

Reference Card - IMAGE

<p>Name and Version: <i>IMAGE framework 3.0</i></p>	<p>Model developer and main users: PBL Netherlands Environmental Assessment Agency/ Utrecht University</p>
<p>Model 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 interlinkages and associated levels of uncertainty in processes of global environmental change.</p>	<p>Model concept: The IMAGE framework can best be described as a geographically explicit assessment, integrated assessment simulation model, focusing a detailed representation of relevant processes with respect to human use of energy, land and water in relation to relevant environmental processes..</p>
<p>Solution Method: Recursive dynamic solution method</p>	<p>Base year: 1970</p>
<p>Time Horizon, and time steps: 2100, 1-5 year time step</p>	<p>Model 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.</p>
<p>Coverage and regions: Global. No. of regions = 26</p> <p>Canada, USA, Mexico, Rest of Central America, Brazil, Rest of South America, Northern Africa, Western Africa, Eastern Africa, Southern Africa, Western Europe, Central Europe, Turkey, Ukraine +, Asian-Stan, Russia +, Middle East, India +, Korea, China +, Southeastern Asia, Indonesia +, Japan, Oceania, Rest of South Asia, Rest of South Africa</p>	<p>Policy implementation: Key areas where policy responses can be introduced in the model are:</p> <ul style="list-style-type: none"> • Climate policy • Energy policies (air pollution, access and energy security) • Land use policies (food) • Specific policies to project biodiversity • Measures to reduce the imbalance of the nitrogen cycle
<p>Economic sectors (represented separately in terms of value added): Agriculture Industry Energy Transport Services Other</p> <p>If other, please list or give number. If no separate sectors please give brief explanation of economy: No explicit economy representation in monetary units. Explicit economy representation in terms of energy is modelled (for the agriculture, industry, energy, transport and built environment sectors)</p>	<p>Exogenous Model Drivers: x Exogenous GDP Total Factor Productivity Labour Productivity Capital Technical progress Energy Technical progress Materials Technical progress x GDP per capita Other</p> <p>If other types or endogenous drivers, please describe: - Energy demand - Renewable price - Fossil fuel prices - Carbon prices - Technology progress - Energy intensity - Preferences - Learning by doing - Agricultural demand - Population - Value added</p>
<p>Development: x GDP per capita (exogenous) x Income distribution in a region (exogenous) x Urbanisation rate (exogenous) Education level Labour participation rate Other</p>	<p>Behaviour and behavioural change: 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.</p>

<p>Cost measures:</p> <p>GDP loss Welfare loss Consumption loss x Area under MAC x Energy system costs Other</p>	<p>Trade:</p> <p>x Coal x Oil x Gas x Uranium Electricity x Bioenergy crops x Food crops Capital x Emissions permits x Non-energy goods Other</p> <p>If other, please briefly describe:</p> <ul style="list-style-type: none"> - Bioenergy products - Livestock products
<p>Resource Use:</p> <p>x Coal x Oil x Gas x Uranium x Biomass x Other</p> <p>If others, please give brief details or number:</p> <ul style="list-style-type: none"> - Distinction between traditional and modern biomass 	<p>Electricity technologies:</p> <p>x Coal x Gas x Oil x Nuclear x Biomass x Wind x Solar PV x CCS x Others</p> <p>If others, please give brief details or number:</p> <ul style="list-style-type: none"> - Offshore wind - CSP - Coal (conventional; IGCC; IGCC+CCS; IGCC+CHP; IGCC+CHP+CCS) - Oil (conventional; OGCC; OGCC + CCS; OGCC+CHP; OGCC+CHP+CCS) - NG (conventional; CC; CC + CCS; CC+ CHP; CC + CHP+CCS) - Biomass (Conventional, CC, CC+CCS, CC+CHP, CC+CHP+CCS)
<p>Heat and other conversion technologies:</p> <p>x CHP Heat pumps x Hydrogen Fuel to gas Fuel to liquid Others</p>	<p>Grid and infrastructure:</p> <p>x Electricity Gas Heat CO2 x H2 Other</p>
<p>Energy Technology Substitution:</p> <p>x Discrete technology choices x Expansion and decline constraints x System integration constraints Other</p>	<p>Energy Service sectors</p> <p>x Transportation x Industry x Residential and commercial</p>
<p><u>Land-use</u> Please list land use types:</p> <ul style="list-style-type: none"> - Forest - Grassland - Cropland - Abandoned land - Protected land 	<p><u>Other Resources</u></p> <p>x Water x Metals (steel) x Cement Other</p>
<p><u>Emissions and climate</u></p> <p>Greenhouse Gases coverage: x CO2 x CH4 x N2O x HFCs x CFCs x SFs</p> <p>Pollutants and non-GHG forcing agents: x NOx x SOx x BC x OC x Ozone x Other</p> <p>If other, please specify:</p> <ul style="list-style-type: none"> - VOC - NH3 - CO <p>Modelling of Climate indicators:</p> <p>x CO2e concentration (ppm) x Radiative Forcing (Wm²) x Temperature change (C°) Climate damages \$ or equivalent</p>	