

THE ROLE OF NATURAL GAS IN THE ENERGY FUTURE OF THE ASIA PACIFIC REGION

a Presentation to

The Kennedy School Seminar on Asia in the World Economy
Harvard University
Cambridge, Massachusetts
February 27, 2008

JAMES T. JENSEN

Jensen Associates

49 Crescent Street; Weston, MA 02493 U.S.A.

Website JAI-Energy.com

Phone (781) 894 2362

Fax (781) 894 9130

E Mail JAI-Energy@Comcast.Net

TOTAL ENERGY CONSUMPTION IN ASIA IS LARGER THAN THAT IN EITHER NORTH AMERICA OR EUROPE

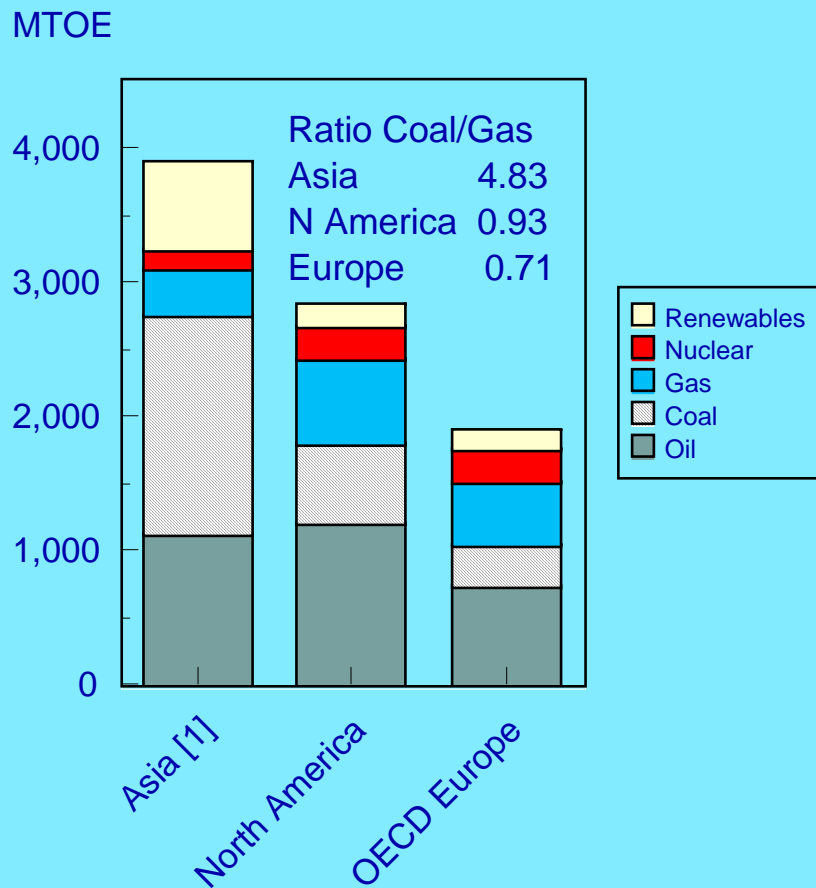
- Transportation and Petrochemical Consumption, Where Oil Predominates, is Not Substantially Different in Asia From That in the Other Two Regions
- But Asia's Consumption for Stationary Applications, Where Gas Competes With Coal and Nuclear Power, is Much Larger
- And While North America and Europe Use More Gas Than Coal in These Applications, Asia Uses Far More Coal

- China, India and Indonesia Alone Account for 50% of the World's Coal Consumption But Only 4% of the World's Gas Consumption
- In a Carbon-Constrained World, Asia - With its Coal Intensity and its High Growth Rates - Represents a Substantial Challenge

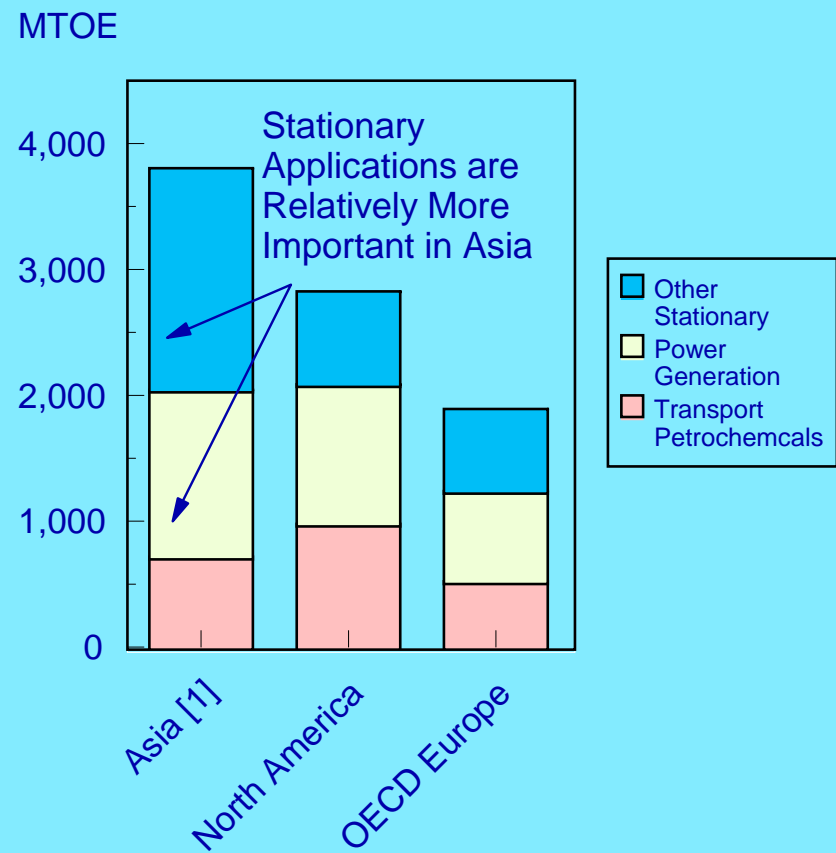
Figure 1

ENERGY CONSUMPTION IN ASIA [1], EUROPE AND NORTH AMERICA - MILLION TONS OF OIL EQUIVALENT - 2005

BY ENERGY SOURCE



BY SECTOR

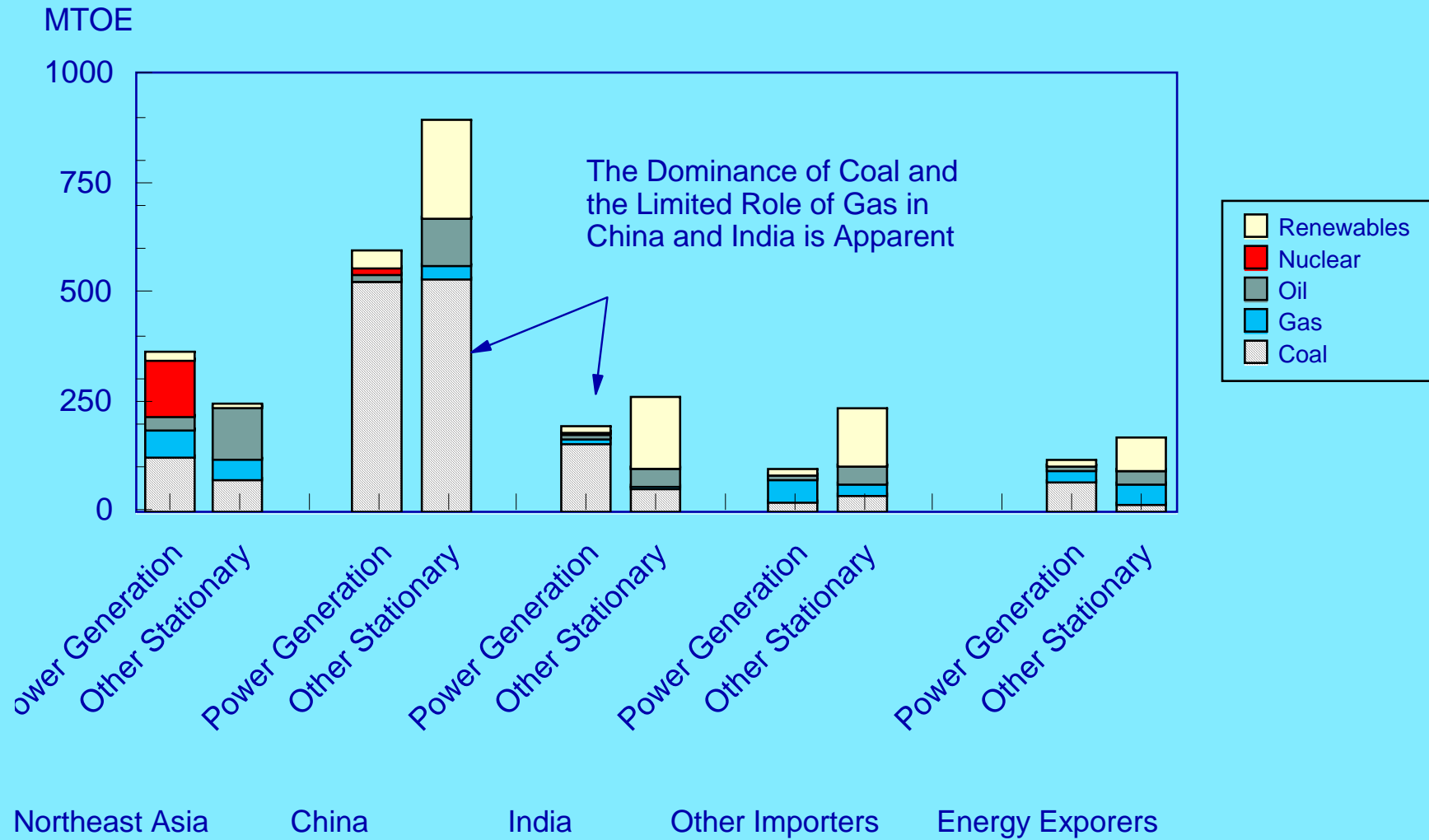


[1] Includes Australasia But Excludes Middle East and FSU Asia

GAS PENETRATION OF STATIONARY ENERGY MARKETS IN THE REGION IS A PRODUCT BOTH OF ECONOMIC DEVELOPMENT LEVEL AND RESOURCE AVAILABILITY

- The Isolated and More Developed Economies of Northeast Asia - Japan, Korea and Taiwan - Lacking Energy Resources of Their Own - Have Utilized LNG and Nuclear Power to Minimize Oil Consumption
- China and India, With Ample Coal Resources and Little Previous Access to Natural Gas, Have Concentrated on Coal
- The Region's Principal Gas Resources are in Southeast Asia and Australia; Some of These Countries Have Become Major LNG Exporters

Figure 2
STATIONARY ENERGY BALANCES FOR ASIAN REGIONS -
MILLION TONS OF OIL EQUIVALENT - 2005

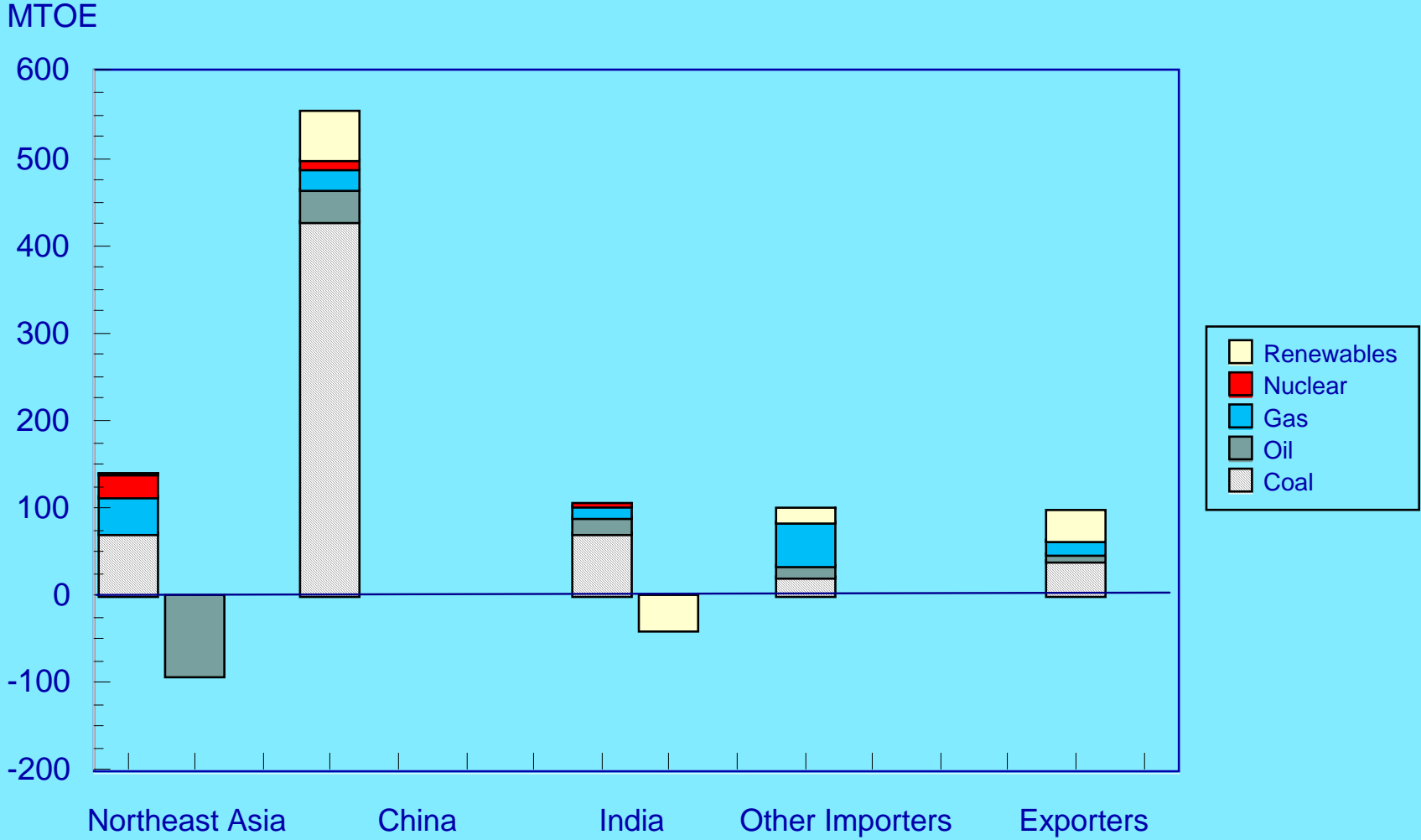


OVER THE DECADE FROM 1995 TO 2005

- The Increase in the Consumption of Coal Exceeded That of Natural Gas in All Major Asian Regions
- Only Northeast Asia Was Able to Reduce Stationary Oil Consumption Through the Use of Gas, Coal and Nuclear
- The Rest of Asia Increased its Consumption of Oil in Stationary Applications

Figure 3

CHANGES IN STATIONARY ENERGY CONSUMPTION - 2005 VERSUS 1995 FOR VARIOUS ASIAN REGIONS

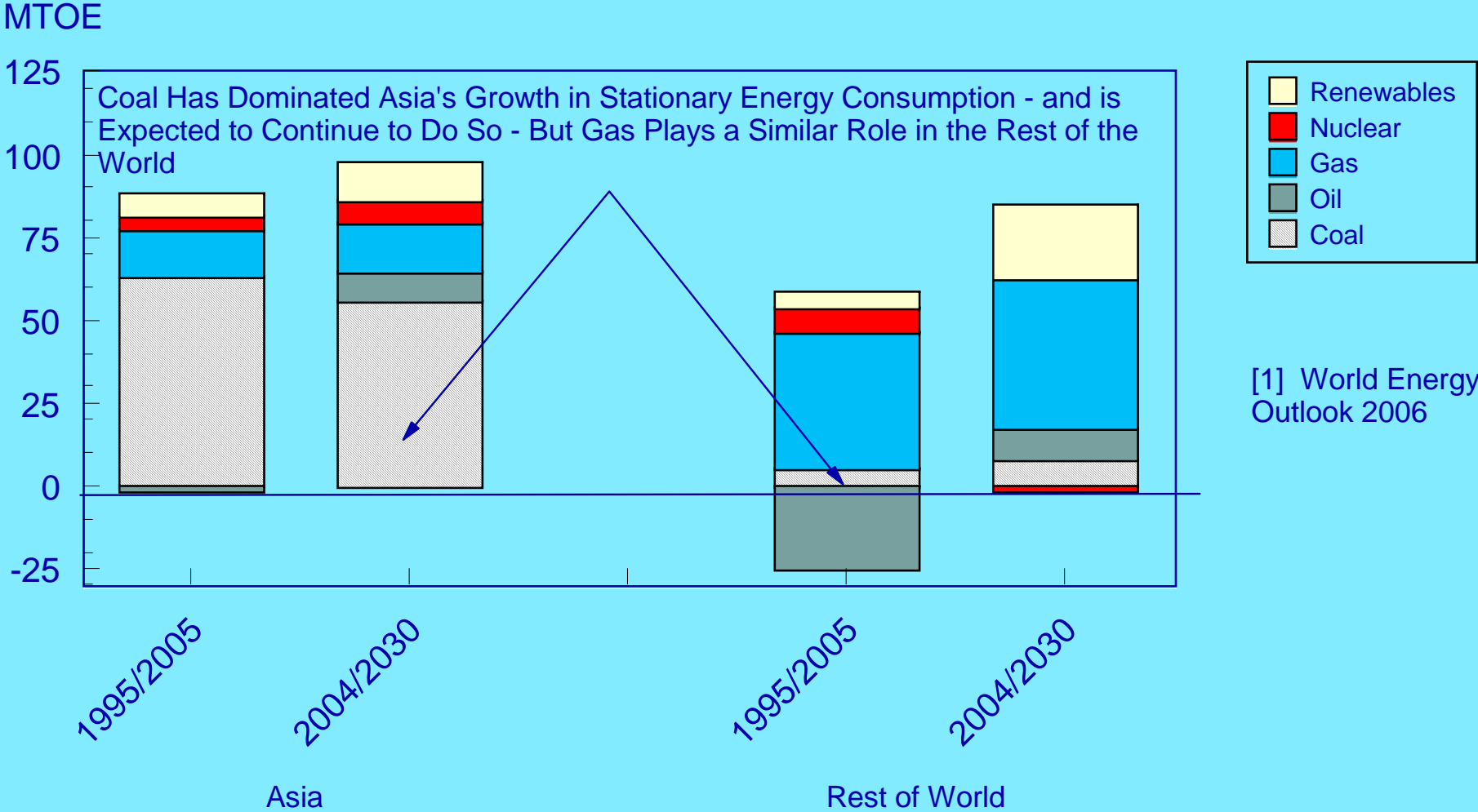


ASIA CURRENTLY ACCOUNTS FOR ABOUT THIRTY PERCENT OF THE WORLD'S STATIONARY ENERGY CONSUMPTION

- But it Contributed Seventy-Two Percent of the Total Growth of Stationary Energy Between 1995 and 2005
- And the International Energy Agency Expects that Its Contribution Out to the Year 2030 Will Also Exceed That of the Rest of the World
- While Natural Gas Has Dominated Stationary Energy Growth Outside Asia, It Has Had a Limited Role in That Region

Figure 4

IEA'S [1] PROJECTED CHANGES IN STATIONARY ENERGY BALANCES - ASIA VERSUS THE REST OF THE WORLD - AVERAGE ANNUAL INCREASE - 1995-2005 AND PROJECTED 2004-2030

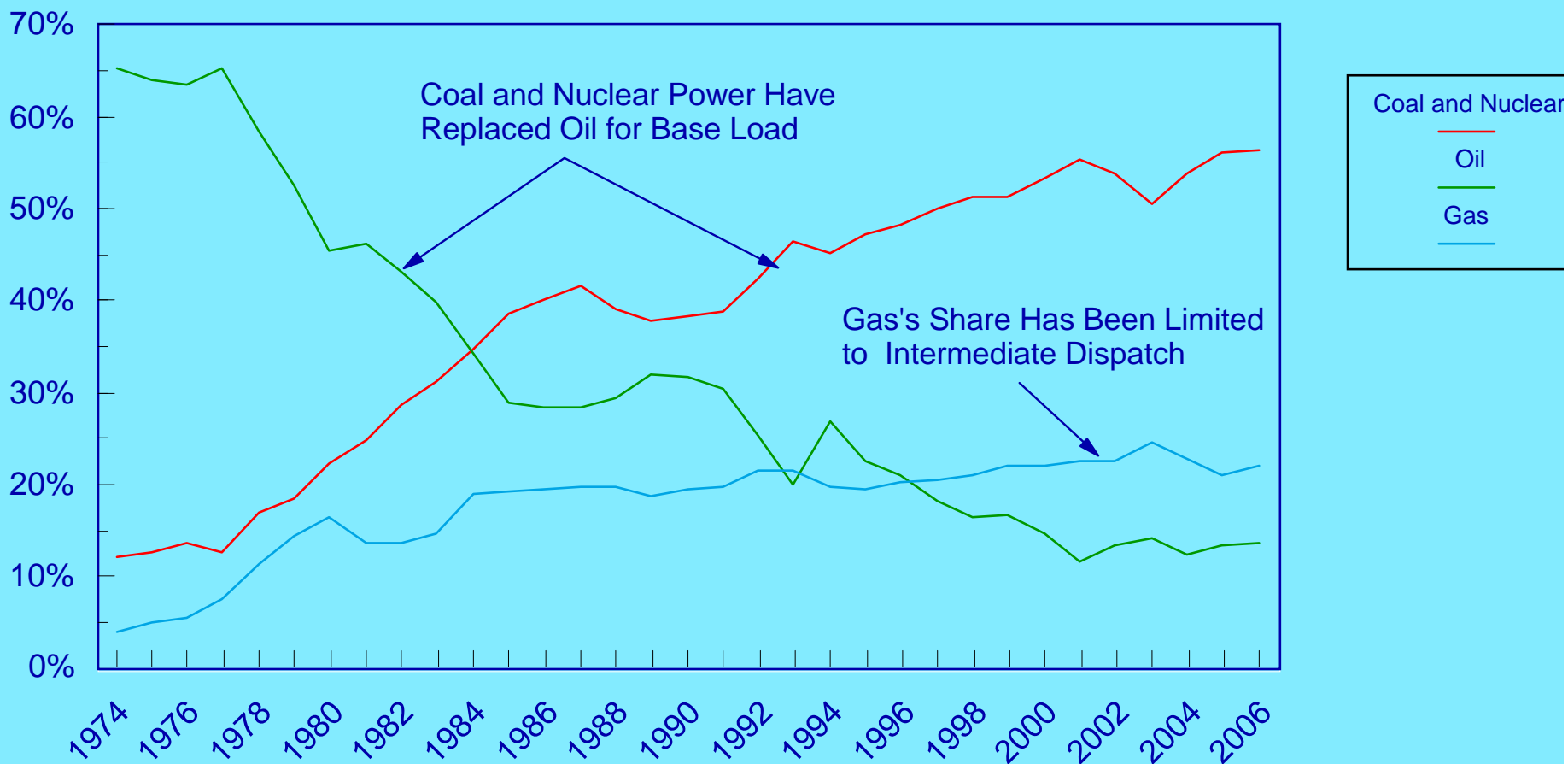


NORTHEAST ASIA - JAPAN, KOREA AND TAIWAN - HAS BEEN THE LARGEST GAS CONSUMING REGION IN ASIA, ACCOUNTING FOR 30% OF GAS DEMAND

- Until India's First Imports in 2004, the Three Were the Only Asian LNG Importers; As Recently as 1994, They Accounted for 77% of Total World LNG Trade
- Power Generation Accounts for 71% of Gas Consumption in Taiwan, 40% in Korea and 37% in Japan
- But the High Price of Gas Compared to Other Generation Alternatives Has Restricted Gas Firing to Intermediate Dispatch Thus Limiting its Share of the Generation Market

Figure 5
SHARES OF JAPANESE ELECTRIC GENERATION
COAL PLUS NUCLEAR, OIL AND GAS

Share of Electric Generation

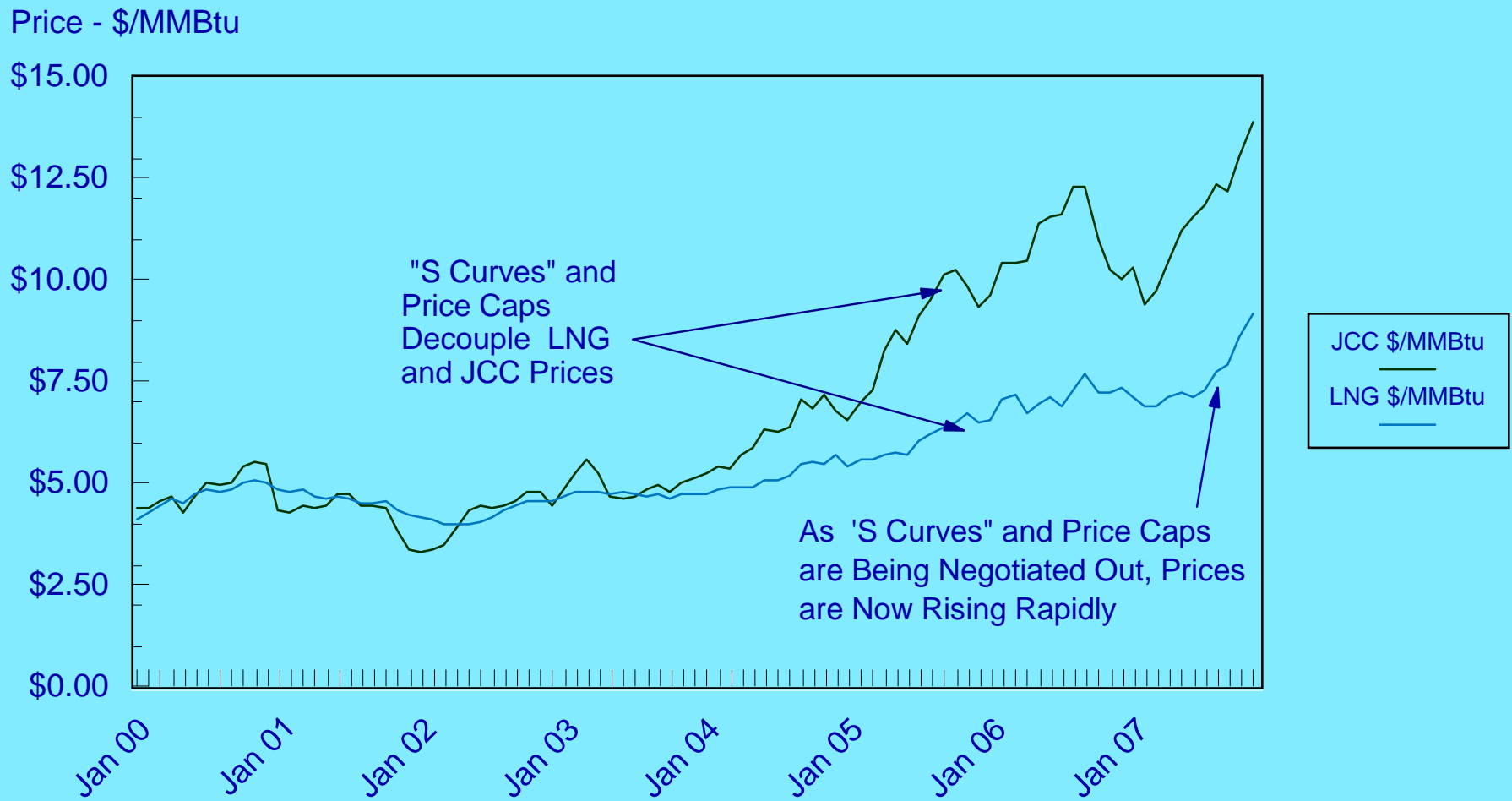


- Another Uncertainty is the Future Role of Nuclear Power in Japan
- Despite its Utilization - Together With Coal - as a Fast Growing Replacement for Base Load Oil Generation, Nuclear Has Experienced Two Major Upsets in the Past Five Years
- In 2002, Safety Problems With Tokyo Electric's Nuclear Plants Forced the Closure of 17 Nuclear Reactors, Some for as Much as Two Years
- Then in 2007, an Earthquake on a Fault Near Tepco's Largest Reactor Forced the Extended Shutdown of 7 Reactors
- Tepco's Efforts to Replace the Lost Generation Has Been Highly Disruptive of Both LNG and Oil Markets in Asia

- Northeast Asia Has Traditionally Bought LNG on Long Term Contracts Linked to Oil Prices - The Japanese Customs Clearing Price for Crude Oil (JCC or the "Japanese Crude Cocktail")
- But the Linkage Has Effectively Been Broken by the Operation of "S Curves" and Price Caps That Were Designed to Protect Buyers from Oil Price Shocks
- In an Extremely Tight Asian LNG Market, Producers Have Been Trying to Restore the Linkage Arguing That Current Prices are the New Normal, Not Temporary Shocks
- To the Extent that They Are Successful, It Suggests Rising Relative Prices for LNG in Power Generation with Unknown Market Consequences

Figure 6

THE DECOUPLING OF JAPANESE LNG AND CRUDE OIL PRICES THROUGH "S CURVES" AND PRICE CAPS AS JCC (OIL) PRICES RISE - A COMPARISON OF OIL AND LNG PRICES



FUTURE CHINESE NATURAL GAS DEMAND - THE GREAT ENIGMA

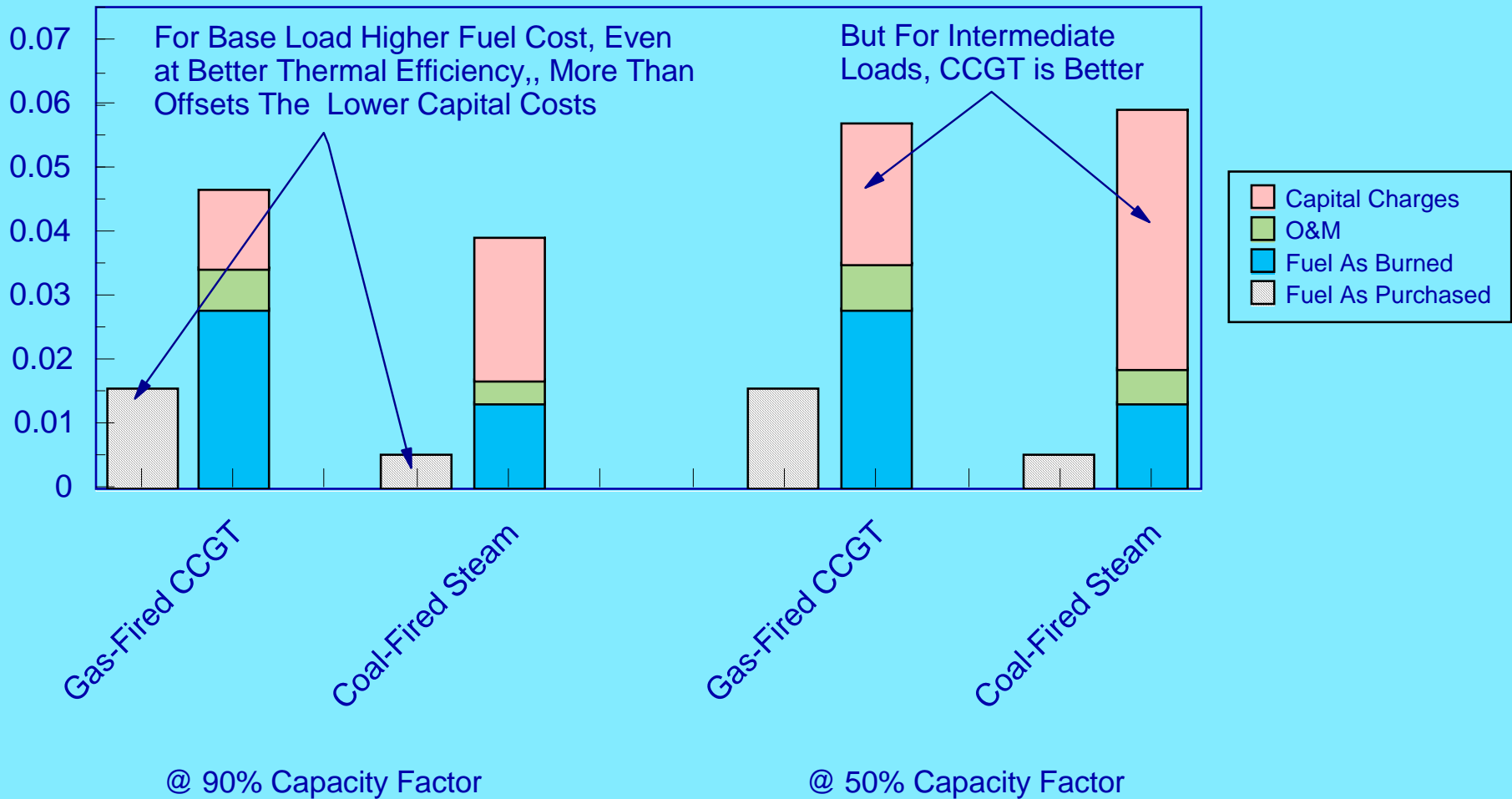
- The Uncertainty Reflects the Underlying Conflict Between Economics and the Environment
- As a Gas Importer, Remote from Sources of Supply, China's Gas is Expensive; Its Domestic Coal Has Been Cheap
- Hence on Economic Grounds it Has Been Difficult to Justify Greater Use of Natural Gas
- Figure 7 - Using U.S. 2005 Generation Economics with Chinese Fuel Prices - Illustrates the Problem

- Under Base Load Conditions, the Low Cost of Chinese Coal Makes Gas-Fired Combined Cycle Power (CCGT) Generation Uneconomic Despite its Lower Capital Costs and Higher Thermal Efficiency
- But For Intermediate Firing, the CCGT Unit Gives Superior Economics
- This Suggests a Gas Utilization Pattern That is Similar to That of Japan
- However, LNG Regasification Can Handle Poor Intra-Day Generation Load Factors More Economically Than Can Pipelines and Coal Costs Vary Regionally Within China
- This Suggests a Strong Regional Bias to Gas Utilization for Power Generation

AN ILLUSTRATIVE COMPARISON OF THE ECONOMICS OF COAL-FIRED STEAM AND GAS-FIRED CCGT GENERATION

(ILLUSTRATION USES 2005 U.S. GENERATING COST ECONOMICS WITH 2005 CHINESE FUEL COSTS)

\$ Per KWH

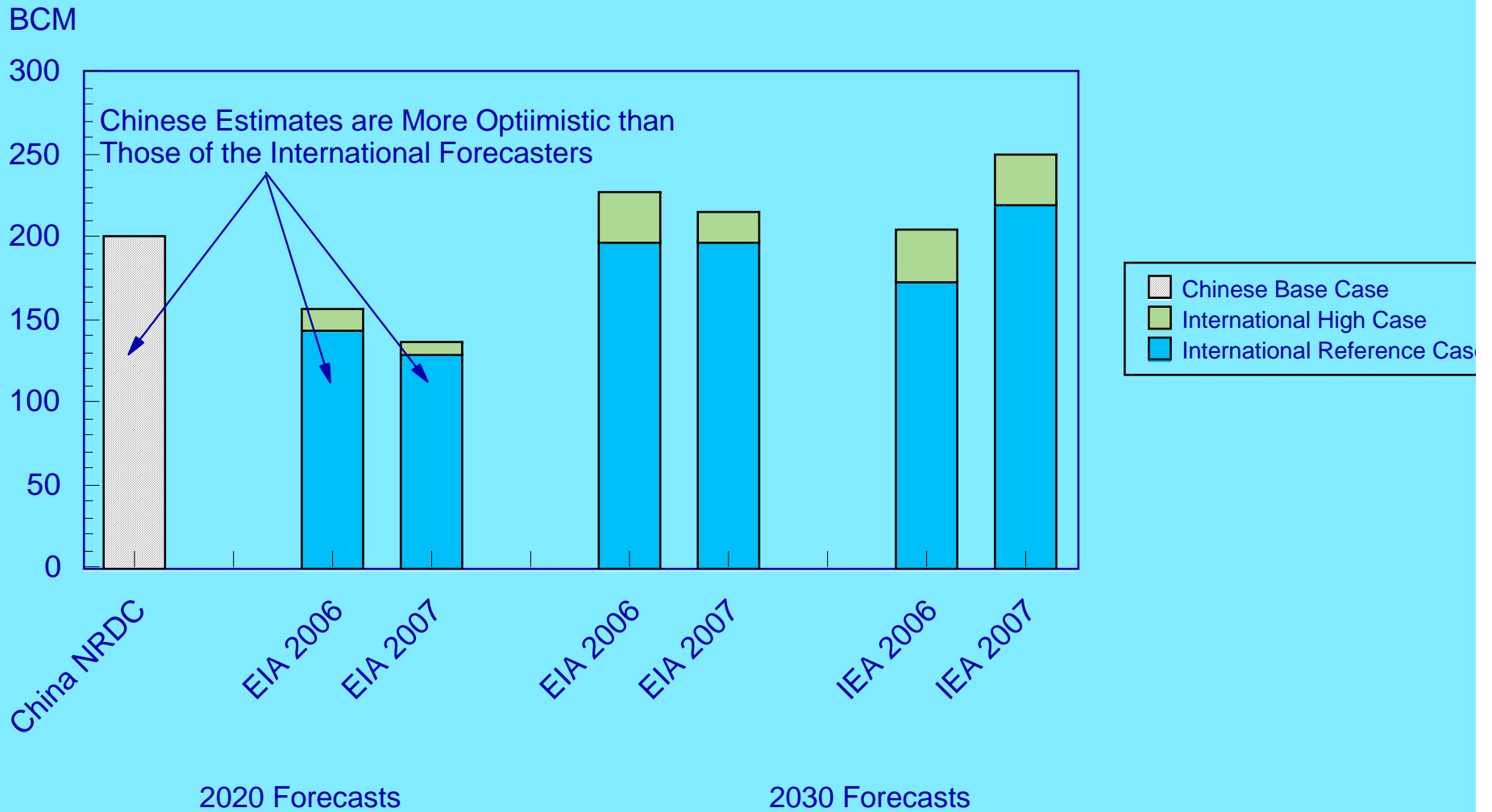


IN GENERAL, CHINESE PROJECTIONS OF GAS DEMAND HAVE BEEN MORE OPTIMISTIC THAN THOSE OF THE INTERNATIONAL FORECASTING AGENCIES

- The Following Figure Compares a 2005 Estimate from the Chinese National Development and Reform Commission with the Two Most Recent Projections from the U.S. Energy Information Administration and the International Energy Agency
- While the International Agencies Seem to be Influenced by Gas's Unfavorable Economics, China - as a Transitioning "Command and Control" Economy - May Elect to Use Gas to Address its Environmental Problems, Regardless of the Economic Consequences

Figure 8

A COMPARISON OF CHINESE AND INTERNATIONAL PROJECTIONS OF NATURAL GAS DEMAND



OTHER ASIAN GAS CONSUMERS HAVE DIVERSE MARKET PATTERNS

- India Faces Many of the Same Problems as China - Low Cost Coal and Higher Cost Gas
- But its Proximity to the Middle East Gives it a Gas Cost Advantage
- The LNG Exporters - Indonesia, Malaysia, Australia and Brunei - Consume About 25% of the Region's Gas
- One of Their Main Problems Has Been Reconciling Domestic Demand With Export Markets
- This Has Been a Problem in Indonesia and Australia

SO WHERE WILL ASIA'S GAS IMPORTS COME FROM AND HOW WILL THEY BE TRANSPORTED?

- The World's Reserves of Natural Gas Are Very Large and Appear More Than Adequate to Support Gas Trade Far Into the Future
- But Many of Those Reserves are Either Already Committed or Located in Places Where Economics, Technology or Geopolitics Raise Questions About How Soon They Will be Commercially Available
- Only 28% of the World's Proved Reserves are Committed to Markets While Another 13% Are Deferred (Involved in Oil Production)

- It is From the 56% That Remain Uncommitted That Most of the Projected Supplies for Interregional Trade Will Come
- But in 2005 84% of Those Uncommitted Reserves - as Well as Most of the Undiscovered Resource Base - Were Located in the Former Soviet Union or the Middle East
- While There are Major Reserves and Resources in Regions Outside Those Two, the Longer Term Outlook for Natural Gas Trade Depends Heavily on How They Respond to World Demand
- And to the Extent That Pacific Basin Supplies Cannot Keep Up With Asian Demand, It is to the Middle East and FSU That Asia Will Turn

Figure 9
THE WORLD'S PROVED GAS RESERVES BY MARKET STATUS
(FOCUSSING ON INTERREGIONAL TRADE)

TCF - Year End 2005

(Source - Jensen Associates Estimates)

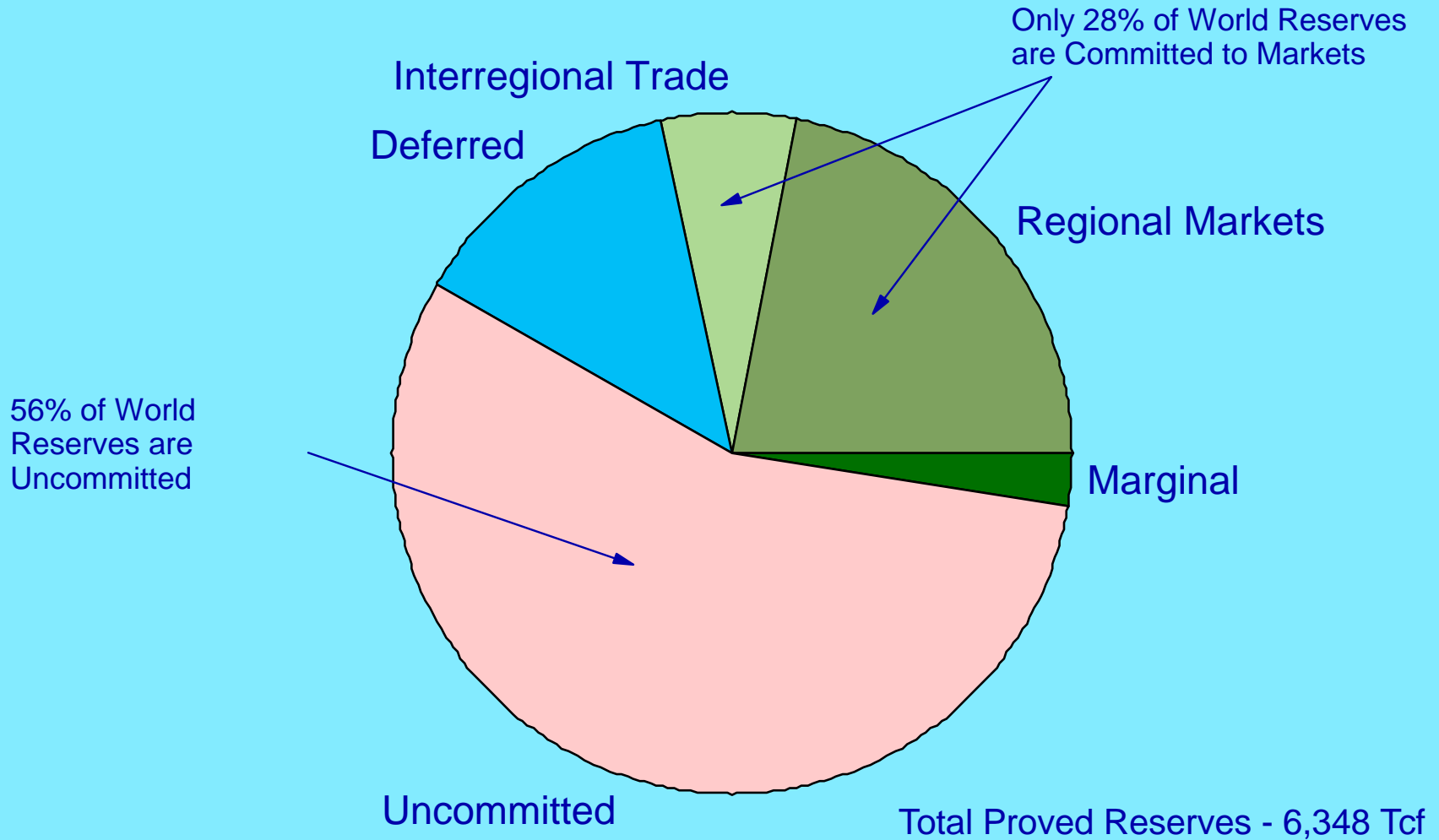
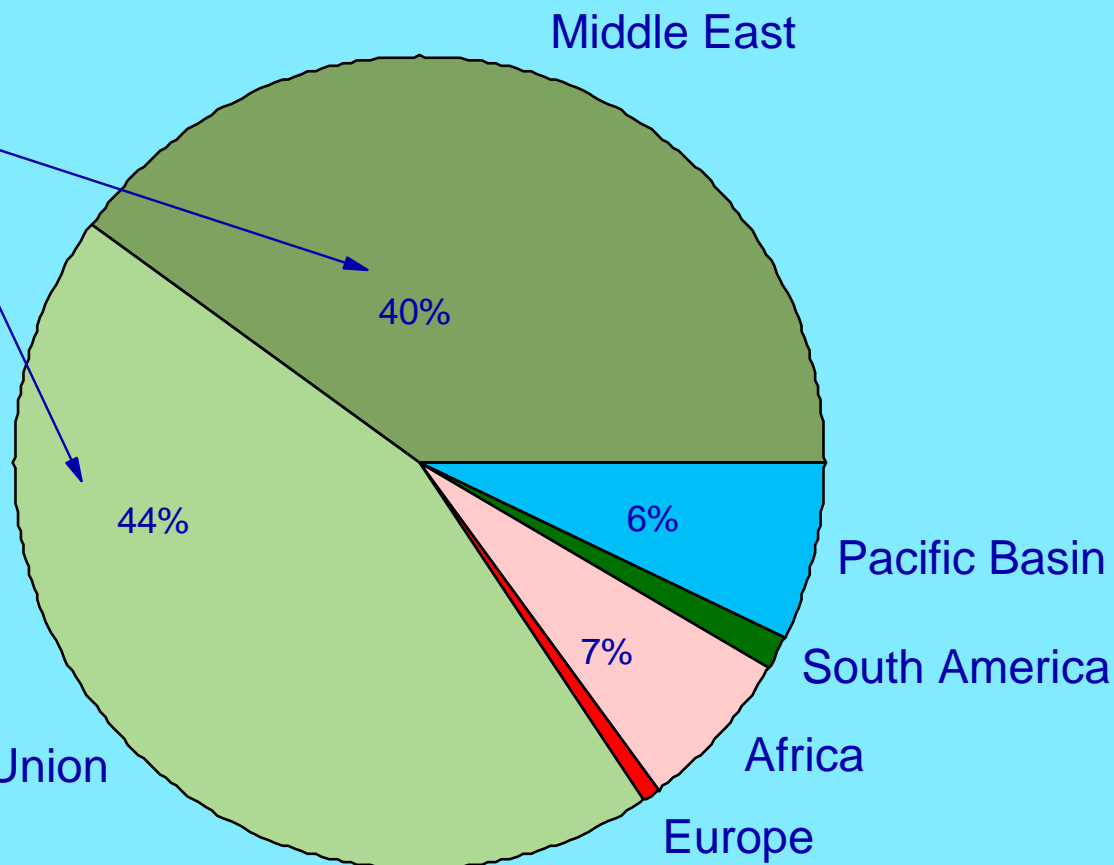


Figure 10
REGIONAL SHARE OF THE WORLD'S UNCOMMITTED GAS
TCF - Year End 2005

(Source - Jensen Associates Estimates)

84% of the World's
Uncommitted Gas
Reserves Are in the
Middle East and the
Former Soviet Union



Total Uncommitted Gas 3,567 Tcf

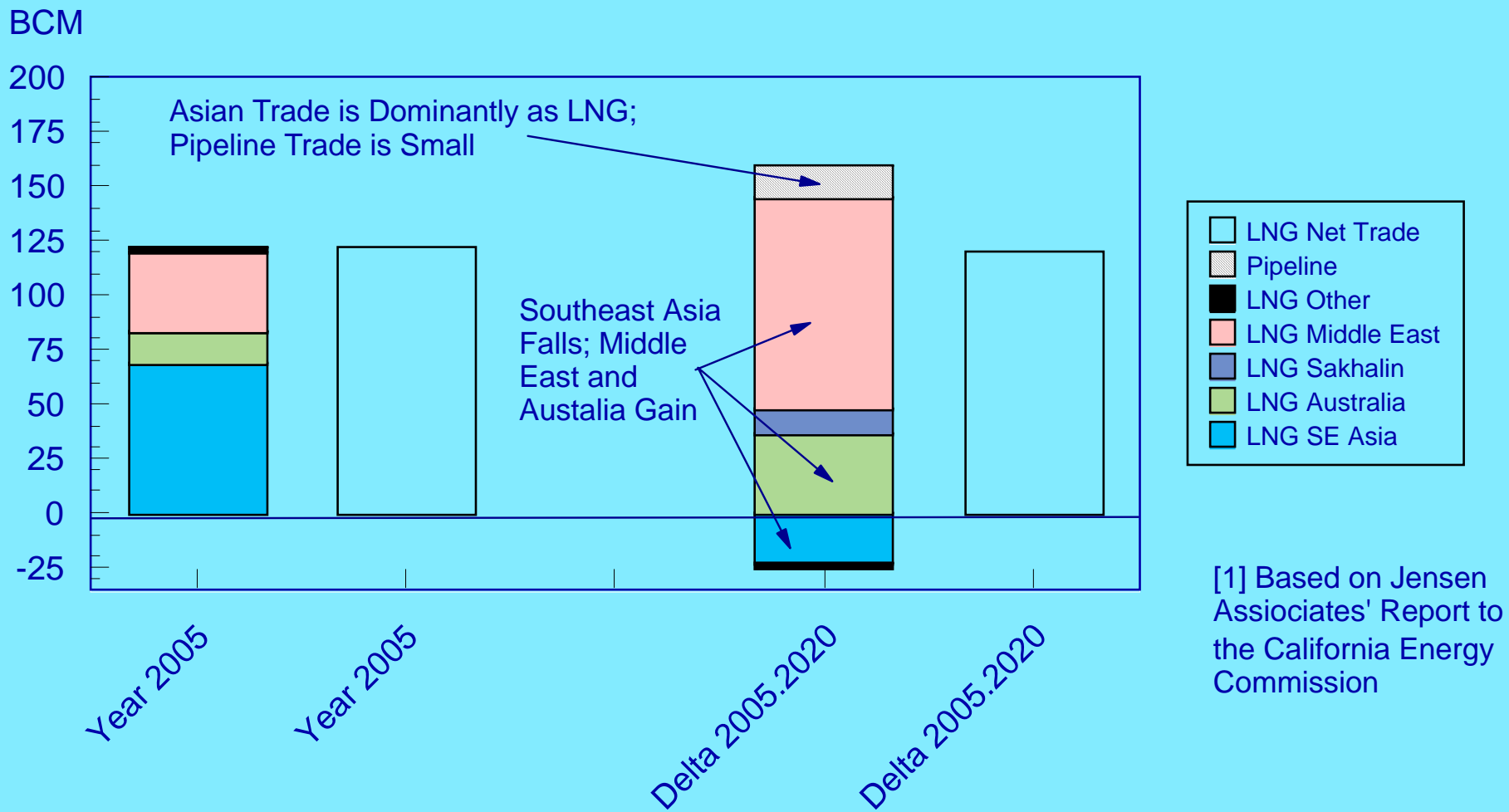
- Northeast Asia Has Traditionally Imported All of its Gas as LNG
- And Despite Some Failed Pipeline Proposals, It is Expected to Continue to Do So
- Both China and the Indian Subcontinent, On the Other Hand, Have Pipeline as Well as LNG Options
- For China, Eastern Siberia and the Central Asian Republics are Pipeline Options; For India and Pakistan, the Middle East is the Most Likely Pipeline Source
- Thus the Middle East is Most Likely to Participate in Asian Markets - Except for the Indian Subcontinent - With LNG; the FSU Supplies Can Come in Either as LNG or by Pipeline

- In a Study for the California Energy Commission in 2007, Jensen Associates Projected World Trade in LNG Out to the Year 2020
- Figure 9 - Based on That Study - Shows an Expected Doubling of Asian Gas Imports Between 2005 and 2020
- We Expect That Pipeline Imports into China from the Former Soviet Union and Into the Indian Subcontinent from the Middle East Will Only Account for 9% of the Growth
- Thus the Dominant Supply Into the Importing Countries in the Region Will Remain in the Form of LNG

- We - Like Most Observers - Do Not Expect Pacific Basin Supplies to Keep Up With Asian Demand
- There is Little Expectation of Growth from Most of the Existing Pacific Basin Suppliers
- Australia is an Exception and the Possible Expansion of Supply from Sakhalin Offers Hope for More Regional Exports
- But Ongoing Supply Troubles in Indonesia Will Actually Reduce Deliveries from Southeast Asia, Requiring that the Middle East and Australia Provide Much of the Growth for the Region

Figure 11

ASIAN TRADE IN NATURAL GAS - YEAR 2005 AND INCREMENTAL GROWTH [1] TO 2020



FIVE PACIFIC BASIN AND THREE MIDDLE EAST COUNTRIES SUPPLY ASIAN LNG MARKETS ON LONG TERM CONTRACT

- In the Pacific, Australia, Brunei, Indonesia, Malaysia and the U.S. (Alaska) Will be Joined Next Year by Russia as the Sakhalin 2 Project Starts Up
- And Abu Dhabi, Oman and Qatar Will be Joined By Yemen Later This Year
- In Addition, Five Countries in the Atlantic Basin Have Supplied Occasional Spot Cargoes to Northeast Asia's Currently Overheated Market

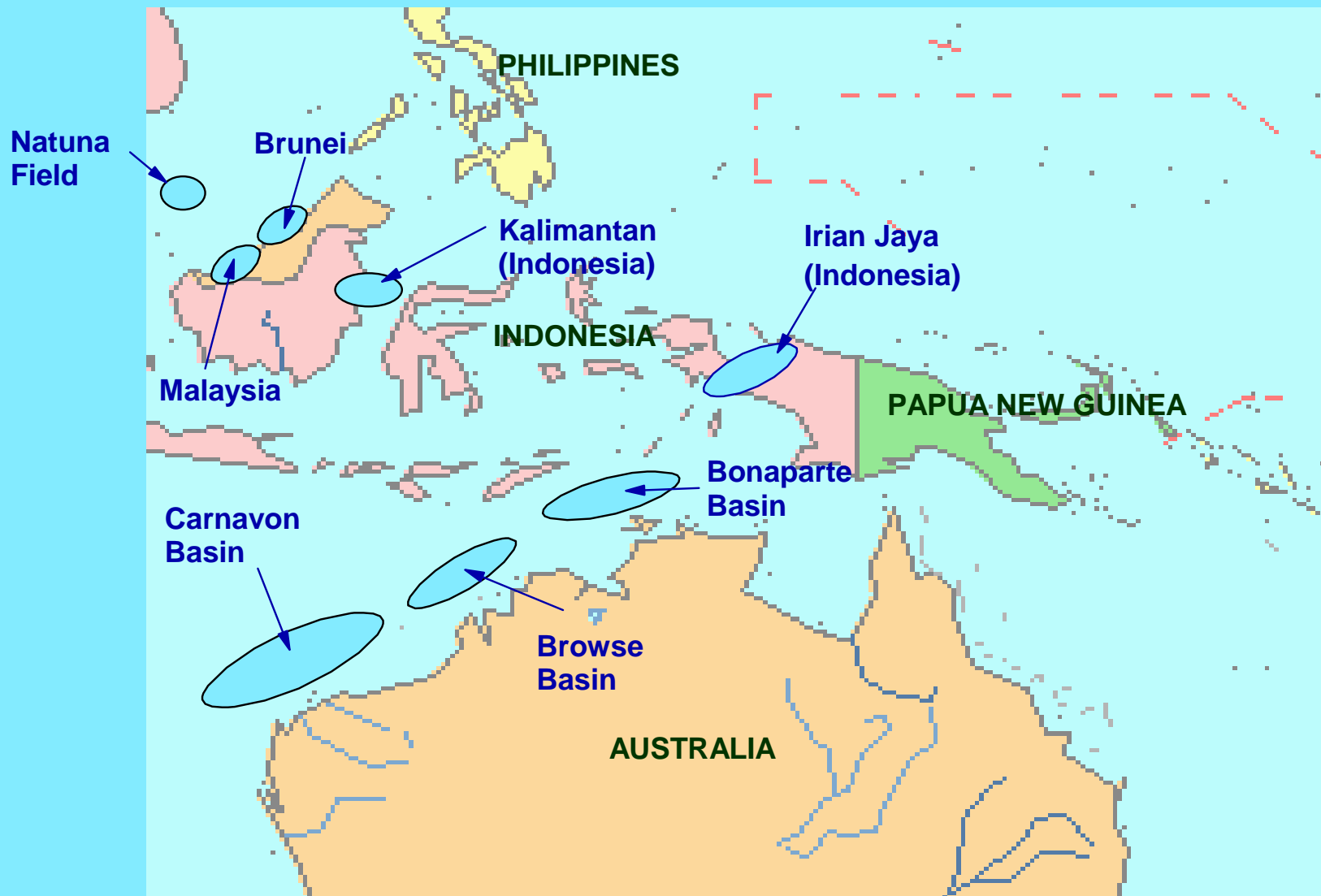
- Neither Brunei nor Malaysia Are Expected to Expand, and Alaska's Cook Inlet Project - the Oldest One in the Pacific Basin - is Nearing the End of Its Useful Life
- For Indonesia, Serious Supply Problems Have Raised Questions About How Much That Country Will be Able to Contribute in the Future
- For Years, the Largest and Most Reliable LNG Supplier, Indonesia Has Recently Been Unable to Meet Its Contract Commitments and Probably Fell 10% Below Contracted Levels in 2007
- The Problem Stems from Declining Production in its Older Fields, Underinvestment in New Supply, Political Unrest and a Desire to Use More of its Gas Internally

- The Shortage Has Forced Indonesia to Purchase LNG for its Own Account and Pulled LNG Cargoes from Atlantic Basin as Well as Middle East Suppliers
- Indonesia Faces Significant Contract Expiration in the 2008/2012 Time Frame and Has Already Signalled that It Will Only Renew the Affected Contracts at Sharply Reduced Levels
- These Reductions Affect the Older Arun (Sumatra) and Bontang (Kalimantan) Supplies
- The Problem Does Not Seem to Have Lessened Interest in the Newer Tangguh (Iran Jaya) Facility, nor Has Indonesia Lost Interest in Several New Smaller Projects

- If Indonesia Were to Renew its Contracts at the 50% Level, Indonesian Supplies for the Region Would Decline Despite New Projects
- That Means That Australia and Sakhalin, with a Possible Future Project in Papua New Guinea or in Alaska, Will Have to Carry the Pacific Basin Load
- Australia Has Two Operating LNG Facilities - the North West Shelf Project in the Offshore Carnarvon Basin and the Bayu Undan Timor Sea Project - and One - Pluto - That Has Had a Final Investment Decision
- There are Seven Other Projects in Various Stages of Consideration

- Western Australia, Where Most of These Projects are Located, Faces a Difficult Domestic Supply Problem
- Despite its Large Surplus of Offshore Exportable Gas Reserves, the Smaller Fields That Supply the Domestic Market are Inadequate to Meet Growing Demand
- Thus it is Attempting to Require Domestic Set-Asides from Any Future LNG Project
- Producers Contend That Such a Requirement Will Adversely Effect Export Project Economics
- Australia Also Seems Heavily Affected by Project Cost Inflation
- Still We are Optimistic About Australian Supply Growth

Figure 12
MAJOR GAS EXPORT REGIONS FOR SOUTHEAST ASIA/OCEANIA



ALASKA ALSO REPRESENTS A POTENTIAL NEW LNG SUPPLY FOR THE PACIFIC BASIN

- The Gas Supplies on the North Slope Have Been a Political Football for More than Thirty Years
- In 1976, Competition to Serve the Lower 48 Between a Pipeline, the Alaska Natural Gas Transportation System, and an El Paso LNG Project Was Resolved in Favor of the Pipeline by an Act of Congress and a Presidential Finding
- Then, When Commercialization of ANGTS Failed, the Yukon Pacific Project Attempted to Ship LNG to Japan

- Yukon Pacific Also Never Succeeded But the North American "Gas Shock" of 2000 Has Revived the Pipeline Concept
- However, the Prospect That the Trunkline Might Not be Completed for a Decade Has Raised Strong Political Concerns in Alaska
- Gas Dedicated to Local Markets in Alaska is Depleting and an LNG Export Project Would Justify a Pipeline South Which Could Deliver Gas to Domestic Markets
- This Has Revived the LNG Option, Although This Time Dedicated to U.S. West Coast Markets

- The Questionable Economics of This Large LNG Scheme Has Led to a Third Option, the "Y" Line
- This Would Pre Build the Trunk Line to a Junction in Alaska, Where a Spur to the South Would Serve Both Domestic Markets and a Smaller LNG Project
- The "Y" Line Pre Build Could be Completed Much More Quickly Than the Complete Trunk Line System
- However, the Economics of the LNG Project Currently Would Favor Shipping the LNG to Japan, Rather than to the West Coast

OUR PROJECTIONS SUGGEST THAT THE MIDDLE EAST WILL BE THE LARGEST INCREMENTAL LNG SUPPLIER TO ASIA BETWEEN NOW AND 2020

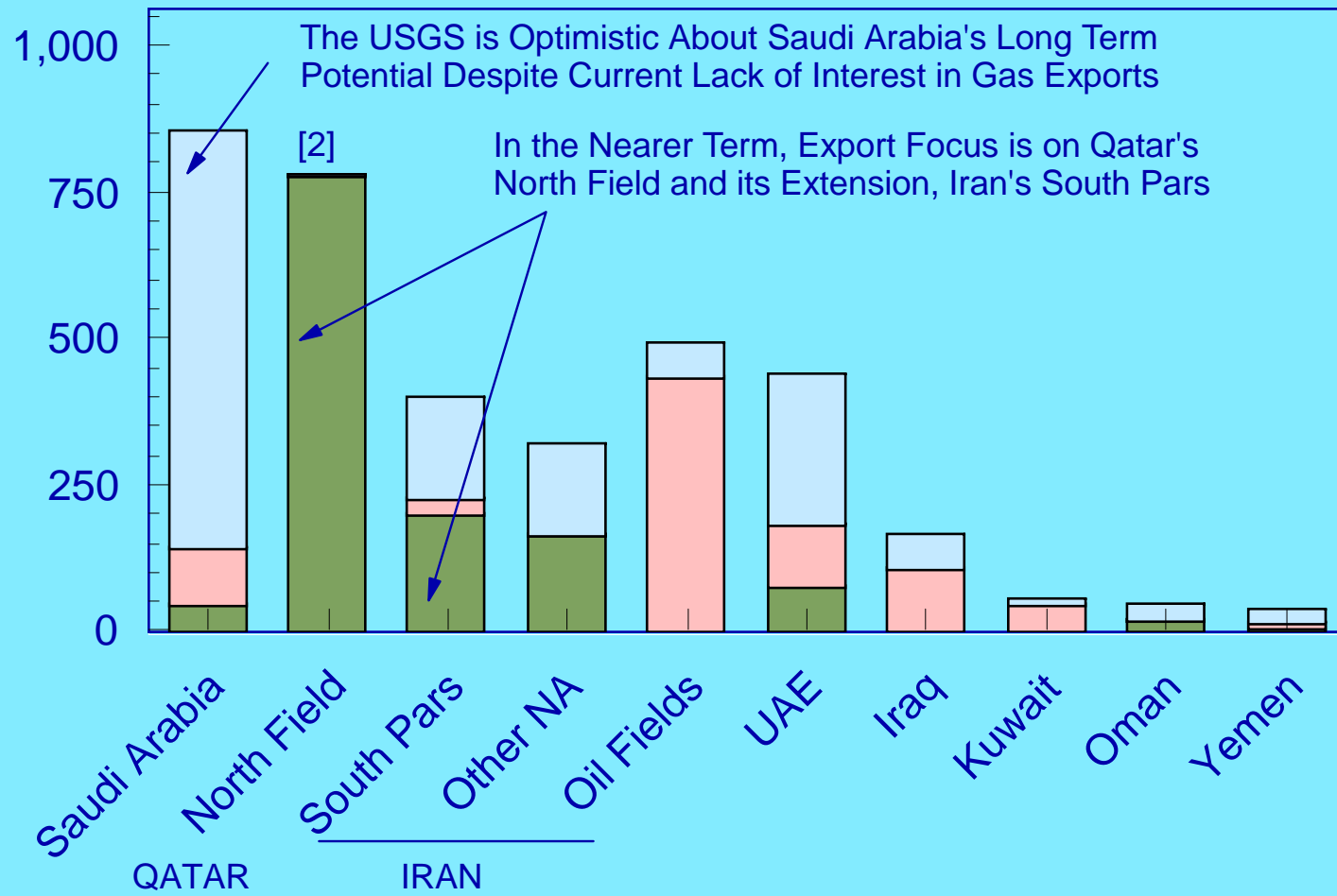
- But 61% of the Middle East's Uncommitted Gas is in a Single Gas Field - The North Field in Qatar and South Pars in Iran
- And If One Includes the Additional Uncommitted Gas in Iran, Those Two Countries Account for Nearly 90% of the Uncommitted Gas in the Entire Middle East
- The U.S. Geological Survey is Optimistic About Saudi Arabia's Resource Base, But Most of that Gas Has Yet to be Discovered and the Saudis Have Shown Little Interest in LNG

- Qatar's Expansion Plans Should Provide a Third of the World's Firm Plus Probable Capacity Additions Between Now and 2012; However, the Country Has Adopted a "Wait and See" Policy on Further Expansion Beyond that Point
- Iran is Currently Preoccupied With Developing Gas for Domestic Markets and Reinjection into its Oil Fields
- In Light of its Priorities and the Geopolitical Controversy It Faces Over International Sanctions, It Has Yet to Establish a Firm Policy on LNG Exports
- Qatar's Caution Plus Iran's Geopolitical Constraints Thus Make It Difficult to Project the Quantities and Timing of Additional Middle East LNG Supplies Beyond 2012

Figure 13

**UNCOMMITTED MIDDLE EAST NATURAL GAS RESOURCES [1]
INCLUDES UNCOMMITTED RESERVES, DEFERRED RESERVES
AND UNDISCOVERED RESOURCES
TRILLION CUBIC FEET AS OF 12/31/2005**

TCF



- UNDISCOVERED RESOURCES [2]
- DEFERRED RESERVES
- UNCOMMITTED RESERVES

[1] Jensen Estimates Based on USGS, Cedigaz, BP, AAPG and Country Data

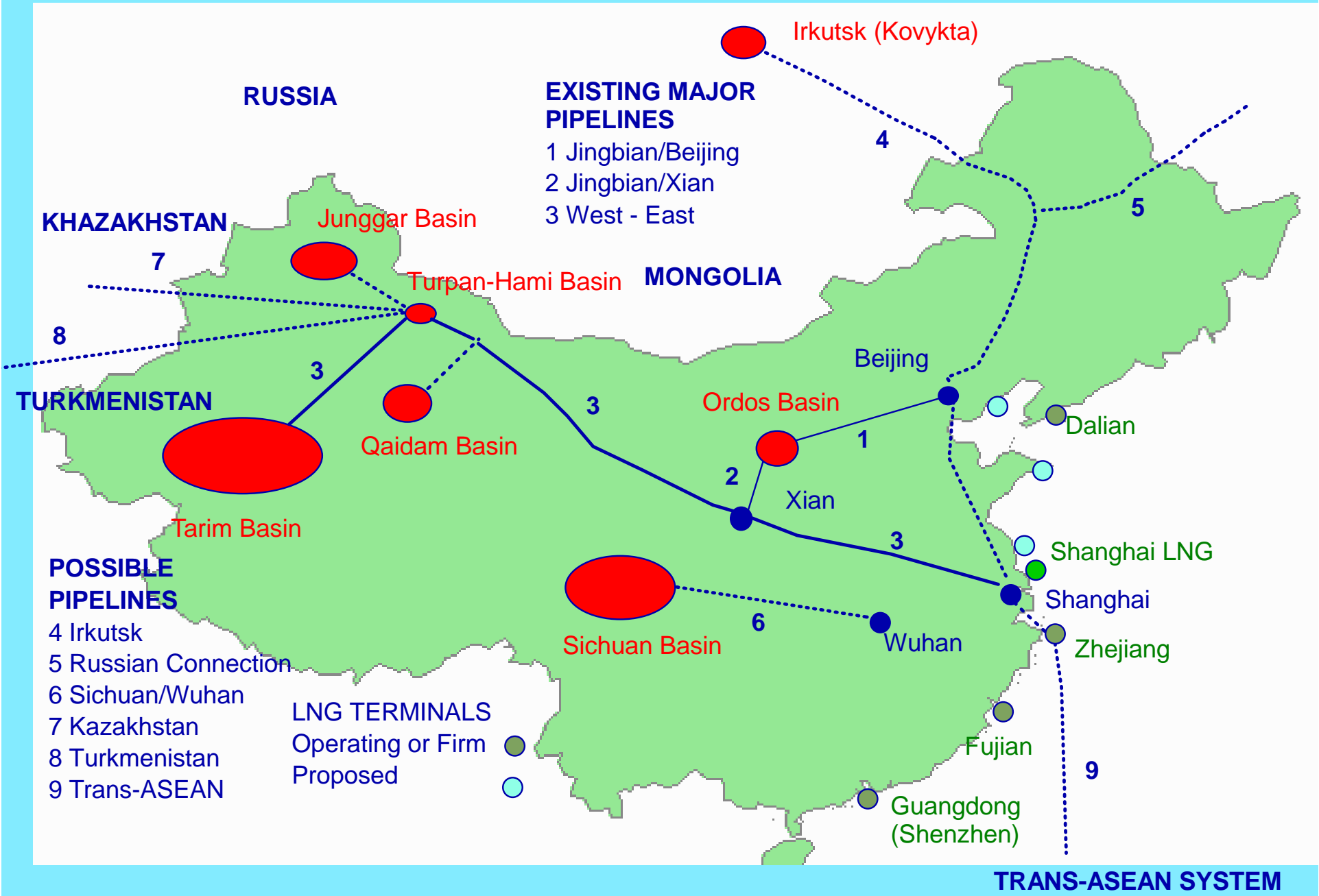
[2] Qatar Uncommitted as of 12/31/07

THE FSU PIPELINE OPTION FOR EAST ASIA DEPENDS ON NEGOTIATIONS AMONG RUSSIA, CHINA AND THE CENTRAL ASIAN REPUBLICS

- These Countries - in Transition from "Command and Control" Economies to Market Economies - Sometimes Make Pipeline Decisions That Appear to be Driven More by Geopolitical Considerations Than by Economics
- China's West to East Pipeline - a Longer Line Than We Have Ever Built in North America - Connects China's Major Gas Resources in the West with Shanghai
- It Would Permit Westward Extensions to Supplies in Turkmenistan and Kazakhstan - the "Silk Road Pipeline"

- But Such an Extension Would be Costly and Russia is Trying to Exert Influence Over the Gas Supplies of the Central Asian Republics
- Thus it is Not Clear Whether and How Such Extensions Might Take Place
- The Nearest Source of Russian Gas is the Kovykta Field Near Irkutsk
- Negotiations Between China and Russia Have Been Off and On and the Pipeline Has Been Rerouted to Avoid Mongolia - Whose Relations With China Have Often Been Strained
- Pricing Has Been an Issue That Has Made it Difficult to Strike a Deal

Figure 14 - CHINESE GAS SUPPLY OPTIONS



THE FORMER SOVIET UNION - RUSSIA TOGETHER WITH THE CENTRAL ASIAN REPUBLICS - HOLDS THE WORLD'S LARGEST STOCK OF UNCOMMITTED GAS RESERVES

- Russia, Traditionally a European Pipeline Exporter, is Interested in Diversifying Into LNG and into Pacific Basin Markets
- But Russia Has Major Policy Issues to be Resolved in Western Siberia and the Offshore Barents Sea Whose Outcome Will Influence How Russia Approaches LNG and Longer Term Expansion into the Pacific

- Its Nadym Pur Taz Region in Western Siberia - the Workhorse of Russian Exports to Europe - is Maturing and Russia Wants Next to Develop Arctic Reserves on the Yamal Peninsula or the Offshore Barents Sea (Shtokman)
- But the Development of These Arctic Reserves is Both Technically and Economically Challenging
- And the Potential Role of the International Oil Companies in Providing Technology and Capital is in a State of Flux

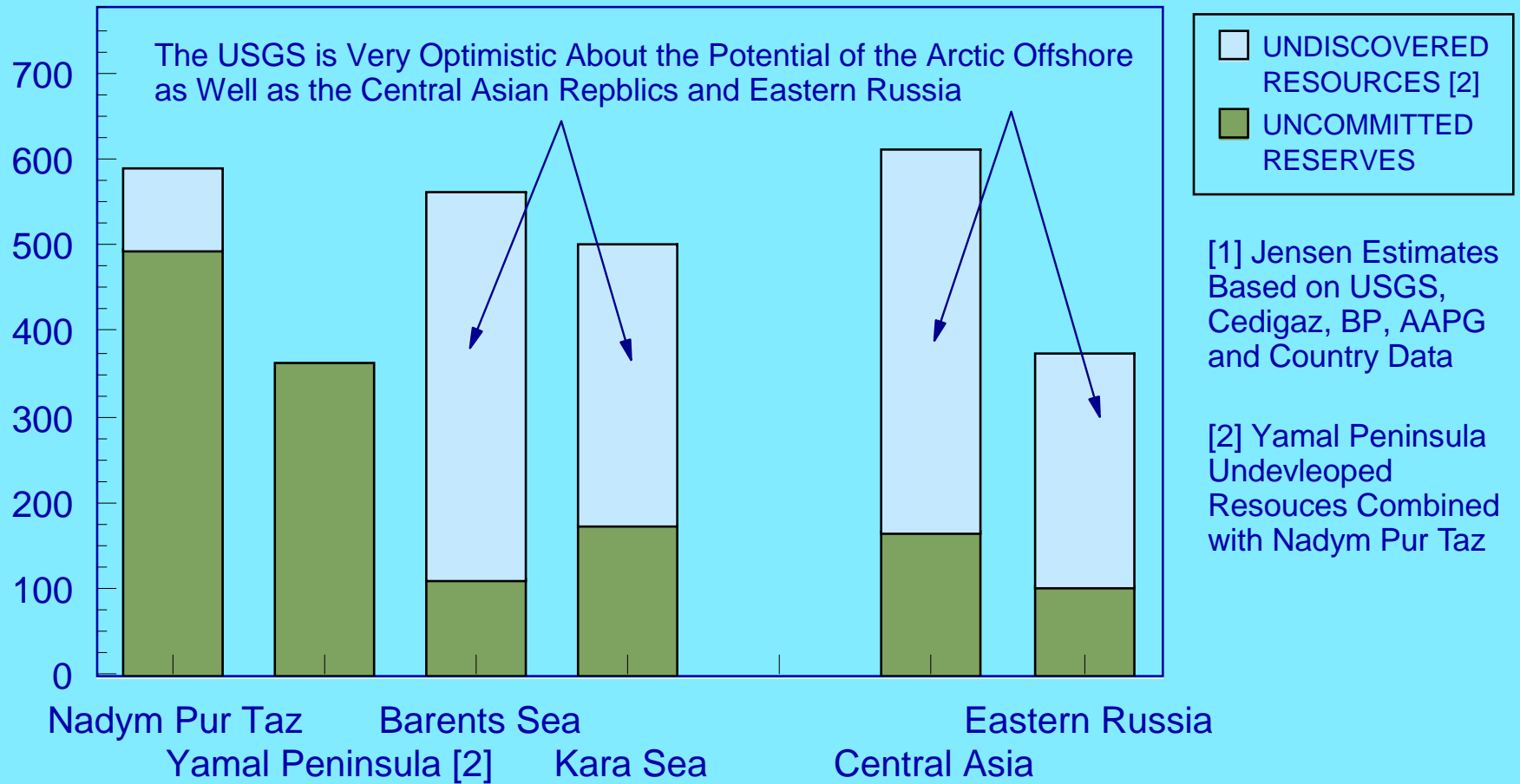
Figure 15
MAJOR GAS EXPORT BASINS FOR
THE FORMER SOVIET UNION



Figure 16

**MAJOR UNCOMMITTED FSU NATURAL GAS RESOURCES [1]
INCLUDES UNCOMMITTED RESERVES
AND UNDISCOVERED RESOURCES
TRILLION CUBIC FEET AS OF 12/31/2005**

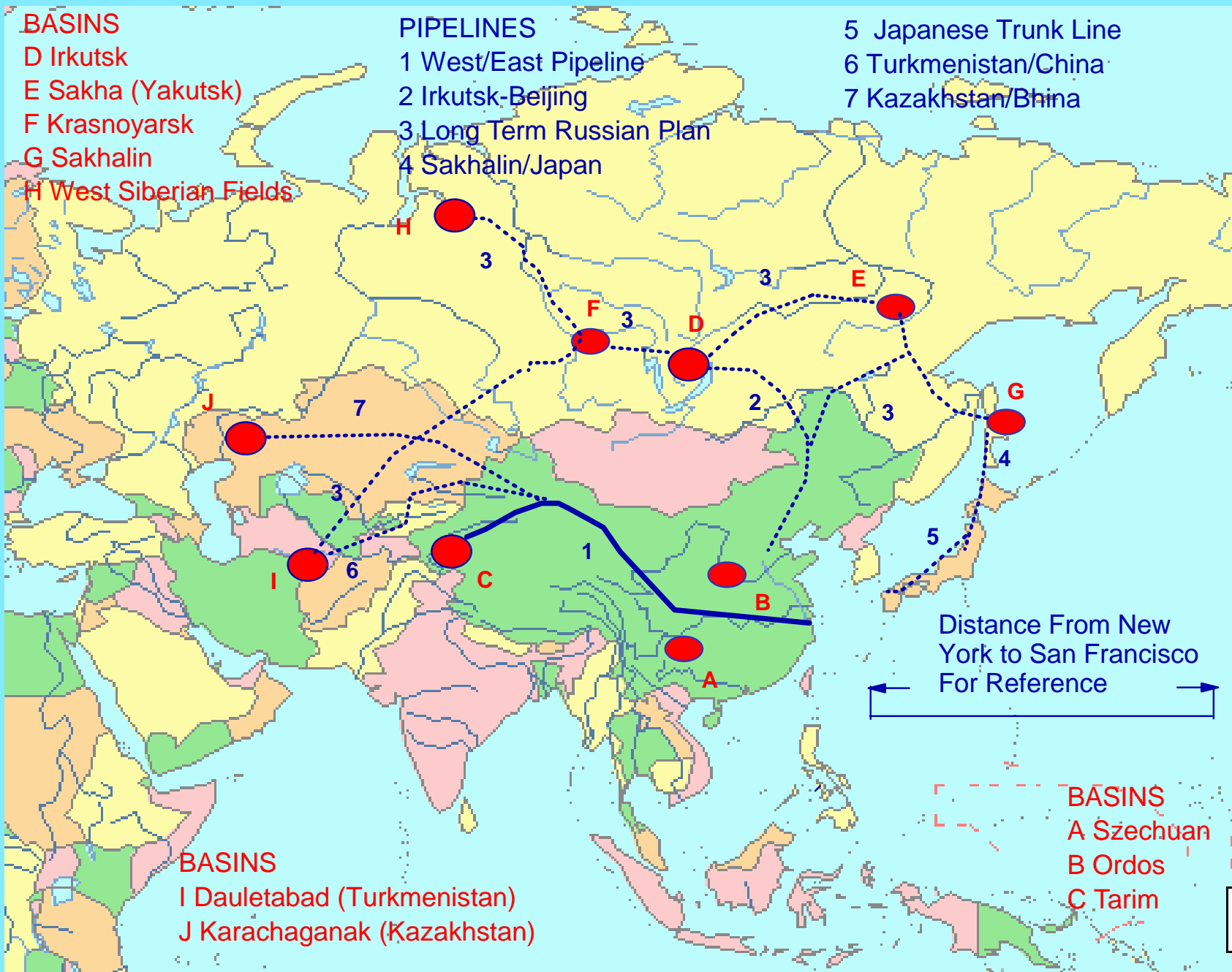
TCF



- Russia's Eastern Reserves in Sakhalin and Irkutsk (Kovykta) Are Presumably Destined for the Pacific Basin - Particularly China - With a Major Question as to How Much of Sakhalin Will Ultimately be Developed as LNG
- Sakhalin Has Two Major Operating Projects - Shell's Sakhalin 2, an LNG Project, and ExxonMobil's Sakhalin 1 Which Has Tried Unsuccessfully to Develop Pipeline Export Outlets
- But Sakhalin Has Four More Undeveloped Blocks That Appear to be Gas-Prone
- Russia Initially Allowed the International Oil Companies a Significant Role in the East Which They Were Denied in the West

- But Russia Appears to be Interested in Reasserting Control Over Eastern Exports, First by Renegotiating its License with Shell in Sakhalin (Russia's First LNG Project), and Now with BP Over Kovykta
- Russia's Moves May Signal an Intention to Build a Trans Siberian Trunk Pipeline System That Would Link Sakhalin on the East with the Nadym pur Taz Reserves in the West
- Such a System, a Very Costly Undertaking, Would Provide Russia Great Flexibility to Select Preferred Markets and to Choose Whether to Feature Pipeline or LNG Exports
- It Would Thus Give Russia Greater Bargaining Flexibility in Dealing With China

Figure 17 - THE EAST ASIAN "GRAND DESIGN"



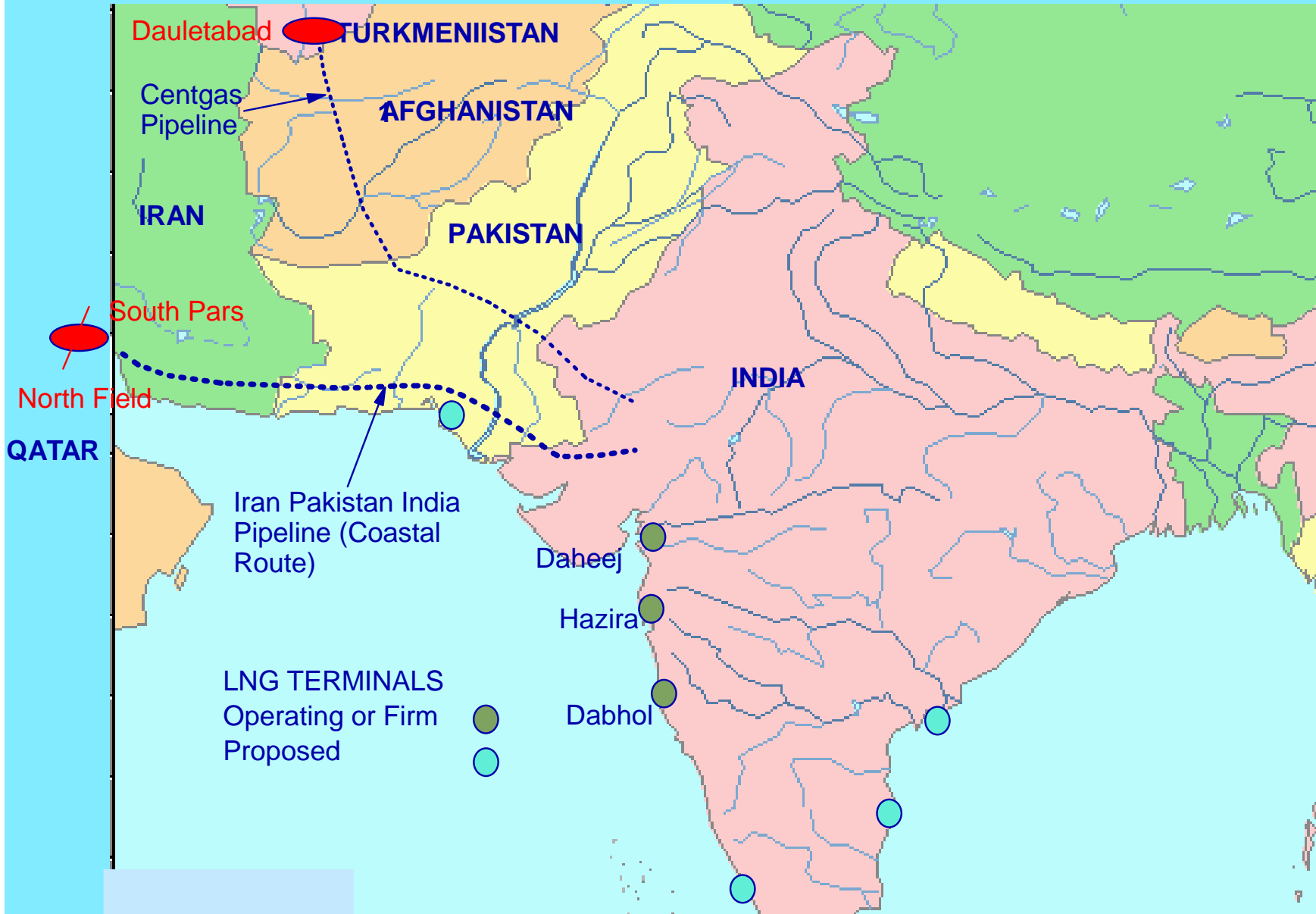
WHILE PIPELINES TO THE INDIAN SUBCONTINENT APPEAR TO BE ECONOMICALLY FEASIBLE

- A Number of Earlier Pipeline Proposals From Iran, Qatar and Turkmenistan Have Failed on Geopolitical Grounds
- The Tensions Between Pakistan and India Have Often Ruled Out the Transit of Pakistan and One Project from Turkmenistan Would Have Required Transit of Afghanistan
- As a Result, the First Gas Imports into India Have Been as LNG, Primarily from Qatar
- Pakistan Also Has its Own LNG Import Proposal

- But Last Year, Serious Negotiations for an Iran-Pakistan-India Pipeline Took Place
- There Was Early Optimism as India and Pakistan Seemed to be Embarked on a Cooperative Effort
- The Negotiations are Currently on Hold, Ostensibly Because of Disputes Over Pricing and Transit Fees
- But Given the Current Unrest in Pakistan and the U.S. Pressures to Isolate Iran, Geopolitics Clearly Cannot be Ruled Out

Figure 18

POTENTIAL GAS SUPPLIES FOR PAKISTAN AND INDIA



IN CONCLUSION

- Asia is a Large and Complex Region Whose Major Markets Tend to be Both Gas-Deficit and Remote From Major Exporting Regions
- Hence, Gas Costs Have Tended to be High and Limited Gas's Penetration of Stationary Energy Markets
- To Date, Northeast Asia Has Lacked Effective Pipeline Supply Options and Thus Has Become a Leader in World LNG Trade
- China and India are Just Emerging as Gas Importers and Have Both LNG and Pipeline Options

- But Both Also Have Low Cost Indigenous Coal, Further Complicating Gas's Ability to Compete for Stationary Markets
- Asia Pacific Exportable Gas Supplies Tend to be Concentrated in Southeast Asia and Australia, But Will Probably be Unable to Keep Up With Asian Demand Growth
- Thus Asia Will Increasingly Look to the Middle East and the Former Soviet Union for Additional Supplies, Thereby Raising Significant Geopolitical Issues

