KUALA LUMPUR 2012 WORLD GAS CONFERENCE

25th world gas conference

"Gas: Sustaining Future Global Growth"

Current and Future Developments of Gas Production

IGU – WOC 1 – Report of Study Group 2

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Rooms 406/407

Patron

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Outline

MESSAGES

WOC 1 REPORT: SECTION II
Current and Future Gas Developments

CONVENTIONAL AND COMPLEX PROJECTS

UNCONVENTIONAL DEVELOPMENTS

FINAL REMARKS

IGU MESSAGE
Natural Gas Cares for the World

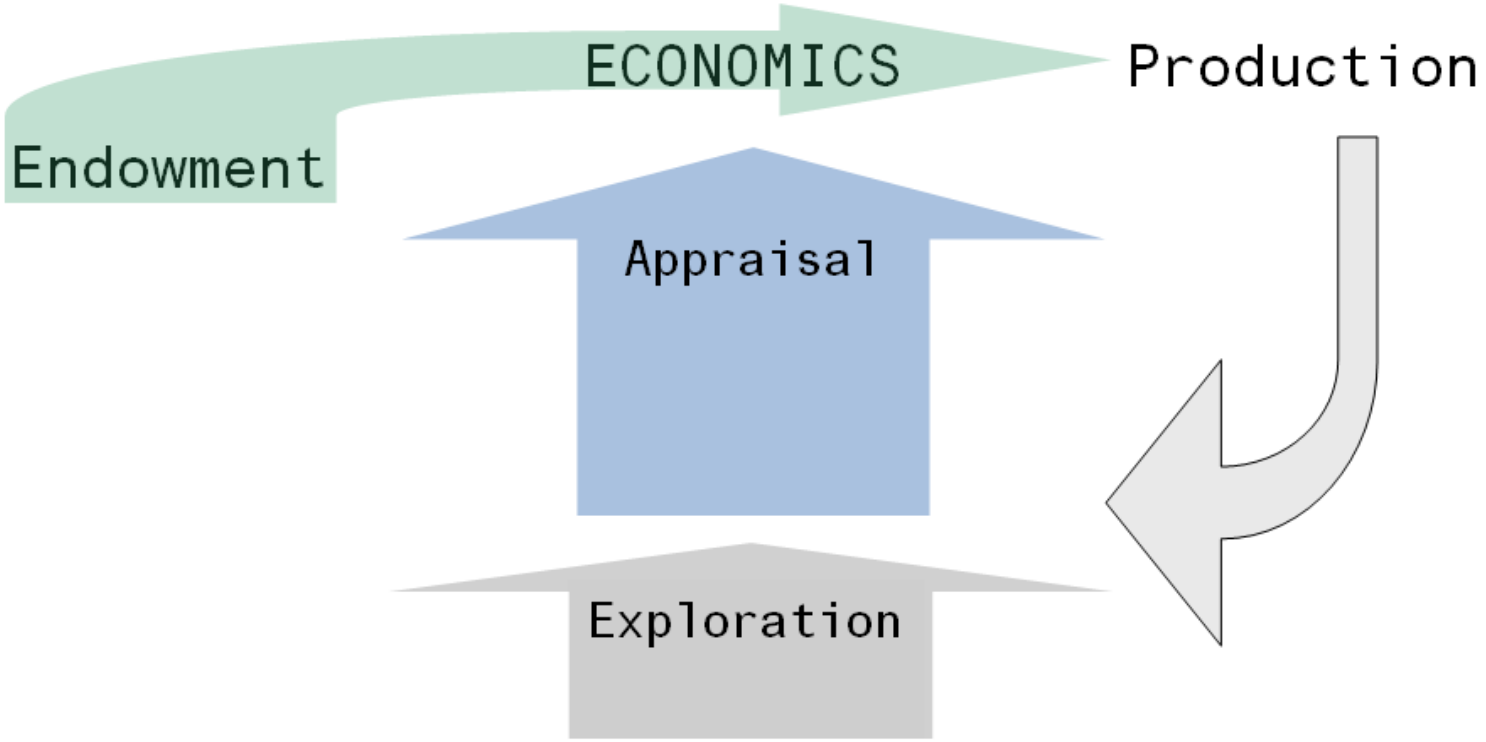
IGU ➔ Natural gas is a clean, affordable, reliable, efficient and secure energy source.

- WOC 1 EXPLORATION ➔ Natural gas endowment is abundant and diversified.

- WOC 1 PRODUCTION ➔ Global production will increase up to 2020 and well beyond, with growing supplies from a wide range of alternatives, both geographically diversified and with a variety of technical challenges and different degrees of geological risks.

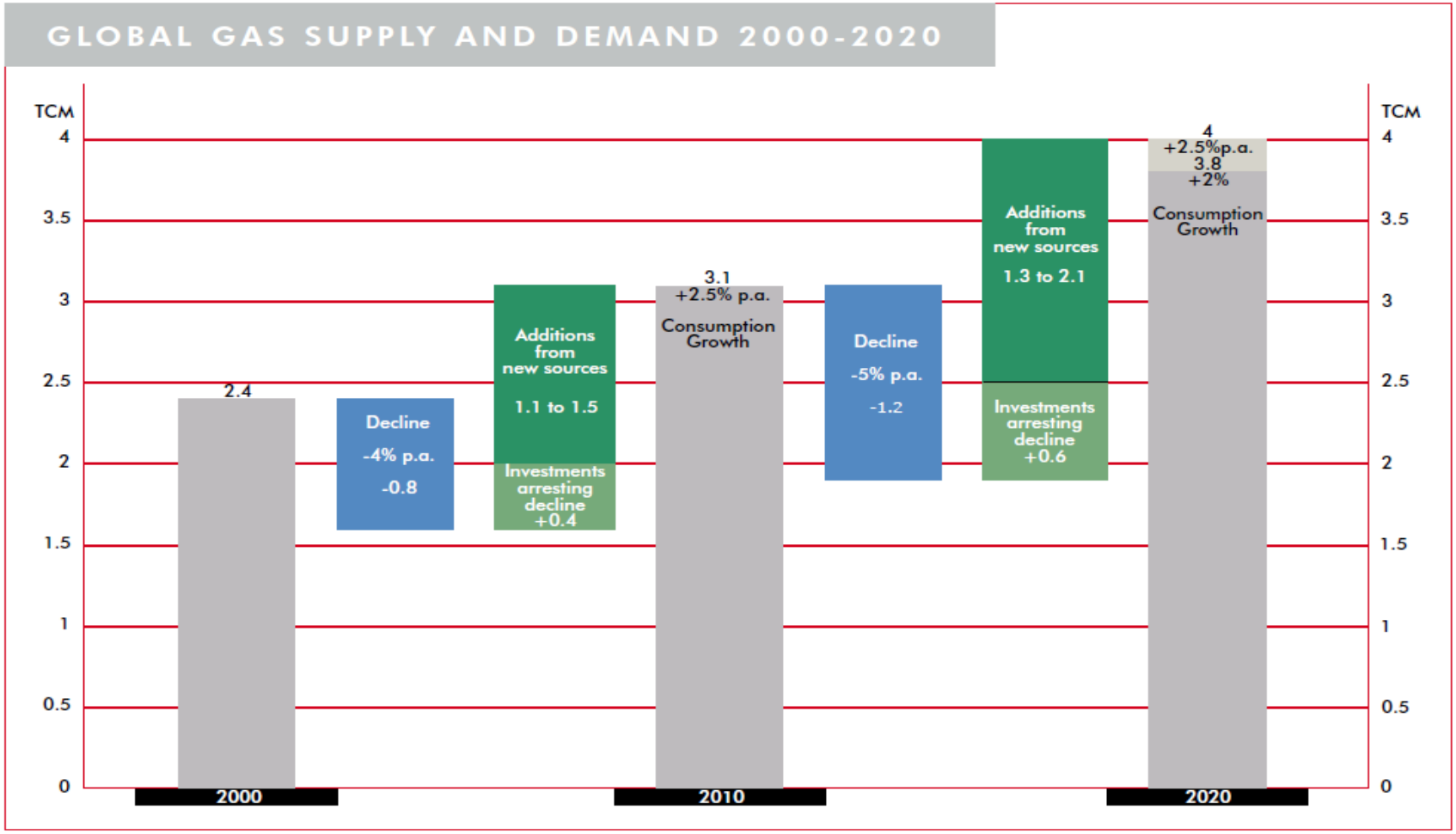
WOC 1 - Overarching Message
E&P Business Dynamics

Massive Endowment → Economically and Environmentally Viable Production



WOC 1 - Overarching Message
E&P Increasing needs of new gas

Increasing needs of new sources of production, in the range of 1.3 to 2.1 TCM/y up to 2020



WOC 1 - Production Report
Two groups of developments

1. "Conventional and complex" projects

- geologically conventional targets; and
  - in harsh environments or remote areas, and/or
  - those that face new technical challenges, and/or
  - those on a scale requiring ad-hoc solutions

2. "Unconventional" developments

- specific exploration techniques, and
- extensive appraisal

Are continuous conditions for estimating economics properly.

WOC 1 Production Report

SECTION 1: "Conventional and complex" projects

- Harsh environments and/or Remote areas
- Technical challenges:
  - Deep gas
  - HP/HT
  - Sour gas
- Scale that requires ad-hoc solutions

Trends in complexity are validated by reviewing Current and Future Flagship Projects

WOC 1 Production Report

Section 2. “Unconventional” developments

- **Basics & Regulation:**

  Definitions - Access to resources - Prices & Economic

  Infrastructure to market

- **Environmental issues:**

  Land use - Drilling and fracturing - Well integrity -Water management – Methane Emissions

- **Risk Assessment:**

  Development phases - Economic evaluation

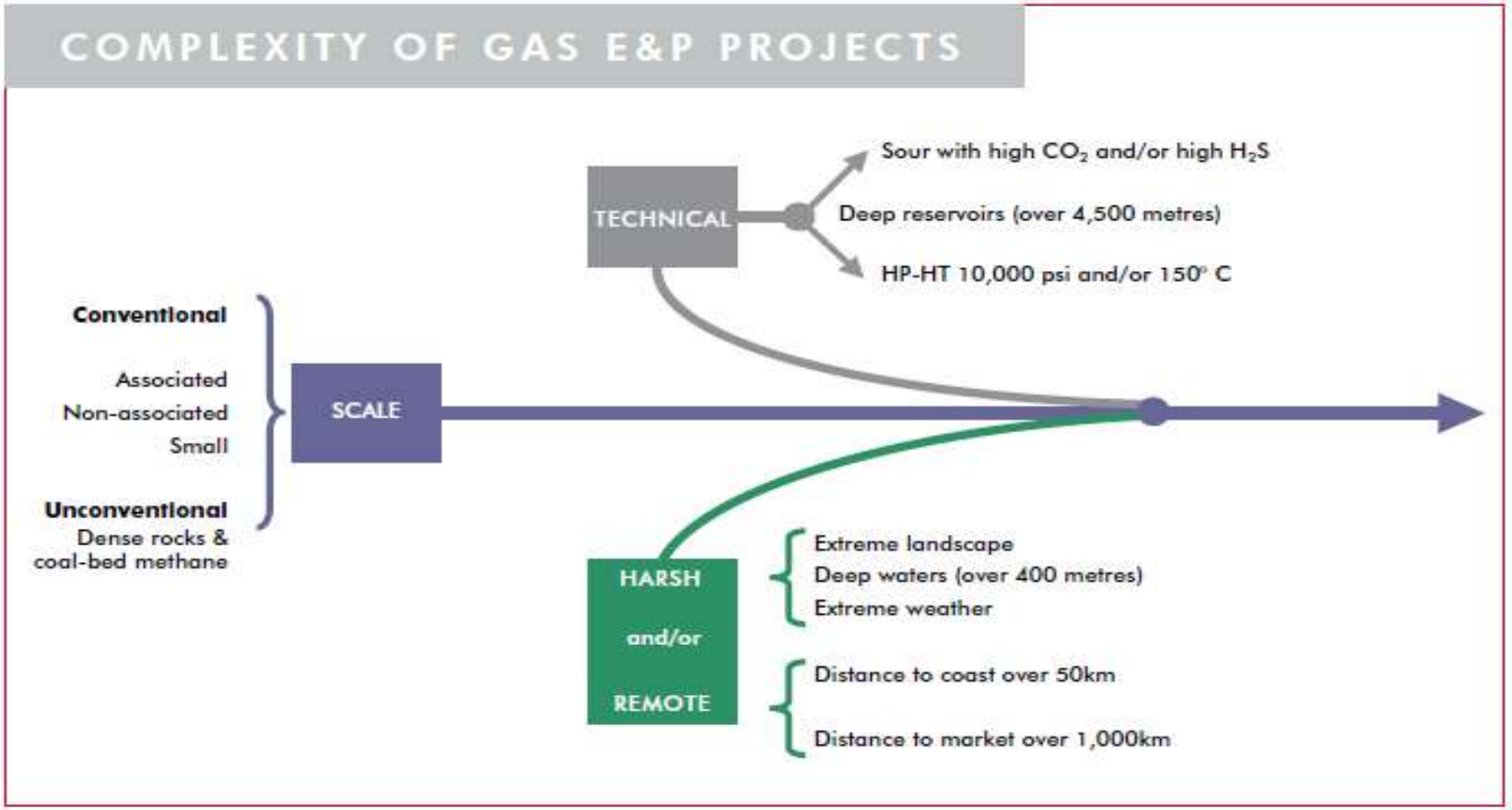
- **Regional Undertakings**

Outline

CONVENTIONAL
&
COMPLEX PROJECTS

Conventional & Complex Projects
Conceptual Categories

No precise parameters, but hurdles to overcome



Conventional and Complex Projects
Harsh and/or Remote Environments

INDICATIVE PARAMETERS:

- Distance to coast longer than 50 km
- Water depths deeper than 400 m
- Distance to market longer than 1000 km, onshore
- Extreme weather and/or fragile ecosystems

MAIN HURDLES are **above-the-well**

- Logistic & Infrastructure
- Flow assurance (Deep water & Arctic)
- Limited seasonal window for operations (X conditions)
- Need to reduce environmental footprint (X conditions)

FLAGSHIP CASES

- Arctic: ANS - Snøhvit 2 - Shtokman
- Extreme conditions: Sakhalin
- Stranded: Kovykta (onshore) – Prelude/Concerto (offshore)

Conventional and Complex Projects
Technical

INDICATIVE PARAMETERS are usually **intertwined**

- Deep Reservoirs, over 4500 m (or 15000 feet)
- Sour, with CO_2 and or H_2S over pipeline specifications, usually 0.3% and 10 ppm, respectively.
- HP – HT, with pressure over 10000 psi and/or temperature over 150 º C

MAIN HURDLES are mainly (not exclusive) **below-ground**

- Well design and drilling operations
- Special materials for wells and processing plants
- Disposal CO_2 and or H_2S - Storage
- HSE challenges

FLAGSHIP CASES

- Deep: Shah Deniz II
- Sour: Gorgon - Shah
- HP - HT: San Alberto

Conventional and Complex Projects Scale

MAIN HURDLES are mainly related with Planning and Marketing

- Size relative to infrastructure and markets
- Associated gas tied to oil
- Time elapsing from discovery to first production
- Clustering for small fields
- Flexible or modular designs for large fields

FLAGSHIP CASES

- Offshore: Shtokman
- Onshore: Unconventional

Case by Case Solutions
&
Step by Step Evolution

UNCONVENTIONAL DEVELOPMENTS

Unconventional Developments
Conceptual Categories

No precise parameters, but inherit characteristics

- Large accumulations not confined by geological discrete boundaries
- Low permeability; below 0.1 mD
- Low recovery factors; usually below 30%
- Dense rocks: tight-sands and shale gas
- Coal Bed Methane
- Methane Hydrates

Unconventional developments
Below-ground potential

Commercial success depends on finding the right interval by proper application of technology

Technology applied is conventional, but

innovation by rapid pace of adopting and assembling different new features for specific purposes ->

technology progressively more advanced and cost efficient

Unconventional developments Regulation

Beyond North America, incomplete regulatory frameworks are deterring developments

- Investment commitments according to risk-reward parameters for each different stages
- Total length of the licenses and sub-periods
- Rights to entitle reserves /resources
- Market conditions: infrastructure and prices
- Fiscal incentives

Unconventional developments
Environmental issues

Certainty of rules & best practices across the entire chain

- Land use: flexible well spacing rules.
- Drilling and Fracturing: frac fluid disclosure.
- Well integrity: to eliminate the risk of the contamination of drinking water.
- Water management: 10 kb/fracture implies large quantities/well. Recycling.
- Methane emissions: green completions.

Unconventional developments
Risk assessment

From finding remaining large traps to finding viable conditions to produce

- Phases to mitigate specific uncertainties and/or risks.
- Drilling approach: Manufacturing or establishing targets (sweet spots) selectively.
- **Learning curve:**
  Barnett reached 0.5 BCF/d, in more than 20 years
  Fayetteville reached 0.5 BCF/d, in 3 years
  Marcellus: increased 4 BCF/d, in 3 years
- Economic evaluation: different approaches

Unconventional developments
Regional Overview – United States

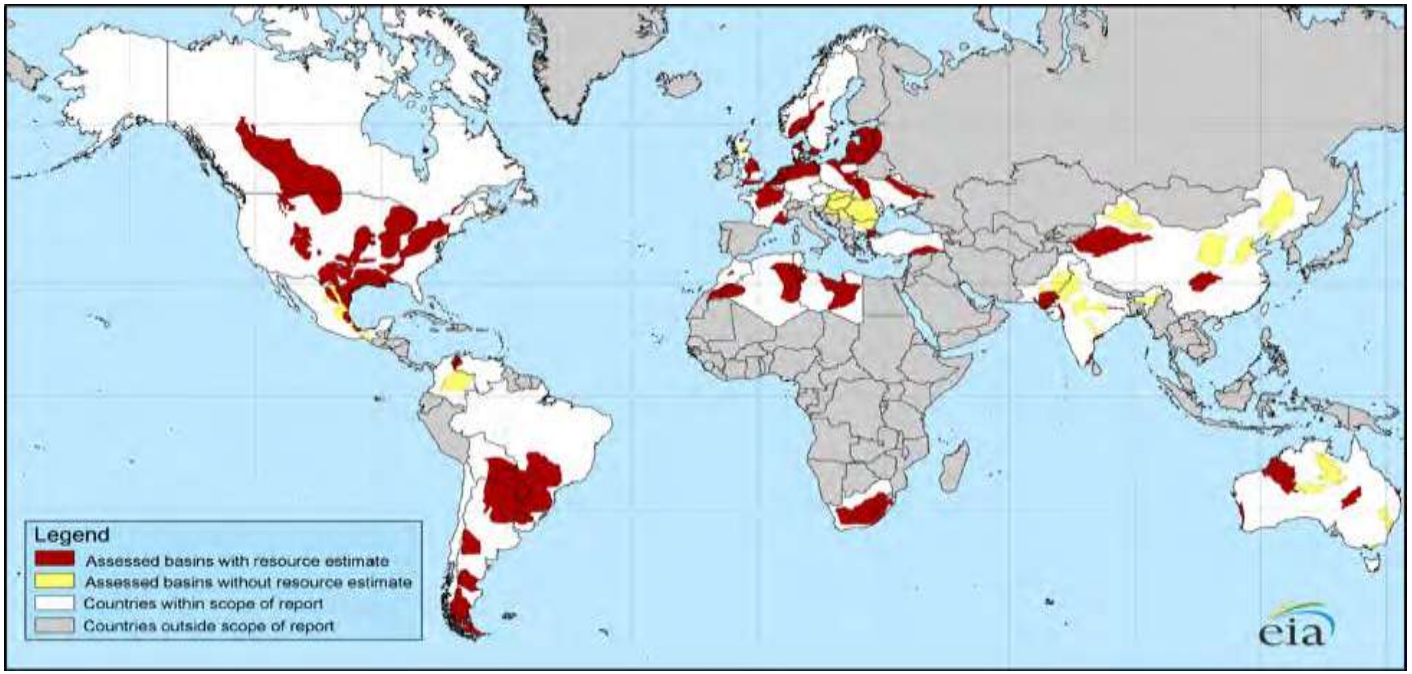
United States could become a net exporter of gas by 2020 subject to shale developments large enough to exceed domestic needs

- To fulfill domestic demand by 2020, it is estimated that shale production should increase by 130 BCM/y, volume similar to the production of shale gas in the United States reached in 2010.

- It is estimated that the increase of shale gas production by 2020 could exceed 200 BCM/y.

Unconventional developments Beyond United States - Endowment

Massive Resources: U. S. DOE Initial Assessment of only 14 Regions outside U. S.



70 shale formations = 5700 TCF assessed.

Unconventional developments Beyond United States – Criteria

Minimum level of near-term promise & sufficient G&G data

- Oil windows could be developed first due to economics.
- Regulation has to be in place.
- Developments as rapid as U.S. are not likely.

Flagship Developments & Drivers

Canada -> LNG to Asia
Australia -> CBM to LNG
China -> tight sands already developed; demand pull
Poland -> diversified source for Europe
Far East -> demand pull & replacing decline
Argentina -> replacing decline & demand pull subject to prices.

Final Remarks

PORTFOLIO OF OPTIONS implies different avenues to translate resources into marketed production.

LARGE DEVELOPMENTS from diversified sources are expected to add production up to 2020, materially.

600 BCM/y OF NEW PRODUCTION FROM ONLY 20 FLAGSHIP PROJECTS are referenced in the report.

Special Thanks

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