Fifth International Forum on Long-Term Energy Scenarios (LTES) for the Clean Energy Transition

September 9 – 11, 2024| Hybrid Event

Day 2 Event Proceedings

Event summary

The 5th LTES Forum hosted approximately 40 attendees at IRENA Innovation and Technology Center offices in Bonn, Germany, while 100 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 Forum focused on alignment between energy and climate planning, the role of scenario planning for de-risking investment for the clean energy transition, scenario communication, lifestyle changes, energy security, and hydrogen integration. Through presentations, panel discussions, and attendees' interventions the Forum facilitated the exchange of knowledge and experiences on different aspects of the planning of LTES.

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- Governments use a mix of insourcing and outsourcing when developing scenarios, the discussions suggested that both approaches, when properly implemented, can contribute to developing realistic and inclusive scenarios
- The discussion highlighted the importance of establishing frameworks to facilitate knowledge transfer and transparency in scenario formulation
- Scenarios ought to be created through an inclusive process that aims to incorporate multiple views and create a sense of ownership and trust.

Session 5

- The discussion highlighted the value for countries in modelling the cost of not transitioning and use these results to inform national policy making.
- The discussions suggested that clear communication and proper public participation are important for building buy-in for national energy plans and projects. Community acceptance can contribute to the faster delivery of renewable energy projects, ultimately benefiting the country.
- Countries are increasingly including socioeconomic analysis in their modelling; often through modelling socioeconomic aspects separately and then integrating these results in the more technical energy planning models. There is a need to improve this integration, and countries ought to work together to build modelling capacity.

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- The discussions highlighted that accounting for geopolitical shocks in the short- and long-term energy planning is an important consideration for enhancing energy security.
- Many emerging and developing countries are often locked into long-term Power Purchase Agreements that are tied to the fossil fuels industry. Countries could consider retrofitting power plants with renewable energy technology to contribute to a gradual and just transition while helping to manage security of supply.
- Climate Change poses a risk to energy security and countries can use mitigation and adaptation measures to address this issue. For instance, in Brazil, recurring drought in the Amazon poses an energy security risk as the country relies on hydroelectric power, to address this the country is leveraging on a centralized energy system combined with increasing energy storage capacity to address supply issues.

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- The discussion concluded on the need to understand the global economy when considering behavioral dynamics and lifestyle change in energy models and scenarios. People in emerging and developing countries often have fewer lifestyle options while people in developed economies have multiple options and can be incentivized to choose low carbon lifestyle options.
- The discussion raised the importance of considering the national political economy when developing scenarios and incorporating lifestyle and planetary boundaries in energy models. Considering these factors can help in presenting scenarios and results that are perceived more neutral, which in turn can foster trust and enable effective, evidence-based policy discourse.
- Globally energy demand is driven by both welfare (meeting people's lifestyle needs) and the private sector investment activities (as firms are investment vehicles aimed at making maximum profit through energy intensive activities. The growth in data centres in Ireland is linked to firm's investment activities and results in additional national energy demand.

Session 4 (Co-hosted with the Danish Energy Agency): Strengthening Institutional Ownership of LTES: Insourcing vs. Outsourcing

Moderator: *Charlie Heaps*, LEAP Developer and Senior Scientist, Stockholm Environment Institute

Panelists:

- *Ali Ahmed Ali*, Ministry of Electricity and Renewable Energy, Egypt
- *Camilla de Araujo Ferraz*, Energy Research Analyst, EPE Brazil
- *Malene Hovgaard Vested*, Energy Advisor, Danish Energy Agency
- *Rosie Collington*, Post-Doctoral Researcher in International Political Economy, Copenhagen Business School

Session Objective: This session explored the roles of insourcing and outsourcing in Long-Term Energy Scenarios (LTES) development. Practitioners gained insights into decision-making, governance structures, and planning ecosystem-building in their specific contexts.

Key Takeaways:

- Governments use a mix of insourcing and outsourcing when developing scenarios, the discussions suggested that both approaches, when properly implemented, can contribute to developing realistic and inclusive scenarios
- The discussion highlighted the importance of establishing frameworks to facilitate knowledge transfer and transparency in scenario formulation
- Scenarios ought to be created through an inclusive process that aims to incorporate multiple views and create a sense of ownership and trust.

Session Summary

Rosie Collington (Copenhagen Business School) set the scene of the session with a presentation on the benefits and critiques of both insourcing and outsourcing modelling capacity. Out-sourcing modelling capacity presents key challenges including: additional costs when updating national strategies, inadequate knowledge transfer during the energy planning porcess, lack of accountability and loss of public trust and a potential conflicts of interest, especially in cases where external planners work with both governments and oil and gas companies.

Insourcing capacity also presents challenges given the costs of training staff and the high cost of hiring talented staff as the private sector offers better employment terms. Finally, strategies developed solely relying on in-house capacity may exclude the priorities of other government departments. To help remedy this situation, the speaker suggested governments could develop contracts that require knowledge and technical skill transfer by external consultants during their studies and work through the formation of working groups with research institutions as opposed to solely relying on private consultants. It was noted that investment in public capacity is crucial and international financial institutions should consider giving unconditional loans for this purpose. Finally, it was noted that platforms for international collaboration and peer-to-peer learning are valuable in building public capacity.

Camila de Araujo Ferraz (EPE, Brazil) made an intervention focused on Brazil's experience with both insourcing and outsourcing modelling capacity, and it was noted that there is no one-size-fits-all solution. EPE worked together with the Inter-American Development Bank and a Brazilian think tank to develop their Energy Transition Programme (ETP), which identifies different paths towards climate neutrality. The ETP's goal was to discuss emerging issues related to the energy transition in Brazil with different stakeholders, and work collectively to create carbon neutral scenarios. Outsourcing the emissions modelling to the Federal University of Rio de Janeiro brought new credibility and expertise to the project due to the different perspectives offered and was a cost-effective measure. EPE also insourced modelling capacity for their long-term energy scenarios until 2055, to achieve this they set up training cycles for different working groups to enhance in-house capacity. The result of this exercise was better integration, the incorporation of diverse perspectives, enhanced coherence of the Energy plan and a sense of collective ownership. It was noted that outsourcing can lead to the involvement of more diverse stakeholders, if properly designed. Further, properly coordinated insourcing can improve the diversity within government and enhance the government's capacity to create more ambitious targets.

Ali Ahmed (Ministry of Electricity, Egypt) shared the experiences of the development of the Egyptian Energy Strategy, which was supported by the European Union (EU). The strategy is regularly updated, in collaboration with EU consultants who work with the TIMES-Egypt model. Concurrently, the Egyptian government is working with the MESSAGE model, which is fully in-house. The mix of internal and external capacity is helpful, as it allows the government to leverage on the knowledge of external experts while ensuring that sensitive data can be processed internally. It was noted that external expertise can also be a source of knowledge to build internal capacity.

Malene Hovgaard Vested (Danish Energy Agency) shared perspectives on the reliance on inhouse capacity in the Danish Energy Agency, where approximately 50 colleagues work on energy modelling. In-house capacity is valuable to DEA, as it ensures that technical questions from the Ministry can be quickly responded to without having to wait for feedback from an external modelling partner. It also promotes a good working environment, since there is always a highly experienced and capable colleague around to collaborate with. It was noted that when working with consultants, it is important to build on existing knowledge and models to facilitate knowledge transfer when the consultant leaves. Additionally, it is important to consider working with a consultant that regularly works with the modelling tool used nationally for its own work, as opposed to consultants who only use the model for clients.

Plenary Session Summary

How do you use outsourcing to build internal capacity and what are the challenges for countries without any internal capacity

Camila de Araujo Ferraz (EPE, Brazil) noted that to develop capacity building through outsourcing it is important to have consistent communication and engagement to build in-house capacity and

understanding of scenario development. The speaker noted that it is important for all stakeholders to work towards similar objectives during the process of scenario building. It is vital to mitigate the risk of over-reliance on external capacity and this can be achieved through transparency, communication and training programs.

Malene Hovgaard Vested (Danish Energy Agency) noted that smaller countries which do not have many energy modelers should use open-source modeling tools such as the TIMES or Balmoral model and work with the global modelling community. Further, it is important to outsource modelling work to companies that use open-source models, as this way it is possible to develop in-house models while developing in-house capacity for the future. The speaker suggested that it can be effective to keep modelling simple and that countries could focus on the biggest emitting sectors or relevant sectors, rather than over-complicating the modelling process.

Rossie- noted that it matters who governments are working with, and selected contractors should have genuine expertise and knowledge to ensure the development of locally appropriate models. This approach helps build in-house capacity and capability.

Ali Ahmed (Ministry of Electricity, Egypt) noted that Egypt is building their modelling capacity using outsourcing. He noted that governments are sensitive when it comes to data sharing even with consultants and this brings some challenges. It is vital for there to be proper coordination amongst ministries as in Egypt the ministries of energy and petroleum are required to model different aspects of the energy sector. It was note that sometimes Egypt faces time delays when contracting external contractors, as such a blend of out-sourcing and in-souring is used. However, the government sometimes loses capacity as modelers tend to leave their government jobs and work for the private sector who pay higher salaries, as such there is need to work towards retaining talent and knowledge.

Question and Answer Session

Youssef Almulla (Danish Energy Agency) commented on the use of open-source modelling for long term planning and the issue around data privacy. He asked panelists how governments see the value of using open source modeling when they have to share data.

Malene Hovgaard Vested (Danish Energy Agency) noted that it is important to stress the importance of data protection when governments work with companies.

Charlie Heaps (Stockholm Environment Institute)- stated that it is important to distinguish between models which are private and contain data and modelling tools which tend to be open source and can be used to develop models.

Farhan Ahmed (Ministry of Planning Development and Special Initiatives – Pakistan) noted that Pakistan is working towards developing in-house modelling capacity as the Ministry of Planning is developing their own modelling tools. However, Pakistan outsources some aspects of modeling and has to balance between government requirements and data privacy. He asked panelists to advise on how modellers should respond to requests which have a short time frame and require some modelling work.

Andrea Wainer (REN21) building on the remarks about working towards similar objectives she noted the need to adopt a multi-stakeholder approach to objective setting. She asked panelists to share their thoughts on how in-house modelling can be done in a manner that ensures a multi-stakeholder approach.

Bo Yuan (State Grid Energy Research Institute (SGERI)China) regarding outsourcing he noted that China as the country has 2 main targets to meet and grapples with data security concerns when considering an outsourcing approach of cooperating internationally on modelling development. The first is on introducing advanced methodologies to in-house models, and outsources modelling to universities and consultant to leverage on their modelling capabilities. The second target is to see comparative studies of energy transition from different viewpoints for instance how decarbonization of the power sector will affect transportation and industry. To achieve this SGERI outsources research to other agencies and consultants. He asked panelists to share their views on how the issues can be resolved.

Alexandra O'Sullivan Fretloft (Danish Energy Agency)- noted that the DEA outsources parts of energy modelling to external consultants as this helps them get credibility from other experts.

Gustavo Naciff de Andrade (Energy research office (EPE) - Brazil) noted that capacity building in the government is essentials and based on this Brazil's G 20 presidency launched the Global Coalition on Energy Planning (GCEP) initiative which is aimed at building capacity. He asked how important it is for governments to cooperate with other stakeholders to create models once in-house capacity is built. He noted that models should be co-created by the public and private sector and highlighted the importance of communication in building trust.

Kaare Sandholt (Energy Research Institute of National Development and Reform Commission – China) asked whether the government should have the monopoly of scenario creation. He highlighted the importance of transparency and noted that in Denmark the government has monopoly of scenario creation, as in the past University developed scenarios but politicians rejected the results. He asked panelists to share their thought on how a multitude of scenarios should be created and jointly used for policy making

Asami Miketa (IRENA) noted that both insourcing and outsourcing approaches are important. She noted that the context is usually different and in Africa countries experience benefits from developing inhouse capacity. She noted that countries should avoid over-relaying on donor initiatives and develop capacity to enable them update models and scenarios. She noted that in Eswatini, the government created a group that consists of universities, other organizations and government organizations to take part in national planning. She noted that countries should create a contextually fitting planning system

Closing Remarks

Malene Hovgaard Vested (Danish Energy Agency) To ensure that proper participatory processes are followed, the speaker noted that while they are time-consuming, having a regular program in place can create a sense of ownership.

In response to the question on time-bound requests it was noted that when the Ministry makes urgent requests for information in countries that mainly rely on outsourced modelling capacity, modelers should provide the information at hand and communicate that it would take slightly longer to provide detailed responses.

Additionally, to address potential security issues when sharing sensitive data with external experts it was acknowledged that data privacy is vital as such trust ought to be built over time with external consultants. It was noted that insourcing can create a monopoly of scenarios, which may prevent transparency; this led the discussion on the need for frameworks to ensure data transparency. To this end it was noted that the Danish Energy Agency creates technology catalogues for external use which are relied on by approximately 150 countries.

Camila de Araujo Ferraz (EPE, Brazil) noted that it is vital to maintain an ongoing dialogue with civil society to ensure a more inclusive and credible process. Further she noted that it is important to understand mission-oriented institutions and ensure that they are designed to look at long term objectives, based on the objectives in-house capacity should be developed in these institutions.

Rosie Collington (Copenhagen Business School It was noted that sometimes governments rely on outsourced modeling capacity to gain credibility. However, it was noted that this approach could potentially damage trust in public institutions given the existence of uncertainties. To remedy this, it is important that modelers communicate the existence of uncertainties to build public trust in public institutions and the modeling exercises. She highlighted the importance of building capacity to better communicate the context of models and scenarios, highlighting that models are projections and not predictions and usually have uncertainties and limitations.

Charlie Heaps (Stockholm Environment Institute) noted that countries do not face a binary choice between insourcing and outsourcing. Insourcing is important to build capacity in government, but outsourcing is also useful in different ways but needs to be done from a position of strength. Despite the approach taken, institutions guiding the process ought to be knowledgeable and have a level of in-house capacity.

Session 5: Broadening LTES to Feature Socioeconomic Aspects

Moderator: *Kaare Sandholt*, International Chief Expert, China Energy Transition Programme, Energy Research Institute of Academy of Macroeconomic Research

Opening presentation: *Gondia Sokhna Seck*, Programme Officer, IRENA

Panelists:

- *Elizabeth Doris*, Director, Joint Institute for Strategic Energy Analysis (JISEA) at NREL
- *Jessica Arias Gaviria*, Deputy Director of Energy Demand, Mining and Energy Planning Unit (UPME), Colombia
- *Yang Hongwei*, Chief Scientist, National Key Basic Research Development Program, Energy Research Institute of Academy of Macroeconomic Research, China
- *Reshma Francy*, Associate Director, Policy Pathfinding and Trilemma, World Energy Council
- *Feng Junshu*, Researcher, Energy Strategy & Planning Research Department, State Grid Energy Research Institute, China

Session Objective: This session examined the inclusion of socio-economic elements in LTES to support a just energy transition. Participants gained insights on how vital socioeconomic factors are incorporated in LTES and broader energy planning and learned from country examples and insights from the audience.

Key Takeaways:

- The discussion highlighted the value for countries in modelling the cost of not transitioning and use these results to inform national policy making.
- The discussions suggested that clear communication and proper public participation are important for building buy-in for national energy plans and projects. Community acceptance can contribute to the faster delivery of renewable energy projects, ultimately benefiting the country.
- Countries are increasingly including socioeconomic analysis in their modelling; often through modelling socioeconomic aspects separately and then integrating these results in the more technical energy planning models. There is a need to improve this integration, and countries ought to work together to build modelling capacity.

Session Summary

Gondia Sokhna Seck (IRENA) Presented on IRENA's approach to incorporating socioeconomic aspects to long-term energy analysis. He noted that IRENA'S socio-economic portfolio included the analysis of employment potential, enhancing domestic capacity, gender & participation of minority groups. IRENA measures the socioeconomic impact of renewable energy through variables such as GDP on welfare through a macroeconomic model.

This approach is informed by the fact that national energy transition roadmaps are deployed to enable the transition, however there is a complex dynamic between economy, energy system and society which is often not accounted for. He noted that understanding the socioeconomic dynamic ought to be properly managed to ensure a just transition in different national contexts.

He noted that in the past, modelers have only focused on only quantifying the economic benefit of the transition, however, the inclusion of a socioeconomic footprint analysis helps identify potential challenges and barriers and governments can use this information to devise solutions to ensure a just transition. He highlighted that IRENA's model measures the impact of transition on GDP, employment, and welfare identifying potential challenges. This model is used to ensure a just transition at the global, national and local levels.

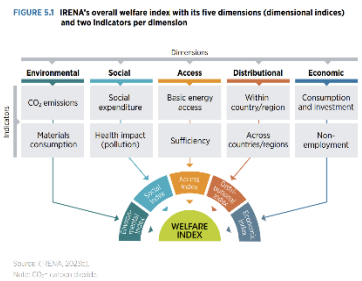


FIGURE 5.1 IRENA's overall welfare index with its five dimensions (dimensional indices) and two indicators per dimension

He noted that IRENA has a welfare index which is informed by 5 dimensions (name) which are with 2 indicators per dimension as illustrated in the World Energy Transitions Outlook 2024: 1.5°C pathway

He noted that the overall welfare index illustrates the gaps that would remain after implementing the IRENA 1.5°C scenario taking a regional and global approach. From the analysis it is evident that the global south usually has additional gaps in the economic domains while in the global north there is a large gap in the environmental domain given the high level of consumption. In closing he noted that the socio-economic work is part of IRENA's effort to move away from a technocentric centric approach toward a more comprehensive and global approach.

Elizabeth Doris ((JISEA) at NREL) introduced NREL and noted the agency works with various stakeholders including indigenous communities. NREL's approach to socioeconomic scenarios involved identifying and addressing challenges.

She expounded on the LA100: The Los Angeles 100% Renewable Energy Study and Equity Strategies project with the Los Angeles Department of Water and Power (LADWP) on how to achieve 100% RE in Los Angeles by 2045. In their analysis, NREL used an air quality model and worked to integrate it with energy models. Given the differences in the models, NREL worked to limit number of scenarios to ensure that the modelling remains cost effective and time efficient. Through this project Los Angeles was able to make progress on demand side programs and energy systems.

While the study was successful NREL encountered 2 main challenges. First, all the scenarios were based on world growth (pre-Covid) and after 2020 NREL had to rework the models with the Covid-19 reality and resultant decline in economic growth in mind. A second issue was that voices on community justice were not reflected in the initial modelling and NREL had to rework methodology to ensure the views were incorporated.

To ensure the integration of socioeconomic aspects in models NREL now develops scenarios differently and are using new data & computing techniques and more probabilistic models. Further, NREL is working on redesigning data collection techniques which will enable them to develop multi sectors socioeconomic scenarios.

Jessica Arias Gaviria (Mining and Energy Planning Unit (UPME), Colombia)-presented on integrating territorial communities in Colombia's national energy plan. She noted that initially energy plans were focused on maximizing mining royalties from coal and oil and only the government institutions, large private sector organizations and academia

were engaged in policy making. In the past few years, Colombia's new approach to energy planning includes 3 key goals, first the Government aims to ensure the proper engagement of communities in national energy planning. The second goal is aimed on ensuring climate action and alignment between energy planning and climate goals. The third goal relates to the integration of energy planning with the national energy transition plans working across sectors including the coal sector and with the ministries of environment and finance amongst others. To achieve these goals, Colombia takes a territorial approach to understand local impact of the energy transition of households and employment and consults multiple stakeholders.

To ensure proper engagement, the Ministry of Energy works with territorial groups in each area who facilitate the engagement with community members during the energy planning porcess. She noted that UPME was conducting stakeholder mapping to facilitate proper engagement during consultation periods.

Finally, she noted that Colombia was analysing the cost of not having a transition and also measuring how jobs can be created and supply chains created during the transition. In this analysis Colombia includes multiple dimensions and indicators while ensuring proper communication

In closing, she noted that the challenges in including socioeconomic factors in energy scenarios include the lack of relevant capacity and lack of data from remote areas which the country is working to address.

Yang Hongwei (Energy Research Institute of Academy of Macroeconomic Research, China) Noted that the China Energy Transformation Program includes a socioeconomic assessment. He clarified that the Energy Research Institute of Academy of Macroeconomic Research, China focuses on energy policy analysis and shares their results with the Chinese government to inform national policymaking.

He noted that it is necessary to consider the socioeconomic aspects of the energy transition in long term energy scenarios, given the fact that China's energy mix is currently dominated by coal, oil and natural gas. The China Energy Transformation Outlook 2023 (CETO 2023) contains 3 main scenarios, a baseline scenario and 2 carbon neutral scenarios illustrating the transition to an energy mix dominated by renewable energy. From a socioeconomic perspective, these scenarios illustrate changes on the employment structure across different sectors, economic changes including the impacts of the transition on GDP growth rate and changes in industry structures.

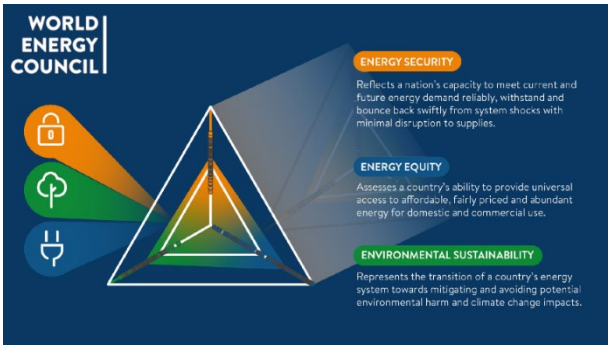
In CETO 2023 when assessing the socioeconomic aspects, the (ERI-EDO) Electricity and District Heating Optimisation Model and (ERI-LEAP) End-Use Energy Demand Analysis Models are used for end use analysis as they consider factors including GDP, employment, industry structure change, environmental and energy productivity. The Computable General Equilibrium (CGE) model is used for socio economic analysis and it accounts for ecological aspects including water forests and agriculture land. It was noted that all 3 models share the same assumptions to address the related socioeconomic impact from the transition.

The socio-economic assessment shows the contribution of the value added to GDP in different sectors and it shows that transitioning the power generation sector contributes more to carbon neutral scenarios. The CGE model demonstrates employment structure change and identifies the non-hydro sector as having more opportunities to increase net employment from energy transition.

Reshma Francy (World Energy Council) Noted that the World Energy Council has 80 member countries.

Since 2000 WEC has developed the World Energy Trilemma and uses these for their positive scenarios analyzing their evolution. In 2009 WEC launched the new trilemma framework as illustrated

Energy equity is defined as (define). Countries have requested the inclusion of resilience and justice in the energy transition. WEC has a score highlighting the economic and social impact of the transition which analyses the impact of subsidies, upskilling and energy equity access. Their approach to energy equity access focuses on access to clean energy not just access to energy. Finally, WEC considers the cost of clean energy technology and geotechnology transfer- going above cost and connection to identifying the end users and who will pay for the transition.



Feng Junshu (State Grid Energy Research Institute, China) Introduced SGERI and noted that SGERI is a think tanks of the State Grid Corporation of China (SGCC) and works on energy strategy and energy planning. It was noted that China takes a regional approach to planning given the country's vast expanse.

It was noted that the northern part of China has low GDP but high renewable energy potential while the east of China has high GDP and low renewable energy potential. Given this reality China is working to balance equality by leveraging local competitive advantages, including renewable energy potential, to stimulate regional development

It emerged that power demand is increasing in all regions of China and the energy planning perspective has evolved. Initially the government would prioritize the development of additional power supply to meet demand passively; however as the country works towards it decarbonization goals the planning is focused on utilizing renewable energy to meet demand in a flexible and low carbon manner. Given the high renewable energy potential in northern China the government intends to invest in transmission infrastructure to meet national demand while increasing the share of renewable energy in the national energy mix. Additionally, the use of innovative technology specifically incorporating hydrogen in the energy mix by retrofitting coal plants to use ammonia and gas to hydrogen technology will be necessary for the transition.

In closing it was noted that long term energy scenarios in China are used to inform investment decisions with regards to transmission infrastructure and supporting the incorporation of new technologies in the national energy system.

Audience Question

Hans-Josef Fell (Energy Watch Group) Noted that China have played a key role in clean energy technology manufacturing and their industry has consistently grown exponentially.

He further noted that biodiversity aspects need to be considered in the renewable energy development process including the impact of wind on avian life amongst others. The challenges should be considered in scenarios to ensure a sustainable and just transition.

Tiina Koljonen (VTT Technical Research Centre of Finland)- Asked about costs and benefits and whether external costs are considered and whether panelist's can quantify benefits. She noted that Finland are doing traditional interactive models which include transitional macroeconomic modelling

Morjana Moreira dos Anjos (Renewable Grids Initiative)- noted the importance of engaging stakeholder which is time consuming and cannot be regularly done. She asked which approaches Colombia was taking to ensure proper stakeholder engagement without necessarily delaying the implementation of renewable energy projects.

She noted that most of the socioeconomic modelling is aimed at creating a result that can be integrated in energy modelling but this often fails to account for emerging socioeconomic issues such a slack of community acceptance which can delay the delivery of renewable energy projects and transmission infrastructure. She asked panelists to shed light on how socioeconomic and energy modelling is integrated and how emerging issues are captured and addressed in energy planning.

Wisdom Ahiataku-Togobo (Alternate Techonology Consult Ghana)- noted that panelists should consider the impact of renewable energy projects in developing countries are working to meet their energy demands to ensure proper industrialization and stimulate economic growth

Charlie Heaps (Stockholm Environment Institute)- asked about the social dimensions of energy scenarios specifically how modelers put together macroeconomic modelling with the engineering aspect of energy modelling. He noted that energy scenarios give themselves to a what if approach with various futures to consider while the macroeconomic modelling observes historical trends and then issues future projections.

Camila de Araujo Ferraz (Energy research office (EPE) – Brazil)- asked about how Colombia addresses the economic dimension in their experience as they only spoke about environment and social dynamics with local stakeholders.

Panelists Responses

Jessica Arias Gaviria (Mining and Energy Planning Unit (UPME), Colombia) noted that public participation is time and resource consuming, therefore it is uncertain whether Colombia's incoming political administration will see the benefits of engagment and continue with the process. She noted that with the current participation procedure, the construction of transmission lines which should take 2 years can take up to 5 years when engaging communities

She noted that UPME was working with the finance ministry to build economic models linked with LEAP to be able to deduce how much investment is needed for various scenarios. Further, UPME is working to include diverse costs related to carbon and health in the different scenarios based on the different technology options.

Yang Hongwei (Energy Research Institute of Academy of Macroeconomic Research, China) noted that in ERI's modelling framework the EDO mode is based on liberal programming and has detailed cost information for each technology which is used to analyse the cost effectiveness and competitiveness of each technology

He further noted that biodiversity protection is a common challenge for renewable energy projects especially for wind farms. He noted that China's government has delineated ecological areas to be protected (national resource protection areas and national parks) which are zones where wind and solar development is not permitted. Increasingly China is situating more solar PV installations in deserts in northwest China and developing solar PV farms in combination of fish pond or agricultural land. The country is working to increase renewable energy capacity while protecting biodiversity.

Reshma Francy (World Energy Council)- On environmental costs and benefits WEC will soon include the planetary boundaries and circularity aspects if energy systems in their energy trilemma index. She noted that Saudi Arabia developed the Circular Carbon Economy Index which is used to measure circularity and planetary boundaries and WEC is developing similar indicators to be incorporated in the energy trilemma. She noted that to ensure proper public participation proper stakeholder mapping is necessary to ensure that the correct groups are consulted. With regards to ensuring energy security she noted that after the 2022 EU Energy Crisis states streamlined their energy permitting processes to ensure that more projects online faster.

Feng Junshu (State Grid Energy Research Institute, China) noted that SGERI'S modelling tools include CGE and LEAP and an in-house model which looks at generating and transmission line and power system simulation models to assess benefits for power sector. SGERI's models include aspects of energy access and cost as SGERI prioritizes energy security to ensure access to affordable energy

Session 6 (Co-hosted with the World Energy Council): Incorporating Energy Security Considerations in Long-Term Energy Scenarios

Moderator: *Reshma Francy,* Associate Director, Policy Pathfinding and Trilemma, World Energy Council

Panelists:

- *Filipe de Padua Fernandes Silva*, Energy Research Analyst, EPE Brazil (co-presenting)
- *Pamella Elleng Rosa Sangy*, Technical Consultant, EPE Brazil (co-presenting)
- *Bo Yuan*, Section Chief, Energy Strategy and Planning Institute, State Grid Energy Research Institute, China
- *Farhan Ahmed Memon*, Senior Research Analyst (Policy), Ministry of Planning Development and Special Initiatives, Pakistan

Session Objective: This session was aimed at facilitating the sharing of country experiences in their evolving approaches to incorporating energy security in long-term energy scenario development. The session highlighted the importance of a multidimensional approach to energy security in long-term energy planning. Participants were able to better understand the importance of a regional approach to energy security and discussed how regions develop LTES that incorporate energy security aspects.

Key Takeaways:

- The discussions highlighted that accounting for geopolitical shocks in the short- and long-term energy planning is an important consideration for enhancing energy security.
- Many emerging and developing countries are often locked into long-term Power Purchase Agreements that are tied to the fossil fuels industry. Countries could consider retrofitting power plants with renewable energy technology to contribute to a gradual and just transition while helping to manage security of supply.
- Climate Change poses a risk to energy security and countries can use mitigation and adaptation measures to address this issue. For instance, in Brazil, recurring drought in the Amazon poses an energy security risk as the country relies on hydroelectric power, to address this the country is leveraging on a centralized energy system combined with increasing energy storage capacity to address supply issues.

Session Summary

Pamella Elleng Rosa Sangy (Energy Research Office (EPE) Brazil)- presented on Brazil's experience modelling the integration of renewable energy and energy efficiency into the Brazilian energy system. She noted that Brazil was working to address the variability of solar and wind energy in their energy mix noting the importance of reflecting the issues associated with potential failure of supply in the national energy system.

Bo Yuan (State Grid Energy Research Institute, China) - noted that the SGCC was established in 2002 by the Ministry of Electricity for China and serves 26 provinces in China. SGCC has built multiple high voltage projects that transmit 9000GW per year and by the end of 2023 wind and solar generation capacity in China was above 900GW

In China Energy security is considered during energy planning as they consider supply & demand security, resource security, transmission, cyber, finance, ecological and international trade security. It was noted that changes occasioned by the energy transition have changed the focus from availability of fossil fuels to the consideration of security of the power system including both the inputs and infrastructure. China plans to achieve carbon neutrality by 2060. According to scenarios by 2060 the terminal electrification level is expected to be 80%, non-fossil energy will account more than 65% and electricity will be dominant by 2060. China is currently working towards increasing their level of electrification to meet 2060 targets.

It was noted that in 2023 the growth rate of electricity demand was 9.7% and renewable energy generation capacity increased by 300 GW which shows that there is still dependence on fossil fuels. To ensure energy security the country plans to diversify supply structures as the country transmission to a low carbon electricity generation system through the use of carbon capture use and sequestration (CCUS) and energy storage technologies. China installed 100GW of electrochemical energy storage in 2023 to guarantee enough capacity to meet peak demand.

Critical minerals in China are a key topic for consideration when considering energy security, as the country intends to achieve 10,000 GW of renewable energy generation capacity by 2060, and critical minerals play a key role for the necessary technology. By 2060 mineral demand in the power sector will increase to 8 to 25 times to achieve carbon neutrality. Copper, chromium and rare earth demand will increase 10-15 times. Cobalt demand will increase approximately 100 times compared to now. It was noted that in China intends to design a recycling economy before increasing renewable energy generation to ensure costs are kept down and reduce demand for critical materials. Additionally, China considers the socioeconomic development parameters when planning for the renewable energy sector and when planning for grid investment is focused on ensuring job creation and beneficiation of citizens.

Farhan Ahmed Memon (Ministry of Planning Development and Special Initiatives, Pakistan)- noted that in Pakistan least cost is a metric used in the energy sector when planning for investment for infrastructure. He asked whether other countries, represented, consider least cost or total system cost in planning.

He further stated that Pakistan was facing high energy prices therefore the country uses a LEAP based model for energy planning to model the most efficient and least cost development options to ensure that energy is affordable. With regards to energy security, Pakistan focuses on the use of indigenous to protect against external shocks and climate change.

He highlighted that Pakistan is concerned about securing the financing necessary to shift from a fossil fuel based energy system to on that relies on renewable energy. The country is further considering how to renegotiate ongoing Independent Power Purchase contracts in line with the planned transition.

Filipe de Padua Fernandes Silva (Energy Research Office (EPE) Brazil)- noted that Brazil has a solid institutional framework for their energy sector. Brazil regulates both the power system and bio-fuels sector through their institutional and regulatory framework. Brazil's regulatory architecture for the energy sector includes a system operator in charge of generation facilities, the Energy Research Office (EPE) and National Energy Policy Council. The three institutions work together to address energy concerns in long term planning and this approach enables the country to manage risks while ensuring sustainability

Bo Yuan (State Grid Energy Research Institute, China)- noted that flexibility is vital to ensure energy security to ensure high penetration for renewable energy in China's power system. China uses capacity expansion simulation software to assess potential flexibility constraints in their energy system. It was highlighted that China's installed capacity of renewable energy was growing and there are many flexibility needs as the daily fluctuation is more than 300GW on the demand side. On supply side China still relies on coal and has energy storage for flexibility but this will account for less than 10% of power system by 2030 further highlighting the flexibility need. To decarbonize their power sector, China has plans to retrofit coal fired generation plants to lower installed capacity of coal to less than 20% of outputs by 2030. SGCC is working towards enhancing grid flexibility and expanding transmission infrastructure to ensure better uptake of electricity from planned solar power plants. To address concerns about flexibility of energy storage China plans to install 400GW of energy storage capacity by 2030.

It was noted that there were 2 new types of flexibility problems, the first relates to the fluctuations of renewable energy generation specifically solar. The second concern is long term flexibility demand given that renewable energy generation levels vary seasonally, and the variation may reach over 100-200 GW per month by 2070. To solve these issues, it is necessary to have long term energy storage consequently China is developing its hydrogen sector. It was noted that the development speed of hydrogen may not meet the energy needs by 2030 and therefore there should be more effort on demand-side and locating industries near areas with massive renewable generation

Pamella Elleng Rosa Sangy (Energy Research Office (EPE) Brazil)- asked about how other countries consider system boundaries when modelling and how they decide which uncertainties are outside their boundaries. It was highlighted that Brazil has diversified its energy sector and is developing a sustainable model for all the fuels used in the sector.

She noted the importance of considering temporal aspects when modelling for fluctuations in the power system was highlighted. It was noted that there is negligible uncertainty of supply on a monthly scale specifically with regards to wind energy, but on an hourly scale there are more pronounced uncertainties. Further, it is important to understand the intensity and probability of fluctuations and to assess their impact to ensure the implementation of proper mitigation measures

Plenary Discussion

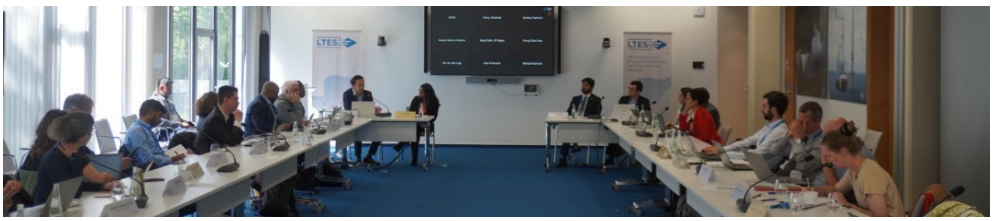
Adrea Wainer (REN 21)- asked how the pace of technological advancement is accounted for when modelling for critical minerals when looking at energy security.

Bo Yuan (State Grid Energy Research Institute, China)- responded that for China, their scenario modelling accounts for technology advancement both forward and back and considers the impact of advancement every 5 years with a focus on cost and efficiency. China uses these parameters to measure impact and

scenario results are used to make technology breakthrough policy proposals for instance on long term energy storage and CCUS technology.

Francesco Mezzera (Politecnico di Milano, Italy)- asked panellists to elaborate their country approaches to energy security and it's the impact of geopolitics especially when looking at export and future energy plans,

Filipe de Padua Fernandes Silva (Energy Research Office (EPE) Brazil)- noted that Brazil shares borders with most countries in South America except Ecuador and Chile. Most of these borders are in remote areas far from major demand centers therefore the country partners with neighbors to ensure supply to the remote areas. Key partnership include the partnership with Paraguay to operate the Itaipu hydroelectric power plant and the partnership with Bolivia to operate the GASBOL gas pipeline. Additionally, Brazil operates transboundary transmission lines with Uruguay, Argentina and Venezuela, operated by Eletrobras, that provide flexibility and allow for electricity trade. To ensure energy security the country prioritizes regional cooperation and partnership.



Hans-Josef Fell (Energy Watch Group, Germany)- noted that energy security is an issue that encompasses the whole energy system, aside from the renewable energy sector, and noted that there are multiple solutions to address the challenges.

Hammad Ur Rahman (Ministry of Planning Development and Special Initiatives – Pakistan)- asked about the availability and reliability issues are faced by countries expanding tehri renewable energy generation capacities.

Filipe de Padua Fernandes Silva (Energy Research Office (EPE) Brazil)- Noted that Brazil's hydropower generation capacity was affected by the drought in the Amazon basin. He noted that a recurring drought would pose a major energy security concern, and the country is leveraging on a centralized energy system combined with increasing energy storage capacity to address supply issues posed by droughts in the Amazon.

Roney Vitorino (Energy Research Office (EPE) Brazil) Noted that initially Brazil had an issue with energy supply and eventually the share of wind and solar generated electricity in the national grid increased. Based on this expansion, Brazil expanded planning to include different aspects of risk and mitigation with a focus on energy supply and capacity planning. Brazil's long-term planning is focused on the flexibility dimension. Given that 90% of national electricity output is met by renewable energy EPE Brazil uses a stochastic model to simulate the system. Further, it was noted that Brazil works with international partners to enhance planning capacity.

Victor Kitange (Commonwealth Secretariat) -noted that it was ambitious for countries to ramp up deployment of renewable energy given the presence of external constraints including supply chain constraints impacting access to critical minerals. Additionally, countries are often locked into long-term Power Purchase Agreements with are tied to the fossil fuels industry. In light of these issues, he asked panelists to elaborate on how their countries are addressing the constraints.

Bo Yuan (State Grid Energy Research Institute, China)- responded that the current potential of critical minerals may not meet global demand. Therefore, countries including China, are working on upgrading their technology to develop renewable energy technology that requires less critical minerals. Further, there is a push to create a recycling economy, in relation to renewable energy technology, to address potential shortfalls in supply in the future. Regarding long term power purchase agreements, China borrows lessons from the fossil fuel sector and is working to retrofit cola plants with renewable energy technologies.

Farhan Ahmed Memon (Ministry of Planning Development and Special Initiatives, Pakistan)- noted that Pakistan considers geopolitical shocks in their planning in the short and long term and implements the necessary measures to ensure energy security.

Reshma Francy (World Energy Council)- highlighted that the World Energy Council conducts horizon scanning with their issue monitor across regions and uses their findings to develop plausible scenarios. The World Energy Council considers system boundaries and other levers and builds these into their scenarios; the results are used to make relevant policy recommendations.

Ilija Batas Bjelic (Institute of Technical Sciences of SASA (Serbia))- asked whether there were plans to increase energy security by building cross border grids? He noted that Brazil considers the generation aspect, they have 2 markets (wholesale and retail markets) and have a list of solar and wind projects awaiting connection to the system. China and the US also have a long queue of projects waiting for connection- however demand is not high, and prices are low hence there is a lag in the construction of transmission lines to integrate renewables to the system

Charlie Heaps (Stockholm Environment Institute)- noted that modelling is no longer least cost or optimal and it is not necessarily robust especially because of extreme events such as drought. He highlighted the importance of using Integrated resilience resource planning (IRRP) which considers distribution and shocks to the system using techniques such as Montecarlo which uses hundreds of scenarios and considers the distribution of outcomes. Further, countries should consider using Integrated Energy Water Modelling to consider the impact of drought. He finally states that the modelling scope is constantly broadening and there is need for additional technical modelling capacity for smaller countries which don't have sufficient technical capacity.

Farhan Ahmed Memon (Ministry of Planning Development and Special Initiatives, Pakistan)- noted that Demand side management is necessary in Pakistan especially for heating and cooling given the need to decrease fossil fuel consumption.

Asami Miketa (IRENA) – noted that the issue of energy security is considered by the different countries according to their contexts and the LTES Network acknowledges that each country has its sovereign right to decide which technologies to pursue.

Session 7 (Co-hosted with the European Commission Joint Research Centre): Incorporating Behavioral Dynamics and Lifestyle Changes into Energy Demand Modeling

Moderator: *Marija Miletic*, Project Officer Energy Systems and Markets Modelling, European Commission Joint Research Centre

Panelists:

- *Hazel Pettifor,* Senior Research Associate, Oxford University
- *Alessio Mastrucci,* Research Scholar, International Institute for Applied Systems Analysis (IIASA)
- *Alexandra O'Sullivan Freltoft*, Advisor, Danish Energy Agency
- *Hannah Daly, Professor*, University College Cork

Session Objective: This session provided a comprehensive overview of how countries are incorporating behavioural dynamics and lifestyle changes into Long-Term Energy Scenarios (LTES). During this session, participants explored the methodologies used to incorporate behavioural dynamics and lifestyle changes into LTES. Additionally, they discussed new developments and interdisciplinary practices in incorporating behavioural dynamics in LTES modelling at a sectoral level and challenges arising and potential solutions to incorporating behavioural dynamics into LTES.

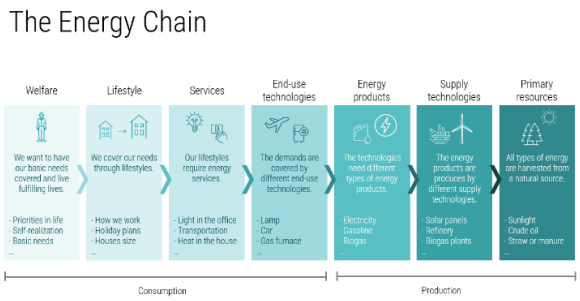
Key Takeaways:

- The discussion concluded on the need to understand the global economy when considering behavioral dynamics and lifestyle change in energy models and scenarios. People in emerging and developing countries often have fewer lifestyle options while people in developed economies have multiple options and can be incentivized to choose low carbon lifestyle options.
- The discussion raised the importance of considering the national political economy when developing scenarios and incorporating lifestyle and planetary boundaries in energy models. Considering these factors can help in presenting scenarios and results that are perceived more neutral, which in turn can foster trust and enable effective, evidence-based policy discourse.
- Globally energy demand is driven by both welfare (meeting people's lifestyle needs) and the private sector investment activities (as firms are investment vehicles aimed at making maximum profit through energy intensive activities. The growth in data centres in Ireland is linked to firm's investment activities and results in additional national energy demand.

Session Summary

Marija Miletic (European Commission Joint Research Centre) – introduced the session and noted that the main theme of discussion was behavioural change in scenarios and how energy models are built to support these the incorporation of behavioural metrics. She noted that behavioural change was viewed as a necessary component for achieving Paris Goals, for instance by supporting the implementation of energy efficiency measures.

Alexandra O'Sullivan Fretloft (Danish Energy Agency)- noted that the DEA had recently been working on including lifestyle in the scenarios through the energy chain. She noted that the energy chain is a framework used to show that there is a big demand for welfare which drives demand for energy. Further, energy demand is driven by welfare which is driven by lifestyles aspects such as work, vacation and daily living choices.



When DEA models the future they assume it is similar as the present and include 2 potential scenarios, one on preventing welfare growth and the second scenario models technological improvement therefore higher efficiency. Model based predictions try to talk about future by extending the present which gives narrow view. To expand the scope of their model-based prediction to understand the choices people make, the DEA worked with stakeholders to map potential futures and used their input when designing potential futures.

Based on this process the DEA has modelled 4 futures as follows: (i) local supply & sector coupling- which envisions growth locally with local resource and local ownership. (ii) Low consumption & new priorities- this is a future envisioned mostly by idealistic young people where they renovate and repair things and have convenient public transport. (iii) Tech-optimism & service economy- this is more from middle aged men where sci-fi is normal have electric, transparent solar and lab grown meat. (iv) Global carbon economy-a future from politicians and includes hydrogen production and carbon capture use and sequestration (CCUS) which supports a carbon economy globally and further global trade.

The DEA uses 4 futures to investigate trends and understand technology. The DEA's outputs are used in strategic discussions and in assessing the feasibility of the different features based on the technical requirements and financial costs.

Hazel Pettifor (Environmental Change Institute, University of Oxford) & **Alessio Mastrucci** (IIASA)- jointly presented on endogenous simulation of low carbon lifestyle and how to introduce low carbon lifestyle change intro global integration assessment models. The introduced the LIFE Model, an empirically based, static model of low-carbon lifestyle which used data from 4 key countries namely USA, Australia, China and the United Kingdom. In this model lifestyle change are used to characterise mitigation pathways focussing on impact.

The model characterises the mechanisms of lifestyle change using 3 elements (i)low carbon cognitions- which are the mental processes that drive behaviours; (ii)low carbon behaviour – which are the physical observable activities and (iii) context- these shapes relationships between cognitions and behaviour.

From the model it emerged that there are 4 different lifestyle clusters (i) the resourceful type- these are long term, climate focused and strong enablers; (ii) active group- goal driven and seek healthier outcomes in life; (ii) constrain type- these have many contextual challenges as they often are

economically disadvantaged and (iv) the cautions- they have the means but lack motivation to make low carbon decisions.

Given the narrow scope of data, it was noted that the modellers extrapolate the date for other countries and have identified 3 different lifestyle mechanisms. The mechanism identifies are as follows: (i) lifestyle a- which as an opportunity effect which is influenced by a cognitively drive; (ii) pathway b-which envisions a change in behaviour or context shifts cognitions; and (iii) pathway c – which is largely cognition driven. Further it was noted that both endogenous or exogenous changes influence the model.

It was noted that for the building sector the MESSAGE and LIFE models are used to match different buildings with different household types thereby linking supply and demand. The models are linked in a manner that allows them to exchange information on energy demand from MESSAGE to the LIFE model and an exchange of the different behavioural propensities from the LIFE model to MESSAGE model. The scenarios have implications for energy demand and are used when designing policy on reducing energy intensity in buildings as they illustrate how behavioural change can help reduce intensity.

It was noted that coupling the LIFE model with global Integrated Assessment Model (IAM) enabled the modellers to simulate the dynamic interaction between low carbon lifestyle change with techno economics processes.

Hannah Daly (University College Cork (UCC))- presented on depicting behavioural change in Long Term Energy Scenarios. Hannah leads a research group that builds scenarios used by Ireland's climate advisory council. The scenarios consider Ireland's equitable contribution to net zero goals- therefore the scenarios build on policy targets and are used to create pathways to achieve net zero.

Given the limited remaining carbon budget to meet 1.5 degree target she highlighted the importance of a faster energy transition. The energy transition is achievable through 2 main pathways, first is through the increased use of renewable energy which makes it possible to stay within the global carbon budget. The second option is through carbon reduction achievable through technological evolution which helps manage and reduce total final energy consumption.

It was noted that modelling has traditionally been done by projecting historical energy demand to the future and then model them with environmental constraints considered. The speaker argued for a shift in modelling approach, suggesting that one should start from the carbon budget before including other constraints. Therefore, the University of Crock have modelled a low energy demand scenario for Ireland, but do not yet include lifestyle aspects in the model. It was noted that in Ireland with the urban and rural sprawl there is higher direct energy demand and the undermining of low carbon infrastructure for instance public transport.

Data centres account for 20% of total electricity consumption in Ireland and are an example of business driving energy demand as opposed to lifestyle choices by individuals. Ireland thereby modelled how much renewable energy is required under different data centre scenarios (high, medium and low). The expansion of data centres in Ireland is driven by the growth in artificial intelligence and investment in cryptocurrency. Historically growth in data centres in Ireland has matched growth in renewable energy generation which has brought a standstill in renewable energy growth. It was stated that the Irish

parliament has previously discussed the role of data centres in the country's energy mix and relied on scenarios when making policy recommendations.

It was noted that it is important to differentiate energy demand drivers as there are instances where demand is linked to welfare and aimed at fulfilling the needs of people, and in other cases (like the data centres) energy demand is linked to private sector demands. From the data centres example, it is evident that technological change is not enough to manage the growth in energy demand; it is necessary to address indirect drivers of consumption and indirect drivers and barriers of transformation to ensure a just transition.

The speaker noted that considering behavioural pathways can open new energy futures that are not apparent when only technology and economic factor are considered. Instead of looking at individual choice modellers should broaden the question to assess how to depict change in long term scenarios. Finally, it was noted that models are not equipped to predict technological innovation and other lifestyle factors and there is need for evolution in modelling approaches.

Panel Discussion

Marija Miletic (European Commission Joint Research Centre)- began the panel discussion by asking panellists to share insights on how behavioural change reduces energy consumption in the different countries.

Hazel Pettifor (Environmental Change Institute, University of Oxford)- noted that different mechanisms are used and have different results. She noted that there was a significant link between cognitive drivers and policy approaches. The LIFE model considers the ability to increase cognitive drivers and also accounts for the role of policy change. She noted that it is difficult to shift values therefore cognition is a difficult driver to change, however it is possible to encourage shifts in behaviours by lowering renewable energy cost, thereby changing the context.

Alessio Mastrucci (IIASA)- noted that most models lack a representation of demand driven by services and different household types. He noted that it is necessary to use engineering models in conjunction with the LIFE model to gain a better understanding of the dynamics that drive energy demand based on different lifestyle. Using more advanced approached that rely on consumption and energy demand are useful and can provide complementary insights on scenarios of lifestyle changes.

Alexandra O'Sullivan Fretloft (Danish Energy Agency)- asked panellists what measures are taken to change cognitive drivers thereby change values.

Hazel Pettifor (Environmental Change Institute, University of Oxford)- commented that one possible option is educating people on the risk of climate change and other environmental messaging. Governments should also work to improve perceptions of life satisfaction and health stemming from low carbon behaviour. She however noted that value shifts are difficult to achieve in real life.

Marija Miletic (European Commission Joint Research Centre)- asked panellists to comment on their work in context of the different stakeholder groups included in their respective studies.

Alexandra O'Sullivan Fretloft (Danish Energy Agency)- noted that the DEA has overlaps with their models with the LIFE model. The DEA uses the Avoid Shift Improve approach in different scenarios. This entails

encouraging low consumption or avoiding unnecessary consumption coupled with technology optimism and supporting the global carbon economy.

When interacting with policy makers the DEA presented evidence on the green subsidies scheme as policy makers sought to understand what futures the investments were focused on and how to diversify them. The DEA plans to put numerical values on the various futures and include them in annual publications which will be used by policy makers and other stakeholders.

Hazel Pettifor (Environmental Change Institute, University of Oxford)- noted that her work was funded by the European Commission funded Horizon 2020 programme and has fed into various stakeholder workshop. They engage with different stakeholders but noted that there are different perceptions as some groups are more receptive while others show more concerned about the proposed futures.

Question and Answers Segment

Ilija Batas Bjelic (Institute of Technical Sciences of SASA, Serbia)- Noted that in Serbia the main barrier to grapple with was the public denying climate change. He noted that lifestyle change was part of the solution on demand side and that it was vital to focus on demand side models. When planning for the reduction of pollution he proposed the use of a model developed by Japanese modellers which considers population, GDP, energy intensity and emission intensity. He highlighted that technology switch and lifestyle change ought to be coupled with pollution reduction initiative to ensure a just transition.

Hannah Daly (University College Cork (UCC))- noted that acceptance of the problem is a key behaviour issue. She noted that the KAI identity was not equipped for discussion as GDP intensity does not reflect the structural aspect for instance the impact of smaller or low energy cars on emission reduction.

Alexandra O'Sullivan Fretloft (Danish Energy Agency)- noted that in Denmark in the 1980s the government supported the renovation of houses to ensure energy efficiency. However, these changes did not change demand as people had better insulated homes but still turned up the heat or got bigger houses.

Charlie Heaps (Stockholm Environment Institute)- highlighted the rebound effect and noted that sometimes it is possible to outrun rebound effect by using technologies for instance how catalytic converters were used to improve air quality despite the increase in industrialisation. He asked panellists for their thoughts why Ireland was very attractive to data centres

Hannah Daly (University College Cork (UCC))- noted that many data centres are located in Ireland because of their taxation framework and geographical closeness to the USA.

Himalaya Bir Shrestha (IRENA)- asked panellists about their experience reflecting behavioural dynamic and lifestyle changes in demand profiles as there is a limited resolution in current models.

Alessio Mastrucci (IIASA)- noted that it is difficult to reflect behavioural dynamics and lifestyle solutions in bigger model which is critical especially when looking at demand side management for instance cooling in the building sector.

Tiina Koljonen (VTT Technical Research Centre of Finland)- Noted that Finland ran the same exercise as Ireland and had a radical change scenario. Based on these results Finland is currently moving on with radical change path which includes fossil free steel and oil refinery industries. There is an increase in the use of electric vehicles and more public transport, however despite these measures' energy consumption

has not decreased. Further, policy makers in Finland are working towards increasing the number of data centres and plan to energy from waste. She noted that, Norway was also considering if they should invite data centres. She asked panellists to share their insights on the views of stakeholders on lifestyle change as this tends to be very emotive. Further she asked how panellists had created risk scenarios and whether these have been effective.

Alexandra O'Sullivan Fretloft (Danish Energy Agency)- noted that the discussion on is a big topic in the European Union given the recent gas crisis suffered by the region. She further noted that there is a discussion on situating infrastructure to ensure energy security by developing shorter supply chains. Further, she noted that Denmark have previously tried to introduce vegetarian lunches 2 days a week which has been possible in municipalities which tax meat-based lunches on the 2 days making them more expensive choices than the vegetarian meals.

Hannah Daly (University College Cork (UCC))- noted that it is vital to carefully frame climate solutions to ensure they proposed solutions cannot be radicalised therefore attract political backlash. She noted that in Ireland there is a tradition of accepting transformative change for instance the country's supporting the end of apartheid in South Africa and the smoking ban. She noted that these changes have been motivated by people working to protect vulnerable people for instance the smoking ban was motivated by the right of workers to work in a smoke free environment. She noted that when scenarios and new lifestyle pathways are properly communicated, people are more willing to make altruistic changes and open to trusting research and science

Rossie Collington (International Political Economy, Copenhagen Business School)- noted that the term welfare is not used in economics and the term preferences is used instead. Consumer preferences are shaped by both structural changes including individual choices and firm choices. She noted that energy demand is not only shaped by preferences but by changes in the way firms conduct their business. The nexus between firms and energy demand stems from the fact that in the 1980s companies evolved from only being producers to becoming investment vehicles aiming to maximize profits in various sectors including fast fashion. Sectors such as fast fashion create short term value for shareholders without changing their overall preference or welfare. She noted that the financial sector, specifically high frequency trading, is a driver of the growth in data centers therefore contributing to the increase in energy demand. She asked panelists to share their thoughts on energy demand drivers and whether models can identify the political economies that firms create and how these drive energy demand.

Filipe de Padua Fernandes Silva (Energy research office (EPE) - Brazil)- asked whether the DEA had encountered challenges of replicating their model in emerging countries like Brazil which have high populations, regional difference and inequalities.

Francesco Mezzera (Politecnico di Milano, Italy)- asked what Denmark's solution was when there was no change in energy demand after renovating buildings to ensure energy efficiency.

Kaare Sandholt (Energy Research Institute of National Development and Reform Commission - China)- noted that a scientific based discussion is necessary when considering behavioral dynamics and drivers of demand as politicians are hesitant to discuss these issues to avoid an unfruitful debate on growth vs degrowth. He noted that Denmark previously had a People's Climate Council which operated for one and a half years and ensured proper engagment between different stakeholders. Currently Denmark runs focus groups which are collecting information on incorporating lifestyle analysis in scenarios using the LEAP models, results will be shared at the conclusion of the study by DEA with all stakeholders.

Florian Knobloch (BMWK - Germany)- noted that Germany faced political pushback when developing scenarios that consider the impact of lifestyle on energy demand as some stakeholders understood it as a conversation on degrowth. He noted that economists in Germany highlighted that a decline in energy demand in one sector may result in a reduction in the spending power of the sector but has the rebound effect of increasing energy demand and spending in a different sector.

Panel Response

Hazel Pettifor (Environmental Change Institute, University of Oxford)- noted that when discussing drivers of lifestyle change it is important to remember that less developed economies have fewer choices- therefore in these cases people are forced into low carbon choices but these can change as the economies develop and people have more options. She noted that it is necessary to understand the global economy when considering behavioral dynamics and lifestyle change.

Alessio Mastrucci (IIASA)- noted that it is important to emphasize both energy demand reduction and the benefits of the reduction when communicating. One benefit in the buildings sector that can be communicated is the improved thermal comfort, and this can be contributed when presenting modelling results.

Hannah Daly (University College Cork (UCC))- highlighted the importance of considering the political economy when developing scenarios and incorporating lifestyle and planetary boundaries in energy models. This will ensure that scenarios are realistic and informative in different contexts.

Alexandra O'Sullivan Fretloft (Danish Energy Agency)- noted that the DEA is working to replicate their models in other countries and is working directly with their partners. Regarding the question on spatial heating and behavioral change she noted that decarbonization in the heating sector and technological innovation resulted in an overall decrease in demand in Denmark's building sector. Regarding changes in behavior in the food system, Denmark has realized that informing people on the impact of their choices and giving people options creates ownership of the decisions to shift to a low carbon lifestyle. She highlighted the importance of analyzing the political climate and perceptions of society when developing scenarios to ensure the development of realistic and helpful scenarios that will inform policy.