IZT

Institut für Zukunftsstudien und Technologiebewertung

Institute for Futures Studies and Technology Assessment

Quantitative co-assessment of the EurEnDel Delphi results

Wolfram Jörß, Timon Wehnert

ArbeitsBericht Nr. 22/2006

This Paper is based on a Working Paper of the *EurEnDel* Research project (www.eurendel.net), which was co-funded by the European Commission, DG TREN

Berlin, April 2006

Contents

1 Introduction

The scope of this report is to compare quantitative data drawn from the *EurEnDel* Delphi [Jørgensen et al. 2004] and used for the *EurEnDel* Scenarios [Velte et al. 2004] with a set of studies based on quantitative modelling. The rationale of this exercise is on one hand to validate the *EurEnDel* results and on the other hand to contribute to the interpretation of *EurEnDel* results in comparison to quantitative forecasting.

The analysis embodies firstly the direct comparison between results of the *EurEnDel* Delphi survey in terms of time of occurrence and quantification of relevance of certain Delphi statements. Secondly the *EurEnDel* scenarios are classified in terms of their implied CO_2 emissions development.

In chapter 2 below, the quantitative studies are presented that were used for the analysis. Further on in chapter 3, the results of the quantitative co-assessment are presented and interpreted.

More information on *EurEnDel* can be found at http://www.eurendel.net.

2 Quantitative Studies

Two quantitative studies were used were used for the comparison with *EurEnDel* Delphi results. These were "European Energy and Transport - Trends to 2030" [Mantzos et al. 2003] and the "With climate policies" scenario [Zeka-Paschou 2003]. Both studies are shortly presented in the following chapters.

2.1 European Energy and Transport - Trends to 2030 (*Trends 2030*)

As a reference a study was to be taken, which is both comparable in geographic terms and in the time frame and additionally politically and scientifically broadly acknowledged. Therefore, as suggested by the EC scientific officer responsible for *EurEnDel*, the "European Energy and Transport - Trends to 2030" study [Mantzos et al. 2003] was used as a first reference. Throughout this document this study will in short be referred to as "*Trends 2030*" study.

The *Trends 2030* study uses the POLES[1], PRIMES[2], and ACE[3] models: POLES is a global model and was used model the international framework. PRIMES is a European model and was used for the EU15[4] countries. As PRIMES was not yet available for the ten accession countries and other neighbouring countries covered in the *Trends 2030* study, these countries were modelled in the less sophisticated ACE model.

---

[1] POLES – Prospective Outlook on Long-term Energy Systems cf. e.g. [Criqui 1999]

[2] cf. e.g. [Capros 2000] or the documentation CD-ROM of [Mantzos 2003].

[3] The Accession Countries Energy (ACE) Model is an energy demand and supply model developed and maintained at the National Technical University of Athens, E3M –Laboratory. A summary description is provided on the documentation CD-ROM of [Mantzos 2003].

[4] The 15 Member States of the European Union up to April 30th, 2004, i.e. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom

The *Trends 2030* study delivers quantitative results for all single countries that were covered in the analysis, as well as aggregations EU15, EU25[5] and Europe30[6]. Generally, the EU25 results were used in the analysis within *EurEnDel*, as these were best comparable to the results of the *EurEnDel* Delphi survey.

The key assumptions are the following [Mantzos 2003a], [Mantzos et al. 2003]:

- The Trends 2030 study is a baseline study that explicitly covers no new policies to reduce greenhouse gas emissions[7]. This is done for analytical reasons in order to assist in identifying any remaining policy gaps in the energy and transport sectors with respect to the EU's Kyoto commitments.
- Assuming the continuation of current world energy market structures and taking a conventional view on fossil fuel reserves, world energy prices develop moderately as no supply constraints are likely to be experienced over the next 30 years under Baseline conditions.
- Baseline assumptions include continued economic modernisation, substantial technological progress, and completion of the internal market. Existing policies on energy efficiency and renewables continue; the fuel efficiency agreement with the car industry is implemented; and decisions on nuclear phase-out in certain Member States are fully incorporated.
- For EU15, the baseline macro-economic scenario assumes continued GDP growth of 2.3% pa on average over the projection period (i.e. 2000 – 2030), similar to that over the past 30 years. The assumed growth rates are modest compared with the ambitions of the Lisbon strategy but also high compared with the current weak state of the EU economy. For the accession states an average GDP growth of 3.5% pa (2000-2030) is assumed, resulting in 2.4% pa (2000-2030) for EU25.
- Furthermore the EU economy is characterised by a further dematerialisation with stronger growth occurring in high value added industrial sectors and services.

2.2 "With climate policies" baseline scenario (WCLP)

In order to account for the above-mentioned shortfall in "realism" of *Trends 2030* in terms of future climate policies (i.e. the baseline character), an additional study was used in the *EurEnDel* analysis as a second reference to the Delphi results. For that purpose, the "With Climate Policies" (*WCLP*) scenario [Zeka-Paschou 2003] was chosen, which is used as one of the baseline scenarios in the EU-wide CAFE (Clean Air For Europe) process[8] managed by the European Commission, DG Environment. Again, high relevance in European policies was

[5] The 25 Member States of the EU as of May 1st, 2004, i.e. EU15 plus Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia

[6] EU25 plus Bulgaria, Norway, Switzerland, Romania and Turkey

[7] A definition is missing, though, which actual policies in the EU and the single Member States and other countries exactly are classified as "new" and "old" policies respectively.

[8] For more information on the CAFE process, see http://europa.eu.int/comm/environment/air/cafe/index.htm

sought after in the choice of the second reference scenario, as well as high consistency with the first reference scenario (see below).

The *WCLP* scenario, and even more its counterpart in the CAFE process, the “Without Climate Policies” (*WoCLP*) scenario [Zeka-Paschou 2003a] are very closely related to the *Trends 2030* study: *WoCLP* and *Trends 2030* are identical despite the fact that in *WoCLP* the Non-EU15 countries could already be modelled within an extended version of the PRIMES model, while the ACE model was used in *Trends 2030*.

The key assumptions for *WCLP* are the same as for *Trends 2030* (depicted in chapter 2.1 above) with one difference: While *Trends 2030* (as well as *WoCLP*) incorporates no new climate policies, *WCLP* assumes the existence of an EU wide CO_2 emissions trading regime. The “with climate policies” scenario assumes a permit price of 12 € per t of CO_2 in 2010, rising to 16 € per t of CO_2 in 2015 and 20 € per t of CO_2 in 2020. In 2020-2030 the permit price remains constant at 20 € per t of CO_2 [Mantzos 2003a].

On the *WCLP* and *WoCLP* scenarios no written examination text as *Trends 2030* exists. However, the datasets available in [Zeka-Paschou 2003] and [Zeka-Paschou 2003a] are nearly identical in structure to the corresponding datasets of *Trends 2030* [Mantzos et al. 2003]. Thus, an almost parallel analysis of the two scenarios could be performed in order to countercheck *EurEnDel* Delphi results.

3 Results

3.1 Delphi Statements

For eight of the total of twenty Delphi statements of *EurEnDel* corresponding and comparable data was found in the reference studies. An overview on the statements is given in Table 3-1:

Statement No.	Statement Short Name	Statement
1	Novel production processes	Industrial energy consumption in Europe is reduced by 50% per produced unit through novel production processes
3	20 % FC cars	Fuel cell driven cars reach a European market share of 20%
4	25% Bio-fuels	Bio-fuels will have a European market share of >25% in the road transport sector
5	15% Freight on rail	Improved logistics based on information and communication technologies raise the railway's market share in Europe's freight transport to 15% [1990: 11%, today: 8%].
6a	H2 from diverse sources	Hydrogen produced from diverse sources and used as an energy carrier constitutes a significant part of the energy system (transport and stationary application)
6b	H2 from RES	Hydrogen produced solely from renewables and used as an energy carrier constitutes a significant part of the energy system (transport and stationary application)
14	25% RES	Renewable energy sources cover 25% of Europe’s total energy supply [Today it is 6%]
15	5% PV	Photovoltaic cells contribute with >5% of European electricity generation [Today it is 0.15%]

Table 3-1: List of Delphi statements subject to comparison with quantitative reference studies

For all covered Delphi statements, the time of occurrence was analysed on one hand. Here, the mean value of 2nd round responses was taken, using only the answers of (self-estimated) expert, knowledgeable and familiar respondents and leaving out the unfamiliar respondents’ answers (compare the *EurEnDel* Delphi report [Jørgensen et al. 2004]. On the other hand the quantification or level of intensity of the Delphi statements was subject to the comparative analysis. Thus, the combination of “intensity” and time of occurrence from the *EurEnDel* Delphi was compared to corresponding data from the reference studies. Where possible, a “level of significance” multiplier was estimated in order to quantify the distance between the results of the *EurEnDel* Delphi and those of the reference studies.

The results of the analysis are presented in the following chapters:

3.1.1 Statement 1: Novel Production Processes

According to the *EurEnDel* Delphi, industrial energy consumption in Europe is reduced by 50% per produced unit through novel production processes by 2028[9] (lower quartile 2022 – upper quartile 2034)[10].

The reference studies give no explicit information on novel production processes. However, development of energy intensity in industry (measured as energy consumption per value added) is reported as a model output. Here *Trends 2030* assumes a 38% reduction by 2030 compared to 2000 while *WCLP* ends up with almost identical 39%.

Taking into account that the time horizons of the *EurEnDel* Delphi and the reference studies are comparable, it can be stated that the *EurEnDel* energy experts are more optimistic than the reference studies. However, with the multiplier between the two levels of intensity being approx. 1.3, the result is in the same order of magnitude.

3.1.2 Statement 3: 20 % FC cars

According to the *EurEnDel* Delphi, fuel cell driven cars reach a European market share of 20% by 2027 (lower quartile 2020 – upper quartile 2032).

The reference studies give no quantified information on the share of fuel cell driven cars. However, the *Trends 2030* study states "fuel cell cars are not expected to gain significant market share until 2030; primarily due to costs but also lack of fuel supply infrastructure" [Mantzos et al. 2003, p.64]. For *WCLP* no information is available.

It is obvious that the *EurEnDel* energy experts are much more optimistic than the reference study. *Trends 2030* does not quantify what a "significant market share" is. However, if one assumes that a level of significance might be approx. 2%, the "level of intensity" multiplier would be at least >10.

However, while assessing the comparison it should be taken into account that the policy framework conditions implied by the *EurEnDel* energy experts are likely to be different from the concept of the *Trends 2030* baseline study. These differences should not be misinterpreted as a lack of expertise on the *EurEnDel* energy experts' side. There are indications showing that economic quantitative models generally tend to underestimate the potentials of emerging technologies. For example, a comparison of projections of the Annual Energy Outlook 2004 by the US Energy Information Administration [EIA 2003] and a Delphi study by the George Washington University (TechCast Delphi; see [Halal and Kallmeyer 2004]) shows significant differences between modelling and Delphi results comparable to the multiplier mentioned above. Additionally it is known from other studies that previous energy models (e.g. from the 1980s) tended to overestimate future energy demands [Laitner 2004].

---

[9] Results of the 2nd survey round: Mean value calculated from "time of occurrence" indicated by respondents who classified themselves as either "experts", "knowledgeable" or "familiar" for the respective topic. (Cf. [Jørgensen et al. 2004])

[10] The given time range refers to the lower and the upper quartile. This means that 50% of the respondents expect an occurrence in the given timeframe, 25% expect an earlier, and 25% expect a later occurrence.

3.1.3 Statement 4: 25% Bio-fuels

According to the *EurEnDel* Delphi, bio-fuels will have a European market share of >25% in the road transport sector by 2027 (lower quartile 2018 – upper quartile 2030).

Both *Trends 2030* and *WCLP* expect bio-fuels to have a market share in transport of slightly above 5% by 2030.

Taking into account that the two time horizons 2027 (*EurEnDel* Delphi) and 2030 (reference studies) are close together, it can be stated that the *EurEnDel* energy experts are much more optimistic than the reference studies: The "level of intensity" multiplier would be 5. However, while assessing the comparison it should be taken into account on one hand that for statement 4 "25% Bio-fuels" a relatively high share of 15% of the Delphi respondents[11] answered "Never". In *EurEnDel* Delphi respondents' comments it was highlighted that the potential for domestically produced biomass might be a limiting factor in order to reach such a high share of bio-fuels [Jørgensen et al. 2004]. Furthermore, as already discussed in chapter 3.1.2, there are indications that energy modelling is likely to fail to cover emerging technologies adequately. Additionally, the policy framework conditions implied by the *EurEnDel* energy experts is likely to be different from the concept of the reference studies.

It is interesting to note, though, that both *WCLP* and *WoCLP* come to identical bio-fuel shares, i.e. the CO_2 prices assumed in *WCLP* seem not to influence the development of bio-fuel shares.

3.1.4 Statement 5: 15% Freight on rail

According to the *EurEnDel* Delphi, improved logistics based on information and communication technologies raise the railway's market share in Europe's freight transport to 15% by 2019 (lower quartile 2012 – upper quartile 2023). It should be noted that the percentages of the comparison data given with the Delphi statement (1990: 11%, today: 8%) included short sea shipping. Thus, the *EurEnDel* Delphi respondents' response must be interpreted in that way.

Unfortunately, the freight transport data in the reference studies do not include short sea shipping, as the related energy use is allocated to international bunkers according to EUROSTAT rules[12]. Thus the reference studies' modal shares in freight traffic are not quantitatively comparable to the *EurEnDel* Delphi data. Despite of intensive research, no other quantitative outlook on absolute snort sea shipping development in the EU25 countries was found which might have supported a quantitative comparison of *EurEnDel* and reference study data. Qualitatively, short sea shipping is generally expected to grow significantly (compare e.g. [European Commission 1999], [European Commission 2003]).

Within the limitations of the reference studies, i.e. taking as 100% only the sum road, rail and inland navigation, the share of freight transport on rail declines in both reference studies from 17% (2000) to 11% (2030).

---

[11] "Respondents" meaning again self-estimated experts, knowledgeable and familiar of the 2nd round. The "Never" share of experts only is even higher (26%). [Jørgensen et al. 2004]

[12] The same concept is applied to international air traffic and deep-sea shipping.

Taking into account that the share of short sea shipping (in a total of road, rail, inland navigation and short sea shipping, i.e. comparable to the reference percentages of the *EurEnDel* Delphi statement) is likely at least to stay constant or rather to grow, the conclusion can be drawn, that the *EurEnDel* energy experts expect the share of rail transport to rise significantly and quickly (until 2019!) while in opposite the reference studies expect the share of rail to decrease significantly and continuously until 2030. Thus the *EurEnDel* Delphi respondents are in clear contradiction to the reference studies. It is impossible, though, to define a “level of intensity” multiplier as for other statements.

3.1.5 Statement 6a/6b: H2 from diverse sources / H2 from RES

According to the *EurEnDel* Delphi, hydrogen produced **from diverse sources** and used as an energy carrier constitutes a significant part of the energy system (transport and stationary application) **by 2031** (lower quartile 2023 – upper quartile 2040) and hydrogen produced **solely from renewables** and used as an energy carrier constitutes a significant part of the energy system (transport and stationary application) **by 2034** (lower quartile 2026 – upper quartile 2043).

The reference studies do not single out hydrogen explicitly in their tables on energy carriers’ shares in energy demand. However, it is likely that the category “New fuels (hydrogen etc.)” is dominated by hydrogen. In the *Trends 2030* study, the share of “New fuels (hydrogen etc.)” is expected to rise to 1,4 Mtoe by 2030, i.e. 0.1% of final energy demand. In *WCLP* [Zeka-Paschou 2003] no detailed information on the use of hydrogen is given.

Taking into account that the two time horizons 2031/2034 (*EurEnDel* Delphi) and 2030 (*Trends 2030*) are close together, it is obvious that the *EurEnDel* energy experts are much more optimistic than the reference study. The *EurEnDel* Delphi questionnaire does not quantify what “a significant part of the energy system” is. If one assumes that a level of significance might be approx. 2%, the “level of intensity” multiplier would be at least >20. However, in order to correctly assess the comparison the discussion of chapter 3.1.2 on the coverage of emerging technologies in modelling and Delphis should be kept in mind.

3.1.6 Statement 14: 25% RES

According to the *EurEnDel* Delphi, renewable energy sources cover 25% of Europe’s total energy supply by 2028 (lower quartile 2020 – upper quartile 2033).

In *Trends 2030* a the share of renewable s is expected to rise from 5.8% (2000) to 8.6% by 2030, while the renewables’ share in *WCLP* rises up to 10.5% by 2030.

Taking into account that the two time horizons 2028 (*EurEnDel* Delphi) and 2030 (reference studies) are close together, it can be stated that the *EurEnDel* energy experts are much more optimistic than the reference studies: The “level of intensity” multiplier would be approx. 3 (*Trends 2030*) and 2.5 (*WCLP*) respectively. Again, in an assessment of the comparison the discussion of chapter 3.1.2 on the coverage of emerging technologies in modelling and Delphis should be regarded.

3.1.7 Statement 15: 5% PV

According to the *EurEnDel* Delphi, photovoltaic cells contribute with >5% of European electricity generation by 2023 (lower quartile 2023 – upper quartile 2040).

Unfortunately, both *Trends 2030* and *WCLP* don't give explicit results on the shares of PV in electricity generation, the fuel split-up for electricity generation is "nuclear", "hydro and wind", and "thermal (incl. biomass)". However in the *Trends 2030* study text it is stated that "solar photovoltaic energy starts emerging beyond 2020 (accounting for 1.3% of total installed capacity by 2030) [Mantzos et al. 2003, p. 124].

It is obvious that the *EurEnDel* energy experts are much more optimistic than the reference study. With 1.3% of total installed capacity maybe corresponding to a share in electricity generation of approx. 0.5% (today it is 0.15%) the "level of intensity" multiplier would be at least >10. Taking into account the relatively high difference between the two time horizons 2023 (*EurEnDel* Delphi) and 2030 (trends 2030) the multiplier would be even higher.

While assessing the comparison it should be taken into account on one hand that for statement 15 "5% PV" a relatively high share of 9% of the Delphi respondents[13] answered "Never". On the other hand, the limitations of energy modelling in regard of emerging technologies as discussed chapter 3.1.2 should be kept in mind.

3.1.8 Conclusion on Delphi Statements

The results of the comparison between the Delphi survey and the reference studies are summarised in Table 3-2. It can clearly be seen that the results of the *EurEnDel* Delphi are generally more "optimistic" in terms of technical developments and structural changes compared to the reference studies. The "level of intensity" multiplier which visualises the distance between the Delphi energy experts' opinion and the model results moves up to >20 for certain statements.

However, these differences should not be misinterpreted as a lack of expertise on the *EurEnDel* energy experts' side. There are indications showing that economic quantitative models generally tend to underestimate the potentials of emerging technologies. A comparison of projections of the Annual Energy Outlook 2004 by the US Energy Information Administration [EIA 2003] and a Delphi study by the George Washington University (TechCast Delphi; see [Halal and Kallmeyer 2004]) shows comparable differences to those presented in this report [Laitner 2004]. The fact that previous energy models tended to overestimate future energy demands and underestimated the potentials of new technologies have led to several improvements of quantitative energy models (e.g. the introduction of learning curves). However the EurEnDel results may indicate that additional ways should be sought for to integrate projections on emerging technologies into quantitative models.

Furthermore it should be kept in mind, that the *Trends 2030* study is a pure baseline study that fails to assume any new policies to reduce greenhouse gas emissions for analytical reason, and

---

[13] "Respondents" meaning again self-estimated experts, knowledgeable and familiar of the 2nd round. The "Never" share of experts only is even higher (16%). [Jørgensen et al. 2004]

can generally be qualified as rather conservative. The *WCLP* scenario seems to be a bit more realistic in terms of climate policy, incorporating at least a CO_2 price.

In contrast, the *EurEnDel* energy experts had their own sets of framework conditions in their minds when responding to the Delphi questionnaire. As a matter of fact, these framework conditions are never made explicit. According to the Delphi methodology the assumption is: if an appropriate survey population participates (high degree of expertise and a large-enough sample), then the means over all answers follows what is perceived as the most likely scenario. So one interpretation of the differences between the Delphi results and the references is that the Delphi respondents consider framework conditions as most likely which differ strongly from the framework conditions of the quantitative models used to calculate the reference scenarios.

A hint to what these framework conditions may look like is given by the analysis of what actions the respondents consider as needed in order to promote an early occurrence of the Delphi statements (cf. [Jørgensen et al. 2004]). It is important to bear in mind that the *EurEnDel* Delphi statements were deliberately formulated to be rather ambitious in the employed 30-year time frame (cf. the *EurEnDel* structural analysis report [López and Velte 2003]). Thus the developments and respective time horizons in the Delphi survey should be between what the experts consider to be “most probable” and what they consider to be “technological feasible” if appropriate promotive actions are taken.

As a conclusion, the differences between the *EurEnDel* Delphi results and the reference scenarios should rather be interpreted as making clear what future developments are realistically achievable, if framework conditions and incentives are set correspondingly.

No.	Statement short	Delphi Statement long	Time of Occurrence *	Reference studies: *Trends 2030* / *WCLP*	Comparison Result	Level of intensity multiplier
Demand						
1	Novel production processes	Industrial energy consumption in Europe is reduced by 50% per produced unit through novel production processes	2028 (2021 – 2034)	No info on novel production processes; energy intensity reduction 2000 - 2030: 38% (*Trends 2030*); 39% (*WCLP*)	Delphi more optimistic than reference studies.	1.3
Transport						
3	20 % FC cars	Fuel cell driven cars reach a European market share of 20%	2027 (2020 – 2032)	Fuel cell cars are not expected to gain significant market share until 2030 primarily due to costs but also lack of fuel supply infrastructure. (*Trends 2030*)	Delphi much more optimistic than reference study.	> 10
4	25% Bio-fuels	Bio-fuels will have a European market share of >25% in the road transport sector	2027 (2018 – 2030)	5% in 2030 (*Trends 2030* and *WCLP*)	Delphi much more optimistic than reference studies.	5
5	15% Freight on rail	Improved logistics based on information and communication technologies raise the railway's market share in Europe's freight transport to 15% [1990: 11%, today: 8%].	2019 (2012 – 2023)	No info on ICT in railways the share of rail freight transport declines from 17.1% (2000) to 11.2% (2030) (excluding short sea shipping) (*Trends 2030* and *WCLP*)	Delphi much more optimistic than reference studies.	-
Storage and Distribution						
6a/ 6b	H2 from diverse sources / H2 from RES	Hydrogen produced from diverse sources (H2 from RES: solely from renewables) and used as an energy carrier constitutes a significant part of the energy system (transport and stationary application)	2031 (2023 – 2040) (H2 from diverse sources) 2034 2026 – 2042) (H2 from RES)	Share of new energies (hydrogen etc.) in final energy demand will rise to 1.4 Mtoe in 2030 (i.e. 0.1%) (*Trends 2030*)	Delphi much more optimistic than reference study.	> 20

* (Mean value of the 2nd survey round considering only respondents who classified themselves as either “experts”, “knowledgeable” or “familiar” for the respective topic. The given time range in brackets refers to the lower and the upper quartile. This means that 50% of the respondents expect an occurrence in the given timeframe, 25% expect an earlier, and 25% expect a later occurrence.)

No.	Statement short	Delphi Statement long	Time of Occurrence *	Reference studies: *Trends 2030 / WCLP*	Comparison Result	Level of intensity multiplier
Supply						
14	25% RES	Renewable energy sources cover 25% of Europe's total energy supply [Today it is 6%]	2028 (2020 – 2033)	"Relatively slow penetration of renewables"; the use of renewables will rise by 74% (*Trends 2030*) between 2000 and 2030 (*WCLP*: 106%); the share of renewables in gross inland consumption rises from 5.8% in 2000 to 8.6% (*Trends 2030*) in 2030 (*WCLP*: 10.5%)	Delphi much more optimistic than reference studies.	3 / 2.5
15	5% PV	Photovoltaic cells contribute with >5% of European electricity generation [Today it is 0.15%]	2030 (2023 – 2040)	"Solar photovoltaic energy starts emerging beyond 2020 (accounting for 1.3% of total installed capacity by 2030). (*Trends 2030*) No data on production shares	Delphi much more optimistic than reference study.	> 10
* (Mean value of the 2nd survey round considering only respondents who classified themselves as either "experts", "knowledgeable" or "familiar" for the respective topic. The given time range in brackets refers to the lower and the upper quartile. This means that 50% of the respondents expect an occurrence in the given timeframe, 25% expect an earlier, and 25% expect a later occurrence.)						

Table 3-2: Overview on comparison results of Delphi statement responses with reference studies

3.2 Qualification of *EurEnDel* Scenarios regarding CO_2

In addition to the direct comparison of Delphi results with quantitative studies (cf. chapter 3.1 above) the *EurEnDel* scenarios [Velte et al. 2004] were quantitatively assessed concerning their respective position in terms of CO_2 emission scenarios. As a reference, again the *Trends 2030* and *WCLP* studies were used. An overview is given in Table 3-3. In the following chapters the qualifications will be given scenario by scenario.

3.2.1 Change of Paradigm scenario

Overview on the scenario

The Change of Paradigm scenario (cf. [Velte et al. 2004]) is most closely related to a strong policy shift towards sustainable development in the years up to 2030: it is due to a combination of political will, technological progress, structural changes in the economy and urgent environmental pressures that Europe 25 is on the way of achieving great progress in energy efficiency. These combined pressures trigger an aggressive and self-learning move towards much lower levels of energy intensity across all processes and countries. It is mostly a universal attitude, which seeps across all layers of societies and spheres of activity, and produces a “democratic” initiative, summing up efforts by many and in many places.

Quantitative CO2 emission classification

With the CO_2 reduction to 1990 levels by 2012, the Kyoto protocol is not complied with domestically, but by means of the flexible mechanisms. The CO_2 reduction by 1.5% annually later on is equivalent to a 25% reduction by 2030 compared to 1990. With this setting, the „Change of Paradigm“ scenario is far more optimistic in terms of CO_2 reduction than the *WCLP* scenario [Zeka-Paschou 2003].

	1990	1995	2000	2005	2010	2015	2020	2025	2030
Quantitative Reference Scenarios									
EU25: EU wide scenario with climate policies (WCLP)									
CO2 Emissions (Mt of CO2)	3769	3652	3665	3681	3615	3619	3686	3742	3851
CO2 Emissions Index (1990=100)	100	97	97	98	96	96	98	99	102
CO2 Emissions Index (2000=100)			100	100	99	99	101	102	105
EU25: EU wide scenario without climate policies (WoCLP)									
CO2 Emissions (Mt of CO2)	3769	3652	3665	3681	3757	3841	4041	4158	4304
CO2 Emissions Index (1990=100)	100	97	97	98	100	102	107	110	114
CO2 Emissions Index (2000=100)			100	100	103	105	110	113	117
EU 25 :Trends 2030									
CO2 Emissions (Mt of CO2)	3805	3663	3671	3683	3763	3845	4057	4172	4324
CO2 Emissions Index (1990=100)	100	96	96	97	99	101	107	110	114
CO2 Emissions Index (2000=100)			100	100	103	105	111	114	118
EU25: EU wide scenario without climate policies (WoCLP) und EU 25 :Trends 2030 are basically the same.									
					2012				
***EurEnDel* Scenarios**									
Change of Paradigm Scenario									
CO2 Emissions Index (1990=100)	100	100+x	100+x	100+x	100				74
CO2 Emissions Index (2000=100)			100						
Fossil Fuel Wars Scenario									
CO2 Emissions Index (1990=100)	100								114
CO2 Emissions Index (2000=100)			100						118
Muddling Through Across The Gas Bridge Scenario									
CO2 Emissions Index (1990=100)	100				100	100	100	100	100
CO2 Emissions Index (2000=100)			100						

Table 3-3: Development of CO_2 emissions in the reference studies and the *EurEnDel* scenarios

3.2.2 Fossil Fuel Wars scenario

Overview on the scenario

The Fossil Fuel Wars scenario (cf. [Velte et al. 2004]) stands for a crisis scenario, in which climate change concerns play a minor role when defining priorities for energy policies. Conflicts between the different interest groups prevail on European, as well as on national levels. Economic, social and environmental policy goals are difficult to integrate and there is a general lack of willingness among companies and citizens to bear the increasing costs of environmental protection.

Quantitative CO2 emission classification

Compliance with the Kyoto protocol is no issue under the "Fossil Fuel Wars" scenario. The envisaged growth of CO_2 emissions by 14% compared to 1990 until 2030 is in line with the *Trends 2030* study [Mantzos et al. 2003].

3.2.3 Muddling Through Across the Gas Bridge scenario

Overview on the scenario

The Muddling Through Across the Gas Bridge scenario (cf. [Velte et al. 2004]) also implies a major drive towards sustainability, but assumes that long-term climate change impacts cannot be avoided. The transition process is slower and natural gas plays a key role as intermediary solution, not only in power generation, but also in transport.

Quantitative CO2 emission classification

As in the "Change of Paradigm" scenario, the Kyoto protocol is not complied with domestically in the "Muddling Through Across the Gas Bridge" scenario, the CO_2 emissions reaching 1990 levels by 2012. With the subsequent stabilisation of CO_2 emissions at 1990 levels, Europe fails to engage in further domestic emission reduction for long term climate protection. The envisaged development of CO_2 emissions is relatively close to the *WCLP* scenario [Zeka-Paschou 2003].

3.2.4 Conclusion on Scenarios

The *EurEnDel* scenarios are consistent with the reference studies in terms of CO_2 emissions development in so far as the reference studies (which have rather baseline character as discussed in chapter 3.1.8 above) accompany the "lower" (in terms of ambition in sustainable development and CO_2 reduction) end of the *EurEnDel* scenarios. The most ambitious *EurEnDel* scenario (Change of Paradigm) implies a much higher emission reduction than given in the reference scenarios.

4 References

[Capros 2000] Capros, P.: “The PRIMES Energy System Model – Summary Description” http://www.e3mlab.ntua.gr/manuals/PRIMsd.pdf

[Criqui et al. 1999] Patrick Criqui, François Cattier, Nicolas Kouvaritakis, Claude Thonet: “POLES: A world energy model developed in the framework of the EC-DGXII JOULE program: Climate Technology Strategy within Competitive Energy Markets towards New and Sustainable Growth” A presentation of the model in 40 slides (PDF format), Feb. 1999, http://www.upmf-grenoble.fr/iepe/textes/pole1.pdf

[EIA 2003] Energy Information Administration, Annual Energy Outlook 2004, DOE/EIA-0383(2004). U.S. Department of Energy, Washington, DC, December 2003.

[European Commission 1999] European Commission: “The Development of Short Sea Shipping in Europe: A Dynamic Alternative in a Sustainable Transport Chain, Second Two-yearly Progress Report”, Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions; COM(1999) 317 final

[European Commission 2003] Commission of the European Communities: Programme for the Promotion of Short Sea Shipping, COM(2003) 155 final, 2003

[Halal and Kallmeyer 2004] Halal, William E. and Jeffrey Kallmeyer, 2004. “Technology Forecasts for Improving National Energy Modelling Efforts.” TechCast LLC, Washington, D.C., March 2004.

[Jørgensen et al. 2004] Birte Holst Jørgensen, Oliver Nielsen, Tobias Reuss, Timon Wehnert: “EurEnDel Delphi report”, July 2004, accessible at http://www.izt.de/eurendel/survey_results/index.html

[Laitner 2004] John A. “Skip” Laitner: “ Exploring the Energy Impacts of Unanticipated but Emerging Technologies: Some Preliminary Insights”, Presented at the WorldFuture 2004: Creating the Future Now!, World Future Society Annual Meeting, World Future Society, Washington, DC, August 2004.

[López and Velte 2003] Juan Pedro López de Araguas, Daniela Velte: “Results of the Cross-Impact Analysis - Identifying Key Issues of Europe’s Energy Future” *EurEnDel* structural analysis report, 2003, accessible at http://www.izt.de/eurendel/survey_results/index.html

[Mantzos et al. 2003] Mantzos, L., Capros, P., Kouvaritakis, N., Zeka-Paschou, M., Chesshire, J., Guilmot, J.F.: “European Energy and Transport - Trends to 2030”, European Commission, Luxembourg: Office for Official Publications of the European Communities, 2003, ISBN 92-894-4444-4

[Mantzos 2003a] Mantzos, L.: “Note on “with” and “without climate policies” scenarios definition” in the framework of the CAFE stakeholder consultation process managed by the European Commission, DG Environment, 2003, http://forum.europa.eu.int/Public/irc/env/cafe_baseline/library?l=/baseline_data/summary_tables/scenarios_definition/_EN_1.0_&a=d

[Velte et al. 2004] Daniela Velte, Juan Pedro López de Araguas, Oliver Nielsen, Wolfram Jörß: “The EurEnDel Scenarios - Europe’s Energy System by 2030”, 2004, accessible at http://www.izt.de/eurendel/survey_results/index.html

[Zeka-Paschou 2003] Zeka-Paschou, M.: Data file containing the aggregated results of the “With Climate Policies” scenario used in the CAFÉ baseline stakeholder consultation; accessible at http://forum.europa.eu.int/Public/irc/env/cafe_baseline/library?l=/baseline_data/summary_tables&vm=detailed&sb=Title

[Zeka-Paschou 2003a] Zeka-Paschou, M.: Data file containing the aggregated results of the “Without Climate Policies” scenario used in the CAFE baseline stakeholder consultation; accessible at http://forum.europa.eu.int/Public/irc/env/cafe_baseline/library?l=/baseline_data/summary_tables&vm=detailed&sb=Title