Proceedings of the UK Energy Research Centre (UKERC)
1st Energy Systems Modelling Theme (ESMT) Workshop: Transport
1 day technical workshop
22nd June 2005
Policy Studies Institute (PSI), 100 Park Village East, London.

Scope and Aims

This workshop was the first in a series of technical workshops under the Energy Systems Modelling Theme (ESMT) of the UKERC. The overall goal of these workshops is to enhance the links between UK energy modelling practitioners, and to learn about different methodologies and analytical techniques. The specific goals of this 1st ESMT workshop on transport modelling was to bring together energy-economic and transport modellers to learn about each others models, their synergies, and to develop potential collaborations in terms of data, insights and projects. The envisaged workshop outputs were:

- An understanding and typology of various energy/transport models
- Opportunities for sharing data and insights
- Opportunities for collaborative ventures

Around 25 modelling experts – representing a broad scope of interests within the energy and transport modelling fields – contributed to a wide ranging and stimulating discussion. The morning session consisted of presentations on four specific models – two energy and two transport models – and highlighted their various methodologies, level of aggregation, data and assumptions, and key insights. The afternoon sessions first broadened the discussion to cover the full range of energy and transport modelling approaches, and then narrowed the discussion onto possible synergies between the two modelling disciplines and potential collaborative projects.

PRESENTATIONS

Overview of ESMT
Professor Paul Ekins, PSI

Link to presentation slides

Paul Ekins opened the workshop with a welcome to participants and an overview of the Energy Systems Modelling Theme (ESMT) of the UKERC. The ESMT program activities are based around E4 (energy-environment-economy-engineering) modelling including technology-focused bottom-up and macro-economic top-down models. In addition, ESMT is involved in mapping UK energy modelling expertise as well as a program of networking to bring together expertise relevant to UK energy modelling. This workshop is one of the first of these networking activities.

MARKAL energy model
Dr Peter Taylor, Future Energy Solutions

Link to presentation slides

Peter Taylor gave the first of the modelling presentations, with an overview of the MARKAL energy model, and examples of the some of the analyses this well known modelling framework has been used for. MARKAL is a dynamic cost optimisation model of an integrated energy system with an emphasis on the technological detail of the various components of an integrated energy system, including resources supply curves, process technologies, conversion to secondary energy carriers, and demand technologies to meet exogenous or endogenous energy service. Multiple emissions and material flows can be tracked, a complex array of energy carriers allows flexibility in the evolution of the system, and a range of physical and policy-induced constraints are used to fully describe the influences upon the choice of fuels and technologies.

The discussion of the MARKAL model included how to better embody behaviour factors in this cost optimisation approach, how best to include demand changes and inter-modal changes in the transportation sub-sector – i.e. either specified by the modeller or endogenously letting the model select this trade-off. Last, the opportunity to link MARKAL to a geographical information system (GIS) to better model spatial constraints (e.g., urban vs. rural demand for energy) was explored. These are examples of potential transport-energy modelling linkages.

MDM-E3 / M3ME family of energy models
Dr Jonathan Kohler, University of Cambridge

Jonathan Kohler gave the second presentation on energy models, focusing on the E3ME (European level) and MDM-E3 (UK level) family of macro-econometric models. These models combine input-output (I-O) tables of a disaggregated set of economic sectors with econometrical estimated equations (based on historical data) to predict overall changes in the energy sector and the overall economy.

The latter half of the presentation and the discussions that followed focused on the integration of such models with a network transport model such as the SCENES model. In such a linkage, key variables are passed between the models which are then iteratively solved. The key outputs from the transport side include the (relative) costs of transportation modes, as well as demand for use of these transport modes. The key outputs from the economic side include economic growth by sector, government, and for imports/exports which impact the requirements for freight transport, as well as the changes in household consumption which impact the demand for personal transportation.

THESIS transport model
Matthew Page, Institute for Transport Studies, University of Leeds

Link to presentation slides
Matthew Page gave the first transport model presentation with a discussion of the THESIS transport model, a relatively aggregated model designed to look at fuel use and

CO_2 emissions projections from the UK transport sector (road, rail, aviation and shipping). Using public data sources (principally DfT) on a limited set on input factors (including data on new car purchases, vehicle speeds, and miles driven as well as sub-models for fleet turnover and fuel consumption), projections based on specified transport scenarios (e.g. diffusion of hydrogen powered vehicles) can be quickly made.

The discussion centred around the worth of added complexity to the model (e.g. in terms of better specification of real driving patterns or a greater menu of potential new vehicles), and the sensitivity of the model to its current range on input parameters. This conceptual basis for the introduction of new technologies is one example of potential linkages between energy and transport models.

ESTEEM Transport model
Helena Titheridge, UCL

Link to presentation slides

Helena Titheridge gave the final modelling presentation, and discussed the ESTEEM model, which operates at a much more local level. This model focuses on understanding the drivers of transportation demands through an origin constrained gravity model. This model is driven by an understanding of population changes, destinations, and distances between all parts of the network. Energy and emissions impacts are then derived based on distance travelled, speed fuel type and vehicle type. Once again this model utilizes readily available data sources. In terms of linkages to energy models, ESTEEM is an example of a level of detail that energy models do not capture but which potentially could incorporate the key insights as to the behavioural determinants of energy demands.

<u>DISCUSSIONS</u>

Major themes and issues in energy modelling
Moderated by Dr Neil Strachan, PSI

The discussion sessions were wide ranging, but several themes emerged from the energy modellers perspective in relation to energy and transport modelling:

1. How to project future demands for transportation services;
2. How should energy modellers seek to incorporate behaviour and non energy drivers, particularly insights from more detailed transport models; and
3. Issues in linking models, particularly those at different conceptual scales

Focusing on incorporating behaviour, it was noted that energy models contain a great deal of energy technology data whilst transport models may provide behavioural insights into the demands for transportation service. Incorporation of such insights is preferable than merely assuming the adoption and improvement of transport technologies, particularly when these technologies may require large scale infrastructure or societal changes (e.g., a move to a hydrogen transport network or a shift to public transportation).

In terms of formally linking models, this can theoretically be done with any models (noting the issues involved when models operate at different spatial or conceptual scales), but the consensus was that the questions to be answered should drive any such model integration.

Major themes and issues in transport modelling
Moderated by Professor John Polak, Imperial College

This discussion opened with the history of transport modelling from the engineering planning using a 4-stage process (Demand, Destination, Mode and Route) to more wide-ranging efforts to better describe discrete choices, types of trips, and overall patterns of transport demands based on an overall budget of time and money. Additional modelling interests have included long term structural changes and interfaces between different transport modes.

Focusing on projecting future demands, modelling efforts have generated tremendous amounts of data to base such projections upon. But this still needs to be improved in two ways;

- The adoption of new energy technologies – transport modelling offers the tools to quantify scenarios of future demands, behavioural considerations and the constraints to technology adoption.
- The economic / productivity impacts on particular sectors – energy modelling offers the tools to quantify scenarios of fuel prices, infrastructure changes and the macro-economic drivers of freight and personal transport

Practical considerations for modelling collaborations
Moderated by Miles Yarrington, Foresight

Led by Miles Yarrington, this discussion honed in on the practical details of collaborations between different energy and transport modelling groups. This is particularly important given the limited time and resources of all potential participants.

The purpose of any model collaboration was discussed; with the emphasis placed on what the questions were to be answered, the relevance to policy and policy-makers and any contributions to model development. Collaborations were seen as a way to tap into a different research discipline or perspective, to access new or improved data sources and to gain access to models themselves as a repository of knowledge. The type of model was deemed to be of great importance in any joint projects, notably whether they were forecasting (predictive) vs. scenario (what-if) models, and at what spatial scale and level of complexity they operated at. Last, questions on funding of joint modelling were raised – one potential starting point for this is the limited funds under the UKERC's ESMT for developing new project ideas.

Collaborative projects and workshop conclusions
Professor Paul Ekins, PSI

Paul Ekins concluded the workshop by highlighting some key themes from the day's discussions. In particular, he noted that transport modelling offers insights into demands for energy services, behavioural considerations and practical constraints on the adoption of new technologies, and that energy modelling offers insights into the details of technological options, the costs and scopes of fuels and infrastructures and the macro-economic drivers of freight and personal transportation.

Some example projects that the two modelling groups could collaborate on include:

- The rates and determinants of long term technological change
- Range of drivers of technology diffusion
- The evolution of hydrogen energy carriers and transport configuration