Snapshot of - PRIMES

Archive of PRIMES, version: PRIMES 2022

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The reference card is a clearly defined description of model features. The numerous options have been organized into a limited amount of default and model specific (non default) options. In addition some features are described by a short clarifying text.

Legend:

☐ not implemented

☑ **implemented**

☑ **implemented (not default option)**

About

Name and version   PRIMES PRIMES 2022

Model link	https://e3modelling.com/modelling-tools/primes/
Institution	E3Modelling (E3M), Greece, https://e3modelling.com/.
Documentation	PRIMES documentation is limited and consists of a reference card
Process state	in preparation

Model scope and methods

Model type	☐ Integrated assessment model ☑ **Energy system model**	☐ CGE ☐ CBA-integrated assessment model
Geographical scope	☐ Global	☑ **Regional**

Objective   PRIMES provides detailed projections of energy demand, supply, prices and investment to the future, covering the entire energy system including emissions for each individual European country and for Europe-wide trade of energy commodities. PRIMES model design is suitable for medium- and long-term energy system projections and system restructuring up to 2070, both in demand and supply. The model can support an impact assessment of specific energy and environment policies and measures, applied at the Member State or EU level, including price signals, such as taxation, subsidies, ETS, technology-promoting policies, RES-supporting policies, efficiency-promoting policies, environmental policies and technology standards. PRIMES 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 draws on comparing the results of scenarios against a reference projection

Solution concept

☑ **Partial equilibrium (price elastic demand)**

☐ Partial equilibrium (fixed demand)

☐ General equilibrium (closed economy)

☑ **The PRIMES model comprises several sub-models (modules), each one representing the behaviour of a** specific (or representative) agent, a demander and/or a supplier of energy. The sub-models link with each other through a model integration algorithm, which determines equilibrium prices in multiple markets and equilibrium volumes meets balancing and overall (e.g. emission) constraints.

Solution horizon   ☐ Recursive dynamic (myopic)   ☑ **Intertemporal optimization**

(foresight)

Solution method	☐ Simulation ☐ Optimization ☑ **Mathematically PRIMES solves an EPEC problem**	**(equilibrium problem with equilibrium constraints) which allows prices to be explicitly determined.**

Anticipation   The PRIMES model is fully dynamic and has options regarding future anticipation by agents in decision-making. Usually, PRIMES assumes perfect foresight over a short time horizon for demand sectors and perfect foresight over a long time horizon for supply sectors. The sub-models solve over the entire projection period in each cycle of interaction between demand and supply and so market equilibrium is dynamic and not static. Other options are available allowing the model user to specify shorter time horizons for foresight.

Temporal dimension   Base year:2015, time steps:5 year, horizon: 2015 to 2070

Spatial dimension   Number of regions:28

1. EU27, UK. Primes has also used for providing projections for the Energy

Community Contracting Parties, Turkey, Iceland, Switzerland.

Time discounting type	☑ **Discount rate exogenous**	☐ Discount rate endogenous

Policies	☑ **Emission tax**	☐ Pricing carbon stocks
	☑ **Emission pricing**	☑ **Eco-design standars, Best Available Technology regulations, Energy Performance standards**
	☑ **Cap and trade**	
	☑ **Fuel taxes**	
	☑ **Fuel subsidies**	☑ **Emission standards or efficiency standards or CO2 standards on vehicles and other transport means,**
	☑ **Feed-in-tariff**	
	☐ Portfolio standard	
	☐ Capacity targets	☑ **Phase-out regarulations, Large Combustion Plant Directive**
	☑ **Emission standards**	
	☑ **Energy efficiency standards**	
	☐ Agricultural producer subsidies	☑ **Additionality rules for the production of renewable hydrogen and synthetic fuels (e-fuels)**
	☐ Agricultural consumer subsidies	
	☐ Land protection	

Socio-economic drivers

Population	☑ **Yes (exogenous)**	☐ Yes (endogenous)
Population age structure	☑ **Yes (exogenous)**	☐ Yes (endogenous)
Education level	☐ Yes (exogenous)	☐ Yes (endogenous)
Urbanization rate	☑ **Yes (exogenous)**	☐ Yes (endogenous)
GDP	☑ **Yes (exogenous)**	☐ Yes (endogenous)
Income distribution	☑ **Yes (exogenous)**	☐ Yes (endogenous)
Employment rate	☑ **Yes (exogenous)**	☐ Yes (endogenous)
Labor productivity	☐ Yes (exogenous)	☐ Yes (endogenous)
Total factor productivity	☐ Yes (exogenous)	☐ Yes (endogenous)
Autonomous energy efficiency improvements	☐ Yes (exogenous)	☑ **Yes (endogenous)**

Macro-economy

Economic sector

Industry	☐ Yes (physical) ☐ Yes (economic)	☑ **Yes (physical & economic)**
Energy	☐ Yes (physical) ☐ Yes (economic)	☑ **Yes (physical & economic)**
Transportation	☐ Yes (physical) ☐ Yes (economic)	☑ **Yes (physical & economic)**
Residential and commercial	☐ Yes (physical) ☐ Yes (economic)	☑ **Yes (physical & economic)**

Agriculture	☐ Yes (physical)	☐ Yes (physical & economic)
	☑ **Yes (economic)**	
Forestry	☐ Yes (physical)	☐ Yes (physical & economic)
	☐ Yes (economic)	

Macro-economy

Trade	☐ Coal	☐ Bioenergy crops
	☐ Oil	☐ Food crops
	☐ Gas	☐ Capital
	☐ Uranium	☑ **Emissions permits**
	☑ **Electricity**	☐ Non-energy goods

Cost measures	☐ GDP loss	☐ Area under MAC
	☐ Welfare loss	☐ Energy system cost mark-up
	☐ Consumption loss	

Categorization by group	☑ **Income**	☐ Gender
	☐ Urban - rural	☐ Education level
	☐ Technology adoption	☑ **Household size**
	☑ **Age**	

Institutional and political factors

☐ Early retirement of capital allowed

☑ **Interest rates differentiated by country/region**

☐ Regional risk factors included

☑ **Technology costs**

differentiated by country/region

☑ **Technological change differentiated by country/region**

☑ **Behavioural change differentiated by country/region**

☐ Constraints on cross country financial transfers

Resource use

Coal	☐ Yes (fixed)	☐ Yes (process model)
	☑ **Yes (supply curve)**	
Conventional Oil	☐ Yes (fixed)	☐ Yes (process model)
	☑ **Yes (supply curve)**	
Unconventional Oil	☐ Yes (fixed)	☐ Yes (process model)
	☑ **Yes (supply curve)**	
Conventional Gas	☐ Yes (fixed)	☑ **Yes (supply curve)**

☐ Yes (process model)

Unconventional Gas	☐ Yes (fixed) ☑ **Yes (supply curve)**	☐ Yes (process model)
Uranium	☐ Yes (fixed) ☑ **Yes (supply curve)**	☐ Yes (process model)
Bioenergy	☐ Yes (fixed) ☑ **Yes (supply curve)**	☐ Yes (process model)
Water	☐ Yes (fixed) ☐ Yes (supply curve)	☐ Yes (process model)
Raw Materials	☐ Yes (fixed) ☐ Yes (supply curve)	☐ Yes (process model)
Land	☐ Yes (fixed) ☐ Yes (supply curve)	☐ Yes (process model)

Technological change

Energy conversion technologies	☐ No technological change ☑ **Exogenous technological change**	☐ Endogenous technological change
Energy End-use	☐ No technological change ☐ Exogenous technological change	☑ **Endogenous technological change**
Material Use	☐ No technological change ☐ Exogenous technological change	☐ Endogenous technological change
Agriculture (tc)	☐ No technological change ☑ **Exogenous technological change**	☐ Endogenous technological change

Energy

Energy technology substitution

Energy technology choice	☐ No discrete technology choices ☑ **Logit choice model** ☐ Production function	☐ Linear choice (lowest cost) ☐ Lowest cost with adjustment penalties
Energy technology substitutability	☐ Mostly high substitutability ☐ Mostly low substitutability	☑ **Mixed high and low substitutability**
Energy technology deployment	☐ Expansion and decline constraints	☑ **System integration constraints**

Energy

Electricity technologies	☑ **Coal w/o CCS** ☑ **Coal w/ CCS** ☑ **Gas w/o CCS** ☑ **Gas w/ CCS** ☑ **Oil w/o CCS** ☐ Oil w/ CCS ☑ **Bioenergy w/o CCS** ☑ **Bioenergy w/ CCS** ☑ **Geothermal power** ☑ **Nuclear power**	☑ **Solar power** ☑ **Solar power-central PV** ☑ **Solar power-distributed PV** ☑ **Solar power-CSP** ☑ **Wind power** ☑ **Wind power-onshore** ☑ **Wind power-offshore** ☑ **Hydroelectric power** ☐ Ocean power
Hydrogen production	☐ Coal to hydrogen w/o CCS ☐ Coal to hydrogen w/ CCS ☐ Natural gas to hydrogen w/o CCS ☐ Natural gas to hydrogen w/ CCS ☐ Oil to hydrogen w/o CCS ☐ Oil to hydrogen w/ CCS	☐ Biomass to hydrogen w/o CCS ☐ Biomass to hydrogen w/ CCS ☐ Nuclear thermochemical hydrogen ☐ Solar thermochemical hydrogen ☑ **Electrolysis**
Refined liquids	☐ Coal to liquids w/o CCS ☐ Coal to liquids w/ CCS ☐ Gas to liquids w/o CCS ☐ Gas to liquids w/ CCS	☐ Bioliquids w/o CCS ☐ Bioliquids w/ CCS ☑ **Oil refining**
Refined gases	☑ **Coal to gas w/o CCS** ☐ Coal to gas w/ CCS ☑ **Oil to gas w/o CCS**	☐ Oil to gas w/ CCS ☐ Biomass to gas w/o CCS ☐ Biomass to gas w/ CCS

Heat generation	☑ **Coal heat**	☑ **Geothermal heat**
	☑ **Natural gas heat**	☑ **Solarthermal heat**
	☑ **Oil heat**	☑ **CHP (coupled heat and power)**
	☑ **Biomass heat**	

Grid Infra Structure

Electricity	☑ **Yes (aggregate)**	☐ Yes (spatially explicit)
Gas	☑ **Yes (aggregate)**	☐ Yes (spatially explicit)
Heat	☑ **Yes (aggregate)**	☐ Yes (spatially explicit)
CO2	☑ **Yes (aggregate)**	☐ Yes (spatially explicit)
Hydrogen	☑ **Yes (aggregate)**	☐ Yes (spatially explicit)

Energy end-use technologies

Passenger transportation	☑ **Passenger trains**	☑ **Private road passenger (cars, powered 2 wheelers), public road passenger (buses and coaches), road freight (HDVs, LDVs), passenger rail (slow and high-speed trains, metro), freight rail, passenger aviation (split into distance classes), freight and passenger inland navigation and short sea shipping, bunkers. Numerous classes of vehicles and transport means with tracking of technology vintages.**
	☑ **Buses**	
	☑ **Light Duty Vehicles (LDVs)**	
	☑ **Electric LDVs**	
	☑ **Hydrogen LDVs**	
	☑ **Hybrid LDVs**	
	☑ **Gasoline LDVs**	
	☑ **Diesel LDVs**	
	☑ **Passenger aircrafts**	
Freight transportation	☑ **Freight trains**	☐ Freight aircrafts
	☑ **Heavy duty vehicles**	☑ **Freight ships**
Industry	☑ **Steel production**	☑ **Paper production**
	☑ **Aluminium production**	☑ **Plastics production**
	☑ **Cement production**	☑ **Pulp production**
	☑ **Petrochemical production**	
	☑ **Space heating**	☑ **Space cooling**

Residential and commercial	☑ Cooking	☑ Washing
	☑ Refrigeration	☑ Lighting

Land-use

Land cover	☐ Cropland	☐ Managed forest
	☐ Cropland irrigated	☐ Natural forest
	☐ Cropland food crops	☐ Pasture
	☐ Cropland feed crops	☐ Shrubland
	☐ Cropland energy crops	☐ Built-up area
	☐ Forest	

Agriculture and forestry demands	☐ Agriculture food	☐ Agriculture non-food crops
	☐ Agriculture food crops	☐ Agriculture non-food livestock
	☐ Agriculture food livestock	☐ Agriculture bioenergy
	☐ Agriculture feed	☐ Agriculture residues
	☐ Agriculture feed crops	☐ Forest industrial roundwood
	☐ Agriculture feed livestock	☐ Forest fuelwood
	☐ Agriculture non-food	☐ Forest residues

Agricultural commodities	☐ Wheat	☐ Sugar crops
	☐ Rice	☐ Ruminant meat
	☐ Other coarse grains	☐ Non-ruminant meat and eggs
	☐ Oilseeds	☐ Dairy products

Emission, climate and impacts

Greenhouse gases	☑ **CO2 fossil fuels**	☐ N2O land use
	☐ CO2 cement	☐ N2O other
	☐ CO2 land use	☐ CFCs
	☐ CH4 energy	☐ HFCs
	☐ CH4 land use	☐ SF6
	☐ CH4 other	☐ PFCs
	☐ N2O energy	

Pollutants	☐ CO energy	☐ VOC energy
	☐ CO land use	☐ VOC land use
	☐ CO other	☐ VOC other
	☑ **NOx energy**	☑ **SO2 energy**
	☐ NOx land use	☐ SO2 land use
	☐ NOx other	☐ SO2 other

☐ BC energy   ☐ OC other

☐ BC land use   ☐ NH3 energy

☐ BC other   ☐ NH3 land use

☐ OC energy   ☐ NH3 other

☐ OC land use

Climate indicators

☑ **Concentration: CO2**   ☐ Radiative forcing: Kyoto gases

☐ Concentration: CH4   ☐ Radiative forcing: aerosols

☐ Concentration: N2O   ☐ Radiative forcing: land albedo

☐ Concentration: Kyoto gases   ☐ Radiative forcing: AN3A

☐ Radiative forcing: CO2   ☐ Radiative forcing: total

☐ Radiative forcing: CH4   ☐ Temperature change

☐ Radiative forcing: N2O   ☐ Sea level rise

☐ Radiative forcing: F-gases   ☐ Ocean acidification

Carbon dioxide removal

☑ **Bioenergy with CCS**   ☐ Soil carbon enhancement

☐ Reforestation   ☑ **Direct air capture**

☐ Afforestation   ☐ Enhanced weathering

Climate change impacts

☐ Agriculture   ☐ Economic output

☑ **Energy supply**   ☐ Built capital

☑ **Energy demand**   ☐ Inequality

Co-Linkages

☑ **Energy security: Fossil fuel imports & exports (region)**   ☑ **Air pollution & health: Health impacts of air Pollution**

☑ **Energy access: Household energy consumption**   ☐ Food access

☐ Air pollution & health: Source-based aerosol emissions   ☑ **Water availability**

                                                                                                      ☐ Biodiversity

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