Stefan Scheuer
Environmental &
Energy Policies
EU Affairs

The EU's energy system modelling

Critique and main elements for improvements in view of the mid-century decarbonisation strategy

17 April 2018

Marion Santini, Stefan Scheuer

With support from Erica Hope (European Climate Foundation)

Table of content

1. Introduction

1.1. The EU's energy system modelling and its use

Since 2003 the European Commission is presenting regular updates of energy trends 2030[1], which allows policy-makers to analyse the long-term economic, energy, climate and transport outlook based on the current policy framework. Since 2013 these trends cover the period until 2050. The work is commissioned from the National Technical University of Athens (E3MLab) using PRIMES, which is a supply and demand model for the energy market (partial equilibrium). PRIMES provides the backbone of the Commission's impact assessments of climate and energy policy.

Input to the model include macro-economic data, like GDP and economic growth; policy related factors, like taxes, environment and financial costs; technical developments; consumption habits and energy efficiency potentials.

Output of the model include energy balances and demand projections per sector; CO_2 emissions; transport activity; investment needs and energy purchase costs per sector[2].

This means that in principle PRIMES can be used to assess impacts of certain policies, in particular pricing policies, like taxation or ETS, or minimum performance standards for products or industry. Regarding target setting policies, like GHG emissions, renewable energy or energy efficiency, the model cannot assess impacts directly. It could only deliver an optimisation via comparing scenarios and in view of rather limited range of impacts, for example the costs from an end user perspective.

Recognising this limitation, the Commission is using additional models to address a broader range of impacts, like health and pollution impacts, and macro-economic modelling for GDP and employment.

1.2. PRIMES role in a mid-century decarbonisation strategy

PRIMES is the Commission's tool "*to deliver scenarios that illustrate the impact of energy and climate policies and long-term targets on the operation of the European energy system*"[3].

This work will feed into a *proposal for a Strategy for long-term EU greenhouse gas emissions reduction in accordance with the Paris Agreement, taking into account the national plans*, which the European Council asked for presenting Q1 2019 and the Commission has put on the agenda for adoption by the College on November 2018.

1.3. The experience from the energy efficiency target

1.3.1. 2030 climate and energy framework

In a communication presented before the European Council, the Commission had proposed a 2030 energy efficiency target of 30%, but Member States opted for a minimum 27%

---

[1] https://ec.europa.eu/energy/en/data-analysis/energy-modelling

[2] PRIMES MODEL 2013-2014. Detailed model description. E3MLab/ICCS at National Technical University of Athens

[3] DG Energy letter from 5 March 2018 to stakeholders, inviting assistance to reviewing PRIMES input

target based on the accompanying IA's figure below[4], which focused solely on the energy system costs and savings.

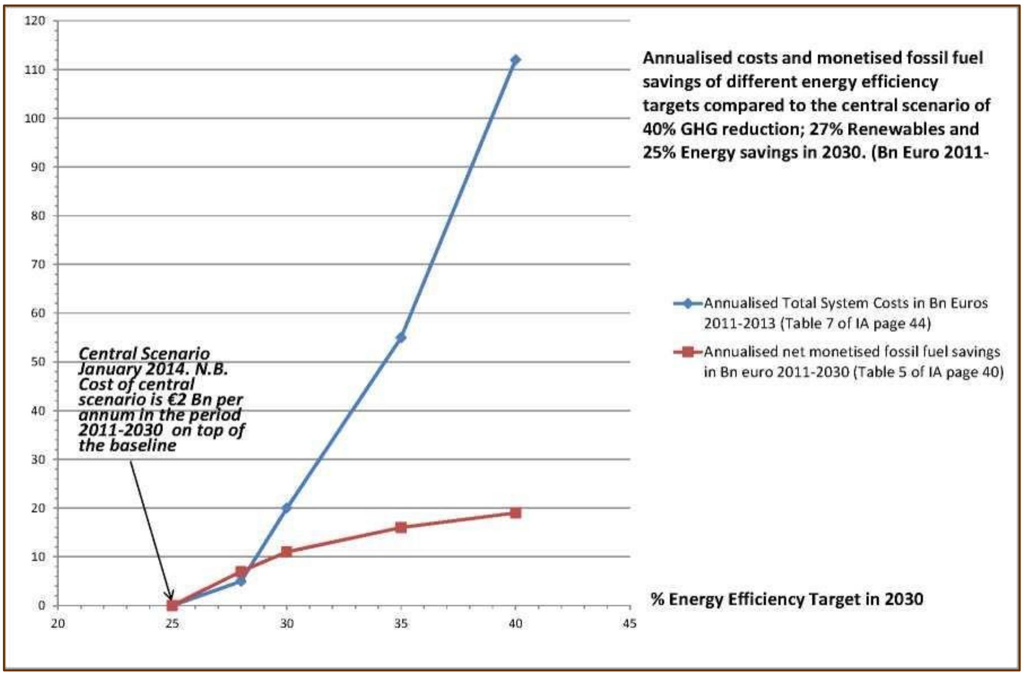

Figure 1 – Presentation of energy system impact of energy efficiency targets in 2014 impact assessment by the European Commission

1.3.2. 2016 proposals for the Energy Efficiency Directive revision

In 2016, the Impact Assessment for the EED revision[5] justified the Commission's proposal for a 30% target based on:

- the relatively small increase in energy system costs 2021-2030 when moving from a 27% to a 30% target (see figure below, €9 billion average yearly). In a 2050 perspective the energy system costs drop - figures which were presented for the first time in an impact assessment of energy efficiency targets - as benefits roll out over time and costs are written off; and
- the additional benefits for jobs and growth. Those benefits were however not weighted against potential costs, which only a cost-benefit analysis would make possible.

Table 24: Energy system costs 2021-2030[159]

Energy system costs (2030)	Ref2016[160]	EUCO27	EUCO30	EUCO+33	EUCO+35	EUCO+40
Total System Costs in billion €'13 (average annual 2021-30)	1,928	1,943	1,952	1,977	2,014	2,077
Change in system costs compared to EUCO27 (in bn €'13)			9	34	71	133
Total System Costs as % of GDP (average annual 2021-30)	12.28	12.37	12.42	12.57	12.80	13.18
Total System Costs as % of GDP increase (average annual 2021-30) compared to EUCO27 in % points			0.05	0.20	0.43	0.80

Source: PRIMES

[4] See SWD(2014) 255 final
[5] SWD(2016) 405 final

Table 25: Energy system costs 2021-2050[161]

Energy system costs (2050)	Ref2016[162]	EUCO27	EUCO30	EUCO+33	EUCO+35	EUCO+40
Total System Costs in billion €'13 (average annual 2021-2050)	2,130	2,264	2,255	2,290	2,324	2,384
Change in system costs compared to EUCO27 (in bn €'13)			-9	26	60	121
Total System Costs as % of GDP (average annual 2021-2050)	11.70	12.35	12.31	12.51	12.70	13.04
Total System Costs as % of GDP increase (average annual 2021-50) compared to EUCO27in % points			-0.04	0.16	0.35	0.70

Source: PRIMES

Figure 2 - Presentation of energy system impact of energy efficiency targets in 2016 impact assessment by the European Commission

1.3.3. 2018 non-paper by the European Commission

In 2018, a non-paper by DG Energy of the Commission about complementary modelling for higher renewable energy and energy efficiency targets based on lower renewable technology costs was presented, in light of the Parliament's demand for 35% targets for both renewable energy and energy efficiency. The complementary modelling showed that higher GHG reductions are coming at lower costs than expected and has been used by the Commission as an argument to back higher targets.

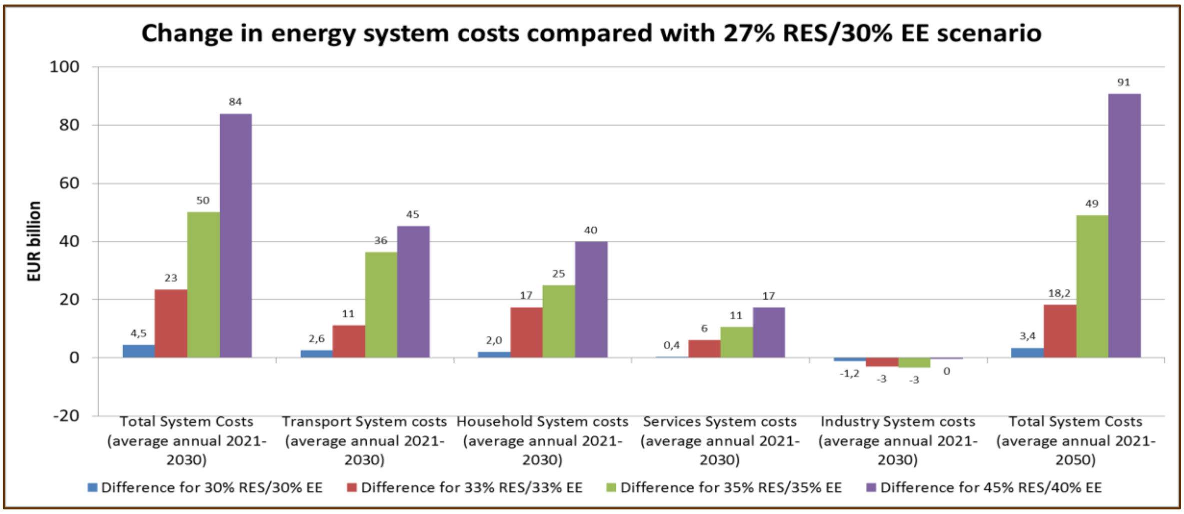

Figure 3 - Presentation of energy system impact of energy efficiency targets in 2018 non-paper by the European Commission

2. Stakeholder critique

There is a long history of criticising the PRIMES modelling and impact assessments by the European Commission, going back to industrial stakeholders criticising already in 2011 the lack of transparency in developing the "Energy Roadmap 2050"[6].

Over the last years energy efficiency stakeholders have voiced their critique regarding the use of discount rates and assessment approach[7].

Based on this critique we have identified issues related to the transparency of the process, the assumptions made (input), and to the presentation of the results (output).

2.1. Transparency and stakeholder involvement

2.1.1. Limited information and missing stakeholder verification of input data

Only few input data are made available in the Commission's publication and those have not been subject to stakeholder verification. Key parameters, like life-times of technologies and investments are missing and cost assumptions appear sketchy.

Discussion about the assumptions concerning technology and development pathways, which are extremely important in determining future energy demand, like upscaling of building renovations, automation and digitalisation; moving toward circular economy and low emission mobility, are sketchy or absent.

2.1.2. No access to the model itself

The model is privately owned by National Technical University of Athens, which refuses access to the code and the software.

2.1.3. No meaningful stakeholder involvement

Given the lack of transparency and access set out above, the process de facto excludes a verification by independent experts and a meaningful involvement of stakeholders experts.

2.2. Key assumptions

2.2.1. Using todays static discount rates to mimic future decision making

The PRIMES model uses discount rates (weighted average cost of capital - WACC, for firms and subjective ones for individuals) to model the decision making of agents. In principle, higher discount rates mean that agents take a shorter-term perspective (they undervalue future costs / benefits and apply a high risk premium) or do not have information and/or access to capital. The discount rates used in the modelling of the 2016 reference scenario[8] are:

---

[6] FT 2011
[7] The Coalition for Energy Savings 2017; BPIE 2015; ECEEE 2015; ECOFYS 2015
[8] EU Reference Scenario 2016. Energy, transport and GHG emissions Trends to 2050

- For supply side investments: 7.5% (for RES with feed in tariff) to 8.5% for competitive markets.
- For the demand side investments
    - 7.5% to 11% for firms; and
    - 9.5% household appliances, 11% private cars and 12% for renovations.

The latter, for private cars and residential sector, are subjective discount rates values which are set below what empirical findings would suggest, as a way to mimic policy impact on behaviour.

For higher energy efficiency scenarios as presented in the IA for the EED revision in 2016[9], these subjective discount rates for households (residential sector) are somewhat reduced, assuming that additional policies will lower the barriers for agents to invest in energy efficiency improvements. But this effect seems rather limited. In case of the IA 2016 modelling for the EED revision the main policy impact reflected by those discount rates is the availability of financial instruments and labelling, which means that the discount rate drops from 12% in the Reference scenario to 10% in the 40% target scenario.

The problems with such an approach are:

- Fixed discount rates are a rather crude and questionable approach to model behaviour of individuals, especially over long time periods. Behaviour can rapidly change triggered by socio-economic, technical and political changes;
- The wide range of available measures to reduce energy efficiency investment barriers is not fully reflected in the choice of discount rates. For example, removal of split incentives in addition to ensuring information and capital access might lower behavioural discount rates below 10%; and
- In the transport sector the discount rate does not reduce in any scenario, ignoring that policies together with economic, societal and technological changes in mobility could foster rational economic mobility choices, see next section.

In conclusion, the use of a few and constant-over-time subjective discount values for individual actors is a very crude and simplified approach to model investment in building renovation, appliances or cars.

<u>The alternative to subjective discount rates, would be to apply a societal discount rate, which would reflect the perspective of public policy making.</u> The Commission accepts that "*This is reasonable from a public perspective, because as appropriate discount rates close to social rates must be used for spending public money, to reflect opportunity costs of drawing funds by the public."*[10].

<u>But it rejects this because the aim of the modelling is not using public, but private funds incentivised by pricing and taxing policies.</u> "*This is a different aim than in the modelling which has the objective of mimicking, simulating, individual behaviours, in order to identify the size of incentives (such as prices or taxes) for increasing energy efficiency. To do this mimicking accurately, the model has to reflect the opportunity costs of drawing funds from a private perspective, which implies using subjective discount rates higher than social ones."*

---

[9] SWD/2016/0405 final

[10] EU Reference Scenario 2016 - See chapter 4.4.3 Methodology for defining values of discount rates

2.2.2. Policies and their impacts

2.2.2.1. Transport

Transport policies appear to have very little impact on delivering energy savings in the PRIMES modelling compared to other models, like the bottom-up modelling of 2030 saving potentials by Fraunhofer, PwC, TU Wien from 2014 and presented in the 2016 EC' IA for the EED revision. The impact of transport policies in PRIMES is weak and limited to CO_2 targets and taxation. The model is unclear on the intensity and diversity of national measures.[11]

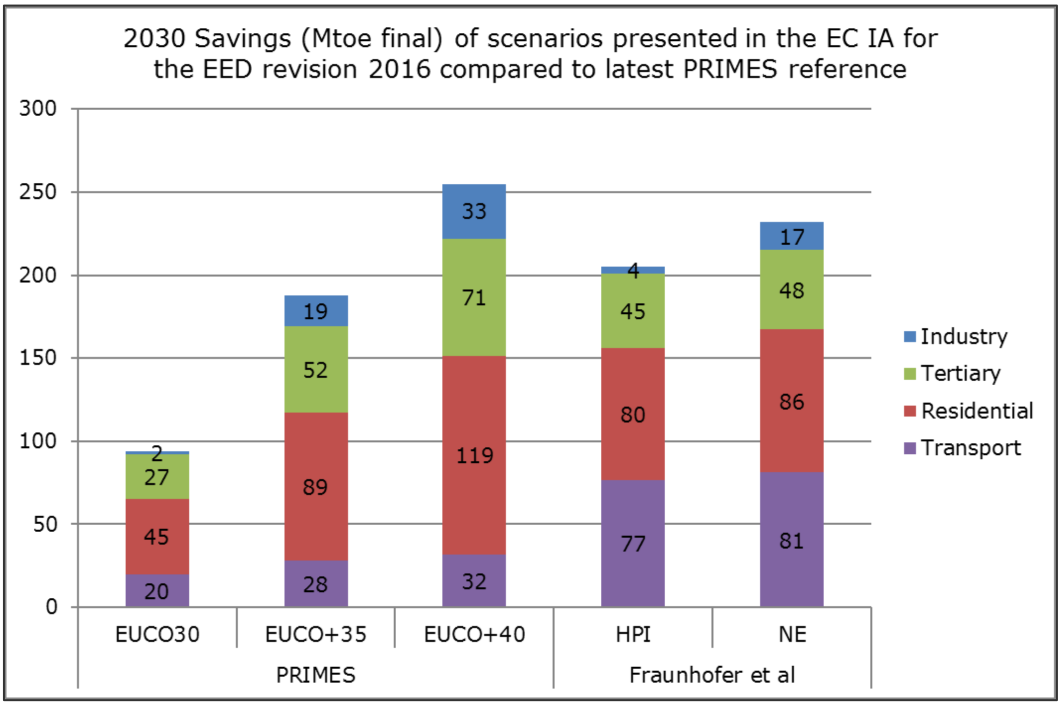

Figure 4 – Comparison of savings by sector in different models (Source: own calculation)

2.2.2.2. Buildings

The model includes a qualitative description of policies, and the effects of these policies on the model are materialised by an adjustment of variables called energy efficiency values. This adjustment automatically increases the renovation rate (up to 3.1%) and depth (up to average 63%) and accelerates the uptake of efficient technologies (appliances, heat pumps). This leads to substantial energy savings in the building sector, as shown by the EC IA 2016.

But in case of the 2018 non-paper modelling for higher RES and EE targets, the output is different. The focus on building renovations is "replaced" by a stronger emphasis on heat pumps installations, and this is unclear whether this is due to the model's input or a result of the target enforcement.

---

[11] In ECOFYS & the Coalition for Energy Savings 2016

2.2.2.3. Renewables

The assumptions about renewable energy deployment policy are unclear and materialised by variables called "RES values". It is unclear who sets those values.

The attractiveness of higher shares of EE and RES depends among other factors on the costs. Conservative costs for RES and EE investments lead to conservative system costs. While many elements of energy efficiency costs are not known, the case for RES became apparent. A complementary modelling by DG Energy, released as a non-paper in March 2018 tries to factor in cost reductions for RES technologies. However, the costs are still extremely high. Offshore wind for example is assumed to cost (Levelized Cost of Energy, LCOE) 125 €/MWh in 2020, and 90 €/MWh in 2050. This is in great contrast to comparable projects, like the Horn Sea2, which has a LCOE of 65€ and will be commissioned over the next years.

2.3. Presentation of results

2.3.1. Misleading presentation of results

On several occasions the EC's IAs and modelling results are presented in a way which would suggest that a comparison of costs and benefits is possible. This is misleading, as a Cost Benefit Analysis requires a completely different approach than the one chosen by the Commission.

Most notably a Cost benefit Analysis typically needs:

- to scope all relevant costs and benefits, which goes well beyond the direct costs and benefits for individuals typically captured by the energy system costs; and
- to ensure an appropriate framework for comparison, for example by choosing a societal discount rate.

2.3.2. Arbitrary choice of a high discount rate which devalues future benefits

The IA 2016 modelling chose to use an arbitrary value of 10% as the discount rate to report and compare annual energy system costs across all scenarios. This should not be confused with the discount rate used for modelling agents' behaviour (see chapter 2.2.1)

From a public policy making perspective such a value is unacceptable.

At Member State level an average 5.7% for private perspective and 3.3% for macro-economic perspective is used. The only place in the EU which uses a high discount rate of 10% in impact assessments is Gibraltar[12].

The below graph shows the dramatic change in costs when discount rates are lowered from a private to a societal perspective.

[12] ECEEE 2015

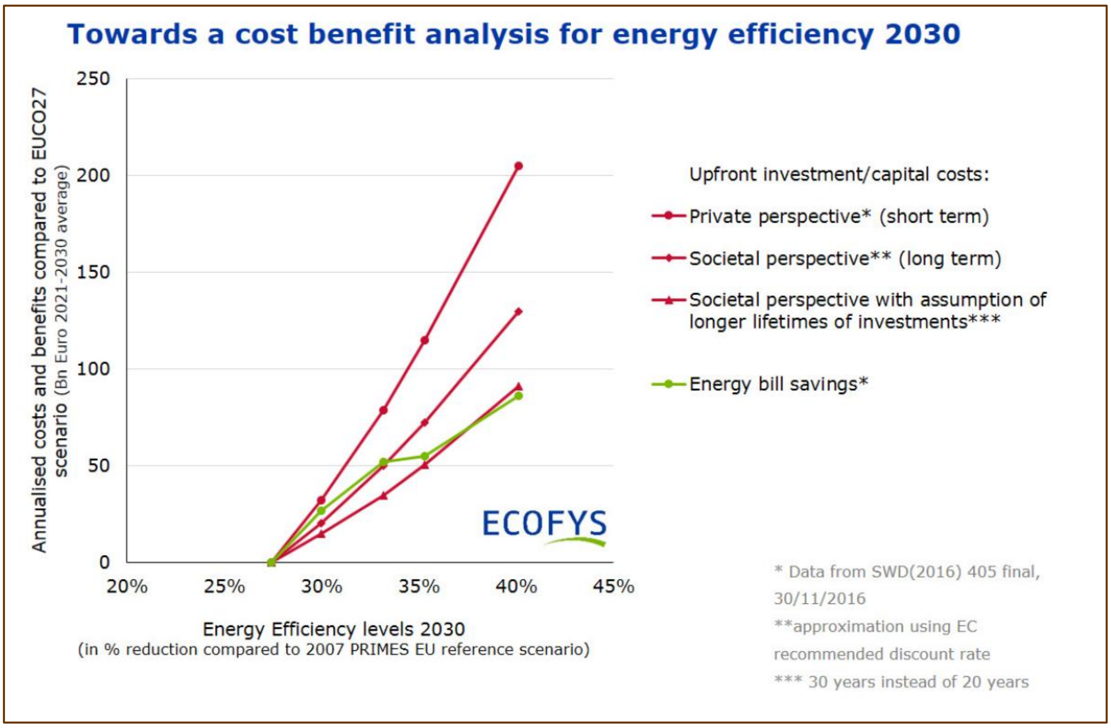

Figure 5 – Effect of applying private or social discount rates on the energy system costs (Source: Ecofys and Coalition for Energy Savings, 2017, Towards a cost-benefit analysis for 2030 energy efficiency target ambition)

3. Recommendations

In the context of preparing a strategy for long-term EU greenhouse gas emissions reduction in accordance with the Paris Agreement, the European Commission should improve the modelling in three areas identified by this paper.

3.1.Full access to and review of input data within a proper stakeholder process

Transparency and stakeholder involvement are important principles in the European Commission impact assessment process and need to be applied especially for the energy system modelling, which determines to a largely degree the results of the assessment.

Access to and verification of all input data should be established immediately. We understand that with the DG Energy letter from 5 March to stakeholders calling for assistance a first step has been made. This needs to be complemented by a process to avoid a one off, one way engagement situation which could cause frustration.

The aim of the stakeholder data verification process should be to:

- allow stakeholders full access and comment all input data; and
- provide data chosen for the modelling and give feedback on how comments were taken into account.

But given the limitations of the model in view of the decarbonisation challenge ahead, it will be necessary to consider a broader stakeholder consultation process, beyond data verification, that can support the

- development of scenarios, which can go beyond projections of the past into the future; and
- interaction and trust between policy makers and industries that are active in the energy services and markets and NGOs that are instrumental in shaping public opinions.

3.2.Key Assumptions - toward dynamic modelling of future changes

The model's assumptions regarding energy efficiency in energy demand are pessimistic regarding the role of public financing and regulatory interventions and limited to very few policies overlooking the variety of national actions already in place.

In addition to that the model applies a static approach to demand side changes over long-time perspective.

This means that we would be modelling a extremely dynamic future with an inherently undynamic model.

As a matter of urgency, the key assumptions regarding the use of subjective discount rates to mimic agents behaviour have to be reviewed in view of substantial technological, socio-economic and policy changes available in a 2050 perspective.

3.3. Presentation of results - only a societal or zero discount rate allows comparing todays' investments with 2050 benefits

Only a societal discount rate, which is commonly set around 4% in the EU, or a 0% rate are appropriate to present and compare the costs of today's investments with long-term benefits of decarbonising the energy system.

Unlike subjective discount rates to mimic agents behaviour in the model, there is no good reason provided why a private discount of 10% across the board has to applied to compare today's investments with future benefits. A 10% rate means that a energy savings benefit in 2050 would be valued today at only 5% of its actual benefit.