Global Energy Systems 2013

Industry
Fossil fuels
Nuclear
Academia
Renewables
Policy

Day 3

Energy Modelling Workshop

Rationale

- Not many forums where energy-economy-greenhouse gas modelling experts can engage each other + individual topic experts present
- To bring together integrated energy-economy-greenhouse gas modellers in UK and abroad
- To hold an open discussion on key mechanisms and missing gaps with large effects on model outcomes, and the applicability of models in wider context (academic/policy)
- To facilitate expansion of respective modeller's networks for future cross-pollination of knowledge

Global Energy Systems conference 2013

Energy Modelling Workshop - Participants

- Dr. Michael Kumhof, IMF Research Department, Modeling Unit
- Dr. Nigel Goddard, University of Edinburgh, 4see model
- James Glynn, University College Cork, Irish-TIMES model
- Steve Lochran, UCL Energy Insitute, TIAM-UCL model
- Dr. Jean-Francois Mercure, University of Cambridge, 4CMR Modelling
- Dr. Scott Milne, Energy Technology Institute, UK ESME models
- Simon Davidsson, University of Uppsala, energy rate limits
- Dr. Mikael Gonzalez, BC3 Basque Centre for Climate Change, BC3-GCAM model
- Prof. Reinhard Haas, Technical University of Vienna, Energy Economics Group
- Tobi Kellner, Centre for Appropriate Technology, Wales, ‘Zero Carbon Britain’ mod
- Dr. Alexander Naumov, Group Economics, BP plc

Participant introduction

- Name
- Size of modelling group
- Class of model / problem area
- Participating in a formal modelling network/advisory group

Topics – Agenda guided by questionnaire

Five topics with ± 15 minutes allocated each:

1. Fossil fuel availability per unit time / substitution
2. Energy Source Scalability constraints & Technological change
3. Impacts of price changes on demand
4. Other key issues
5. Model applicability

Questionnaire results

The maximum in the global production of conventional oil due primarily to below-ground resource limits:

a). … has already passed [5]; is likely within 15 years [1]; will happen, but probably after 15 years from now [2]; do not know [2]?

-Here 'conventional oil' ***includes*** *deepwater and polar regions; but* ***excludes*** *oil from tar sands and other very heavy deposits (such as Orinoco oil), 'light-tight oil produced by 'fracking', NGLs (natural gas liquids), liquids from GTL, CTL, and biomass.*

- 'Below-ground resource limit' here means production decline in existing and new fields, combined with relatively small volumes of oil in new fields and from increases recovery factors, will act together to limit the practical rate of production possible,
resulting in a peak and decline in production.

Global Energy Systems conference 2013

The maximum in the global production of conventional oil due primarily to below-ground resource limits:

b). … is likely to be important in terms of impacting the global price / availability of oil [**5**]; will be of no consequence because non-conventional oils will come on-stream sufficiently fast to offset the fall in conventional oil [**2**]; will be of no consequence because climate-change measures or other factors will cause global demand for oil to fall faster than potential supply [ ]; do not know [**3**]?

c). … is reflected in our group's current model [**4**]; might be worth including in our future modelling [ ]; has no impact on our type of modelling [**3**]?

The maximum in the global production of conventional gas due primarily to below-ground resource limits:

***a*).** ... is likely within 20 years [**6**]; will happen, but probably after 20 years from now [**1**]; do not know [**3**]?

b). ... is likely to be important in terms of global price / availability of gas [**4**];
will be of no consequence because non-conventional gas will come on-stream sufficiently fast to offset the fall in conventional gas [**2**];
will be of no consequence because climate-change measures or other factors will cause global demand for gas to fall faster than potential supply [ ]; do not know [**3**]?

Notes: 'Conventional gas' includes associated and non-associated gas and 'normal' tight gas; but excludes shale gas, and gas from coal gasification and methane hydrates. 'Below-ground resource limit' has the same definition as for oil.

The maximum in the global production of conventional gas due primarily to below-ground resource limits:

c). … is reflected in our group's current model [**2**]; might be worth including in our future modelling [ ]; has no impact on our type of modelling [**4**]?

Other answers:

- Is reflected in our model, however including unconventional gas resources as well.

- We don't distinguish between conventional/unconventional sources of gas in our model, so this issue is reflected in our model only insofar as we adjust the cost of the resource input.

Related answers "Open Q" - Priority areas of research for model improvement?

1. The basic, status quo supply outlook. Ideally this should be a whole spectrum that specifies profiles of future supplies as a function of profiles of future prices.

3. The most appropriate mathematical modeling of future output profiles using curve-fitting. Very different curves should apply to crude, oil sands, and light tight. Whatever its perceived other shortcomings, statistical curve-fitting is an essential ingredient of any cutting edge forecasting technique that does not just produce point forecasts but measures of uncertainty.

4. A dynamic global marginal cost curve for oil production. Dynamic meaning not just its current shape, but also its evolution through time as more and more easy-to-produce reserves are depleted.

5. An overview of the sustainability of an industrialized society's key technologies in the presence of limited oil availability and associated very high oil prices.

Below-ground resource limits on the availability of **internationally-traded coal**:

Note: 'Below-ground resource limit for traded coal' means the difficulty of producing physical coal (i.e. excluding in-situ gasification) from countries that export coal, due to problems of access to especially deep or thin seams, or other resource-related constraints to production.

a). … are likely to impact the global price / availability of coal within the time horizon of our model **[2]** beyond the time horizon of our model [**2**]; do not know [**3**]?

b). … are reflected in our current model [**3**]; might be worth including in our future modelling [**1**]; has no impact on our type of modelling [**4**]?

- We don't distinguish between conventional/unconventional sources of coal in our model, so this issue is reflected in our model only insofar as we adjust the cost of the resource input / We want to analyse a less optimistic resource availability case in our model.

Topics - Agenda

Five topics with ± 20 minutes allocated each:

1. Fossil fuel availability per unit time / substitution
2. **Energy Source Scalability constraints & Techological change**
3. Impacts of price changes on demand
4. Other key issues
5. Model applicability

Rate limits (and in particular net-energy rate limits) to the introduction of energy savings measures, and new energy sources:

a). … are likely to be significant in terms of the practical range of energy futures that Mankind needs to consider [**4**]; are not likely to be significant [ ]; do not know [**4**]?

Or other answer: - It's all about rates!

b). … are incorporated in our current model [**3**]; might be worth including in our future modelling [**2**]; are not needed in our modelling [**2**]?

Or other answer:

- [Also] might be worth including in our future modelling
- Connected to the question of substitution elasticities.
- We have a maximum build rate constraint that can be applied to technologies in our model

Related answers "Open Q" - Priority areas of research for model improvement?

- Absence of likely realistic (physical) limits, on the speed of technological growth & energy transitions
- Adjustment of cost optimisation approaches because of underestimation of technology lock-in and a too large degree of assumed coordination
- Price elasticities of supply, both short-run and long-run, including the lag structure.
- Modelling of technological diffusion / Socio-technical regimes
- Expected levels of growth in each industry of a country and industry energy intensity evolution over time

The energy return on energy invested (EROEI) ratios of most non-conventional fossil fuels, and some renewable energies

a). … are significantly lower than for most conventional fossil fuels [**6**]; are not significantly lower than for most conventional fossil fuels [**1**]; do not know [**1**]?

Or other answer: - EROEI for renewables are mostly higher than for all else: wind up to 80:1, PV up to 25, hydro up to 200 (Harvey 2010) CCGT 5? Even with shale gas?

b). … are reflected in our current modelling [**2**]; might be worth including in our future modelling [ ]; are not required in our modelling because: EROEI ratios are largely irrelevant in assessing future energy supply [**1**]; OR: are not an aspect bearing on our results [**2**]?

Or other answer: - We mainly use renewables

- Reflected in our current modelling
- indirectly, in our judgment about the supply outlook.
- We don't use EROEI directly in our cost optimisation model.

Global Energy Systems conference 2013

Topics - Agenda

Five topics with ± 15 minutes allocated each:

1. Fossil fuel availability per unit time / substitution
2. Energy Source Scalability constraints & Techological change
3. Impacts of price changes on demand
4. Other key issues
5. Model applicability

Global Energy Systems conference 2013

The impacts of high energy cost on levels of economic activity, and on available investment and economic resource allocation.

a). … are, in general, sufficiently well understood [**1**]; … are not, in general, sufficiently well understood [**7**]; do not know [**2**]?

Or other answer: - East Asian manufacturers have much higher energy costs than EU, yet are highly competitive.

b). … are adequately reflected in our current model [**3**]; might need significant investigation and/or model upgrading to be adequately reflected in our model [**4**]; are not an aspect the needs to covered by our model [**1**]?

Or other answer: - The impact of high energy costs on the total cost of the energy system is captured in our model. Implications for the wider economy must form part of a qualitative judgement/interpretation/sense-checking of the model outcomes.

Related answers "Open Q" - Priority areas of research for model improvement?

- The economic impacts of price levels of different energy carriers
- The interaction between economic growth (by sector), energy efficiency, and energy consumption
- Substitution elasticities between oil and other inputs into production and consumption. In other words, price elasticities of demand, both short-run and long-run. Where one important question is the lag structure, i.e. with what lag do higher prices lead to substitution.
- Expected levels of growth in each industry of a country and industry energy intensity evolution over time
- The modeling of energy services instead of energy demand (cost per unit of service provided such as hour of light/km. of transport versus unit of fuel, electricity etc.).

Topics - Agenda

Five topics with ± 20 minutes allocated each:

1. Fossil fuel availability per unit time / substitution
2. Energy Source Scalability constraints & Techological change
3. Impacts of price changes on demand
4. **Other key issues**
5. Model applicability

Q – Other key issues

- Irreversible processes of technological change induced by energy prices / energy policy, impacting strongly on energy consumption. For instance, the reductions in electricity consumption in contexts of high electricity prices is not well studied, but may generate nearly half of emissions reductions by 2050.
- Discussing using more integrated multi-disciplinary approaches than has been done in traditional energy modelling (e.g. technology innovation and diffusion, socio-technical regimes, climate science, agriculture/land-use modelling, evolutionary economics)

Topics - Agenda

Five topics with ± 20 minutes allocated each:

1. Fossil fuel availability per unit time / substitution
2. Energy Source Scalability constraints & Techological change
3. Impacts of price changes on demand
4. Other key issues
5. **Model applicability**

Applicability model output in policy support

- Very important as a tool for interpreting results to energy policy makers and to help them understand the effects of their measures (when communicated cautiously)
- A probabilistic cost optimisation model through to 2050 - can certainly support policy makers, for example by identifying ‘no-regret’ technology choices that come through again and again under a wide range of uncertainty.
- Outcomes not welcome unless supporting pre-defined views
- Lack of public understanding on how energy systems can work with variable energy sources (wind, solar etc.)

Applicability model output in policy support

- Not very transparent to outsiders, including policymakers. Transparency and teachability is key to achieve buy-in by decision-makers. “Trust me, I know” is not enough.
- Modellers could aim to get better at being open with how good models have predicted the future historically
- Biggest danger of non-modellers interpreting the results is that they can never fully understand under what assumptions these results are reached
- Problem with mix-up of descriptive and normative. Most models normative in their setup (using desirable scenarios) but interpreted as likely pathways. Also between models (emission scenarios use in climate modelling)

Global Energy Systems conference 2013

Applicability model output in policy support – suggested move forward

The need for an actor based approach to complement macro energy scenarios as per Nick Hughes and Neil Strachan (in Energy Policy Jan 2013).

Most energy system models results are based on changes through high level trends and constraints, without much reference to the actors and the actions necessary to bring about that change.

An actor based approach would assist in understanding the real world obstacles to a 'cost optimal' sustainable energy system and help to identify feasible pathways.

Global Energy Systems conference 2013