ACHIEVING 60% EMISSION REDUCTIONS BY 2030

ASSESSMENT OF POLICY OPTIONS

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Cambridge Econometrics, Cambridge UK

THE GREENS/EFA in the European Parliament

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Part 1

Objectives

This short report analyses impacts of increased climate action in the EU27 using a macroeconomic model. The key questions are:

- Is an increase to a 60% GHG reduction target possible?
- What could be key policy elements?
- What would be the economic and employment effects of meeting this target?

Part 2

Methodology

1. HOW THE RESEARCH WAS CARRIED OUT

A macro-econometric model, E3ME is used to provide answers to the above questions. E3ME is a global E3 (Energy-Environment-Economy) model that is frequently used for the assessment of climate and energy policy. Recent E3ME applications include modelling contribution to the Stepping up Europe's 2030 climate ambition Impact Assessment (55% target) for the European Commission[1], Halfway There: Existing policies put Europe on track for emission cuts of at least 50% by 2030 report for EMBER Climate[2], and analysis of the China Net Zero target[3].

ECONOMETRICS APPROACH

The key distinction of the E3ME model is its econometric approach. The model can fully assess both short and long-term impacts and is not limited by many of the restrictive assumptions common to Computable General Equilibrium (CGE) models. In practice, this means that stepping up the ambition level of EU climate policies will not by assumption result in additional burden to the economy. Instead, the measures can be assessed across relevant sectors, reflecting policy-driven access to financial resources. Further information about E3ME is given in the final section of this document.

1 https://ec.europa.eu/clima/sites/clima/files/eu-climate-action/docs/impact_en.pdf
2 https://ember-climate.org/project/halfway-there/
3 https://www.carbonbrief.org/analysis-going-carbon-neutral-by-2060-will-make-china-richer

This note covers three different scenarios based on the level of EU ambition:

- Baseline (including preliminary COVID impacts)
- 55% GHG reduction target
- 60% GHG reduction target

The E3ME model baseline includes preliminary COVID impacts and current policies prior to the pandemic. For the 55% and 60% scenarios, a combination of climate and energy policies is used to achieve the targets. The targets are set in line with the existing regulatory framework in relation to 1990 emission levels and do not include sinks through land use, land-use change and forestry (LULUCF).

It must be stressed that the modelling of the 55% scenario here is different to the E3ME analysis in the European Commission Impact Assessment. In this report the scenarios are determined by the policies outlined below, rather than modelling from the PRIMES energy system model. Furthermore, as noted above, here the 55% target does not include LULUCF. It must be stressed that the modelling of the 55% scenario here is different to the E3ME analysis in the European Commission Impact Assessment. In this report the scenarios are determined by the policies outlined below, rather than modelling from the PRIMES energy system model. Furthermore, as noted above, here the 55% target does not include LULUCF.

Part 3

Policy Options

1. POLICIES ASSUMPTION TO ACHIEVE CLIMATE TARGET

The following table summarises policy options in E3ME that were used to achieve the climate targets of 55% and 60% respectively for 2030[4]. It is assumed that these policies are introduced from 2021 onwards unless otherwise stated. The policy mix reflects recent political developments and trends and has been developed with the project Steering committee at the kick-off meeting.

TABLE 3.1: E3ME POLICIES TO ACHIEVE CLIMATE TARGET

	SECTORS	55%	60%
ETS	EU-ETS	ETS price Consistent with 55% IA (DG Clima)[5]	ETS price increase by 20%
CARBON TAX (FROM 2025 ONWARD)	All non-ETS sectors (same ETS price)	All non-ETS sectors (same ETS price)	All non-ETS sectors (same ETS price)
COAL PHASE OUT REGULATION	Power	Announced national policies[6]	Announced national policies + 2030 regulations for MS with no planned regulations (2035 for Poland)
NUCLEAR PHASE OUT REGULATION	Power	Consistent with 55% IA (DG Clima)	Announced national policies[7] + 2035 for France
RENEWABLE SUBSIDIES	Power	Wind and solar subsidies 20% of investment cost for three years	Wind and solar subsidies 30% of investment cost for five years

4 Energy-related CO_2 emissions including international aviation, excluding international shipping.
5 €42/tCO_2 in 2030 (2015 price)
6 Coal free: Estonia, Latvia, Lithuania, Belgium, Malta, Luxembourg, Cyprus
Phase out: 2020 Sweden & Austria, 2021 Portugal, 2022 France, 2023 Slovakia, 2025 Ireland & Italy 2028 Greece, 2030 Finland, Hungary, Netherlands, Denmark & Spain, 2038 Germany. Considering: Slovenia, Czechia. No phase out: Poland, Romania, Bulgaria, Croatia
7 Germany 2022, Belgium 2025, Spain 2035

	SECTORS	55%	60%
BAN ON PETROL & DIESEL ENGINES BY REGULATION[8]	Road transport	Announced national policies[8]	Announced national policies + extended to new cars in other MS in 2030
EV SUBSIDIES	Road transport	EV subsidies of €1000 per vehicle	EV subsidies of €2000 per vehicle
ENERGY EFFICIENCY INVESTMENT	Buildings and industry	Consistent with 55% IA (DG Clima)	Increase investment by 20%
COAL, GAS AND OIL BOILER REGULATIONS	Buildings	Announced national policies	Announced national policies
STEEL SECTOR	Steel	Small regulation of blast furnace (switch to recycled steel)	Small regulation of blast furnace (switch to recycled steel)

2. REVENUE RECYCLING OPTIONS

Some of the policies listed in the table above generate revenues and others incur additional public spending. The standard treatment in E3ME is to assume revenue neutrality in the scenario. The key elements are:

• Revenues: carbon tax (after 2025), auctioning revenues from ETS
• Spending: public energy efficiency investment, renewables subsidies, and cost of stranded power plant assets

The net revenues, if positive, are assumed to be used to reduce income tax rates and employers' social security contribution, split equally. Similarly, if revenues are less than spending, then income tax and employers' social security rates are increased to ensure revenue neutrality.

8 New petrol and diesel car ban: Denmark 2030, France 2040, Ireland 2030, Germany (only diesel) 2030. Netherlands 2030 and Sweden 2030.

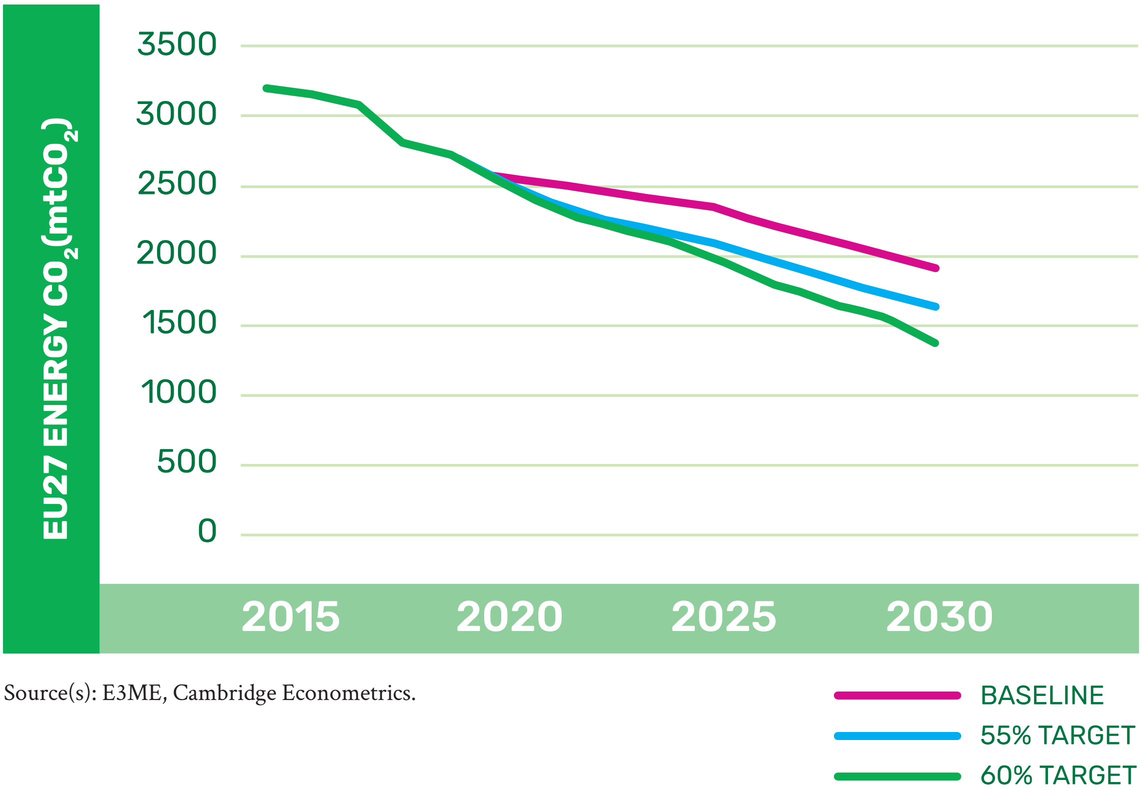
Part 4

Results

1. CLIMATE AND ENERGY RESULTS

Figure 4.1 shows the emissions trajectories in the three scenarios. The chart shows energy CO2 only. The reductions in emissions are broadly linear, with a straight trajectory up to 2030. In the 60% target scenario, coal regulation in all Member States means remaining coal power plants are forced to close in 2030, resulting in a drop in emissions between 2029 and 2030.

FIGURE 4.1: CO2 TRAJECTORIES

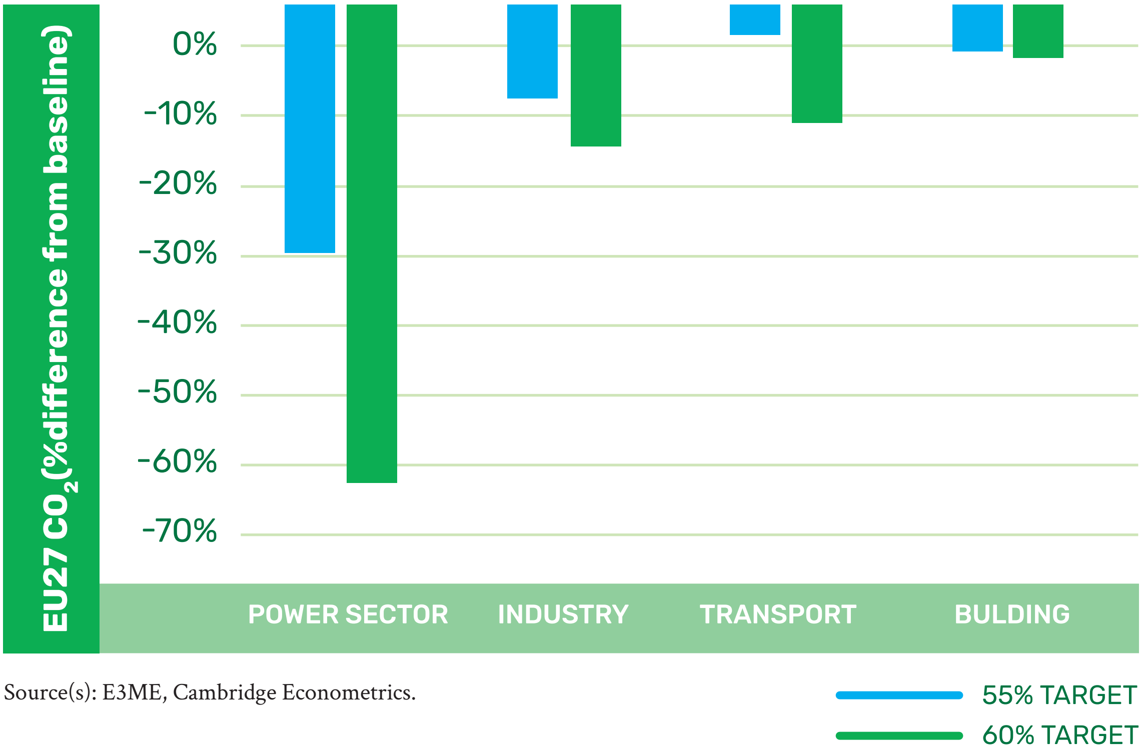


Source(s): E3ME, Cambridge Econometrics.

All sectors reduce emissions in both scenarios (Figure 4.2). In the 55% scenario, the largest reductions are in the power sector, with smaller contributions from transport and buildings. When the level of ambition is increased to 60%, there are larger contributions from the power sector and transport.

These results reflect the specific policies that are introduced in the 60% scenario. Notably, the 60% scenario includes additional coal regulation and an extension of phase-out of petrol and diesel vehicles in the transport sector. Higher ETS prices also contribute to technology switching across all sectors but there is a particularly strong interaction effect in the power and transport sectors, where alternative technologies are near cost-parity.

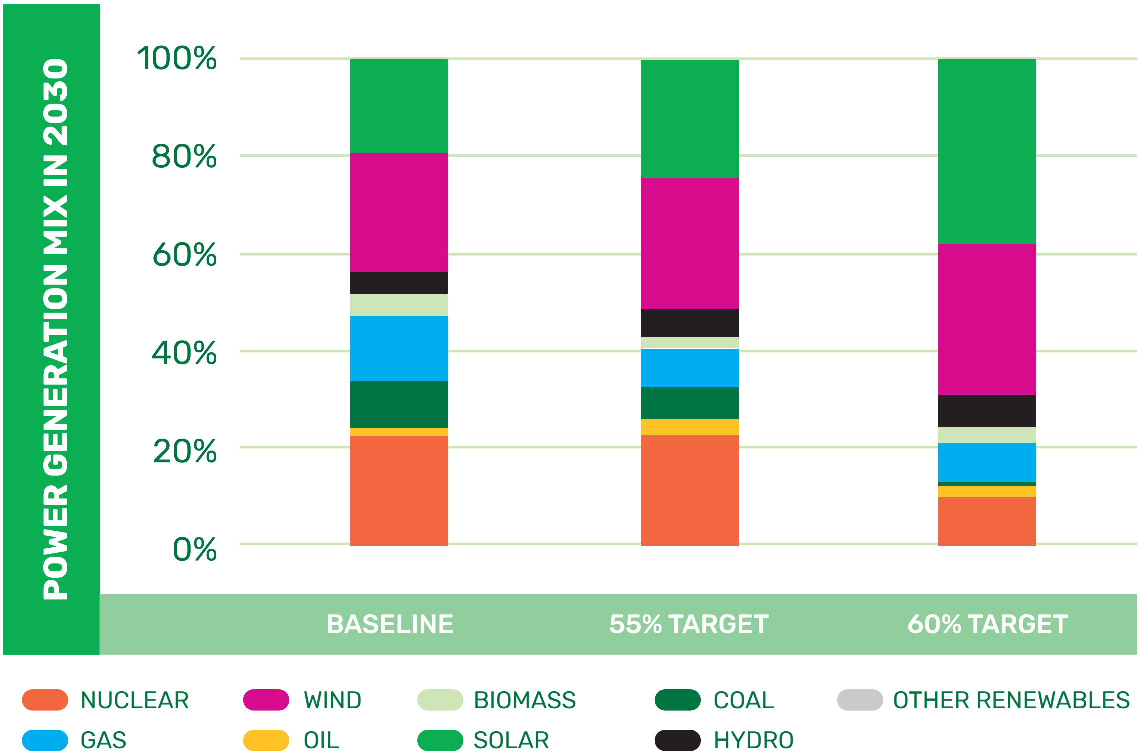
FIGURE 4.2: CO2 REDUCTIONS BY SECTOR IN 2030 AS % DIFFERENCE FROM BASELINE



Source(s): E3ME, Cambridge Econometrics.

Figure 4.3 shows the power sector mix in the three scenarios. Total generation does not change much between the scenarios; improvements to energy efficiency are balanced by increased demand due to electrification (e.g. from electric vehicles).
The share of nuclear in the 60% scenario reflects planned phase-out in Belgium, Germany, Spain and France. As the level of ambition increases, together with coal regulation, there is a large increase in the share of solar and wind generation. This means that remaining gas generation is squeezed, which leads to the reduction in emissions from the sector.

FIGURE 4.3: THE POWER GENERATION MIX



Source(s): E3ME, Cambridge Econometrics.

2. ECONOMIC RESULTS

Figure 4.4 shows the impacts of the policies on GDP. In both cases there is a small increase in GDP, with a larger increase (after 2022) in the 60% scenario.

The GDP increases are driven by three main factors:

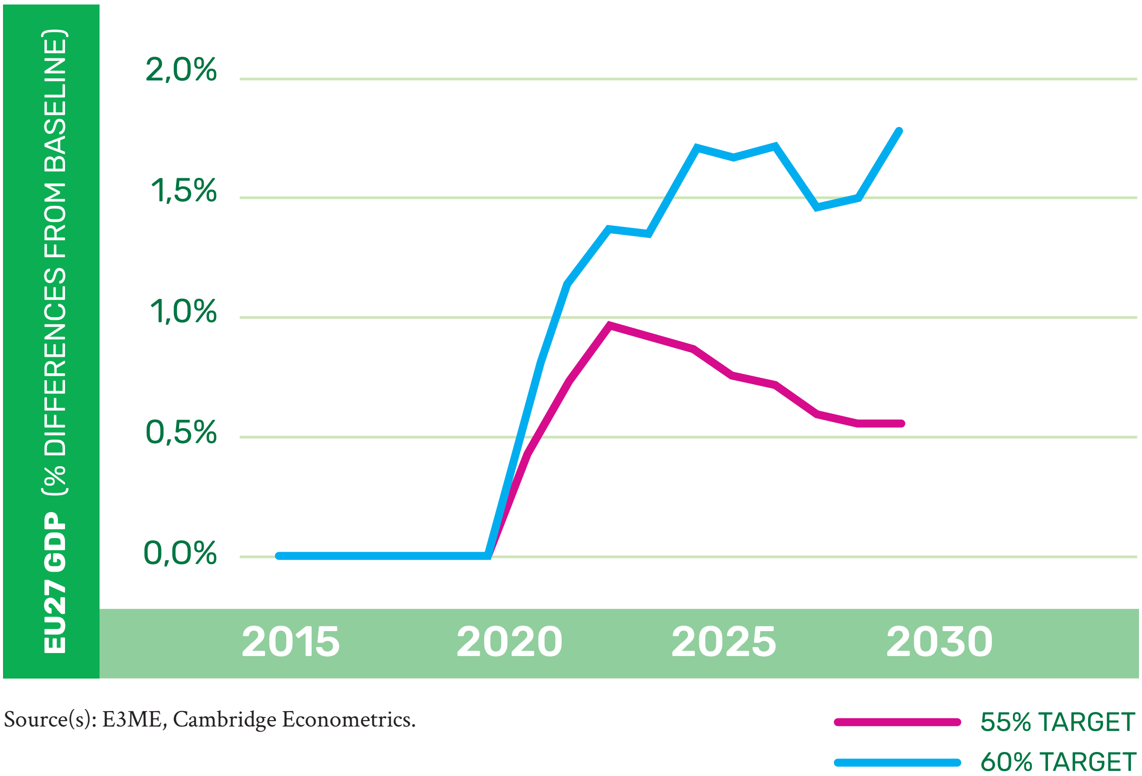
- higher levels of investment (approximately €112bn extra in 2030 compared to the baseline), in particular in energy efficiency and renewables
- higher disposable income from energy savings, lower electricity prices, and revenue recycling from ETS and tax revenues leading to more consumption
- an improvement in the EU's trade balance from reduction of fossil fuel imports (around €20bn reduction in extra-EU energy imports in 2030) but this is somewhat compensated by increase in non-energy imports

The carbon pricing elements of the scenarios have both positive and negative impacts. There are negative effects through increased prices of products, but also positive effects from the use of the revenues raised.

GDP comes out higher in the 60% scenario mainly because of the additional investment required in the period up to 2030.

GDP increases in all Member States (see Appendix B) and is consistently higher in the 60% scenario. This is mainly due to the additional renewable investment required as a result of coal regulation. The exception is Poland where GDP impacts are less positive in the 60% scenario than in the 55% scenario. Poland's benefits from additional investment is dampen by the faster decline of its coal sector.

FIGURE 4.4: GDP IMPACTS IN THE SCENARIOS



Source(s): E3ME, Cambridge Econometrics.

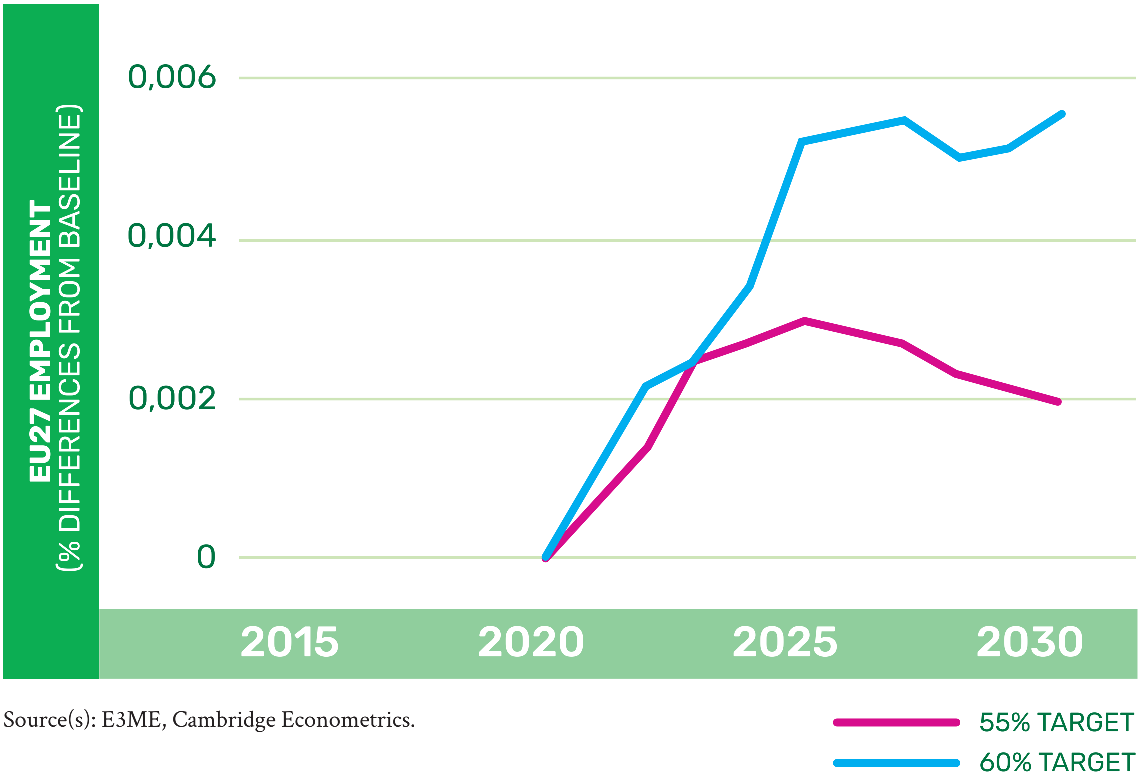
There are also positive effects on employment (Figure 4.5). The effects are smaller in magnitude (i.e. the percentage increases are less) because some of the additional GDP is realised through higher rates of productivity, leading to higher wage rates and profits.

The employment effects continue to grow beyond 2025, when the increase in renewables investment is fastest. During this period, higher renewable investment is required to replace coal power plants and some nuclear plants that are due to close down in 2030.

It is noted that there are limits to how much employment could increase by. If the level of ambition was raised too high, then constraints on the number of available workers would reduce both the economic impacts (mainly causing inflation rather than real growth) and could prevent the targets from being met.

The constraints in E3ME match historical patterns, following the econometric approach. In general this means that the workers required to increase production in expanding sectors are generally available. In a rapid transition, skills shortages may become more of an issue. However, an increase in total employment of 0. 6 % seems manageable, especially given the current situation with covid-19. Employment results by MS are given in Appendix B.

FIGURE 4.5: EMPLOYMENT IMPACTS IN THE SCENARIOS



Source(s): E3ME, Cambridge Econometrics.

Table 4.1 summarises the impacts on key macroeconomic indicators. The impacts on consumer expenditure broadly match those on GDP. Although some household products become more expensive because of carbon pricing, improvements to efficiency reduce the prices of others. The leftover revenues from carbon pricing are used to reduce income tax and employers' social security contributions, which also boosts real disposable income and spending.

TABLE 4.1: IMPACTS ON ECONOMIC INDICATORS (% FROM BASELINE IN 2030)

	55% TARGET	60% TARGET
GDP	0.6%	1.8%
CONSUMER SPENDING	0.7%	1,4%
INVESTMENT	0.2%	3,1%
EXPORTS	0.1%	0,5%
IMPORTS	-0.2%	0,0%
EMPLOYMENT	0.2%	0,6%
INFLATION (CONSUMER PRICE)	-0.2%	-0,7%

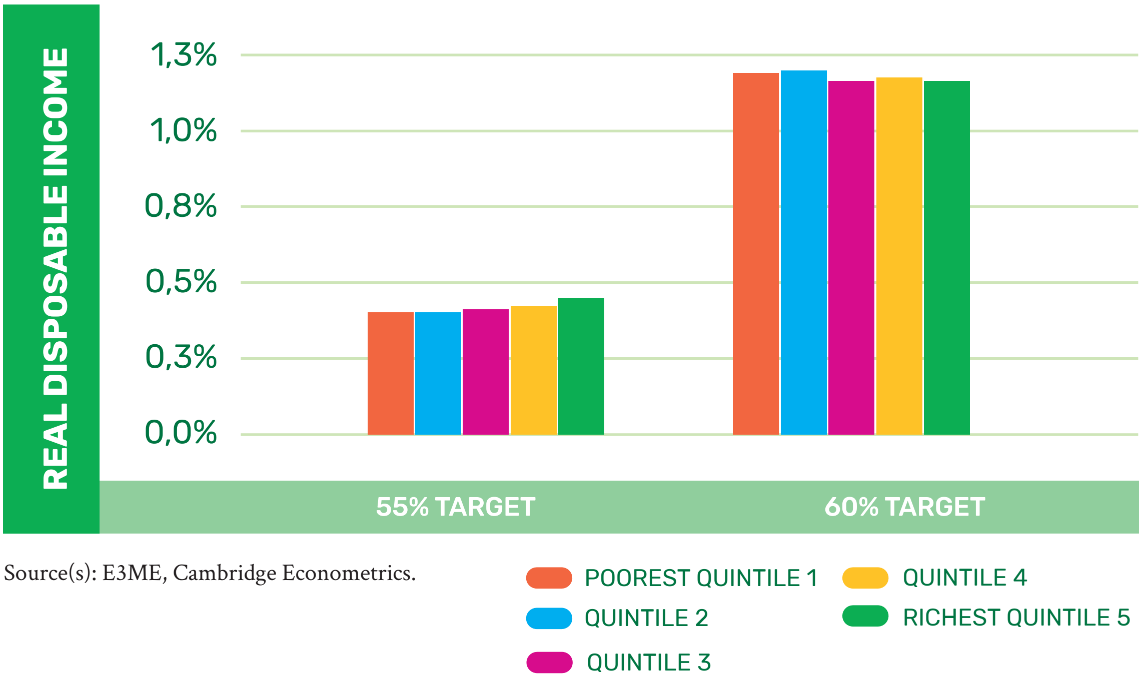
Source(s): E3ME, Cambridge Econometrics.

Investment increases in both scenarios, but by more in the 60% scenario. Much of this additional investment is in solar panels and wind turbines.

Exports increase slightly, but the positive and negative competitiveness effects of carbon pricing and increased efficiency roughly balance out. Despite increases in GDP and consumption (which would usually result in higher imports) there is a small fall in imports in both scenarios. The reason for the fall is a reduction in fossil fuel imports. In the 60% target scenario, there are higher import demands for investment and consumer goods, which cancel out the reduction in fossil fuel imports.

All household groups experience higher real disposable incomes in both scenarios but the increase is greater under the 60% scenario. There is a small difference in distributional outcomes between the scenarios. In the 55% scenario, higher income groups benefit slightly more, while in the 60% scenario the lower income groups benefit more (see Figure 4.6). This is mainly because of lower electricity prices through renewables subsidies and lower energy bills from higher energy efficiency investment, funded through carbon tax and ETS revenues.

FIGURE 4.6: EU27 REAL DISPOSABLE INCOME IMPACTS IN 2030, % DIFFERENCE FROM BASELINE



Source(s): E3ME, Cambridge Econometrics.

Table 4.2 shows the impacts on sectoral production. Aside from the extraction and utilities sectors, the impacts are uniform across sectors with a modest increase of 0.2-0.5% in the 55% scenario, and 1.0%-2.3% in the 60% scenario. The measure used here is the total volume of production in each sector; the total impact is less than that for GDP, which also accounts for more efficient production.

Large losses in production by the coal sector mean that the mining sector sees an overall reduction in output. The figure in the table is reduced somewhat by other mining activities (e.g. aggregates) that do not change production levels in the scenarios.

In the 55% target, the utilities sector sees a reduction in output because of the measures to improve efficiency. However, higher rates of electrification in the 60% scenario, particularly in vehicles, means that overall output remains more or less the same. It should be noted that within this category there are likely different impacts for the electricity (higher from electrification) and gas supply sectors (lower from stricter climate policies).

TABLE 4.2: SECTORAL OUTPUT IMPACTS (% FROM BASELINE IN 2030)

	55% TARGET	60% TARGET
AGRICULTURE	0.5%	1.1%
MINING & REFINERIES	-2.4%	-5.6%
UTILITIES	-1.9%	0.0%
MANUFACTURING & CONSTRUCTION	0.3%	2.3%
DISTRIBUTION, RETAIL, HOTELS & CATERING	0.4%	1.5%
TRANSPORT AND COMMUNICATIONS	0.3%	1.5%
SERVICES	0.2%	1.1%

Source(s): E3ME, Cambridge Econometrics.

3. POLICY COSTS AND REVENUES

In the first few years of the ambitious 60% target scenario, the direct revenue gap can be as large as €87bn from policy costs and stranded coal and nuclear plants, although part of this gap is recouped through tax receipts related to the additional people employed. In the later period, ETS and carbon tax (applied after 2025) revenues are large enough to pay for these costs. In some Member States there are enough revenues to reduce other taxes.
Renewables investments are funded privately, and are not included in the public revenues calculation in the table below.

TABLE 4.3: POLICY COSTS AND REVENUES IN THE 60% SCENARIO EU27, €BN CURRENT PRICE

	2021	2022	2023	2030
REVENUES FROM ETS AND CARBON TAX	65,8	66,0	66,4	84,2
COSTS OF ENERGY EFFICIENCY PROGRAMS	2,8	5,8	8,8	28,5
COSTS OF STRANDED FOSSIL FUEL PLANTS	15,3	33,8	67,0	34,9
COSTS OF RENEWABLE SUBSIDY POLICIES	50,4	68,7	77,5	0,0
DIFFERENCES IN POLICY REVENUES AND COSTS	-2,7	-42,3	-86,9	20,8
CHANGES TO INCOME TAX*	0.0	0.3	0.5	-0.3
CHANGES TO SOCIAL SECURITY CONTRIBUTION*	0.0	0.3	0.5	-0.3

Note(s): * average percentage point change in tax rates across EU27.
Source(s): E3ME, Cambridge Econometrics.

Part 5

Key Findings

1. KEY FINDINGS

This report has explored two scenarios of different decarbonisation targets for 2030. The first scenario includes a 55% target and the second scenario sets a 60% target. In both cases the targets exclude any contribution from LULUCF.

Both scenarios are formed by combining policy options that cut across all sectors of the economy. They are compared to a business-as-usual baseline case so that the impact of the policies may be identified.

The key findings are:

- A 60% greenhouse gas reduction target for 2030 is possible and could be met with increased contributions from the power (166 mtCO2) and transport (73 mtCO2) sectors, compared to current 55% plans.
- The key policies in these sectors to meet the targets are more rapid coal phase-out and support for electric vehicle deployment through a range of regulatory (e.g. fixed ICE phase-out dates) and market-based (e.g. variable taxation) instruments.
- The amount of additional investment to achieve the more ambitious target is substantial and could require annual public expenditure of up to €87bn more than would be raised from the ETS and carbon taxes modelled. Provision of this finance is therefore important to meet the targets.
- Total investment could be up to €112bn or 3.1% higher in the 60% scenario by 2030 compared to baseline. Even with all public contributions funded by higher tax rates, this investment drives higher GDP in the EU by 1.8% and employment by 0.5% (1.1 million jobs).
- EU fossil fuel imports are reduced by €20bn annually.
- The distributional effects are quite uniform in the scenarios that were modelled. There is relatively little difference between the scale of impacts across Member States. The effects are also similar between different income groups.
- At sectoral level there will be costs to fossil-fuel energy providers (e.g. gas distribu-

tion). The largest positive impacts will be in the sectors that produce and install new equipment, for example engineering and construction.

2. PRIORITIES FOR FURTHER ANALYSIS

This report was prepared in a relatively short time period to meet the needs of the Greens/EFA Group in the European Parliament. It shows the potential impacts of increasing the level of ambition in the 2030 greenhouse gas reduction target. However, during the course of the analysis, several pressing questions have been raised that have not yet been possible to address. A short summary is provided below.

LINKING THE IMPACTS TO POLICIES

The report has not been able to assess the impacts of each of the individual policy measures, or the key interactions between measures (or alternative combinations of measures). Although the modelling team has a sense that the key policy combinations are coal phase-out, carbon pricing, aggressive energy efficiency mandates and support for electric vehicles, this has not yet been tested in the E3ME model. The process would require multiple additional scenarios but could answer questions such as whether meeting the targets hinges on successful carbon pricing.

LOOKING FURTHER AT THE LABOUR MARKET

It was noted in the results section that skills shortages could be a barrier to transition. Under a baseline case that includes covid-19 it is reasonable to assume that the available workforce will be able to adapt to the needs of companies leading the transition. However, particularly beyond 2025, it would be beneficial for both companies and workers to identify where the potential bottlenecks in the labour supply might be, while there is still time to address and issues.

FINANCING THE TRANSITION

The assumption in the modelling puts a large investment cost on to government, financed at the Member State level through higher taxes. Some of the bill (e.g. for energy efficiency improvements) could be passed to companies. The remaining public cost could be funded in other ways, for example with a contribution at European level (as announced in the Recovery Plan for Europe). This area remains largely unexplored.

ACTIVITIES IN THE REST OF THE WORLD

The modelling in this report assumes that the rest of the world carries on following existing trajectories, meaning limited climate action. This assumption reflects current policies but is not necessarily in line with announcements from East Asia or the US. What happens in the rest of the world is important because it determines technology costs, but also any competitiveness effects in trade.

Appendix A.

The E3ME model

E3ME is a computer-based model of the world's economic and energy systems and the environment. It was originally developed through the European Commission's research framework programmes and is now widely used in Europe and beyond for policy assessment, for forecasting and for research purposes. A technical model manual of E3ME is available online at www.e3me.com.

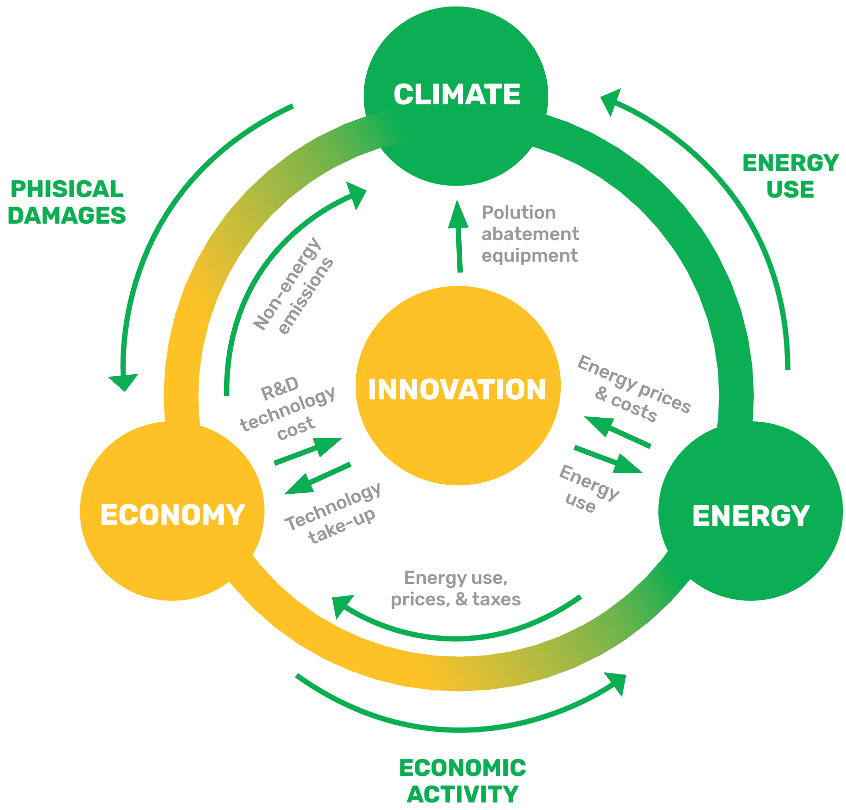
E3ME is often used to assess the impacts of climate mitigation policy on the economy and the labour market. The basic model structure links the economy to the energy system to ensure consistency across each area.

As a global E3 model, E3ME can provide comprehensive analysis of policies:

direct impacts, for example reduction in energy demand and emissions, fuel switching and renewable energy; secondary effects, for example on fuel suppliers, energy prices and competitiveness impacts, rebound effects of energy and materials consumption from lower prices, spending on energy or higher economic activities overall macroeconomic impacts; on jobs and economy including income distribution at macro and sectoral level.

1. THEORETICAL UNDERPINNINGS

Economic activity undertaken by persons, households, firms and other groups in society has effects on other groups after a time lag, and the effects persist into future generations, although many of the effects soon become so small as to be negligible. But there are many actors and the effects, both beneficial and damaging, accumulate in economic and physical stocks. The effects are transmitted through the environment (with externalities such as greenhouse gas emissions contributing to global warming), through the economy and the price and money system (via the markets for labour and commodities), and through the global transport and information networks. The markets transmit effects in three main ways: through the level of activity creating demand for inputs of materials, fuels and labour; through wages and prices affecting incomes; and through incomes leading in turn to further demands for goods and services. These interdependencies suggest that an E3 model should be comprehensive and include many linkages between different parts of the economic and energy systems.



E3ME is often compared to Computable General Equilibrium (CGE) models. In many ways the modelling approaches are similar; they are used to answer similar questions and use similar inputs and outputs. However, underlying this there are important theoretical differences between the modelling approaches.

In a typical CGE framework, optimal behaviour is assumed, output is determined by supply-side constraints and prices adjust fully so that all the available capacity is used. In E3ME the determination of output comes from a post-Keynesian framework and it is possible to have spare capacity. The model is more demand-driven and it is not assumed that prices always adjust to market clearing levels.

The differences have important practical implications, as they mean that in E3ME regulation and other policy may lead to increases in output if they are able to draw upon spare economic capacity. This is described in more detail in the model manual.

The econometric specification of E3ME gives the model a strong empirical grounding. E3ME uses a system of error correction, allowing short-term dynamic (or transition) outcomes, moving towards a long-term trend. The dynamic specification is important when considering short and medium-term analysis (e.g. up to 2020) and rebound effects, which are included as standard in the model's results.

2. BASIC STRUCTURE AND DATA USED

The structure of E3ME is based on the system of national accounts, with further linkages to energy demand and environmental emissions. The labour market is also covered in detail, including both voluntary and involuntary unemployment. In total there are 33 sets of econometrically estimated equations, also including the components of GDP (consumption, investment, international trade), prices, energy demand and materials demand. Each equation set is disaggregated by country and by sector.

E3ME's historical database covers the period 1970-2018 and the model projects forward annually to 2050. The main data sources for European countries are Eurostat and the IEA, supplemented by the OECD's STAN database and other sources where appropriate. For regions outside Europe, additional sources for data include the UN, OECD, World Bank, IMF, ILO and national statistics. Gaps in the data are estimated using customised software algorithms.

The main dimensions of E3ME are:

- 61 countries – all major world economies, the EU28 and candidate countries plus other countries' economies grouped
- 70 industry sectors, based on standard international classifications
- 43 categories of household expenditure
- 22 different users of 12 different fuel types
- 14 types of air-borne emission (where data are available) including the 6 GHG's monitored under the Kyoto Protocol

Appendix B.

GDP and Employment Impacts by Member States

TABLE B1: GDP BY MEMBER STATE IN 2030, % DIFFERENCE FROM BASELINE

	55% TARGET	60% TARGET
BELGIUM	0.3%	0.7%
BULGARIA	0.1%	4.0%
CZECHIA	0.7%	1.2%
DENMARK	0.6%	1.0%
GERMANY	0.3%	2.6%
ESTONIA	0.8%	1.3%
IRELAND	0.2%	0.4%
GREECE	0.7%	1.6%
SPAIN	1.1%	1.4%
FRANCE	0.4%	1.8%
CROATIA	1.1%	2.2%
ITALY	0.8%	2.6%
CYPRUS	0.9%	2.1%
LATVIA	3.4%	4.7%
LITHUANIA	0.6%	1.0%
LUXEMBOURG	0.6%	0.8%
HUNGARY	0.5%	1.4%
MALTA	0.2%	0.3%
NETHERLANDS	0.9%	1.6%
AUSTRIA	0.6%	0.9%
POLAND	0.8%	0.4%
PORTUGAL	1.0%	1.5%
ROMANIA	0.8%	1.2%
SLOVENIA	0.9%	1.6%
SLOVAKIA	0.7%	1.6%
FINLAND	0.2%	0.5%
SWEDEN	0.6%	0.8%

TABLE B2: EMPLOYMENT BY MEMBER STATE IN 2030, % DIFFERENCE FROM BASELINE

	55% TARGET	60% TARGET
BELGIUM	0.0%	0.3%
BULGARIA	0.2%	0.5%
CZECHIA	0.2%	0.4%
DENMARK	0.2%	0.3%
GERMANY	0.1%	0.7%
ESTONIA	0.2%	0.3%
IRELAND	0.1%	0.2%
GREECE	0.3%	0.5%
SPAIN	0.5%	0.7%
FRANCE	0.0%	0.4%
CROATIA	0.2%	0.5%
ITALY	0.4%	1.2%
CYPRUS	0.3%	0.4%
LATVIA	0.2%	0.5%
LITHUANIA	0.3%	0.4%
LUXEMBOURG	0.2%	0.3%
HUNGARY	0.0%	0.4%
MALTA	0.0%	0.1%
NETHERLANDS	0.1%	0.3%
AUSTRIA	0.2%	0.3%
POLAND	0.3%	0.1%
PORTUGAL	0.4%	0.7%
ROMANIA	0.1%	0.2%
SLOVENIA	0.2%	0.4%
SLOVAKIA	0.2%	0.5%
FINLAND	0.6%	0.8%
SWEDEN	0.0%	0.1%

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