Guidelines for policy-science interface

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List of acronyms used in this document

ENTSO-E	European Network of Transmission System Operators for Electricity
JRC	Joint Research Centre
Open ENTRANCE	open ENergy TRansition ANalyses for a low-Carbon Economy
TSO	Transmission System Operator

Executive Summary

This report describes the science-policy interface in the H2020 project Open ENTRANCE and gives the project's recommendations to how future energy system projects in Europe may strengthen their interaction with policy and decision makers.

The science-policy interface has been defined as "social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making" [1].

Policy and decision makers should in this report be understood in a broader context as politicians at both EU, national and local level together with the policy forming and policy implementing entities but also decision makers related to the energy system like Transmission System Operators (TSOs), ENTSO-E, ETSOG, ACER and national regulators, energy producers, distribution system operators (DSOs) etc.

Open ENTRANCE's interactions with policy- and decision makers have mainly taken place in six workshops in the beginning and in the final stages of the project work with themes covering:

- development of scenarios for decarbonisation of the energy system
- macro-economic analyses of the energy transition
- case studies of specific challenges of the energy transition.

Furthermore, Open ENTRANCE was the main responsible project for the EMP-E 2020 conference, which was a meeting place for around 500 energy system modellers and policy and decision makers in Europe. Finally, the 10 newsletter and active dissemination via Twitter and LinkedIn have also been an important part of Open ENTRANCE's policy science interface.

The main recommendations for the future are: i) a strategy plan for the science-policy interface should be developed early in the project ii) energy system modelling projects should work with policy relevant cases and questions iii) ECEMP should be kept and further developed as a meeting place for policy and decision makers and energy system modellers.

1. Science-policy dialogue in the energy transition

The science-policy interface has been defined as "social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making" [1].

Open ENTRANCE developed, used and disseminated an open, transparent and integrated modelling platform for assessing low-carbon transition pathways in Europe. The platform was used for developing:

- Low-emission scenarios for the energy system towards 2050
- Macro-economic studies of the energy transition
- Case studies of specific challenges of the energy transition, particularly flexibility needs and measures for increased flexibility

The outputs of these analyses are answering questions that are high up on the political agenda in the EU like: the EU Climate Strategies and targets, The European Green Deal and also the climate targets and plans at the EU Member State level, the National Energy and Climate Plans (NECPs)

Open ENTRANCE is one of several ongoing EU projects developing knowledge relevant for politicians at the EU and national levels. Both politicians at the pan-EU and member state levels, as well as these projects, share a mutual interest in developing and exchanging knowledge. The usefulness for the politicians is to be informed about and understand science-based result from energy system modelling. For scientist, the relevance is to understand policy goals and be able to implement and assess the consequences of the goals in their modelling.

This report describes how Open ENTRANCE has interacted with policy makers. Based on this interaction, it provides recommendations for future energy modelling projects and their interplay with actors at the policy level. "Actors at the policy level" should be understood in a broader context as politicians at the EU, national and local levels, the policy forming and policy implementing entities, but also decision makers like Transmission System Operators (TSOs), ENTSO-E, ETSOG, ACER and national regulators, energy producers, distribution system operators (DSOs) etc.

2. About Open ENTRANCE

Open ENTRANCE (open ENergy TRansition ANalyses for a low-Carbon Economy) (2019-2023) developed, used and disseminated an open, transparent and integrated modelling platform for assessing low-carbon transition pathways in Europe.

The modelling platform can be used to shed light on the implications and economic costs associated to the different energy pathways that Europe can take towards its climate goals. With this scientific basis, openENTRANCE aimed at helping social, economic and political actors in a better decision making.

The EU has set the ambition to reduce greenhouse gas emissions to the point of becoming climate neutral by 2050 and prevent the negative and irreversible effects of climate change. This goal includes shifting the energy system to renewable and clean system, as well as technological, behavioural and organisational changes in the economy and society. For doing so, the coordination of relevant technologic solutions, policies, funding and actors, with well-defined targets based on scientific analyses are required.

In response, openENTRANCE developed an open-source modelling platform that:

- Allows carrying out scientific calculations and assessments for different future options of a low-carbon Europe.
- Links and integrates macro-economic and energy system models, and provides economic (e.g. GDP, employment) and human behavioural data (e.g. energy consumption habits) relevant for the energy transition to be used in modelling analyses.
- Supports stakeholders to determine macro-economic consequences of the energy transition and identify the best ways to transition to a 'low-carbon' economy.
- Is openly available to use by any interested users, targeting mainly researchers and modellers.

Open ENTRANCE intended to engage with policy and decision makers, businesses, researchers and civil society to increase openness to collaborative research on energy system modelling. Research questions, approaches, assumptions and input data were discussed with politicians and other stakeholders in the beginning of an analyse conducted in Open ENTRANCE. Towards the end of an analyse process, the preliminary outcome was discussed again, before the finale conclusions were drawn. Figure 1 illustrates this intercation between research activities and decision makers in Open ENTRANCE.

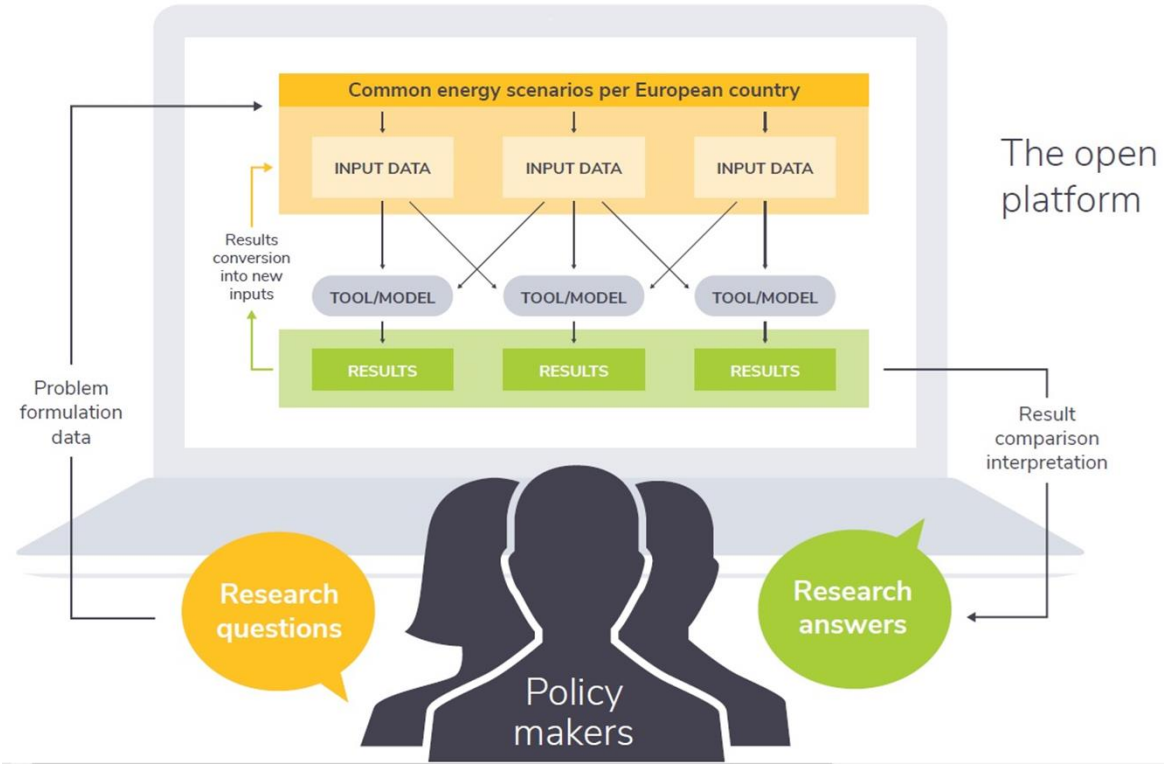


Figure 1 Illustration of the science-policy dialogue in Open ENTRANCE

Open ENTRANCE engaged policy and decision makers in workshops and conferences and disseminated results via newsletters, social media post and tweets. This is described in Chapter 3. Chapter 4 gives the recommendations from Open ENTRANCE to future energy system modelling projects about how to interact with politicians and descision makers.

3. Policy interactions in Open ENTRANCE

Engagement of policy and decision makers has been one of the main pillars in Open ENTRANCE. This chapter describes the workshops (Chapter 3.1 and 3.2) and conferences (Chapter 3.3) that took place in the project. Chapter 3.4 and 3.5 describes the dissemination activity in terms of newsletters and social media dissemination.

3.1 Workshops

Scenarios

Open ENTRANCE developed complete and consistent scenarios for transitioning to low-carbon futures in open collaboration with stakeholders through workshops. The scenarios provide valuable insights about the future energy system based on present assumptions of opportunities and barriers to reach a low carbon Europe. The scenarios are flexible, making it possible for users to adjust the input, as well as the energy system model, according to their own needs. This way, it is possible to conduct new scenario building exercises after the project's conclusion using different assumptions (e.g. varying fuel prices) to the present ones. Open ENTRANCE developed energy transition pathways in order to provide strategic recommendations to policymakers to reach a low carbon Europe. The pathways include specific technology choices and innovations, as well as socio-economic and other social and human aspects related to these.

The scenarios were discussed with stakeholders in two workshops, one in the early phase of the development and in a second one when preliminary results were available.

The first workshop to get input to useful assumptions for the scenarios, took place on 23 September 2019 in the SINTEF Brussel offices. More than 40 participants, including policy makers and scientists, attended in person or via videoconference. The workshop discussed the long-term scenarios for transition to a low emission energy system in Europe, which have been drafted by the project consortium. Scenarios describe different options, strategies, technologies, etc. that can be applied and implemented. Figure 2 shows the agenda for the first workshop.

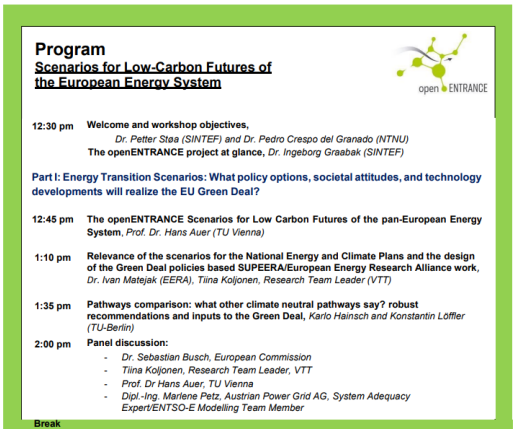
23 Sep. – Long term scenarios for transition to a low emission energy system in Europe

Time	Content	Format
10:30	Walk in & registration	
11:00	**Welcome and Introduction to the H2020 project openENTRANCE** Petter Støa, Vice President Research, SINTEF Energy (openENTRANCE)	Plenary
11:20	**European Commission Long-Term Strategy: what are the preconditions for it to work?** Tom Van Ierland, Head of Unit C1 "Strategy & Economic Assessment" DG CLIMA Q&A	Plenary
11:50	**The IPCC Special Report on 1.5°C: The use of quantitative integrated assessment pathways** Daniel Huppmann, Research Scholar, IIASA (openENTRANCE) Q&A	Plenary
12:15	**Lunch**	
13:15	**openENTRANCE draft storylines: actors, factors and dimensions to define scenarios** Hans Auer, Associate Professor, TU Wien (openENTRANCE) Q&A	Plenary
14:00	**Discussions on the openENTRANCE draft storylines** • Is there any key actors, driving factors and dimensions of the storylines missing? • How could the storylines be more comprehensive? Wrap-up	Group discussions
15:00	**Coffee break**	
15:15	**Integrating the pieces into scenarios** • How to integrate these key actors, driving factors and dimensions into scenarios? Wrap-up	Group discussions
16:15	**Closing keynote** Petter Støa, Vice President Research, SINTEF Energy (openENTRANCE)	Plenary

Figure 2 The Agenda for the first Open ENTRANCE stakeholder workshop about development of low carbon scenarios for Europe

The first workshop discussed the draft of long-term storylines for transition to a low emission energy system in Europe. The storylines described different options, strategies, technologies, etc. that can be applied and implemented. Storylines are narratives describing possible futures that the energy system could take. A variety of different scenario outcomes within one storyline describe and quantify the possible "solution space" per storyline, depending on the input settings. The storylines and scenarios provide common frames for the case studies about selected topics, which then can be used to put in practice the main outcome of the project: The Open modelling Platform.

The second workshop about scenario development took place on 4 March 2021 when the scenarios first quantifications and intial results were discusses. This workshop was an on-line event and more than 140 attendees signed up for the event. In the end, about 60 people joined the workshop. The event was a organised in collaboration with EERA and the SUPEERA project. EERA distributed invitations to the workshop via their network in addtion to the invitations send to the Open ENTRANCE stakeholders.



Program
Scenarios for Low-Carbon Futures of the European Energy System

12:30 pm	**Welcome and workshop objectives,** *Dr. Petter Stea (SINTEF) and Dr. Pedro Crespo del Granado (NTNU)* **The openENTRANCE project at glance,** *Dr. Ingeborg Graabak (SINTEF)*
Part I: Energy Transition Scenarios: What policy options, societal attitudes, and technology developments will realize the EU Green Deal?	
12:45 pm	**The openENTRANCE Scenarios for Low Carbon Futures of the pan-European Energy System,** *Prof. Dr. Hans Auer (TU Vienna)*
1:10 pm	**Relevance of the scenarios for the National Energy and Climate Plans and the design of the Green Deal policies based SUPEERA/European Energy Research Alliance work,** *Dr. Ivan Matejak (EERA), Tiina Koljonen, Research Team Leader (VTT)*
1:35 pm	**Pathways comparison: what other climate neutral pathways say? robust recommendations and inputs to the Green Deal,** *Karlo Hainsch and Konstantin Löffler (TU-Berlin)*
2:00 pm	**Panel discussion:** - *Dr. Sebastian Busch, European Commission* - *Tiina Koljonen, Research Team Leader, VTT* - *Prof. Dr Hans Auer, TU Vienna* - *Dipl.-Ing. Marlene Petz, Austrian Power Grid AG, System Adequacy Expert/ENTSO-E Modelling Team Member*
Break	

Figure 3 The Agenda for the second Open ENTRANCE stakeholder workshop about development of low carbon scenarios for Europe

Some conclusions from the workshop were:

- The Open ENTRANCE low-carbon scenario studies presented comply with the (European fraction of) 1.5/2.0°C global warming targets. The model results show that resource and technology portfolio availability as well as technology exchange rates (triggered by CO2 prices) are main determining parameters for achieving carbon neutrality in Europe in 2040 or 2050. The quantified scenario results show what needs to be done in practice in the future European energy system if we seriously intend to comply with the 1.5/2.0°C global warming limitation targets. Our (European) experience/imagination from the past on what's supposed to be feasible (in terms of speed of technology exchange rates) and/or financeable might not be sufficient anymore. Our ambitions need to be significantly increased and we must start acting now!
- Since there exists a wide range of decarbonisation studies of the European energy system, it is important to synthesize common findings, no-regret options and areas of action through a thorough analysis of pathway results, assumptions and specifications. Here, special attention needs to be paid to understanding the scope and scenario assumptions of every single study. This is also true for any country-specific and/or sector-specific study – for example those conducted in the context of the NECPs (National Energy and Climate Plans) and/or the SET-Plan. Comparative scenario studies have shown that the European Green Deal (EGD) covers a lot of relevant and required areas of action through action plans. However, ambitions still need to be further increased in Europe to comply with carbon neutrality (sufficiency aspects are not yet covered enough – neither in the European Green Deal, nor in energy system modelling).

Case studies

Open ENTRANCE analysed the selected challenges of the energy transition and demonstrated the ability of The Open Modelling Platform to answer a wide range of questions linked to the energy transition by carrying out case study simulations. These case studies covered different key aspects of the energy transition in Europe, based on the targets for the EU Energy Union. For example, the role of different technologies to enhance the flexibility of the energy system, or the energy demand behaviour of communities. The case studies also served to test and demonstrate the functioning of The Modelling Platform and the linkages between models through the analysis of the eight case studies. Open ENTRANCE discussed the relevance of the case studies with stakeholders in workshops in the beginning of the work with the case studies and towards the end of the research when preliminary results were available.

The first workshop to get input to useful assumptions for the scenarios, took place on 24 September 2019 in the SINTEF Brussel offices. More than 40 participants, including policy makers and scientists, attended in person or via videoconference. Figure 3 shows the agenda for the workshop.

24 Sep. – Case Studies of the energy transition

Time	Content	Format
8:30	Walk in & registration	
9:00	**Welcome and "Who is who"** Petter Støa, Vice President Research, SINTEF Energy (openENTRANCE)	Plenary
9:10	**Overview of the H2020 project openENTRANCE** Petter Støa, Vice President Research, SINTEF Energy (openENTRANCE) **Objectives of case studies for testing models** Sandrine Charousset, Project Manager, EDF (openENTRANCE) **Brief introduction case studies** Case study leaders Sandrine Charousset, Project Manager, EDF (openENTRANCE)	Plenary
10:10	**Coffee break**	
10:30	**Presentation and discussion of case studies** Presentations by case study leaders Q&A	Group discussions
12:00	**Lunch**	
13:00	**Feedback on Case Studies** • Where is the interest and added value of the case studies? • What aspects should be highlighted? Do they miss any approaches or factors of the energy transition? Should alternative approaches be considered? • Should openENTRANCE consider more data sources, or additional relevant case studies to compare? Q&A	Group discussions
14:00	**Wrap up and closing notes** Petter Støa, Vice President Research, SINTEF Energy (openENTRANCE)	Plenary

Figure 4 Agenda for the first case study workshop

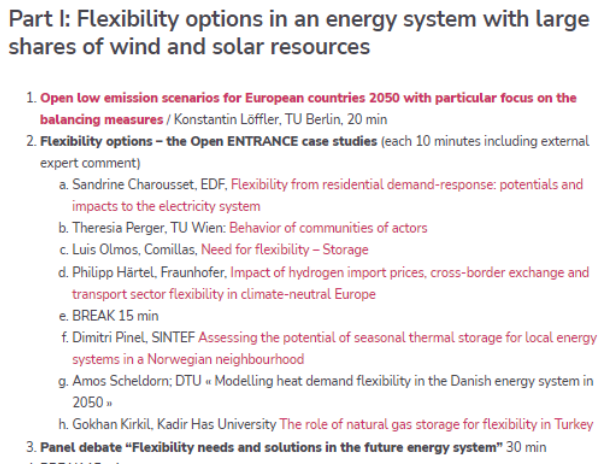
Some conclusions from the first workshop about the case studies were that the main objective of the case studies is to demonstrate the ability of the Open ENTRANCE modelling platform to make analysis processes easy, transparent and comparative. Eight proposed case studies were presented and discussed with participants. These are not meant to cover all the aspects of the energy transition, but are rather selected key examples of potential solutions in Europe.

In this regard, the workshop discussion showed that there are areas not covered by the case studies, such as agriculture and industry sectors. However, the intention of the case studies is not to be exhaustive but to serve as examples of potential modelling analyses, still covering relevant aspects of the transition. Since Open ENTRANCE will create an open modelling platform, other modellers will be able to use the platform and conduct additional case studies covering further areas that may be missing in the eight proposed ones.

In addition, case studies will be part of the validation process of the scenarios and storylines, either for the whole Europe or on different "zoom" areas. This part of the scenario validation is important so that policy makers can be confident using the scenarios.

Nevertheless, not all storylines will be used in each of the project's case studies. The process to further develop each case study will integrate the storyline choice decision. On top of that, storylines can be amended following the needs of the case studies. Lastly, as suggested by participants, the project will consider delivering a "Manual" about "How to conduct a case study".

The second case study workshop took place on 16 January 2023. It was an on-line event with approximately 60 attendees. The objective for the workshop was to Present and discuss analyses results related to flexibility options and impacts on the future low-emission energy system as most of the case studies were about flexibility alternatives. The case-studies were presented in a preliminary version. Each case study was presented in 8 minutes followed by a 2-minute comment from a stakeholder.



Part I: Flexibility options in an energy system with large shares of wind and solar resources

1. **Open low emission scenarios for European countries 2050 with particular focus on the balancing measures** / Konstantin Löffler, TU Berlin, 20 min
2. **Flexibility options – the Open ENTRANCE case studies** (each 10 minutes including external expert comment)
   a. Sandrine Charousset, EDF, Flexibility from residential demand-response: potentials and impacts to the electricity system
   b. Theresia Perger, TU Wien: Behavior of communities of actors
   c. Luis Olmos, Comillas, Need for flexibility – Storage
   d. Philipp Härtel, Fraunhofer, Impact of hydrogen import prices, cross-border exchange and transport sector flexibility in climate-neutral Europe
   e. BREAK 15 min
   f. Dimitri Pinel, SINTEF Assessing the potential of seasonal thermal storage for local energy systems in a Norwegian neighbourhood
   g. Amos Scheldorn; DTU « Modelling heat demand flexibility in the Danish energy system in 2050 »
   h. Gokhan Kirkil, Kadir Has University The role of natural gas storage for flexibility in Turkey
3. **Panel debate "Flexibility needs and solutions in the future energy system"** 30 min

Figure 5 The agenda for the second stakeholder workshop about the Open ENTRANCE case studies

One interesting result of several of the case studies is that (green) hydrogen has become an additional flexibility option to be considered. The role of hydrogen is twofold because it contributes

with electrolysis (to use surplus electricity for hydrogen production) and with hydrogen power plants (i.e. gas turbines running on hydrogen that provide electricity in peak load times). This reflects today's discussions across Europe, and several openENTRANCE models were adjusted to better reflect the role of (green) hydrogen.

An important point brought up by the case studies and the debate is the strong role of decentral and distributed actors to provide flexibility to the power system. Decentral actors like communities of actors, but also like local heat storage and heat providers, can contribute to shaving of peaks in the transmission grid, even more so when coupled with decentral renewable electricity generation (e.g. solar PV production).

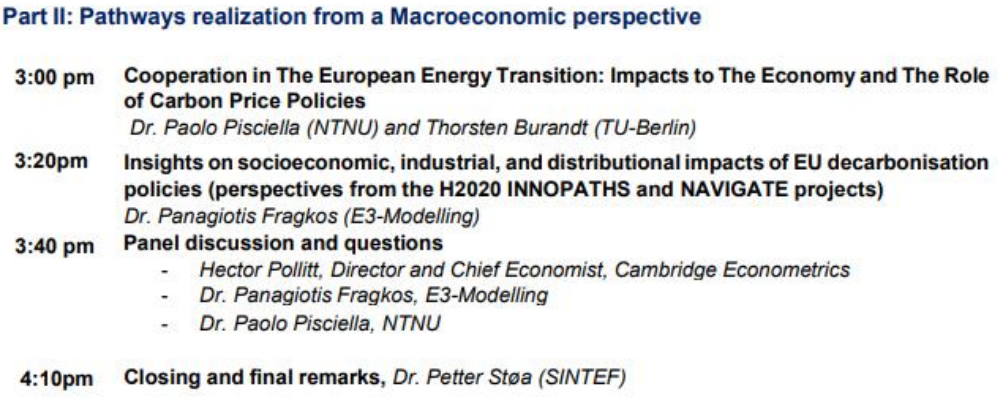
Moreover, the important role of sector coupling was highlighted several times. While the debate focused on the integration of electricity and heat, some case studies also investigated the potential of the transport sector (and electric mobility) to provide flexibility.

Finally, all panelists agreed that it is a mix of flexibility options that will enable a renewable-based energy system that conforms to the climate targets of the European Union.

Macro-economic impacts of a low-carbon transition in Europe

Open ENTRANCE conducted a comparative analysis of macroeconomic impacts of the four openENTRANCE decarbonization scenarios until the year 2050 using two Computable General Equilibrium models. The models, EXIOMOD and REMES-EU, show strong declines in CO2 emissions, forced by the cap-and-trade system implemented in the EU. Furthermore, both models predict an exponential growth in ETS-price between 2040-2050. The last CO2 emissions are the costliest to prevent from emitting. In order to keep emissions below the cap on carbon, both models predict a steep increase in demand for electricity and a decline in demand for fossil-based energy sources. The effect of the decarbonisation scenarios on GDP is limited. Feedback effects from climate on economy are included via decreasing labour productivity due to higher temperatures.

The macro-economic analyses were presented and discussed in two workshops with stakeholders. The first took place as a joint veture with the second scenario workshop, online on 4 March 2021 with about 60 stakeholders attending. As earlier metioned, the event was a collaboration with EERA and the SUPEERA project. Moreover, these workshops brought interactions and exchange with other Horizon 2020 projects. This complemented greatly the discussion on studies or share perspectives from other projects (e.g. H2020 projects: INNOPATHS, NAVIGATE, ECEMF)



Part II: Pathways realization from a Macroeconomic perspective

3:00 pm	**Cooperation in The European Energy Transition: Impacts to The Economy and The Role of Carbon Price Policies** *Dr. Paolo Pisciella (NTNU) and Thorsten Burandt (TU-Berlin)*
3:20pm	**Insights on socioeconomic, industrial, and distributional impacts of EU decarbonisation policies (perspectives from the H2020 INNOPATHS and NAVIGATE projects)** *Dr. Panagiotis Fragkos (E3-Modelling)*
3:40 pm	**Panel discussion and questions** - *Hector Pollitt, Director and Chief Economist, Cambridge Econometrics* - *Dr. Panagiotis Fragkos, E3-Modelling* - *Dr. Paolo Pisciella, NTNU*
4:10pm	**Closing and final remarks,** *Dr. Petter Støa (SINTEF)*

Figure 6 Agenda for the first stakeholder workshop about macro-economic analyses

The discussions in the workshop centred on understanding the energy transition pathways' impacts on the economy, for example changes in GDP and sectoral production level, investments, prices, trade and welfare, of the implemented scenarios. The modelling analysis showcased the welfare and distribution effects in different sectors and regions of the economy. In the panel discussion, panellists had a conversation on:

- limitations of Macro-economic models and their interpretations (e.g., assumed agents behaviours and finance/monetary aspects)
- ensuring a just energy transition through policy design, discussion on factors of "uncertainty & complexity" and how they can be incorporated into the models
- bridging the science-policy interface gap – how to integrate political perspectives into the models and how to integrate the models into the policy design.

The second workshop about macro-economic analyses was online on 11 October 2022.

Programme

- 13:00 **Welcome and workshop objectives** – Dr. Petter Støa (SINTEF) and Prof. Dr. Pedro Crespo del Granado (NTNU)
  - **The openENTRANCE project at a glance** – Dr. Ingeborg Graabak (SINTEF)
  - **The openENTRANCE scenarios: What policies, societal attitudes, and technology developments will realise the EU Green Deal?** – Prof. Dr. Pedro Crespo del Granado (NTNU)
- 13:20 **The macroeconomic impact of policy measures, technological progress and societal attitudes in energy transition scenarios** – Dr. Hettie Boonman
- 14:00 **Linking a macroeconomic CGE model and an energy system model for the analysis of techno-economic aspects of decarbonisation scenarios** – Dr. Paolo Pisciella, (NTNU)
- 14:25 **Break**
- 14:40 **Recent GEM-E3 advances in macroeconomic analyses of the energy transition** – Leonidas Paroussos (E3M)
- 15:00 **Panel discussion** – Dr. Paolo Pisciella (NTNU), Dr. Hettie Boonman, Dr. Frederic Reynes
- 15:30 **Break**
- 15:40 **The openENTRANCE platform**
- 16:00 **Closing remarks**

Figure 7 Agenda for the second stakeholder workshop about macro-econimic analyses

Around 40 attendees joined the event.

3.2 Other workshops

On 7 February 2023, Open ENTRANCE held a workshop at the EU parliament in Brussels, titled ***Solutions for the European Energy Transition and Economic Consequences – Answers from H2020 project Open ENTRANCE***. Research scientists involved in the project presented an overview of the fundamental changes that the energy system must undergo to reach climate targets, as well as the expected economic impacts of these changes.

Figure 8 Open ENTRANCE Workshop in the EU-Parliement

After the presentations, a panel debate was held under the theme "Decarbonisation of the European energy system – is Europe on track according to the required transformation?" Participants were:

- Marion Labatut, EDF EU Affairs
- Anne Bolle, Statkraft
- Mario Sisinni, ENTSO-W
- Timm Krägenow, TenneT
- Petter Støa, SINTEF (moderator)

Highlights from a selection of Open ENTRANCE's case studies were also presented to the audience.

On 21 September 2021 there was an Open ENTRANCE workshop for the Joint Research Centre (JRC). The Open Platform, the scenarios, the macro-economic analyses, and the case studies were presented and discussed.

3.3 EMP-E/ECEMP conferences

The Open ENTRANCE project organised the EMP 2020 conference in close collaboration with eight other on-going energy modelling projects. Experts from the European Commission contributed to develop the program. The event was on-line due to the covid-19 situation. This was the first year the event was on-line.

The EMP-E (now ECEMP) brings together scientists and policy makers working on current energy modelling and energy policy issues, looking at the current and future opportunities for change.

The EMP-E creates an environment for exchange and sharing of ideas, where research and development in energy modelling currently undertaken across Europe can reach policy makers and other modellers. By creating this space to share ideas, European energy modelling data, tools and results can help inform the next energy innovations and policy.

535 people from around 50 countries, many outside Europe, signed up for the conference. Of those were 22 from authority/government and 36 from the EU Commission. The description of the plenaries, the focus sessions and the take-aways from each session are given in appendix. Table 3-1 shows an overview of the sessions in EMP-E 2020.

3-1 Overview of the sessions in EMP-E 2020

Session	Title
Plenary 1	Impacts of COVID-19 on the energy system - What are the consequences for future energy modelling?
Plenary 2	Climate Neutral Pathways, scenarios and storylines: Useful lessons learned and strategies for the European Green Deal
Plenary 3	Socio and economic impacts of the transition
Plenary 4	Sector Integration – Decarbonisation through multi-energy carrier integration
Focus group 1	Climate Neutrality: energy modelling, weather and climate
Focus group 2	Circularity and use of raw materials
Focus group 3	Consumer and Citizen Engagement
Focus group 4	Smart cities, smart grids and digitalisation: modelling insights and lessons learned
Focus group 5	Infrastructure for integrating open-source models across spatial and sectoral scales to facilitate open science and transparency
Focus group 6	How can energy modelling tools from H2020 projects contribute to National Energy and Climate Plans?
Focus group 7	Transformation of the Energy system: centralisation vs further decentralisation
Focus group 8	Uncertainty and modelling: lessons learned and gaps

3.4 Newsletters

Open ENTRANCE sent a total of 10 newsletters to a list of subscribers since the launch of the project. As the time of writing this, the newsletter has 138 subscribers. The table below provides a list of the newsletters, with an overview of the main topics they touched.

3-2 Overview of Open ENTRANCE Newsletters

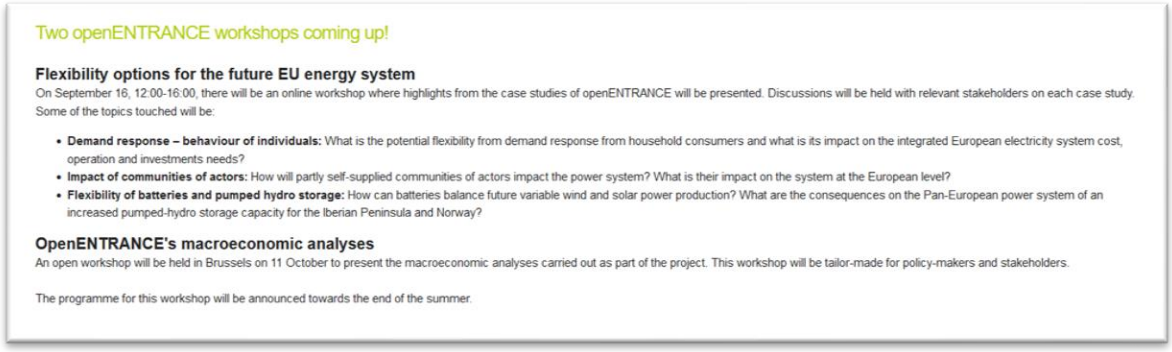
Date	Title	Main topics
2020.03.24	Newsletter Feb 2020	Description of the project, with video; Overview of the scenario development and case studies; Recap of the September 2019 workshop; Promotion of EMP-E
2020.08.21	Newsletter 2 August 2020	Promotion of the EMP-E 2020 conference; Summary of deliverable D3.1; Summary of deliverable D6.1
2020.11.30	Newsletter 3 December 2020	Recap of the EMP-E 2020 conference; Overview of the interlinkage between the scenarios and the database
2020.12.23	Special Newsletter December 2020	Progress update, including links to reports D6.1, D3.1, D5.2; Reminder about the 2021.03.04 workshop
2021.06.02	Newsletter – May 2021	Open Platform now open for third party users; Overview of the Open Platform; Recap of the 2021.03.04 workshop.
2021.11.30	Newsletter – November 2021	Third party users can upload to the Open Platform; IAEE webinar; Open ENTRANCE now on Zenodo; Special issue of EMP-E 2020 in Journal Energy
2022.07.07	Newsletter – Summer 2022	Promotion of two upcoming workshops; Quantitative Scenarios for the Low-Carbon Futures of the European Energy System on Country, Region and Local Level
2022.09.07	Open ENTRANCE workshop 11 October	Promotion of the 2022.10.11 workshop "Macroeconomic perspectives of a low-carbon EU energy system" with programme and registration link.

2023.01.17	Newsletter – January 2023	Description of the workshop at the EU parliament; Summary of deliverable D7.2 "Macro-economic consequences of the energy transition"; Summary of D7.3 "Policy Measures that Address Barriers and Market Failures in the Low-carbon Transition"
2023.04.20	Newsletter – April 2023	Recap of the EU parliament workshop and overview of case studies 2, 4, 6 and 7.

Figure 9 shows example from a newsletter. A short recap of a workshop is provided in the newsletter, together with a link to a more comprehensive summary of the discussions on the Open ENTRANCE website.

Figure 9 Example from newsletter - May 2021

Figure 10 shows example from "Newsletter – Summer 2022". The newsletter is used to promote upcoming project workshops



Two openENTRANCE workshops coming up!

Flexibility options for the future EU energy system

On September 16, 12:00-16:00, there will be an online workshop where highlights from the case studies of openENTRANCE will be presented. Discussions will be held with relevant stakeholders on each case study. Some of the topics touched will be:

- **Demand response – behaviour of individuals:** What is the potential flexibility from demand response from household consumers and what is its impact on the integrated European electricity system cost, operation and investments needs?
- **Impact of communities of actors:** How will partly self-supplied communities of actors impact the power system? What is their impact on the system at the European level?
- **Flexibility of batteries and pumped hydro storage:** How can batteries balance future variable wind and solar power production? What are the consequences on the Pan-European power system of an increased pumped-hydro storage capacity for the Iberian Peninsula and Norway?

OpenENTRANCE's macroeconomic analyses

An open workshop will be held in Brussels on 11 October to present the macroeconomic analyses carried out as part of the project. This workshop will be tailor-made for policy-makers and stakeholders.

The programme for this workshop will be announced towards the end of the summer.

Figure 10 Example from newsletter – Summer 2022

3.5 Social media

Open ENTRANCE has a presence both on Twitter and on LinkedIn. At the time of writing, the LinkedIn account has 391 followers, and the Twitter account has 345. Both accounts were used extensively to share results and promote events. Figure 11 shows a tweet from Open ENTRANCE promoting the ECEMP conference 2022.

Figure 11 Example of a tweet from Open ENTRANCE

Figure 12 shows an example of a tweet showing research results, and Figure 13 shows a tweet highlighting how Open ENTRANCE results are already being used by other research projects.

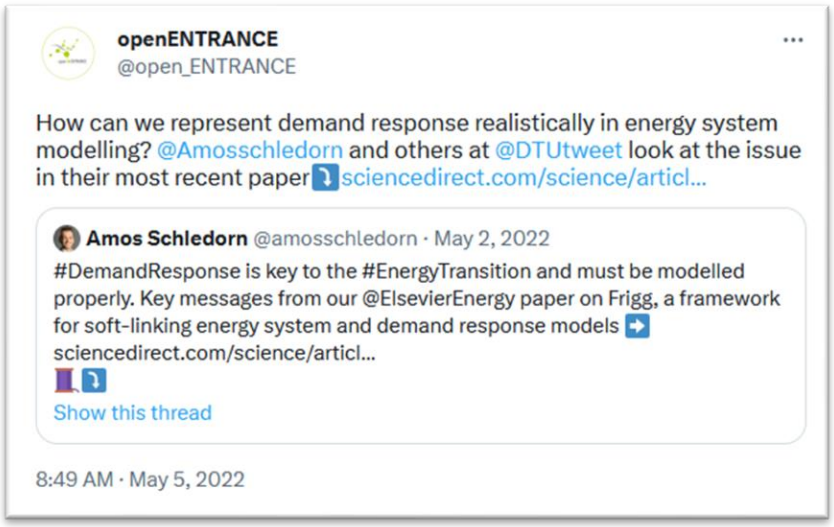


Figure 12 Example of a tweet from Open ENTRANCE

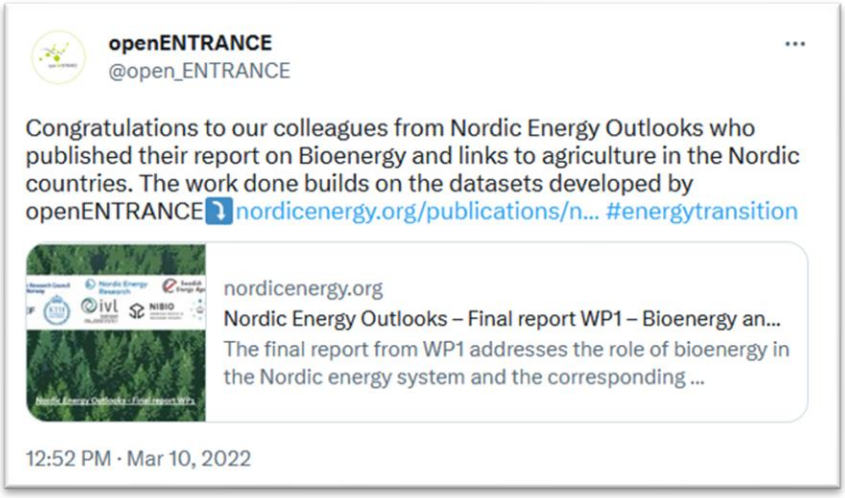


Figure 13 Example of a tweet from Open ENTRANCE

Figure 14 shows a LinkedIn post providing a short recap of the EU Parliament workshop (left) and a LinkedIn post promoting an online workshop about Flexibility options in low-carbon scenarios for the European energy system (right).

Figure 14 Example of a LinkedIn post from Open ENTRANCE

4. Recommendations for Science-policy interactions in future energy system modelling projects

This chapter describes the policy interface recommendations that Open ENTRANCE considers important for future energy system projects. These recommendations are based on the experiences that the project management has collected and discussed during the project. It is related to the execution of the work and stakeholder dialogue in the project activities as described in the previous sections.

Energy system modelling projects should develop a strategy for engagement of politicians and decision makers early in the project. This strategy should identify which stakeholders are relevant for the project, which parts of the project are interesting for the identified stakeholder and how the project aims to interact with the different organisations and stakeholder groups. Such a strategy will facilitate a continued science-policy dialogue. Dialogue is more effective when common ground is established. Involved stakeholders should receive newsletters and other information from the project as well as being invited to the relevant workshops and conferences facilitated by the project.

A consistently engaged stakeholder group and a common knowledge basis is useful for a relevant policy-science intercation in the project period. The following points are relevant to consider in the science-policy strategy:

An Open Science strategy increases impact

The stakeholder meetings have demonstrated how the open science strategy attracts attention from both academia, research institutions and industry and how it creates trust and stimulates discussion among the participants. It will be very valuable if a similar effect can be obtained in the policy interface.

We recommend that open science becomes mandatory in future modelling activities and that it becomes described into and applied in the science-policy interactions.

Relevance of the project is important

Open ENTRANCE adressing challenges to real problems of high policy relevance in the development and demonstration of the methodologies it proposed has had great value. Targeting pressing issues such as the climate challenge, improving methodology and input to National Energy and Climate Plans (NECP) has contributed to the interest and further use of the Open ENTRANCE results. An

example is the use and modification of Open ENTRANCE scenarios for analysing Scandinavian NECP's considering REPowerEU. This would have been difficult to achieve without the Open ENTRANCE results.

We recommend that energy system projects should address pressing policy questions and that the questions are established based on input from policy makers and in dialogue with them.

The ECEMP conference

Open ENTRANCE was the main organiser of the EMP conference 2020 and this obligation was of great value to the project. It was a important arena for dissemination of results to the policy level, and the dialogue with the policy level highly contributed to forming Open ENTRANCE research.

We recommend that the conference is kept as a science-policy meeting place and not transformed into a regular scientific conference.

We recommend further improving the ECEMP by involving even more participants from the political sphere and relevant industries.

Before 2020 (Covid), EMP was a physical conference at the European Commission's premises. Some years it should still be physical to give a better opportunity to networking and small talks.

We recommend developing a short summary, or white paper, of the main outcomes from the presentations and discussions after each conference.

Leveraging the partners' networks

Outreach to policy level stakeholders that can contribute and make a difference to the project is dependent on the network of the project partners and the personal networks of science resources working in the project.

We recommend that future energy system project carefully consider the combination of partners, their merit and resources and demonstrate this capability in the application. In addition, Open ENTRANCE has benefited from having a mix of junior and senior personnel contributing to the project and we see this combination as important for ensuring and strengthening future science-policy networks.

Electronic meeting arenas

Open ENTRANCE has demonstrated how digital meeting places are advantageous for facilitating regular meetings between project partners as well as stakeholders. Using digital meetings can increase participation of policy stakeholders for whom time is a limiting constraint.

Digital meetings enable participation from diverse stakeholders, regardless of their geographical location, thus increasing the pool of experts, policymakers, and industry representatives who can

contribute to the discussions and decision-making processes. Furthermore, digital workshops can offer training sessions and tutorials for policymakers and practitioners to better understand and utilize energy system models in policy design and implementation. Finally, Digital meetings can be recorded, transcribed, and archived, providing a valuable resource for future reference and analysis.

We recommend that digital meeting places are planned and used by future projects to improve the science-policy interface.

Reaching the right levels in the policy environment

The experience with the Open ENTRANCE workshop at the EU Parliament shows the potential and the difficulty of bridging the gap between science and policy. It challenged the researchers to formulate Open ENTRANCE results in a policy-relevant manner. It is complicated but enlightening for the project to put results into concrete recommendations.

We recommend that energy system projects are challenged to meet the EU administration at a suitable level, to present ideas and result, and receive feedback on relevance and knowledge needs identified by the policy level.

Importance of the local anchoring

The Open ENTRANCE case studies have been important for engaging local stakeholders including the national policy levels. These studies are one of the key components that gave the project local relevance.

We recommend that energy system projects engage with the national policy level by delivering relevance for national stakeholders. Local universities and research institutes have a key role in engaging local policy stakeholders.

Creating continuation

In Open ENTRANCE, we have experienced the importance of early involvement of policy stakeholders. Their engagement is valuable for forming and giving direction to the research. Furthermore, we recognise the importance of delivering something useful back by demonstrating to the policy stakeholders that their input was heard and understood, and made a difference to the result.

We recommend as a minimum that a science-policy dialogue is included in the startup phase of the project and again when response to the policy input and recommendations are available. We believe that involving the policy level in the entire research process would yield even better impact.

5. References

[1] S van den Hove: "A rationale for science-policy interfaces". Futures, volume 39, issue 7, September 2007, p 807-826. https://www.sciencedirect.com/science/article/pii/S0016328706002060

Appendix

Plenary 1 - Impacts of COVID-19 on the energy system - What are the consequences for future energy modelling?

Plenary 1 - Impacts of COVID-19 on the energy system - What are the consequences for future energy modelling?

Plenary 1 was hosted by the openENTRANCE project with the goal of better understanding the effects of COVID-19 on the development of the energy system and incorporating this shock into energy system models by reviewing the ramifications of the shock, showing first efforts at modelling it, and facilitating exchange between modelers, policymakers and stakeholders.

Summary of presentations

The macro-economic and energy system impacts of COVID-19 so far, Prof. Claudia Kemfert, DIW Berlin

- Main points: COVID crisis has reduced energy demand and economic activity across nearly all indicators. The question moving forward is how this will affect green growth plans for the economy to fight climate change

Energy system modelling under shocks and disruption, Prof. Reinhard Haas, TU-Wien

- Main points: Most disruptions to the energy system are related to changes in GDP. The energy demand equation remains mostly static throughout, will this also be the case for the COVID crisis?

Modelling the French power system during COVID-19: Cascading effects from stay-at-home regulations, Dr. Clemence Alasseur, EDF

- Main points: During stay at home regulations in France the energy system operated in a low-carbon fashion, with nuclear providing flexibility for intermittent solar generation.

Transport, mobility patterns and digitalization in Italy during and after COVID-19, Prof. Manfred Hafner, FEEM

- Main points: A dual econometric/foresight approach was used to assess the potential changes to Italian transport demand moving forward. Italians will use public transit ~30% less and private cars ~2% more even after the pandemic ends.

What did we learn from Plenary 1?

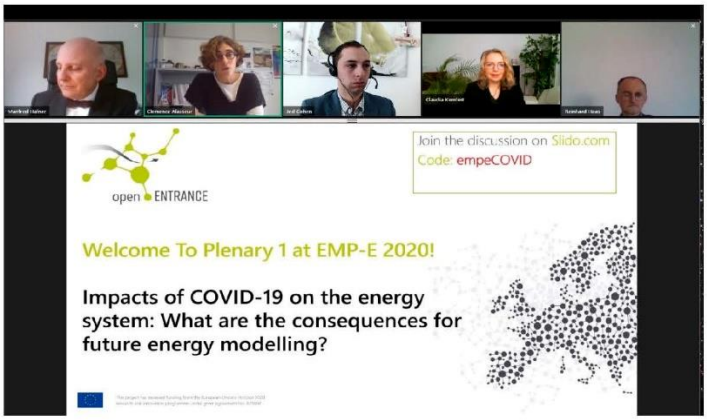
1. Large reductions in energy use and associated environmental damages during the pandemic
    - This is largely due to regulations and recessions ß decreased income!

- However, there is some evidence for changing structures of energy demand – especially in transportation – less use of public transit is likely moving forward, less travel overall (work from home) and less flying (virtual conferences)

2. In the French case we saw a window into a 'different' energy world – one with lower demand, lower prices and fewer emissions
   - A low-carbon, energy efficient future might look very similar to this
   - This was a positive takeaway – nuclear was able to provide the flexibility needed for integration of the French solar production!
   - More frequent negative energy prices would provide more incentive for energy service business models (e.g. flexibility and storage)
3. Key questions moving forward
   - How will the pandemic impact the economy and the ability to invest in sustainable energy?
   - Besides in transportation, what other structures of energy demand might change long-term?

Comments from the Audience

- COVID-19 has shown that change (e.g. behavioural and regulation wise) can happen much faster than anticipated - given a political (and societal) will, based on perceived urgency to act. Therefore, stressing the climate emergency even more gives hope for sufficient (political) measures to combat the situation
- Please be aware about the "fracture numérique " which means that quiet a lot of people and in particular the most vulnerable in the pandemic have problems to access the digital world and deal with digital solutions



Plenary 2 - Climate Neutral Pathways, scenarios and storylines: Useful lessons learned and strategies for the European Green Deal

Energy Modelling Platform for Europe

Key Takeaways for Plenary 2 – Climate Neutral Pathways, scenarios and storylines: Useful lessons learned and strategies for the European Green Deal

Session Objectives

To be consistent with the Paris climate target, Europe is discussing to become climate neutral by mid-century. Much more debated than the goal is the means to get there. Carbon dioxide removal from the atmosphere will be necessary to offset unavoidable emissions, but to what extent will this be possible and which are the best options? The objective of this session is to outline different strategies for carbon neutral pathways and analyse their preconditions and impacts.

The main part of this session comprises four presentations showing potential pathways and different possibilities/opportunities towards climate neutrality. In the following discussion, similarities and differences of pathway results were discussed. In this context, most importantly, attempts were made not only to identify robust findings and no regret mitigation options across several analyses, but also to understand the driving factors for differences in modelling results (model-design/type related, input-data related, etc.). These kinds of discussions among modelling teams is very important to be able to come up with robust and consolidated synthesis of modelling results across modelling teams and thus actually support policy makers.

Session Organization

Pao-Yu Oei (TU Berlin) chairs and moderates the session. After introducing the session and the corresponding interactive web-tools to enable pools and comments (like Slido) he presents the results from the questionnaire (sent to all participants upon registration). Afterwards, the four presentations on recent pathway model runs are scheduled. Finally, the moderators leads the discussion with the audience, while also reviewing and incorporating the Slido inputs into the discussion. Special focus is also put in the discussion to elaborate on how to integrate the pathway results in the EU Green Deal initiative.

Summary of Survey and Presentations

Responses to the Survey

- Majority expects large-scale hydrogen application across Europe not before year 2040
- The same is true for carbon capture in the *energy* sector on large-scale across Europe. Some responses expect it beyond 2050 or even never
- Carbon capture in the *industry* sector is seen different: majority expect it in 2050 or afterwards. CO_2 capture cost are more challenging/expensive in the industry sector; less responses say it will never come
- Majority expect carbon dioxide removal technologies to be applied on large-scale across Europe in 2050 or never

- The question: "How many new nuclear reactors will be built by 2050?" is answered as follows: a few say "no one"; majority votes for 5 or 5-10; a minority expects a renaissance on nuclear
- The three most important aspects for climate neutrality are: renewables, change of behaviour, storage improvements (chosen among nine different options for selection)

Presentations

Alessia De Vita (E3M): "Modeling carbon neutral pathways for EU Green deal and climate neutrality"

Main points: Overview of contribution of PRIMES based modeling in European and national studies in recent year. Elaboration on options for decarbonisation - no regret options versus disruptive changes. PRIMES modeling to explore contrasted strategies show that climate-neutrality is feasible. Elaboration on challenges on demand side modeling in the different sectors (incl. circular economy). Challenges in industry sector in terms of process heat&emissions (limits of electrification). Challenges about huge investments. Conclusions: climate neutrality feasible, technology/infrastructure cost estimations uncertain, no regret options are clear, disruptive changes also needed, uncertainty about not mature technologies by 2030, big question on how to incentivize investments by individuals and firms

Karlo Hainsch (TU Berlin): "Quantitative Scenarios for Low Carbon Futures of the pan-European Energy System"

Main points: Presentation of the 3-dimensional openENTRANCE storyline topology with 4 storylines (3x 1.5°C target, 1x 2.0°C target): societal commitment, techno-friendly, directed transition, gradual development. Model setup and specifications of the open source energy system model GeneSys-MOD. Presentation of selected highlights on quantitative results of the 4 openENTRANCE scenarios derived from GeneSys-MOD. Several scenarios show significant reduction of primary energy demand. Discussion of different technology trade-offs in the different scenarios. Comparison of several scenarios until 2050 in terms of energy demand reductions, electricity generation, CO_2 emissions, installed power capacities, hydrogen production. Hydrogen production capacities change at different points in time in the future in the different scenarios. Conclusions: scenario results show need to accelerate climate-neutrality measure implementation. No one of the scenarios is "favorable", several show different nuances of possible ways to go ahead. Transparency and openness of scientific research are a necessity.

Jessica Strefler (PIK): "The path to climate neutrality – residual sector emissions and CDR"

Main points: Presentation of pathways to carbon neutrality from the Navigate project. Elaboration on remaining residual emissions, negative emission technologies. Distribution of emissions – mitigation versus offsetting. Potential and policies for carbon dioxide removal – ETS (Emission Trading Scheme), competitive bidding, etc. Elaboration on electrification in the industry sector – current share 19%; exploitation of achievable electrification potential industry very high (excluding feedstock). Climate neutrality - how to distribute ETS versus ESR (Effort Sharing Regulations). From -40% target in 2030 -> -55% in 2030: doubling CO_2 prices in current split (for -60% even higher prices). Conclusions: Sufficient carbon price crucial to leverage potential of ETS and avoid overburdening of ESR sectors – additional policies can significantly reduce CO_2 price in ESR.

Jörg Mühlenhoff (CAN Europe): "Civil society's Paris Agreement Compatible (PAC) scenario for net zero emissions by 2040"

Main points: Presentation of Paris Agreement Compatible (PAC) scenarios. Civil society developed scenario (participatory bottom-up approach of more than 150 members and experts). Starting point 1.5°C IPCC and UNEP Emission Gap report. Scrutinise studies and models. Scenarios meet energy demand in several sectors. Then matched with supply. Checking several targets. Iterative approach with Öko-Institute model (hourly basis, no grid model). Main objective: checking

feasibility of net zero emissions by 2040. It is feasible! Results of pathways quite similar to the others presented in this session (e.g. incl. effects like electrification in industry sector also confirmed). Residential sector needs deep-renovation. Agricultural/transport sector – phase out of fossils very fast. Hydrogen an option rather beyond 2040. Electrification doubles until 2050. Finally, elaboration on several flexibility options.

Session Outcomes (incl. Comments from the Audience) and Lessons Learned

- Climate neutrality pathway modelling (PRIMES, GENeSYS-MOD, NAVIGATE) and a Civil Society Scenario show similar trends and confirm feasibility to decarbonize Europe by 2050.
- Key insights: consensus on no-regret options (bio-fuels are sensitive in this context (land-use) notably in terms of transport sector), but also need for disruptions and technology breakthroughs is expected
- Strong electrification of the energy system (dependent on availability (and when) of hydrogen and carbon capture and storage technologies)
- In terms of effectiveness and efficiency of carbon pricing, split between ETS and ESR is crucial
- Better understanding consumer behaviour and behavioural changes is important in residential and tertiary sector (in industry it rather is technologies only; in transport more research on modal split necessary)
- Main topics to improve models and thus better support policy making: more focus on behavioural and life style changes, socio-economic drivers in general, transport/ agricultural sector, circular and sharing economy, link/interface to climate modelling
- Key discussion points: open source models/data, forum to coordinate pathway assumptions, results and methods appreciated

Consolidated final conclusion: Developing a comprehensive understanding of similarities and differences of modelling results of different modelling teams not only is important for serving policy making, but also for identifying existing research gaps and future research needs (see above) which will benefit from the increasingly visible development towards open source modelling and thus bring closer together the different modelling teams.

Video-Link of P2

https://www.youtube.com/watch?v=A2sLEbOgJXM

Plenary 3 - Socio and economic impacts of the transition

EMP E
Energy Modelling Platform for Europe

Key Takeaways for Plenary 3: Socio and economic impacts of the transition

Session overview

Moderator: Pao-Yu Oei (PO)

Welcome and introduction to the session

Presentation of results from registration-questionnaire, Diana Süsser (DS), IASS Potsdam

- **Tackling social drivers and constraints of the energy transition in energy modelling**, Diana Süsser (DS), IASS Potsdam
- **Socio-economic and competitiveness impacts of EU Green deal and climate neutrality**, Leonidas Paroussos (LP), E3Modelling
- **Regional impacts of electricity system transition in Central Europe until 2035**, Jan-Phlipp Sasse (JS), UNIGE
- **Addressing issues of inequality**, Johannes Emmerling (JE), CMCC

Plenary 3 was jointly hosted by the openENTRANCE, SENTINEL, NAVIGATE and CINTRAN H2020 projects that feature some of the leading European researchers in the field of energy systems and macro-economic modelling and assessment. The change of energy systems and technologies will have profound economic and social impacts in the EU member states, especially for regions that are carbon-intensive or that are rich in renewable energy sources. This includes distributional implications for GDP, industrial trade and competitiveness, structural changes (i.e. away from fossil fuel and energy-intensive industries towards renewable energy), changes in employment and labour skills, or in general financial requirements and welfare distribution. Reaching a political consensus for a joint European strategy for a European Green Deal is therefore conditional upon the idea of leaving no one behind. Understanding the challenges of a "just transition" is needed to examine how far incorporation into existing models is possible and needed. The aim of this session is to create a more politically relevant analysis of distributional impacts of various energy transition pathways to allow for higher societal and political acceptance (at the cost of in some cases slightly higher technological costs) while minimising the negative impacts on most vulnerable regions (i.e. coal regions), income classes, and trade-exposed industries.

PO: *The EU parliament just voted for a 60% GHG reduction target by 2030, so the session becomes increasingly important in the context of ambitious EU climate targets*

Presentation of results from the questionnaire, Diana Süsser, IASS Potsdam

DS briefly presented the results from the questionnaire on the important of socio-economic analysis in mitigation pathway. Forty replies are received, both from modelers and non-modelers.

Key takeaways

- Social and economic impacts are not sufficiently integrated in energy models, which should be expanded and improved to capture the socio-economic impacts of the transition.
- Distributional aspects, social costs and external costs are the economic aspects that should be prioritized to be included in energy system models.
- Social acceptance of technologies, social barriers, consumer behavior and energy poverty are the social aspects that should be integrated in energy system models.
- Increasing demand from stakeholders to integrate macro-economic and social impacts in energy system modelling, but questions remain on how to integrate them properly.

Tackling social drivers and constraints of the energy transition in energy modelling, Diana Süsser, IASS Potsdam, SENTINEL project

DS stressed the important of capturing social drivers and constraints in energy transition modelling, as social acceptability matters a lot for energy transition as demonstrated by the Not In My BackYard effect in Germany. Social narratives should be properly integrated in the scenario specification. She then introduced the QTDIAN 'toolbox' of socio-political-technological modelling tools that capture different drivers and constraints to better understand their influence on the renewable energy development and energy transition. By integrating these non-technical factors, models will be able to provide more realistic, relevant and sustainable decision-advice. Regional preferences and public opposition matter a lot in the renewable energy uptake and decarbonization transition (e.g. wind onshore preferences in Germany), so these are included in QTDIAN approach. The integration of social factors and distributional impacts in models is essential to provide more realistic and relevant advice, but further research is required to better integrate social drivers and constraints in models, while availability of good data is essential.

Socio-economic and competitiveness impacts of EU Green deal and climate neutrality, Leonidas Paroussos, E3Modelling

LP presented a recent analysis using the leading multi-sectoral Computable General Equilibrium model GEM-E3-FIT exploring the socio-economic and competitiveness impacts of the EU Green Deal goals of 55% GHG emission reduction in 2030 and climate neutrality by mid-century. The model-based analysis shows that decarbonization is a capital-intensive process (transition from OPEX to CAPEX) and requires new infrastructure, labour skills and coordination of market players. Ambitious and predictable policies are required to incentivize investment by reducing risk premiums over time. The EU Green Deal targets would lead to a more investment-intensive EU economy, which remains services-oriented but construction and clean energy technologies become increasingly important. Changes in employment depend on the sector position in the decarbonization context, which also involves a transition towards more skilled labour. The impacts on industrial competitiveness are dynamic depending on cost changes with largest impacts for metals and chemicals, while key countries for relocation of industrial activities are Russia, China and India

Regional impacts of electricity system transition in Central Europe until 2035, Jan-Philipp Sasse, UNIGE

JS presented the regional impact of electricity system transition focusing on Central Europe and showed that social acceptability matters a lot for the transition (e.g. reduced investment in wind farms in Germany due to NIMBY effect). Therefore, they integrate social narratives into the specifications of techno-economic scenarios, aiming to meet three goals: cost-efficiency, GHG reduction and minimum distributional impacts. Their model-based analysis showed that the maximum equality would have high cost impacts and thus cost-efficiency in the entire system increases regional inequality. There is a trade-off between mitigation costs, equality and uptake of renewable electricity. Compared to 2018, the Central European electricity targets for 2035 increase system costs by 12–22%, increase regional equality of system costs by 18–43%, but increase renewable electricity generation by 97–140% across scenarios. The Regional impacts on system costs, employment, greenhouse gas and particulate matter emissions, and land use are mostly driven by changes in generation capacity from solar PV, wind, nuclear, coal, and gas. The aims of improving cost-efficiency, regional equality, and renewable electricity uptake have different implementation pathways and are difficult to be reached simultaneously.

Addressing issues of inequality, Johannes Emmerling, CMCC

The presentation of JE focused on three topics emerging from the NAVIGATE analysis, i.e. distributional impacts of climate change, social impacts of climate policies and shifts in the economy in terms of labour. The topic is highly relevant to the Just Transition concept, but high level of spatial data is needed. They developed an inequality module capturing 10 income deciles in Brazil and France and showed that there are large negative distributional impacts of climate policies for low-income deciles with the Gini index increasing in Brazil demonstrating higher inequality as a result of climate policies. There is a relationship between inequality and climate, with inequality being statistically lower in low-temperature climates. In addition, climate change has huge detrimental impacts on inequality globally and in South Africa. Finally they quantify the direct energy-related jobs based on country-level data, split by main technology and show that the implementation of ambitious Paris goals would increase direct energy jobs, especially in wind and solar PV.

Questions to EMP-E 2020 speakers during Plenary 3 "Socio-economic impacts of the transition"

1) Do we need to understand better social-economic impacts of climate policies to model it?

DS: A lot is done already, but further methodological and modelling improvements are required to improve our understanding of the socio-economic impacts of energy transition.

LP: It is preferable to start with a solid and robust economic theory, consistent with the reality in order to model it, e.g. neo-classical vs neo-Keynesian model paradigms. In addition, rigorous evaluations of models and their behavior is critical to understand potential problems.

2) How do you define inequality?

JS: In our study, the focus is on Spatial inequality, e.g. how the economic impacts are distributed at NUTS-3 regions. Employment impacts are quantified based on indicators from scientific literature. For this analysis, good disaggregated data are required, and it is preferable to use open-source data to the extent possible.

3) How important are aspects that cannot be quantified (e.g. social acceptance)? Can we include these issues into models?

DS: The social acceptance aspects are critical for the design of effective policies and should be included in energy system models. However, modellers should not try to include everything and should be selective on which aspects should be modelled depending on the specific questions. DS suggests to use the social science to reflect these dimensions in energy models. The Agent-Based Models have already incorporates social aspects and thus can be used for learning purposes by energy system modellers.

4) How lock-in effects are accounted?

LP: Generally, it has proved difficult to properly model structural and disruptive change, as energy-economy models use a lot of historical data and are difficult to change parameterization to account for disruptive changes. Energy-economy Models have to identify the drivers for disruptive change (e.g. low-carbon innovation, digitization), but these are difficult to quantitatively capture.

5) Do you expect that returns to capital increase in a decarbonisation context ?

LP: In the general equilibrium modelling framework, the reallocation of investment induced by decarbonization would pose a stress in the capital market (increasing the returns to capital) in the short term. However, in the longer term, these impacts will be smoothed, as the economy would transition towards its steady-state level.

6) How do you model job creation by technology?

JE: Their analysis focuses only on direct job requirements for the different stages of energy and power generation technologies (e.g. manufacturing, installation, operation and maintenance)

7) Should the models capture Wellbeing instead of GDP?

JE: It is important to look beyond conventional GDP measures and capture issues like well-being and inequality. However, these aspects are very difficult to be included in models, as they require good and reliable data and methodological advancements beyond the state-of-the-art.

8) What method did you use for the calculation of carbon leakage?

LP: All calculations are based on GEM-E3-FIT modelling results, comparing the changes in emissions in the EU and non-EU regions across scenarios. Our analysis identifies two key channels contributing to carbon leakage: the energy price channel (reduced global energy prices leading to increased fossil fuel consumption in non-abating countries) and industrial competitiveness through relocation of energy intensive manufacturing activities to countries without strict environmental regulation. The study focuses more on the industrial competitiveness channel.

9) What are the assumptions on technology costs learning?

JS: We used publicly available cost assumptions from peer-reviewed literature for key energy, transport and power generation technologies.

10) Are there available database on jobs per MW by technology?

JE: We used the IRENA studies for renewables, and performed data collections for other technologies in non-EU countries, as there are data for EU countries

Concluding Remarks/Identification of key issues in the survey

PO: granularity of data (and open data) is the key issue for modelers, while a variety of other issues are also important

Non-modelers: they expect additional analysis on the energy transition impacts on growth, lifestyle changes, social justice, circular economy, and decarbonisation co-benefits.

Plenary 4 - Sector Integration – Decarbonisation through multi-energy carrier integration

Plenary 4 - Sector Integration – Decarbonisation through multi-energy carrier integration

Plenary 4 was hosted by the Magnitude and Planet projects, with the goal of presenting sector integration from the perspective of different actors in the energy system. Spatial aspects of integrating energy sectors at all levels were considered. Barriers, approaches and recommendations were outlined and discussed during the session.

Summary of Presentations:

Welcome and introduction, Alessandro Provaggi (Euroheat & Power / DHC+ Technology Platform)

- Energy integration is a key pillar of the Green Deal. During the Summer, the European Commission released a strategy on energy integration to break silos between the different networks. A more circular pathway based on energy efficiency is needed.

Sector integration from the multi-energy system operator and aggregator perspective, Christophe Gutschi (cyberGRID)

- Multi-energy systems (MES) can be used to explore synergies between energy networks. The Magnitude project has deployed technical simulation at a range of sites. Static consumption is needed to balance the electricity grid. MES act as both a generator and consumer of electricity

Small and medium prosumers in Flexibility Markets: the Italian case, Federico Boni Castagnetti (IREN)

- IREN is a multi-utility based in the North-West of Italy. Their work in the PLANET project consists of the integration of RES in the electricity network and coordination of energy vectors to overcome balancing problems.

Impact of Sector Coupling – exemplary aspects from Heating and Power-To-Gas, Dieter Most (Siemens)

- A 90% CO2 reduction is possible in Europe with pan-European cooperation around sector integration. If we don't follow the optimum pathway, we will need carbon-negative technologies and huge hydrogen usage, which brings increased costs. District heating has a key role to play, it is a future-proof technology that can facilitate heat recovery and provide flexibility to the broader energy system.

The whole system approach: a regulatory perspective on sector integration, Luca Lo Schiavo (ARERA – Italian Authority for energy)

- Regulators and market and grid operators have to the net benefit to the entire energy system when making investment decisions. Currently, regulation of the energy system is structured vertically covering only a few sectors, which can be sub-optimal. We need to consider network operators as a whole (transmission and distribution), the whole chain of the system (from generation to supply) and finally looking at energy across sectors e.g. water, waste-management, district heating. Institutional building is the first barrier.

Key Session Outcomes:

- Energy integration is a key pillar of the European Green Deal. The silos dividing different energy networks can be broken down by adopting a circular approach, with energy efficiency as a central priority.
- Multi-energy systems can act as both generators and consumers of electricity and allow for exploration of the synergies between the different energy networks.
- District heating systems, integrating large-scale heat pumps are a key technology for enabling cost-efficient sector integration, especially at local level and in rural areas. DH is future proof, can facilitate heat recovery and can provide flexibility and energy storage.
- Customers are fundamental to the energy transition. Energy communities are increasingly becoming and important actor in the energy system, enabling the participation of a wide variety of stakeholders.
- Mobility is an increasingly important topic – big changes are coming, we need price signals and an integrated approach to avoid over investment.
- Cooperation is essential on European level and between sectors. 90% CO2 reduction is possible in Europe with pan-European smart cooperation aimed at integrating different energy sectors.

Focus Group 1 - Climate Neutrality: energy modelling, weather and climate

1. As regards the sampling of (historical) weather data, often we use one or few weather years, not representative enough of what might happen in the future! The 'optimum' of an energy system model with respect to, e.g., wind capacity to install, changes **a lot** if changing weather year - e.g. from 1 GW to 35 GW; optimising across all weather years, instead, gives you some 17 GW.
2. And are results robust to future climate modifications? No, because the impact of climate-induced changes in weather is only just beginning to be unveiled.

There's some good news, however. Renewable generation estimates are becoming common in meteorological data. And Global Circulation Models (GCMs) are starting to appear more frequently within detailed energy system planning analyses. But there are many challenges:

- Sometimes GCMs give completely different responses; how to handle that for use in energy models?
- Changes in the energy system change the type of weather variable we care the most about - e.g. maybe we cared a lot about temperature before, now we still do but we care a lot more about wind speed.
- And then, of course, there's plenty of intrinsic uncertainties in reanalyses and weather models more generally
- There's also an issue concerning the fact of having at some point just too much data - even just in terms of TBytes of memory needed for performing, e.g., uncertainty analyses across different realisations/sources of those. So computational tractability is a thing.

To conclude: energy-system and climate modellers need to interact more, and build bridges, because there's poor mutual understanding at the moment. We need to build a clearer *common language* based on which the two disciplines can better interact.

D: Pitfalls when using weather and climate data for energy applications. (No speaker, discussion group host: Stefan Pfenninger)
This resource is new and very useful (started by Matteo De Felice):

https://github.com/energy-modelling-toolkit/climate-driven-energy-datasets

- Contributions to add detail to this list are welcome!
- We need better way to formalize and share informal knowledge, i.e. what is "known" in specific research groups about where specific datasets really shine or where they have issues.

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FG1: Climate neutrality: energy modelling, weather and climate

Session description

It is clear that by mid-century Europe has to be climate neutral with respect to its use of energy. That will likely demand the transition to an energy system based on 100% renewable electricity and fuels. Given the environmental limitations to expanding hydropower production, and the likely high costs of geothermal energy over most of the continent, the primary source of energy is likely to be intermittent solar and wind power production. It is well known that this creates challenges for the stability and reliability of the electric supply system. The means of coping with this problem are temporal balancing through storage and load management, geographic balancing making use of long-distance transmission lines, and utilizing overcapacity in the power generation system to synthesize hydrogen and hydrocarbon fuels. Each of these has its drawbacks, whether associated with high costs or lack of public acceptance. Finding the right combination of these mechanisms will be crucial for ensuring that energy remains affordable and the European economy strong.

Spatially and temporally highly resolved energy and power system models being developed through H2020 funding are increasingly being used to investigate credible designs for this future European energy system. Because weather-dependent renewable electricity is likely to play such a key role, a particularly important aspect of this research area is the linking of energy, meteorology, and climate models. Representing weather parameters at highly resolved temporal and spatial scales is crucial for projecting wind and solar power production and variability. The changing climate will be a major driver of hydropower production on the one hand, and heating and cooling demand on the other. State-of-the-art models can operate over a wide range of geographic coverage, from local and potentially energy self-sufficient communities to an entire fully integrated European energy system. Ultimately the results from these models form the basis for developing scenarios to identify the pathways to achieve such a system in the time available.

In this session, we will examine the state of the art of spatially and temporally resolved energy system models, the kinds of questions they have recently answered and still need to answer, what the weather and climate community is ready to provide for energy applications, and what critical issues remain open at this intersection.

Summary of results from the four topics discussed in the session

A: Key insights from the most recent generation of spatially and temporally resolved energy system models (Input speaker: Tim Tröndle, IASS Potsdam)

Discussion focus was on creating an "energy-modeller's wishlist" for climate scientists.

Two focus points:

1. What do we need to answer the research questions that we are not currently able to tackle?

2. What can we do already today but could be made easier through better climate products?

Resulting wishlist:

- Interoperability of existing projects - climate scientists more strongly interacting with projects providing singled catalogued data (e.g. Power Genomics)
- Ensure that climate data are open licensed (e.g. Open Energy Data Initiative).
- Produce a single point of access through an API.
- Slice atmospheric data so as to be easily usable by energy modelers (so to reduce shear mass and irrelevant overload of data on upper atmosphere). Focus on useful data fields: 2mT, wind fields at different heights, soil temperature, direct and diffuse radiation.
- Deliver standardised data and methodologies relevant for demand and supply side of energy.
- Data formats in CSV and NetCDF.
- Increase time resolutions (e.g. to address problem of low inertia in energy systems) and spatial resolutions (e.g. to address problems of urban heat island effects or complex topographies).
- More strongly characterise the responses of different climate models so to assess the robustness of energy models to them.

B: Energy-relevant weather and climate data through the Copernicus Climate Change Service (C3S) and related initiatives (Input speaker: Alberto Troccoli, WEMC)

Discussion issues:

- What is actually out there? Operational products, CLIM2power, CCRS, → Matteo's table
- Often no good help available with decisions when using data: e.g. which historic year to use?
- Comparison of different input data would be valuable.
- Where to find specific data such as future heating degree days?
- Co-production: lots of overhead, understanding terminology, but really important to manage expectations, helps to build more robust services that are more useful for end users
- Embedding climate satisfactorily will take years

C: Critical questions at the intersection of weather, climate, and energy models (Input speaker: David Brayshaw, University of Reading)

Decarbonisation (i.e. pushing for high renewable penetration) increases energy system dependence on weather. Yet, are solutions currently being generated by energy models robust to climate-change-related future modifications of weather? How much are energy modelling 'solutions' (i.e. power system configurations) robust to multiple possible realisations of uncertain future climate/weather?

Focus Group 2 - Circularity and use of raw materials

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Overview for FG2 - Circularity, and use of Raw Materials

Focus Group 2 was organized by the H2020 SENTINEL project with the objective to discuss about the nexus between raw materials and energy technologies and learnt about how some energy systems models (ESM) are working to integrate raw materials in their models. This is a topic that has progressively gained importance in the past years. The session started with the presentation about the ongoing work in the area of raw materials and circularity at the EC JCR. The session continued with two examples (MEDEAS-LOCOMOTION and SENTINEL projects) about how raw materials are being taken on board in ESM. Then the participants were split in four discussion groups to discuss about: data availability, the computation of raw materials and circularity, policy harmonization and the implementation of circular economy strategies within ESM. The session concluded with a discussion about aspects relevant for the EMP-E 2021.

Summary of presentations

Presentation 1: ***2020 list of CRMs for the EU and JRC foresight study on CRMs in strategic sectors.*** Prof. Gian Andrea Blengini (DG JRC).

- Main points: Access to resources is a strategic security question to meet EU's climate neutrality by 2050. Raw materials play a hugely important role in the transition towards a low carbon economy. One of the latest JRC reports includes the estimates of some raw materials for strategic technologies and sectors (EV batteries, fuel cells, wind, and PV among others).

Presentation 2: ***Mineral requirements associated to energy transitions: the MEDEAS approach to identify availability risks.*** Iñigo Capellán-Pérez, Group of Energy, Economy and System Dynamics of the University of Valladolid (https://geeds.eu)

- Main points: The transition to renewables will boost demand of some minerals to extract from mines. The primary requirements are larger than the current estimated reserves and resources, and pressure to extract minerals form new geographies will increase. ESM needs to integrate sustainability dimensions to provide robust policy advise. The materials module from the MEDEAS model is due to be expanded by the LOCOMOTION project by including better models for energy requirements to extract minerals and more robust indicators for mineral scarcity.

Presentation 3: ***Development of an environmental and Bio-economic assessment for Energy System models: the case of ENVIRO.*** Cristina Madrid López (ICTA-UAB, EU project SENTINEL).

- Main points: Within the SENTINEL platform, ENVIRO is a new module that aims to monitor raw materials and circularity. It uses life cycle assessment and metabolism data to understand the potential constraints in energy scenarios. Some of the challenges encountered for its development are the availability of data, a clear method for the computation of raw materials and circularity, and how to integrate/model circular economy strategies in ESM

What did we learn from FG2?

1. **Dependence on critical raw materials (CRM) is likely to replace current fossil fuel dependency**

The low carbon technologies are highly dependent on non-renewable and limited material resources. As the EU increases their share in renewable energy sources, it is likely that it becomes highly dependent on the materials needed for such technologies. For example, rare earth elements for magnets in wind turbines, or gallium, germanium and tellurium for solar Photovoltaics. Many of these materials are targeted by the EU as critical raw materials (CRM) partially because they have a high risk of supply disruption and their recycling is still low. Ensuring a secure supply of those resources is key to meet the EU climate neutral goals.

2. **There is a need of data in a formalized format usable by Energy System Models to allow assessing the nexus raw materials-energy technologies.**

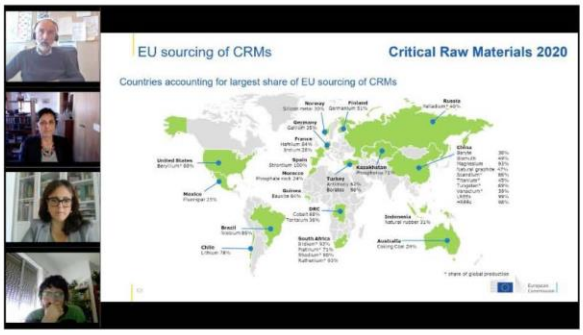
There are studies accounting for the total material requirements needed for low carbon technologies, however such data is generally published in papers or reports, and not available on an electronic format that allows for their direct use in ESM. Making data available in a formalized format requires a high investment on data gathering, data validation, and data formalization in an electronic version.

3. **Join effort from Academia and policy makers to build more useful models.**

An improved dialogue between academia and policy makers will help deliver better models. Models from Academia can provide a more robust and detailed information which many times tends to be simplified in models used by policy makers (for example, the decline of ore grade in minerals for a period of time). Policy makers require models for some specific issues that are not covered well by academia (for example, supply risk from a geopolitical perspective). By having continual discussions on energy system models both parties could get the best out of each approach.

4. **'Newcomers' in the ESM aiming to model raw materials (any platform available?).**

During the sub-group discussions, we identified many new researchers that would be active in the area of raw materials assessment linked to ESM. It will be good to identify possible on-line platforms where they can follow discussions on the topic raw materials and circularity within ESM.



Focus Group 3 - Consumer and Citizen Engagement

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Focus Group 6 - How can energy modelling tools from H2020 projects contribute to National Energy and Climate Plans?

The objective of this session was to enhance exchanges and discussions between H2020 funded projects and national authorities in charge of National Energy and Climate Plans, regarding "How can EC funded projects support national policy makers".

1. What are the models needed of national authorities for assessing progress in implementation of measures in their NECPs for the period 2021-2030?
2. What are the models needed of national authorities for development of next generation of NECPs (2031-2040)?
3. What are the available tools from EC funded projects that could be useful for national modelling exercises?

In a first part, Clement Serre from the European Commission (DG ENER) opened the session by talking about "National Energy and Climate Plans: what are they, why they need be built on strong analytical foundation?" He told us that the NECPs are a foundation for the Green Deal. To reach the EU targets for reduction of GHG emissions, coordination and cooperation between the members states are necessary. Trust is important for cooperation. Robust analytic modelling helps a neutral conversation between partners and improves trust. Zhecho Stankov, Deputy Minister of Energy in Bulgaria described the content of the NECP for his country. He also pointed to the challenges for the industries and the possibility for carbon leakages to neighbouring countries that are not EU-Members. This is particularly relevant for steel, cement, and fertiliser industry. Miriam Bueno Lorenzo, Deputy Directorate General of Prospective, Strategy and Regulation on Energy, Ministry for the Ecological Transition and the Demographic Challenge in Spain presented the modelling processes for development of the NCEP in Spain. Her main conclusions related to modelling were:

- Modelling the energy system depends on the exercise and analysis proposed
- In addition to modelling, a process must be put in place to involve the actors in the energy system.

The second part of the session was devoted to presentation of a sample of tools that have been / are implemented within H2020 projects and may be useful for the implementation of National Energy and Climate Plans:

- *GENeSYS-MOD (OpenENTRANCE) is a linear techno-economic framework, ideally suited to analyze medium to long term developments of the energy system. It includes modelling of the electricity, industry, buildings, and transportation sectors, over a flexible geographic and temporal scope. Typical outputs include capacity expansion, emission reductions, as well as dispatch of all considered energies, use of storages, flexibility options and sector coupling.*

- *The Multi-Carrier Market-Design tool (Magnitude) allows to evaluate how market mechanisms and coordination tools may increase and optimize synergies between electricity, gas and heat systems. it includes a Bid generator, an aggregation platform and market simulator that computes cleared*

volumes and prices, for different kinds of market designs (timing, sequence, frequency, products, carriers....), over various scenarios.

- *The Plan4EU modelling suite (plan4res) is focused on the electricity system. It computes an optimal capacity expansion for a given future year (generation mix, storage, interconnection capacities), an operation strategy for seasonal storages (hydro but also demand-response), and an optimal operation schedule for all assets. It accounts for a wide range of technical constraints (power and ancillary services supply, inertia, interconnections, and plants limits and ramps...) and uncertainties. It can be use to assess the cost and feasibility of a given future scenario.*
- *OpenTEPES (openENTRANCE) is focused on the electricity system. It computes an optimal generation and transmission expansion plan, while considering detailed system operation via a Unit Commitment which schedules the operation of medium and shirt-term storages. It can be used for assessing the impact of planning, policy and technology options on the transmission network development.*
- *FRESH:COM and GUSTO (openENTRANCE) are local energy system models focusing on urban neighborhoods and local energy communities. FRESH:COM models local PV-Batteries systems, associated to allocation mechanisms (peer-to-peer trading under the consideration of each prosumer's individual willingness-to-pay); GUSTO computes the optimal energy technology portfolio and technology dispatch of a local community, including different operation strategies for small-scale batteries.*
- *EXIMOD (OpenENTRANCE) is a macro-economic model that computes economic consequences of energy transition plans : employment and output per sector, household consumption, prices indices, trades.... for given supply and use as well as scenario (GDP, population, electricity mix...) assumptions. It can be used for evaluating the impact of policy measures (eg fuel efficiency, circular economy....).*
- *REMES (openENTRANCE) is a regional equilibrium model with focus on energy systems. it computes prices, volumes, import/exports, value added, unemployment for the whole economy, based on complementary conditions. It includes a modeling of policies such as taxes/subsidies, availability of resources, changes in productivity.*

Focus Group 4 - Smart cities, smart grids and digitalisation: modelling insights and lessons learned

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FG4 - Smart cities, smart grids and digitalization: modelling insights and lessons learned

Organisers

This session is organised by the H2020 MAGNITUDE and Planet projects. The contacts are:

- for MAGNITUDE: Regine Belhomme - regine.belhomme@edf.fr; Edoardo Corsetti – edoardo.corsetti@rse-web.it
- for Planet: Mariapia Martino - mariapia.martino@polito.it; Konstantinos Kanellos - konstantinos.kanellos@vaasaett.com

Short description

Cities are at the forefront of the decarbonisation challenge and represent living labs for the study of innovative smart grid technologies and initiatives.

This focus group considers four different aspects of the future energy systems in the cities:

- Multi-energy systems (e.g. district heating/cooling systems, industrial sites, campuses, public and commercial buildings) in their urban environment
- Renewables and flexibility resources in the cities - how to integrate and exploit them?
- Electrification of transportation at city level
- Evolution of the role of distribution system operators.

The priority is given to the presentation and discussion of real-life case studies and how the technical outcomes of these projects can inform policy.

The following aspects are considered: strategies and modelling, market and regulatory issues, data management and digitalization, and policy recommendations

Main takeaways

The participants in the focus group were split in four sub-groups corresponding to the above four topics. The main takeaways of these four parallel breakout sessions can be summarized as follows.

Multi-energy systems (MES): there is a need of clear requirements for the services they can provide and of standardization of the equipment for control and measurements. In fact, there is no standardization as such in Europe in this field and this is a big issue for replicability of the very sophisticated tools, which have to face with very low level functionality but tailored on different regulation systems. MES, as electricity service providers, are subject to fragmented European regulation and market rules. This makes the MES assessment difficult in terms of potentials (e.g., new business opportunities, reliable and distributed flexible resources for the electrical system) as well as barriers (e.g., regulation - service duration, shape - and market - payment for availability/energy provision, downward services, and so on).

Renewables (RES) and flexibility resources in the cities: it is important to consider the contribution of industries both in term of installation of renewables and the exchange of energy flows with the networks. Demands of industries are easier to predict than residential users but there is a significant diversity among the different types of industries. For RES integration in city or town environment

there are some issues to solve, such as the integration of PV in buildings (e.g. light weight panels) and vibration for wind turbines (in case of installation close to built-up area).

Electrification of transportation at city level: in this case, it is necessary to properly define what "electric vehicles (EV)" means and to investigate the barriers/enablers for their development. Some participants indicated only Battery EV as EV (putting in evidence that the «fuel» is electricity), whereas others indicate that also Fuel Cell EV, Plug-in EV are «electric vehicles» (the electricity is used to make it work). Regarding barriers/enablers, some of them have been highlighted in the discussion:

i) user needs and willingness to own an EV (e.g., work paths versus holiday usage, first or second family car, and so on),
ii) technical limitations of some batteries in terms of km (strictly coupled with the first point),
iii) the request of new infrastructures (not only the electrical ones, but also adequate spaces to install the private chargers),
iv) the role of shared mobility (also public transportation) in pushing the installation of public charging stations

Evolution of the role of distribution system operators: two main aspects have been discussed:

- Regulatory aspects necessary to properly implement storage and flexibility in the planning procedure: the regulatory aspect is key whatever new mechanisms are to be put in place. Storage and flexibility should find their way, also in terms of definitions of services (maybe also in support to planning) and products.
- Clear definition of the roles of TSO and DSO for coordinated service procurements: if a coordinated system services procurement has to be carried out between transmission and distribution a clear definition of the roles of TSO and DSO and of their coordination needs is strongly necessary.

Focus Group 5 - Infrastructure for integrating open-source models across spatial and sectoral scales to facilitate open science and transparency

FG5: Infrastructure for integrating open-source models across spatial and sectoral scales to facilitate open science and transparency

Focus Group 5 started with introductory presentations by the four convening consortia: OpenEnergyPlatform, SENTINEL, Spine, and openENTRANCE. Each team highlighted complementary aspects of their ongoing work: data models, ontologies, workflows, visualization, and different database frameworks all geared for high-powered energy system scenario analysis.

The group then split into two break-out groups to discuss potential areas of collaboration across the four consortia and the wider community participating at EMP-E. The insights from the break-out groups can be summarized as follows:

1) Given the breadth of domains & use cases for energy systems modelling in the context of the European Green Deal and related decarbonization targets, parallel and complementary data models will be required to support all relevant research questions.

2) Even implementations of the same high-level standards like the „frictionless data package" can lead to incompatible data formats.

3) There is limited scope of harmonization for the data processing workflow from raw source data to a usable model input, but the participants identified substantial potential for collaboration on visualization and processing of results.

The participants agreed that the main challenge going forward is to not repeat the „curse of a thousand parallel solutions" which happened in the open-source modelling community over the past decade. Instead, the community must work harder to identify synergies and build on (or compatible to) existing data formats, standards, and tools.

Focus Group 6 - How can energy modelling tools from H2020 projects contribute to National Energy and Climate Plans?

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Focus Group 7 - Transformation of the Energy system: centralisation vs further decentralisation

Focus Group 7 - Transformation of the Energy system: centralisation vs further decentralisation

Focus group 7 was organized around three presentations tackling the topics of centralization and decentralization of the energy system. The first presentation focused on optimization tools developed in the H2020 MERLON and PLANET projects enabling the planning and operation of decentralized flexibilities in integrated local energy systems. The second presentation was set up in an interactive manner to gather input from the session attendees to flesh out a case study about the decentralization of investment decisions in power systems to be carried out within the OpenEntrance project. The third talk presented the key results of a case study from the H2020 project AURES II, assessing the impact of coordinated auction mechanisms by European countries on renewable energy sources investments. Each presentation was followed by a poll (via slido.com) initiating interactions and discussions with the attendees. The major takeaways emerging from the discussions are:

- Decentralization is a major trend of current energy systems because it promotes acceptance and active participation of communities in the energy transition. This is essential to be able to exploit the whole potential of local flexibilities such as variable renewable potential, multi-sector coupling, demand-side management...

- Investments are a key challenge that are difficult to organize efficiently in a decentralized way. Many techniques have been considered with limited success: subsidies, capacity markets, CO2 markets, Auctions mechanisms,...

- Crude decentralization induces inefficiencies in both operation and investment decisions. Coordination mechanisms are required both at the operation and investment level to recover efficiency.

- Modelling tools are critical to assess various mechanisms designs and propose new relevant coordination schemes.

Focus Group 8 -Uncertainty and modelling: lessons learned and gaps

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FG8- Uncertainty and modelling: lessons learned and gaps: Main takeaways

- **Planning-under-uncertainty optimisation frameworks** are fundamental for identifying **openings for strategic action**
- Capturing **short-term uncertainty** is crucial for long-term energy planning. In this case **statistical properties and correlations** matter more than predictive power when describing this uncertainty.
- **Flexibility** (such as storage) investment effective in dealing with **large uncertainty**
- **More efficient computational** and **decomposition algorithms** still need to be further developed to deal with a huge increase in the **size of optimisation problems** factoring in uncertainty