SIXTH FRAMEWORK PROGRAMME

EUSUSTEL

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

PRIORITY SSP-3

Policy Support and Anticipating Scientific and Technological Needs

Contract for:

SPECIFIC SUPPORT ACTION

Annex I - "Description of Work"

Project acronym: EUSUSTEL
Project full title: **European Sustainable Electricity; Comprehensive Analysis of Future European Demand and Generation of European Electricity and its Security of Supply**
Proposal/Contract no.: 006602

Date of finalisation of Annex I: October 08, 2004

Start date of contract:

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1. Project summary

The proposed project aims at providing a fully consistent framework for a secure electricity provision, that is at the same time environmentally friendly and affordable. The conclusions of the project must result in policy recommendations for the member states and the Commission. The methodology used mixes two directions of analysis. In a first (horizontal) one, the existing electricity systems of the 25 EU countries are analysed and national policy choices and future projections are studied. Next, vertically then, a subject-wise treatment is considered, whereby both the demand side as well as the supply side technologies and system integration are treated. Furthermore, the regulatory and liberalised market framework for an integrated European electricity market is carefully examined and appraised. Based on these analyses, it is then in a combined approach attempted to summarise the 'static' overall social cost (private cost plus external cost) for electricity generation. Subsequently, these cost figures are used as input in carefully screened simulation models in order to perform some well-defined and contrasting scenarios, but in line with the regulatory framework of the energy market. From these results, it must be possible to obtain the 'most optimal solution' (from an economic-effectiveness point of view —including environmental burdens) for the electricity provision in Europe.

2. Objective(s) of the project and state of the art

The **strategic objective** addressed by this project is summarised as follows.
To provide the 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.

In a sense, 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.

The **measurable and verifiable objectives** are:

1. 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.

2. 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.

3. 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 are 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.

4. 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 – 2050) 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.

5. 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).

6. 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 5 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.

7. Create a platform for interaction with the public at large to permit outside inflow of ideas by means of a web site. Assure that the information obtained via this project, its conclusions and recommendations find their way into the public domain.

   The proper dissemination of the results will be done through a web site, a final international seminar and the editing of a final well-readable document with conclusions and recommendations.

8. Establish clearly the overall scope, boundary conditions and hypotheses of the project. Guarantee that a consensus is reached on the framework for 'sustainability'. Assure well-managed project coordination.

   For practical reasons, this 'fundamental' objective to define the 'area of applicability' of this project and the establishing of a 'sustainability framework' is put under the last objective, although chronologically these objectives are to be reached at the beginning of the project. The way to pursue these objectives is put together with the project-coordination activity.

The means to realise the objectives are grouped into workpackages 1 through 8, to be detailed below. The deliverables and planning for reaching these objectives are those of the workpackages.

<u>State of the art</u>

To a large extent, the work proposed effectively consists of a major <u>critical review and evaluation exercise</u> of *existing* studies, published papers, reports, policy documents, scenarios, etc., whereby those are held against the light of coherence, and expertise and experience of the Scientists and electric industry. Indeed, much has been published over the last years on the energy issue in general and electricity provision in particular, but regrettably, very few critical reviews of the published material have been undertaken. Often, there is plenty of inconsistency of the material published within a particular country, let alone that the material is consistent for whole regions. Assuming that the presentation of the data is not manipulated, the discrepancy often lies in the definitions and conventions behind the numbers. Even stronger, for future projections, many (often hidden) boundary conditions and hypotheses are imposed and assumed, which then lead to a variety of conclusions that may lead to very unrealistic scenarios, mostly insufficiently checked with regard to full consistency. In addition, policy documents often have a style of good intentions, usually wrapped in some diplomatic language, that may reflect a short-sided approach or project nice-looking visions, which may turn out to be very 'undesirable' in the long run. By means of an extensive "reviewing exercise", complemented with own insights, this project intends to "set the record straight" and to deliver a fully consistent picture of future electricity provision.

3. Participants list

List of Participants

Partic. Role*	Partic. No.	Participant name	Participant short name	Country	Date enter project**	Date exit project**
CO	1	Katholieke Universiteit Leuven	KULeuven	Belgium	Month 1	Month 24
CR	2	Universitaet Stuttgart	USTUTT	Germany	Month 1	Month 24
CR	3	Helsinki University of Technology	HUT	Finland	Month 1	Month 24
CR	4	National Technical University of Athens	ICCS/NTUA	Greece	Month 1	Month 24
CR	5	Uppsala University	UU	Sweden	Month 1	Month 24
CR	6	Associazione Italiana Economisti dell'Energia	AIEE	Italy	Month 1	Month 24
CR	7	Imperial College of Science, Technology and Medicine	Imperial	United Kingdom	Month 1	Month 24
CR	8	ECRIN	ECRIN	France	Month 1	Month 24
CR	9	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas	CIEMAT	Spain	Month 1	Month 24
CR	10	Risø National Laboratory	Risoe	Denmark	Month 1	Month 24

*CO = Coordinator
CR = Contractor

** Normally insert "month 1 (start of project)" and "month n (end of project)"
These columns are needed for possible later contract revisions caused by joining/leaving participants

4. Relevance to the objectives of the specific programme and/or thematic priority

The objective of the project is certainly relevant towards the support of policy. The project will automatically be faced with the consequences and boundary conditions of several EU directives, regulations and guidelines:

- directive on the liberalisation of the electricity markets
- directive on the liberalisation of the gas markets
- regulation on cross border transmission
- policy guidelines on Trans European Networks – Energy (TEN-E)
- proposal for a directive on infrastructure
- directive on renewable electricity generation
- (proposal) of directive on energy efficiency
- directive on cogeneration
- directive on emission trading
- proposal for a linking directive.

In addition, the study will scrutinise earlier EU policy studies such as the Green Paper and other documents, amongst which Commission Communications. Furthermore, the study will be able to draw conclusions on a possible future of nuclear power in Europe (especially given the fact that some countries have opted for a phase out, while in other countries there seems to be a renaissance).

The study will furthermore permit to draw conclusions concerning a properly functioning liberalised electricity market, thereby providing recommendations so as to minimise the risks for black outs as happened in the summer/fall of 2003.

The results of this work will certainly find their way into future legislation.

5. Potential Impact

- The results of this work will support European Union legislation in the energy field;
- linking environment and social issues;
- possible contribution to various energy technologies in the medium to long-term future;
- EU added value: coordination and exchange of information amongst organisations from 10 different member states;
- scientific consensus on a very uncertain issue;
- policy recommendations on the EU level.

6. Project management and exploitation/dissemination plans

6.1 Project management:

The project management activities for this project constitute mainly the proper timely organisation of the different workpackages and their subdivisions. For each workpackage, the

detailed allocation of tasks (which already exists and which will be part of the Consortium Agreement), but then with recognition of the planning, milestones and deliverables, will be made. This is a so-called '*WP-ordinance*'. All sub-tasks will be spelled out there in comprehensive but concise format (summary sheet).
The overall project management will in addition steer and check the flow of information and documents. The planning and the deliverable dates are the guideline for this.

Additional project management activities, as explained in the work plan, are the practical organisation of the meetings with the Consultative Committee, and the international seminar.

Finally, the project management oversees the flow of information for the editing of the final report.

The project-management activities throughout the development of the project will be overseen by a *Steering Committee*, made up of the project co-ordinator, the workpackage leaders and the Commission's responsible officer.

6.2 Plan for using and disseminating knowledge:

Throughout the project, and after the study has been performed it is planned to communicate the progress and the final results by means of a *website,* an international information *seminar*, and a *well-readable document* summarising the project.

The website will be 'open' after the first intermediate results are available. There will be a possibility for web visitors to react to the documents, such that throughout the process a sort of public consultation & interaction can take place. The web site will also be used to communicate between the project participants through a members-only area.

The website will contain a well-structured section with the list of documents consulted and used for the study. The sources will be clearly indicated and where possible, the web addresses are provided.

The seminar will be at the end of the project and it will be of an informative nature. This is consistent with an 'open web site' during the project.

A final publication will be the most visible and lasting result for policy makers. This document will contain the methodology, results, recommendations and conclusions of the project.

6.3 Raising public participation and awareness:

At the formal beginning of the project, perhaps at the time of the kick off meeting, it is contemplated to issue a press release / communiqué and a press conference for the science & technology, and/or environmentally and/or economy oriented reporters in Brussels. It may be considered to write articles in the energy magazines of Europe to inform about the start of the project.

The seminar and the publication, will be other occasions to draw the public's attention.

7. Workplan – for the full duration of the project

7.1 Introduction - general description and milestones

In line with the specifications of the call, this project will be performed by a group of high-level energy scientists, supported by their laboratories or research groups, in close collaboration with the electric industry.

The scientists of the consortium have been chosen to guarantee a well-covered geographical representation in Europe, on the one hand, and to draw on their energy-related expertise in their own country and internationally. It has been tried to gather a consortium of scientists that will rely on rational reasoning and common sense, rather than to choose a-priory 'ideologically-coloured' advocates of a particular energy vision. Nevertheless, it may be the case that the group covers a variety of insights, approaches and viewpoints, reflecting the differing existing policy orientations in Europe. The combination of the rational approach, but with perhaps different 'beliefs' with regard to future technology breakthroughs and public acceptance of particular technologies, may be a guarantee for a well-balanced outcome of the exercise.

To help guarantee that the views of the scientists are not too different from what real life shows, intensive interaction with electric industry, especially via its umbrella organisation, Eurelectric, is planned. Hereby, Eurelectric will act in this project as a '*Special-Focus Industrial Advisor*'. To hear the voice of other major stakeholders, a *Consultative Committee*, will be established.

As explained under § 2 on the "Objectives and State of the Art", the work for this project entails a major effort of reviewing and evaluating existing studies and publications, carefully complemented with the project participants own expertise and views. This review and evaluation must be undertaken with regard to studies referring to *countries or regions*, as well as with regard to the state of the art, the future projections and the likelihood of penetration and/or renaissance of particular energy-conversion *technologies* (both on the end-use side as on the supply side). Furthermore, the study must take into account policy trends such as the drive towards a liberalised and fully integrated European electricity (and gas) market, the consequence of climate-change-abatement measures and the promotion of renewable sources and Combined Heat and Power (CHP).

The review and evaluation exercise will consist of a major effort of sifting through the documents, verifying and crosschecking the results and conclusions and of confronting the different viewpoints so as to try to detect the underlying assumptions and boundary conditions. The review performed by one particular project partner will effectively be 'verified' as the whole group gets a chance to comment on the conclusions of the reviews. It is the goal that the whole group reaches a consensus on the treated subjects. As mentioned above, the results will be reviewed by the '*Special-Focus Industrial Advisor*', Eurelectric, and will be discussed with the Consultative Committee.

After all technology-related and country-oriented reviews have been finished and a consensus on the technical, economic and environmental data of the technologies and their evolution, and their degree of implantation in particular countries has been reached, a limited number of well defined <u>scenario runs will be performed</u> with the code(s) chosen from an analysis exercise of simulation codes. The boundary conditions and hypotheses of these scenarios will to a large extent be determined by the so-called context issues such as liberalised markets, climate change and other specific policy trends (such as renewables, CHP, energy efficiency, etc).

The work will deal with the entire EU, i.e., the EU-25. Because of expected difficulties with the availability of 'good' documentation on the most recently acceded 10 member states, some analysis may be more detailed for the EU-15 than for the EU-25.

To be clear, little original research is expected from this project. The emphasis lies on consistency of data, approaches and policies. Hopefully some new insights might emerge, both from the *country* and *technology reviews,* and from the *scenario runs*, but they will perhaps be more of a global methodology-related nature than having a novel and innovative character.

Roughly speaking, the different partners are each individually responsible for two types of tasks, after which, in a next phase of the project, all are co-responsible for the integration of the work. In addition, the co-ordinator defines, in collaboration with the partners that perform the work, the detailed objectives and working method for each task (which may depend on the subject). Furthermore, the co-ordinator manages the appropriate flow of information from one partner to the others, and will be the stimulating factor to reach a consensus amongst the partners in the individual tasks as well as in the overall integration phase.

Workpackage 1: **Country-wise analysis for EU-25**

The first type of tasks is situated in the '*horizontal*' direction. It concerns a review about the energy-related documents of countries or groups of countries. The idea is that a partner belonging to a particular country (or familiar with it) thoroughly reviews the appropriate 'relevant' documents dealing with the electricity-related energy policy of that country. One should start from international reviews such as the tri-annual *IEA reviews per country* [1] (if they exist for the country in question). Next, typical European reports, dealing with the different countries (such as '*Annual Energy Review*' [2], '*European Union Energy Outlook to 2020*' –Nov 1999-[3], *European Energy to 2020*' – Spring 1996 [4], '*European Energy and Transport; Trends to 2030*' – January 2003 [5]). Then, appropriate other international reports dealing with that country should be consulted, after which all 'relevant' national reports should be studied in detail. As examples for these last ones, we mention –non exhaustively– the reports issued by generators, utilities, federations, etc and reports such as '*Analysis of the Means for the Production of Electricity and the Re-orientation of the Energy vectors*' (*AMPERE)* in Belgium [6], the governmental white paper in the UK '*Our Energy Future; Creating a Low-Carbon Economy'* [7] and the reaction to it by a.o. Laughton '*Power to the people; Future-proofing the security of UK power supplies'* [8], the French white paper '*Livre blanc sur les énergies'*, resulting from '*Le débat national sur les énergies*'[9]. For the newly acceded countries, a good starting point is the Commission's memo *'Enlargement and European Union Energy Policy'* [10]. Also, the information of Ref [5] will be highly relevant in that respect, as will be the documentation on *'Trans European Energy Networks'* [11].

The reviews are to take into account the different policy orientations in different countries (e.g., the nuclear option in France and the wind option in Denmark) but should not consider these policies as being frozen. Political reality demands that flexible policy options are kept open; but the reviewers should certainly indicate the degrees of freedom for 'policy freewheeling'.

A critical analysis should result, whereby the reviewers do not necessarily have to 'agree' with the conclusions of official documents. The review and evaluation by the (home) partner will be scrutinised by the project management and can be checked by a different partner, if so desired. The conclusions of these (initial) reviews are to be written down in a report (of limited-size, with a maximum of 10 pages) with clear explanatory and justifying statements.

The proposed distribution of work will be as follows:

Sub 1.1: BeNeLux	partner from BE
Sub 1.2: Germany & Austria	partner from DE
Sub 1.3: Finland	partner from FI
Sub 1.4: Greece	partner from EL
Sub 1.5: Sweden	partner from SE
Sub 1.6: Italy	partner from IT
Sub 1.7: UK & Ireland	partner from UK
Sub 1.8: France	partner from FR
Sub 1.9: Spain & Portugal	partner from ES
Sub 1.10: Denmark	partner from DK
Sub 1.11: Baltic States	partner from FI
Sub 1.12: Cyprus & Malta	partner from EL
Sub 1.13: Hungary, Poland, Slovakia, Slovenia and Czech Republic	partner from EL, BE and DE

These different country reviews are considered as a single Work Package, with subdivisions 1.1 through 1.13. The project co-ordinator is the overall WP responsible, but with each of the partners being responsible for their sub-WP. Permanent review and making available of information (especially on the new member states) will be done by the '*Special-Focus Industrial Advisor*' Eurelectric.

Workpackage 2: **Anticipation of future electricity demand**

2.1 Economic evolution of the European Union (as part of a world-wide economy), primary energy provision and 'projected' fuel prices;
2.2 Evolution of demand for energy services and the influence on electricity demand
2.3 Rational use of electricity, energy efficiency of end-use technologies and demand side management.

On the future *demand for electricity*, a careful analysis is needed. Before considering the electricity supply side it is necessary to evaluate possible electricity consumption evolutions in the future. In fact, one can only guess the need for energy *services*. The required electricity demand follows from things such as the efficiency and the cost of end-use technologies, exchange between energy carriers (depending on the price of electricity versus other energy carriers), etc. Based on a global comparison of the total cost of a saved kWh versus a supplied one (given that that can really be determined), it should be possible to appreciate 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' (Lovins, Geller, et al) and the 'classical economists' (Joskow, Sutherland); furthermore, shifts between energy carriers may lead to less desirable effects, for environment, flexibility of use, etc.

Given that encouraging stimuli are desirable to reduce the demand for electricity, it is important to figure out precisely what is meant by the so-called energy-savings potentials. Top-down considerations will have to be confronted with bottom-up approaches (based on end-use technologies) to determine the technical, economic and market potentials. Furthermore, it is important to find out appropriate measures (that do not distort the markets and therefore do not lead to undesirable feedback effects) that should be used to manage a justified evolution of the electricity demand.

Workpackage 3: **Electricity generation technologies and system integration**

3.1 Fossil-based electricity generation technologies:
   a. Coal fired technologies
   b. Oil & gas fired technologies
   c. Combined heat and power
   d. CO_2 capture and storage

3.2 Nuclear electricity generation
   a. Nuclear fission
   b. Nuclear fusion (limited scope)

3.3 Renewable flows & 'alternative' technologies & carriers
   a. Wind power
   b. Photo-Voltaic conversion
   c. Biomass applications (including waste)
   d. Hydro power
   e. Geothermal conversion
   f. Fuel cells
   g. Hydrogen economy
   h. Electricity storage
   i. Less-conventional and speculative forms of renewables (ocean currents, space solar, other)

3.4 System integration
   a. Integration of centralised and decentralised generation; influence on the grid
   b. Greenhouse-gas emissions due to interaction centralised and decentralised generation (because of operation-time effects and investment consequences)

Most of these subjects are self explanatory, although some comments are in order on the aspect of 'system integration'.

The *grid-related system integration* at this stage only concentrates on the technical integration of decentralised and centralised generation, with respect to the electrical grid. At this level, it is treated in general; geographic international bottlenecks are not yet considered. These will be dealt with in a later workpackage, where the aspects of the liberalisation (including cross-border transmission capacity and congestion) are considered. This workpackage also pays attention to the appropriate infrastructure for gas supply for decentralised and centralised generation, and possible conflicts with heating requirements in dwellings. The issue of storable-fuel requirements is contemplated here. As to environmental effects, the interaction of centralised and decentralised generation leads to non-trivial effects because limited operation times of some decentralised generation (such as CHP) together with postponement of investments in centralised generation, may lead to higher than expected emissions.

Workpackage 4: **Regulatory Framework of Energy Markets**

4.1 Analysis of the current legislation & regulation of the liberalised market, the directives on renewables and CHP, and on emission trading;
4.2 Specification of 'boundary conditions' and 'guidelines' for proper functioning of future energy markets.

A fundamental challenge of a future integrated electricity (and gas) market is the guarantee of a secure supply at affordable cost, through sufficient generation capacity and cross-border transmission capability, but in an environmentally friendly way. As a basic hypothesis of this study, the future energy markets are supposed to be liberalised and fully integrated (subject to an appropriate regulatory framework).

This work package firstly analyses the current state of affairs on the electricity market, starting from the Commissions DG TREN's Strategy Working Paper *'Medium term vision for the internal electricity markets'* [12]. Clearly, reference will be made to the recent *directive on the electricity market [2003/54/EC],* the *regulation on cross-border exchange [1228/2004],* the *proposal on a directive for infrastructure investments [COM (2003) 740],* as well as to the *European Regulator's Group* [13] and the *Florence Forum* [14]. In addition, the *directives for supply of renewable electricity* [15], and *CHP* [16] on the one hand, and the *directive on emission trading* [17], on the other hand, will be scrutinised as to their influence on the proper functioning of the integrated market and the security of supply.

In the second part of WP 4, the project partners will reflect upon an 'ideal' type of regulatory framework and will propose guidelines and boundary conditions to be used later in scenario runs.

Workpackage 5: **Most optimal solution for electricity provision**

In the next steps, the information and the wisdom obtained from the earlier phases needs to be 'collected' and brought into a form that is usable for scenario simulation. This refers, on the one hand, to the energetic, environmental and economic data characteristic for the technologies considered. On the other hand, the demand for energy services and the projections for electricity demand are likewise collected. Also, at this stage the country-related aspects, such as the nature and the characteristics of the electricity generation systems, as well as the geographic differences in demand for energy services and electricity, are introduced here. Furthermore, the whole synthesis exercise takes into account appropriate boundary conditions of a consistent regulatory framework for sustainable energy markets.

A first exercise is to establish a summary of the '*static' private cost* of generation technologies. The "static" cost is obtained through discounting of investment cost, maintenance and operational costs *at rated conditions* of the technology. In order to have meaningful projections towards the future, each of these costs is to be 'reconsidered' in the light of the market-diffusion possibilities and realities. Next, the so-called hidden costs are to be looked at. This refers to back-up costs, risk-premium costs in case of 'unilaterally' relying on a single primary source, etc. In a further stage, the environmental aspects are grouped together, but also taking into account the (hidden) lifecycle emissions, as well as the country-dependent system-related effects. From all of the above costs and the effects, the overall *external costs* can be evaluated, which in turn leads to the *total 'static' social cost.*

This ‘static’ cost computation is to be contrasted with the *overall social cost* found as a result *from scenario-simulation codes*, whereby the codes themselves determine the evolution of the demand for energy, the investments in end-use or supply-side technologies, and the shift between the different energy carriers (all taken into account the external costs, price elasticity etc.). Also, the ‘true’ cost obtained by simulation codes should take into account partial-load conditions and interaction within the whole system.

In order to do a good job, it is important to make an in-depth *comparative analysis* of the different currently used *scenario-simulation codes*; so as to identify their major differences and to delineate their domains of application and complementarities. Furthermore, the different *existing scenarios* on electricity generation *should be scrutinised.*

Indeed, a variety of scenario-simulation codes exist and are being used. Each of these codes has its merits, but it has been insufficiently reported how the boundary conditions and hypotheses behind these codes and their inputs influence the results. It is therefore necessary to make an in-depth comparison of these models and codes, whereby their strengths and weaknesses are clearly identified. Equally important is the identification of the part of “application space” where these codes are applicable and to find out how they can be complementary. If some cover similar domains of application, then means to validate them should be stipulated.

The most suitable models and codes should then be used to *perform* a limited number of some typical (preferentially contrasting) *scenarios*. From the different results due to different codes (for the same scenarios), an effort will be undertaken to clearly understand the reasons why they are different, leading to particular conclusions on the models and their input. In addition, from the different scenarios, it should be possible to understand the dynamics of the electricity provision system (interacting with the overall energy ‘context’ with its different constraints, including regulatory elements related to fully integrated markets and GHG-reduction strategies). These scenarios must in principle permit to find the ‘most optimal’ type of electricity provision (from a total minimal social-cost viewpoint).

The above is organised under workpackage 5 as follows:

5.1 Determination of the overall static social cost for electricity

- i) Summarise private cost for generation technologies and project to the future, taking into account technology diffusion;
- ii) Considerations on ‘shadow costs’ such as back-up costs, risk premium etc;
- iii) Identification of the differences in CO_2 emissions due to electricity generation, depending on the different generation systems in the EU-25 countries;
- iv) Determination of global external costs.

5.2 Comparison and evaluation of simulation models & codes and existing scenarios for electricity generation

5.3 Performing and interpreting four (contrasting) scenarios with one or two of the most appropriate models (with ‘improved’ input data)

- i) Scenario 1: according to present policy in different EU-25 countries (maybe revisiting of existing scenarios);
- ii) Scenario 2: e.g., total nuclear phase out in EU-25 with stringent post-Kyoto limits;
- iii) Scenario 3: e.g., overall nuclear renaissance in EU-25 with stringent post Kyoto limits;
- iv) Scenario 4: based on the interpretation and conclusion of Scenarios 1, 2 & 3.

Workpackage 6: **Compatibility check and validation**

To guarantee that the results of the 'most optimal solution' are well defendable, it is necessary to do several 'quality control checks'. These checks are performed continually throughout the project through cross reviewing, but mainly by critical reviews and feedback from the '*Special-Focus Industrial Advisor*', Eurelectric. In addition, at particular instances during the project, structured interactions with other stakeholders, which will be invited to become member of the *Consultative Committee,* are organized.

Mutual *interaction with members of the Consultative Committee* (CC) will be organised. Firstly, the Consultative Committee will be invited to the kick-off meeting, the mid-term assessment meeting and the final meeting. In addition, three times during the two-years lasting project, i.e., after 8, 14 and 20 months, respectively, a dedicated workshop with the CC is planned to help 'qualify' the results obtained in the workpackages. During these workshops, detailed discussions on the project's results can take place. The CC will be invited to write a statement on the results of the project.

On the basis of the letters of intent received, the CC will be composed of about 10 persons, coming from, e.g.,

- EURELECTRIC, 'Special-Focus Industrial Advisor', representing the electric industry of Europe;
- two energy-conversion manufacturers (one non-nuclear, one nuclear);
- an architect engineer (e.g., Tractebel Engineering, …)
- some umbrella organisations like VGB, Erec, Eurogas, Eurocoal, Foratom;
- organisations like UCTE, ETSO
- a representative of the CEU DG-Energy, the Council of European Energy Regulators (CEER) and the IEA will be invited.

The composition of the CC may be enlarged, if during the kick-off meeting a consensus is reached on desirable additional members.

Under this workpackage, an *External Peer Review Exercise*, at the same time of the 2-nd Consultative Committee workshop (i.e., a mid term assessment), will be organised. This independent quality-control check will focus on the objectivity, reasonableness ('correctness') of the work. This Committee should work with independent experts and should contain no more than 4 people (not counting the DG RTD responsible officer).

Two additional particular consistency checks need to be performed, the *compatibility with, and the influence of, liberalised markets* and the check with regard to *security of supply*. Based on the outcome of this "reality check", possible feedback to the scenarios is foreseen.

It must be verified that all results obtained are in accordance with the reality of *liberalised markets*, as set out in WP 4. In short, issues such as cross-border transmission capacity and congestion must be checked. In addition to trade, there is the need for back-up power if large amounts of correlated fluctuation power generation is present. Furthermore, the issues of investment in transmission capacity, sufficient base-load and peak-power capacity, dispatch-ability of decentralised generation will have to be considered. In this respect, the difference between (time-) average power, or energy, and instantaneous power is of utmost importance. This WP will illustrate the consequences of consistent basic regulatory rules for a secure electricity provision in an integrated European market.

Security of supply is another aspect that must be guaranteed by the 'most optimal solution'. This requires that one confronts the requested generation mix with the availability of primary sources (such as gas) and at what price. In this respect, some aspects of the California electricity crisis in 2000 might be useful to reflect back on. In addition, the results of the above exercise have to be checked against the findings of the EU's Green Paper on Energy Security '*Towards a European strategy for the security of energy supply'* [18], and the recent analysis '*European Energy and Transport; Trends to 2030*' – January 2003 [5]. The major black outs of the summer/fall 2003 in North America, Denmark/Sweden and Italy will carefully be reflected upon.

Finally, in a last element, the global result for Europe and the methodology is to be held against the light of *global (enveloping) international studies* (such as the European reports mentioned above [1-4], the WEC/IIASA's study on '*Global Energy Perspectives*' [19], the EU's '*World Energy Technology and Climate policy Outlook; WETO*' report [20], IEA's '*World Energy Outlook*' [21], the UNDP/UNDESA/WEC report on '*World Energy Assessment*' [22], amongst others. In addition, it would be interesting to compare the European outcome with other OECD countries such as the USA and Japan (for the USA, e.g., National Energy Policy Report, May 2001 '*Reliable, affordable and environmental sound energy for America's future*' [23], and the EPRI's Electricity Technology Roadmap –1999 and 2003 Summary and Synthesis [24]).

In summary then, workpackage 6 is organised as follows:

6.1 Timely consultations with Consultative Committee

6.2 Mid-term assessment peer review of the results

6.3 Compatibility with liberalisation of the electricity and gas markets

6.4 Cross check concerning security of supply

6.5 Compatibility and validation with other international studies

Workpackage 7: **Dissemination of results**

Throughout the project, and after the study has been performed it is planned to communicate the progress and the final results by means of a *website,* an international information *seminar*, and a *well-readable document* summarising the project.

The website will be 'open' after the first intermediate results are available. There will be a possibility for web visitors to react to the documents, such that throughout the process a sort of public consultation and interaction can take place. The web site will also be used to communicate between the project participants through a members-only area.

The seminar will be at the end of the project and it will be of an informative nature. This is consistent with an 'open web site' during the project.

A final publication will be the most visible and lasting result for policy makers. This document will contain the methodology, results, recommendations and conclusions of the project.

Workpackage 7 is subdivided into 3 sub-WPs:

7.1 Exchange of information through a website

7.2 Organisation of International Seminar

7.3 Co-ordination and editing of final public document.

Workpackage 8: **Project guidance, coordination and management**

The final workpackage deals with the overall project guidance, coordination and management. Time-wise, most of the activities of this WP run throughout the project (and sometimes at particular instances); two of them, however, will have to be started right at the beginning of the project. A first important activity is to define clearly the *scope* (effectively the objectives as explained in this proposal), the *boundary conditions* and the *hypotheses* to be used in this project. It is of utmost importance to do this as early as possible and to have a first consensus amongst the partners. Secondly, to assure that everybody understands the same thing under 'sustainable development', a second task under this workpackage is to establish a *conceptual framework for sustainable electricity supply.*

Other activities under this WP are the practical organisation of the Consultative-Committee-interaction meetings and the international seminar.

The overall organisational follow up of the project will be supervised by a Steering Committee formed by the project coordinator, the workpackage leaders and the Commission's Responsible Officer.

The project coordinator will be responsible for the actual management of the work, i.e., to assure that the *project* is *implemented according to plan*. Throughout the project, as long as this is reasonable, he will try to reach a *consensus*. In cases of no consensus, a majority viewpoint will be pushed along, but with the minority viewpoint clearly documented.

Finally, the coordinator is responsible for the final editing of the overall technical final report, with clearly indicated *conclusions and recommendations*.

In summary for this workpackage:

8.1 Definition of scope, boundary conditions and hypotheses

8.2 Development of conceptual framework for sustainable electricity supply

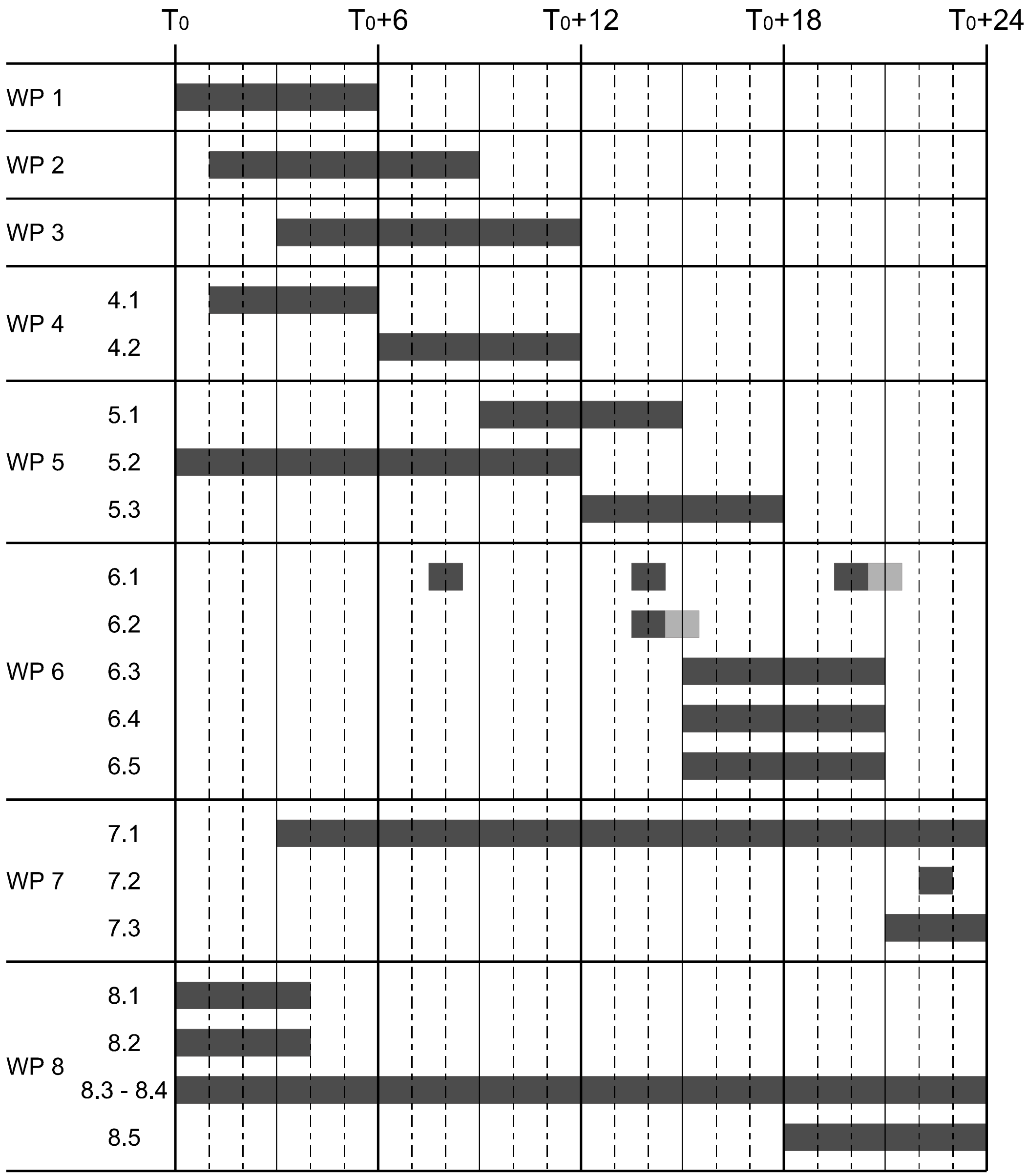
8.3 Practical organisation of CC meetings and international seminar

8.4 Overall project coordination & management

8.5 Editing of final technical report

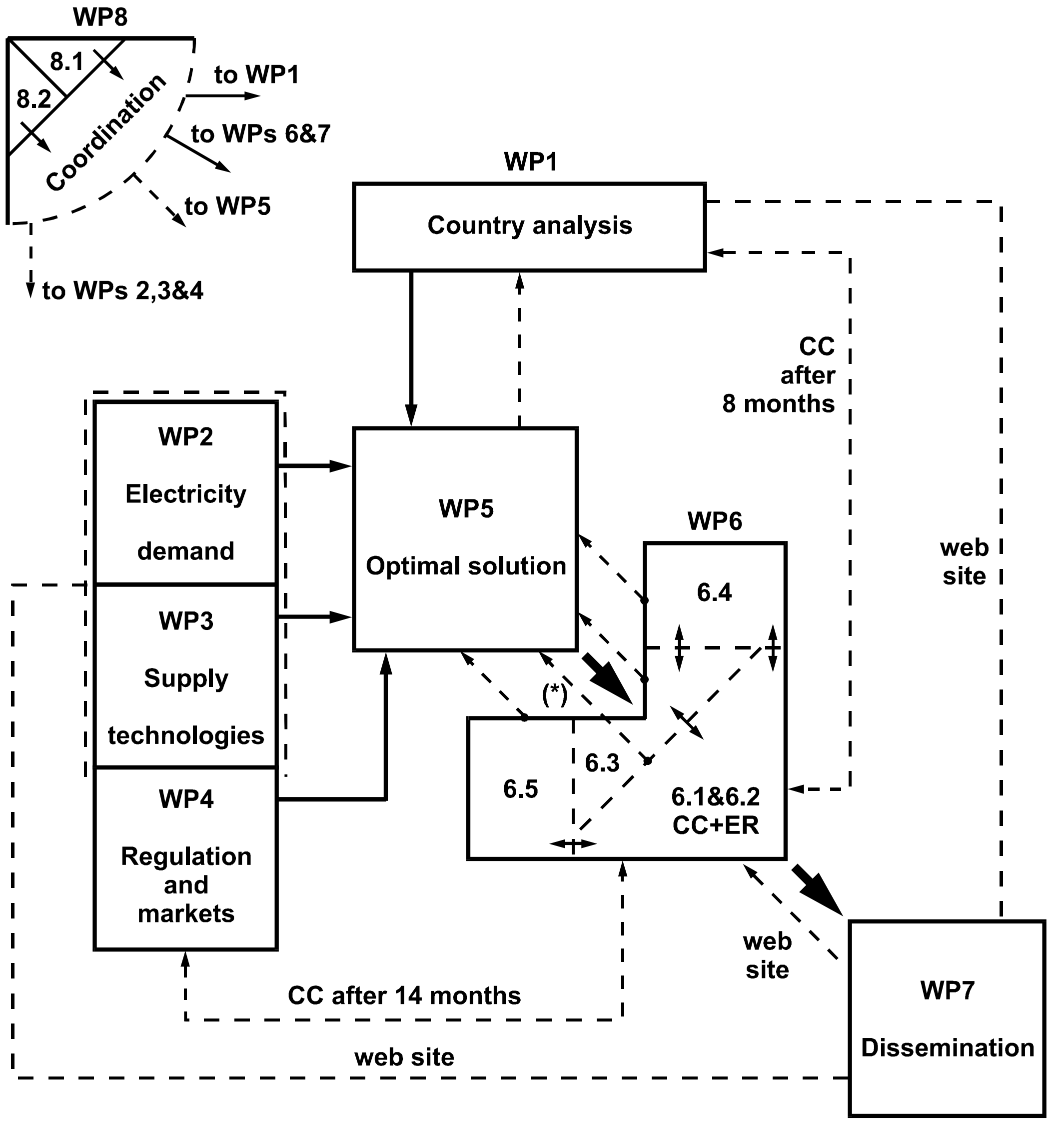
7.2 Planning and timetable

The figure below gives the available time spread for the workpackages.



Comment: sub-WPs of not-broken-down WPs are allowed to run in parallel without particular priorities.

7.3 Graphical presentation of the work packages



CC: Consultative Committee
ER: External Review
(*): CC after 20 months

7.4 Work package list

Workpackage list (full duration of project)

Work-package No[1]	Workpackage title	Lead contractor No[2]	Person-months[3]	Start month[4]	End month[5]	Deliv-erable No[6]
WP 1	Country-wise analysis for EU-25	1	15.3	0	6	D 1
WP 2	Anticipation of future electricity demand	6	9.8	1	9	D 2
WP 3	Electricity generation tech-nologies and system integration	3	23.5	3	12	D 3.1 D 3.2 D 3.3 D 3.4
WP 4	Regulatory framework of energy markets	1	4	1	12	D 4
WP 5	Most optimal solution for electricity provision	2	20.75	0	18	D 5.1 D 5.2 D 5.3
WP 6	Compatibility check and validation	1	10.70	8	21	D 6.1 D 6.2
WP 7	Dissemination of results	1	7.65	3	24	D 7
WP 8	Project guidance, coordination and management	1	7	0	24	D 8.1 D 8.2
	TOTAL		98.7			

[1] Workpackage number: WP 1 – WP n.
[2] Number of the contractor leading the work in this workpackage.
[3] The total number of person-months allocated to each workpackage.
[4] Relative start date for the work in the specific workpackages, month 0 marking the start of the project, and all other start dates being relative to this start date.
[5] Relative end date, month 0 marking the start of the project, and all ends dates being relative to this start date.
[6] Deliverable number: Number for the deliverable(s)/result(s) mentioned in the workpackage: D1 - Dn.

7.5 Deliverables list

Deliverables list (full duration of SSA)

Del. no. [1]	Deliverable name	WP no.	Lead particip-ant	Estimated person-months	Nature[2]	Dissemination level [3]	Delivery date[4] (proj. month)
D 1	**Report on the countries of the EU-25**	1	1 coordinator as WP leader; all participants for sub reports	15.3	R	PU	6
D 2	**Report on the future electricity demand** (economic conditions and primary fuel; energy services and electricity demand; energy efficiency and DSM measures)	2	6 coordinator as WP leader	9.8	R	PU	9
D 3.1	**Overview report on fossil-based electricity generation technologies** (coal, oil, gas, CHP, CO_2 capture and storage)	3	3 coordinator as WP leader; Chapters written by 1, 2 & 10 with contribution from 9	4.25	R	PU	12
D 3.2	**Overview report on nuclear electricity generation** (fission and fusion)	3	3 coordinator as WP leader; Mainly written by 8	2.25	R	PU	12
D 3.3	**Overview report on renewable flows & 'alternative' technologies and carriers** (wind, PV, biomass, hydro, geothermal, fuel cells, hydrogen, storage, unconventional and speculative renewables)	3	3 coordinator as WP leader; Chapters written by 1, 3, 5, 7, 10 with contribution from 8, 9	11.75	R	PU	12

[1] Deliverable numbers in order of delivery dates: D1 – Dn

[2] Please indicate the nature of the deliverable using one of the following codes:

- **R** = Report
- **P** = Prototype
- **D** = Demonstrator
- **O** = Other

[3] Please indicate the dissemination level using one of the following codes:

- **PU** = Public
- **PP** = Restricted to other programme participants (including the Commission Services).
- **RE** = Restricted to a group specified by the consortium (including the Commission Services).
- **CO** = Confidential, only for members of the consortium (including the Commission Services).

[4] Month in which the deliverables will be available. Month 1 marking the start of the project, and all delivery dates being relative to this start date.

D 3.4	**Overview report on system integration** (centralised and decentralised generation; influence on GHG emissions)	3	3 coordinator as WP leader; Chapters written by 1 with contributions from 5, 7	5.25	R	PU	12
D 4	**Report on regulatory framework in liberalised markets** (analysis of the existing, and guidelines for a 'proper' framework)	4	1 with contribution from 10	4	R	PU	12
D 5.1	**Report on total static[♣] social cost** (private cost, shadow cost, generation-mix influence on GHG emissions; external costs)	5	2 coordinator as WP leader; Chapters written by 1, 2, 3, 5, 9 with contributions from 7, 8	9	R	PU	15
D 5.2	**Report on evaluation simulation models and existing scenarios**	5	2 coordinator as WP leader; Written by 1, 2, 4, 10	3.5	R	PU	12
D 5.3	**Report on 4 scenarios and 'most optimal solution'**	5	2 coordinator as WP leader; Chapters written by 1, 2, 4	8.25	R	PU	18
D 6.1	**Conclusions from the Consultative Committee**	6	1 coordinator as WP leader	5	R	PU	21
D 6.2	**Report on quality checks** (compatibility with liberalised markets, security of supply, comparison with international studies)	6	1 coordinator as WP leader; Chapters written by 1, 4, 8,10	5.7	R	PU	21
D 7	**Final publishable document**	7	1 coordinator as WP leader	7.65	R	PU	24
D 8.1	**Report establishing the scope, boundary conditions and hypotheses**	8	1	1	R	PU	4
D 8.2	**Report on framework for sustainability**	8	2	1	R	PU	4
D 8.3	**Final Technical Report**	8	1 coordinator as WP leader	2	R	PU	24
TOTAL				95.7			

[♣] The "static" cost is obtained through discounting of investment cost, maintenance and operational costs *at rated conditions* of the technology. This is in contrast with the true cost obtained by simulation codes, which take into account partial-load conditions and interaction within the whole system.

7.6 Work package descriptions (WP coordinator in bold)

Workpackage number	1	**Start date or starting event:**				Month 0				
Participant id	**1**	2	3	4	5	6	7	8	9	10
Person-months per participant	3.25	1.30	2.25	2.5	0.75	0.75	1.25	0.50	2.0	0.75

Objectives

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

Description of work

Each partner will perform a critical review of the overall electricity-provision aspects in his home country (and for some partners also of a neighbouring or other country). Firstly, known international documents on that country (IEA, EU, others) will be studied, after which national documents will be considered.

Each local analysis will be scrutinised by the project management and cross-checked by the 'special-focus industrial advisor' from electric industry, Eurelectric.

The distribution of country reviews is as given here below. There are 13 sub-workpackages, whereby some sub-workpackages deal with two or more countries:

Sub 1.1: BeNeLux	partner from BE
Sub 1.2: Germany & Austria	partner from DE
Sub 1.3: Finland	partner from FI
Sub 1.4: Greece	partner from EL
Sub 1.5: Sweden	partner from SE
Sub 1.6: Italy	partner from IT
Sub 1.7: UK & Ireland	partner from UK
Sub 1.8: France	partner from FR
Sub 1.9: Spain & Portugal	partner from ES
Sub 1.10: Denmark	partner from DK
Sub 1.11: Baltic States	partner from FI
Sub 1.12: Cyprus & Malta	partner from EL
Sub 1.13: Hungary, Poland, Slovakia, Slovenia and Czech Republic	partner from EL, BE and DE

Deliverables

On each country a summarizing document will be provided of maximum 10 pages. The combination of these country reports constitutes the first deliverable:

D 1 Report on the countries of the EU-25

Milestones and expected result

Month 6: Report D 1 ready

Workpackage number	2	**Start date or starting event:**				Month 1	
Participant id		1	4	**6**	7		
Person-months per participant		1.8	1	5	2		

Objectives

Make projection for reasonable evolution of demand for energy services and determine the relationship with electricity demand. Propose justified Demand Side Management measures.

Description of work

This workpackage deals with the demand side for electricity. The demand for electricity is, however, not a-priori easy to 'predict' independently. The demand of electricity depends on the demand for energy services, which in turn depends on the anticipated economic growth (and the structure of that economy). This WP is therefore subdivided into three sub-WPs.

WP 2.1 Economic evolution of the European Union (as part of a world-wide economy); primary-energy provision and 'projected' fuel prices;

WP 2.2 Evolution of demand for energy services and the influence on electricity demand;

WP 2.3 Rational use of electricity, energy efficiency of end-use technologies and demand side management measures.

Deliverables

On each sub-workpackage, a summarising chapter is provided with conclusions and recommendations that are given to the following sub-WP. These chapters will be combined into a WP report with overall conclusions and recommendations to be 'forwarded' to WP 4

D 2 Report on the future electricity demand, dealing with:

- economic conditions and primary fuel
- energy services and electricity demand
- energy efficiency and DSM measures

Milestones and expected result

Month 9: Report D 2 ready

Workpackage number	3		Start date or starting event:			Month 3		
Participant id	1	2	**3**	5	7	8	9	10
Person-months per participant	5.5	1	4.5	4.0	3.0	1.5	1.5	2.5

Objectives

Make in 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.

Description of work

This workpackage concentrates on the supply side. The most important technologies for electricity generation (and storage) are treated, ranging from well-established ones all the way up to unconventional and even speculative conversion technologies. Each of these technologies will be scrutinised, especially with its potential for further development in the future. In addition, the integration of decentralised generation into the overall electricity generation system is treated, both from an energetic-technical and environmental point of view. For each sub-WP, several partners (at least two) are involved, to avoid bias. This WP is therefore subdivided into 4 sub-WPs, which in turn are subdivided in subtasks.

WP 3.1 Fossil-based electricity generation technologies:
- Subtask 3.1.1 Coal fired technologies
- Subtask 3.1.2 Oil & gas fired technologies
- Subtask 3.1.3 Combined heat and power
- Subtask 3.1.4 CO_2 capture and sequestration

WP 3.2 Nuclear electricity generation
- Subtask 3.2.1 Nuclear fission
- Subtask 3.2.2 Nuclear fusion (limited scope)

WP 3.3 Renewable flows and ‘alternative’ technologies and carriers
- Subtask 3.3.1 Wind power
- Subtask 3.3.2 Photo-voltaic conversion
- Subtask 3.3.3 Biomass applications (including waste)
- Subtask 3.3.4 Hydro power
- Subtask 3.3.5 Geothermal conversion
- Subtask 3.3.6 Fuel cells
- Subtask 3.3.7 Hydrogen economy
- Subtask 3.3.8 Electricity storage
- Subtask 3.3.9 Unconventional & speculative forms of renewables (ocean currents, space solar,…)

WP 3.4 System integration
- Subtask 3.4.1 Integration of centralised and decentralised generation; influence on the grid
- Subtask 3.4.2 Greenhouse-gas emissions due to interaction centralised and decentralised generation

Deliverables

On each subtask, a summarising chapter is provided with summary and conclusions on that particular technology or system effect. Besides description on the state of the art and the future evolution, a summary template will be provided to summarise data, uncertainty ranges and future projections. These chapters will be combined into four reports referring to the 4 sub-WPs, with overall conclusions to be 'forwarded' to WP 4

D 3.1 Overview report on fossil-based electricity generation technologies
(coal, oil, gas, CHP, CO_2 capture and storage)

D 3.2 Overview report on nuclear electricity generation (fission and fusion)

D 3.3 Overview report on renewable flows and 'alternative' technologies and carriers
(wind, PV, biomass, hydro, geothermal, fuel cells, hydrogen, storage, unconventional and speculative renewables)

D 3.4 Overview report on system integration
(centralised and decentralised generation; influence on GHG emissions)

Milestones and expected result

Month 12: Reports D 3.1, D 3.2, D 3.3, D 3.4 ready

Workpackage number	4	Start date or starting event:			Month 1	
Participant id		**1**	10			
Person-months per participant		3	1			

Objectives

Study the regulatory and market framework of energy markets.

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). Suggest guidelines for 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.

Description of work

A fundamental challenge of a future integrated electricity (and gas) market is the guarantee of a secure supply at affordable cost, through sufficient generation capacity and cross-border transmission capability, but in an environmentally friendly way. As a basic hypothesis of this study, the future energy markets are supposed to be liberalised and fully integrated (subject to an appropriate regulatory framework).

This work package firstly analyses the current state of affairs on the electricity market, starting from the Commissions DG TREN's Strategy Working Paper *'Medium term vision for the internal electricity markets'*. Clearly, reference will be made to the recent *directive on the electricity market [2003/54/EC],* the *regulation on cross-border exchange [1228/2004],* the *proposal on a directive for infrastructure investments [COM (2003) 740],* as well as to the *European Regulator's Group* and the *Florence Forum.*In addition, the *directives for supply of renewable electricity*, and *CHP* on the one hand, and the *directive on emission trading*, on the other hand, will be scrutinised as to their influence on the proper functioning of the integrated market and the security of supply.

In the second part of WP 4, the project partners will reflect upon an 'ideal' type of regulatory framework and will propose guidelines and boundary conditions to be used later in scenario runs.

The workpackage is organised as follows:

WP 4.1 Analysis of the current legislation & regulation of the liberalised market, the directives on renewables and CHP, and on emission trading;

WP 4.2 Specification of 'boundary conditions' and 'guidelines' for proper functioning of future energy markets.

Deliverables

D 4 Report on regulatory framework in liberalised markets
(analysis of the existing, and guidelines for a 'proper' framework)

Milestones and expected result

Month 12: Final report D 4 ready.

Workpackage number	5			**Start date or starting event:**				Month 0		
Participant id	1	2	3	4	5	6	7	8	9	10
Person-months per participant	4.0	7.0	1.25	2.75	0.75	0.25	1	0.25	2.50	1.0

Objectives

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.

Description of work

Using the information available from the WPs 3 & 5, it is possible to find the total social cost for electricity generation. As the social cost consists of private cost and external cost, both should be considered. The private cost should follow from WP 3 (except for technology diffusion and experience curves), but for the external cost, careful considerations within this WP are necessary. Based on these numbers, the static cost can be obtained. To find the global cost (taking into account system interaction), scenarios must be performed with the newly obtained data from WP5. To do a proper job, it is first necessary to make a critical comparison between the presently used models and codes, and existing scenarios must be evaluated and interpreted. Having determined the most appropriate model(s), some basic scenarios will be run so as to minimise the total cost, leading to the overall 'most optimal solution'. All members take part in the interpretation of the scenarios. The workpackage is organised as follows.

WP 5.1 Determination of the overall static social cost for electricity

- Subtask 5.1.1 Summarise private cost for generation technologies and project to the future, taking into account technology diffusion
- Subtask 5.1.2 Considerations on 'shadow costs' such as back-up costs, risk premium etc;
- Subtask 5.1.3 Identification of the differences in CO_2 emissions due to electricity generation, depending on the different generation systems in the EU-25 countries;
- Subtask 5.1.4 Determination of global external costs.

WP 5.2 Comparison and evaluation of simulation models & codes and existing scenarios for electricity generation

WP 5.3 Performing and interpretation of four (contrasting) scenarios with one or two of the most appropriate models (with 'improved' input data)

Deliverables

D 5.1 Report on total static social cost

(private cost, shadow cost, generation-mix influence on GHG emissions; external costs)

D 5.2 Report on evaluation simulation models and existing scenarios

D 5.3 Report on 4 scenarios and 'most optimal solution'

Milestones and expected result

Month 12: Report D 5.2 ready

Month 15: Report D 5.1 ready

Month 18: Report D 5.3 ready.

Workpackage number	6	Start date or starting event:							Month 8	
Participant id	1	2	3	4	5	6	7	8	9	10
Person-months per participant	5.00	0.40	0.50	1.00	0.25	0.50	0.25	1.25	0.30	1.25

Objectives

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.

Description of work

This workpackage organises the quality control of the work performed. This happens through regular meetings with the Consultative Committee of ‘players in the field’, it carefully studies whether the obtained results are compatible with the dynamics of liberalised markets and the physical limits related to it. Furthermore, the aspect of security of supply is to be checked upon, both concerning primary fuels as well as deliverability of electricity and gas. Finally, the conclusions of our study obtained will be compared to international studies. All partners are (even if only to a minor extent) involved in this quality control exercise.

This WP is subdivided into five sub-WPs.

WP 6.1 Timely consultation with Consultative Committee after 8, 14 and 20 months

WP 6.2 Mid-term assessment peer review of the results

WP 6.3 Compatibility with liberalisation of electricity and gas markets

WP 6.4 Cross check concerning security of supply

WP 6.5 Compatibility and validation with other international studies

Deliverables

D 6.1 Conclusions from the Consultative Committee

D 6.2 Report on quality checks —result of WPs 6.3, 6.4 and 6.5—
(compatibility with liberalised markets, security of supply, comparison with international studies)

Milestones and expected result

Month 21: Deliverables D 6.1 ready

Month 21: Report D 6.2 finalised

Workpackage number	7	Start date or starting event:				Month 3				
Participant id	**1**	2	3	4	5	6	7	8	9	10	
Person-months per participant	4.70	0.4	0.5	0.25	0.25	0.5	0.25	0.25	0.30	0.25	

Objectives

Create a platform for interaction with the public at large to permit outside inflow of ideas by means of a web site. Assure that the information obtained via this project, its conclusions and recommendations find their way into the public domain.

Description of work

This workpackage sets up the means for information exchange with non-project participants. A webs site, created three months after project initiation, will display also the working documents to allow 'comments' and inflow of information from the outside world. At the end of the project, the final project documents will be available and downloadable at the web site. Futhermore, the methodology, the final conclusions and recommendations will be communicated by organising an international seminar and by editing a well readable report. All project partners participate in this dissemination activity (even if only marginally). This WP is therefore subdivided into three sub-WPs.

WP 7.1 Exchange of information through web site

WP 7.2 Organisation of international seminar

WP 7.3 Coordination and editing of final public document.

Deliverables

D 7 Final publishable document

Milestones and expected result

Month 24: Final public document available in electronic form.

Workpackage number	8		Start date or starting event:				Month 0
Participant id		1	2				
Person-months per participant		6	1				

Objectives

Establish clearly the overall scope, boundary conditions and hypotheses of the project. Guarantee that a consensus is reached on the framework for 'sustainability'.

Assure well-managed project coordination.

Description of work

In this final WP, the overall project guidance, coordination and management are grouped together. Before the work can really be started it is important to write down the scope, boundary conditions and hypotheses. This needs to be agreed upon with the project partners ASAP. The project coordinator is responsible for that. In addition, everybody must understand the same under 'sustainability'. For that reason, partner 2 will establish a framework for the concept of sustainability. Also here, consensus amongst the partners is required. Both activities take place at the beginning of the project. The remainder of the WP deals with overall project coordination and management. Note that the project coordination will be supervised by a Steering Committee, made up of the project coordinator, the workpackage leaders and the Commission's Officer. This WP is subdivided into five sub-WPs.

WP 8.1 Definition of scope, boundary conditions and hypotheses

WP 8.2 Development of framework for 'sustainability'

WP 8.3 Practical organisation of CC meetings and international seminar

WP 8.4 Overall project coordination

WP 8.5 Organisation of information flow for editing final report

Deliverables

D 8.1 Report establishing the scope, boundary conditions and hypotheses

D 8.2 Report on framework for sustainability

D 8.3 Final Technical Report —result of WP 8.5—

Milestones and expected result

Month 4: Report D 8.1 on scope, boundary condition and hypotheses ready

Month 4: Report D 8.2 on framework for sustainability ready

Month 24: Report D 8.3 , the final technical document, ready

8. Project resources

See the following pages; SSA effort forms.

SSA Effort form - Full duration of project

Project number & acronym: **006602 - eusustel**

	Partner 1 KULeuven	Partner 2 USTUTT	Partner 3 HUT	Partner 4 ICCS/NTUA	Partner 5 UU		TOTAL PARTNERS
Support activities							
WP 1 Country review	3.25	1.3	2.25	2.50	0.75		Next page
WP 2 Electricity demand	1.8			1			Next page
WP 3 Technologies	5.5	1	4.5		4.0		Next page
WP 4 Regulation & Markets	3						
WP 5 'most optimal solution'	4.0	7.0	1.25	2.75	0.75		Next page
WP 6 Quality checks	5.0	0.4	0.5	1.0	0.25		Next page
WP 7 Dissemination	4.70	0.4	0.5	0.25	0.25		Next page
WP 8 Project Guidance	3	1					Next page
Total Support activities	30.25	11.1	9	7.50	6		Next page
Management activities							
WP 8 Management	3						Next page
Total Management activities	3						Next page
TOTAL ACTIVITIES	33.25	11.1	9	7.50	6		Next page

SSA Effort form - Full duration of project

Project number & acronym: **006602 - eusustel**

	Partner 6 AIEE	Partner 7 Imperial	Partner 8 ECRIN	Partner 9 CIEMAT	Partner 10 Risoe		TOTAL PARTNERS
Support activities							
WP 1 Country review	0.75	1.25	0.50	2	0.75		15.3
WP 2 Electricity demand	5	2					9.8
WP 3 Technologies		3	1.5	1.5	2.5		23.5
WP 4 Regulation & Markets					1		4
WP 5 'most optimal solution'	0.25	1	0.25	2.5	1		20.75
WP 6 Quality checks	0.5	0.25	1.25	0.30	1.25		10.7
WP 7 Dissemination	0.5	0.25	0.25	0.30	0.25		7.65
WP 8 Project Guidance							4
Total Support activities	7	7.75	3.75	6.6	6.75		95.7
Management activities							
WP 8 Management							3
Total Management activities							3
TOTAL ACTIVITIES	7	7.75	3.75	6.6	6.75		98.7

TOTAL TO BE FUNDED **98.7**

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Appendix A - Consortium description

A.1 Participants and consortium

The consortium grouped together for this project consists of 10 major energy-research institutions, represented and supervised by senior scientists and/or group heads (as requested in the call), well geographically distributed.

As to the expertise in overall energy issues and electricity provision of the different institutions, there can be little doubt. Some institutions are even 'national' laboratories, in part providing scientific input for their national energy policy. Other institutions (usually universities) have demonstrated to possess both wide and in-depth expertise.

In the consortium, a wide variety of domains of expertise is present, ranging from overall economic considerations, to energy efficiency & the electricity-demand side, over all kinds of generation technologies (going from fossil, nuclear, renewables etc) to system integration aspects and the regulatory and market framework. Both 'technologists' and 'modellers' are present, some paying more attention to energetic aspects, others focussing on the environmental aspects. The consortium consists of a mixture of scientists, engineers and economists.

Some specific (but very summarised) elements on each of the partners is now mentioned. More information on the expertise of institutions and CV's of the persons in charge are added as Appendix B to this document.

University of Leuven (KULeuven) Energy Institute, BE; **W. D'haeseleer** coordinator.

The University of Leuven Energy Institute is an inter-university consortium grouping together a variety of expertises, such as energy conversion (group lead by W. D'haeseleer), electric systems aspects (group lead by R. Belmans), environmental-economics aspects (group lead by S. Proost). The Energy Institute focuses mainly on interdisciplinary and system integration aspects of the energy issue. Three members of the Energy institute have been members of the Belgian AMPERE Commission (D'haeseleer, Proost, and Mertens from IMEC – PV experts). R. Belmans is presently president of the Belgian Transmission System Operator ELIA, and W. D'haeseleer is an active member of the Commission's Advisory Group on Energy (AGE) and its Strategic Working Group (S-WOG). Most of the work for the KULeuven will be done under the supervision of W. D'haeseleer; the electric and economic aspects, will be supervised by R. Belmans and S. Proost, respectively.

Inst. of Energy Economics and Rational Use of Energy, Universitaet Stuttgart, DE; **A. Voss**

The Institute for Energy Economics and the Rational Use of Energy (IER) carries out research and teaching in the field of renewable energies, system analysis, technology assessment and energy economics. The institute currently employs about 60 staff members. The department Energy Economics and System Analysis (ESA) of IER has a broad experience in analysing energy-economy-environment linkages. Key areas of research work include life cycle assessment of energy technologies, energy and sustainable development, evaluation of strategies for reducing of greenhouse gas emissions, and the development and improvement of simulation and optimisation process engineering models.

A. Voss is presently member of the Commission's Advisory Group on Energy (AGE) and Chairman of its Strategic Working Group (S-WOG).

Advanced Energy Systems Group, Helsinki University of Technology, FI; **P. Lund**

Present systems research in the group related to the proposal include distributed energy generation systems modelling, energy storage and wind power, and ICT for DSM reserves. On policy side, market transformation and technology diffusion are topical themes. The group has contributed e.g. to the national action plan on renewable energy sources for the Kyoto targets (MTI) and done recently a hydrogen review for the National Technology Agency.

P. Lund is presently Chairman of the Commission's Advisory Group on Energy (AGE) and is an active member of its Strategic Working Group (S-WOG).

E3M Lab , National Technical University of Athens, (ICCS), EL; **P. Capros / N. Kouvaritakis**

E^3M-Lab specialises in the field of energy systems analysis and economics, macroeconomics and environmental economics by using and developing large-scale mathematical models based on advanced techniques of Applied Econometrics, Operations Research and Computer-based Information Systems.

This is the group behind the well known simulation code PRIMES.

Div. of Electricity & Lightning Research, Uppsala University, SE; **M. Leijon**

Research in this division is focused on industrial applications of Maxwell's electromagnetic equations and of other basic physical laws like Navier Stoke law in conventional and complementary electromagnetic systems for production of electric power and for energy storage systems. The scope of research and experimental development is directed to economical, environmental and ecological low impact energy conversion.

M. Leyon is inventor of the 'powerformer'

Associazione Italiana Economisti dell'Energia, (AIEE), IT; **U. Farinelli /** E. Curcio

The work will be performed by Ugo Farinelli, under the umbrella, and with support of, the AIEE. Dr. Farinelli is presently a consultant in energy, environment and economy, with a particular interest in energy efficiency. He has been Director of the Energy Department of ENEA (the Italian National Commission on Energy, Environment and New Technology).

Imperial College Centre for Energy Policy and Technology, London, UK; **M. Leach /** D. Anderson

The ICCEPT was formed to study technologies and policies on energy and environment. It brings three long-standing strengths of Imperial College London to bear on modern energy and environmental problems: The science and technology of all aspects of energy production and use and pollution abatement; the analysis of the environmental impact of energy-related pollution on ecosystems and human health; and

the economic, legal and institutional aspects of energy and environmental problems.

ECRIN, Paris, FR; **C. Ngô**

ECRIN is a 100% daughter institute of the CEA. The CEA is the national laboratory of France for mainly Nuclear Energy, although activities on other carriers are pursued as well. The work will be performed by C. Ngô, Director General of ECRIN and Scientific Director at the High Commissioner's Office. Dr. Ngô has a well-recognised expertise not only on nuclear-energy aspects but also on the broader picture of environmental en economic impact of and on the global energy provision picture.

CIEMAT, Renewable Energy Department, ES; **R. Saez & H. Cabal**

CIEMAT is the major governmental energy-related laboratory in Spain. CIEMAT has as main objectives: to find solutions to improve the use of resources and energy generation systems, to develop alternative energy sources and to solve the problems of the Spanish companies regarding energy and its effects on the environment. The aims of the CIEMAT's Department involved (Socio-economic Studies of Energy and Environment) are to provide economic assessment of the costs and benefits associated with the production and consumption of energy produced by different fuel cycles, and to study possible strategies for promoting the introduction of cleaner energies into the market through their environmental and socio-economical implications.

Systems Analysis Department, Risø National Laboratory, DK; **H. Larsen**

The Systems Analysis Dept of 'Risoe', in active in research on the modelling of energy policy, with emphasis on the combination of environmentally friendly, but economic energy provision. Dr. Larsen is the director of the Systems Analysis Department, and is the author of the recently published Risoe Energy Report 1 on New and 'Emerging Technologies; Options for the Future'.

This Consortium possesses all the means to make the realisation of the objectives successful. The people in charge guarantee that the work will be performed either by themselves or under their supervision. As said elsewhere, the overall capacity of the consortium is more than large enough to 'absorb' any mishap in case of unexpected illness or accident. In that case, perhaps a redistribution of funds might have to be considered.