EUSUSTEL

European Sustainable Electricity; Comprehensive Analysis of Future European Demand and Generation of European Electricity and its Security of Supply

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WORK PACKAGE 8

Project guidance, coordination and management

Subtask 8.1

Definition of scope, boundary conditions and management

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1. Scope and Objectives

1.1. Strategic objectives

The **strategic objective** addressed by the project EUSUSTEL is summarised as follows.

To provide the EU Commission and the member states with coherent guidelines and recommendations to optimise the future nature of electricity provision and the electricity generation mix in Europe so as to guarantee an ***affordable, clean and reliable*** *, i.e., '****sustainable****', electricity supply system.*

The aim is to establish a common European methodology to evaluate the 'sustainability' (in terms of cost, environmental impact and security of supply) of future electricity provision systems. The implementation of a particular electricity provision system in the different member states can take into account different policy preferences and geographic realities, but the overall social cost (including all kinds of externalities) of the chosen system should be computable following the same methodology. Clearly, the consequences of particular choices by some member states on other member states should be clearly identifiable. In summary, there is no problem with a mosaic of electricity supply systems in the EU, but the consequences of possible non-coherence should be clearly understood in terms of GHG emissions, security of supply, electricity generation and transmission capacity, back-up costs, etc. The resulting picture should indeed be compatible with an integrated liberalised European market for electricity (and gas). Without compromising the 'visionary' projections of this work, throughout the project, the degree of realism is continually checked by the electric industry. The guidelines provided by this project will allow the Commission to help steer national energy policies if that is desirable.

1.2. Measurable and verifiable objectives

The **measurable and verifiable objectives** are:

1. Delineate the overall **scope, boundary conditions and hypotheses** of the project and establish a framework for the concept '**sustainability**'.

2. Make a **review analysis of the electricity provision in the EU-25 countries**, and establish a summarising report per country.

   The aim is to identify the current 'weak points' (if any) in the European electricity generation mix and electricity provision system with respect to cost, environmental impact and security of supply. Through a review exercise of *existing* electricity generation technologies, the overall integrated generation systems and their interconnections (for electricity and gas) in the European countries, it will be evaluated what are the environmental effects, the global cost and the reliability of each electricity supply system. In addition, the *future* electricity provision, as envisaged in policy documents of the member states (if available), will be carefully looked at and commented upon. The 15 EU member states up till April 30, 2004, for which 'good' information is widely available, a well-documented country analysis will be provided.

For the 10 new members, acceded on May 01, 2004, the 'quality' of the country analysis will depend on the available documentation in non-local languages such as English, French or German.

3. Make projections for reasonable evolution of **demand for energy services** and determine the relationship with **electricity demand**. Propose justified Demand Side Management (DSM) measures.

   To study the evolution of electricity consumption, one must first establish the 'desirability' to reduce electricity demand. Economic growth and demand for energy *services* are usually strongly related. But the *electricity* demand does not necessarily show the same trend. Both top-down and bottom-up approaches must be considered to determine the so-called technical, economic and market energy-savings potentials. Comparison of the total cost of a saved kWh versus a supplied one, should clarify whether electricity reductions should be exogenously encouraged or whether the market should be allowed to determine the growth of electricity demand. This issue is not trivial and is characterised by a fierce debate between the 'conservationists' and the 'classical economists'. Furthermore, shifts between energy carriers may lead to less desirable effects, for environment, flexibility of use, etc. Based on the outcome of the demand issue, appropriate DSM measures should be proposed to manage a justified evolution of the electricity demand in the different countries.

4. Make an analysis of **electricity generation technologies** (including aids such as storage) and their **integration into the overall generation system**. For each technology, a realistic range of technical, environmental and economic characterising parameters are to be identified and future evolutions are to be estimated, with a horizon of 2030 (-2050).

   New supply-side conversion technologies will be necessary in the future. A detailed analysis of the current electricity generation technologies and a projection of the evolutionary improvements is to be undertaken. The whole range of centralised and decentralised technologies will be considered. The horizon of this technology projection is 2030-2050.
   Four extra items have to be considered: electricity storage, the possibilities of fuel cells including the reasonableness of a future hydrogen economy, CO_2-capture and storage, and the possibilities for unconventional, speculative and bifurcation-causing technologies. All of these aspects must be critically evaluated.

5. Make an analysis of the current **regulatory framework and its technical and economic consequences concerning the liberalisation of the electricity market** (and the influence of the directives on renewable energy, CHP and emission trading). Reflect on an 'ideal' fully consistent framework for a fully integrated European electricity (and gas) market, so as to establish appropriate boundary conditions for the overall EU generation system (centralised versus decentralised, generation mix, geographical location of generation capacity, dispatch-able or not).

   Although it is not certain that the future European electricity provision context (of 2030) will be based on an integrated liberalised market, it is a basic hypothesis of the present study that the current trends of liberalisation and EU-wide integration will continue to develop, culminating in an optimal liberalised sustainable energy market. On the one hand, the guidelines for a liberalised market will influence the electricity generation setting: incentives for new capacity building, consequences of network congestion and newly constructed cross-border transmission lines, rules of the game concerning availability of, and easy access to, gas transport lines, needed reserve capacity, degree of penetration of correlated fluctuating generation capacity, etc. Conversely, the nature of generation capacity, e.g., centralised versus decentralised, base load versus peak load, easily dispatch-able, etc, has consequences for the implementation of the market. In addition, the consequences of the directives for renewable electricity, combined heat & power (CHP), and emission trading, must be evaluated with respect to the liberalised market, on the one hand, and the composition and location of the different components of EU electricity generation system, on the other hand.

6. Determine the **total social cost** for electricity generation, both statically and taking into account system interaction. Perform **scenarios to determine the 'most optimal solution'** for electricity provision in the EU.

   To have a common denominator for the "value" of an electricity system the *total social cost* is used as a common denominator. It at least permits to compare indicative trends. The social cost includes the 'private cost' and the (usually environmentally related) 'external costs'. Also other 'shadow costs' such as back-up costs, extra electricity transmission systems, risk premiums, etc should be considered. All costs are to be evaluated using a life-cycle approach. To obtain the *overall total cost*, it is furthermore necessary to compute it for a completely integrated system. Towards that end, it is important, using the static cost figures as input for simulation codes to find the 'most optimal solution' (from an economic-efficiency point of view).

7. Assure that the results of this project are **appropriately screened** with respect to the degree of realism, compatibility with liberalised markets and the 'desire' for security of supply. Furthermore the results should be validated against international studies.

   The 'most optimal solution' obtained in Objective 6 should not be a mere 'academic' result, but it must be scrutinised with respect to the real-life expectations of different players on the energy scene. In addition, the solution must be compatible with the dynamics of the liberalised markets and must offer a sufficient degree of security of supply. Lessons can also be learned from comparison with other enveloping international studies. Towards that end, a Consultative Committee with stakeholders will be established.

2. Boundary Conditions

Defined as such or fixed constraints

- Time horizon: focus on 2030; reflect upon 2050
- Physical constraints: wind conditions, insolation, available area…(potentials)
- No physical shortage of fuels (but at what price?)
- Postulate common electricity & gas market based on current directives (take perfect transposition) -- To be discussed.
- Accept current environmental & safety standards of EU (NO_x, SO_x, PM10, …but not on GHG) throughout
- Post-Kyoto too uncertain as boundary condition → via hypotheses
- Other existing legislation & regulation as basis (other variations later as different hypotheses) EU & MS

3. Hypotheses

Basic assumptions ('debatable')

Some basic hypotheses throughout study → act as boundary conditions
Hypotheses in the proper sense can be varied in different scenarios
First set of hypotheses defines "reference" scenario
Different hypotheses allow sensitivity analysis
Examples:

- Introduce varying schemes for DSM (e.g., white certificates)
- Post-Kyoto: -16% in 2030 (linear extrapolation)
- Change nuclear policies: phase out or not

- Fuel prices: Assume latest (fall 2005) PRIMES evolution:

Table 1 presents the world fuel price projections that are currently used within the PRIMES exercise for the European Commission. The word Base indicates the baseline; High-indep means higher oil price and higher but less than oil gas price, and High-depend. means higher oil and gas prices scenario. Consistency is ensured through our world energy model Prometheus and the Poles model. Figure 1 gives a schematic representation.

PRIMES prices scenario									
Euro'00 per boe	1990	1995	2000	2005	2010	2015	2020	2025	2030
	1990	1995	2000	2005	2010	2015	2020	2025	2030
Oil high	18.71	14.14	30.57	39.32	45.05	49.21	56.51	63.49	71.74
Gas - independ.	7.55	6.95	14.47	22.07	25.19	28.28	30.41	35.12	40.66
Gas - depend.				22.07	26.82	32.55	38.61	44.33	53.38
Coal high	8.84	8.72	8.23	9.69	9.92	10.34	11.86	12.57	14.38

$05 per boe		1990	1995	2000	2005	2010	2015	2020	2025	2030
Oil	High				54.00	61.87	67.58	77.61	87.21	98.53
	Base				54.00	44.61	44.91	48.06	54.44	57.60
Gas	High - indep.				30.31	34.60	38.84	41.77	48.23	55.85
	High - depend.				30.31	36.84	44.70	53.03	60.89	73.31
	Base				30.31	33.89	34.22	36.98	42.87	44.75
Coal	High				13.31	13.63	14.20	16.29	17.27	19.75
	Base				13.31	12.54	13.36	14.07	14.59	14.95

(ratios)	1990	1995	2000	2005	2010	2015	2020	2025	2030
Oil/gas-base	2.48	2.03	2.11	1.78	1.32	1.31	1.30	1.27	1.29
Oil/gas-high depend	2.48	2.03	2.11	1.78	1.68	1.51	1.46	1.43	1.34
Oil/gas-high independ	2.48	2.03	2.11	1.78	1.79	1.74	1.86	1.81	1.76
Coal/gas base	1.31	1.55	0.81	0.63	0.52	0.53	0.52	0.46	0.46
Coal/gas high depend	1.31	1.55	0.81	0.63	0.48	0.41	0.36	0.33	0.28
Coal/gas high independ	1.31	1.55	0.81	0.63	0.51	0.47	0.46	0.41	0.37

Table 1 Fuel price assumptions according to PRIMES prices scenarios.

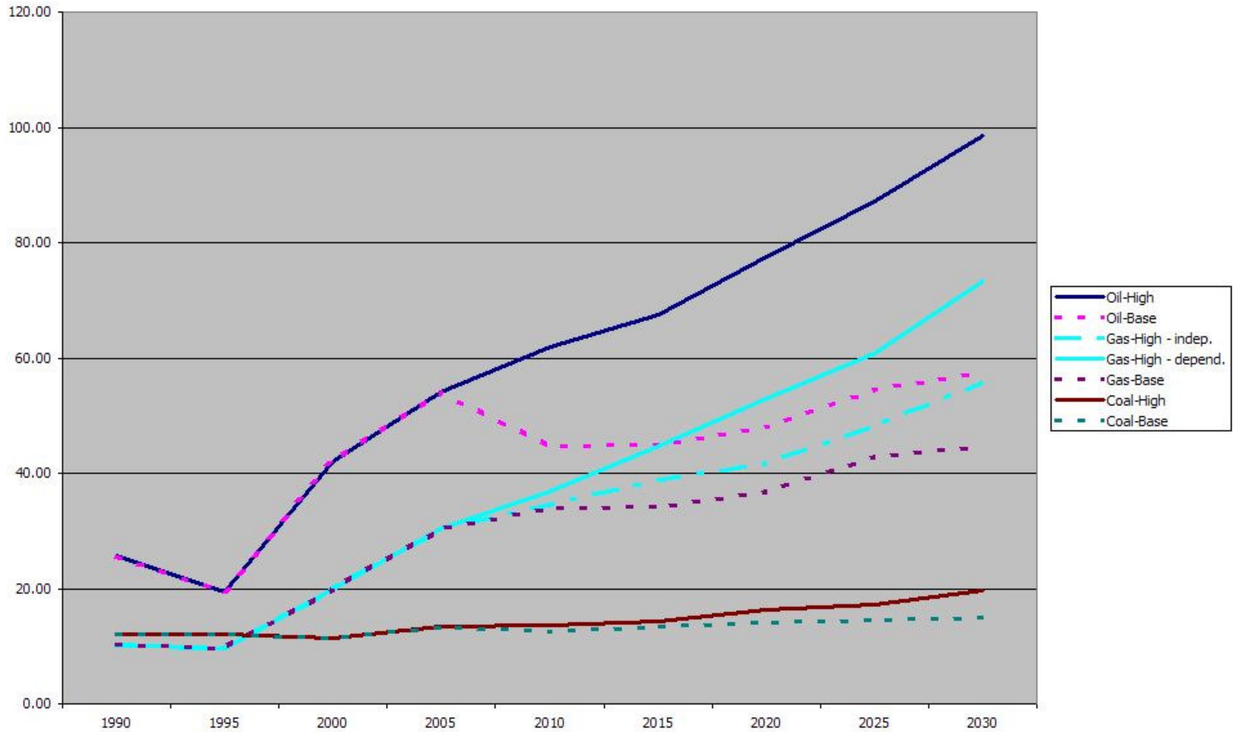

Figure 1 Fuel price assumptions according to PRIMES prices scenarios

- Scenarios: 4 basic cases will be studied.
    1. Baseline scenario: High prices + no post Kyoto limit + baseline nuclear and other options
    2. Baseline scenario, but post Kyoto
    3. Scenario 2, but free nuclear option (no extra promotion on other options)
    4. Scenario 3, but promoted energy efficiency and distributed generation.