

# Snapshot of - IPAC-Global

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Archive of IPAC-Global, version: 1.0

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### Model Documentation - IPAC-Global

## Reference card - IPAC-Global

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>	IPAC-Global 1.0
<b>Model link</b>	<a href="http://www.ipac-model.org.cn/About%20IPAC%20Model.html">http://www.ipac-model.org.cn/About%20IPAC%20Model.html</a>
<b>Institution</b>	Energy Research Institute (ERI), China, <a href="http://en.cctp.org.cn/m5/product/35982.html">http://en.cctp.org.cn/m5/product/35982.html</a> .
<b>Documentation</b>	IPAC-Global documentation consists of a referencecard and <u>detailed model documentation</u>
<b>Process state</b>	in preparation

## Model scope and methods

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*Model documentation: Model scope and methods - IPAC-Global*

<b>Model type</b>	<input checked="" type="checkbox"/> <b>Integrated assessment model</b>	<input type="checkbox"/> CGE
	<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

**Objective**

IPAC-Global model is an extended version of the AIM-Linkage model used in IPCC Special Report on Emission Scenarios (SRES). This model links the social and economy development, energy activities and land use activities, and forms a full range of emission analysis. IPAC includes mainly four parts: (1) society, economy and energy activities module, which mainly analyzes the demand and supply in the condition of social and economic development, and determines the energy prices; (2) energy technology module, which analyzes the short and mid-term energy utilization technologies under different conditions, and determines the energy demand under different technology compositions. The energy demand in energy technology module will modify the short and mid-term energy demand in society, economy and energy activities module, which makes the energy analysis in macro-economic model better reflect the short and mid-term energy activities; (3) land use module, which analyzes the emissions from land use process. This mainly includes emissions from agricultural food supplies, stock raising, forest management and biomass energy production; (4) industrial process emission module, which mainly analyzes the emissions from all kinds of industrial productions. The society, economy and energy activities module is built based on ERB model developed by Pacific Northwest National Laboratory (PNNL) in US. Energy technology module is the IPAC-AIM/technology module developed collaboratively by Climate Change Strategies Assessment Research Team

in ERI and National Institute of Environmental Studies in Japan. Land use module is modified and extended based on the AGLU model developed by PNNL.

<b>Solution concept</b>	<input checked="" type="checkbox"/> <b>Partial equilibrium (price elastic demand)</b> <input type="checkbox"/> Partial equilibrium (fixed demand)	<input type="checkbox"/> General equilibrium (closed economy)
<b>Solution horizon</b>	<input type="checkbox"/> Recursive dynamic (myopic)	<input checked="" type="checkbox"/> <b>Intertemporal optimization (foresight)</b>
<b>Solution method</b>	<input type="checkbox"/> Simulation	<input checked="" type="checkbox"/> <b>Optimization</b>
<b>Temporal dimension</b>	Base year:2010, time steps:5 years and 25 years, horizon: 1990-2100	
<b>Spatial dimension</b>	Number of regions:9	
	1. US 2. West Europe and Canada 3. Asia Pacific OECD countries 4. Economies in Transition Countries	5. China 6. Middle East 7. Other Asian Developing Countries 8. Africa 9. Latin America
<b>Time discounting type</b>	<input checked="" type="checkbox"/> <b>Discount rate exogenous</b>	<input type="checkbox"/> Discount rate endogenous
<b>Policies</b>	<input checked="" type="checkbox"/> <b>Emission tax</b> <input checked="" type="checkbox"/> <b>Emission pricing</b> <input checked="" type="checkbox"/> <b>Cap and trade</b> <input checked="" type="checkbox"/> <b>Fuel taxes</b> <input checked="" type="checkbox"/> <b>Fuel subsidies</b> <input type="checkbox"/> Feed-in-tariff <input checked="" type="checkbox"/> <b>Portfolio standard</b> <input checked="" type="checkbox"/> <b>Capacity targets</b>	<input checked="" type="checkbox"/> <b>Emission standards</b> <input checked="" type="checkbox"/> <b>Energy efficiency standards</b> <input checked="" type="checkbox"/> <b>Agricultural producer subsidies</b> <input checked="" type="checkbox"/> <b>Agricultural consumer subsidies</b> <input checked="" type="checkbox"/> <b>Land protection</b> <input type="checkbox"/> Pricing carbon stocks

## Socio-economic drivers

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*Model documentation: Socio-economic drivers - IPAC-Global*

**Population**  **Yes (exogenous)**  Yes (endogenous)

<b>Population structure</b>	<b>age</b>	<input checked="" type="checkbox"/> <b>Yes (exogenous)</b>	<input type="checkbox"/> Yes (endogenous)
<b>Education level</b>		<input checked="" type="checkbox"/> <b>Yes (exogenous)</b>	<input type="checkbox"/> Yes (endogenous)
<b>Urbanization rate</b>		<input checked="" type="checkbox"/> <b>Yes (exogenous)</b>	<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 checked="" type="checkbox"/> <b>Yes (exogenous)</b>	<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 checked="" type="checkbox"/> <b>Yes (exogenous)</b>	<input type="checkbox"/> Yes (endogenous)
<b>Autonomous energy efficiency improvements</b>		<input type="checkbox"/> Yes (exogenous)	<input checked="" type="checkbox"/> <b>Yes (endogenous)</b>

## Macro-economy

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*Model documentation: Macro-economy - IPAC-Global*

### Economic sector

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

<b>Agriculture</b>	<input type="checkbox"/> Yes (physical) <input type="checkbox"/> Yes (economic)	<input checked="" type="checkbox"/> <b>Yes (physical &amp; economic)</b>
<b>Forestry</b>	<input checked="" type="checkbox"/> <b>Yes (physical)</b> <input type="checkbox"/> Yes (economic)	<input type="checkbox"/> Yes (physical & economic)
<b>Macro-economy</b>		
<b>Trade</b>	<input checked="" type="checkbox"/> <b>Coal</b> <input checked="" type="checkbox"/> <b>Oil</b> <input checked="" type="checkbox"/> <b>Gas</b> <input checked="" type="checkbox"/> <b>Uranium</b> <input checked="" type="checkbox"/> <b>Electricity</b>	<input checked="" type="checkbox"/> <b>Bioenergy crops</b> <input checked="" type="checkbox"/> <b>Food crops</b> <input checked="" type="checkbox"/> <b>Capital</b> <input checked="" type="checkbox"/> <b>Emissions permits</b> <input checked="" type="checkbox"/> <b>Non-energy goods</b>
<b>Cost measures</b>	<input checked="" type="checkbox"/> <b>GDP loss</b> <input type="checkbox"/> Welfare loss <input type="checkbox"/> Consumption loss	<input checked="" type="checkbox"/> <b>Area under MAC</b> <input checked="" type="checkbox"/> <b>Energy system cost mark-up</b>
<b>Categorization by group</b>	<input type="checkbox"/> Income <input checked="" type="checkbox"/> <b>Urban - rural</b> <input type="checkbox"/> Technology adoption <input checked="" type="checkbox"/> <b>Age</b>	<input checked="" type="checkbox"/> <b>Gender</b> <input type="checkbox"/> Education level <input type="checkbox"/> Household size
<b>Institutional and political factors</b>	<input checked="" type="checkbox"/> <b>Early retirement of capital allowed</b> <input checked="" type="checkbox"/> <b>Interest rates differentiated by country/region</b> <input type="checkbox"/> Regional risk factors included <input type="checkbox"/> Technology costs	differentiated by country/region <input type="checkbox"/> Technological change differentiated by country/region <input type="checkbox"/> Behavioural change differentiated by country/region <input type="checkbox"/> Constraints on cross country financial transfers
<b>Resource use</b>		
<b>Coal</b>	<input type="checkbox"/> Yes (fixed) <input checked="" type="checkbox"/> <b>Yes (supply curve)</b>	<input type="checkbox"/> Yes (process model)
<b>Conventional Oil</b>	<input type="checkbox"/> Yes (fixed) <input checked="" type="checkbox"/> <b>Yes (supply curve)</b>	<input type="checkbox"/> Yes (process model)
<b>Unconventional Oil</b>	<input type="checkbox"/> Yes (fixed) <input checked="" type="checkbox"/> <b>Yes (supply curve)</b>	<input type="checkbox"/> Yes (process model)
<b>Conventional Gas</b>	<input type="checkbox"/> Yes (fixed)	<input checked="" type="checkbox"/> <b>Yes (supply curve)</b>

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

## Energy

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*Model documentation: Energy - IPAC-Global*

### Behaviour

energy technology module, which analyzes the short and mid-term energy utilization technologies under different conditions, and determines the energy demand under different technology compositions. The energy demand in energy technology module will modify the short and mid-term energy demand in society, economy and energy activities module, which makes the energy analysis in macro-economic model better reflect the short and mid-term energy activities

## 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 - IPAC-Global](#)

**Land cover** **Cropland** Cropland irrigated Cropland food crops Cropland feed crops Cropland energy crops **Forest** Managed forest Natural forest **Pasture** Shrubland **Built-up area****Agriculture and forestry demands** **Agriculture food** Agriculture food crops Agriculture food livestock **Agriculture feed** Agriculture feed crops Agriculture feed livestock Agriculture non-food Agriculture non-food crops Agriculture non-food livestock **Agriculture bioenergy** Agriculture residues Forest industrial roundwood **Forest fuelwood** Forest residues**Agricultural commodities** **Wheat** **Rice** Other coarse grains Oilseeds Sugar crops **Ruminant meat** Non-ruminant meat and eggs Dairy products

## Emission, climate and impacts

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Model documentation: [Emissions - IPAC-Global](#), [Climate - IPAC-Global](#), [Non-climate sustainability dimension - IPAC-Global](#)

**Greenhouse gases** **CO2 fossil fuels** **CO2 cement** **CO2 land use** **CH4 energy** **CH4 land use** **CH4 other** **N2O energy** **N2O land use** **N2O other** **CFCs**

HFCs SF6 PFCs**Pollutants**

- CO energy
- CO land use
- CO other
- NOx energy
- NOx land use
- 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 - IPAC-Global

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