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Technology Innovation in Exploration and Production (E&P)

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Acknowledgements

Information used in this discussion is derived from many sources including:

Sharpe (2013): Innovation in Canadian Natural Resource Industries: A System-Based Analysis of Performance, Policy and Emerging Challenges, World Financial Review

Bastian (2009): Technological innovation strategy in natural resource based industries.

Various SPE articles

Robert K. Perrons, Queensland University of Technology, and John Donnelly, JPT Editor (2012)

The views expressed in this discussion are the author's own and does not represent the views of Petronas.

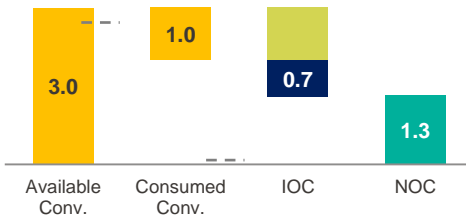
E&P companies are constantly finding ways to meet the increasing world appetite for hydrocarbons



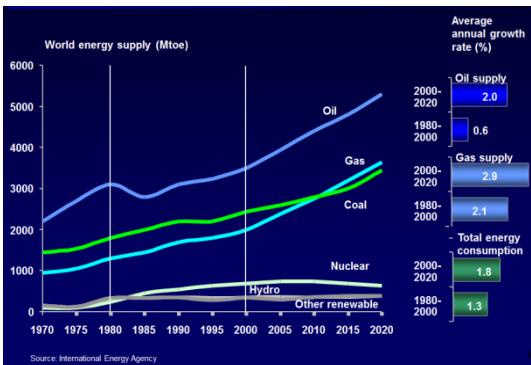
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The majority of conventional reserves is within NOCs' control...

Estimated volume of conventional hydrocarbons (Trillion boe)



- SPE's estimated volume of conventional resources is at 3 trillion boe globally
- Increasing world demand for oil and gas is on the rise
- This results in the push to explore more challenging fields



...Increasingly lack of access with liberalizing energy markets and policies have made unconventional an attractive investment



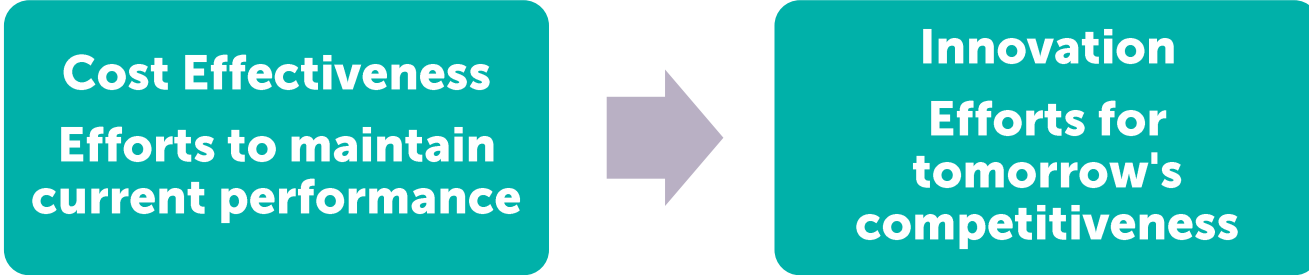
- Legend:
- Tight Oil/Gas Deposits
 - Oil Shales
 - Extra Heavy Oil/Bitumen

- Shifting energy policy in North America and Europe has led to the opening of the market and incentives for the fields to be developed
- Technology is being used to drive exploration and production to new frontiers including unconventional fields, ultra deepwater and arctic environments

E&P Innovation is a lever to tomorrow's competitiveness



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- **Malaysia's Oil and Gas Industry is one of 12 pillars in ETP to create economic wealth and social progress by 2020**
- **Hence innovation in E&P is particularly relevant**



Oil, Gas & Energy

**Incremental GNI by
Year 2020
RM Bil 131.4**

**Number of Jobs
Generated by Year
2020
52,300 Jobs**

Taking a comprehensive view of innovation enables identification of innovation opportunities



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- **Broad Context**

- **Research and development (R&D) expenditures,**
- **Capital investment in plant machinery and equipment**
- **Staff education and skills**
- **The use of information and communications technology (ICT) and**
- **Organizational Innovation (new structures for improving performance on margins)**

Often taken together as Technological Innovation

- **Regulatory Innovation**

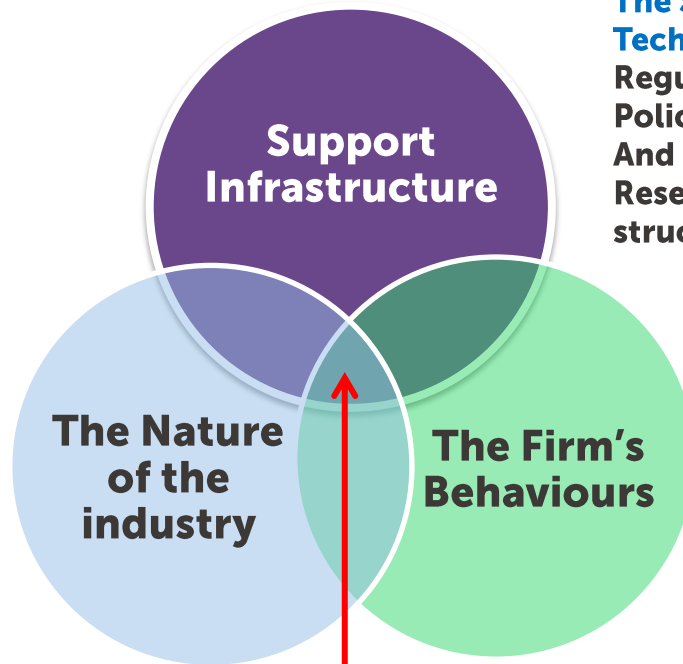
- **Improved fiscal terms for EP investors.**

Successful innovation requires these three elements to work in concert



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- High capital intensity
- Homogeneous products
- Highly competitive international markets
- Price volatility
- Environmental Effects
- Complex regulatory Environment
- Significant inter-industry vertical linkages
- High degree of foreign ownership
- High profitability



- The State of Science and Technology**
- Regulatory Framework, Policies And Incentives
- Research infrastructure and structures

Outcomes

- Leadership
- Entrepreneurial zeal
- Willingness to take risks
- Willingness to cooperate
- Structure
- Managerial training

Innovation

1. R&D led innovation
 - Innovation in goods and process and in organizational structures as a result of R&D

2. Organizational innovation
 - Adoption of new products, processes and services
 - New organizational structures



Outcome

Higher Productivity
Increased competitiveness

The level of innovation can be measured systematically and benchmarked on several perspectives



Support Infrastructure

Fiscal:
2X tax deductions for R&D
Incentives for Enhanced Oil Recovery

Support Infra and Structures:
Science and Engineering Universities including UTP
Technology Parks
National Incubation Engines
Public-Private Partnerships



The Firm's Behaviours

Mindsets and actions:
NOC and IOC

Risk sharing:
high risk and marginal fields

Staff Training (local, international; technical and managerial, under- and postgraduate)

Collaboration:
Intra, inter and global R&D networks
Continuing investments in growth opportunities and M&A



The Nature of the industry

Capex Spending

Price Swings

Bid intensities

New players

National Supply and Demand

Interbusiness linkages: E&P, Gas and Power and Chemicals

Value for investments in R&D and technology can be evaluated on an equal basis to organizational innovation and transparency of outcomes help decisions on continuing investments



Innovation Outcomes

1. R&D led innovation

- Innovation in goods and process and in organizational structures as a result of R&D

2. Organizational innovation

- Adoption of new products, processes and services
- New organizational structures

Subsurface Imaging gas cloud solutions

Stranded Gas Monetization: FLNG

New Offshore Pipeline Rehabilitation
Materials and Methods

New Inspection Tools

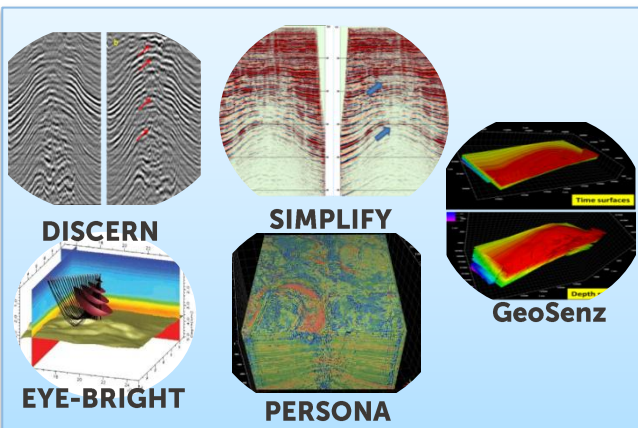
Integrated Operations Center

Drilling, Project Management, Production Academies,
Marine Logistics center,
Integrated Supply Base

VESTIGO

EPOMS

EPUE (EP Unconventional Energy)

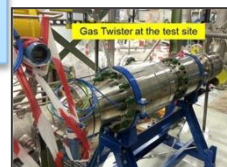


Seismic solutions



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membranes**

Cryogenics



IFL™

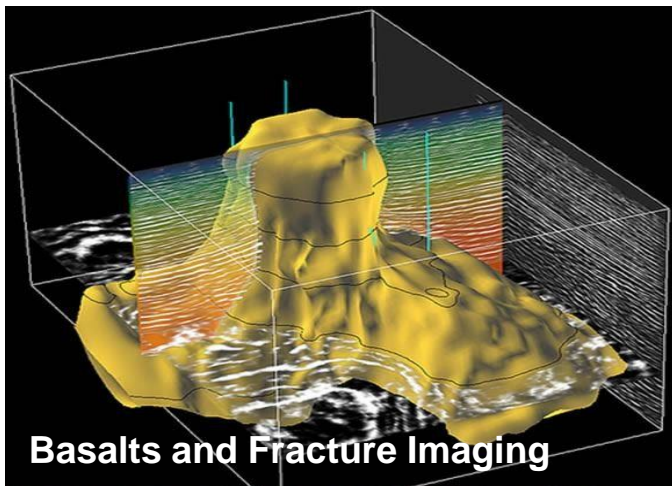
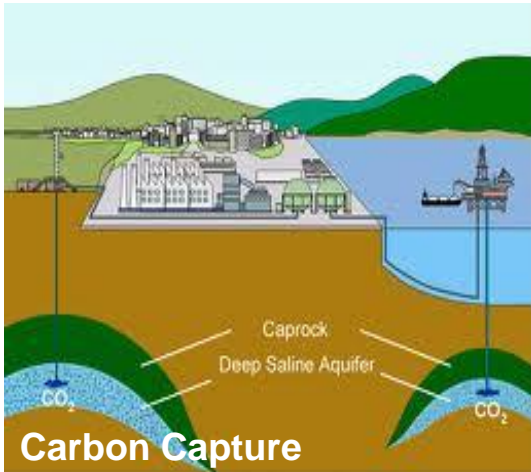


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As the world enters into the gas golden age, future technology developments promises exciting technologies in gas extraction and processing



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Thank You