LTES LONG-TERM SCENARIOS FOR THE ENERGY TRANSITION

A CAMPAIGN OF THE CLEAN ENERGY MINISTERIAL

IRENA
International Renewable Energy Agency

LONG-TERM ENERGY SCENARIOS

for the clean energy transition

First-year campaign findings

May 2019

ABOUT THE REPORT

Long-term energy scenarios (LTES) have emerged as a vital planning tool for the world's shift to a clean, sustainable and increasingly renewable-based energy system. A campaign was initiated in May 2018 under the Clean Energy Ministerial to promote the improved use and development of LTES for the clean energy transition, drawing on practical experience from 11 participating countries and seven technical institutions.

The Long-term Energy Scenarios for the Clean Energy Transition campaign, also known as the LTES campaign, is led by the governments of Denmark and Germany and co-ordinated by the International Renewable Energy Agency (IRENA).

This document summarises the main findings of the campaign's first year of activities (2018–2019).

The campaign's events and discussions showcased many examples of the value and effective use of scenarios in governments' long-term energy planning processes and several examples of good practice were identified that may inform the work of others. Discussions also revealed that, in the context of the broad and complex challenges of a clean energy transition, much more must be done to encourage the more effective and extensive use of long-term energy scenarios.

The following key insights for policy makers, identified in discussions to date, can help make the most of using long-term energy scenarios:

MAIN FINDINGS AND RECOMMENDATIONS

1 LTES DEVELOPMENT

Establish a strong governance structure for the scenario development process

- The clean energy transition will require broad participation and stronger co-ordination across different government institutions. Examples of strong governance structures exist and can be learnt from.

Expand the boundaries of the scenarios being developed

- Model results are inevitably shaped by the scope of the model itself. To adequately reflect the complexities of the clean energy transition, models and scenarios need to better address new technologies, business models and disruptive innovations.

2 LTES USE

Clearly convey the purpose of the scenarios you build and use

- Scenarios can be used for different purposes, depending on the context and the goals being pursued. Being clear regarding the distinctions is essential to avoid misunderstandings and make the most of insights.

Be transparent and explore effective scenario communication methods

- Transparency enhances the quality of scenarios and builds trust. To be useful, scenario assumptions and results also need to be clearly communicated – particularly given the breadth and complexity of the clean energy transition. Successful examples of innovative and engaging communication methods are emerging.

3 LTES CAPACITY BUILDING

Build the right type of scenario capacity within governments

- The capacity to use scenarios can be created through the use of modelling tools within government institutions. If modelling is outsourced, governments must still ensure they have the capacity to understand the results.

THE CLEAN ENERGY TRANSITION: A CHALLENGE FOR DECISION MAKERS

The clean energy transition presents an unprecedented challenge for decision makers – particularly energy planners and policy makers – that differs substantially in scope and scale from past energy transitions.

The future energy system could look entirely different from that of the present, with a vast expansion of low-cost renewables, a smarter and much more flexible electricity grid, and considerable increases in the numbers of vehicles and other products and processes that run on electricity. Digitalisation, decentralisation and electrification, supported by innovative policy frameworks and market instruments, are poised to create new business models, change consumer behaviour and radically transform established systems. The urgent need to reduce greenhouse gas emissions, as outlined in the climate objectives of the Paris Agreement, calls for deep decarbonisation of the energy sector, which will require a fundamentally different approach to previous strategies that sought to stabilise or halve emissions.

Long-term energy policy formulation and planning pose far more complex challenges than in the past. More than ever, policy makers and investors must make strategic, forward-looking energy decisions that consider new trends and uncertainties in technology, markets and policies.

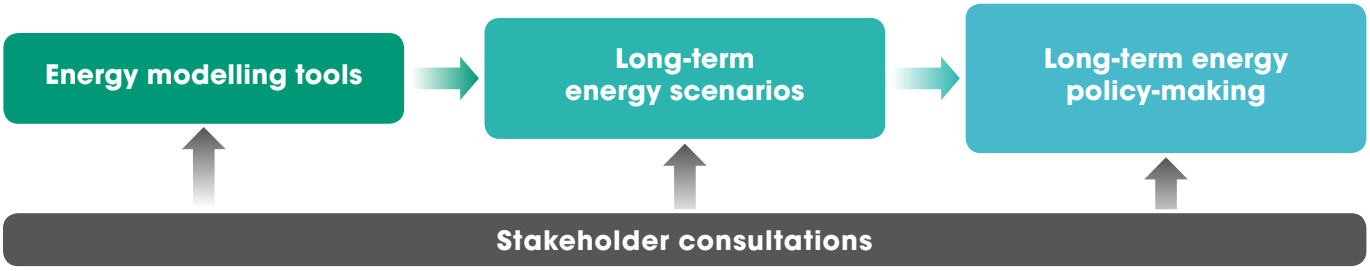
LONG-TERM ENERGY SCENARIOS FOR THE CLEAN ENERGY TRANSITION

Long-term energy scenarios (LTES) that explore socio-technical pathways over c. 20+ years can help trigger productive national and international policy debates, allowing governments to develop well-informed long-term visions and associated energy policies. LTES help governments to prepare for the long-term interventions required by policy goals; they also assist in identifying the short-term challenges and opportunities of achieving the desired energy future. LTES can also be used to inform recommendations on where to direct investment.

Energy modelling tools are often used to support the development of LTES. They assist in quantifying the implications of different technological pathways and can improve the understanding of the complexities and interdependencies within an energy system. Meanwhile, the qualitative aspects of scenarios – such as visions and storylines for the future – are formed through stakeholder consultation at varying levels.

LTES are an essential tool for strategic decision making, but the way in which they are developed and used must evolve and improve to fully support the complex clean energy transition. The participating countries and technical institutions of the LTES campaign are exploring ways to ensure this occurs through various campaign activities. This document summarises the key findings gleaned from these activities so far.

How scenarios are developed and used: A mental model for the LTES campaign



ACCELERATING THE ENERGY TRANSITION IN CEM COUNTRIES

Launched at the 9th Clean Energy Ministerial (CEM) in May 2018 and co-ordinated by IRENA, the **Long-term Energy Scenarios for the Clean Energy Transition** campaign (LTES campaign) aims to promote the wider adoption and improved use of model-based LTES to support and accelerate the energy transition in CEM countries.

Key stakeholders involved in the campaign are scenario users within government planning teams and policy-making institutions, as well as scenario developers within government modelling and development teams.

Focus themes of the LTES campaign

1

STRENGTHENING DEVELOPMENT

Key question:

How can scenarios be developed to better account for potentially transformational changes?

2

IMPROVING USE

Key question:

How can scenarios be better used for strategic decision-making by governments and investors?

3

BUILDING CAPACITY

Key question:

What approaches can enhance institutional capacity for scenario planning?

Key activities of the LTES campaign: First year

EVENTS

- Latin America LTES Workshop in Brasilia (February 2019).
- International LTES Forum in Berlin (April 2019).
- CEM Ministerial Meeting in Vancouver (May 2019).
- 10+ additional sessions during energy conferences.
- Hundreds of expert attendees in total.

WEBINAR SERIES

- 20 webinar presentations from LTES experts.
- 500+ registrants.

LTES REPORTS

- Real-life good practice examples from LTES campaign participants and partner technical institutions.

*Campaign materials and the webinar series are available on IRENA's LTES webpage.

HOW COUNTRIES ARE USING AND DEVELOPING SCENARIOS

Through the LTES campaign's activities, the participating CEM countries shared their various experiences of developing and using LTES for official long-term planning purposes. The table below briefly summarises how key institutions in each participant country have utilised LTES.

Experiences of LTES campaign participating countries:

 **Brazil**	Under the co-ordination of the Ministry of Mines and Energy, the Energy Research Office (EPE) published the National Energy Plan to 2030 based on LTES developed by in-house modelling teams at EPE. EPE is currently developing the national energy plan to look further forward to 2050.
 **Canada**	The National Energy Board (NEB) publishes Canada's Energy Future based on LTES, while Environment and Climate Change Canada (ECCC) publishes LTES for both international and domestic reporting purposes. Both the NEB and ECCC have in-house modelling teams. These activities are supported by data from Statistics Canada and Natural Resources Canada (NRCan).
 **Chile**	The Ministry of Energy publishes a long-term energy planning document every five years with a 30-year time horizon, based on LTES developed by in-house modelling teams.
 **Denmark**	The Danish Energy Agency (DEA), a government agency under the Ministry of Energy, Utilities and Climate, annually publishes the Danish Energy and Climate Outlook and the Power and Gas Infrastructure Outlook based on LTES developed by its System Analysis Department. The System Analysis Department also produces the National Energy and Climate Plan requested by the European Union.
 **Finland**	The energy and climate strategy in Finland up to 2030 was developed by cross-ministry joint work and supported by LTES modelling teams from the VTT Technical Research Centre of Finland and four other research organisations. LTES play an important role in the forthcoming Long-term Energy and Climate Strategy of Finland, which seeks to formulate sustainable pathways to carbon neutrality.
 **Germany**	The Federal Ministry for Economic Affairs and Energy (BMWi) and the German Environmental Agency (UBA) use various LTES procured from research institutions. These LTES usually reflect the renewable energy-related targets of the Energy Concept 2010. The Federal Network Agency (BNetzA) uses LTES as a starting point for transmission grid planning.
 **Japan**	The Ministry of Economy, Trade and Industry (METI) co-ordinates the development of the Strategic Energy Plan, which comprises LTES for 2050 using inputs from the expert panel appointed by the government and considering the energy mix from the outlook for 2030.
 **Mexico**	The Federal government has published the National Energy Strategy, in which the vision for 2050 is established based on LTES with 15- and 30-year time horizons developed by in-house modelling teams at the Mexican Secretariat of Energy (SENER).
 **The Netherlands**	The Netherlands Environmental Assessment Agency (PBL) publishes the Dutch National Energy Outlook, providing four Ministries (Economic Affairs and Climate; Interior; Infrastructure and Water Management; and Finance) with LTES developed by in-house modelling teams. From 2019 onward, this Outlook will be renamed the 'Climate and Energy Outlook' and will have legal status as reference for policy progress as stated in the new Climate Law.
 **United Arab Emirates**	The Ministry of Energy and Industry (MOEI) launched the National Energy Strategy 2050, informed by LTES developed by in-house modelling teams. It has developed the Future Lab to communicate LTES results to high-level political leaders.
 **United Kingdom**	The Department for Business Energy and Industrial Strategy (BEIS) maintains a national energy system model with a 2050 planning time-horizon in close co-operation with academia to inform policy development – the Clean Growth Strategy is a good example.

1. STRENGTHENING THE DEVELOPMENT OF SCENARIOS

ESTABLISHING A GOOD GOVERNANCE STRUCTURE

The clean energy transition will require broad participation and stronger co-ordination across different government institutions.

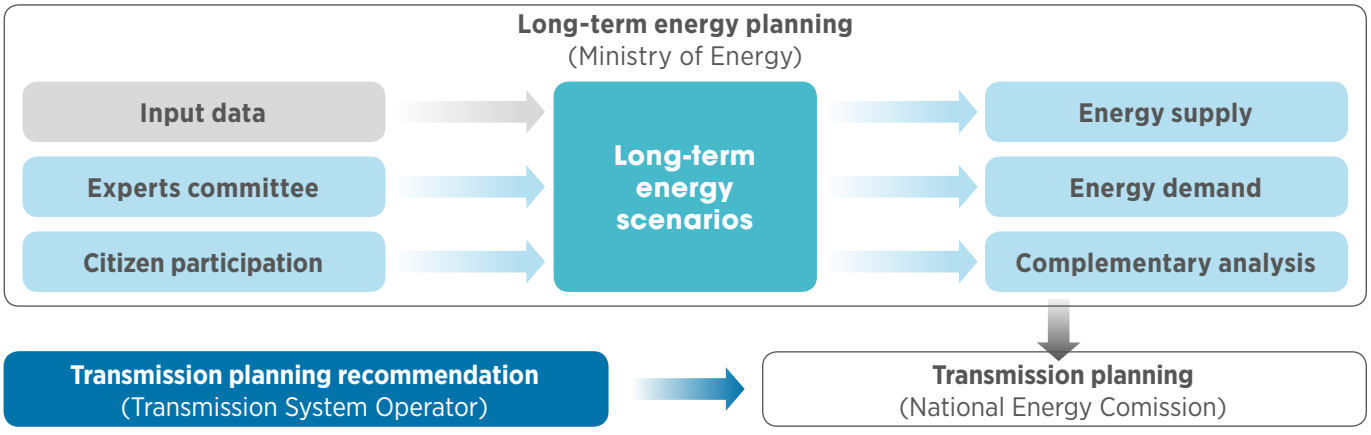
The process of LTES development varies widely across different countries and contexts. Some governments have particular steps and outputs stipulated in national law, while others have less formal processes or none at all. The same variations can be seen in the scope of stakeholder involvement and consultation, which differ significantly across jurisdictions.

It has become clear from the LTES campaign's discussions, however, that the clean energy transition requires more co-ordinated and expansive governance of LTES development than in the past, involving a broader set of stakeholders. For example, the emergence of distributed energy sources and smart grid technologies can turn energy consumers into more active participants in the energy system, which will likely increase the prominence of their participation in the LTES development process.

Electrification of new sectors and the unique geographic and production patterns of renewables such as wind and solar require better co-ordination among institutions that develop scenarios spanning different temporal granularities and spatial boundaries (e.g. cities and regions). Given that the clean energy transition is inextricably linked with climate policy, better co-ordination is also required across energy and climate scenarios, which often fall under different institutional jurisdictions.

The LTES campaign has identified a range of good scenario governance practices. Impressive stakeholder consultation is practised in many of the campaign member countries and the process is increasingly opening up to include civil society to build a broader consensus for clean energy transition pathways. For example, the Ministry of Energy of Chile now incorporates citizen participation in every step of its LTES development process. In Finland, dedicated cross-Ministry workshops are held during the LTES development process. In some campaign member countries, a co-ordinated process is in place for both energy and climate to be approached in an integrated manner (e.g., the United Kingdom's Department for Business, Energy and Industrial Strategy [BEIS]).

Long-term energy and transmission planning: Governance structure in Chile



Adapted from the LTES webinar series: presentation by Chile Ministry of Energy, 29 November 2018

EXPANDING THE BOUNDARIES OF SCENARIOS

Model results are inevitably shaped by the scope of the model itself. To adequately reflect the complexities of the clean energy transition, models and scenarios need to better address new technologies, business models and disruptive innovations.

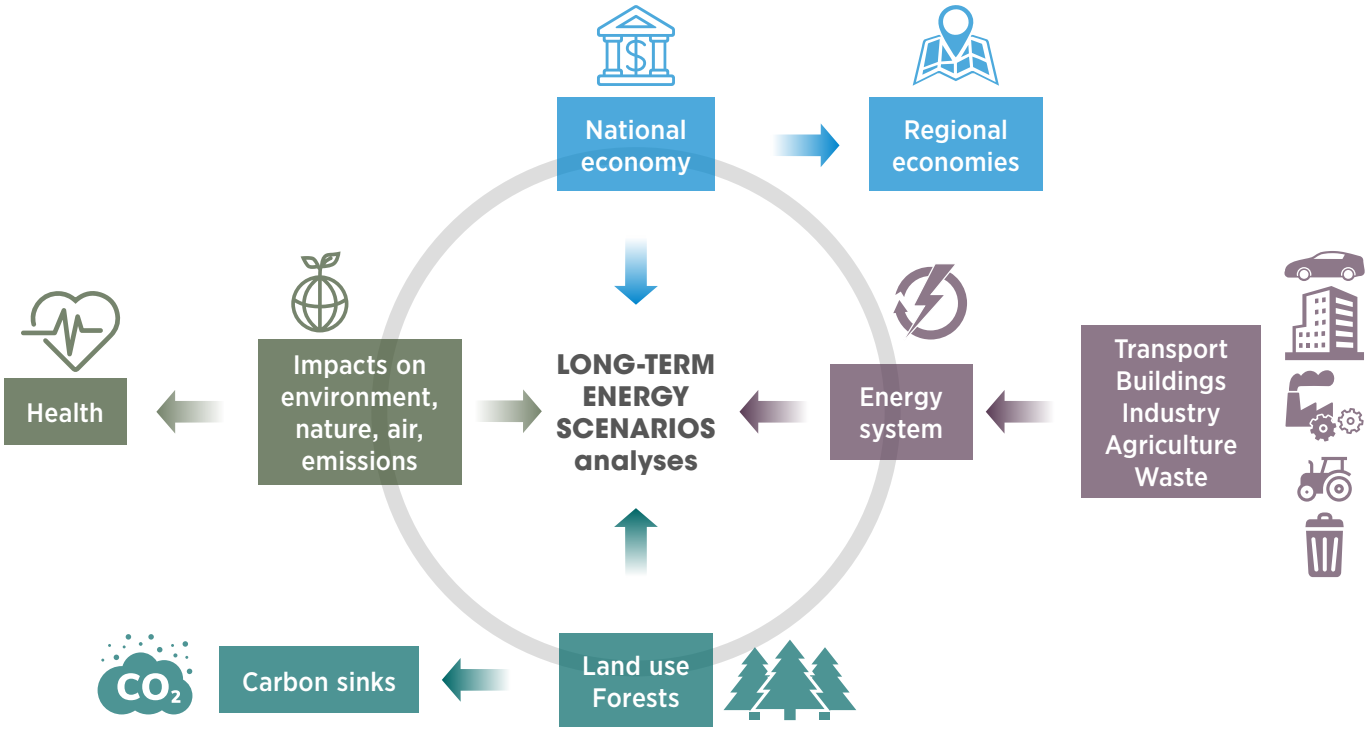
The energy transition is no longer solely concerned with specific technology or cost evolutions, but now also involves managing structural change. Many innovations are coming together, both within and around the energy sector, such as digitalisation, decentralisation and electrification. The means by which these innovations will be fully developed and deployed remains uncertain, and unexpected breakthroughs may occur. Unconventional non-energy players are also increasing their interaction with the energy sector (e.g. facilitating prosumer activity), making the supply side harder to distinguish from the consumer side.

Many of the recent or emerging trends underlying the clean energy transition are not well reflected in – or are absent from – LTES, due primarily to gaps in the current capability of modelling tools. For example, consumer behaviour such as maximising self-consumption from rooftop solar PV systems by connecting with residential battery storage and electric vehicles was simply not in the minds of model designers 20–30 years ago.

The hydrogen economy, and the way in which it may co-evolve with electricity infrastructure, remains largely absent from current techno-economic modelling. Today's scenarios also likely underestimate the growth of variable renewable energy, electrification of end-use demand and sector coupling (among transport, buildings and industry).

Representing such disruptive innovations and dramatic social changes in LTES remains a challenge for campaign members. It is important not only because the boundaries of a given energy model determine the results, but also because the comparability of LTES can be hindered by vastly different or unclear model boundaries.

Modelling framework to study the impacts of long-term energy policies in Finland



Adapted from the LTES webinar series: presentation by VTT Technical Research Centre of Finland, 13 December 2018

2. IMPROVING THE USE OF SCENARIOS

CLARIFYING THE PURPOSE OF SCENARIO BUILDING

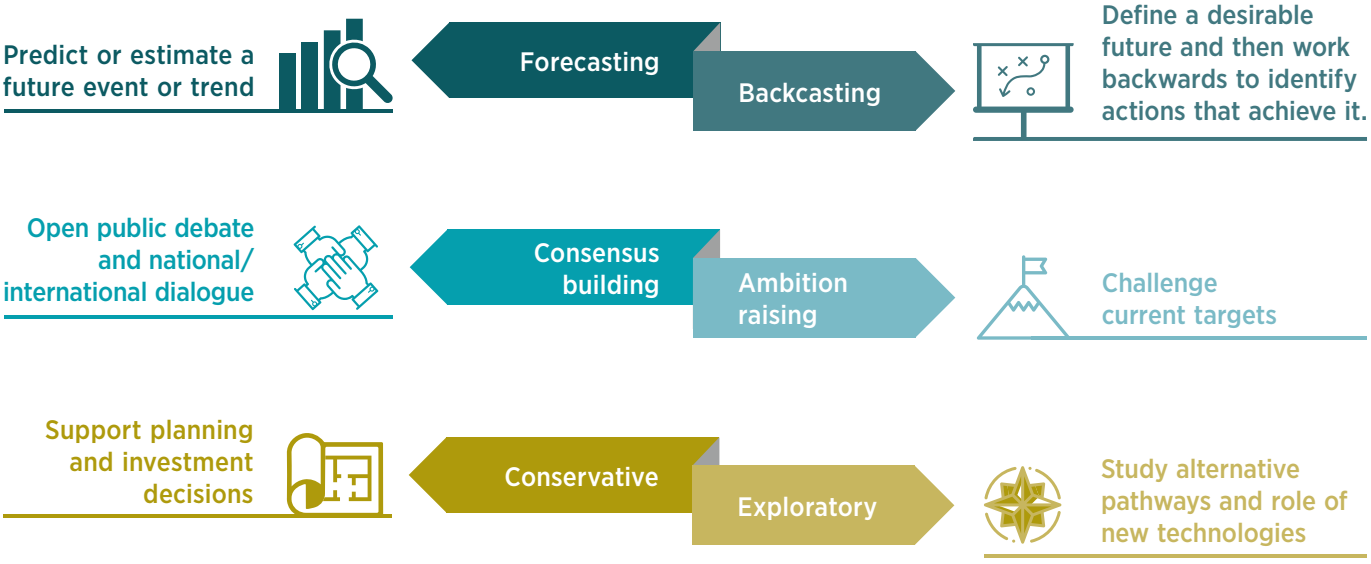
Scenarios can be used for different purposes, depending on the context and the goals being pursued. Such distinctions should be clear to avoid misinterpretation of clean energy transition scenarios.

Although the inherent purpose of a scenario is to portray a vision of the future, expectations as to what scenarios can provide and how they are used can vary significantly depending on the context; this must be well-understood in their application. While some policymakers might expect scenarios to provide forecasts and a clear answer to a policy question, others use them to explore a range of future uncertainties to inform choices.

Discussions during the LTES campaign indicate a clear consensus among those who develop scenarios that exploring uncertainties is becoming increasingly important as the clean energy transition progresses. The campaign has found that conservative scenarios tend to be used for infrastructure planning (such as that undertaken by public utilities) while more exploratory scenarios tend to remain as academic exercises to explore more radical or even extreme transformations. Such distinctions are useful in better understanding scenario insights.

Most scenarios developed by the LTES campaign participants fall somewhere in the middle of the conservative–exploratory spectrum. In the context of national policy making, using scenarios for consensus building through an open and participatory process is critical; in other contexts, scenarios can be used to pursue a specific agenda and raise ambitions. While consensus-building processes may appear to limit the role of ambitious views, experience from LTES campaign members shows that civil society often demands a cleaner energy future – thus, an open and participatory process may result in higher ambitions.

Types and purposes of long-term energy scenarios



TRANSPARENT AND EFFECTIVE COMMUNICATION

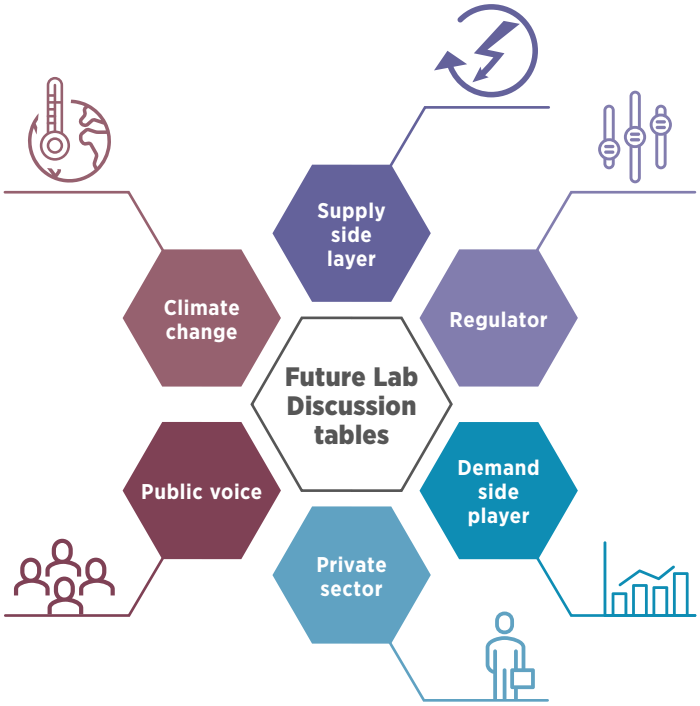
Transparency ensures the quality of scenarios and builds trust. Scenario assumptions and results need to be clearly communicated in the context of more complex clean energy transitions and innovative communication methods are now emerging.

Scenarios are often most useful as a communication tool that translates the complexities of the energy system into understandable and internally-consistent messages. The clean energy transition introduces new elements and dynamics into energy systems; through effective scenario communication, policymakers can develop a better understanding of how these elements and dynamics play out and thereby make more informed decisions. Transparency is required in terms of input data, methodology and assumptions. This allows scenarios to be thoroughly scrutinised and decision-makers to trace which assumptions drive specific results.

In LTES campaign discussions, however, communication was flagged as one of the main challenges in the use of scenarios. The abundance of scenarios offering diverse pathways to achieve the clean energy transition often confuses decision makers. Recognising this issue, an increasing number of research institutions have created web-based platforms that allow comparison of LTES, and some LTES campaign member countries have initiated innovative approaches for improved communications.

For example, the UAE's Ministry of Energy and Industry set-up FutureLab to conduct a specially-designed 'game' that opens-up the scenario development process to high-level policymakers and allows for stress testing of assumptions and results. Another, comparable approach has been taken by the Technical University of Denmark in engaging political parties through the Model Lab concept, supported by an online interactive scenario communication tool.

A game to improve scenario transparency:
The FutureLab communication exercise used by policy makers in the United Arab Emirates



Adapted from the LTES webinar series: presentation by the Ministry of Energy and Industry, United Arab Emirates, 21 February 2019

3. IDENTIFYING APPROACHES TO SCENARIO CAPACITY BUILDING

BUILDING THE RIGHT TYPE OF SCENARIO CAPACITY IN A GOVERNMENT

Capacity to use scenarios can be created through the use of modelling tools within government institutions. If modelling is outsourced, then governments must still ensure they have the capacity to understand the results.

Some governments build in-house modelling capacities to elaborate on the technical aspects of scenarios. Governments that opt to build and maintain modelling capacity in-house do so directly in energy ministries, energy agencies or other government-dependant institutions. Among LTES campaign members, Chile, Canada, Denmark, Mexico, the United Arab Emirates and the United Kingdom may be placed in this category.

Governments can also choose to outsource all or part of their scenario development work to one or several research/technical institutions or consultancies. Scenario development in Finland, Germany and Japan is broadly centred around this model. Independent energy agencies or technical institutions can be a middle-of-the-road option for allocating scenario-building capacity and boosting in-house capacity building. The approaches in Brazil and The Netherlands are examples of this category.

LTES campaign discussions identified several key factors that broadly determine the approach used to source modelling capacity; these are summarised below.

Advantages and challenges of insourcing and outsourcing LTES development capacity

INSOURCING: LTES capacity within ministries or energy agencies		**OUTSOURCING:** LTES capacity out-sourced to research/ technical institutions or consultancies
Ensures closer and faster interaction with policymakers.	**GOVERNMENT INVOLVEMENT**	Can result in intermittent and shorter interactionswith policymakers.
Tends to have a limited number of scenarios, often reflecting more conservative viewpoints.	**SCENARIO DIVERSITY**	Tends to cover a broader range of scenarios, reflecting the client's views and agenda.
Depends on government technical capacity and access to tools and information.	**QUALITY OF RESULTS**	Allows procurement from different high-end commercial tools tailored for purpose.
Quick response to pressing government policy needs, subject to the capacity of the team.	**RESPONSE RATE**	May take time to procure scenarios but offers a range of execution timings as specified by government needs.
Ensures full transparency of inputs and outputs through closer interaction with an in-house modelling team.	**TRANSPARENCY**	Tends to be black-box, and proprietary licences may potentially limit full access to the tools.
Can be cheaper but requires significant efforts to build modelling capacity.	**COST**	Tends to be expensive to hire commercial consultancy firms.
• **Quality assurance (e.g. engaging with academia).** • **Team or agency dedicated to modelling and scenario building.** • **Setting an institutional process for regular updates of LTES.**	**KEYS FOR SUCCESS**	• **Absorptive capacity within a government to understand the modelling results.** • **Full disclosure of scenario data and modelling methodology.** • **Access to enough high-quality research institutions.**

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About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity. **www.irena.org**

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Participating countries in the CEM LTES campaign: Ministry of Mines and Energy/Energy Research Office (EPE) – Brazil, Natural Resources Canada – Canada, Ministry of Energy – Chile, Ministry of Climate, Energy and Buildings – Denmark, Technical Research Centre of Finland (VTT) – Finland, Federal Ministry for Economic Affairs and Energy (BMWi) – Germany, Ministry of Economy, Trade and Industry (METI) – Japan, Mexican Secretary of Energy (SENER) – Mexico, Netherlands Environmental Assessment Agency (PBL) – The Netherlands, Ministry of Energy and Industry – United Arab Emirates, Department for Business Energy and Industrial Strategy – United Kingdom.

Participating technical institutions in the CEM LTES campaign: China National Renewable Energy Centre (CNREC), International Energy Agency (IEA), IEA Energy Technology Assistance Programme (IEA–ETSAP), Joint Institute for Strategic Energy Analysis (JISEA – U.S.)/National Renewable Energy Laboratory (NREL – U.S.), European Commission Joint Research Centre (JRC), State Grid Energy Research Institute (SGERI – China), World Energy Council (WEC).

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