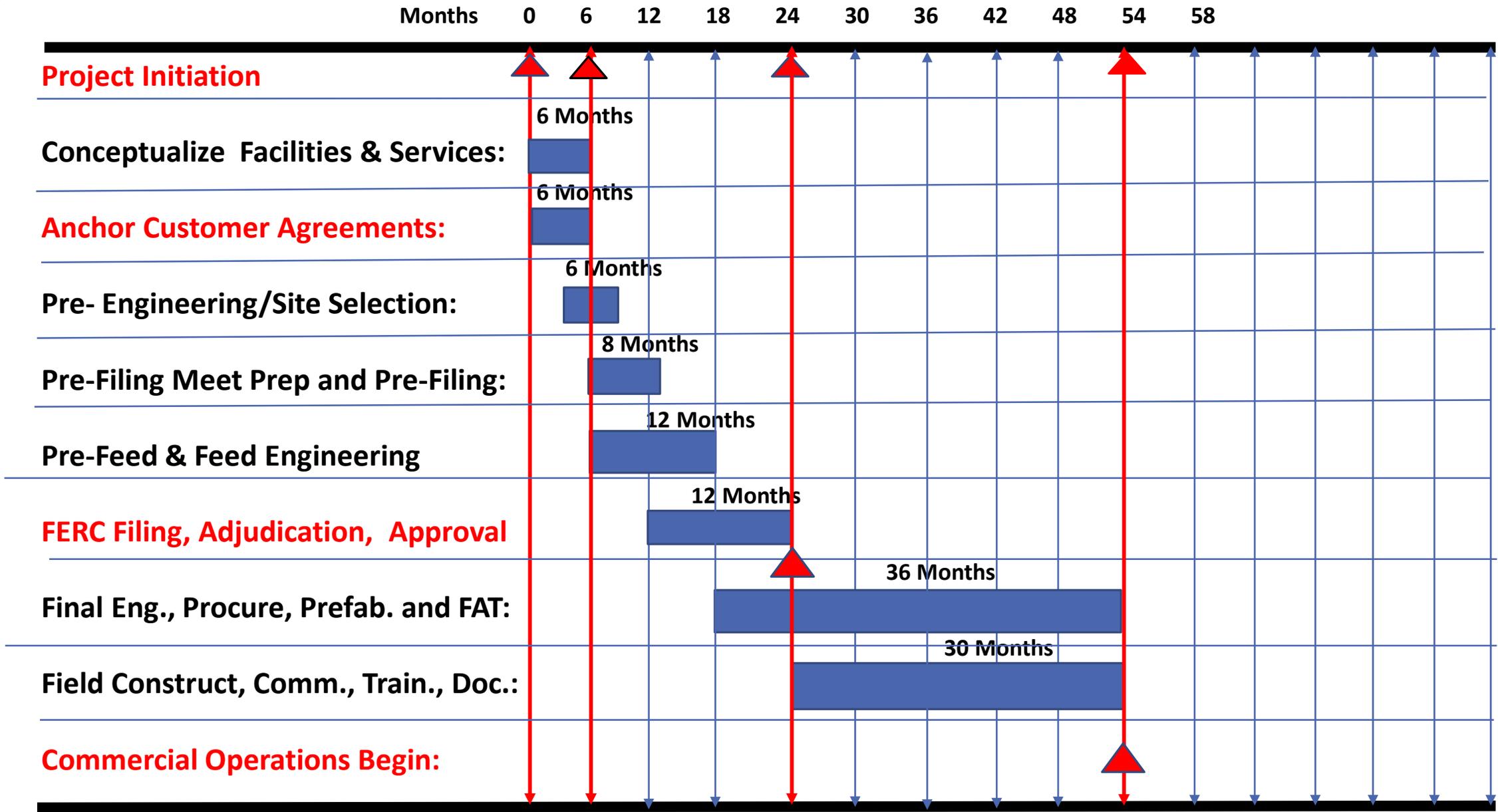
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## 30 Month Phase 3

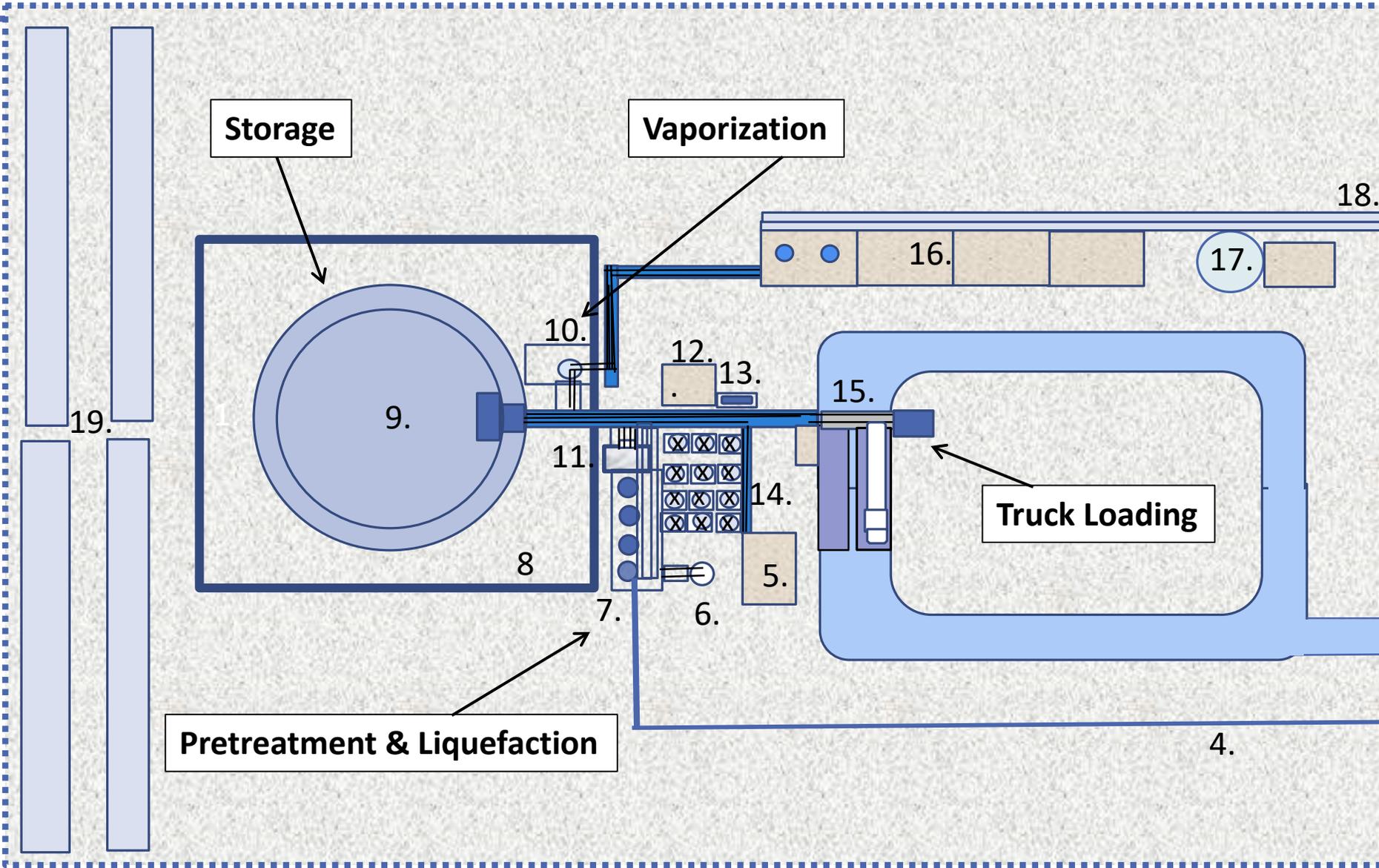
- Procure Equipment, Prefabricate Components Buildings, Conduct Factory Acceptance Testing (FAT)
- Conduct Field Construction,
- Hire Operating Team Early In Process
- NDT Testing, Environmental and quality Inspections,
- Commissioning, Training, Documentation TO Commercial Operations



# LOW FINANCIAL RISK PROJECT SCHEDULE & MILESTONES

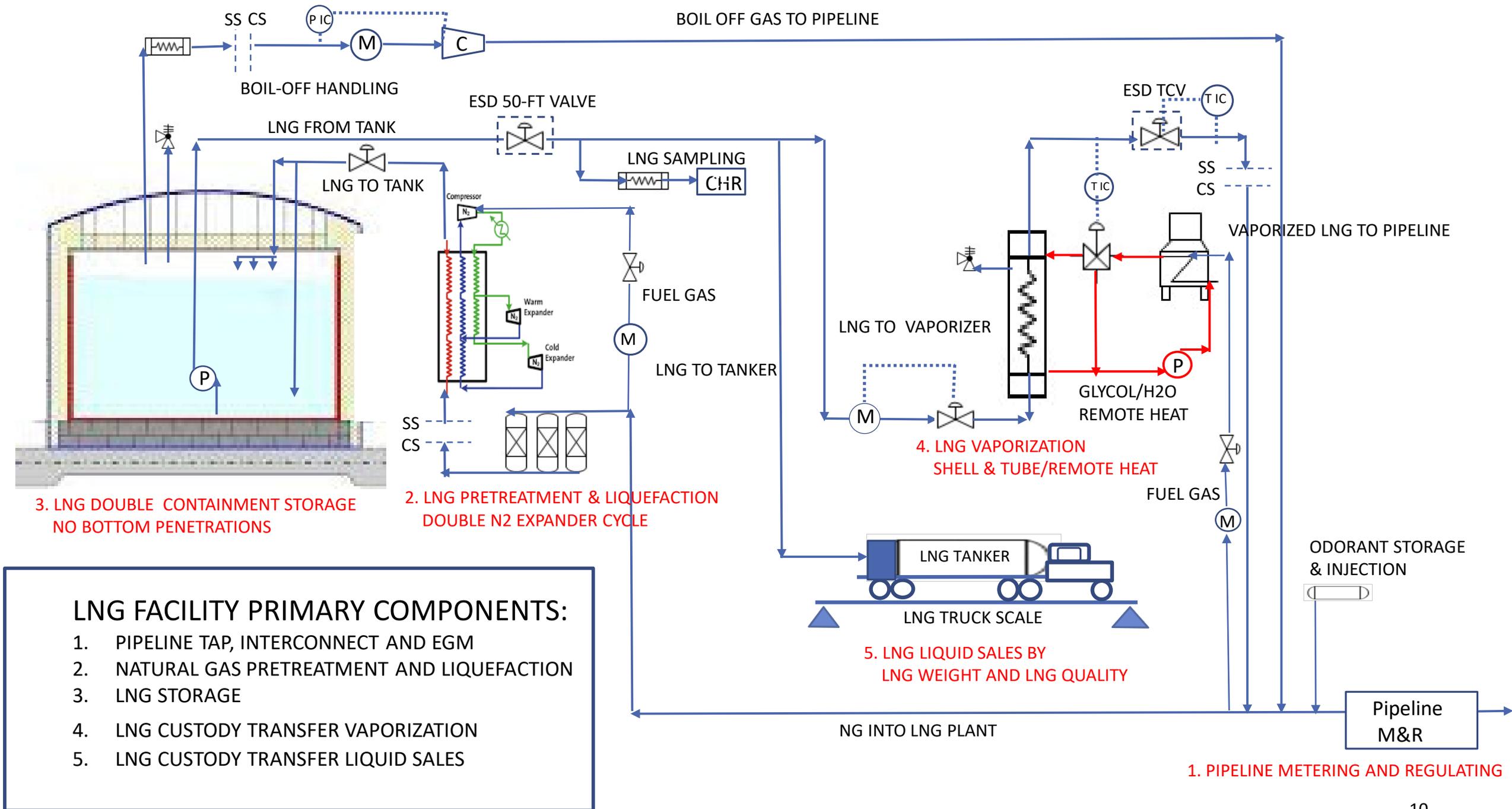


SITE LAYOUT LNG FACILITY: PRE-TREATMENT, LIQUEFACTION, TRAILER LOADING, VAPORIZATION, GREEN POWER 15 ACRE FACILITY FOOTPRINT EQUAL TO ONLY 1 MILE OF NG PIPELINE



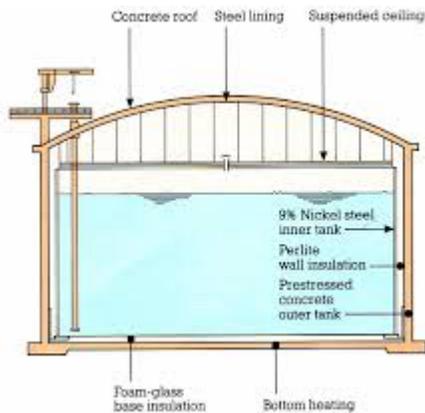
**LNG FACILITY MAJOR EQUIPMENT LIST**

1. Natural Gas Line To/From TGP
2. TGP M&R Facility and EGM Building.
3. Security Gate Checkpoint Via Access Road
4. NG Connecting plant Pipe
5. N2 Refrigeration Compressor
6. LN2 Storage Tank and Vaporizer
7. LNG Pretreatment
8. LNG Tank Tertiary Impoundment
9. LNG Storage Tank Internal Pumps
10. LNG Vaporizer and Sub-impoundment
11. LNG Cold Box and Expander Skids
12. Boil off Handling
13. Odorant Storage and injection system
14. LNG Refrigeration Cooling Fans
15. LNG Load Rack, Scales, Sub-imp., Shelter
16. Control Room, Heaters, Elect/MCC, AUX.
17. Fire Prot. Water tank and Pump House
18. Utilities ROW: Water, Elec., Comm., Sewer
19. Solar Array



**LNG FACILITY PRIMARY COMPONENTS:**

1. PIPELINE TAP, INTERCONNECT AND EGM
2. NATURAL GAS PRETREATMENT AND LIQUEFACTION
3. LNG STORAGE
4. LNG CUSTODY TRANSFER VAPORIZATION
5. LNG CUSTODY TRANSFER LIQUID SALES



## VAPOR DISPERSION PROTECTION

The regulations instruct that provisions need to be made to minimize the possibility of a flammable mixture of vapors from a design spill, from reaching a property line that can be built upon that would result in a distinct hazard.

For LNG tanks with no bottom penetrations, the design spill for calculating vapor dispersion is a 10-minute spill. Even at 100,000 dekatherms per day of flow, that is less than a 10,000 USG spill. Very manageable.

# 49 CFR 193 LNG THERMAL EXCLUSION ZONES WILL BE LIMITING FACTOR IN SITING:

The Following Zones are Defined in Siting Regulations:

1,600 Btu/hr.ft<sup>2</sup>

At a property line that can be built upon for ignition of a process design spill.

1,600 Btu/hr.ft<sup>2</sup>:

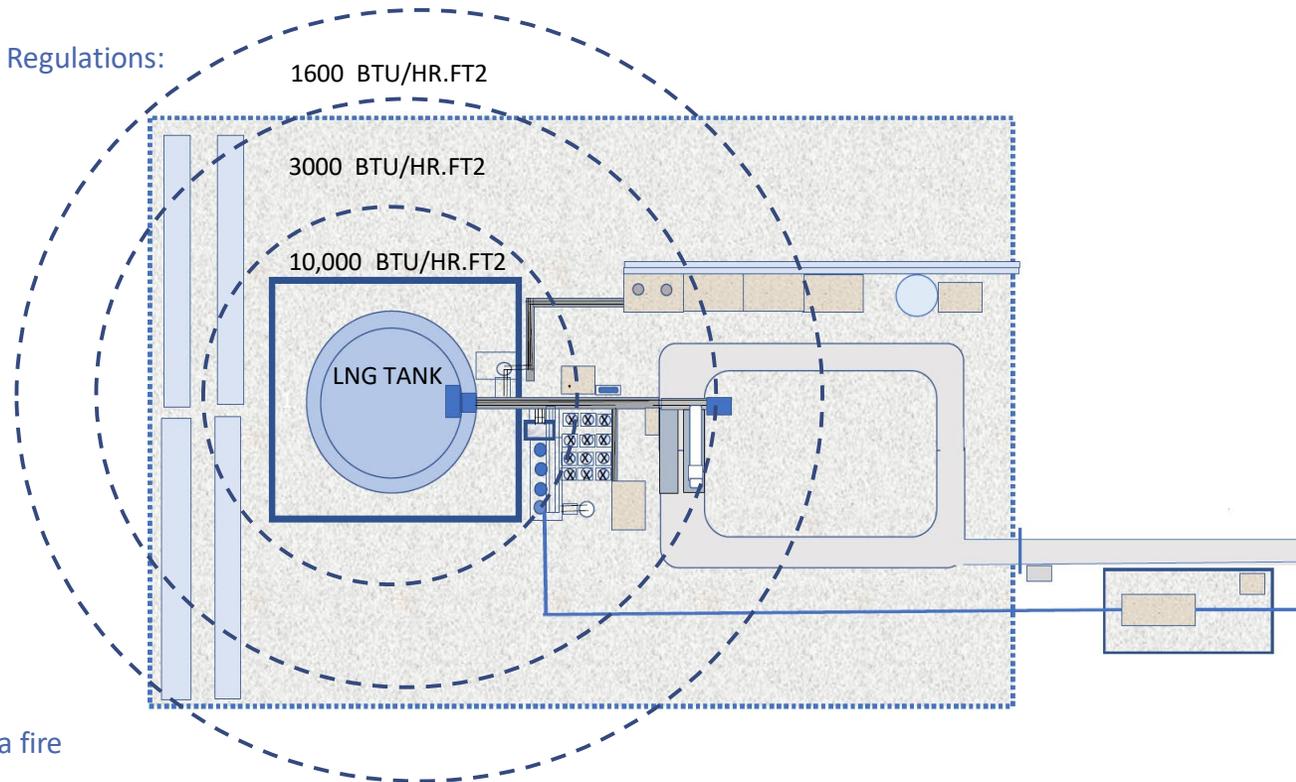
At the nearest point located outside the owner's property line that, IS used for outdoor assembly by groups of 50 or more persons

3,000 Btu/hr.ft<sup>2</sup>:

at the nearest point of the building or structure outside the owner's property line used for occupancies

10,000 Btu/hr.ft<sup>2</sup>

A property line that can be built upon for a fire over an impounding area.



For a Facility WITH LNG tanks with no Bottom Penetrations , the limiting Factor for Siting will be the Thermal Radiation Zone Created by the LNG Tank secondary Containment.

It is recommended that the Project will meet, and in some cases, exceed the Requirements.

# 49 CFR Part 193 and NFPA-59A SITING CONSIDERATIONS

- THERMAL RADIATION ZONE
- VAPOR DISPERSION ZONE
- FULL SEISMIC INVESTIGATION LIMIT
- 100 YEAR FLOODING
- SOIL CONDITIONS
- DESIGN WIND SPEED
- OTHER SEVERE WEATHER
- ADJACENT ACTIVITIES TO THE SITE
- PROPERTY LINES AND EQUIPMENT SEPARATION
- PROXIMITY TO AIRPORTS
- LOCAL SITE ZONING

## PRACTICAL SITING CONSIDERATIONS

- MEET OR EXCEED SITING REQUIREMENTS
- OVER SIZER SITE TO LIMIT EXCLUSION ON SITE
- SITE FACILITIES IN COMMUNITIES THAT SUPPORT

# THERMAL EXCLUSION ZONES:

The Following are Defined:

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At a property line that can be built upon for ignition of a process design spill.

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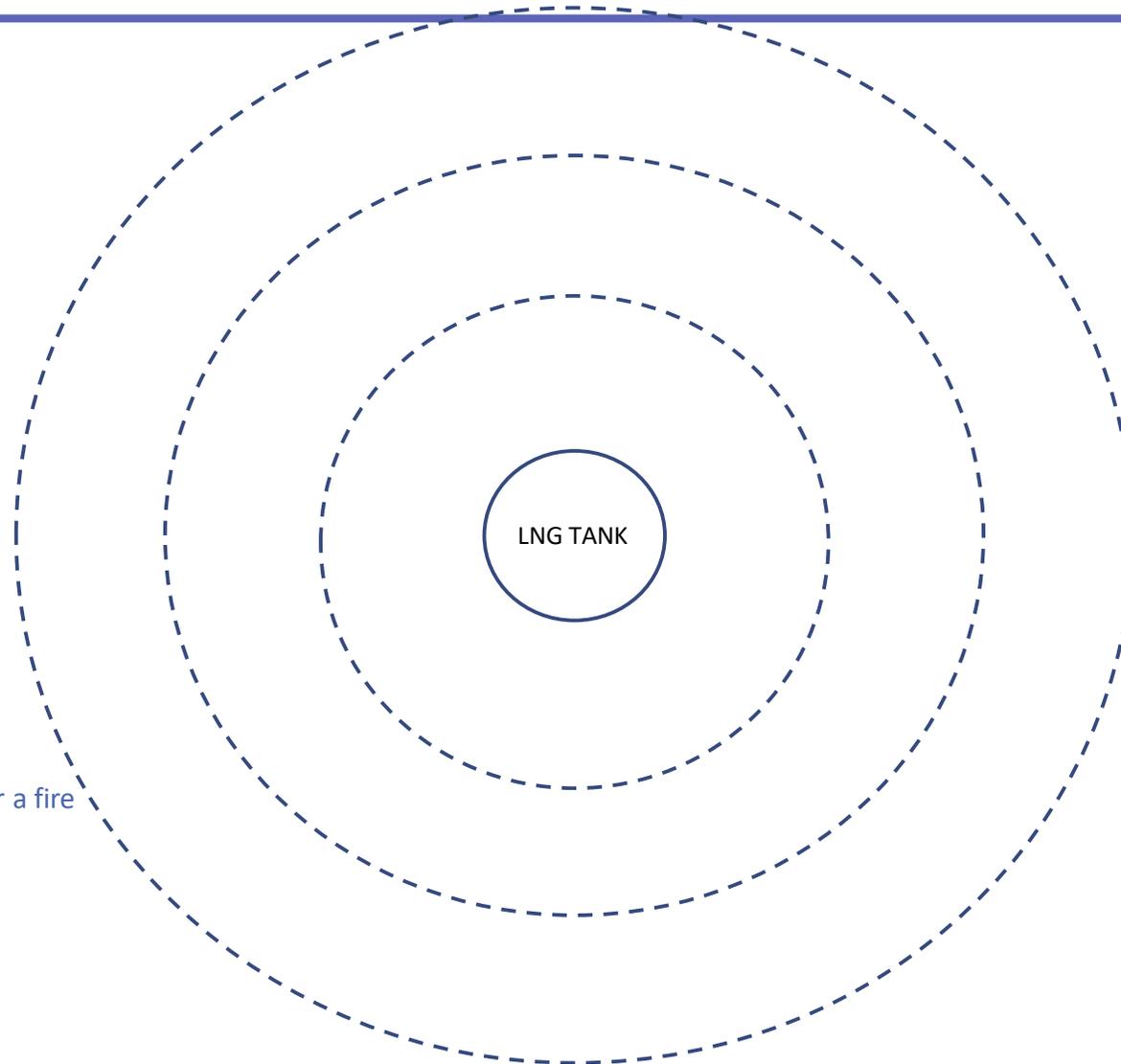
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# LNG Rules of Thumb



For Leak Detection:  
Colorless

Boiling point:

Expansion Ratio from Liquid to Vapor:

Expansion Ratio of 9,100 PSIG CNG:

Gallons LNG liquid per dekatherm:

Dekatherms 10,000 Gallon LNG Trailer:

GPM LNG for 100,000 DEK/D Vapor Flow:

10 Minute Design Spill at 100,000 Dek/D

Specific Gravity of LNG (Water = 1):

Specific Gravity of NG Vapor -260 F (Air = 1):

Latent Heat Vaporization Atmospheric P:

Specific Heat of Vapor at Atmospheric P:

LNG is Odorless and

-260 Degrees F.

618 to 1

618 to 1

12.1 Gallons

826 dekatherms

840 US GPM

8,400 US Gallons

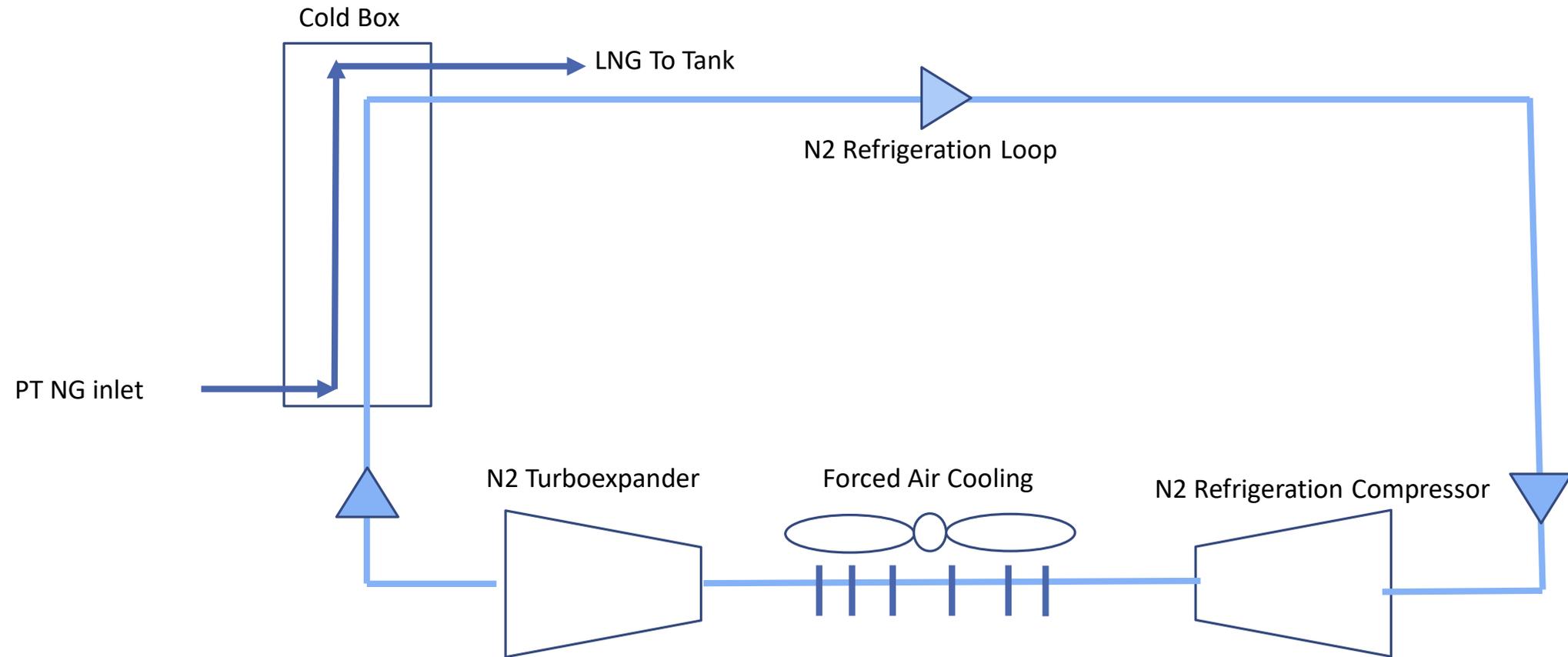
.46

1.43

219 Btu's / #

.52 Btu's / # / Degree F.

# SIMPLIFIED LNG NITROGEN GAS (N2) REFRIGERATION CYCLE





LNG FACTS	
Detection	Odorless, Colorless
Hazards	Extreme Cold, Asphyxiation
Boiling Point at Atm Pressure	- 260 Degrees F
Expansion Ration Liquid to Vapor	618 to 1
CNG Expansion Ratio at 10,000 PSIG	618 to 1
Latent Heat of Vaporization	219 BTU's per Pound
Specific Heat of gas at Atm Pressure	.52 BTU's/Pound- Degree F
CNG Comp Trailer @ Weight Limit	450 MMBTU
LNG Trailer @ Max Weight	833 MMBYU/10,000 USG
LNG Rail Car Carrier	2,499 MMBTU/30,000 USG
LNG CONVERSIONS	
12.1 US Gallon	1 MMBTU/1MSF
1 US Gallon	3.6 Pounds
1 International Tonne	2,200 Pounds
1 International Tonne	611 US Gallons
1 Cubic Meter	264.2 US Gallons
1 US Gallon	82,645 BTU
1 US Gallon Diesel	139,000 BTU
1 US Gallon Gasoline	126,000 BTU
1 Horse power	745 Watts
1 Therm	105.5 Megajoule
1 Cubic Foot of Natural Gas	.045 Pounds