



## Natural Gas HHP Market Update

**Erik Neandross**



February 21, 2018




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PURPOSE: US DOE Clean Cities NGV Technology Forum – February 21, 2018




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## Presentation Overview


- GNA Intro & Overview
- Natural Gas for HHP Applications
  - Marine
  - Rail
  - Industrial
  - Mining
- Areas of Opportunity and Growth




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## GNA OVERVIEW






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## GNA Overview

- North America's Leading Full Service Alternative Fuel Vehicle Consulting Firm
- Southern California & NYC
- Founded Dec. 1993
- Diverse Staff of 35
  1. Technical Team
  2. Programs
  3. Public Affairs
  4. Events & Marketing



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## GNA: Heavy-Duty Commercial Transport





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## GNA Overview

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technical

funding  
with 360

gnacreative

strategy

 <b>25 YRS</b> <small>of experience</small>	 <b>421M</b> <small>in revenue</small>	<table border="0" style="width: 100%; font-size: 8px;"> <tr> <td>WHAT GNA WORKS WITH</td> <td></td> </tr> <tr> <td>ORIGINAL FLUETS</td> <td style="text-align: right;">30%</td> </tr> <tr> <td>UTILITARIAN SUPPLIES</td> <td style="text-align: right;">19%</td> </tr> <tr> <td>NON-PROFIT/INDUSTRY GROUPS</td> <td style="text-align: right;">12%</td> </tr> <tr> <td>TECHNOLOGY SUPPLIERS</td> <td style="text-align: right;">21%</td> </tr> <tr> <td>OFF-ROAD VEHICLES</td> <td style="text-align: right;">8%</td> </tr> <tr> <td>GOVERNMENT AGENCIES</td> <td style="text-align: right;">11%</td> </tr> </table>	WHAT GNA WORKS WITH		ORIGINAL FLUETS	30%	UTILITARIAN SUPPLIES	19%	NON-PROFIT/INDUSTRY GROUPS	12%	TECHNOLOGY SUPPLIERS	21%	OFF-ROAD VEHICLES	8%	GOVERNMENT AGENCIES	11%
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gna

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## Heavy-Duty NGV Deployment



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## GNA HHP NG Projects



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## GNA LNG Import / Export




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## Stakeholder Engagement



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## Engagement, Education & Training

- LNG 101 & Familiarity
- Safety Demonstrations
- LNG Safety & Handling
- Permitting Officials
- Fire Department
- First Responders
- Community Outreach
- All Project Personnel





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## Annual HHP Summit: Nov. 2017, JAX






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## NATURAL GAS FOR HHP: MARINE





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## Tremendous Growth of LNG Marine in N.A.





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## Harvey Gulf LNG Project

1. Harvey Energy: 3 years 3 months
2. Harvey Power: 2 years 4 months
3. Harvey Liberty: 1 year 10 months
4. Harvey Freedom: 9 months

**2,790 days of total operation  
(7 years 8 months)**





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## Harvey Gulf LNG Project

**February 2015 – January 2016**

- 92 Truck-to-Vessel Transfers
- 900,000 gallons transferred





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### Harvey Gulf LNG Project



**Port Fourchon LNG Fueling Facility**

**January 2016 – Present**

- 654 Truck-to-Tank Transfers
- 211 Tank-to-Vessel Transfers
- 6,393,000 gallons transferred
- 303 Vessel Bunkerings (total)
- 7,240,000 gallons transferred

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### Harvey Gulf LNG Project



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### Harvey Gulf LNG Project

- ATB/articulated tug barge vessel for bunkering liquefied natural gas
  - Load / discharge rate of 600 cubic meters (nearly 160,000 gallons) per hour
- ABS Approval in Principle (AIP) and U.S. Coast Guard design base approval
- 3,996 cubic meters (> 1 million gallons) total storage capacity



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### TOTE LNG Marine Project

- Isla Bella operational since October 2015
- Sister ship Perla del Caribe entered service Feb 2016



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### TOTE LNG Marine Project

- Have loaded over 3,262 trailer loads of LNG as of Jan. 31, 2018
- Requirement is to load about 250,000 LNG gallons in 5 hours while simultaneously discharging and loading container cargo



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### TOTE LNG Bunkering



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### TOTE LNG Bunkering

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### JAX LNG Production Plant

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### TOTE LNG Bunkering

- Keel Laid September 9, 2015
- Enters service in JAX when plant commissioned in 2018
- Dimensions 232' L x 49' B x 16' D Jones Act
  - US Flag vessel
  - Built in US
  - Owned by US citizens
  - Manned by US mariners

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### TOTE LNG Bunkering Barge

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### Crowley LNG Project

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### Eagle LNG: Maxville LNG Plant

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### Crowley + Exxon LNG Bunkering

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### Eagle LNG Export

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### Seaspan LNG Project

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### BC Ferries LNG Project




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### BC Ferries LNG Project



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### BC Ferries LNG Project



**Strategy No.5 - Communicate:** Develop and execute a plan that communicates *effectively* to all stakeholders how LNG fuel is being safely introduced into the fleet.

Who are the stakeholders?  
 Understand their perspective.  
 Address concerns, build on positives and establish a sustainable communication platform that encourages dialogue as perspectives change over time.

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### Fortis BC: Tilbury LNG Plant Expansion

~140 Million gallons/year production and 18 million gallons LNG storage = 50 days of LNG storage at full rate



**FORTIS BC**

### STQ (Quebec) Ferries LNG Project



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### Groupe Desgagnés LNG Project



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### Pasha & Matson: SoCal to Hawaii

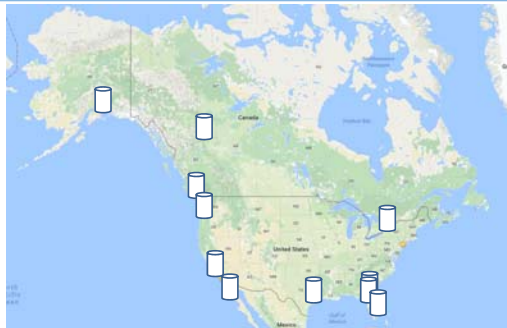





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### New & Expanded LNG Fuel Supply





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### Carnival Cruise Lines LNG Commitment





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### Carnival Cruise Lines LNG Commitment

**Project XL – ONE platform for ANY brand**

Brand	Delivery	Tank
ADA1	1/2018	Openning
Costa 1	9/2019	Turku
PRC	3/2018	Openning
CC1	8/2018	Turku
ADA2	5/2021	Openning
Costa 2	9/2021	Turku
CC2	10/2022	Turku



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### CMA CGM LNG Container Ship Order

**The Immediate future: A game changer**

- ▶ 9 vessels with a capacity of 22K TEU for CMA CGM
- ▶ To be built in HZ and SWS shipyards
- ▶ First delivery beginning of 2020
- ▶ To be deployed on the Europe Asia trade
- ▶ First large LNG fueled container ships
- ▶ Largest container ships ever built

**LNG Fuel Tank:**

- ▶ One LNG integrated membrane tank of 18 600 cbm
  - ▶ Space optimization
- ▶ Mark III (270 mm) containment system
  - ▶ Sea proven technology
- ▶ Maximal pressure: 700 mbarg
  - ▶ Flexibility to handle and store boil off gas
- ▶ One bunkering operation per round trip
  - ▶ To cover a round trip





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### Next Generation of LNG Bunkering





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- TOTAL & Mitsui Partnership
- 18,600 cubic meter capacity
- 2020 delivery



### Next Generation of LNG Bunkering

 Cadriassat: 6,500 m3	 Coralius: 5,800 m3
 Engle Zeebrugge: 7,500 m3	 Bomin Linde: 7,500 m3

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### LNG Supply Chain Driving Investment



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### USCG Commitment to Making LNG Work

USCG Liquefied Gas Carrier National Center of Expertise  
 HHP Summit  
 November 09, 2017

#### Future Liquefied Gas Port




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### LNG Pioneers!



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### NATURAL GAS FOR HHP: RAIL



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### LNG for Freight Locomotives



### Florida East Coast Rail LNG Project



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### Florida East Coast Rail LNG Project



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### Florida East Coast Rail LNG Project

First Jacksonville to Miami LNG Run...



- Completed over 2,400 trips, travelling over 800K miles while consuming more than 2.7M gallons of LNG



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### Florida East Coast Rail LNG Project

Transporting LNG as a commodity

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### Innovative LNG Supply Chains



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### Rail Transport of LNG





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## Alaskan Interior Energy Project

- 350 miles Anchorage to Fairbanks
- 11 hours 45 minutes by train
- Cost to average home in Fairbanks is 8100/year - \$675/month
- Four times the national average

**INTERIOR ENERGY PROJECT FULL SUPPLY CHAIN FOCUS**

**Natural Gas Supply and Liquefaction Alternatives**  
AIDEA and Private Industry

**Transportation: Trucking or Railroad**  
Private Trucking Contractors or Alaska Railroad

**LNG Storage and Regasification**

**Natural Gas Distribution System**  
Interior Gas Utility Fairbanks Natural Gas

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## NATURAL GAS FOR HHP: INDUSTRIAL

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## Innovative LNG Supply Chains

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## Innovative LNG Supply Chains

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## CNG Has a Huge Role Here Too!

- Installed CNG compression capacity for industrial markets: >200,000 MCF/day
- Equivalent to > 2.5 million LNG gallons of production/day

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## Innovative CNG Supply Chains

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## Innovative CNG Supply Chains

### Case Study Port Townsend Paper, Washington State (XNG)



Trucks XNG with press vans in Washington. Load owned by XNG and used to serve Port Townsend Paper Co.



Route from Tacoma Industrial Park to Port Townsend, WA. From Hexagon.com

**Key statistics on the conversion**

- Facility converted from #6 oil to Compressed Natural Gas
- Conversion made in September, 2016
- Estimated mill conversion cost: \$3.1MM including boiler upgrades.
- Facility is now in compliance with Maximum Achievable Control Technology (MACT) boiler rules.
- Natural gas pipeline average price of Henry Hub (\$3.02)
- First year financial savings of \$1,200,000 includes fuel savings, maintenance savings, and lower regulatory compliance costs
- Natural gas prices are stable now, and according to US Energy Information Agency, will remain stable for the foreseeable future. Provides financial stability for energy price at mill
- Estimated reduction of 22,660 tons of CO<sub>2</sub> (33%) per year by burning natural gas.

**Port Townsend Paper**

**Key Equipment Load Profile**

- Line Mill: 400,000 MMBtu/yr
- Recovery Boiler: 300,000 MMBtu/yr
- Package Boiler: 100,000 MMBtu/yr
- Power Boiler: 300,000 MMBtu/yr

Current XNG deliveries are ~800,000 MMBtu/yr. Actual consumption values vary due to mill demands & price of waste wood.



Quantum Natural Gas



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## Innovative CNG Supply Chains

### Case Study

**Situation**


- Cheese Cooperative Northeastern United States
- Needed to upgrade fuel systems (still burning dirty oil) and wanted to serve their long-term operational needs and make a positive environmental change
- Natural Gas cheaper & cleaner – but no pipeline nearby

**Solution**

- Provide non-stop CNG delivery services


**Results**

- \$300,000 annual savings financial savings over traditional fueling oil (2-year ROI)
- Clean air and a compelling sustainability story
- Burners responding quicker with natural gas, positive impact w/ production. Boiler room cleaner with NG (no oil messes)



Quantum


PROPRIETARY & CONFIDENTIAL



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## NATURAL GAS FOR HHP: MINING




**NGVTF**  
Natural Gas Vehicle Technology Forum



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## Natural Gas for Mining

### Cat DGB Mining Trucks Running Well at Customer Sites

- Cat 785C DGB truck running well at three sites in North America since early 2015
- Demonstrating 65% cycle substitution and successful LNG refueling and mine site operations
- Trucks meeting full payload, diesel power and transient response
- Validation testing complete
- Mines around the world are converting fleets over to DGB







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## Natural Gas for Mining









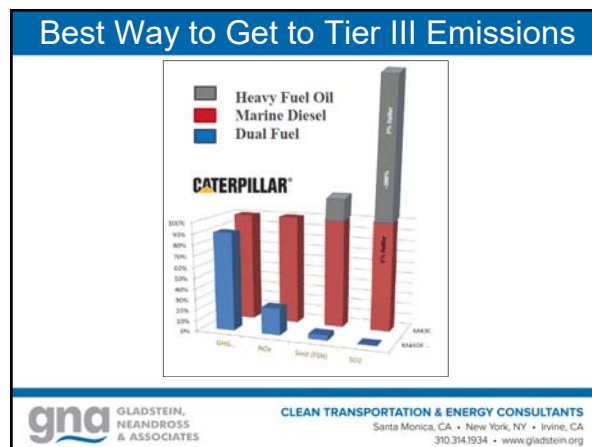
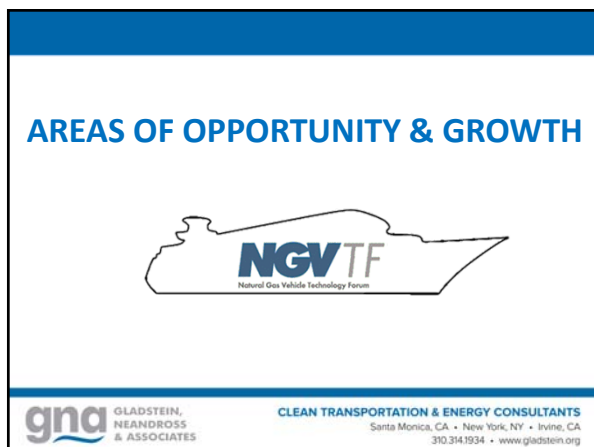
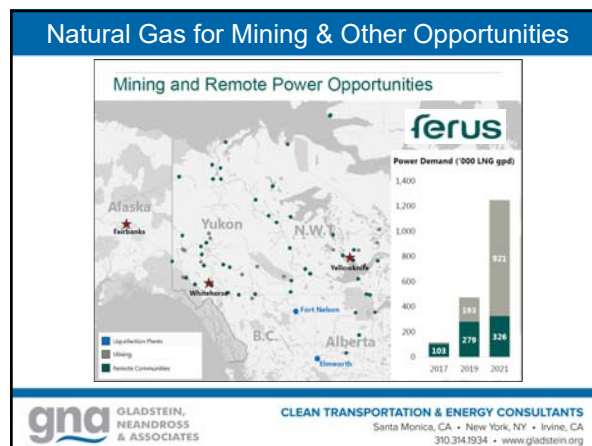
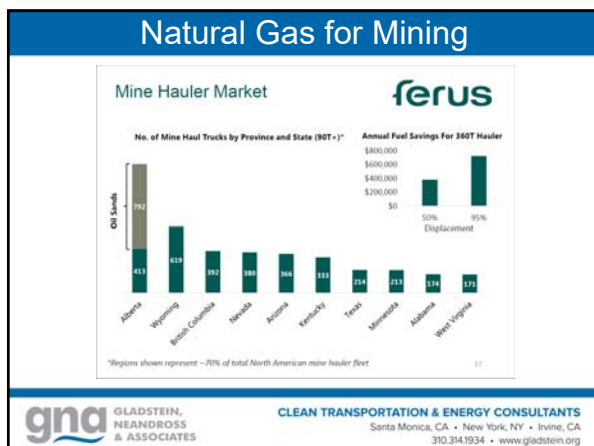
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## Forward Growth Opportunities




Potential for  
Natural Gas Adoption in 2021



Rail

Oil & Gas   Mining   Remote Power   Marine

3




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## Some Closing Thoughts...

- No shortage of opportunity – from the Equator to the North Pole
  - Strong economic and environmental drivers remain
- Marine will continue to be large demand center in near term
  - Best way to get to Tier III emissions > improve regional air quality
  - Synergies with long-term investment in RNG projects
  - Marine can drive supply chain > leverage for other local markets
- Utilities are playing a large role (Pivotal, Gaz Metro, Fortis BC, etc.)
- Continued role of multi-national energy companies (Shell, Exxon) is meaningful
- Leverage synergies between markets (i.e. mining & remote communities; marine & industrial)
- Don't rule out CNG! Huge market opportunities here, especially in industrial markets.
- Don't forget about rail. Near term opportunity for commodity transport and strong potential for diesel substitution in mid term.
- More natural gas HHP engine technology development work is needed to achieve lower criteria + GHG emissions
- Stakeholder engagement is more critical than ever...don't let natural gas be the Big Bad Wolf



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THANK  
YOU!

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