

Technology Impact on Oil and Gas Production and Reserves

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Introduction

- Oil and gas demand expected to increase over the next decade
- Major economies highly dependent on imported hydrocarbons with increasing demand in developing markets
- Hydrocarbon reserves adequate, but security of supply in the short and medium term is a concern hampered by lack of information
- Heavy investment will be needed but difficult to quantify without better knowledge of supply and capacity
- Technology can help improve recovery and mitigate decline

Source: IEA World Energy Outlook 2002

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Production Decline and Reservoir Depletion

- Decline – the decrease in rate of production with time
- Depletion – the decrease in the amount of hydrocarbon remaining with time
- Generally expressed in % per year



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Significance of Decline Rate

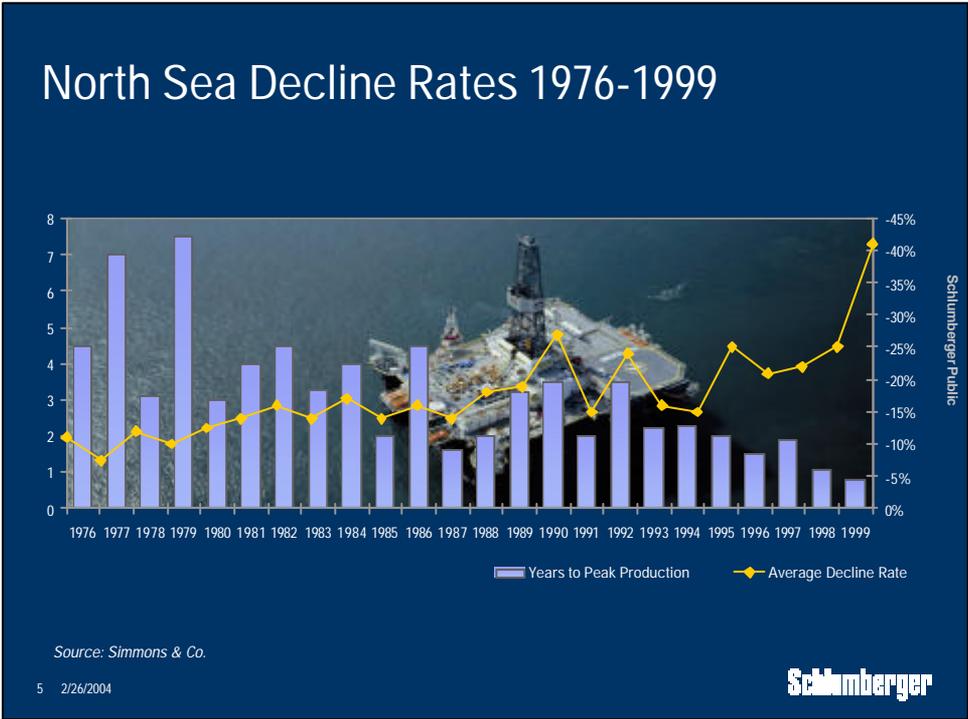
- 1.7% annual energy increase translates to need for 11 million b/d extra oil by 2010
- 5% decline rate leads to need to add 33 million b/d extra oil over the same time period – three times more than demand growth
- Actual decline rates not well known leading to large uncertainty in additional supply planning



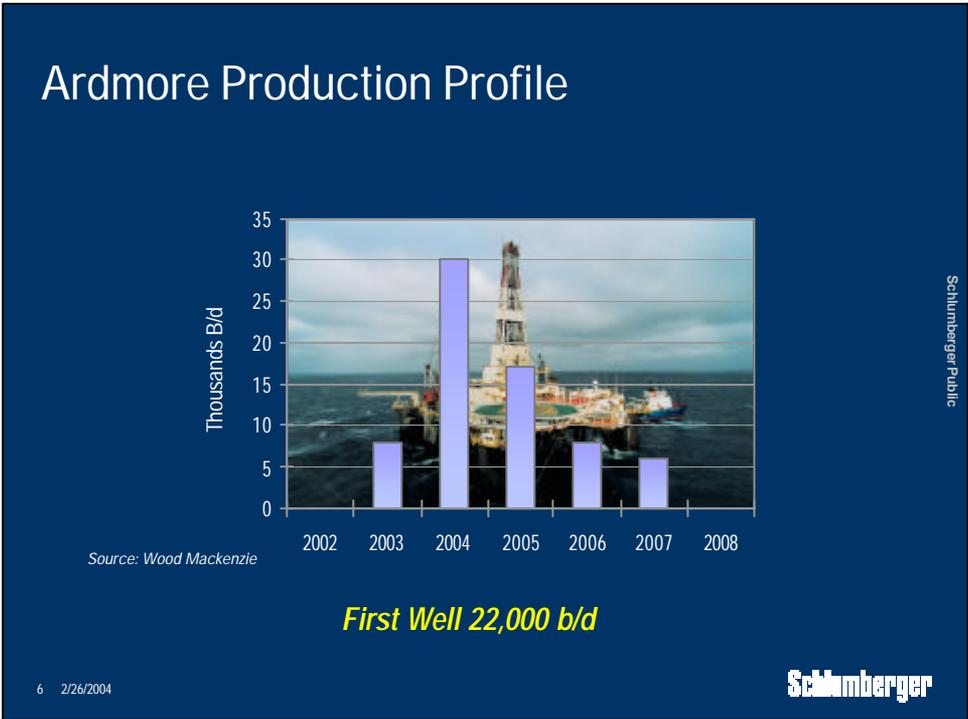
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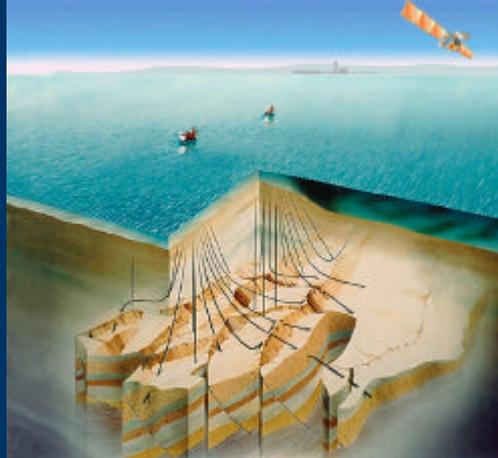
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Advanced Oilfield Development

- Production analysis
- Imaging infill locations
- Optimised well placement
- Optimising production with the completion
- Stimulation to revive oil production



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Technology, Production and Decline

- **Advanced wireline logging**
- 3D and multicomponent seismic
- Advanced steering of the drill
- **4D seismic**
- Underbalanced perforating
- Multilateral completions
- Permanent downhole sensors
- Intelligent completions
- Optimised production systems – real-time management



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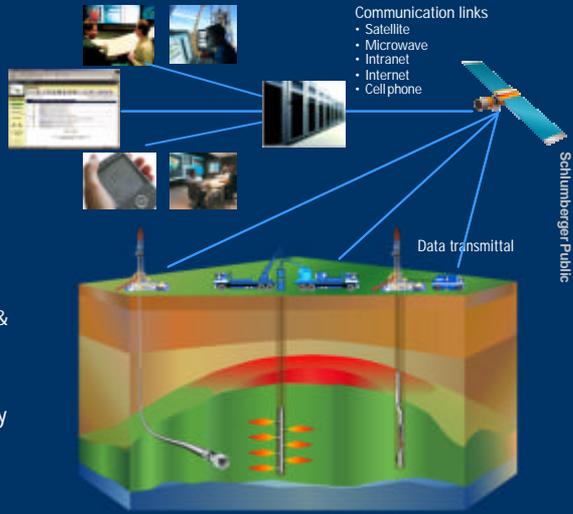
Increasing recovery...
... boosting production

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Accelerating Recovery – Real-Time Data

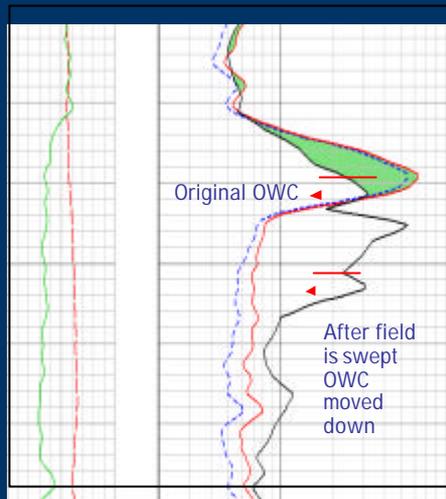
- Oil companies seek to optimize field production from the reservoir to the point of sale
- Real-time data & information delivery:
 - Components range from monitoring and surveillance to diagnostics & optimization
 - Results in improved economic performance through increased production & enhanced recovery
- Reduced operating expense & accelerated cash flow



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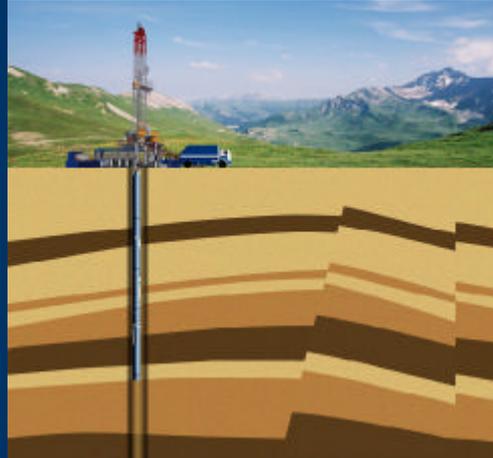
Analysis Behind Casing – Resistivity Logging



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Analysis Behind Casing – Formation Testing

- CHDT Testing and sampling fluids behind casing
- Locate bypassed hydrocarbons by drilling through casing and cement
- Mechanical plug for seal to 10,000-psi differential pressure
- Multiple samples on a single descent



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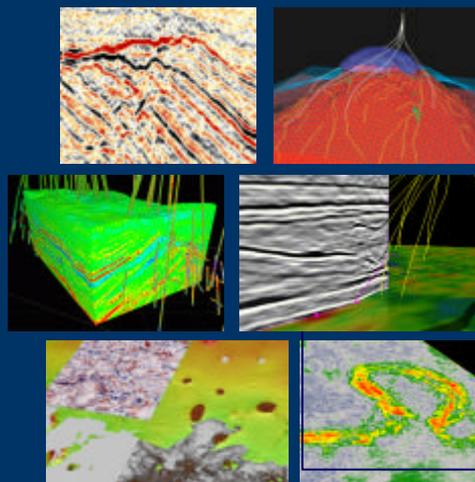
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Seismic Technology – A Step Change

- Digital signal treatment offers superior resolution and repeatability
- Better resolution leads to better imaging of in-fill locations and improved reservoir characterization
- Better repeatability leads to better production monitoring in 4D



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Shaping the Future

Conventional Seismic

New "Q" 4D Seismic

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Impact of Technology

Evolution of North Sea Output Forecasts

Source: IEA WEO 2001

■ Forecast output (1983)
■ Forecast output - probable case (1997)
■ Forecast output - low case (1997)

Production in 2000 was 10 times higher than forecast in 1983
Advances in drilling, seismic exploration

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Final Thoughts

- Hydrocarbon reserves expected to meet growing demand in the short-term, however they are finite and should be depleted efficiently to achieve high recovery
- Production decline is a physical phenomenon that influences the capability of the suppliers to supply. It is poorly understood and data are scarce
- Technology has done a good job in maintaining production from mature assets but this has often been at the expense of accelerating production decline
- Much investment will be needed but the amount is difficult to quantify without better knowledge of supply and capacity

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