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ISI

Policy Report

Contribution of Energy Efficiency Measures to Climate Protection within the European Union until 2050

IMPRINT

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Foreword

The European Union has set itself the goal of reducing greenhouse gas emissions by at least 80 percent by 2050 to contribute to worldwide climate change mitigation and to generate momentum for innovation and progress in the member states. If we want to achieve this goal we need to completely overhaul our energy systems, from the production of electricity and heat to energy consumption in the home and our modes of transport. Developments in Germany are making it plain that a transformation to a green economy is technologically feasible and economically sensible. We are already generating 25 percent of our electricity from modern wind power, solar energy, biomass and hydropower installations. This helps to mitigate climate change. It makes us independent of fossil fuels and replaces expensive imports with domestic added value.

Production is one aspect, consumption is another. We must – and we can – use energy more efficiently. New technologies and services enable us to save electricity, heat and fuel and thereby reduce our spending. We can build houses in such way that they produce more electricity and heat than they consume themselves. The latest office computers only need a fraction of the electricity consumed by older models. Our engineers are working miracles: they have just succeeded in lowering the electricity requirement of large cooling installations by up to 80 percent.

The Fraunhofer Institute for Systems and Innovation Research's study "Contribution of Energy Efficiency Measures to Climate Protection within the European Union until 2050" is a trailblazer. Rarely have European energy saving potentials been broken down in such detail, and for the first time ever researchers have been able to make precise suggestions for specific technologies that help reducing energy consumption over the coming decades. Even more importantly, the study scrutinises the important contribution of increased energy efficiency in the energy consumption and power sector to greenhouse gas emission reduction.

The findings are gratifying: The opportunities and possibilities offered by a massive backing of energy efficiency are much greater than many expected. Although the importance of electricity in the energy system is continuously rising, the authors of the study believe that it is technologically feasible to stabilise electricity consumption. What is more: it is conceivable that consumption of final energy can be more than halved and consumption of primary energy reduced by more than two thirds. And it does not necessarily have to cost anything, though upfront investment is needed. In 90 percent of the cases, the savings gained from reduction cover the costs of the measures. Researchers have identified yearly savings of up to 500 billion euro by the year 2050 for the whole of Europe.

Contrary to what some still claim, climate change mitigation is not an obstacle to business investments in Europe. Quite the opposite. The study shows in detail that energy efficiency is an indispensable element of our climate policy. Energy efficiency offers tremendous economic opportunities, and we must make the most of them. It is the job of the European Union and its member states to help us do just that by supporting our enterprises with smart political decisions. This is why I advocate that we commit ourselves to energy efficiency – in order to combat climate change and establish a strong European industry in the growing lead markets of environmental, energy and efficiency technologies.

Peter Altmaier
Federal Minister for the Environment,
Nature Conservation and Nuclear Safety

Executive summary

Given the risks associated with global warming and its potential consequences due to the emissions of greenhouse gases (GHG), the European Union (EU) has pledged to reduce its emissions by at least 20 percent until 2020 and by at least 80 percent until 2050 compared to 1990 levels.

In this context, the energy sector plays a crucial role, since approximately 80 percent of European GHG emissions in 2009 originate from this sector. Moreover, this sector offers the chance of almost complete decarbonisation based on a variety of technologies ranging from carbon-neutral electricity generation through highly-efficient energy conversion processes to energy saving options.

The political challenge consists of developing a set of technology options which will ensure the shift takes place towards a sustainable European energy system which still complies with the constraints imposed by competitiveness and the security of supply. Since energy efficiency represents a powerful option to tackle these objectives, the present study analyses in detail to what extent energy savings can contribute to GHG emission mitigation in the EU until the year 2050 and which technologies are required for the energy saving potentials identified.

This policy report contains a summary of the main results. The accompanying scientific report provides much more detailed information on the potentials and the technologies behind. The technology-based, bottom-up approach distinguishes this study from most of the other existing reports. The study comparison clearly shows that most of the time energy efficiency options are not being considered to their full extent as a technology option for carbon mitigation in the various scenarios. Moreover, the level of detail regarding the deployment of efficiency measures is well below the accuracy usually applied to the analysis of the energy supply side, particularly the power sector.

The analysis of the different sectors reveals the largest final energy saving potential to be in the buildings sector, whereas the highest financial benefits can be gained in the transport sector. In 2050, the overall final energy demand could be reduced by 57 percent compared to the baseline projection, with annual cost savings of about 500 billion €'05. With regard to primary energy demand, efficiency improvements when converting primary to final energy are also considered. The shift towards a highly efficient power sector results in reductions of 25 percent in the primary energy demand and 15 percent in GHG emissions. Saving options related to final energy use deliver additional reductions of 42 percent and 52 percent, respectively. The comparison of the energy-saving potentials with the energy demand trajectories presented in the recently published EU Energy Roadmap 2050 of the European Commission shows that none of the Energy Roadmap scenarios analysed meets the 20 percent efficiency target for 2020. Moreover, in the Energy Roadmap the demand side is analysed in a highly aggregated manner which prevents a more detailed analysis of the concrete technologies and policies assumed.

1 Background and objectives of the study

There is a worldwide recognition that the global average temperature rise should not exceed 2°C above pre-industrial levels; a higher temperature increase implies considerable threats to our planet and life according to the present strong scientific evidence. To ensure that 2°C are not exceeded, it is vital that global greenhouse gas emissions (GHG) peak by 2020 and are then reduced to half the level of 1990 emissions by 2050[1] [UNEP, 2011]. In order to achieve this target, both developed and developing countries need to make considerable efforts. Developed countries, and in particular the European Union, need to play a prominent role and reduce their GHG emissions by at least 80 percent by 2050[2].

Potential pathways towards this 80 percent reduction target were analysed in the framework of the EU Energy Roadmap 2050, which was published in December 2011 by the European Commission [European Commission, 2011a]. Apart from a Reference Scenario, five decarbonisation scenarios were analysed, which combine to varying degrees the low-carbon options of renewables, nuclear, energy efficiency and Carbon Capture and Storage (CCS). The scenarios show that meeting the 80 percent GHG reduction target is feasible regardless of the technology mix applied.

In order to actually reach these ambitious long-term targets, the EU needs to reduce its emissions by around 30 percent by 2020 compared to 1990 as an interim target. In 2008, the European Union presented the European Climate and Energy Package containing concrete measures and directives up to 2020, which shall reduce the GHG emissions in the period 1990–2020 by 20 percent or 30 percent if a sufficiently ambitious global agreement is reached. Within this package, it is intended to increase the share of renewables in the total EU gross final energy consumption to 20 percent by 2020 and reduce primary energy consumption by 20 percent compared to the projected trend up to 2020. This latter target has not been translated into a legally binding text in the Climate and Energy Package of 2008. Nevertheless, the European Council included the 20 percent energy efficiency target in March 2010 – together with the two other climate protection and energy policy targets – as an important key target of the central economic and competition strategy of the EU [European Council, 2010]. In the document "Europe 2020: Strategy for intelligent, sustainable and integrated growth" [European Commission, 2010a] it is stated that the progress made towards this target together with the other targets in the strategy, is to be monitored annually based on indicators.

The EU energy efficiency strategy was followed up in March 2011 in the form of an EU Energy Efficiency Plan (EEP) [European Commission, 2011b]. The EU takes a two-step approach here, postponing a possible overall mandatory energy efficiency target to 2014 (originally 2013), but pushing individual energy efficiency policies. This was affirmed in the proposal for a new Energy Efficiency Directive from 22 June 2011. The EEP details the envisaged energy efficiency actions sector by sector, with an emphasis on the building sector.

1 The Council of the European Union adopted the following conclusions on the 17th session of the Conference of the Parties (COP 17) to the United Nations Framework Convention on Climate Change (UNFCCC) in Durban, South Africa, 28 November–9 December 2011: The Council recalls the urgent need for operationalising the objective of staying below 2ºC through a decision on a time frame for peaking of global emissions and a global emission reduction goal; In this context, it reiterates that global greenhouse gas emissions need to peak by 2020 at the latest and be reduced by at least 50 percent by 2050 compared to 1990 and continue to decline thereafter. [European Council, 2012].

2 In October 2009 the EU Head of States decided on a long-term reduction target of 80–95percent by 2050 in comparison to 1990. [European Council, 2009]

King's fjord in the Northern Polar Sea, Spitsbergen

At the same time, public awareness of issues like the security and cost of energy supply has been growing due to the economic and financial crises, the very volatile prices on the international energy markets, the increasing concentration of energy resources in few supplier countries with markets that are largely regulated by governments, temporary supply bottlenecks due to political events and new energy resources which are more difficult to explore or generate even more impacts on the environment such as non-conventional gas sources. Improving energy efficiency in the medium to long term is one way to tackle these challenges.

The main purpose of this study is to analyse the potentials and possible contributions of energy efficiency and energy-saving options to meeting the climate policy targets in the EU up to 2050[3]. The following issues were addressed in detail:

1. Analysis of the contribution **final energy savings** can make to reducing GHG emissions by 2050 through increased end-use energy efficiency and energy savings.

2. **Cost-benefit analysis** of climate protection measures through enhanced energy efficiency and energy savings.

3. Contribution of enhanced energy efficiency in the energy conversion and the energy end use sector to **primary energy savings** and **climate protection** in 2050.

After determining the potentials, the results are compared to the scenario results of the recently published EU Energy Roadmap 2050 [European Commission, 2011a].

While this policy report summarises the main results of the project, an accompanying scientific report gives more detailed insights into the results obtained within the framework of the project as well as the underlying assumptions and the general methodology [Fraunhofer ISI, 2011a].

3 A second study investigates in detail the design of a European electricity sector based on almost 100 percent renewables (cf. "Tangible ways towards climate protection in the European Union - EU Long-term scenarios 2050", [Fraunhofer ISI, 2011b]).

2 Study comparison

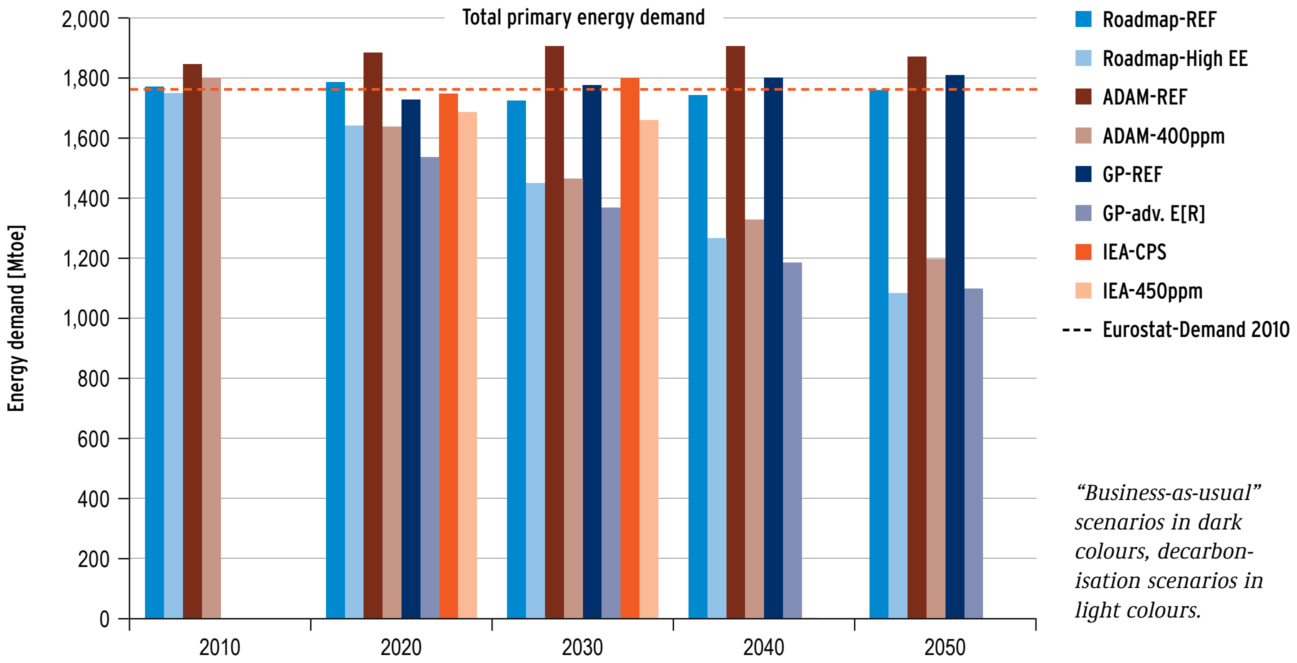
The majority of energy scenario studies analysing the future development of the European energy system have a clear focus on reducing CO_2 emissions. Energy efficiency is considered to be one of the most effective ways to reduce GHG emissions. However, renewable energy sources (RES), Carbon Capture and Storage (CCS) and other "pro-active" measures (such as e-mobility, nuclear power) are being discussed in much more detail than energy-saving and energy-efficiency measures. Most of the studies lack a detailed analysis of individual energy-efficiency technologies.

The studies included in the comparison are:

- "Roadmap": European Commission, *EU Energy Roadmap 2050*, [European Commission, 2011d] (further information can be found in section 5.5)
- "ADAM": Fraunhofer ISI, *ADAM report*, [Fraunhofer ISI, 2009b]
- "GP": Greenpeace, *Energy [R]evolution*, [Greenpeace, 2010]
- "IEA": International Energy Agency, *World Energy Outlook 2010*, [IEA. 2010]

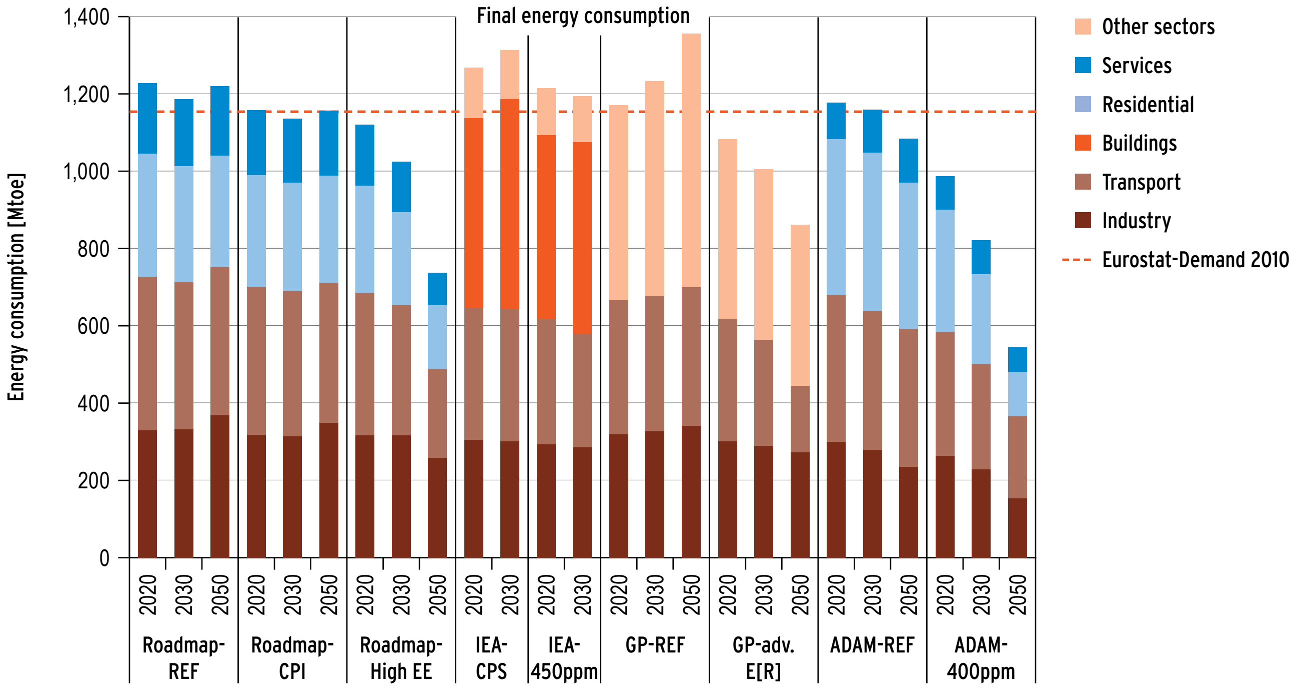
Figure 1 depicts the primary energy demand projections of the different scenarios in these studies. All of them forecast an approximate stagnation of energy demand at today's level (cf. red dotted line) under "business-as-usual" conditions (cf. the Reference "REF" or the Current Policy "CPS" scenarios, in dark colours). A similar homogeneous picture emerges from all the reports with regard to primary energy demand under decarbonisation scenarios (in light colours). Energy demand is reduced by between 36 percent and 39 percent by 2050 compared to the respective reference scenario.

Figure 1: Study comparison with regard to primary energy demand



Source: [European Commission, 2011d], [IEA, 2010], [Greenpeace, 2010], [Fraunhofer ISI, 2009b], [Eurostat, 2012]

Figure 2: Study comparison with regard to sectoral final energy demand



Source: [European Commission, 2011d], [IEA, 2010], [Greenpeace, 2010], [Fraunhofer ISI, 2009b]

The 20 percent efficiency target, which represents a reduction of overall (energy related plus non-energy related) primary energy demand to the level of 1,602 Mtoe by the year 2020, is not met in any of the scenarios analysed apart from the ambitious Greenpeace scenario.

Regarding final energy demand, the results are much more heterogeneous than is the case for primary energy demand. Under the business-as-usual developments (cf. the CPS- and REF-scenarios in Figure 2), the energy demand projections vary between further growth of up to 18 percent and continuous decline to 6 percent below the 2010 level. Therefore, the projections in the decarbonisation scenarios also diverge, triggering demand reductions of at least 36 percent and up to 50 percent in the reports considered. The bulk of savings results from efficiency improvements in the building sector (mainly in residential and service sector buildings).

Apart from the ADAM report, all the studies conclude that electricity demand will increase in the decarbonisation scenarios. This is due to further electrification in the industrial, heat and transport sectors (such as electric vehicles, heat pumps for industrial and residential use). The main driver behind the shift towards the expanded use of electricity is the fact that electricity is easier to decarbonise than other energy sources.

Assigning carbon a price is a major prerequisite for successful climate policy, even though this is not sufficient as a stand-alone instrument. However, all the studies agree that a worldwide, multi-sectoral and strictly organised emissions trading scheme with an ambitious cap is an important incentive for a further increase in energy efficiency.

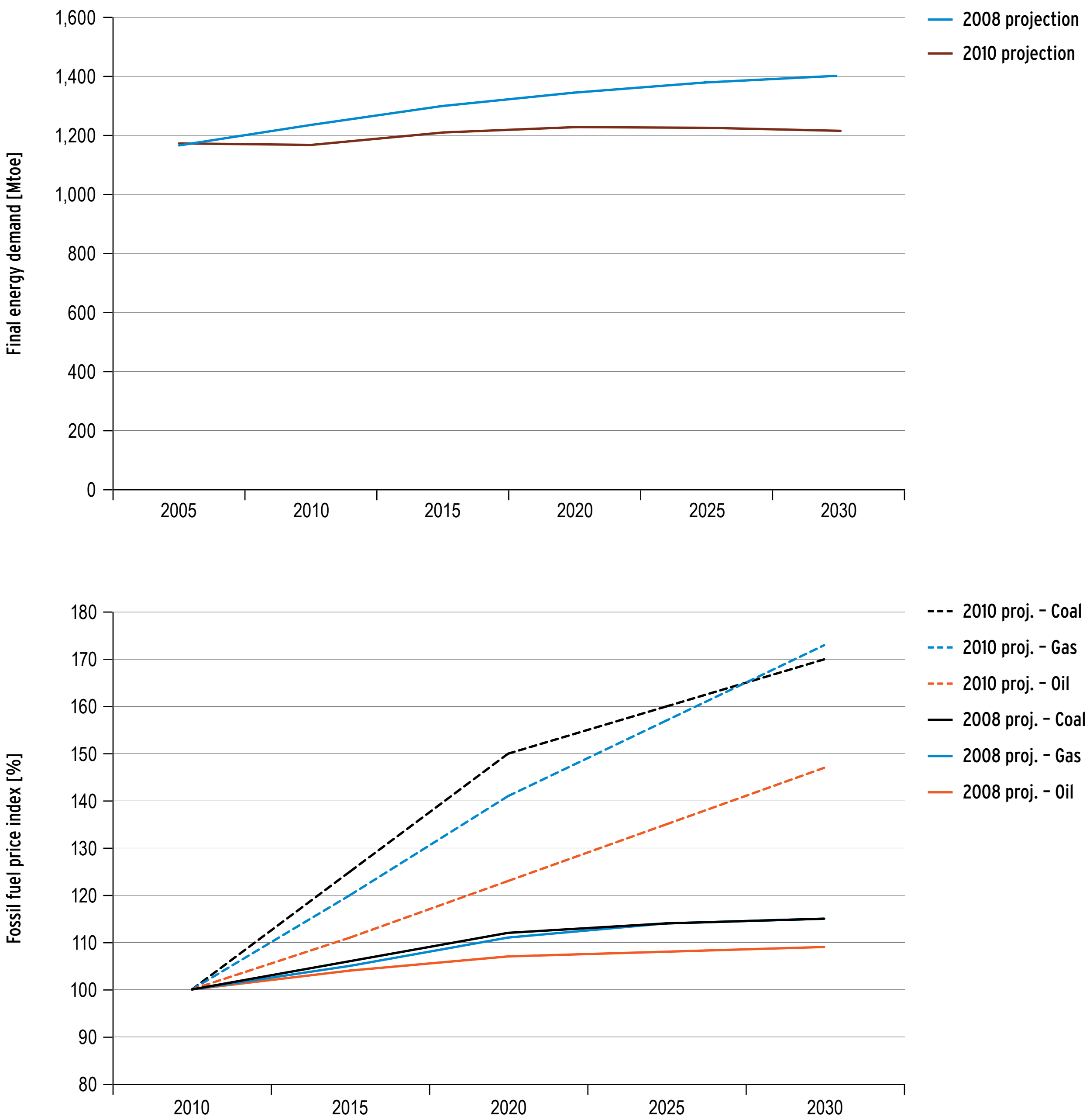
3 Methodology to determine the saving potential

Determining the energy saving potential is mainly based on two previous studies: the “Study on the Energy Saving Potentials in EU Member States, Candidate Countries and EEA Countries” [Fraunhofer ISI, 2009a], which includes the quantification of energy saving potentials up to 2030 based on a technology-specific, bottom-up simulation and the ADAM project [Fraunhofer ISI, 2009b] which served as a basis for extrapolating the potentials as well as the baseline development up to 2050. Due to the increasing uncertainty of the longer term view, it is not possible to allocate potentials to specific technologies. Therefore, the share of the technology potential in the year 2030 was assumed to remain constant for the next 20 years in order to obtain a rough idea about the significance of the individual technologies.

The original data were determined in comparison to the baseline energy demand projection of the European Commission from the year 2008 [European Commission, 2008]. In order to take into account the effects of the economic crisis in 2008/2009 and to ensure comparability with the latest demand projection of the European Commission (in the following termed as “baseline” based on [European Commission, 2010b]), the saving potentials were adjusted taking the updated final energy demand into account (cf. Figure 3). Similarly, the energy cost savings were also adjusted based on the latest fossil fuel price projections from [European Commission, 2010b].

Thermal imaging and insulation materials

Figure 3: Comparison of final energy demand and energy carrier prices in the 2008 and 2010 baseline projections of the European Commission

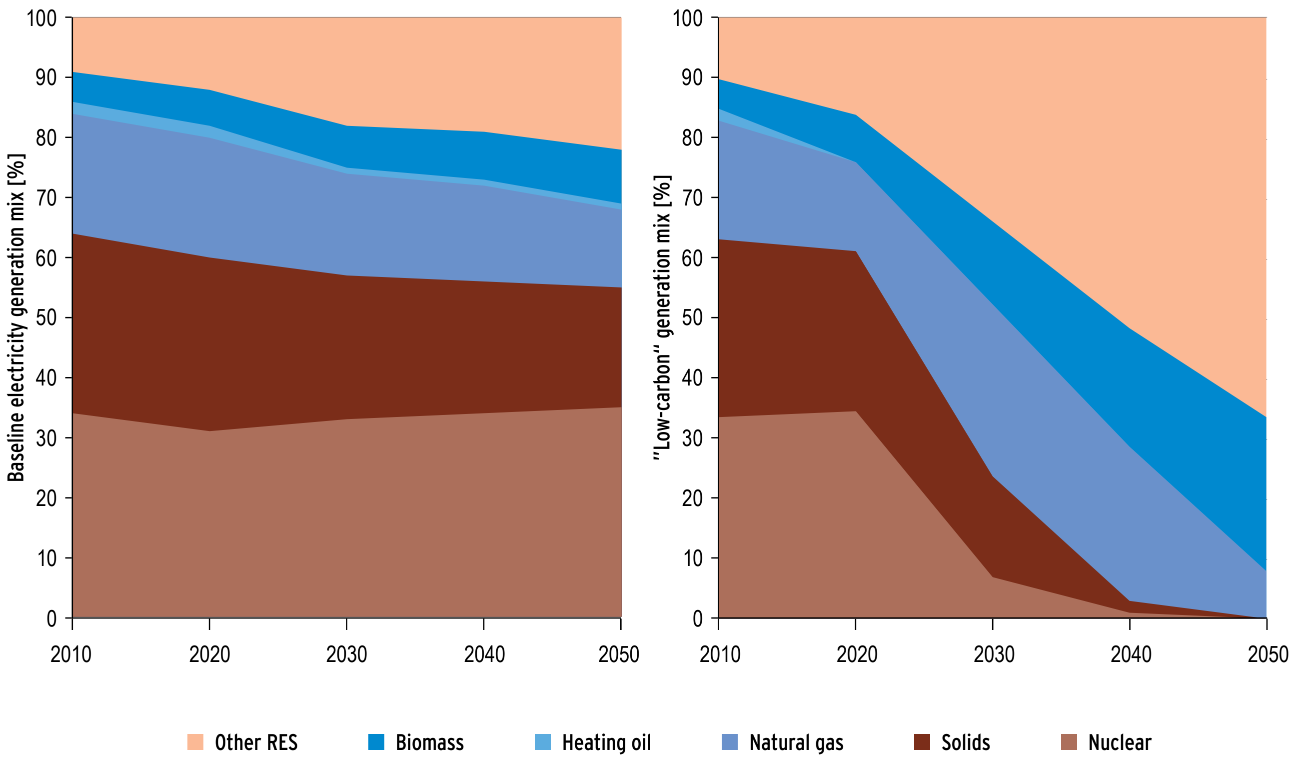


Source: based on [European Commission, 2008], [European Commission, 2010b]

The saving potentials identified should be understood as "realistic technical potentials" rather than theoretical potentials since their method of calculation follows a scenario approach that considers dynamic aspects in the uptake of technologies as well as the time horizon during which a technology may reasonably be available. Realistic technical energy-saving potentials depend on the future development of drivers such as the economic or social development (e.g. the stock of existing buildings or appliances may increase or decrease over time etc.). This takes into account that there are reinvestment cycles which depend on factors other than energy efficiency. Hence the usual investment cycles are not substantially modified with few exceptions. This is why the diffusion of energy efficiency potentials takes time and the technological potential identified does not penetrate the market immediately but takes at least the lifetime of the reference technology unless reinvestment cycles can be accelerated.

With regard to the cost-effectiveness of efficiency technologies, only economic technologies are selected (i.e. the financial savings for the avoided fuel procurement exceed the additional investments required to implement the efficiency technology) or at least near-economic ones, in order to include only technologies that are likely to reach market maturity.

Figure 4: Baseline and "low-carbon" electricity generation mix



Source: Based on [European Commission, 2010b] and [Fraunhofer ISI, 2011b]

Primary energy saving potentials are the result of conversion efficiency as well as final energy related efficiency measures. On the one hand, savings are triggered by the shift towards a highly efficient electricity generation mix[4] (see Figure 4, comparison between the baseline generation mix and a "low-carbon" generation mix). On the other hand, the fuel-specific conversion of final energy into primary energy saving potentials (considering the highly efficient electricity generation mix) takes into account the impact of declining final energy demand on primary energy demand. The overall primary energy saving potential is used as a basis to determine the greenhouse gas emission reduction potential by applying fuel-specific emission factors. Consequently, primary energy and emission reduction potentials are split into one part related to the shift towards a highly efficient electricity supply system and another part resulting from the actual final energy savings.

The energy saving potential is determined using a bottom-up approach to identify saving potentials directly linked to the application of a specific technology or the implementation of specific behaviour-related measures. Within the project, eleven packages[5] (so-called wedges[6], see Table 1) were put together for an in-depth analysis. They include specific energy efficiency options and the underlying technologies which can be addressed by individual policy measures. For detailed information about these packages see the accompanying scientific report. The presentation of the overall saving potentials in section 5 also refers to this list of wedges. All saving potentials not covered through these wedges are represented en bloc as "estimated wedges".

Table 1: Overview of the energy efficiency wedges

#	Sector	Wedge
1	Households, tertiary sector	Building envelope
2	Households, tertiary sector	Heating and cooling systems
3	Households, tertiary sector	Lighting
4	Households, tertiary sector	Green ICT
5	Households	Household appliances
6	Industry (PT)	Paper and pulp industry
7	Industry (CCT)	Steam/hot water generation
8	Industry (CCT)	Electric drives
9	Industry (CCT)	E-drive system optimisation
10	Transport (road)	Technical improvements
11	Transport (road)	Behavioural changes

PT=process technologies
CCT=cross-cutting technologies

4 The electricity generation mix is based on scenario A of the "EU Long-term scenarios 2050" study which is also being carried out by Fraunhofer ISI [Fraunhofer ISI, 2009b]. In this study, renewable energy sources account for 94 percent of electricity generation; the net electricity demand amounts to 3246 TWh in 2050 and the overall mean efficiency is 80 percent.

5 An additional package deals with the impacts of e-mobility to the reduction of final energy demand. Given the high complexity of this topic, it is addressed in a separate section (see text box in section 4.4)

6 For further information regarding the wedge approach see the extended scientific report, [Fraunhofer ISI, 2011a].

4 Sectoral saving potentials

4.1 Household sector

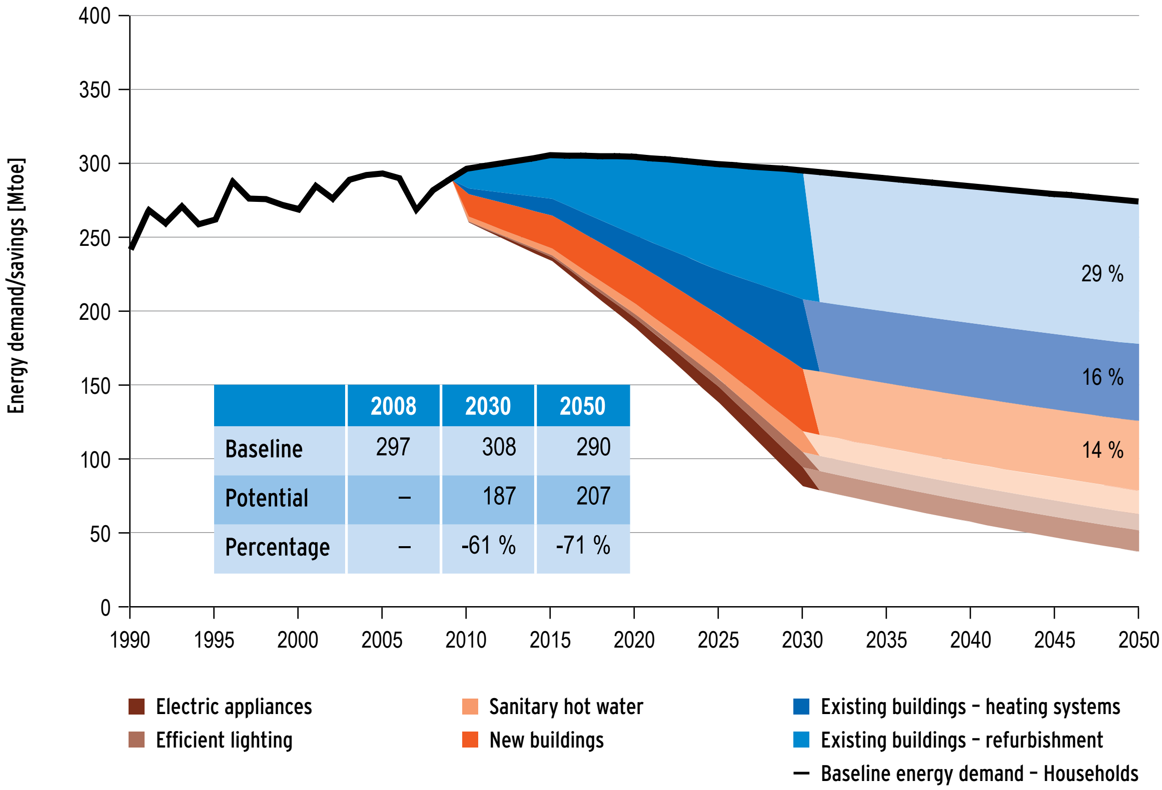
- ▶ Baseline final energy demand will decline after 2015 reaching today's level by 2040
- ▶ Final energy demand can be reduced by 71 percent by 2050 compared to the baseline
- ▶ Half of the savings relate to the building shell refurbishment of existing buildings
- ▶ By 2050, net energy cost savings amount to 124 billion €'05 annually
- ▶ Building-related efficiency options (refurbishment, replaced heating systems, highly efficient new buildings) trigger 80 percent of the cumulative energy cost reduction

By 2050, the final energy saving potentials identified lead to a reduction in final energy demand of 71 percent compared to the baseline development (see Figure 5).

Among economic options, electric appliances and lighting represent the most attractive energy saving options regarding their specific cost reduction per unit of energy saved. However, their contribution to the overall energy cost reduction is rather small compared to building-related measures, including efficient sanitary hot water generation: 13 billion €'05 versus 110 billion €'05 by 2050.

The net benefits that take into account the additional financial efforts needed to implement near-economic

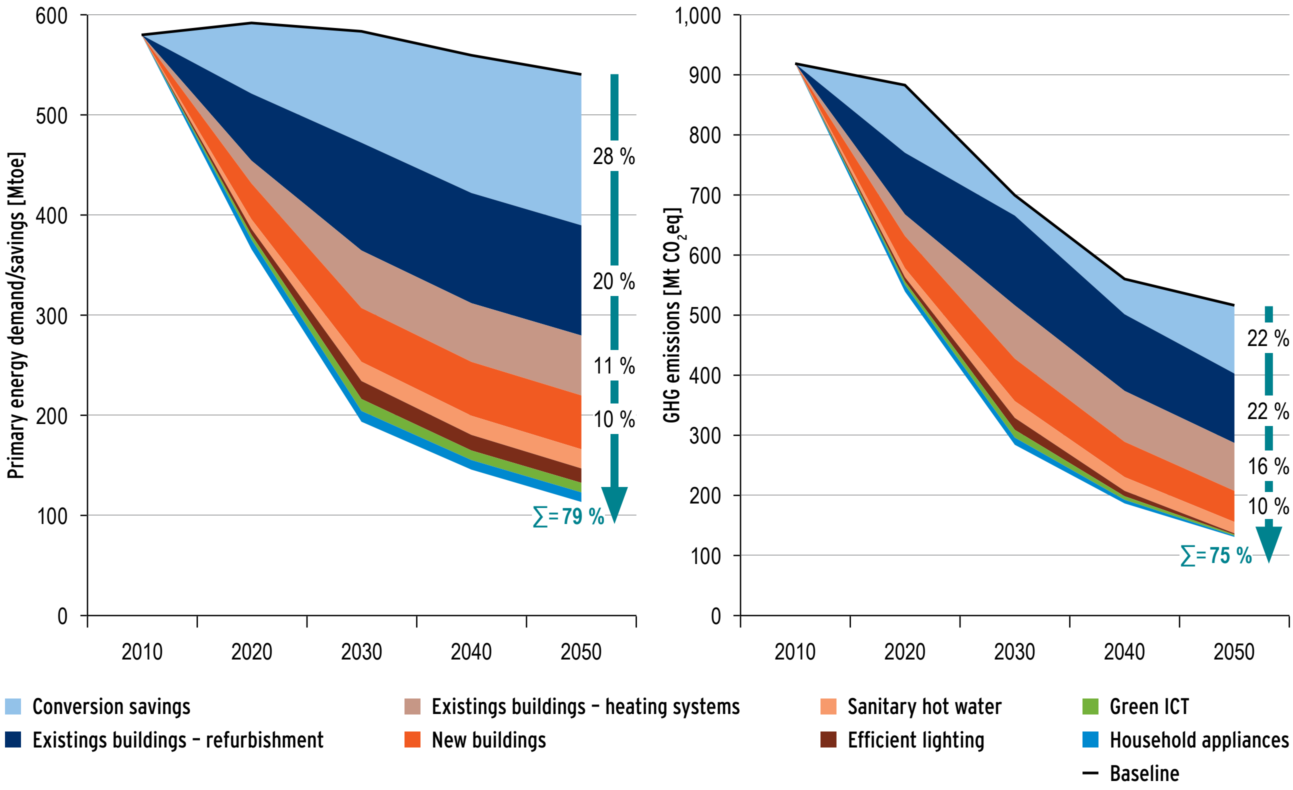
Figure 5: Total final energy saving potentials in the household sector



	2008	2030	2050
Baseline	297	308	290
Potential	–	187	207
Percentage	–	-61 %	-71 %

Source: Fraunhofer ISI

Figure 6: Primary energy savings and GHG emission reduction potentials in the household sector compared to the baseline energy demand



Source: Fraunhofer ISI

technologies reach 124 billion €'05 by 2050 (127 billion €'05 benefits from cost-efficient technologies minus nearly 4 billion €'05 additional costs for not yet cost-efficient options). The high cost reduction is due to increasing fuel prices that make the additional investments economically attractive. Based on these results, it is obvious that the majority of potentials are cost-efficient over their life-time, but they need to be activated by political measures that address in particular also behavioural barriers such as high up-front investments.

If no additional measures were undertaken (baseline development), overall primary energy demand would continue to increase up to 2020 before dropping to a level of 451 Mtoe by 2050 (Figure 6). A more efficient electricity generation mix could reduce this by up to 28 percent. The overall primary energy saving potential due to final energy related efficiency measures could contribute an additional 51 percent compared to the baseline. Building-related efficiency measures represent roughly 80 percent of the overall primary energy savings.

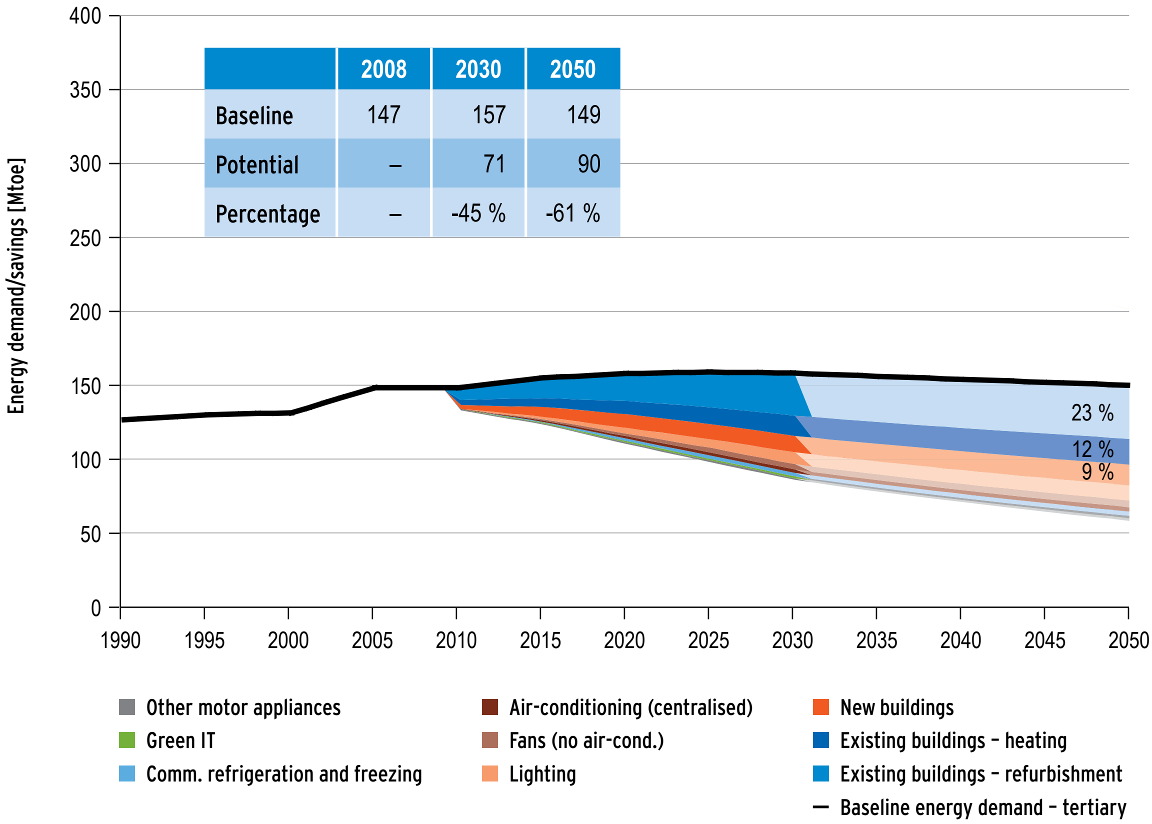
Under the baseline development, GHG emissions decline by 42 percent between 2010 and 2050 due to increasing decarbonisation of the power sector and electrification of the heating sector. Given the fact that the greater diffusion of heat pumps triggers an increase in electricity demand, the household sector benefits additionally from the decarbonisation of the power generation sector. An additional 22 percent of GHG emissions could be reduced by conversion savings from the shift to a "low-carbon" electricity generation mix in 2050 (see the "conversion savings" slice in Figure 6). Final energy related efficiency measures account for additional emission reductions of 53 percent in 2050.

4.2 Tertiary sector

- Baseline energy demand will increase slightly before dropping again to today's level by 2050
- Final energy demand is reduced by 61 percent compared to the baseline
- Two thirds of the savings are building-related
- By 2050 all the potentials identified are cost-efficient, triggering net savings of 71 billion €'05 annually

In the baseline scenario, final energy demand stops increasing after 2030 and returns to today's level. Final energy demand could be reduced by 61 percent compared to the baseline projection. Similar to the residential sector, efficient heating and insulation systems in existing and new buildings represent three quarters of the total savings.

Figure 7: Total final energy saving potentials in the tertiary sector



	2008	2030	2050
Baseline	147	157	149
Potential	–	71	90
Percentage	–	-45 %	-61 %

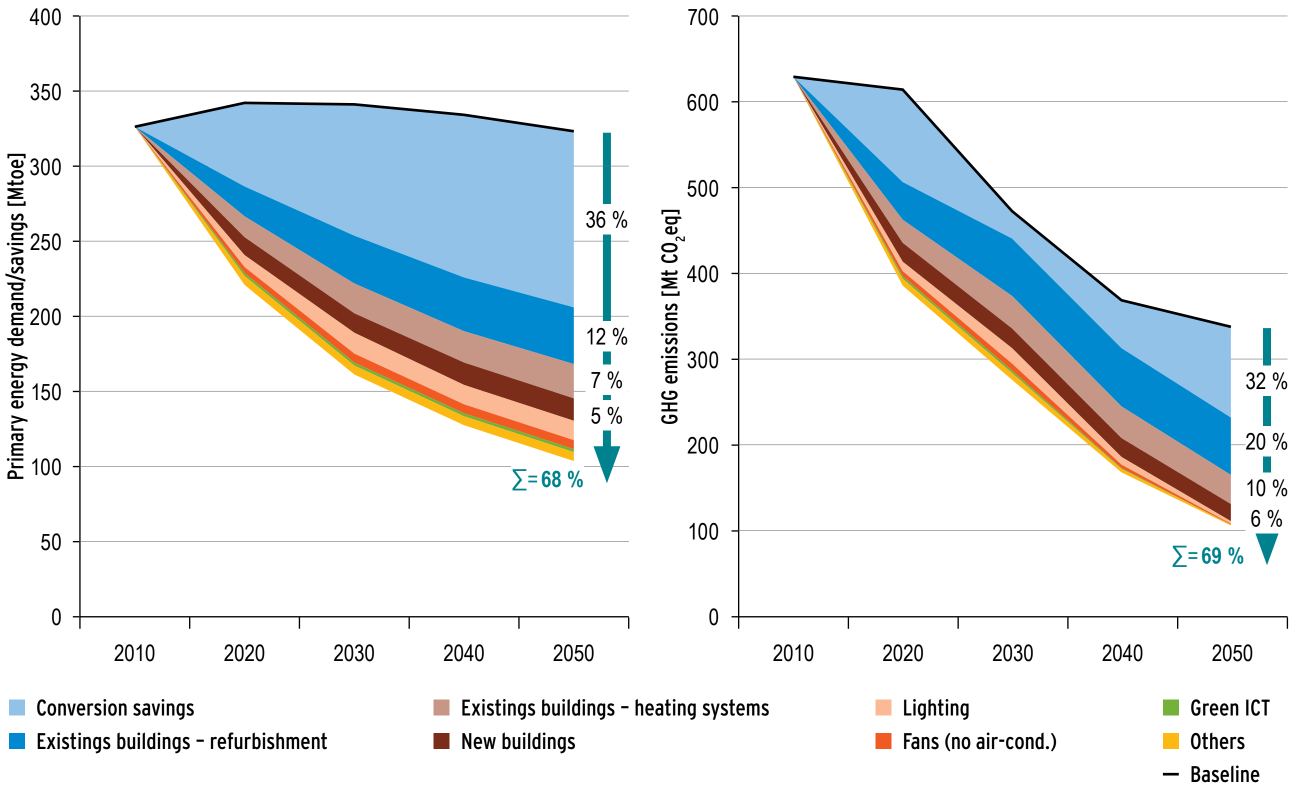
Source: Fraunhofer ISI

From 2040 onwards, the entire final energy saving potential is economic. While efficient electric appliances represent the most attractive saving option given their particularly high specific energy cost savings, building-related efficiency measures trigger the highest overall benefits due to the size of the potential. Building-related measures are responsible for nearly 60 percent of the total net cost reductions of 71 billion €'05 in 2050.

In terms of primary energy savings, the shift towards a highly efficient power sector reduces tertiary primary energy demand by more than one third in 2050 (cf. Figure 8). This effect is much stronger than in any of the other sectors which is mainly due to the fact that the final energy demand of the sector is dominated by electricity. Energy efficiency measures account for another third of the reduction in primary energy demand.

Emissions already decline strongly by 46 percent under the baseline projection between 2010 and 2050 as a result of the decarbonisation of the power sector. By 2050, some 32 percent of the remaining energy-related GHG emissions from the tertiary sector could be cut as a result of additional conversion savings. Final energy related efficiency measures contribute an additional 36 percent reduction in GHG gases.

Figure 8: Primary energy savings and GHG emission reductions from the tertiary sector compared to the baseline energy demand



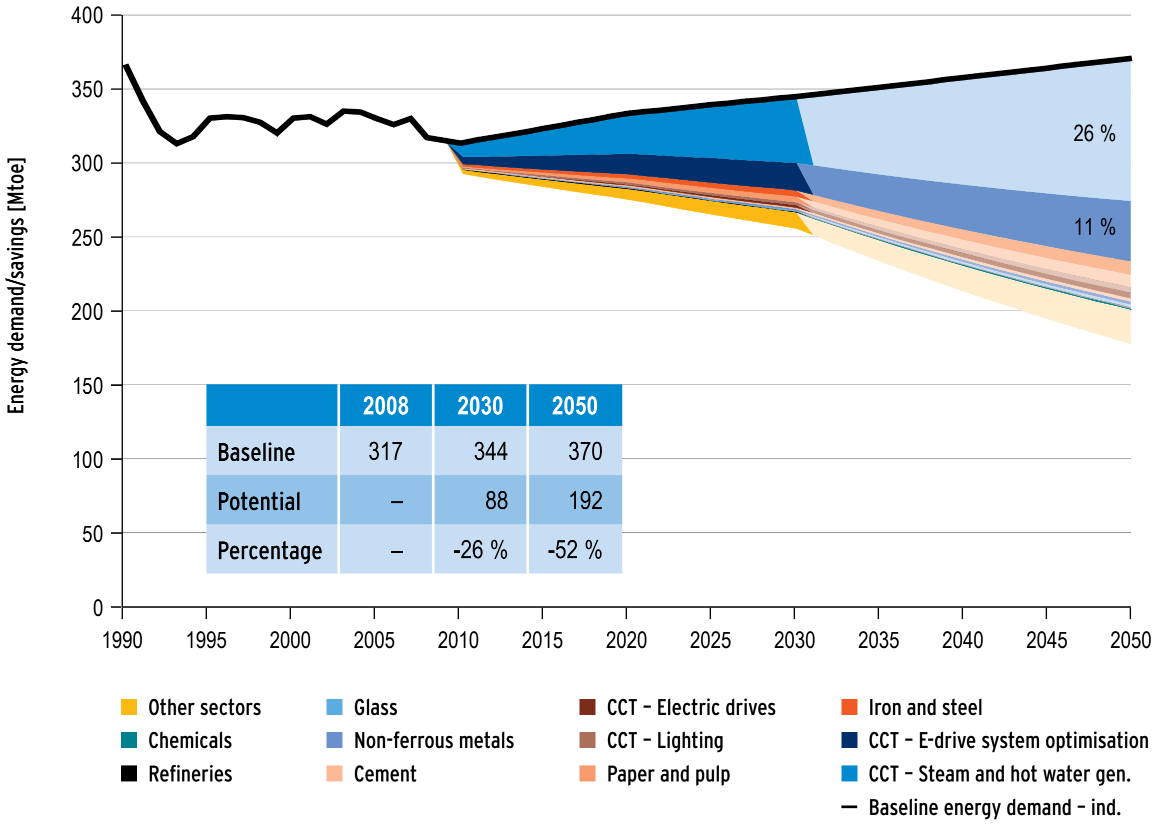
Source: Fraunhofer ISI

4.3 Industry sector

- Baseline final energy demand grows by another 17 percent compared to 2008
- Final energy demand reduction potential of 52 percent compared to the baseline
- 75 percent of savings from cross-cutting technologies (efficient steam and hot water generation as well as optimisation of entire systems relying on electric drives)
- Total net energy cost savings in 2050 amount to 102 billion €'05

Most of the short-term energy savings in the industry sector are related to optimised electric motor driven systems and energy-efficient heat generation. In the longer term, further energy savings can compensate the increased baseline energy demand and promise even higher demand reductions. Provided all the potentials are implemented by 2050, final energy demand can be reduced by 52 percent compared to the baseline.

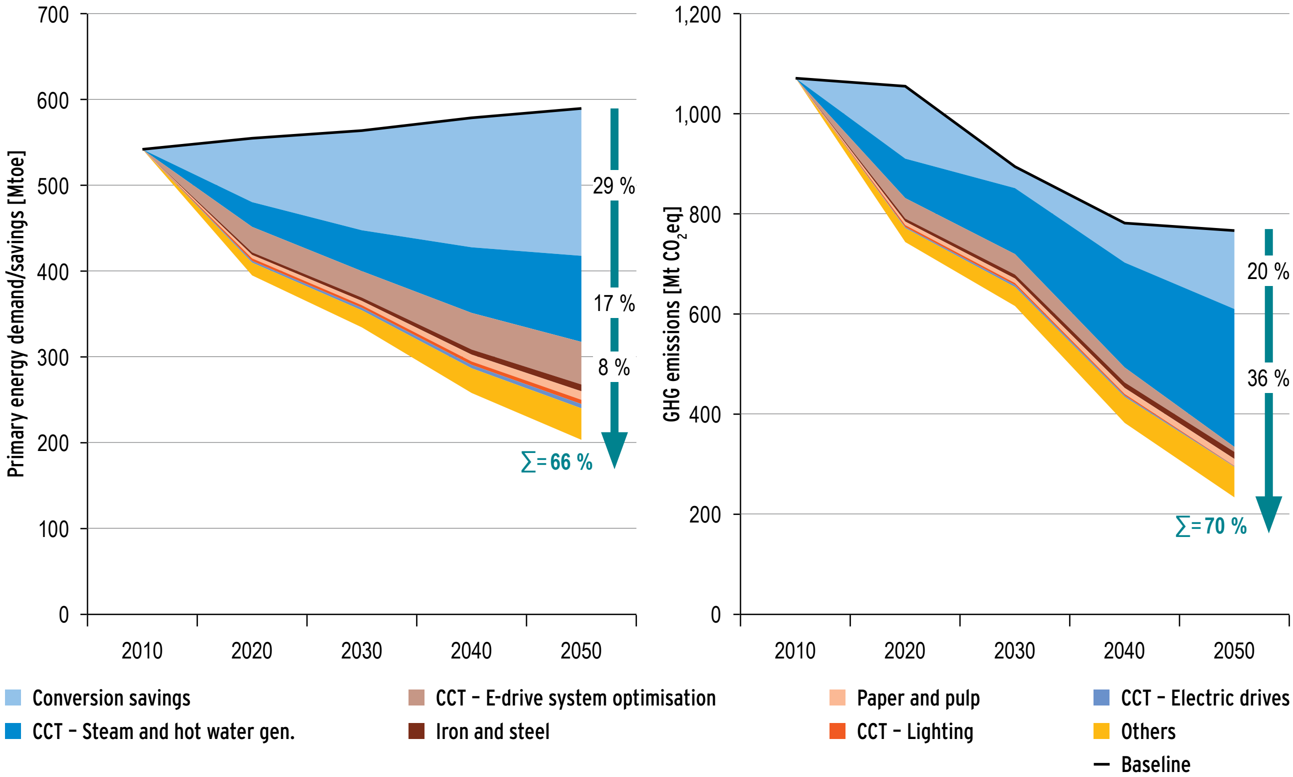
Figure 9: Total final energy saving potentials in the industry sector (CCT: cross-cutting technologies)



	2008	2030	2050
Baseline	317	344	370
Potential	–	88	192
Percentage	–	-26 %	-52 %

Source: Fraunhofer ISI

Figure 10: Primary energy savings in the industry sector compared to the baseline energy demand



Source: Fraunhofer ISI

Even though efficient steam and hot water generation technologies (i.e. improved efficiency of heat generation units, further diffusion of combined heat and power technology (CHP) and highly efficient industrial space heating) represent half of the final energy saving potential, their contribution in terms of cost savings is much smaller and depends heavily on the assumptions made about the fuel mix of the generation capacities displaced by CHP. Electric drive-based system optimisation, on the other hand, triggers an immediate cost reduction. Adding up all the benefits yields a net cost reduction of 105 billion €'05[7] by 2050, of which 3 billion €'05 would be needed to compensate the additional costs of near-economic efficiency measures.

The baseline primary energy demand further increases by 8 percent between 2010 and 2050 (see Figure 10). While in the short term more than one third of the savings from final energy related measures come from optimising electric drive based systems, this share declines subsequently. This is due to the fact that the increasing efficiency of power generation partly compensates the significance of electricity-saving measures. Hence, efficiency technologies for steam and hot water generation become more important, representing nearly half of the primary energy saving potential from final energy related efficiency technologies by 2050.

Even in the baseline projection GHG emissions decrease autonomously by 28 percent between 2010 and 2050. The overall saving potential equals 70 percent in 2050 compared to the baseline, with 50 percent arising from final energy savings.

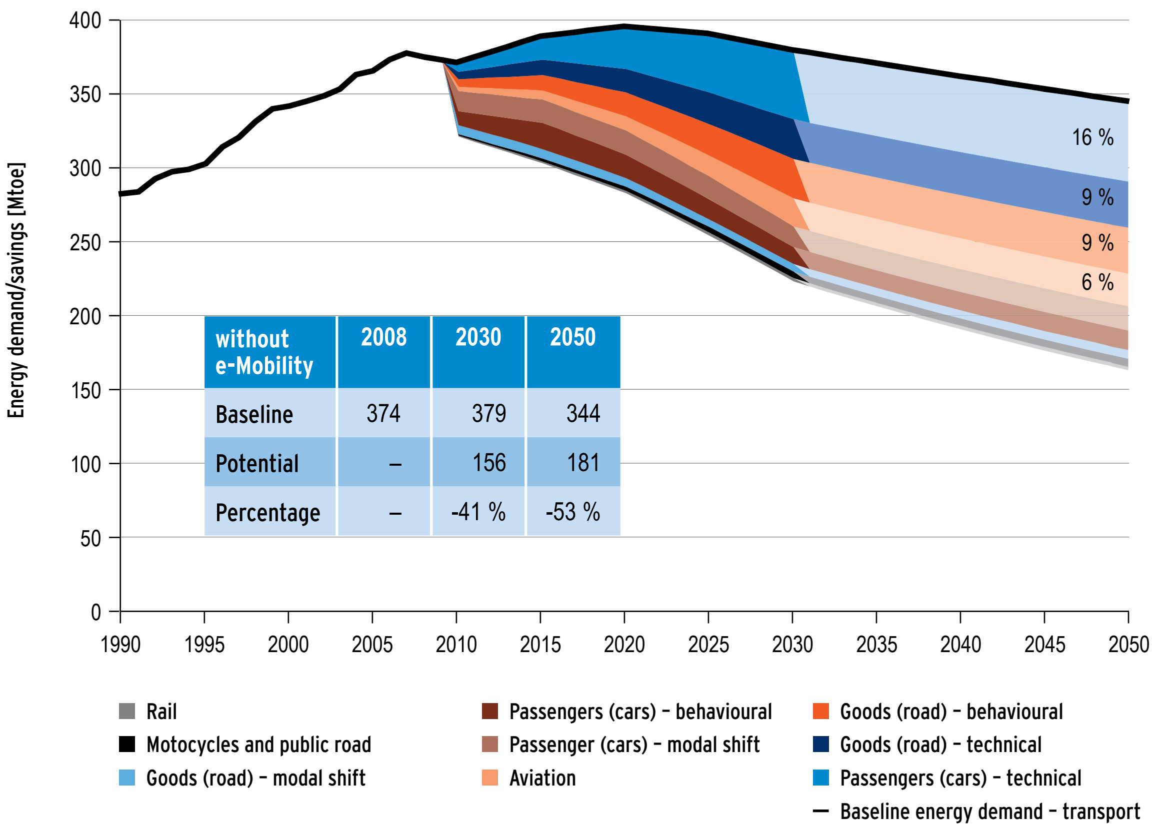
7 Excluding the cost benefits from CHP which are highly sensitive to price and fuel mix assumptions reduces the net benefits to 90 billion €'05.

4.4 Transport sector

- Autonomous baseline demand reduction beyond 2020
- Final energy demand reduction of 53 percent by 2050 compared to the baseline
- Nearly half of the savings are related to technical improvements in road transport
- Behavioural measures and modal shift contribute respectively 13 percent and 7 percent
- Net energy cost savings mount up to 191 billion €'05 annually by 2050

In the baseline scenario net final energy savings are expected in the transport sector beyond 2020 due to the marked autonomous shift towards more efficient transport technologies. The expected reduction of final energy demand could be accelerated by pushing technical improvements in passenger as well as freight road transport, which account for nearly 50 percent of the overall saving potential in 2050 (savings due to e-mobility are addressed separately; see text box at the end of this chapter). The potentials of other traffic modes (technical as well as behavioural measures in the rail, air and public road transport sector) are less significant.

Figure 11: Total final energy saving potential in the transport sector



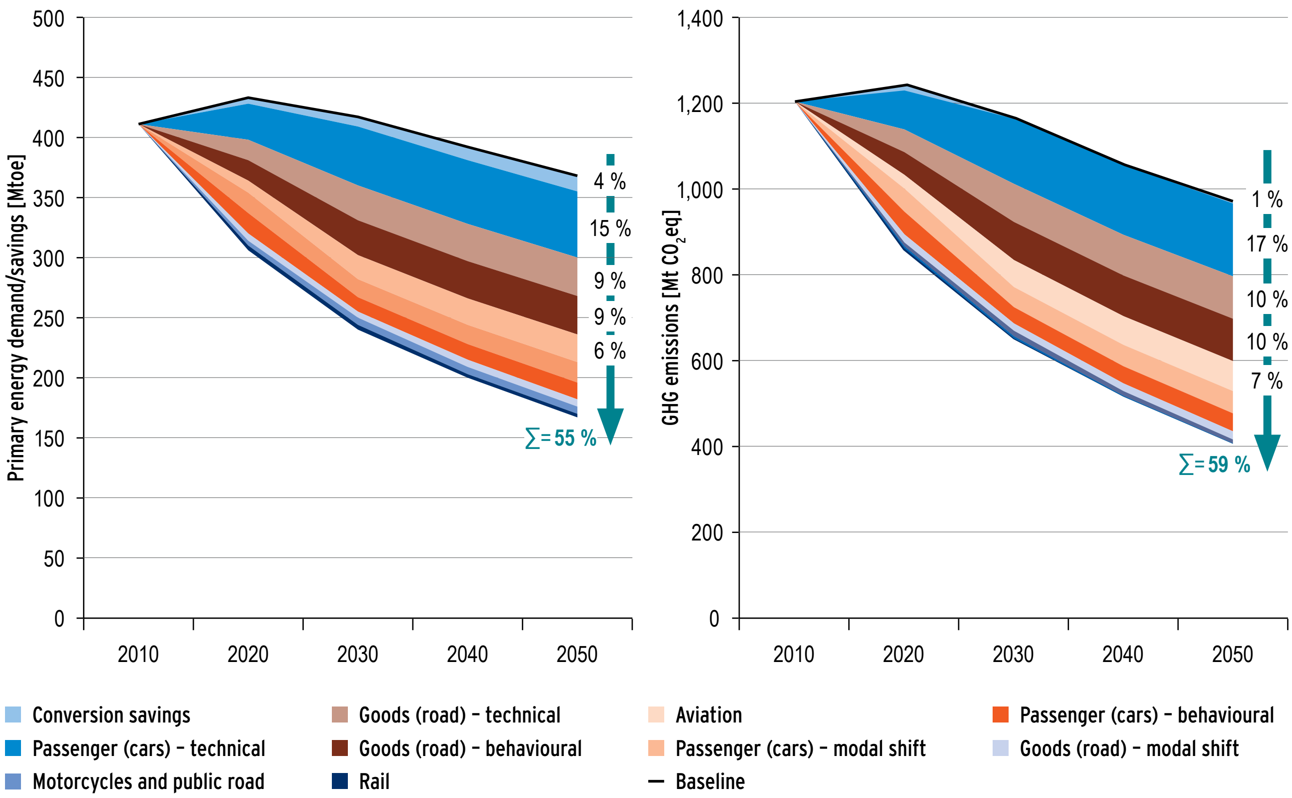
without e-Mobility	2008	2030	2050
Baseline	374	379	344
Potential	–	156	181
Percentage	–	-41 %	-53 %

Source: Fraunhofer ISI

In the upcoming decades, final energy savings in the transport sector are associated with increasing cost savings assuming a further increase of the oil price. This is especially true for cars and motorcycles running on gasoline. By 2050, energy cost savings from economic saving measures total 210 billion €'05, of which 19 billion €'05 would be needed for additional expenditures on efficiency investments that are not able to be met by avoided fuel costs due to fuel savings.

In compliance with the baseline final energy demand projections, primary energy demand is likewise supposed to decline beyond 2020 (see Figure 12). It is a specific feature of the transport sector that efficiency improvements in the power generation sector have only a marginal impact on the overall primary energy demand here (4 percent savings by 2050). This can be explained by the assumed low share of electricity as a final energy carrier in the baseline scenario. In terms of GHG emission reductions, the impact is similarly marginal.

Figure 12: Primary energy savings from the transport sector compared to the calculated emissions from the baseline energy demand



Source: Fraunhofer ISI

SPOTLIGHT TOPIC – eMobility

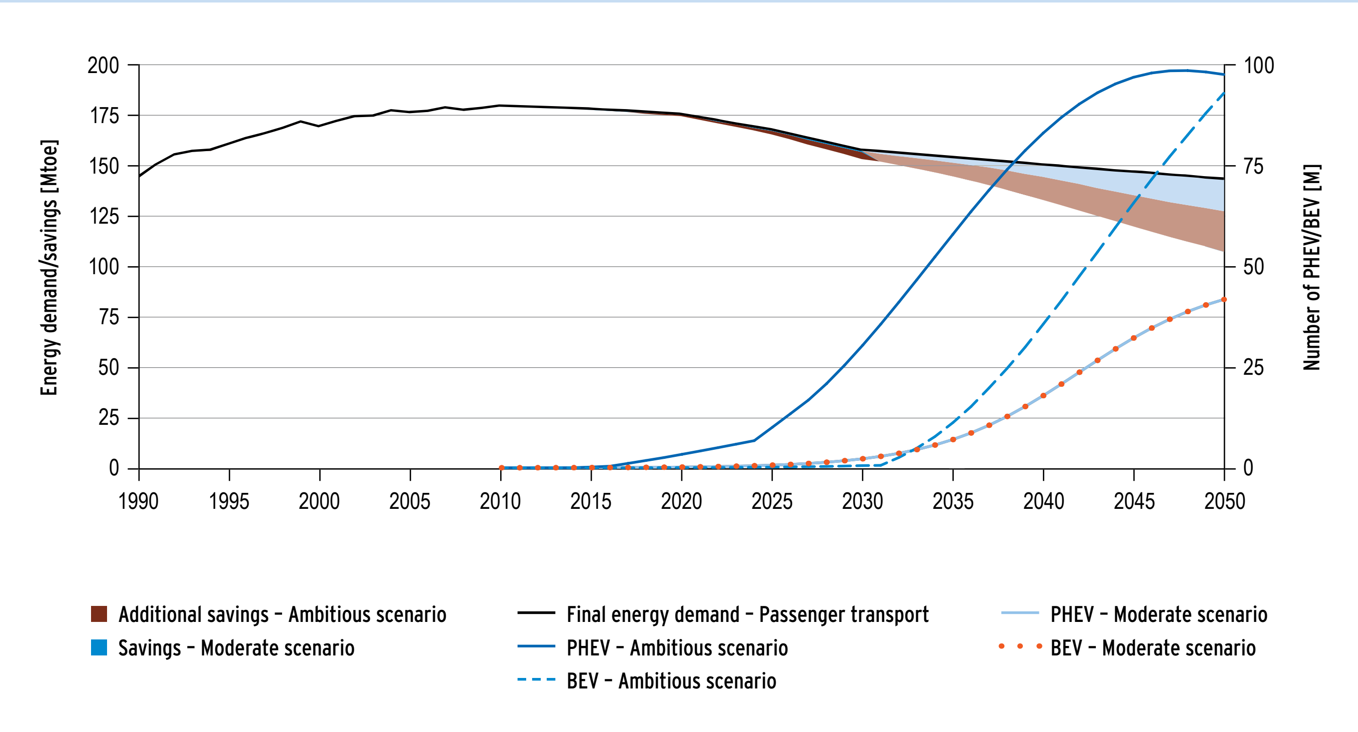
Electric vehicles are currently being discussed as one way to decarbonise the transport sector and provide electricity storage to better integrate fluctuating renewable energy sources. However, they also represent a relevant option for reducing final energy demand. Given the fact that all kinds of grid connected vehicles (plug-in hybrid vehicles, PHEV, as well as battery electric vehicles, BEV) are still considered to be niche applications, it is difficult to forecast how they will actually perform compared to competing technologies (such as hydrogen, biofuel or gas-powered cars) and catch on in the market. Hence, two diffusion scenarios were analysed.

The moderate scenario presumes a relevant stock increase of electric vehicles (BEV and PHEV at the same pace) from 2025 onwards, leading to a 30 percent share of electric vehicles by 2050 (as expected in [EWI, 2010]). This is equivalent to roughly 80 million electric cars, considering a total car stock of 280 million passenger cars (cf. [Fraunhofer ISI, 2009b]).

The ambitious scenario is based on a study by Fraunhofer ISI [2008] that forecasts an early growth of PHEV numbers from 2020 onwards, whereas BEV only experience large-scale market introduction from 2035 (cf. Figure 13). In 2050, two out of three cars on Europe's roads are either PHEV or BEV, i.e. 190 million electric cars in total.

Under the two scenarios, the final energy saving potentials total 16 and 36 Mtoe respectively in the year 2050. This equals an 11 percent/25 percent reduction of the forecasted final energy demand in passenger transport. At the same time, the shift towards electric vehicles implies a further increase in electricity demand of 140 TWh and 318 TWh, respectively.

Figure 13: Final energy savings through and number of electric vehicles



Source: Fraunhofer ISI

4.5 Cross-sectoral overview

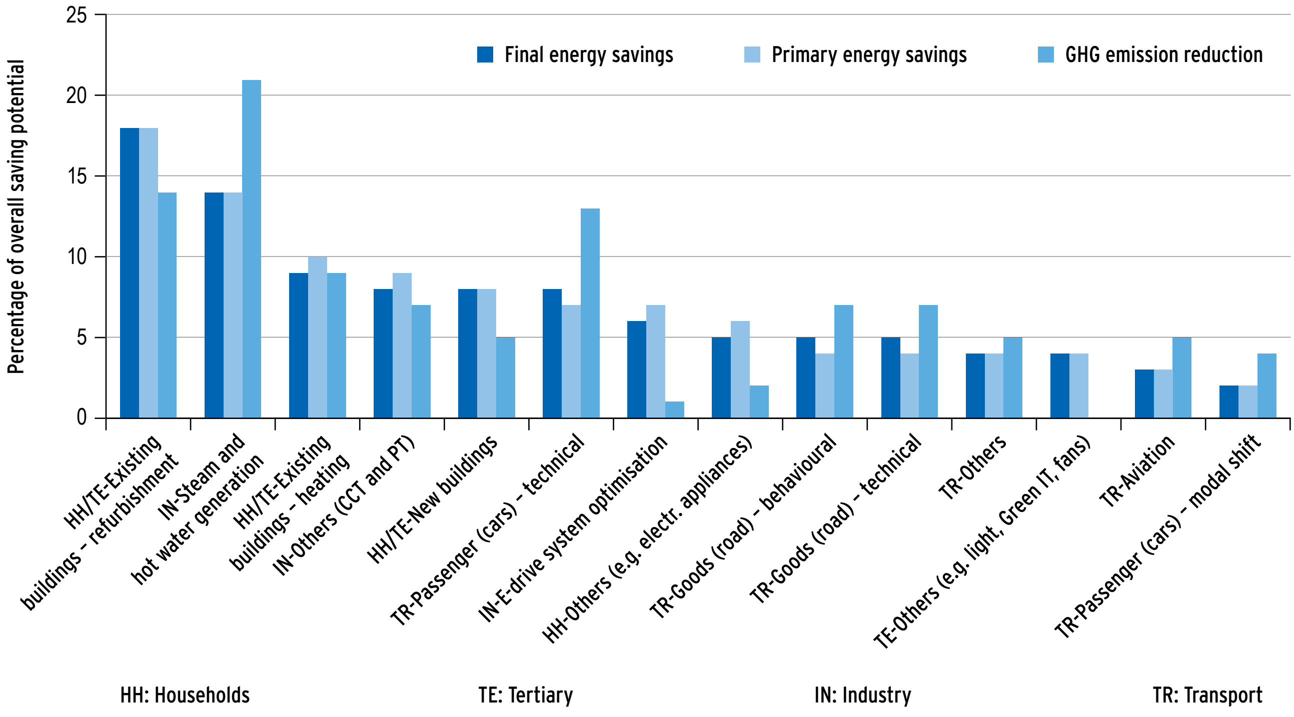
Figure 14 depicts the contribution of various efficiency options to reducing energy demand and GHG emissions. The graph clearly shows that the individual efficiency measures do not have the same reduction impact on final energy demand, as on primary energy demand or GHG emissions.

The main reason for this is the diversity of final energy carriers with varying conversion efficiencies used in the different sectors (e.g. heat versus electricity). At the same time, a high degree of electrification within a specific branch increases the reduction impact on primary energy savings due to the assumed progression in the efficiency of the electricity supply system.

With regard to GHG emissions, the different emission factors of the various primary energy carriers result in another potential gap between primary energy savings and GHG emission reduction.

Hence, energy efficiency options can only be effectively addressed if the entire energy conversion chain is considered and a clear target has been defined in advance. Figure 14 clearly shows that transport-related efficiency options have a significant impact on GHG emission reduction, whereas building-related efficiency improvements primarily help to lower the final energy demand.

Figure 14: Potential contributions of saving options in all sectors to final/primary energy and GHG reduction (the total saving potential equals 100 percent)



Source: Fraunhofer ISI

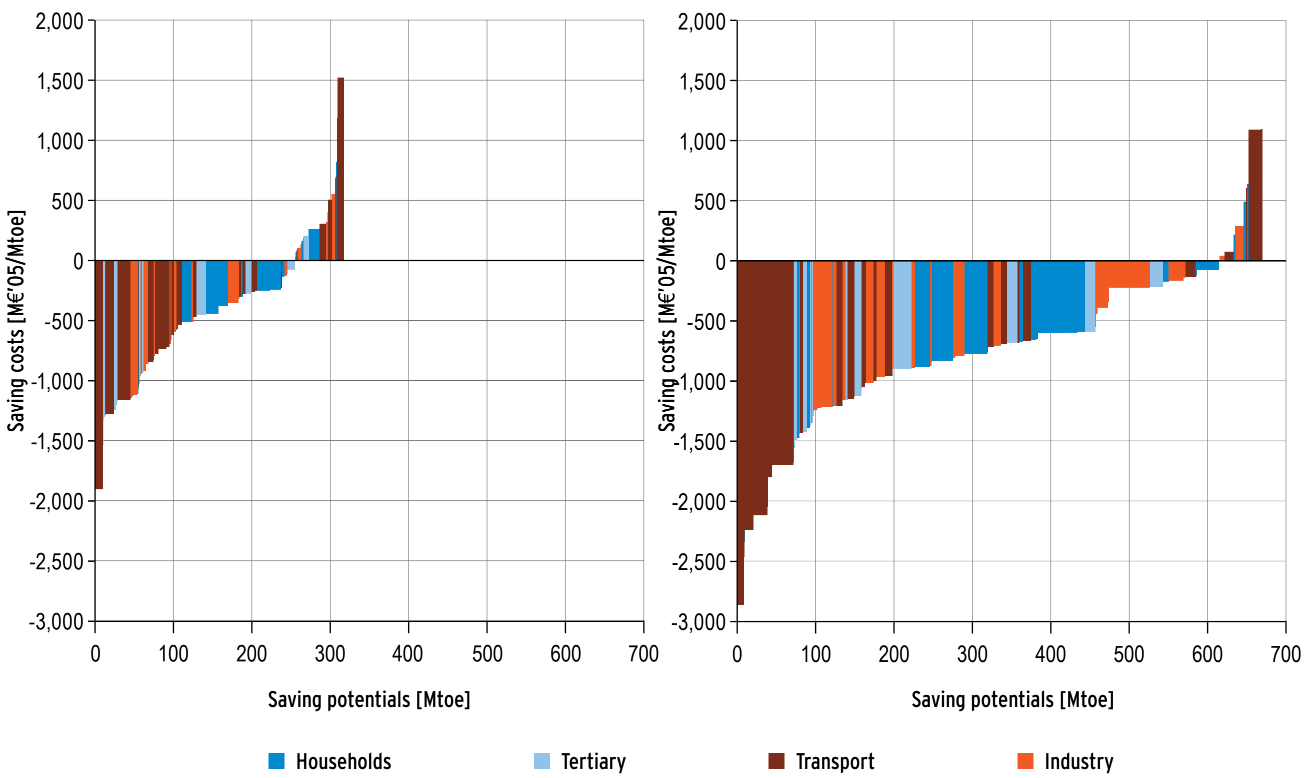
The cost-curves for the years 2020 and 2050 shown in Figure 15 further underline that the overall technical saving potentials more than double in this time period. Learning effects and assumed energy price increases further reduce the specific costs of energy saving measures (if market penetration occurs as assumed for the technologies). This affects mainly technologies relying on relatively expensive fuels such as diesel, gasoline and electricity.

Due to the specific cost decrease, the share of cost-effective measures (all those featuring negative costs) increases from 80 percent to 92 percent compared to the total technical saving potential identified.

The technologies with the highest specific energy cost savings in 2050 are:

- technical improvements and behaviour-related measures (such as modal shift) in passenger road transport, i.e. cars and motor cycles;
- residential ICT appliances such as modem routers, set-top boxes, computers and monitors; and
- domestic white appliances such as washing machines, dryers and refrigerators.

Figure 15: Multi-sectoral cost curves for 2020 and 2050



Source: Fraunhofer ISI

Building automation: modern heating control technology reduces energy costs by up to 40 percent

5 Summary and discussion of overall results

This chapter includes the summary of the main results with regard to final and primary energy saving potentials as well as GHG emission reduction potentials (see Table 2 for the general overview).

Table 2: Overview of the main sectoral and overall results in 2050

Saving results in 2050		HH	TE	IN	TR	Total
Final energy demand	2008 level [Mtoe]	296	147	317	374	1,161
	Baseline [Mtoe]	290	149	370	344	1,183
	Cost-efficient savings	69 %	60 %	47 %	44 %	52 %
	Overall savings	71 %	60 %	52 %	53 %	57 %
Net benefits[8] [bn €'05]	from cost-efficient savings	127	71	105	210	514
	from cost-efficient and near-economic savings	124	71	102	191	488
Primary energy demand	2008 level [Mtoe]					1,802
	Baseline [Mtoe]	451	323	592	368	1,735
	Conversion savings	25 %	36 %	29 %	4 %	25 %
	Final energy related savings	51 %	32 %	36 %	51 %	42 %
	Overall savings	76 %	68 %	65 %	55 %	67 %
GHG emissions	1990 level [Mt CO_2eq]					3,934
	Baseline [Mt CO_2eq]	538	336	767	978	2,619
	Conversion savings	21 %	32 %	20 %	1 %	15 %
	Final energy related savings	55 %	37 %	49 %	57 %	52 %
	Overall savings	76 %	69 %	70 %	59 %	67 %

Source: Fraunhofer ISI, [UNFCCC, 2011], [Odyssee, 2011]

8 Net benefits can be understood as the energy cost savings due to avoided fuel procurement minus the additional investment costs needed to implement the applied efficiency technologies.

5.1 Final energy saving potentials

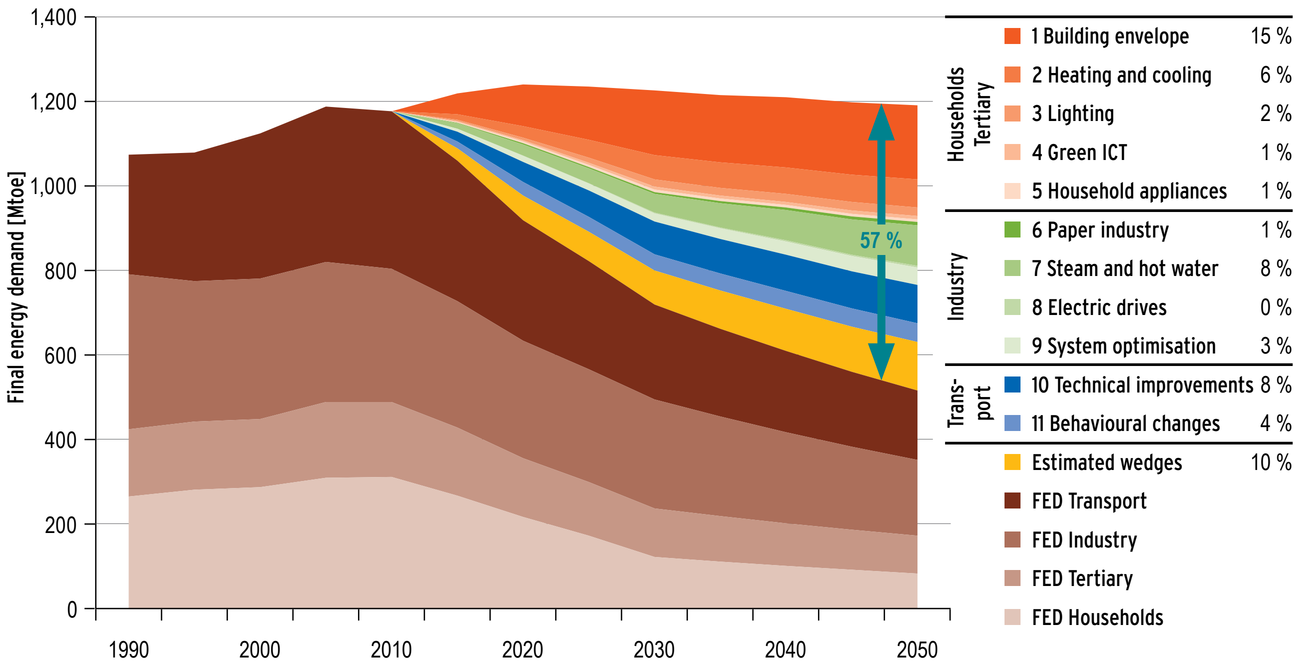
- ▶ Overall saving potential: -57 percent by 2050 compared to the baseline
- ▶ Household, industry, transport deliver -17 percent/-16 percent/-15 percent, tertiary -8 percent by 2050
- ▶ 20 percent final energy demand reduction solely through building-related measures

The baseline final energy demand continues its previous growth trend until 2020 (+6 percent compared to 2008). By 2050, however, this trend has been reversed which limits growth to 2 percent.

Compared to this baseline development, final energy demand could potentially be reduced by 57 percent in the year 2050. Figure 16 displays that households, industry and the transport sector each contribute about 16 percent, while the tertiary sector delivers about 8 percent[9].

11 x Poland's final energy demand from the year 2008 could be saved in 2050 through final energy related efficiency measures.

Figure 16: Overall final energy demand and final energy savings (figures shown in the key represent the relative saving potential in 2050 compared to baseline)



Source: Fraunhofer ISI

9 In Figure 16 orange shares belong to the households and tertiary sector, green shares to the industry sector and blue shares to the transport sector. The “estimated wedges” block (in yellow colour) covers any other saving potential in all sectors that are not covered by the wedges one to eleven.

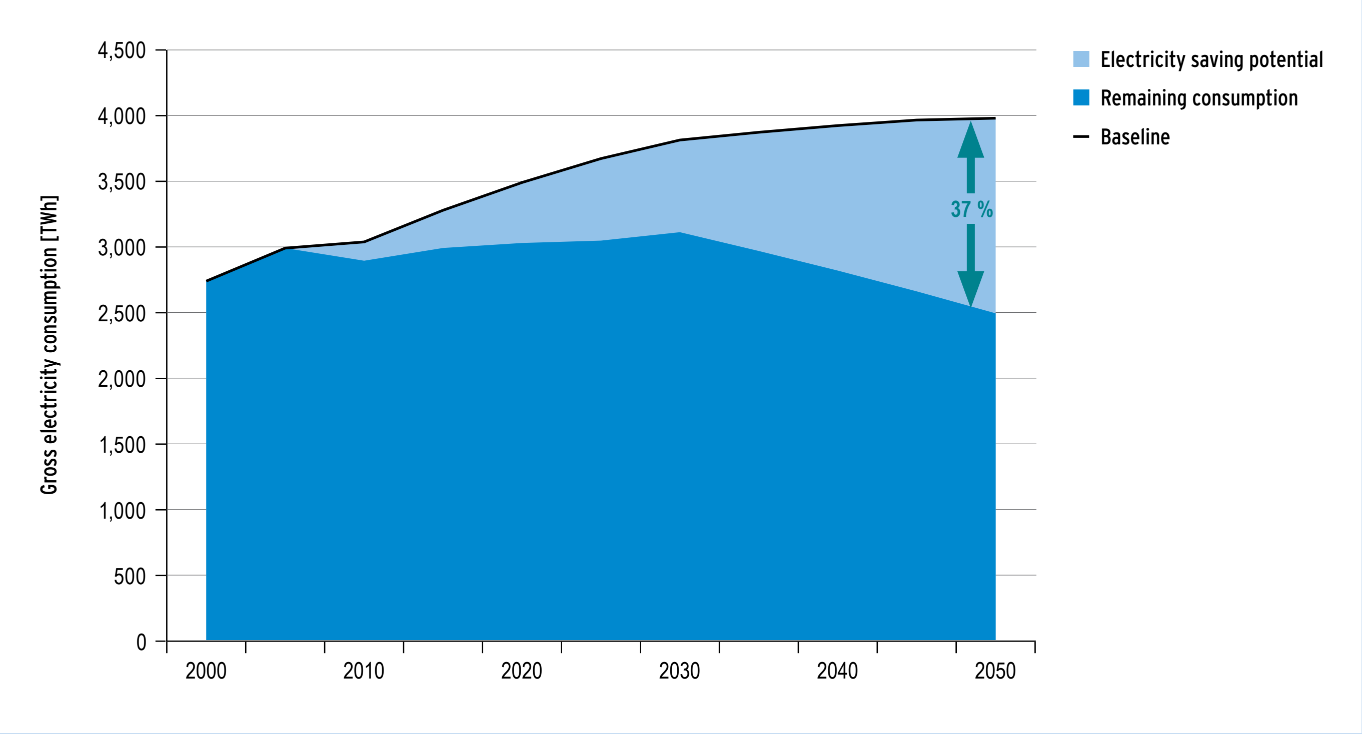
SPOTLIGHT TOPIC – Electricity saving potentials

Figure 17 shows that, if substantial electricity saving measures were undertaken, gross electricity consumption in the EU-27 could be reduced to less than 2,500 TWh by 2050. This value is comparable to a 37 percent reduction below the projected baseline electricity demand and 13 percent below the value of the year 2008.

In turn, such an ambitious reduction of electricity demand implies a limited electrification of the heat generation and the transport sector. For the year 2050, the underlying scenario considers some 60 TWh for about 23 million electric vehicles (8 percent of the car stock, considering a total car stock of 280 million passenger cars) and nearly 70 TWh for electric heat pumps in the households and tertiary sector. The developments assumed previously in the Spotlight Topic eMobility would add an additional electricity demand of 80 TWh and 258 TWh, respectively.

Energy audit for pumps

Figure 17: Gross electricity consumption and saving potentials



Source: Fraunhofer ISI

5.2 Costs and benefits

- 92 percent of the total saving potential in 2050 is cost-efficient
- More than 500 billion €'05 energy cost savings annually if all final energy saving potentials were implemented
- Highest benefits due to efficiency technologies in the transport sector
- Highest near-economic saving potentials also in the transport sector

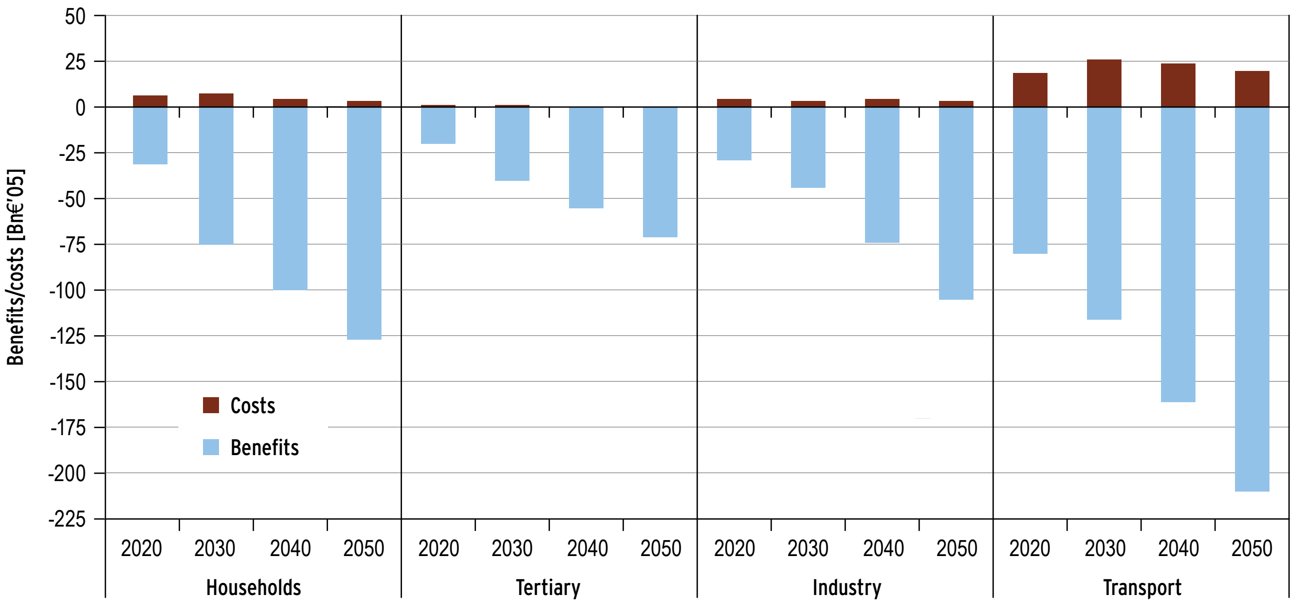
The aggregated sectoral energy cost savings as the product of the specific cost savings and the respective saving potential given in the cost-curves are shown in Figure 18. It is obvious that transport is the sector with the highest monetary benefits in 2050 accounting for more than 40 percent of the overall monetary net benefits due to the realisation of cost-efficient energy saving options (513 billion €'05 in total).

At the same time, it is also the transport sector which features efficiency technologies requiring additional financial investments (19 billion €'05 in 2050) because they are not covered by cost savings due to reduced fuel demand.

In order to deploy all the near-economic saving potentials identified in every sector by 2050 (equivalent to an increase of 8 percent in the potential), the net benefits would be reduced by 5 percent.

1,000 € less energy costs annually for each European citizen in 2050 if all final energy saving options identified would be implemented.

Figure 18: Aggregated sectoral net energy cost savings from economic (blue) and additional investment costs for near-economic (red) efficiency measures



Source: Fraunhofer ISI

5.3 Primary energy saving potentials

- ▶ 25 percent reduction in primary energy demand achievable in 2050 via the shift to a highly efficient electricity supply system
- ▶ Additional savings of 42 percent due to final energy-related efficiency technologies
- ▶ In the household sector, primary energy demand could even be reduced by 75 percent
- ▶ Final energy savings could deliver nearly twice the savings required by the 20 percent efficiency target in 2020

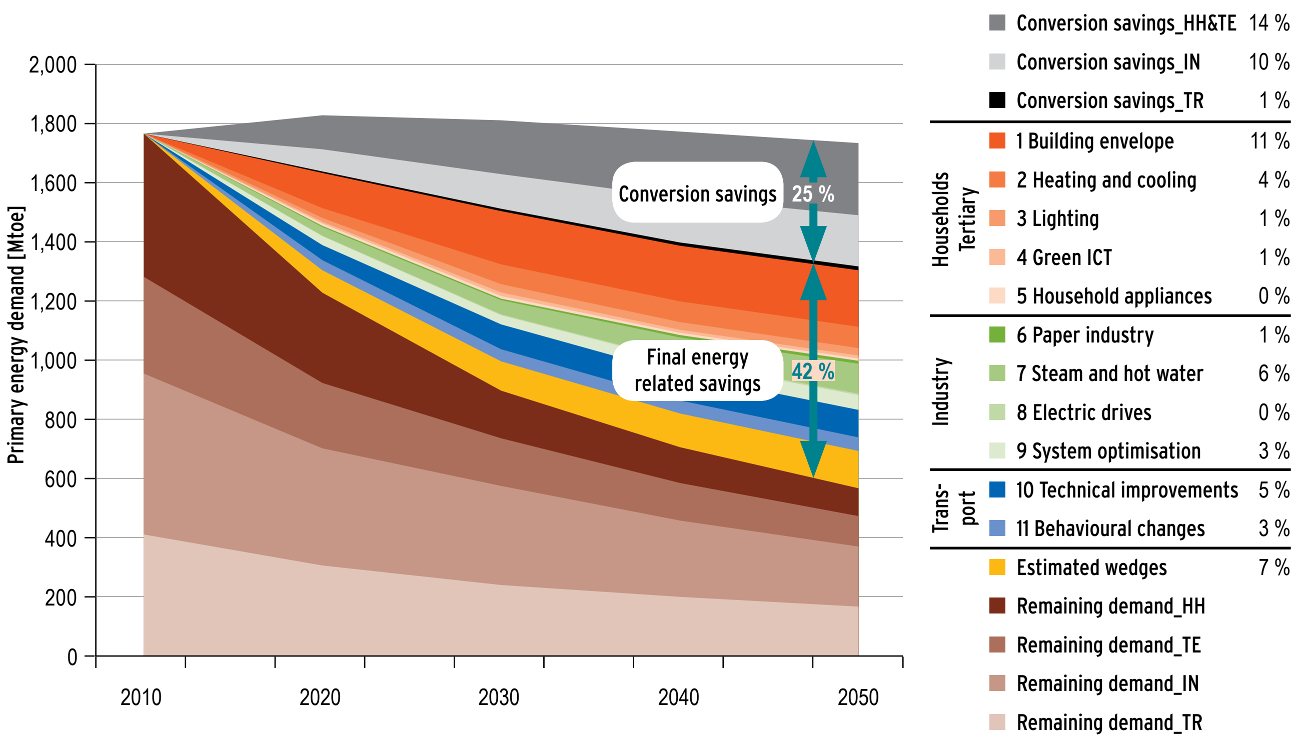
In the baseline development, primary energy demand grows by 2 percent until 2020 before declining to 4 percent below the level of 2008 by 2050.

The primary energy saving potentials, as shown in Figure 19 are divided into "conversion savings" triggered by the shift towards a highly-efficient, mainly renewable energy-based electricity supply system (see also section 3) and "final energy savings" due to exploiting the final energy saving potentials described above.

The overall primary energy saving potential in 2050 equals

118 percent of all EU's energy imports in the year 2008.

Figure 19: Overall primary energy demand and savings (figures shown in the key represent the relative saving potential in 2050 compared to baseline)



Source: Fraunhofer ISI

Primary energy demand can be reduced by up to 25 percent by 2050 due to conversion savings[10]. The transport sector's contribution here is negligible since it does not benefit from an increase in conversion efficiency (e.g. for oil products) and has comparatively low electrification in the baseline scenario.

Final energy related savings imply an additional 42 percent reduction in primary energy demand making two thirds of the total primary energy demand avoidable. On a sectoral level, households can even reduce their primary energy demand by 76 percent, whereas the saving potential in the transport sector reaches 55 percent.

The European Commission has announced in its Energy 2020 strategy a 20 percent primary energy demand reduction by the year 2020 compared to the baseline prepared in the year 2007 [European Commission, 2010a]. This target can be translated into an absolute primary energy demand reduction to a level of 1,602 Mtoe[11] by the year 2020. The exclusive use of final energy savings can contribute a primary energy demand reduction to the level of 1,423 Mtoe by the year 2020. Conversion savings would imply additional savings of 195 Mtoe, leading to a potential overall demand reduction to the level of 1,229 Mtoe.

Mining in Garzweiler

10 This does not consider a reduction of transmission losses but solely the shift towards a highly-efficient electricity supply system dominated by renewable energies.

11 The 20 percent efficiency target only holds for the energy related primary energy demand. Hence, the 20 percent target being applied to the projected energy demand for the year 2020 of 1,971 Mtoe less the non energy use of 125 Mtoe results in an absolute primary energy demand reduction of 369 Mtoe. The overall demand of 1,971 Mtoe less the absolute reduction of 369 Mtoe gives the overall reduction target of 1,602 Mtoe.

5.4 GHG emission reduction potentials

- ▶ Autonomous reduction of GHG emissions does not necessarily imply ambitious demand reduction and increased security of supply
- ▶ Additional reductions through the shift towards a highly efficient electricity supply system are limited to 15 percent
- ▶ Half of baseline emissions avoidable through final energy related saving options
- ▶ 80–95 percent decarbonisation of the energy system requires additional measures such as fuel-shift in the transport sector

While primary energy demand continues to grow under the baseline, GHG emissions are subject to a 31 percent reduction between 2010 and 2050 (see Figure 20). This is based on the fact that electricity is increasingly generated using low-carbon generation technologies. Hence, the additional emission reduction potential due to "conversion savings" is limited to 15 percent in 2050 compared to the baseline.

The overall contribution from energy efficiency measures related to final energy lowers total GHG emissions by an additional 52 percent compared to the baseline emissions. In total, this can be translated into a 79 percent emission reduction compared to the 1990 level.

By 2050, improved conversion efficiency as well as the highly efficient use of final energy can potentially reduce GHG emissions by

79 percent below the level of 1990.

The contribution of the different sectors shows a clear three-way split of the emission reduction potential in 2050: roughly one third originates from effi-

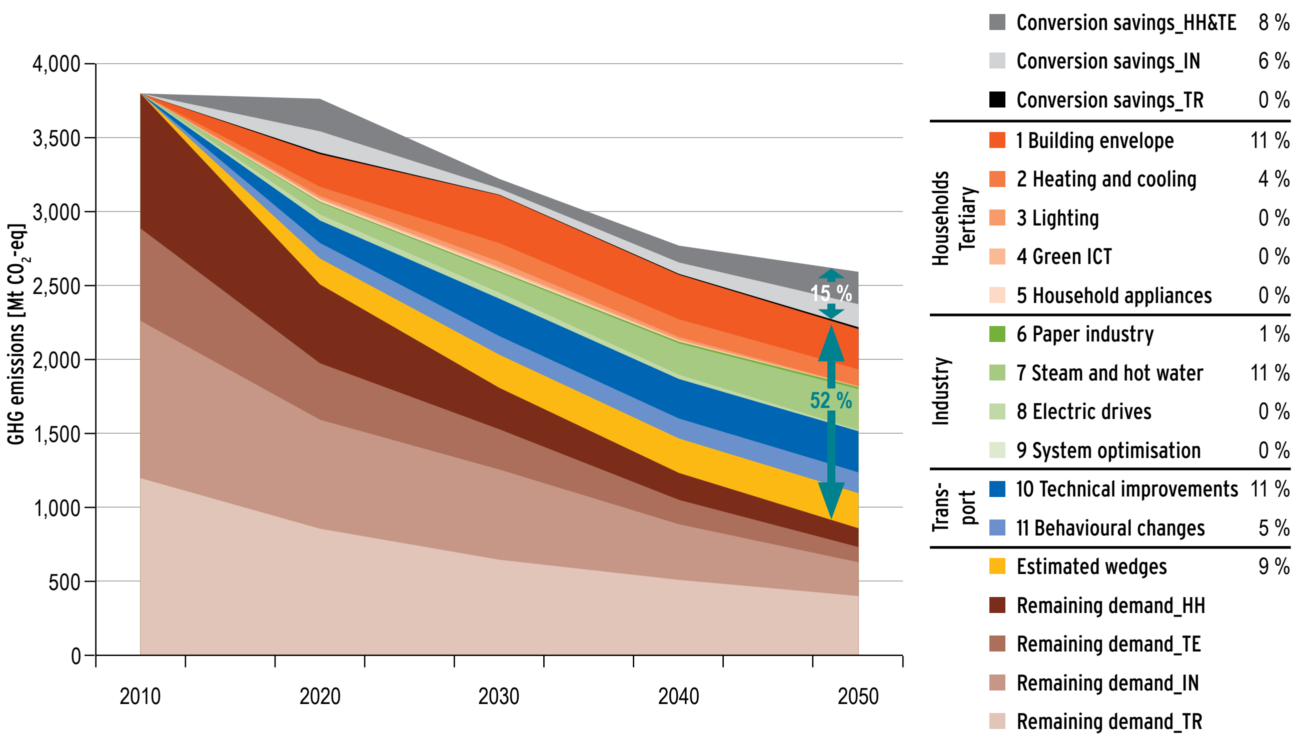
Transforming a former lignite mine into a centre of renewable energies (Germany, Brieske near Senftenberg)

Electric vehicle at a charging station

ciency measures in the transport sector, nearly one third from industry and the remaining third comes from the household and tertiary sector.

As already mentioned, it is worth pointing out once again that the higher the share of electricity as a final energy carrier in a sector, the lower the contribution of this sector to additional GHG emission reduction (compared to the baseline) as a result of the autonomous decarbonisation of the power sector under the baseline.

Figure 20: Greenhouse gas emissions and reduction potentials (figures shown in the key represent relative saving potentials in 2050 compared to baseline)



Source: Fraunhofer ISI

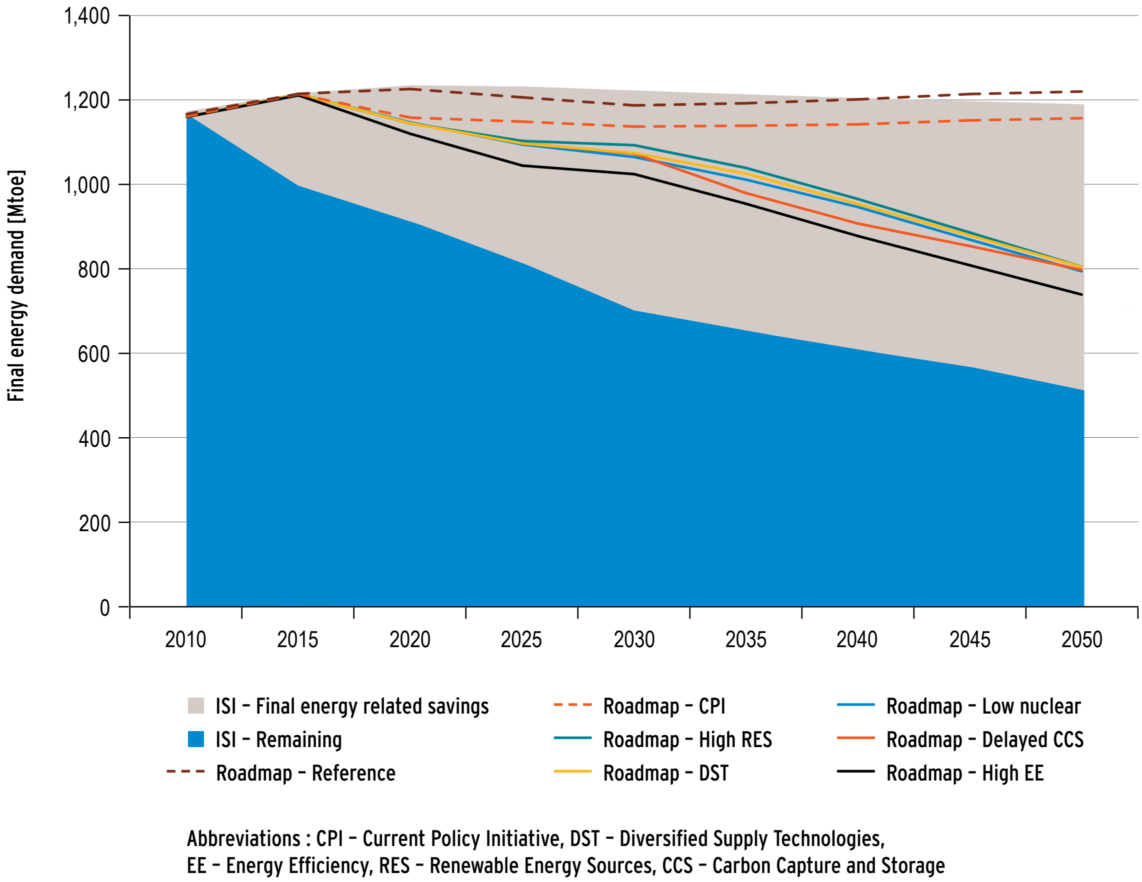
5.5 Comparison with the EU Energy Roadmap 2050

- The efficiency scenario of the Energy Roadmap requires realizing 72 percent of the overall final energy saving potentials identified in this study
- The largest differences between the Energy Roadmap scenarios and this study are in the household and industry sectors (only 50 percent of the potentials identified are realized in the Energy Roadmap)
- Limited use of energy saving options in the Energy Roadmap due to high discount rates and stagnating energy carrier prices

The European Commission published the EU Energy Roadmap 2050 in December 2011 (in the following referred to as the Energy Roadmap). The Energy Roadmap analyses two baseline developments as well as five scenarios towards a decarbonised energy system (which reduces its energy-related CO_2 emissions by nearly 85 percent compared to the 1990 level). Further information on the Energy Roadmap is provided in the text box on page 32.

Figure 21 compares the Energy Roadmap's pathways with the identified final energy saving potentials. The fact that the baseline development in the Energy Roadmap (dotted red line) and the saving potential assessment (upper bound of the range depicting the saving potential) are nearly identical justifies the comparison of the two studies.

Figure 21: Final energy saving potential compared to the final energy demand trajectories of the Energy Roadmap scenarios



Source: Fraunhofer ISI, [European Commission, 2011d]

QUICK FACTS – EU Energy Roadmap 2050

Structure

- Part 1 focuses on the business-as-usual (BAU) developments, analysing the impacts of current national and EU policies
- Part 2 analyses possible pathways towards a sustainable European energy system by 2050 (so-called decarbonisation scenarios)

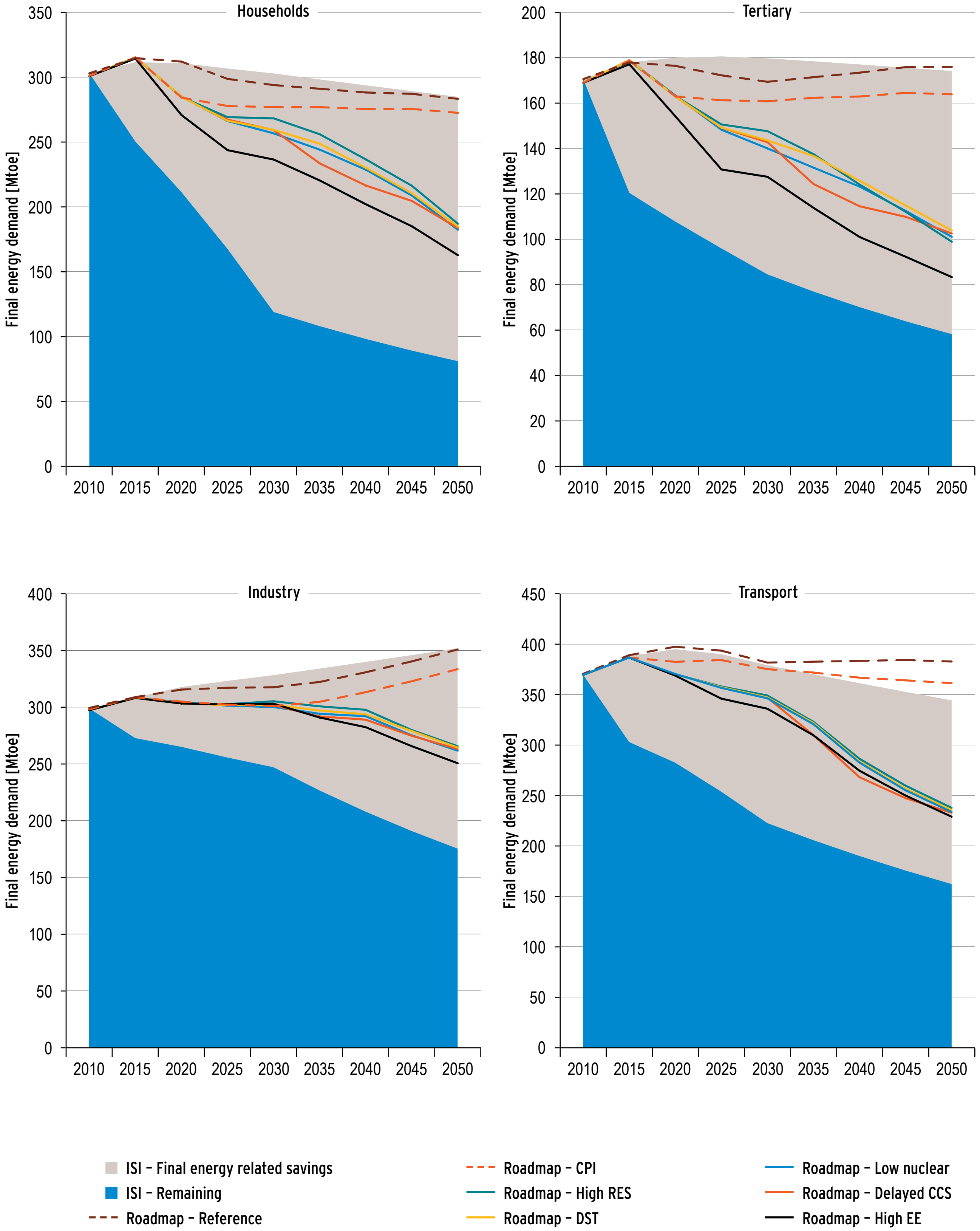
General assumptions

- Similar GDP and population development in all scenarios
- Decarbonisation scenarios are required to reduce energy-related CO_2 emissions by 85 percent
- A global climate agreement is a prerequisite in the decarbonisation scenarios leading to lower global fuel demand and hence decreasing energy carrier prices (oil price in 2050 127 US$'08/bbl in the BAU scenarios vs. 70 US$'08/bbl in the decarbonisation scenarios)
- The model assumes perfect foresight regarding policies, energy prices and technology developments, allowing investors to make cost-effective investment choices without stranded investments

Scenario descriptions

- **Business-as-usual scenarios**
  - **Reference scenario**: assumes the continuation of current trends and long-term projections on the economic level; national and EU policies and measures implemented until March 2010 are considered (including the binding 20 percent RES and the 20 percent GHG emission reduction target by 2020)
  - **Current Policy Initiatives** (CPI) scenario: includes measures adopted and being proposed in the context of the "Energy 2020 communication" [European Commission, 2010a]
- **Decarbonisation scenarios**
  - **Energy efficiency** (High EE): commitment to ambitious energy savings related to efficiency gains in a broad sense (including structural changes) but not involving income losses
  - **Diversified supply technologies** (DST): no technology preference, hence similar use of RES, CCS as well as nuclear power; decarbonisation is driven by carbon pricing
  - **High Renewables** (High RES): Strong support measures for RES triggering increased domestic RES supply (including off-shore wind and CSP)
  - **Delayed CCS**: due to acceptance difficulties regarding storage sites and transport, large-scale CCS deployment only after 2040, leading to higher shares of nuclear
  - **Low nuclear**: lack of acceptance for nuclear power leads to cancellation of any new projects under consideration (those currently under construction will be finished); hence higher penetration of CCS

Figure 22: Sectoral final energy saving potentials compared to the Energy Roadmap scenarios



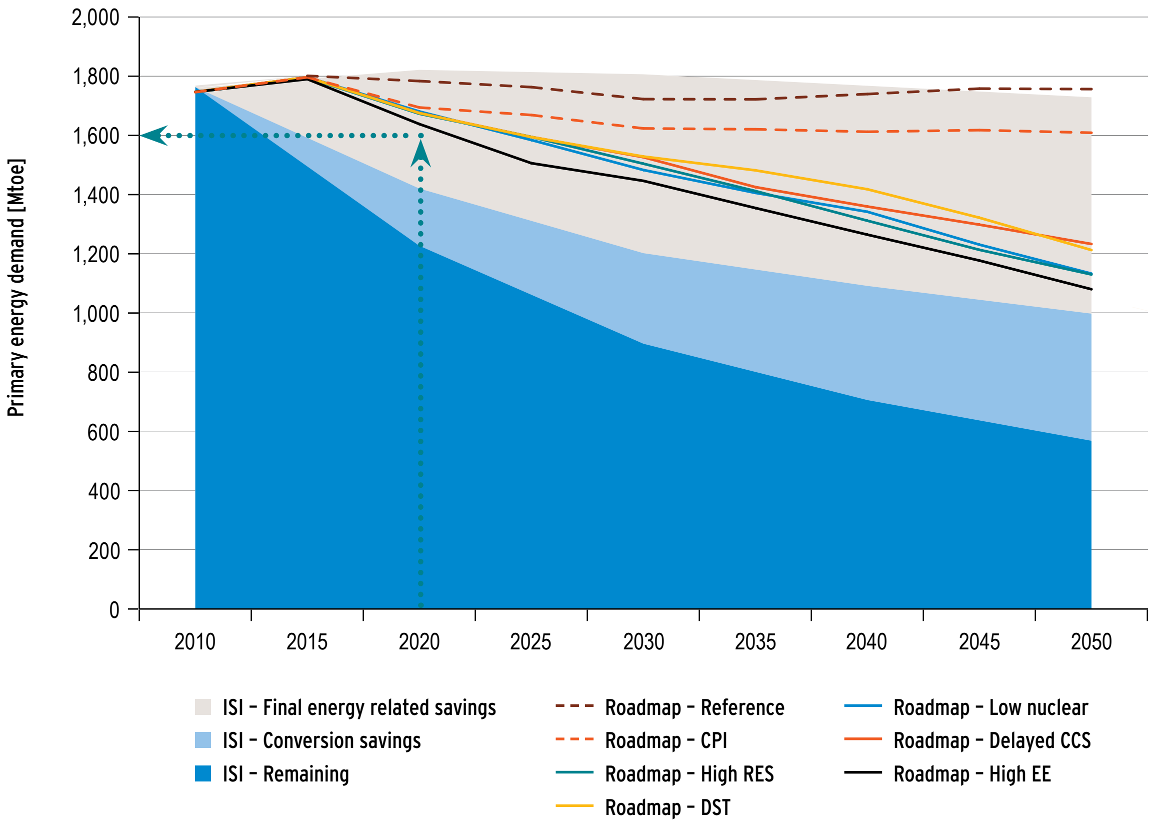
Source: Fraunhofer ISI, [European Commission, 2011d]

In 2050, the majority of the Energy Roadmap scenarios exploit on average about 62 percent of the overall saving potential identified within the framework of this study (cf. section 5.1). The highest potential of 72 percent is exploited in the efficiency scenario (in the figures termed as "High EE"). Figure 22 takes a more detailed look at the sectoral energy demand trajectories. This shows an above average utilisation of the efficiency options identified in the tertiary and the transport sectors (67 percent and 82 percent, respectively). Apart from the high efficiency scenario, no scenario is able to tap even half of the potential identified in the household and in the industry sector.

One of the two reasons that might explain the rather limited use of energy efficiency options in the Energy Roadmap scenarios is the assumption of relatively high discount rates of 12.0 percent and 17.5 percent for industry/tertiary and private households, respectively. These rates were designed in such a way in order to consider non-economic barriers (e.g. risk aversion). At the same time they lead to theoretical costs for the implementation of efficiency technologies that make them non-profitable despite proven cost-efficiency. The assumption of stagnating or even declining energy carrier prices (cf. also the text box above) represents the second potential reason. Lower energy prices result in a reduced profitability of investments in efficiency technologies, since reduced energy cost savings become insufficient to entirely cover the investment costs.

With regard to primary energy demand, Figure 23 shows that none of the Energy Roadmap scenarios meets a level of primary energy demand (i.e. 1,602 Mtoe) compatible with the 20 percent reduction target formulated in the European Commission's Energy 2020 strategy [European Commission, 2010a]. The efficiency scenario achieves an 18 percent reduction. The overall primary energy saving potential as identified in this study, however, is considerably higher than the target. Instead of the targeted 20 percent, a 40 percent demand reduction is achievable by 2020, compared to the baseline of the year 2007 which was used for the target definition.

Figure 23: Primary energy saving potentials compared to the energy demand trajectories of the Energy Roadmap scenarios



Source: Fraunhofer ISI, [European Commission, 2011d]

Moreover, the primary energy trajectories of the Energy Roadmap scenarios could be realised by applying only the saving options related to final energy (cf. Figure 23 where the energy demand trajectories of all Energy Roadmap scenarios are located within the light orange area depicting the primary energy saving potentials related to final energy). Only between 47 percent and 58 percent of the overall primary energy saving potentials identified within this study (cf. 5.3) are exploited in the Energy Roadmap scenarios.

None **of the EU Energy Roadmap 2050 scenarios meets the 20 percent energy efficiency target by 2020 despite a saving potential of 40 percent compared to the respective reference.**

Apart from the limited use of final energy related saving options the restricted exploitation of the primary energy saving potential has another reason: the mean efficiency of the conversion of primary into final energy is steadily increasing in all scenarios until the year 2030 due to the expansion of renewable energy capacities and the installation of high efficiency energy conversion technologies. However, in the subsequent years the trend reverses and the conversion efficiency deteriorates as a consequence of an increased electrification of the energy sector, the installation of low-efficient CCS or nuclear power plants and a more frequent part-load operation of conventional power plants as well as increasing energy conversion losses in energy storage devices due to the growing share of electricity generation through intermittent renewable energy sources.

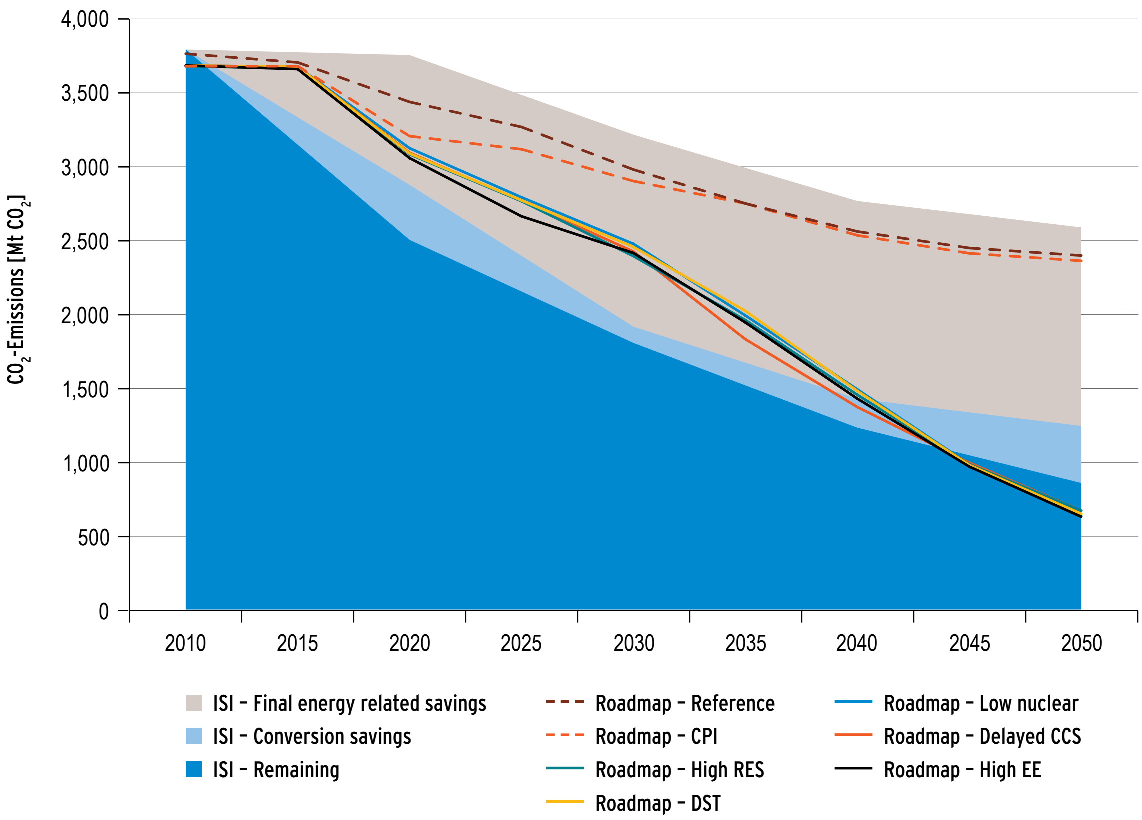
By 2050, the primary energy demand reduction in the efficiency scenario is not significantly higher than in the high renewables and the low nuclear scenarios (38 percent vs. 36 percent and 35 percent compared to the baseline trajectory). This underlines the limited contribution of final energy related efficiency measures in the Energy Roadmap to primary energy demand reduction (as in the efficiency scenario) which can be equally realized through a highly efficient[12] electricity supply system (as in the high renewables scenario).

One should note the fact that the complementary use of highly-efficient electricity generation with final energy related efficiency technologies is the most

Roof modernisation

12 The contribution of renewable energy carriers to primary energy demand reduction is based on the fact that most renewable energy carriers, especially wind and solar electricity (apart from biogenic energy sources) are calculated with a conversion efficiency of 100 percent. Further information on the influence of renewable energy sources on reducing primary energy demand is also included in section 3.

Figure 24: CO_2 emission reduction potentials compared to the emission trajectories of the Energy Roadmap scenarios



Source: Fraunhofer ISI, [European Commission, 2011d]

promising option to reduce primary energy demand, ensuring both security of supply and a smaller external fuel bill. Moreover, applying efficiency measures related to final energy use helps to lower energy demand and hence raises the share of decarbonised energy conversion technologies. This makes it easier to meet specific targets such as the 20 percent renewable energy target (which aims at a 20 percent share of renewables in final energy demand in 2020 [European Commission, 2010a]).

Despite the fact that this study aims for assessing the technical energy saving potentials and not the GHG emission reduction, it is worth noting that only the shift towards a highly-efficient electricity supply system together with maximum use of efficiency technologies related to final energy may potentially reduce the energy-related GHG emissions by 79 percent compared to the 1990 level (depicted as dark and light orange areas in Figure 24; see also section 5.4). Given the 85 percent CO_2 emission reduction[13] of the Energy Roadmap decarbonisation scenarios, it can be concluded that efficiency improvements deliver substantial contributions to meet these targets. Further emission reduction can be triggered, for example, by the decarbonisation of the transport sector due to a shift towards alternative drive concepts.

13 The Energy Roadmap only reports CO_2 emissions and not GHG emissions. Given the fact that CO_2 represents 99 percent of all energy related emissions in the European Union, CO_2 and GHG emissions are directly compared within the present analysis [UNFCCC, 2011].

6 Conclusions

The main insights gained in this analysis can be summarised in three key messages:

Huge saving potentials – but one saving option is not just like another

The overall conclusion that can be drawn from the analysis carried out is very simple: there are huge energy saving potentials available: final energy demand could be reduced by 57 percent compared to the baseline development by 2050. Nevertheless, it is worth noting that some saving options trigger extremely high energy demand reduction (such as building-related efficiency improvements in the household and tertiary sector), whereas others create particularly high monetary benefits, e.g. where expensive final energy carriers are used such as electricity and petroleum products (e.g. technical improvements in the transport sector or optimising efficiency in electrically powered industry systems). Assuming that all the saving options identified within this study were implemented, annual energy cost savings of approximately 500 billion €'05 could be realised in the year 2050.

Exploiting the saving potential requires concrete political action addressing specific energy demand branches.

Renewables and efficiency – together more effective than each alone

The concept of efficiency not only concerns the use of final energy carriers to provide energy services, but also the conversion of primary energy into final energy. Efficient energy conversion can likewise make a large contribution to the reduction of primary energy demand as final energy related efficiency measures. Given the fact that 100 percent conversion efficiency is assumed for all renewable energy carriers (apart from biogenic sources), they have a significant impact not only on the reduction of primary energy demand but also on lowering GHG emissions. By 2050, 25 percent of the projected primary energy demand can be reduced via the shift towards a highly efficient power sector, and an additional 42 percent results from final energy related efficiency measures. This can be translated into a direct increase in security of supply as well as a significant decrease of Europe's external fuel bill, thus enhancing Europe's competitiveness in the global economy. GHG emissions can be reduced by 15 percent via conversion savings and by an additional 52 percent on top of this due to final energy efficiency improvements compared to the baseline value of the year 2050. This is equivalent to a 79 percent emission reduction compared to 1990, underlining the crucial role of energy efficiency and renewables.

It therefore seems to be most profitable to pursue a combined strategy of expanding renewable capacities as well as pushing efficiency measures.

Efficiency – the stepchild of current energy policy and energy research

When presenting its draft Energy Efficiency Directive in June 2011 [European Commission, 2011e], the European Commission stated that current measures at EU and national levels would only lead to an energy demand reduction of 9 percent and not the envisaged 20 percent stated in the Energy Strategy 2020 [European Commission, 2010a]. This underlines the fact that up to now the topic of efficiency has been underrepresented on the political agenda despite the cost-effectiveness of most of the technologies involved whose implementation is often hindered due to their up-front investment costs. The study comparison also revealed that various scenarios published recently do not take energy efficiency options properly into account as a technology option for carbon mitigation. In addition, the level of detail regarding the deployment of efficiency measures is far below the accuracy applied to the analysis of the energy supply side, particularly the power sector. A good example is the recently published EU Energy Roadmap 2050 which focuses mainly on the application of carbon-neutral electricity generation technologies and in which energy efficiency plays only a minor part: none of the scenarios analysed meets the 20 percent efficiency target mentioned above. Moreover, all the available information on the demand side is highly aggregated which prevents a more detailed analysis of the concrete technologies and policies assumed.

Hence, energy efficiency needs to be given a higher priority on both the political as well as the scientific agendas.

New energy era in the Lausitz: wind turbines at a former mining site

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