Methane to Markets Partnership Expo

Development of Markets

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Beijing, China
30 October – 1 November 2007

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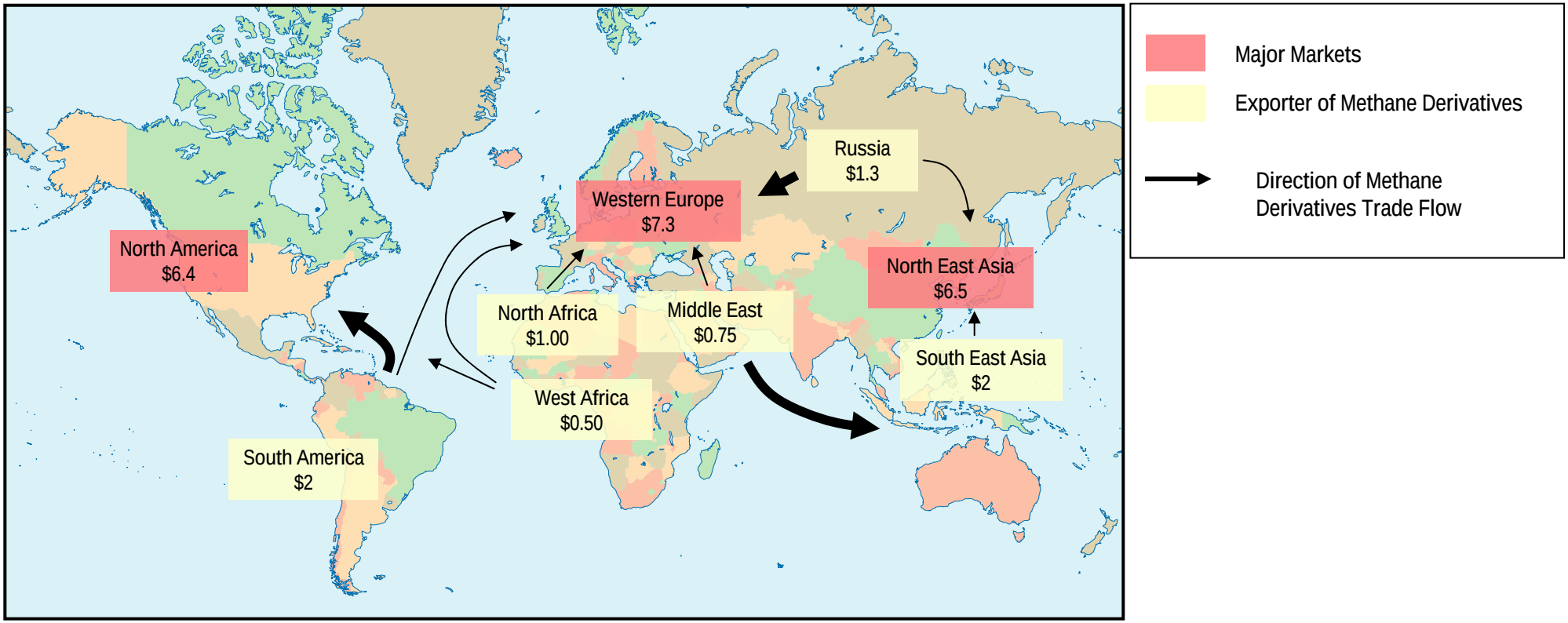
Agenda

- Overview of associated gas flaring and venting
- Associated gas monetization options
- Market development requirements
- Case studies
  - West African Gas Pipeline for power generation
  - CNG for urban clean fuels
  - Gas to chemicals
- Investment climate
- Conclusions

Source: The New York Times (2007)

Associated gas – an energy source that is too valuable to be wasted

GLOBAL NATURAL GAS COSTS
(Q2 2006, US$ per mm BTU)



Large supply of low-cost natural gas gives the Middle East a substantial competitive advantage

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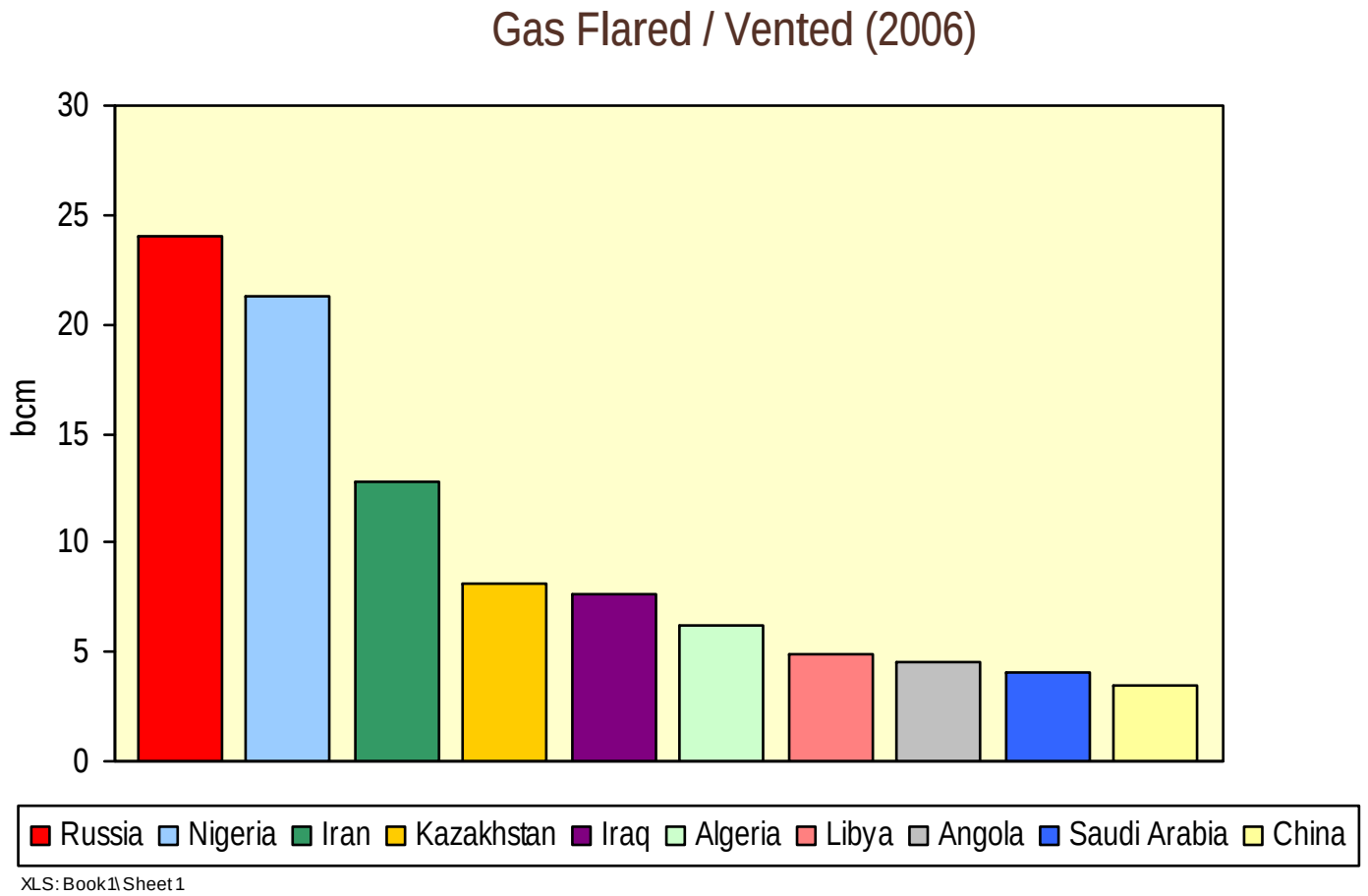
Top gas flaring / venting countries



Significant improvement has been achieved over the past 20 years

Source: U.S. National Oceanic and Atmospheric Administration, Final Report to the World Bank (2007)

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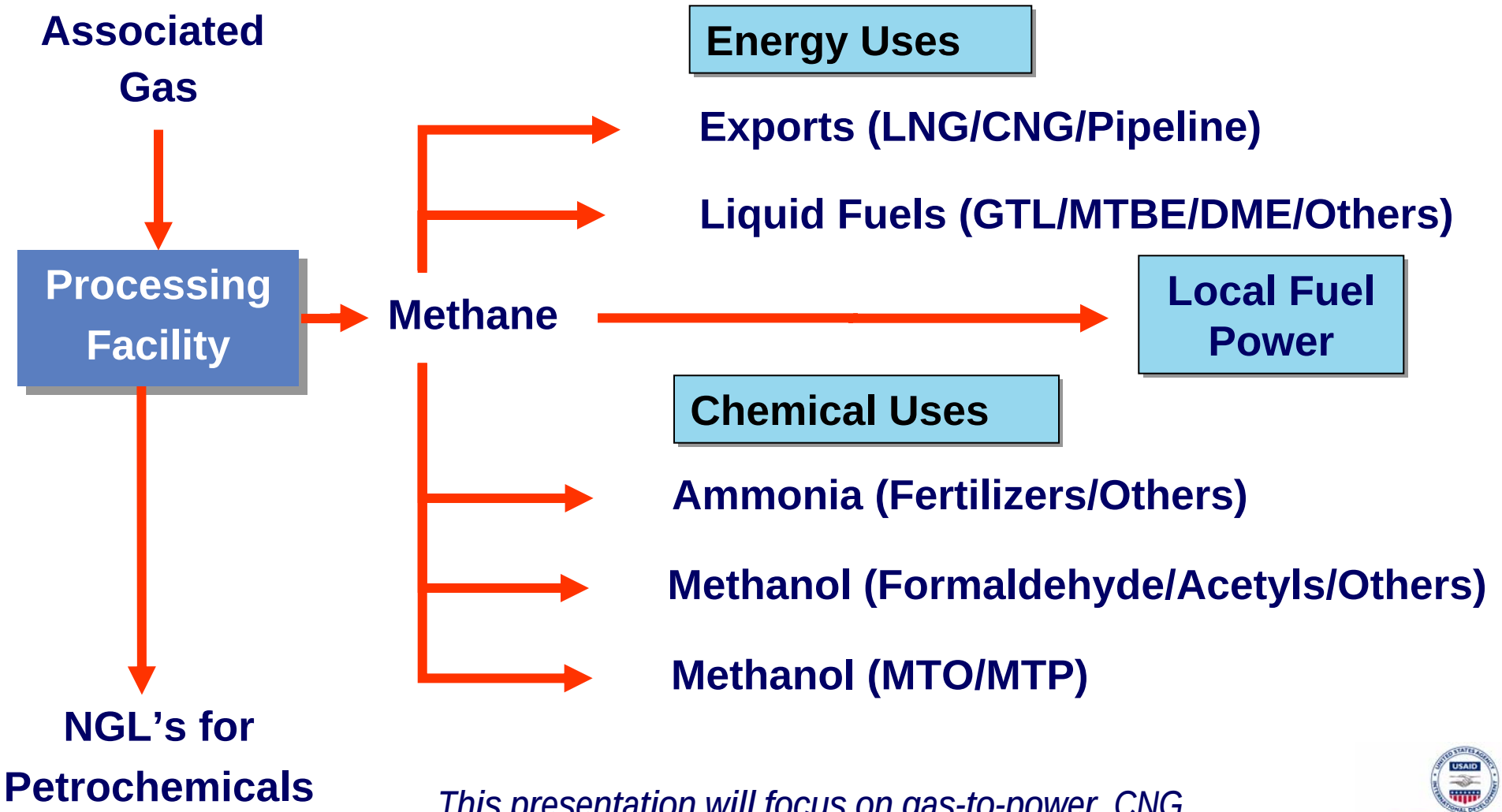
Potential opportunities for adding value to associated gas in order to develop its markets



This presentation will focus on gas-to-power, CNG as urban fuel and gas-to-chemical markets

Associated Gas

Monetization Options

Pipelines are typically used to distribute gas for distances within 2000 km

- **Pipelines are the most mature and developed form of gas transportation**
- **Gas pipeline projects are highly capital intensive**
- **Generally pipelines are more economic than LNG below 2000 km**
- **Significant fixed cost component**
- **Economics are highly volume dependent (economies of scale)**
- **Successful pipeline development requires:**
  - **Sustainable market size**
  - **Competitive pricing of gas**

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CNG - compressed natural gas

- Compressed gas – 100 to 170 bar & -17 to 5 deg C
- Being used as bus/taxi fuel in major cities but uses existing gas supplies
- Particularly attractive concept as gas can be loaded onto a vessel directly from the field or processing plant and delivered to off grid power plants and industrial users
- Low infrastructure costs - no need for specialized liquefaction or regasification terminals
- Logistics flexibility – can use barges, vessels or trucks
- More cost effective than LNG or pipelines for modest gas volumes (3 to 15 million Nm^3/d)
- Would enable monetization of small stranded reserves (< 60 bcm)
- Scalability good – just add more vessels

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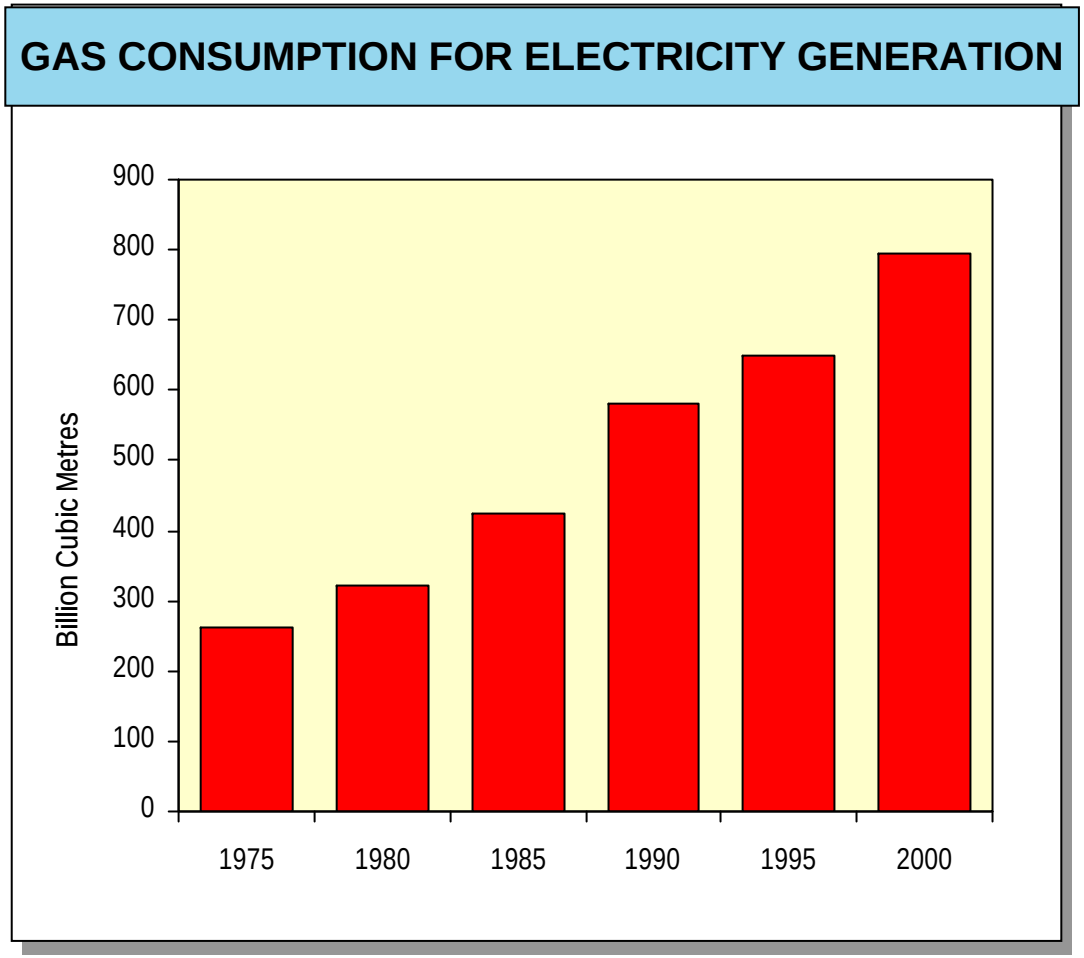
Gas-to-power



- Gas consumption for electricity generation is continuing to increase steadily
- Combined Cycle Gas Turbines are increasingly the technology of choice for electricity generation
- Capital and operating costs are lower than alternative fuels
- Development flexibility
- Environmentally friendly

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Market Development Requirements

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Issues to be addressed in order to develop gas markets and promote their growth

- **Economic incentives to support the investments needed in producing, capturing, transporting, and utilizing methane**
- **Policy, legal and regulatory framework**
  - **Property rights of methane**
  - **Tariffs**
  - **Multi-country collaboration and regional integration, if cross border**
- **Access to pipeline transportation**
- **Access to power grid**
- **Access to distribution channel of product value chain**

Case Studies

WAGP – Associated Gas to Power

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WAGP – a cross-border pipeline that transports associated gas from Nigeria to its three neighboring countries for power generation

The pipeline will be operational shortly

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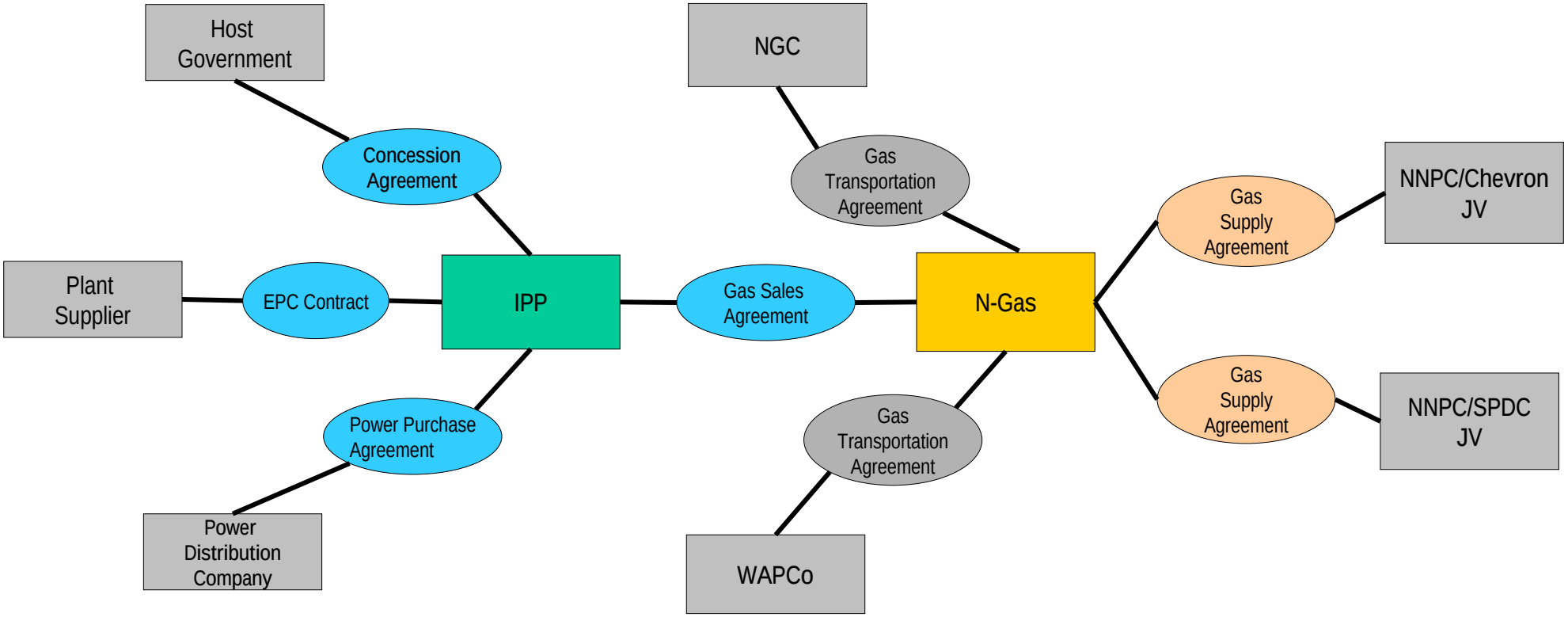
Gas-to-power chain involves government, international agencies, financial institutes, oil companies and power distributors, etc

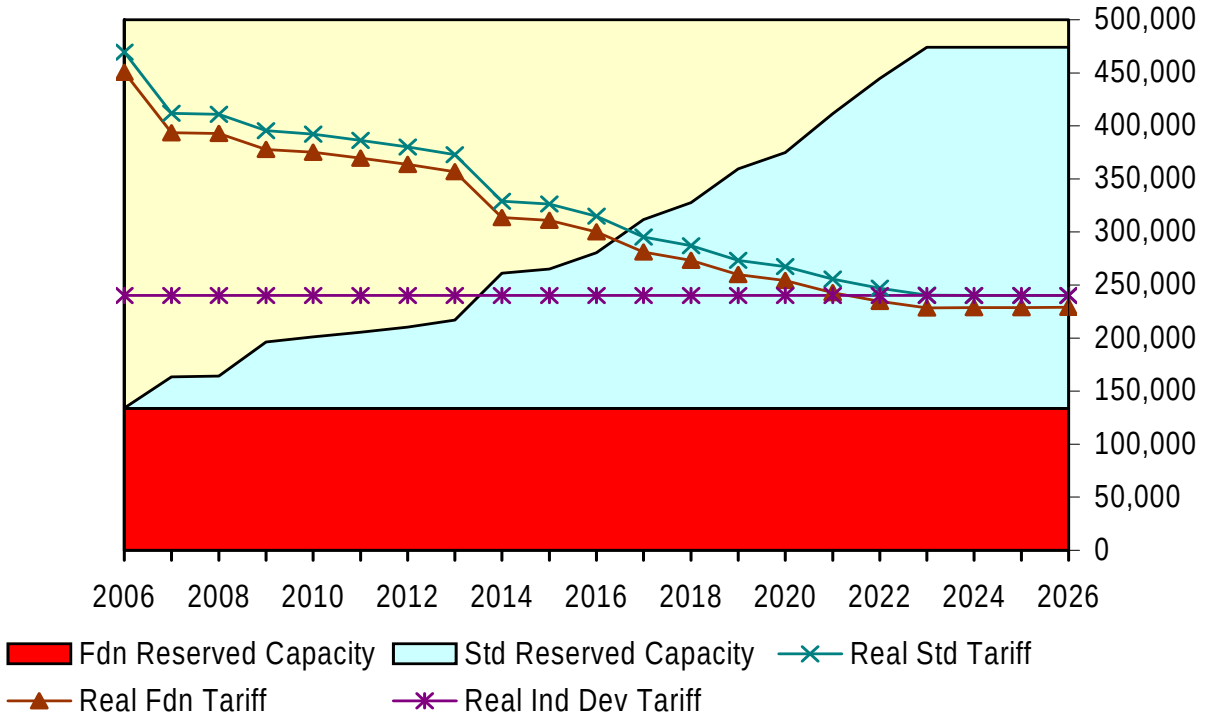


The complexity of the gas-to-power chain, and multiple cross-border agreements, required extensive negotiations

WAGP's tariff structure was tailored to ensure project success

- **Sponsors early on tabled a scheme to:**
  - Take market growth risk
  - But with a floor rate of return
  - All stakeholders benefit as pipeline fills
  - Foundation customers compensated for risk
  - Special tariff for industry
- **Economic efficiency requirement added to judge Pipeline Development Plan options – Weighted Average Tariff**
- **Excess profits limited by tariff formula and pipeline capacity**

RELATION OF REAL TARIFFS TO RESERVED CAPACITY
(reserved capacity in MMBtu/day (RH axis))



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Lessons learned from WAGP for gas-to-power market development

- **Major success**
  - **USAID-funded technical assistance to the governments of Ghana, Benin, Togo and Nigeria resulted in over $600 million of private sector investment**
  - **The pipeline will take formerly flared or vented gas from Nigeria and transport it to Benin, Togo and Ghana for power generation, replacing heavy fuel oil**
  - **The use of flared/vented gas significantly reduces greenhouse gas emissions**
  - **The WAGP is expected to result in a reduction of greenhouse gas emissions of 100 million tons (CO_2 equivalent) over twenty years**
  - **Novel tariff model creates win-win environment for economic efficiency**
  - **Strong political support and regional integration**
  - **Strong vote of confidence by project sponsors, participants and World Bank**
  - **Will add stability to country power grids, supporting creation of a regional power market structure**

West Africa Gas Pipeline
– delivering reliable energy supplies to West Africa

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CNG for Urban Clean Fuels

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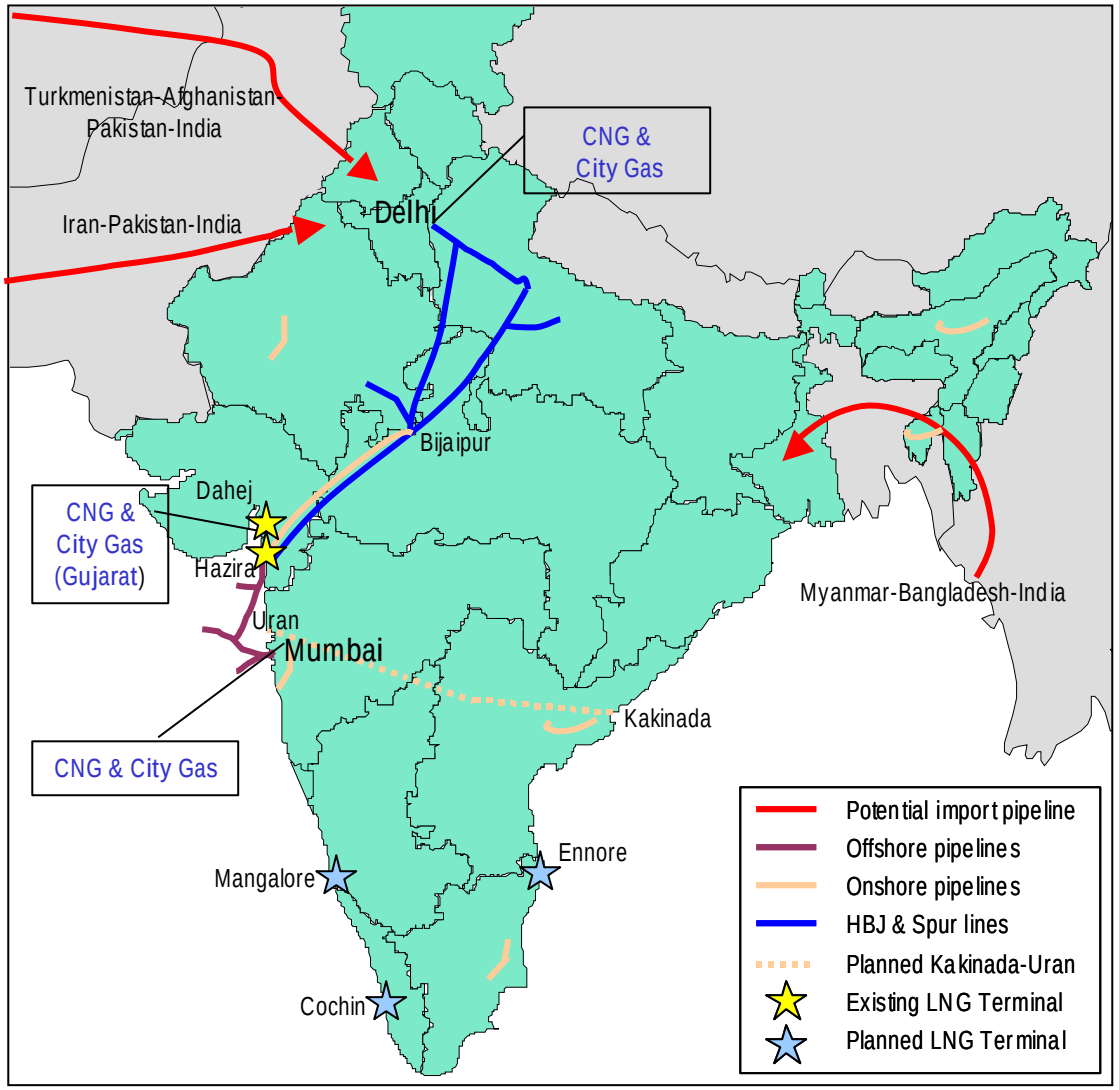
Natural gas, including associated gas, was pipelined to Mumbai and New Delhi for use as CNG for transport and city gas



Key Market Drivers

- Environmental
- Fuel substitution
- Energy security
- Energy conservation
- Job creation

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Lessons learned from Mumbai and New Delhi market development for urban clean fuel

- Combination of judicial intervention, incentives and pricing is critical
- Advanced planning and co-ordination between various agencies is essential
- A firm plan for introduction of clean fuel should be laid down explicitly specifying the vehicle categories to be targeted
- Infrastructure at the gas supply level and vehicles and equipment should be in place
  - Adequate number of CNG stations should be in place ensuring proper spread and taking into account the vehicle mix and needs
  - Conversion kits, equipment, spares, etc. should be available
- Safety norms should be in place
- Strong inspection and maintenance regime should be in place
- Vehicle conversions should be undertaken by trained/approved workshops
- Availability of adequate CNG vehicles and CNG refuelling stations must be in place

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Gas to Chemicals

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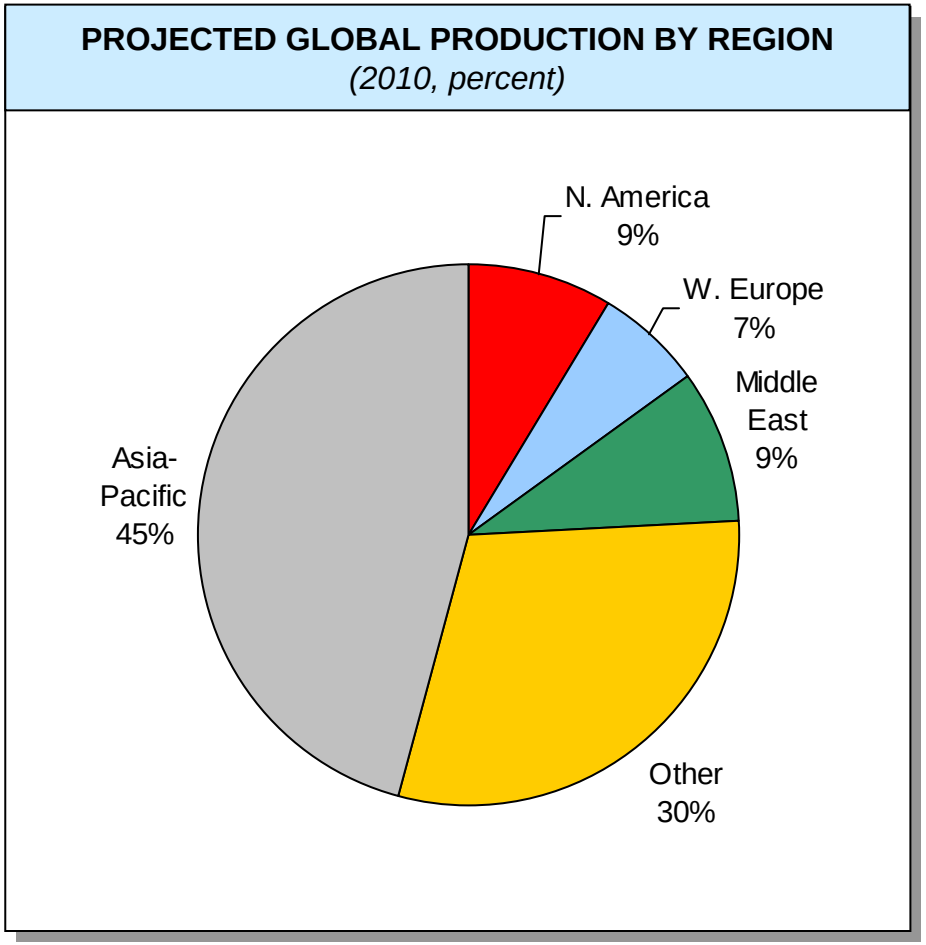
Ammonia and other commodity chemicals are ideal for converting associated gas to high value market products



- Final product is easier to transport to market
- Projected growth higher in Asia though still below GDP
- Large market size means around 4 new plants required per year
- 41 million tons per year of new capacity is expected to be required by 2020
- Indian production facilities have historically been based on naphtha as a feedstock but some are switching to gas
- Middle East investments will leverage low natural gas costs, integrated ammonia units and low delivered costs to Asia

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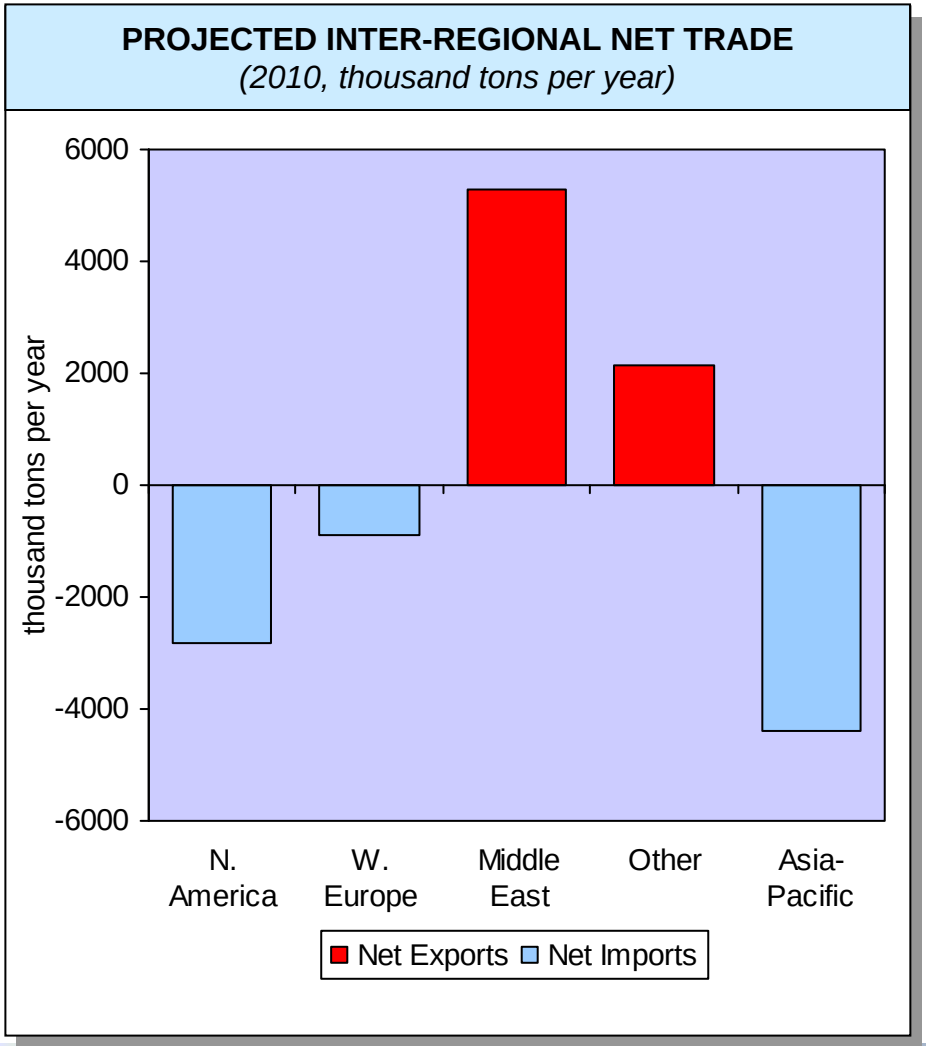
Urea made from ammonia can be easily shipped to consumer markets



- **Middle East and other gas rich regions in Latin America, Russia/Eastern Europe and Caribbean will provide surplus urea as exports to large Asian and North American deficits**
  - **China will continue as the world's largest producing country though India is projected to be in deficit**
  - **Middle Eastern trade flows will target large volumes into India and smaller volumes into Pakistan and smaller South Asian markets**
  - **Latin American and Caribbean exports will go to North America**
- **Middle East will become the world's urea supplier**

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Investment Climate

Good investment climate is essential in order to attract investors and to pay back infrastructure development cost for utilizing wasted gas

- **Advantages of private sector participation**
  - Less capital constrained
  - Have right level of skills and experiences
  - More efficient and can implement projects faster
- **Regulatory framework for private sector participation**
  - Rules and regulations pertaining to safety, environment, land use, etc. must be in place
  - Fiscal incentives to reduce upfront cost
    - Tax concessions
    - Depreciation allowances
    - Advantageous pricing structure
    - Subsidized loans and/or other financing opportunities
  - Regulatory stability and sustainability

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Potential private sector participation options

- BOTs (Build, Operate and Transfer)
- BOOTs (Build, Operate, Own and Transfer)
- Annuity scheme
- Special purpose vehicles
- Management contracts

Conclusions

Market development for associated gas

- There are multiple options for developing associating gas for local and world markets
- Projects tend to be large and high capital, although some smaller options have been successful
- Policy and regulatory framework are critical for successful market development
- Economic incentives are often needed initially, but projects need to be economically viable to be sustainable
- Government has to help create right investment climate to attract private sector participation

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