

# Snapshot of - MESSAGE-GLOBIOM

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Archive of MESSAGE-GLOBIOM, version: 1.0

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# Reference card - MESSAGE-GLOBIOM

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

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<b>Name and version</b>	MESSAGE-GLOBIOM 1.0
<b>Model link</b>	<a href="https://docs.messageix.org">https://docs.messageix.org</a> ; <a href="http://data.ene.iiasa.ac.at/message-globiom/">http://data.ene.iiasa.ac.at/message-globiom/</a> ; <a href="https://github.com/iiasa/message_ix">https://github.com/iiasa/message_ix</a> ; <a href="https://github.com/iiasa/ixmp">https://github.com/iiasa/ixmp</a>
<b>Institution</b>	International Institute for Applied Systems Analysis (IIASA), Austria, <a href="http://data.ene.iiasa.ac.at">http://data.ene.iiasa.ac.at</a> .
<b>Documentation</b>	MESSAGE-GLOBIOM documentation consists of a referencecard and <u>detailed model documentation</u>
<b>Process state</b>	published

## Model scope and methods

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*Model documentation: Model scope and methods - MESSAGE-GLOBIOM*

<b>Model type</b>	<input type="checkbox"/> Integrated assessment model	<input checked="" type="checkbox"/> <b>CGE</b>
	<input type="checkbox"/> Energy system model	<input type="checkbox"/> CBA-integrated assessment model
<b>Geographical scope</b>	<input checked="" type="checkbox"/> <b>Global</b>	<input type="checkbox"/> Regional
<b>Objective</b>	MESSAGE at its core is a technology-detailed energy-engineering optimization model used for energy planning. Through linkage to macro-economic, land-use and climate models it is capable of taking into account important feedbacks and limitations in these areas outside of the energy system.	
<b>Solution concept</b>	<input type="checkbox"/> Partial equilibrium (price elastic demand)	demand)
	<input type="checkbox"/> Partial equilibrium (fixed	<input checked="" type="checkbox"/> <b>General equilibrium (closed economy)</b>
<b>Solution horizon</b>	<input type="checkbox"/> Recursive dynamic (myopic)	<input type="checkbox"/> Intertemporal optimization (foresight)

**Solution method** Simulation **Optimization****Temporal dimension**

Base year:2030, time steps:10, horizon: 2110

*Note: From 1990 to 2010 MESSAGE employs 5-year time steps with 10-year steps employed thereafter*

**Spatial dimension** Number of regions:11

- |  |                                       |
|--|---------------------------------------|
| 1. AFR (Sub-Saharan Africa)              | 6. MEA (Middle East and North Africa) |
| 2. CPA (Centrally Planned Asia & China)  | 7. NAM (North America)                |
| 3. EEU (Eastern Europe)                  | 8. PAO (Pacific OECD)                 |
| 4. FSU (Former Soviet Union)             | 9. PAS (Other Pacific Asia)           |
| 5. LAM (Latin America and the Caribbean) | 10. SAS (South Asia)                  |
|  | 11. WEU (Western Europe)              |

**Time discounting type** Discount rate exogenous Discount rate endogenous**Policies** **Emission tax** **Capacity targets** **Emission pricing** **Emission standards** **Cap and trade** **Energy efficiency standards** Fuel taxes Agricultural producer subsidies Fuel subsidies Agricultural consumer subsidies Feed-in-tariff Land protection **Portfolio standard** Pricing carbon stocks**Socio-economic drivers**

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*Model documentation: Socio-economic drivers - MESSAGE-GLOBIOM***Population** **Yes (exogenous)** Yes (endogenous)**Population structure****age**  Yes (exogenous) Yes (endogenous)**Education level** Yes (exogenous) Yes (endogenous)

<b>Urbanization rate</b>	<input type="checkbox"/> Yes (exogenous)	<input type="checkbox"/> Yes (endogenous)
<b>GDP</b>	<input checked="" type="checkbox"/> <b>Yes (exogenous)</b>	<input type="checkbox"/> Yes (endogenous)
<b>Income distribution</b>	<input checked="" type="checkbox"/> <b>Yes (exogenous)</b>	<input type="checkbox"/> Yes (endogenous)
<b>Employment rate</b>	<input type="checkbox"/> Yes (exogenous)	<input type="checkbox"/> Yes (endogenous)
<b>Labor productivity</b>	<input checked="" type="checkbox"/> <b>Yes (exogenous)</b>	<input type="checkbox"/> Yes (endogenous)
<b>Total factor productivity</b>	<input type="checkbox"/> Yes (exogenous)	<input type="checkbox"/> Yes (endogenous)
<b>Autonomous energy efficiency improvements</b>	<input type="checkbox"/> Yes (exogenous)	<input checked="" type="checkbox"/> <b>Yes (endogenous)</b>
<b>Other socio economic driver</b>	<input checked="" type="checkbox"/> <b>Behavioural change</b>	

## Macro-economy

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Model documentation: Macro-economy - MESSAGE-GLOBIOM

### Economic sector

<b>Industry</b>	<input checked="" type="checkbox"/> <b>Yes (physical)</b> <input type="checkbox"/> Yes (economic)	<input type="checkbox"/> Yes (physical & economic)
<b>Energy</b>	<input checked="" type="checkbox"/> <b>Yes (physical)</b> <input type="checkbox"/> Yes (economic)	<input type="checkbox"/> Yes (physical & economic)
<b>Transportation</b>	<input type="checkbox"/> Yes (physical) <input type="checkbox"/> Yes (economic)	<input type="checkbox"/> Yes (physical & economic)
<b>Residential and commercial</b>	<input type="checkbox"/> Yes (physical) <input type="checkbox"/> Yes (economic)	<input type="checkbox"/> Yes (physical & economic)
<b>Agriculture</b>	<input type="checkbox"/> Yes (physical)	<input type="checkbox"/> Yes (economic)

Yes (physical & economic)

## Forestry

Yes (physical)

Yes (physical & economic)

Yes (economic)

## Other economic sector

**Services (physical)**

## 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

differentiated by country/region

Interest rates differentiated by country/region

Technological change differentiated by country/region

Regional risk factors included

Behavioural change differentiated by country/region

Technology costs

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 (process model)

**Yes (supply curve)**

**Uranium**

Yes (fixed)

Yes (process model)

**Yes (supply curve)**

**Bioenergy**

Yes (fixed)

Yes (process model)

**Yes (supply curve)**

**Water**

Yes (fixed)

Yes (process model)

Yes (supply curve)

**Raw Materials**

Yes (fixed)

Yes (process model)

Yes (supply curve)

**Land**

Yes (fixed)

Yes (process model)

Yes (supply curve)

## Technological change

**Energy conversion technologies**

No technological change

change

Exogenous technological

Endogenous technological change

**Energy End-use**

No technological change

**change**

**Exogenous technological**

Endogenous technological change

**Material Use**

No technological change

change

Exogenous technological

Endogenous technological change

**Agriculture (tc)**

No technological change

change

Exogenous technological

Endogenous technological change

**Other technological change**

**Energy Conversion - Exogenous Technological**

**Change**

## Energy

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Model documentation: [Energy - MESSAGE-GLOBIOM](#)

## 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
- Natural gas heat
- Oil heat
- Biomass heat

- Geothermal heat
- Solarthermal heat
- CHP (coupled heat and power)

**Grid Infra Structure****Electricity**

- Yes (aggregate)

- Yes (spatially explicit)

**Gas**

- Yes (aggregate)

- Yes (spatially explicit)

**Heat**

- Yes (aggregate)

- Yes (spatially explicit)

**CO<sub>2</sub>**

- Yes (aggregate)

- Yes (spatially explicit)

**Hydrogen**

- Yes (aggregate)

- Yes (spatially explicit)

**Energy end-use technologies****Passenger transportation**

- Passenger trains
- Buses
- Light Duty Vehicles (LDVs)
- Electric LDVs
- Hydrogen LDVs

- Hybrid LDVs
- Gasoline LDVs
- Diesel LDVs
- Passenger aircrafts

**Freight transportation**

- Freight trains
- Heavy duty vehicles

- Freight aircrafts
- Freight ships

**Industry**

- Steel production
- Aluminium production
- Cement production
- Petrochemical production

- Paper production
- Plastics production
- Pulp production

**Residential and commercial**

- Space heating
- Space cooling

- Cooking
- Refrigeration

Washing Lighting

## Land-use

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*Model documentation: Land-use - MESSAGE-GLOBIOM*

### Land cover

- |  |   |
|--|---|
| <input type="checkbox"/> Cropland              | <input type="checkbox"/> Managed forest |
| <input type="checkbox"/> Cropland irrigated    | <input type="checkbox"/> Natural forest |
| <input type="checkbox"/> Cropland food crops   | <input type="checkbox"/> Pasture        |
| <input type="checkbox"/> Cropland feed crops   | <input type="checkbox"/> Shrubland      |
| <input type="checkbox"/> Cropland energy crops | <input type="checkbox"/> Built-up area  |
| <input type="checkbox"/> Forest                |   |

### Agriculture and forestry demands

- |   |   |
|---|---|
| <input type="checkbox"/> Agriculture food           | <input type="checkbox"/> Agriculture non-food crops     |
| <input type="checkbox"/> Agriculture food crops     | <input type="checkbox"/> Agriculture non-food livestock |
| <input type="checkbox"/> Agriculture food livestock | <input type="checkbox"/> Agriculture bioenergy          |
| <input type="checkbox"/> Agriculture feed           | <input type="checkbox"/> Agriculture residues           |
| <input type="checkbox"/> Agriculture feed crops     | <input type="checkbox"/> Forest industrial roundwood    |
| <input type="checkbox"/> Agriculture feed livestock | <input type="checkbox"/> Forest fuelwood                |
| <input type="checkbox"/> Agriculture non-food       | <input type="checkbox"/> Forest residues                |

### Agricultural commodities

- |  |   |
|--|---|
| <input type="checkbox"/> Wheat               | <input type="checkbox"/> Sugar crops                |
| <input type="checkbox"/> Rice                | <input type="checkbox"/> Ruminant meat              |
| <input type="checkbox"/> Other coarse grains | <input type="checkbox"/> Non-ruminant meat and eggs |
| <input type="checkbox"/> Oilseeds            | <input type="checkbox"/> Dairy products             |

## Emission, climate and impacts

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*Model documentation: Emissions - MESSAGE-GLOBIOM, Climate - MESSAGE-GLOBIOM, Non-climate sustainability dimension - MESSAGE-GLOBIOM*

### Greenhouse gases

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> CO2 fossil fuels | <input checked="" type="checkbox"/> N2O land use |
| <input checked="" type="checkbox"/> CO2 cement       | <input checked="" type="checkbox"/> N2O other    |
| <input checked="" type="checkbox"/> CO2 land use     | <input checked="" type="checkbox"/> CFCs         |
| <input checked="" type="checkbox"/> CH4 energy       | <input checked="" type="checkbox"/> HFCs         |
| <input checked="" type="checkbox"/> CH4 land use     | <input checked="" type="checkbox"/> SF6          |
| <input checked="" type="checkbox"/> CH4 other        | <input type="checkbox"/> PFCs                    |
| <input checked="" type="checkbox"/> N2O energy       |  |

### Pollutants

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> CO energy   | <input checked="" type="checkbox"/> NOx energy |
| <input checked="" type="checkbox"/> CO land use | <input type="checkbox"/> NOx land use          |
| <input checked="" type="checkbox"/> CO other    | <input checked="" type="checkbox"/> NOx other  |

- VOC energy
- VOC land use
- VOC other
- SO2 energy
- SO2 land use
- SO2 other
- BC energy
- BC land use
- BC other
- OC energy
- OC land use
- OC other
- NH3 energy
- NH3 land use
- NH3 other

### Climate indicators

- Concentration: CO2
- Concentration: CH4
- Concentration: N2O
- Concentration: Kyoto gases
- Radiative forcing: CO2
- Radiative forcing: CH4
- Radiative forcing: N2O
- Radiative forcing: F-gases
- Radiative forcing: Kyoto gases
- Radiative forcing: aerosols
- Radiative forcing: land albedo
- Radiative forcing: AN3A
- Radiative forcing: total
- Temperature change
- Sea level rise
- Ocean acidification

### Carbon dioxide removal

- Bioenergy with CCS
- Reforestation
- Afforestation
- Soil carbon enhancement
- Direct air capture
- Enhanced weathering

### Climate change impacts

- Agriculture
- Energy supply
- Energy demand
- Economic output
- Built capital
- Inequality

### Co-Linkages

- Energy security: Fossil fuel imports & exports (region)
- Energy access: Household energy consumption
- Air pollution & health: Source-based aerosol
- emissions
- Air pollution & health: Health impacts of air Pollution
- Food access
- Water availability
- Biodiversity

# Model Documentation - MESSAGE-GLOBIOM

## Introduction

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The IIASA IAM framework consists of a combination of five different models or modules - the energy model MESSAGEix, the land use model GLOBIOM, the air pollution and GHG model GAINS, the aggregated macro-economic model MACRO, and the simple climate model MAGICC - which complement each other and are specialized in different areas. All models and modules together build the IIASA IAM framework, also referred to as MESSAGEix-GLOBIOM because the energy model MESSAGEix and the land use model GLOBIOM are its most important components. The five models provide input to and iterate between each other during a typical SSP scenario development cycle.

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