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
Pathways to Sustainable Energy

- **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](https://www.unece.org/energy/pathwaystose.html)
UNECE Region
Sub-regional Clusters

- 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](http://data.ene.iiasa.ac.at/message-globiom/message_globiom/overview/spatial.html)
Pathways to Sustainable Energy
Project Implementation (Phase I)

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 policies (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
  - Quantification 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

May 2017 – Dec 2017
June 2017 – Oct 2018
Feb 2018 – Jun 2019
**Focal question: How can countries attain sustainable energy by 2050?**

<table>
<thead>
<tr>
<th>I</th>
<th>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?</th>
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<tbody>
<tr>
<td></td>
<td>- Energy mix</td>
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<td>- Role of sub-regional energy trade / Regional cooperation</td>
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<td>- Geopolitical consequences by increased RE upscaling / SE transition (tbd)</td>
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<td>- Country leadership</td>
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<td>II</td>
<td>What can be drivers for the transition towards a sustainable energy system?</td>
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<td>- Policies</td>
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<td>- Technologies</td>
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<td>- Infrastructure</td>
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<td>- Finance / Investments</td>
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<td>III</td>
<td>How to track progress towards achieving and for maintaining a sustainable energy system?</td>
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<td>- Key performance indicators for continuous improvement &amp; feedback-loop</td>
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<td>- „Early warning“ system</td>
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Project Outline

Technological Portfolio and Zoom-In (2017)

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 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)
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

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

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

- Energy for Quality of Life
  - Energy affordability / prices
  - Physical energy Access
  - Energy Services

- Environmental Protection
  - Energy Services
Energy security

• Primary and final energy prices: \textit{USD/GJ}
• Energy expenditures: \textit{price} * \textit{consumption}
• Energy imports: \textit{share of energy consumption}
• Energy exports: \textit{share of GDP}
• Investment requirements: \textit{Indicator to be defined}
• Producer behavior: \textit{Indicator to be defined}
• Consumer behavior: \textit{Indicator to be defined}
• \textit{Others?}
Building the Scenarios
Metrics (Outputs)

Quality of life

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

- Others?
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: *CO₂, CH₄, NMVOC, …*
- Non-GHG pollutant emissions/concentrations: *SO₂, NOₓ, PM2.5, NH₃*

- Others? - methane emissions related (coal, oil, gas)?
Questions to the Group & Discussion
Methane Management as Enabler to attain Sustainable Energy?

- **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?**
Thank you!

Lisa Tinschert
Lisa.Tinschert@unece.org
Sustainable Energy Division
UNECE
Date 23 I 10 I 2017, Geneva
Background Slides
Project Timeline
Engagement with the Expert Community

Status update 26th CSE
Geneva, Sep 2017

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

Modeler Kick-off Workshop
Oberhausen, May 2017

Expert Workshop
U.S., Q2 2018 (tbc)

Expert Workshop
Western-Central Europe, Q1 2018 (tbc)

Expert Workshop
Central Asia, Q2/3 2018 (tbc)

Expert Workshop
at 9th IFESD
Ukraine, Q4 2018

Preparatory Meeting
Geneva, Q1 2019 (tbc)

Policy Dialogue &
Workshop at 27 CSE
Geneva, Sep 2018

High-level Political Dialogue
Q2 (2019)

CSE = Committee on Sustainable Energy
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.
As part of IIASA’s Integrated Assessment Framework

MESSAGE

Socio-economic drivers

GLOBIOM
integrated agricultural, bioenergy and forestry model

G4M
spatially explicit forest management model

MESSAGE
systems engineering model (all GHGs and all energy sectors)

MACRO
Aggregated macro-economic model

GAINS
GHG and air pollution mitigation model

MAGICC
simple climate model

Energy service prices

Scenario Storyline
- demographic change
- economic development
- technological change
- policies

National level Projections
Population
Economy

Iteration

Consistency of land-cover changes (spatially explicit maps of agricultural, urban, and forest land)

Carbon and biomass price

Agricultural and forest bioenergy potentials, land-use emissions and mitigation potential

MESSAGE-Access
consumer fuel-choice model

Slides: IIASA
MESSAGE
Inputs and Outputs

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:
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
**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

ENERGY

• 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.