Briefing paper [1]

Sectoral RES and EE targets for 2030: a cost-effective option to achieve the EU's climate and energy objectives?

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Background

European policy makers currently shape the 2030 framework for climate and energy policies. This includes the question, whether dedicated targets for renewable energies (RES) and energy efficiency (EE) should be set besides a binding greenhouse gas (GHG) target and which ambition level should be fixed. In this context, the European Commission (EC) has suggested a GHG-target of 40%, a RES-target of at least 27% in final consumption by 2030 and an EE-target of 25% (European Commission, 2014b). Based on the impact assessment conducted by the EC (European Commission, 2014a) the 40% greenhouse gas emission reduction target alone would result into a RES-share of 26.4% by 2030. Therefore this ambition level was interpreted as the economic optimum and used as a basis for the determination of the RES target. However both, the impact assessment as well as further in-depth analysis (e.g. Employ-RES, 2014) have shown that a RES target of 30% would lead to higher macro-economic benefits as compared to a target of 27%. Thus, increasing the RES-target to 30% is still being discussed as an alternative option.

In the recent Communication on Energy Efficiency (European Commission, 2014c), the European Commission proposes an energy efficiency target of 30% for 2030 "given the increased relevance of bolstering EU energy security and reducing the Union's import dependency". Although a 25% EE-target was initially considered as cost-optimal option, the Com-

[1] The full report can be found at: http://www.isi.fraunhofer.de/isi-en/x/projekte/targets-2030_331333.php

mission concluded that the higher target “would still deliver tangible economic and energy security benefits”. The decision on the concrete design of the 2030 climate change and energy policy package can be expected for European Council Meeting on 23/24 October 2014.

When discussing the target architecture as well as different ambition levels of EU RES and EE-targets, their impact on the competitiveness of the European economy is of key interest. However, many discussions tend to emphasize the current situation without considering the potential long-term developments of energy technologies.

In view of the above, it is the objective of this briefing paper to show the future costs of the energy system by 2030 for different RES and EE-target levels. We present the impact of energy efficiency and renewable energy targets on the overall energy sector as well as for the power sector.

This briefing paper is based on the study “Estimating energy system costs of sectoral RES targets in the context of energy and climate targets for 2030” is carried out by an international project consortium led by Fraunhofer Institute for System and Innovation Research (ISI) on behalf of the German Ministry for Economic Affairs and Energy (BMWi) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Project partners are Fraunhofer ISE, the Energy Economics Group from the Vienna University of Technology, Prognos, Comillas University and ECN.

Key findings

- The combined implementation of specific targets for energy efficiency and renewable energies in addition to a pure GHG emission reduction target will lead to **reduced total system costs of up to € 21 billion for the overall energy system**. This is mainly based on lower investment risks and financing costs for energy efficiency and renewable energy technologies if targets for EE and RES are in place.
- Additional costs resulting from the RES-targets without setting a specific target for energy efficiency remain moderate and are estimated to **€ 3.6 to 5.1 billion per year**, which corresponds to less than 0.25% of the total system costs. Considering the lower demand due to a 30% EE-target the additional costs of **RES will be reduced to € 1 to 4 billion** per year.
- In the power sector a **RES-target of 30%** leads to **slightly lower total system costs and lower costs per unit of electricity generated** than a scenario with a pure GHG emission reduction target due to lower risk premiums and financing costs.
- Estimating the impacts of target setting options for RES and EE requires the **application of modeling tools** with high level of detail regarding the costs and potentials of RES-use and energy efficiency measures. In this respect the modeling framework used in the present analysis provides significant added value by assessing impacts of targets for RES and EE with higher resolution as compared to the analysis used in the Impact Assessment by the EC.

The used approach

A model-based approach to estimate the future costs of the energy system has been chosen, by combining different energy sector models.

We realise modelling analyses for the future renewables deployment pathways by 2030 (and beyond) with the Green-X model, a specialised model that allows assessing future RES deployment and related costs and benefits for European countries. We complement the analysis with the power sector model PowerACE, assessing impacts on and inter-linkages with conventional electricity supply as well as infrastructural prerequisites. A comprehensive optimisation of the European power sector until 2050 was carried out including the detailed modeling of renewable generation data with a high spatial and temporal resolution. Thus, capacity planning for conventional power plants, the operation of the power system and grid extension, reinforcement and management are taken into account[2]. For modelling the power sector we incorporate the investor's risk in terms of the used discount rates. Thereby, we assume a default discount rate of 6.5% for 2013, which is assumed to increase slightly to 7.5% by 2020. Additional risk elements for policy-induced, technology-induced and country-specific risks are introduced by multipliers modifying the default interest rate.

The modelling takes into account most recent assessments on the dynamic development of technology costs for conventional and RES-technologies as well as the available renewable resource potential. Location-specific characteristics of RES including the available resource potential (e.g. available amount of biomass) and conditions (e.g. wind speed, solar irradiation) have been considered for the modelling. This is required to adequately analyze costs of RES-technologies, since the resource availability and the associated conversion costs are heterogeneously distributed across Europe. Thus, electricity generation costs of wind onshore depend on the prevailing wind conditions, wind offshore costs on wind conditions, water depth and distance to shore, and solar PV on solar conditions and the plant size.

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[2] Results from power generation have been fed into the grid model TEPES in order to assess grid-related issues of RES-E integration in more detail. However, this work is still ongoing and will be published at a later stage.

Figure 1 shows the structure of the analysis for potential calculations. To receive valid results high resolution of the input data had been used also considering the computing capacity. To achieve different aggregation levels, the input data had been implemented on its highest resolution on up 500 and 7500 meters and afterwards aggregated into cluster cells of 10 km.

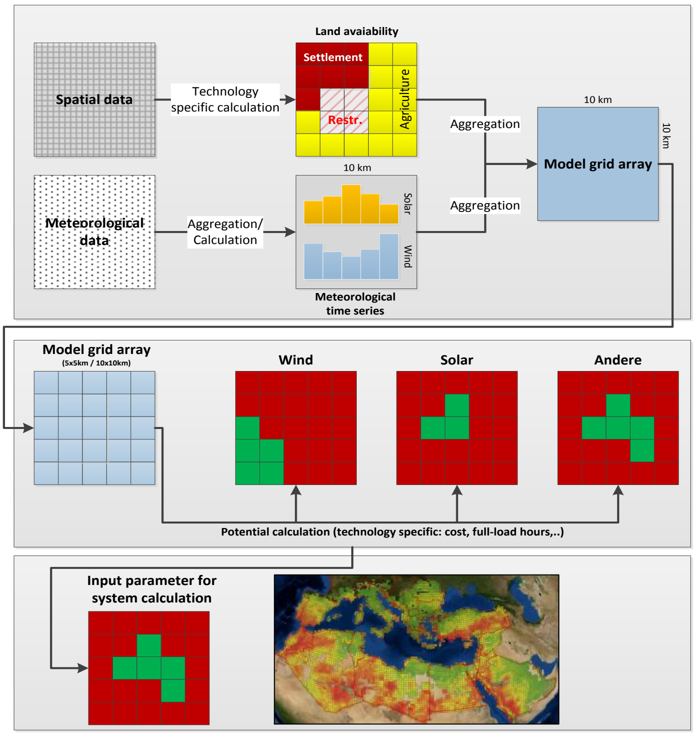

Figure 1: Workflow structure of renewable potentials

In addition, energy efficiency measures have been analysed based on detailed bottom-up analyses based on various modelling tools. These include the INVERT/EE-Lab model for buildings, the FORECAST platform for energy demand in industry as well as electricity uses in the residential and service sector and the ASTRA model providing potentials for energy demand in the transport sector. The discount rates used in the different scenarios underlying the investigation of energy efficiency potentials and costs in this study are presented by sector in Table 1.

Table 1: Overview of discount rates used for the different sectors

Sector	Discount rate
Household – space heating and hot water	3.1% to 3.7%
Tertiary – space heating and hot water	4.7% to 5.4%
Household – Appliances	2% (assuming removal of barriers from 2020) to 6%
Tertiary – Appliances	5% to 15%
Industry	3% to 15%

Based on the this detailed determination of bottom-up potentials, the associated cost impacts were estimated by identifying the share of the technical potential that is already cost-efficient and the remaining part that is still limited by financial barriers. The result of the analysis is depicted in a cost curve (see Figure 2) showing the specific potential as well as the financial impacts involved for different years.

As indicated in Figure 2 the energy efficiency options for building envelopes are largely cost-effective, except some options for existing buildings in the household and tertiary sector that are uneconomic. When looking at the development of the options between 2020 and 2050 one can witness that in the long run they will become cost-effective as can be seen in 2040 and beyond. This illustrates that the specific costs for energy saving options in buildings change crucially on a long term basis due to increasing fuel prices and learning effects.

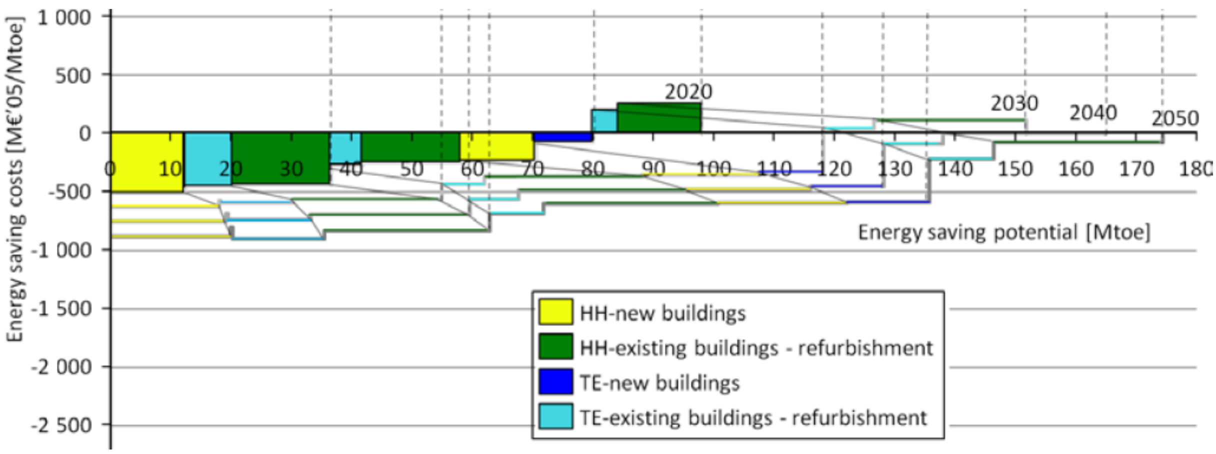

Figure 2: Exemplary illustration of the cost curve arrangement for residential and service sector buildings[3]

3 For the year 2020, the single measures are pointed out by means of coloured blocks. For the subsequent years, the order of the cost curve from the year 2020 is maintained and orientation lines help identifying the evolution of every single measure over time.

Scenario set-up

Based on the scenario structure of climate and energy targets analysed in the EU Commission impact assessment, we analyse the impact of 2030 targets and policies for renewable energy sources (RES) and energy efficiency (EE) for the following scenarios:

(1) GHG-target: GHG40
There is a target of reducing GHG emissions by 40%, but not specific targets for RES nor EE in place. The European Trading Scheme (ETS) is used to drive low carbon investments based on a uniform carbon price. A RES-Share of 27% as well as an EE share of 25% is achieved in this case.

(2) GHG-target and RES-target: GHG40 RES30 EE25
There is a target of reducing GHG emissions by 40% and a RES-target of 30%[4] by 2030 but no specific target for EE in place. The ETS is supplemented by a harmonised RES-quota and tradable green certificates for reasons of comparability with the COM Impact Assessment[5]. A RES-Share of 30% as well as an EE target of 25% is achieved in this case[6].

(3) Triple target GHG, RES and EE: GHG40 RES30 EE30
There is a target of reducing GHG emissions by 40%, a RES-target of 30% and an EE-target of 30% by 2030. The ETS is supplemented by an EU wide RES targets implemented in modelling terms based on a common RES quota and tradable green certificates (see above).

Comparing the impacts of different target setting options

1. A triple target for GHG, energy efficiency and renewable energy will lead to substantial cost savings of up to € 21 billion for the overall energy sector as compared to a single GHG target. Additional costs resulting from the RES-targets remain moderate.

Based on our analysis, we estimated and compared the cost impact of the different target setting options presented above. Thereby, we calculate the additional costs or savings of

[4] The RES-target is expressed in terms of RES-share in gross final energy consumption.

[5] At this stage the main focus is on the analysis of the impact of a RES target compared to a GHG-only target. A more comprehensive comparison of strengthened national policies with harmonized quota schemes for the electricity sector can be found in the full report of this study. Thereby the detailed analysis of the adequacy of different RES support policies includes distributional effects besides the system costs.

[6] The EE-target is expressed in terms of primary energy savings compared to the 2030-projection of the 2007 baseline.

GHG40 RES30 EE25 and GHG40 EE30 RES30 compared to the scenario without specific target for RES nor EE in place, i.e. the GHG40 scenario (see Figure 3).

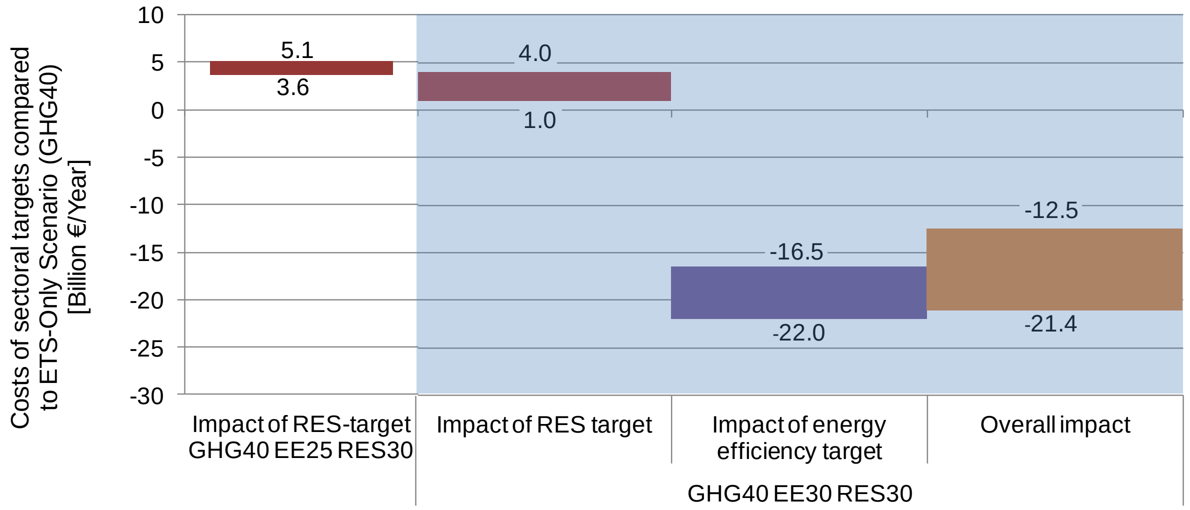

Figure 3: Costs of specific targets (renewable energy and energy efficiency) compared to a scenario with a pure GHG-reduction target

If we consider a GHG-target of 40% and a 30% RES-target in the absence of a target for energy efficiency (GHG40 EE25 RES30), the additional costs for the energy sector arising compared to the GHG40 scenario amount to € 3.6 to 5.1 billion per year (left side of Figure 3), which corresponds to less than 0.25% of the total system costs. Costs are shown as annual average over the period 2021-2030. The range of costs shown results from sensitivity analysis regarding the detailed approach used for the burden sharing regarding the RES target among MS. As the development of energy demand is the same in both scenarios there are no additional costs from energy efficiency measures.

If an energy efficiency target is added, the 30% RES-target requires a reduced amount of renewable-based final energy – instead of 331 Mtoe in the “GHG40 EE25 RES30” Scenario only 307 Mtoe are needed to achieve the 30% RES-target in the “GHG40 EE30 RES30” Scenario. As a consequence, additional costs arising from the increased use of RES that can be directly attributed to the RES-target are reduced to € 1 – 4 billion for a triple target of 40% GHG-reductions, 30% for RES and 30% for energy efficiency. Again these costs compare to the reference of the “GHG40” Scenario. The application of energy efficiency measures do not lead to an additional cost, but to economic savings ranging from € 16.5 to 22 billion per year. The **combined financial impact** of the 30% RES-target and the 30% energy efficiency target thus results in **savings in total system costs of € 12.5 to 21.4 billion on average** (see Figure 3). Savings due to the energy efficiency target result in particular from the fact that lower discount rates have been applied in a proactive policy environment.

In the next step we present the results for the detailed analysis of a RES-target on the power sector.

2. <u>Overall system costs in the power sector of a 30% RES-target do not increase compared to a scenario with a pure GHG emission reduction target.</u>

Cost development in both analysed scenarios varies only slightly. The GHG40 EE30 RES30 Scenario leads to slightly lower total system costs than under the GHG40 scenario by 2030 due to the use of least cost resource allocation in both scenarios and lower discount rates for the GHG40 EE30 RES30 scenario. Whilst annual system costs in the GHG40 Scenario amount to € 221 bn by 2030, system costs in the GHG40 EE30 RES30 Scenario add up to € 219 bn. The difference in costs is more pronounced on the longer term by 2050, where annual system costs under the GHG40 are estimated to € 264 bn and under the GHG40 EE30 RES30 Scenario to € 259 bn.

One can observe a moderate increase of annual systems costs after 2030 by about 13-15% until 2050 (see Table 2). This development is mainly based on the fact that electricity demand increases by 22% between 2030 and 2050. Specific system costs decrease by about 4% between 2020 and 2050. The key reason is that technology learning reduces the specific generation costs of the individual generation technologies, in particular of RES technologies. By 2050 both scenarios are characterized by very similar specific system costs amounting to 60 €/MWh in the GHG40 EE30 RES30 Scenario and to 61 €/MWh in the GHG40 Scenario, respectively. This is in particular due to the **lower investment risk** for capital intensive RES-technologies under the RES-target option, leading to lower financing and therefore capital costs in case of a specific RES-target.

Table 2: Development of annual system costs and specific system costs[7]

Annual system costs		2020	2030	2050
GHG40	bill. $€_{2010}$	233	221	264
GHG40 EE30 RES30	bill. $€_{2010}$	231	219	259
Specific system costs				
GHG40	$€_{2010}$/MWh	65	63	61
GHG40 EE30 RES30	$€_{2010}$/MWh	64	62	60

7 Annual system costs include fuel cost, operation cost and annual capital cost calculated by the method for annuities for all generation technologies, storages and grid connection between countries.

Results of this analysis show that policies causing higher levels of RES-E in the scenarios do not lead to higher electricity generation costs as compared to other decarbonisation options.

Summary

The combined implementation of specific targets for energy efficiency and renewable energies in addition to a pure GHG emission reduction target will lead to **lower total system costs for the overall energy system**. This is mainly based on lower investment risks and financing costs for energy efficiency and renewable energy technologies if targets for EE and RES are in place.

Additional costs resulting from the RES-targets without setting a specific target for energy efficiency remain moderate and are estimated to **€ 3.6 to 5.1 billion per year until 2030**, which corresponds to less than 0.25% of the total system costs. Considering the lower demand due to a 30% EE-target the additional costs of **RES will be reduced to € 1 to 4 billion** per year. The **combination of energy efficiency targets and RES targets** leads to overall average annual **savings in terms of total system costs amounting to € 12-21 billion with 30% RES and 30% energy efficiency.** The range of cost savings results in particular from different assumptions regarding the policy intensity to reduce non-economic barriers for EE.

With regard to the power sector, we have learned that a **renewable energy target of 30% does not lead to higher average electricity generation costs,** if suitable approaches for burden sharing and RES policies are implemented. The main reason for this finding is that dedicated targets and policies for RES help reduce risk premiums, financing costs and support costs.

Estimating the impacts of different target setting options requires the application of detailed modeling tools with high level of detail regarding the costs and potentials of RES-use and energy efficiency measures. As to the power sector, the increasing share of variable RES asks for a detailed modeling of supply and demand match with a high temporal resolution. In this respect the modeling framework used in the present analysis provides significant added value by assessing impacts of targets for RES and EE in more detail as compared to the analysis used in the Impact Assessment by the EC.

References

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