



# New Energy Development Company

*STRATEGY | PROJECT DEVELOPMENT | CAPITAL*

*Your GreenER™ LNG & Hydrogen Facility Development Partner*

LNG | Hydrogen | Storage  
Sustainable Investments  
*With GreenER™ technology*

# The New Energy Development Company Story



**New Energy  
Development Company**  
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*Hap Ellis*

## **Alexander "Hap" Ellis III, Managing Partner**

- Served 18 years as General Partner at RockPort Capital Partners, a multi-stage sustainability venture capital firm.
- 40 years of executive experience originating, developing, funding independent power companies and sustainable energy firms.
- Chairman, The George and Barbara Bush Foundation.
- Chairman, The Old Westbury Funds (~\$44 Billion mutual fund).
- MPPM, The Yale School of Management and BA, Political Science, Colorado College.



*Thomas Quine*

## **Thomas G. Quine, Partner**

- Founder, CEO, & Chairman of Northstar Industries LLC, a prominent and respected North American LNG and natural gas engineering and construction business.
- Revolutionized the peak shaving LNG and natural gas midstream industries over 45 years, introducing innovative modular liquefaction designs & patented systems.
- Leader in the green hydrogen and peak shaving LNG industry and founder of multiple patents, patents pending, and GreenER™ technologies.
- Operated Portland Natural Gas System (PNGTS) after designing and constructing all M&R on the system.
- BS, Electrical Engineering, The Wentworth Institute of Technology and BA, Legal Studies from the University of Massachusetts, Amherst.



*Scott Shields*

## **Scott M. Shields, Partner**

- Founded Morgan Shields Energy LLC in 2009.
- Co-founder, board member of Oasis Bank SSB before its merger and subsequent IPO in 2018 with \$1 billion in assets (NASDAQ: STXB).
- Served 4 years each at Repsol LNG (VP), Exxon Corporation (finance), and Enron Capital & Trade (BD).
- LNG, gas trading, power & corporate development from Repsol, Pivotal LNG (AGL), Enserco Energy, and 13 LNG projects.
- Led Investment bank and FINRA-licensed (expired), Series 79, 82, and 63.
- MBA, the University of Chicago Booth School of Business and BS, Finance, the Pennsylvania State University.
- Active Duty, U.S. Army, flight engineer on Chinook helicopters; trained officer candidates & was Captain in reserve component.



- **New Energy Development Company Mission**

- ✓ GreenER™ Hydrogen & LNG Facilities
- ✓ Using Energy Recovery, proprietary designs & techniques

- **Background and New England / East Coast Energy Fundamentals**

- **How Hydrogen Fits into these Fundamentals**

- **H2 Project Examples**

- ✓ GreenER™ Hydrogen Cost example
- ✓ Project New Energy™ Hub
- ✓ What's next





## New Energy™ Mission

Develop **GreenER™ LNG & Hydrogen** facilities,

- from feasibility study to complete project development and co-investment capital
- typically incorporate our PER™: Pipeline & Process Energy Recovery technology & know-how

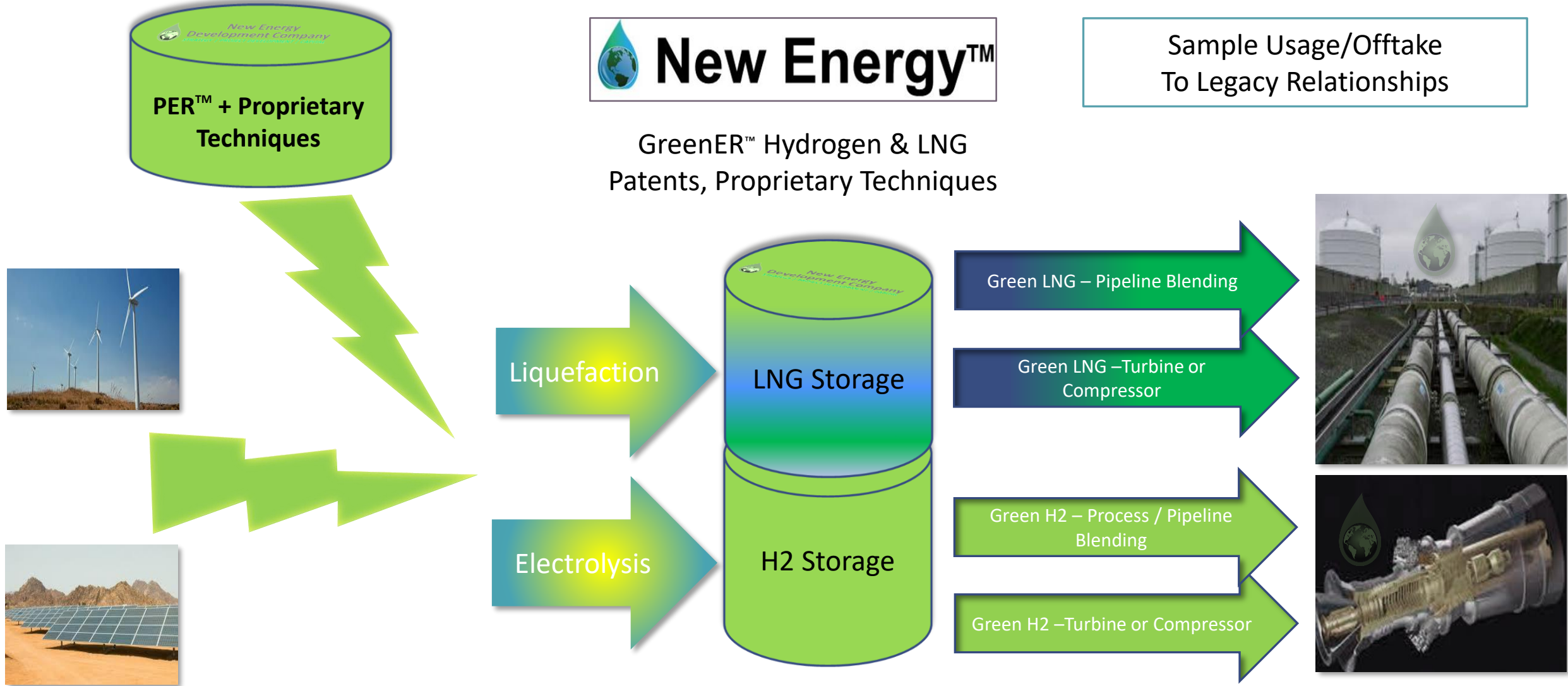
## Strategy Incorporates Core Competencies

Leveraging legacy relationships, markets knowledge, technology, and co-investment capital into two segments:

1. *Developing Sustainable Hydrogen and LNG projects*
2. *Providing market, design, engineering, and technology advisory services to fund our projects*

Proprietary New Energy Development Plant Design







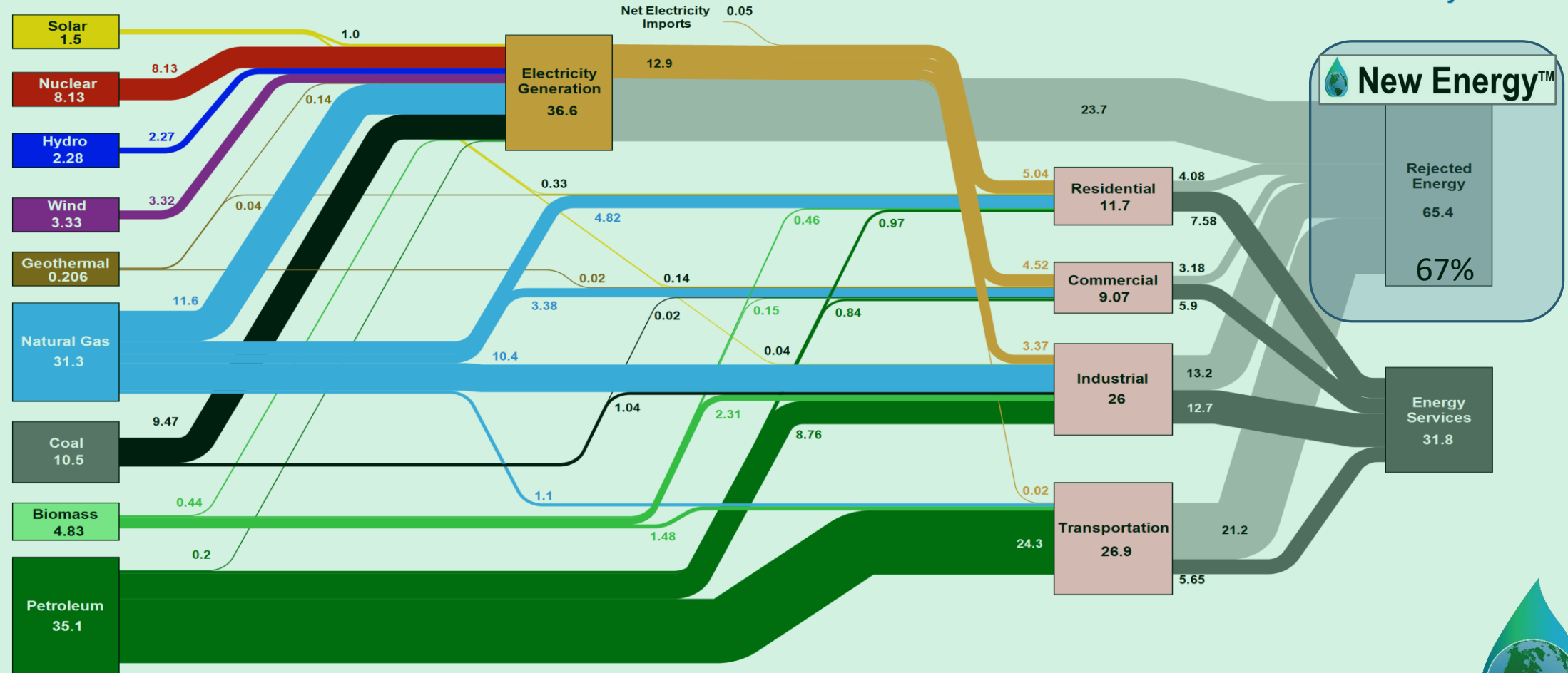
# Big Picture: New Energy Development Company PER™



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## Estimated U.S. Energy Consumption in 2021: 97.3 Quads

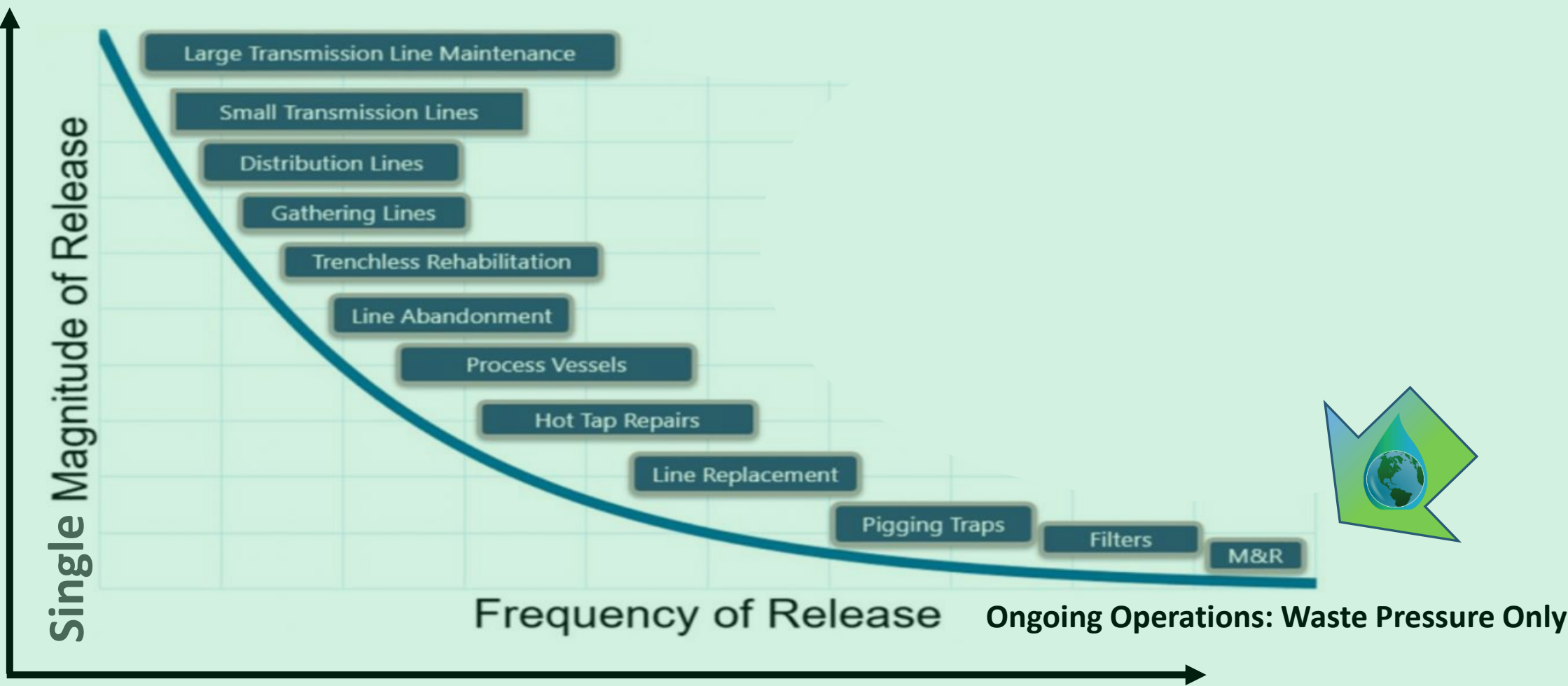
Lawrence Livermore National Laboratory



Source: LLNL March, 2022. Data is based on DOE/EIA MER (2021). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

# Example of Pipeline/Storage PER™

Spectrum of Pipeline Energy Waste





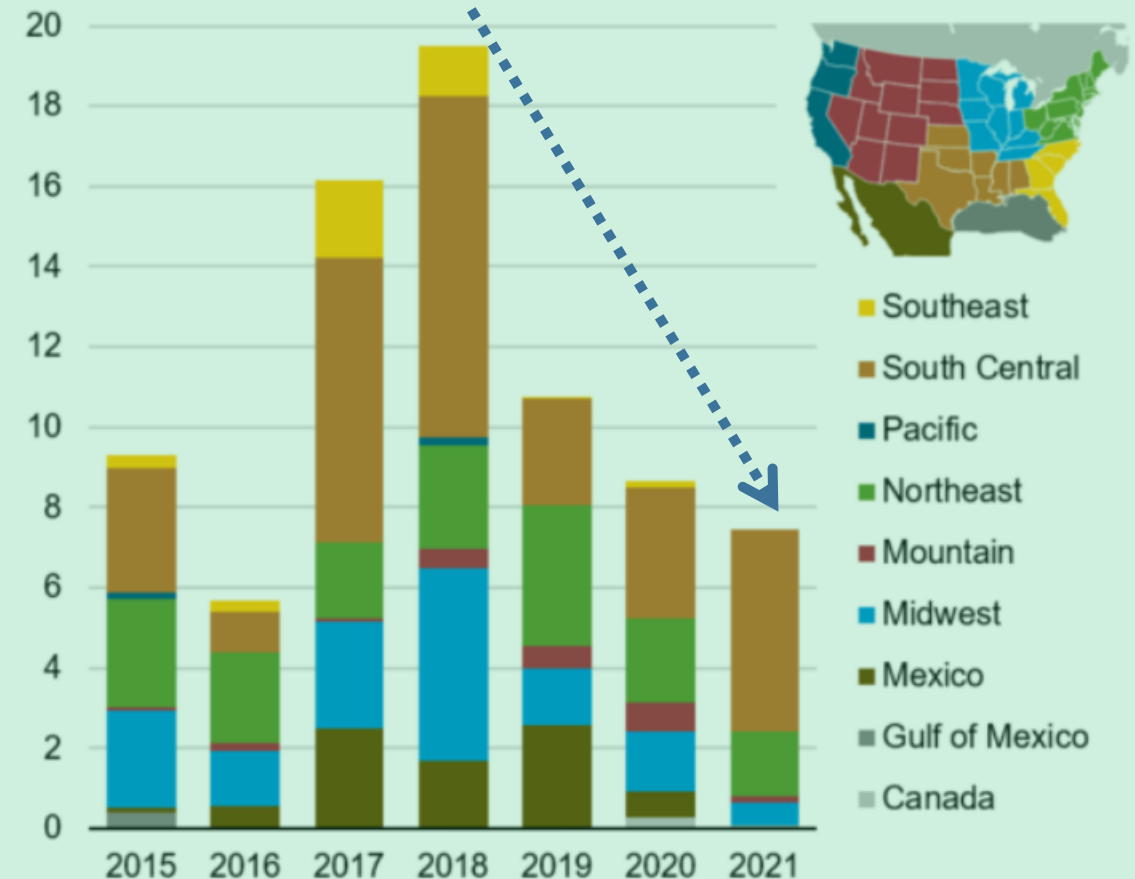
## Effect of ESG Money, Gov't, SEC, FERC, NIMBY

- Government directing sustainability
- Regulators, FERC, SEC increasing scope of ESG authority
- Environmental activist activities on the increase
- ESG moneys directed toward sustainable investments
- Yet, demand for NG continues to grow

### Result:

- Very expensive or
- Unattainable FT
- Openings for Green Hydrogen substitution

**Interstate pipeline capacity additions into regions, 2015–2021**  
billion cubic feet per day

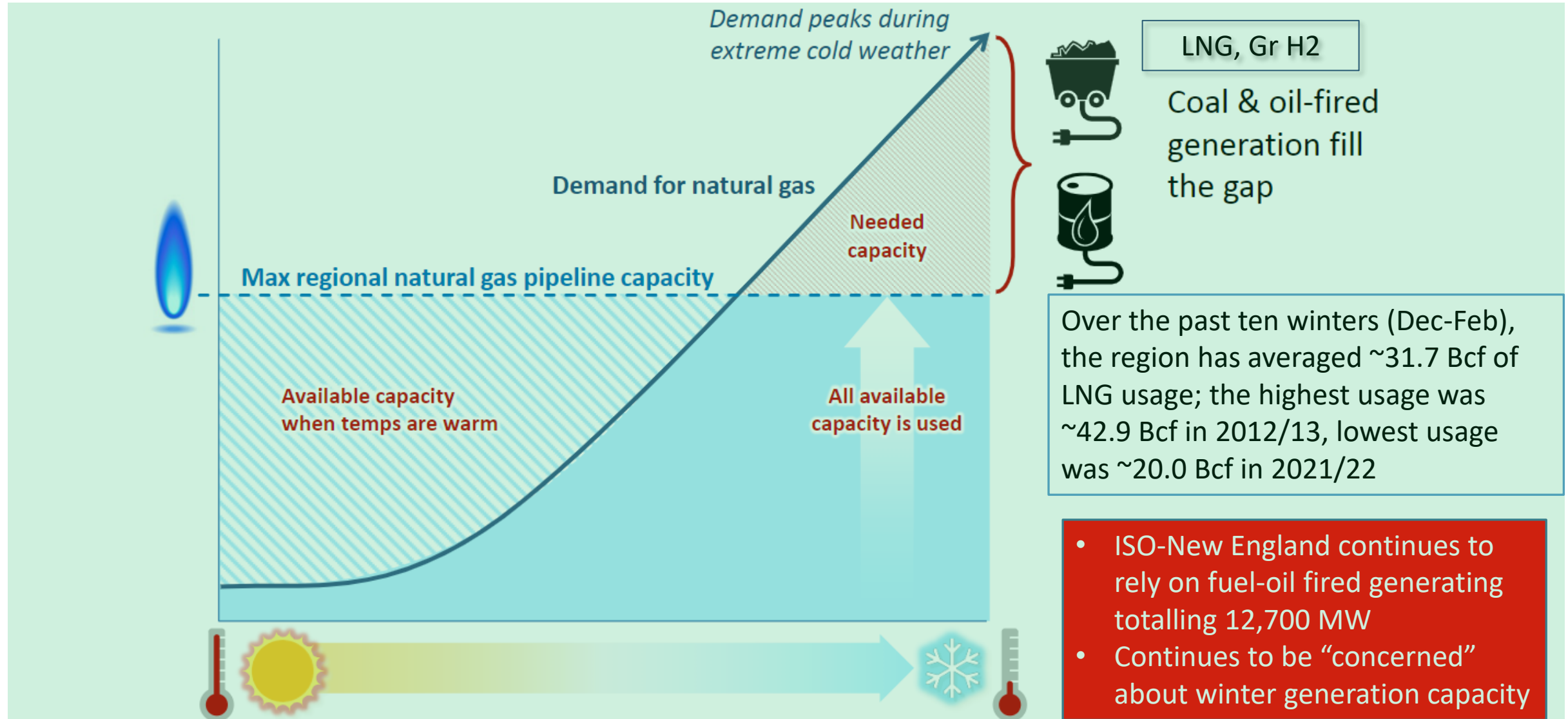




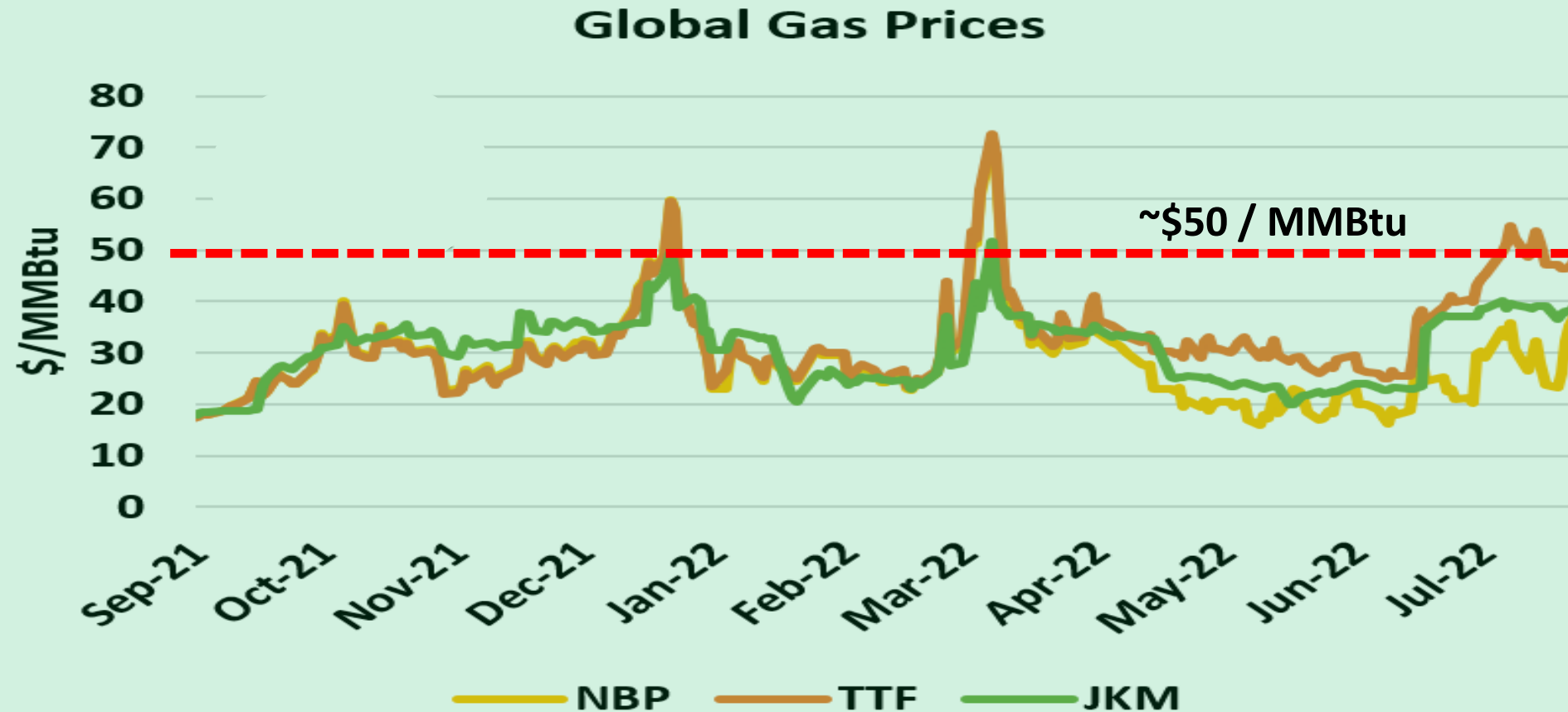
# Does New England Need LNG and Green Hydrogen?



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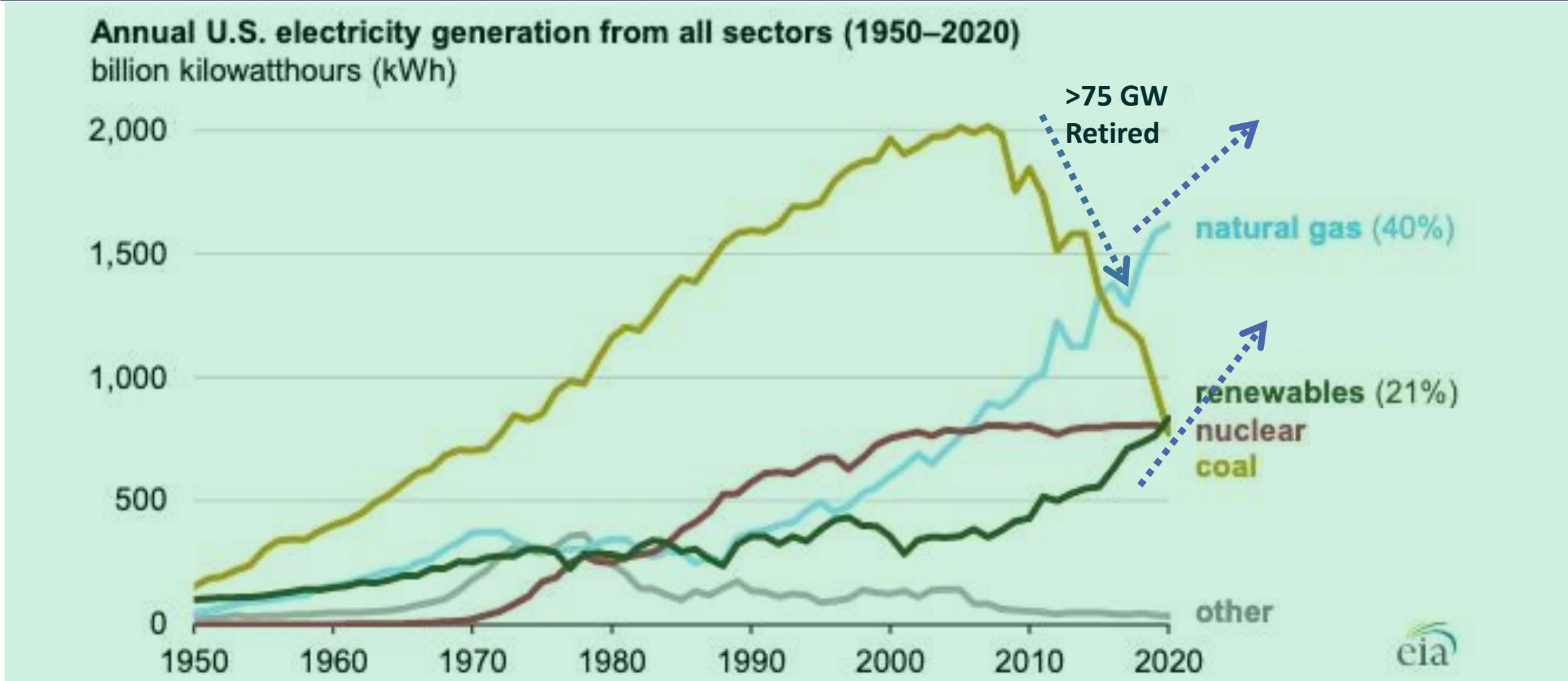


# Can LNG Imports Fill the Peak-Day Gas Supply Needs?



# Generation Fuels Fundamental Shift Toward Nat Gas

Next Stage: Hydrogen will begin to chip away at Nat Gas



\* 2022 EIA forecast. Price elasticity of demand for gas fired gen disappearing as gas prdn growth decreasing and renewables are increasing (Duck curve appearing in part driven by renewables). Coal mix decreasing >75GW cut over last 10yrs; gas/renewables increasing – Matthew Henderson, Conoco Phillips, Orlando Alvarez, BP.



Press Release: Effective 4-12-2021

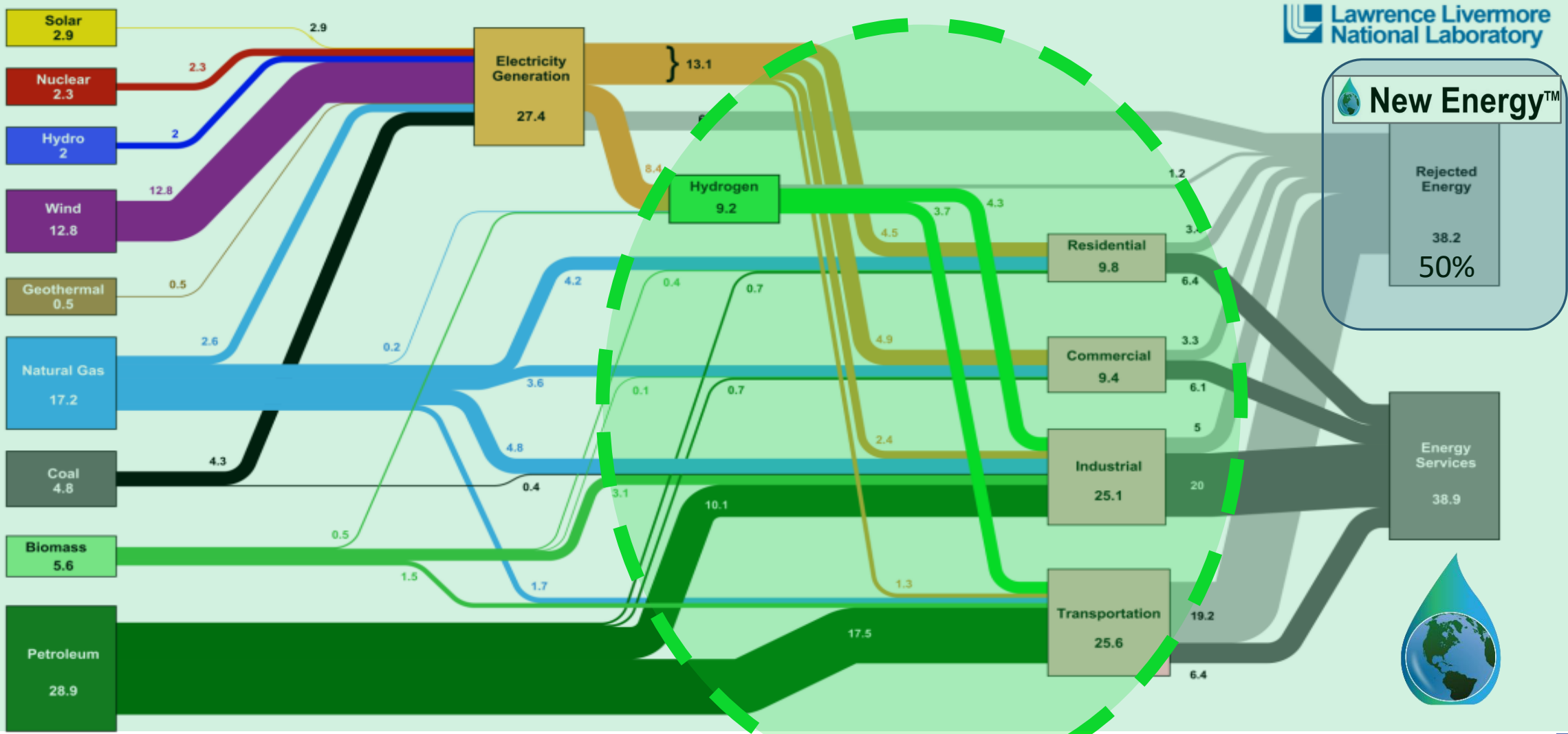
## New Energy Development Company

McDermott's CB&I Storage Solutions and New Energy Complete Engineering for Green Hydrogen Generation Facility

HOUSTON, April 12, 2021 /PRNewswire/ -- McDermott International, Ltd and New Energy Development Company LLC today announced the completion of engineering for two transformative 50-megawatt energy projects. Each modular, expandable hydrogen facility will produce nearly 24,000 kilograms per day of renewable hydrogen.

# New Energy™ Hydrogen Market Development View

New Energy™ expects significant residential and commercial adaptation based upon customer requests and relationships



Lawrence Livermore National Laboratory

New Energy™





# What-if: CO<sub>2</sub> Savings From Green Hydrogen Pipeline Blending



Percentage by Volume of Green Hydrogen in U.S. Natural Gas Pipeline	Million Tons of CO <sub>2</sub> Saved/Year	Equivalent Millions of Cars Driven for a Full Year
3%	50.1	10.9
10%	167	36.3
15%	250	54.3

Advanced blending studies are positive re H2 blending: ... distribution line pipes with size ranging from 0.15 m to 0.30 m were selected resulting in, even the worst-case scenario, the X42 line pipes with initial crack depths which were less than 40% of the wall thickness, axial cracks do not reach 75% of the wall thickness over a period of 100 years. [Energies peer review journal. | An Open Access Journal from MDPI](#) 7. Dadfarnia, M.; Sofronis, P.; Brouwer, J.; Sosa, S. Assessment of resistance to fatigue crack growth of natural gas line pipe steels carrying gas mixed with hydrogen. Int. J. Hydrog. Energy 2019, 44, 10808–10822. [CrossRef] <https://www.sciencedirect.com/science/article/abs/pii/S036031991930878X?via%3Dihub>

# Hydrogen Use in North America is Prolific



- Over 13 Bcf of hydrogen is produced each day, more than the volumetric equivalent of all Permian natural gas production.
- The U.S. has an extensive network of 300,000 miles of natural gas transmission pipelines (not counting distribution systems) - but only about 1,600 miles of dedicated hydrogen pipelines.
- These provide clues into the potential future markets for green hydrogen...

# Projected Hydrogen Evolution

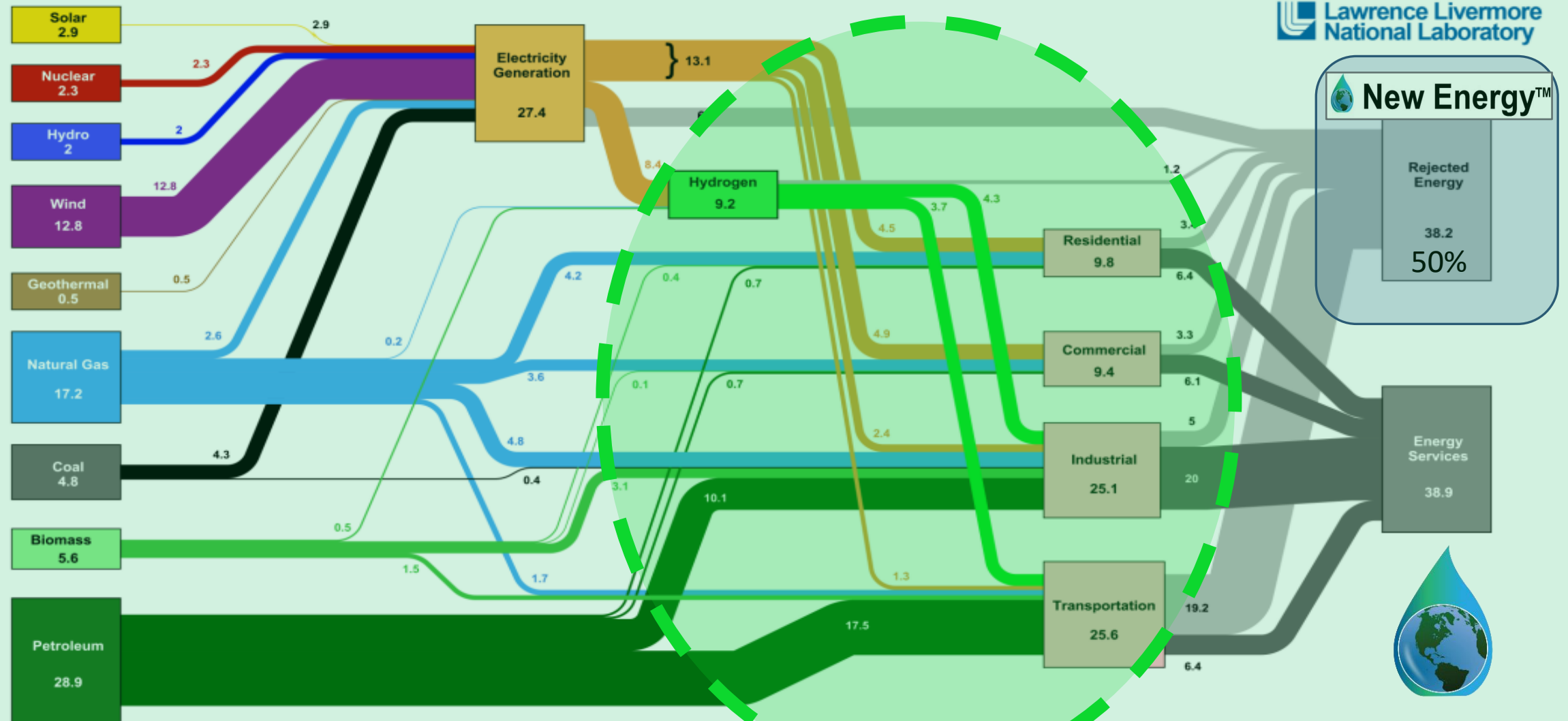


- “Switch” to hydrogen? - think adaptation curves of wind, oil, nat gas, propane, renewables, even RNG
- Large hydrogen hubs can work, and they are indicative of a “master-planned” roll-out\*
- But, more focused & specialized uses may prevail in Green Hydrogen’s pre-growth market development stage
  1. More expensive natural gas markets, restrictive permitting
  2. High volatility energy markets,
  3. Over-capacity energy markets
  4. Specific applications and those with supplemental energy sources (e.g. underutilized nuclear, unused compressors station pressure and heat, off-peak high renewables penetration, etc.



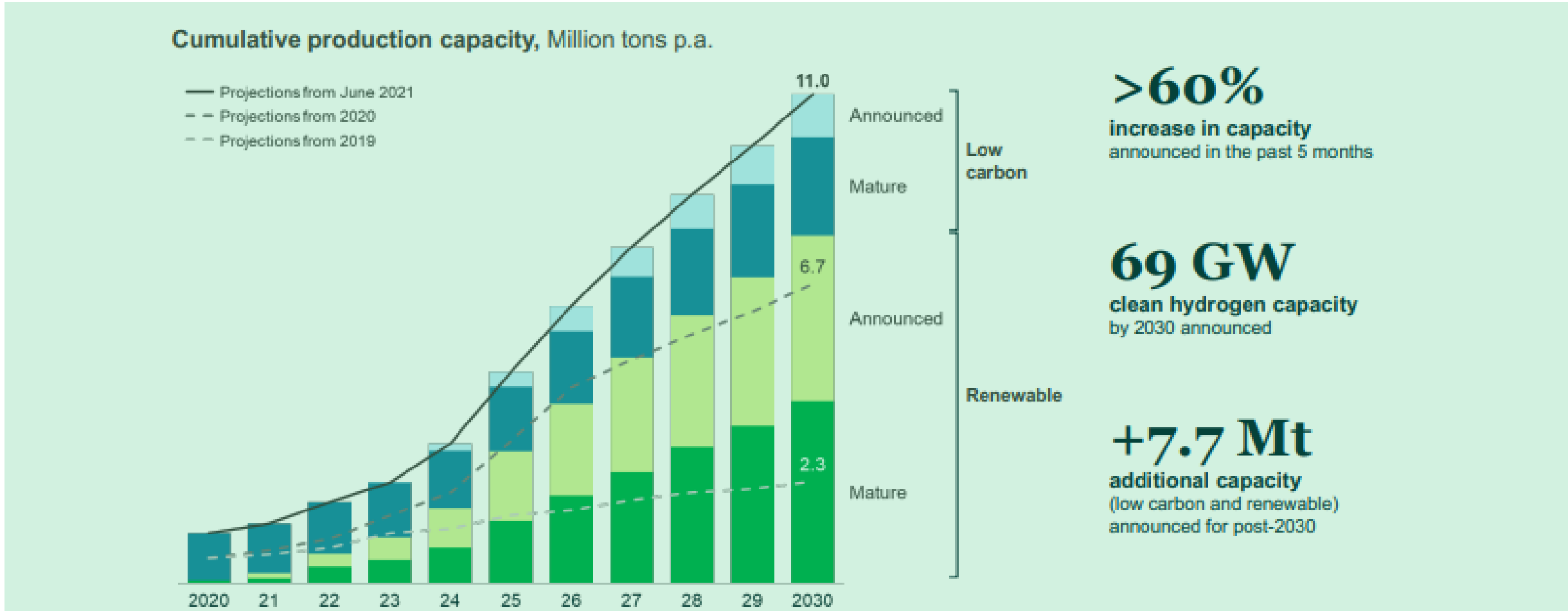
# New Energy™ Hydrogen Integration View

New Energy™ expects significant residential and commercial adaptation based upon customer requests and relationships



# New Energy™ Market: Green Hydrogen is Being Deployed at Scale

• 520 large-scale projects announced globally; (November 2021); >90 GW Electrolyzers Announced; 70% Green Hydrogen; “~\$150B FID+”, H2 Fuel Market expected to experience a 45X growth rate by 2030, expanding to \$90 billion







- Typical hydrogen blends in natural gas pipelines range from 3% to 15% hydrogen.
- The highest concentration of hydrogen reported by any U.S. gas utility is Hawaii Natural Gas pipeline
  - ✓ Currently carries approximately 12% hydrogen gas.
  - ✓ The 1,100-mile pipeline network and currently accommodates a mix of renewable natural gas (RNG), synthetic natural gas (SNG), liquid natural gas (LNG), and up to 15% hydrogen.
- Several other gas utilities are piloting hydrogen-natural gas blending in pipelines, including Southern California Gas (SoCalGas) and Dominion Energy.
- Enbridge and others are blending in Canada (Markham @2%+ 3,600 customers)

# Green Hydrogen is now being blending in North America

- 1

**Northwest Natural**

Testing how different blends of hydrogen and natural gas work in their equipment and various types of appliances.

2

**SoCalGas and SDG&E**

Planning multiple hydrogen blending projects throughout their respective service territories, starting with an isolated section of a plastic distribution system in SoCalGas' service territory. The initial hydrogen blend level is planned at 1% and may increase to as much as 20%.

3

**Southwest Gas**

Studying how hydrogen-blended natural gas can further reduce carbon emissions while providing clean, reliable energy.
- 6

**Dominion**

Analyzed and confirmed via a pilot project that 5% of hydrogen could be blended into the gas distribution network without impairing either the distribution network or appliance performance.

7

**New Mexico Gas**

Conducting a pilot project that will test the blend in appliances in a closed system, then move to small segments of the distribution system that serves customers.

8

**Hawaii Gas**

Existing pipeline network is currently accommodating a mix of synthetic natural gas, renewable natural gas, and up to 15% hydrogen.
- 9

**CenterPoint**

Evaluating use of a less than 5% blend into existing natural gas system.

10

**Southern Company Gas**

Conducting an R&D initiative, HyBlend, which will address the technical barriers to blending hydrogen in natural gas infrastructure and study life cycle emissions of hydrogen blends.

11

**Dominion**

Piloting a 5% hydrogen blend with gas lines and appliances at a test facility. Plans are currently under review by the North Carolina Public Utilities Commission.
- 12

**South Jersey Industries**

Piloting a feasibility study to produce hydrogen and blend into natural gas delivery systems.

13

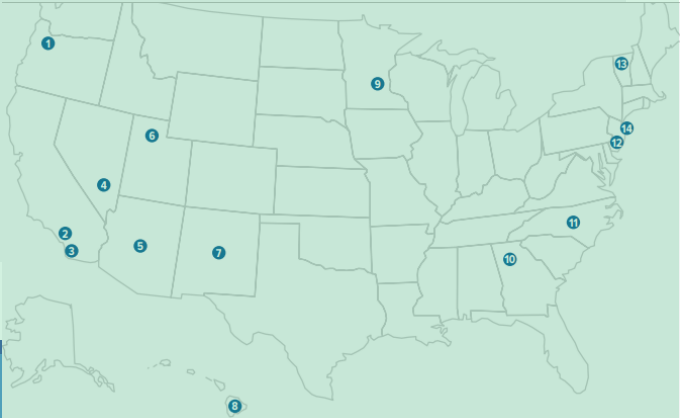
**Vermont Gas Systems**

Piloting a green hydrogen blend in the natural gas pipeline for heating at a GlobalFoundries' semiconductor fabrication plant.

14

**National Grid**

Plans to blend green hydrogen into the existing distribution system to heat approximately 800 homes and fuel 10 municipal vehicles.



# What-if: CO<sub>2</sub> Savings From Green Hydrogen Pipeline Blending



## New Energy Development Company LLC

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# Example PER™: GreenER™ H2 Project Waste Heat



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## Situation

- Client needed strategy to identify system targets to produce H2
- Six Solar Titan 250 turbines in one compressor station
  - ✓ ~2.5 Bcf 48-inch interstate pipeline
  - ✓ Derated to 183,000 Horsepower

## Action

- New Energy™ leveraged from its GreenER™ Hydrogen plant designs
- Manifold for 6 Waste Heat turbine nozzles to create a near continuous flow of power
- Designed to power Siemens Proton Exchange Membrane electrolyzer stack to most effectively utilize the Waste Heat

## Result

- Planned high utilization of PEM electrolyzer despite <100% capacity factor of all turbines
- Detailed Engineering Estimate \$11 / MMBtu cost of GreenER™ Hydrogen



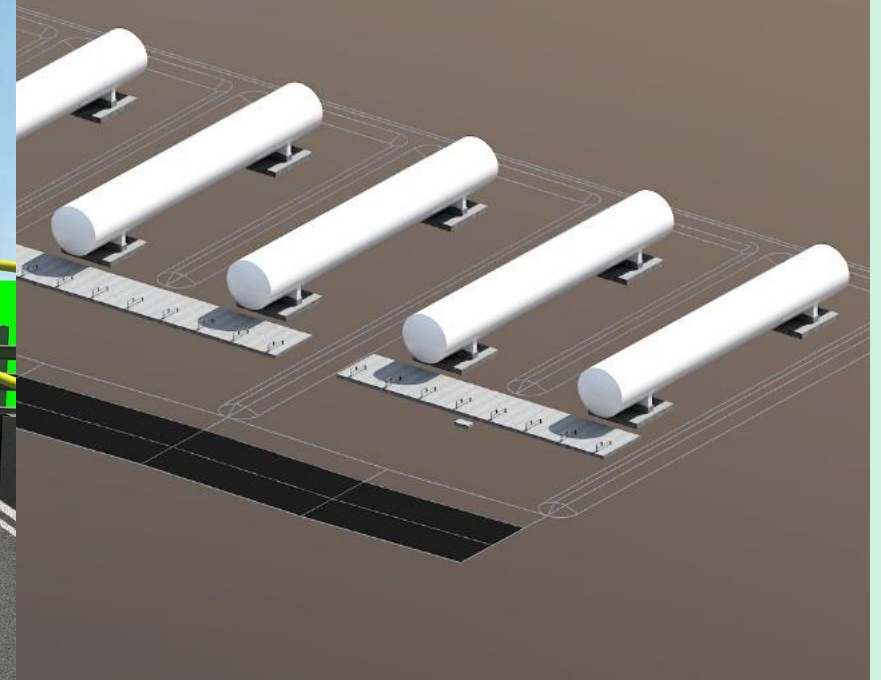
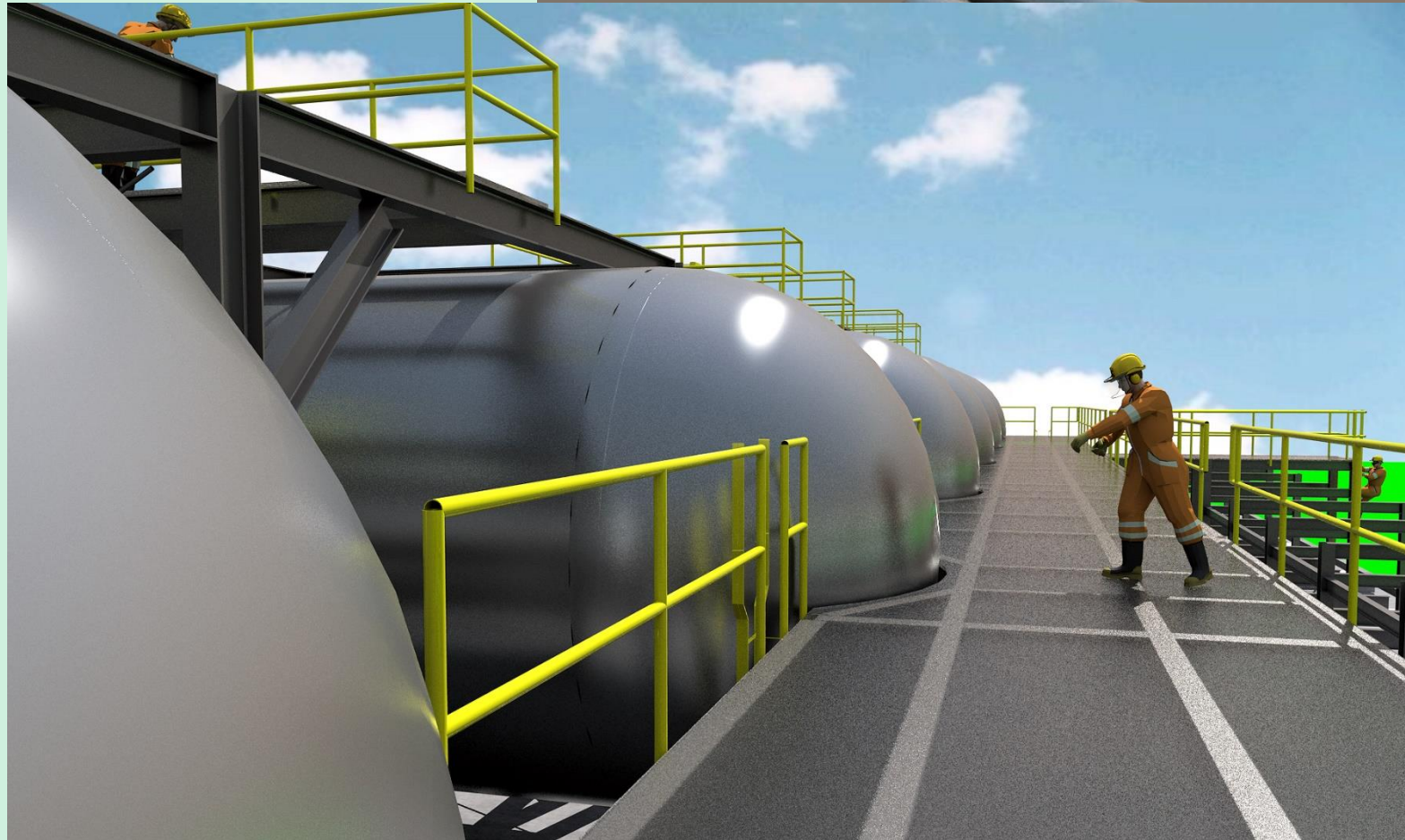
Solar Titan 250



# Example: New Energy™ Project GUC



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## Examples

- Patent Pending\* can reduce capital + O&M up to 20%
  - ✓ Reduction in required space, e.g. exclusion zones
  - ✓ Applicable to H2 and LNG
- Patent on designed-build for PECO Energy as a 100,000 dt/d M&R standalone under owned US Patent #6,176,046
- Project awarded “American Gas Association Environmental Excellence Award” for repeatable and sustainable high impact energy innovation



### (12) **United States Patent** **Quine et al.**

(10) **Patent No.:** **US 6,176,046 B1**  
(45) **Date of Patent:** **Jan. 23, 2001**



US006176046B1

#### (54) **PORTABLE, PRE-MANUFACTURED, MODULAR NATURAL GAS DELIVERY STATIONS**

(75) Inventors: **Thomas G. Quine**, Methuen; **John E. Rafferty**, Lowell; **James M. Hunt**, Methuen; **James M. Smilikis**, Georgetown, all of MA (US)

(73) Assignee: **Northstar Industries, Inc.**, Andover, MA (US)

(\*) Notice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

(21) Appl. No.: **09/198,269**

(22) Filed: **Nov. 24, 1998**

(51) **Int. Cl.**<sup>7</sup> ..... **F17D 1/04**

(52) **U.S. Cl.** ..... **52/79.1; 52/79.5; 52/79.9; 52/220.2; 52/745.02; 52/745.2; 290/1 A; 290/1 R; 48/190**

(58) **Field of Search** ..... **52/79.1, 79.4, 52/220.2, 745.01, 745.02, 79.5, 79.9, 745.2, 750; 290/1 A, 1 R; 48/190**

#### (56) **References Cited**

##### U.S. PATENT DOCUMENTS

Re. 30,280	5/1980	Berman et al. .	
3,690,077	9/1972	Dalglish, Jr. et al. .	
3,925,679 *	12/1975	Berman et al. ....	290/1 A
4,136,432 *	1/1979	Meely .....	290/1 A
4,539,844	9/1985	Grove, Jr. .	
4,658,634	4/1987	Killough et al. .	
4,666,340	5/1987	Cox .	
4,763,451	8/1988	Butcher .	
4,788,802	12/1988	Wokas .	
5,265,384	11/1993	Menke et al. .	

5,353,558	10/1994	Shea, Sr. et al. .	
5,628,191 *	5/1997	Kueck et al. ....	60/655
5,644,871	7/1997	Cohen et al. .	
5,656,491 *	8/1997	Cassani et al. ....	52/79.1
5,727,353 *	3/1998	Getz et al. ....	52/79.1

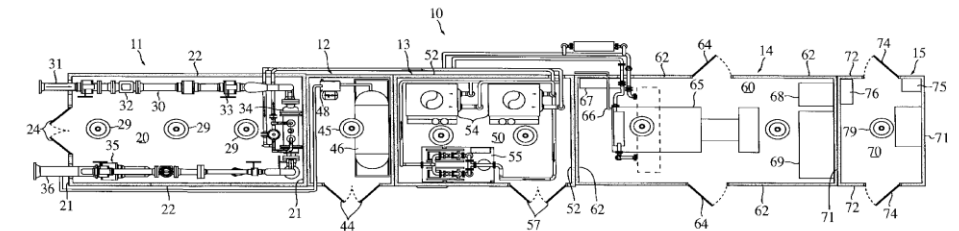
cited by examiner

**Primary Examiner**—Robert Canfield  
(74) **Attorney, Agent, or Firm**—Shinju Global IP Counselors, LLP

#### (57) **ABSTRACT**

A pre-manufactured natural gas delivery station is presented to a client that filters, measures, controls, pre-heats, pressure reduces, odorizes, and provides excess communication, provides excess power, and provides excess heat for a host site. The design is pre-approved by supply pipeline, end users and regulatory bodies. The final configuration is welded, assembled, wired, painted, tagged, and tested, at a factory site and then shipped to an installation site in accordance with customer's requirements. The station is commissioned, operators are trained and a three volume project DATA book is installed in the control room for documentation. The pre-manufactured natural gas delivery station can include a high pressure gas metering room and regulating room that can be selectively coupled to other prefabricated modular rooms or modules. Preferably, the other prefabricated modules include an odorant room, a heating room, an energy generation room and an electrical control and communications room. The equipment and control systems for each room is preinstalled and secured to the building structure in each of the different modules at the factory site. The energy generation room and the electrical control room allows the gas metering station to be operated by electrical energy from a local utility line or from an internal generator that is fueled by the gas being metered.

**45 Claims, 7 Drawing Sheets**



# Example: Project Pink Hydrogen



## Situation

1. Owner of major nuclear power plant seeks to maximize revenue from its plant
  - ✓ >1000 MW name plate capacity
  - ✓ Only ½ MW subscribed
2. Legacy LDC / utility requires engineering design to leverage to produce and store hydrogen

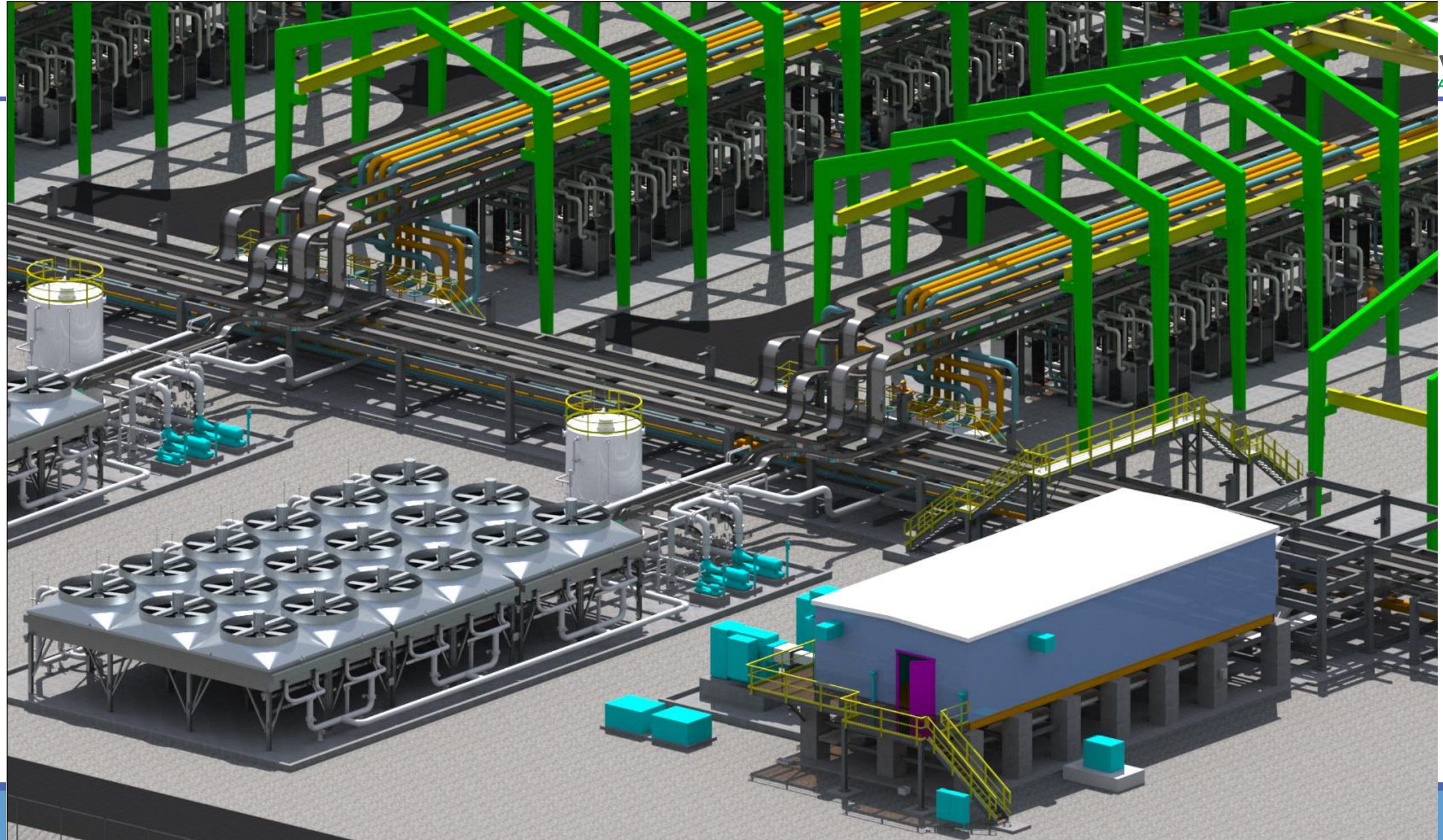
## Action

- Secured engineering contract to design to produce, liquefy, and offload liquid hydrogen
- Third party transporter and offtaker
- Client has expressed interest in co-investment capital from New Energy Development Company
- Initial Stage (preliminary) 60 MW + 90 MW alkaline electrolyzer production facility



**By 2030, surplus nuclear has the potential to power an annual 6 million tons of additional hydrogen production.\***







# Example: Project New Energy™ Hub



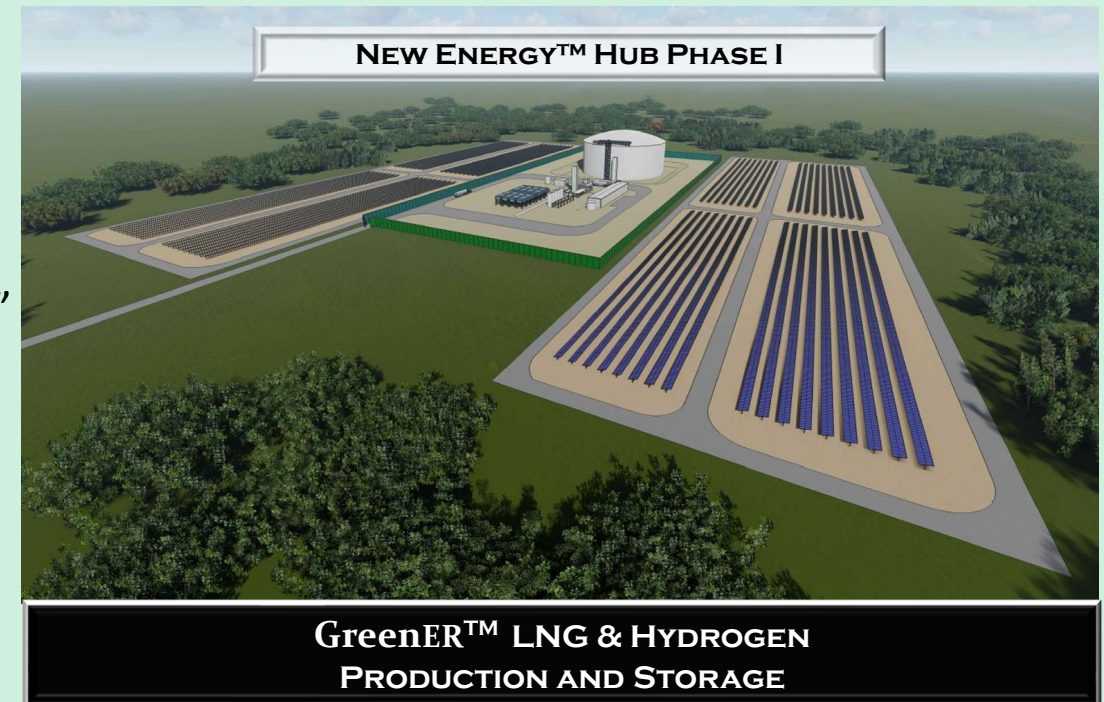
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## Situation

1. Legacy LDC requires security of natural gas supply
  - ✓ Constrained gas supply and high prices during times of need
  - ✓ Extensive sustainability goals, with plans to derate certain support injections
2. Local power plants seek peak shaving gas supply and may seek L-T green hydrogen blending opportunity
3. Nearby pipeline seeks winter and summer pressure support and
  - ✓ Lofty carbon reduction goals
  - ✓ Seek augmented commercial capabilities

## Action

- Secured >300-acre site for GreenER™ Energy Hub
- Favorable permitting environment; “DOE H2Hubs Program”
- Substantial preexisting logistics assets in place
  - ✓ Pipeline, LDC, plant proximity
  - ✓ Favorable trucking distances
  - ✓ Rail – unit train



# Cont'd: Project New Energy™ Hub



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**Phase I: GreenER™ (sustainable) LNG terminal of 2.0 Bcf of storage; 200,000 MMBtu / day of gas supply**

**Phase II: Scalable GreenER™ Hydrogen production and storage: Anticipate Initial prod @10,000 mcfd**

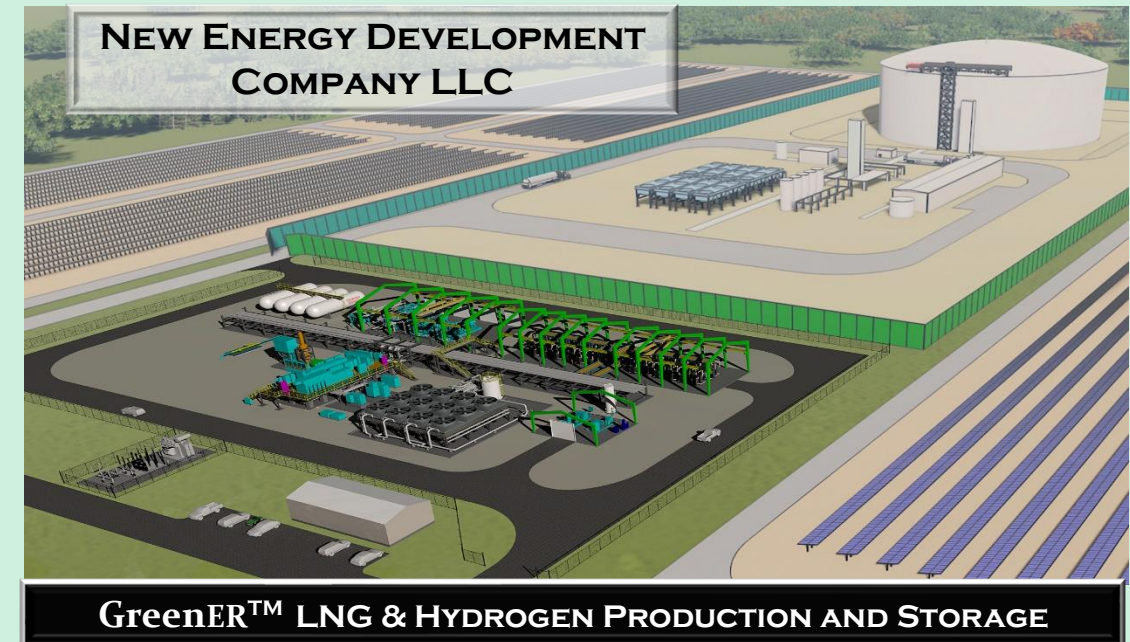
New Energy Development Company SPV, New Energy Hub LLC, will majority own and operate

## Contributing factors

- Environmental Credentials
  - ✓ PSG, RSG and RNG inc. required use - Phase 1
  - ✓ All electric drive
  - ✓ 50-60 MW on-site photo voltaic solar
- Evaluating and quantifying PER™, tech, and other sustainability components & opportunities
- Property tax cuts of ~\$9 mm, 60% of local property tax

## Current Status

- Detailed cost and rate models
- Multiple term sheet negotiations Phase I



July 1, 2022: TGP received approval for its producer certified gas (PCG) or responsibly sourced gas (RSG), aggregation pooling service from the Federal Energy Regulatory Commission (FERC), Solar takes 2.5-7.5 acres/MW; Town property tax rate is 25.58%. 2021-total property tax roll \$32 mm. 6,000 pop, 3/ house, 1% x 600 mm = \$750/person = \$2.2 mm/household. \$171 million–\$173 million for a 100-MW PV system co-located with 60 MW/240 MWh of storage - <https://www.nrel.gov/docs/fy21osti/77324.pdf> = \$1.7mm / MW, which including land lease at 15% UL IRR requires ~ a \$22.83 / MW price of 24/7 power.

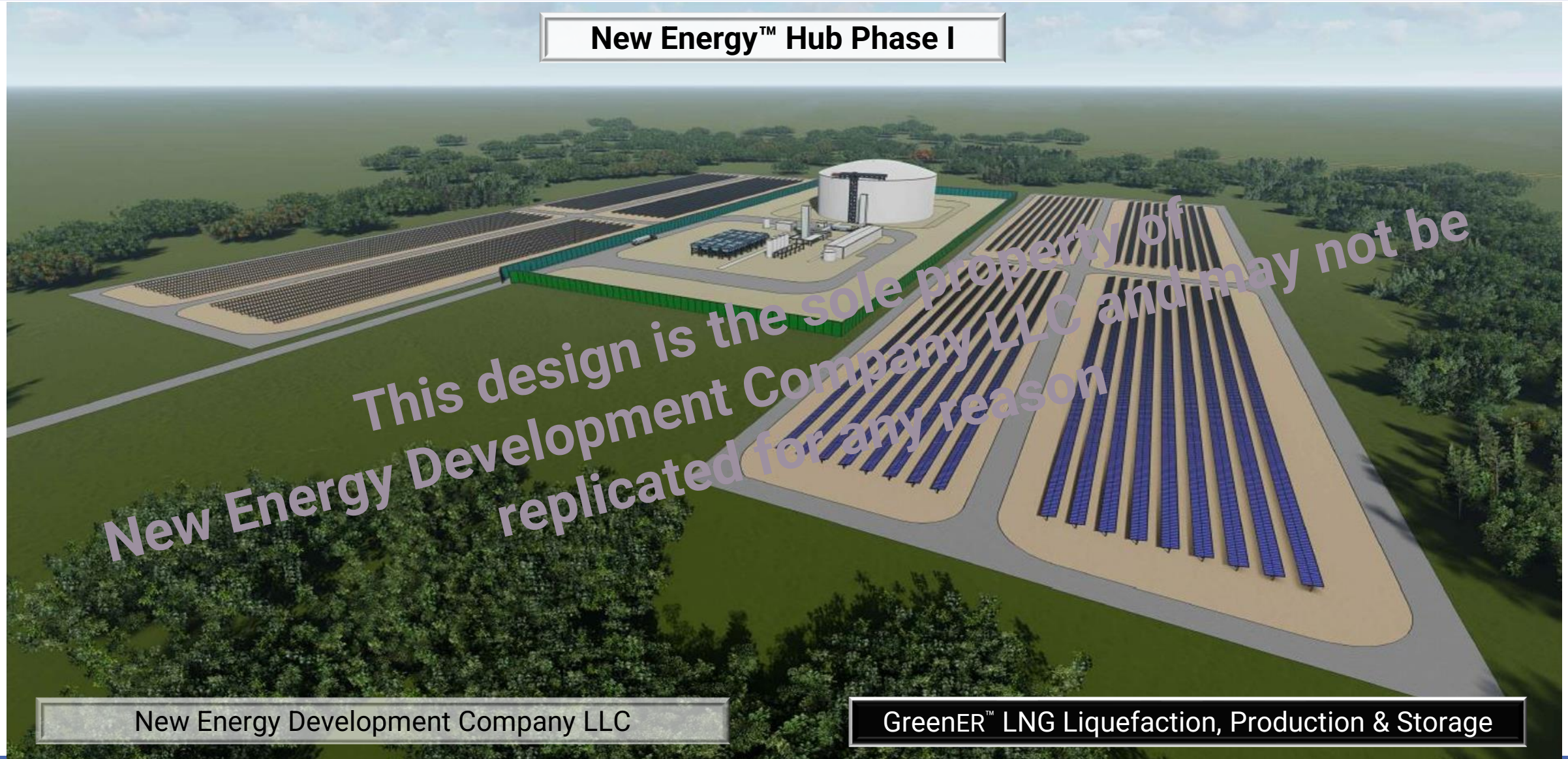


# New Energy™ Hub: Phase I



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## New Energy™ Hub Phase I



New Energy Development Company LLC

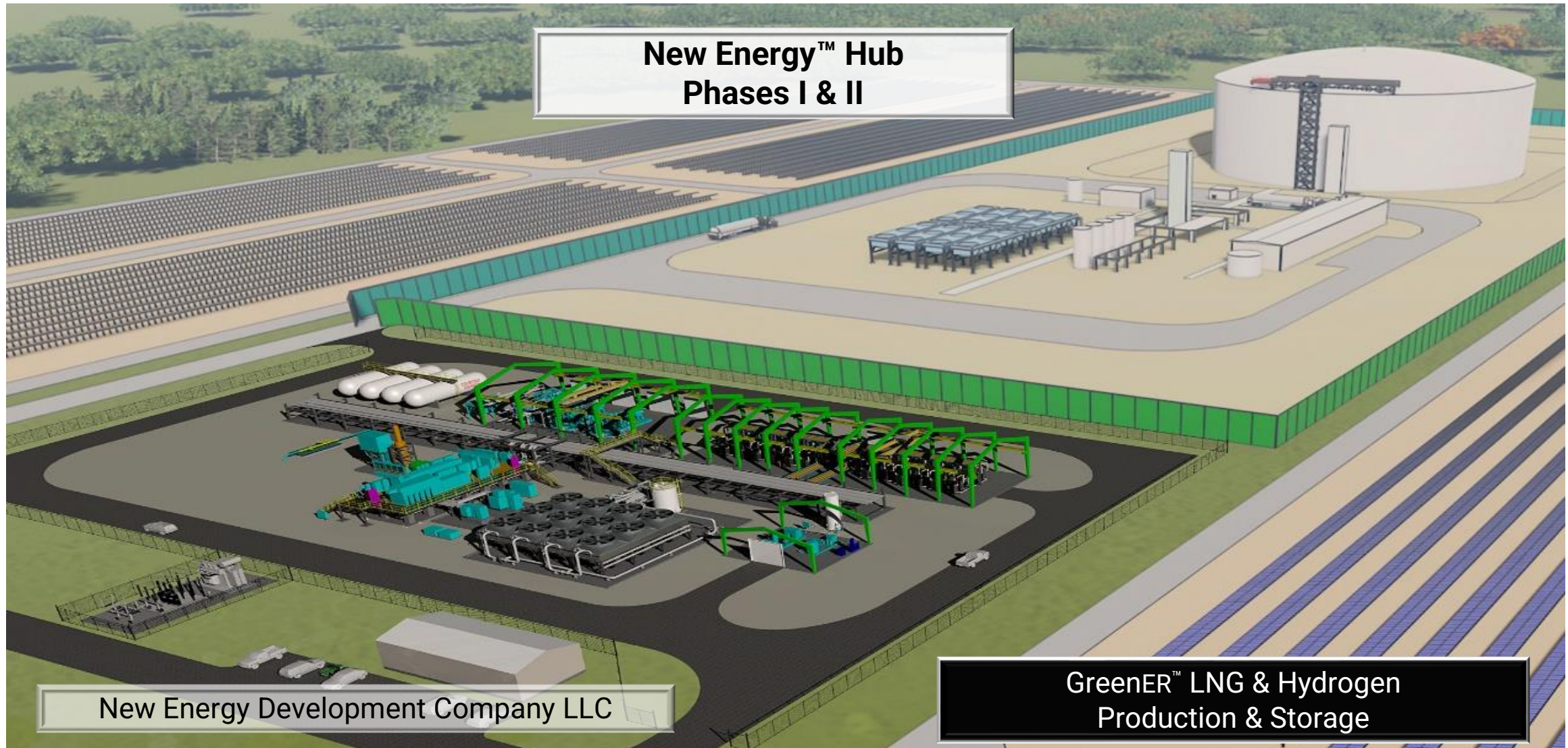
GreenER™ LNG Liquefaction, Production & Storage



# New Energy™ Hub: Phase II



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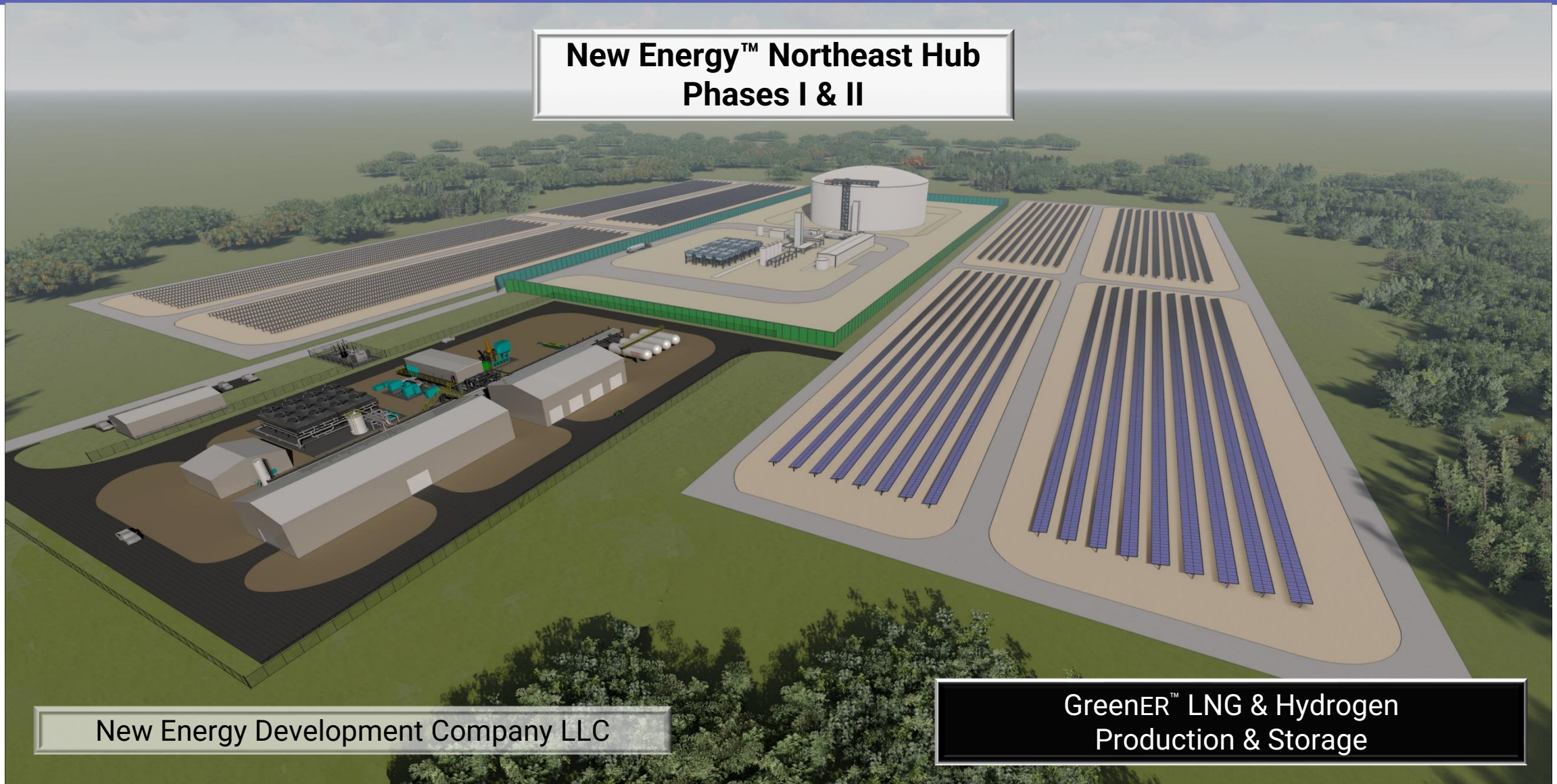


# What's Next? New Energy™ Northeast Hub



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## New Energy™ Northeast Hub Phases I & II



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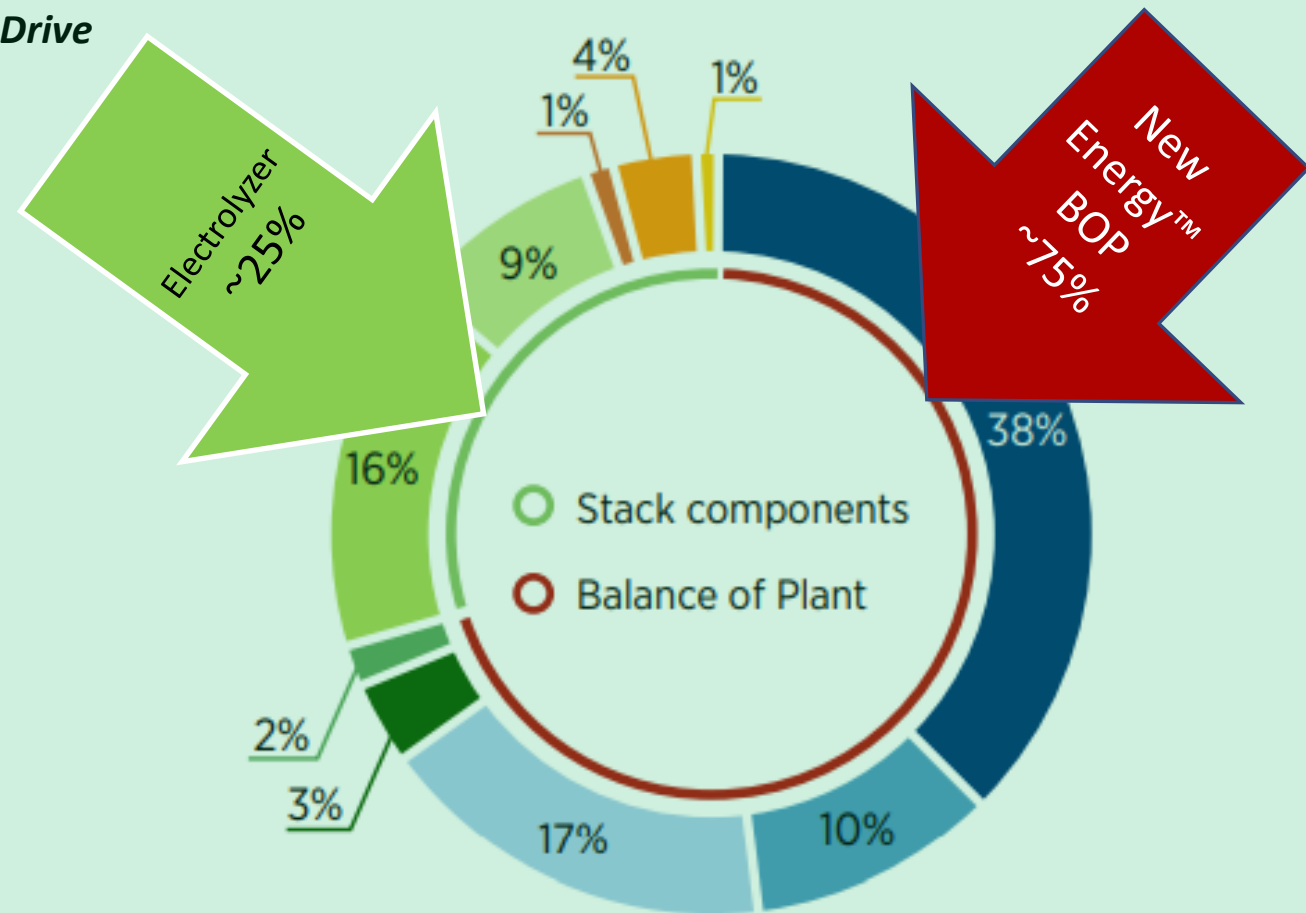
GreenER™ LNG & Hydrogen  
Production & Storage

# Core Competence: Balance of Plant = 75% of Project Cost



*Balance of Plant (BOP) and Power Price Drive majority of Green Hydrogen Cost*

- Power supply
- Water circulation
- Hydrogen processing
- Cooling
- Others
- CCM
- PTL
- Frame
- MEA
- Assembly



Power price represents ~38% of the cost of green hydrogen (typically quoted at \$20/MW, which is why GreenER™ Hydrogen is so important in green hydrogen projects. PTL = porous transport layer; CCM = Electrolyzer Catalyst Coated Membrane; MEA = Membrane electrode assembly

# New Energy™ Does Things Differently



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## Long-Standing Relationships with

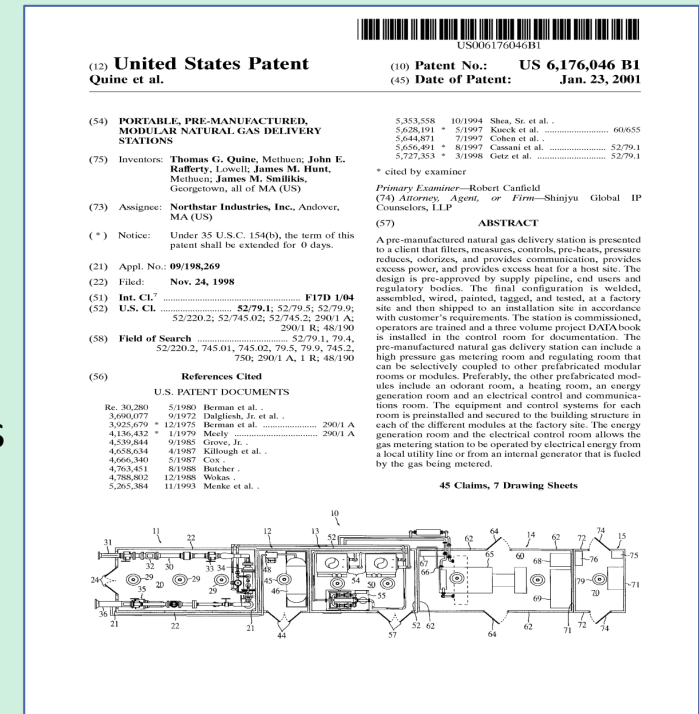
- Customers and offtakers
- Capital
- EPC
- Technical, others

## Environmentally Focused Product & Service

- Sustainability focus using GreenER™ technology and proprietary techniques while leveraging deep experience in the natural gas and power grid
- Enables enhanced permitting & acceptance in challenging environment

## Seasoned Experience

- Project development
- Technical
- EPC
- Sustainability
- Commodity
- Capital structuring







# New Energy Development Company

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***Your GreenER™ LNG & Hydrogen Facility Development Partner***

**LNG | Hydrogen | Storage**  
**Sustainable Investments**  
*With GreenER™ technology*