4th International Forum

Long–term Energy Scenarios for the Clean Energy Transition

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

7-9 December 2022 | Hybrid event

Event Proceedings (Day 1)

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Event summary

The 4th LTES Forum hosted approximately 35 attendees at IRENA Innovation and Technology Center offices in Bonn, Germany, while 359 people participated in the Forum online. The participants represented a diverse array of stakeholders, such as government officials, intergovernmental organisations, development partners and non-profit organizations. The discussions conveyed during the Forum covered various topics including the alignment of long-term energy scenarios (LTES) with climate change strategies, demand-side assessment, hydrogen development strategies, and geopolitical issues, among others.

Through presentations, panel discussions, and attendees' interventions the Forum facilitated the exchange of knowledge and experiences on different aspects of the planning of LTES. An Interactive Workshop conducted on the final day of the Forum enriched the participants' understanding and perspectives on effective stakeholder engagement in the development of long-term energy scenarios (LTES).

Key takeaways

Session 1 - Aligning Long-Term Energy Scenarios (LTES) with Long-Term Low-Emission Development Strategies (LT-LEDS) to strengthen climate action

- **Energy Scenarios play a crucial role in the long-term planning for the energy transition** as they often capture the strategic dimensions of the energy sector while considering the alignment and interplay with other sectors and development strategies.

Session 2 - Demand-side assessments in Long-Term Energy Scenarios

- **A multidisciplinary approach is required to assess demand-side aspects on energy scenarios,** this approach allows the inclusion of quantitative results and narrative pathways in LTES. It is important to consider multiple techno-economic and societal factors to ensure effective long term energy planning.

Session 3 - Long-Term Energy Scenarios as an explorative tool for policymaking

- It is important to **understand the objectives and goals of decision-makers** to distill the right scenarios and concrete messages by technical experts to ensure the efficient use of scenarios in policymaking.
- To properly plan for the future, **LTES tools, techniques, and good practices** should be utilized to ensure a quick and efficient energy transition.

Session 4 - Role of 100% renewable electricity for the energy system transition in scenarios • **Accounting for 100% renewable electricity** in LTES is a challenging but necessary process. It is important to further interrogate key aspects in LTES such as sustainability metrics, measures for cleaning the power system, impacts of supply chains, materials and resources constraints, and societal impacts.
Session 5 - Incorporating global hydrogen insights for national LTES narratives • **Hydrogen is part of the bigger energy transition picture.** Setting the right priorities for hydrogen use will be essential for rapid scale-up and long-term contribution to decarbonization efforts. Scenarios help to assess different options for market development of hydrogen for national strategies.
Session 6 - Key geopolitical considerations in national LTES for planning a clean energy transition • **National long-term scenarios help governments navigate uncertainties globally.** The use of these scenarios is vital in addressing the latest socio-technical challenges and making the most of the opportunities offered by the transition to a low-carbon economy.
Workshop 1 - Participatory processes for developing national long-term energy scenarios • Refer to the section *Workshop 1: Group discussion session on participatory processes*
Workshop 2 - Country and expert cases on stakeholder consultations • **Proper participation and engagement** of the different stakeholder groups is vital in Long Term Energy Planning.

Session summaries

Day 1 - Wednesday December 7th, 2022

Opening and keynote presentations

Asami Miketa (International Renewable Energy Agency), provided some introductory remarks to set the scene for the 4th Long-Term Energy Scenario Forum. Miketa highlighted the unique nature of LTES forum as it allows for discussion on scenarios developed in the context of national energy planning. The forum was organized under the framework of the LTES Network, the global platform that fosters international dialogues and exchange of experiences to improve the development and use of LTES from an institutional and methodological perspectives. It was noted that IRENA's recent World Energy Transition Outlook report shows that the clean energy transition goes beyond technology and encompasses structural changes and, if leveraged, can bring economic and social benefits if governments adopt holistic policy and planning frameworks. Miketa remarked that Long-Term Energy Scenarios play a key role in the development of policy frameworks in compliance with midcentury goals, as such, the LTES network has collected good practices on the development and use of scenarios and mapped the challenges that may arise when developing energy scenarios. Participants were encouraged to take advantage of the Forum by exchanging good practices, discussing different perspectives and, ultimately, contribute to a sustainable future for all.

Christian Stenberg (Ministry of Climate, Energy and Utilities, Denmark). Provided some opening remarks. Stenberg acknowledged the complexity and challenges of predicting the future, a task which scenario developers are being asked to carry out by governments. This process requires careful consideration of many variables and uncertainties. However, as demonstrated by recent events such as the Covid-19 pandemic, swift execution and decision-making are critical to ensure an effective response. Stenberg emphasized the importance of collaboration among practitioners in achieving this. He recognized that the Long-Term Energy Scenarios (LTES) Network offers an opportunity for countries to collaborate and learn from each other. Furthermore, the LTES Forum serves as an excellent platform for discussing, sharing knowledge, and enhancing best practices in energy scenario development.

Highlighting the significance of energy scenarios, Stenberg stated that they are essential for providing data that enables policymakers to make urgent decisions. They also contribute to

emission reduction efforts in alignment with the Paris Agreement and help establish a stable, transparent investment framework, thus reducing the risk premium for the private sector. Stenberg closed his intervention by acknowledging Denmark's long-standing experience in scenario development. He noted that input from civil society experts over several decades has greatly contributed to the growth of Denmark's renewable energy sector.

Jan Weidner (Federal Ministry for Economic Affairs and Climate Action Germany), Provided opening remarks to the Forum. Weidner acknowledged Germany's appreciation for the work done by IRENA (International Renewable Energy Agency) on long-term energy scenarios and the transition to clean energy. He expressed Germany's readiness to support the LTES Campaign, jointly with Denmark. The German government firmly believes that a flexible, clean energy system is instrumental for stimulating the economy and enhancing economic competitiveness.

Weidner noted Germany's ambitious plan to double its renewable energy consumption to 80 percent by 2030. Considering this, he underscored the importance of energy scenarios in expediting the transformation of the energy supply system. The key components of Germany's policy framework include an energy concept document published in 2010, the Climate Change Act aimed at achieving climate neutrality by 2045, and the use of energy scenarios to evaluate policy effectiveness. He further highlighted the role of the LTES Forum as a platform for discussing the applications and challenges related to the use of long-term energy scenarios.

Melisande Liu (Clean Energy Ministerial). Finalized the segment of opening remarks by thanking IRENA for taking the lead in the energy scenarios and modelling work. She noted that the Forum is empowering for least developed and developing nations and enables them to access information on long-term energy scenarios. It was noted that the development and use of long-term energy scenarios is one of the key challenges of the energy transition and is one of the strongest Clean Energy Ministerial (CEM) workstreams. Since 2021 the CEM has been working with 29 members to strengthen their LTES commitments, and the current forum will be relevant to furthering the ongoing work.

IRENA presentation on LTES Network

Juan José Garcia (International Renewable Energy Agency). Delivered the initial presentation of the Forum to introduce the LTES Network to the attendees. Garcia emphasized that the LTES Network aims to support the wider and more effective use of long-term energy scenarios for policymaking in the energy and climate sectors. He also noted that IRENA has been coordinating the LTES Network since 2018, and currently it is composed of 26 country members and 12 technical partners.

He introduced the LTES Network mental model on Long-Term Energy Scenarios to explain the framework within which discussions and knowledge exchange occur in the LTES Network. He explained the interaction between energy modeling tools, stakeholder participation, long-term energy scenarios, and energy policy instruments, emphasizing the strategic value of each in the decision-making process and how knowledge exchange is structured within this mental model.

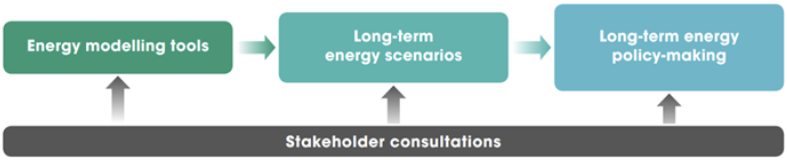


Figure 1: The mental model of the LTES

Garcia highlighted that numerous international forums, events, and workshops have been held to facilitate this exchange of knowledge and practices, and IRENA's role is to gather, synthesize, and make this information available to countries, the LTES flagship publications can be found on the IRENA website.

Garcia shared some key findings of the LTES Network. Firstly, governments see energy scenarios as a fundamental tool for policymaking, useful for exploring net-zero pathways and building consensus among stakeholders. Secondly, governments use energy scenarios to evaluate the impact of international agreements and technological innovations on their economy. Thirdly, scenarios aid in coordinating the efforts of energy and environment ministries and strengthening governance structures. Participatory processes enhance the relevance of scenarios and aid in their development while fostering trust. Finally, he noted that outsourcing the scenario-building process can enhance government capacity while concurrently building in-house expertise.

Session 1: Aligning Long-Term Energy Scenarios (LTES) with Long-Term Low-Emission Development Strategies (LT-LEDS) to strengthen climate action

Simon Benmarraze (International Renewable Energy Agency)— Benmarraze introduced the session, emphasizing the need for more ambitious country scenarios. Given the robust guidance for the development of LT-LEDS, he stressed that LTES stakeholders should be closely involved in their formulation. The session's objective was to encourage participants to discuss the importance of coordination between LTES and LT-LEDS and to highlight the added value of scenario-driven analysis in LT-LEDS development. He further pointed out that the discussion would concentrate on the necessity of proper stakeholder engagement during the scenario development process. The specific guiding questions for this session included:

- *What efforts are being made to align LTES with global net-zero targets? What are the main challenges to doing so? (e.g., alignment with the 2050 horizon, the inclusion of negative emission technologies, etc.)*
- *What is the benefit of using scenario-based LT-LEDS?*
- *What levels of coordination are required to efficiently link LTES with LT-LEDS?*
- *How can the use of LTES facilitate inter-ministerial coordination for developing LT-LEDS?*
- *What are the key challenges for integrating the use of LTES in the development of LT-LEDS, in terms of governance, institutional arrangements, and scenario development and coverage?*

LT-LEDS synthesis report

Kenichi Kitamura (UNFCCC)— Noted that sixty percent of LT-LEDS described multiple pathways and interdependence between sectors such as electricity generation and end-use sectors. In addition to sectoral-level projections and scenarios, more than 30% LT-LEDS have ambitious objectives relating to 100% clean energy. Institutional arrangements are critical to support efficient planning. It is important to ensure high-level government planning involves prime ministers and inter-ministerial bodies with coordination functions to develop and implement LT-LEDS.

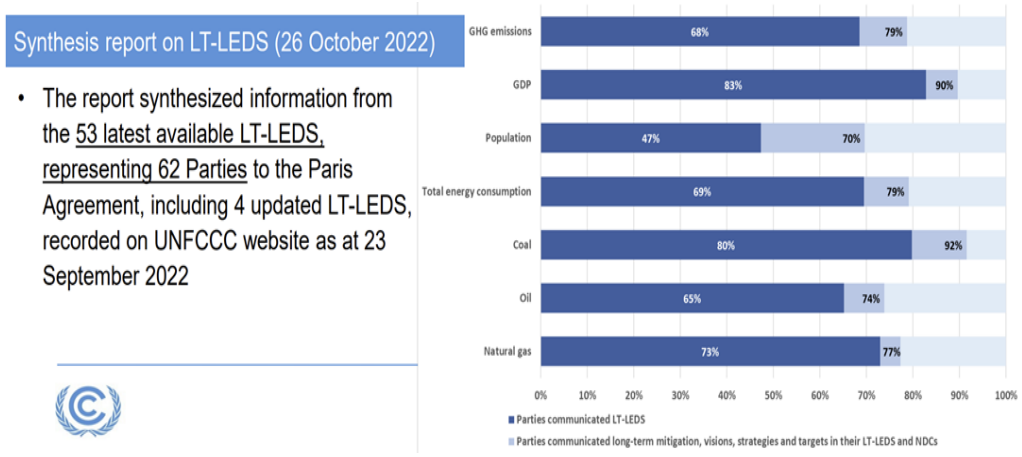


Figure 2: Long Term- Low Emissions Development Strategies (LT- LEDS) Synthesis Report Data

What efforts are being made to align LTES with global net-zero targets and use of scenarios?

Ploypailin Sundarajumpaka (NDC Partnership)— The NDC Partnership is a coalition of more than 200 countries and development partners that supports developing countries in climate action and sustainable development. Ploy noted that many more countries need support to develop and submit their LT-LEDs. In this light, the NDC Partnership has launched the Thematic Call on LT-LEDS and NDC Alignment, Update, and Enhancement. This targeted and cross-cutting support is available to NDC Partnership members on a rolling basis and on multiple opportunities until the third quarter of 2023. More information about the Thematic Call can be found here: https://ndcpartnership.org/lt-leds-and-ndc-alignment-update-and-enhancement.

LTES and LT-LEDS alignment report

Nadeem Goussous (International Renewable Energy Agency)— Noted that the objective of the report was to develop a comparative analysis of the institutional and governance process which contributes to the development LTES and LT-LEDS. In developing the report, IRENA looked at sixty scenario-based documents to complement the UNFCCC synthesis report.

During the research process, the LTES Team carried out country surveys, utilizing a method that combined extensive desk research with country validation. The findings were structured into three main sections in the report. The first part discusses the institutional results, revealing that the majority of LTES were developed by energy ministries while LT-LEDS were mostly developed by environmental ministries or integrated ministries. The second part of the report delves into the technical aspects, highlighting the different types of technology and

renewable energy sources incorporated in the scenarios. Lastly, an analysis of countries with both LTES and LT-LEDS showed that these countries are modeling the advantages of the energy transition, with special focus on economic and health impacts. The report concludes that there is a clear necessity for improved communication and coordination among key stakeholders.

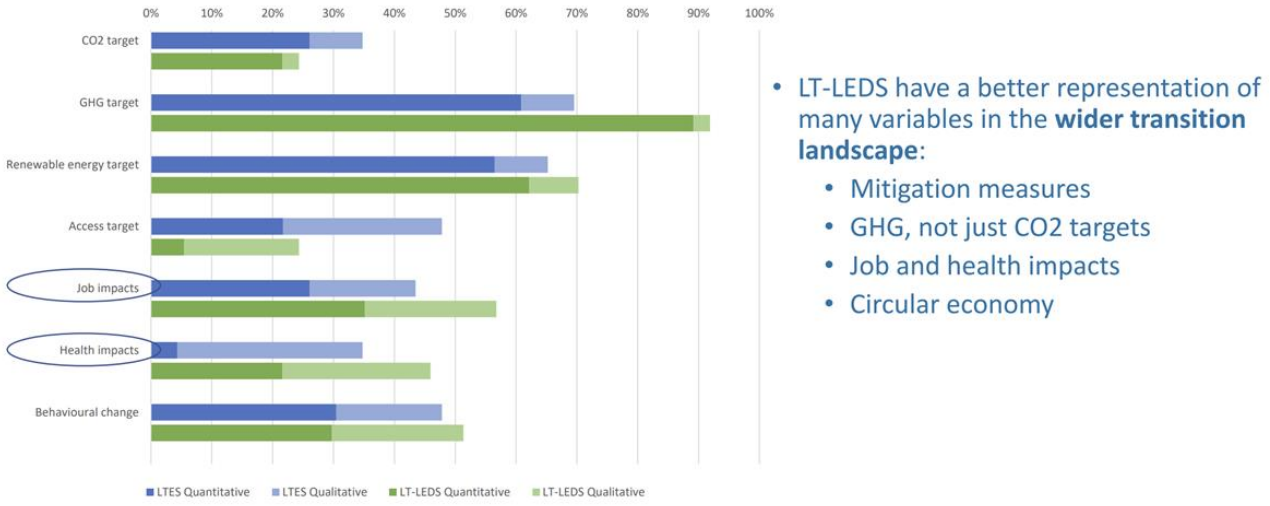


Figure 3: Illustration of what LTES can learn from LT-LEDS

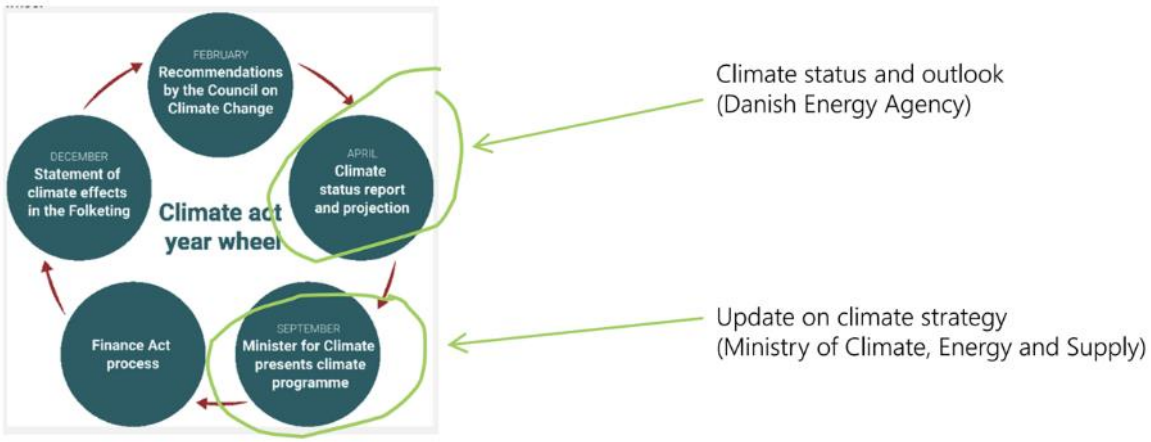
Henri Waisman (Institute for Sustainable Development and International Relations)— Noted that it is important to make the connection between scenarios in LTES and LT-LEDS documents. It was noted that the LTES and LT-LEDS alignment report illustrated the role of LTES in capturing multiple dimensions of long-term energy planning. LT-LEDS seek to answer the climate question while concurrently providing feedback to the LTES development and implementation process. The main aim of this discussion is to ensure alignment and highlight the interplay between LT-LEDS and LTES and not to merge the two processes.

Country example

Malene Hovgaard Vested (Danish Energy Agency)— Hovgaard highlighted that in 2020, Denmark passed a new Climate Act which includes a target to reduce emissions by 70% in 2030 compared to the 1990 levels. The Climate Act requires the government to follow the climate year wheel in climate and energy policy development. Every April, the Danish Energy Agency publishes a Climate Status and Outlook for 2035. Every September, the Minister for Climate and Energy Supply presents a Climate Program, which is an update on the climate strategy to the parliament for approval. Every February, the Climate Strategy is evaluated by the Climate Council, which consists of 8 climate experts.

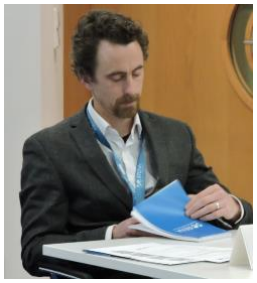
Again, in April, a new energy scenario is published to ensure continuity in updating climate strategies and scenarios.

Figure 4: Danish Climate Wheel



What uncertainties exist and how do you deal with them?

Malene Hovgaard Vested— Noted that there is uncertainty in two categories. First is the uncertainty in the method of emission projection specifically in determining the data and emission factors. The second category is uncertainty about future development.



Paul Deane— Pointed out that it is not possible to predict the future, but it is possible to forecast to prepare for the future. He conveyed the importance of the tools, techniques, and good practices presented during the session, stating that they enable practitioners to take a proactive rather than a reactive approach towards the future. Deane highlighted that models and scenarios serve as valuable blueprints for the future. He further stressed the importance of de-risking the future, explaining that it aids policymakers in better understanding what lies ahead. In line with this, Deane underlined the necessity of conducting annual reviews and updates to ensure effective modelling and policymaking.

Malene Hovgaard Vested was asked how many people work on the Danish Climate Outlook. She noted that there are 80 people in the Center for System Analysis in the Danish Energy Agency, but only 20 people are engaged full-time in creating the annual Climate Outlook.

Paul Deane— Noted that in Ireland, only a small number of people are involved full-time in working on the climate outlook. As such it is important for governments to build capacity and provide adequate funding.

Intervention from the audience

How does the Danish Energy Agency assess the efficacy of their energy efficiency measures? Do they take into account the energy demand from all sectors?

- **Malene Hovgaard Vested**— Noted that energy efficiency is only related to direct energy use, meeting efficiency targets would require a change in a specific sector, then this is assigned to the sector in national energy planning.
- **Miriam Bueno Lorenzo** — Noted that in Spain's case, it is vital that the whole system is reviewed to ensure all the impacts are accounted for and better long-term energy planning occurs.
- **Brad Little** — Noted that the mandate of the Danish Energy Agency is very broad, and it seems they moved from producing LT-LEDS to LTES and asked for clarification if that was the case. Further, he asked where the Danish end-use sector planning falls.
- **Malene Hovgaard Vested** — Noted that the transport sector is located under the ministry of transport, while the CO_2 emission path planning is in the energy ministry. The ministry of energy plays that role as it has a strong track record of modelling and publishing an updated energy outlook every year.
- **Asami Miketa** — Asked if there are any challenges in communicating energy planning results to government officials.
- **Malene Hovgaard Vested** — Noted that sometimes the ministry of climate disputes the statistics published by the Danish Energy Agency (DEA), however, the DEA has the freedom to conduct their research and publish their findings. It was noted that the models published are complex, which further helps with ensuring the DEA's independence in computation and modelling. The data is published every year and shared with all other agencies to give their input and after this a model is developed.
- **Henri Waissman** — Noted that it is important to promote proper model development by involving both climate and energy experts and development experts, especially in developing countries. While governments may be tempted to use external experts, in the long run, it is more sustainable to develop in-house capacity.

Given that government institutions in some cases are very weak, is capacity building enough or is it imperative to pay solid wages and retain talent? How can governments establish continuity in this context?

- **Ploypailin Sundarajumpaka** — Noted that it is vital to deploy in-country advisors to support the government in coordinating the implementation of long-term energy plans and build in-house capacity. Another approach to building capacity is to embed expert advisors in the ministries of the economy to ensure that economic policies include a climate lens thereby supporting inter-ministerial coordination.

- **Henri Waissman** — Noted that it is important to establish government capacity. Further, there ought to be more funding directed at supporting the development of LTES and LT-LEDS. Support should also be directed to the scenario development stakeholders including academia, think tanks and NGOs to build their capacity.

Session 2: Demand-side assessments in Long-Term Energy Scenarios

Derck Koolen (European Commission Joint Research Centre)— Introduced the session, noting the importance of developing and comparing scenarios as part of the Centre's work. He elaborated that they create multiple scenarios which contribute to discussions at the European level, covering topics such as demand-side issues, technological innovation, and electric vehicles.

Scene Setting Presentation 1

Nicole van den Berg (Utrecht University)— Presented on her research work which uses the intent-oriented versus impact-oriented mental framework to analyze behaviour and lifestyle changes. The research is of an interdisciplinary nature and uses different perspectives to guide the scenario development process.

The first step in scenario development involves developing scenario narrative building blocks based on criteria and gaps in modelling. The second stage is to use the building blocks to create divergence frameworks and define inputs for quantification. The third step is to refine the narrative and translate it to quantitative assumptions. The final stage involves modelling long-term emission scenarios.

There are 2 extreme types of change that scenarios can result in, the first is the top-down, exogenous, externally driven outcome which is often compared to the bottom-up, endogenous and internally driven outcome. Scenarios may be focused on individual-level change versus societal change. It emerged that there should be different scenarios for the global north and global south. In conclusion, it emerged that a transdisciplinary approach to creating scenarios results in both quantitative results and narrative pathways, which are important in accounting for multiple dimensions and societal changes.

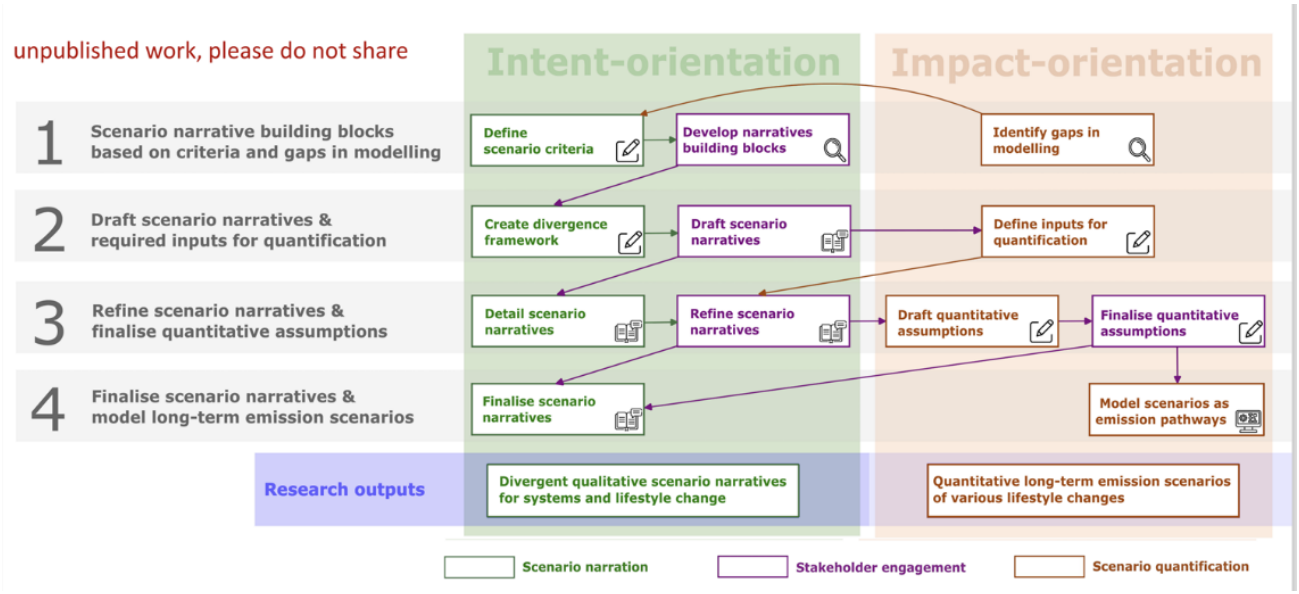


Figure 5: Developing Sustainable Lifestyles In Models (SLIM) scenarios using the Intent-orientation and Impact-orientation approaches.

Given that there are a number of lifestyle scenarios, what is the uncertainty around these perspectives?

Nicole van den Berg — Responded that there is a lot of uncertainty when it comes to lifestyle changes, to address this, modelers consider how to model cost in relation to lifestyle changes. The approach taken was to engage with experts in the relevant fields and be explicit that they are creating "what if" scenarios based on assumptions. The more diverse the scenarios and the more extreme the scope/results are, the more likely they are to capture aspects of the future.

How did the modelers build consensus when developing scenarios?

Nicole van den Berg — Noted that given the length of the co-creation process it is easy to reach a consensus over assumptions and scenarios over time.

How much can you realistically expect people to change their behaviour to climate-conscious behaviour?

Nicole van den Berg — Responded that people reject behaviour change because they see that their freedom is being taken away, but scenarios are supposed help change perception by showing gains from behaviour change.

How does one account for equity concerns?

Nicole van den Berg — Responded that to account for equity, different income groups were included in the residential model. The plan is to incorporate a more equitable approach in their models in the future.

Given that lifestyle is related to place and culture and how to we model the latter?

Nicole van den Berg —The data is too aggregated for local analysis, but it is possible to exogenously model culture and eating habits and travel patterns in scenarios.

Panel discussion with the moderator

Kaare Sandholt (Energy Research Institute of the Academy of Macroeconomic Research)— Noted that it is important to have a very detailed model for the supply side and the end-use sectors. This includes modelling the shift from coal to electricity in the energy sector and oil to electricity in the transport sector. Some sectors are in theory, quite easy to model for instance in the transport sector it is easy to know the stock of cars and how much each car emits.

How does one model political change?

Thomas Krutzler (Environment Agency Austria)—Austria has a detailed energy balance and a statistics institute which publishes an enormous amount of data. Given the availability of a lot of historical data, it is easier to make generally accurate and credible assumptions.

Kaare Sandholt (Energy Research Institute of the Academy of Macroeconomic Research)— Noted that while it is difficult to predict the future, collecting data, making clear assumptions, and checking them against expert opinions improves the process of scenario development.

Intervention from the audience

Given that China is one of the countries with dramatic increases in energy demand. What is your method for forecasting demand?

- **Kaare Sandholt** — Noted that the most rapid growth witnessed in China was recorded 10 years ago, this is used in forecasting.
- **George Partasides** — How do you combine the increase in demand with the grid expansion and general infrastructure expansion projections?
- **Kaare Sandholt** — Responded that they use an optimization model, which is limited because China does not really have functioning energy markets.
- **Thomas Krutzler**— Noted that one has to model possible technological change first and then behavioural change to establish a more accurate model.

- **Ardian Islami**— Given that Albania faces discrepancies in data, what approach would be recommended in such cases?
- **Thomas Krutzler**— Responded that some European training programs would be helpful in the case of Albania. Cooperation between the European Union and other states can help build the capacity for data gathering.
- **Víctor Bazán—** Noted that the models in Costa Rica incorporate planned development, including electric vehicles.

Scene Setting Presentation 2

James Glynn (Columbia University)— Made a presentation titled 'Demand-side assessments in Long-Term Energy Scenarios'. Glynn noted that there is a need to significantly decouple energy demand from economic growth. He pointed out the relevance of this session as currently partitioners do not pay enough attention to demand when modelling.

Highlighting the general correlation between wealth, prosperity, and energy consumption, Glynn stated that GDP per capita is often linked to per-person electricity consumption. However, he pointed out exceptions like Ireland, which boasts a high GDP per capita but low electricity consumption.

He emphasized the importance of using insights from different countries and energy systems, recommending a closer look at the International Energy Agency (IEA) database to ensure more accurate modeling.

In conclusion, Glynn explained that Columbia University extends its analysis beyond simple regression, studying historical trends per sector and incorporating climate modeling.

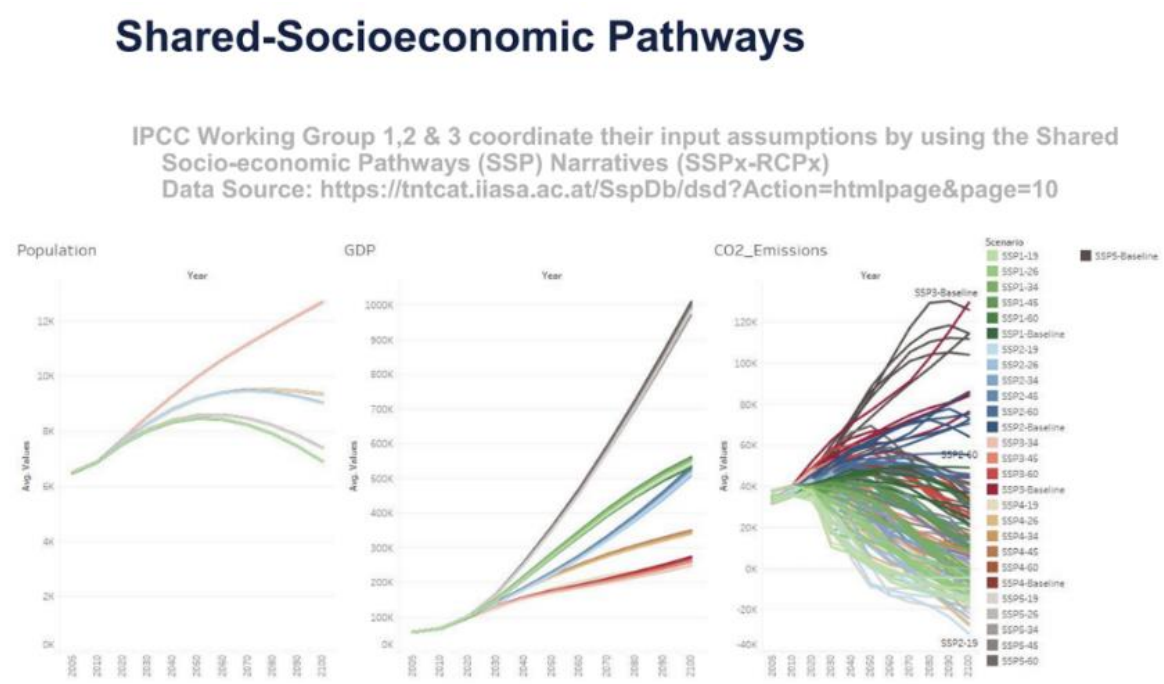


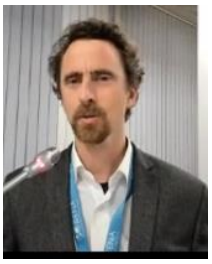
Figure 6: Shared Socio-Economic Pathways

Intervention from the audience

Do you model critical mineral demand?

- **James Glynn** — Noted that they lack the data to do the models given that the focus is to change the oil system to a critical mineral system. Most models don't endogenize the need for 400 times the current consumption of lithium for the number of batteries needed in a greener economy.
- **Asami Miketa** — Given that assessing energy consumption is different from assessing the distribution of demand across the year. How should LTES practitioners go about modelling peak demand and modelling the fact that demand is becoming more flexible?
- **James Glynn** — Noted that there is emerging literature on flexible load curves. Additionally, there are increasingly smart and integrated markets on the demand side. To ensure more accurate demand-side modelling the TIMES model is increasing its capacity to model flexible loads.
- **Derck Koolen—** Concluded the session by noting the need for a multidisciplinary approach to modelling demand. It was noted that it can be challenging to bring rational models to bear on irrational behaviour from people. The session resulted in a good discussion regarding new technology driving change forward.

Session 3 - Long-Term Energy Scenarios as an explorative tool for policymaking



Moderator- Paul Deane (University College Cork)

Country Presentations

Adonay Urrutia (National Council of Energy, El Salvador)— Noted that El Salvador's goal is to achieve climate neutrality by 2050. To this end, there is a 4-stage long-term energy planning process in use. Stage 1 involves the identification of the most critical factors. Stage 2 involves defining inputs to scenarios, stage 3 requires the quantification of inputs in scenarios by clustering and prioritizing them and finally, stage 4 is the determination of energy scenarios and economic, social, and environmental regulations in the future.

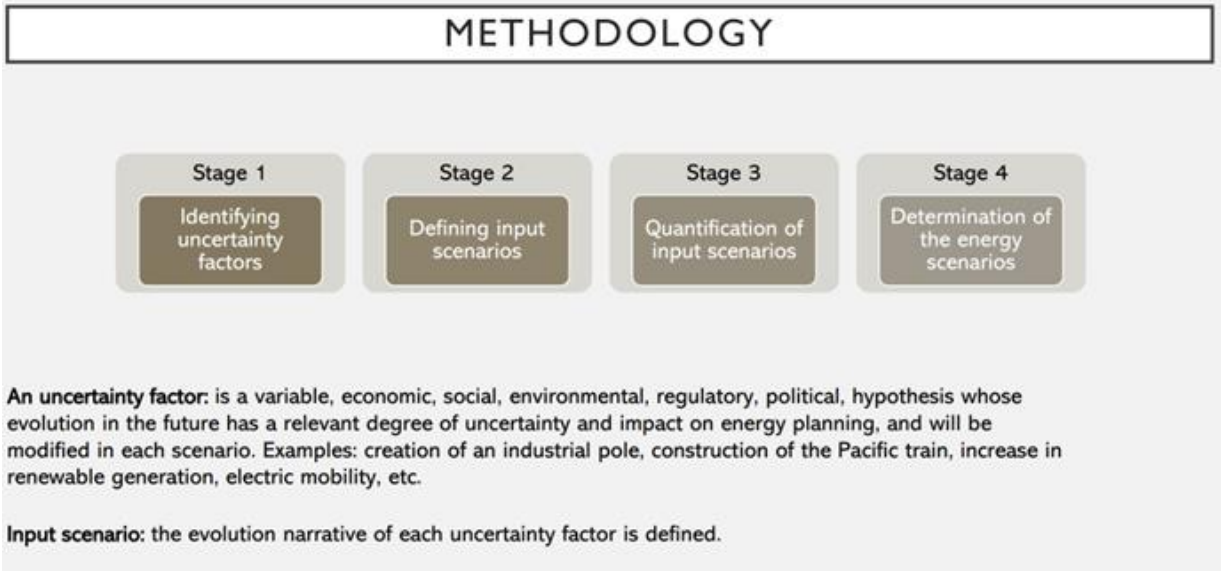


Figure 7: Energy Planning Methodology

Thiago Barral (Energy Research Office, Brazil)— Noted that scenarios are crucial in providing information for the customization of national energy strategies and in understanding how each region can better integrate global value chains. The Energy Research Office (EPE) of Brazil has developed two main plans based on energy scenarios. First, The National Energy Plan 2050, which has a 30-year timeframe and is updated every 5 years and second, the 2030 10-Year National Energy Expansion Plan, which is updated annually. For the 10-year plan, there is one reference scenario and 2 additional scenarios that represent a lower and upper economic and energy demand growth pathway. Based on the reference scenario, EPE develops a what-if sensitivity analysis about scenarios they wish to explore. Some of the questions asked are 'What if there is no rainfall in one year?' or 'What if the cost of Solar PV rises?', this allows them to explore variables. The 30-year plan is based on 2 scenarios, the first is a growth challenge scenario, and the second is a stagnation scenario in addition to sensitivity analysis. In the case of the power generation mix, 60 different sensitivities were explored.

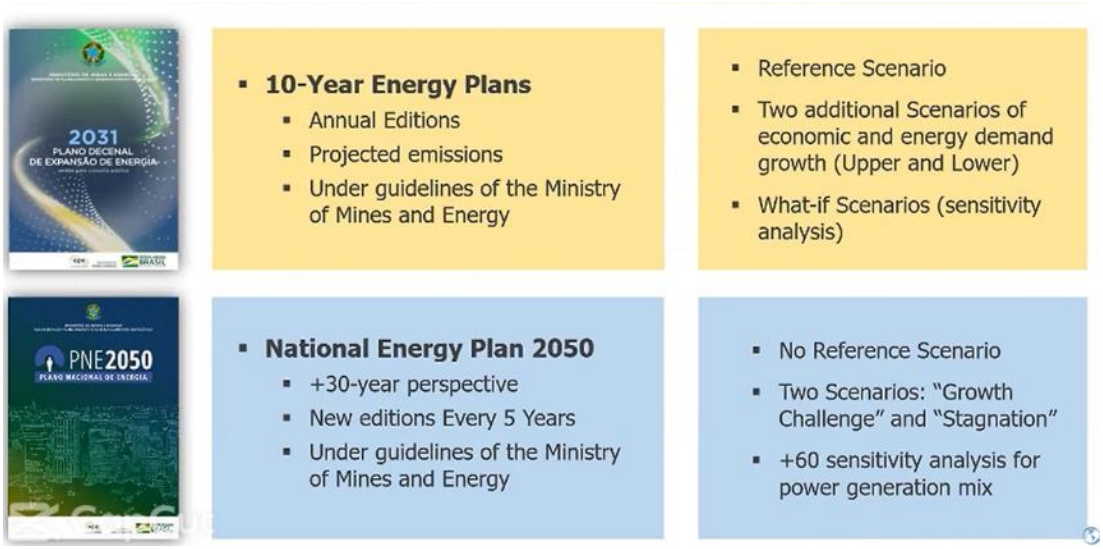


Figure 8: Long-Term Energy Scenarios Developed by the Energy Research Office, Brazil

Bradley Little (Natural Resources Canada)— highlighted that multiple authorities are dedicated to energy management in Canada, including Natural Resources Canada, Statistics Canada, the Canada Energy Regulator, and Environment and Climate Change Canada. Canada has committed to roughly seven new climate policies. He noted that, before 2015, institutional capacity was merely adequate for fulfilling reporting requirements. However, these institutions have since expanded their capabilities to explore potential routes for achieving net zero emissions by 2050.

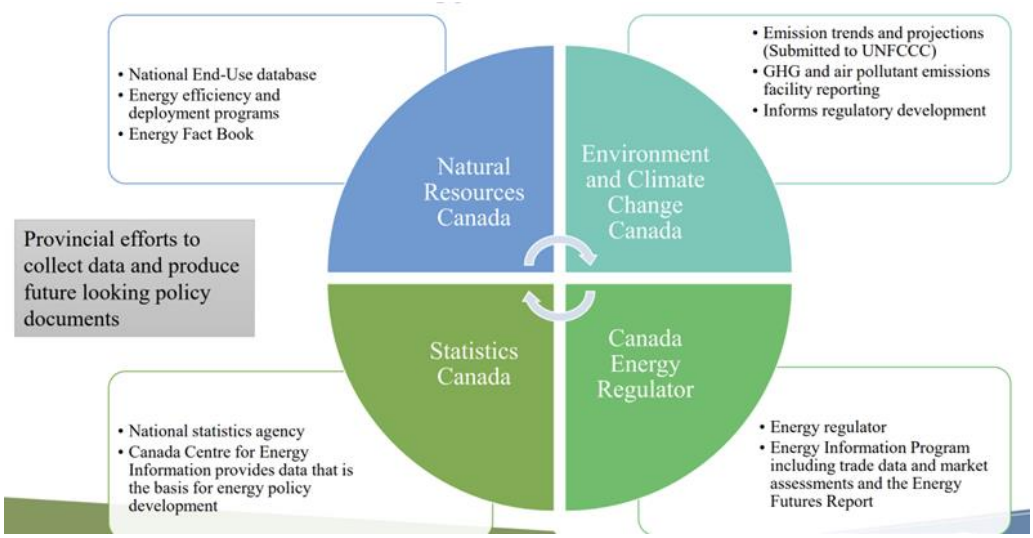


Figure 9: Federal Energy Information Framework

Karsten Hedegaard (Danish Energy Agency)— Presented the scenarios developed by the Danish Energy Agency. The scenarios are used to

illustrate 1) That it is technically possible to achieve climate neutrality by 2050 (the latest) and the 70% reduction target by 2030 and 2) That there are different way to achieve the targets. For the scenario work, Denmark uses a TIMES-based model and applies the UN principles of accounting for greenhouse gases, while including energy consumption for international aviation and shipping. Biomass is considered a constrained resource in all the scenarios. Scenarios are constructed based on an informal stakeholder dialogue and a comprehensive screening of scenario studies from research institutions and other actors. The scenarios are formed by varying factors that have a great impact on the big picture and are at the same time uncertain. This has led to 4 scenarios, namely: “Bio & CCS”, “Electrification”, “Behavior”, and “New Markets”.

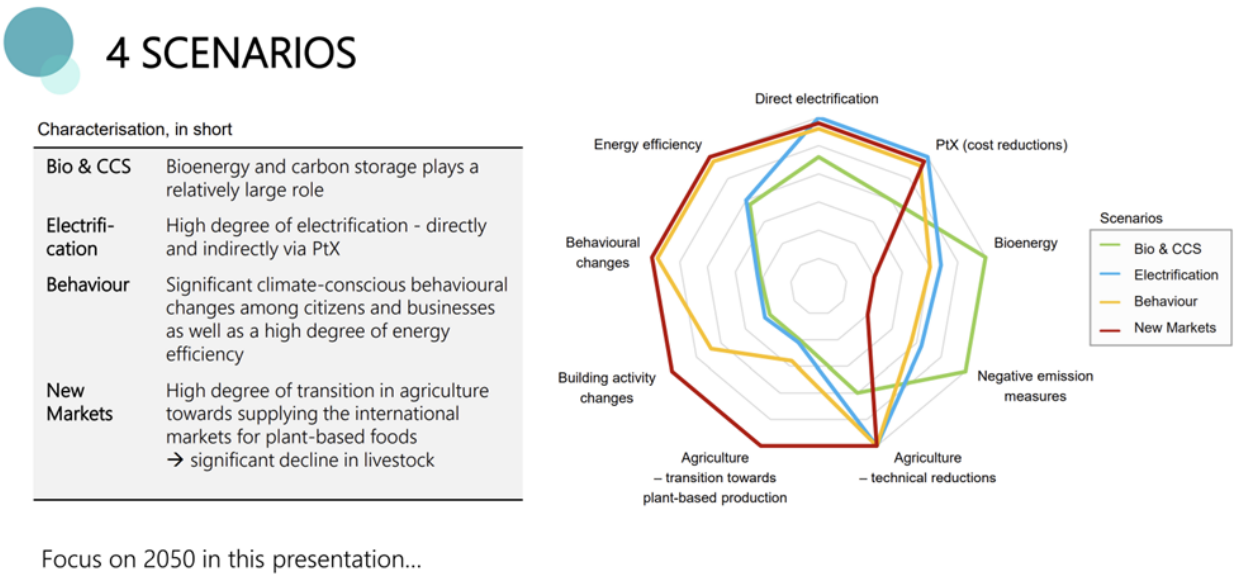


Figure 10: Denmark's four Long Term Energy Scenarios

Panel discussion with the moderator

When is exploring the future too much exploring?

Thiago Barral — Noted that it is not always clear at the Ministry level what questions policymakers want to be answered by scenarios and the modelling process. The first challenge for the Energy Research Office is to understand the policy dilemma to enable them to narrow down to the relevant scenarios to present. Currently, 2 scenarios are used. However, it is evident that these are not enough to model net zero. He pointed out that it is important to have scenarios that reach 2050, and countries should strive to use between 3 and 4 scenarios using sensitivity analyses to create more data.

Is it necessary to make value judgements when looking at scenarios?

Thiago Barral — Noted that to make a value judgement, the political context should be taken into account.

How many scenarios and sensitivities are efficient? How do you ascribe weight to uncertainty factors? Does it come from policymakers, the modelling team or stakeholder engagement?

Adonay Urrutia — Noted that it is a good idea to include a Business As Usual scenario and a modernization scenario to capture more uncertainties. Scenarios should be built accounting for factors critical to the government. In El Salvador, there are 80 different sensitivity factors taken into account and are used to analyze uncertainty factors.

In relation to sensitivity and roadmaps, when is exploring too much?

Brad Little — Currently, numerous scenarios are used and there are new methods, including machine learning allows academics to analyze up to 135 000 scenarios. The new challenge shall be how to sift through the results as opposed to limiting the number of scenarios.

How are these four scenarios being used in Denmark? How do you look at the commonalities or common threads between scenarios?

Karsten Hedegaard — Scenarios are used at a high level for illustration purposes. The Danish Energy Agency elaborates key messages while exploring robust solutions based on commonalities across the 4 scenarios.

Is there a risk of focusing too much on 2050 and missing what we need to do in 2023?

Karsten Hedegaard — There is currently a big focus on 2030, however, the long-term is important to avoid the risk of sub-optimal investments headed the wrong way.

Elaborate on net zero priorities in modelling.

Thiago Barral — In Brazil's modelling, it emerged that it is possible to reach net zero in multiple ways using many technologies. It is important to have more scenarios to make sure people are not too confident that the future is about one technology above all others; however, it is also vital not to open up the spectrum too much, as it is possible to lose focus.

Adonay Urrutia — It is important for scenarios to comply with Nationally Determined Contributions, as these help narrow the scope of possible scenarios.

What has been the experience on communication in modelling?

Karsten Hedegaard — To ensure effective communication, it is vital to use precise messages, including summaries for policymakers. It is important to help people understand the dynamics of energy planning, and this can be achieved through transparency and communicating with different stakeholders using the language they interact with.

Brad Little — It is important to communicate a broad spectrum of possible futures when engaging with policymakers.

Paul Deane— Noted that it is ineffective to send long reports or peer-reviewed papers to policymakers. Instead, it is more effective to use short and concise messaging in the form of one pagers summarizing the research, its aims and its impact in policy making.