Conventional and Non Conventional Oil Supply for 2030: a world-Wide Economic Analysis based on a Modelling Approach

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Overview

The global energy trend forecasts point out an increasing demand over the next decades, especially for electricity and automotive fuel. Over the next 25 years, the growing activity of the transport sector will involve increasing quantities of liquid fuels. On the supply side, the crude oil share in the total primary energy supply should remain to around 35% until 2030. Thus, the the non conventional supply, coming from non-conventional oil (tar sands, extra-heavy oil and oil shale) as well as technologies transforming gas or coal to liquids should give a significant and necessary contribution to the global crude oil availability. We have analysed the potential development of the non conventional supply in a world-wide model which aims to satisfy the oil products demand until 2030. In this analysis, several geographical areas have been distinguished, to take into account the regional dimension of the supply and the demand. Furthermore, in an alternative scenario, we point out the influence of environmental constraints to limit the carbon emissions (through carbon taxes) and energy policy decisions on this development.

Methods

The non conventional crude supply has been introduced in a world-wide refining model. Linear programming (LP) models are frequently used in the refining industry, both for refinery management and for investment analysis. As marginal cost pricing is relevant for the oil products, an LP model has been built for this world-wide refining model. For a given set of crude oil available production, oil prices and oil product demand, the refining model provides : the crude oil supply of the refineries, the refineries throughput and the oil product balances of each region, the products blending (allowing compounds from biomass), the investments (refining processes) and the marginal cost of oil products. Furthermore, under some assumptions, the long run marginal costs could be used as ex-refinery prices. Then, they could be used on the demand side modelling. Nine main regions are considered in the model: North America, Latin America, Northern and central Europe, South Europe, Former Soviet Union, Africa, Middle East, China and Asia (except China). In our simulations, the oil price is exogenous. Then, according to the demand of oil products, the non conventional oil supply pattern is determined from the model optimisation. In the model framework, the extra-heavy oil and the tar sand productions are introduced to supply the refineries ; the Gas-To-Liquid (GTL) and Coal-To-Liquid (CTL) productions are introduced through processing units in the refineries schemes. For the simulations, we have used international market prices for coal and gas and also lowest values to test the sensitivity of these production to the feedstock prices. Finally, biomass compounds (alcools and esthers) are considered as an exogeneous supply to the refineries. As the carbon emissions from the diffrenet processes are calculated, thus carbon taxes on both non conventional crude oil production and refineries activity could be introduced. Thus, we test the consequences of such taxation in the environmental scenario.The model has been developped on the Gams software associated with the CPLEX optimization codes. According to the size of the model (around 14,000 constraints and 66,000 variables), both an interior point method (primal-dual barrier method with predictor-corrector) and a simplex method are performed.

Results

The oil product demand has been simulated over the next 25 years in a business as usual scenario and in an environmental scenario. In the reference case scenario, the demand of oil products reach around 5360 Mt/year (107.6 Mb/d) for the final year. The evolution of the final oil product demand is driven by the activity of the transport sector which stands for around 60 % of the demand in 2030. The oil product demand is addressed to the world-wide refining industry through the optimisation process described before. However, this demand is moderated in the environmental scenario (impact of increasing oil product prices). The crude oil price is 55 $/bbl in 2030. After the optimisation, the total primary oil supply is around 113 Mbbl/d in this scenario. The marginal cost of gasoline is around 513 $/T in North America, 458 $/T in Europe and 460 $/T in Asia. For diesel oil, the marginal cost is around around 390 $/T in North America, 485 $/T in Europe and 470 $/T in Asia. The conventional crude oil supply represents around 102 Mbbl/d with an important share of the Middle East (46.9 Mbbl/d) and the extra-heavy oil production raises at 6.2 Mbbl/d and stands for 5.6% of the global supply.The GTL and CTL contribution is around 2.5 Mbbl/d. Moreover, the value of the feedstock for GTL and CTL production influence the development of these technologies. Finally, biomass compounds represents 1.7 Mbbl/d.

In 2030, non conventional supply should represent 9% of the world oil supply. These results are mitigated in the environmental scenario with a lower rate of growth of the non conventional productions.

Conclusions

Non conventional resources represent a huge potential in terms of resources. They are either of a high strategic importance in term of diversification of oil supply and enhancement of supply security. In fact, the non conventional resources are more balanced over the five continents than the conventional crude oil. The increasing oil products demand in 2030 involves the development of the non conventional supply. Thanks to the tar sands development, North America should keep a quite stable share of the total world-wide oil supply at 18%. Liquids fuels from GTL and CTL technologies should give significant contribution to the increasing automotive fuel demand (especially in Asia). However, the developement of such technology is strongly depending on the coal and gas value. Concerning oil shale, according to the improvement of the industrial technologies, they could slightly reinforce the North American supply. However, environmental constraints should moderate the non conventional oil supply

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