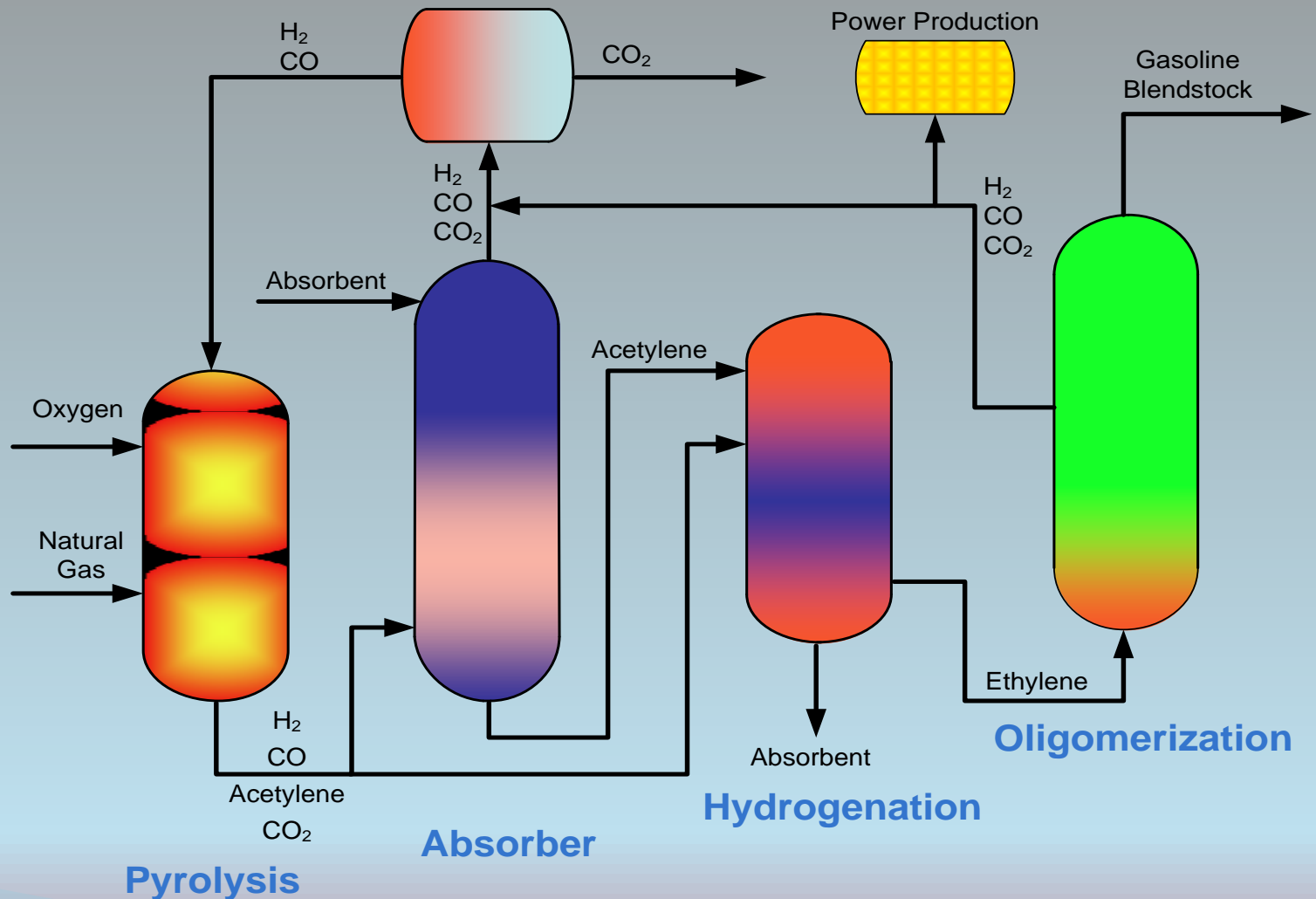




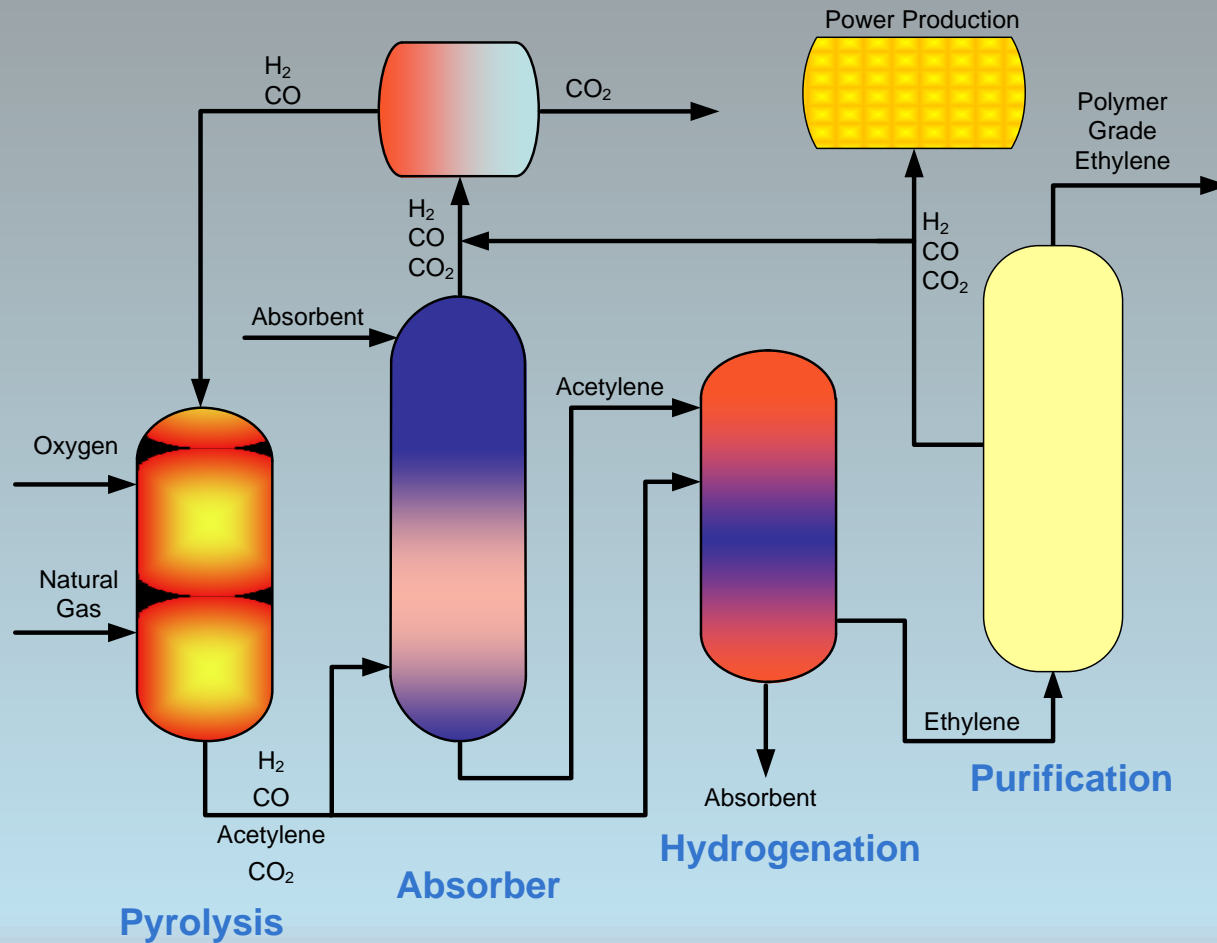
Synfuels GTE *TRANSPORT*

A Mother and Child Reunion

The Synfuels GTL Process



The Synfuels GTE Process



Ethylene Purification

- ▶ Ethylene is separated from the other gases and purified to chemical or polymer grade
- ▶ Synfuels Purification Process
 - A cryogenic process to make polymer grade ethylene using well known technology
 - Individually separated gases can be used for energy generation or for other chemical processing

Technology

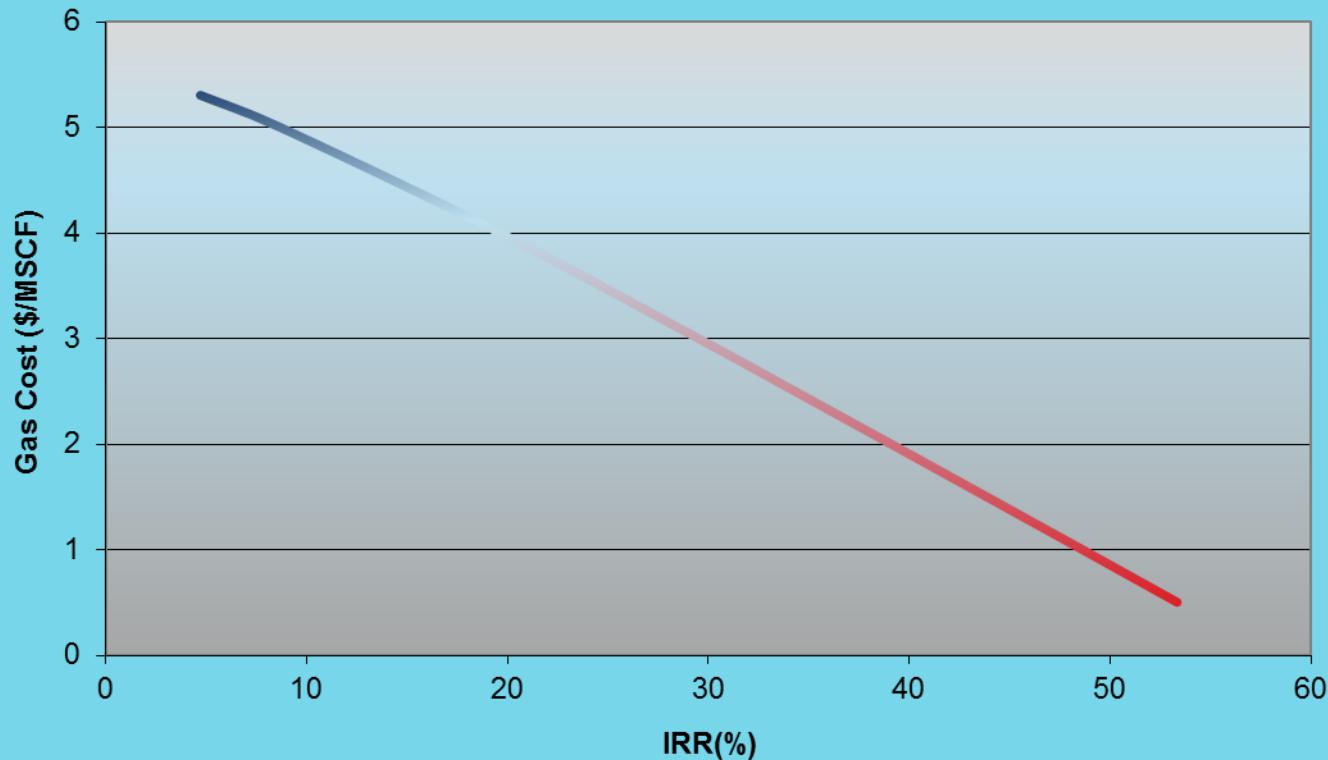
- ▶ Small Pyrolysis reactors that are easy to install
- ▶ Fixed bed catalyst reactors that operate at moderate pressure and temperature
- ▶ Stable, self moderating liquid phase hydrogenation
- ▶ All Vaporizable Hydrocarbons Qualify as Feed
- ▶ Single pass design

Mission One

- ▶ Convert Low Value Natural Gas to High Value Ethylene
 - Gas Cost in US between \$2 and \$3 /MSCF long term
 - \$100 and \$150 /tonne
 - High Value Ethylene (\$800 to \$1600/tonne) globally

Internal Rate of Return vs Gas Cost

IRR vs Gas Cost



Plant Size:
100 MMSCFD

Ethylene Value:
\$1000/tonne

Gas MW: 18.75

IRR vs Gas Cost, Plant Size, Ethylene Value and Gas Quality

Gas Cost is \$2/MSCF						
GAS FEED RATE (mmscfd)				ethylene value		
CN	10	50	200	\$/tonne	\$/pound	
1	25.51	46.03	64.84	1500	0.68	
1.3	46.93	78.65	109.59			
1.6	72.1	117.39	162.78			
GAS FEED RATE (mmscfd)				ethylene value		
CN	10	50	200	\$/tonne	\$/pound	
1	1.14	33.8	48.14	1200	0.54	
1.3	34.74	59.97	83.96			
1.6	54.94	90.97	126.51			
GAS FEED RATE (mmscfd)				ethylene value		
CN	10	50	200	\$/tonne	\$/pound	
1	10.78	25.1	36.41	990	0.45	
1.3	26.09	46.88	66.01			
1.6	42.91	72.48	101.12			

Gas Cost is \$3/MSCF						
GAS FEED RATE (mmscfd)				ethylene value		
CN	10	50	200	\$/tonne	\$/pound	
1	21.49	40.06	56.68	1500	0.68	
1.3	43.06	72.71	101.44			
1.6	68.25	111.46	154.63			
GAS FEED RATE (mmscfd)				ethylene value		
CN	10	50	200	\$/tonne	\$/pound	
1	12.78	27.75	39.96	1200	0.54	
1.3	30.83	54.03	75.81			
1.6	51.08	85.03	118.36			
GAS FEED RATE (mmscfd)				ethylene value		
CN	10	50	200	\$/tonne	\$/pound	
1	5.72	18.84	28.13	990	0.45	
1.3	22.07	40.93	57.86			
1.6	39.04	66.54	92.97			

Mission One Conclusion

- ▶ The Synfuels GTE Process can make Ethylene from Methane and Heavier Natural Gas
- ▶ Excellent Returns can be Expected for Natural Gas in the range of \$2 to \$3 per MSCF

Mission Two

- ▶ Provide a means to Transport Ethylene Made at Low Cost to High Value Regions
 - Ethylene is typically not made from Natural Gas
 - Little Ethylene is transported by sea going vessel
 - There is a wide manufacturing cost difference globally
 - Naphtha, an Ethylene Precursor, is growing expensive

LNG Ships are Available



LNG shipping capacity

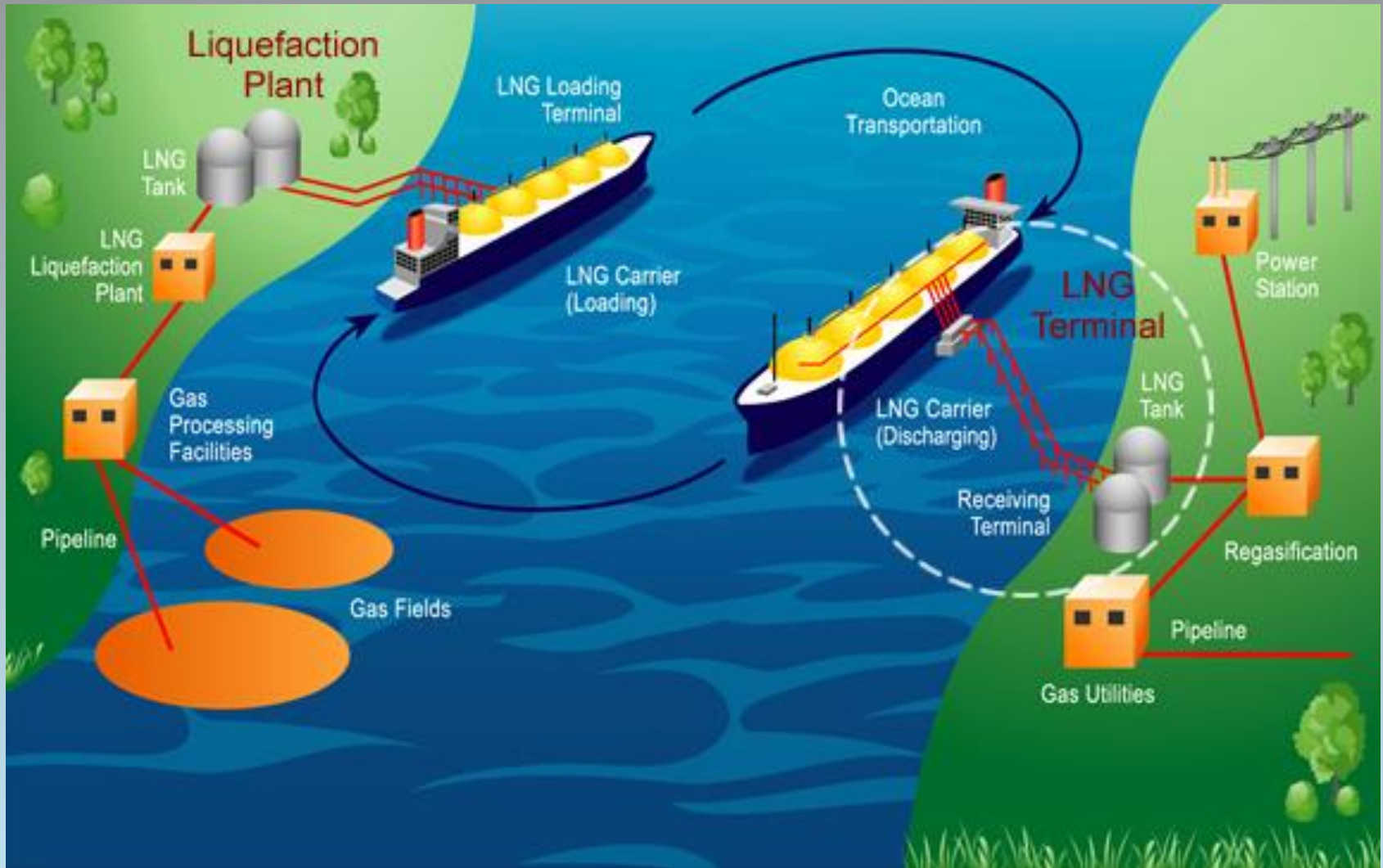
- 48 Million cubic meters (20.3 Million Tonnes)
- 800 Million cubic meters annual transport capacity

LNG annual transport

- 390 Million cubic meters (165 Million Tonnes) in 2008
- 520 Million cubic meters (220 Million Tonnes) in 2010

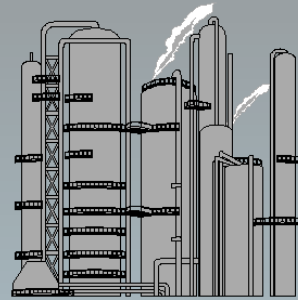
**A THIRD OF THE EXISTING SHIPPING
CAPACITY IS DORMANT**

The LNG Transport Cycle

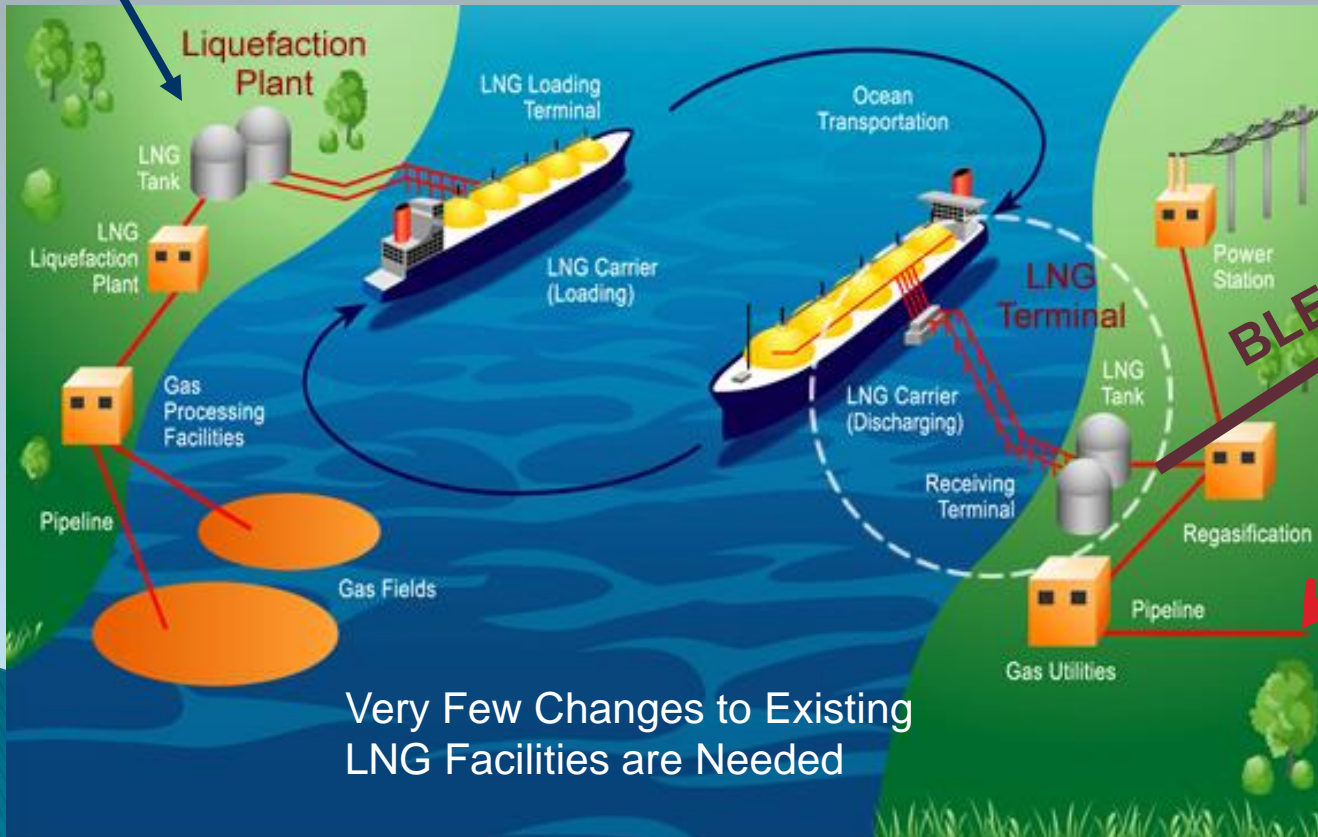


Ethylene Transported with LNG

Ethylene Manufacturing Plant



Pure Ethylene



Very Few Changes to Existing LNG Facilities are Needed



BLEND

Pure Natural Gas

Cryogenic Separation of Ethylene from LNG

Ethylene Transported with LNG

- ▶ Build 215 MMSCFD GTE Plant. Install Modifications (\$500 million) to Handle Blends. Gas Price is \$2.50/MSCF. Methane Feed.
 - Cost to produce Ethylene is \$610/tonne
 - Production: 0.51 Million tonnes/year
- ▶ Use single 138,000 Cubic Meter displacement LNG ship, fill with 75 wt% ethylene, one delivery per month. Ethylene value is \$1200/tonne. Estimated Delivery cost is \$50/tonne. Zero value assumed for LNG.
 - Added Value per shipment \$38 Million
 - Annual return: \$459 Million
 - **IRR of 23%**

Mission Two Conclusion

- ▶ The Synfuels Gas Transport Technology can move relatively low cost ethylene to locations where its value is high.
- ▶ Excellent Returns can be Expected for Natural Gas in the range of \$2 to \$3 per MSCF.

Partnerships

- ▶ TAMU - gave Synfuels access to novel process and patents
- ▶ AREF - provides marketing access to MENA countries for production

Patent Applications

USPTO 20120017639 - METHODS AND SYSTEMS FOR STORING AND TRANSPORTING GASES, January 26, 2012

USPTO 20110041518 - METHOD OF STORING AND TRANSPORTING LIGHT GASES, February 24, 2011