WHAT ARE THE PROSPECTS OF OIL CONSUMPTION IN THE 21ST CENTURY?

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Overview

Debate exists over future availability of both conventional and unconventional oil, with opinion often polarised into 'optimistic' and 'pessimistic' viewpoints: pessimists foresee a supply constrained peak in oil production in the near-term (with some believing that it has already occurred) while optimists dismiss entirely this concept of 'peak oil'. Most of this debate focuses on the ultimately recoverable resource and temporal availability of conventional oil. This analysis is considered to be systematically flawed however as it fails to address many other factors that will play an equally important part in determining the future consumption of oil. These factors include the role of unconventional oil, the costs at which both conventional and unconventional resources can be extracted, end-use demand, and the role of substitutes such as biofuels and Fischer-Tropsch liquids. This paper seeks to examine possible projections of future oil demand by incorporating all of these aspects under a range of scenarios within the detailed global energy systems model TIAM-UCL. The work will also provide insights into the timing and relative importance of the transition to and from unconventional oil sources as well as how these will be influenced if carbon emission constraints are imposed.

Related research

Future projections of oil supply and demand have previously been produced by a variety of authors, a number of which were reviewed in a recent report by Sorrell et al. (2010). As mentioned above, these are generally divided into 'optimistic' and 'pessimistic' camps: the former of which consists mainly of those who tend to focus on the economic factors (see e.g. OPEC, 2008), while the latter generally consists of those who concentrate on the geological aspects of oil supply (see e.g. Schindler and Zittell, 2008).

These geological models tend to rely upon 'curve-fitting' procedures whereby regional historical production is employed to minimise residuals from curves, which are then extrapolated forwards to project future production. An example is the well known Hubbert (logistic) function. These models are often over-simplified focussing solely on the supply side of conventional oil and neglecting unconventional oil, as well as the economics of oil extraction, oil demand, and the role that oil substitutes can play. In contrast, the economic models tend to assume that supply will always be sufficient to meet demand and so ignore, or attach less significance to, geological factors governing the rate at which oil can be brought into the market.

Methods

To understand the key drivers of future projections an approach that incorporates both the economic and geological factors is required. This paper seeks to do so by running a number of scenarios using a technology rich bottom–up model, TIAM-UCL (TIMES Integrated Assessment Model), and a detailed oil field level database to constrain the temporal availability of conventional oil.

TIAM-UCL, is an extension of ETSAP-TIAM, a global 15- region implementation of the TIMES (The Integrated Markal Efom System) model generator with an objective function that maximises consumer and producer surplus throughout the 21st century. TIAM-UCL includes the United Kingdom as a further separate region, uses 2005 as a base year, and provides data at 10 year intervals (Anandarajah, 2011).

The oil field level database provides information on the maximum capacity of oil production that can be brought on line from conventional oil fields. It is used to represent geological conditions and provide an upper bound on conventional production within each region as well as details of possible 'reserves growth' from fields that have been discovered in the past but not yet brought into production (fallow fields).

The scenarios that are investigated in this paper include variations in remaining recoverable volumes of conventional and unconventional oil. High, low and 'most likely' global volumes of remaining recoverable oil for each category of oil (which include all conventional oil and natural bitumen, extra-heavy oil and oil shale) were described in a recent paper that examined the key uncertainties that exist in developing such estimates and are used in this work (McGlade, 2010).

The effects that restrictions on global carbon dioxide emissions can have on future oil consumption are also investigated. Scenarios include those in which greenhouse gas levels are kept below 450 parts-per-million (ppm) CO_2-eq, the level at which the Intergovernmental Panel on Climate Change considers will give a 50:50 chance of not exceeding a 2°C rise in temperatures above pre-industrial levels, a 550ppm level, and a scenario without any restrictions. A total of nine scenarios will therefore be examined.

Results and conclusions

Consumption of oil by resource category between 2005 and 2100 is demonstrated in Figure 1. No carbon constraints are applied and the 'most likely 'estimate of conventional and unconventional oil is used with approximately 2,000Gb and 2,500Gb of each respectively. Demand grows in every period and natural bitumen provides around 50% of oil towards the end of the century, with Fischer-Tropsch liquids contributing around 20 million barrels/day in 2100. The peak of conventional oil is projected to occur in 2040.

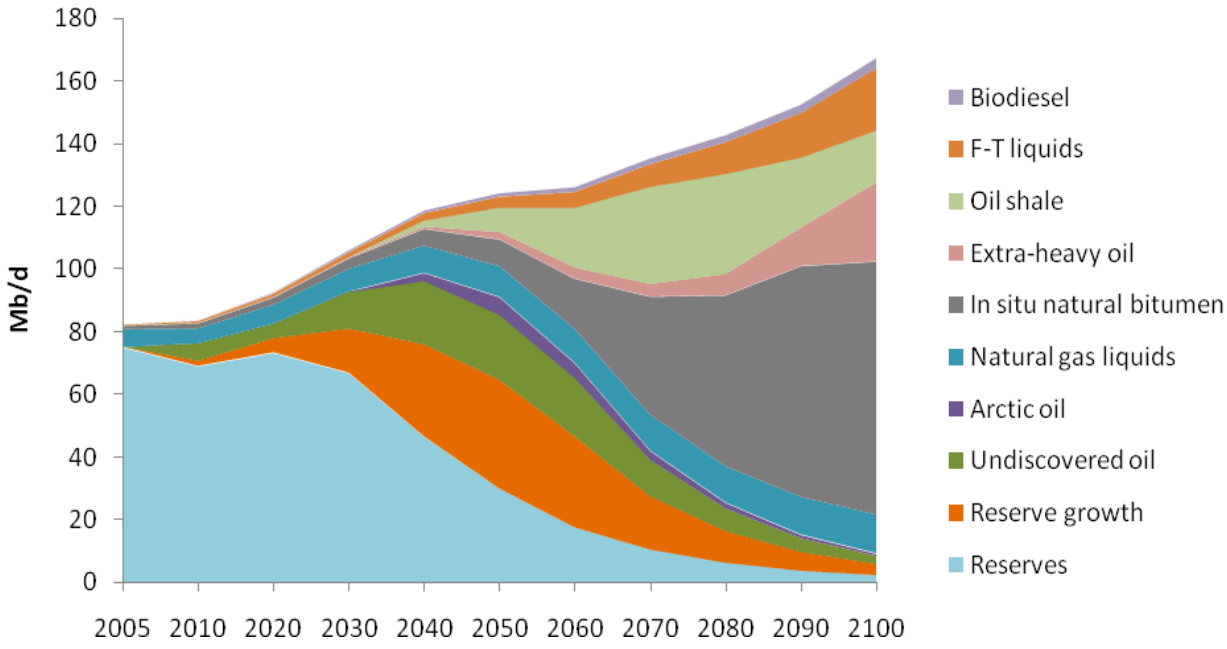

Figure 1: Consumption of oil in the 21st Century with 'most likely' resource scenario and no carbon constraints

References

Anandarajah, G., Pye, S., Usher, W., Kesicki, F., McGlade, C., (2011) *TIAM-UCL Global Model Documentation*
McGlade (2010) *Uncertainties in the Long-Term Availability of Crude Oil* 34th IAEE International Conference
OPEC (2008) *World Oil Outlook 2008*
Schindler and Zittell (2008) *Crude Oil: The Supply Outlook Energy Watch Group,* EWG-Series
Sorrell et al. (2010) *Oil futures: A comparison of global supply forecasts* Energy Policy (2010) 38-9