UNECE

ENERGY

Pathways to Sustainable Energy Project

Project Kick-off and Scenario Scoping

14 June 2017, Astana

Agenda

ENERGY

- Project Overview
- Modeling Approach, Models
- Review: Storylines, Scenarios and Target Definition

Project Overview

- Objectives and approach
- Implementation phases
- Stakeholder engagement

Project Overview

Pathways to Sustainable Energy

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- Timeframe: May 2017 – Dec 2018
- Expected accomplishments
  - (1) Modelling of Sustainable Energy Scenarios

  Enhanced understanding of the UNECE member States of alternative pathways for transitions to a sustainable energy future.
  - (2) Conceptualisation of an early-warning system

  Enhanced knowledge of member States to apply early-warning indicators and a mechanism to track implementation of national contributions towards reaching common goals.
  - (3) Policy Dialogue and Formulation of Adaptive Policy Pathways

  Increased capacities of national energy ministries to develop, implement and track national sustainable energy strategies.
- Key deliverables
  - Energy scenarios modeled based on UNECE-SSP merged storylines
  - Definition of adaptive policy pathways
  - Development of policy and technology options / technology portfolio, roadmap
  - KPIs to conceptualize early-warning system to track progress
  - 2-4 energy expert workshops to define and discuss policy options
  - High-level policy dialogue planned for 2018

Project Stakeholders

Pathways to Sustainable Energy

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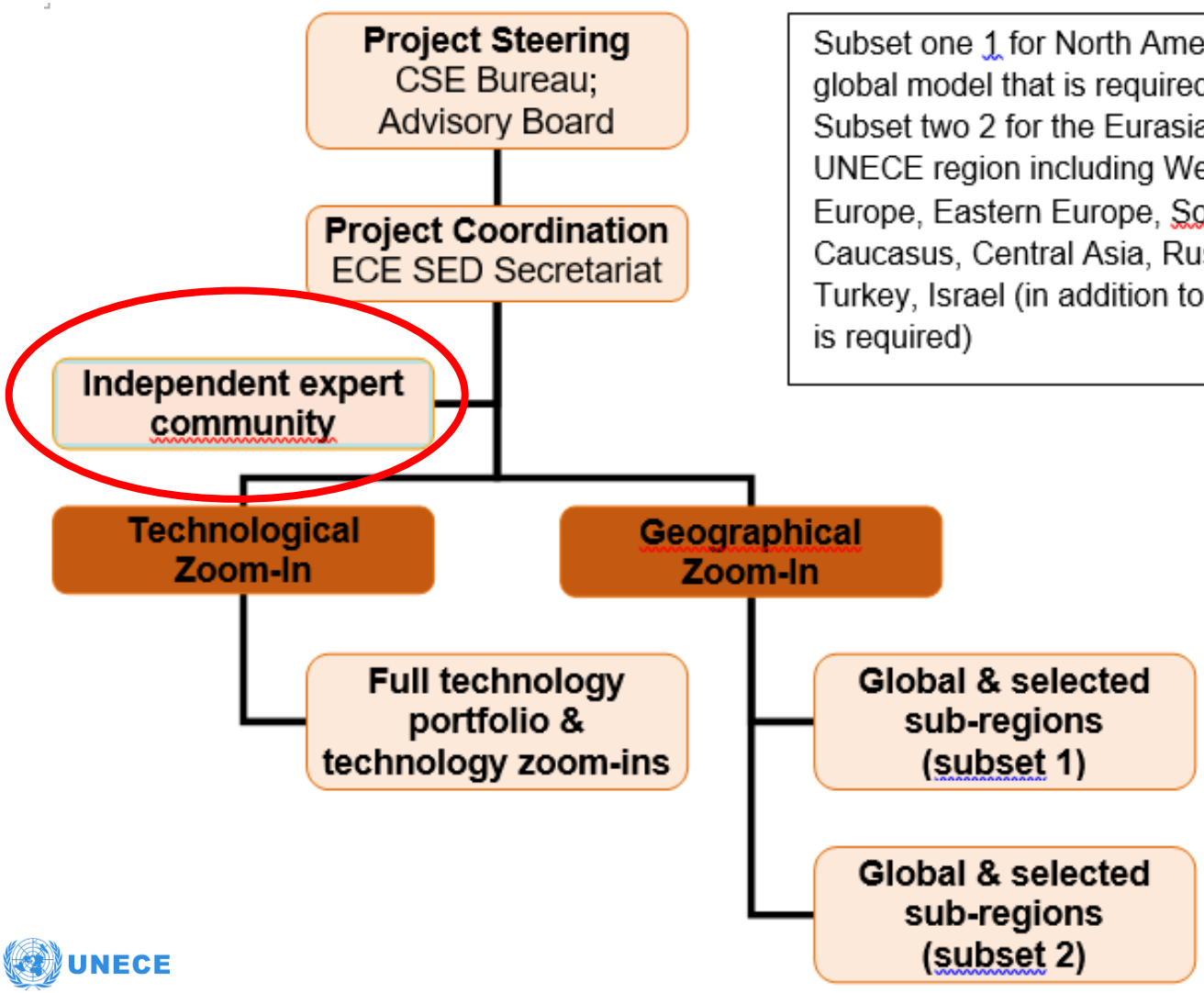

Subset one 1 for North America (in addition to a global model that is required).
Subset two 2 for the Eurasian part of the UNECE region including Western and Central Europe, Eastern Europe, Southeastern Europe, Caucasus, Central Asia, Russian Federation, Turkey, Israel (in addition to a global model that is required)

UNECE Region
Sub-regional Clusters

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- Global 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

Project Outline
Division of Work

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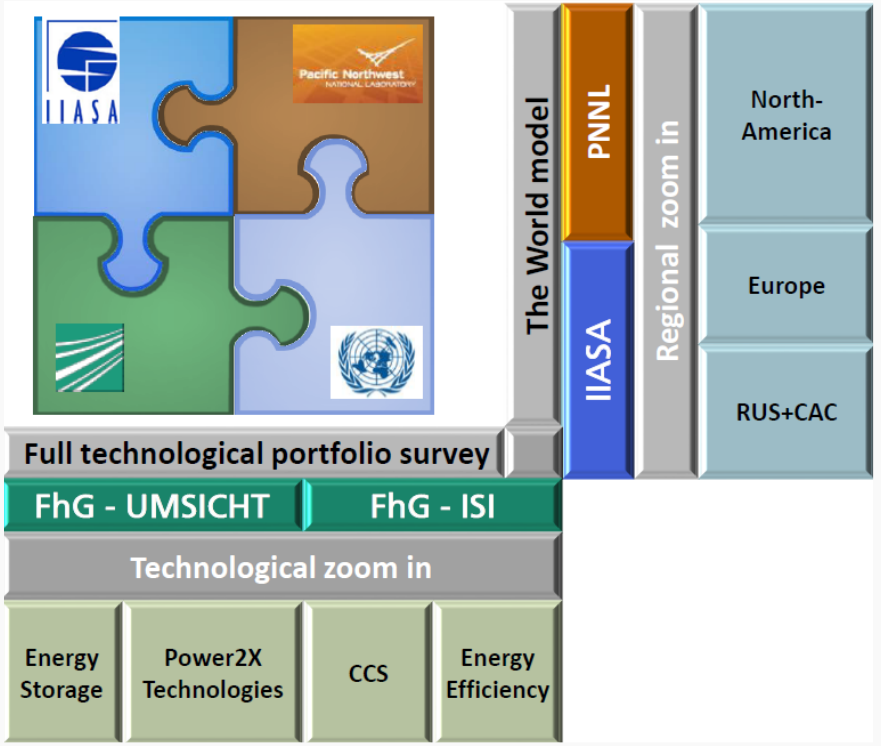
- **UNECE**
  - Overall project coordination
  - Policy dialogues
  - Project steering (CSE)
- **IIASA**
  - World Model (MESSAGE)
  - Regional and thematical zoom-ins
- **PNNL**
  - World Model (GCAM)
  - Regional and thematical zoom-ins
- **Fraunhofer**
  - Full technology portfolio survey
  - Technological zoom-in for system integration technologies
  - International coordination of modelers



Pathways to Sustainable Energy

Project Implementation Phases

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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

Nov 2017 – Dec 2018

Adaptive Policy Pathways
- Policy Briefs
- Policy dialogues

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

Technology Pathways
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

Project Timeline

Engagement with the Expert Community

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Project Update session at CSE
Geneva, Sep 2017

Policy Dialogue at CSE
Discuss policy options & pathways
Geneva, Sep 2018

Expert Workshop - tbc
Discuss technology & policy options
tbd, Q1 2018

May 2017

Dec 2018

Modeler Kick-off Workshop
Oberhausen, May 2017

Expert Workshop at 9th IFESD
Derive / discuss policy options / pathways
Ukraine, Q3 2018

High-level Political Dialogue
Russia (tbc), Q1 (2019)

Kick-off & Expert Workshop at 8th IFESD
Astana, Jun 2017

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

Modeling Approach, Models

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.
- Description of state of the art
- Key parameters (Fuel costs, Capex, Efficiency (energy output/input)

Data input:

- Literature (meta-analysis); comparison of results with data used in models

Data output:

- Market share, global / regional energy demand & consumption, CO2 emissions

Project Outline

Technological Portfolio and Zoom-In (2017)

ENERGY

Technology Zoom-In

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

Data input:

- Literature (meta-analysis); comparison of results with data used in models

Data Output:

- State of the art (Power2X, storage)
- **Overview** on CCS/CDR technologies & energy efficiency **potentials** by sectors: buildings, industry, appliances, transport
- Expected development of currently available technologies plus cutting edge technologies with the potential to play a significant role in future energy systems
- **Technological relevance**: regional case studies, global/regional technology demand, market penetration/spatial share of technologies
- **Technology cost**: Current and future cost figures, Capex evolution, Development of marginal abatement cost curves

Project Outline
Modelling Approach: 2017

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- Disaggregation of the FSU region into Russian Federation, Central Asia, Caucasus and sub-region Ukraine, Belarus and Moldova.
  a) Base year energy flows and generation mix calibration
  b) Add and aggregate current and expected national policies
  c) Make sub-regions consistent with SSP2 scenario (2015-2050/2100)
- Update technology portfolio to reflect imminent deep technology dives (input Fraunhofer) for all 14 IIASA model regions
- Ensure consistency/harmonization of technology and scenario assumption among PNNL/IIASA & Fraunhofer
- Modelling and testing of 'Research Questions'
- Testing adaptive policy pathways as well as KPIs
- Present to, and discuss with, UNECE and stakeholders, initial set of scenario outcomes (1st Q 2018)
- Based on feedback received refine workplan for 2018

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

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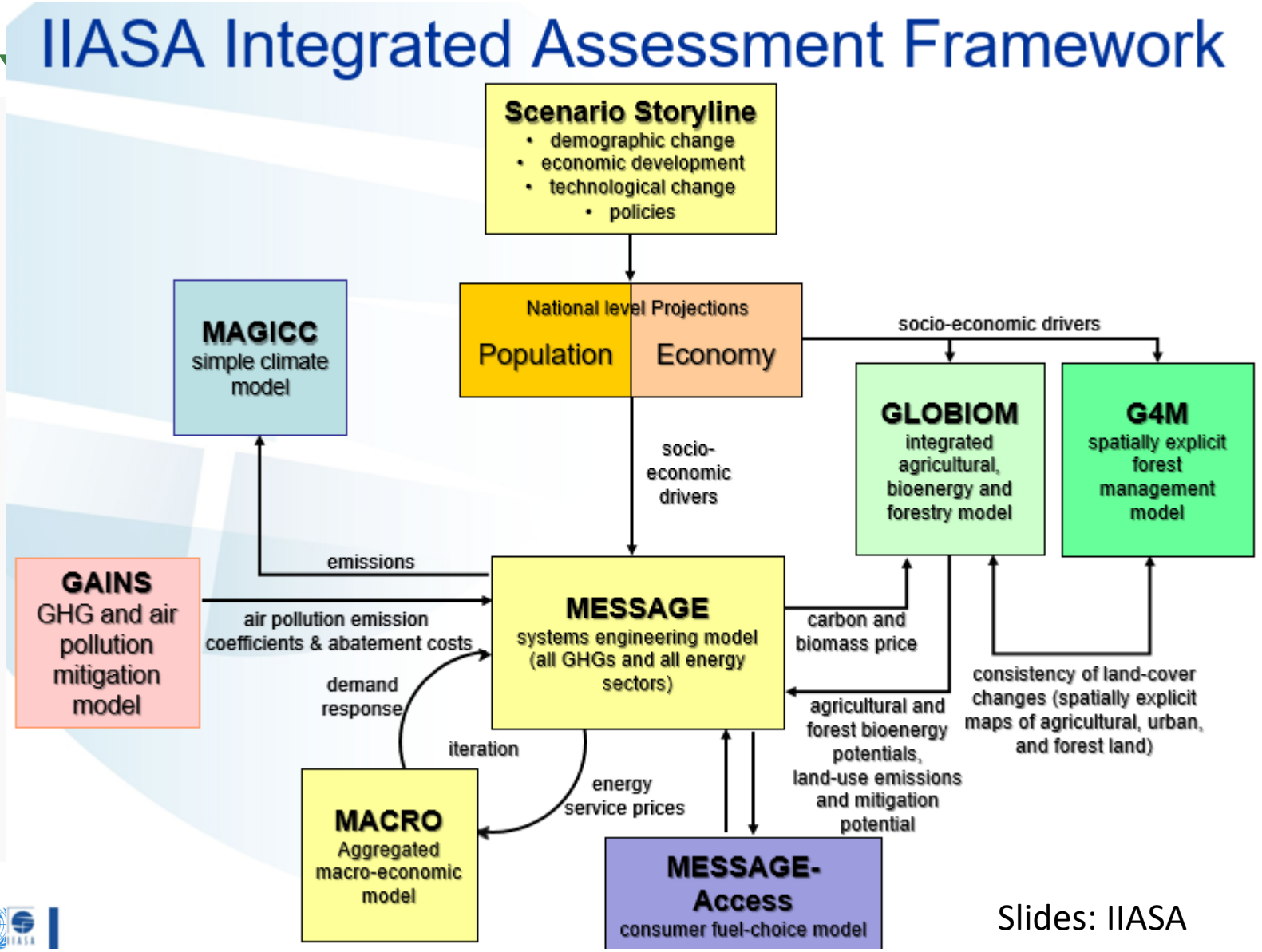
- MESSAGE is a dynamic, multi-period **optimization model**.
- It is **a bottom-up** systems engineering model designed for **medium- to long-term energy system planning, energy policy analysis, and scenario development**.
- MESSAGE currently features 11 **world regions** covering the entire globe.
- 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

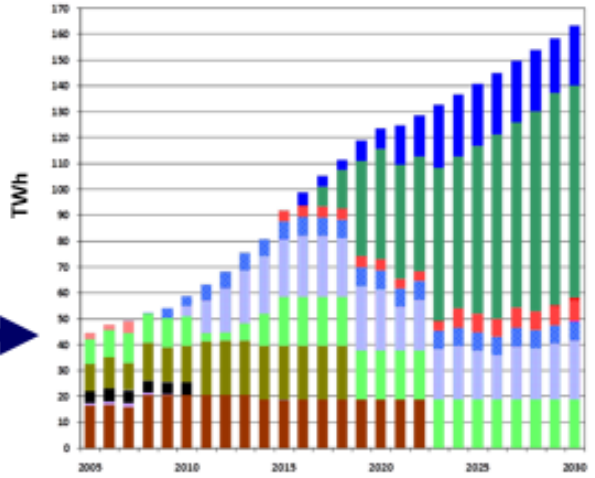
MESSAGE
Inputs and Outputs

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

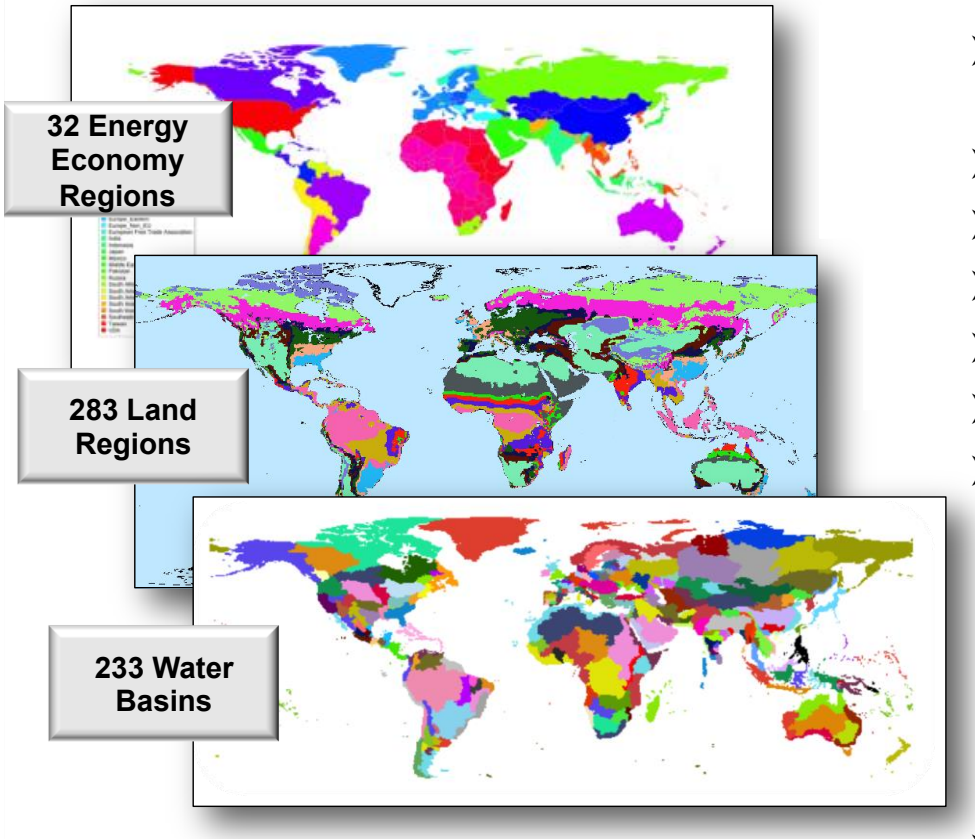
OUTPUT



- 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



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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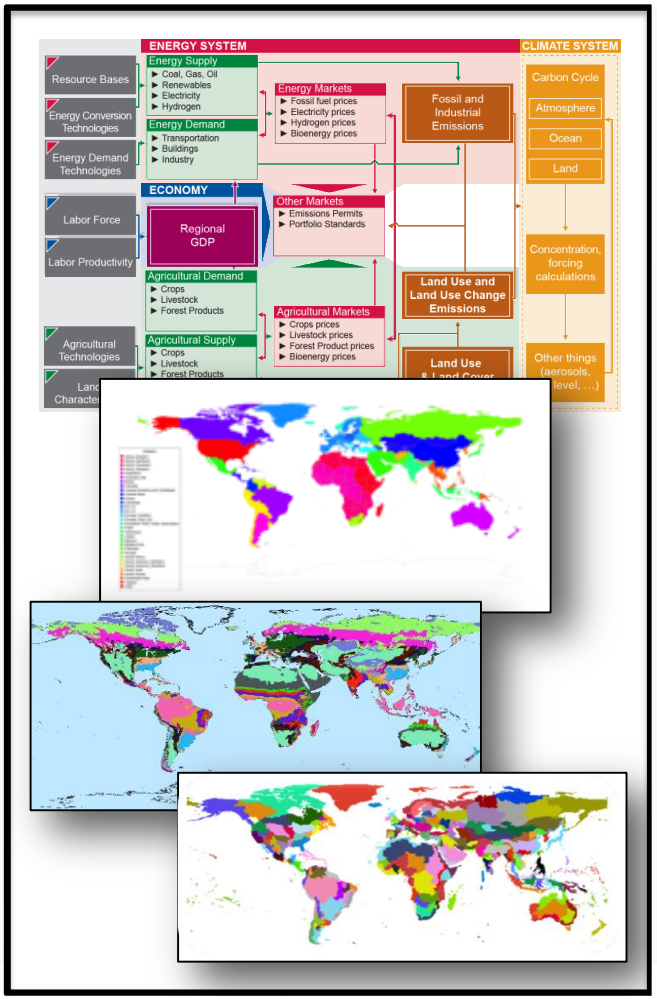
Scenario Assumptions

- 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

Data Inputs from countries

Seeking support

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- National energy statistics, energy and electricity balances (if different from IEA)
- Current national policies (energy, environment, NDCs, other relevant development policies)
- (Large) energy projects under construction, advanced planning
- A contact person for potential future interaction

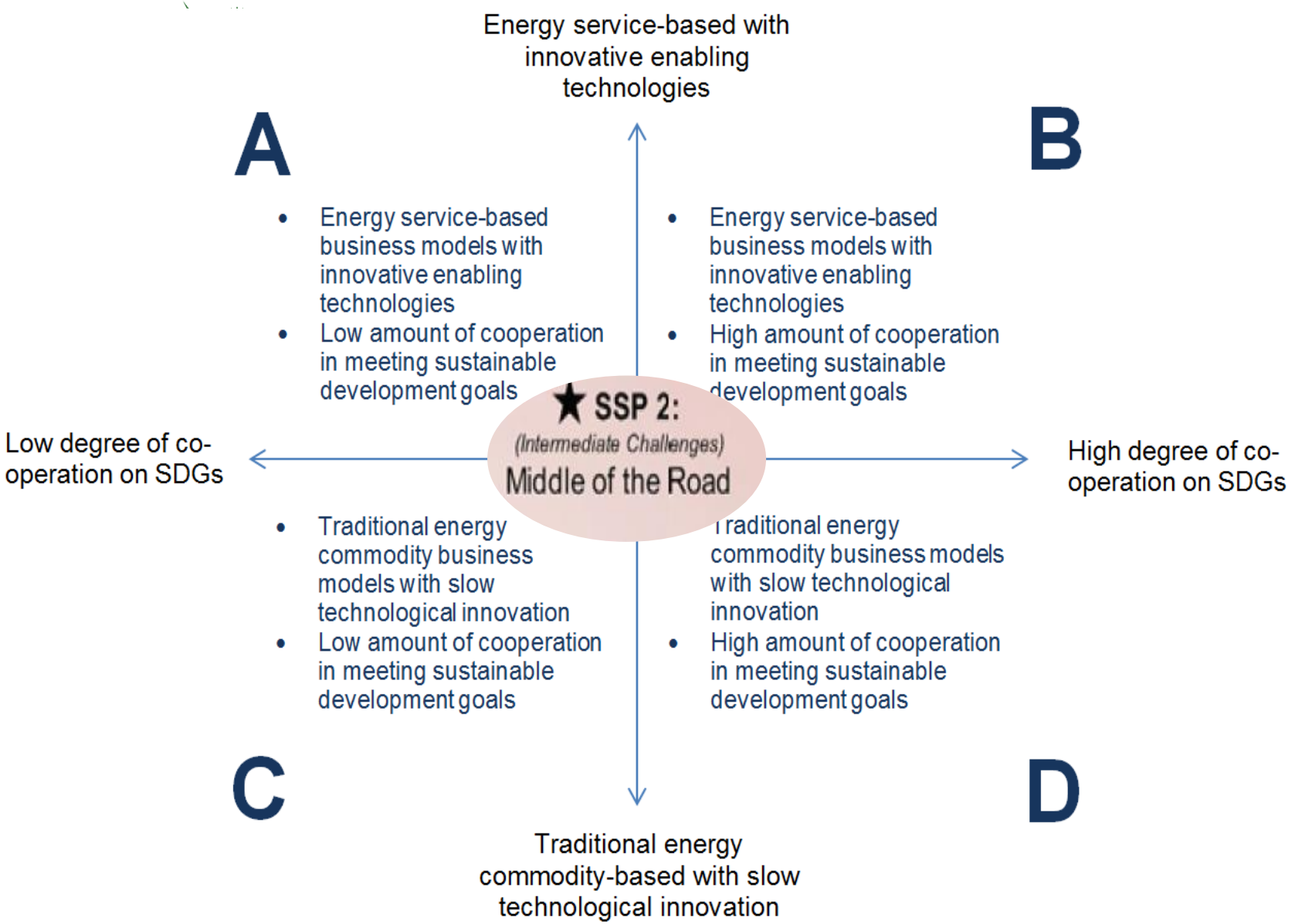
please send to lisa.Tinschert@unece.org

Review: Storylines, Scenarios, and Target Definition

- UNECE Sustainable Energy Storylines
- Key challenges of defining Sustainable Energy

Visionary Storylines (narratives)

Overview



Visionary Storylines (narratives)

DRAFT Summaries

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A	**Innovative but less cooperative** Technology development and innovation in home markets, with service-based business models and decarbonisation of fossil fuels and system-wide efficiency.
B	**Innovative, collaborative and green** Service-based business models with emergence of energy "prosumers", increased decentralisation, increased trade and interconnection, aggressive application of innovative low-carbon technologies.
C	**Focusing inward: Energy independence fueled by fossil energy** Strong acceleration of energy efficiency measures from source to use; focus on domestic energy sources and energy independency / security.
D	**The conservatives: Progress step by step** Sustained high penetration of fossil fuels in the energy system with increased application of decarbonisation approaches based on technology transfer; extension of networks and collaboration

Shared Socio-Economic Pathways (SSPs)

Overview

- **2007-2013:**

Development of narrative socio-economic scenarios, to derive emissions scenarios without and with climate policies

- **Purpose**:

Integrated analysis of future climate impacts, vulnerabilities, adaptation, and mitigation

- **2013-2016**:

Quantified datasets for Population and GDP Growth, Urbanisation

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

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.

Target Definition: Sustainable Energy

Draft: 3 Components

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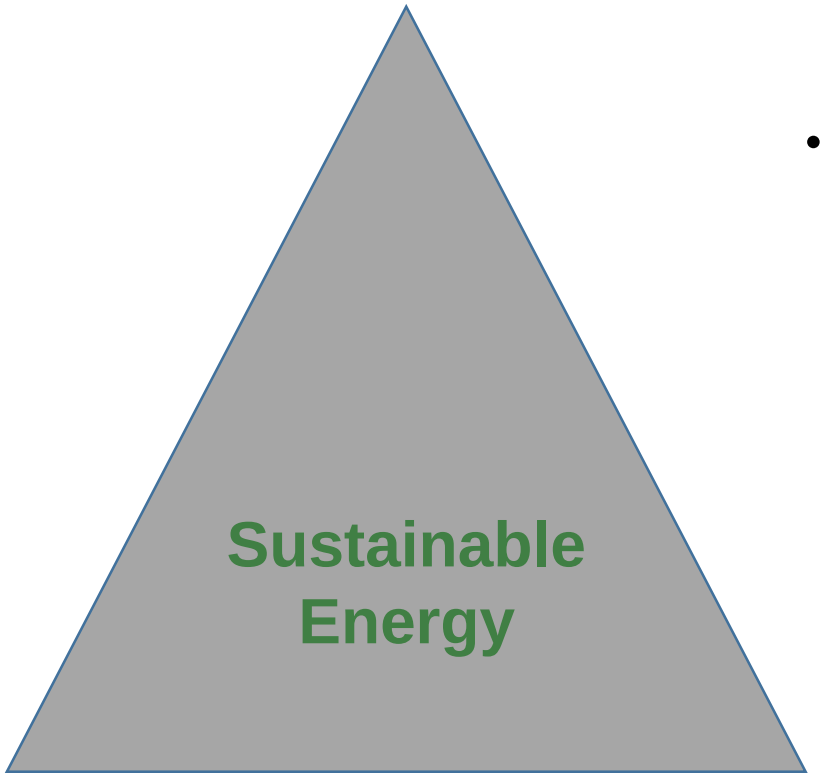
Energy Security

- Supply to meet demand (but differing conceptualisations)
- …



- Energy affordability
- …

Quality of Life

- Air pollution control
- Climate commitments
- …

Environmental Sustainability

Building the Scenarios, based on SSP2
Drivers (Inputs)

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- Meta Drivers (underlying characteristics of energy system)
  - International Cooperation (degree of openness to trade)
  - Innovation (technology costs development, changes in efficiency, business models)
- Drivers (Range definitions)
  - Energy efficiency (end-use, conversion)
  - Energy Storage
  - Electric Vehicles
  - Abundance of fossil fuels (all types), extraction costs
  - CCS (incl. BECCS)
  - Power to X (efficiency, CapEx)
  - Nuclear
  - Renewable energies (BM, non-BM, system integration, CapEx, efficiency)
- Policies
  - Subsidies (carbon price, taxes, etc.)

Building the Scenarios, based on SSP2

Indicators (Outputs)

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- Indicators
  - Final energy intensity (SDG7)
  - Carbon intensity (SDG13)
  - Carbon budget (temperature change)
  - Energy prices
  - Share of RE (SDG7)
  - Investment requirements (SDG7)
  - Energy imports and exports
  - Food prices / consumption (SDG2)
  - Energy access (energy use?) (SDG7)
  - Water use of energy sector (SDG6)
  - Pollutants (SDG9)

DRAFT Research Questions

Thematical / Sub-regional Case Studies & Deep Dives

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Focal question: How can countries attain sustainable energy?

- Role of FF in a future sustainable energy system
- Methane leakage from extraction, transmission, distribution
- Competitiveness of RE compared to FF; synergies of RE & FF; RE grid-integration; RE and Gas
- Energy efficiency policies as enabler for other policies / holistic approach
- Investment requirements to attain certain level of RE, changing of investment patterns for transition towards SE system
- Quantum leap of technologies: Technologies as game changer
- Sub-regional topics to be defined
- Others

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Thank you!

Elisabeth Tinschert, Stefanie Held
Lisa.Tinschert@unece.org, stefanie.held@unece.org
Sustainable Energy Division
UNECE
Date 14 I 07 I 2017, Astana