

# THE LNG OPTION FOR MIDDLE EAST GAS TRADE

a presentation to

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# A FAR SMALLER PROPORTION OF WORLD GAS PRODUCTION (22%) IS TRADED INTERNATIONALLY THAN IS THE CASE OF OIL PRODUCTION (57%)

- There Are Two Major Reasons for This Disparity

Gas's High Transportation Costs, Particularly by Sea

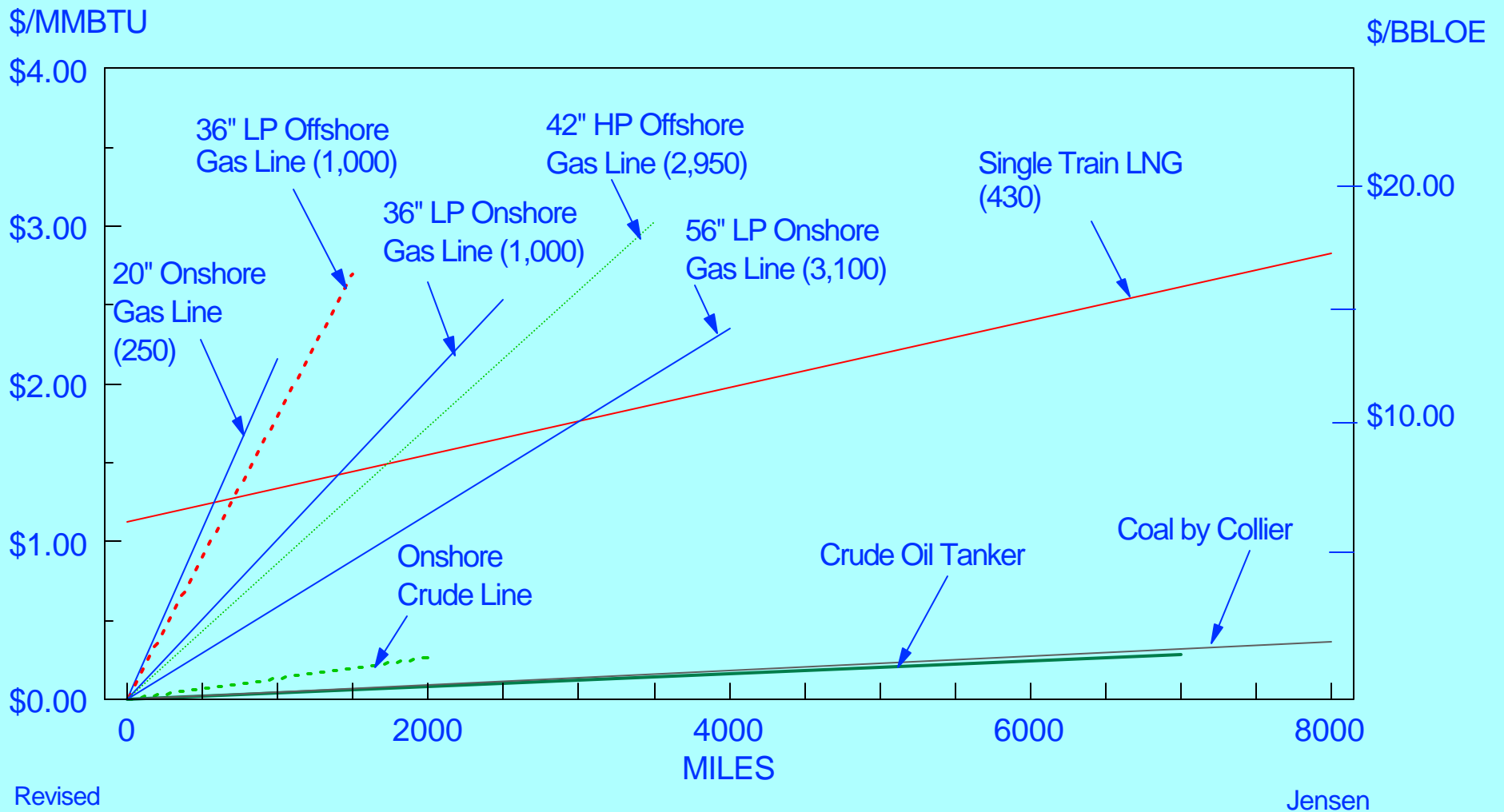
And Its Significant Diseconomies of Scale in Transportation and Distribution, Which Makes It Difficult to Serve Small Markets and Small Gas Discoveries Economically

- Gas's Transportation Cost Disadvantages in Inter-Fuel Competition Extend to Coal as Well, Since the Cost of Marine Transport of Coal is Not Significantly Greater Than That of Oil

# ILLUSTRATIVE COSTS OF GAS, OIL AND COAL TRANSPORTATION

## SHOWING GAS'S HIGHER COSTS AND THE EFFECT OF SCALE

(Gas Delivery Capability in MMcfd)



- For the Middle East These Problems are Especially Acute, Since It Has 34% of the World's Proved Natural Gas Reserves, But Its Nearby Regional Markets Account for Only 7% of the World's Gas Consumption
- But the Middle East is Not Alone
- An Estimated 53% of the World's Proved Gas Reserves are Surplus to Domestic or International Market Commitments or to Oil Production Operations and Thus Can be Described as "Exportable Surpluses" or "Stranded Gas"
- Many of These Exportable Surpluses Are Located at Great Distances From the Major Gas Markets

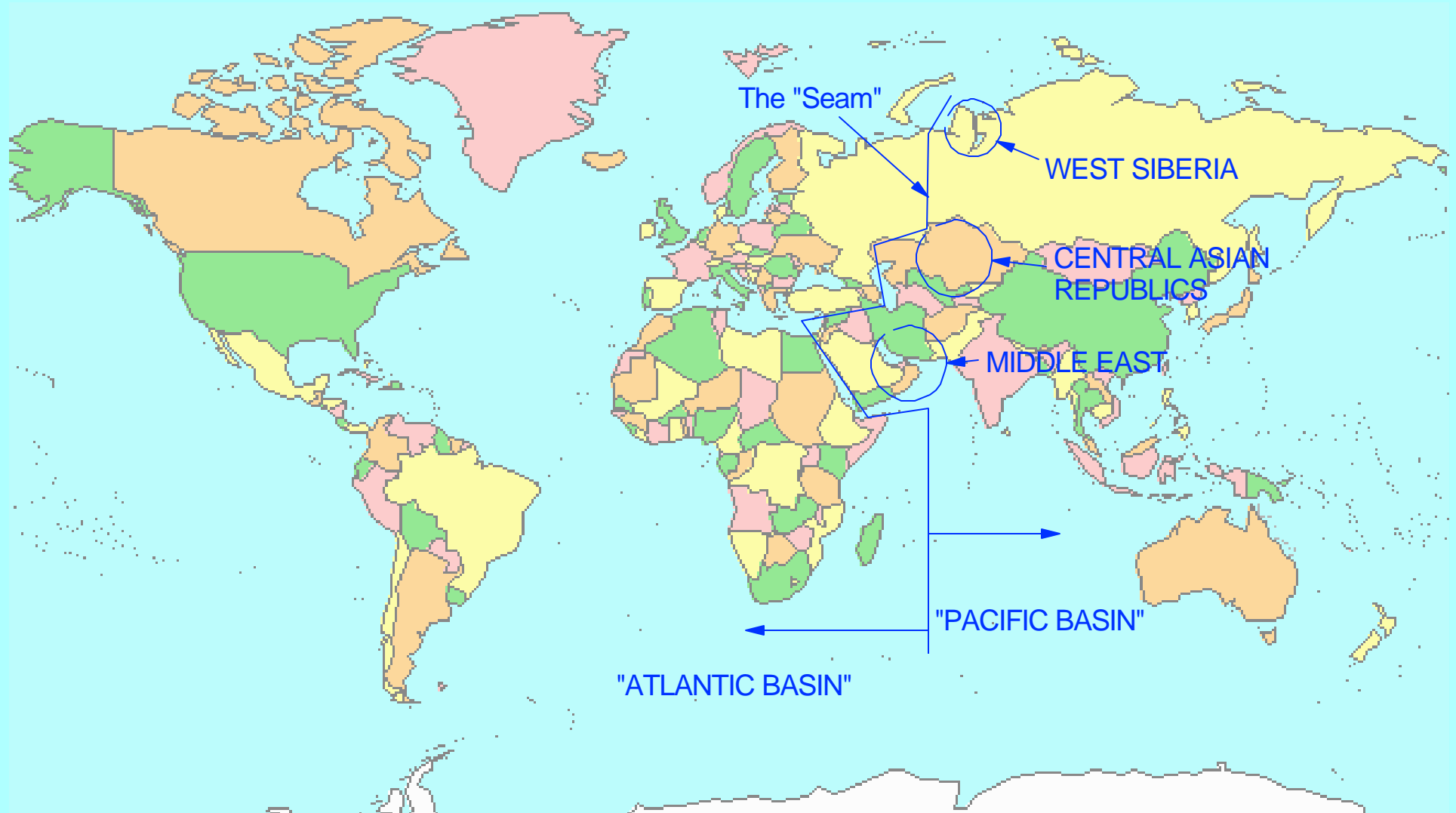
- While the Regional Markets for Pipeline Gas are Determined by the Layout of the Pipeline System, LNG - Able to Move Much Longer Distances by Tanker - Has Developed a Much Broader Definition of Market Regions -

The "Atlantic Basin" (Including the Mediterranean)

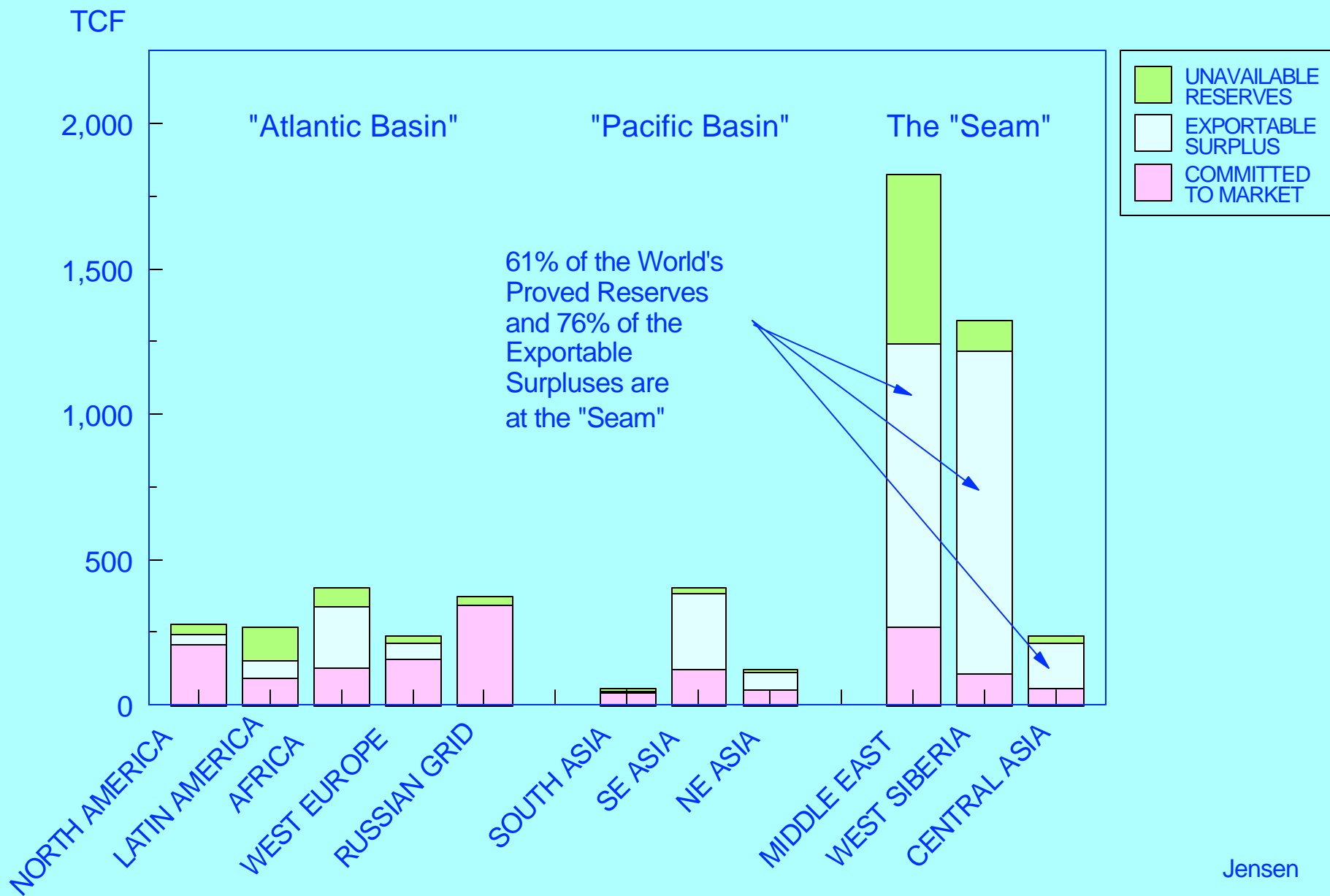
And the "Pacific Basin"

- By This Definition, the Three Largest Blocks of Surplus Gas - the Middle East, Western Siberia and Central Asia - are at the "Seam" Between Basins and Thus Most Remote from the Large North American, European and East Asian Markets
- Fully 62% of the World's Proved Gas Reserves and 75% of its Exportable Surpluses Are Located at the "Seam" Between Regions and Thus Provide Substantial Challenges to the Development of Cost-Effective Gas Transportation Infrastructure

# THE "ATLANTIC" AND "PACIFIC" GAS BASINS TOGETHER WITH "SEAM" SUPPLY AREAS



# NATURAL GAS RESERVES BY REGION SHOWING THE CONCENTRATION AT THE "SEAM" YEAR END 1999





- The Western Siberian Reserves Have Been the Backbone of the FSU Grid and Thus, Supplemented by Small Volumes from Turkmenistan and Kazakhstan , Have Been a Major Source of Pipeline Supply to Eastern and Western Europe
- But the Gulf, Lacking Pipeline Access to Distant Markets, Was Largely Shut Out of International Gas Trade Until the Combination of Combined Cycle Power Generation (CCGT) and LNG Transportation Enabled it to Look Eastward for Markets, First in Japan, Korea and Taiwan, More Recently in India, and Now Westward to the Mediterranean and Possibly Even North America

- By Creating Large Markets That Could Pay Premium Prices for the Fuel, CCGT Technology Enabled Gas to Break Out of Its Twin Constraints

Its Premium Markets Developed Too Slowly to Justify New Transportation Projects

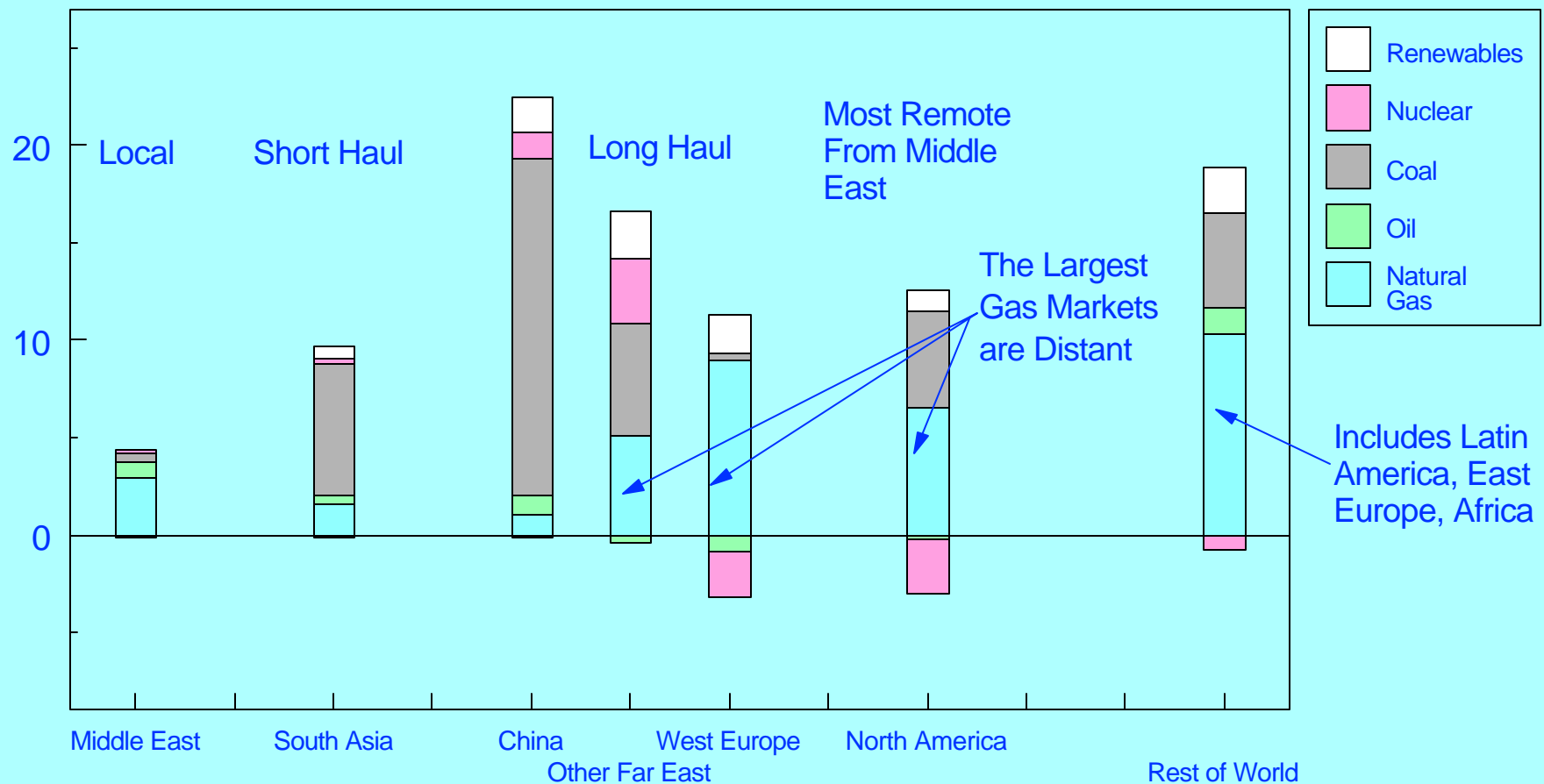
But Its Large Markets Were Low Valued "Black Fuel" Applications

- CCGT Units Have Lower Capital Costs and Higher Thermal Efficiencies Than Conventional Steam Boilers, Permitting a Tradeoff of Higher Fuel Prices for Lower Capital Recovery Costs
- Power Generation Markets Are Now Driving International Gas Trade Throughout the World, But the Greatest Market Growth is Still Distant from Middle East

# PROJECTED CHANGES IN WORLD PRIMARY ENERGY SUPPLY FOR POWER GENERATION BY REGION - FORECAST 1997/2020 [1]

AVERAGE ANNUAL CHANGE DURING PERIOD IN MTOE  
GROUPED BY ROUGH DISTANCE FROM MIDDLE EAST SUPPLY

MILLION TONS OF OIL EQUIVALENT



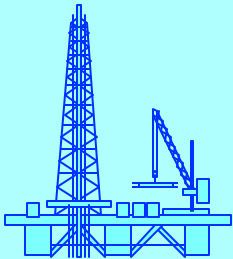
[1] From World Energy Outlook 2000 - IEA

# LNG PROJECTS ARE HEAVILY CAPITAL-INTENSIVE REQUIRING DEDICATED RESERVES AND LONG TERM MARKET CONTRACTS FOR FINANCING

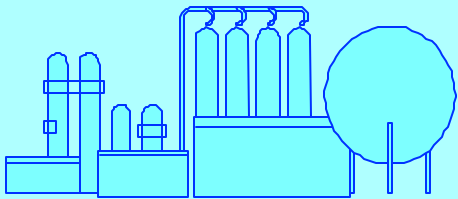
- A Typical Two Train Greenfield Project from the Gulf to East Asian Markets Today Might Require an Overall Investment of About \$5 Billion in Field Development, Liquefaction, Tankers and Receipt and Regasification Terminals
- The Cost of Service for the Trade, While Varying for Specific Projects, Should be Somewhat More than \$3
- This is a Distinct Improvement Over Earlier Projects as LNG Costs Have Come Down With Increased Train Sizes, Standardized Construction, and Less Concern for Security-Driven "Gold Plating"

# ELEMENTS OF AN LNG DELIVERY SYSTEM

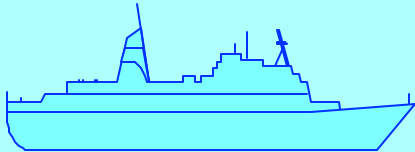
BASIS: TWO 3.3 MMT TRAINS - 6,500 NAUTICAL MILES [1]  
(APPROXIMATELY THE DISTANCE FROM THE GULF TO JAPAN)  
REQUIRES ABOUT 8.7 TCF OF RESERVES TO SUPPORT  
A 20 YEAR CONTRACT



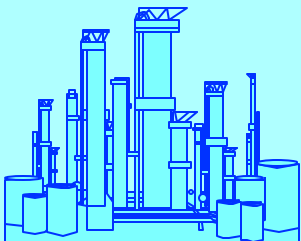
	CAPEX	MARGIN
Field Development (Varies)	\$1.3 Bn	\$0.80



Liquefaction	\$1.4 Bn	\$0.94
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Tankers (10 @\$180 Mn)	\$1.8 Bn	\$1.00
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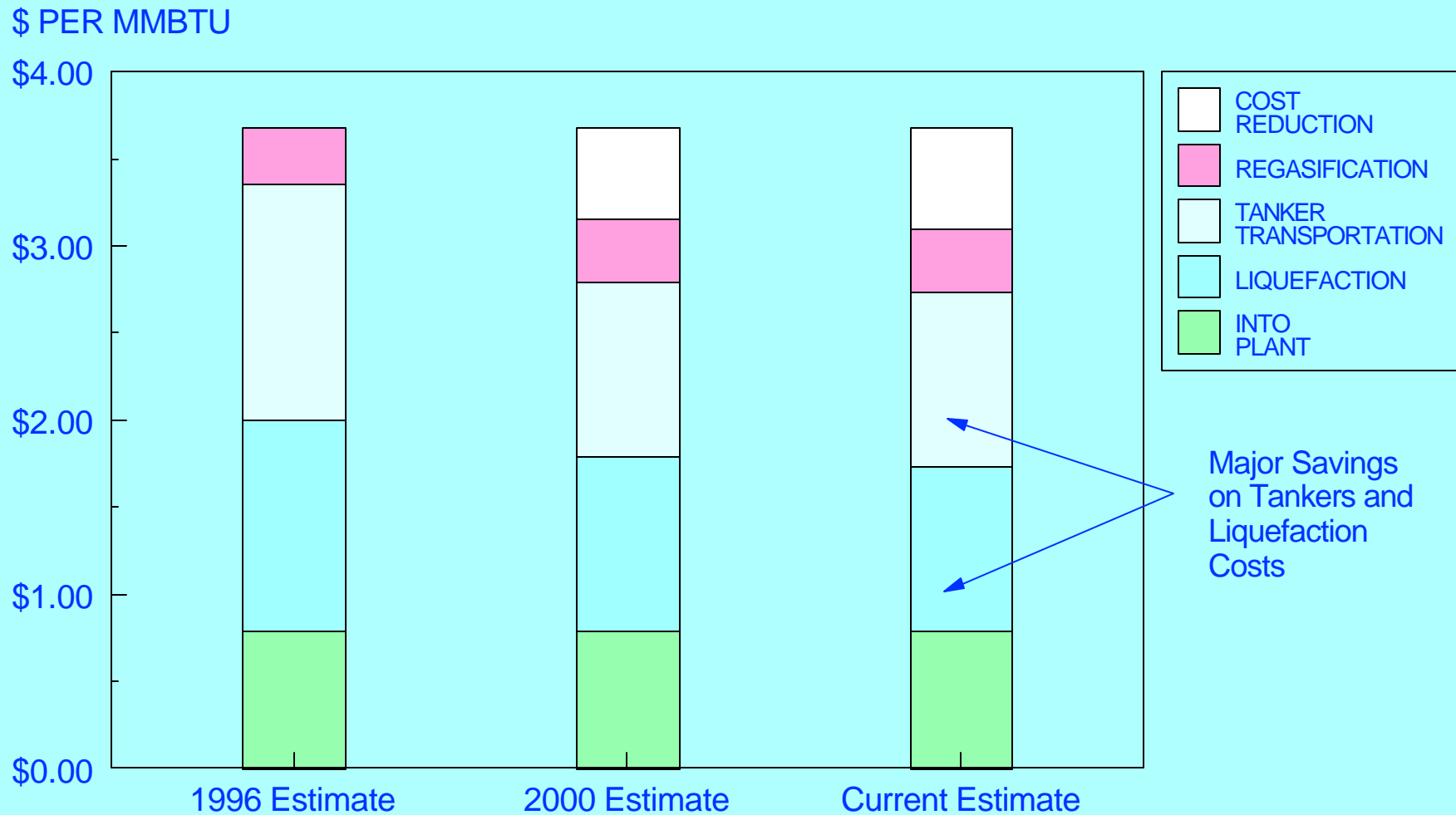


Regasification (Varies)	<u>\$0.5 Bn</u>	<u>\$0..37</u>
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Total	\$5.0 Bn	\$3.11
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[1] Revised 7/24/02

AN ILLUSTRATION OF THE IMPROVEMENT IN  
 LNG TRANSPORTATION COSTS WITH NEWER DESIGNS  
 THREE COST ESTIMATES MADE AT DIFFERENT TIMES  
 6.6 MMT EXPANSION MIDDLE EAST TO JAPAN [1]  
 (ASSUMING AN \$0.80 FIELD PRICE)

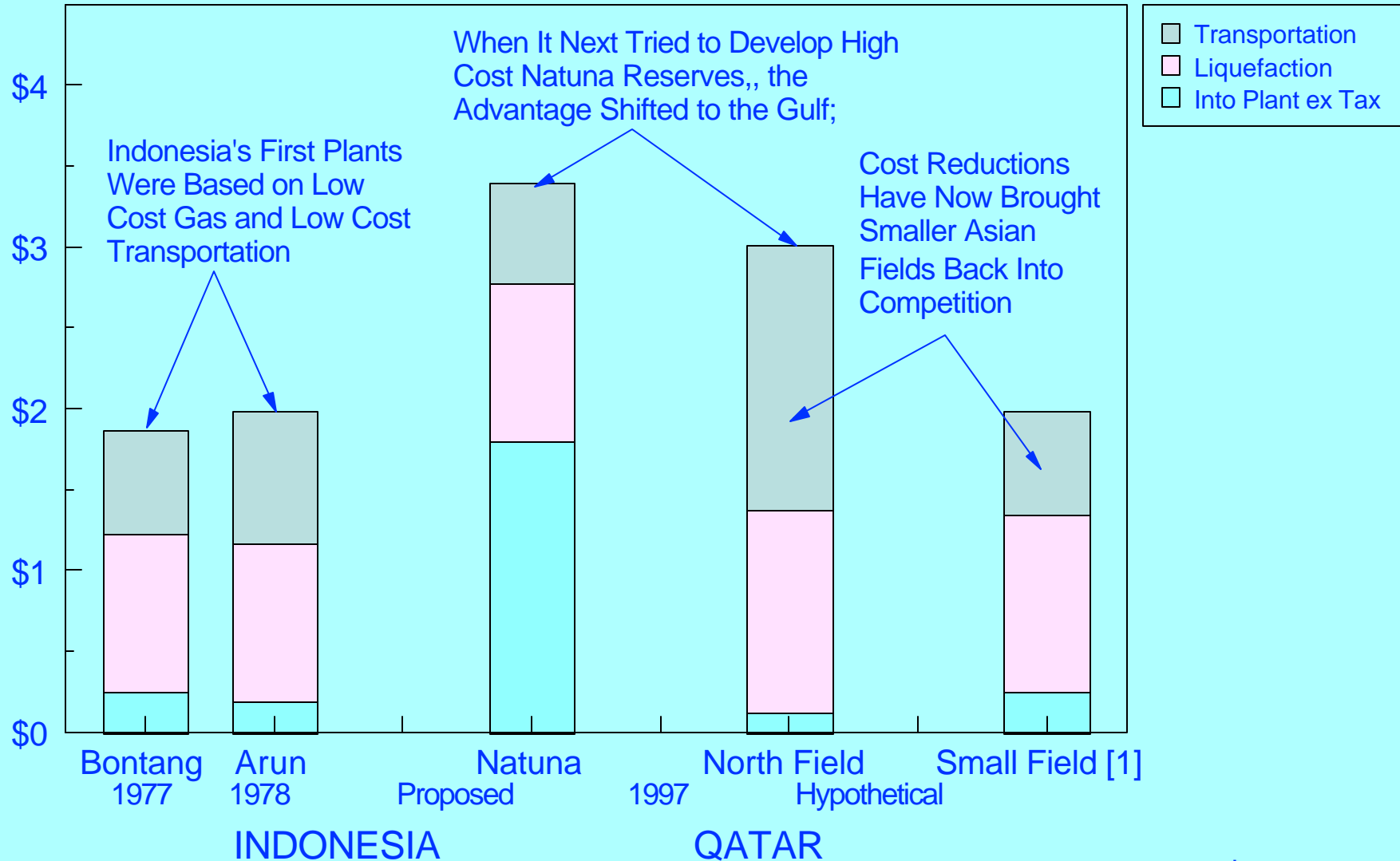


[1] Revised 7/23/02

# WHILE A REDUCTION IN TANKER COSTS CLEARLY FAVORS THE COMPETITIVE POSITION OF THE MIDDLE EAST,

- It is Less Clear That Reduced Liquefaction Costs Do So
- Liquefaction Cost Reduction Makes it Possible to Consider Gas Sources Nearer Markets That Were Previously Considered Too Small to Support a Greenfield LNG Project
- The Large, But Distant, Gulf Reserves Had an Advantage in Northeast Asia During the Early Nineties as Some of the Best Nearby Reserves Were Fully Committed, But the Reduction in Liquefaction Costs Brought Smaller Fields in Southeast Asia Back Into Competition

# TRADING OFF TRANSPORTATION, PLANT SIZE AND WELLHEAD COSTS THE QATAR/INDONESIA EXAMPLE



[1] Small Field with Bontang's Location and Economics



# PIPELINE COMPETITION FOR LNG HAS ALSO BEGUN TO APPEAR FOR CERTAIN TRADES

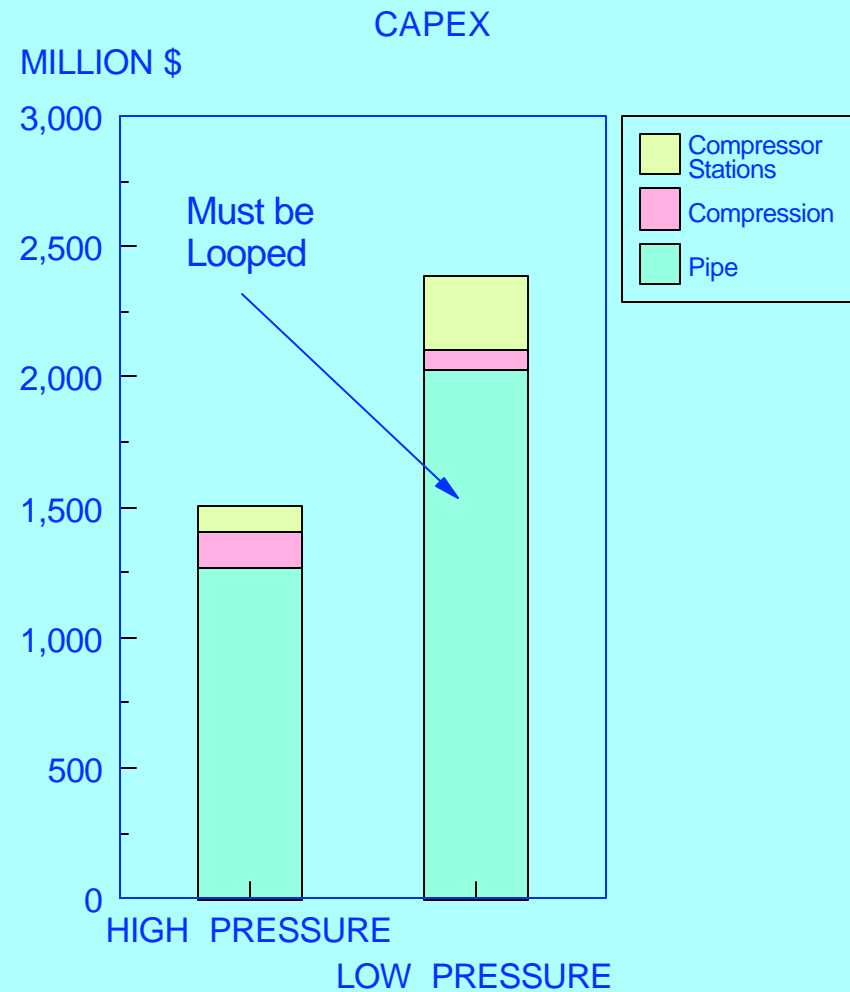
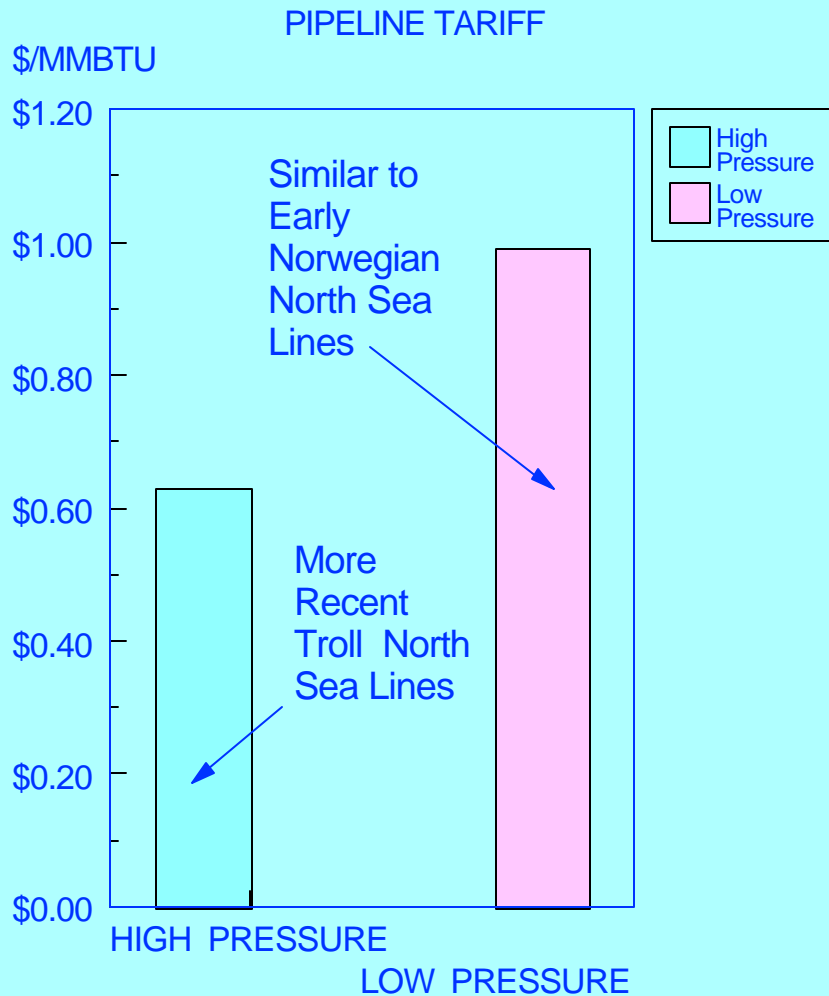
- This Is a Result of Newer Pipeline Technology and the Growing Energy Consumption of Nearby Markets
- The Development of High Pressure Pipelining Brings Down Costs By Utilizing Steel Pipe More Efficiently
- High Pressures Have Been Particularly Important Offshore, Since They Sharply Reduce the Need for Expensive Riser Platforms for Compressor Stations
- Deep Water Pipelining, as Characterized by the SNAM/Gazprom Blue Stream Line (7,000 Feet Deep) Across the Black Sea to Turkey, Has Opened Up New Marine Pipeline Competition for LNG

# ILLUSTRATIVE MARINE PIPELINING COSTS

## NEWER HIGH PRESSURE MARINE LINE COMPARED TO OLDER LOW PRESSURE LINE WITH COMPRESSOR RISER PLATFORMS

### 850 KM LINE, 15 BCM CAPACITY

(APPROXIMATELY THE CHARACTERISTICS OF THE NORTH SEA FRANPIPE LINE)



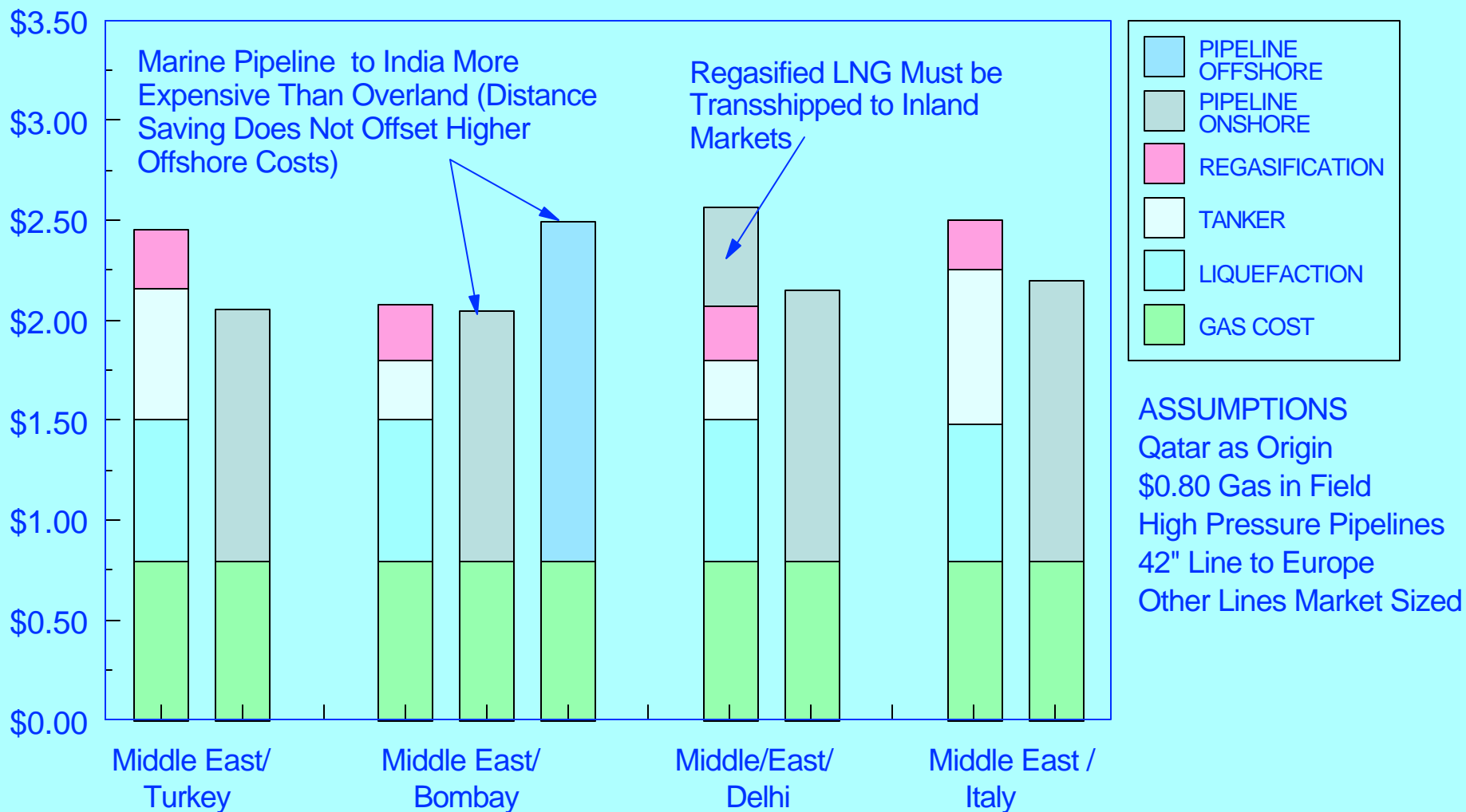
- For Many Trades, Including Mediterranean Europe, LNG May Be More Costly Than Pipelining
- But Pipeline Transit Fee and Political Risk Issues Tend to Preserve Some of These Markets for LNG Despite Poorer Economics
- However, As the Longer Hauls to Europe and North America Have Begun to Develop, LNG Is Clearly Favored
- But, Since Many of these New Trades Are Significantly More Costly Than the Historic Options That These Markets Are Accustomed To, Project Development Will Be a Challenge

# COMPARISON OF PIPELINE AND LNG DELIVERY COSTS

## TO SELECTED DESTINATIONS

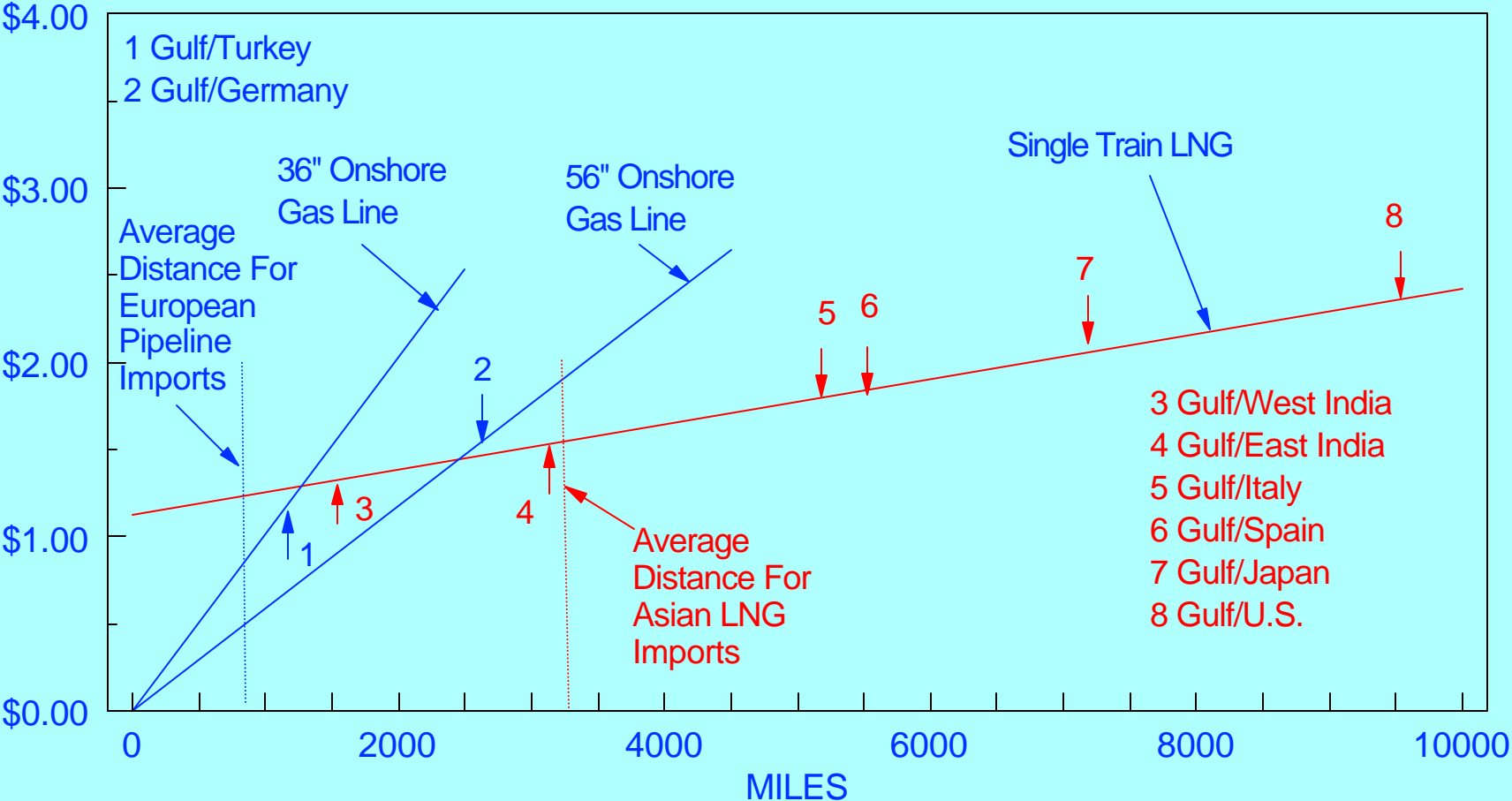
PIPELINE IS USUALLY THE LOWER COST OPTION FOR NEARBY MARKETS

\$/MMBTU



# APPROXIMATE DISTANCES AND TRANSPORTATION COSTS FOR SELECTED SUPPLIES TO SELECTED MARKETS (EXCLUDING COST OF GAS)

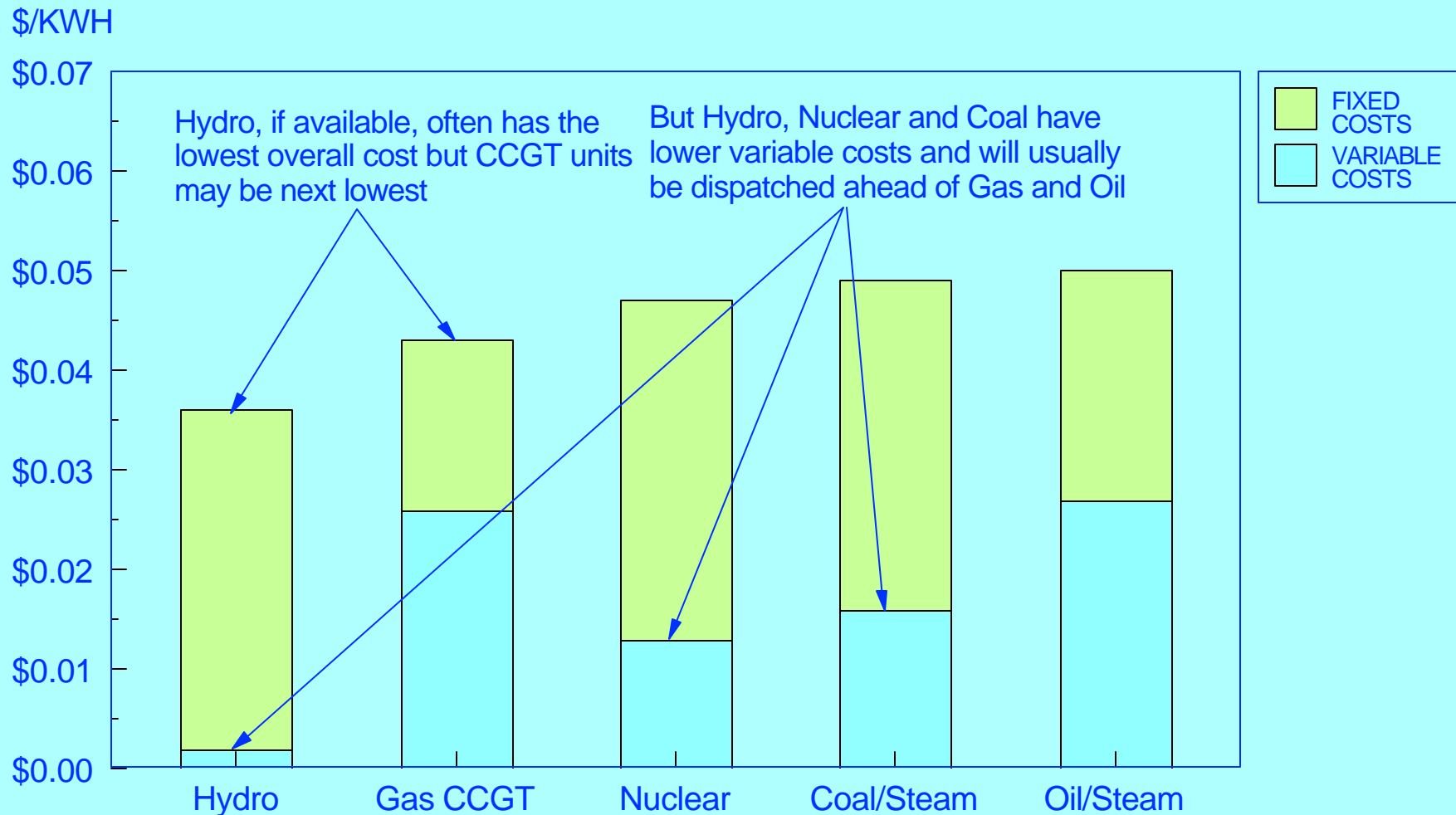
TRANSPORTATION COSTS IN \$/MMBTU



# THE ATTRACTIVE LNG PRICE PREMIUMS THAT CCGT UNITS PERMIT CAN BE A DISTINCT DISADVANTAGE IN SOME POWER GENERATION MARKETS

- Because of Their Lower Short Run Marginal Costs, Coal, Nuclear or Hydro May be Dispatched Preferentially Over CCGT Units, Particularly During Periods of Overcapacity
- Thus It May Be Dangerous to Assume That Gas-Fired CCGT Units Will Play the Same Role in New Markets That They Have in Earlier Ones
- A Failure to Understand This Principle Has Complicated Recent Price Negotiations for LNG in Asian Markets and Led to Difficulties in Introducing Gas-Fired Power Generation into Hydro-Rich Markets Such as Brazil

# ILLUSTRATIVE POWER GENERATION COSTS BY UNIT TYPE BASED ON 1999 JAPANESE IMPORTED FUEL PRICES 500 MW UNITS



# THE SHARE OF THE GENERATION MARKET THAT GAS CAN COMMAND IS INFLUENCED BY THE RELATIVE PRICES OF GENERATING FUELS

- Gas Pricing Patterns in the U.K. During the "Dash for Gas" - 1993/1996 - Featured Expensive British Coal and Cheaper Gas and Led to Substantial Replacement of Existing Coal Units
- In the U.S., a Combination of Cheap Gas and Cheap Coal Has Been Fuelling the Rapid Growth of Gas-Fired Generation, But It Has Not Shut Down Coal Generation as it Did in the U.K.



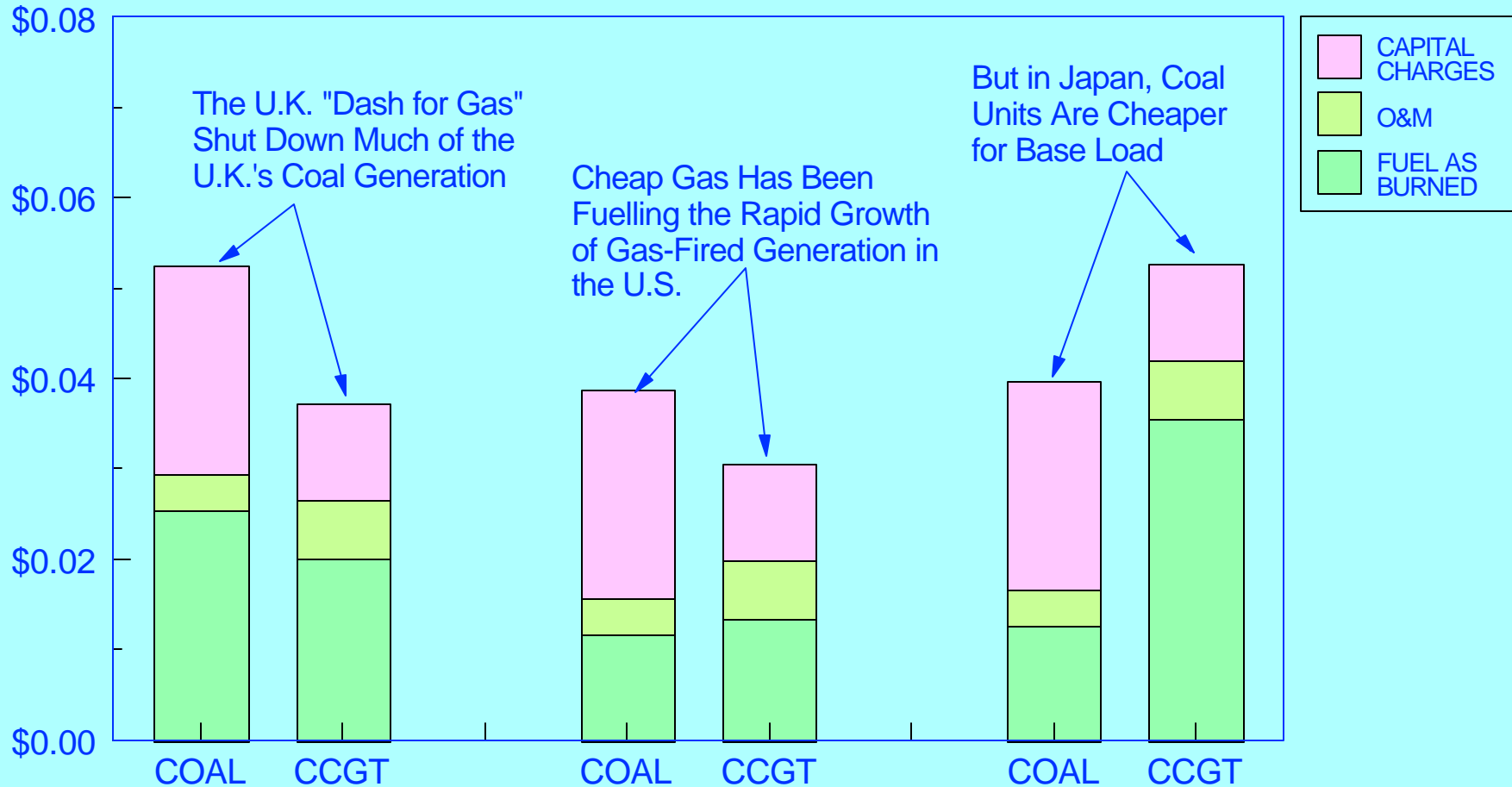
- For Japan, However the Availability of Cheaper Imported Coal in Combination with Expensive Gas Has Limited the Market for the CCGT Units to Intermediate-Firing at Reduced Capacity Factors
- In Japan, Oil Units Are Being Marginalized and in Some Cases Gas is Assuming More of a Peaking Role
- Thus, Despite Environmental Concerns With Coal, Upward Price Pressures on Gas May Threaten Gas's Share of the Power Generation Market
- The Gulf, Faced With Long Haul Transport to Northeast Asia, Europe and North America is Particularly Vulnerable to Such a Competitive Disadvantage

# ILLUSTRATING THE EFFECT OF FUEL COSTS ON MARKET PENETRATION OF GAS-FIRED CCGT UNITS

BASELOAD OPERATION - 7000 HOURS (80% CF)

USING FUEL PRICES FOR U.K. 1995, U.S. 1995 AND JAPAN 2000 \$/KWH

\$/KWH



U.K.  
1995 Fuel Prices  
Cheap Gas,  
Expensive Coal

U.S.  
1995 Fuel Prices  
Cheap Gas,  
Cheap Coal

Japan  
2000 Fuel Prices  
Expensive Gas  
Cheap Coal

## IN CONCLUSION

- Like Western Siberia and Central Asia, The Middle East Has Very Large Surpluses of Discovered Natural Gas Reserves That Are Surplus to World Markets
- While It Is Beginning to Find Some Potential Outlets Relatively Nearby in Markets Such as South Asia, to Reach the Large, Developed Gas Markets of East Asia, Western Europe and North America, It Must Rely on LNG
- Here, the Optimistic News is that LNG Costs Have Been Coming Down
- But the Economics of Long Distance LNG Transportation Remain "Thin"; Competition From Pipelines and Other Fuel Is An Issue and Project Development Will Remain a Challenge

