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The Institute for Impact Assessment and Scientific Advice on Policy and Legislation

"Impartial Analysis for Policy Making"

Report on transparency, consistency and feasibility in the Impact Assessments accompanying the European Commission Communications:

"A policy framework for climate and energy in the period from 2020 up to 2030" SWD (2014) 15

and

"Energy efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy" SWD (2014) 255.

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Accompanying statement

This report has been written according to the guiding principles of the Impact Assessment Institute: transparency, objectivity, legitimacy and credibility. It therefore analyses the subject matter critically from a purely factual and scientific point of view, without any guiding policy orientation. In respecting these principles it has been compiled following its written Study Procedures, available at this link. Certain elements of the Study Procedures will become applicable as the Institute develops. Procedures are to be developed continuously in cooperation with stakeholders.

The analysis is open to review and criticism from all parties, including those whose work is scrutinised. To provide transparency, where contact with interested parties has been made in order to gain additional information, these instances are reported in an annex, either showing the identity of the contact or, where anonymity is preferred, the type of individual or organisation with which contact was made.

By its nature the report has a critical characteristic, since it scrutinises the subject document with its main findings entailing the identification of errors, discrepancies and inconsistencies. In performing this work, the intention of the report is to be constructive in assisting the authors of the subject document and its background information as well as all relevant stakeholders in identifying the most robust evidence base for the policy objective in question. It should therefore be seen in this positive light as a cooperative contribution to the policy making process.

This report is also to be considered as a call for additional data. Peer review is an important element of the procedures of the Impact Assessment Institute and this is manifested in the openness to further comment and to new data. Even after publication of the final report, additional input is welcome, in particular where the readily available data was not sufficient to complete all intended analysis.

Executive Summary

Main findings

Climate and energy is a key public policy domain, for which the European Commission develops policies and legislative proposals for subsequent negotiation and adoption by the European Parliament and Council. Proposals must be based on high quality Impact Assessments, since their assumptions, methodology and mathematical models have a critical impact on the results. Transparent presentation of evidence relating to future policy making is essential to generate confidence in the resulting policy initiatives.

The IAI studied two Impact Assessments [SWD (2014) 15 and 255] to scrutinise how the Commission's recommendations of a 40% greenhouse gas reduction target and a 30% energy efficiency target for 2030 were supported by its analysis. The study identified a lack of transparency in the analytical modelling, due in part to the confidential nature of the proprietary models used, as well as the absence of clear descriptions of the scenarios investigated. Together these factors prevent external assessment and scrutiny of the underlying assumptions, parameters, methodology and results.

The main finding is therefore that the evidence presented in the Impact Assessments did not provide the European institutions and interested stakeholders with a comprehensive and understandable platform for policy development. This has prevented full external scrutiny of the data in this key area of public policy. The IAI therefore recommends that the Commission provide full public access to the details of the data, modelling analysis and results used to generate current and future scenarios. This enables decision makers and stakeholders to understand and investigate potential policy measures, providing additional expertise and oversight to the development of Climate and Energy policy.

In this paper, the following two Impact Assessments on European Commission communications have been analysed in detail:

SWD (2014) 15:	A policy framework for climate and energy in the period from 2020 up to 2030 (2030 Impact Assessment)
SWD (2014) 255:	Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy (Energy Efficiency Impact Assessment)

The Impact Assessments and their corresponding policy communications were published in January and July 2014 respectively. Even though more than a year has elapsed since then, their content remains highly relevant. They are the basis for subsequent political decisions on climate and energy, the Energy Union strategy as well as relevant published and expected legislative proposals in this domain.

In both Impact Assessments, the critical element of the analysis is the simulation performed using the PRIMES model. Being a proprietary model, the specific mechanism of the PRIMES calculations is not made freely available, which was confirmed to the author by the European Commission in response to an access to document request.

Due to the importance of the public policy conclusions underpinned by the Impact Assessments, the ideal situation would be full public access for interested stakeholders to the details of the modelling mechanism, allowing reproduction of the results and sensitivity analysis to be performed. This would provide a transparent comprehensive record of the evidence accompanying the policy recommendations. It is acknowledged that the nature of the model used does not currently support such a step. However, consideration could be given in future analysis to providing full transparency of the modelling to allow all interested stakeholders the possibility understand in detail how the results have been reached.

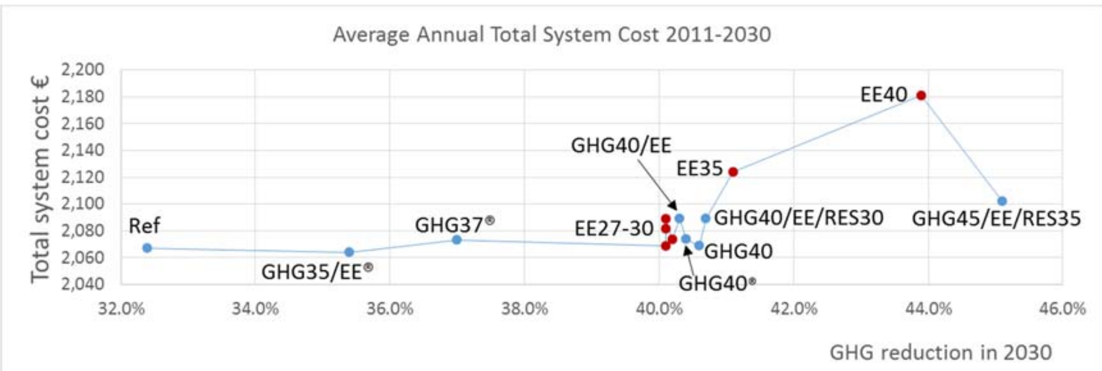
In the absence of such full transparency, ideally the Impact Assessments would detail fully the relevant inputs and raw outputs of the modelling in a comprehensible fashion. This would provide stakeholders with all relevant information to link the investigated parameters to the corresponding results and gain an insight into modelling mechanism. Furthermore it would allow sufficiently motivated stakeholders to reproduce the results using publicly available information by feeding the inputs into the PRIMES model or an alternative model, and thereby to perform their own scenario analysis. A further access to document request was filed on 29th July 2015 requesting full detail of the inputs and outputs of the modelling used for the two Impact Assessments, with no additional information received as of 23rd October.

Additionally it would be beneficial to present the key results in the Impact Assessments, in particular the total system costs, with greater chronological resolution. Specifically, data would be more informative and comparable if presented at the 5-year intervals inherent to the PRIMES model, instead of the annual average over 20 years presented in the Impact Assessments.

The transparency of scenario conditions was alluded to in the first Impact Assessment Board (IAB) report on the 2030 Impact Assessment[i], requesting "more information … regarding the assumptions underlying the baseline scenario and the options." However, this request and its partial reiteration in the second IAB report[ii] did not result in a full description of the conditions sufficient to enable understanding of the underlying assumptions for stakeholders.

Numerical analysis

The main conclusion of the policy communication associated with the 2030 Impact Assessment is the recommendation for a 40% reduction in GHG emissions by 2030 compared to 1990, enabling the eventual fulfilment of the E.U.'s 2050 roadmap with an 80% reduction. Therefore the modelling outputs, in particular total system costs for the analysed scenarios, leading to this conclusion are the most critical element of the Impact Assessments, as summarised in the chart below.



Total system costs 2011-2030 for GHG reduction (•) and energy efficiency scenarios (•)

The increase in average annual total system costs in 2011-2030 going from the reference scenario to the preferred GHG40 scenario (under enabling conditions) is €2bn per year, about 0.1%. Due to the significance of this result, implying a total system cost effect very close to zero for reaching the policy objective, straightforward scrutiny of the mechanism for the reaching the results should be possible, as argued above.

Similarly for scenarios reaching 45% GHG reduction in 2030 and close to 80% GHG reduction in 2050 exhibiting 0.6% and 5% total system cost increase respectively compared to the reference, the underlying mechanisms need to be fully understood to generate confidence in the results.

Further, the policy communication associated with the Energy Efficiency Impact Assessment concludes that it would be appropriate to propose a 30% energy efficiency target (EE30 scenario), which generates additional average total system costs €20bn per year (1.0%) above the GHG40 scenario. As above, a full understanding of the conditions and mechanism underlying this result is necessary in order to provide confidence in the figures and the selection of this scenario as the appropriate level of ambition.

The key input parameters in the different scenarios in the two Impact Assessments are the underlying conditions, which include reference conditions, enabling conditions, ambitious/extra ambitious energy efficiency measures and dedicated energy efficiency scenarios. The descriptions of the underlying conditions are not fully comparable and the mechanism by which these translate into inputs to the model is not presented. The effect of the scenario conditions on the input to the model therefore requires clarification in order to understand how the outputs have been generated. This is the key technical issue identified in this report, since its resolution would allow stakeholders to gain a full understanding of the conditions and thereby confidence in the results.

Conclusion

The analysis summarised above leads to the conclusion that significantly more detail is required on the precise inputs to the PRIMES model, including their enabling conditions, and on the raw outputs generated, for each scenario. This information is essential in order to understand and justify the highly significant policy conclusions based on these results, in particular to provide confidence in the selection of the 40% GHG reduction and 30% energy efficiency targets.

It is therefore recommended that in continuing work on energy, climate and energy efficiency policy, full transparency is provided to stakeholders on the inputs and outputs to the model(s) used (whether PRIMES or others). Additionally, it is recommended to identify a method to open up the modelling mechanism to full scrutiny, to enable comprehensive explanation of the evidence presented for this key area of public policy making.

Additional data requested

As specified in the report below and the executive summary, further detail is necessary to explain the important results generated by the PRIMES model leading to the main policy conclusions.

In the particular the following additional information is required:

- Full set of relevant numerical input parameters to the PRIMES model for each scenario in both the 2030 Impact Assessment and the Energy Efficiency Impact Assessment, for the 2030 and 2050 timeframes.
- Full set of raw outputs for all scenarios.
- Comprehensive and comparable explanation of the conditions underlying all scenarios.
- Full explanation of how the underlying scenario conditions translate into the numerical input parameters to the model.

1 Report on the content of the Impact Assessments

Energy and Climate is a highly complex policy area. It is therefore to be expected that the corresponding background analysis will be complex and therefore require significant resources to compile as well as subsequently to read and understand.

The two Impact Assessments under analysis are highly detailed and thorough pieces of work, containing a large amount of information. For the reader the data and reasoning are not fully consistent, since not all the necessary information is presented or otherwise made available. These issues are explored further in the following sections.

Throughout this paper, the two Impact Assessments will be referred to as follows:

SWD(2014) 15[iii]:	2030 Impact Assessment
SWD(2014) 255[iv]:	Energy Efficiency Impact Assessment

2 Transparency of data

The key element of the two Impact Assessments is the data produced by the PRIMES model, which give rise to figures on energy usage, CO_2 emissions and costs presented clearly in the Impact Assessments. The details of the calculation methodology of the PRIMES model, which would be necessary for a complete understanding of how the figures quoted in the Impact Assessment arise, are not publicly available. This is to be expected, since PRIMES is a proprietary commercial model containing valuable intellectual property.

On the basis of the currently valid assumption that the modelling mechanism is not open to scrutiny, the test of transparency has two elements:

1. Firstly, any interested stakeholder should be able to reproduce the results using publicly available information by feeding the same input data into the PRIMES model or an alternative model, or to generate amended scenarios with different input data.
2. Since the resources required to commission PRIMES modelling are not available to all interested parties, sufficient information in the Impact Assessments themselves is required to describe the scenarios qualitatively and numerically, such that every interested party can gain an understanding of how the conditions influence the modelling inputs and outputs.

The information provided publicly in the Impact Assessments and supporting documentation is not in itself sufficient to achieve either of the above objectives. This is discussed in more detail below.

2.1 Inputs to modelling

For optimum transparency, the explicit presentation in the Impact Assessments or accompanying documentation of all relevant numerical input data to PRIMES would be necessary. This would allow a feasibility check on the input data itself and, for those parties wishing to commit resources to a more in-depth reassessment, allow a rerun of the model with the original parameters, also enabling alternative scenarios to be investigated.

The PRIMES handbook lists the following “typical” inputs to the model:

- GDP and economic growth per sector (many sectors)
- World energy supply outlook – world prices of fossil fuels
- Taxes and subsidies
- Interest rates, risk premiums, etc.
- Environmental policies and constraints
- Technical and economic characteristics of future energy technologies
- Energy consumption habits, parameters about comfort, rational use of energy and savings, energy efficiency potential
- Parameters of supply curves for primary energy, potential of sites for new plants especially regarding power generation sites, renewables potential per source type, etc.

Scenario analysis with PRIMES on the basis of the modelling performed for the Impact Assessments has indeed been performed by another organisation on the basis of the analysis performed for the 2030 Impact Assessment[v]. It is understood that that party was able to gain access to the input parameters used in the Impact Assessments when commissioning the analysis.

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How the parameters of the scenarios included in the Impact Assessments translate into numerical values for the above inputs is also important information for interested stakeholders wishing to understand and reanalyse the data, and is a key target of the analysis in this report (see in particular Section 3.2.2).

2.2 Outputs of modelling

Similarly to the above, a greater level of clarity of the results of the PRIMES model would be necessary in order to allow a full understanding of the policy options under investigation. In the Impact Assessments, the energy system impacts (including gross energy consumption, import dependency etc.) are presented for the years 2030 and 2050. The cost figures (including systems costs and investment costs) are presented as averages over a 20 year period (2011 to 2030 and 2031 to 2050, see figure below). These figures do indeed provide a relatively easy to understand set of figures for comparing the various presented scenarios.

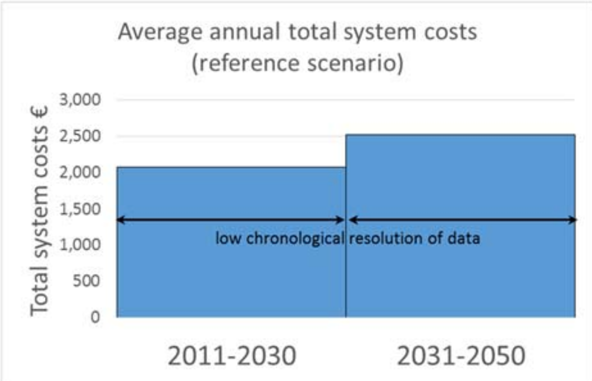

Figure 1: Average annual total system costs for the reference scenario presented in the Impact Assessment

However, it does not allow a full understanding of the development of the energy impacts and costs over time, which is necessary for a complete third party analysis. Literature on the PRIMES model indicates that it produces outputs at five year intervals and it is therefore this level of resolution for all output parameters that would ideally be made available as an annex to the Impact Assessments.

An attempt was made, by a stakeholder organisation through an access to document request, to gain access to more detailed information. The further information subsequently provided took the form of the final report on the PRIMES modelling[vi] and a data table[vii]. However, the information contained did not include the five-yearly detail, nor was it compatible with the data presented in the Impact Assessments, since total system costs for the specific years 2020, 2030 and 2050 were presented instead of the annual average in the original document, see figure.

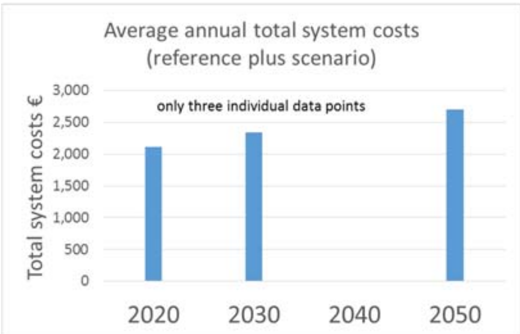

Figure 2: Average annual total system costs for the reference-plus scenario presented in the modelling report

2.3 General commentary on form of modelling results

Due to the absence of the full set of input parameters to the PRIMES model and of sufficient detail in the output, it has not been possible to gain a full understanding of the results presented. This is particularly important in the instances described in the following two chapters, where feasibility checks are required to verify the results or where inconsistency in the figures has been identified.

3 Feasibility and consistency check on data and results

This section focuses mainly on the total system costs of each presented scenario in the two Impact Assessments. The comparison of policy options elaborated in section 6 of the Impact Assessment takes into account a number of factors, including environmental, energy, economic, social and distributional impacts. Section 6.2.2.1 specifically assesses the GHG targets in economic terms, with the stated objective to maintain the cost effective track to meet the EU's 2050 GHG objective. Total system costs are therefore assumed to be the primary factor in comparing scenarios.

3.1 Overview of scenarios

The following table summarises the scenarios presented in the two Impact Assessments.
Key: • = Energy & Climate 2030 scenario; • = Energy Efficiency scenario

	In Impact Assessment SWD(2014)		Conditions				GHG reduction		Annual av. total system costs €bn	
Scenario name	15	255	Reference	Enabling	EE policy measures	EE targets	2030	2050	2011 to 2030	2031 to 2050
Ref. •	✓	✓	✓				-32.4%	-43.9%	2,067	2,520
GHG35/EE ® •	✓		✓		✓		-35.4%	-54.1%	2,064	2,584
GHG37 ® •	✓		✓				-37.0%	-53.4%	2,073	2,569
GHG40 ® •	✓		✓				-40.4%	-56.2%	2,074	2,590
GHG40 •	✓	✓		✓			-40.6%	-79.6%	2,069	2,727
GHG40/EE •	✓			✓	✓		-40.3%	-80.1%	2,089	2,881
GHG40/EE/RES30 •	✓			✓	✓		-40.7%	-80.0%	2,089	2,891
GHG45/EE/RES35 •	✓			✓	✓		-45.1%	-77.5%	2,102	2,925
EE27 •		✓		✓		✓	-40.1%	-77.6%	2,069	2,649
EE28 •		✓		✓		✓	-40.2%	-78.0%	2,074	2,686
EE29 •		✓		✓		✓	-40.1%	-78.3%	2,082	2,747
EE30 •		✓		✓		✓	-40.1%	-78.5%	2,089	2,806
EE35 •		✓		✓		✓	-41.1%	-79.5%	2,124	3,001
EE40 •		✓		✓		✓	-43.9%	-80.2%	2,181	3,355

Table 1: Summary table of all scenarios from the two Impact Assessments

Based on the figures presented above, further analysis is reported below.

3.2 Cost comparison of 2030 GHG reduction scenarios

Of key importance is the total system cost of meeting the primary objective, the reduction of greenhouse gas (GHG) emissions. In particular the target of meeting the EU roadmaps for GHG emissions is quoted, being a 40% reduction by 2030 and an 80% reduction by 2050, compared to a 1990 baseline.

3.2.1 2030

For 2030, the most important result of the analysis is the stability in total system costs for different levels of GHG emission reduction up to 40%, as evident in the graph below.

The graph plots the total system cost against GHG reduction in 2030 for all scenarios from the two Impact Assessments.

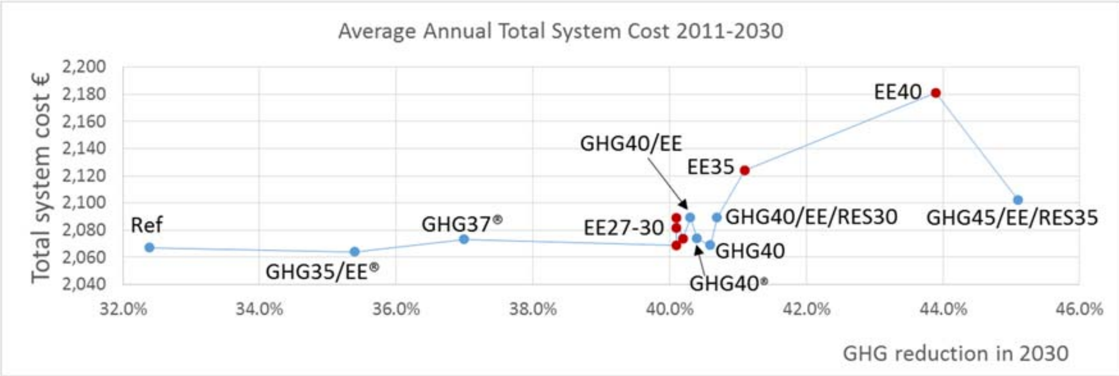

Figure 3: Graph of average annual total system cost in 2011-2030 vs. GHG reduction in 2030

Specifically, the average total system costs for the following scenarios, encompassing GHG reductions in 2030 from 32% to 40%, have a spread of €7bn per year over a baseline of about €2,000bn (less than 0.5% - see box highlighted with thick border):

Scenario name	Scenario characteristics	GHG reduction in 2030	Total system costs 2011-2030	ETS carbon price
Ref.	Reference scenario	32.4%	€2,067bn	€35
GHG35/EE®	Reference conditions, ambitious EE measures	35.4%	€2,064bn	€27
GHG37®	Reference conditions	37.0%	€2,073bn	€35
EE27	Dedicated EE measures	40.1%	€2,069bn	€39
GHG40®	Reference conditions	40.4%	€2,074bn	€53
GHG40	Enabling conditions	40.6%	€2,069bn	€40

Table 2: Summary table of total system costs for scenarios up to 40% GHG reduction

In particular, the increase in average total system costs between the reference scenario and the GHG40 scenario (both shaded above) is €2bn, about 0.1%. This is a highly significant result, since it provides the main economic justification for the ultimate policy conclusion to aim for a 40% GHG reduction in 2030. Due to their importance, generating confidence in these figures through an understanding of the mechanism of their calculation would be an important objective of the evidence presented.

Further to this, amongst the energy efficiency scenarios (•) the EE30 scenario achieves a 30% energy efficiency target with average total system costs €20bn higher than for the EE27 and GHG40 scenarios, a 1.0% increase. The main policy conclusion resulting from this work is the recommendation for the 30% energy efficiency target. As above, a full understanding of the underlying conditions and how these influence the total system cost figures is necessary to generating confidence in the final conclusion. For the Energy Efficiency scenarios in particular, discount rates also have an important influence, as addressed in section 3.4.

Going to GHG45

A further question relates to the increase in average total system costs of going from a 40% GHG reduction scenario to the GHG45 scenario in 2030. In order to present a valid comparison, the GHG40/EE/RES30 scenario is compared to the GHG45/EE/RES35 scenario, which is based on similar underlying conditions.

Scenario name	Scenario characteristics	GHG reduction in 2030	Total system costs 2011-2030	ETS carbon price
GHG40/EE/RES30	Ambitious energy efficiency measures, 30% renewables	40.7%	€2,089bn	€11
GHG45/EE/RES35	Ambitious energy efficiency measures, 35% renewables	45.1%	€2,102bn	€14

Table 3: Summary table of total system costs for comparable scenarios with 40% and 45% GHG reduction

The comparison exhibits a significant reduction in GHG emissions in 2030 over and above that achieved by the preferred GHG40 scenario, at a relatively small incremental cost (€13bn / year ~ 0.6% for a further 4.4% GHG reduction). This is a similarly significant result to that related to the 40% GHG reduction scenarios above.

Again, more information is needed about the underlying conditions and modelling inputs to gain an understanding of how these results have been generated and confidence in their accuracy.

3.2.2 Comparing underlying conditions of scenarios – key transparency issue

The following chart shows total system costs for scenarios which achieve 40% GHG reduction in 2030:

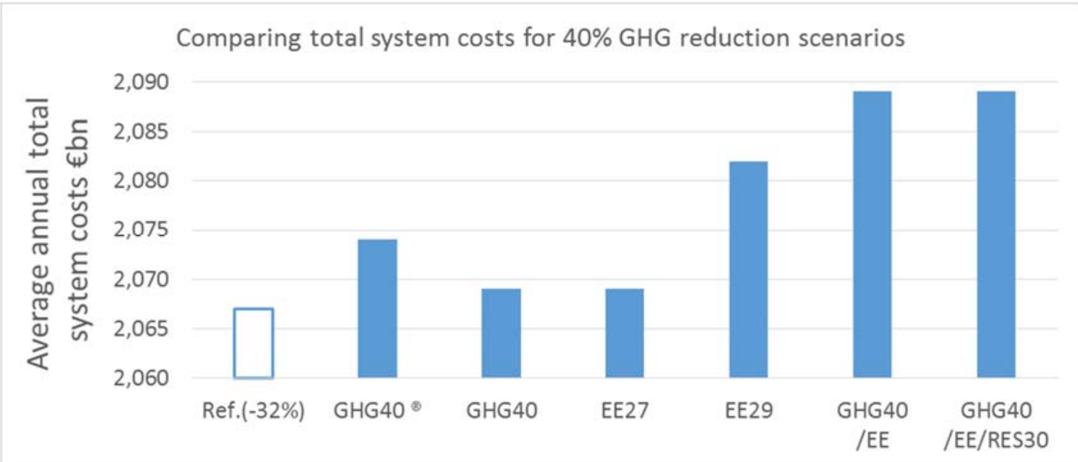

Figure 4: Graph of average annual total system cost in 2011-2030 for five scenarios reaching 40% GHG reduction

The lowest total system cost is exhibited by the EE27 and GHG40 scenarios, implying that the (different) conditions underlying these scenarios both represent the optimum regarding costs to the reach the -40% GHG target. In comparison, the conditions underlying the GHG40/EE and GHG40/EE/RES30 scenarios give rise to a significant increase in total system costs.

The EE29 scenario and the GHG40/EE scenario, by definition, both entail more ambitious energy efficiency conditions than the GHG40 scenario (and both achieve the same 29% energy saving in 2030). However the total system costs from 2011-2030 are somewhat higher for GHG40/EE than for EE29 – the underlying difference between these scenarios achieving the same energy and GHG results with different total system costs would be a key element of the understanding necessary.

The differences between these scenarios lie in their underlying conditions, as described in the two Impact Assessments, and compared side-by-side in Annex I.

In general, the descriptions of the enabling conditions, ambitious/extra ambitious measures and the energy efficiency scenarios provided in the Impact Assessments do not present a comparable and comprehensible framework. The following observations are made in particular:

- Where numerical values for parameters are provided for some scenarios, for example for building renovation rates and energy savings, district heating and cooling, equivalent values are not presented for enabling conditions nor for ambitious/extra ambitious scenarios. For CO_2 standards for vehicles the values are not available for the ambitious/extra ambitious scenarios (only a qualitative explanation).
- The provisions relating to Eco-design and labelling are qualitative, with no description of how these are input to the model.
- Details on conditions for transport are not consistent and comparable between scenarios.
- For taxes, incentives and access to finance, no information is given for the ambitious/extra ambitious scenarios and the energy efficiency scenarios.
- How discount rates are generated from the various conditions is not explained in detail (see Section 3.4 below for further commentary on discount rates).

In order to verify the results, a consistent comparison of the scenario conditions is necessary, as well as a detailed understanding of the mechanism by which the conditions are translated into numerical inputs to the model. This is the key element in understanding how the modelling mechanism generates the results in the Impact Assessments and to provide confidence in the data.

3.3 Comparison of 2050 GHG reduction scenarios

Five of the scenarios illustrate questions about the costs of reaching the roadmap target of -80% GHG in 2050. These scenarios all reach the 40% GHG reduction in 2030 and approach or reach the 80% GHG reduction in 2050.

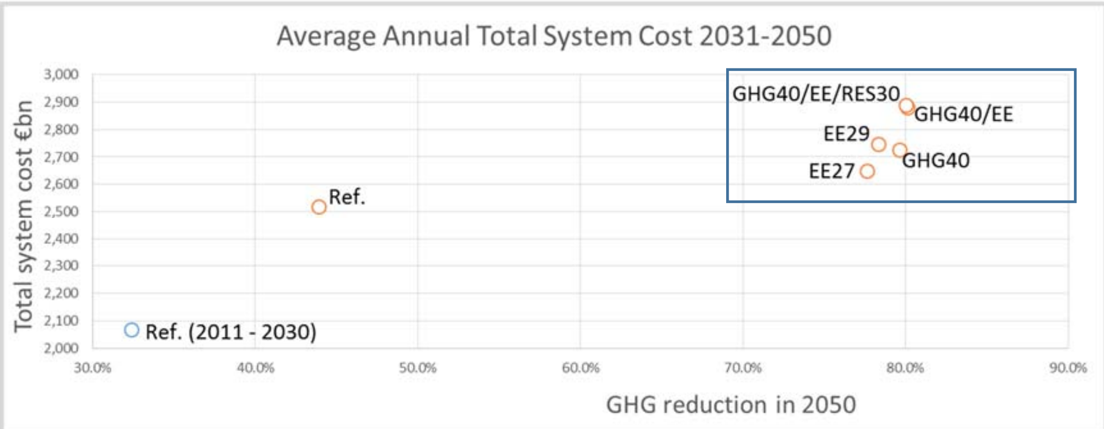

Figure 5: Graph of average annual total system costs in 2011-2030 vs GHG reduction in 2050

The highlighted box is expanded below to view the scenarios more easily.

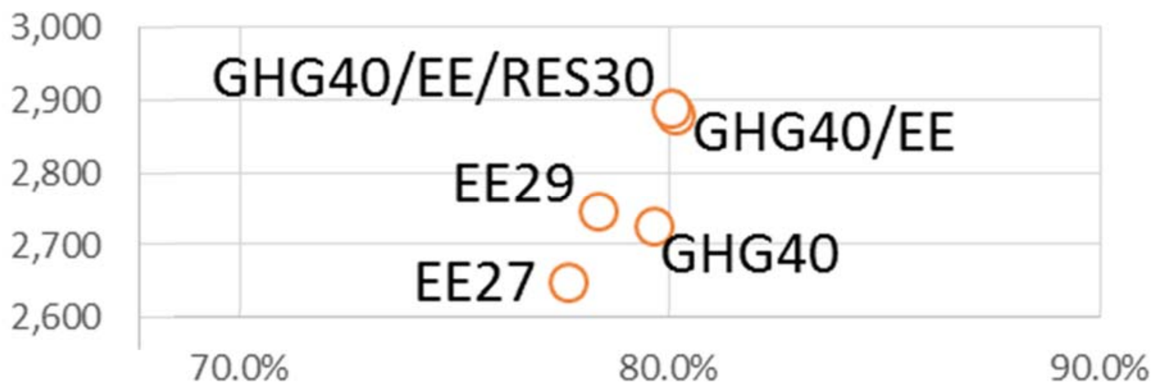

Figure 6: Close up of main scenarios

The following observations are made:

- The increase in average annual total system costs for the reference scenario in 2031-2050 compared to 2011-2030 is €543bn associated with a decrease in GHG emissions of 11.5%, due, according to the 2030 Impact Assessment, to a large extent to the increase in the cost of fuel over that period, in particular fossil fuel.
- Average total system costs for the EE27 scenario in 2031-2050 are €129bn (5%) higher than the reference scenario, less than a third the above figure for the change in the reference scenario itself. For a large GHG reduction of approximately 34%, it is important for stakeholders to understand fully how the scenario's underlying conditions have enabled this significantly smaller additional increment in total system costs. The evidence presented does not provide this detail.
- The argument above is also valid for the other three presented scenarios, for which the increase in total system costs compared to the reference is also significantly lower than the increase in the reference scenario itself.
- The GHG40/EE and GHG40/EE/RES30 scenarios exhibit substantially higher total system costs than the other scenarios. As stated in Section 3.2.2, the reason for the significant difference in the results for these two scenarios compared to energy efficiency scenarios EE27 and EE29 is not to be found in the presented evidence.

In the above points, it is well understood that the temporal effects going from 2030 to 2050 within one scenario cannot be fully compared to the effects of differing scenario changes in the 2050 timeframe. However the change in the reference scenario provides a useful orientation to put the incremental total system costs into context and this informal comparison has indeed been introduced in the 2030 Impact Assessment itself on pages 75, 82 and 132.

The phenomena identified above are illustrated graphically below, showing change in total system costs per percentage reduction in GHG emissions for all the above 2050 scenarios compared to the reference scenario, with the same ratio for the 2050 reference scenario compared to the 2030 reference scenario shown for reference.

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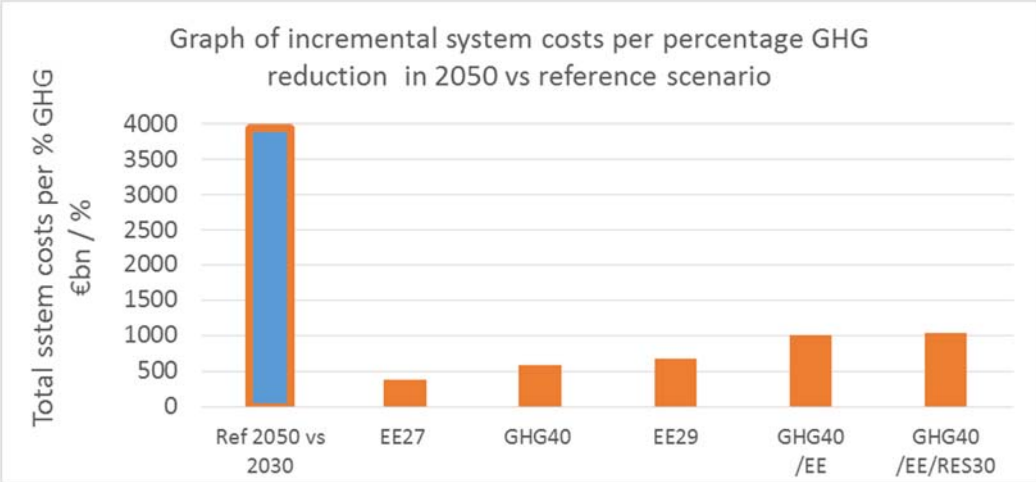

Figure 7: Graph of incremental total system costs 2031-2050 per percentage GHG reduction

Further, the two scenarios (EE27 and GHG40) reach almost the same goal, but with EE27 exhibiting significantly lower total system costs. The following explanation is given on page 46 of the Energy Efficiency Impact Assessment:

> "…both EE27 and EE28 appear to be less costly than GHG40, both in 2050 and in average yearly terms over 2031-2050. This can be mainly explained by the lower ambition of EE27 and EE28 in terms of GHG emissions reductions over the projection period, but also the introduction of some low-cost EE policies for dismantling non-market barriers…"

The statement implies that lower GHG ambition is associated with lower cost, even when comparing scenarios with different underlying conditions, but as shown above, this relationship is highly non-linear. Detailed information is required on the differing underlying conditions assumed for the two scenarios in question in order to provide a full explanation.

The 80% target is clearly a high level of ambition and a key element in the E.U. long term strategy on climate change. A full understanding of the results is critical and more information on how the results are generated is necessary in order to validate the analysis and provide the necessary confidence.

3.4 Analysis of discount rates

Discount rates are defined, evaluated and discussed in both Impact Assessments, where they "play a role in determining annuities for investments in the context of calculating energy system costs" (2030 Impact Assessment Section 5.1.4.1 p76). They thus are a primary input to the PRIMES model (bullet point "Interest rates, risk premiums, etc." in Section 2.1 above) and a key parameter for calculation of total system costs and therefore of great interest for comparing scenarios. Other studies and initiatives have addressed the methodology for determining discount rates (for example Ecofys[viii]), an analysis which is not included in the scope of this report. This section of the report briefly focuses only on elements of consistency of the discount rates.

Two types of discount rate are used for each energy sector: a "subjective" personal rate for technology selection by consumers, which reduces over time to reflect developing market conditions, and a social rate for calculating total system costs, remaining constant over time.

A full table of the discount rates used for all sectors and all scenarios is shown in Annex II. Of these, only the subjective discount rates for the residential and tertiary sectors change over time and between scenarios. Subjective discount rates for all other sectors remains constant over time and across all scenarios. Within each of the residential and tertiary sectors all scenarios have the same subjective discount rates in 2020, which then reduce at different rates according to scenario as from 2025. All social discount rates remain constant over time.

The following chart extracts as an illustration the subjective discount rates for all GHG and EE scenarios at 2030 and 2050 in the residential and tertiary sectors

Figure 8: Subjective discount rates in 2030 and 2050 for all scenarios

Immediately apparent are the significantly lower discount rates associated with moderate, ambitious and highly ambitious energy efficiency measures (GHG35/EE®, GHG40/EE etc.) and the energy efficiency scenarios (EE27-EE40). These lower rates in comparison to the scenarios under reference conditions can be expected to have a significant bearing on the simulated technology selections by substantially reducing the weight of early investments in energy efficiency, leading to effects on total system costs.

Not included in either Impact Assessment or their accompanying documentation is an explicit explanation of the methodology of translating the inherent conditions for each scenario into a numerical value for the discount rate. Without this information, an interested external stakeholder does not have sufficient information to understand and verify the calculation mechanism.

A specific discontinuity is apparent between the discount rates for the EE29 and EE30 scenarios (arrowed in the above chart ↑). Since the descriptions of these scenarios are very similar, there is no apparent reasoning for such a discontinuity. This observation leads to the broader question, why in most cases discount rates are quoted in increments of 0.5%, whereas the expected nuances of such scenarios could be expected to generate finer differentials for all sectors and scenarios.

Finally, it can also be questioned why the discount rates for the other sectors (power generation, industry etc., see Annex II) do not reduce over time and are not different between scenarios in the same manner as those for the residential and tertiary sectors. For example for private cars (17.5%), the scenarios with ambitious energy efficiency measures and the energy efficiency scenarios include progressively developed supporting conditions over time as well tightening of emissions standards for vehicles. Different scenarios include different levels of support and differing emission standards. In line with the methodology for the residential and tertiary sectors, changes over time and by scenario in the discount rate for private cars and other sectors could be expected. Evidence to explain the lack of this phenomenon is not provided in the Impact Assessments.

It is understood that in continuing work in this policy area, amended discount rates are being generated.

3.5 Feasibility and consistency check with ETS price

A reasonable first order expectation is that ETS price correlates to total system cost, since ETS price represents marginal abatement cost in the ETS sectors (with implicit non-ETS price representing marginal abatement cost in the other sectors). In the Impact Assessments, the presence of ambitious energy efficiency and renewable energy policies works to reduce GHG emissions outside the direct influence of the ETS price mechanism, diminishing the role of the ETS carbon price mechanism in achieving the target, as explained for example in the 2030 Impact Assessment page 80. The differing scenario conditions therefore work to break the expected first order correlation between ETS price and total system costs.

A check is performed for scenarios in the absence of the effect of energy efficiency and renewables policies by comparing the following three scenarios under reference conditions:

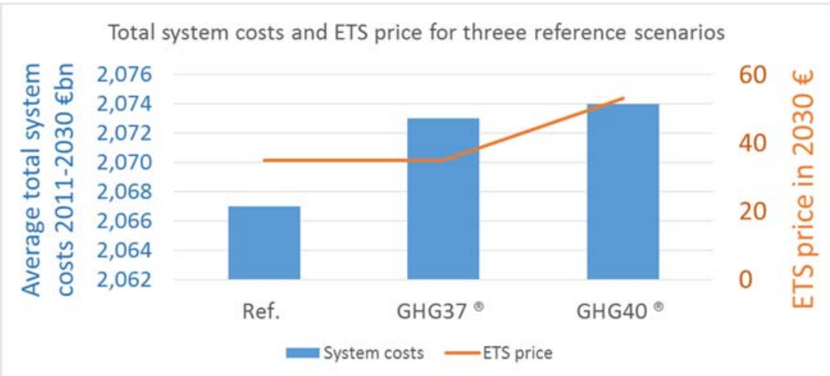

Figure 9: Graph of average annual total system cost in 2011-2030 vs. ETS price in 2030 for three scenarios

In this case, the total system costs and ETS/implicit non ETS price would be expected to demonstrate a correlated development as the GHG reduction parameter increases, but this correlation is not apparent. Again additional explanation of the modelling is required.

It is apparent that the detailed reasoning for the identified phenomena lies in the mechanism of the PRIMES model's calculations. This is therefore a further argument for providing additional transparency on the model, at the very least to show clearly the input parameters and more detailed output results as discussed above.

4 Additional inconsistencies identified

The following commentary identified specific inconsistencies identified in the text of the Impact Assessments.

4.1 2030 Impact Assessment

It is stated on p42 that scenario GHG35/EE® is under reference conditions but includes moderate, explicit EE policies. This appears to be a contradiction, whereby the uncertainties in the enabling conditions have already been discussed in section 3.2.1 above.

The description of the GHG40® scenario on p43 states "it does not achieve GHG emission reductions in line with the Roadmaps in a 2050 perspective." then continues "achievement of 40% and 80% reduction targets in respectively 2030 and 2050". The GHG reduction in 2050 projected under this scenario is 56%. This appears to be a simple discrepancy in the text.

4.2 Both 2030 Impact Assessment and Energy Efficiency Impact Assessment

GHG reductions are quoted against a 1990 baseline, whereas the breakdown of the reductions into the ETS & non-ETS sectors uses the 2005 baseline. Although 2005 is a relevant baseline due to the start of operation of the ETS in that year, for the purposes of third party analysis, it would be beneficial for the separate figures for these two sectors also to be quoted against the 1990 baseline.

5 Conclusion

No definitive conclusion can be reached from the above analysis. Additional information is required in order to understand how the results represented in the Impact Assessments have been generated. In summary the issues identified are the following:

- The increase in average annual total system costs of the preferred 40% GHG reduction scenario compared to the reference scenario represents a less than 0.1% increase in total system costs for an 8% GHG. Further explanation of the mechanism is needed in order to underpin the reasoning for selecting a -40% GHG scenario.
- Similarly, the significant additional (5%) GHG reduction going from the GHG40/EE/RES30 to the GHG45/EE/RES35 scenario is associated with average annual total system cost increase of €13bn or ~0.6%, again requiring more detail on the mechanism in reaching this important result.
- The increase in 2031-2050 average annual total system costs in going from the reference scenario (-43% GHG) to the EE27 scenario (-77.6% GHG) is €129bn, about 5% and significantly lower than the change in the reference scenario. Again more detail on the mechanism of achieving this result is necessary.
- Further to the above, similar questions arise on the correlation between the scenario conditions and the modelling results, in particular total system costs, in the 2050 timeframe.
- A consistent and comprehensible comparison of the scenario conditions is not presented, preventing an understanding of the scenario conditions and how these are translated into numerical inputs to the model.
- The generation of the discount rates for the different sectors and scenarios gives rise to a number of questions.
- A number of minor additional inconsistencies have been identified.

As listed above, the data presented give rise to a number of questions on the mechanism for reaching the quoted modelling results. This information is necessary in order to provide full evidence backup for the important conclusions that have been reached in the Impact Assessments and their corresponding policy communications.

Annex I: Comparison of conditions for scenarios

The information on underlying conditions of the scenarios is taken from the following sections of the Impact Assessments:

2030 Impact Assessment:

- Section 4.1.2.1 Box 2 p39 – qualitative description of enabling conditions
- Section 4.1.2.2 Table 2 p42ff – mainly qualitative description of scenarios
- Annex 7 – comprehensive qualitative descriptions of the reference conditions, enabling conditions and energy efficiency measures

Energy Efficiency Impact Assessment:

- Section 4.2 table 2 – numerical and qualitative descriptions
- Annex V – mostly qualitative descriptions plus overview of discount rates

	Reference scenario	**Enabling conditions**	**Ambitious/ extra ambitious energy efficiency measures over and above enabling conditions**	**Energy efficiency scenarios over and above enabling conditions**	
Scenario	**Ref.**	**GHG 40**	**GHG40/EE**	**EE27**	**EE40**
Primary energy savings	21.0%	25.1%	29.3%	27.4%	39.8%
GHG reduction in 2030 (1990)	32.4%	40.6%	40.6%	40.1%	43.9 %
RES share in 2030	24.4%	26.5%	26.4%	27.8%	27.4 %
Buildings	EPBD	Until 2020: vigorous implementation of EPBD From 2020: in line with 2050 roadmaps: additional national policies (thermal integrity)	Speeding up renovation rate: -cost-optimality -near-zero standards new buildings -EE obligations on utilities & retail -Energy Performance Contracting -removal of regulatory barriers -Energy management in new construction -renovation rate 1.69% average 2020-2050	Continued energy savings obligation. Elimination of market failures and imperfections (e.g. ESCOs, labelling, information campaigns, addressing landlord-tenant problems) reflected in the reduction of discount rates.	
Renovation rates 2015-2020 2021-2030	1.28% 1.37%	n/a	n/a	1.44% 1.67%	1.65% 2.42%

2031-2050	1.11%			1.11%	1.33%
Energy savings after renovation 2015-2020 2021-2030 2031-2050	 20.91% 31.47% 35.68%	n/a	n/a	 21.78% 40.73% 42.73%	 22.11% 46.18% 48.85%;
Energy Efficiency	EED	Until 2020: vigorous implementation of EED From 2020: in line with 2050 roadmaps: --accelerated technology uptake -lowering perceived cost, higher learning rates of technologies. -carbon values drive some additional energy efficiency in comparison to the Reference.	Extended energy efficiency obligations Wide deployment of EPC & ESCOs Strengthening of other measures under EED Support smart grids etc Lower transmission losses in the grid	EED is implemented and enhanced beyond 2020. Measures limiting grid losses.	
Eco-design Directive	Eco-design Directive		Tightened & broadened Eco-design Regulations Additional measures on industry regarding BAT	Increased Eco-design & BAT uptake	
Labelling	Energy Labelling Directive			Increased uptake of advanced technologies by improved labelling	
CHP & district heating/cooling			Wider deployment of CHP & district heating/cooling	Higher penetration of district heating and CHP through promotion of investments in CHP and in distributed steam and heat networks	
% of households connected to district heating & cooling in 2030/2050	11% / 11%	n/a	n/a	11% / 16%	14% / 16%
Transport	CO_2 measures	Enabling electrification long term.		Measures leading to improvements in the fuel efficiency of heavy duty vehicles. Shift to CO_2 based taxation. Internalisation of external costs. Wide deployment of intelligent transport systems.	

				Development of infrastructure for alternative power-trains and other soft measures like fuel labelling and eco-driving in line with the measures put forward in the 2011 White Paper on Transport.	
Excise and emission taxes, fiscal incentives (e.g. tax rebates)	As planned	Access to finance: -Soft loans etc -Favourable tax regime -Risk guarantees etc -Structural Funds -EIB support	n/a	n/a	
Discount rates 2020 / 2050 Residential Tertiary	12% / 12% 10% / 10%	12% / 12% 10% / 10%	12% / 9% 10% / 8.5%	12% / 10.2% 10% / 9%	12% / 9% 10% / 8.5%
CO_2 standards 2030/2050 PC LDV	95 g	95 g / 25 g 147 g / 60 g	Stronger CO_2 standards for passenger cars & LDVs HDVs 1.1%/yr 2010 2050 Standards on CO_2 motorcycles and mopeds Other additional transport measures Improvements in non-road mobile machinery	76g / 26g 110g / 60g HDVs 1.1%/yr 2010 2050	70g / 17g 110g / 60g HDVs 1.1%/yr 2010 2050
Industry					Increased uptake of BAT
Enabling conditions (to meet 2050 objectives)		✓	✓	✓	✓
Also applies to scenarios	**GHG35/EE®** **GHG37®** **GHG40®**		**GHG40/EE/RES30** **GHG45/EE/RES35**	**EE28, EE29, EE30, EE35**	

Annex II: Discount rates

Subjective discount rates in the residential (housing) sector:

Discount Rates of the Residential Sector (%)	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Ref.	17.5	17.5	14.75	12	12	12	12	12	12	12
GHG35/EE ®	17.5	17.5	14.75	12	11.7	10.5	10.2	10.2	10.2	10.2
GHG37 ®	17.5	17.5	14.75	12	12	12	12	12	12	12
GHG40 ®	17.5	17.5	14.75	12	12	12	12	12	12	12
GHG40	17.5	17.5	14.75	12	12	12	12	12	12	12
GHG40/EE	17.5	17.5	14.75	12	11	10	10	9	9	9
GHG40/EE/RES30	17.5	17.5	14.75	12	11	10	10	9	9	9
GHG45/EE/RES35	17.5	17.5	14.75	12	11	10	10	9	9	9
EE27	17.5	17.5	14.75	12	11.7	10.5	10.2	10.2	10.2	10.2
EE28	17.5	17.5	14.75	12	11.7	10.5	10.2	10.2	10.2	10.2
EE29	17.5	17.5	14.75	12	11.7	10.5	10.2	10.2	10.2	10.2
EE30	17.5	17.5	14.75	12	11	10	9.5	9	9	9
EE35	17.5	17.5	14.75	12	10	10	9	9	9	9
EE40	17.5	17.5	14.75	12	10	10	9	9	9	9

Subjective discount rates in the tertiary (services) sector:

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Ref.	12	12	11	10	10	10	10	10	10	10
GHG35/EE ®	12	12	11	10	9.7	9.2	9	9	9	9
GHG37 ®	12	12	11	10	10	10	10	10	10	10
GHG40 ®	12	12	11	10	10	10	10	10	10	10
GHG40	12	12	11	10	10	10	10	10	10	10
GHG40/EE	12	12	11	10	9.5	8.5	8.5	8.5	8.5	8.5
GHG40/ EE/RES30	12	12	11	10	9.5	8.5	8.5	8.5	8.5	8.5
GHG45/ EE/RES35	12	12	11	10	9.5	8.5	8.5	8.5	8.5	8.5
EE27	12	12	11	10	9.7	9.2	9	9	9	9
EE28	12	12	11	10	9.7	9.2	9	9	9	9
EE29	12	12	11	10	9.7	9.2	9	9	9	9
EE30	12	12	11	10	9.5	9	8.5	8.5	8.5	8.5
EE35	12	12	11	10	9	9	8.5	8.5	8.5	8.5
EE40	12	12	11	10	9	9	8.5	8.5	8.5	8.5

Subjective discount rates in other sectors (unchanging over time and for different scenarios):

Sector	**Discount rate**
Power generation	9%
Industry	12%
Public transport	8%
Trucks and inland navigation	12%
Private cars	17.5%

Social discount rates in all sectors (unchanging over time and for different scenarios)

Sector	**Discount rate**
Power generation	9%
Industry	12%
Tertiary	12%
Public transport	8%
Trucks and inland navigation	12%
Private cars	17.5%
Households	17.5%

Annex III: Contact with interested parties

The following contacts have been made with interested parties in order to gain additional information in the compilation of the report.

Organisation / type of organisation	Communication medium	Date	Nature of contact
European Commission DG ENER	Telephone	10th June 2015	Discussion on initial access to document request
	Email	14th July	Exchange regarding the IAI study
	Email	29th July	Response on access to document request
NGO	Meeting in person	6th July 2015	Background discussion on Impact Assessments
NGO	Telephone	1st October 2015	Background discussion on Impact Assessments
Industry association	Telephone	20th July 2015 22nd September 2015	Background discussions on Impact Assessments
Industry association	Telephone	15th September 2015	Background discussions on Impact Assessments

Annex IV: Responses to peer review

The following groups of interested stakeholders were invited on 23rd October 2015 to provide their feedback to a draft version of the study:

- The European Commission departments with responsibility for the policy initiative;
- The main European trade associations representing industry affected by climate and energy policy;
- The main European civil society organisations (NGOs) with interest in climate and energy policy.

The following responses were received by 14th December in respect of the Climate & Energy/Energy Efficiency study (in chronological order of their receipt).

Stakeholder organisation	Response received
IFIEC Europe (International Federation of Industrial Energy Consumers)	IFIEC Europe […] encourages the independent scrutiny of European Commission´s Impact Assessments as demonstrated e.g. in the Impact Assessments Institute's study on Energy & Climate & Energy Efficiency.
Climate Action Network Europe	[…] it is an extremely important topic to shed light on. Highlighting that the EC uses a "black box" approach on many of its models and then comes to results and conclusions that cannot be verified is highly troubling. I therefore think that your paper could be really important also given the many delegated acts that will follow after the ETS directive has been passed. These will be developed solely by the Commission, the more we are able to call them out on arbitrary assumptions or lack of transparency the better.
European Climate Foundation	With respect to your draft study, whilst not commenting in detail, we found your analysis to be both well undertaken and indeed also consistent with concerns that several of our partners had with the process, namely that the Commission's IA was constrained by some unexplained and arbitrary assumptions and that the transparency of its methodology could be improved.

References

[i] Impact Assessment Board draft opinion "DG CLIMA and DG ENER - Impact Assessment for a 2030 climate and energy policy framework" Ares(2013)3546781, 5th November 2013 (Link)

[ii] Impact Assessment Board draft opinion "DG CLIMA and DG ENER - Impact Assessment for a 2030 climate and energy policy framework" Ares(2014)33267, 12th December 2013 (Link)

[iii] Impact assessment accompanying the document "A policy framework for climate and energy in the period from 2020 up to 2030" SWD(2014)15, European Commission, 22nd January 2014 (Link)

[iv] Impact assessment accompanying the document "Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy" SWD(2014)255 including annexes 1-9, European Commission, 23rd July 2014 (Link)

[v] "Power Upgrade 2030, The New Economic Rationale for an Ambitious EU Climate and Energy Framework", German Federal Ministry of Economic Affairs and Energy, October 2014 (Link)

[vi] "PRIMES modelling for the Impact Assessment of the Commission's 2014 assessment according to Articles 24 (7) and 3(2), (3) of Directive 2012/27/EU on energy efficiency", Final Report for (ENER/C3/2013-1000), E3Mlab, 24th July, 2014 (Link)

[vii] "Macro-economic results E3ME model 03.06.2014" Excel spreadsheet, E3Mlab, 3rd June 2014 (Link)

[viii] "Evaluating our future - The crucial role of discount rates in European Commission energy system modelling", Ecofys report for ECEEE, 19th October 2015 (Link)