Integrated impact assessment of decarbonisation pathways for the EU

Insights from the REEEM Project

Dr. Francesco Gardumi
division of Energy Systems Analysis
KTH Royal Institute of Technology
gardumi@kth.se

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Overview of REEEM

Key figures

Funded under GA N. 691729, Horizon 2020 Low-Carbon Energy call LCE21-2015.

Objective

To gain comprehensive understanding of the **system-wide implications of energy strategies.**

Focus

Energy strategies focus on **transitions to a competitive low-carbon EU energy society**, as described by the Strategic Energy Technology (SET) Plan.

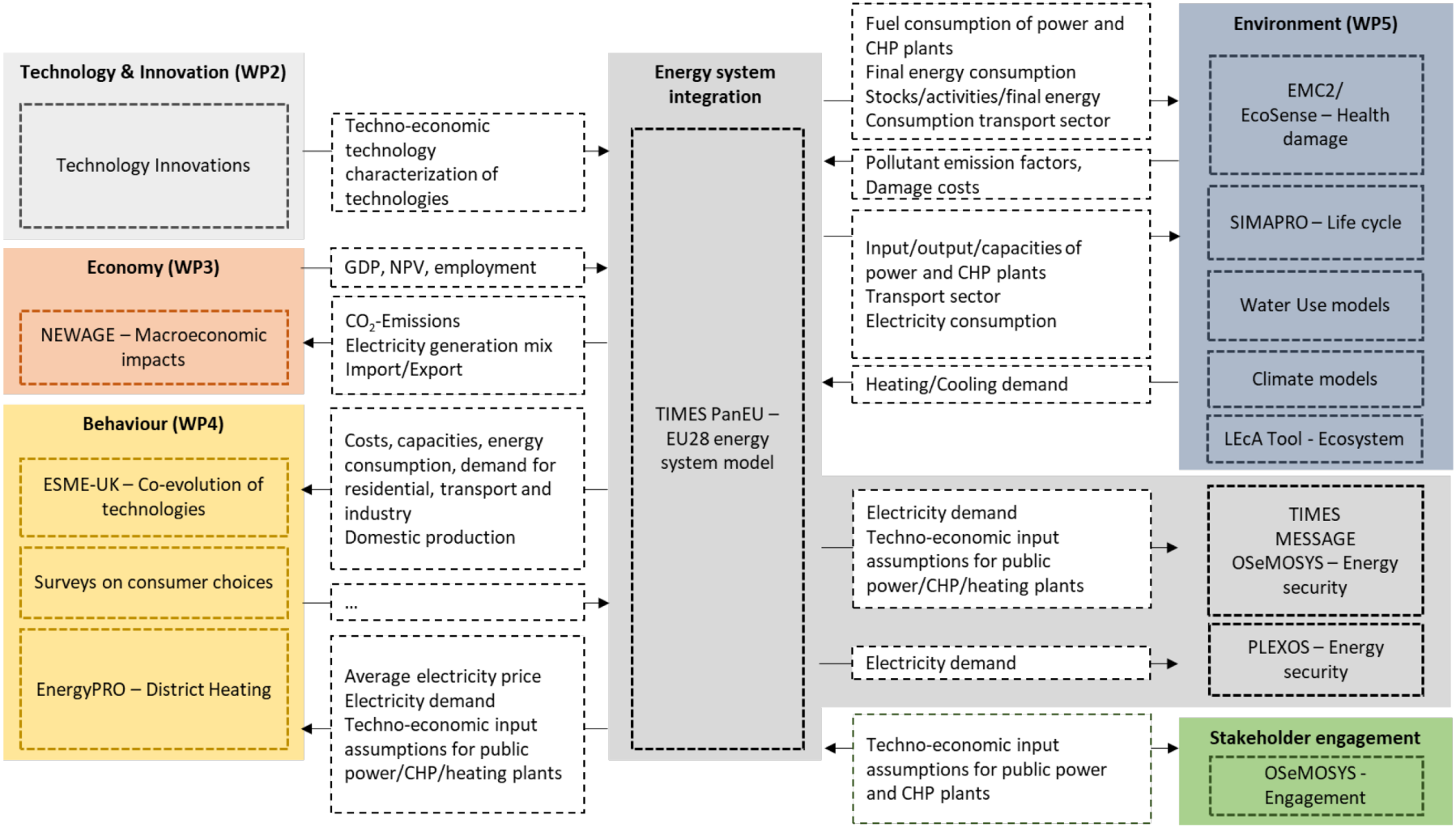
Methodology

A **large ensemble of models** to study the **role of technologies, innovation and consumers** in **EU decarbonisation pathways.**

Integrated economic, environmental and social **impact assessments** produced.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Methodology



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

REEEM

Methodology

Analysis in three parts

1. **Collection of technology innovation data on selected technologies**
2. **PanEU modelling**
3. **Regional / National / Local case studies**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Methodology

1. Collection of technology innovation data

Collection coordinated by KIC InnoEnergy through networks of experts in industry, literature work, local experts and workshops.

Three themes chosen (technologies relevant in the EC's Strategic Energy Technology Plan):

- **Energy storage**
- **Renewables**
- **Efficiency measures in buildings**

Techno-economic data projections for these technologies **produced and fed to all models**, both for PanEU modelling and regional/national/local modelling.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Methodology

2. PanEU modelling

EU28 energy system model and impacts on economy, environment and society.

- Energy system model – **TIMES PanEU**
- GDP, employment and competitiveness effects - **NEWAGE**
- Health damage costs of emissions – **Ecosense, EVA, EMC2**
- Life cycle consumption of resources – **SimaPro**
- Critical materials – **literature study**

All models calibrated on a **Base Pathway** (and, further on, on others).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Methodology

2. PanEU m

EU28 energ

- Energy s
- GDP, em
- Health d
- Life cycl
- Critical r

Energy system **decarbonisation** in a EU political, economic, social, technological and environmental setting **evolving from the current one without major disruptions**.

- Political: stronger policy parallels between clusters of countries
- Economic: growth restarts, at different speeds
- Societal: no strong engagement in energy transition
- Climate: RCP2.6, lower availability of water locally
- Technological: currently commercially available techs, no breakthrough

All models calibrated on a **Base Pathway** (and, further on, on others).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Methodology

2. PanEU modelling

EU28 energy system model and impacts on economy, environment and society.

- Energy system model – **TIMES PanEU**
- GDP, employment and competitiveness effects - **NEWAGE**
- Health damage costs of emissions – **Ecosense, EVA, EMC2**
- Life cycle consumption of resources – **SimaPro**
- Critical materials – **literature study**

Some of the models, **one-by-one soft-linked with TIMES to endogenise** economic and environmental impacts.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Methodology

3. Regional / national / local case studies

- **UK**: Co-evolution and crowding out of technologies
- **Lithuania**: Ecosystem services
- **Helsinki, Kaunas and Warsaw**: District heating networks
- **Baltic countries**: Energy supply security
- **Balkans**: Grid dispatch
- **UK, Finland, Croatia**: consumer choices of end-use technologies – surveys

Pathways are region/country specific.

One Base Pathway in each case, calibrated as much as possible on the PanEU one, **plus branchings / sensitivities around this pathway**.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Mid-term insights

Pan EU scale

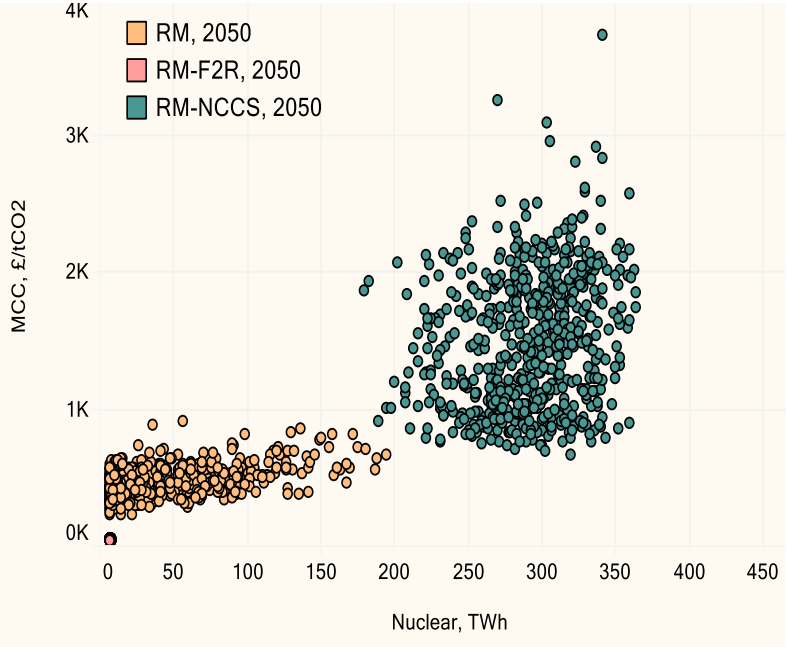
- In a cost-optimal transition, emission reduction burden sharing according to **marginal abatement costs** of countries
- Decarbonisation per se negative impact on GDP and Job growth. But we must **account for returns** on technology learning, avoided externalities, brain-drain phenomenon
- Technology-wise, **rooftop solar PV and onshore wind** cost competitive, storage not always

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Mid-term insights

Regional / national / local scale

- **UK – Co-evolution and crowding out of technologies**: CCS can be cost competitive and replace wind generation and nuclear, with lower mitigation costs

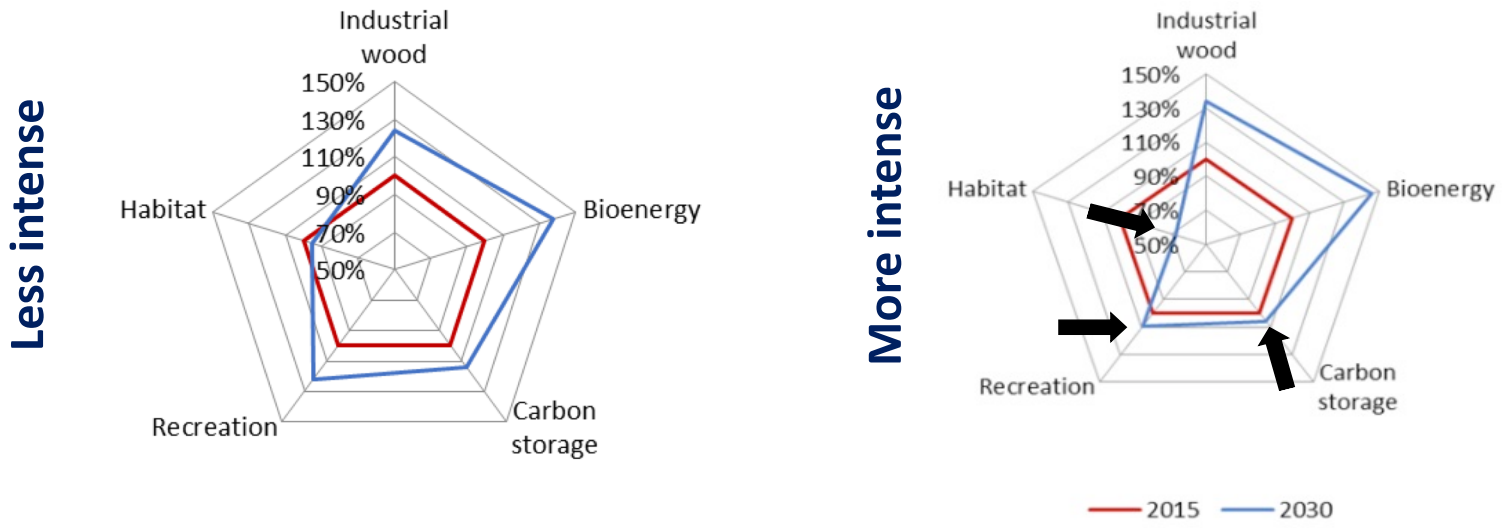


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Mid-term insights

Regional / national / local scale

- **Lithuania – Ecosystem services**: the cost optimal energy system decarbonisation strategy may imply too high utilisation of forestry biomass than what the ecosystem can provide.
- **Lithuania – Ecosystem services**: also intensity of use of biomass has trade-offs.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Thoughts

- **Soft-linking models with different spatial scales:** aggregation and disaggregation of modelling inputs (capacity, efficiency, emission factors, costs, etc.)
- **How to harmonise pathway assumptions when different geographic scope**: e.g. policy assumptions – sometimes just qualitative match
- **Boundaries of the analysis**: careful when making assumptions / extracting insights on Life Cycle consumption of resources, critical materials and technology learning
- **Extrapolating results from a regional / national / local case study and feeding them to the PanEU models**: is it always possible?

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Dissemination of the insights

1) **Policy briefs/Reports/Technology Roadmaps:** insights and recommendations from the assessments, for EC and national policy makers;

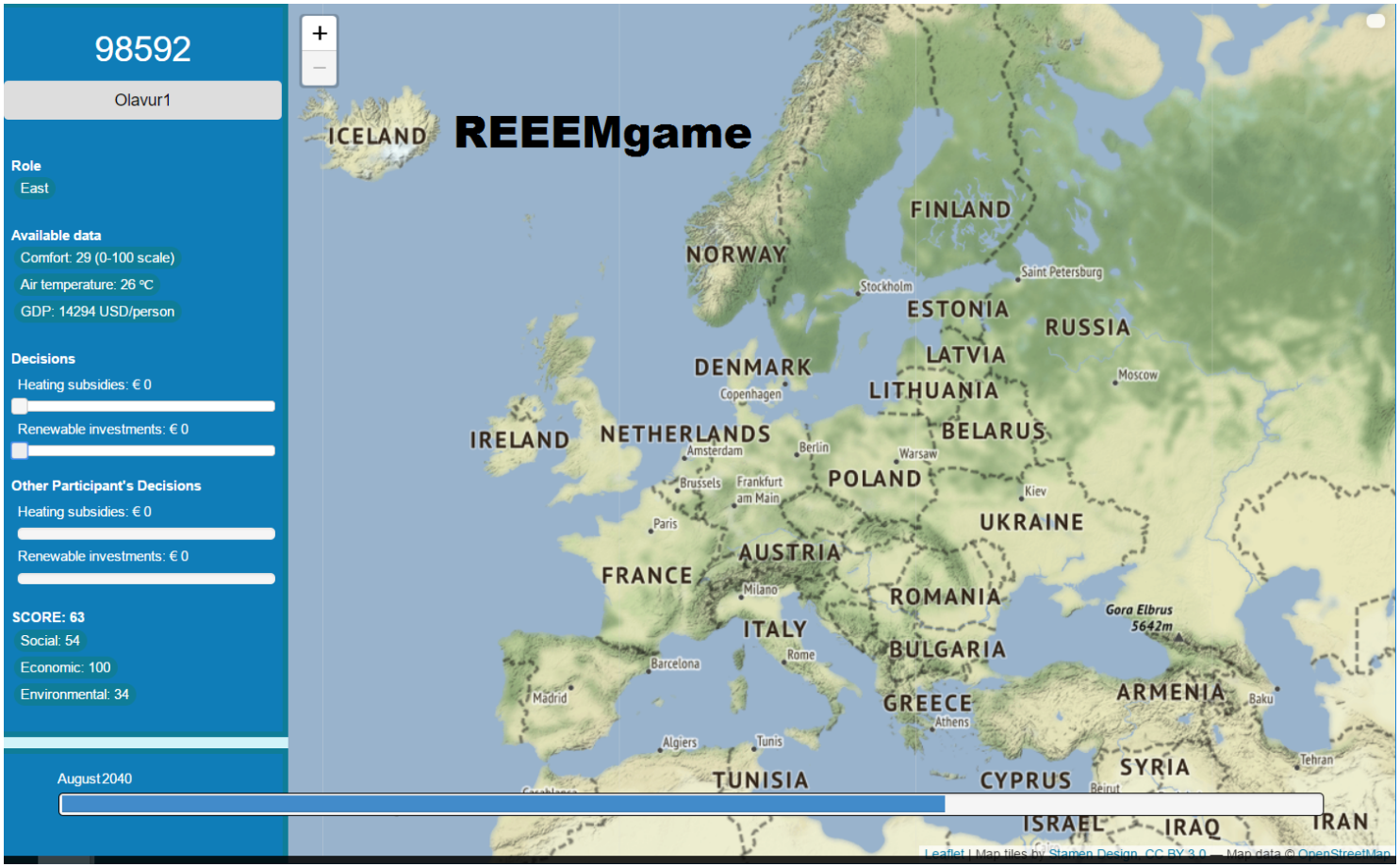
2) **Online pathway diagnostics tool:** open source and linked to ***pathway database***, enable comparison and prioritization of pathways;

3) **Open Source Engagement Model:** low-threshold model in OSeMOSYS to emulate key findings

4) **Learning simulation:** serious game based on the results of the Engagement Model, to be played in HEI and demonstration sessions with pedagogical intent.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Dissemination of the insights
(Learning simulation: a REEEM Game)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

REEEM Consortium

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Thank you

Dr. Francesco Gardumi - gardumi@kth.se

division of Energy Systems Analysis

Department of Energy, KTH Royal Institute of Technology

More info and presentation at: www.reeem.org

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.

Pathway Database concept

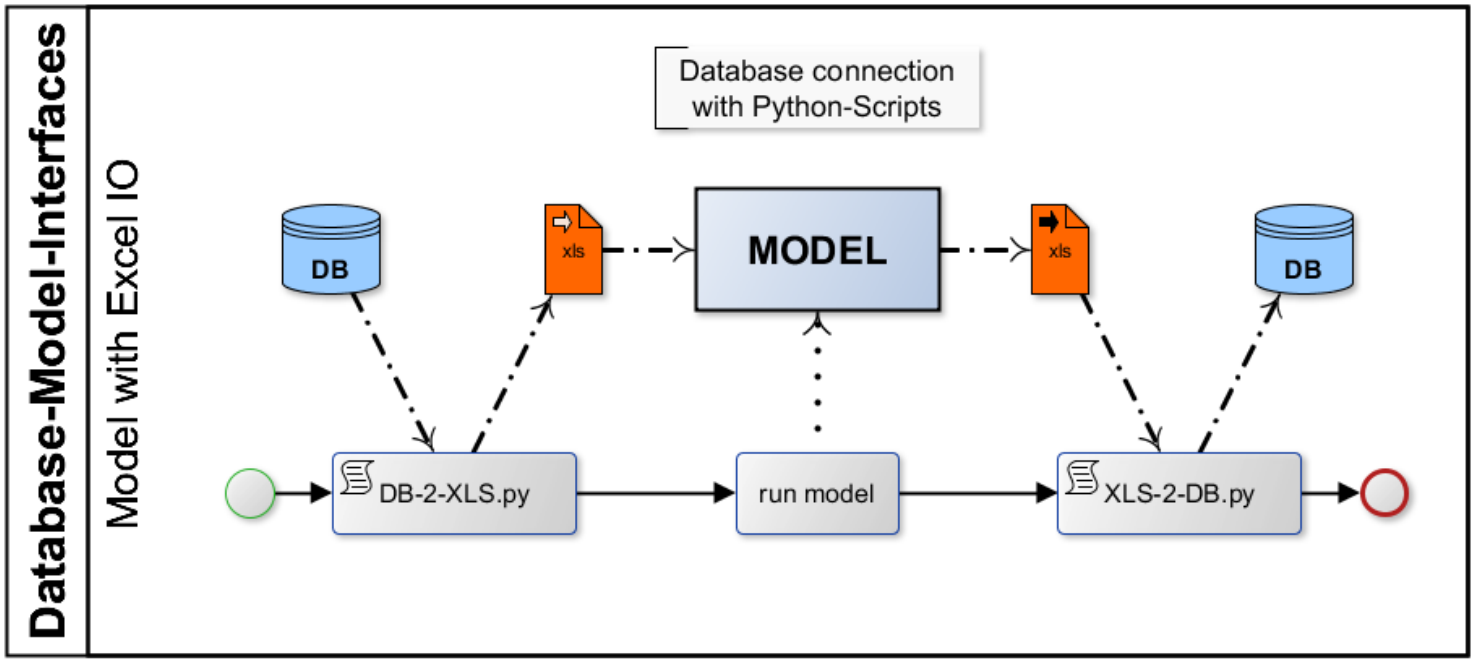
Open source pathway database including inputs and outputs of the models

Language: SQL

Host: DTU

Accessed by the partners through **PGAdmin4**

Open source routines for import/export of data on the **REEEM GitHub**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739.