

# LNG AS A MARINE FUEL: KEEPING IT REAL

GREAT LAKES MARITIME COMMUNITY DAYS  
SNAME REGIONAL CONFERENCE  
GREAT LAKES & GREAT RIVERS  
23, 24, 25 FEBRUARY 2012



*Presented by Bob Kamb*  
*Mystic River Partners LLC*  
*Representing Clean Energy*



# AGENDA

## 1. LNG as Fuel: Keeping it Real

- A Solution, not THE Solution ◇ Lets Not Guess ◇ This Ain't Rocket Science

## 2. LNG Sources & Availability

- Near Term (1-3 years out) ◇ Mid Term (3-5 years out) ◇ Long Term (5 years +)

## 3. Trucking Delivery

- Limitations: Fuel Cost Implications ◇ Distance ◇ Practical volume limits

## 4. Liquefaction: Small Scale vs Large Scale

- Economies of Scale ◇ Localized liquefaction vs Regional liquefaction ◇ Relative Competitiveness Trends

## 5. Fuel Quality, Heating Value & Composition

- Composition of CNG and LNG ◇ Nationwide Standard? ◇ Maritime Fuel Standard?

# Frequently Given Answers (FGA)

- **It depends....**
  - Where can I get LNG?
  - How much does it cost?
  - Will it work for me?
  - What about Fed, state, local , port, international regulators?
- **Lets not guess....**
  - What about safety?
  - Who will train my crew / staff?
  - What about Coast Guard, EPA, Class, insurers?
  - Will it save me money?
- **Well, this ain't rocket science...**
  - The technical aspects seem pretty complex...

# The President wants us to use LNG...



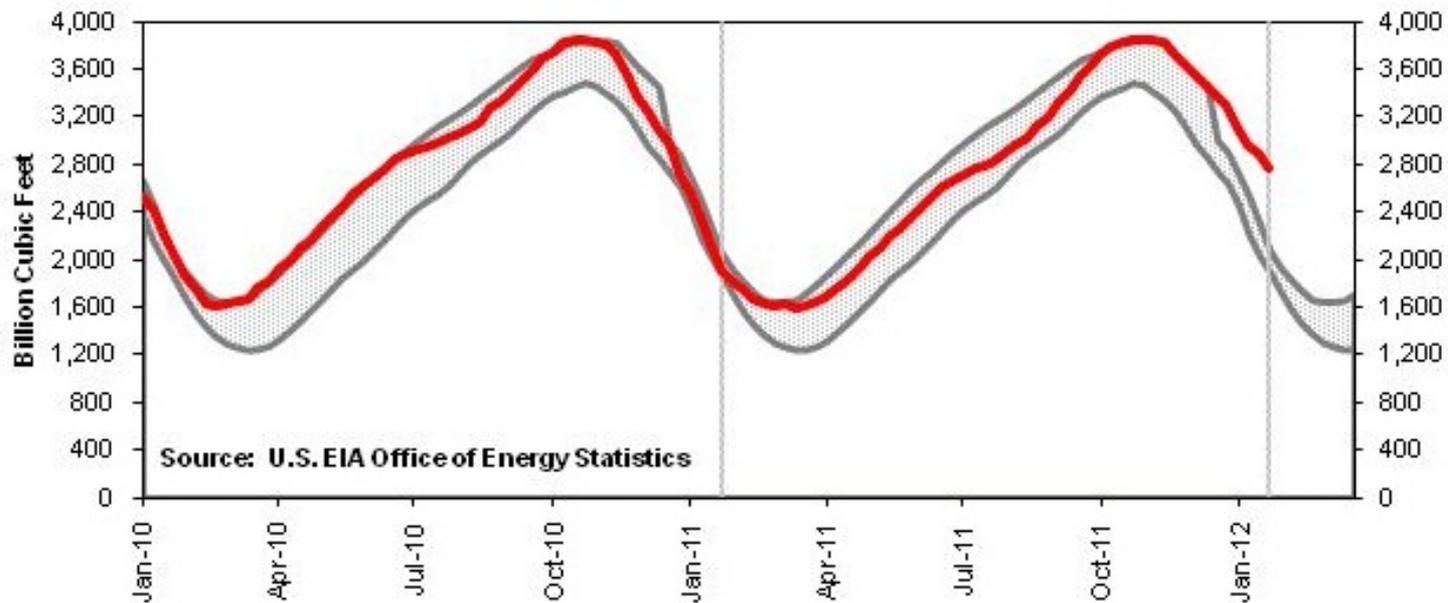
Producers want us to use LNG...



- Chesapeake Energy , the continent's second-largest gas producer, ....curtailing production by 500 million cubic feet per day.....prepared to double that to one billion cubic feet per day...will also reduce the number of rigs it has operating in natural gas fields to 24, or a third of the 71 rigs it employed in gas fields on average last year...(http://www.theglobeandmail.com/)

# Gas in storage: 2761bcf, 765bcf above 5yr avg- that's a lot of gas!

Working Gas in Underground Storage Compared with 5-Year Range



# LNG AVAILABILITY

America's Natural Gas Highway  
LNG Fuel Stations under development (Feb 2012)



 **Clean Energy**<sup>®</sup>  
North America's leader in clean transportation

# Its already here!

- Recently inaugurated truck fueling station in Seville, Ohio
- Partly funded by grant from Clean Fuels Ohio,  
<http://www.cleanfuelsohio.org/>



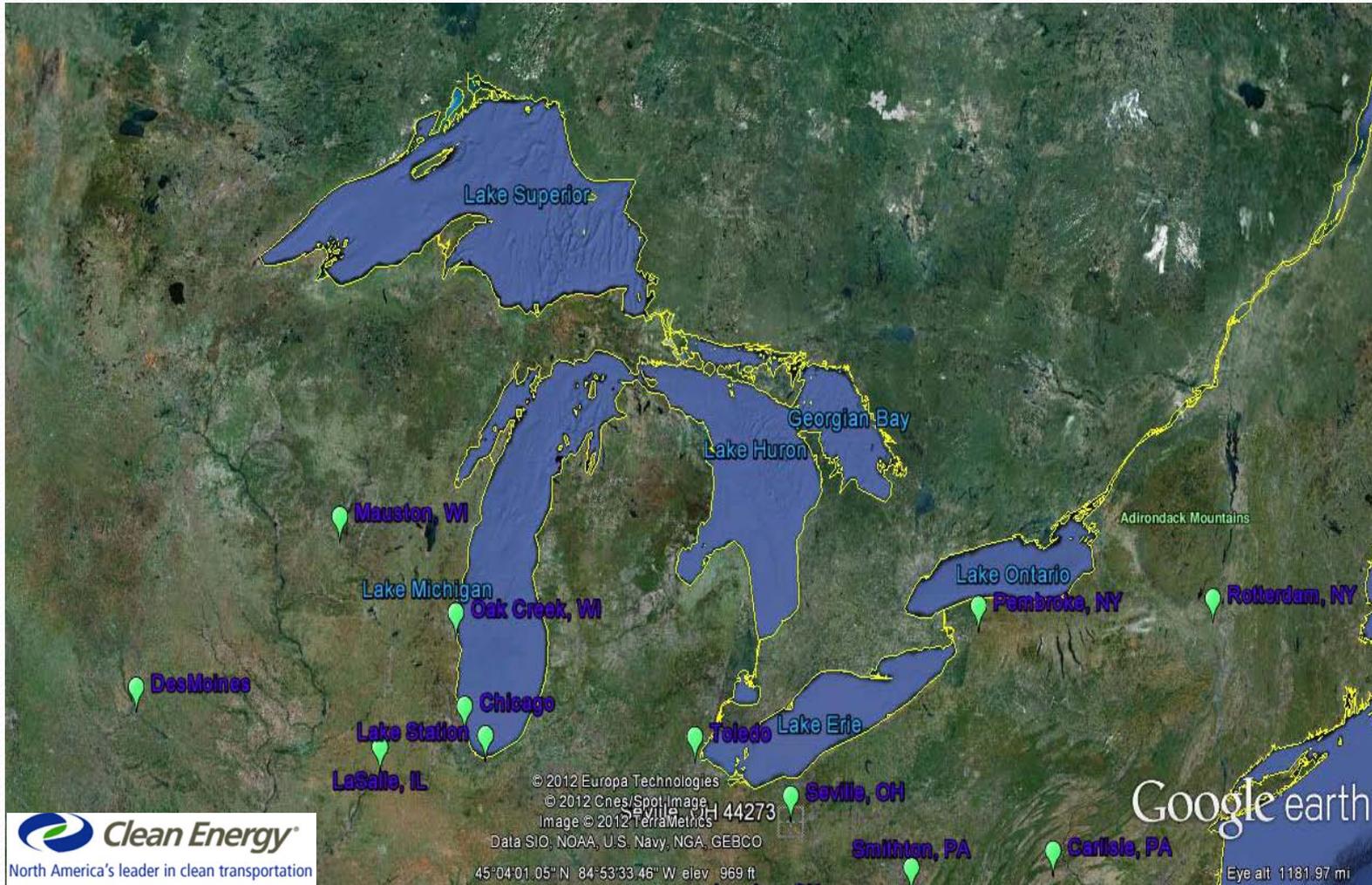
Clean Fuels Ohio

Andrew Conley, *Program Director*

(614) 884-7336 ext. 303

Andrew@cleanfuelsohio.org

# America's Natural Gas Highway: LNG Stations In Development and Planned



# LNG Supply Assurance

- LNG delivered Cost-Effectively Anywhere in Lower 48
- Nation-Wide & Growing Network of Supply
  - Utility peak shaver plants, gas field cryo plants, import terminals, dedicated plants
- Own & Operate 2 Plants
  - We know what we are doing when it comes to LNG plants
- 60 LNG Delivery Trailers - & More on Order
- Comprehensive Logistics & Contingency Planning
  - Multiply Supply Sources means Reliability
  - We Have Delivered LNG from Over 1,500 Miles Away
  - Delivery Trailer Staging Example
- Numerous LNG Plants Near Great Lakes in Indiana, Illinois, Iowa
- Great Lakes Requirements Can Be Easily Handled



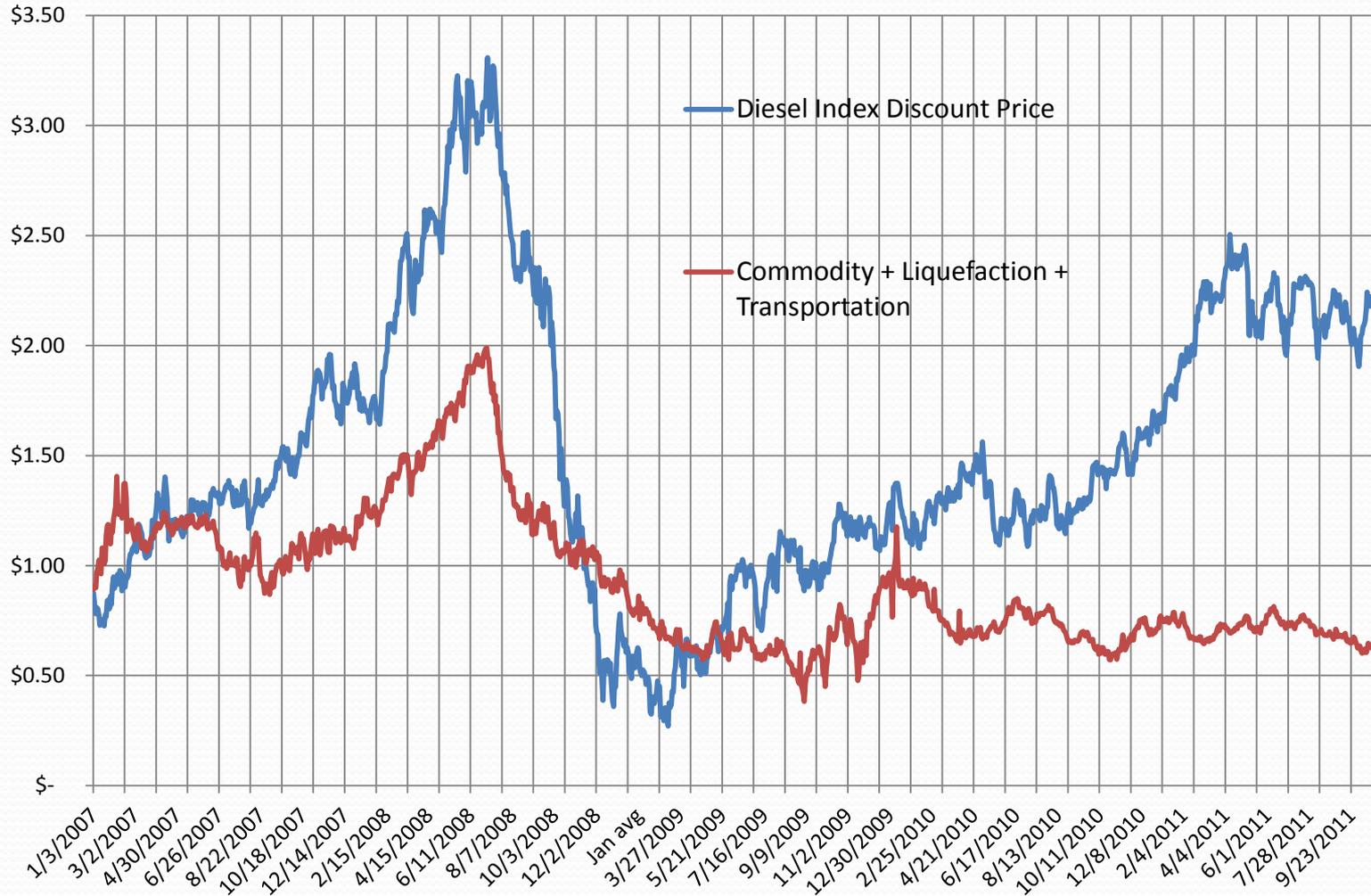
North America's leader in clean transportation

# Price & Conversion Calculator

Gas Commodity Cost \$/mmbtu	\$ 2.54
Commodity cost per LNG gallon	\$ 0.21
Liquefaction(per gal)	\$ 0.50
Transportation (per/gal)	\$ 0.36
<b>LNG Per Gal cost:</b>	<b>\$ 1.07</b>
Diesel Gal Equiv Cost:	\$ 1.81
Current Diesel per gal cost:	\$ 3.50
Difference (per gal):	\$ 1.69
Diesel Fuel consumption (gal):	50000
Diesel Fuel Cost	\$ 175,000.00
Equiv LNG Fuel Cost	\$ 90,803.80
Savings w/LNG:	\$ 84,196.20
<b>% Savings</b>	<b>48%</b>

Gas Commodity Cost \$/mmbtu	\$ 10.54
Commodity cost per LNG gallon	\$ 0.86
Liquefaction(per gal)	\$ 0.50
Transportation (per/gal)	\$ 0.36
<b>LNG Per Gal cost:</b>	<b>\$ 1.72</b>
Diesel Gal Equiv Cost:	\$ 2.92
Current Diesel per gal cost:	\$ 3.00
Difference (per gal):	\$ 0.08
Diesel Fuel consumption (gal):	50000
Diesel Fuel Cost	\$ 150,000.00
Equiv LNG Fuel Cost	\$ 146,563.80
Savings w/LNG:	\$ 3,436.20
<b>% Savings</b>	<b>2%</b>

# Indicative pricing comparison 2007 thru 2011



# Minimum Pricing, Capturing Infrastructure Cost vs ULSD Waterborne Diesel Index



# Delivery by Truck- Pros

- Minimal infrastructure costs
- Available NOW!
- Increases supply source potential, possible price advantage
- Distance up to 500 miles, but 250 mi delivery radius better
- For vessels, fuel goes to you, not you to the fuel



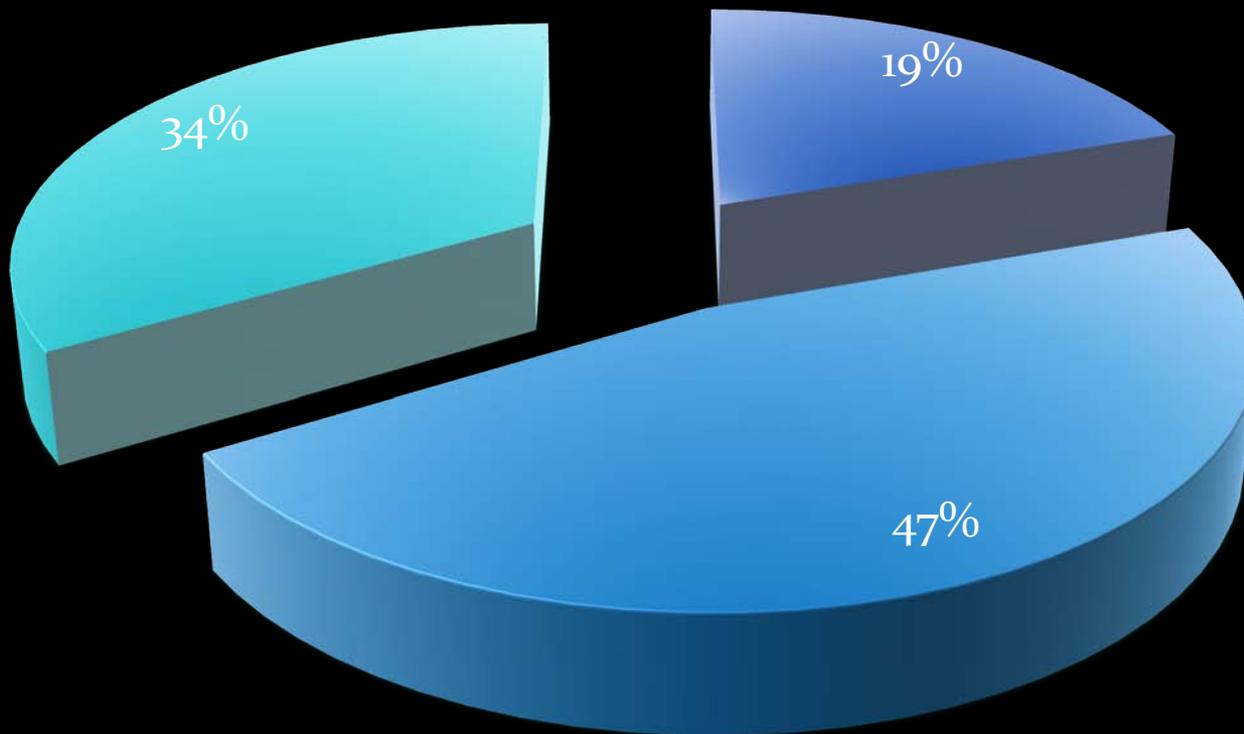
# Delivery by Truck: Cons

- Greater distance causes logistical challenges
- More volume, more trucks
- Road weight limits– 80,000 pounds, subject to local regulation, bridge heights, hazmat routes, etc
- Will your dock or terminal allow an LNG truck on the property?
- What will USCG say about truck drivers as Persons-in-Charge (PIC) of LNG fuel transfers?
- What are the training and certification implications?

# LNG Fuel Cost Breakdown (Feb 2012)

## Cost Breakdown

- commodity
- Liquefaction
- Transportation



# CNG vs LNG?

- (10) IMW Series 50 700 scfm, 300hp compressors
- (1) 7,000 scfm dryer Xebec or PPC or PSB
- (3) storage vessels Fiba or CPI, 11,500 scf each at 4,500 psig
- (1) custom dispensing system
- (1) custom priority panel
- **Ballpark Estimate: \$5mm to \$5.5mm**
- Considerations
  - Available space to install equipment?
  - Available gas supply?
  - Requires significant (and expensive) power
  - Built for peak season, over-sized for offseason
  - Significant heat of compression issues
  - Compressing & transferring this much gas is a significant project
  - LNG has been marine fuel of choice, not CNG

# CNG vs LNG?

	LNG \$/mmBTU	CNG \$/mmBTU
Commodity Gas Cost	\$ 4.00	\$ 4.00
Transportation	\$ 2.00	\$ 2.00
Liquefaction Fee	\$ 9.00	\$ -
O&M, Repairs	\$ -	\$ 3.00
Utilities	\$ -	\$ 2.00
<b>Total Cost</b>	<b>\$ 15.00</b>	<b>\$ 11.00</b>
<b>\$/Diesel Gallon Equivalent</b>	<b>\$ 2.08</b>	<b>\$ 1.53</b>
Infrastructure	~\$250,000	\$5,000,000 to \$7,000,000
Major Gas Pipeline	No	Yes
Major Electrical Power	No	Yes
Significant Engineering	No	Yes

# LNG Fuel Standards- Gas Composition

- Gas “Quality” is a misnomer– Gas Composition is the key measure
- Supply contracts should specify the required heating value, methane percentage, etc
- All natural gas is subject to applicable pipeline specifications set by FERC
- Field gas can be treated to meet required specifications
- Most LNG will have an adequate methane content since the high value components (propanes, butanes, ethanes) will be stripped out

# LNG Fuel Standards- Gas Composition

- Checkout CumminsWestport fuel calculator:  
[http://www.cumminswestport.com/fuels/fuel\\_specification.php](http://www.cumminswestport.com/fuels/fuel_specification.php)
- Chart Industries also does a great job listing applicable standards and specs: [http://www.nexgenfueling.com/t\\_codes.html](http://www.nexgenfueling.com/t_codes.html)
- LNG fuel will meet the specifications of the major engine manufacturers:



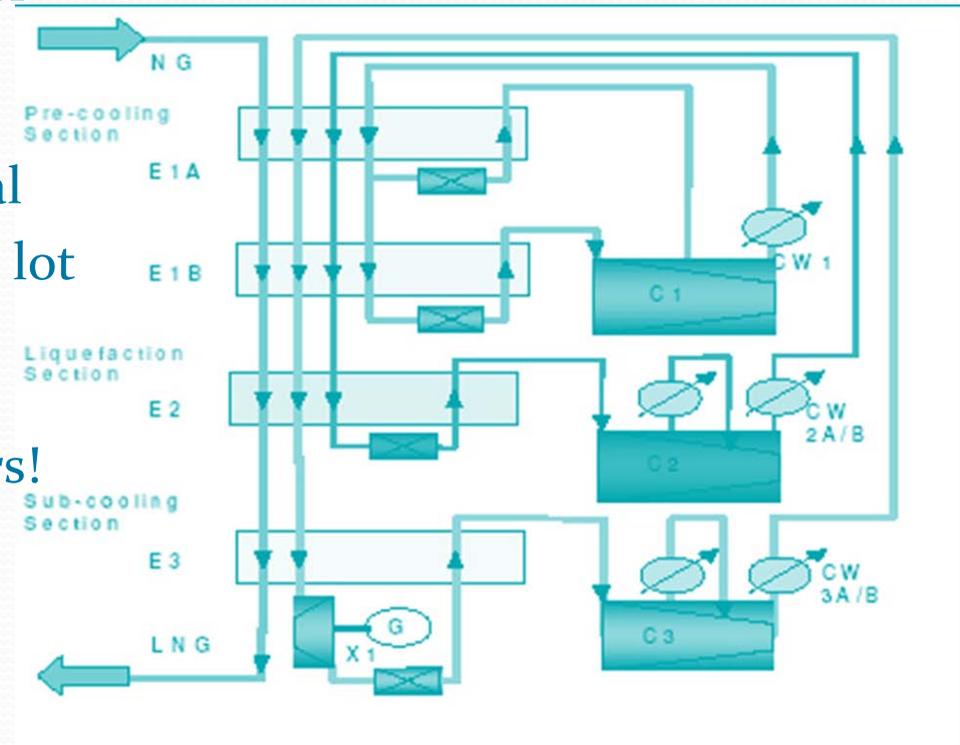
# Liquefaction

It Depends!

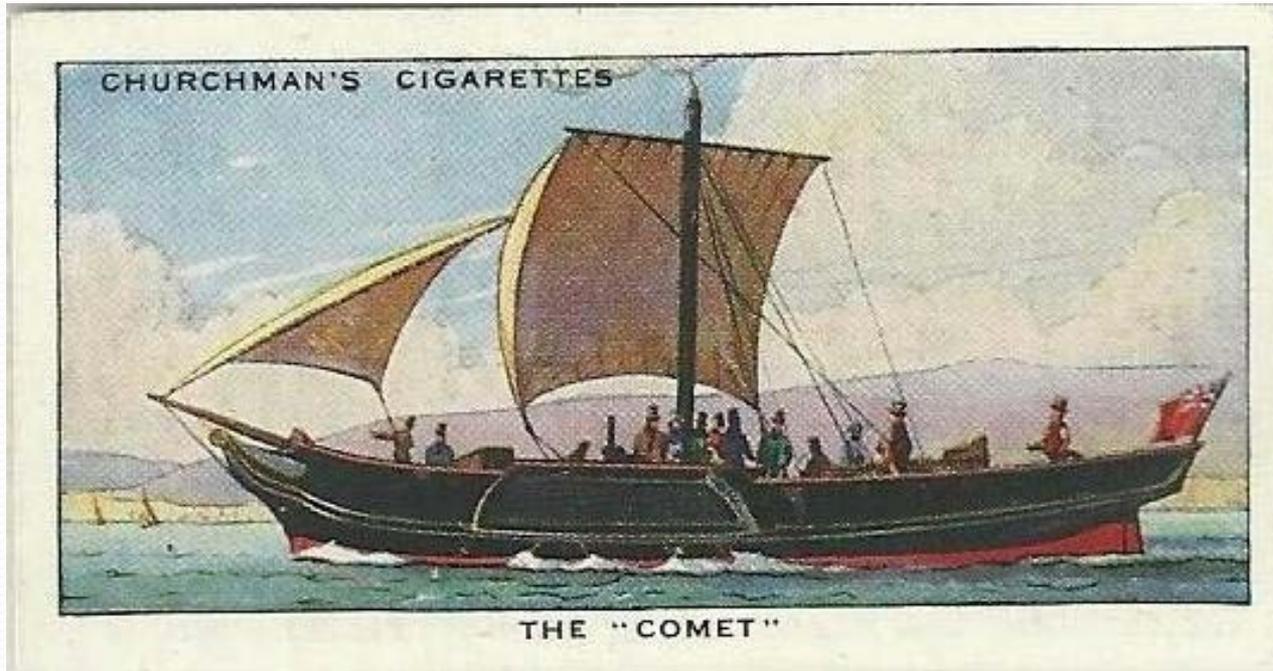
- Fuel volume requirement, project economics will determine if liquefaction is indicated
- Makes the most practical and economic sense when the daily volume is in the 100K to 300K gallons per day range

# Liquefaction

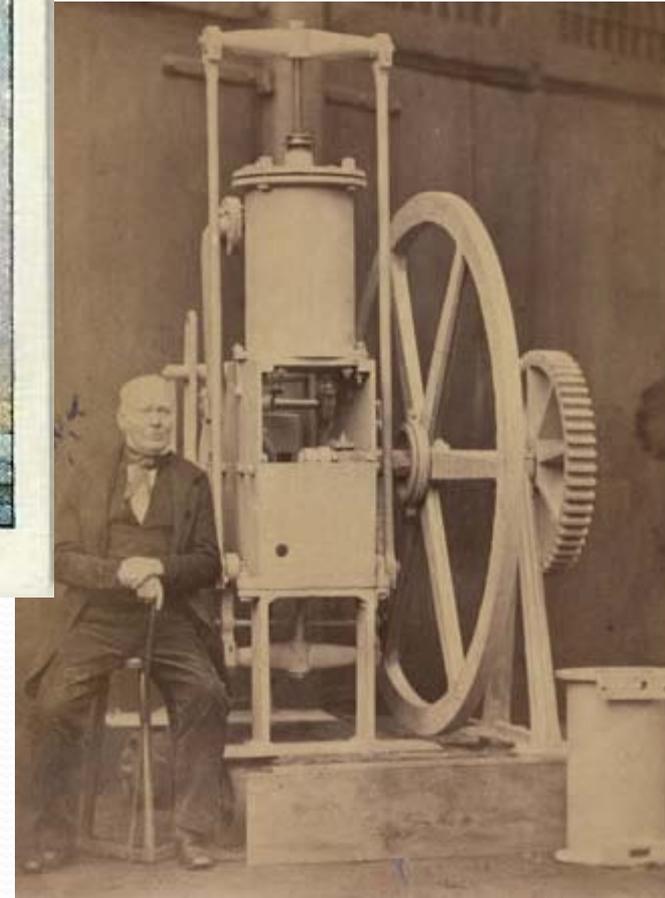
- Larger Trains face permitting, foot print and public acceptance issues
- Economic benefit for more / larger trains is marginal from 300K to 2M gpd
- Smaller is uneconomic, bigger is unwieldy and cost benefit minimal
- From 300K to 2M gpd not a whole lot of difference in price, but...
- It Depends! Bring your project to your supplier and run the numbers!



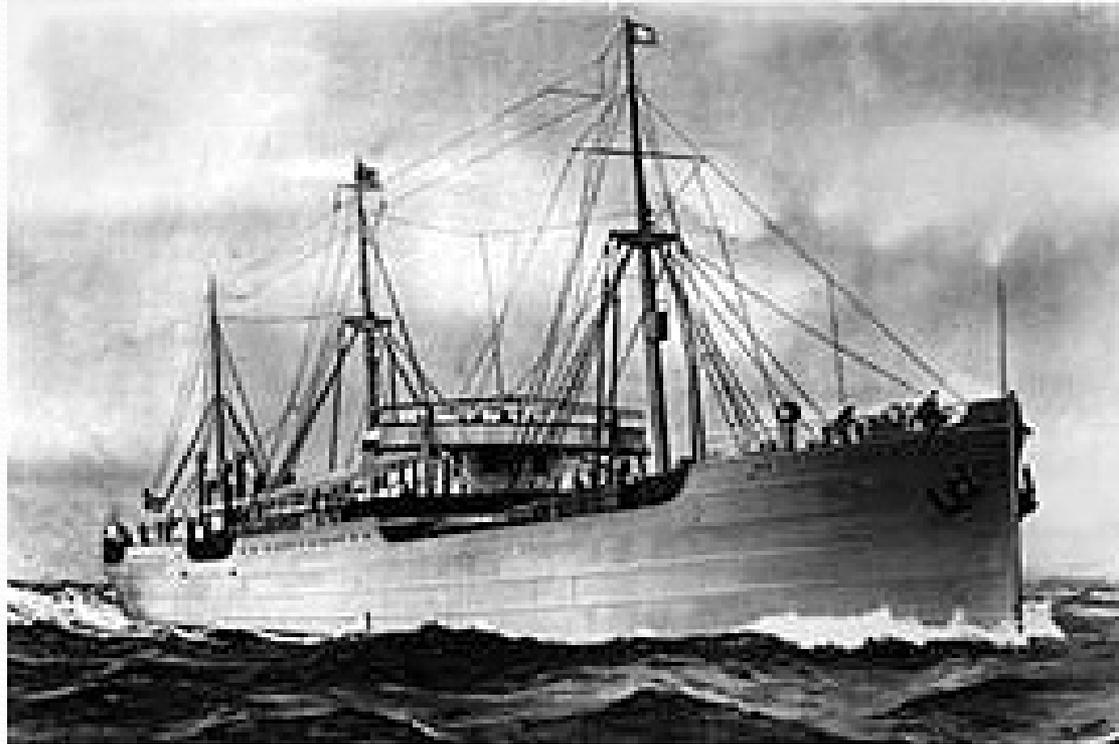
# 100 years to revolutionize propulsion...1812, sail to steam...



- 200 years ago, in 1812, the Scottish passenger vessel "The Comet" sailed as the first steamship in open sea.



# Coal fired steam to diesel, 1912...



- Exactly 100 years later, M/S Selandia initiated the diesel era with her maiden voyage to Bangkok.

# LNG Fuel: Keeping it Real-

## Conclusions:

### A solution, not THE solution

Owners Have Other Alternatives to comply with ECA and EPA regs:

- Improved diesel engine technology
- Improved Fuels- Catalysts, oxygenates, biofuels
- Scrubbers and Exhaust After Treatment

Game Changers that make LNG less attractive:

- An LNG accident or disaster that solidifies public resistance
- Fracking banned, supply evaporates and nat gas price rises
- Alternate fuel / Bio-fuel Breakthrough
- New Technology
- EPA Backs off implementation of regulations

# Conclusions (continued)

- The supply of gas is real, absent any external factors, pricing will remain stable
- There is room for the price to rise and still be economic with diesel, especially given current geo-politics
- It is also possible that the price of gas will decouple from HH or other indices and be priced locally based on supply & demand, availability, contractual arrangements
- It will take a while to develop-- consider the Comet, Selandia and Norway...

# Conclusions (continued): It Depends!

- Every project is different, whether LNG works for you depends on your specific circumstances
- Bring your project to the supplier, the builder, the charterer, the regulator– you will need their early input to avoid costly errors

## Let's not guess!

- Know the safety, training and design standards before you start – or at least get everyone to agree on them
- One accident however slight, can set back the whole business