IAEA
International Atomic Energy Agency
Atoms for Peace and Development

IAEA Modelling Tools for National Energy & Climate Plans (NECPs)

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Introduction to the IAEA

and its

Planning and Economic Studies Section (PESS)

Introduction to the IAEA

IAEA

- Set up in 1957 for cooperation in the nuclear field
- Promotes the safe, secure and peaceful use of nuclear technologies
- Nobel peace prize in 2005 to IAEA & its Director General (Mohamed ElBaradei)
- Headed by Yukiya Amano as Director General
- 170 member states
- 2500 employees from > 100 countries

Introduction to PESS

Planning & Economic Studies Section

To strengthen Member States' capacities in energy system analysis, guided by national sustainable energy strategies

To investigate the most suitable mix of energy technologies

Energy Modelling & Capacity Building at PESS

Supporting Member States (MS) with

… energy data & analytical tools

- Development of new tools with multi-lingual user interfaces
- Updates of existing models
- Provision of tools to MS at no cost

… training local experts

- Distance e-learning
- Expert missions, fellowships & exchange of experience
- Online support & manuals

… support to energy planning

- Technical guidance & assistance in conducting national studies

Energy Planning Tools

by the Planning and Economic Studies Section (PESS)

PESS Energy Planning Tools

are used by

147 Member States (MS)
21 Regional & International Organizations
~20 ongoing national & regional technical cooperation projects

>100 MS not engaged in nuclear power

Example of Partners using PESS tools

IRENA

- IRENA uses IAEA energy modelling tools
- IAEA draws on IRENA's analytical work
- Joint support to Member States (e.g., Sierra Leone, Eswatini)

Joint Launch of Energy Master Plan of Eswatini, Oct. 2018

PESS Energy Planning Tools

cover sustainable energy from demand to supply

MAED

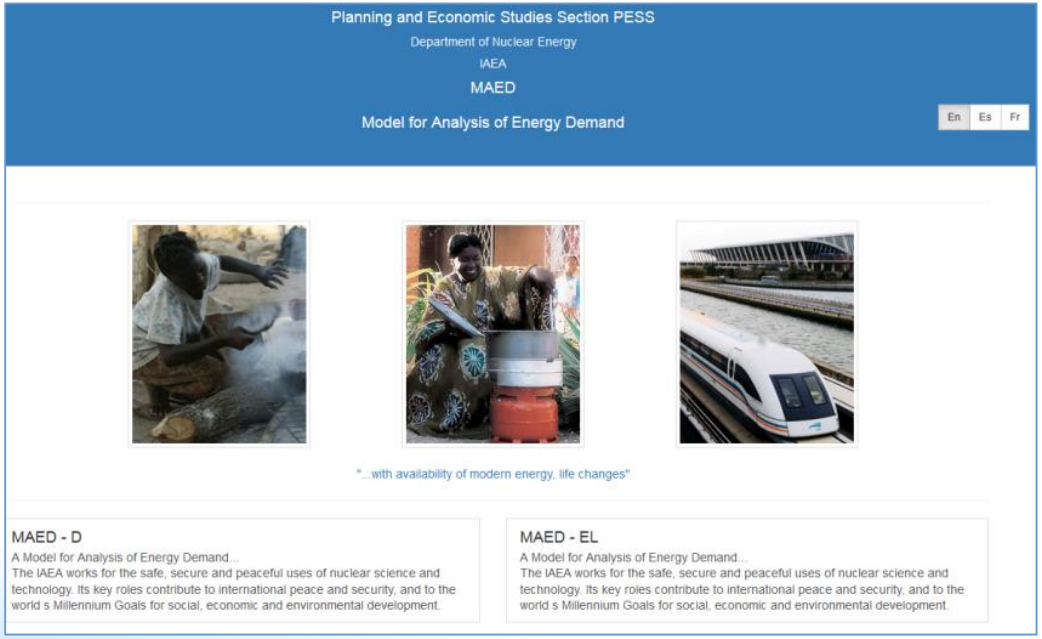
Model for Analysis of Energy Demand

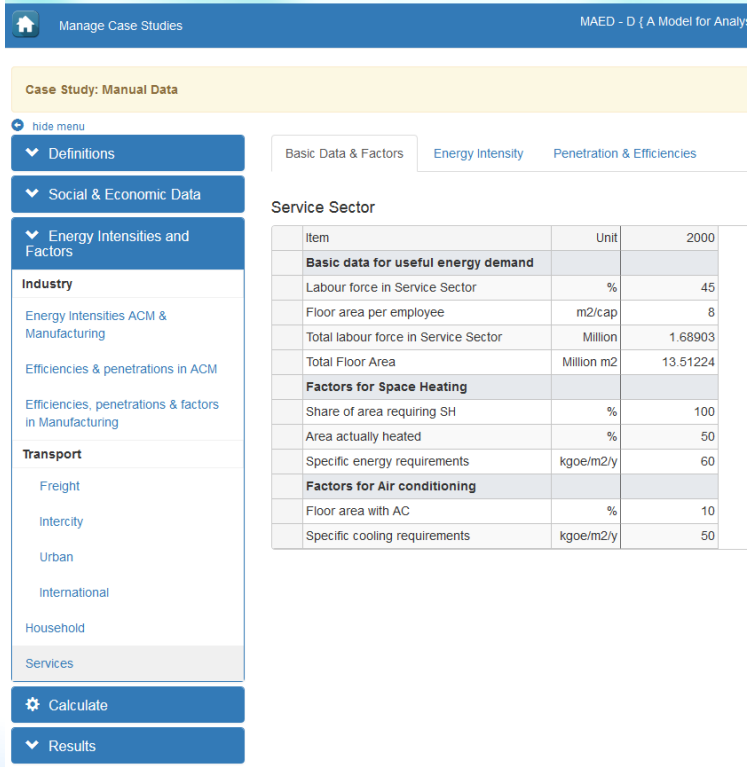
Bottom-up scenario simulation tool

Considers energy forms (incl. traditional fuels) in all economic (sub-)sectors at end-use level

2 Modules: Energy (MAED-D) and Electricity (MAED-EL)

Outputs: useful & final energy/electricity demand by sector/fuel, hourly electric load, load duration curve





MESSAGE

Model for Energy Supply System Alternatives and their General Environmental impacts

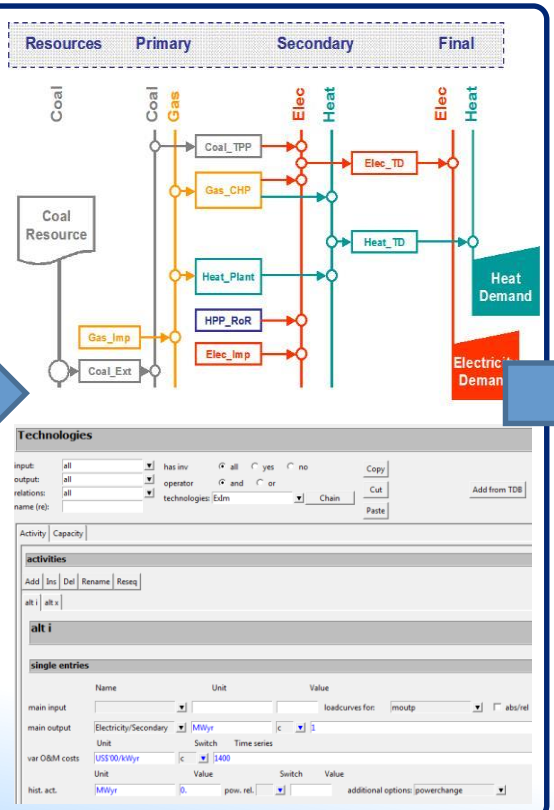
Long-term energy system model to analyze cost optimal energy pathways.

Originally developed by IIASA, enhanced by IAEA with new features & user interface

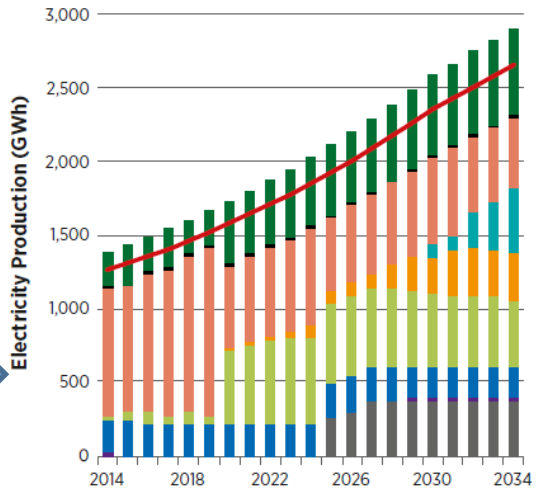
INPUT

- Energy system structure
- Energy demand projections (MAED)
- Technology and resource options, incl. techno-economic performance
- Technical, environmental and other policy constraints

MESSAGE



OUTPUT



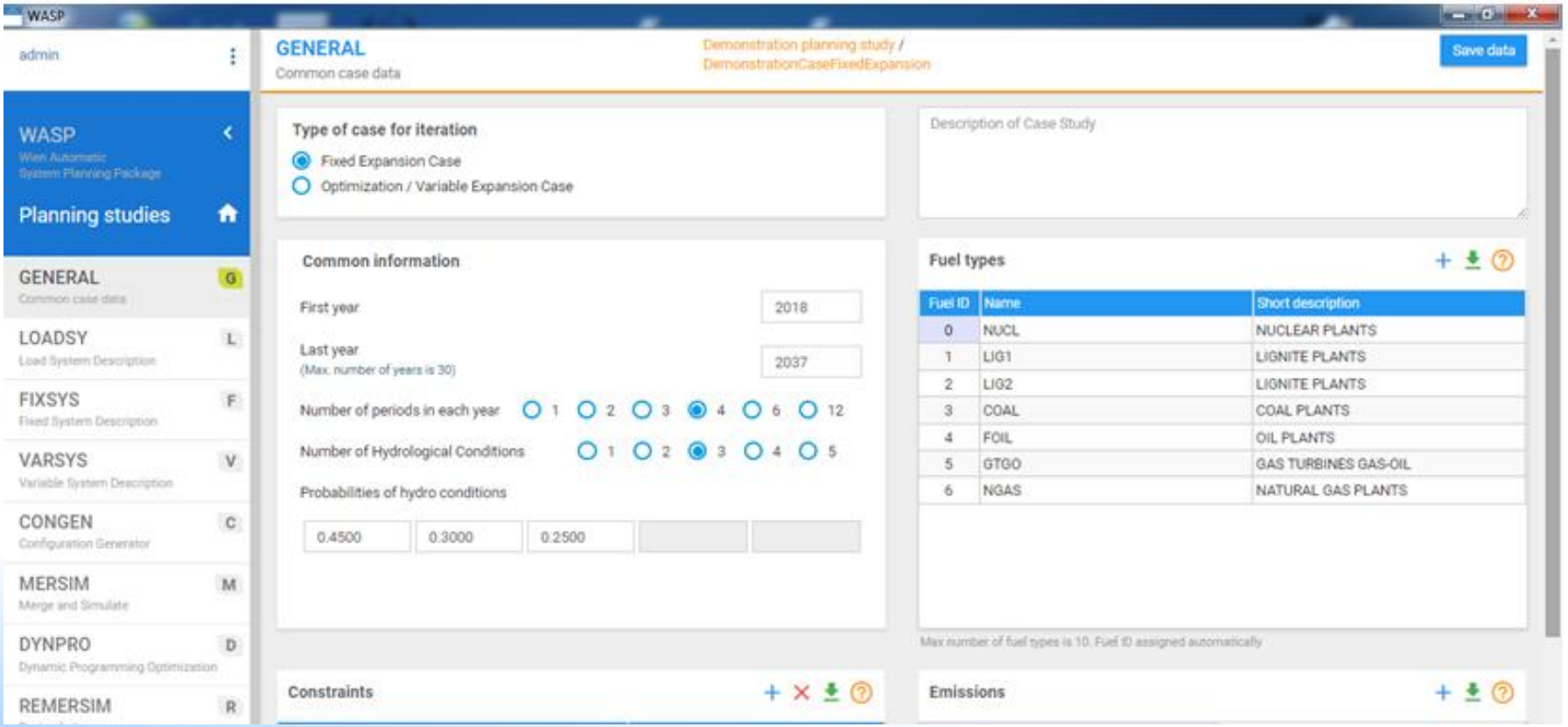
- Primary & final energy mix
- Emissions
- Resource use
- Import dependence
- Investment requirements
- Land & water use, etc.

WASP

Wien Automatic System Planning Package

Long-term power system model based on probabilistic production cost simulation & optimisation.

Outputs: Construction schedule of individual plants, generation, emissions, LOLP, etc.



Example of Applications

Assessing Nationally Determined Contributions (NDCs) in collaboration with our partners, such as UNFCCC and IRENA

Regional NDC Workshops

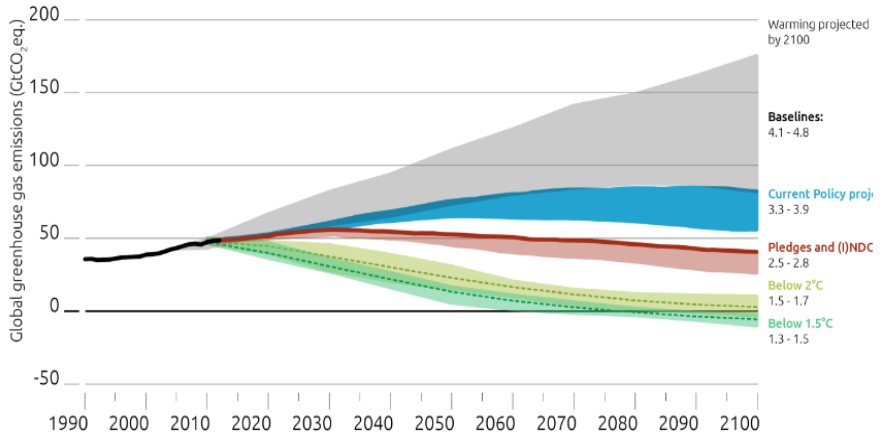
for Europe, Asia, Africa and Latin America

National energy plans: 20 countries currently supported

Research programmes

Outputs

- Investment pathways
- Greenhouse gas (GHG) emission profiles
- Optimal technology mix to achieve GHG targets
- Strengthened expertise for evaluating energy options



IAEA Tools for NECPs
Practical Experience

PESS Tools to inform NECPs

Example from Practice

Five dimensions of NECP

1. Security, solidarity & trust - diversification
2. Fully integrated internal energy market
3. Energy efficiency
4. Climate action
5. Research, innovation & competitiveness

Demand analyses with MAED (e.g., energy efficiency and savings, fuel switching...=

Supply analyses with MESSAGE/WASP (e.g., supply diversification, regional markets, system flexibility)

General approach

- Scenario analysis
  - Iterative Demand-Supply analysis
  - Predefined set of scenarios – Current policies (Existing measures), Additional measures, *Deep measures, Net zero emission (by 2050)*
- Planning/analysis period (predefined)
  - Annual until 2030, outlook for 2040
  - Models developed for 5-year steps resolution

- Work overlapped with National Energy Strategy development (harmonization and synergy)

Tools applied

- MAED
  - Energy demand projections
  - Separate module for demand in transport
  - Synthesis of future hourly load curves
- MESSAGE
  - Electricity and centralised heat (CHPs)
- *PLEXOS (commercial software)*
  - *Checking feasibility of hourly operation for selected years*
- Energy balances compilation
- *Other aspect*
  - *Grid development/impact*
  - *Expert estimates for several areas and Re-use of existing studies*
  - *Extremely short period for drafting (less than six months)*
  - *Core modelling team – 8 experts (cumulative experience of 100+ years), extensive previous knowledge and data sets on national energy system*

Demand Analysis 1

- NECP requires detailed demand categories to be considered (to take into account targets, model various measures and policies and be able to calculate required indicators, i.e. to conform to a predefined structure)
  - Bottom-up demand analysis and consumption sectors structure should be aligned to NECP requirements
  - Need to clearly connect demand modelling with “real world” measures
  - Data availability issues (measures require fine granularity)
  - Estimate of financial needs for each measure or group of measures (not directly modelled within software – scenario/variants approach; out of model estimates)

Demand Analysis 2

- Demand in transport modelled with high level of details (other demand categories should follow similar approach)
  - Expertise and data were immediately available
  - Expertise in individual fields neeeded
  - Data sets needed
- Synthesis of future hourly load curves and customer storage operation
  - Pre-optimised charging of electrical vehicles to reduce peak loads

Supply Analysis 1

- Electricity system
  - Divided into two sub-regions
  - Zonal modelling of RES potential and availability (solar, hydro, wind)
  - Grid and customer-side batteries
  - Interconnections/market
- Centralised heating systems (only CHP part)
  - Possible energy storages and flexibility provision (heat accumulators, electric boilers…)
  - Switching to alternative solutions (heat pumps)

Supply Analysis 2

- Grid analysis
  - Relatively high level conclusions, especially for distribution
  - Regional cooperation considerations
- Smart networks/systems
  - Expert judgment

Some observations

- IAEA's tools were used for core demand-supply modelling
- Several other tools/utilities used to complement analysis or provide aggregated inputs (e.g. Improvement of thermal insulations in buildings; system flexibility needs; grid impact...)
- Expertise still dominates models
  - I.e. it is important to have a well trained experts
  - Use of several models (i.e. not one catch-all model)
- Some challenges
  - First of a kind activity, limited time
  - Data availability, reliability (estimates) and verification
  - Data management and team coordination
  - Automatization of overall process and connecting the models

Potential future work

- Demand side
  - Improve background data and modelling (sectoral market studies, increase resolution of consumption categories, uses, fuels, technologies...)
- Supply side
  - Integrate other subsectors (target – total energy system integration into one software?)
- Models, teams and work-flow integration (connecting plan production chain – demand-supply-balances)

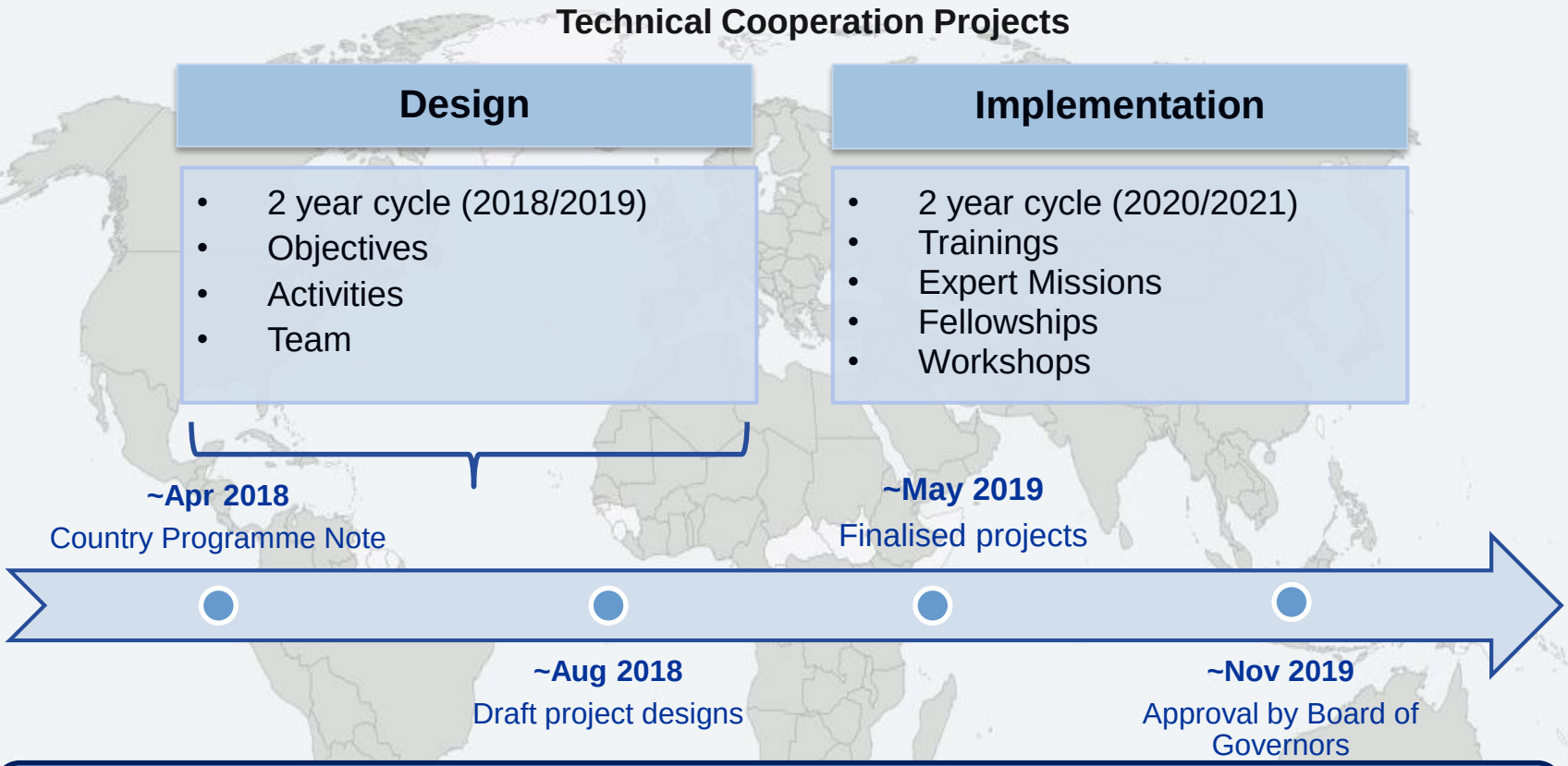
Organisational aspects are important

- Study/work was conducted by a team external to the ministry in charge of energy and environment
  - Ability of national bodies to conduct, monitor, follow and/or direct process
  - This is not a one-time effort and stable planning/modelling teams are needed (e.g. a planning system should be established)
  - Lead times to establish teams/planning structure
  - Effort to maintain and train teams/experts should not be underestimated
  - Imposing plans prepared by „outside" does not fit well (create partnership through knowledge sharing)
  - Secure system "memory" (databases and detailed documentation – irrespective of modelling platform and teams)
  - Part of required reporting was compiled from other studies (i.e. it was not possible to "model everything")
  - Harmonization of assumptions across all sectors (i.e. coherent scenarios development)

Engaging with us

IAEA energy planning support

Requested through National Liaison Officer (NLO)



Each IAEA Member State has one NLO, who is in charge of overall coordination of the project design stage (and assigning project counterparts).

RER Project Design for 2020/2021

Member States

Eastern European Countries, incl. Black and Caspian Sea and beyond, overlapping with those of the Energy Community

Key Outputs

1. Strengthened expertise to evaluate and assess energy technologies and their potential contribution to climate change mitigation to support countries in defining their commitments under the Paris Agreement (NDCs).
2. Knowledge and expertise in all aspects of nuclear power technologies, including SMRs, increased

Key Activities under Output 1

1. Capacity building and exchange of experience on assessing energy technologies
2. Develop case studies

Topics currently discussed under Output 1 – Key Activity 1

- Paris Agreement & NDCs: Implications for the Energy/Power Sector
- Low-Carbon Electricity Systems – Upcoming challenges
- Assessing Future Energy Technology Mixes in Support of NDCs
- Economic and Financial Analysis of Low Carbon Power Generation

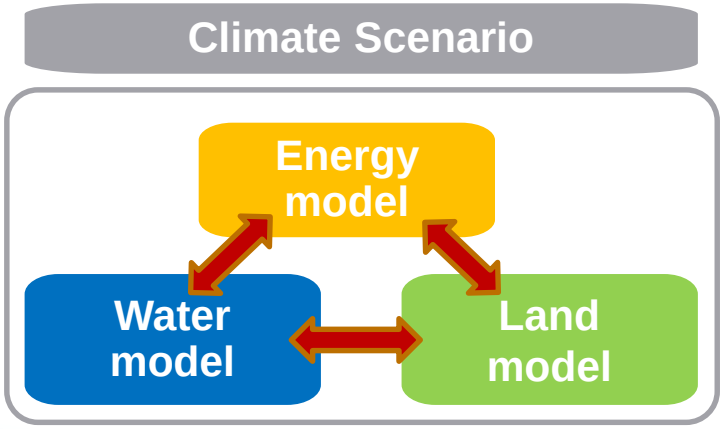
Further Examples of our Work & Collaborations

outside of NECPs

Examples of our Work

CLEW - Supporting integrated energy planning

- SDGs are highly interlinked
- Need for integrated energy planning
- CLEW: combined analysis of **C**limate, **L**and-use, **E**nergy & **W**ater

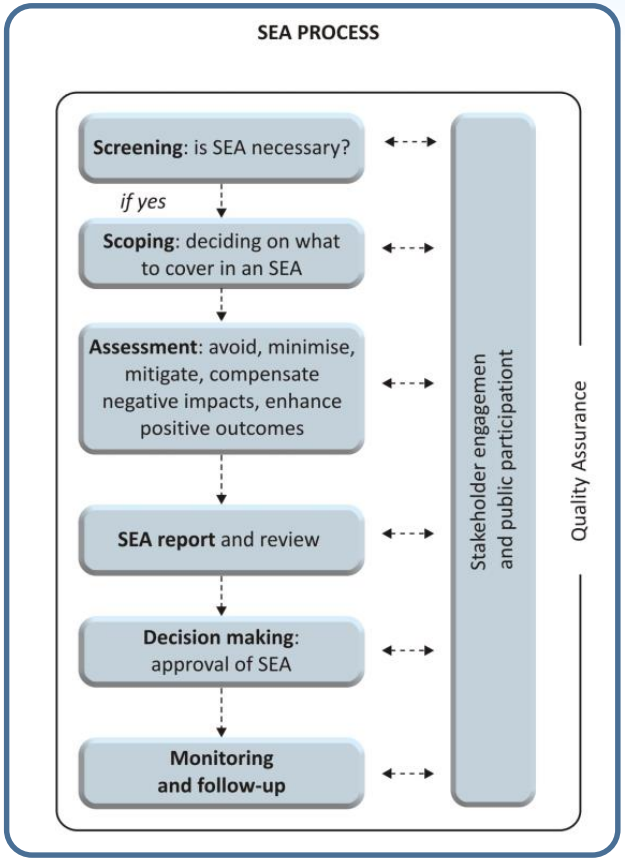


Examples of our Work

Supporting environmental assessments

Strategic Environmental Assessments for nuclear power programmes

- A process to ensure that environmental impacts arising from policies, plans & programmes are considered
- PESS developed guidelines and organises training workshops

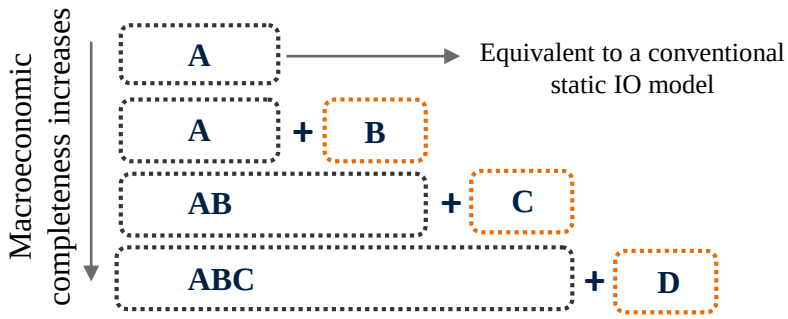


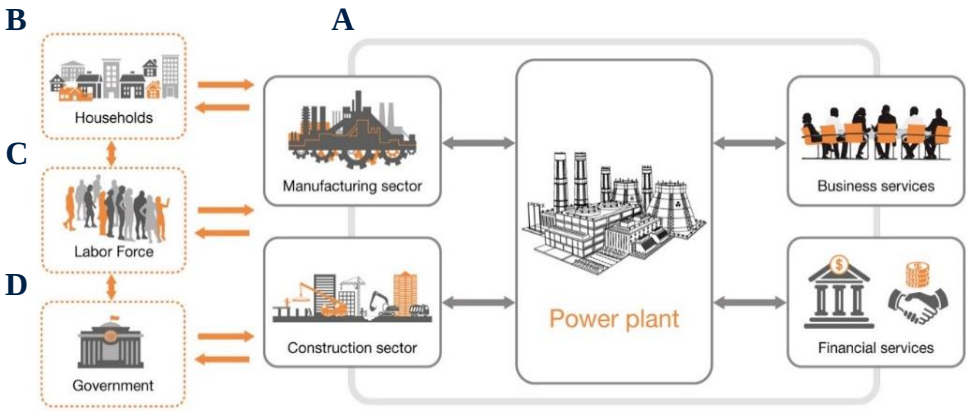
Examples of our Work

EMPOWER – Macroeconomic analysis

EMPOWER enables to quantify ex-ante and ex-post effects associated with construction & operation of nuclear power plant (NPP) programme.

Each model contains 4 different **modules.**





IAEA Collaborations

IAEA

IRENA
International Renewable Energy Agency

UN DESA

UNITED NATIONS
ESCAP
Economic and Social Commission for Asia and the Pacific

CEDEAO
ECOWAS

UNECA

United Nations
Framework Convention on
Climate Change

IIASA

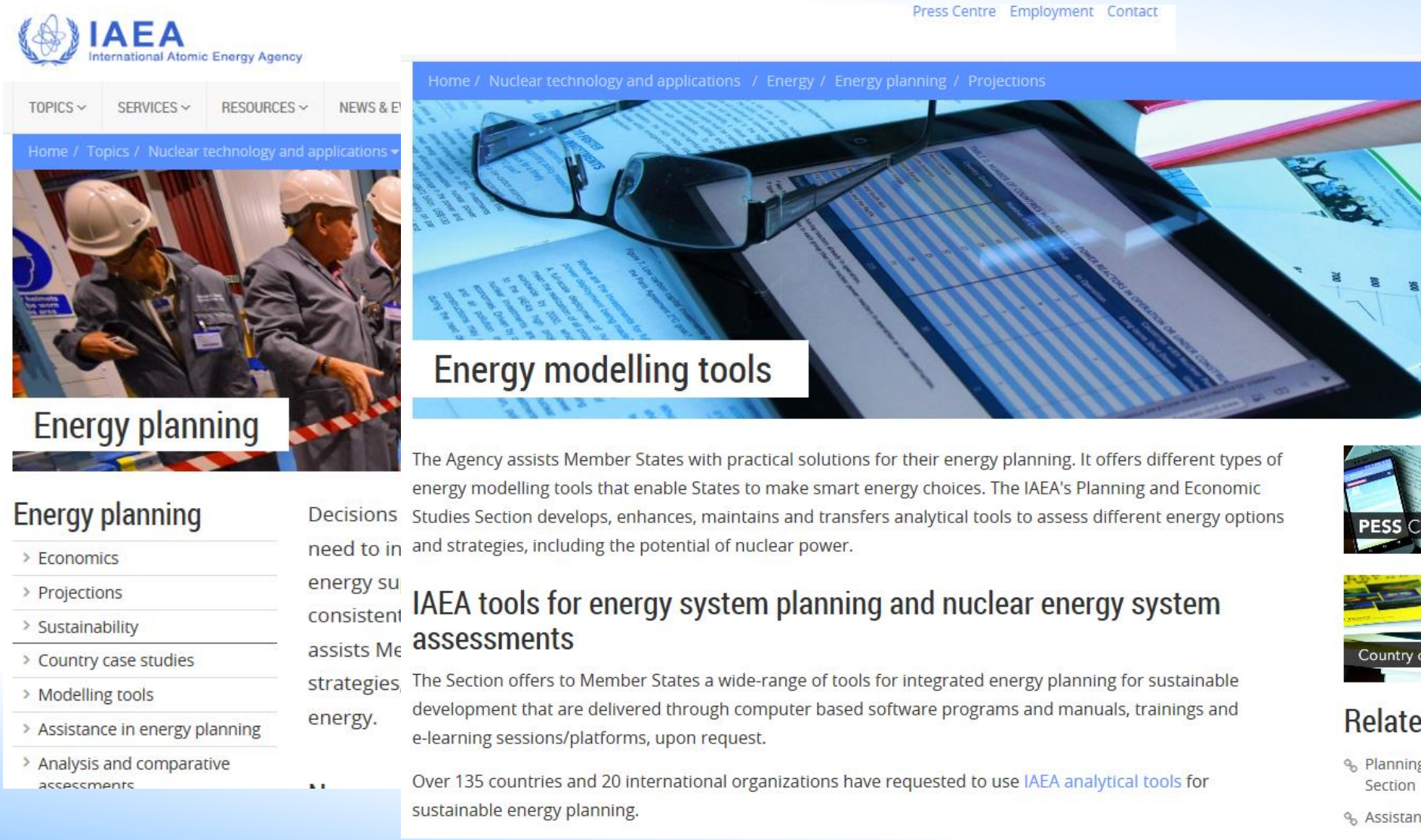
KTH
VETENSKAP
OCH KONST

iea International Energy Agency

Caribbean Community
Climate Change Centre

Visit our webpage:

iaea.org/topics/energy-planning or google IAEA + energy planning)



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Thank you!