MIDAS includes the descriptions of models in use by the Commission in support to the policy cycle. MIDAS is developed and managed by the **Competence Centre on Modelling** of the European Commission.

Find out more at https://knowledge4policy.ec.europa.eu/modelling/about_en
Contact: EU-MIDAS@ec.europa.eu

Factsheet

SWD/2021/643 final

IMPACT ASSESSMENT REPORT Accompanying the document Proposal for a regulation of the European Parliament and of the Council establishing a carbon border adjustment mechanism

Supporting model(s)

GEM-E3, Euromod, PRIMES

Document based on Ares(2021)4395917

Impact assessment
SWD/2021/643 final

Fact sheet on model contributions

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 02/09/2021

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Table of Contents

Overview

Title
IMPACT ASSESSMENT REPORT Accompanying the document Proposal for a regulation of the European Parliament and of the Council establishing a carbon border adjustment mechanism

Document ID
SWD/2021/643 final

Year of publication
2021

Led by
TAXUD

Model(s) used
GEM-E3, Euromod, PRIMES

Additional information on model use for this Impact assessment

For the assessment of policy options, the models JRC-GEM-E3, EUROMOD and PRIMES are used.

The baseline scenario builds on the most recent EU reference scenario [1]. For details, please check the text of the impact assessment report.

The evaluation of policy options was supported by the "Study on the possibility to set up a carbon border adjustment mechanism on selected sectors" (Ramboll, DIW, Umweltbundesamt, FAU Erlangen-Nuremberg and Ecologic Institute, *Study on the possibility to set up a carbon border adjustment mechanism on selected sectors. Final report*, Contract number: TAXUD/2020/AO-14, 14.07.2021, https://ec.europa.eu/taxation_customs/green-taxation-0/carbon-border-adjustment-mechanism_en).

[1] European Commission, EU Reference Scenario 2020: Energy, Transport ad GHG Emissions: Trends to 2050, Publications Office, Luxembourg, 2021, https://doi.org/10.2833/35750.

GEM-E3

Full title

General Equilibrium Model - Economy, Energy, Environment

Run for this impact assessment by

European Commission

Contributed to

Baseline and assessment of policy options

Helped to assess the following impacts

Impact area	Impact category	Impact subcategory
Economic impacts	Operating costs and conduct of business	Equal treatment of products and businesses
Economic impacts	Operating costs and conduct of business	Affects on individual Member States
Economic impacts	Trade and investment flows	EU Exports & imports
Economic impacts	Trade and investment flows	Investment flows & trade in services
Economic impacts	Trade and investment flows	Non-trade barriers
Economic impacts	Competitiveness (sectoral) of business	Cost of doing business
Economic impacts	Competitiveness (sectoral) of business	Business' capacity to innovate
Economic impacts	Competitiveness (sectoral) of business	Market share & advantages in international context
Economic impacts	Functioning of the internal market and competition	Free movement of goods, services, capital and workers
Economic impacts	Functioning of the internal market and competition	Competition
Economic impacts	Innovation and research	Innovation for productivity/resource efficiency
Economic impacts	Public authorities	Budgetary consequences for public authorities
Economic impacts	Consumers and households	Consumer's ability to benefit from the internal market or to access goods and services from outside the EU
Economic impacts	Consumers and households	Prices, quality, availability or choice of consumer goods and services
Economic impacts	Specific regions or sectors	Significant effects on sectors
Economic impacts	Specific regions or sectors	Disproportionately affected region or sector
Economic impacts	Third countries and international relations	Adjustment costs in developing countries
Economic impacts	Third countries and international relations	Goods traded with developing countries
Economic impacts	Macroeconomic environment	Economic growth and employment
Economic impacts	Macroeconomic environment	Investments and functioning of markets
Economic impacts	Macroeconomic environment	Macro-economic stabilisation
Social	Employment	Impact on jobs

Social	Employment	Impact on jobs in specific sectors, professions, regions or countries
Social	Employment	Indirect effects on employment levels
Social	Working Conditions	Wages, labour costs or wage setting mechanisms
Social	Social impacts in third countries	Employment, social protection and poverty impacts in non-Member States (including developing countries)
Environmental	Climate	Emission of greenhouse gases
Environmental	Climate	Economic incentives set up by market based mechanisms
Environmental	Sustainable consumption and production	Sustainable production and consumption
Environmental	Sustainable consumption and production	Relative prices of environmental friendly and unfriendly products
Environmental	Sustainable consumption and production	Polution by businesses
Environmental	International environmental impacts	Environment in third countries
Environmental	Transport and the use of energy	Energy and fuel consumption

EUROMOD

Full title

EUROMOD Microsimulation

Run for this impact assessment by

European Commission

Contributed to

Baseline and assessment of policy options

Helped to assess the following impacts

Impact area	Impact category	Impact subcategory
Economic impacts	Consumers and households	Consumer's ability to benefit from the internal market or to access goods and services from outside the EU
Economic impacts	Consumers and households	Prices, quality, availability or choice of consumer goods and services
Economic impacts	Consumers and households	Impact on vulnerable consumers
Social	Employment	Impact on jobs
Social	Employment	Impact on jobs in specific sectors, professions, regions or countries
Social	Working Conditions	Wages, labour costs or wage setting mechanisms
Social	Effects on income, distribution and social inclusion	Households income and at risk of poverty rates
Social	Effects on income, distribution and social inclusion	Inequalities and the distribution of incomes and wealth
Social	Effects on income, distribution and social inclusion	Financing and organisation of social protection systems
Social	Effects on income, distribution and social inclusion	Cross-border provision of services, referrals across borders and cooperation in border regions

PRIMES

Full title

PRIMES Energy System Model

Run for this impact assessment by

Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens.

Contributed to

Baseline and assessment of policy options

Helped to assess the following impacts

Impact area	Impact category	Impact subcategory
Economic impacts	Trade and investment flows	EU Exports & imports
Economic impacts	Trade and investment flows	Investment flows & trade in services
Economic impacts	Competitiveness (sectoral) of business	Cost of doing business
Economic impacts	Competitiveness (sectoral) of business	Business' capacity to innovate
Economic impacts	Competitiveness (sectoral) of business	Market share & advantages in international context
Economic impacts	Functioning of the internal market and competition	Free movement of goods, services, capital and workers
Economic impacts	Functioning of the internal market and competition	Competition
Economic impacts	Innovation and research	Innovation for productivity/resource efficiency
Economic impacts	Public authorities	Budgetary consequences for public authorities
Economic impacts	Consumers and households	Consumer's ability to benefit from the internal market or to access goods and services from outside the EU
Economic impacts	Consumers and households	Prices, quality, availability or choice of consumer goods and services
Economic impacts	Specific regions or sectors	Significant effects on sectors
Economic impacts	Specific regions or sectors	Disproportionately affected region or sector
Economic impacts	Third countries and international relations	Impacts on third countries
Economic impacts	Third countries and international relations	Goods traded with developing countries
Economic impacts	Macroeconomic environment	Investments and functioning of markets
Social	Employment	Impact on jobs
Social	Employment	Impact on jobs in specific sectors, professions, regions or countries
Social	Working Conditions	Wages, labour costs or wage setting mechanisms
Environmental	Climate	Emission of greenhouse gases
Environmental	Sustainable consumption and production	Sustainable production and consumption
Environmental	Sustainable consumption and production	Relative prices of environmental friendly and unfriendly products
Environmental	Sustainable consumption and production	Polution by businesses
Environmental	International environmental impacts	Environment in third countries
Environmental	Transport and the use of energy	Energy intensity of the economy
Environmental	Transport and the use of energy	Fuel mix used in energy production
Environmental	Transport and the use of energy	Energy and fuel consumption

GEM-E3

General Equilibrium Model - Economy, Energy, Environment

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 02/09/2021

Dissemination: Public

Overview

Acronym GEM-E3

Full title General Equilibrium Model - Economy, Energy, Environment

Main purpose

A macro-economic model used to assess energy, climate and air quality policies.

Summary

The GEM-E3 model is a global multi-sectoral general equilibrium model. GEM-E3 covers the interactions between the economy, the energy system and the environment. The model is used to calculate macro-economic impacts such as GDP, welfare, consumption, trade, employment, sectoral output, and carbon price.

It covers all EU Member States and the rest of the world, which is divided into 19 major economies. Countries are linked through endogenous bilateral trade. The calibration of the model is based on the GTAP database and uses techno-economic inputs from sectoral models such as POTEnCIA, PRIMES, POLES, GAINS, and GLOBIOM. The model simultaneously computes the equilibrium prices of goods, services, labour, capital and tradable emission rights such that all markets are in equilibrium. It integrates micro-economic behaviour into a macro-economic framework and allows assessing the medium to long-term implications of policies. The model evaluates the emissions of carbon dioxide (CO_2) and other GHG (e.g. CH_4). There are three mechanisms of emission reduction: (i) substitution between fuels, and between energetic and non-energetic inputs, (ii) emission reduction due to less production and consumption, and (iii) purchasing abatement equipment.

The model can be used for policy anticipation, formulation and implementation to assess macro-economic impacts of energy, climate and air quality policies. The model has been used, among others, for the Impact Assessments of the 2030 Framework of Energy and Climate Policies, its implementation in the context of the Energy Union, the Paris Agreement, and the Clean Air Package.

Keywords

Energy , Environment , Climate , General equilibrium , Climate policy , Air Pollution

Model category (thematic)

Economy

Model home page

https://ec.europa.eu/jrc/gem-e3

Ownership & license

Ownership

Joint copyright

Ownership details

The ownership is shared with the institutions that developed the model and the JRC, European Commission: a) Institute of Communication and Computer Systems - National Technical University of Athens (ICCS/NTUA); b) CES, Centre for Economic Studies, Katholieke Universiteit Leuven c) DG JRC, European Commission (C6) which has developed various modules for GEM-E3, as well as extended and updated the supporting databases (incl. GTAP).

Licence type

Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

GEM-E3 structure and approach
GEM-E3 can be used for policy anticipation, formulation and implementation.

In terms of anticipation and formulation, as applied general equilibrium model covering the interactions between the Economy, the Energy system and the Environment with high level of details, the GEM-E3 Model is well suited to assess the impact of climate, energy, and transport regulations, as well as fiscal, air quality, and labour market policies. It can simulate the welfare effects of alternative regulation regimes as well as the consequences of emission targets.

The Clean Air Programme for Europe envisages a regular update of the impact assessment analysis, to track progress towards the objectives of the Directive and to serve as input into the regular Clean Air Forum. In 2018 GEM-E3 was used to update the Impact Assessment during the implementation phase. For more information see http://ec.europa.eu/environment/air/clean_air/outlook.htm. Results featured in the First Clean Air Outlook.

One of the applications of the model includes an economic and employment impact assessment of different EU decarbonisation scenarios for 2050. This is included in the in-depth analysis accompanying the European Commission's *Clean Planet for All* communication of 2018. See https://ec.europa.eu/clima/policies/strategies/2050_en#tab-0-1

See https://ec.europa.eu/jrc/en/gem-e3 for latest updates.

Input and parametrization
- Input/Output tables and SAM (GTAP, Eurostat)

- Energy balances (International Energy Agency, IEA)

- Elasticity of Substitution and Armington elasticity (economic literature)

- Costs of Abatement Technology (Research Projects)

- Emission coefficients (Research Projects)

- Techno-economic inputs from sectoral models such as POTEnCIA, PRIMES, POLES, GAINS, and GLOBIOM

Main output
GEM-E3 analyzes the economic and distributional effects of environmental and economic policies for sectors, agents and regions. The output of GEM-E3 includes projections of

- input-output tables

- employment

- trade

- capital flows

- government revenues

- household consumption

- energy use

- atmospheric emissions.

The model allows the evaluation of the welfare and distributional effects of various environmental policy scenarios, including different burden sharing scenarios, environmental instruments (i.e. taxes, pollution permits or command-and-control policy) and revenue recycling scenarios.

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage (Spatial) resolution	Global coverage; EU 27 Member States + UK and 18 World Regions
	Country level for each of the 27 EU Member States and for 8 non-EU countries; regional resolution for the rest of the world
Temporal extent	Currently, typical runs go up to 2050 (but can be extended beyond if there is a need to)
Temporal resolution	The model is solved in 5-year steps

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	yes	Policy uncertainty is covered by running several scenarios in a what-if fashion
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	Sensitivity of output results is done on ad-hoc basis
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	The output published in academic papers and presented on academic conferences have been reviewed by peers. In addition, separate versions of the model are run independently by JRC and NTUA / E3M-Lab in Athens, enabling comparison of findings and investigation of differences.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	As the model does not aim to predict the future, we mainly validate the model through results with our peer group. In addition, elasticity parameters are based on historical data to validate partial model responses, such as reactions to changes in energy prices

References related to external peer-review and publication in scientific journals:

- Vandyck T; Keramidas K; Saveyn B; Kitous A; Vrontisi Z. A global stocktake of the Paris pledges: Implications for energy systems and economy. GLOBAL ENVIRONMENTAL CHANGE-HUMAN AND POLICY DIMENSIONS 41; 2016. p. 46-63. JRC101134

- Vandyck, T., Keramidas, K., Kitous, A., Spadaro, J., Van Dingenen, R., Holland, M. and Saveyn, B., Air quality co-benefits for human health and agriculture counterbalance costs to meet Paris Agreement pledges, NATURE COMMUNICATIONS, ISSN 2041-1723 (online), 9, 2018, p. 4939, JRC111245.

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	yes	The core data, GTAP, are publicly available (if purchased) Other major inputs like IEA energy balances etc. are as well. The input-output tables for future years are published and freely available for the GECO report (from 2018 onwards).
Can model outputs be made publicly available?	yes	Output usually is published in Report and academic papers. Most of them can be downloaded from https://ec.europa.eu/jrc/en/gem-e3/publications

		More detailed output can be published upon request
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	See model documentation. JRC C.6 published a complete manual as an open-access Technical Report in 2013 with a detailed description of the model. Documentation of the NTUA/E3M-Lab version is also available online under http://www.e3mlab.eu/e3mlab/index.php?option=com_content&view=article&id=56%3Amanual-of-gem-e3-model&catid=36%3Agem-e3&Itemid=71&lang=en
Is the model source code publicly accessible or open for inspection?	no	The GAMS model code is not published as such, but can be replicated from the published set of equations.

References related to documentation:

- Capros P, Van Regemorter D, Paroussos L, Karkatsoulis P, Fragkiadakis C, Tsani S, Charalampidis I, Revesz T, authors Perry M, Abrell J, Ciscar Martinez J, Pycroft J, Saveyn B, editors. GEM-E3 Model Documentation. EUR 26034. Luxembourg (Luxembourg): Publications Office of the European Union; 2013. JRC83177

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas
- Climate action
- Taxation
- Employment and social affairs
- Energy
- Environment
- Transport

The model is designed to contribute to the following phases of the policy cycle
- Anticipation
- Formulation
- Implementation

The model's potential
GEM-E3 can be used for policy anticipation, formulation and implementation.

In terms of anticipation and formulation, as applied general equilibrium model covering the interactions between the Economy, the Energy system and the Environment with high level of details, the GEM-E3 Model is well suited to assess the impact of climate, energy, and transport regulations, as well as fiscal, air quality, and labour market policies. It can simulate the welfare effects of alternative regulation regimes as well as the consequences of emission targets.

The Clean Air Programme for Europe envisages a regular update of the impact assessment analysis, to track progress towards the objectives of the Directive and to serve as input into the regular Clean Air Forum. In 2018 GEM-E3 is used to update the Impact Assessment during the implementation phase. For more information see http://ec.europa.eu/environment/air/clean_air/outlook.htm. Results featured in the First Clean Air Outlook.

One of the applications of the model includes an economic and employment impact assessment of the European Commission's strategic long-term vision for greenhouse gas reductions, a document that sets the stage for the debate on the long-term climate policy in the EU.

Concerning contributions to Impact Assessments see www.gem-e3.net for latest updates.

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments <u>since July 2017</u>.

In the Year	GEM-E3 contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2021	Impact assessment accompanying the document Proposal for a Council Directive: restructuring the Union framework for the taxation of energy products and electricity (recast) SWD/2021/641 final	TAXUD	Baseline and assessment of policy options	*European Commission*	The model helped to assess the following impacts: - Equal treatment of products and businesses - Affects on individual Member States - EU Exports & imports - Investment flows & trade in services - Cost of doing business - Business' capacity to innovate - Market share & advantages in international context - Free movement of goods, services, capital and workers - Competition - Innovation for productivity/resource efficiency - Budgetary consequences for public authorities - Consumer's ability to benefit from the internal market or to access goods and services from outside the EU - Prices, quality, availability or choice of consumer goods and services - Significant effects on sectors - Disproportionately affected region or sector - Goods traded with developing countries - Economic growth and employment - Investments and functioning of markets - Macro-economic stabilisation - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Indirect effects on employment levels - Wages, labour costs or wage setting mechanisms - Employment, social protection and poverty impacts in non-Member States (including developing countries) - Emission of greenhouse gases

					- Economic incentives set up by market based mechanisms - Emissions of acidifying, eutrophying, photochemical or harmful air pollutants - Sustainable production and consumption - Relative prices of environmental friendly and unfriendly products - Polution by businesses - Environment in third countries - Energy intensity of the economy - Fuel mix used in energy production - Demand for transport - Vehicle emissions - Energy and fuel consumption
2021	Impact assessment accompanying the Proposal for a Directive of the European Parliament and the Council: amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 SWD/2021/621 final	ENER	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The model helped to assess the following impacts: - Significant effects on sectors - Economic growth and employment - Investments and functioning of markets - Macro-economic stabilisation - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Indirect effects on employment levels - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth - Access to and quality of social protection benefits
2021	Impact assessment accompanying the Proposal for a Directive of the European Parliament and of the Council: on energy efficiency (recast) SWD/2021/623 final	ENER	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The model helped to assess the following impacts: - EU Exports & imports - Cost of doing business - Economic growth and employment - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Wages, labour costs or wage setting mechanisms
2021	Impact assessment accompanying the document Proposal for a regulation of the European Parliament and of the Council: establishing a carbon border	TAXUD	Baseline and assessment of policy options	*European Commission*	The model helped to assess the following impacts: - Equal treatment of products and businesses - Affects on individual Member

	adjustment mechanism SWD/2021/643 final			States - EU Exports & imports - Investment flows & trade in services - Non-trade barriers - Cost of doing business - Business' capacity to innovate - Market share & advantages in international context - Free movement of goods, services, capital and workers - Competition - Innovation for productivity/resource efficiency - Budgetary consequences for public authorities - Consumer's ability to benefit from the internal market or to access goods and services from outside the EU - Prices, quality, availability or choice of consumer goods and services - Significant effects on sectors - Disproportionately affected region or sector - Adjustment costs in developing countries - Goods traded with developing countries - Economic growth and employment - Investments and functioning of markets - Macro-economic stabilisation - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Indirect effects on employment levels - Wages, labour costs or wage setting mechanisms - Employment, social protection and poverty impacts in non-Member States (including developing countries) - Emission of greenhouse gases - Economic incentives set up by market based mechanisms - Sustainable production and consumption - Relative prices of environmental friendly and unfriendly products - Polution by businesses - Environment in third countries - Energy and fuel consumption
2021	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council:	CLIMA	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory,*	GEM-E3 is used for macroeconomic assessment of different CO2 emission standards for vehicles levels.

	amending Regulation (EU) 2019/631 as regards strengthening the CO2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition SWD/2021/613 final			*National Technical University of Athens*	
2020	Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Stepping up Europe's 2030 climate ambition SWD/2020/176 final	CLIMA	Baseline only	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	GEM-E3 is used for sectoral economic assumptions used as inputs for the PRIMES energy system model.
2020	Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Stepping up Europe's 2030 climate ambition SWD/2020/176 final	CLIMA	Baseline and assessment of policy options	*European Commission*	GEM-E3 is used for the assessment of the impacts of policy options on key economic variables, including GDP, sectoral output and aggregate and sectoral employment.
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast) SWD/2017/0650 final	CLIMA	Baseline and assessment of policy options	*European Commission*	GEM-E3 was used to assess macroeconomic impacts of target setting based on GDP per capita.
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast) SWD/2017/0650 final	CLIMA	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The model has been used by E3MLab/ICCS to provide the macro assumptions for the Reference scenario and for the policy scenarios.

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EUROMOD

EUROMOD Microsimulation

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 02/09/2021

Dissemination: Public

Overview

Acronym EUROMOD
Full title EUROMOD Microsimulation

Main purpose
A static tax benefit microsimulation model, covering the EU Member States and the UK (up to 2020), used to assess the budgetary and distributional consequences of consolidated and prospective policy reforms.

Summary
EUROMOD is a static tax-benefit microsimulation model. Originally maintained, developed and managed by the Institute for Social and Economic Research (ISER), since 2021 EUROMOD is maintained, developed and managed by the Joint Research Centre (JRC) of the European Commission, in collaboration with EUROSTAT and national teams from the EU countries. The project is financially supported by DG EMPL, DG ECFIN, DG TAXUD and DG REFORM.

EUROMOD covers all European countries in a consistent manner, allowing for flexibility of the analyses and comparability of the results. EUROMOD combines information on policy rules with detailed and representative micro-data on individual and household circumstances drawn from the EU Statistics on Income and Living Conditions (EU-SILC). The simulations cover a large part of the tax and benefit components of household disposable income, in particular direct taxes and non-contributory cash benefits. The components of disposable income which are not simulated are taken directly from the data. Additionally, a specific EUROMOD module allows performing simulations based on hypothetical household data, a synthetic set of microdata where family and labour market characteristics are defined by the user.

EUROMOD can be used for policy formulation or evaluation, to analyse the effects of actual and prospective changes in tax-benefit policies over time, studying for example their budgetary implications, the effects on poverty and inequality and the impact on work incentives.

A EUROMOD extension (Indirect Tax Tool) allowing the simulation of indirect taxes in 18 EU countries is currently under development. The JRC intends to further extend the number of countries included by end 2021.

Keywords
tax-benefit , microsimulation

Model category (thematic)
Economy

Model home page
https://euromod-web.jrc.ec.europa.eu/

Ownership & license

Ownership
Joint ownership [Original code owned by 3rd party]

Ownership details
European Union, Institute for Social and Economic Research, University of Essex. Between 2004 and 2018, EUROMOD was developed, managed, maintained and updated by the Microsimulation Unit of the Institute for Social and Economic Research, based at the University of Essex, with support and funding of the European Union. Since 2018, EUROMOD has been co-developed by the University of Essex and by the Joint Research Centre of the European Commission. The intellectual property rights, including copyright, on EUROMOD are jointly owned by the University of Essex and the European Union. The Joint Research Centre of the European Commission has taken over the sole responsibility for the further development, management, maintenance and update of EUROMOD as of January 2021. The transfer of EUROMOD has been a joint effort by DG EMPL together with DG ECFIN, DG TAXUD, DG REFORM, DG ESTAT and DG JRC.

Licence type
Free software licence. The license grants freedom to run the programme for any purpose; freedom to run the program for any purpose; freedom to study (by accessing the source code) how the program works, and change it so it does enable computing; freedom to redistribute copies; and freedom to distribute copies of modified versions to others.

Details

EUROMOD structure and approach

For a complete overview of EUROMOD readers are invited to consult Sutherland and Figari (2013), "EUROMOD: The European Union Tax-Benefit Microsimulation Model", International journal of microsimulation, 6(1) 4-26". The paper is the main source of information for the following sections (Detail on EUROMOD structure and approach; Input and parameters).

EUROMOD is a static tax-benefit calculator that allows the simulation of tax liabilities and benefit entitlements for a representative sample of households and individuals in each EU Member State and the UK (up to 2020). The model is static and non-behavioural, in the sense that it does not take into account socio-demographic changes and behavioural responses of individuals. The scope of EUROMOD simulations includes Personal Income Tax, Social Insurance Contributions paid by employees, self-employed and employers and most non-contributory benefits. Contributory benefits (e.g. pensions) are usually not simulated because of lack of relevant information (e.g. contribution history) in the underlying data. Nevertheless, some contributory benefits such as unemployment benefits are simulated making use of assumptions where needed. For those not simulated, the values collected in the underlying data are used and included in the concept of disposable income.

Depending on when a country module was first introduced in EUROMOD, the first policy system included in the model varies from 2005 to 2007 (2011 for Croatia). All the following policy systems are included up to the current year (2021) with the exception of the UK, which is updated until 2020.

EUROMOD baseline simulations are validated and tested both at a micro level (i.e. case-by-case validation) and at macro level (comparing aggregate amounts and recipients/payers with official statistics). A similar process is applied to income distribution and poverty statistics. The results of the validation exercises are reported in the Country Reports (available on the EUROMOD web pages).

Although EUROMOD simulations usually assume full benefit take up and full tax-compliance, adjustments for benefit non take-up and/or tax evasion are simulated in a number of country modules. Such adjustments are modelled in a transparent way that can be activated or deactivated by users.

EUROMOD code is written in C# and compiled. Users use the model through a standalone user interface, programmed using Microsoft .net Framework.

See Sutherland and Figari (2013) for a complete overview of EUROMOD.

Input and parametrization

EUROMOD input datasets are usually derived from the European Union Statistics on Income and Living Conditions (EU-SILC), as harmonised by EUROSTAT. In some cases the EU-SILC is enriched using variables contained in the national SILC surveys, which are the basis for the harmonised version. In some other

cases the national SILC surveys are used directly. The EUROMOD input datasets include the following key inputs:

- demographics at household and individual level

- labour market characteristics

- gross incomes from market and other income sources (i.e. pensions, public transfers and private incomes)

A network of teams of national experts also collects information on the policy rules in place in each country each year.

The original survey data undergo a process of transformation and imputation before being used as EUROMOD input dataset. In particular, a process of imputation aimed at "splitting" the aggregated benefit variables provided in EU-SILC is applied. The process is described in the EUROMOD country reports. In addition, variables are renamed to follow the EUROMOD naming conventions (aimed at improving cross-country comparability).

The income variables contained in a EUROMOD input dataset are uprated using specific uprating factors when the year to which the income variables refers to differs from the tax-benefit systems to be simulated.

Starting from 2021, EUROSTAT and JRC, with the agreement of the National Statistical Institutes, are gradually implementing a new data production workflow. It consists in EUROSTAT producing and distributing to National teams a new dataset called EUROMOD SILC Database (EMSD) containing the harmonised EU-SILC already enriched with selected variables form national SILC and information derived from the SILC production database (PDB). The new data workflow simplifies the process of accessing Nationals SILC variables and the dissemination of the EUROMOD input data among users.

See Sutherland and Figari (2013) for a complete overview of EUROMOD.

Main output
The output microdata contains information on the:

- demographic characteristics of individuals and households, as well as their financial circumstances

- simulated and non-simulated tax-benefit instruments

- disposable income.

The information contained in the output microdata can be analysed using built-in plugins (Statistics Presenter and In-depth analysis) or other statistical software (such as R or STATA).

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	EU Member states 27 and UK
(Spatial) resolution	Individual and household level
Temporal extent	2005 – current year (8 countries); 2006 – current year (17 countries); 2007-current year (26 countries); 2011-current year (27 countries); 2005-2020 (UK)
Temporal resolution	Yearly

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	no	Deterministic model. Users can design uncertainty through simulating various scenarios.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	not_applicable	Due to the nature of the model this does not apply.
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	Model review is assured by its academic and policy uses and annual validation. EUROMOD coding language allow users to check what is modelled and how. Papers using EUROMOD are published in peer-reviewed journals.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	Simulation results are validated against official statistics. The validation process is documented in a series of country reports.

References related to external peer-review and publication in scientific journals:

- No references provided in MIDAS

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	no	Underlying input data are made available by the European Commission (for EU member states) and the University of Essex (for the UK) to researchers who have a EUROMOD-related Research Project Proposal (RPP) approved by EUROSTAT. See EUROMOD website for more information. However, the model also runs with hypothetical data created by the user, for which no authorization is needed. Additionally, users can create their own input microdata based on other sources, e.g. administrative registers.
Can model outputs be made publicly available?	yes	Output microdata can be only made shared among approved researchers. However, aggregate indicators derived from the output microdata can be made publicly available, as long as they respect the confidentiality rules set by the data providers. Selected indicators are made available in the EUROMOD website.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	The coding of all tax-benefit policies is visible for the users. The model structure is documented in built-in help and user documentation included in the model. Model simulations and content are described in country reports publicly available on the EUROMOD website. The process

		of data manipulation for the creation of the EUROMOD input dataset is described in the Data Requirement Documents (DRDs), provided together with the EUROMOD input datasets.
Is the model source code publicly accessible or open for inspection?	yes	EUROMOD is released as open source. The model can be downloaded from the EUROMOD website: https://euromod-web.jrc.ec.europa.eu/access-euromod. The source code of the software can be downloaded from GitHub: https://github.com/ec-jrc/JRC-EUROMOD-software-source-code

References related to documentation:

- No references provided in MIDAS

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas
- Economy, finance and the euro

The model is designed to contribute to the following phases of the policy cycle
- Formulation
- Evaluation

The model's potential

EUROMOD is unique in being a research tool that is relevant not only at national level and as an integrated tool for European comparative social science research, but also as a model of the EU as a whole. EUROMOD brings a distinctive economic research on the redistributive effects of tax-benefit policies across Europe.

The JRC has developed an interaction of EUROMOD with the DG ECFIN model QUEST in close collaboration with DG ECFIN and ZEW-Mannheim (see Barrios et al., 2016). Published JRC research includes analyses of in-work tax expenditures for low income workers (see Barrios et al., 2015) and contributions to the Commission Tax reforms in the EU Member States report (see European Commission 2014, 2015). EUROMOD is also used in combination with the GEM-E3 model to analyse the distributional impact of green taxes. EUROMOD provides also the micro-parameters needed to run the EDGE-M3 model.

The model has increasingly been used by the Commission services over the past few years. DG EMPL uses results from the model for its Quarterly and Annual reports on Employment and Social Developments in Europe (European Commission 2018) and different research notes delivered in the context of the Social Situation Monitor are based on EUROMOD. EUROMOD based simulations are also used by DG ECFIN in the Report on Public Finances in EMU (European Commission 2017). EUROMOD is also used by ESTAT for the production of the flash estimates on income and poverty: https://ec.europa.eu/eurostat/web/experimental-statistics/income-inequality-and-poverty-indicators. Improved timeliness in the data production and the flash estimates using EUROMOD are part of a two-pillar strategy in order to ensure more recent data for income indicators for policy making. The use of the EUROMOD model for the provision of near-real time information on income indicators is therefore critical in the context of the European Semester. The JRC uses the model in cooperation with policy DGs, in particular DG ECFIN, DG TAXUD, DG EMPL and the SRSS. Since 2015 the JRC contributes to the preparation of the Country reports for the European Semester and produces regular notes also circulated in other policy DGs (the so-called "In-depth analyses of tax reforms using the EUROMOD model"). These notes were extensively used in the Country reports of the European Semester. EUROMOD has also been used for the Social Impact Assessment of the third Greek Stabilisation programme in cooperation with DG EMPL and DG REFORM for the assessment of the reform of the

personal income system in Greece in 2015 and 2016. EUROMOD has also been used to provide technical assistance to the Greek Ministry of Finance (2018-2021) and it is currently being used for technical support to Romania, Lithuania and Slovakia (since 2020).

Work with DG TAXUD extended the model to improve the coverage of wealth taxation and for future analyses of tax shifting between corporate income taxes and personal income taxes. The model has been extended to account for labour supply adjustment combining EUROMOD and an econometrically estimated labour supply model. This extension covers all the EU Member States. The JRC is also currently extending the model to cover consumption taxation (VAT and excises). The model provided also input to a study on the fiscal impact of migration (2020) in cooperation with IIASA.

The JRC has developed a "simplified" version of EUROMOD, based on a web interface, which can be accessed upon request by researchers and policy analysts.

EUROMOD has been used extensively to assess, among others, the extent to which policy responses to the COVID-19 crisis in Member States have cushioned household incomes losses during the pandemic. The Commission Staff Working Documents analysing the recovery and resilience plans of several Member States (June 2021) cite this work.

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments <u>since July 2017</u>.

In the Year	EUROMOD contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2021	Impact assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council: to strengthen the application of the principle of equal pay for equal work or work of equal value between men and women through pay transparency and enforcement mechanisms SWD/2021/41 final	JUST	Baseline and assessment of policy options	*European Commission*	The model helped to assess the following impacts: - Budgetary consequences for public authorities - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth - Specific effects on particular risk groups - Different impact on women and men
2021	Impact assessment accompanying the document Proposal for a Council Directive: restructuring the Union framework for the taxation of energy products and electricity (recast) SWD/2021/641 final	TAXUD	Baseline and assessment of policy options	*European Commission*	The model helped to assess the following impacts: - Consumer's ability to benefit from the internal market or to access goods and services from outside the EU - Prices, quality, availability or choice of consumer goods and services - Impact on vulnerable consumers - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Wages, labour costs or wage setting mechanisms - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth - Financing and organisation of social protection systems - Cross-border provision of services, referrals across borders and cooperation in border regions
2021	Impact assessment accompanying the document Proposal for a regulation of the European	TAXUD	Baseline and assessment of policy options	*European Commission*	The model helped to assess the following impacts: - Consumer's ability to benefit

	Parliament and of the Council: establishing a carbon border adjustment mechanism SWD/2021/643 final				from the internal market or to access goods and services from outside the EU - Prices, quality, availability or choice of consumer goods and services - Impact on vulnerable consumers - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Wages, labour costs or wage setting mechanisms - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth - Financing and organisation of social protection systems - Cross-border provision of services, referrals across borders and cooperation in border regions
2020	Impact assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council: on adequate minimum wages in the European Union SWD/2020/245 final	EMPL	Baseline and assessment of policy options	*European Commission*	The model helped to assess the following impacts: - Budgetary consequences for public authorities - Economic growth and employment - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Wages, labour costs or wage setting mechanisms - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth
2018	Impact assessment accompanying the document Proposal for a Council recommendation on: access to social protection for workers and the self-employed SWD/2018/070 final	EMPL	Baseline and assessment of policy options	*European Commission*	The model helped to assess the following impacts: - Employment protection - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth - Financing and organisation of social protection systems
2018	Impact assessment accompanying the document Proposal for a Council recommendation on: access to social protection for workers and the self-employed	EMPL	Baseline and assessment of policy options	*Fondazione Giacomo Brodolini*	The model helped to assess the following impacts: - Employment protection - Households income and at risk of poverty rates

SWD/2018/070 final	- Inequalities and the distribution of incomes and wealth - Financing and organisation of social protection systems Documented in: - DOI 10.2767/65810

Bibliographic references

- *Employment and social developments in Europe 2018. - 10.2767/875456*

- *Report on public finances in EMU 2017. - 10.2765/256263*

- *The fiscal effects of work-related tax expenditures in Europe. - 10.2765/6099*

- *Tax reforms in EU Member States 2015 : tax policy challenges for economic growth and fiscal sustainability. - 10.2765/274179*

- *Tax reforms in EU Member States : tax policy challenges for economic growth and fiscal sustainability : 2014 report. - 10.2778/68699*

PRIMES

PRIMES Energy System Model

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 02/09/2021

Dissemination: Public

Overview

Acronym PRIMES
Full title PRIMES Energy System Model

Main purpose
Energy system model designed to project the energy demand, supply, prices, trade and emissions for European countries and assess policy impacts.

Summary
The PRIMES (Price-induced market equilibrium system) model is being developed by E3Modelling, a spin-off of the E3MLab at National Technical University of Athens (NTUA). The model is suited for medium-term and long-term (up to 2070) projections in 5-year steps and covers all EU Member States, and EFTA (except Lichtenstein) and candidate countries.

PRIMES combines micro-economic foundations of the behavioural modelling with the engineering and energy-system approach, covering all energy sectors and markets at a disaggregated level. The model determines energy prices, energy supply, energy demand, trade, emissions, costs and investment. Furthermore, the model captures the technology learning and economies of scale.

PRIMES can be used for policy analysis and impact assessment. It provides energy sectors, markets and system projections including energy system restructuring, both in the demand and supply sides. The model can support the impact assessment of specific energy, transport and environment policies and measures applied either at the Member State or EU level, including taxation, subsidies, emissions trading system, technology promoting policies, renewable energy sources policies, efficiency promoting policies, environmental policies and technology standards.

PRIMES can be linked to other models such as GAINS and GLOBIOM for a full coverage of sectors when assessing climate or environmental policies.

Keywords
emissions , energy demand , energy supply

Model category (thematic)
Energy

Model home page
https://e3modelling.com/modelling-tools/primes/

Ownership & license

Ownership

Sole ownership [3rd party]

Ownership details

E3Modelling and E3Mlab at NTUA

Licence type

Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

PRIMES structure and approach

The PRIMES model (Price-Induced Market Equilibrium System) is a large scale applied energy system model that provides detailed projections of energy demand, supply, prices and investment into the future, covering the entire energy system including emissions. The distinctive feature of PRIMES is the combination of behavioural modelling (following a micro-economic foundation of optimisation by agent or sector) with engineering aspects, covering all energy sectors, and with market equilibrium. The model includes a detailed representation of instruments for policy impact assessment related to energy markets, technology adoption and climate mitigation, including market drivers, standards, and targets by sector or overall. It simulates the EU Emissions Trading System in its current form (changes can be simulated). It handles multiple policy objectives, such as GHG emissions reductions, energy efficiency, and renewable energy targets, and provides pan-European simulation of internal markets for electricity and gas.

PRIMES offer the possibility of handling market distortions, barriers to rational decisions, behaviours and market coordination issues and it performs a full accounting of costs (CAPEX and OPEX) and investment in equipment, energy savings and infrastructure. The model covers the horizon up to 2070 in 5-year interval periods and includes all Member States of the EU individually, as well as neighbouring and candidate countries in Europe. PRIMES is designed to analyse complex interactions within the energy system in a multiple agent – multiple markets framework.

Decisions by agents are formulated based on microeconomic foundation (utility maximization, cost minimization influenced by market equilibrium) embedding engineering constraints and explicit representation of technologies and capital vintages; optionally perfect or imperfect foresight for the modelling of investment applies in all sectors. The model allows simulating long-term transformations/transitions and includes non-linear formulation of potentials by type (resources, sites, acceptability etc.) and technology learning.

The PRIMES model is modular and consists of several sub-models (modules), each one representing the behaviour of a specific agent, a demander or supplier of energy. Sub-models link with each other through a model integration algorithm, which determines equilibrium prices in multiple markets and equilibrium volumes, including cap and trade systems (e.g. ETS), which satisfy balancing and policy, e.g. emissions, constraints and policy targets.

Demand modules formulate a representative agent who maximises benefits (profit, utility, etc.) from the energy demand and non-energy inputs (commodities, production factors) subject to prices, budget and other constraints. Constraints relate to activity, comfort, equipment, technology, environment or the fuel availability. In the demand sub-models, the agents may be simultaneously self-producers of energy services (e.g. using a private car, heating using a residential boiler, etc.) and purchasers of marketed energy commodities. The pricing of self-supplied energy services is endogenous and reflects average total costs. The mix of self- supply and the purchasing from external suppliers (e.g. private cars

versus public transportation, residential boiler versus district heating) derives from agent's optimisation, which depends on market conditions where the agents are price-takers.

Supply modules formulate stylised companies aiming at minimising costs (or maximising profits in model variants focusing on market competition) to meet demand subject to constraints related to capacities, fuel availability, environment, system reliability, etc. Supply-side modules determine commodity and infrastructure prices by end-use sector (tariffs) by applying various methodologies by sector as appropriate for recovering costs depending on market conditions and regulations.

Both demand and supply modules are subject to system-wide constraints, mirroring overall targets for example on emissions, renewables, efficiency, import dependency, etc. When binding, constraints convey non-zero shadow prices (dual values) to the demand and supply modules. Hence, the PRIMES model has overall a mixed-complementarity mathematical structure.

Agents are price-takers when being energy demanders and price-makers when being energy suppliers. Optionally, the model can handle non-perfect market competition regimes. The electricity and gas market modules can optionally include explicit companies and apply the Nash-Cournot competition with conjectural variations. Pricing and costing includes taxes, subsidies, levies and charges, congestion fees, tariffs for use of infrastructure etc. Usually, these instruments are exogenous to the model and reflect policy assumptions.

PRIMES follows a descriptive approach concerning factors which influence decisions by private entities, where perceived costs and uncertainty factors play a significant role. Policy measures can reduce uncertainty and decrease perceived costs: such mechanism in the model is often used to simulate policy inducing higher uptake of advanced technology or investment enabling accelerated energy efficiency progress.

The capital formation derives from an economically driven investment and follows a dynamic accounting of equipment technology vintages: equipment invested on a specific date inherits the technical-economic characteristics of the technology vintage corresponding to that date. Capital turnover is dynamic and the model keeps track of capital vintages and their specific technical characteristics. The agent's investment behaviour consists in building or purchasing new energy equipment to cover new needs, or retrofitting existing equipment or even for replacing prematurely old equipment for economic reasons.

The PRIMES model is fully dynamic and has options regarding future anticipation by agents in decision-making. Usually, PRIMES assumes a perfect foresight over a short time horizon for demand sectors and an imperfect foresight over long time horizon for supply sectors. All economic decisions of agents are dynamic and concern both operation of existing equipment and investment in new equipment, both when equipment is using energy and when it is producing energy.

The PRIMES model also includes a detailed numerical model on biomass supply, namely PRIMES-Biomass, which simulates the economics of supply of biomass and waste for energy purposes through a network of current and future processes. The PRIMES-Biomass model is a key link of communication

between the energy system projections obtained by the PRIMES energy system model and the projections on agriculture, forestry and non-CO2 emissions provided by other modelling specialist tools (CAPRI, GLOBIOM/G4M, GAINS).

Computationally, PRIMES solves an EPEC problem (equilibrium problem with equilibrium constraints), which allows prices to be explicitly determined. The overall convergence algorithm simultaneously determines multi-market equilibrium while meeting system-wide constraints.

Input and parametrization
A summary of database sources, in the current version of PRIMES, is provided below:

- Eurostat and EEA: Energy Balance sheets, Energy prices (complemented by other sources, such IEA), macroeconomic and sectoral activity data (PRIMES sectors correspond to NACE 3-digit classification), population data and projections, physical activity data (complemented by other sources), CHP surveys, CO2 emission factors (sectoral and reference approaches) and EU ETS registry for allocating emissions between ETS and non ETS, Process CO2 emisssions

- Technology databases: ODYSSEE-MURE, ICARUS, Eco-design, VGB (power technology costs), TECHPOL – supply sector technologies, NEMS model database, IPPC BAT Technologies

- Power Plant Inventory: ESAP SA and PLATTS

- RES capacities, potential and availability: JRC ENSPRESO, JRC EMHIRES, RES ninja, ECN, DLR and Observer, IRENA

- Network infrastructure: ENTSOE, GIE, other operators

- Other databases: District heating surveys (e.g. from COGEN), buildings and houses statistics and surveys (various sources, including ENTRANZE project, INSPIRE archive, BPIE), JRC-IDEES, update to the EU Building stock Observatory

The model is fully calibrated to match the historical energy balance of the last PRIMES historical year (5-year step modelling: historical points years are 2000, 2005, 2010, 2015, ..) and to capture the more recent evolution since that year.

Main output
The PRIMES model provides, per country represented and for the EU as a whole detailed and comprehensive energy balances of the energy system, related CO2 emissions and detailed economic information associated to the energy system (investments, costs, prices, taxes, ..).

In association with the GAINS model and the GLOBIOM model, it provides comprehensive GHG balances per country represented and for the EU as a whole.

Spatial - temporal extent
The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	EU Member States plus United Kingdom, Norway, Switzerland, Iceland, Albania, Serbia, Montenegro, Kosovo, Bosnia-Herzegovina, FYROM and Turkey.
(Spatial) resolution	Country level
Temporal extent	Until 2070
Temporal resolution	5 yearly

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	yes	Uncertainties on assumptions can be addressed by producing variants with the model.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	Sensitivity analysis can be produced with the model.
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	The model has undergone a peer review. See Commission staff working paper: SEC(2011)1569.

Results have been published in peer-reviewed journals. The model has been used in multiple peer reviewed publications, that can be found here: https://e3modelling.com/publications/ |
| Has model validation been done? Have model predictions been confronted with observed data (ex-post)? | not_applicable | The model is calibrated on historical data. The model does not do predictions but comparative scenario analysis based on assumptions. |

References related to external peer-review and publication in scientific journals:
- No references provided in MIDAS

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	yes	The input data to the model is not published, but it builds on multiple sources, a large number of which being publicly accessible.
Can model outputs be made publicly available?	yes	Selected model outputs are made publicly available. Published outputs are defined by the Commission and are project-specific.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	The model documentation is publicly available. The model documentation includes the architecture and logic of the model and its different modules as well as the mathematical formulation.
Is the model source code publicly accessible or open for inspection?	no	The code is not open. However, the mathematical formulations of the model are published in the manual as well as in peer reviewed articles.

References related to documentation:

- No references provided in MIDAS

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas
- Climate action
- Energy
- Transport

The model is designed to contribute to the following phases of the policy cycle
- Formulation

The model's potential
The PRIMES model is designed to provide long-term energy system projections and system restructuring up to 2070, both in demand and supply sides. The model (including its transport module PRIMES-TREMOVE) can support impact assessment of specific energy, climate, transport and environment policies and measures, applied at Member State or EU level, including price signals, such as taxation, subsidies, ETS, as well as technology promoting policies, RES supporting policies, efficiency promoting policies, environmental policies and technology standards. The PRIMES model is sufficiently detailed to represent concrete policy measures in various sectors, including market design options for the EU internal electricity and gas markets. Policy analysis is based on comparative analysis of policy scenarios against a "baseline" projection.

NOTE *The field 'use of the model in ex-ante impact assessments of the European Commission' focuses on the contributions of the model to the assessment of policy options.*

In addition, please note that the model has also been extensively used in impact assessments to contribute to the construction of the baseline as part of the modelling framework of the EU reference scenario 2016 Energy, transport and GHG emissions : trends to 2050, Luxembourg: Publications Office of the European Union, 2016, doi:10.2833/9127.

The use of the Reference Scenario is reported under 'Additional information' in the entries of the related impact assessments.

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments <u>since July 2017</u>.

In the Year	PRIMES contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2021	Impact assessment accompanying the Proposal for a Regulation of the European Parliament and of the Council: on the use of renewable and low-carbon fuels in maritime transport SWD/2021/635 final	MOVE	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	PRIMES is one of the core models of the modelling framework for energy, transport and greenhouse gas emissions projections. PRIMES-Maritime, a module of PRIMES and PRIMES-TREMOVE transport model, provided the developments in the maritime transport activity, energy use in the maritime sector, the greenhouse gas emissions and air pollution emissions, as well as the associated costs. The PRIMES model also provided an assessment of the biomass feedstock and the electricity consumption for producing synthetic fuels, while ensuring the links with the rest of the energy system.
2021	Impact assessment accompanying the Proposal for a Directive of the European Parliament and the Council: amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 SWD/2021/621 final	ENER	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The model helped to assess the following impacts: - Significant effects on sectors - Economic growth and employment - Investments and functioning of markets - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Households income and at risk of poverty rates - Emission of greenhouse gases - Economic incentives set up by market based mechanisms - Emission of ozone-depleting substances - Ability to adapt to climate change - Energy intensity of the economy - Fuel mix used in energy production

					- Demand for transport - Vehicle emissions - Energy and fuel consumption - Change in land use
2021	Impact assessment accompanying the Proposal for a Directive of the European Parliament and of the Council: on energy efficiency (recast) SWD/2021/623 final	ENER	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The model helped to assess the following impacts: - Investment cycle - Markets for Innovation - Innovation for productivity/resource efficiency - Investments and functioning of markets - Emission of greenhouse gases - Energy intensity of the economy - Fuel mix used in energy production - Energy and fuel consumption
2021	Impact assessment accompanying the Proposal for a Regulation of the European Parliament and of the Council: on ensuring a level playing field for sustainable air transport SWD/2021/633 final	MOVE	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	PRIMES is one of the core models of the modelling framework for energy, transport and greenhouse gas emission projections. The PRIMES-TREMOVE model, a module of PRIMES, provided the developments in the air transport activity, the energy use in the aviation sector, the greenhouse gas emissions and air pollution emissions, as well as the associated costs. The PRIMES model also provided an assessment of the biomass feedstock and the electricity consumption for producing synthetic fuels, while ensuring the links with the rest of the energy system. Supporting study: Ricardo et al. , Study supporting the impact assessment of the ReFuelEU Aviation initiative
2021	Impact assessment accompanying the Proposal for a Regulation of the European Parliament and of the Council: on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council SWD/2021/631 final	MOVE	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	PRIMES is one of the core models of the modelling framework for energy, transport and greenhouse gas emission projections. The PRIMES-TREMOVE model, a module of PRIMES, provided the developments in the vehicle fleet and the associated recharging and refuelling infrastructure, as well as the developments in CO2 emissions and air

					pollution emissions. The PRIMES model ensured the links with the rest of the energy system in developing the baseline and the policy scenarios. Supporting study: Ricardo et al. (2021), Impact assessment support study on the revision of the Directive on the Deployment of Alternative Fuels Infrastructure (2014/94/EC) (for details, see the impact assessment report).
2021	Impact assessment accompanying the document Proposal for a regulation of the European Parliament and of the Council: establishing a carbon border adjustment mechanism SWD/2021/643 final	TAXUD	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The model helped to assess the following impacts: - EU Exports & imports - Investment flows & trade in services - Cost of doing business - Business' capacity to innovate - Market share & advantages in international context - Free movement of goods, services, capital and workers - Competition - Innovation for productivity/resource efficiency - Budgetary consequences for public authorities - Consumer's ability to benefit from the internal market or to access goods and services from outside the EU - Prices, quality, availability or choice of consumer goods and services - Significant effects on sectors - Disproportionately affected region or sector - Impacts on third countries - Goods traded with developing countries - Investments and functioning of markets - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Wages, labour costs or wage setting mechanisms - Emission of greenhouse gases - Sustainable production and consumption - Relative prices of environmental friendly and unfriendly products

					- Polution by businesses - Environment in third countries - Energy intensity of the economy - Fuel mix used in energy production - Energy and fuel consumption
2021	Impact assessment accompanying the document Proposal for a regulation of the European Parliament and of the Council: amending Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement SWD/2021/611 final	CLIMA	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The PRIMES model and its variants are used to model all aspects of the energy system, including buildings, transport and industry. Regarding greenhouse gas emissions it reports all CO2 emissions from these sectors.
2021	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: amending Regulation (EU) 2019/631 as regards strengthening the CO2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition SWD/2021/613 final	CLIMA	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The PRIMES model is used to assess the projected evolution of the transport system, as part of the wider energy system, resulting from different policies, including CO2 emission standards for vehicles.
2021	Impact assessment accompanying the document Directive of the European Parliament and of the Council: amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union, Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and Regulation (EU) 2015/757 SWD/2021/601 final	CLIMA	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	(1) General modelling of ETS strengthening and possible extension to buildings and transport/ all fossil fuel combustion. (2) Extension of emissions trading to maritime transport and alternatives. The PRIMES-Maritime module has been used to assess the impact of the various maritime policy options. PRIMES-Maritime is a specific sub-module of the PRIMES-TREMOVE transport and the overall PRIMES energy systems model aiming to enhance the representation of the maritime sector within the energy- economy- environment modelling nexus.

| 2020 | Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Stepping up Europe's 2030 climate ambition

SWD/2020/176 final | CLIMA | Baseline and assessment of policy options | *Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens* | The PRIMES model and its variants are used to model all aspects of the energy system, including buildings, transport and industry. Regarding greenhouse gas emissions it reports all CO2 emissions from these sectors. |
| 2018 | Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council on: the establishment of a framework to facilitate sustainable investment and; Proposal for a Regulation of the European Parliament and of the Council on: disclosures relating to sustainable investments and sustainability risks and amending Directive (EU) 2016/2341 and; Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) 2016/1011 on: low carbon benchmarks and positive carbon impact benchmarks

SWD/2018/264 final | FISMA | Problem definition | *Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens* | The yearly average investment gap for the period 2021 to 2030 was based on PRIMES projections |

Bibliographic references

- *EU reference scenario 2016 : energy, transport and GHG emissions : trends to 2050. - MJ-01-15-793-EN-N*

- *EU energy, transport and GHG emissions, trends to 2050 : reference scenario 2013. - 10.2833/17897*