



# **Breakthrough Technologies and Incremental Innovation: the Edge of Innovation in Oil and Gas industry, Level of R&D expenditure Versus Results in the Energy Companies**

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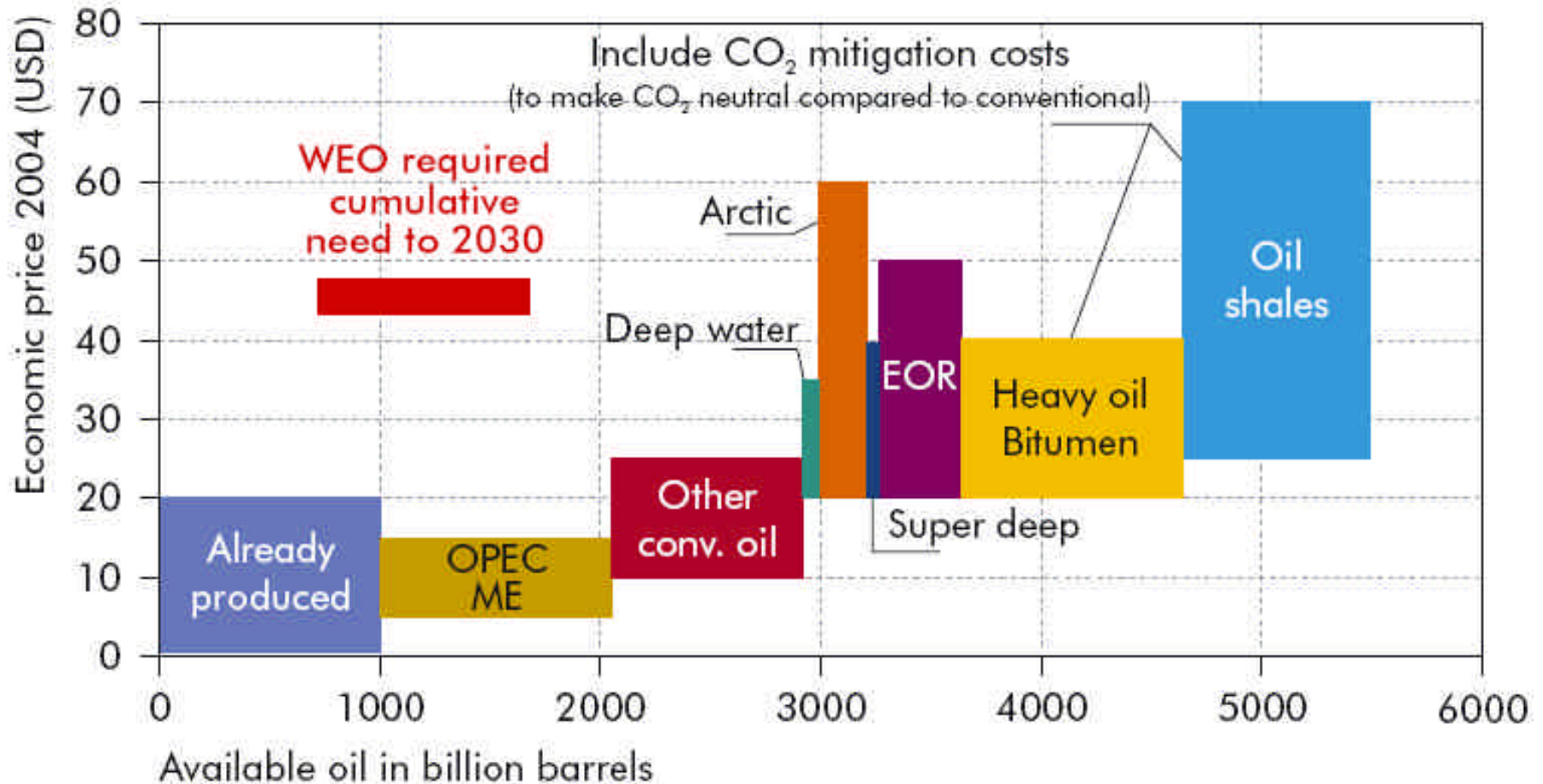
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# INTRODUCTION

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- 1 Trillion barrels of oil consumed till today
- 1 Tbbbl in next 35 years & 3° Tbbbl 35-70 years after that
- *"Greater recovery, Greater discovery, and Greater diversity"*, Tony Meggs, BP Group VP for Technology
- Greater Recovery: recovery rates being achieved now are far higher than were envisaged even only 20 years ago
- Greater Discovery: reserves deeper below the surface, in deeper water and in hostile environments like the arctic regions
- Greater Diversity: future hydrocarbons. unconventional resources – heavy oil and bitumen, oil shales, tight gas sands, shale gas, coal bed methane, and gas hydrates
- Ever increasing concerns on environmental issues and stringent restrictions and standards

# Challenges



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# Environment

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- Intergovernmental Panel on Climate Change (IPCC): *"Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations"*
- Growing concerns that the climate is warming due to CO2 emissions ( use of fossil fuels)
- Focus on Carbon capture and sequestration (CCS) technology (cleaner environment, use in EOR)
- Need of demonstration of fully integrated CCS at commercial scale, along with an established legal and regulatory environment



# Exploration

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- Subsalt and Sub-basalt reservoirs
- Rich hydrocarbon reservoirs at several volcanic margins, North Atlantic ocean, off the coast of West Africa and offshore India
- High velocity basaltic rocks underlain by low velocity rocks
- complex setup caused by multiple basalt flows and inter-fingering of sediments within the individual flows
- Severe effects on quality of the conventional seismic data
- long-offset seismic data acquisition using low frequency sources and making use of locally converted waves
- The integrated Seismic Imaging and Modeling of Margins (iSIMM): processing thorough shot-by-shot signature monitoring allowing waveshaping and careful demultiple
- Magnetotelluric (MT) methods: better resolution and imaging, successfully applied in sub-salts of GoM and sub-basalts of North Atlantic
- sophisticated acquisition methods that use varying azimuths and offsets: Wide Azimuth (WAZ), multi-azimuth (MAZ) and Rich Azimuth (RAZ)

# Drilling

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- Deep water Challenges: access to the oil and gas that lies deeper, in dispersed reservoirs or difficult to produce, new global standards for vertical completion systems (EVDT)
- Deep well drilling challenges: drilling deeper wells and completion strategy (expandable tubulars)
- Future drilling technology challenges: managing difficult pressure environments, remotely operated drilling is possible, Automated Drilling System (ADS), dynamic real-time analysis of drilling processes and simulation.



# Production

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- Historically the elements of the production process has remained relatively constant
- Focus on cost-savings (efficient production systems and maintenance)
- Research and Technological Advancement for increased production (secondary and tertiary recovery techniques)
- Emerging Technologies in Production: NANO Technology (enhanced emulsion separation), In-situ Seismic Wave Stimulation (IOR), Bright Water (EOR), EXCAPE (Simultaneous Dual Well Completion), Teleperf (sand control completion without gravel packing)



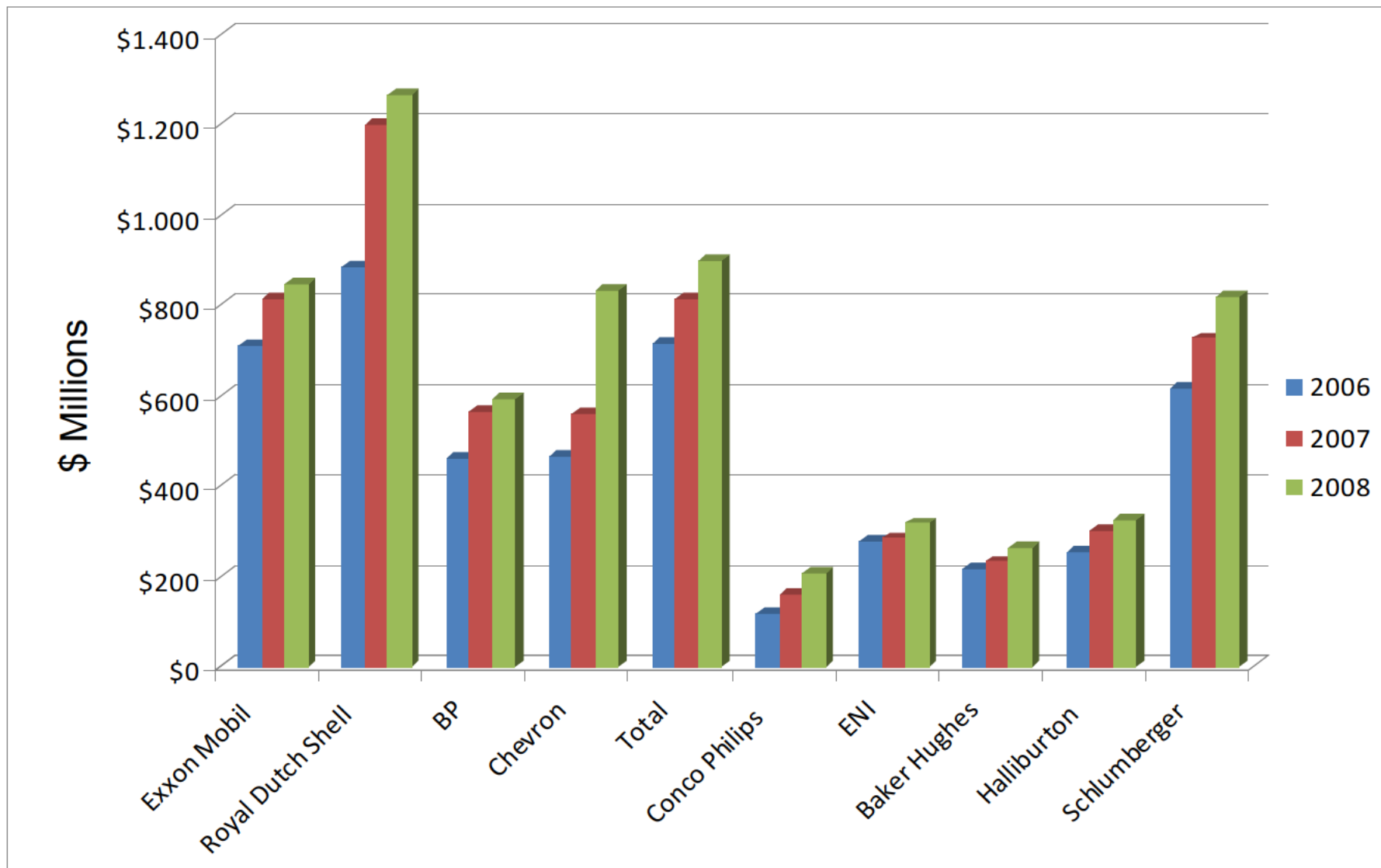
# R & D Investments and Trends

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- R&3D, referring to the Discovery, Development, and Deployment phases
- Low level of R&D spending in oil and gas industry compared to other industries (less innovative, costly and time-intensive, 16 years from concept to commercialization)
- Estimated industry R&D spendings more than \$6 billion annually
- Shift of technology and R&D activities from traditional major operators to service companies who now are the major source of innovations in oil industry (resulting technological advancement in exploration, drilling, well completion etc)
- Much of R&D is either being outsourced or decentralized by the companies
- As majors are merging to become super-majors, they are eliminating redundancy in terms of the numbers of labs and research personnel
- Unlike the last two decades, R&D spending increased significantly in many E&P organizations in 2006, 2007, 2008 (especially in Majors)







\*Source: Annual Reports of Majors

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## Future of Investments in R&D

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- Focus on alternative energy, frontier hydrocarbons and advanced end-use technologies
- High global demand for electricity and transportation fuels, rapidly growing sectors within the energy field: renewables, solar power & wind turbine systems, most prominently in bio-fuels and oil-exploration technologies.
- Environmental regulations an added effect on investments, resulting diversification (focus on greener fuels, zero-carbon emissions, CCS)
- Decelerating world economy will always have an effect on global research and development (R&D), with some global R&D growth absorbed by the inflation rate for a net result of flat R&D spendings consequently diminishing the resources available for new R&D investments.
- One of the major research area evolving is the development of processing technologies (eg.GTLs an innovation)
- Notwithstanding, R&D spending likely will be a work in progress with unforeseen changes affecting the amount of money available, much of that hinging on the eventual price of oil

