GE Oil & Gas

MT LNG
Study Trip

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18-Sept-2013

GE imagination at work

GE Oil & Gas

is a world leader in advanced technologies and services with 43,000 employees in more than 100 countries supporting customers across the industry — from extraction to transportation to end use. Our unrelenting commitment to the environment, health and safety, quality and integrity defines us: it's The Way We Work.

The GE Oil & Gas business

Operating in **100+** countries **43,000** employees Revenue '12: **~$15.2B**

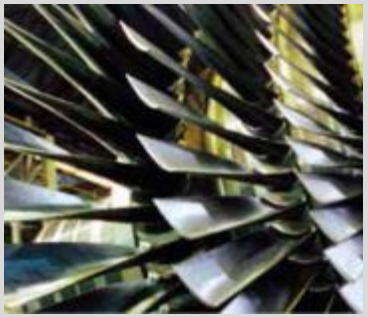
Subsea Systems

Drilling & Surface

Lufkin

Measurement & Control

Turbomachinery



Global Services

PII

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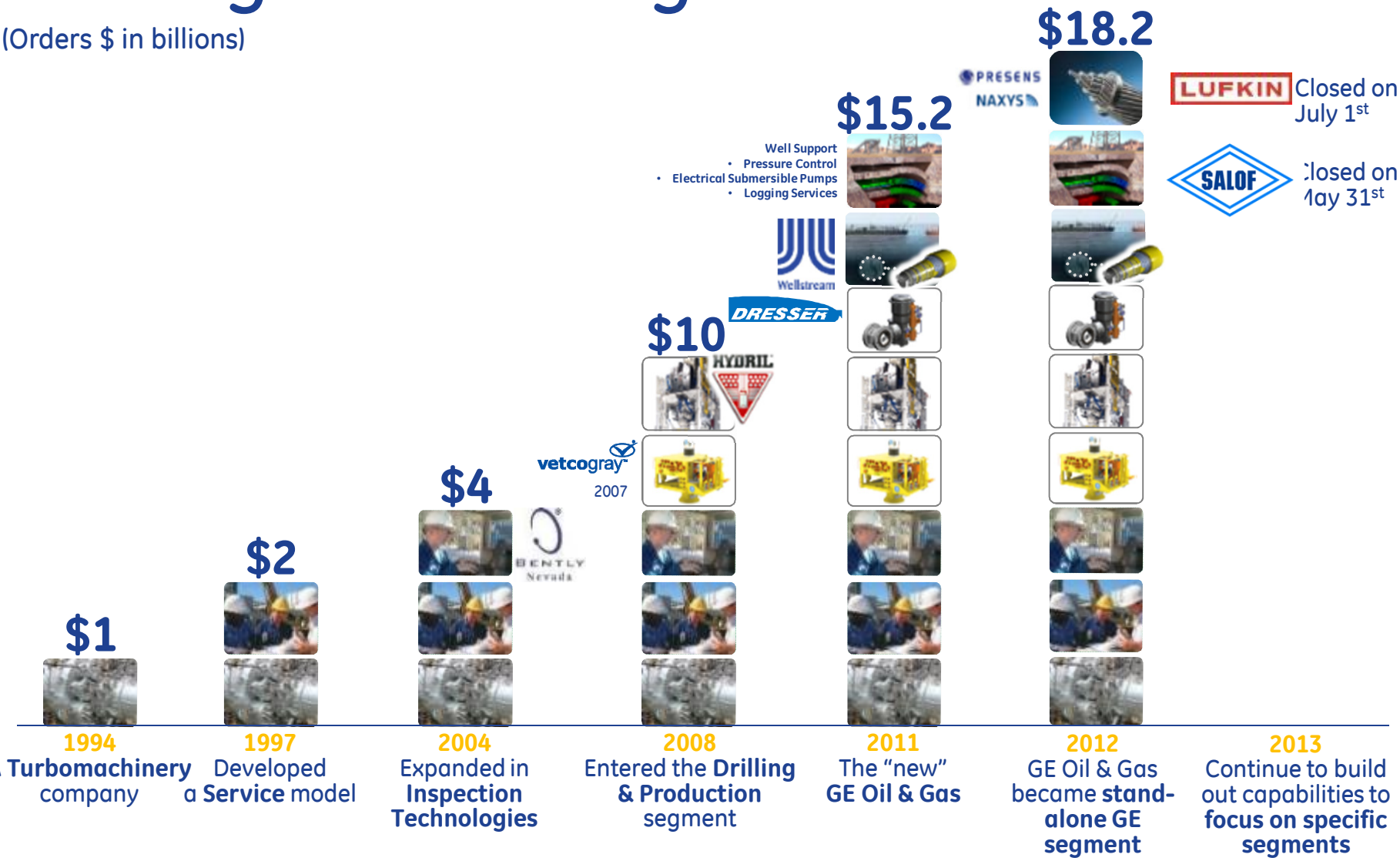
Building on a strong foundation …

(Orders $ in billions)

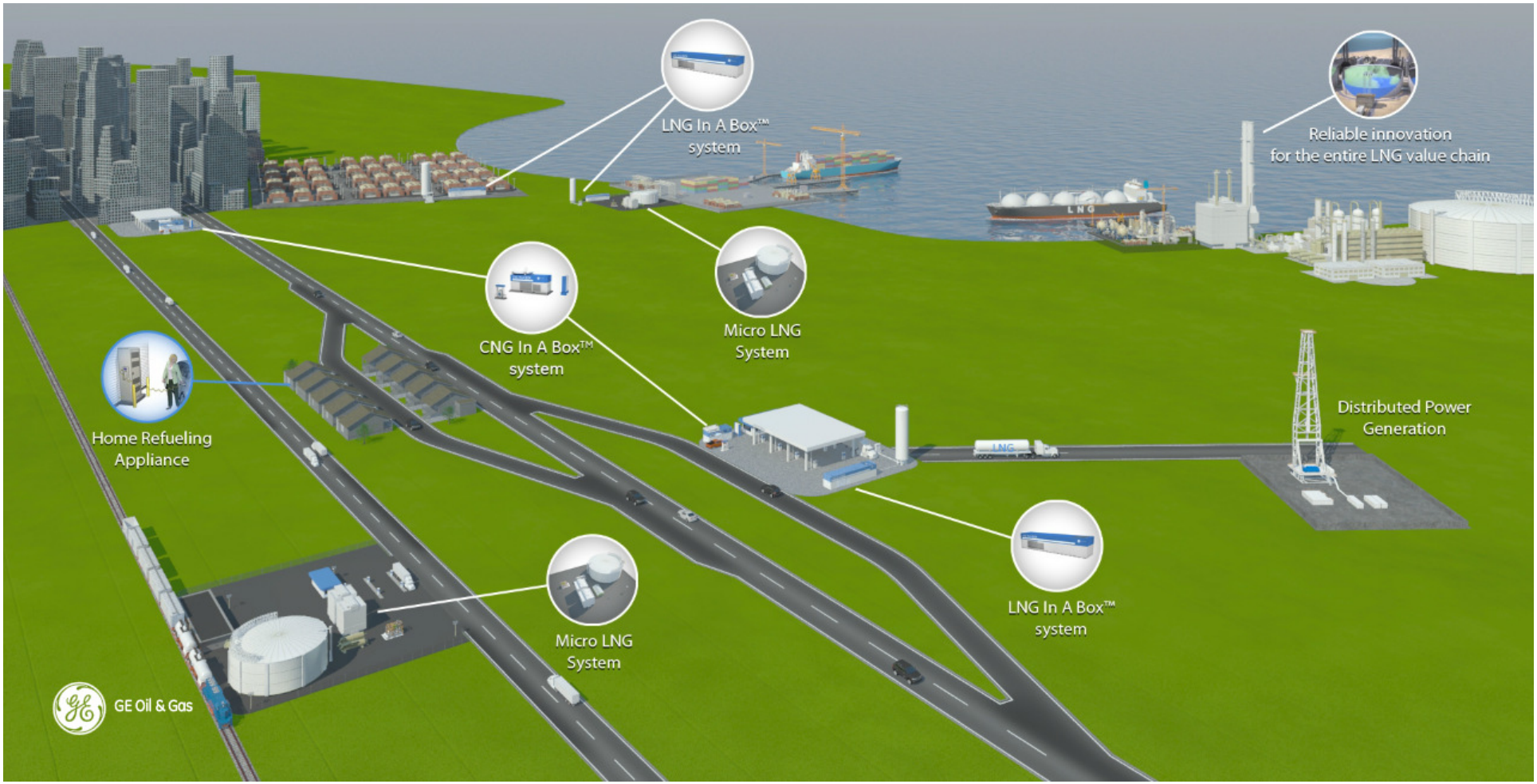


… GE Oil & Gas today

GE imagination at work

SOLUTIONS FOR SMALL SCALE LNG

GE solutions for natural gas fueling infrastructure



GE imagination at work

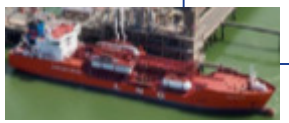
LNG infrastructure for marine

Gas Source

Pipeline Gas

Large LNG terminal

LNG Container



Marine Transport

@Port

Road Transport

TTS Bunkering

Small-Scale LNG

LNG Station

LNG Storage

L/CNG Station

Power Station

STS Bunkering

Users

Marine fleets
- Ro-Ro
- Lo-Lo
- Ro-Pax

Industrial fleets
- Rail
- Heavy duty
- Medium duty

Personal NGV/Fleets
- Light/medium duty

Distributed Power
- Emerging markets
- Remote power
- Peaking
- Marine fleets

GE Offerings

Micro LNG
Salof MMLS

LNG In A Box
CNG In A Box

Gas Engines
Drill Motors
Gas Turbines

imagination at work

Transforming LNG fueling infrastructure model

Traditional Large LNG

- Up to 72 months
- Custom, project-based
- Capital intensive
- High logistics complexity & cost

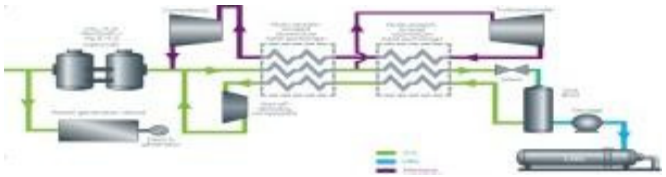
LNG for Transportation

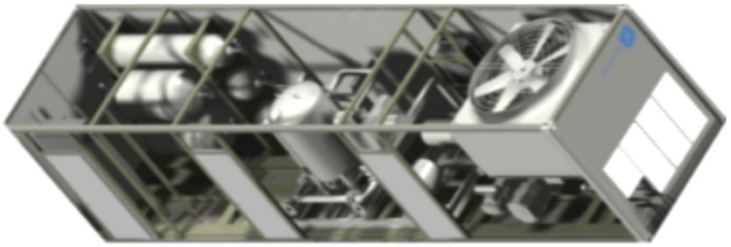
- 6-24 months
- Modular & standard, product-based
- Reduced CapEx & OpEx
- Simplified logistics, on-site production

Breaking down traditional, complex LNG plants into modular, rapidly deployable solutions

GE imagination at work

Small LNG solutions





2011

Micro LNG – Gen 1

- 30-90 Ktpa
- Liquefaction only
- Custom
- API
- EPC heavy
- Construct on site
- 24 months lead time

2012 - 2013

Micro LNG – Gen 2

- 30-150 Ktpa
- Turnkey solution
- Multiple standard packages
- Non API
- Factory tested skids, GC only
- Plug&play, light civil work
- Target 12-15 mo lead time

LNG in a Box

- 6-30 Ktpa
- Turn key solution
- 1 standard box
- Non API
- Factory tested solutions
- Plug&play, pad prep only
- Target 3-6 mo lead time
- Equipment financing

LNG In A Box™ system

Ideally suited for:

- Heavy-duty truck fueling stations
- Virtual pipeline
- Distributed power generation

Performance:

- 10,000-50,000 gallons per day LNG production (38 – 190 m3)
- Inlet gas: Pipeline
- Gas recovery: 80-82%
- Specific power 1.4 kWh/gal (1.3MJ/liter)

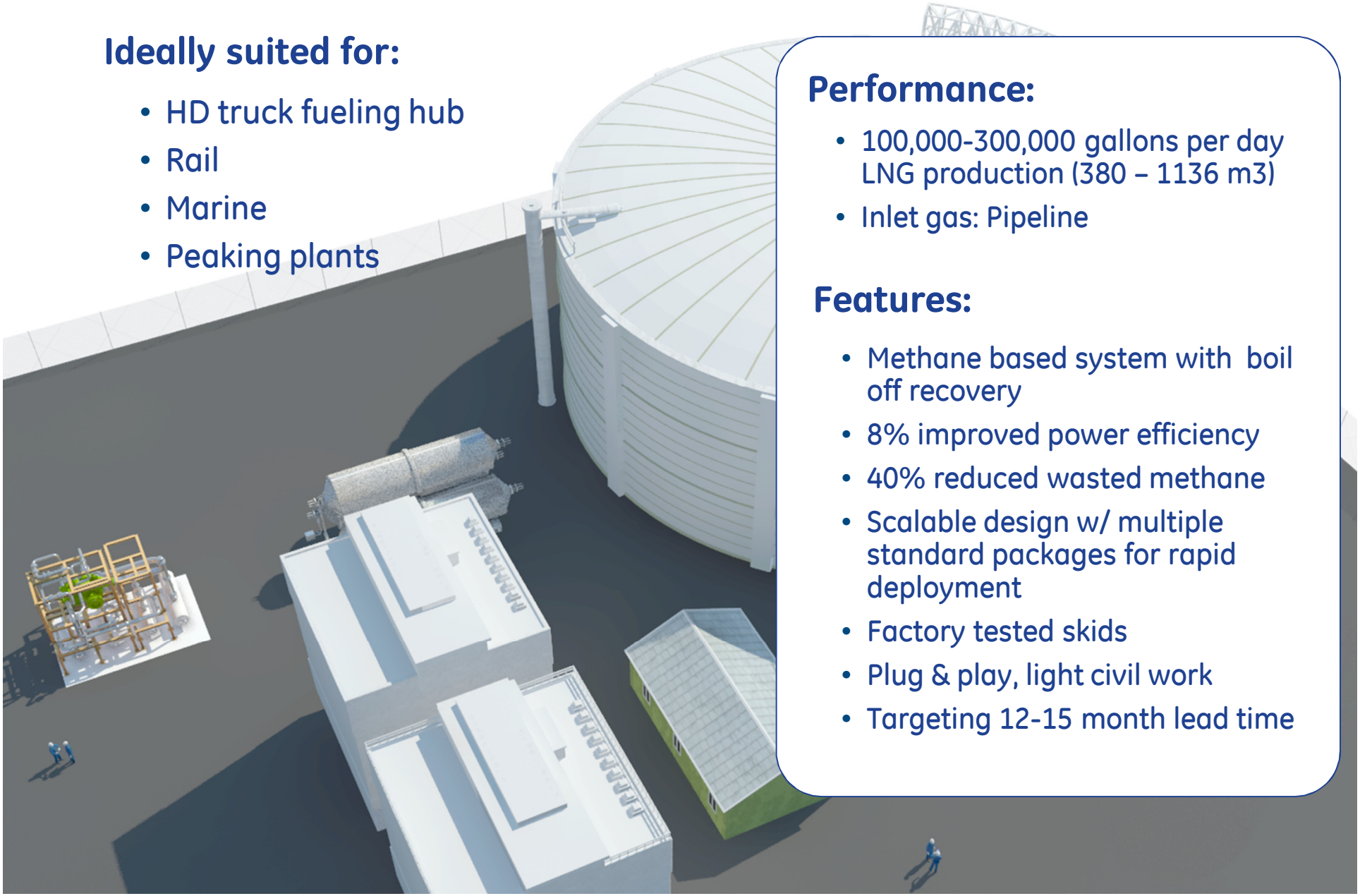
Features:

- Modular, rapidly (re)deployable design
- Simple methane cycle
- Minimal pad prep & quick installation
- 6-12 month lead time
- Highly automated operation
- Gas engine option available
- Equipment financing available

Micro LNG system

Ideally suited for:

- HD truck fueling hub
- Rail
- Marine
- Peaking plants



Performance:

- 100,000-300,000 gallons per day LNG production (380 – 1136 m3)
- Inlet gas: Pipeline

Features:

- Methane based system with boil off recovery
- 8% improved power efficiency
- 40% reduced wasted methane
- Scalable design w/ multiple standard packages for rapid deployment
- Factory tested skids
- Plug & play, light civil work
- Targeting 12-15 month lead time

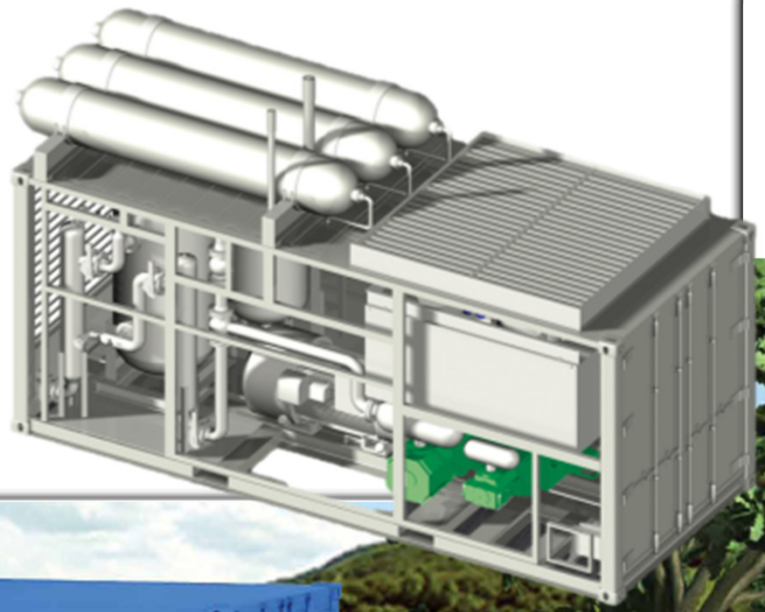
CNG In A Box™ system

Performance:

- 10,000-20,000 gallons (1 gallon = 3.8 liter) per day gasoline equiv. production
- Inlet gas: Pipeline

Features:

- Portable, Modular design
- Minimal pad prep & quick installation
- 2-4 month lead time
- Highly automated operation
- Gas engine option available
- Equipment financing available



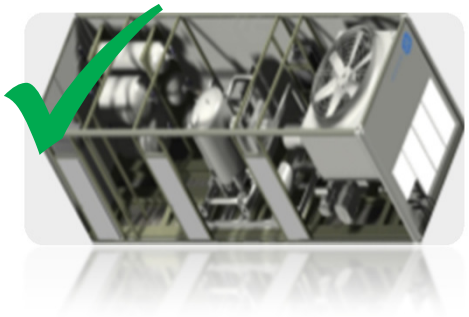
Ideally suited for:

- Cars, trucks, buses fueling stations
- Rig-site gas distribution, flare capture
- Storage, remote sites

CNG Portfolio

CNG In A Box - 400

- 10,000 gasoline gallons per day … 7.5 GGE / min
- Cars, trucks, buses
- Launched in Mar '12 … first unit delivered Sep '12



CNG In A Box High-Flow

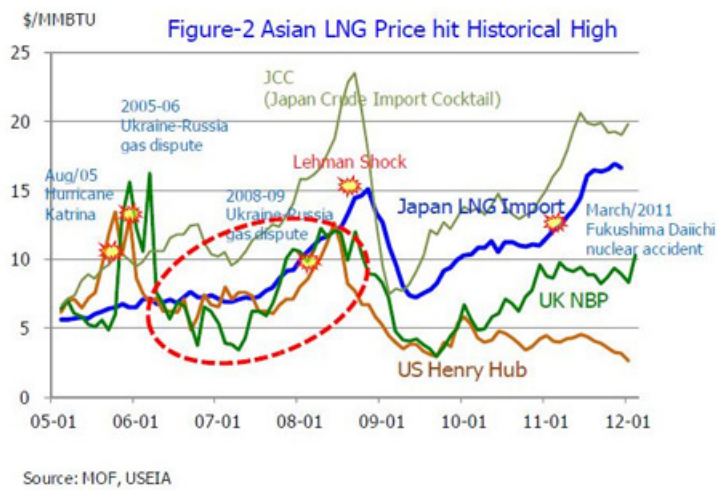
- 20,000 gasoline gallons per day … 15 GGE / min
- Rig-site gas distribution, large trucks, flare capture
- Launched in Sep '12 … first unit delivered Mar '13

CNG In A Box Stand-alone

- 10-20,000 gasoline gallons per day … gas-engine driven
- Storage, remote sites
- Under development

BRAIN FOOD
(Low calories)

HILP event – Having a "Plan B"



http://www.siew.sg/topics/asian-premium-gas-strikes-lng-importing-countries

Various scenarios where LNG supply chain is disrupted

- Demand / Supply balance
- Technical
- (Geo) Political

Prepare for the unexpected!

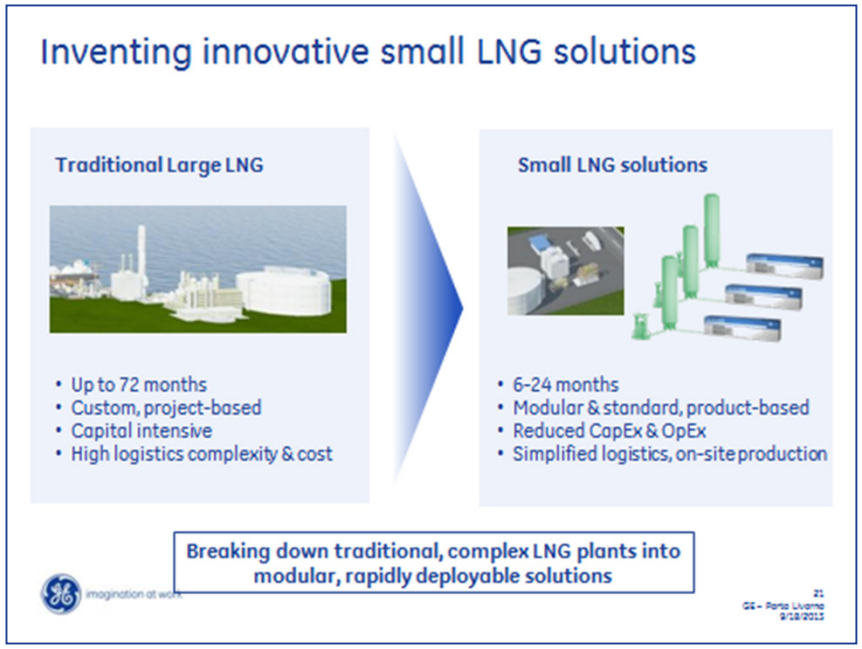
- Storage solutions (ST)
- Alternative fuels
- (small scale) Liquefaction
  - Conventional gas
  - Unconventional gas

Change in assumptions

Various scenarios where LNG supply & demand changes

- New applications competing for supply
  - Cars, Trucks, Power Gen
- New sources of supply
  - Biogas (BLG)
  - Shale Gas
  - Pipeline
  - Other unconventional gas

Small scale liquefaction provides flexible, modular, mobile solutions



Optimizing operations

"Boil off gas" (BOG) along the LNG cycle

- Shipping
- Storage
- Handling … on/off-loading

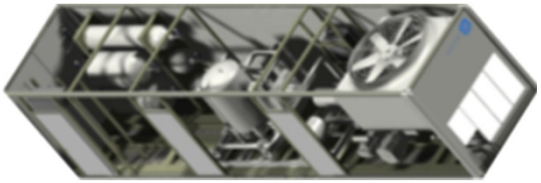
Optimization of BOG

- Process
- BOG compression
- Gas engines / boilers
- Re-liquefaction

Re-liquefaction solutions for BOG during periods of low-demand or under-utilization

Also operates as back-up for (main) BOG Compressor

Power (drive) for compressors can be produced using gas-engines



Nano LNG (LNG In A Box)

Gas Monetization… CNG/LNG

NA transportation fuel share
by vehicle type

On-road 85%

- Personal vehicles 37% — CNG
- Light-duty trucks 28% — CNG
- Medium 5% — CNG/LNG 70/30*
- Heavy-duty 15% — CNG/LNG 30/70*

Rail 10% — LNG

Marine/ off-road 5% — LNG

GE Gas Monetization Solutions

Gallons/day	GE fueling solution
	Large LNG
1,000,000	
	Micro & Mini LNG
50,000	
	LNG In A Box ™ *
20,000	
	CNG In A Box™ / CNG In A Box™ Hi-Flow
100	
	CNG HFA* (Home Fueling Appliance)
5	

* Under development

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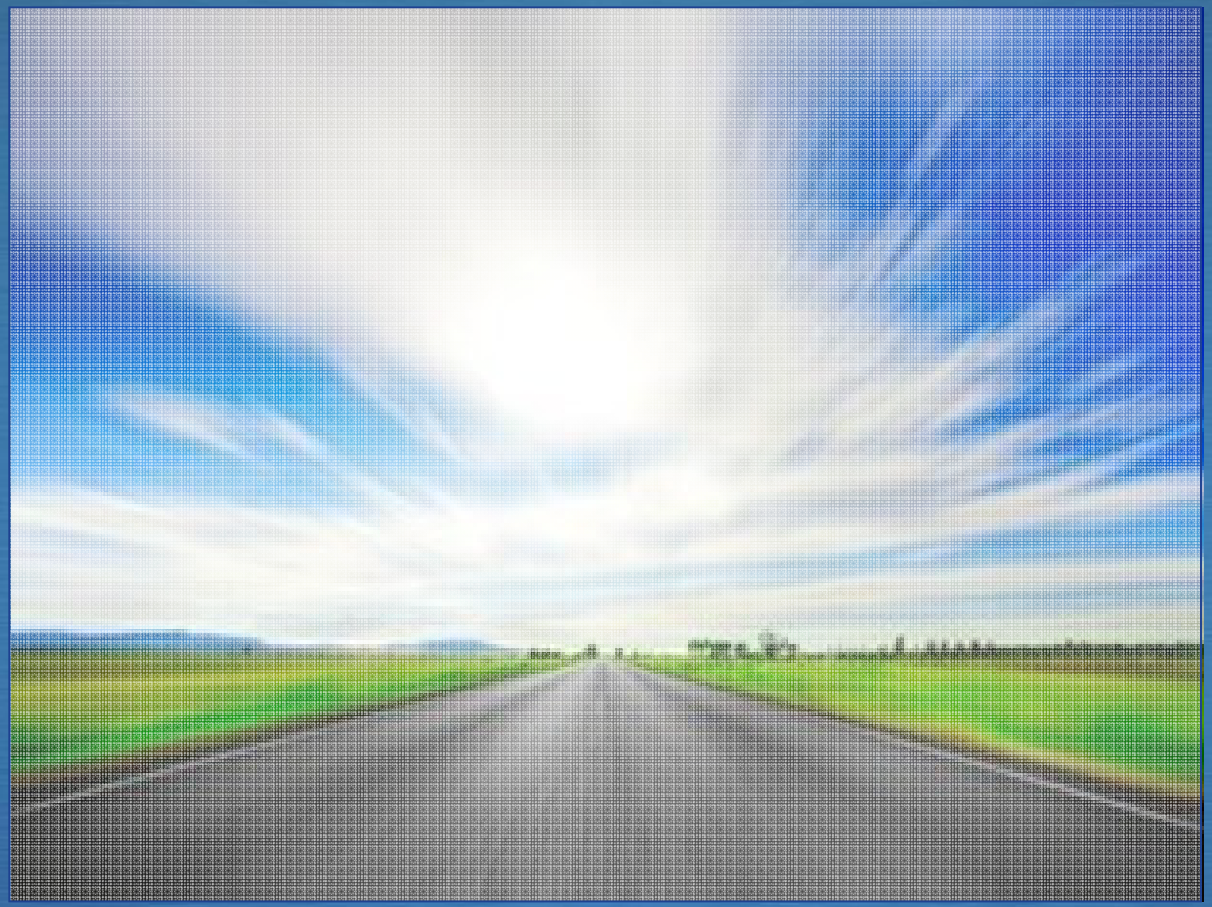
Source: 2007 EIA: Transportation Energy Data Book
*2017 estimate by Frost & Sullivan **N8CF-18. Medium is average of Class 6 & 7 trucks, Heavy duty is Class 8 trucks**
**NTI/BD under exploration



Summary and conclusions

Small LNG … key points

- Strong heritage and experience in large scale LNG
- Integrated LNG solutions for wide production capacity range
- Complete life cycle solution utilizing best-in-class GE capabilities
- Product structure … Single design for multiple plants
- Modular design … Plug & play
- Flexible … can de redeployed or scaled up/down if needed

Bringing GE-proven LNG experience
to rapidly deployable, small-scale solutions

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