Proceedings

3rd International Forum on Long–term Energy Scenarios for the Clean Energy Transition

The role of long-term energy scenarios (LTES) in achieving net-zero commitments

8-10 June 2021 | Virtual event

Recording, presentation and further information of the event is available here.

For more information contact ltes@irena.org

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Key takeaways

Session 1 - What do the climate neutrality goals mean to national LTES?

- **While many countries have committed to climate neutrality over the last few years, the definition of "climate neutrality" is not yet well-established in policy discourse**. The term may refer to either carbon neutrality (reaching net-zero CO2 emissions), climate neutrality (stopping global warming) or GHG neutrality (reaching net-zero GHG emissions), which have considerably different outcomes with regards to climate targets. To better understand country's climate targets and strategies, clearer definitions need to be set when presenting climate-neutrality scenarios.

- **To define national climate-neutrality goals, countries may align their national LTES with global climate targets.** To achieve this alignment, some countries have included in their national scenarios a calculation of the carbon budget that is expected to be allocated to the country, or on its participation in global effort sharing principles. However, such a calculation might face limitations as they depend on the rapid evolution of global climate circumstances, thus potentially preventing LTES from offering relevant pathways for the future.

Session 2 - Strategies towards climate neutrality goals: How are LTES used to develop Long-term Low Emission Development Strategies (LT-LEDS)?

- **LTES can provide useful basis for the development of LT-LEDS under the Paris Agreement Framework**. Several countries that have submitted their LT-LEDS have included long-term scenario analyses in their strategy and some countries have mentioned their intention to develop scenarios in the future. LTES can support LT-LEDS development by exploring new pathways towards long-term net-zero targets, informing policy decisions and providing modelling methodology.

- **The coordination of LTES and LT-LEDS development among national institutions is crucial for a country to reach the necessary consensus on a common understanding on long-term pathways**. On the one hand, some countries have multiple institutions to develop official energy and climate scenarios and strategies. This requires strong coordination and dialogue between all stakeholders. On the other hand, other countries have preferred to attribute the competency to one single institution in charge of the whole coordination. In such a case, it is important to simplify and clarify the process by ensuring continuous dialogue between the coordinating institution and other stakeholders.

Session 3 - Climate-related scenario analysis in the financial sector

- **LTES are increasingly used by financial institutions to help make investment decisions and capital allocation, most importantly in the areas of risk-return calculations, regulatory changes and portfolio commitments that align with net-zero targets.** The financial sector found LTES especially useful for portfolio target-setting and risk management by testing the resilience of portfolios in different scenarios. They are also used for climate risk disclosure required by financial regulators. Over the last few years, a significant number of new tools

have been made available to investors, allowing them to access more data and better use LTES.

- **Several areas of improvement are identified in order for LTES to be more relevant for the financial sector. They include:** an improved regional and sectoral granularity in scenarios, the integration of macroeconomic indicators, a stronger involvement of financial stakeholders in the scenario development process, a better articulation between the commitments and the required strategies to reach them, and a better understanding of the transmission channels and exposure to climate risk by firms.

Session 4 - Building resilient net-zero business strategies using long-term energy scenarios

- **Long-term energy and climate scenarios have been devised and used by companies to assess the resilience of their business strategies with regards to future transition pathways, thereby aligning internal decisionmaking with their long-term commitments**. Over the last few years, many companies have committed to significantly reduce their emissions along the value chain until reaching carbon neutrality, making it essential for companies to examine transition and physical risks that might impact their business.

- **To conduct scenario analysis inside the company, some companies examine available scenarios published by external institutions, while others have established in-house scenario-building capacities**. Both types of internal scenario use and development can help companies make more relevant strategic decisions in a future characterized by uncertainty. However, current available LTES can be improved to be more relevant for the private sector. In particular, the level of detail of the key outcomes of scenarios could be refined, especially transition features and technologies that directly concern the private sector.

Session 5 - Distilling critical energy transition features in net-zero scenarios

- **Scenarios can enable broader consensus-building over future technology choices and support countries in defining non-regrets investment strategies to reach net-zero targets.** Finding the common technologies across scenarios (such as electrification, renewable energies, energy efficiency, fuel decarbonisation, negative emissions technologies and energy system flexibility) can enable a greater convergence among stakeholders on technologies and investments necessary for reaching ambitious targets. While broad groupings of technology have emerged as consensus, the exact choices of technology depend on a country's specifics and priorities. Rather than trying to build consensus on specific technologies, net-zero scenarios are more useful in reaching a consensus on the relevant decisions that have to be made in the short-term to reach net-zero targets, by fostering dialogue and exploring alternative decarbonisation pathways.

- **In the scenario development process, several elements can be improved**, such as allocating deeper involvement of stakeholders throughout the process, providing transparency in the models and the underlying data, considering a wider range of indicators in models, and developing detailed narratives that are intelligible for policymakers. When considering national net-zero scenarios, challenges include aligning scenarios with the socio-economic priorities of the country, while ensuring the consistency of the scenario with global climate objectives.

Session 6 - Capturing technological disruptions and behavioural change in long-term energy scenarios

- **The integration of technological disruptions and behavioural change in LTES models is crucial for exploring potential pathways to reach net-zero targets**. Their inclusion in energy models can help deal with uncertainty by considering energy transition alternatives.

- **Technological disruptions and behavioural change need to be captured better in LTES**. To better account for them, LTES can be improved by defining storytelling around the modelling, coupling models, better understanding the role of LTES in understanding the changes that might happen, exploring sensitivity, considering different technologies in models, and including different policy options in scenarios.

Session summaries

DAY 1 – Tuesday, June 8th, 2021

Opening and keynote presentations

Opening

Asami Miketa (International Renewable Energy Agency) welcomed attendees and set the context for the 3rd LTES Forum. This online event is the flagship annual event of IRENA LTES Network, which provides a platform to exchange knowledge and best practices in the development and use of LTES. She explained that the topic of this year's Forum, namely the role of LTES in achieving net-zero commitments, was chosen according to LTES Network members interest and the discussions that have been held over three years within the Network. Government energy planners, the private sector and academia will be gathered in six sessions over three days to discuss this topic. She specified that the sessions of the first day would feature national energy planners' perspectives, while the following day would focus on the private sector, and the final day would feature the key components of net-zero scenarios. She added that each session had been co-organized with partner institutions.

Keynote

Dolf Gielen (International Renewable Energy Agency) provided a keynote presentation on the insights from IRENA's preview of the World Energy Transition Outlook "1.5°C Pathway" published in March 2021. He mentioned the key features that emerge from this report to reach climate neutrality. He then presented a study in which IRENA's *1.5C Scenario* was compared to other global scenarios to find the main commonalities and divergences between net-zero scenarios.

Session 1: What do the climate neutrality goals mean to national LTES?

Moderator:

Tiina Koljonen

Research Team Leader

Technical Research Centre of Finland (VTT)

Scene-setting:

Joeri Rogelj

Director of Research and Lecturer in Climate Change and the Environment

Imperial College London

Panellists:

Andreas Kuhlmann

Chief Executive

German Energy Agency

Brian O'Gallachoir

Professor in University College Cork, Director of the MaREI Centre and Chair of the Executive Committee of the IEA Technology Collaboration Programme ETSAP

Kaare Sandholt

Chief Expert, China National Renewable Energy Centre

Keigo Akimoto

Group Leader and Chief Researcher, System Analysis Group

Research Institute of Innovative Technology for the Earth (RITE), Japan

Scene-setting

The scene-setting by **Joeri Rogelj** was aimed at answering the questions: "Why are we talking about climate neutrality goals, and what do they imply for LTES?". First, Joeri Rogelj explained that the variety of terms used in scientific literature, policy and media to define climate neutrality may have different meanings. In this regard, he clarified the differences between carbon and climate neutrality, pointing out their different outcomes with regards to global warming (Figure 1). More specifically, "climate"-neutrality achieves more than "carbon"-neutrality. He then presented the main areas in which countries should showcase more clarity when announcing net-zero targets, namely the scope and types of emissions that are targeted, the adequacy and fairness of the target, and the development of a long-term roadmap to get to net-zero and after reaching the target. He finally underlined that national and sectorial net-zero targets might be more complicated to define than global ones.

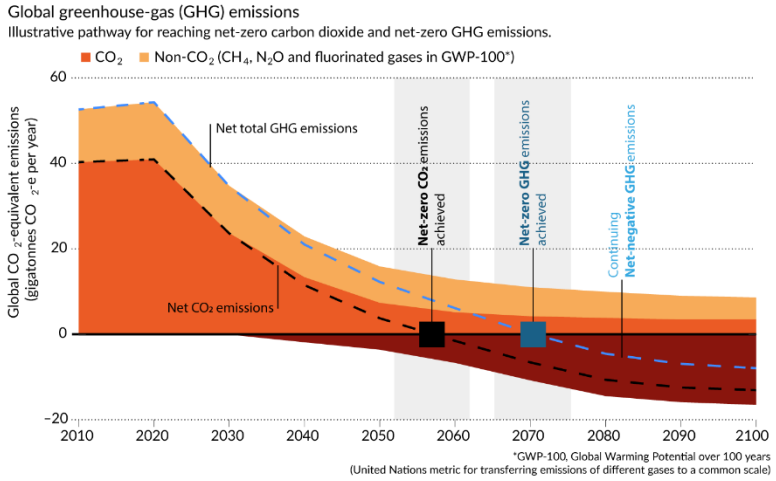


Figure 1. Typical global mitigation pathway. Reaching net-zero CO2 and net-zero GHG emissions is different. Reaching net-zero GHG may require more efforts, such as a larger amount of CO2 removal

Scene-setting questions from the audience

- *What can be the role of CO2 removal technologies?* To reach net-zero, a certain amount of CO2 removal is required. In the IPCC special report, even the pathways that try to avoid any CO2 removal end up with some land-based carbon removal. It is important to develop a diverse portfolio of different technologies to deploy with a holistic policy development of technologies. However, the sustainability concerns of CO2 removal should also be considered.
- *What can be the role of biomass for carbon neutrality?* When talking about biomass, we should not forget that if we remove CO2 removal from the solutions to reach carbon neutrality, models tell us that we will require more biomass to decarbonize the energy system, thus actually generating the trade-offs that we wanted to avoid.
- *What are the priorities setting for non-CO2 greenhouse gases, and the technologies that are being considered to remove those gases from the atmosphere?* Methane is a powerful greenhouse gas yet short-lived so it does not accumulate in the atmosphere, while CO2 stays a long time in the atmosphere. If we reduce methane emissions in the short term, the near-term rate of warming can thus be reduced but if it goes to the detriment of CO2 emissions

reduction, we end up with higher long-term warming. The most relevant strategy would therefore be to reduce all GHG as quickly as possible. Recent research has been published on methane and fluorinated gas removal methods, but the main concern is about the time to scale up this technology, which is beyond the time horizon required to quickly reduce our emissions. We should not rely on such technologies if we want to act now.

- *Is there a chance for sectors as the industry, agriculture and shipping to decarbonize and reach carbon neutrality, as expected in long-term net-zero scenarios?* First, the industry sector has good ways to decarbonize and there have been strong advancements in the decarbonisation of cement and steel production for instance, with a potential to combine with CCS. In agriculture, some emissions are very hard to eliminate, but good management of agricultural land can provide carbon sinks. Finally, the shipping and aviation industry has some potential to decarbonize thanks to new low-carbon fuels.

Lightning presentations

Andreas Kuhlmann presented the pathways to climate neutrality large-scale study published by the German Energy Agency in 2020. This multi-stakeholder project gathered companies, academia, politicians and civil society to understand how they participate in the country's effort to reach climate neutrality. As the terms usually used to describe climate targets - climate neutrality, carbon neutrality or GHG neutrality- are still confusing among German policymakers, it was agreed for this study that GHG neutrality would be chosen as the main target. He mentioned the main areas of improvement for scenarios: a clarification of the definitions and a better understanding of trade-offs. Finally, he pointed out that if scenarios are relevant in bringing new features into the discussion, such discussion must translate into robust policy decisions.

Brian O'Gallachoir began by presenting the IEA-ETSAP (Energy Technology System Analysis Program) that provides energy systems modelling tools to inform policy decisions. The program particularly analyses how global climate targets can be translated to individual countries and what actions are required for each country. The book, "Limiting Global Warming to Well Below 2°C: Energy System Modelling and Policy Development", published in 2018, is the result of this program's work. He then highlighted the fact that besides the timing of the target, which is already a highly-discussed topic, the pathways are also of great importance and should be further discussed because they may have different consequences on global warming (Figure 2). He finally presented a case study for a net-zero energy system in Ireland by 2050, highlighting the non-regrets options that have been identified.

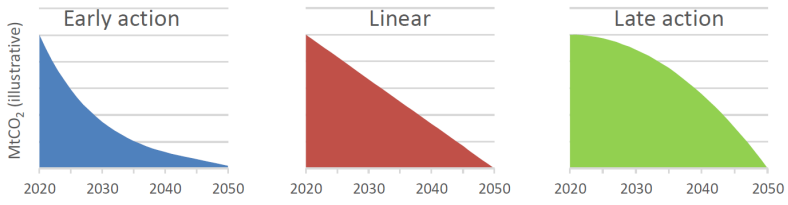


Figure 2. Illustrative decarbonisation trajectories to 2050[1]. Each pathway above reaches the same 2050 goal of net-zero CO2 emissions, but in the Late Action pathway, cumulative emissions are double that of the Early Action pathway, leading to double the warming impact.

Kaare Sandholt started his presentation with a reminder that China announced in September 2020 the ambitious climate goals of reaching climate neutrality by 2060 and peak CO2 emissions before 2030. Thus, there is an ongoing dialogue in China to know how to reach these targets, based on LTES developed by research institutes. According to him, LTES can be useful at two stages: first, in setting goals and providing insights on the possibility for the country to reach these targets; and second, in helping policy implementation and roadmap development to reach the target (Figure 3). He concluded by stating that LTES are therefore extremely useful in the decision-making process.

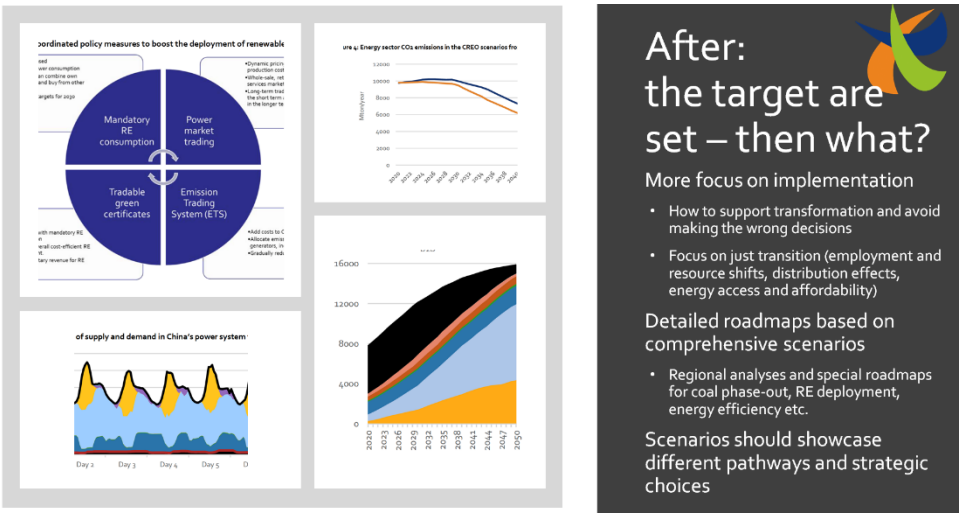


Figure 3. The use of LTES in the process of policy implementation once the national target has been set

Keigo Akimoto started his presentation by stating that as Japan has committed to reaching net-zero GHG emissions by 2050, the country is currently developing scenarios using energy systems models. After presenting the Japanese primary energy mix required for net-zero emissions in 2050, as well as the main requirements and challenges to overcome, Keigo Akimoto showcased the seven scenarios for Japan that have been developed by the Research Institute of Innovative Technology for the Earth, following a request by the government (Figure 4). The scenarios included different perspectives on key technologies for the countries. One of the major challenges highlighted by this analysis is that Japan will have to face a significant increase in electricity costs due to high costs of renewables, integration costs and CO2 storage potentials, especially in the most ambitious scenarios.

[1] Mc Guire J., Rogan F., Daly H., Glynn J., Balyk O. and Ó Gallachóir B. 2020 The role of carbon budgets in translating the Paris Agreement into national climate policy

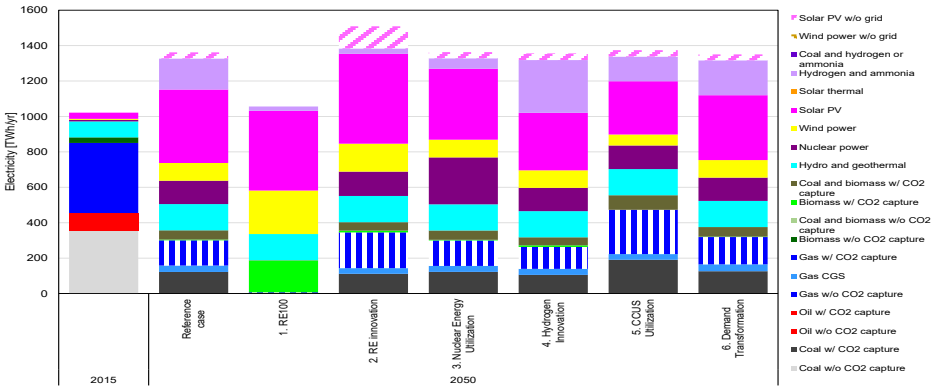


Figure 4. Electricity supply in Japan in 2050 in the 7 RITE scenarios. The most ambitious scenario, RE100 (Renewable Energy 100%), is characterized by a significant increase of renewables while implying higher electricity costs and a decrease in electricity demand.

Panel discussion with the moderator

How have net-zero emissions being defined in your countries? Is the net-zero focusing on specific sectors? What is your definition of net-zero of the energy sector, if different from your national definition?

- **Andreas Kuhlmann** answered first by explaining that the definition of net-zero is still unclear in Germany, but that the Energy Agency decided to focus on GHG neutrality in its study. He added that this study was an overall approach of the whole country, taking into account all sectors.
- **Brian O'Gallachoir** explained that Ireland considers all GHG emissions for climate neutrality. Usually, the MaREI Centre focuses on both the energy and agriculture sector, but it now includes land-use change and forestry which is a challenging sector causing significant emissions. He also specified that MaREI modelling takes into account not only net-zero emissions but also a carbon budget, which is essential when defining transition pathways and their impact on global warming.
- **Tiina Koljonen** picked up on Brian O'Gallachoir's answer, explaining that Finland is also focusing more and more on land-use change and the forestry sector.
- **Kaare Sandholt** highlighted that, as opposed to many other countries, China has no official LTES. However, the LTES developed by the China National Renewable Energy Centre focus on the energy system. One of the most important elements when developing LTES is to develop different levels of ambition, rather than focusing on one specific target that may change over time.
- **Keigo Akimoto** answered that while the Japanese government stated the target of net-zero GHG emissions, there are not many differences between carbon and climate neutrality as over 90% of the GHG emissions of the country is CO2. He added that non-power sectors will have more difficulties reaching net-zero emissions so new technologies such as CCS will be needed.

What kinds of efforts are being made in your country to align official or unofficial LTES with global targets?

- **Tiina Koljonen** opened this second topic of discussion by explaining that the Finnish carbon neutrality objective by 2035 was developed in the context of the global effort sharing discussion.
- **Andreas Kuhlmann** gave the example of a German study developed for the government that tried to calculate the share that Germany would get from the global carbon budget. This report concluded that the country would have to reach carbon neutrality by 2035, but such results should not guide the entire country's strategy as the carbon budget assumption might change rapidly, thus leading to obsolete results.
- **Brian O'Gallachoir** followed up by explaining that in the Irish legislation, in addition to the emissions reduction targets, a 5-year carbon budget is also being defined and discussed within the country.
- **Keigo Akimoto** added that the Japanese government asked institutes to develop LTES for net-zero GHG emissions, but they are not the official country's targets. LTES are rather considered as the base for discussion.

Are there any specific targets related to coal, or more generally fossil fuels in your country?

- **Andreas Kuhlmann** pointed out that for EU countries, this discussion happens at the European Commission level. According to him, European institutions will set new targets that will quickly force coal phase-out.
- **Brian O'Gallachoir** highlighted the interplay between emissions reduction and energy security. In Ireland, the role of natural gas will certainly be highly discussed in the next few years at it provides energy security to the country.
- **Kaare Sandholt** stated that in China there is a strong political push for coal reduction for power generation and the industry sector. Yet, China National Renewable Energy Centre doesn't foresee a total coal phase-out by 2050, as this energy source may provide flexibility in the transition period as a complement to renewables.
- **Keigo Akimoto** highlighted that coal power plants must be reduced in Japan while taking also into account the main challenges of the energy sector, namely energy flexibility, electricity costs and the just transition.

Questions from the audience

In meeting Net Zero emission and to keep the Global Temperature Raises below 1.5 C there are two scenario the Carbon Removal and Solar Radiation management (SRM). In the scenario of the clean energy scenario of the long-term horizon which one is operationally feasible?

- Joeri Rogelj - Carbon dioxide removal (CDR) and solar radiation modification (SRM) are two fundamentally different approaches. CDR is part of mitigation strategies - it reduces the causes of climate change. SRM is not part of mitigation strategies, as it doesn't reduce the causes of climate change, but intends to counteract the effects of greenhouse gas pollution with additional pollution of reflecting particles. This means that using SRM to keep warming to 1.5°C can defeat the purpose of limiting the risks of climate change. The increase in average temperature of the planet is limited, but not the change to our climate, which would be larger than when we keep global warming to 1.5°C through emissions reductions.

Session 2: Strategies towards climate neutrality goals: How are LTES used to develop Long-term Low Emission Development Strategies (LT-LEDS)?

Moderator:

Phillip Eyre

Programme Officer

United Nations Framework Convention on Climate Change (UNFCCC)

Scene-setting:

Kenichi Kitamura

Associate Program Officer

United Nations Framework Convention on Climate Change

Panellists:

Ricardo Aguiar

Researcher

Directorate-General for Energy and Geology, Portugal

Rocío Rodriguez

Energy and Climate Change Coordinator

Secretary of Energy Planning, Argentina

Scene-setting

Kenichi Kitamura first provided background information on LT-LEDS that countries are encouraged to formulate under the Paris Agreement. He then shared the main common elements found in the different LT-LEDS (Figure 5), including the presence of long-term scenarios and emission trajectories. He also highlighted the main contributions of LTES for the development of net-zero LT-LEDS: exploring pathways towards long-term net-zero targets, informing policy decisions especially on long-term implications of today's choices, and providing methodologies for models with their underlying assumptions and indicators. After that, he mentioned in order to reach economy-wide net-zero emissions by 2050, energy sector needs to achieve net-zero emissions well before 2050 given challenges in harder-to-abate sectors. Lastly, he argued that LTES can be useful tool to strengthen governance, by facilitating interaction and coordination between scenario modelling experts and policymakers in different sectors.

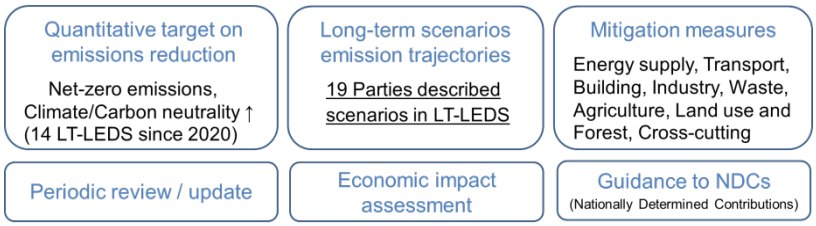


Figure 5. LT-LEDS common elements. Among the 29 countries that have submitted LT-LEDS, 19 described long-term scenarios in their strategy.

Scene-setting questions from the moderator

- *How prominent the decarbonisation of the energy sector has been in the LT-LEDS that have been submitted so far? And are there any common approaches in the different countries?* The energy sector plays a crucial role in LT-LEDS. Several key areas can be identified such as electrification.

Scene-setting questions from the audience

- *What are other non-typical GHG included in LT-LEDS?* The primary purpose of the Paris Agreement is to limit temperature rise and countries are requested to report several GHGs, but some countries have mentioned other gases such as black carbon to address their negative socioeconomic and environment impact.
- *Why are so many LT-LEDS still missing in 2021 (only 29 out of 197 have been submitted)?* Some countries have fewer resources than others to project future GHG emissions or are lacking coordination capacity inside government. However, more than 10 countries have publicly announced that they would submit the strategy before COP26 this year, so there should be more LT-LEDS soon.
- *Is there a plan to address the issues/emissions related to hard-to-abate sectors for the long term? How about any long-term strategies for developing countries?* Hard-to-abate sectors tend to require innovation breakthroughs to decarbonize production process in the long term. That said, there are other approaches that can be taken today as an immediate action to reduce emissions such as improving energy efficiency, resource and material efficiency in the context of a circular economy. These efforts tend to generate non-GHG emissions

reduction benefit such as raw material cost reduction in not only developed countries but also developing countries.

Lightning presentations

Ricardo Aguiar presented the three climate strategies that Portugal has published in the last year in the context of LT-LEDS: the national Carbon Neutrality Roadmap for 2050 (Figure 6), the NECP, and the National Hydrogen Strategy. These three plans include different long-term energy scenarios that led to different conclusions, depending on the more or less realistic assumptions. In this regard, the national Carbon Neutrality Roadmap for 2050, which contains more unrealistic assumptions, should be rather considered as an optimal pathway than a possible future. Developed under the Environment Agency or the Energy Directorate-General, these national plans and roadmaps are either developed in-house, either with consultants. Ricardo Aguiar concluded on the fact that a strong dialogue between government, environment, energy agency and LTES modellers is required to implement such climate-energy plans.

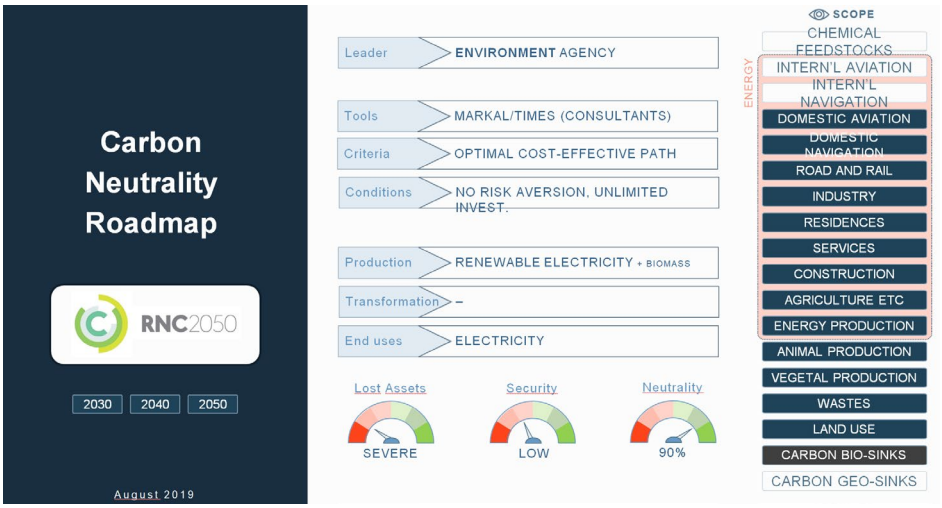


Figure 6. Main takeaways from the Portuguese Carbon Neutrality Roadmap (RNC2050)

Rocio Rodriguez began her presentation on Argentina by sharing the current energy mix of the country and the associated GHG emissions (Figure 7). She explained that Argentina's climate governance is structured at the State policy level and involves dialogue between various institutions and society. This coordination was particularly important in the development of national plans such as the NDC, the Climate Action Plan for 2030 and LTS. As the country is currently working on the development of long-term climate strategies, the government has recently published a report to investigate the main pillar and goals of Argentina's energy transition by 2050 and launched a study to assess the implications of the energy transition and new technologies for the country. These publications are the resultof constant dialogue between several institutions (academia, private sector, civil society, NGOs, etc.).

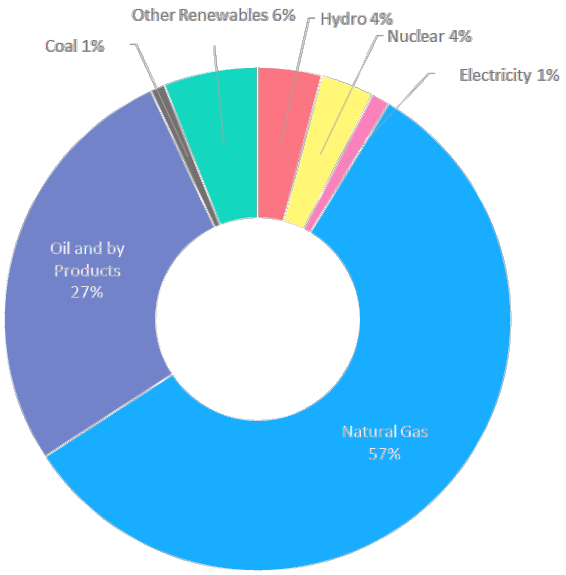


Figure 7. Primary Energy mix in Argentina (2020). The figure shows the significant role of fossil fuels in the energy mix. In the last few years, however, the share of renewable electricity has increased.

Panel discussion with the moderator

How do you see the role of emerging technologies that are not yet commercialized (such as hydrogen, batteries, energy storage, negative emissions technologies) in achieving net-zero targets in your countries?

- **Ricardo Aguiar** stated that as carbon neutrality is now an obligation, it is necessary to introduce in the modelling some technologies that do not exist yet but that must be taken into account for climate neutrality. It is therefore more relevant today to include technologies that are still at a relatively low technology readiness level in the models and make new kinds of assumptions. And the choices of technologies to include in the models put a high responsibility on the modelling community which develops long-term views for policy discussion. He added that Portugal tries to include “unicorn technologies” in their modelling which are characterized by very high potential uncertainties.
- **Rocío Rodriguez** explained that Argentina considers that it has a high potential for the deployment of renewable hydrogen. The country is also developing studies to assess the potential role of emerging technologies such as storage, digitalization and CCS.

How is your country coordinating the development of national LTES with LT-LEDS?

- **Rocío Rodriguez** stated that the development of the national LT-LEDS in Argentina is currently taking place thanks to a multi-stakeholders coordination process. Many dialogues are taking place in the form of ministers' meetings, focal points working groups (with representatives from the policy and scientific community), roundtables of federal articulation, working meetings with different sectors and the civil society (on topics such as transport, energy, infrastructure, finance, etc.). All these initiatives are coordinated with the national cabinet on climate change. This approach allows Argentina to reach the necessary consensus for the construction of a collective vision of the future of the country.

- **Ricardo Aguar** picked up on what Rocio Rodriguez explained, stating that Portugal, similarly to Argentina, has a lot of committees and articulation processes for the development of LT-LEDS. However, he highlighted that this architecture of existing institutions has been destabilized very recently due to the need for rapid articulation of goals between all sectors and communities for a common goal. The answer of the government has thus been to give all competencies to a unique institution responsible for the whole coordination, the Environment Agency. The growing power of this agency regarding climate issues has induced a loss of government dialogue on those topics. Therefore, the reports published by the Environment Agency will have to be realigned with the expectations of the other institutions.

What advice would you give to other model practitioners, based on your key learnings?

- **Rocío Rodriguez** stated that the main three success factors in Argentina have been: the institutionalization of climate objectives and institutions competencies in law, the compromise of a national government, and the coordination through a specific cabinet.
- **Ricardo Aguar** gave as key advice the "backcasting" process, which consists of defining a long-term view for 2050 first and then developing actions in the present that are needed to reach that objective.

Questions from the audience

It has been said the best place to use hydrogen is where it is produced. In the US, we have cities that don't have natural gas because of safety concerns. Aren't these safety issues amplified with the use of hydrogen?

- Kenichi Kitamura – Efforts to expand areas of hydrogen application should include consideration of new or update infrastructure as well as regulation to address safety concerns along with greater hydrogen penetration in various end-use sectors.

Shouldn't we be looking into integrated energy systems that can better integrate energy producers and energy-intensive end-users?

- Kenichi Kitamura – Locational aspect of energy production and energy use will be of importance including implication on transmission and distribution system. Many energy intensive end-users such as large steel plants have on-site power generation equipment for their own consumption, but such equipment mostly relies on fossil fuel at the moment. Transition to decarbonized energy supply and end-use will benefit from a holistic view of energy systems.

DAY 2 – Wednesday, June 9th, 2021

Session 3: Climate-related scenario analysis in the financial sector

Moderator and scene-setting:

David Carlin

Task Force on Climate-Related Financial Disclosures Program Lead

United Nations Environment Programme Finance Initiative

Panellists:

Laurent Clerc

Director for research and risk analysis, French Prudential Supervision and Resolution Authority (ACPR)

Banque de France

Nicholas Dodd

Senior Portfolio Analyst, Climate Scenario Analysis Program

2 Degrees Investing Initiative (2DII)

Peter Sandahl

Head of Sustainability

Nordea Life & Pension

Scene-setting

David Carlin started the scene-setting by explaining that it is crucial for financial markets to have access to the relevant information to assess climate risk and allocate properly investment. UNEP-FI has thus developed the Task force on climate-related financial disclosures (TCFD) to provide standardized, comparable and useful information on climate risk to internal and external stakeholders. TCFD, which has become the *de facto* standard for climate risk disclosure, uses climate scenarios to explore different features. Scenarios are also used for other applications in the financial sector, such as internal or external reporting, or decision making on future business (Figure 8). According to him, the key transition factors in scenarios for the financial sector are carbon price, future energy composition and energy use, year of peak emissions and temperature overshoot, negative emissions technologies, emissions reduction technologies and socioeconomic assumptions. Finally, climate scenarios can be improved to become more useful to the financial sector by clarifying sectorial and regional assumptions and including physical impacts and macroeconomic indicators.

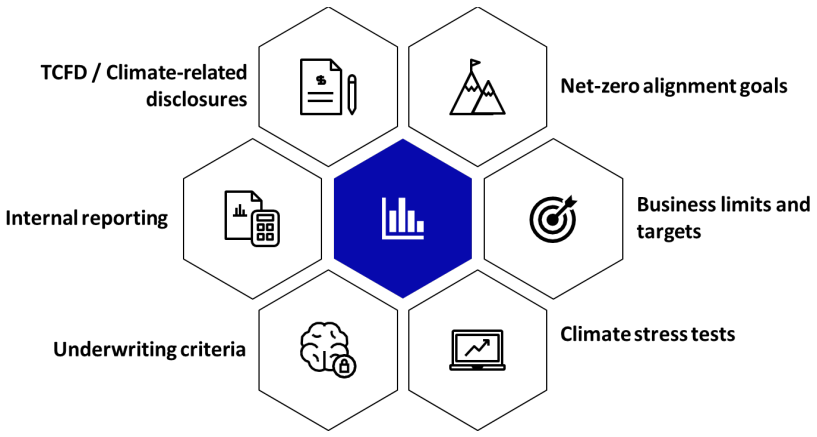


Figure 8. Areas of application of climate scenarios in the financial sector. Climate scenarios are becoming a critical input into processes throughout financial institutions

Lightning presentations

Laurent Clerc provided a presentation from the regulator's point of view. He explained that the French Prudential Supervision and Resolution Authority (ACPR) at Banque de France started working on climate change issues a few years ago when France introduced mandatory disclosures for financial institutions within its climate law. The work was organized in three parts: the promotion of good practices for climate risks governance, the exposure monitoring to climate-related risks of French institutions, and scenario analysis with the stress test. The 30-years horizon stress test was a bottom-up approach built on the inputs from banks, firms and financial institutions and included an assessment of their global exposure. In this exercise, the economy was decomposed into 55 sectors and both transition and physical risks were assessed. Laurent Clerc presented the outcomes of the transition and physical risk scenarios. They eventually showed that the most disorderly the transition, the higher the cost of risk.

Nicholas Dodd gave an overview of the PACTA tool (Paris Agreement Capital Transition Assessment tool) developed by 2DII to bridge the existing assets currently held by investors with the capital allocation that will be required for the transition (see Figure 9). It shows the actions that are needed to change capital allocation and influence company's investment strategies. One of the main challenges of the transition for the financial sector is to maximise the impact of investment decisions on companies' activities to tackle climate change. PACTA also made available a variety of energy scenarios to financial institutions and processed them to make them relevant for the financial sector (e.g. make them compatible, compare their assumptions, etc.). Lastly, Nicholas Dodd presented the forward-looking metrics that PACTA considers in energy scenarios for capital allocation investment strategies

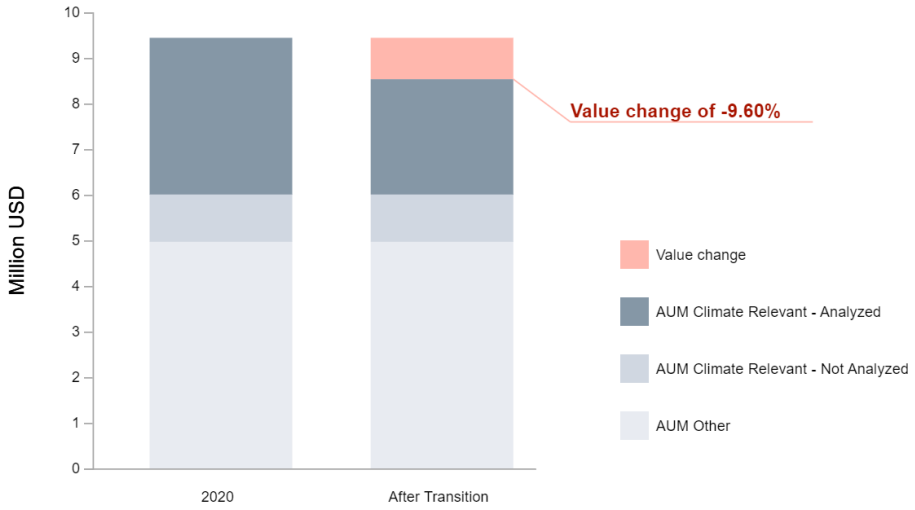


Figure 9. Equity: Potential value changes in a stress scenario

Peter Sandahl provided a perspective on climate-related risk from an investor's point of view. As asset owners are on the top of the investment value chain, they have a significant role to play in climate change: on the one hand, they are exposed to climate risk, and on the other hand, they have the opportunity to invest in transition technologies. To help future investment decision making and capital allocation, climate scenarios are thus becoming more and more important and used by investors, due to risk-return considerations, regulations and an increasing amount of portfolio alignment initiatives and net-zero targets. Investing institutions use scenarios for two main purposes: target-setting (portfolio alignment), and risk management to test the resilience of portfolios in different scenarios (Figure 10). Peter Sandahl concluded by stating that while there have been strong improvements in stakeholder's collaboration to enhance the way scenarios are used by the financial sector, more dialogue is still needed.

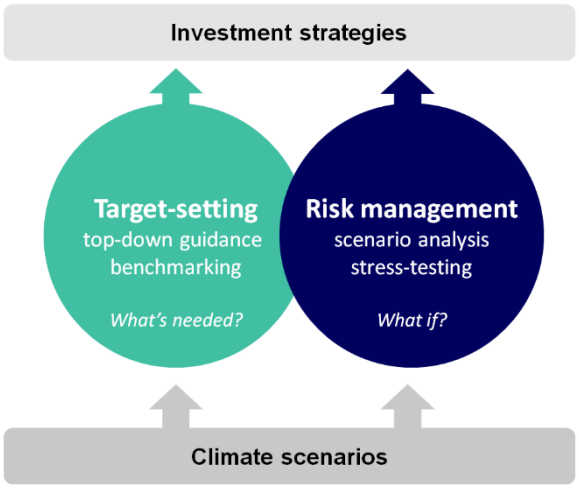


Figure 10. The use of climate scenarios for investment strategies

Panel discussion with the moderator

What are the key functions of climate and energy scenarios across the financial sector?

- **Laurent Clerc** stated that some of the most important roles of scenarios are to raise awareness of institutions with respect to climate change risk and on the need to take this risk as financial risk, and to improve the tools and capacities to address this risk, including by considering new practices such as the assessment of sectorial exposure. The current trend is that more regulators are asking firms to disclose their exposure related to some climate scenarios, which is why scenario analysis is becoming very important and enable the introduction forward-looking elements to the existing data.
- **Peter Sandahl** added that the increased demand for the use of scenarios in the investment industry is driven by both the regulators side, and by investors themselves for target-setting as more and more are committing to portfolio transition targets. Over the last few years, a significant variety of new tools and available data have emerged to guide investors in this transition. Finally, scenarios have enabled a more mature and technical discussion on climate issues.
- **Nicholas Dodd** relied on the use of the PACTA tool by banks to illustrate the topic. Banks have started by tracking metrics sector by sector to assess the performance against scenarios, but they are now more and more looking into the individual firms' level to understand how companies are transitioning. The challenge for banks is not only to engage with sustainable companies but also with existing major firms which historically have fossil fuel assets to help them plan their transition and provide the necessary financial capital.

How financial institutions address the challenge of different time horizons between present decisions and longer-term commitments?

- **Laurent Clerc** answered that scenarios help in addressing uncertainty. Especially, extreme scenarios can help to reach an expansive view of what could happen in the near future if the transition happens either earlier than expected or later. For instance, the carbon pricing

assumptions vary significantly depending on scenarios, so the objective is to have scenarios that could encompass such future uncertainties.

- **Peter Sandahl** added that Nordea is indeed confronted with the challenge of assessing how compatible their 2050 long-term climate commitments are with the 2025 objectives, and how those objectives align with the required pathways for sectors. To do so, it is thus crucial to combine the overall portfolio targets with clear sectoral targets, this is why Nordea has significantly enhanced its sectorial granularity analysis. From the risk management perspective, he highlighted the difficulties to use the results ensuing from the wide variety of scenarios and change investment strategies accordingly.
- **Nicholas Dodd** stressed the importance for 2DII to frame strategies at a 5-years horizon while expanding the range of tools and metrics that investors have to track the changes in assets and investments. Working on a short time horizon enables to start implementing strategies based on current investments in existing winning technologies for the transition.

How to make scenarios easier to integrate and more credible for financial institutions?

- **Laurent Clerc** explained that from a financial regulator point of view, it has been interesting to force institutions to link their public commitments with scenario analyses, to avoid commitments that are only communication tools. The two main elements that could be improved today would be a better articulation between the commitments and the required strategies to reach them, and a better understanding from firms of the transmission channels and the exposure to climate risk.
- **Peter Sandahl** first underlined the need for more regional and sectoral granularity in scenarios. He then explained the importance of conducting climate scenario analysis and stress testing as an integral part of the existing stress testing practices and to review any significant differences in common areas such as macroeconomic assumptions.

Questions from the audience

Could you please share the sources of the studies and reports that you are referring to?

- **Laurent Clerc** – Here are the links which might be useful for the participants of the conference:
  - A first assessment of financial risks stemming from climate change: The main results of the 2020 climate pilot exercise
  - Scenarios and main assumptions
  - Modelling framework and scenario details
  - Guidance and scenario data
  - Governance and climate-related risk management
  - French insurers facing climate change risks
  - French banking groups facing climate change-related risks

Does France plan to phase out nuclear in its LTES?

- **Laurent Clerc** – guess not: nuclear energy is considered as a source of renewable energy and its key role in the production of electricity explains why GHG emissions are so low in France compared to other industrialized countries. Phasing out nuclear will represent a considerable challenge.

Do the financial tools include lifecycle analysis of existing and proposed energy systems?

- **Nicholas Dodd** – The decarbonisation alignment tool PACTA developed by 2DII only currently addresses scope 1 (direct) and 2 (indirect from electricity) emissions from the sectors it covers. For some sectors and specific technologies identified in energy scenarios, such as biofuel production for aviation, we are considering for the future whether to address scope 3 (life cycle) emissions.

Do too many scenarios and pathways inhibit Decision Making and visibility for investments in low emissions

infrastructures?

- **Peter Sandahl** – It's a fine balance. Somewhat simplified I would say that for target-setting purposes the use of normative scenarios needs to be limited as those steer capital allocation decisions towards a defined objective. Here I also believe that standardization is an important consideration to ensure that the collective actions from the financial sector rest on the same assumptions. However, for risk-management purposes, the applied scenarios are by nature more exploratory and you would need a larger number of assumptions/scenarios to cater for different potential outcomes.
- **Nicholas Dodd** –This will depend on the end-user, who may consider it important to analyse the sensitivity of investment strategies to different future scenarios and transition risks. At the core of most current energy scenarios, there tend however to be a consistent set of technologies and investments required, particularly in the new Net Zero scenarios, where the options for the future tend to become quite constrained, so for decision-makers, it is now more a question of timing/urgency than specific pathways.

Is Carbon Pricing the silver bullet to reach the net-zero target before 2050?

- **Peter Sandahl** – Carbon pricing is a key tool in the toolbox. Its effectiveness depends on a number of things but designed right it will have a critical role in the transition. However, my personal view is that it alone cannot solve all the challenges we are facing. We need complementary policies that e.g. address market barriers and infrastructure needs and ensure that carbon pricing doesn't lead to unintended consequences or lock-in effects.
- **Nicholas Dodd** – With PACTA we focus on the investment trajectory entailed to realise what is described in the scenarios and sectoral pathways. Whilst carbon pricing is likely to be an important factor influencing the pace of change, we currently allow users of PACTA to choose which scenarios to use and their associated choice of influence for different economic instruments.

What is assumed for the improvement in output of renewable energy resources?

- **Nicholas Dodd** – This aspect of performance improvement is addressed within the scenarios we provide to PACTA users.

Session 4: Building resilient net-zero business strategies using long-term energy scenarios

Moderator:

Nate Aden

Senior Associate with WRI's Business Center and WRI Climate Program

World Resources Institute (WRI)

Panellists:

Davide Puglielli

Head of Scenario Planning and Group Strategic Positioning

ENEL

David Radermacher

Vice President Sustainability

E.ON

Sim van der Linde

Project Director Renewable Energy

Royal DSM

Lightning presentations

David Puglielli presented the climate strategy of ENEL and the role of scenarios in the company's strategy. The energy firm has recently committed to climate targets, including reaching net-zero emissions along the whole value chain by 2050. To reach this objective, ENEL has established its scenario planning capacity, structured in two parts: the analysis of external scenarios (global and regional), and the in-house development of scenarios (see Figure 11). The latter aims at mapping the main uncertainties that may affect the business of the firm over different time horizons, based on a reference scenario and 'brighter future' scenarios in line with the Paris Agreement. ENEL has also developed quantitative tools to test and disclose the resilience of the firm's strategy to physical and transition scenarios.

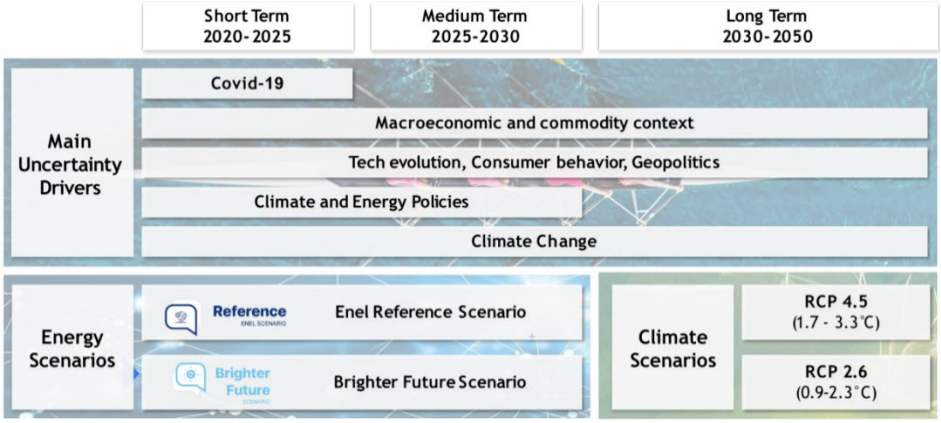


Figure 11. Enel's overarching framework for scenario planning

David Radermacher explained that E.ON is using scenarios to align its business strategy to the energy transition. The energy company has especially committed to becoming carbon neutral in all scopes by 2050 (and in scopes 1 and 2 by 2040). To help to reach that objective and assess the resilience of the current business strategy against the future energy system, E.ON examines two long-term energy scenarios: a Reference Case and the EU Green Deal scenario (Figure 12). One of the key indicators that have been assessed is the evolution of the primary energy demand mix from now to 2050. As E.ON's business is characterized by long investment cycles (up to 40-50 years), a 10 years horizon does not represent a long time for the company strategy and therefore requires the use of scenarios to ensure relevant business decisions for the future.

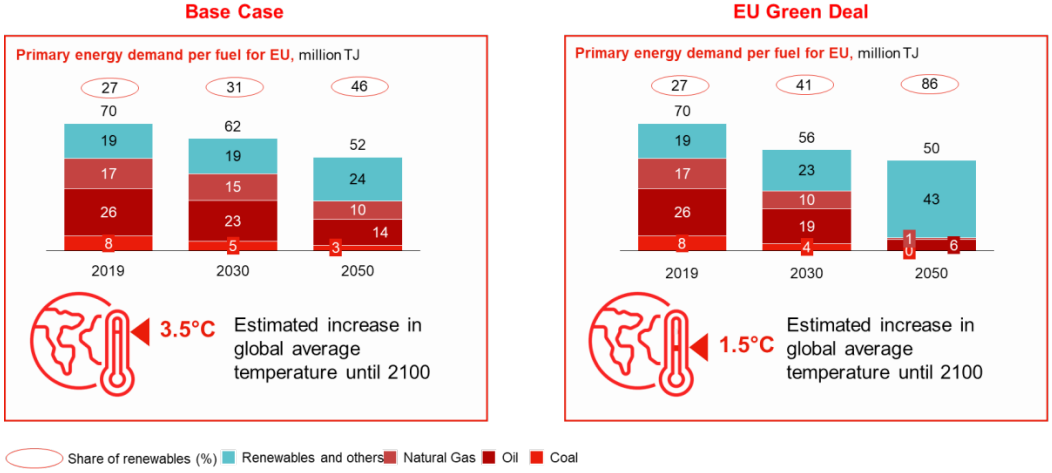


Figure 12. Evolution of the primary energy demand per fuel for EU in the 2 scenarios assessed by E.ON. Until 2030, primary energy demand in Reference Case and for EU Green Deal are similar, thereafter Green Deal decarbonizes more to meet the 1.5°C target.

Sim van der Linde introduced his presentation by explaining that DSM uses energy for its chemical processes. As part of its climate strategy, the firm committed to net-zero GHG emissions by 2050, inside the company and across the value chain (see Figure 13), and therefore investigates LTES. The key features that DSM considers in those scenarios are the new opportunities that may emerge from the transition (emergence of low-carbon products and innovations), the risks (e.g. carbon price), GHG roadmaps and energy forecasting. One other point of focus is also to consider the relationship between the company's business and national governments: on the one hand, the company's long-term renewable energy agreements enable the realization of additional assets, and on the other hand, national government scenarios can be used to determine the growth potential for renewable energy.

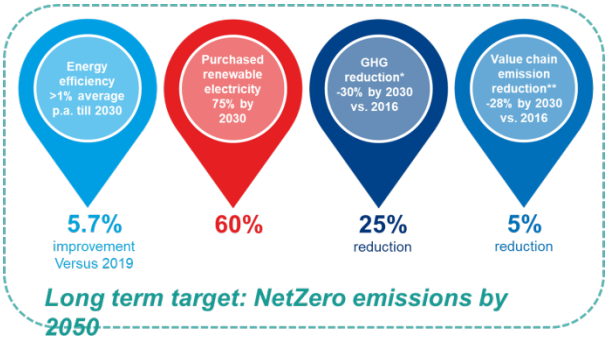


Figure 13. DSM's climate targets

Panel discussion with the moderator

What do you think of the IEA 2050 scenario released last month and how could it be improved to better support your work and set targets in your organization?

- **Davide Puglielli** recognized the importance and usefulness of this scenario and outlined the clarity of the few messages that emerge from the report. However, some level of detail is missing for companies such as ENEL to be able to take actions based on the scenario's results. However, more detail should be made available in the next releases.
- **David Radermacher** also pointed out the massive work that has been achieved with this report and the clarity of messages. From the company's perspective, it would be interesting to have more clarity and details on how the firm's ambitions can be delivered on some specific features such as hydrogen.
- **Sim van der Linde** added that from an energy consumer point of view, the message of the study is very strong and comes at the right moment.

What do you hope to see out of the COP26?

- **Davide Puglielli** stated that he expects more clarity and accountability in terms of climate ambitions from both governments and the private sector.

- **David Radermacher** expressed his hope that this COP26 shows that multilateralism can reach global agreements for a global challenge, and become a signal of a joined effort.
- **Sim van der Linde** added that more ambitions from all companies around the world to globally reduce emissions would be a great signal, which especially requires larger countries to lead that transition.

Questions from the audience

Are the ENEL scenarios run for a specific country or at regional/global level?

- **Davide Puglielli** – Enel considers the whole energy system at the national level. The study is limited to the countries that represent the highest share in Enel's business or where there are more integrated parts of the value chain. However, this approach is complemented with other modelling instruments, including some views at the regional level for some parts of the energy system. For the global view, Enel mainly relies on external benchmarks.

While distributed energy systems are good for electricity centric energy systems, don't we need centralized energy systems to meet thermal intensive processes energy needs in a carbon-constrained world?

- **David Radermacher** – Some industrial processes require centralized energy systems, but E.ON believes that the energy transition should also be driven on the customer side, with distributed and decentralized energy systems. E.ON delivers high-temperature solutions based on hydrogen or electricity produced on-site for industrial customers, so this combines high temperature and intensive processes with decentralization.

Why doesn't E.ON's 2040 climate target include scope 3 emissions?

- **David Radermacher** – E.ON wants to commit to a realistic target. The firm knows that it cannot promise to full net-zero at this horizon.

Sim, do you see a scenario where DSM or other companies will discontinue producing certain products because of their high energy content?

- **Sim van der Linde** – DSM is a company in constant transformation: it has notability transformed from a coal company to a chemical company. What is important is to look at the whole value chain: a product that is highly energy-intensive to produce may help saving energy at the end-use consumer side, so it is important to look at the more complex picture to determine which products have the higher carbon content.

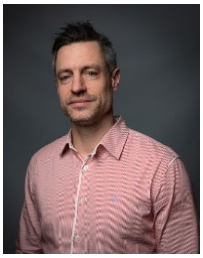
What are the opportunities that are being missed by companies that are reluctant to embrace the clean energy transition?

- **Davide Puglielli** –Enel has started acknowledging that the clean energy transition would bring economic benefits. Besides the positive impact on climate, being a sustainable business is indeed attractive from the cost and returns point of view, while fossil fuels will become more costly. One other important point of focus for Enel lies in the downstream part of its business and concerns the electrification of end-uses, also gaining attractiveness due to technology improvements and changes in customer's behaviours.
- **David Radermacher** – We are in a decade of massive investments in renewable energy generation and infrastructures. The companies that are trying to be part of the solution rather than the problem with regards to climate issues are becoming more and more attractive, while the ones who refuse to embrace the energy transition will have to face growing risks (stranded assets, regulatory risks, etc.) and therefore higher financing costs.
- **Sim van der Linde** – The energy and climate transition is bringing many opportunities for the business sector. There is now an enormous market for sustainable assets and investments and the risk of increasing costs by refusing to become sustainable is getting more important. And at the same time, customers are also asking for more sustainable products so it brings new opportunities.

DAY 3 – Thursday, June 10th, 2021

Session 5: Distilling critical energy transition features in net-zero scenarios

Moderator and scene-setting:



Wouter Nijs

Researcher

Joint Research Centre,
European Commission

Panellists:

Bjarke Christian Nepper-Rasmussen

Advisor

Danish Energy Agency

Claire Nicolas

Energy Specialist

World Bank

Henri Waisman

Senior Researcher in the Climate Group, Coordinator of Deep Decarbonization Pathways Projets

Institute for Sustainable Development and International Relations (IDDRI)

Scene-setting

For the scene-setting, **Wouter Nijs** first focused on the role that scenario can play in building consensus on some winning technologies. To illustrate it, he presented two reports, published by JRC ("Towards net zero emissions in the EU energy system by 2050", 2020) and IRENA ("Scenarios for the energy transition: Global experience and best practices", 2020) that have compared different net-zero scenarios. These analyses have shown that there are some features that gather a consensus among most of the scenarios (see Figure 14). Comparison studies can therefore be the basis for greater convergence among stakeholders on technology development and investment. Then, he presented the critical energy technologies that have been identified within all scenarios, namely: massive electrification, high share of renewable energy, disruptive technologies and the use of negative emissions technologies to offset remaining emissions. Some key socio-economic transition features can also be highlighted. Finally, Wouter shared the main improvements that would be needed for scenario development: improvement in the choice and number of indicators used, communication of understandable results, engagement of stakeholders and transparency.

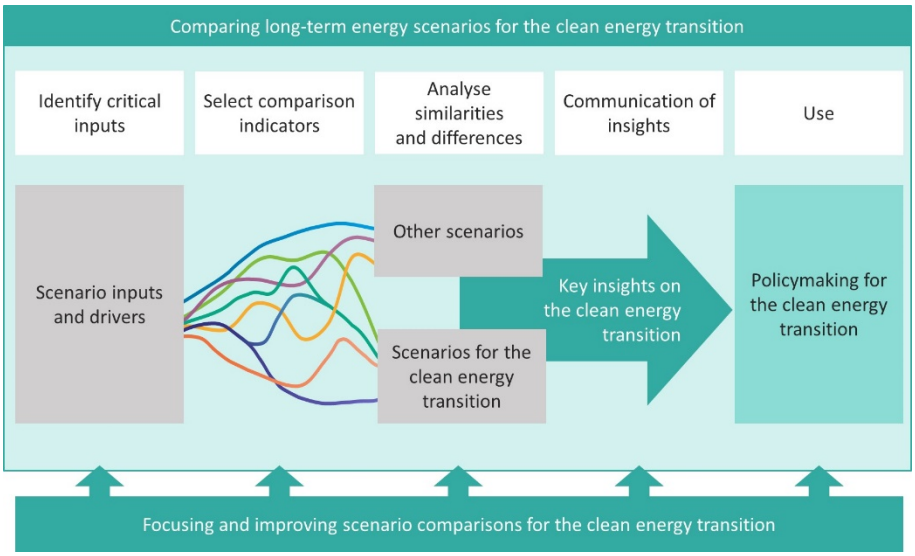


Figure 14. How can scenarios be used to build consensus? This figure from the forthcoming IRENA - JRC workshop synthesis report shows how key energy transition features can emerge from scenario comparison analysis.

Scene-setting questions from the audience

- *Is there any scale-up disruptive technology for low carbon cooling systems in buildings?* Reversible heat pumps will have an important role to play for cooling systems.

Lightning presentations

Bjarke Christian Nepper-Rasmussen started his presentation by explaining how the Danish Energy Agency undertakes the development of long-term energy scenarios. To produce LTES, the Agency collaborates with other government agencies in partner countries, especially on data gathering and energy modelling. This process (see Figure 15), for which its main objective is to eventually inform

policy decisions, is designed to be transparent and to bring consensus among stakeholders. The main transition features that have been identified by the Danish Energy Agency have then been exposed, namely: efficiency, renewable energies, electrification, and flexibility.

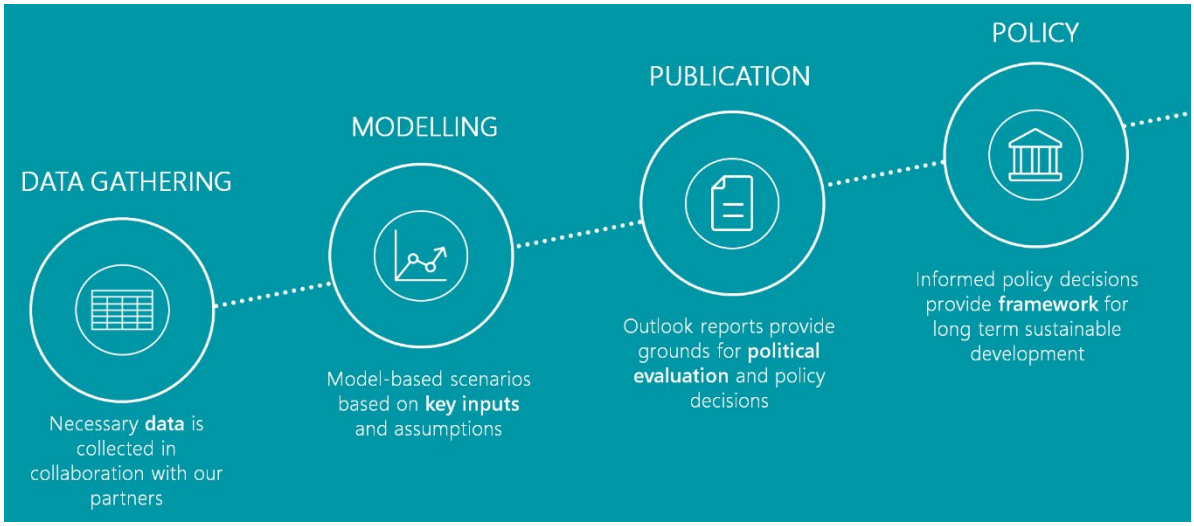


Figure 15. The overall scenario development process of the Danish Energy Agency

Claire Nicolas presented the approach that is currently being developed at the World Bank for non-regret investment strategies. The work is a multi-level approach as it includes three different levels of study: the multisectoral long-term level, the sectoral level and the project level. At the multisectoral long-term level, the World Bank has developed a tool called CCDR (Country Climate and Development Report) which aims at understanding how country's development goals can be met in the context of climate change mitigation. It uses global scenarios and is designed to bring a long-term vision to all sectors and across countries. At the sectoral level, the institution is building scenarios together with countries, to discuss the required national investments for the transition and assess the robustness of the current investments (see an example Figure 16). The main objective is to inform the country dialogue and identify non-regret investments, while assessing the costs of decarbonisation and understanding how it can impact the economy at sectoral level.

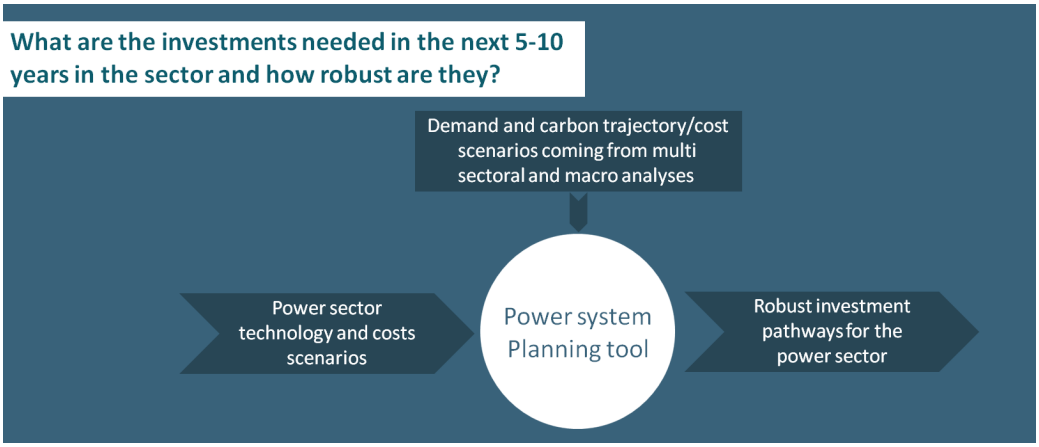


Figure 16. World Bank's sectoral analyses: power sector example. This analysis aims at understanding how the economy wide decarbonization ambition will impact the power sector as well as at identifying non-regret investment, assessing the cost and job impact of power sector decarbonization and at identifying policies to support power sector decarbonization.

Henri Waisman shared the main lessons that have been learned with the IDDRI DPP Initiative (Deep Decarbonization Pathways Initiative). The initiative, which is driven by countries in collaboration with international institutions, aims at helping countries understand how they can transform consistently with global carbon neutrality and national socio-economic and development priorities (Figure 17). The purpose of scenario analysis is less to build consensus than to inform choices that need to be made by countries, explore alternative decarbonisation pathways and reveal the impact of short-term choices. From their analysis, no specific energy technology has emerged as the silver bullet for the transition as it depends on country's specificities and priorities and should be considered with regards to national socio-economic features. Henri Waisman finally presented the areas of improvements for scenario development tools: a stronger focus on the detailed narratives that have to be understandable by all stakeholders, the integration of key socio-economic priorities in the country context, and a better articulation and consistency between national and global dimensions.

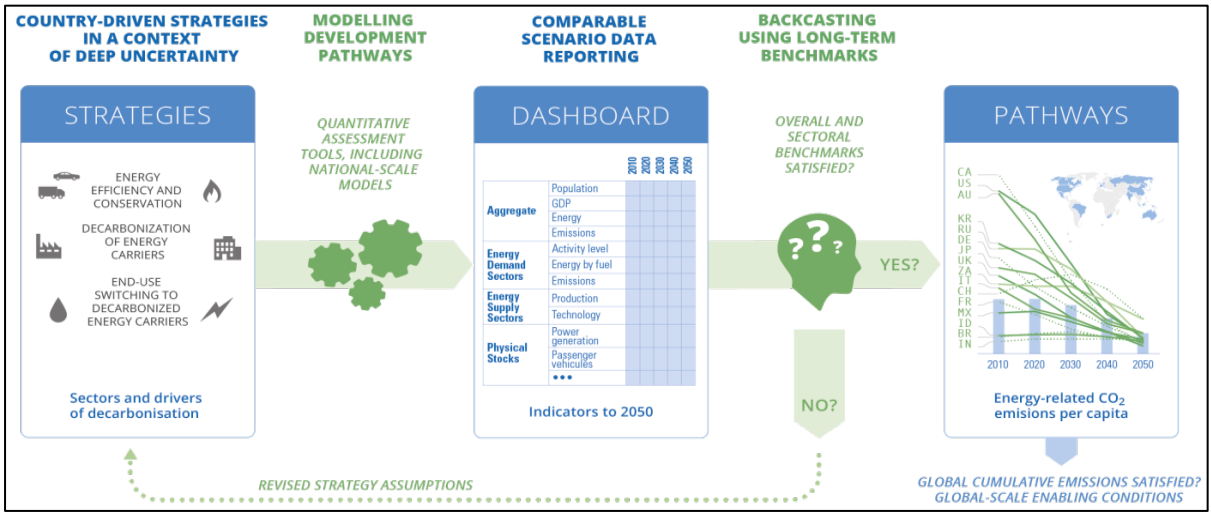


Figure 17. DDP pathways design framework[2]

Panel discussion with the moderator

How can scenarios be used to build consensus on some winning technologies?

- **Bjarke Christian Nepper-Rasmussen** answered that the assumptions can be the starting point for consensus building. As a critical part of the scenario development process, the choice of the assumptions on which the models will rely can be done in collaboration and discussion with various stakeholders, including policymakers and the industry. However, in anticipatory scenarios, the main objective is to go beyond current pathways and explore divergent directions.

[2] *Waisman et al (2019) « A pathways design framework for national low greenhouse gas emission development strategies » Nature Climate Change 9.4 (2019): 261-268*

- **Claire Nicolas** declared that the World Bank's objective is not to build consensus around one specific scenario or future, but rather to build consensus about non-regret investment strategies that have to be made in the short-term depending on various futures.
- **Henri Waisman** added that to ensure that scenarios are used to seek a consensus on the relevant decisions to be made, the involvement of policymakers in the building process is critical. Otherwise, there is a risk of missing some important aspects in the scenario or making assumptions that are seen as irrelevant by the country.

How can scenarios developers avoid the self-reinforcement biases when benchmarking scenarios?

- **Wouter Nijs** introduced the question by stating that it is a key danger when looking only at similarities. Benchmarking should not be used to tweak scenarios output.
- **Henri Waisman** confirmed that there is a tendency to refer always to the same reference. To avoid this risk and ensure scenarios are used not to seek a consensus on a vision but rather a consensus on relevant decisions, the involvement of decisions makers in the scenario development process is crucial.

What are the critical energy technologies that must be accounted for in LTES?

- **Bjarke Christian Nepper-Rasmussen** stated that energy efficiency and renewable energies can be considered as winner or non-regret technologies.
- **Claire Nicolas** answered by highlighting the importance of renewable energies and storage technologies in the power sector.
- **Henri Waisman** explained that one should not forget that winning technologies are the non-regret technologies for the long term. Indeed, some technologies might be considered as winners in the short-term but then will then become less relevant. He added that most of the technologies that are needed in the future are already there, but specific innovations will also have to be accelerated. He gave the example of CCS which should be in the discussion landscape but which faces many uncertainties.

What are the areas of improvement in the development or communication of net-zero scenarios?

- **Bjarke Christian Nepper-Rasmussen** answered that in order to better communicate and develop scenarios with policy makers, it could be important to include new features such as climate obligations, or socio-economic indicators such as health effects or job creation.
- **Claire Nicolas** added that from the scenario user's point of view, the World Bank would need scenarios that take into account the country's development objectives. That would especially enable to have scenarios that are more relevant for developing and emerging countries. On socio-economic aspects, scenarios could include jobs issues and spatial organization of the country.
- **Henri Waisman** stressed the importance of including socio-economic features in LTES. For instance within the DPP initiative, the starting point before developing the scenario is always to wonder what the key priorities of country are (e.g. jobs, inequalities, poverty, etc.). Understanding how a country can achieve its socio-economic priorities while organizing a net-zero transition around it is the crucial question that should be asked when developing scenarios. This is why it is the backbone on which DPP scenario analysis is structured.

Questions from the audience

How do you select the best modelling tools?

- **Bjarke Christian Nepper-Rasmussen** – It depends on the goal and the focus of the analysis. In practice DEA uses TIMES and LEAP for overall energy sector analysis, while Balmorel is used for power sector analysis. Balmorel is particularly adapted to the power sector as it is flexible enough to integrate flexible renewable energies.
- **Claire Nicolas** – The World Bank is agnostic: it works with the modelling tools that the countries already have. What is important is the scenario building process, not the specific tool.
- **Henri Waisman** – The DPP has three criteria to select the most relevant model: understanding policy priority of the question to address, recognizing the systems characteristics, and evaluate the capacity constraints. For instance, a very complex model with poor data will give weak results, so it is better in that case to choose a simpler model.

How can we reconcile the long-term nature of the decisions to be taken with the short-term of legislative period? Can LTES help with this conflict?

- **Henri Waisman** – In reality, the long-term analysis is not aimed at informing long-term decisions, but rather short-term decisions. Indeed, the requirement for long-term transformation translates into policy actions in the short term. The role of LTES is there to connect the time horizons and reveal what things must or must not happen in the short term if we want the long-term targets to be met.
- **Claire Nicolas (World Bank)** – LTES are also about informing the short term on how much the transition pathways will cost.

In building a model, what guiding criteria do you use in selecting or choosing the boundaries?

- **Wouter Nijs**: The purposes of scenario building include impact analysis of new policies, identification of pathways to a preferable future and decision making under uncertainty. The boundaries of a model used for long term energy scenarios depend on the case analysed. Energy models differ in the degree of including materials, water, different emissions and co-benefits. Many energy system models are created based on the boundaries of historical energy data and are expanded in in different phases. Specific for the EU context, some EU funded projects map models and their boundaries such as:
  - http://www.paris-reinforce.eu/publications/deliverables
  - https://sentinel.energy/outputs/deliverables/
  - https://openentrance.eu/activities/

Session 6: Capturing technological disruptions and behavioural change in long-term energy scenarios

Moderator and scene-setting:

Doug Arent

Executive Director, Strategic Public-Private Partnerships

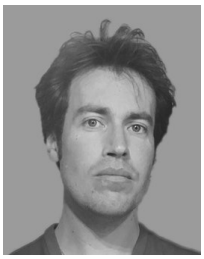
NREL

Panellists:

Charlie Wilson

Researcher

Tyndall Centre for Climate Change Research, UK



Daniel Crow

Energy & Climate modeller

International Energy Agency (IEA)

Elena Verdolini

Professor, University of Brescia

Senior Scientist, RFF-CMCC European Institute on Economics and the Environment, Milan

Scene-setting

The scene-setting presentation by **Doug Arent** started with an overview of the global breadth of the different technologies that are considered by LTES. Many LTES consider the traditional outlines of energy supply technologies, but some other disruptive low-carbon technologies also play an important role in some of them. Doug Arent illustrated this idea with global and national LTES examples, including the Los Angeles 100% Renewable Energy Study recently published by NREL (Figure 18). He then exposed the mains implications of technology change to consider: understanding commercial and near-commercial technologies, characterizing pre-commercial technologies, understanding implications for behaviour, institutional, policy and regulatory change, and addressing unknown unknowns. Among the disruptive technologies that may have a strong impact on the future, he mentioned electrification, multiday demand response, storage, hydrogen, renewable natural gas and power-to-X. Finally, Doug Arent presented the evolving practices that enable to improve the development and use of LTES, namely ensemble approaches, robust decision making, improved characterizations and incorporation into LTES models, as well as transparency on assumptions and methodology.

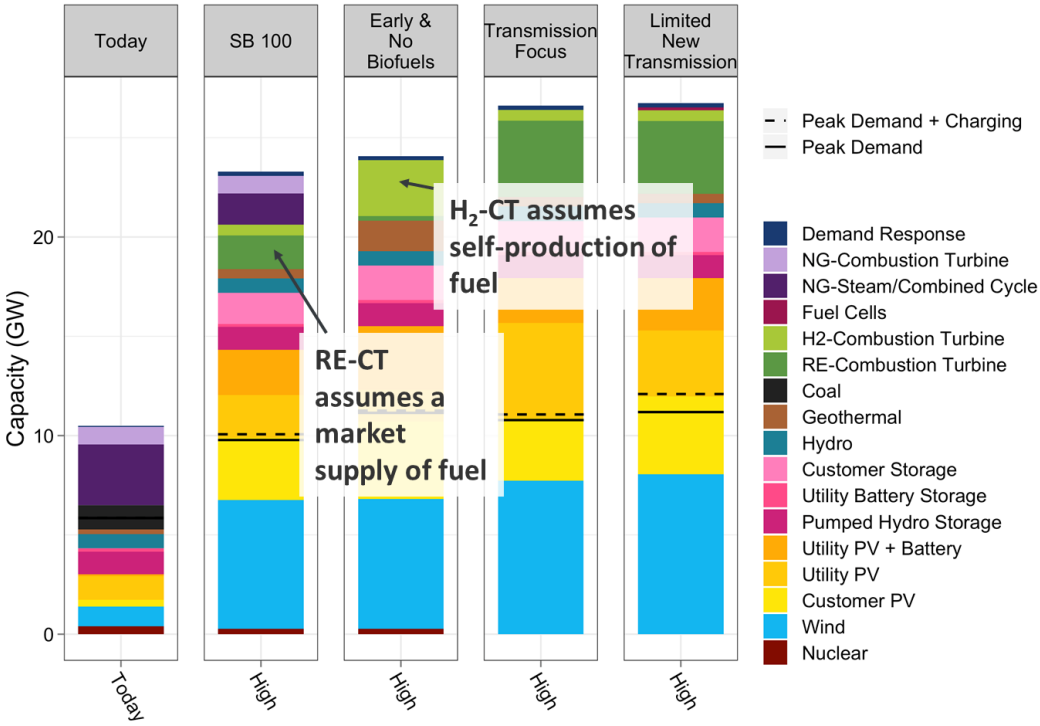


Figure 18. Capacity mix in 2045 in High Load Scenarios compared to 2020 in LA100 study. It shows the significant role of renewable and new low-carbon technologies in the different scenarios compared with today.

Lightning presentations

Charlie Wilson focused his presentation on the behavioural dimension. According to him, there is good evidence of potential contribution of behavioural change in climate change mitigation. He clarified that behavioural change is more than just activity reduction, as it includes all the changes in the ways consumer behave and express their preferences. Then, he presented some insights on how to model the social dynamics that explain behavior change. Tyndall Centre for Climate Change

Research has analyzed different studies that investigated the social influence on electric vehicles choices and the results showed that the adoption rates are different if social behavior is taken into account or not (see Figure 19). Disruptive social dynamics are therefore important for net-zero targets, but they are currently weakly captured in LTES. At the moment, most LTES consider common parameters such as energy demand, prices, and technology availability, while the inclusion of disruptive behavior changes could enable the exploration of new potential pathways. The capability to address these features should thus be improved, especially as those dynamics will be triggered only in a few decades, which is within the long-term horizon for net-zero.

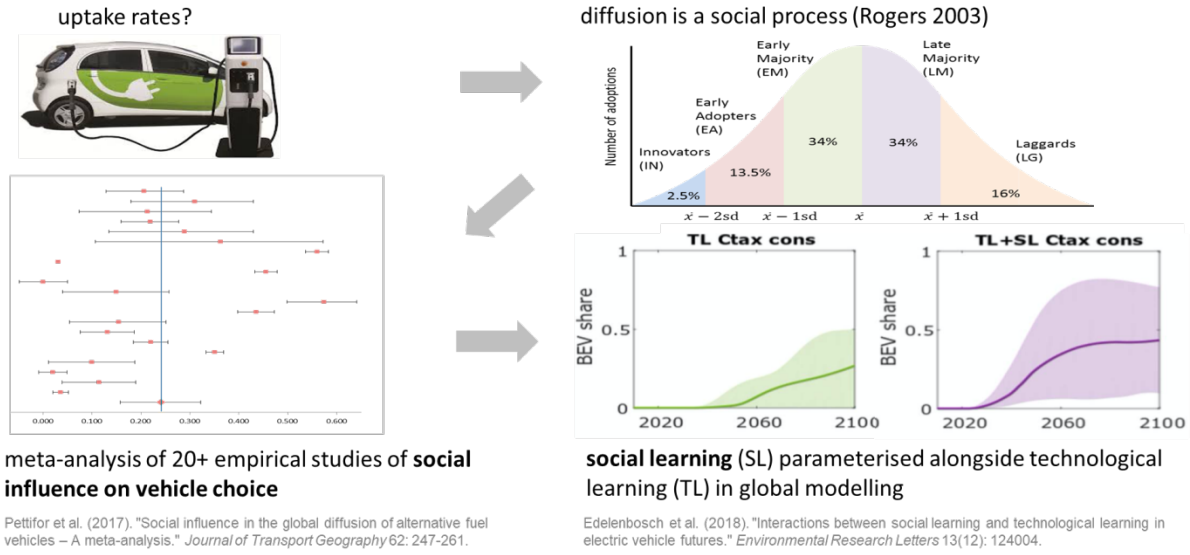


Figure 19. Capturing the social influence on vehicle choice. The meta-analysis conducted by Tyndall Centre for Climate Change Research shows that the adoption rate of electric vehicles is different if social behaviours are taken into account or not in the models.

Daniel Crow presented the key insights with regards to behavioural changes in the IEA Net Zero by 2050 Roadmap that was recently published. According to this report, if the major part of the emissions reduction by 2050 will come from low-carbon technologies with the active involvement of consumers, a remaining part will be attributable to behavioural changes and materials efficiency. The latter will play a role in different sectors such as transport, building and the industry. One of the key questions is to wonder whether it is possible to reach net-zero by 2050 without behavioural changes. Based on a graph representing the share of low-carbon technologies in end uses with and without behavioural changes in 2030 (Figure 20), Daniel Crow showed the significant role of social behaviour in the acceleration of low-carbon technologies. As a conclusion, he stated that behaviour change plays an important role for the quick reduction of emissions.

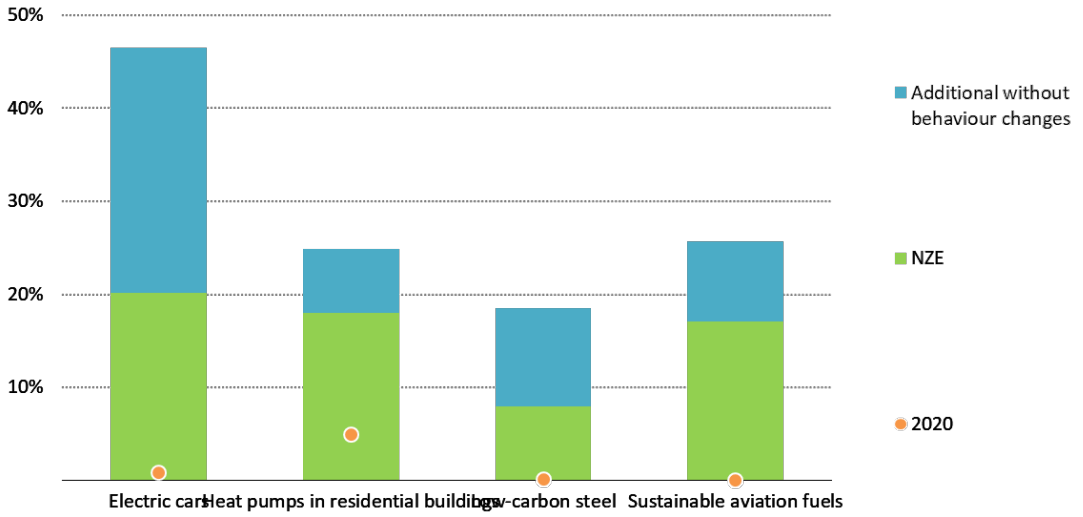


Figure 20. Share of low-carbon technologies and fuels in end uses with and without behavioural changes in 2030 (IEA Net Zero by 2050 Roadmap, 2021).

Elena Verdolini introduced her presentation by stating that innovation is a key driver to reach decarbonisation targets, as it allows getting technologies that are not available yet. Failing to capture innovation dynamics appropriately, including the most disruptive ones, in LTES therefore leads to the development of scenarios that are less useful to guide policy making and investments decisions. She then presents three main aspects of this challenge: the cost dynamics, the technology diffusion dynamics, and technological disruption. Concerning the cost dynamics, she pointed out the difficulties in accounting for uncertainty around future technology costs, which leads to a systematic underestimation of the rate of cost reduction in model-based and expert methods on cost projections. On the technology diffusion perspective, most of the LTES scenarios don't take into account non-technological barriers and enablers that may yet have an impact on the attractiveness of some technologies. Finally, she underlined the poor inclusion of disruptive low-carbon technologies in current models, even the ones that are already available. The statement was illustrated with the example of digitalization (see Figure 21).

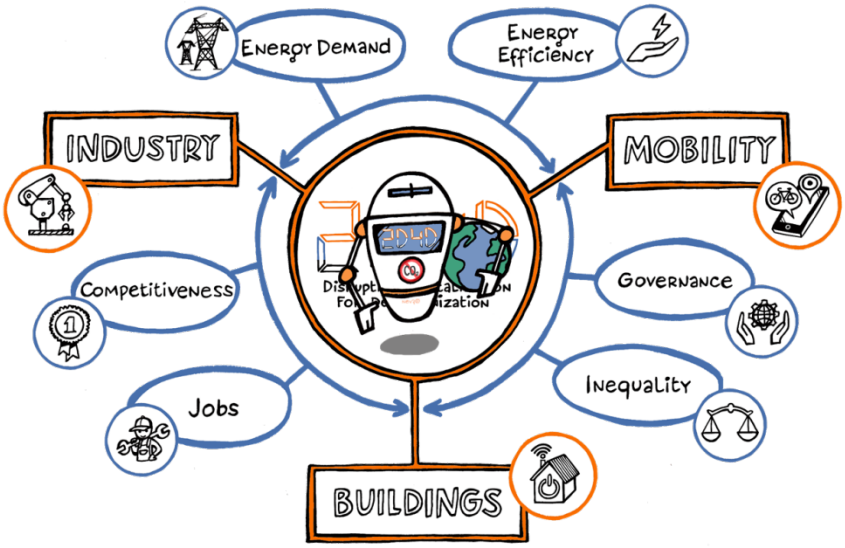


Figure 21. Digitalisation and decarbonisation. The figure shows that digital technologies may have an impact on a variety of sectors and sections of the economy. Because of the complexity of these impacts, it is not known yet if digitalization will be an enabler or a barrier for decarbonisation.

Panel discussion with the moderator

How can digitalization enable behavioural changes?

- **Charlie Wilson** explained first that studies generally give extreme alternative pathways (eg. utopia/dystopia) on the future impact of digitalization on climate outcomes because the uncertainties are so enormous. Then, he stated that digitalization can definitely offer a value proposition for low-carbon behaviour changes, such as switching from owning goods to using digital services, avoiding waste by sharing unused assets, managing energy demand, etc. However the negative impacts of digitalization should also be considered.
- **Daniel Crow** highlighted the complex interplay between digitalization and behavioural change. What IEA called behaviour change in its study is traditional changes that happen on the end-user side.

What is the most important technological innovation or behavioural change that, according to you, is critical for LTES?

- **Charlie Wilson** stated that consumer behaviour and engagement in the energy system should better be accounted in LTES models, such as the use of electric vehicle or energy demand management.
- **Daniel Crow** mentioned the need to integrate social behaviours such as long-haul aviation and diets.
- **Elena Verdolini** answered that the ability to electrify industrial production is be a key component to include in LTES. She added that hydrogen technologies would also have to be clarified, especially in the pros and cons regarding its production and use.

How to account for technological innovation and behavioural change in LTES models?

- **Elena Verdolini** answered that based on the example of digitalization and its weak representation in LTES, some areas of improvements would be: defining a storytelling around the modelling, coupling different models together, and acknowledging that as models are not supposed to give an answer but to help understand the changes that might happen, the importance is not the data but the delta.
- **Daniel Crow** reminded that there are different types of scenarios which require different methodologies (exploratory scenarios and normative scenarios). For instance, while exploratory scenarios should better capture people behaviour changes, it is not the focus of normative scenarios. Then, he explained that to better capture behavioural changes in LTES, exploring sensitivity is key, as well as considering the whole scenario by mixing different types of technologies that are available and their cost evolution.
- **Charlie Wilson** added that incorporating behavioural changes and disruptions in scenarios and models is actually an active research frontier in the academic community. What could help capturing those elements in LTES could be by increasing awareness of policy decision making in the scenario development process.

Final thoughts form the panellists

- **Elena Verdolini** concluded that improving LTES is really important but one should not forget that they have to be implemented in real life by policy makers.
- **Daniel Crow** stated that given the extremely impressive challenge of net-zero targets by 2050, it is highly important that the community keeps a strong focus on the energy demand side, especially in terms of behaviour. The way people will react to policies will be crucial in the next decades.
- **Charlie Wilson** closed the final thoughts by stressing the importance to take into account the role of people in the transition and the necessity to better capture it in models.

Questions from the audience

How do you see digitalization affecting developing economies? How will technology be diffused around the world?

- **Elena Verdolini** – What will greatly mater is the governance around these technologies. The main challenge is that technology governance is often separated from climate governance in countries. Because these two issues interact together, we should address them together. Before the Green Deal, only two countries were taking about climate and digital in the same papers. Concerning developing countries, digitalization brings a great potential to help them face extreme challenges such as the growing population and growing energy demand.

How do we apply cultural context to behavioural change?

- **Daniel Crow** – It is difficult to account for it. The IEA study's results were global, but they were modelled on a regional level. Some regional behavioural changes dimensions were considered to understand how quickly they would come about, and their ultimate potential, based on infrastructure, current activity levels, etc. The IEA also took some cultural dimensions from the World Value survey to better understand people's attitudes concerning the environment, social cohesion, willingness to change. These elements were included in the modelling.
- **Charlie Wilson** – it is possible and important to take cultural variation into account with a very sound empirical basis. There are good standardized measures to account for it, for instance the role of social influence in different countries or lifestyle changes.

Wouldn't industrial behaviour be easier to change and be more effective than trying to rely on personal behaviour change?

- **Charlie Wilson** – To reach net-zero, change is needed in both industrial behaviour and personal behaviour - this is inescapable. Some industrial sectors are hard-to-abate, particularly if electrification is not a viable strategy. However reducing or managing demand for industrial output is a robust mitigation strategy, and this can also involve behaviour change.

Does anyone really believe people in the future will use or demand less energy? For transportation in a global, mobile, and integrated world, I predict more people will travel to more places more often. It has been shown that the more efficient we become in one area means there will be a greater demand in the other areas that will now have time to do.

- **Charlie Wilson** – Yes, energy demand reduction is both possible, desirable, and achievable. Efficiency standards historically (since the 1970s) have demonstrably saved energy. In the UK where I live, energy demand in the buildings sector has gone down year-on-year over past decades due to improvements in building efficiency, heating system efficiency, and behavioural change. The International Energy Agency refer to efficiency and demand reduction as 'the first best resource'. It has very strong co-benefits for health, cost savings, air pollution, warm homes, liveable cities, and so on. Energy efficiency improvements that reduce the effective cost of heating or driving are associated with some 'rebound' as the cost savings are invested in more heating or driving (or other polluting activities). But this rebound only partially offsets the energy savings, and can also be welfare-enhancing (i.e., a good thing overall).

Do we believe that people will recognize the importance of behaviour changes themselves? What if they don't? How can governments or policy makers - on the local, national or international level - help people to recognise their role and act?

- **Charlie Wilson** – Public support for action on climate is stronger now than ever before. Public

awareness of how certain behaviours contributes to climate change is very high in some areas - driving, energy at home, flying - and less high but strengthening in other areas - diet, material consumption. But individual change and systemic change have to go hand-in-hand. Behavioural change legitimises and creates a demand for political and corporate action which in turn further enables behavioural change.

As the world becomes more global, won't cultural differences diminish?

- **Charlie Wilson** – In some areas, possibly - e.g., standardised technologies (e.g., solar panels, electric vehicle batteries) or standardised products (e.g., smartphones). But in other areas, not necessarily - e.g., the role of consumption in constructing social identity.