Coalition for Energy Savings

2030 EU energy efficiency target: The multiple benefits of higher ambition

cambridge econometrics
clarity from complexity

Final Report

November 2022

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Executive Summary

Well-designed energy efficiency policies can result in significant environmental, economic, social and health benefits.

This study aims at further informing the Coalition for Energy Savings' analysis and input to the Energy Efficiency Directive (EED) trilogues. The study provides estimates of the multiple benefits of energy savings for the European citizens and the economy that are associated with different levels of the 2030 EU energy efficiency target. The study models three scenarios, which are the ones that will be discussed during the trilogue negotiations: an energy efficiency target of at least 9% (Minimum Efficiency), 13% (REPowerEU Efficiency) and 14.5% (Enhanced Efficiency), respectively (compared to PRIMES Reference Scenario 2020). **The modelling focused on the following key aspects: GDP and jobs impact, dependence on fossil fuel imports, distributional impacts (captured by the share of household expenditure spent on energy and transport); key GHG emissions and air pollution damages.**

The analysis shows that the greatest impacts are associated with the Enhanced Efficiency scenario, which is characterised by more ambitious efficiency targets and higher investments in energy efficiency goods and services.

The analysis identifies two major trends in the distribution of impacts across different groups;

- **The reduction in energy bills is expected to be more impactful for lower-income groups**, as they currently spend a greater proportion of their income on energy and transport – and as such, the modelled savings are a greater proportion of their overall household expenditure.
- There are winners and losers in the transition; for example, the mining sector is expected to face job losses as demand for fossil fuels falls. However, these will be more than offset by increased investment and resultant employment in other sectors producing energy efficiency products and services (such as construction or manufacturing). **A key finding is that the overall impact on employment will be positive at the EU level.**

The results suggest that more ambitious energy efficiency targets deliver greater benefits to European citizens. Higher energy efficiency targets are expected to lead to improved energy security (through decreasing fossil fuel imports), higher GDP, decreasing household energy and transport expenditure, and contribute to overall climate goals through mitigating emissions.

1 Introduction

1.1 Background

In this research, we contribute to the debate around the energy efficiency target in the EU by building on the findings of the Impact Assessment accompanying the European Commission's (EC) proposal for the Energy Efficiency Directive (EED)[1], and the findings of a recent report by COMBI[2].

The EC assessment finds that there is significant energy savings potential in the EU, while the work done by COMBI attempts to calculate and operationalise the multiple benefits of energy efficiency in Europe.

To further inform the Coalition for Energy Savings' analysis and input to the EED trilogues we provide estimates of different benefits of energy savings for the European citizens and the economy that are associated with different levels of the 2030 EU energy efficiency target. The three modelled scenarios are those that will be discussed during the trilogue negotiations: an energy efficiency improvement target of at least 9% (Minimum Efficiency), 13% (REPowerEU Efficiency) and 14.5% (Enhanced Efficiency) respectively (compared to PRIMES Reference Scenario 2020).

For completeness, multiple benefit estimates are reported together with other key impact and cost indicators, such as the investment costs needed to achieve the required savings, or the distributional impacts resulting from the increased targets.

Well-designed energy efficiency policies can result in significant environmental, economic, social and health benefits. This research focuses on the following key aspects: GDP impacts; jobs impact; dependence on fossil fuel imports; sectoral investments; net benefits for energy bills; distributional impacts (captured by the share of household expenditure on energy and transport); firms' energy expenditure; CO_2 and GHG emissions; air pollution damages.

1.2 Report structure

The remainder of the report is structured as follows:

- **Chapter 2** presents our approach and the modelling assumptions applied for the analysis.
- **Chapter 3** presents the key findings from the research, including headline results, and presenting economic impacts, societal impacts as well as environmental impacts in more detail.
- **Chapter 4** concludes with a summary of key findings, highlighting key equity considerations in delivering the energy efficiency benefits.

[1] Proposal for a Directive of the European Parliament and of the Council on energy efficiency (recast)
[2] combi-project.eu

2 Approach and modelling assumptions

2.1 Our approach

The modelling for this research is done using the E3ME macro-econometric model developed by Cambridge Econometrics and is complemented by available literature, where necessary.

2.2 Modelling assumptions

The E3ME baseline

The E3ME energy trends are updated to match the PRIMES Reference Scenario 2020[3]. The following energy variables are aligned:

1. **Final energy demand** by energy carrier, fuel user and Member State. For each Member State the final energy demand by different fuel types and users was updated to match PRIMES trends to 2030.
2. **Power sector capacity**. For each Member State power sector electricity generating capacity by different technologies (e.g. nuclear, solar etc.) are set to match PRIMES trends to 2030.
3. **CO_2 emissions**. Energy-related CO_2 by sector and Member State are set to match PRIMES trends.
4. **EU-ETS prices** and **sector coverage** as well as current assumptions about auctioning / grandfathering.

For the commodity prices for fossil fuels, trends from the *Non paper on complementary economic modelling undertaken by DG ENER analysing the impacts of overall energy efficiency target of 13% to 19% in the context of discussions in the European Parliament on the revision of the Energy Efficiency Directive*[4] are used. The fossil fuel prices from this paper reflect the projected impacts on energy prices of the war in Ukraine at the time the non-paper was written (June 2022), which are significantly higher compared to the fuel price trajectories proposed in the Fit-for-55 package (especially for natural gas) - further details on the prices used can be found in the non-paper. These prices are held the same across the baseline and all scenarios – so we are assuming that changing energy demand in Europe (and therefore changing also demand for fossil fuels) does not have any impact on the prices of globally-traded fuels.

Scenario assumptions

While it is considered that renewable energy and energy efficiency are mutually supportive and additional synergies are expected when both renewable energy and energy efficiency targeted measures are implemented, the modelled scenarios are setting the benefits of energy efficiency "in isolation" from other impacts. Therefore, the share of electricity met by renewables is kept unchanged across the scenarios. Nevertheless, it is very

[3] As proposed by the European Commission in July 2021, although the most recent proposal from the European Parliament is to revert to a target compared to the PRIMES 2007 Reference Scenario.
[4] https://energy.ec.europa.eu/system/files/2022-06/2022_06_20%20EED%20non-paper%20additional%20modelling.pdf

likely that a scenario that maximize both is the one that would deliver higher overall benefits for the society.

The following scenarios are modelled to assess the benefits of energy efficiency (EE):

1. A **Minimum Efficiency scenario**, based on the initial EED recast proposal of July 2021, leading to an EE target of at least 9% (compared to PRIMES Reference Scenario 2020)
2. A **REPowerEU Efficiency scenario**, based on an EE target of at least 13%[5] (compared to the projections of PRIMES Reference Scenario 2020)
3. An **Enhanced Efficiency scenario**, based on an EE target of at least 14.5% as voted by the European Parliament[6] (compared to the projections of PRIMES Reference Scenario 2020).

The reason for the selection of these scenarios to be modelled is that they are the ones that will be discussed during the trilogue negotiations. It is key to note that the 14.5% target, the highest target across the here-modelled scenarios, does not represent the most ambitious target possible, it is rather the highest figure that is being considered by co-legislators in the interinstitutional negotiations which, in fact, is a moderate ambition compared to figures modelled in other studies recently. The cost-effective energy savings potential for 2030 is found to be much higher in recent research[7], given the current increase of energy prices, and is estimated to reach -19% if wholesale energy prices increase by 30% by 2030, and as much as -23% if wholesale energy prices double by 2030.

The main assumptions across all the three scenarios are the energy savings resulting from energy efficiency measures, the sectors they occur in, and the investment requirement to achieve the savings and how this investment is financed.

Across all the scenarios, the focus is on the "*what if* these are achieved", rather than "*how* are these achieved", so the applied modelling approach is not looking at the impact of any specific policy (including any changes to the ETS price) but at the impacts of higher energy efficiency targets being achieved. Accordingly, we assume no changes to technology mixes in the power generation sector compared to those used in the PRIMES 2020 Reference scenario (assuming a 33.2% share of renewables in Gross Final

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[5] Based on the European Commission's proposal to increase the 2030 energy efficiency target as introduced by REPowerEU in May 2022.

[6] As supported by the European Parliament in the EED plenary vote of September 2022. The Parliament however, expresses the 2030 EU energy efficiency target in comparison to the PRIMES 2007: "at least 40 % in 2030 in final energy consumption and 42.5 % in primary energy consumption compared to the projections of the 2007 Reference Scenario", which is equivalent to 14.5% compared to the PRIMES 2020 baseline.

[7] Fraunhofer ISI – Stefan Scheuer Consulting (2022) Assessing the impact of high energy prices on the economic potentials for energy savings in the EU. Available at: http://www.stefanscheuer.eu/wp-content/uploads/2022/04/20220419-FraunhoferISI_Scheuer_Report_EE_Potentials_HighEnergyPrices_final.pdf

Energy Consumption in 2030[8]), as any changes here would make isolating the macroeconomic and sectoral impacts of energy efficiency more difficult. Instead, we assume that generation scales down proportionally across all technologies, and investments in new capacity are reduced accordingly.

Across all the scenarios, benefits have been calculated on the basis of final energy consumption.

Assumptions for the Minimum Efficiency scenario

The reduction of energy use by 9% (compared to PRIMES 2020 Reference) is assumed to be in line with the PRIMES MIX policy scenario, with the distribution of the savings by Member State and energy user set to match this policy scenario.

Primary energy consumption corresponding to this scenario is 1023 Million tonnes of oil equivalent (Mtoe), while final energy consumption is 787 Mtoe as per the Commission`s proposal on the EED recast[9].

The investment requirement is consistent with the direct energy efficiency costs assumed in the modelling for the MIX scenario as outlined in the Climate Target Plan - Impact Assessment (SWD/2020/176 final), and allocated to Member States and energy users based on their energy efficiency efforts. The costs of measures are assumed to be borne by the energy users doing the investment (i.e. households pay the up-front costs for their energy efficiency measures, while firms pay for the costs of measures which affect their own energy use).

Assumptions for the REPowerEU Efficiency scenario

The reduction of energy use by 13% (compared to PRIMES 2020 Reference) is assumed to follow a similar distribution pattern (by Member State and fuel user) as in the Minimum Efficiency scenario.

Primary energy consumption corresponding to this scenario is 980 Mtoe, while final energy consumption is 750 Mtoe as per RePowerEU[10].

The investment requirement is calculated using a coefficient for energy saved per million euros based on inputs from the Minimum Efficiency scenario. This coefficient is then applied to the more ambitious energy savings level. It is to be noted that the assumption of a constant coefficient is a conservative approach, in that it probably underestimates the total investment requirement (as in reality, the EE investment options with higher returns and lower costs are likely to be picked first; although mitigating this, the investment requirements would also decrease over time driven by economies of scale).

As in the Minimum Efficiency scenario, the allocation to Member States and energy users is done based on the level of effort in implementing reduction in energy use. The financing is the same as in the Minimum Efficiency scenario.

[8] https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en
[9] https://eur-lex.europa.eu/resource.html?uri=cellar:a214c850-e574-11eb-a1a5-01aa75ed71a1.0001.02/DOC_1&format=PDF
[10] https://www.europarl.europa.eu/legislative-train/carriage/repower-eu-plan-legislative-proposals/report?sid=6201

Assumptions for the Enhanced Efficiency scenario

The reduction of energy use by 14.5% compared to PRIMES 2020 is assumed to follow a similar distribution pattern (by Member State and fuel user) as in the Minimum Efficiency scenario.

Primary energy consumption corresponding to this scenario is 960 Mtoe, with final energy consumption of 740 Mtoe.

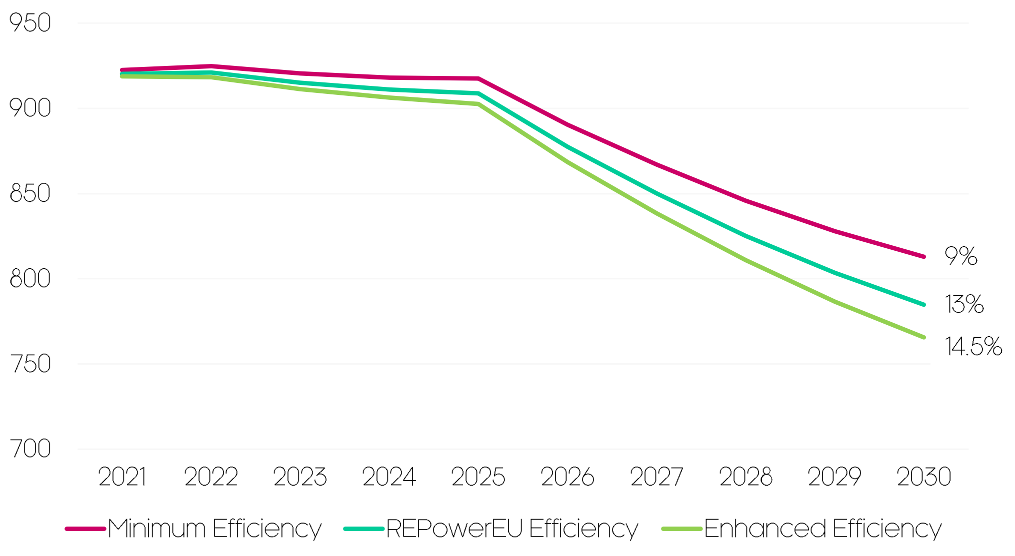
The investment requirement is calculated using a coefficient for energy saved per million euros based on inputs from the Minimum Efficiency scenario. This coefficient is then applied to the more ambitious energy savings level. It is to be noted that the assumption of a constant coefficient is a conservative approach, in that it probably underestimates the total investment requirement (as in reality, the EE investment options with higher returns and lower costs are likely to be picked first; although mitigating this, the investment requirements would also decrease over time driven by economies of scale).

As in the Minimum Efficiency scenario, the allocation to Member States and energy users is done based on the level of effort in implementing energy efficiency savings. The financing is the same as in the Minimum Efficiency scenario.

Assumptions on energy demand reduction

The figure below shows the underlying assumption made with regards to final energy demand in the EU[11], resulting from energy efficiency measures. Baseline energy prices in the modelling were aligned with the European Commission's recent modelling[12]. These assumptions were used to design the three scenarios.

Figure 2.1 EU27 overall final energy demand, Mtoe



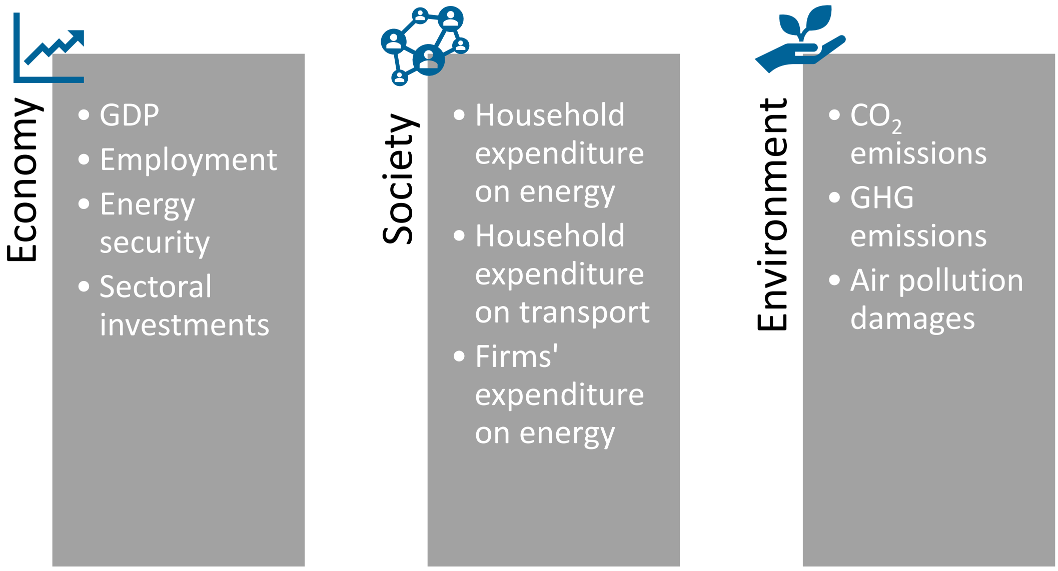
[11] Total final energy demand presented here also includes non-energy use, which is not affected by the energy demand reduction target in the modelling.

[12] https://energy.ec.europa.eu/system/files/2022-06/2022_06_20%20EED%20non-paper%20additional%20modelling.pdf

Energy efficiency benefits considered

The below figure presents the various benefits of energy efficiency that are assessed in this research. Most of these benefits were estimated within the E3ME macroeconomic model. However, due to limitations in the scope of the modelling, the assessment of some of these benefits required further processing of the E3ME results and off-model calculations. When this is the case, details on the off-model estimations are provided in Chapter 3 for the relevant benefits.

Figure 2.2 Summary of multiple benefits of energy efficiency quantified in this study



To facilitate the use of our results in future studies, we also estimated coefficients linking the reduction in energy consumption (in Mtoe) to each of the benefits this delivers. Coefficients are calculated in the following way: first, a coefficient for each benefit is estimated for every scenario by dividing the E3ME results for 2030 by the reduction of energy demand in 2030 for the given scenario. These ratios were then averaged across scenarios to derive unique coefficients. These coefficients are useful for adapting the quantification of benefits depending on the absolute energy consumption equivalent of each 2030 energy efficiency target level proposed.

A major limitation of this approach is that it assumes a linear correlation between the amount of energy consumption saved and the multiple benefits regardless of the level of the target (i.e. there are no tipping points where benefits increase/decrease after a certain amount of energy saved). While this is very unlikely to hold indefinitely (i.e. the first Mtoe saved is likely to have larger benefits than the last), by anchoring our modelling around the latest Commission proposal, we estimated a pro-rata value which is approximately correct for incrementally less or more challenging energy efficiency targets than the ones assessed in this study. Nevertheless, the E3ME modelling, which allows a more dynamic estimation of the correlation between energy saving and the benefits it delivers, provides a more accurate representation of the benefits, while the coefficients provide an approximate information of the average impact of the multiple benefits.

3 Key findings

This chapter presents deeper dives into the different multiple benefits of energy efficiency. For clarity, benefits are presented in both absolute terms and as a percentage difference from the baseline scenario. First, economic impacts are discussed, followed by societal impacts and finally, environmental impacts of the scenarios are presented.

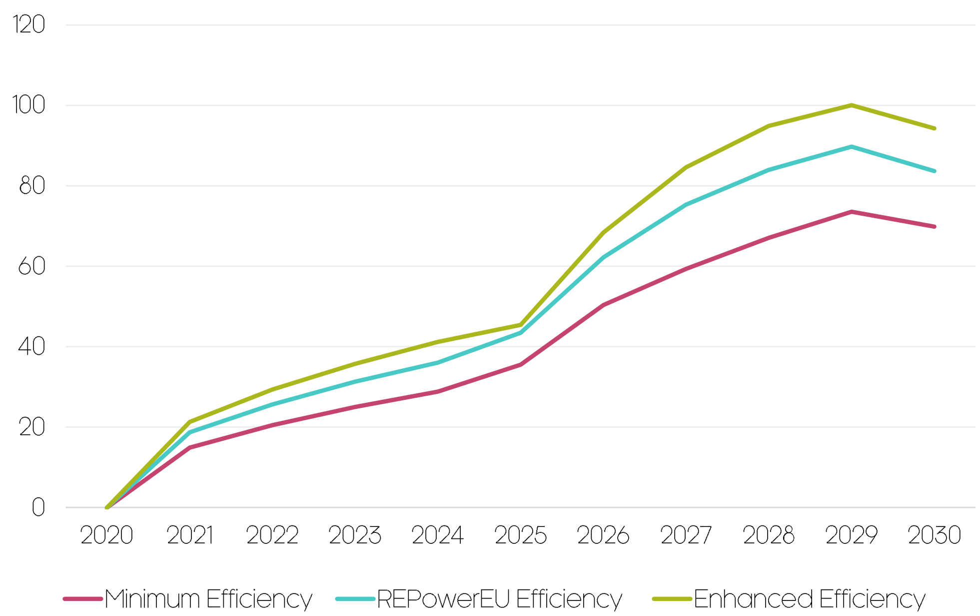
Detailed modelling results can be found in Annex 1 – Summary tables.

3.1 Economic impacts

Overall economic activity

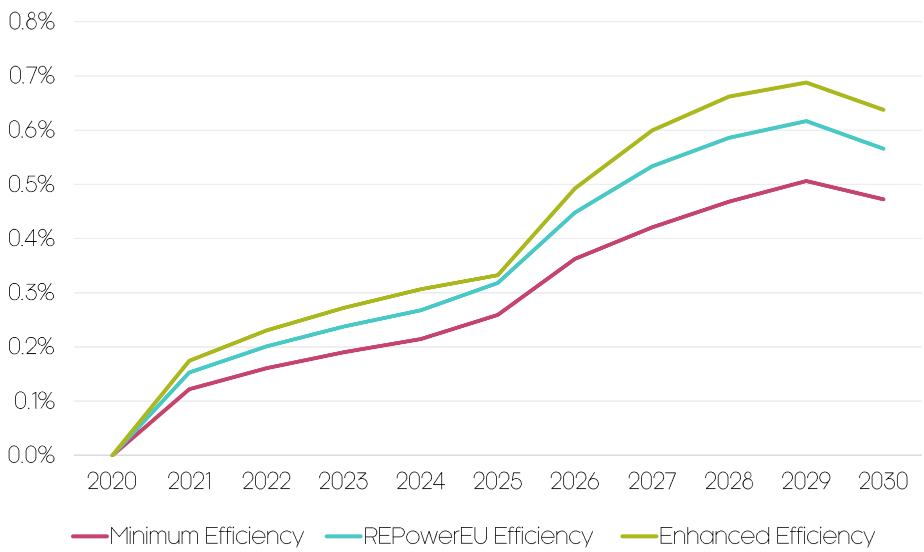
The introduction of energy efficiency measures in the European Union is expected to have a positive impact on the overall economic activity (on key indicators, such as GDP, employment and investments) in the next decade in all the three scenarios. While this study considers impacts across the EU as a whole, the resulting impacts will be different from one member state to another. The projected impacts on Gross Domestic Product (GDP) over time for the EU27 are shown in Figure 3.1 and Figure 3.2. Over the period to 2030, the impacts on GDP growth are in line with the increasing level of cumulative energy efficiency, reflecting the scale of investments needed to achieve more ambitious energy efficiency targets. Changes in the shape of the curve (of the GDP trajectory) in 2025 and in the last year (2030) are explained largely by the profile of investment assumed in the modelling which is consistent with the Commissions MIX scenario. The largest impacts on GDP are achieved by the REPowerEU Efficiency and Enhanced Efficiency scenarios. Specific quantitative impacts, both in absolute terms and compared to the baseline, are laid out in Annex 1 – Summary tables.

Figure 3.1 EU27 Gross Domestic Product (GDP), difference from the baseline, 2010 EUR billions



The Enhanced Efficiency scenario leads to the largest positive effect on GDP, namely an increase of just above 0.3% in 2025 and 0.6% in 2030, compared to the baseline levels. The Minimum Efficiency and REPowerEU Efficiency scenarios lead to GDP being between roughly 0.2% and 0.3% higher in 2025 and between around 0.4% and 0.5% higher in 2030, compared to the baseline. Overall, the positive economic impacts are driven by higher level of investments designated to achieve efficiency targets.

Figure 3.2 EU27 Gross Domestic Product (GDP), % change from the baseline



Employment impacts

Similarly, employment is positively affected by the introduction of energy efficiency measures. The employment impacts are shown in Figure 3.3 and Figure 3.4. All the three scenarios demonstrate positive impacts on employment, due to higher levels of production in the economy (i.e., higher levels of GDP) and a shift in production towards labour intensive sectors (i.e., construction, engineering, manufacturing). This is mainly due to the fact that the achievement of efficiency targets requires substantial investments in the sectors producing energy efficiency goods and services, namely construction, engineering and manufacturing, which are characterised by being more labour intensive (it is to be noted that there are current issues which are expected to persist and which might dampen this effect, as the construction sector across Europe is currently experiencing problems in resourcing materials and labour, which could last years into the future). The investments in these sectors ultimately lead to a boost in their production and the creation of new jobs to meet higher production levels. Moreover, there are positive 'multiplier effects' from higher consumer expenditure, largely driven by increased aggregate wages in the economy, resulting from the higher employment primarily in construction, engineering and manufacturing sectors. This leads to further job creation in the wider economy.

The increase in employment across the scenarios is broadly in line with the increase in ambition of the energy efficiency target; the greatest impact on jobs is associated with the Enhanced Efficiency scenario, which by 2030 leads to around a 0.4% increase in economy-wide employment compared to the baseline.

Figure 3.3 EU27 Employment impacts, difference from the baseline, thd

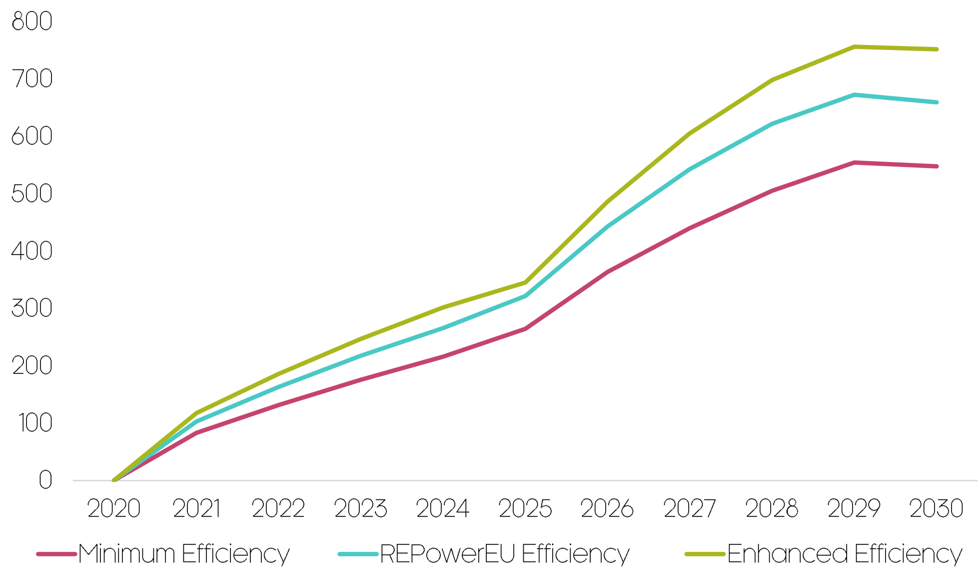
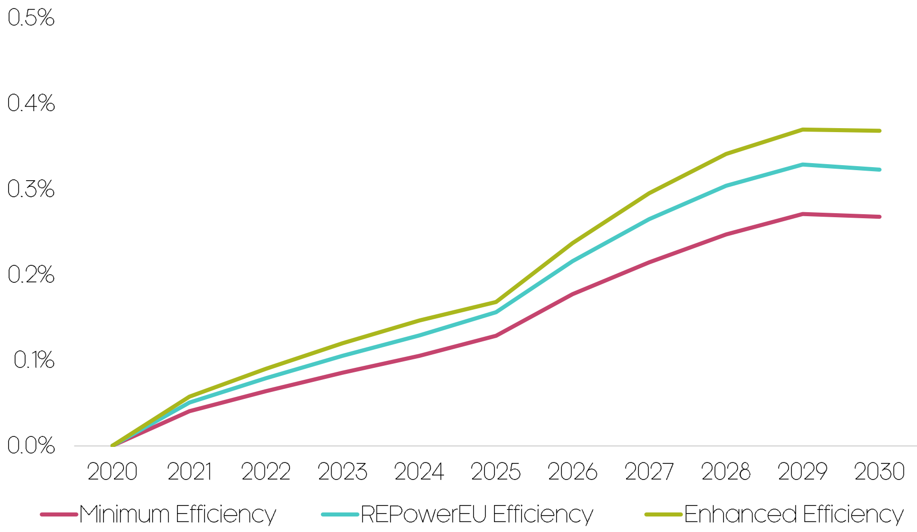


Figure 3.4 EU27 Employment impacts, % difference from the baseline



Energy efficiency measures lead to lower demand for all fuels, and ultimately reduce the need for fossil fuels extraction. Therefore, the introduction of energy saving measures leads to a substantial reduction in employment in the mining and fossil fuel extraction sector ranging from 9.6% in the Minimum Efficiency scenario to 11% in the Enhanced Efficiency scenario, compared to the baseline (Figure 3.6).

However, the negative impacts in the mining sector are offset by higher employment in all other sectors, which benefit from investments in energy efficiency improvements (directly and/or indirectly through supply chains) and from enhanced economic activity (i.e. through the induced higher spending across the economy as a whole). The largest increase in employment is associated with the sectors producing energy efficiency goods and services (i.e., construction and manufacturing, utilities), which receive substantial investments between 2022 and 2030. For instance, the construction sector, which is heavily involved in the retrofitting and insulation of buildings, is characterised by an increase in employment ranging between 1.1% in the Minimum Efficiency scenario and 1.4% in the Enhanced Efficiency scenario (Figure 3.6), compared to the baseline by 2030. In the same year, the utility sector sees an increase in employment ranging from 0.4% in the Minimum Efficiency scenario and 0.6% in the Enhanced Efficiency scenario compared to the baseline.

Figure 3.5 EU27 Job impacts by broad sector in 2030, difference from baseline, thd

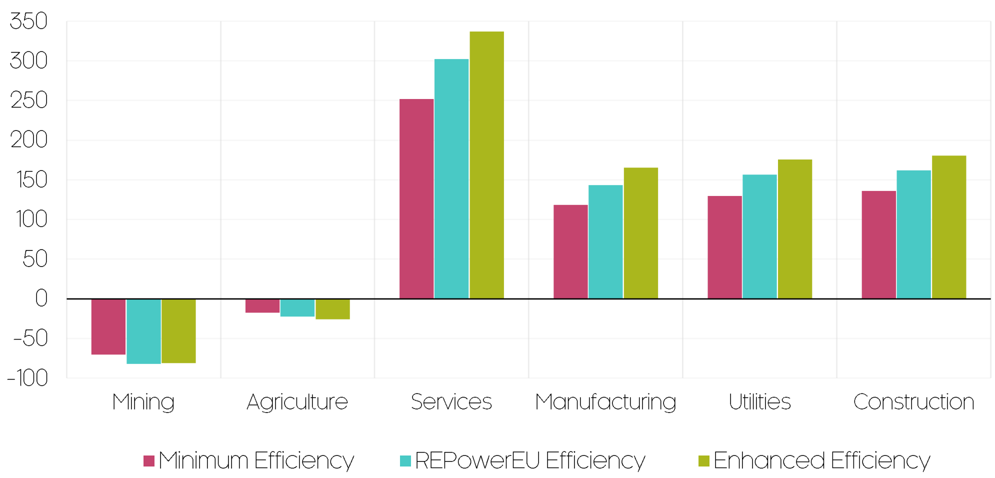
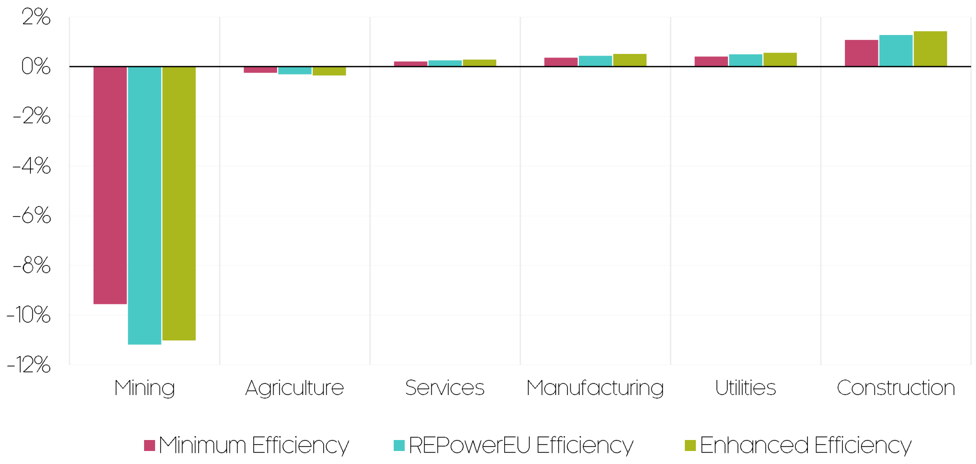


Figure 3.6 EU27 Job impacts by broad sector in 2030, % difference from baseline



Energy imports

The measure of energy security used in this study is the economic value of fossil fuel imports (calculated with the prices assumed in line with the non-paper[13]). Key results for this indicator are shown in Figure 3.7 and Figure 3.8. These results show significant improvements in energy security in all the three

[13] https://energy.ec.europa.eu/system/files/2022-06/2022_06_20%20EED%20non-paper%20additional%20modelling.pdf

scenarios. Enhanced energy security is reflected in lower imports for coal, oil, gas and other manufactured fuels in 2030, which is mainly driven by reduced energy demand. Improvements in energy security ultimately lead to reduced exposure to changes in the supply of, and volatile prices of, supplies from international sources.

The reduction in imports of coal compared to the baseline in 2030 ranges from 12% in the Minimum Efficiency scenario to 13% in the Enhanced Efficiency scenario, while the decrease in imports of oil and gas and manufactured fuels ranges between 8% in the Minimum Efficiency scenario to and 13% in the Enhanced Efficiency scenario. In absolute terms, the difference from the baseline scenario is largest for oil and gas: between 18 and 24 billion euros in the Minimum Efficiency and the Enhanced Efficiency scenario, respectively. In 2030, the aggregated monetary benefit of reducing imports from coal, oil & gas and manufactured fuels (38 billion euros) corresponds to about 40% of the EU spending on energy imports from Russia before the beginning of the war (in 2021 the EU imported 99 billion euros worth of energy from Russia[14]). Overall, the largest impacts on energy security are associated with the Enhanced Efficiency scenario, which is characterised by high efficiency targets and greater reductions in overall energy demand.

The extent of change in coal imports do not vary substantially across the scenarios (compared to the baseline), as a large part of energy savings is done by households and offices, which are major final users of gas and electricity, but not coal to the same extent. There are relatively higher savings in gas, electricity and oil, because those are more widely used by the sectors who achieve the energy savings. Additionally, coal use falls considerably in the baseline too.

Figure 3.7 EU27 Imports by fossil fuels type in 2030, difference from the baseline, 2010 EUR billions

[14] https://www.weforum.org/agenda/2022/03/eu-energy-russia-oil-gas-import/

Figure 3.8 EU27 Imports by fossil fuels type in 2030, % difference from the baseline

Sectoral investments

The introduction of more ambitious energy efficiency targets affects the investments across different sectors of the economy. In particular, the achievement of efficiency targets requires substantial investment in energy efficiency technologies, which contribute to reduce energy demand and ultimately affect the overall profile of investment in energy supply technologies. Figure 3.10 shows that energy efficiency measures in Europe are expected to reduce investments in the mining sector by 2030. This is mainly driven by reduced energy demand resulting from the implementation of energy savings measures.

Overall, the reduction in investments in the mining sector ranges between 5% in the Minimum Efficiency scenario and 6% in the Enhanced Efficiency scenario, compared to the baseline levels. By 2030, the investments in the utility sector are also lower than baseline. In particular, the reduction in investment in the utility sector is greater for the REPowerEU Efficiency and Enhanced Efficiency scenarios, which are characterized by high efficiency targets, hence leading to greater reductions in energy demand, and ultimately in energy investments. At the same time, different utilities will not all be affected in the same way, for example an electricity utility is likely to be less affected than a gas one.

However, the negative impacts on investment in the mining and utility sectors is offset by increased investment in other sectors. This is because, in order to achieve efficiency targets, substantial investments are put forward in the sectors producing energy efficiency goods and services (i.e., construction, manufacturing, services). In addition, as demand increases across the economy (through indirect and induced effects), investment increases in other sectors to facilitate higher levels of output. In particular, the results show that by 2030 investment increases in the construction, manufacturing, and services sectors. Across these sectors the additional investment is between 1% in the Minimum Efficiency scenario and 3% in the Enhanced Efficiency scenario, compared to baseline. It is estimated that the increase in investment need at the EU level by 2030 is between 62 and 86 billion euros in the Minimum Efficiency and in the Enhanced Efficiency scenarios, respectively.

Figure 3.9 EU27 Investments by broad sector in 2030, difference from the baseline, 2010 EUR millions

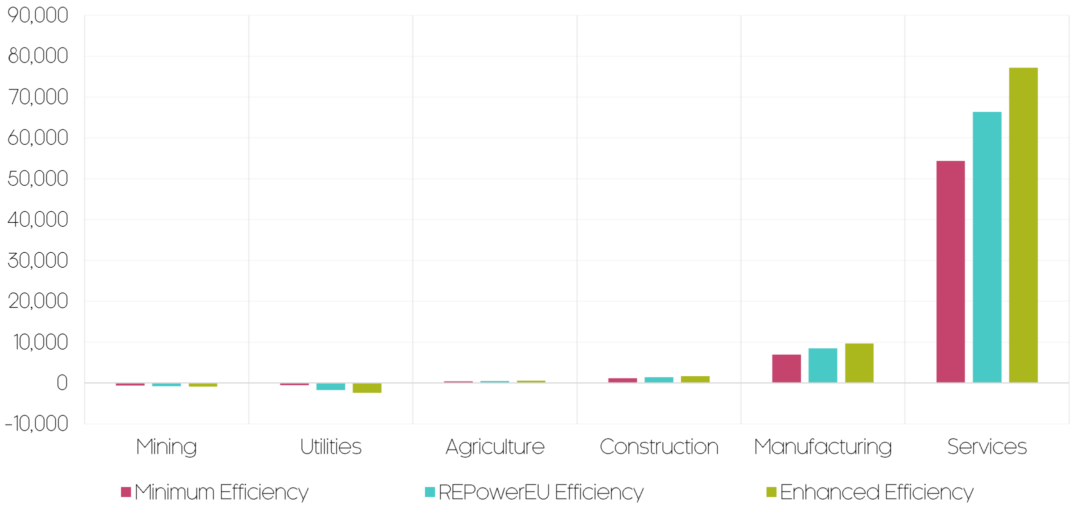


Figure 3.10 EU27 Investments by broad sector in 2030, % difference from the baseline

3.2 Societal impacts

Household expenditure

The modelling show that energy efficiency measures lead to substantial reductions in household expenditure on both energy and transport. This is mainly driven by the shift away from fossil fuel use and a greater deployment of energy efficiency products, both in the building and transport sectors. By 2030, the greatest impact comes from the Enhanced Efficiency scenario, which, compared to the baseline levels, leads to 10% reduction in energy expenditure for consumers and 9% decrease in household spending for transport (see the figures below). Both the percentage and the absolute difference from the baseline are much greater in 2030 than in 2025, driven by the time that it takes for the energy efficiency investments to accumulate and exert greater impact over the energy demand of the economy-wide stock, and an overall increase in spending on energy and transport (on which policies can have a relatively larger impact).

Distributional impacts

The introduction of energy efficiency measures is expected to have varied impacts on different groups across society. Energy bills impose a heavier burden on lower-income groups (specifically, on those in the lowest income quintile, the poorest 20% of households), as they tend to spend a higher proportion of their income on electricity and gas compared to high-income households[15]. Figure 3.12 and Figure 3.11 present how household expenditure on energy and transport are expected to change under the various scenarios (left figures are for energy, right figures are for transport).

Figure 3.11 EU27 Household expenditure on energy and transport in 2025 and 2030, % change from the baseline (energy on left hand side, transport on right hand side)

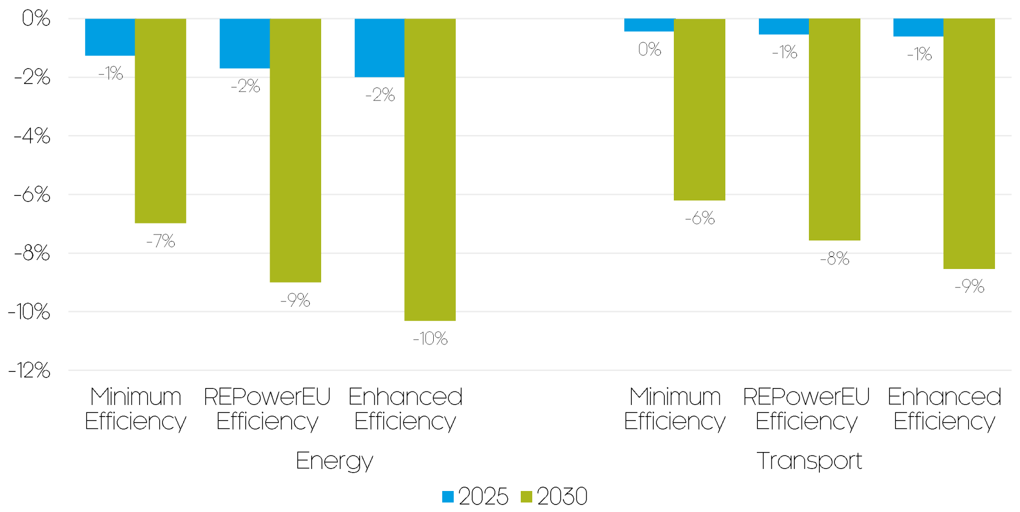
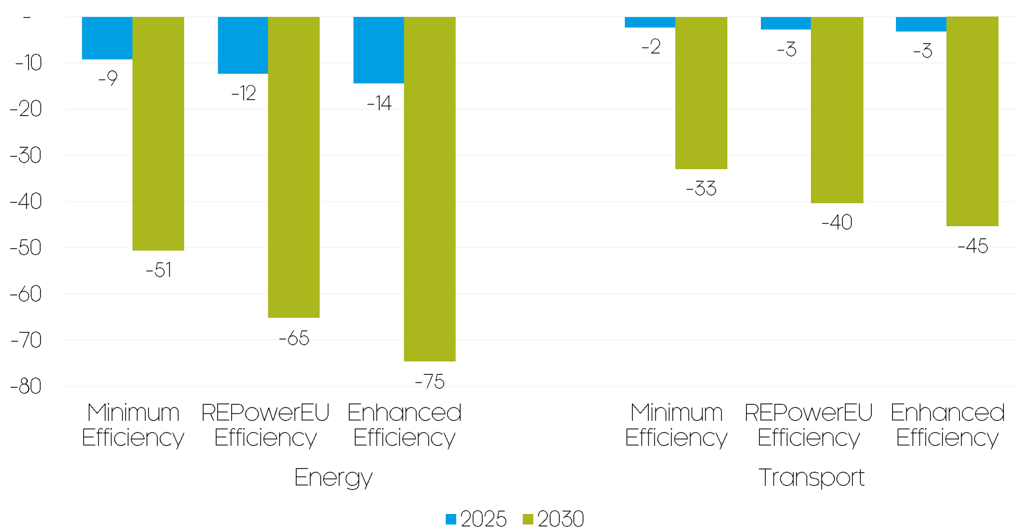


Figure 3.12 Household expenditure on energy and transport in 2025 and 2030, difference from the baseline, 2010 EUR billions (energy on lhs, transport on rhs)



[15] https://blogs.imf.org/2022/08/03/how-europe-can-protect-the-poor-from-surging-energy-prices/

Figure 3.13 shows that in most EU27 countries, the poorest households achieve greater reductions in energy expenditure compared to the richest groups in society as a result of energy efficiency programmes[16].

The same pattern was found in all the three scenarios, although the highest impacts are associated with the Enhanced Efficiency scenario. Although these impacts are small in magnitude, the introduction of energy efficiency measures for the poorest households could lead to the share of overall consumption spent on energy to decrease from 7.2% to 5.9% by 2030, while for the richest households this translated in a reduction from 4.5% to 3.7%. Therefore, energy efficiency policy has a progressive impact on society, since the largest savings are achieved by the low-income groups, which are typically more vulnerable to energy poverty.

[16] This is not the case in a few countries, where the difference between the poorest and richest households are only marginal already in the Baseline (according to Eurostat data), such as Sweden and Finland. The reason for this relates mostly to existing inequalities and distribution of wealth within these countries.

Figure 3.13 Share of overall consumption spent on energy in 2030 by Member State (%), absolute difference from the baseline (%)

Note: *Results are based on Eurostat data on the structure of consumption expenditure by income quintile and COICOP consumption purpose and refer to the share of overall consumption spent on electricity, gas and other fuels, assuming the overal consumption to remain equal. Results for Italy are not included in this chart, due to missing data in the underlying data used for the modelling.*

Firms' expenditure on energy

As a result of efficiency measures, reductions in energy demand are also achieved by firms[17], as well as households. In all three scenarios, firms' expenditure on energy decreases in both 2025 and 2030 (Figure 3.14 and Figure 3.15). Although the differences across scenarios are modest, the greatest savings comes from the Enhanced Efficiency scenario.

Figure 3.14 Expenditure on energy by firms in 2025 and 2030, difference from the baseline, 2010 EUR billions

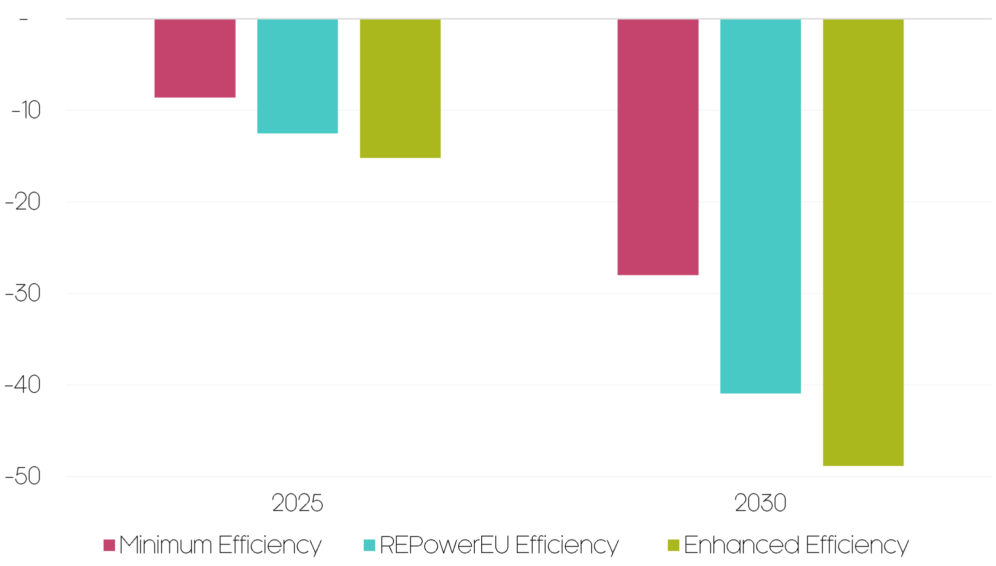
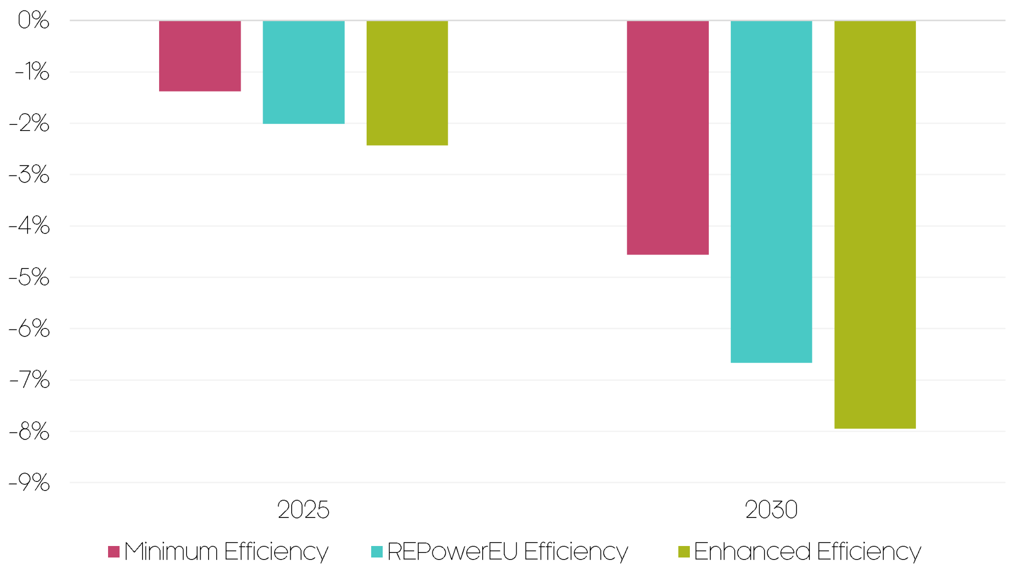


Figure 3.15 Expenditure on energy by firms in 2025 and 2030, % difference from the baseline



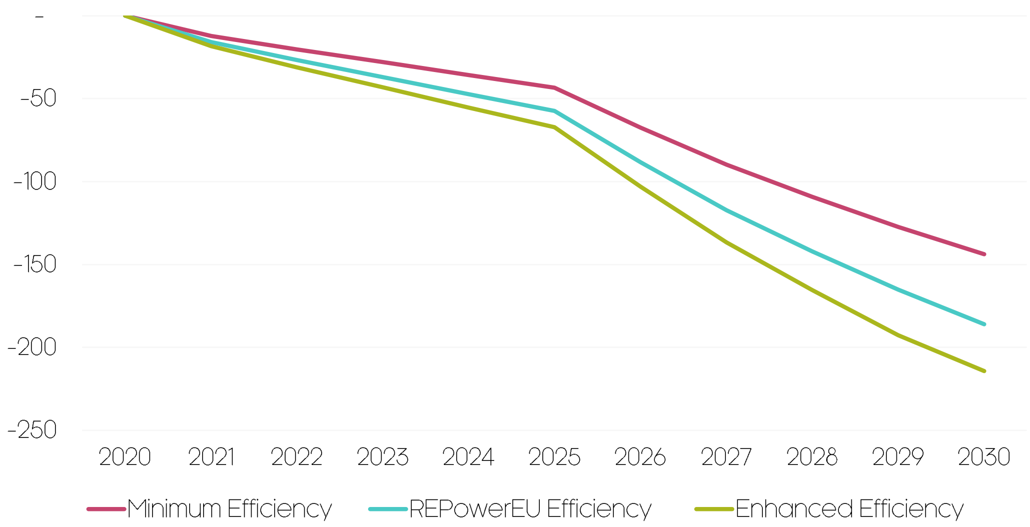
[17] Results represent an economy-wide average across firms.

3.3 Environmental impacts

Emissions

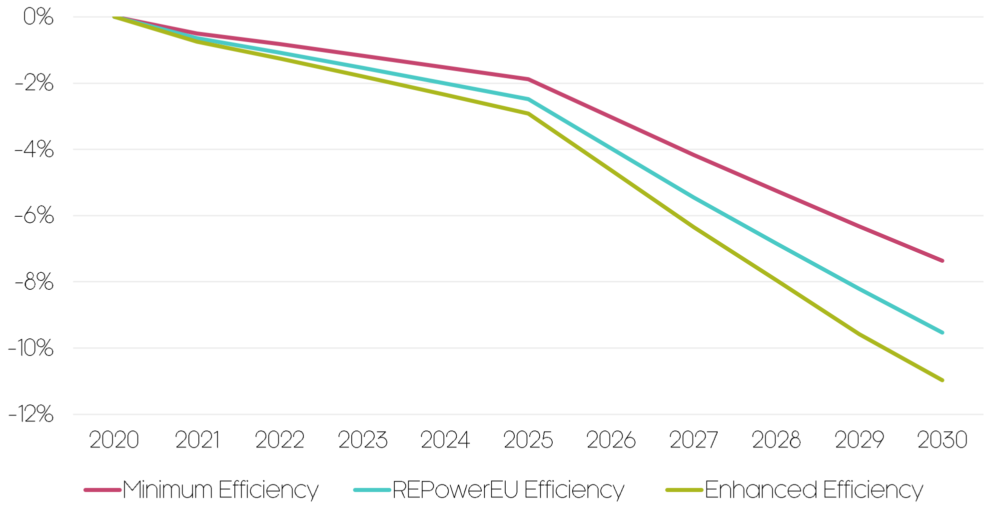
The introduction of energy efficiency measures is expected to reduce energy consumption, and hence reduce CO_2 emissions over time. Figure 3.17 below figure shows that CO_2 emissions decrease between 2020 and 2030 due to the introduction of energy efficiency measures. The modelling suggests that the greatest reduction is associated with the Enhanced Efficiency scenario, which leads to higher energy savings by 2030. In particular, the Enhanced Efficiency scenario shows a 11% reduction in CO_2 emissions by 2030 compared to the baseline, while the Minimum Efficiency and the REPowerEU scenarios achieve reductions in CO_2 emissions of 7% and 10% respectively by 2030, compared to the baseline[18].

Figure 3.16 EU27 CO_2 Emissions, difference from the baseline, MtCO2



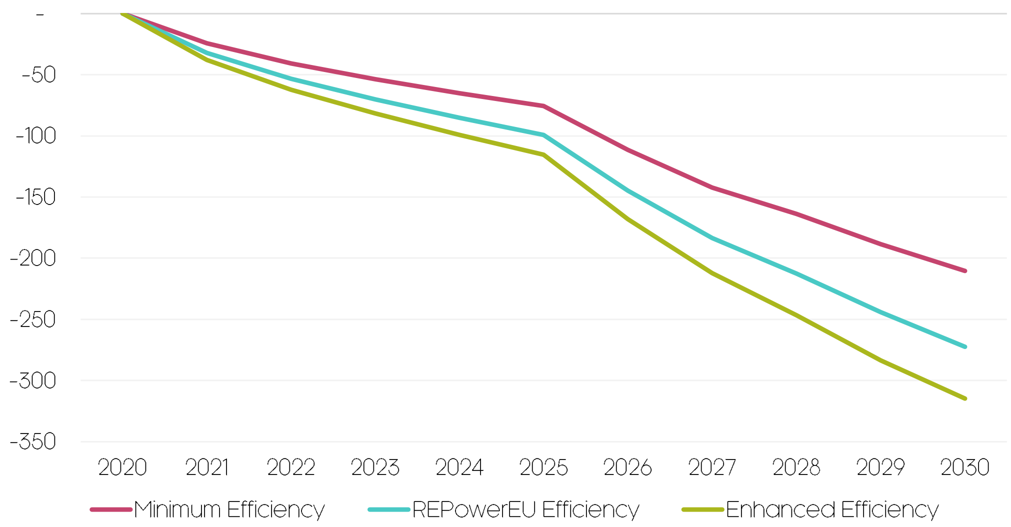
[18] It should be noted that reducing emissions from power generation in this way means that other ETS sectors will require smaller emissions reductions to respect the ETS cap. This is particularly important because reductions in other ETS sectors are typically more costly and therefore difficult to achieve. The implication is that energy efficiency can make it easier/cheaper to meet the 2030 targets specified under Fit-for-55.

Figure 3.17 EU27 CO_2 Emissions, % change from the baseline



When other GHGs are added, aggregated GHG emissions[19] decrease even more in percentage terms than CO_2, across all scenarios (as shown in the charts below). This is likely to be explained by some of the key sectors (e.g. agriculture[20] or mining) emitting more of other GHGs than CO_2.

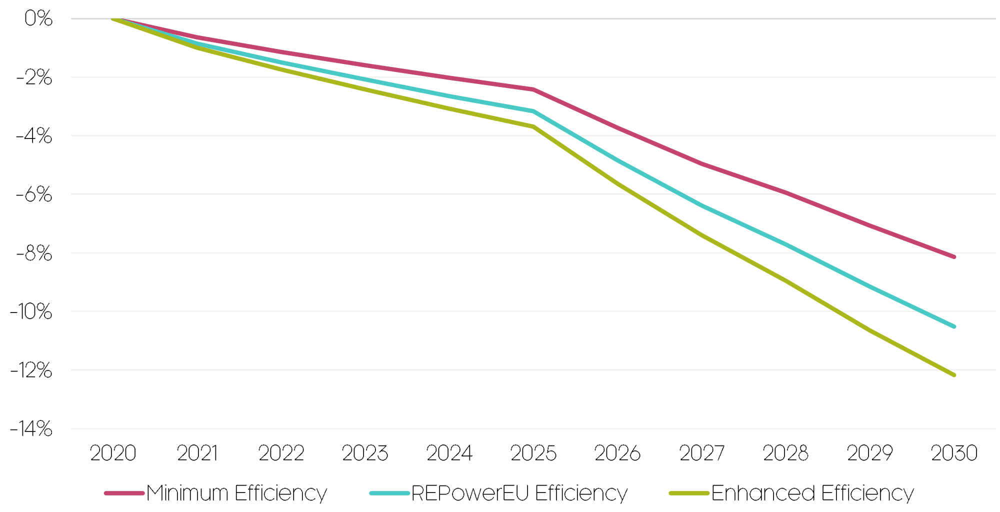
Figure 3.18 EU27 GHG Emissions, difference from the baseline, MtCO2



[19] Only energy-related CO_2 emissions are covered in detail in the model and explicitly linked to fuel consumption. CO_2 industrial process emissions are calculated as moving with economic activity in the corresponding sector. LULUCF emissions are not modelled directly; using countries' land-use data they are kept constant from the last year of historical period.

[20] In agriculture, for example, CH_4 emissions from enteric fermentation and N_2O emissions from soils are responsible for more than 80% of total agricultural GHG emissions. Source: https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-agriculture

Figure 3.19 EU27 GHG Emissions, % change from the baseline



Air pollution damages

The combustion of fossil fuels for space heating, hot water provision, transportation and electricity production leads to an increase in emissions of air pollutants, which ultimately affect air quality. Energy efficiency measures also contribute to reducing adverse impacts arising from air pollution that is generated from the use of fossil fuels, as well as inefficient heating systems and modes of transport. These impacts are:

- **Human health**: airborne emissions such as NO_X, SO_2 and VOC are associated with increased risk of cancer, respiratory and cardiovascular diseases.
- **Ecosystems**: air pollution leads to eutrophication and acidification of soils, with adverse consequences on biodiversity and crop yields.
- **Building & cultural heritage**: high concentrations of air pollutants also lead to corrosion and damage to sites of cultural heritage and building surfaces, which ultimately leads to increase maintenance costs.

In this analysis, the cost of air pollution damages on human health, ecosystems, buildings and cultural heritage are aggregated together (due to available data for the analysis) and reported at the EU27 level. These are derived by multiplying the modelled impacts in terms of the change in the emission levels of air-borne pollutants by damage cost coefficients per unit of emissions. Data on unit damage costs are taken from the European Commission[21].

Figure 3.20 and Figure 3.21 show that the introduction of energy efficiency measures is associated with a substantial decrease in damage costs caused by airborne pollutants. The reduction in air pollution damages is greatest in the

[21] https://ieep.eu/uploads/articles/attachments/134d9257-53c5-4a20-885b-9f6615452486/Green%20taxation%20and%20other%20economic%20instruments%20%E2%80%93%20Internalising%20environmental%20costs%20to%20make%20the%20polluter%20pay_Study_10.11.2021.pdf?v=63807385248

Enhanced Efficiency scenario, which is characterised by higher energy efficiency targets. In 2030 the largest impacts come from damage costs associated with coarse particulate matter (PM_{10}) and Sulphur dioxide (SO_2), whose reduction ranges between 12% in the Minimum Efficiency scenario and 19% in the Enhanced Efficiency scenario, compared to the baseline. This is mainly driven by a fall in the extraction and manufacturing of fuels and the reduced energy supply, which are the main source of SO_2 emissions. Similarly, the reduction in air pollution damages caused by coarse particulate matter (PM_{10}) are driven a fall in energy consumption from residential, commercial and institutional activities, which are the principal sources of PM_{10} emissions[22].

Despite the lower magnitude, significant improvements are also associated with reductions in damages from volatile particulate matter (VOC) and nitrogen oxides (NO_X) ranging from 5% in the Minimum Efficiency scenario to 13% in the Enhanced Efficiency scenario, compared to the baseline.

Figure 3.20 Air pollution damage costs in 2030, % difference from the baseline

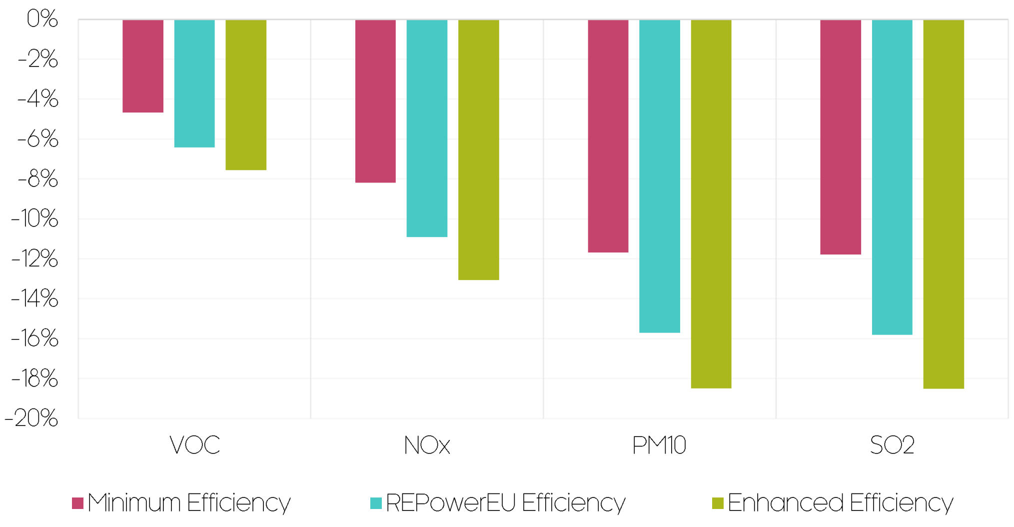
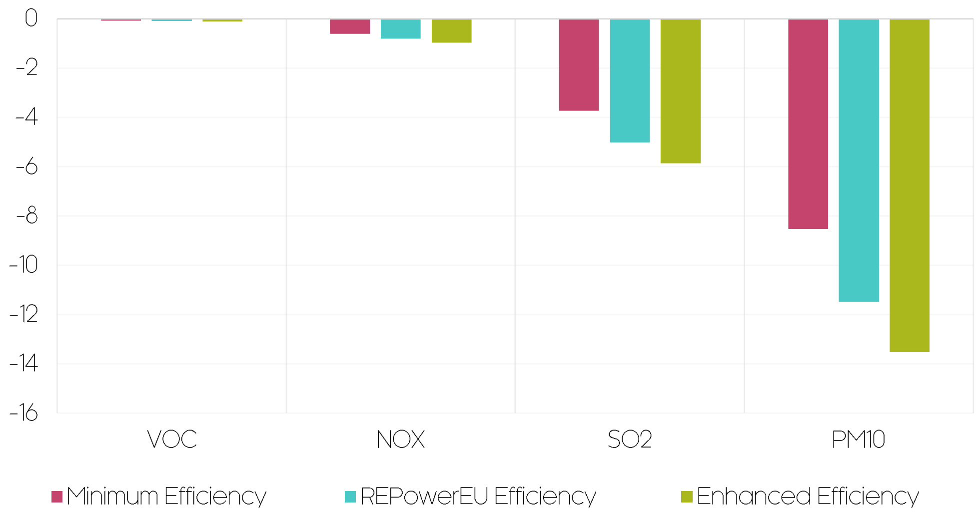


Figure 3.21 Air pollution damage costs in 2030, difference from the baseline, 2010 EUR billions



[22] https://www.eea.europa.eu/publications/air-quality-in-europe-2021/sources-and-emissions-of-air

3.4 Average coefficients for energy efficiency benefits

The adoption of ambitious energy efficiency measures is expected to deliver multiple benefits to European citizens and to the economy. In this chapter we quantify estimates of the multiple benefits of energy efficiency in Europe, based on the scenarios that have been modelled.

Based on the analysis of the three modelled scenarios, we estimate coefficients linking the reduction in energy consumption (in Mtoe) to each of the benefits this delivers. For example, Table 3.1 shows that for each Mtoe of energy saved from energy efficiency measures, CO_2 emissions are reduced by 1.82 $MtCO_2$. Similarly, each Mtoe of energy saved reduces household energy expenditure by 0.71 billion euros.

Importantly, the coefficients presented below represent average coefficients across the scenarios, and are based on an assumption of linear relationship between energy consumption and benefits. The actual impacts of moving from one scenario to another might not align with these average figures (because the first Mtoes saved deliver higher benefits than the last ones saved).

Table 3.1 Summary of energy efficiency benefits coefficients per unit of energy savings

	Indicator	Unit	Coefficient
Economy	GDP	€billion/Mtoe	0.93
	Employment	thousands jobs/Mtoe	6.61
	Energy security (fossil fuel imports)	€billion/Mtoe	0.38
	Investments in the mining sector	€million/Mtoe	-8.35
	Investments in the construction sector	€million/Mtoe	16.13
	Investments in manufacturing sector	€million/Mtoe	94.71
Society	Household energy expenditure	€billion/Mtoe	-0.71
	Household transport expenditure	€billion/Mtoe	-0.45
	Firm energy expenditure	€billion/Mtoe	-0.43
Environment	CO_2 emissions	$MtCO_2$/Mtoe	-1.82
	GHG emissions	$MtCO_2$/Mtoe	-2.67
	Air pollution damages	€billion/Mtoe	-0.19

Note: *Coefficients were derived as a ratio between the E3ME results for 2030 for each indicator and the reduction in energy demand achieved in each sceanario; these ratios were then averaged across scenarios to derive unique coefficients. All monetary values are expressed in €2015 prices.*

4 Concluding remarks

In this study we analysed the impacts of three different levels of 2030 energy efficiency targets in Europe on a wide range of potential benefits. The study was carried out using the E3ME macro-econometric model, with supplementary analyses for impact areas that the model was not able to cover. Three scenarios of possible future efficiency targets were assessed. The study modelled three scenarios, which are the ones that will be discussed during the trilogue negotiations:

- **Minimum Efficiency**: based on the Energy Efficiency Directive recast proposal of July 2021, leading to an energy efficiency target of at least 9% (compared to PRIMES Reference Scenario 2020);
- **REPowerEU Efficiency**: based on an energy efficiency target of at least 13% (compared to the projections of PRIMES Reference Scenario 2020);
- **Enhanced Efficiency**: based on an energy efficiency target of at least 14,5% (compared to the projections of PRIMES Reference Scenario 2020).

The analysis shows that energy efficiency measures will bring substantial benefits for the European economy, society and environment. The greatest impacts are associated with the Enhanced Efficiency scenario, which is characterised by a high efficiency target, and higher investments in energy efficiency goods and services. The results suggest that more ambitious energy efficiency targets deliver greater benefits to European citizens. Higher energy efficiency targets are expected to lead to improved energy security (through decreasing fossil fuel imports), higher GDP, decreasing household energy and transport expenditure, and contribute to overall climate goals through mitigating emissions.

The analysis identifies two major trends in the distribution of impacts across different groups;

- The reduction in energy bills is expected to be more impactful for lower-income groups, as they currently spend a greater proportion of their income on energy and transport – and as such, the modelled savings are a greater proportion of their overall household expenditure.
- There are winners and losers in the transition, particularly in terms of sectors; for example, the mining sector is expected to face job losses as demand for fossil fuels falls. However, these will be more than offset by increased investment and resultant employment in other sectors producing energy efficiency products and services (such as construction or manufacturing). A key finding is that the overall impact on employment will be positive at the EU level.

Annex 1 – Summary tables

The tables below summarise the results in each scenario and for each benefits indicator in 2025 and in 2030, in terms of:

- % difference from the baseline
- Absolute difference from the baseline

Table 1 Results for the scenarios, % difference from the baseline, 2025

% diff from baseline	Unit of measurement	Scenario 1 - Minimum Efficiency	Scenario 2 - REPowerEU Efficiency	Scenario 3 - Enhanced Efficiency
GDP	%	0.3%	0.3%	0.3%
Employment - Total	%	0.1%	0.2%	0.2%
Employment - Mining	%	-3.7%	-4.7%	-5.4%
Employment - Agriculture	%	-0.1%	-0.1%	-0.1%
Employment - Services	%	0.1%	0.1%	0.1%
Employment - Manufacturing	%	0.2%	0.3%	0.3%
Employment - Utilities	%	0.2%	0.3%	0.3%
Employment - Construction	%	0.7%	0.8%	0.9%
Fossil fuel imports - Coal	%	-16.7%	-21.2%	-24.2%
Fossil fuel imports - Oil and Gas	%	-1.8%	-2.3%	-2.6%
Fossil fuel imports - Manufactured fuels	%	-1.9%	-2.4%	-2.8%
Investment - Mining	%	-0.5%	-0.6%	-0.7%
Investment - Utilities	%	0.5%	0.5%	0.5%
Investment - Agriculture	%	0.3%	0.4%	0.4%
Investment - Construction	%	1.5%	1.7%	1.6%
Investment - Manufacturing	%	0.8%	0.9%	0.9%
Investment - Services	%	1.3%	1.6%	1.7%
Air pollution damages - PM_{10}	%	-3.8%	-5.2%	-6.1%
Air pollution damages - NOX	%	-3.4%	-4.4%	-5.2%
Air pollution damages - SO_2	%	-3.7%	-4.9%	-5.8%
Air pollution damages - VOC	%	-1.7%	-2.4%	-2.9%
CO_2 emissions	%	-1.9%	-2.5%	-2.9%
GHG emissions	%	-2.4%	-3.2%	-3.7%
Household energy expenditure	%	-1.3%	-1.7%	-2.0%
Household transport expenditure	%	-0.4%	-0.5%	-0.6%
Firm energy expenditure	%	-1.4%	-2.0%	-2.4%

Table 2 Results for the scenarios, absolute difference from the baseline, 2025

% diff from baseline	Unit of measurement	Scenario 1 - Minimum Efficiency	Scenario 2 - REPowerEU Efficiency	Scenario 3 - Enhanced Efficiency
GDP	billions of 2010 Euros	35	43	45
Employment - Total	thd	265	321	345
Employment - Mining	thd	-27	-34	-39
Employment - Agriculture	thd	-7	-8	-9
Employment - Services	thd	69	85	90
Employment - Manufacturing	thd	72	86	88
Employment - Utilities	thd	71	88	99
Employment - Construction	thd	85	105	117
Fossil fuel imports - Coal	billions of 2010 Euros	-2	-2	-2
Fossil fuel imports - Oil and Gas	billions of 2010 Euros	-5	-6	-7
Fossil fuel imports - Manufactured fuels	billions of 2010 Euros	-2	-3	-3
Investment - Mining	millions of 2010 Euros	-115	-150	-176
Investment - Utilities	millions of 2010 Euros	1,408	1,456	1,482
Investment - Agriculture	millions of 2010 Euros	194	236	246
Investment - Construction	millions of 2010 Euros	1,309	1,556	1,428
Investment - Manufacturing	millions of 2010 Euros	3,561	4,299	4,287
Investment - Services	millions of 2010 Euros	33,699	41,265	43,543
Air pollution damages - PM_{10}	billions of 2010 Euros	-3	-4	-5
Air pollution damages - NOX	billions of 2010 Euros	-0	-0	-1
Air pollution damages - SO_2	billions of 2010 Euros	-1	-2	-2
Air pollution damages - VOC	billions of 2010 Euros	-0	-0	-0
CO_2 emissions	$MtCO_2$	-43	-57	-67
GHG emissions	$MtCO_2$	-76	-99	-115
Household energy expenditure	billions of 2010 Euros	-9	-12	-14
Household transport expenditure	billions of 2010 Euros	-2	-3	-3
Firm energy expenditure	billions of 2010 Euros	-9	-13	-15

Table 3 Results for the scenarios, % difference from the baseline, 2030

% diff from baseline	Unit of measurement	Scenario 1 - Minimum Efficiency	Scenario 2 - REPowerEU Efficiency	Scenario 3 - Enhanced Efficiency
GDP	%	0.5%	0.6%	0.6%
Employment - Total	%	0.3%	0.3%	0.4%
Employment - Mining	%	-9.6%	-11.2%	-11.0%
Employment - Agriculture	%	-0.2%	-0.3%	-0.4%
Employment - Services	%	0.2%	0.3%	0.3%
Employment - Manufacturing	%	0.4%	0.4%	0.5%
Employment - Utilities	%	0.4%	0.5%	0.6%
Employment - Construction	%	1.1%	1.3%	1.4%
Fossil fuel imports - Coal	%	-12.4%	-13.1%	-13.0%
Fossil fuel imports - Oil and Gas	%	-8.0%	-9.7%	-10.7%
Fossil fuel imports - Manufactured fuels	%	-9.1%	-11.4%	-13.0%
Investment - Mining	%	-2.5%	-3.1%	-3.5%
Investment - Utilities	%	-0.2%	-0.6%	-0.8%
Investment - Agriculture	%	0.6%	0.7%	0.8%
Investment - Construction	%	1.2%	1.4%	1.7%
Investment - Manufacturing	%	1.4%	1.7%	2.0%
Investment - Services	%	1.9%	2.3%	2.7%
Air pollution damages - PM_{10}	%	-11.7%	-15.7%	-18.5%
Air pollution damages - NOX	%	-8.2%	-10.9%	-13.1%
Air pollution damages - SO_2	%	-11.8%	-15.8%	-18.5%
Air pollution damages - VOC	%	-4.7%	-6.4%	-7.6%
CO_2 emissions	%	-7.4%	-9.5%	-11.0%
GHG emissions	%	-8.1%	-10.5%	-12.2%
Household energy expenditure	%	-7.0%	-9.0%	-10.3%
Household transport expenditure	%	-6.2%	-7.6%	-8.5%
Firm energy expenditure	%	-4.6%	-6.7%	-8.0%

Table 4 Results for the scenarios, absolute difference from the baseline, 2030

% diff from baseline	Unit of measurement	Scenario 1 - Minimum Efficiency	Scenario 2 - REPowerEU Efficiency	Scenario 3 - Enhanced Efficiency
GDP	billions of 2010 Euros	70	84	94
Employment - Total	thd	548	660	752
Employment - Mining	thd	-70	-82	-81
Employment - Agriculture	thd	-18	-22	-26
Employment - Services	thd	252	302	337
Employment - Manufacturing	thd	118	143	166
Employment - Utilities	thd	130	156	176
Employment - Construction	thd	136	162	181
Fossil fuel imports - Coal	billions of 2010 Euros	-1	-1	-1
Fossil fuel imports - Oil and Gas	billions of 2010 Euros	-18	-22	-24
Fossil fuel imports - Manufactured fuels	billions of 2010 Euros	-9	-11	-13
Investment - Mining	millions of 2010 Euros	-606	-756	-865
Investment - Utilities	millions of 2010 Euros	-569	-1,759	-2,362
Investment - Agriculture	millions of 2010 Euros	390	486	557
Investment - Construction	millions of 2010 Euros	1,207	1,424	1,656
Investment - Manufacturing	millions of 2010 Euros	6,985	8,525	9,699
Investment - Services	millions of 2010 Euros	54,351	66,378	77,201
Air pollution damages - PM_{10}	billions of 2010 Euros	-9	-11	-14
Air pollution damages - NOX	billions of 2010 Euros	-1	-1	-1
Air pollution damages - SO_2	billions of 2010 Euros	-4	-5	-6
Air pollution damages - VOC	billions of 2010 Euros	-0	-0	-0
CO_2 emissions	$MtCO_2$	-144	-186	-214
GHG emissions	$MtCO_2$	-211	-272	-315
Household energy expenditure	billions of 2010 Euros	-51	-65	-75
Household transport expenditure	billions of 2010 Euros	-33	-40	-45
Firm energy expenditure	billions of 2010 Euros	-28	-41	-49