

Projections of the World's Future Hydrocarbon Resources and Reserve Depletion in the 21st Century

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The world economy is highly dependent on the availability of large amounts of hydrocarbons. Oil and natural gas represent currently about 60% of all energy traded. Transportation as we know it on land, on water and in the air would be unthinkable without hydrocarbons. Oil and natural gas are also valued raw materials for a thriving petrochemical industry which converts them into a dazzling array of products for our daily life. How long the known hydrocarbon reserves and the yet to be discovered resources will last is a question of great importance to humankind.

Our estimates as per January 1, 1997 are:

- hydrocarbons produced so far 1,150 billion (G) barrels (bbl) Oil Equivalent (OE) (790 G bbl oil and 2,000 trillion cubic feet (Tcf) natural gas)
- proven reserves: 2,020 G bbl OE (1,100 G bbl oil and 5,100 Tcf natural gas)
- field growth is conservatively expected to contribute additional reserves of 510 G bbl OE (400 G bbl oil and 600 Tcf natural gas)
- undiscovered resources of hydrocarbons: 2,110 G bbl OE (1,010 bbl oil and 6,100 Tcf natural gas)
- the worldwide Ultimate Recovery of hydrocarbons (Produced + Proven Reserves + Field Growth + Undiscovered Resources) are projected to be 5,700 G barrels OE (3,300 G barrels being oil and 13,800 Tcf natural gas)

We do not believe that a distinction between "conventional" and "non-conventional" hydrocarbons is useful.

Future reserves, field growth, undiscovered resources and ultimate recovery will differ from the 1997 estimates as a consequence of technology advances and of changes in economic, social and political conditions. Increasing the recovery factor above the current average of about 0.35 alone would contribute substantial amounts of oil.

We created three scenarios to illustrate how projections of the world's ultimate hydrocarbon recovery and reserve depletion might have changed as of Jan. 1, 2101: a high demand scenario "Another Century of Oil and Gas"; a low demand scenario "The

End of the Internal Combustion Engine”; and a scenario with intermediate demand and increasing importance of other energy resources, “Energy Mix”.

As the demand for hydrocarbons grows, the more economically attractive the search becomes for the production of oil and gas. Consequently, on Jan. 1, 2101 cumulative production of hydrocarbons is projected to stand at 7,450 G bbl OE and ultimate recovery at 12,000 G bbl OE, under the scenario “Another Century of Oil and Gas”; under the scenario “The End of the Internal Combustion Engine”, we project cumulative hydrocarbon production at 3,700 G bbl OE and ultimate recovery at 5,200 G bbl OE; and under the scenario, “Energy Mix”, we project a cumulative production of 5,650 G bbl OE and an ultimate recovery estimate of 8,750 G bbl OE.

Under all three scenarios, reserves and undiscovered resources are sufficient to allow hydrocarbon production well into the 22nd century. Until then hydrocarbon production is not constrained by the physical availability of hydrocarbons, but rather by the price of competing energy sources and by the political will of humankind to use hydrocarbons. The three scenarios represent a thesis, an antithesis and a synthesis and we feel that actual hydrocarbon production during the 21st century will be close to the “Energy Mix” scenario.

Predictions are difficult to make - especially about the future.