Snapshot of - IMAGE

Archive of IMAGE, version: 3.4

Contents

Reference card - IMAGE

Model Documentation - IMAGE

Reference card - IMAGE

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:

☐ <u>not</u> implemented

☑ **implemented**

☑ **implemented (not default option)**

About

Name and version	IMAGE framework 3.4
Model link	https://models.pbl.nl/image
Institution	PBL Netherlands Environmental Assessment Agency (PBL), Netherlands, https://www.pbl.nl/en.
Documentation	IMAGE documentation consists of a referencecard and detailed model documentation
Process state	published

Model scope and methods

Model documentation: Model scope and methods - IMAGE

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

Objective   IMAGE is an ecological-environmental model framework that simulates the environmental consequences of human activities worldwide. The objective of the IMAGE model is to explore the long- term dynamics and impacts of global changes that result. More specifically, the model aims

1. to analyse interactions between human development and the natural environment to gain better insight into the processes of global environmental change;
2. to identify response strategies to global environmental change based on assessment of options and
3. to indicate key inter-linkages and associated levels of uncertainty in processes of global environmental change.

Solution concept

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

demand)

☐ Partial equilibrium (fixed

☐ General equilibrium (closed economy)

Solution horizon	☑ **Recursive dynamic (myopic)**	☐ Intertemporal optimization (foresight)
Solution method	☑ **Simulation**	☐ Optimization

Anticipation — Simulation modelling framework, without foresight. However, a simplified version of the energy/climate part of the model (called FAIR) can be run prior to running the framework to obtain data for climate policy simulations.

Temporal dimension — Base year:1970, time steps:1-5 year time step, horizon: 2100

Spatial dimension — Number of regions:26

1. Canada
2. USA
3. Mexico
4. Rest of Central America
5. Brazil
6. Rest of South America
7. Northern Africa
8. Western Africa
9. Eastern Africa
10. South Africa
11. Western Europe
12. Central Europe
13. Turkey
14. Ukraine +
15. Asian-Stan
16. Russia +
17. Middle East
18. India +
19. Korea
20. China +
21. Southeastern Asia
22. Indonesia +
23. Japan
24. Oceania
25. Rest of South Asia
26. Rest of Southern Africa

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

Policies

☑ **Emission tax**		☑ **Portfolio standard**	
☑ **Emission pricing**		☑ **Capacity targets**	
☑ **Cap and trade**		☑ **Emission standards**	
☑ **Fuel taxes**		☑ **Energy efficiency standards**	
☐ Fuel subsidies		☐ Agricultural producer subsidies	
☐ Feed-in-tariff		☐ Agricultural consumer subsidies	

☑ **Land protection**   ☑ **Pricing carbon stocks**

Socio-economic drivers

Model documentation: Socio-economic drivers - IMAGE

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

Model documentation: Macro-economy - IMAGE

Economic sector

Industry	☐ Yes (physical) ☐ Yes (economic)	☑ **Yes (physical & economic)**

Energy	☐ Yes (physical)	☑ **Yes (physical & economic)**
	☐ Yes (economic)	

Transportation	☐ Yes (physical)	☑ **Yes (physical & economic)**
	☐ Yes (economic)	

Residential and commercial	☐ Yes (physical)	☐ Yes (physical & economic)
	☑ **Yes (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**	**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 (supply curve)**

☐ Yes (process model)

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

Model documentation: Energy - IMAGE

Behaviour

In the energy model, substitution among technologies is described in the model using the multinomial logit formulation. The multinomial logit model implies that the market share of a certain technology or fuel type depends on costs relative to competing technologies. The option with the lowest costs gets the largest market share, but in most cases not the full market. We interpret the latter as a representation of heterogeneity in the form of specific market niches for every technology or fuel.

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**
- ☑ **Coal to hydrogen w/o CCS**

- ☑ **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

- ☑ **Coal to hydrogen w/ CCS**

Hydrogen production	☑ **Natural gas to hydrogen w/o CCS**	**CCS**
	☑ **Natural gas to hydrogen w/ CCS**	☑ **Biomass to hydrogen w/ CCS**
	☑ **Oil to hydrogen w/o CCS**	☐ Nuclear thermochemical hydrogen
	☑ **Oil to hydrogen w/ CCS**	☑ **Solar thermochemical hydrogen**
	☑ **Biomass to hydrogen w/o**	☑ **Electrolysis**
Refined liquids	☐ Coal to liquids w/o CCS	☑ **Bioliquids w/o CCS**
	☐ Coal to liquids w/ CCS	☑ **Bioliquids w/ CCS**
	☐ Gas to liquids w/o CCS	☑ **Oil refining**
	☐ Gas to liquids w/ CCS	
Refined gases	☐ Coal to gas w/o CCS	☐ Oil to gas w/ CCS
	☐ Coal to gas w/ CCS	☑ **Biomass to gas w/o CCS**
	☐ Oil 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**	

Note: CHP also has a CCS option

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** | ☑ **Light Duty Vehicles (LDVs)** |
| | ☑ **Buses** | ☑ **Electric LDVs** |

☑ **Hydrogen LDVs**   ☑ **Diesel LDVs**

☑ **Hybrid LDVs**   ☑ **Passenger aircrafts**

☑ **Gasoline LDVs**

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

Residential and commercial

☑ **Space heating**   ☑ **Refrigeration**

☑ **Space cooling**   ☑ **Washing**

☑ **Cooking**   ☑ **Lighting**

Land-use

Model documentation: Land-use - IMAGE

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 feed   ☑ **Agriculture bioenergy**

☑ **Agriculture feed crops**   ☑ **Agriculture residues**

☑ **Agriculture feed livestock**   ☑ **Forest industrial roundwood**

☑ **Agriculture non-food**   ☑ **Forest fuelwood**

☑ **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

Model documentation: Emissions - IMAGE, Climate - IMAGE, Non-climate sustainability dimension - IMAGE

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	☑ SO2 other
	☑ CO land use	☑ BC energy
	☑ CO other	☑ BC land use
	☑ NOx energy	☑ BC other
	☑ NOx land use	☑ OC energy
	☑ NOx other	☑ OC land use
	☑ VOC energy	☑ OC other
	☑ VOC land use	☑ NH3 energy
	☑ VOC other	☑ NH3 land use
	☑ SO2 energy	☑ NH3 other
	☑ SO2 land use	

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

Carbon dioxide removal	☑ Bioenergy with CCS	☐ Soil carbon enhancement
	☑ Reforestation	☑ Direct air capture
	☑ Afforestation	☐ Enhanced weathering

Climate change impacts	☑ Agriculture	☑ Energy demand
	☑ Energy supply	☐ Economic output

☐ Built capital

Co-Linkages

☑ **Inequality**

☑ **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 - IMAGE

Introduction

Integrated Model to Assess the Global Environment (IMAGE) 3.0 is a comprehensive integrated modelling framework of interacting human and natural systems. The model framework is suited to large scale (mostly global) and long-term (up to the year 2100) assessments of interactions between human development and the natural environment, and integrates a range of sectors, ecosystems and indicators. The impacts of human activities on the natural systems and natural resources are assessed and how such impacts hamper the provision of ecosystem services to sustain human development.

The model identifies socio-economic pathways, and projects the implications for energy, land, water and other natural resources, subject to resource availability and quality. Unintended side effects, such as emissions to air, water and soil, climatic change, and depletion and degradation of remaining stocks (fossil fuels, forests), are calculated and taken into account in future projections.

Table of contents

Model scope and methods

Socio-economic drivers

- **Economic activity**

Macro-economy

- **Production system and representation of economic sectors**
- **Capital and labour markets**
- **Monetary instruments**
- **Trade**
- **Technological change**

Energy

- **Energy resource endowments**

  - Fossil energy resources
  - Uranium and other fissile resources
  - Bioenergy
  - Non-biomass renewables

- **Energy conversion**

  - Electricity
  - Heat
  - Gaseous fuels
  - Liquid fuels
  - Solid fuels
  - Grid, pipelines and other infrastructure
  - Energy end-use
  - Transport
  - Residential and commercial sectors
  - Industrial sector
  - Other end-use

- **Energy demand**
- **Technological change in energy**

Land-use

- **Agriculture**
- **Forestry**
- **Land-use change**
- **Bioenergy land-use**
- **Other land-use**
- **Agricultural demand**

- **Technological change in land-use**

Emissions

- **GHGs**
- **Pollutants and non-GHG forcing agents**
- **Carbon dioxide removal (CDR) options**

Climate

- **Modelling of climate indicators**
- **Climate damages, temperature changes**

Non-climate sustainability dimension

- **Air pollution and health**
- **Water**
- **Other materials**
- **Other sustainability dimensions**

Appendices

- **Mathematical model description**
- **Data**

References

Retrieved from "https://www.iamcdocumentation.eu/index.php?title=Snapshot_of_-_IMAGE&oldid=13967"

This page was last edited on 7 August 2020, at 16:44.