Reasonable Transition, Part 2, International Liquidity

By John Benson

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1. Introduction

This is the second part in a short series. The first part is described and linked below.

Reasonable Transition: *There is a debate in Europe regarding what constitutes a renewable electricity source, and specifically whether natural-gas fired plants should be considered "renewable" under reasonable conditions. Natural Gas is labeled as a "transition fuel", and investments in a natural gas plant will count as "green power" if:*

- *The plant emits no more than 270 grams of CO2 equivalent greenhouse gas (GHG) per kWh of electricity produced*
- *The natural gas plant must replace a plant with higher GHG emissions per kWh*

The key point here is this discussion regarding natural gas seems to be an "either or" discussion. In fact, a modern combined cycle plant fueled with geologically sourced natural gas can evolve to very low GHG emissions in the future.

https://energycentral.com/c/gn/reasonable-transition

In fact we (the U.S. The E.U. and many others) need natural gas currently, as we have not completed the transition to low, and very-low greenhouse gas (GHG) generation. However modern cogeneration plants can participate in the transition, per Part 1 of this series.

Also, there is a better and much more immediate need to improve international liquidity for this commodity. Some countries are really bad actors, and some of those same countries rely on natural gas exports to keep their economy afloat. Some of these same countries have become methane ultra-emitters. See the earlier paper described and linked below.

Damn Satellite Part 3: Super-emitters and Ultra-emitters: *In the part 2 of this series, we identified several methane Super-emitters in the Permian basin oil fields in West Texas and Eastern New Mexico.*

The Permian Super-emitters have now been located with better precision at the completion of a multi-year aerial survey, and additional surveys have been performed via multiple satellites.

Also, an international consortium has identified a new class of methane Ultra-emitters.

https://energycentral.com/c/cp/damn-satellite-part-3-super-emitters-and-ultra-emitters

I believe these bad-acting countries need (as my drill sergeant in the Army once said) an "attitude adjustment." One thing that might help is to provide sufficient international natural gas liquefaction and transport capacity to assure a high degree of liquidity for this

commodity. That way other countries that wished to respond to bad actions by curtailing imports of natural gas from the bad acting countries could do so.

The good news is that the U.S. is in the midst of a major build-out of the facilities to enable these, and they can be transitioned clean fuel.

2. LNG Terminals

First (and most important) I need to note that Liquefied Natural Gas (LNG) terminals are not limited to liquefying geologically-sourced natural gas (GNG). These facilities can load and unload LNG transport ships with (1) biomethane (a.k.a. renewable natural gas or RNG), (2) any mixture of GNG and RNG, or (3) Ammonia. The latter is probably the best carrier of hydrogen (see the earlier post below), and today uses LNG terminals / ships for international transport.

Release the Crackers: *This paper will investigate why ammonia is probably the best carrier for hydrogen, possibly can be used directly as a fuel, and the latest developments in ammonia technology including crackers.*

https://energycentral.com/c/ec/release-crackers

Thus today's LNG terminals and ships can slowly evolve to facilitate the transport of 100% renewable fuels that produce minimal greenhouse gases. Furthermore, RNG will mainly be produced from agricultural & forestry products (crop residues, woody biomass and manure)[1], and the U.S. is a major producer of these sources, so our LNG terminals and ships will probably lead the world in transporting these and the U.S. could be at the vanguard of producing renewable fuel and the technology for doing this.

2.1. LNG Liquefaction Growth

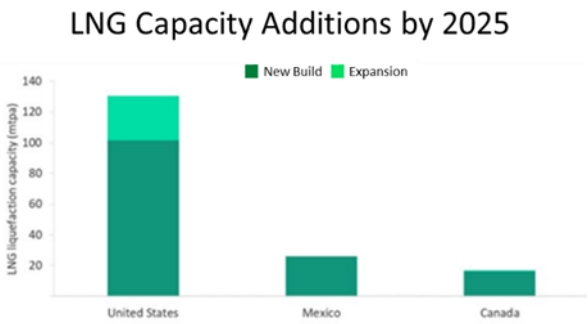
GlobalData's latest report, 'North America Capacity and Capital Expenditure Outlook for LNG Liquefaction Terminals, 2021-2025', indicates that North American liquefied natural gas (LNG) liquefaction capacity is expected to grow by more than 200% over the next four years, potentially increasing from 72.9 million tonnes per annum (mtpa) in 2021 to 241.6mtpa in 2025. The capacity additions are both from planned projects with identified development plans, and early-stage announced projects that are undergoing conceptual studies and that are expected to get approved for development.[2]

Among countries, the US dominates North America with 130.5 mtpa of liquefaction capacity additions by 2025. Mexico and Canada follow with capacities of 26.0mtpa and 16.8mtpa, respectively…

See the figure below (next page).

The United States is set to become the world's biggest liquefied natural gas (LNG) exporter in 2022, surpassing Qatar and Australia, and may hold that title for years to come.[3]

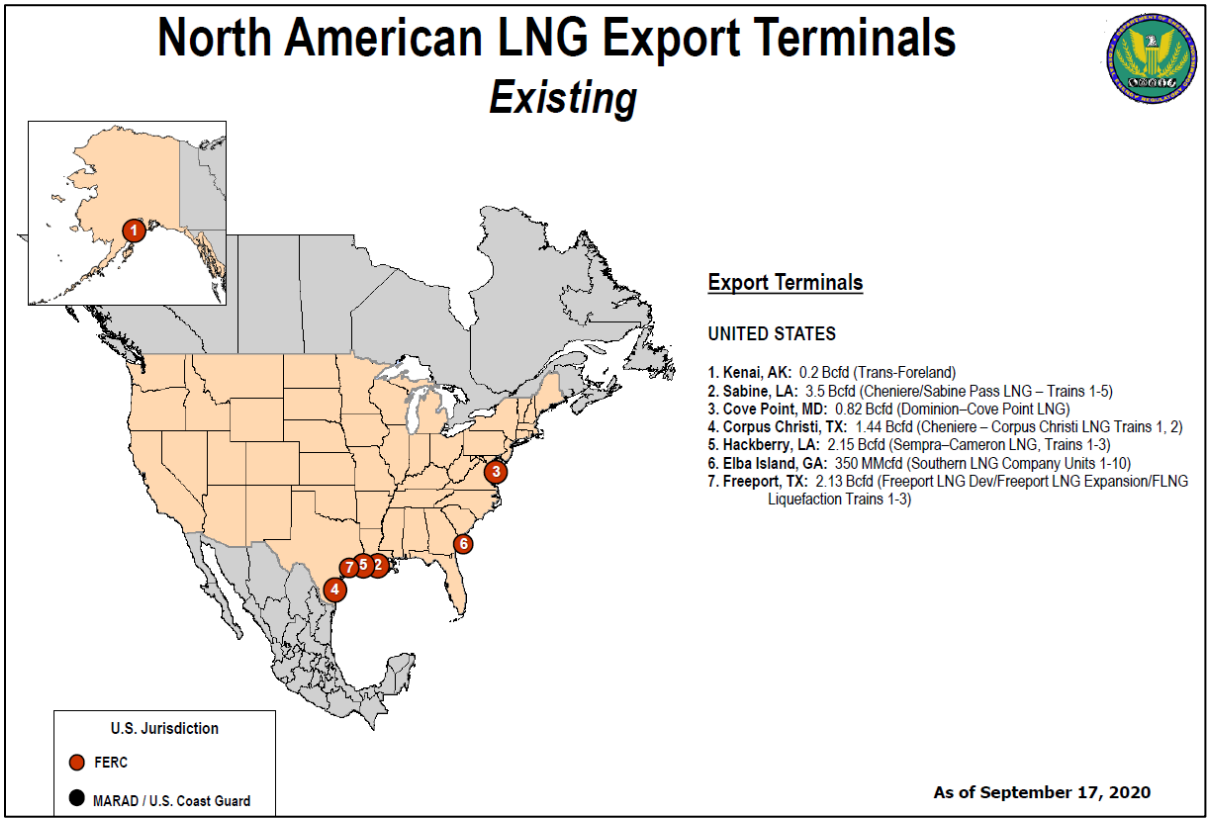
[1] Energy Central, "Tech Race," Section 3, July 2021, https://energycentral.com/c/cp/tech-race
[2] GlobalData Energy via Offshore Technology, "The US dominates LNG liquefaction capacity additions in North America by 2025," Oct 2021, https://www.offshore-technology.com/comment/us-dominates-lng-liquefaction-2025/
[3] Scott Disavino, Reuters, "U.S. to be world's biggest LNG exporter in 2022," Dec 2021, https://www.reuters.com/business/energy/us-be-worlds-biggest-lng-exporter-2022-2021-12-21/



In a year when China and other large economies in Europe and Asia scrambled to source enough supply for heating and power generation, the United States was sitting on a bevy of supply - one that will grow in coming years.

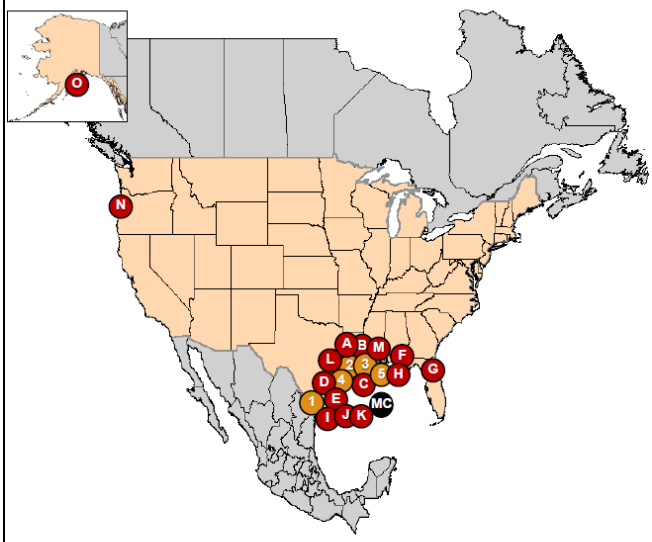
Global LNG demand has hit record highs each year since 2015, due mostly to surging demand in China and the rest of Asia. Much of that global appetite has been met by steadily rising U.S. LNG exports, which have reached new records every year since 2016 and is poised to continue in 2022…

The three slides pasted below are from a FERC presentation referenced at the end of this paragraph. Although the presentation is over a year old, it has the best view of current and future LNG terminals.[4]



[4] Federal Energy Regulatory Commission (FERC), "North American LNG Export Terminals," Sep 2020, https://www.ferc.gov/sites/default/files/2020-11/LNG_Maps_Exports-9-17-2020.pdf

North American LNG Export Terminals
Approved, Not Yet Built



U.S. Jurisdiction & Status

- FERC - Approved, Under Construction
- FERC - Approved, Not Under Construction
- MARAD / U.S. Coast Guard

Export Terminals

UNITED STATES

FERC – APPROVED, UNDER CONSTRUCTION

1. **Corpus Christi, TX:** 0.72 Bcfd (Cheniere–Corpus Christi LNG Train 2) (CP12-507)
2. **Sabine Pass, LA:** 0.7 Bcfd (Sabine Pass Liquefaction Train 6) (CP13-552)
3. **Cameron Parish, LA:** 1.41 Bcfd (Venture Global Calcasieu Pass) (CP15-550)
4. **Sabine Pass, TX:** 2.1 Bcfd (ExxonMobil – Golden Pass) (CP14-517)
5. **Calcasieu Parish, LA:** 4.0 Bcfd (Driftwood LNG) (CP17-117)

FERC – APPROVED, NOT UNDER CONSTRUCTION

- **A. Lake Charles, LA:** 2.2 Bcfd (Lake Charles LNG) (CP14-120)
- **B. Lake Charles, LA:** 1. 186 Bcfd (Magnolia LNG) (CP14-347)
- **C. Hackberry, LA:** 1.41 Bcfd (Sempra - Cameron LNG Trains 4 & 5) (CP15-560)
- **D. Port Arthur, TX:** 1.86 Bcfd (Port Arthur LNG Trains 1 & 2) (CP17-20)
- **E. Freeport, TX:** 0.72 Bcfd (Freeport LNG Dev Train 4) (CP17-470)
- **F. Pascagoula, MS:** 1.5 Bcfd (Gulf LNG Liquefaction) (CP15-521)
- **G. Jacksonville, FL:** 0.132 Bcf/d (Eagle LNG Partners) (CP17-41)
- **H. Plaquemines Parish, LA:** 3.40 Bcfd (Venture Global LNG) (CP17-66)
- **I. Brownsville, TX:** 0.55 Bcfd (Texas LNG Brownsville) (CP16-116)
- **J. Brownsville, TX:** 3.6 Bcfd (Rio Grande LNG – NextDecade) (CP16-454)
- **K. Brownsville, TX:** 0.9 Bcfd (Annova LNG Brownsville) (CP16-480)
- **L. Corpus Christi, TX:** 1.86 Bcfd (Cheniere Corpus Christi LNG) (CP18-512)
- **M. Sabine Pass, LA:** NA Bcfd (Sabine Pass Liquefaction) (CP19-11)
- **N. Coos Bay, OR:** 1.08 Bcfd (Jordan Cove) (CP17-494)
- **O. Nikiski, AK:** 2.63 Bcfd (Alaska Gasline) (CP17-178)

MARAD/USCG – APPROVED, NOT UNDER CONSTRUCTION

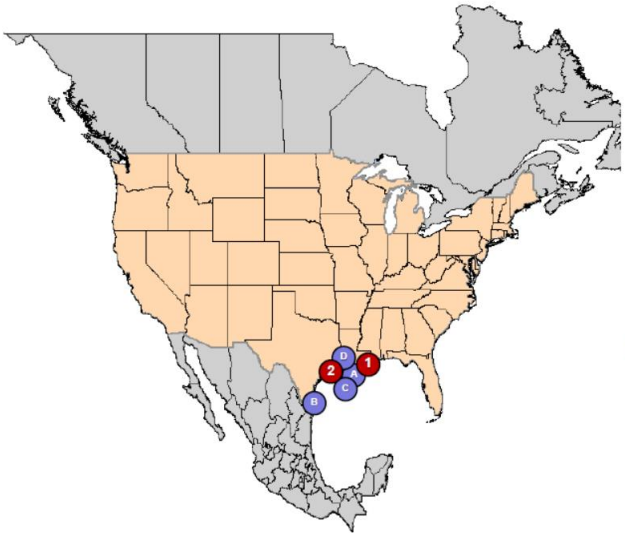
- **MC. Gulf of Mexico:** 1.8 Bcfd (Delfin LNG)

CANADA - LNG IMPORT AND PROPOSED EXPORT FACILITIES

https://www.nrcan.gc.ca/energy/natural-gas/5683

As of September 17, 2020

North American LNG Export Terminals
Proposed



UNITED STATES

PROPOSED TO FERC
Pending Applications:

1. **Cameron Parish, LA:** 1.18 Bcfd (Commonwealth, LNG) (CP19-502)
2. **Port Arthur, TX:** 1.86 Bcfd (Sempra - Port Arthur LNG Trains 3 & 4) (CP20-55)

Projects in Pre-filing:

- **A. LaFourche Parish, LA:** 0.65 Bcfd (Port Fourchon LNG) (PF17-9)
- **B. Galveston Bay, TX**: 1.2 Bcfd (Galveston Bay LNG) (PF18-7)
- **C. Plaquemines Parish, LA:** 0.9 Bcfd (Pointe LNG) (PF18-8)
- **D. Plaquemines Parish, LA:** 2.76 Bcfd (Delta LNG - Venture Global) (PF19-4)

CANADA

F **For Canadian LNG Import and Proposed Export Facilities:**

https://www.nrcan.gc.ca/energy/natural-gas/5683

As of September 17, 2020