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ENERGY

Pathways to Sustainable Energy - Policies for Methane Management

Workshop on Coal Mine Methane and Abandoned Mine Methane in the context of Sustainable Energy

23 October 2017, Geneva

Project Overview

Pathways to Sustainable Energy

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- Timeframe: May 2017 – June 2019 (Phase I)
- Overarching Question

  How can the UNECE Region attain Sustainable Energy?
- Key deliverables
  - Development of policy and technology options / technology portfolio
  - Modelling of Sustainable Energy scenarios
  - Definition of adaptive policy pathways
  - Definition of Key Performance Indicators
  - Conceptualization of an early-warning system
  - 2-4 workshops to define & discuss policy options
  - High-level policy dialogue planned for 2019

https://www.unece.org/energy/pathwaystose.html

Project Stakeholder Community

Pathways to Sustainable Energy

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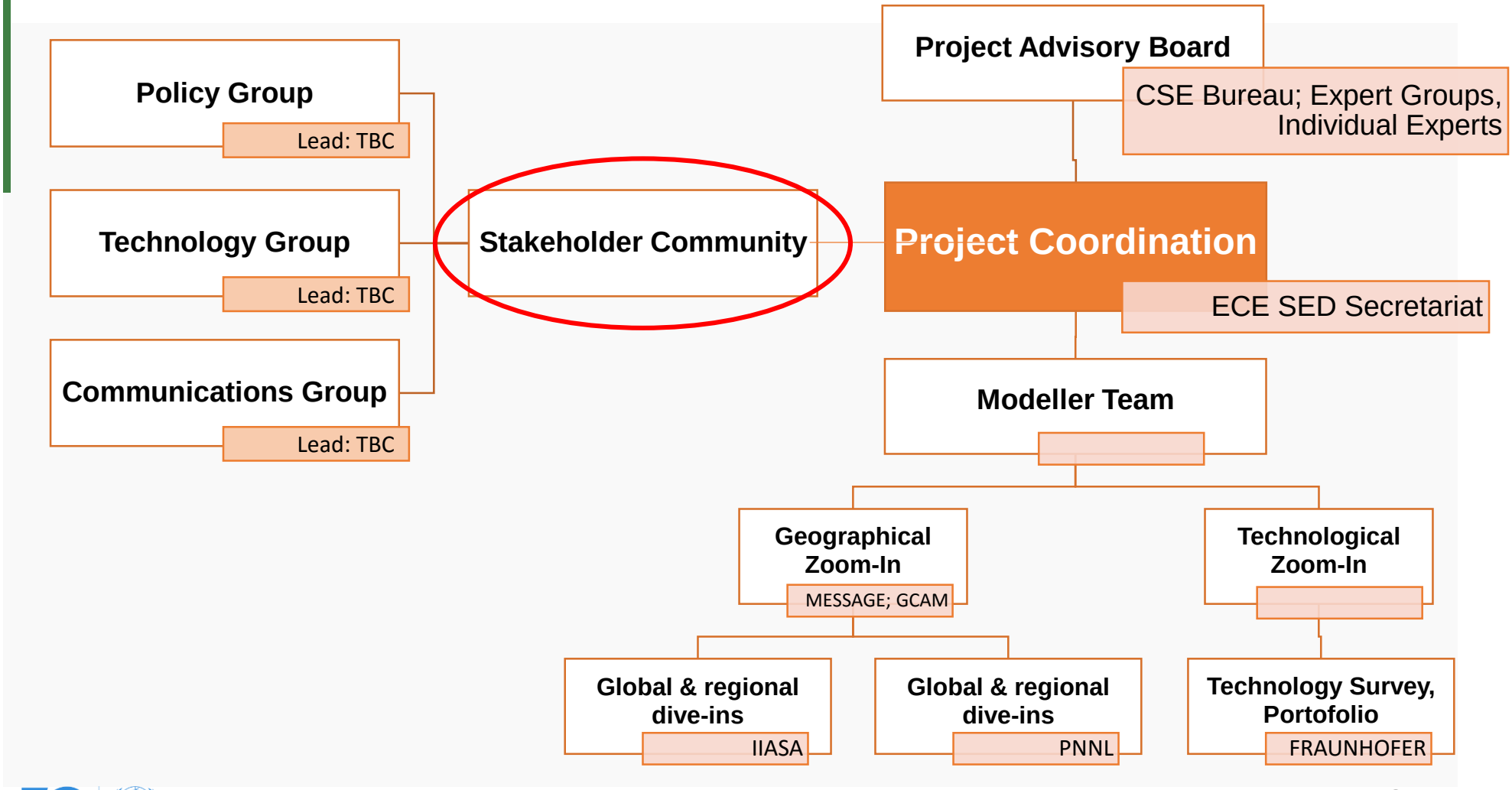

UNECE Region
Sub-regional Clusters

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- **Global Modelling**
- **UNECE modelling**
- **Regional subsets**
  - North America
  - Western Europe
  - Central and Eastern Europe
  - Southeast Europe
  - Caucasus
  - Central Asia
  - Ukraine, Belarus, Moldova
  - Russian Federation
  - Turkey
  - Israel

See countries in each cluster here:
http://data.ene.iiasa.ac.at/message-globiom/message_globiom/overview/spatial.html

Pathways to Sustainable Energy

Project Implementation (Phase I)

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Trends
May 2017 – Dec 2017

Sustainable Energy Storylines
- Definition of trends & uncertainties
- Narrative Descriptions

Research Questions (Case Studies, Deep Dives)
- Definition of particular thematic or sub-regional aspects, policies
- Definition of research questions

Technology Assessment
- Trends and cost evaluations for sustainable energy technology options

Energy Policies Research
- Current policies
- Other polices (NDCs, energy related)

Analysis
June 2017 – Oct 2018

Modell preparation
- Definition of Input Assumptions (drivers) & Indicators (energy security, climate, quality of life, etc.)
- Adaptation of SSP datasets based on (new) data requirements
- Quantfication of SE target
- Model development / finalisation

Modelling / Assessment
- Energy scenarios: energy supply, demand, technology mix, costs, climate budget, etc.
- Modelling / testing of policy options
- Topical / Sub-regional deep dives

Policy options
- 2-3 Policy energy expert workshops

Results
Feb 2018 – Jun 2019

Adaptive Policy Pathways
- Policy Briefs
- Policy dialogues

Case Studies / Deep Dives Results
- 3-5 selected SE Scenarios

Technology Options
Portfolio, Roadmap

Early-Warning System
- Defining KPIs
- Concept development

Engagement of Energy Expert Community

- Storylines
- Technology trends
- Policies

- Defining assumptions / indicators
- Developing policy options
- Policy energy expert workshops

- Outreach
- Policy dialogues

DRAFT Research Questions

Draft Deep Dives & Case Studies* (Technology, Policy, Regional)

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Focal question: How can countries attain sustainable energy by 2050?

I	**What is the optimal energy-mix for different sub-regions within the UNECE region in order to help achieve the 2030 Agenda and create a sustainable energy system?**
	- Energy mix - Role of sub-regional energy trade / Regional cooperation - Geopolitical consequences by increased RE upscaling / SE transition (tbd) - Country leadership
II	**What can be drivers for the transition towards a sustainable energy system?**
	- Policies - Technologies - Infrastructure - Finance / Investments
III	**How to track progress towards achieving and for maintaining a sustainable energy system?**
	- Key performance indicators for continuous improvement & feedback-loop - „Early warning“ system

*Case Study: Further analysis of an existing national, sub-regional, sectoral case; Deep Dive: Further analysis of modeling results as part of a research question.

Project Outline

Technological Portfolio and Zoom-In (2017)

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Technology Portfolio

- Nuclear energy, hard/soft coal, natural gas, oil, biomass, wind, solar, CCS/ CDR, energy efficiency technologies in final energy uses etc.

Technology Zoom-In

- Energy Storage
- Power2X,
- CCS / CDR technologies
- Energy Efficiency

Scenario Methodology

Stages for Scenario Development

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Scenario design composed of four stages

- Base scenario, no policy new interventions
- Base scenario + Current Policies (NDCs, existing energy related policies)
- Base + Current Policies + (multiple) sensitivities around development of energy technologies and energy trade
- Base + current policies + sensitivities + **policy** = Sustainable Energy in 2050 (depending on definition)

Scenario Methodology

Shared Socio-Economic Pathways (SSPs)

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- **Purpose**: Integrated analysis of future climate impacts, vulnerabilities, adaptation, and mitigation
- Quantified datasets for Population and GDP Growth, Urbanisation
- SSP2 is the **base scenario** for the Pathways Project

Full SSP database available online:
https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=welcome

Target Definition: Sustainable Energy

Three pillars

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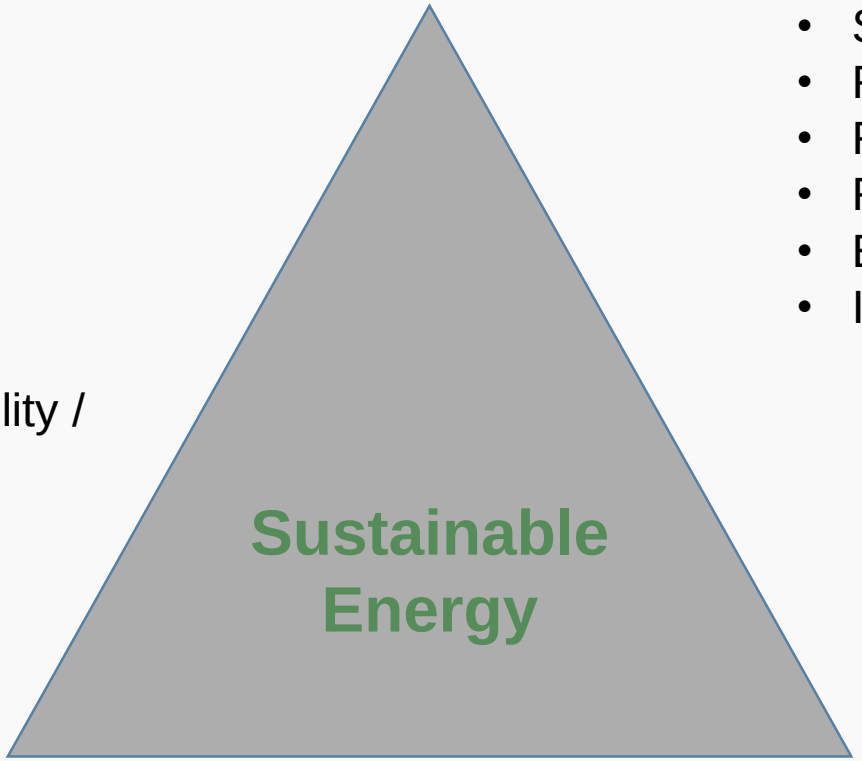
Energy Security

- Energy Intensity (Final, primary)
- Share of RE
- Resilience
- Robustness
- Reliability
- Energy imports vs. Exports
- Investment requirements



- Energy affordability / prices
- Physical energy Access
- Energy Services

Energy for Quality of Life

- Carbon intensity of GDP & of energy
- Air pollution
- Land use
- Water use
- Waste produced

Environmental Protection

Building the Scenarios

Metrics (Outputs)

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Energy security

- Primary and final energy prices: *USD/GJ*
- Energy expenditures: *price * consumption*
- Energy imports: *share of energy consumption*
- Energy exports: *share of GDP*
- Investment requirements: *Indicator to be defined*
- Producer behavior : *Indicator to be defined*
- Consumer behavior: *Indicator to be defined*
- ***Others?***

Building the Scenarios

Metrics (Outputs)

ENERGY

Quality of life

- Energy consumption per capita: *EJ per capita per year*
- Energy services per capita: *efficiency-adjusted energy consumption*
- GDP per capita: *USD/person*
- Food security:
  - Expenditures: *(consumption * prices)/GDP*
  - Nutrition: *share of calories from staple foods*
  - Distributional effects: *share of population at risk of hunger*
- Reliance on solid cooking fuels*: *share of population*
- Other potential measures (specific metrics TBD)*: distributional impacts, access
- ***Others?***

Building the Scenarios
Metrics (Outputs)

ENERGY

Environmental Protection

- Renewable energy: *share of primary energy from renewable sources*
- LCA impacts*
  - Land occupation of energy technologies, excluding bioenergy supply
  - Eutrophication
  - Mineral resource depletion
  - Release of ionizing radiation
  - Human toxicity
  - Ecotoxicity
- Land cover: *thousand hectares forest, other protected lands, …*
- Irrigation: *share irrigated cropland*
- Water deficit*: *demand/supply*
- Global average temperature change: *degrees C above preindustrial*
- GHG emissions/concentrations: CO_2, CH_4, *NMVOC, …*
- Non-GHG pollutant emissions/concentrations: SO_2, NO_X, *PM2.5*, NH_3

- ***Others? - methane emisisons related (coal, oil, gas)?***

Questions to the Group & Discussion

Methane Management as Enabler to attain Sustainable Energy?

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- Modelling Approach
  - Defining sustainable energy: Outcome Indicators
  - Research questions: 3 key methane related questions for the model?
- Data
  - Possible data sources and inputs to the modelling work
  - Which type of data, relevance, availability
- Technology options
  - Methane related technologies for the technology portfolio
- Policy Options & Policy Pathways
  - Inputs, discussion: methane management as enabler?
  - Involvement in the policy development phase
  - Hearing from countries
- Regional deep dives
  - Case studies from specific countries / UNECE sub-regions?
  - Countries for deep-dives (largest emitters, etc.)
- Linkages to other initiatives?

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Thank you!

Lisa Tinschert
Lisa.Tinschert@unece.org
Sustainable Energy Division
UNECE
Date 23 I 10 I 2017, Geneva

Background Slides

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Project Timeline

Engagement with the Expert Community

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CSE = Committee on Sustainable Energy
IFESD = Internat. Forum on Energy for Sust. Dev.

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MESSAGE - Model for Energy Supply System Alternatives & their General Environmental Impacts

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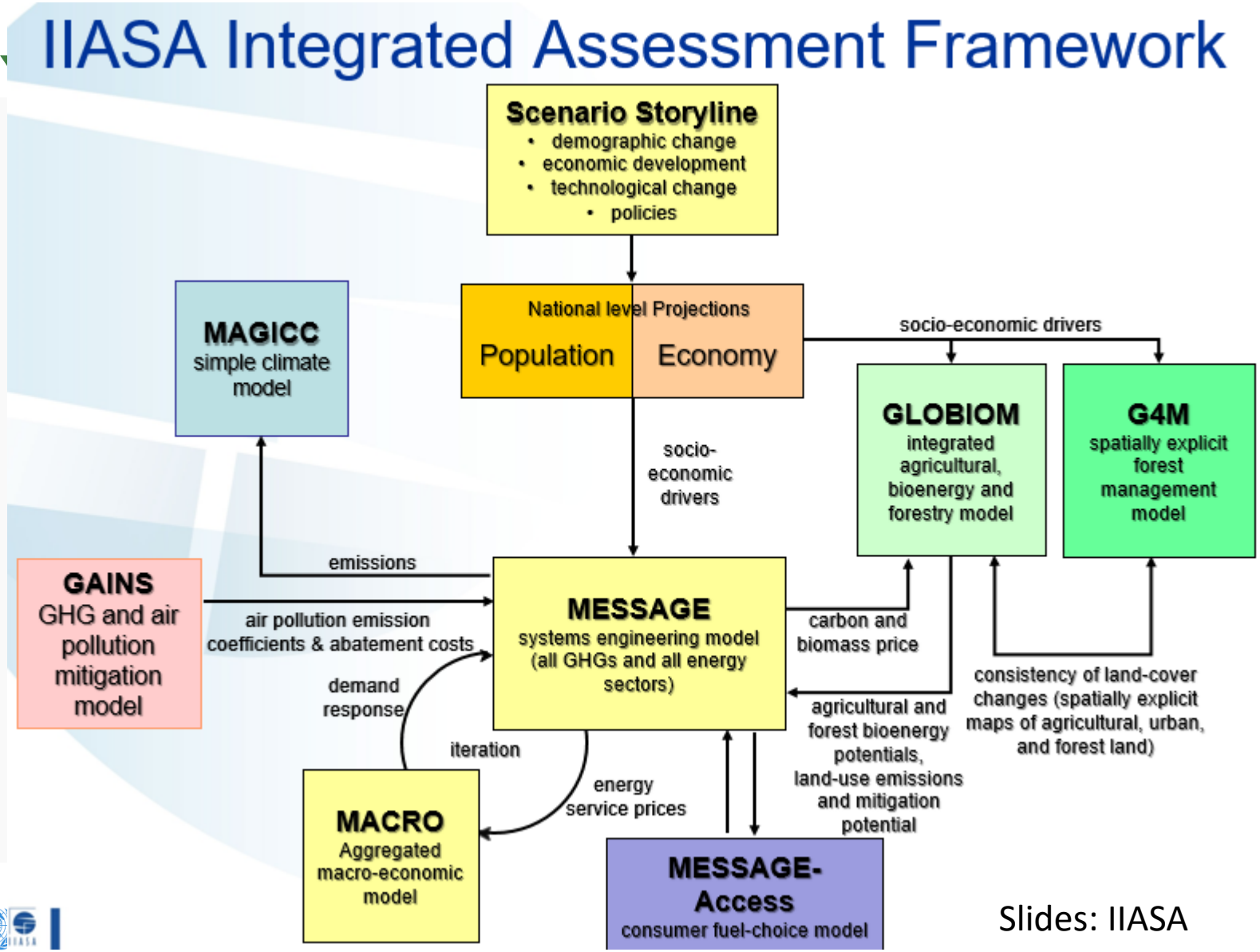
- MESSAGE is a dynamic, multi-period **optimization model**.
- It is **a bottom-up** systems engineering model designed for **medium- to long-term energy system planning, energy policy analysis, and scenario development**.
- MESSAGE currently features 11 **world regions** covering the entire globe.
- It is a **scenario-oriented energy system model**; scenarios are developed through **minimizing model total discounted energy system costs** under a set of engineering and user defined constraints imposed on the energy system.
- **Future demands** for energy services is one of the key scenario inputs. MESSAGE provides information on the utilization of domestic resources, energy imports & exports, investment requirements, technologies selected, pollutant emissions, etc.
- It informs the user **if policies imposed on the model are 'technically' and financially feasible** (and if, at what costs and trade-offs).
- The model takes into account **existing installations**, their vintage and retirement schedules. The optimisation process, then determines the **need for new generating capacity and the investment requirements**

MESSAGE

As part of IIASA's Integrated Assessment Framework



Slides: IIASA

Slides: IIASA

MESSAGE

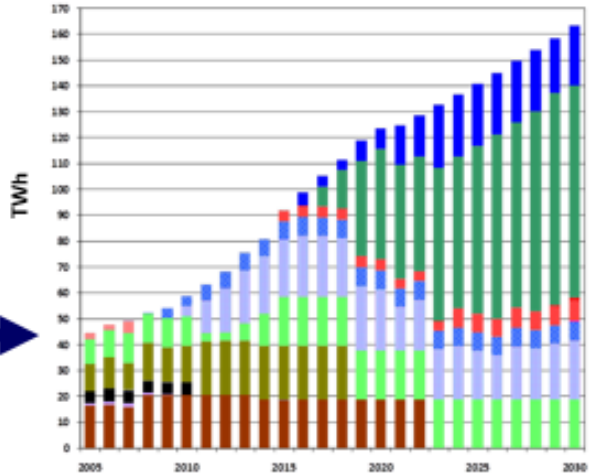
Inputs and Outputs

ENEI

INPUT

- Energy system structure (including vintage of plant and equipment)
- Base year energy flows and prices
- Energy demand projections (e.g. MAED)
- Technology and resource options & their techno-economic performance profiles
- International fuel market prices
- Technical and policy constraints
- Subsidies, taxes and feed-in tariffs
- ..and much more

OUTPUT

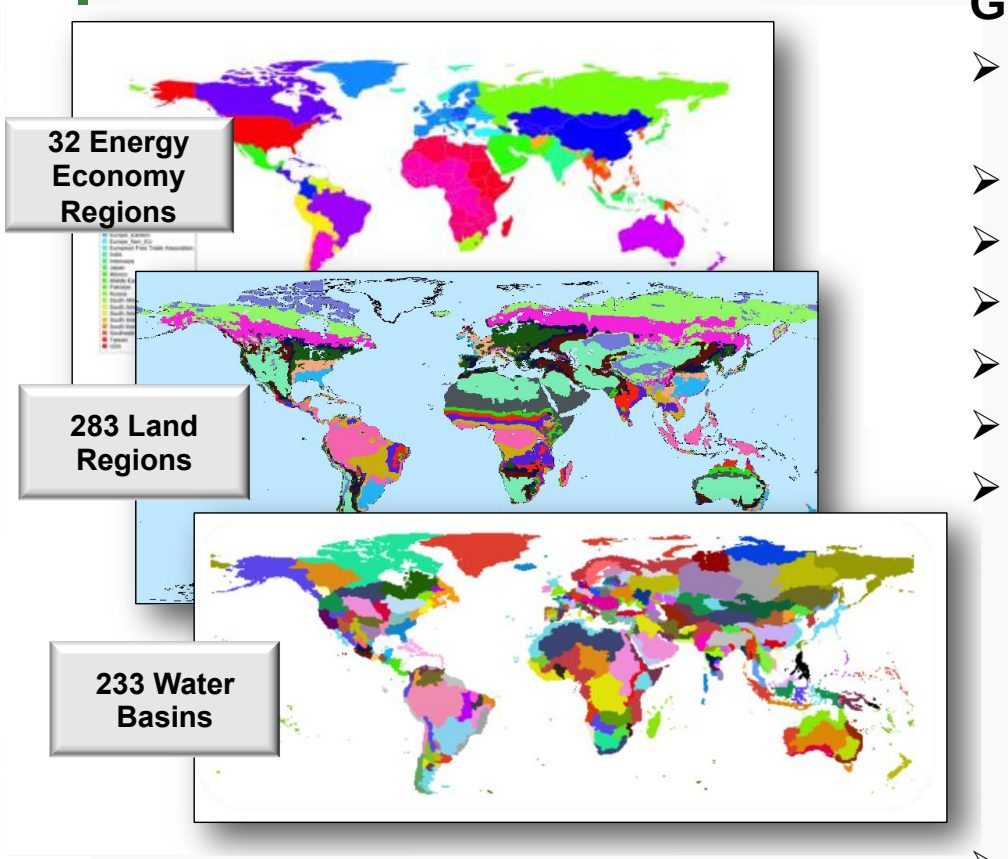


- Primary and final energy mix by fuel
- Electricity generating mix by technology and fuel
- Capacity expansion/retirement
- Emissions & waste streams
- Resource use (energy, water, land, etc.)
- Trade & import dependence
- Investment requirements
- Prices
- .... and much more

Mathematical Formulation behind MESSAGE:
http://data.ene.iiasa.ac.at/message-globiom/message_globiom/annex/message/index.html

GCAM - The Global Change Assessment Modeling Framework

ENERGY



GCAM: a global integrated assessment model

- Links economic, energy, land use, water, and climate systems
- 32 geopolitical regions
- 283 land-use regions
- 233 water basins
- Runs through 2100 in 5-year time steps
- Emissions of 24 GHGs and short-lived species
- Used to analyze consequences of interdependencies between human and Earth systems
  - Energy, climate, and other policies
  - Socioeconomic development
  - Technology and resource changes
  - Climate impacts and adaptation
- Community model
- Developed and housed at the Joint Global Change Research Institute, research collaborations

Slides: PNNL

GCAM
Inputs and Outputs

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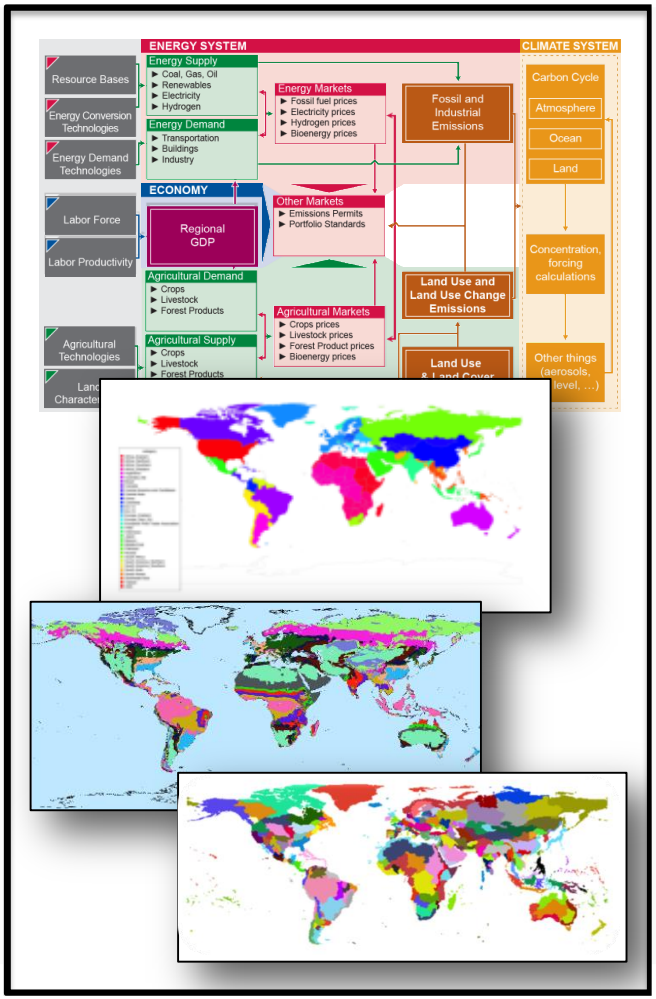
Scenario Assumptions

- Socioeconomic development
- Energy, land use, and water technologies
- Policies
- Resources



Scenario Outputs

- Prices, quantities
  - Energy production
  - Agricultural demand and production
- Land use
  - Crop (by type)
  - Pasture
  - Forest
  - Unmanaged
- Water demand
- Greenhouse gas emissions
- Economic indicators
  - Income transfer
  - Policy costs

Slides: PNNL

SSP2: Middle of the Road
Overview

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- SSP2 does not imply a simple extrapolation of recent experience, but rather a **development pathway that is consistent with typical patterns of historical experience observed over the past century** Social, economic, and technological trends follow historical patterns:
- Global population growth is moderate and levels off in the second half of the century;
- **Moderate population growth**, persisting income inequality
- Most economies are politically stable; Globally connected markets function imperfectly. **Medium economic growth**
- **Slow progress in achieving SDGs**
- Environmental systems degrade, overall resource & energy intensity declines.
- Even though fossil fuel dependency decreases slowly, there is no reluctance to use unconventional fossil resources.
- Technological progress continues without major slowdowns or accelerations.