

RICE GLOBAL FORUM: 2005

CAN WE BUILD IT??

**ARE THE TECHNICAL RESOURCES
AVAILABLE TO BUILD THE
FUTURE LNG INDUSTRY?**



STUDY DETAILS

- ❑ Multi-client Study Sponsored By Super-Majors, LNG Engineering Contractors And Equipment Companies
- ❑ Study Undertook Between September 2004 And March 2005
- ❑ 112 Experts From The World Of LNG Personally Interviewed. Experts From Operators, Contractors, Equipment Companies, Investment Bankers, Government Agencies, International Energy Agencies, Academics and Headhunters.

Sufficiency Of Technical Resources Depends On The Future Size Of The Global LNG Market

So What Is Likely LNG Demand In The Medium Term?

**“Can anyone out
there give me a
straight answer?
Please**



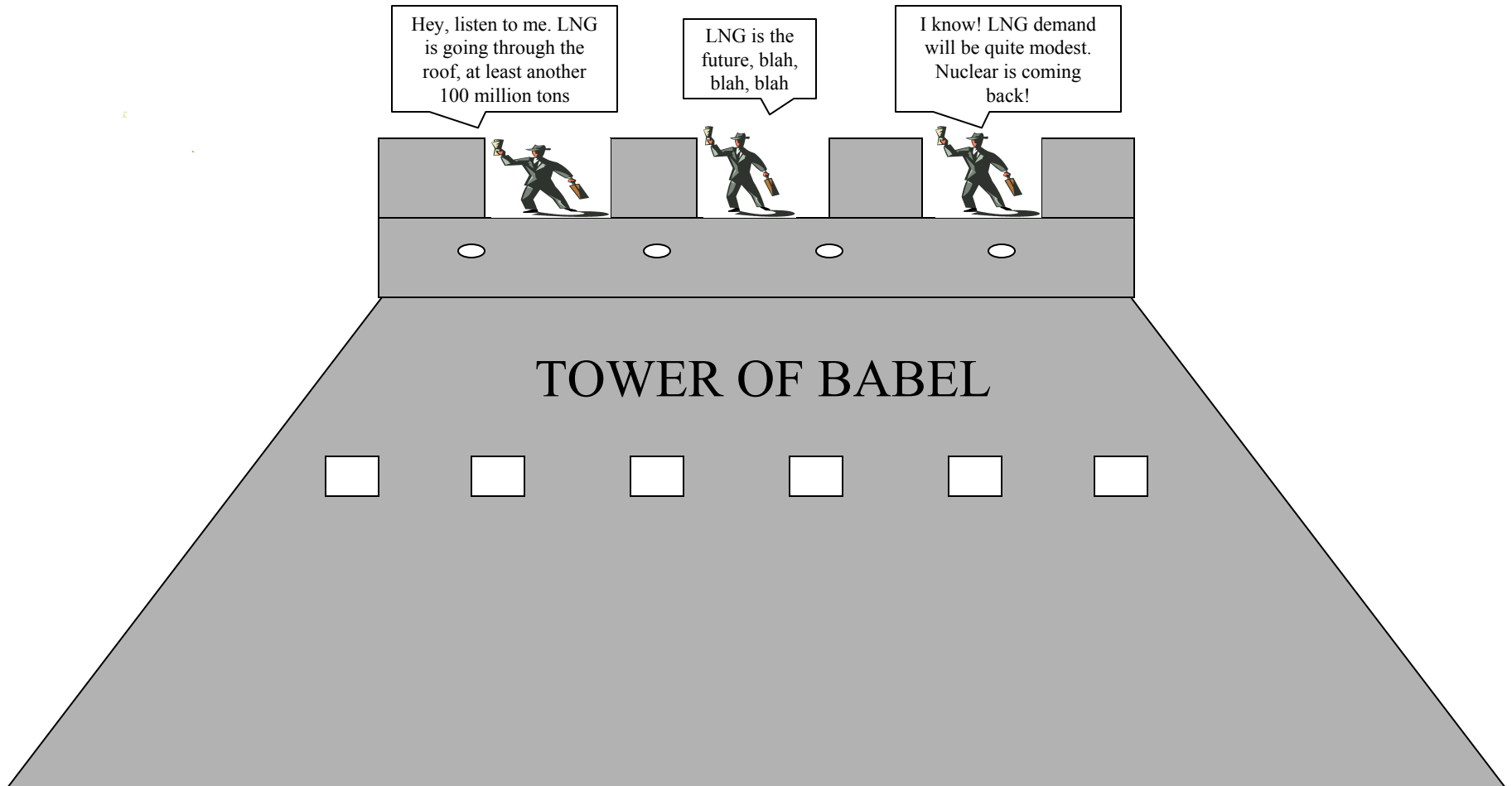
WHO CAN PROVIDE A CLEAR ANSWER?



“We Live In The Land Of A Thousand Answers”

“The Tower of Babel”

“Who To Believe????”



We Need An Accurate Projection, Forecast,
Or Prophecy But Are Obviously Surrounded
By False Prophets



PROPHETS AND PROPHECY

- ❑ **FORECASTS**. Find Its Roots In The Greek Work “Prophetes”. The Word Is Made Up Of “Pro” meaning “For” And “Phet” Meaning Speak. Together = “One Who Speaks For God.”
- ❑ Many “Voices Of God” And Frequently They Conflict And Contradict One Another. Who To Believe? We Have Too Many False Prophets.

PROPHETS



**SHELL PLANNING
EXECUTIVE**

“I believe we are underestimating the importance of price in potentially dampening demand. The two most important markets for natural gas are U.S. and China. If LNG and/or natural gas prices are too high, then the U.S. and China might shift to more coal and perhaps atomic energy. I think it is far from conclusive that either the U.S. or China will need to import 2, 3, or 4 TCF of LNG annually in the next decade... Officially, we see (Shell) global capacity at 340 million metric tons, but all depends on price.”

PROPHETS



“We have a more modest view of LNG’s prospects than most. In the U.S. LNG consumption today represents considerably less than 1 TCF per year. In our view... we estimate that U.S. LNG consumption will grow to (only) 2.2 TCF by 2010: This means about two new terminals are needed to meet anticipated new demand. The nonsense about 30-40 new U.S. terminals being built is just that – nonsense. Similarly, talk about booming global LNG demand is also nonsense.”

PROPHETS



**INTERNATIONAL
ENERGY AGENCY
Research Analyst**

“LNG global demand in 1997 was a mere 4 TCF or about 89 million metric tons. Well, by 2002, LNG demand jumped to 5.4 TCF with capacity climbing to 135 million metric tons. Therefore, in our view, the future is bright and we see LNG liquefaction capacity soaring to 192 million metric tons by 2007. The world is very hungry for environmentally friendly natural gas. By 2007, LNG will represent more than 10% of all natural gas consumption. By 2030, global consumption will double. Natural gas will surpass coal as the second largest energy source.”

PROPHETS



McILLVANE COMPANY
RESEARCH ANALYST

“We think that the IEA and many other forecasters have it all wrong. Coal will play a bigger role in the energy mix than they are forecasting. Behavior always changes with price, and high natural gas prices will be a plus for coal demand. For example, by 2012 electricity generation in the world will require 80 quads of coal fired power and 36 quads of natural gas fired power. Not the 40 quads of gas and only 76 quads of coal fired power forecast by the DOE. One reason DOE has it wrong is that they are underestimating China’s use of coal fired power. We think it is very likely that coal generated power will grow by 30 GW a year in China. Coal consumption in China will double in the next 20 years.”

PROPHETS



“It seems likely that the world production of oil and gas is approaching its peak. A majority of producing countries, including Saudi Arabia, are approaching their peak production. The oil and gas is just not there and the world will need to adjust. Obviously, we will not see the LNG boom that so many anticipate.”

PROPHETS



**TOTAL TECHNICAL
EXECUTIVE**

“We have two major projects coming up – Yemen and Pars, and believe that LNG is a good business. LNG capacity commitments should almost double in the next 5-6 years. The U.S., China, and India are relatively new markets, with much potential. There are also renewal contracts coming up in Japan and Korea, the main LNG markets. Certainly, we will see an average at least two liquefaction plants committed each year. This means at least 10 – 12 new LNG plants and several important expansions resulting in between 80 – 100 million metric tons of new capacity.”

SO WHO HOLDS THE TRUTH?



**THIS
BEATS
ME!**

What Does The Study Findings Tell Us?

Can It Help?

**These Findings Represent
The Collected Available
Global Wisdom**



STUDY FINDINGS: COLLECTIVE WISDOM

TABLE 1: OUTLOOK FOR RE-GASIFICATION PLANTS IN THE MEDIUM TERM (2010 – 2012)

- **Number Of LNG Re-gasification Terminals: Forecasts Ranged From 5 To 50.**
- **The Mean Average Forecast Of Re-gasification Terminals: 14.1.**
- **The Median Forecast: 10.**
- **38% Of The Operators Could Not Or Would Not Provide A Forecast.**

STUDY FINDINGS: COLLECTIVE WISDOM

TABLE 2: OPERATOR OUTLOOK FOR LNG SHIP TRANSPORT IN THE MEDIUM TERM (2010 – 2012)

- Number Of LNG Transport Vessels: Forecasts Ranged From 40 - 100.
- The Mean Average Forecast Of LNG Transport Vessels: 70.
- The Median Forecast For LNG Transport Vessels: 70.

“We will need 65 new LNG tankers by 2010. We should be fine because 60 are under construction and another 40 are on order. As the production of LNG gets further from its markets, we will need a lot more tankers. That could be a problem, but it is a long term problem.”

Shell International – Senior E&P Executive

STUDY FINDINGS: COLLECTIVE WISDOM

TABLE 3: OPERATOR OUTLOOK FOR LIQUEFACTION PLANTS IN THE MEDIUM TERM (2010 – 2012)

- **Number Of LNG Trains: Forecasts Ranged From 5 To 25 Trains.**
- **The Mean Average Forecast: 14.2 Trains**
- **The Median Forecast: 14**
- **33% Of The Operator Personnel Interviewed Would Not Or Could Not Provide A Forecast.**

TRANSMAR MEDIUM TERM FORECAST FOR LNG



TRANSMAR SAYS

- ❑ Growth of 85 Million Metric Tons of LNG demand in medium term. Therefore, total demand of 218 million metric tons by 2010 – 2012.
- ❑ LNG global production capacity grows by 110 million metric tons.

REASONS BEHIND TRANSMAR FORECAST NO MAGIC! ONLY SOLID REASONING

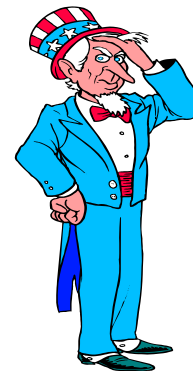
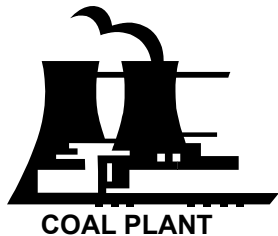
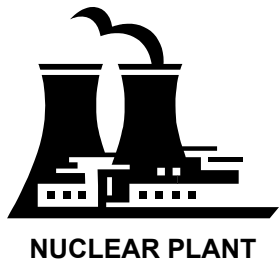


TRANSMAR REASONS FOR MODEST GROWTH OF GLOBAL LNG LIQUEFACTION CAPACITY

- ❑ Future Growth Of LNG Demand Depends On Key Markets Like China, India, And The United States. These Key Markets Have Alternative Energy Options.
- ❑ Key Markets For LNG Are Also Very Cost Conscious. Note That Over The Last 20 Years America's 4 Re-gasification Terminals Operated At Less Than 20% Capacity And At A Loss.
- ❑ A Further Dampening Factor On LNG Growth Is The Renaissance, The Re-birth Of Nuclear Power And Aggressive Coal Plant Capital Programs.

TRANSMAR REASONS FOR MODEST LNG FORECAST

- ❑ Likely to Have 1 – 3 New Nuclear Plants in Construction/operation by 2015-2020. Bush Administration Has Heavily Revamped the U.S. Regulatory Agencies and New More Environmentally Friendly Reactors Like the Westinghouse AP-1000 Are Now Certified. Also, China Is Planning on 30-32 New Nuclear Plants in the Medium- Long-term.
- ❑ U.S. Is Currently Closing Down Gas-fired Capacity and Re-opening Coal Plants. China And India Are Pursuing an Aggressive Coal Plant Building Program.



TRANSMAR REASONS FOR MODEST LNG FORECAST

- ❑ Another Reason for Modest LNG Forecast for LNG Demand and Capacity Additions Is the Historically Large Number of Project Delays. For Example, One Operator Interviewee Tracked 25 LNG Project Delays in 2002 and 23 in 2003.
- ❑ Another Reason for a Sober Assessment of LNG Projects Is Potential Technical Resource Constraints. There Is Currently a Fierce Headhunting War for Top Level LNG Talent.
- ❑ Finally, There Are Important Financial Constraints to LNG Growth. Global Financial Markets Are Only Willing to Expose a Finite Amount of Risk Capital.

RE-GASIFICATION TERMINALS: **THE TRANSMAR VIEW**

TABLE 4: TRANSMAR GLOBAL FORECAST
FOR RE-GASIFICATION TERMINALS:
MEDIUM TERM

(Millions metric tons)



TRANSMAR SAYS

<u>REGION</u>	<u>NO.TERMINALS</u>	<u>CAPACITY</u>
Europe	16	50.8
Asia	11	27.5
North and South America	12	71.4
Total	39	149.7

RE-GASIFICATION TERMINALS:

TRANSMAR ESTIMATE

- ❑ In the Medium Term, Terminal Capacity Increases by 150 Million Metric Tons Far More Than Anticipated Growth of Liquefaction Capacity.
- ❑ Lots of Terminals in New Geographic Locations.
- ❑ Limited Terminal Growth in U.S., China and India. A Lot of Growth Through Expansion.
- ❑ LNG in Key Countries Is a Peak Shaving Not Base Load Fuel.

TRANSMAR LNG TANKER FORECAST

**TABLE 5: THE MEDIUM TERM
OUTLOOK FOR LNG VESSELS**
(Millions cubic meters)



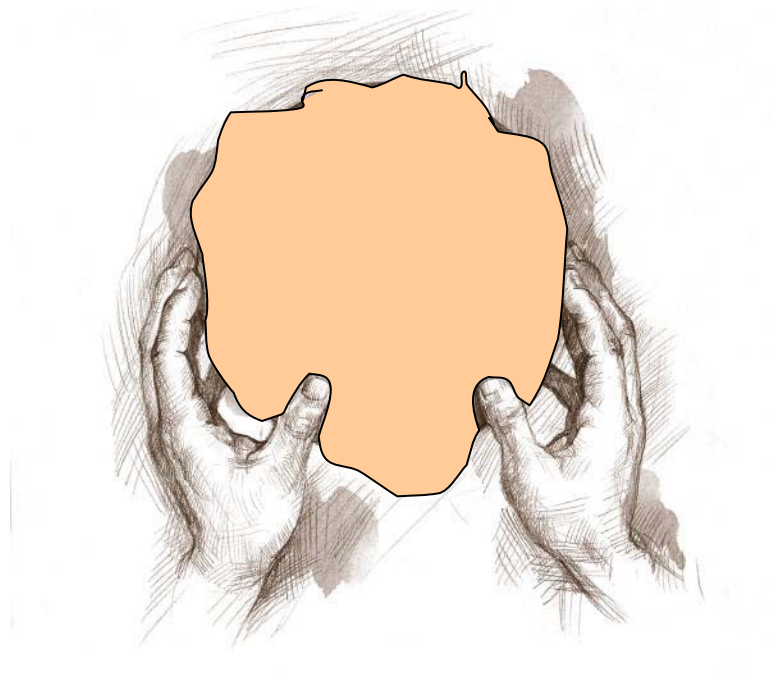
TRANSMAR SAYS

	<u>2000</u>	<u>2004</u>	<u>2010</u>
Number of Vessels	114	175	280
Capacity	13.9	21.3	34.1

LNG TANKERS

- ❑ LNG Tanker Growth Far Outstrips LNG Demand And Capacity Additions.
- ❑ LNG Tanker Capacity More Than Doubles Over The Decade 2000 – 2010 From 13.9 Million Cubic Meters To 34.1 Million Cubic Meters.
- ❑ LNG Tanker Fleet Also Significantly Increases In Ship Size And Efficiency. New Ships Replace Steam Turbines With Fuel Propulsion Incorporating Gas Turbines, Diesel Engines And Electric Drives.
- ❑ New Tankers Less Costly And Will Travel Longer Distances Between Producer Countries And Consuming Countries.

FACTORS SHAPING OUR THINKING



DYNAMIC FACTORS THAT INFLUENCE OUR VIEW OF THE STRUCTURE AND DEMAND LEVEL OF THE LNG GLOBAL MARKET



REGULATORY CHANGES

- ❑ Most Consuming Country Governments Are Fostering Pro-energy Policies. President Bush, The Republican Congress And The Chairman Of The Federal Reserve Bank Pushing More Environmentally Friendly And Pro Business Energy Policies.

POLITICS

❑ Three Political Factors Strongly Impact LNG and Investment:

1. Terrorism Threat

- 👍 Single terror act could shut down LNG activity in the U.S. or a western European country.

2. NIMBY (Not In My Backyard)

3. Growing European Over Dependence On Russian Gas

GROWING PRODUCER COUNTRY BUSINESS DEMANDS

- ❑ Producer Countries Increasingly Demand More of the Value-added From LNG Projects. Over Time, This Makes LNG Less Attractive to Major Oil Companies. This Trend Will Dampen LNG Capacity Additions and Cause Delays.

“The producer countries are not going to continue to allow the major oil companies to skim \$2.00 or \$3.00 or even \$4.00 off the top by importing LNG. They will take a bigger share by taxing it away.”

Bank of America Securities – Senior Energy Analyst

CRITICAL MATERIALS SHORTAGES

- ❑ Over 82% of Study Interviewees Foresee Critical Material Shortages in the Future.
 - Shortages Are Caused by Both Cyclical and Structural Factors.
 - Interviewees Are Concerned About Growing Consolidation and Concentration in Key Material Industries.

“There is tightness in the areas of steel, specialty steel and equipment like power generation and compressors. Part of this problem is due to the Asian boom which means China and India. However, some of the problem is also structural. Because of consolidation, there are far fewer companies manufacturing compressors, turbines, specialty valves, and many other things.”

Shell International – Senior Project Director

THE SUBSTITUTION EFFECT

- ❑ The Substitution Effect Is an Important Dynamic Factor. It Refers to the Human Tendency to Substitute One Product or Service for Another If the Price Climbs Above a Perceived Critical Level. Many Interviewees Believe That Too High Natural Gas/LNG Prices Will Prod Customers to Substitute Coal or Nuclear Power As a Fuel.

Coal Consumption: The Future (Millions metric tons)			
<u>Region</u>	<u>2001</u>	<u>2025</u>	<u>% Change</u>
U.S.	1,060	1,567	47.8
Western Europe	574	463	-19.3
Former Soviet Union	446	436	-2.2
China	1,383	2,757	99.3
Worldwide	5,300	7,600	43.4

SUBSTITUTION EFFECT COMMENTARY

“We are the leader with Exxon-Mobil in GTL and its advancement in the commercial marketplace. Shell has spent over \$1 billion on GTL research and facilities and Exxon Mobil about \$600 million. My guess is that we will have about 600,000 barrels per day of global GTL production by 2012. By 2020-2025, the global production of GTL will be about 1 million barrels per day.”

Shell International - Technology Executive

“Yes, we now have ‘clean coal’ but clean coal is cleaner – not really clean! It seems clear to me and many of my colleagues that China and India will go to coal and nuclear power if oil and nuclear gas are too costly. In the West, I see growing interest in nuclear power.”

MIT Energy Laboratory – Retired Professor of Technology & Strategy

IMPACT OF PIPELINE NATURAL GAS?

- ☐ Investment and LNG Demand Are Strongly Impacted by Anticipated Energy Pipelines.
- ☐ Possibility of Alaska and Mackenzie Delta Natural Gas Pipelines.
- ☐ Possibility of Pipeline Projects for Both India and China.

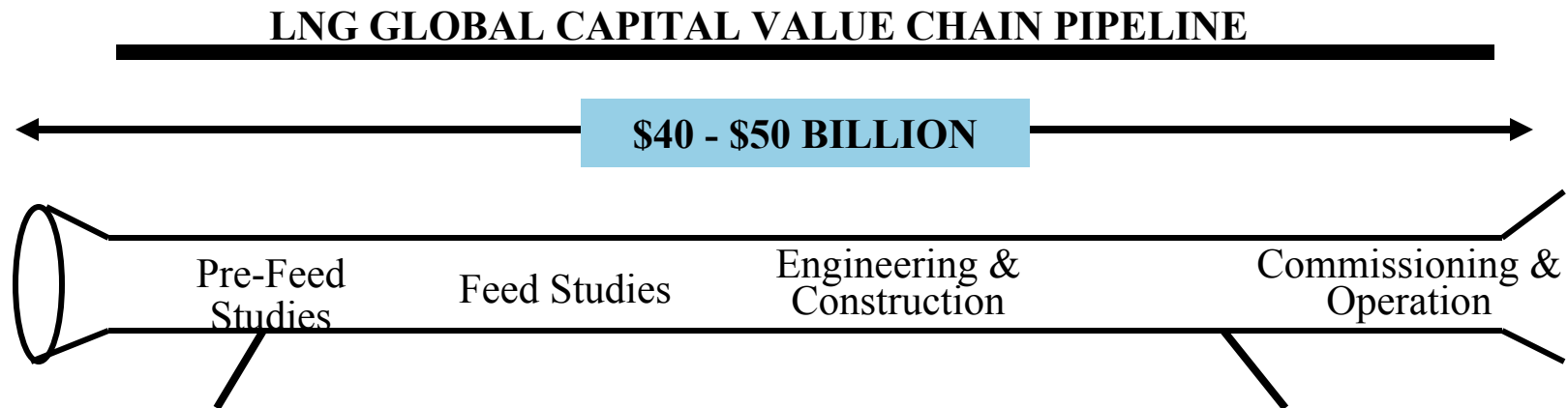
PIPELINE IMPACT ON LNG GROWTH

“In order to lower its dependency on the Russians and Gazprom, European countries like Italy, France, and Spain may build more pipelines to bring in North Africa natural gas. The French, for example, are doing this with Algeria. Now that Libya is no longer a leper country, it too could build pipelines across the Mediterranean Sea to feed gas to European clients. These pipelines would impact to some degree the LNG trade. Exactly how much of an impact is less clear.”

Dynegy Energy – Vice President

FINANCIAL EXPOSURE AND THE LNG INDUSTRY

- ❑ The Support of the Financial Community Is the Lifeblood of the LNG Industry.
- ❑ Transmar's Analysis Indicates That Currently the Global Financial Community Is Willing to Expose About \$40 - \$50 Billion of Risk Capital at Any One Time.



FINANCIAL EXPOSURE COMMENTARY

“The markets and its financial community, call us The Wall Street crowd, are only comfortable exposing so much risk capital to a particular industry. The exact amount of (risk) capital exposure will vary from industry to industry and varies over time. For example, the current judgment of Wall Street is that the global petroleum industry has too much capital for the opportunities available. Therefore, the financial community is pushing ‘Big Oil’ to give some capital back through share buybacks and dividends. Similarly, there is a current level of capital financial exposure for the LNG industry. I would put it at \$45 - \$50 billion.

Goldman Sachs – Senior Energy Staff Analyst

DECLINING LNG COSTS

- ❑ The Cost of Building Liquefaction Trains, Re-gasification Terminals, and Tankers Declined Sharply Over the Last Decades.
- ❑ Four Key Reasons for Costs Declining.
 1. **Pioneering projects were over-designed.**
 2. **The development of larger and albeit fewer storage tanks.**
 3. **Incremental improvements in technology, e.g., better gas turbines, larger axial compressors, the replacement of steam turbines with diesel propulsion for tankers.**
 4. **Widespread use of EPC lump-sum bids for entire LNG projects.**

DECLINING LNG COSTS: COMMENTARY

- ❑ Liquefaction Costs Have Declined Over 40% Over the Last 12 Years.
- ❑ The Cost of LNG Tankers Are Down by 45% - 50% Over the Last Two Decades. A 138,000 Metric Ton Tanker Cost Over \$280 Million in 1985. Today, the Same but Improved Vessel Cost \$160 Million.
- ❑ Terminals Are Also Less Expensive Today Ranging From \$100 Million to Almost \$2 Billion.

CONCLUSIONS:

THE DYNAMIC FACTORS

- ❑ These Key Dynamic Factors Shape LNG Demand and Investment.
- ❑ On the Whole, the Aggregate of the Dynamic Factors Are Slightly on the Negative Side. Therefore, Our Judgment That LNG's Prospects Are Lower Than Many Forecasters and Analysts Believe.

REVIEWING THE ADEQUACY OF TECHNICAL RESOURCES FOR LNG?

O TANKERS?

O RE-GASIFICATION TERMINALS?

O LIQUEFACTION PLANTS?

THE ADEQUACY OF LNG TANKER RESOURCES

- ❑ No Problem in the Medium Term. There Is Currently a Surplus of LNG Tankers and the Growth of the Fleet Is More Rapid Than That of Liquefaction Capacity.

“There is some degree of tightness in the global shipbuilding industry. The tightness is on the oil tanker side, not really on the LNG side. There are globally 3600 oil tankers in service with 435 of the VLCC category capable of transporting 2 million barrels of crude. The Suez Max category of oil tanker which is the next largest after the VLCC is also at full capacity. Many tankers will soon be retired and replaced by double hull vessels. This will put a strain on the shipyards. But there are nine shipyards in the world capable of building LNG tankers. They are pumping out 25-30 LNG tankers a year. That is more than enough to keep up with LNG demand.”

Pronay Shipping Management – Director

THE ADEQUACY OF RE-GASIFICATION

TERMINAL CAPACITY

- ❑ No Problem. There Is a Huge Surplus of Re-gasification Capacity in the World.
- ❑ Globally, LNG Re-gasification Utilization Averaged About 35%. In Japan the Largest Consumer of LNG, Terminal Capacity Utilization Was Only 33%.
- ❑ There Is, However, a Need for Re-gasification Terminals in Many Countries New to LNG, i.e., China.
- ❑ There Is Also No Shortage of Contractors Capable of Building LNG Re-gasification Terminals. The Top Seven Contractors Were Ranked in the Following Descending Order.

**Table 6: The Perceived “Best” Contractors
For Building Re-Gasification Terminals**

<u>Company</u>	<u>Number of Nominations by Interviewees</u>
1. CB&I	22
2. Bechtel	18
3. KBR	16
4. Technip	14
5. Aker Kvaerner	10
6. JGC	8
7. IHI	8

THE ADEQUACY OF LIQUEFACTION PLANT TECHNICAL RESOURCES?

- ❑ Liquefaction Is the Most Critical Technical Resource Area for Operators and Contractors.
- ❑ Liquefaction Is Also the Most Profitable LNG Activity and Was Historically Dominated by Two Operators: Shell and Mobil.
- ❑ Many New Entrants Into the LNG Business Challenging the Established Operators Exxon-Mobil and Shell.
- ❑ Dilution of Talent As Operators and Contractors Use Headhunters to Recruit Each Others Key LNG Personnel.

THE ADEQUACY OF LIQUEFACTION PLANT TECHNICAL RESOURCES

- ❑ All Operators Require Experienced Contractors to Manage, Design and Construct Their LNG Trains. There Are 4 LNG Process Contractors Capable of Supplying the Top Level, “A” Teams Necessary to Handle a Major LNG Liquefaction Project.
- ❑ The Four Proven Engineering Contractors Are:
 1. Chiyoda
 2. KBR
 3. JGC
 4. Bechtel
- ❑ There Is an Argument That Linde Is a 5th LNG Process Contractor.

THE ADEQUACY OF LIQUEFACTION

PLANT TECHNICAL RESOURCES

- ❑ The Five Contractors Possess a Total of 6 “A” Teams Each Capable of Handling a Major LNG Project. The Aggregate Capability of These “A” Teams Place a Limit on the Number of Projects That Can Be Handled Over a Time Period.

Table 7: Available “A” Teams From LNG Process Contractors

<u>Company</u>	<u>Number of Nominations by Interviewees</u>
1. Bechtel	1
2. Chiyoda	1
3. JGC	1
4. KBR	2
5. Linde	<u>1</u>
	6

THE ADEQUACY OF LIQUEFACTION

PLANT TECHNICAL RESOURCES

- ❑ What, Then, Is the Limit of the 5 or 6 “A” Teams?
- ❑ Between 1995 – 2000, the Contractors Easily Engineered and Constructed 10 Trains Including 5 Grassroots Installations Plus Numerous Feasibility Studies and Bids.
- ❑ In 2004, A Moderately Busy Year, The Global Engineering and Construction Industry Satisfactorily Handled The Workload – Delays Were Rare.
- ❑ In 2003, The Activity Level Was Very High With Over 40 Million Metric Tons Of Capacity Under Construction. The Result Was A Multitude Of Serious Delays.

THE ADEQUACY OF LIQUEFACTION PLANT TECHNICAL RESOURCES

- ❑ It Seems That the Current LNG Contracting Industry, Which Is Populated by a Majority of Their Personnel in Their Sixties Handle About 25 – 30 Million Metric Tons of Annual Workload, Plus Various Technical and Commercial Studies, Plus Bidding.
- ❑ Therefore, If the LNG Liquefaction Capacity Demand Is for Less Than 120 Million Metric Tons in the Medium Term (2012), There Should Be No Problem.
- ❑ If Demand Approaches Some of the More Optimistic demand forecasts the LNG industry will suffer significant delays.