1. EUSUSTEL WP6.3: Compatibility with liberalisation of electricity and gas markets

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1.1 Introduction

The compatibility with liberalisation of electricity and gas markets in the results of the modelling exercise depends on the type of models, the scenario assumptions and the results for the structure of the future electricity supply as calculated by the models.

The models used for the EUSUSTEL scenarios are technology-rich bottom-up models, which describe a future that is optimal under a set of quantitative assumption. These assumptions may reflect different ways of organising the energy market.

Least-cost optimisation of the supply of a planned expansion of electricity consumption – using a discount rate that reflects a social time preference – was a classical way of using these models for a planned development of large-scale power plants.

A main characteristic of a market economy is that consumers normally demand less at high prices than at low prices. Consumer behaviour can be reflected by introducing income and price elasticities into the model. Instead of minimising cost, the model will now maximise profit or utility – the economist's concept of the benefit for the various agents within the market. In its simple form, the model shall maximise the sum of "consumers' benefit" and "producers' benefit".

Another key feature of the market is that producers face competition and commercial risks. Thus, the discount rate must be higher than the one used for a least cost optimisation of investment options over a planning period.

1.2 Discount rates

The main source for demand forecasts for the EUSUSTEL scenarios is the report "European energy and transport — Trends to 2030 - update 2005" published by the European Commission, Directorate General for Energy and Transport. This report contains a description of a reference case to 2030, which was also used by EUSUSTEL.

The use of discount rates in PRIMES is described as follows:

"The discount rate plays an important role within the PRIMES model. It is a crucial element in the determination of investment decisions by economic agents regarding energy using equipment. Three (real) rates are currently used within the model. The first, used mostly for large utilities, is set at 8 %; the second, used for large industrial and commercial entities, is set at 12 %; the third, used for households in determining their spending on transportation and household equipment, is set at 17.5 %."

Different discount rates have been applied in the studies, which were used as reference for the scenario building.

The SAPIENT project considered technology opportunities, R&D and market experience, refering to different modelling studies. In one of these model studies "Two-factor learning curves in ERIS" by Leonardo Barreto (IIASA-ECS) and Socrates Kypreos (PSI), a 5 % discount rate is used in all calculations. For other models in the study, ISPA meta-Model and TIMES-WEU, a constant 4% discount rate throughout as requested by the Commission. Also in the following study, SAPENTIA, the overall discount rate used is 4 %, in line with the Commission's request for the SAPIENT project. However an 8 %

discount rate was used for a harmonised framework for the comparison of production costs of electricity.

The choice of discount rate for long-term models is difficult from a theoretical point of view. It may also have significant practical impact on the results, because higher discount rates will discourage capital-intensive technologies, such as nuclear and renewables.

The 8 % real discount rate used in PRIMES for large utilities should be considered consistent with a liberalised electricity and gas market, which will continue to be dominated by large entities with a long time-horizon.

1.3 Elasticities

The use of elasticities is described in the SAPIENTIA report:

"The end demands are attributed with a price-elasticity that allows them to differ from the input value under the effect of changing commodity prices. Commodity price changes are for instance induced by CO_2 constraints that will increase the internal price for fossil fuels. This mimics an actor behaviour and results in an estimate of the change of the producers and consumers surplus. This latter can be used as an approximation of the welfare loss under the given scenario assumptions."

Ideally, these elasticities should be quantified using econometric estimations. In practice this is difficult, so the elasticities used in models will be based on pragmatics and model experience, and reflect the different behaviour of different types of electricity consumers. Some consumers are more likely to react on prices than others, and price elasticities in the long term will be different from the short term.

The impact of price elasticities in the PRIMES model is reflected in the aggregate demand. Total electricity demands in the three scenarios differ from the baseline as follows:

– Post-Kyoto (PK) -1 %
– Post-Kyoto, All Technologies (PKAT) +0.5 %
– Limited Import Dependency (LID) -1.5 %

1.4 Model differences

PRIMES is a price-driven and agent based simulation of markets. It is different from other models in the sense that the behaviour of types of agents is simulated separately from others (agents: e.g. households, steel industry, trade sector, power generation, etc.); the behaviour is modelled according to microeconomic theory, including behavioural patterns, such as habits, comfort, risk management and simultaneity with other economic decisions

– As a result of individual behaviours, demand and supply of energies is formulated.
– A set of simultaneous energy markets are then cleared to determine prices that balance demand and supply; if price regulation applies, price determination

follows a Ramsey-Boiteux methodology (adaptable to both regulated monopoly and competitive markets);

- Market equilibrium is static within a period but evolution is dynamic in a time forward manner as investment is endogenously driven by supply demand imbalances and technology profitability expectations.

In TIMES the optimisation is more straightforward and transparent. All parameters are controlled by the user. The discount rate is a parameter, which is set by the user for a particular study. Normally, an overall discount rate is used for the system described by the study. The TIMES-EG model for the EUSUSTEL project covers the electricity and gas market in the 25-30 European countries, using the same key assumptions as the PRIMES model.

1.5 Security of supply – hedging strategies

Some features of the new baseline scenario used for EUSUSTEL have impact on market compatibility compared to the previous EU baseline scenario to 2030.

The key to the compatibility with liberalisation of electricity and gas markets lies in the new baseline scenario for the EU.

The previous 'dash for gas' is now a part of the infrastructure, which will complement a larger share of intermittent generation, in particular wind. Technology advance and progressive deregulation of electricity markets supports significant growth of gas based plants in the medium term. However, recent uncertainty with high gas prices slows down this process; however the EU ETS related costs may sustain gas plant investments

An important feature of the new EU Baseline Scenario is that massive substitution from coal to gas is replaced by moderate substitution from coal to wind. In addition, gas capacity will be used more as complement for wind, rather than base-load.

This may lead to a more competitive market for wholesale electricity, which will be less dependent of the oligopolistic gas market.

Renewables and other small-scale electricity generating technologies may be purely market driven or market driven with public support or subsidies.

Nuclear investment requires very strong institutions as well as political support, cf. Nikula and Kätkä 2004. In terms of the scenario models this issue is handled by allowing the nuclear option for some countries, but not all.

In evaluation of the market compliance it must be kept in mind that overcapacity in the first phase of liberalisation in many countries was a part of the infrastructure, which supported an electricity market with competition based on short-term marginal costs.

1.6 Model and data weaknesses

The main weaknesses of the model results are due mainly to weak data for scenarios on

- Electricity demand variations
- New demand segment with special characteristics concerning load variations, e.g. space cooling and transport.

– Heat market infrastructure, i.e. district heating and industrial heat/steam demand.

– Distributed electricity generation

Some of these weaknesses may have significant impact on the compliance with a liberalised market. CHP and district heating network infrastructure is very difficult to treat in an optimisation or market balance model, because all networks are very site specific, and regulation is essential to build up an infrastructure on which a market could work. Allowing competition to oil and gas for space heating and cooling will require investment in network infrastructure, which is not easily handled in models of the type used for this project.

1.7 Conclusion

The results from the two models are substantially the same, in particular concerning electricity generating technologies. The main difference is that the split between coal and gas is more sensitive to parameter variations in TIMES. This is explained by the more straightforward optimization in TIMES compared to PRIMES.

The cost of electricity generation is systematically lower in TIMES than in PRIMES, in particular in the starting year, but decreasing during the optimization period. This is also explained by the structure and calibration of the models. PRIMES has been calibrated to represent the European energy markets over more than ten years and used in many studies. The version of the TIMES-EG model used for EUSUSTEL is using a dataset that is specific for the study, and the results on electricity prices are in dual values from the linear programming optimization.

In of the weaknesses mentioned above, the conclusion is that both sets of model results represent the state-of -the-art for scenario models available for the European electricity market.

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