IAEA BRIEF 2018/6

Energy

IAEA Methodologies and Models for Sustainable Energy Planning

SUMMARY

1. Energy is essential for all human activities, and increased energy production and availability is a challenge for economic and social development. Today, the world faces major challenges in ensuring access to modern energy services.
2. Developing effective national energy strategies is crucial to address concerns over energy resource availability, climate change, air quality and energy security.
3. The IAEA strengthens its Member States' capacities through training and technical assistance to perform integrated energy assessments and formulate long term strategies.

The IAEA tools and methodologies for energy planning are aimed at improving national and regional capabilities for performing integrated energy assessments to formulate long-term strategies for sustainable energy development.
(Photo: T. Kalapurackal/IAEA)

INTRODUCTION

Access to reliable and affordable energy is critical to social and economic development. Today, over one billion people around the world still lack basic access to electricity, and a substantial increase in supply will be required over the next decades to support economic development and meet the United Nations Sustainable Development Goals (SDGs).

Integrated energy planning is critical to designing the energy strategies needed to achieve sustainable development. It systematically analyses a wide range of factors influencing the evolution of energy systems. Such a framework can also foster exchange among the many stakeholders involved in decision-making on energy supply and ensure consistency with national development goals.

WHAT IS ENERGY PLANNING?

Energy planning is the process of developing long-term strategy to help guide the future development of the energy system that is being evaluated. It is mainly carried out by governmental organizations and electric utilities using data drawn from different stakeholders. Careful energy planning is important given power plants' significant capital costs and long-life span.

The IAEA assists Member States in national and regional energy systems analysis and planning to help them independently set out their own national energy strategies. As one of the sources of energy, nuclear power can help meet growing global energy demand. Over 450 nuclear power reactors in operation in 30 countries produce almost 10.3% of worldwide electricity generation and roughly one-third of the world's clean electricity.

Today, about 150 countries and 21 international organizations are using the IAEA analytical tools for developing sustainable energy strategies.

(Infographic: IAEA)

Depending on a country's own resources, its stage of infrastructure development and its sustainable development objectives, the energy system analysis may or may not conclude that nuclear energy should be part of its future energy mix.

WHAT IS AN ENERGY SYSTEM?

Energy services are required for virtually every human activity. The energy system is made up of the energy supply sector, energy end-use technologies needed for everyday life activities, and the associated infrastructure that converts the energy commodities provided by the energy sector into energy services.

EFFECTIVE ENERGY STRATEGIES

Development of energy strategies aims at ensuring that decisions on energy system development involve all stakeholders, consider all possible energy supply and demand options, and are consistent with overall goals for national sustainable development. The concept of sustainable development encompasses the three interdependent and mutually reinforcing pillars of social development, economic development and environmental protection, linked by effective government institutions.

The energy planning process starts by taking stock of a country's or region's overall energy situation using a set of indicators that encompasses all aspects of sustainable development, and then generating an image of the existing energy system, from resource extraction to the provision of energy services.

IAEA SUPPORT IMPROVES CAPABILITIES

The IAEA provides technical assistance to its Member States, in particular to developing countries, to improve their capabilities to perform integrated energy assessments and formulate long term strategies. Support for sustainable energy development and the possible role of nuclear power in meeting future energy needs includes:

- Transferring energy assessment methodologies and analytical tools;
- Training for energy model set-up and application;
- Analyzing and translating model outputs to practical policy formulation;
- Providing services aimed at specific aspects of capacity building in energy analysis and planning, and training courses with topical and specialized lectures.

OPTIONS FOR ENERGY PLANNING

Computer-assisted modelling forms the core of the IAEA's approach to energy system analysis and planning. National economic and energy statistics provide inputs to the models to reflect the current energy system as well as its interaction with the principal drivers of energy demand and supply, such as demographics, economic development, technology change and environmental policy.

Using IAEA energy planning tools, energy planners or policy analysts can create profiles of projected energy service demands and optimal supply mixes, and propose the most cost-effective approach to meeting future energy needs.

What are NESA and INPRO?

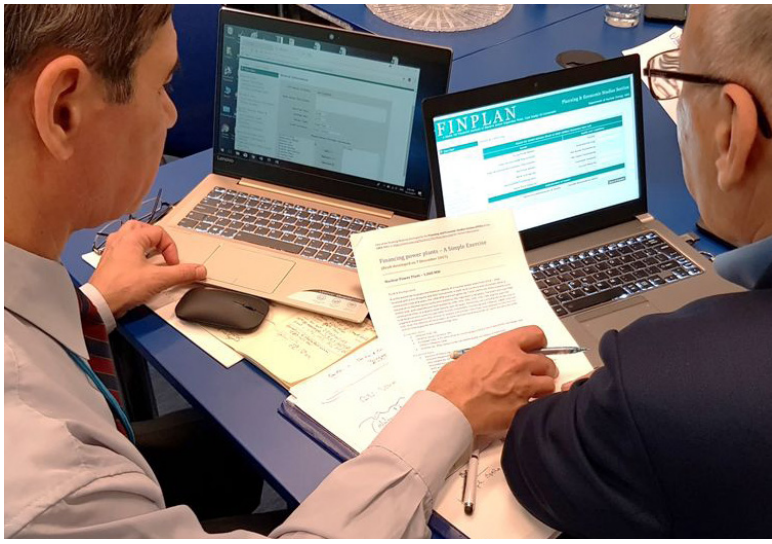
A Nuclear Energy System Assessment (NESA) helps energy planners in Member States make informed decisions on the choice of the most appropriate nuclear system and determine whether their strategic deployment plan is sustainable. It is a holistic approach, using an internationally validated tool — the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) methodology — to support strategic decision-making in countries planning to establish a new nuclear power programme or expand an existing one.

INPRO is a membership based project that supports long term planning and collaboration on innovation in reactors, fuel cycles and institutional approaches to promote the sustainable development of nuclear energy. The INPRO methodology was developed as a tool to undertake national, regional or global NESAs. It covers seven areas related to reactors and nuclear fuel cycle facilities: economics, infrastructure, waste management, proliferation resistance, physical protection, environment, and safety.

If all criteria are met in the assessment areas, the nuclear energy system represents a source of energy consistent with a country's sustainable development criteria. If only some of the criteria are met, a given nuclear energy system may still represent an excellent interim energy supply system, but will need to evolve to become sustainable in the longer term.

IAEA Analytical Tools and Methodologies for Energy Planning

The **Model for Analysis of Energy Demand (MAED)** evaluates future energy demand based on a set of consistent assumptions on medium to long term socioeconomic, technological and demographic



The IAEA's wide-range of energy planning tools for sustainable development are delivered through computer based software programs and manuals, trainings and e-learning platforms, upon request by its Member States.
(Photo: M. Welsch/IAEA)

developments in a country or region. Future energy needs are linked to the production and consumption of goods and services; technology and infrastructure innovation, lifestyle changes brought about by increasing personal incomes; and mobility needs. Energy demand is computed for a host of end-use activities in the main 'demand sectors' — household, services, industry and transport. MAED provides a systematic framework for mapping trends and anticipating change in energy needs for socioeconomic development.

The **Model of Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE)** combines technologies and fuels to construct so-called 'energy chains', making it possible to map energy flows from resource extraction and energy conversion (supply side) to the distribution and provision of energy services (demand side). This model can help design long term energy supply strategies, or assess energy policy options by analysing cost optimal energy mixes, investment needs and other costs for new infrastructure, energy supply security, energy resource utilization, the rate of introduction of new technologies, and environmental constraints.

The **Wien Automatic System Planning Package (WASP)** is an effective tool for power planning in developing countries. It helps to determine 'optimal' expansion plans for power generation within constraints identified by local analysts, which may include limited fuel availability, emission restrictions and system reliability requirements, among others. WASP explores all possible sequences of capacity additions that are capable of satisfying demand while also meeting system reliability requirements.

The **Model for Financial Analysis of Electric Sector Expansion Plans (FINPLAN)** is used for financial analysis of electricity generation projects and includes financing sources, expenditures, revenues, taxes, interest rates and weighted average capital costs. Since financial constraints are often the biggest obstacle to implementing an optimal energy strategy, the model is particularly helpful for exploring the long term financial viability of projects by preparing cash flows, income statements, balance sheets and financial ratios.

The **Simplified Approach for Estimating Impacts of Electricity Generation (SIMPACTS)** estimates and quantifies health and environmental damage costs, so-called 'externalities', of different electricity generation technologies. This tool is particularly useful for comparative analyses of fossil, nuclear and hydro-electricity generation, siting of new power plants or cost-effectiveness of environmental mitigation policies.

The **Indicators for Sustainable Energy Development (ISED)** framework provides a flexible tool for analysts and decision-makers to better understand their national energy situations and trends, and the impacts of policies and policy changes on the energy system. The indicators reflect the interaction of energy with the economic, social and environmental aspects of sustainable development over time. The ISED can also be used to monitor the progress of policies and strategies for sustainable energy development.

The **Energy Balance Studio (EBS)** is an effective tool for providing a systematic framework in organizing the energy statistics data that can be used for constructing inputs for energy planning models like MAED and MESSAGE.

The **Energy Scenarios Simulation Tool (ESST)** is a simple tool for exploring energy system development that allows the assessment of future simplified energy balances and provides a first screening of alternative scenarios in terms of capacity expansion, investment and GHG emissions.

About 150 countries and 21 international organizations already use IAEA analytical tools for sustainable energy strategies, including energy supply options, energy investment planning and policy formulation.

AREAS WHERE MEMBER STATES MAY BENEFIT FROM IAEA ASSISTANCE

- Supporting Member States' energy development strategies, with or without an interest in assessing the role of nuclear power.
- Boosting understanding of nuclear technology's possible contributions to socioeconomic development, climate protection and energy security.

IAEA Briefs are produced by the Office of Public Information and Communication
Editor: Aabha Dixit • Design and Layout: Ritu Kenn
For more information on the IAEA and its work, visit www.iaea.org
or follow us on
or read the IAEA's flagship publication, the IAEA Bulletin, at www.iaea.org/bulletin

IAEA, Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Email: info@iaea.org • Telephone: +43 (1) 2600-0 • Facsimile +43 (1) 2600-7