

Long-term planning with a high share of variable renewable energy

- Introduction and workshop overview -

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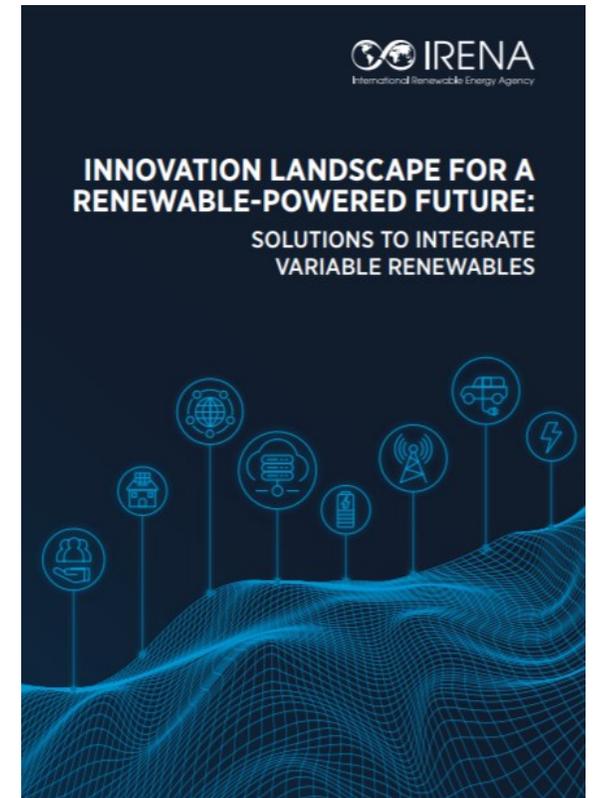
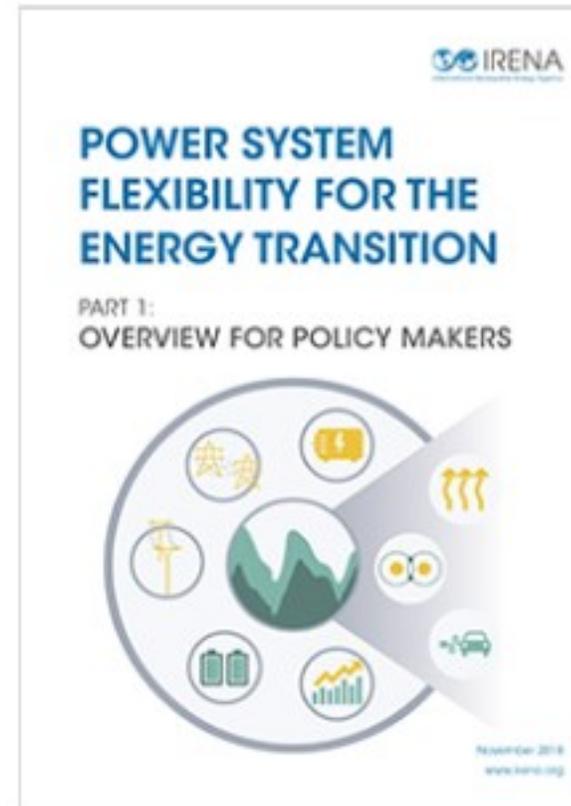
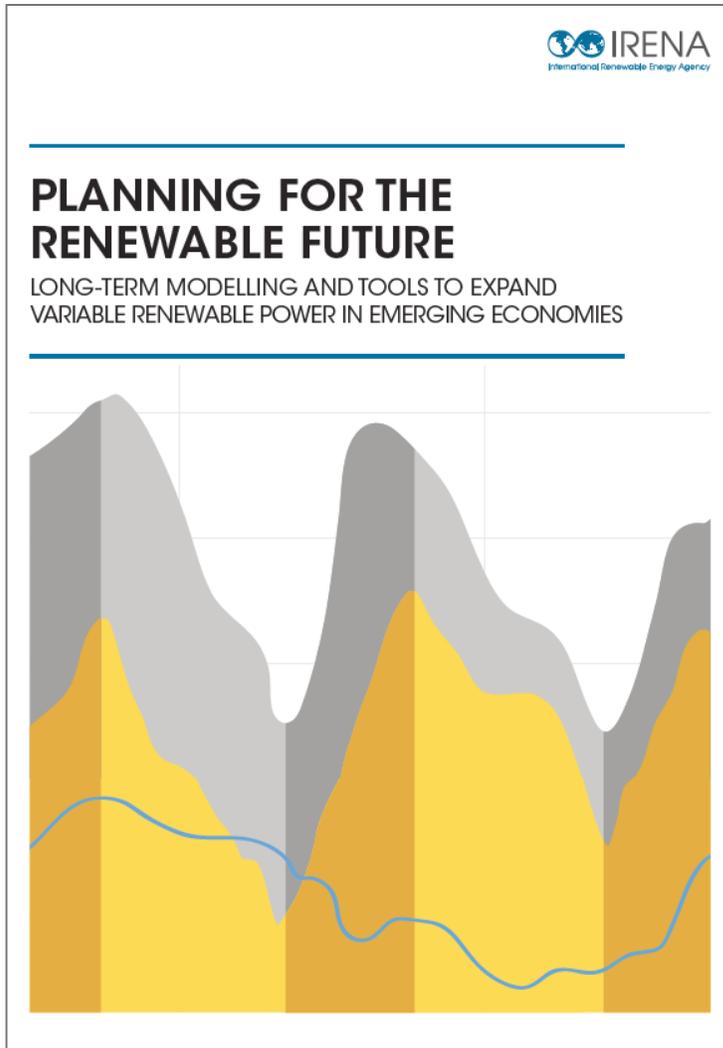
21 April 2019

Objectives: (1) Exchange **best practices** in long-term energy planning with VRE, and (2) Identify **possible gaps**

- » The scope of “long-term energy planning”
 - Processes and methodologies
- » Key elements for planning with VRE
 - 5 thematic sessions for gap identification – they represent the major planning impacts of VRE
 - Input presentations
 - Moderated discussion based on the planning survey responses

Background materials for the workshop

Addressing Variable Renewables In Long-term planning (AVRIL) project



Long-term generation expansion models

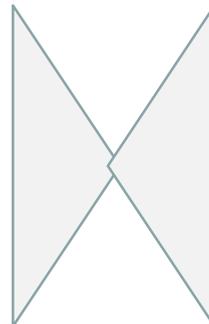
- Primarily focused on economic assessment of options
- System-wide optimization
- Reduced representation of operational aspects
- Does not necessarily answer “reliability” questions

Policy makers

“Deploying variable renewables (VRE) is beneficial.”

“Our country should adopt ambitious long-term VRE targets.”

Energy planning officials



System operators

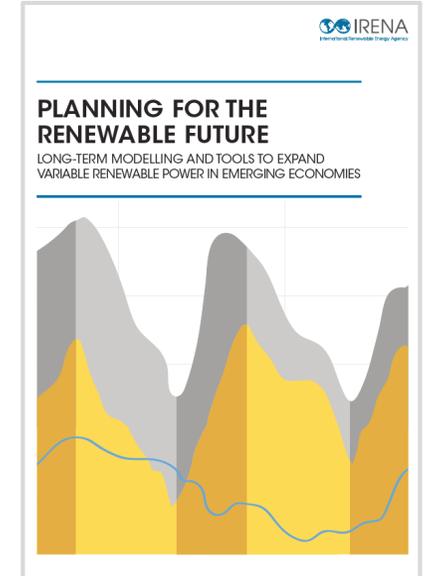
“VRE’s short-term variability endangers power system reliability”

“There is an upper limit of X% VRE”

Addressing VRE in long-term planning (AVRIL) project

Based on expert inputs

- IEW 2014, 2015
- AVRIL expert meeting
- Interviews



In consultation with energy planners in North Africa, and Latin America



How does long-term generation expansion planning need to change when aiming for a high share of VRE?

- Planning impacts of VRE's distinct features

What needs to change?

- Institutional aspects (Planning process)
- Techno-economic assessment methodologies (Modelling)

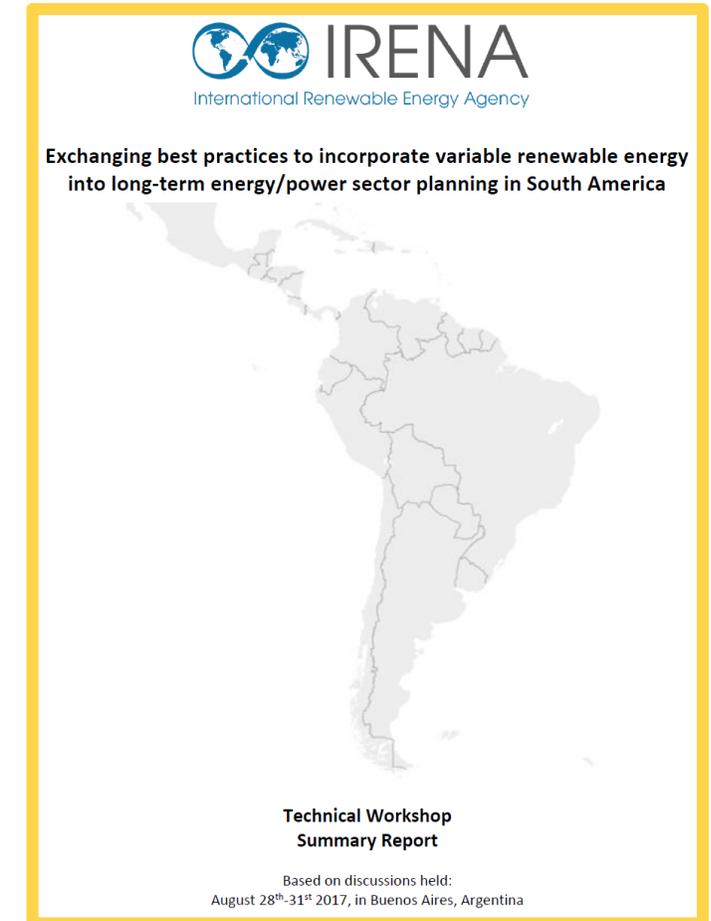
Deep-dive workshops held in the LATAM and Central Asia regions



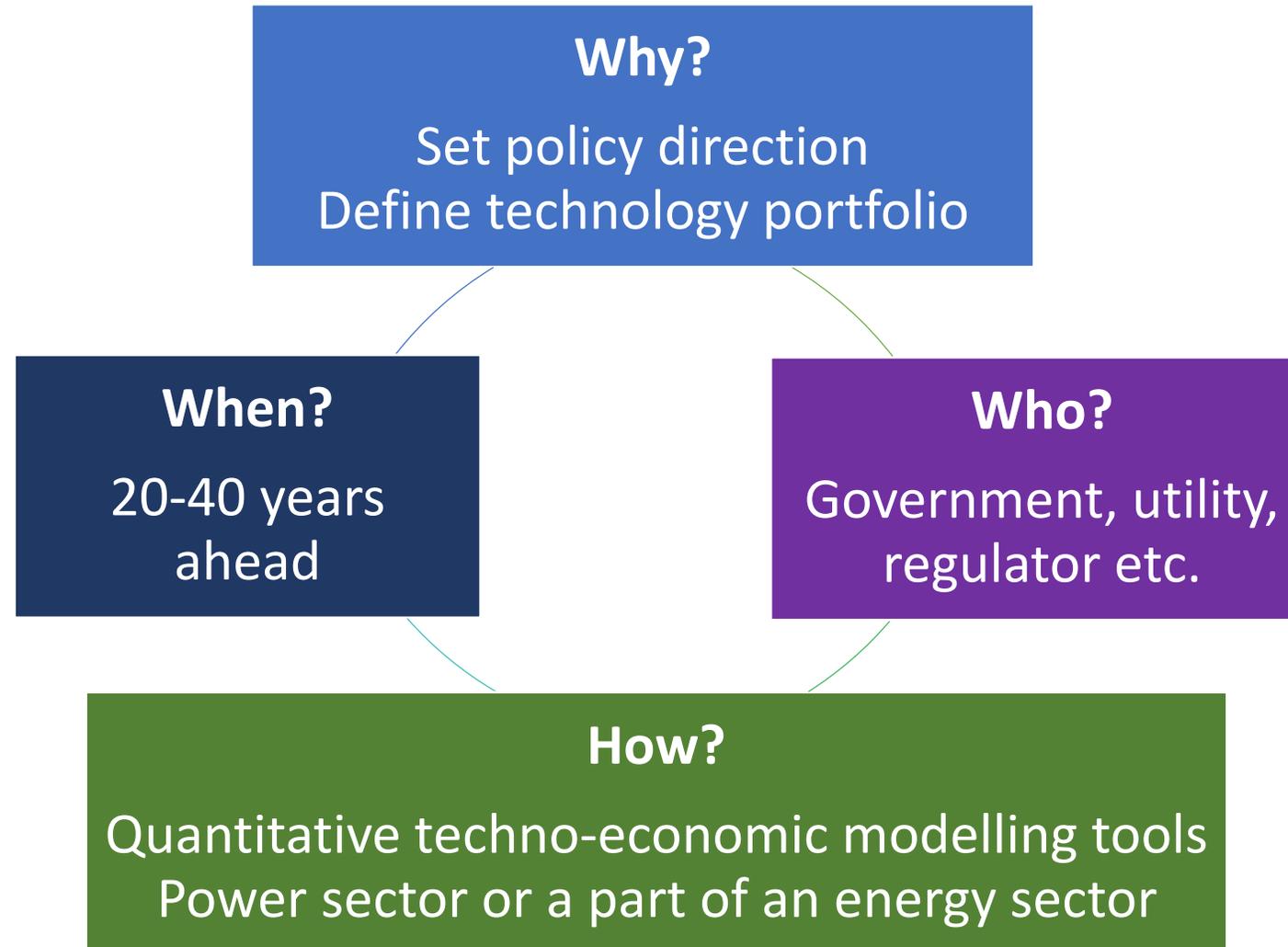
**Buenos Aires,
Argentina 2017**



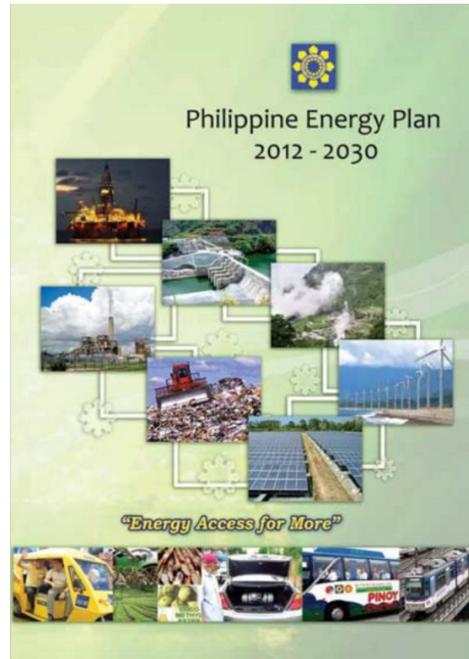
**Astana,
Kazakhstan
2019**



Generation capacity expansion planning – typical characteristics

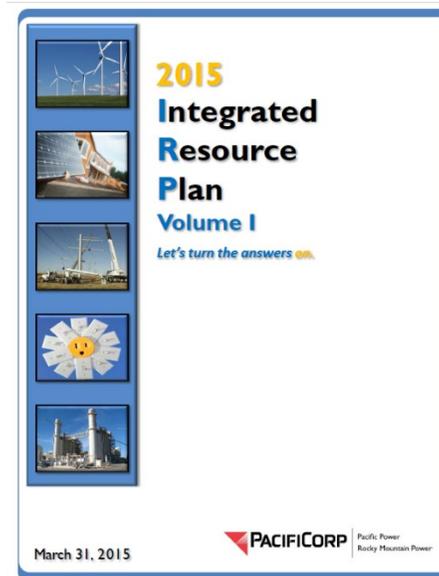


Some examples

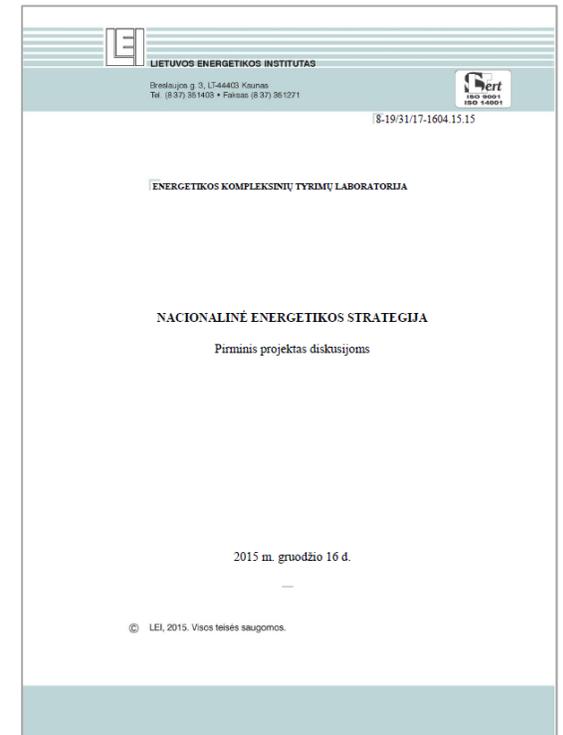
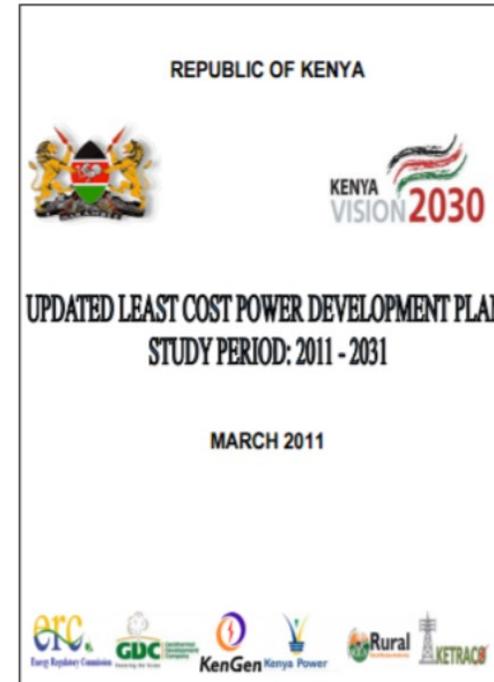


Department of Energy
[Philippines]

Utility
[USA]



Regulatory commission
[Kenya]



Specialized agency
[Lithuania]



How much electricity demand will there be?



How much and what type of generation is needed to serve this demand?



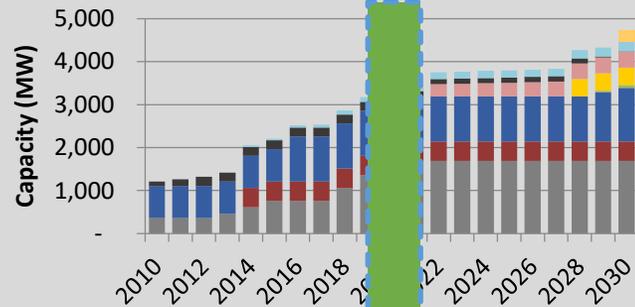
What enhancements to the network are needed to ensure the reliable supply of electricity?

Energy/power system models are used to answer these questions while taking into account economic and technical consequences of alternative choices.

Power system planning: Scopes of analysis

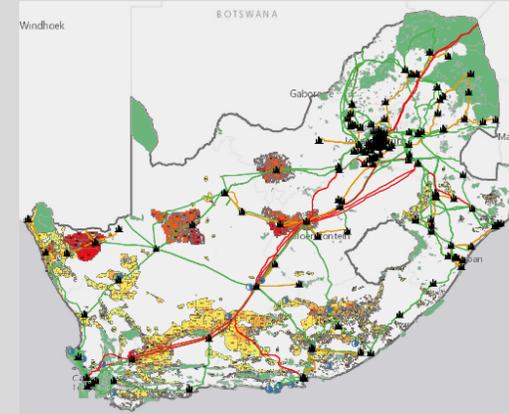
Capacity expansion planning

- Ministry of Energy
- Utility
- Planning agency



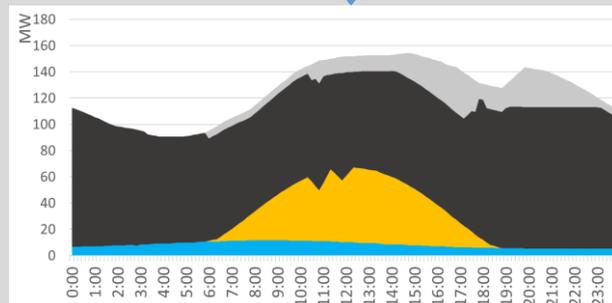
Geo-spatial planning

- Government planning office
- Planning agency
- Utility
- TSO



Dispatch simulation

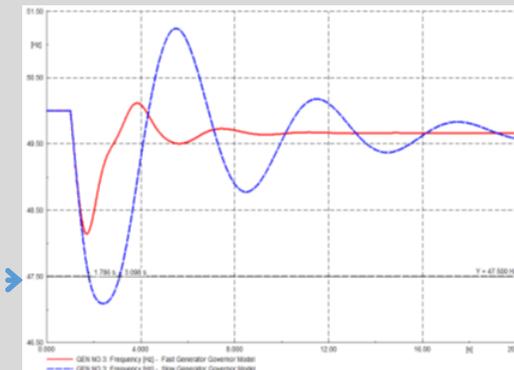
- Utility
- Regulators
- TSO



Snapshot of one year

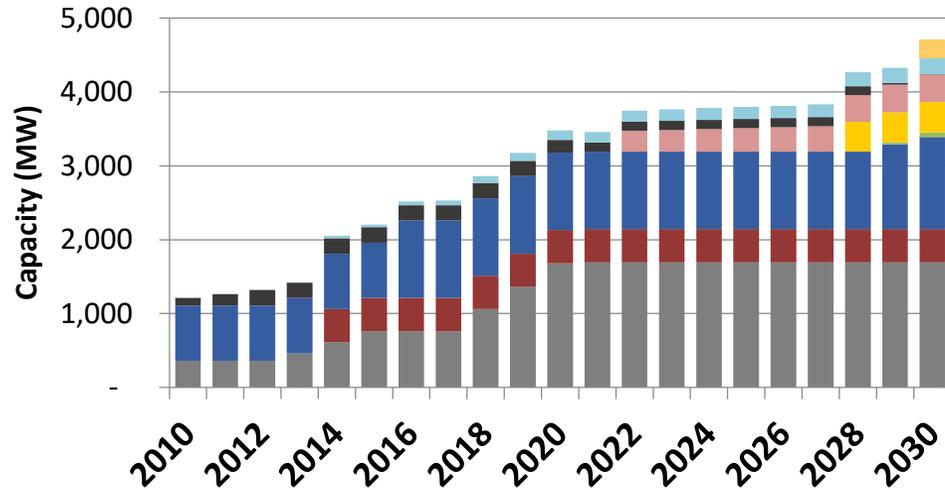
Technical network studies

- TSO
- Regulator
- Project developer

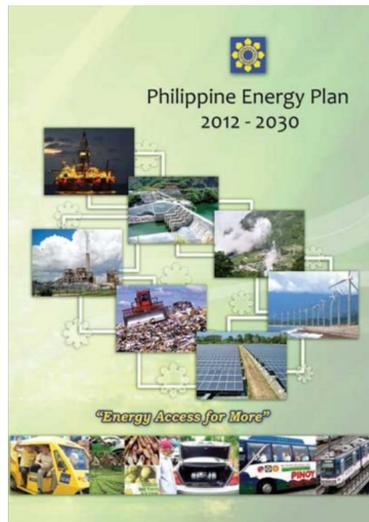


Snapshot of one moment

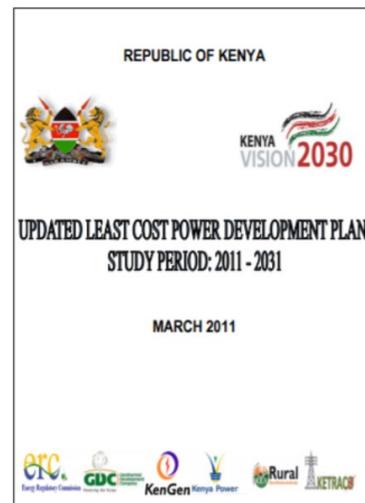
1. Generation expansion planning



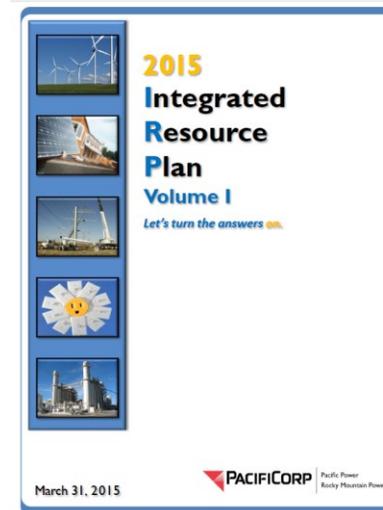
- » Future energy mix and investment path
- » Compliance with long-term energy policy goals
- » Political consensus making
- » Linked often with non-power sector planning



Department of Energy



Regulatory commission

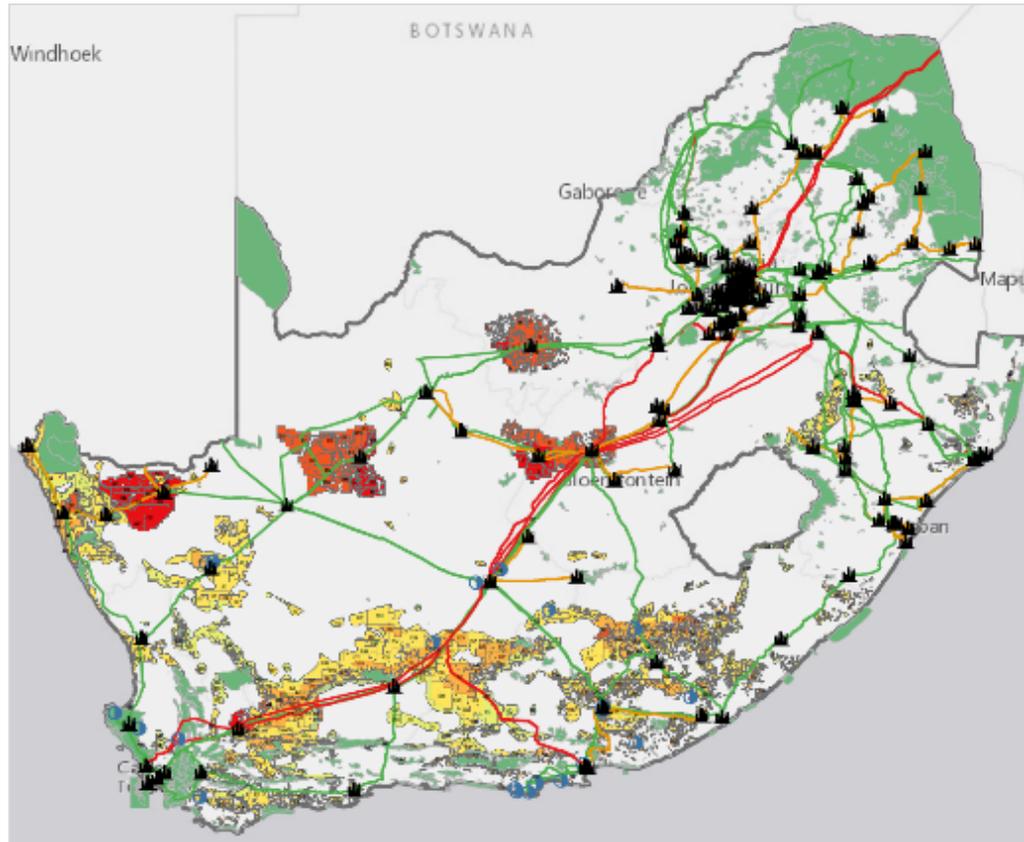


Utility



Specialized agency

2. Geo-spatial planning

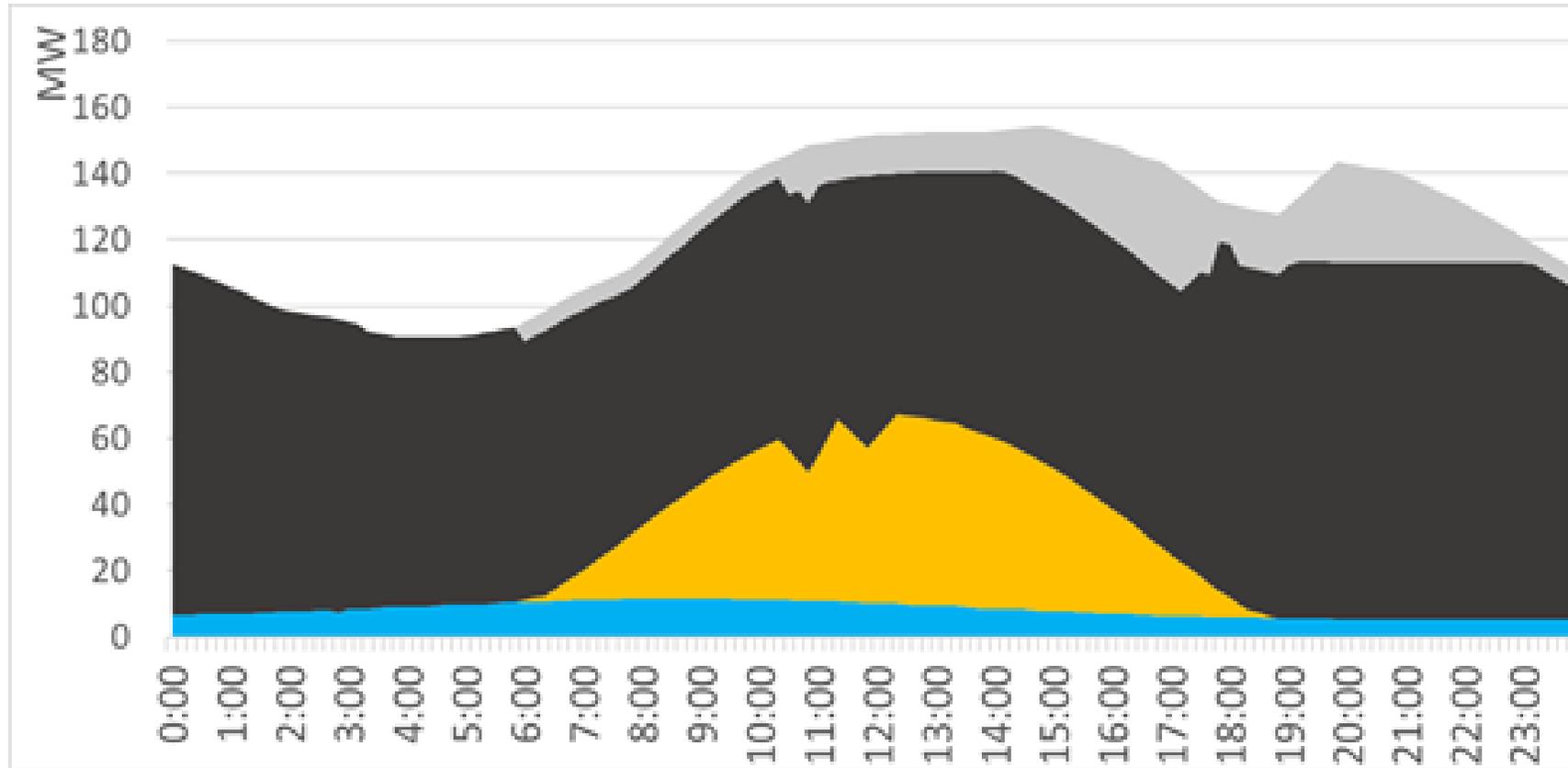


- » Generation siting and long-term transmission development needs
- » High-level screening scenarios for transmission network development
- » Zone identification for investment promotion

Tools: Maps, Geographical Information System (GIS)



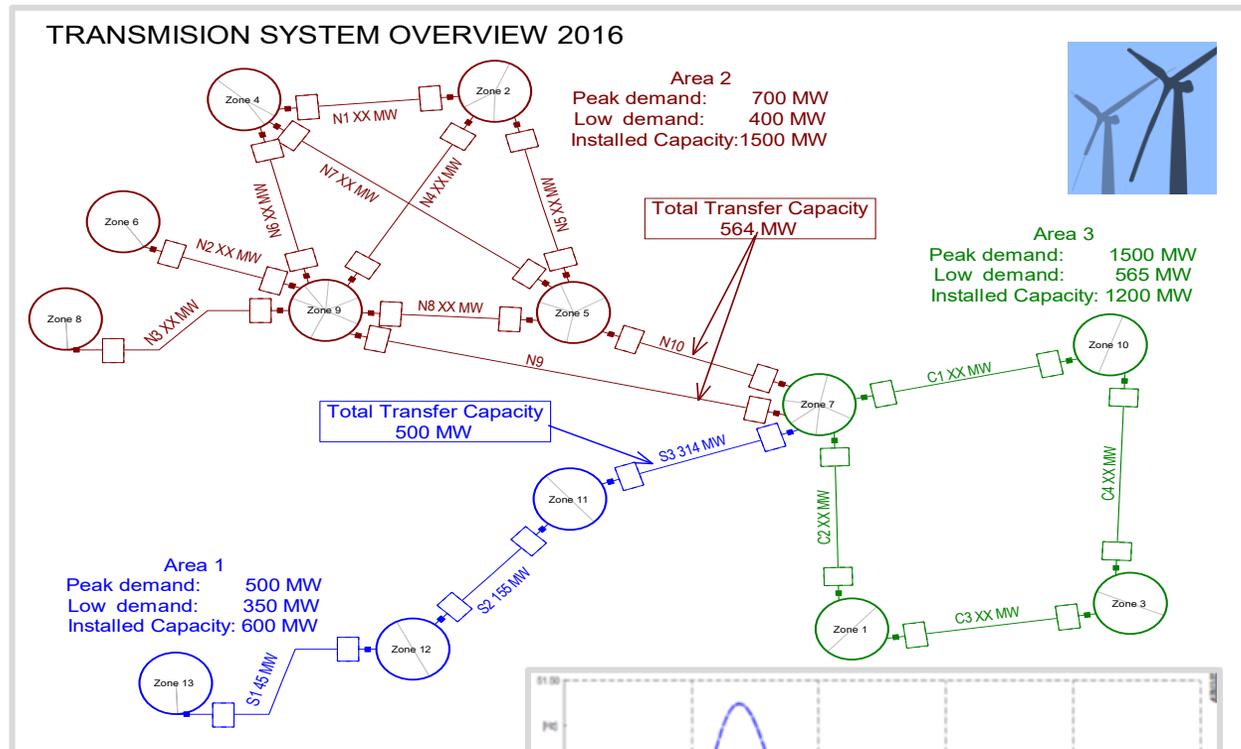
3. Dispatch simulation



- » Fuel and operation cost calculation
- » Maintenance scheduling
- » Economic power flow

- » Market and regulation design
- » VRE integration study

4. Technical network studies

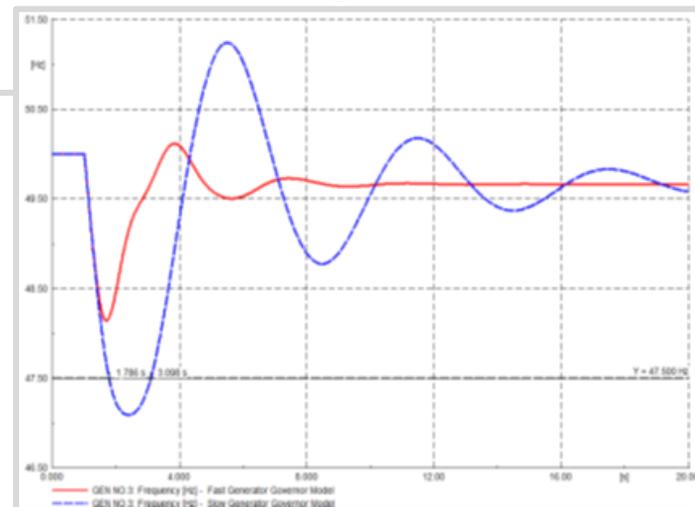


Load flow analysis

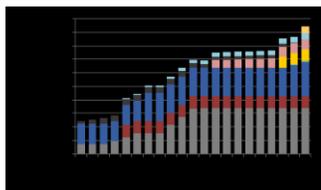
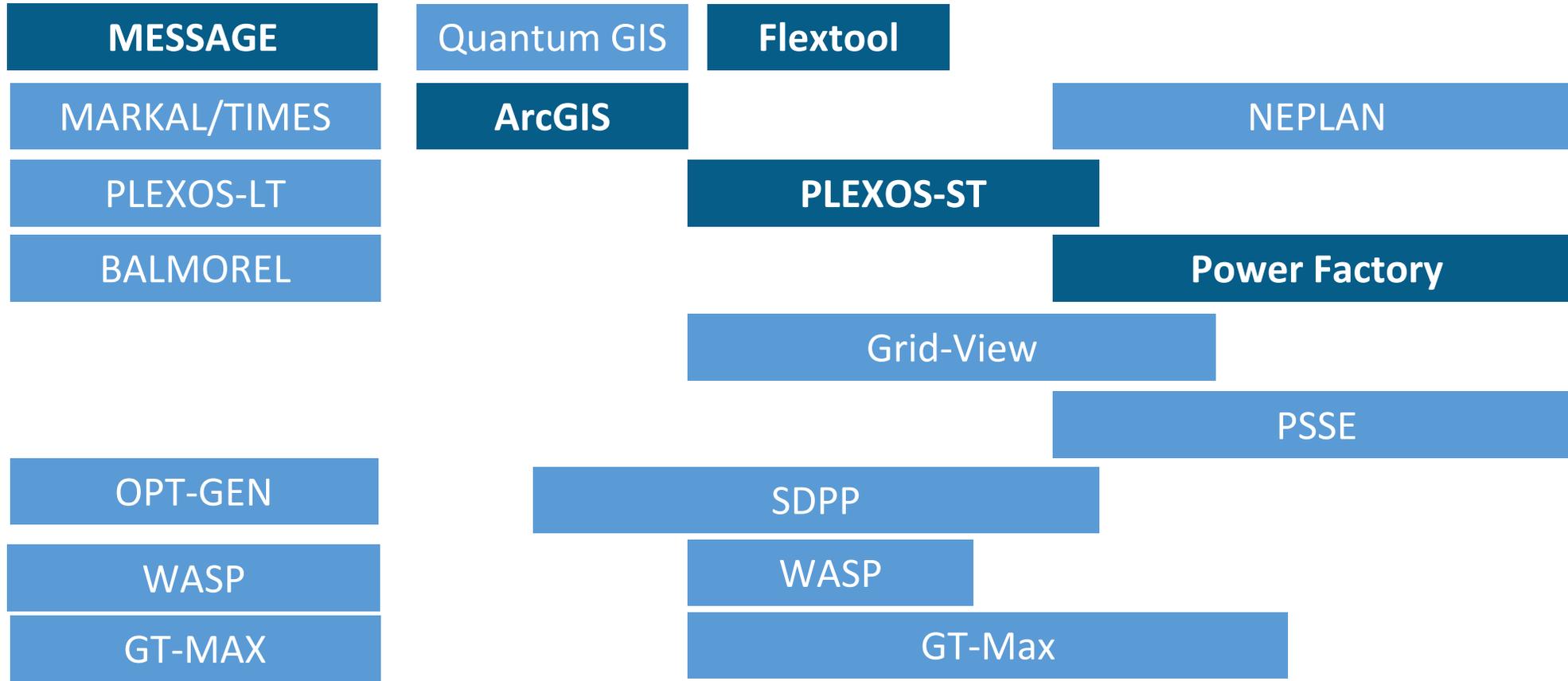
- » Simulate power flow of a given network under a challenging situation
- » Identify network enhancement needs
- » VRE integration study

Stability assessment

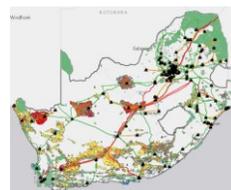
- » Simulation of frequency and voltage response in a network to a contingency event
- » VRE integration study



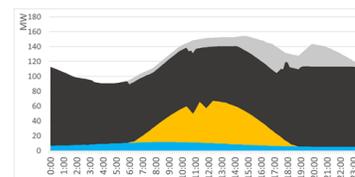
Modelling software: Indicative coverage



Cap expansion



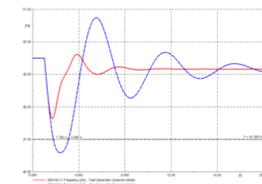
Geo-spatial



Dispatch



Static



Dynamic

Techno-economic planning studies - Application examples at IRENA

Long-term generation expansion

- **MESSAGE**: Five African power pools and national master plans (Swaziland, Sierra Leone), Cyprus

Geo-spatial analysis

- **Transmission investment assessment**: Dominican Republic
- **MapRE**: Eastern and Southern Africa

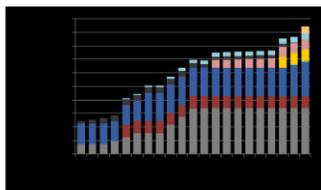
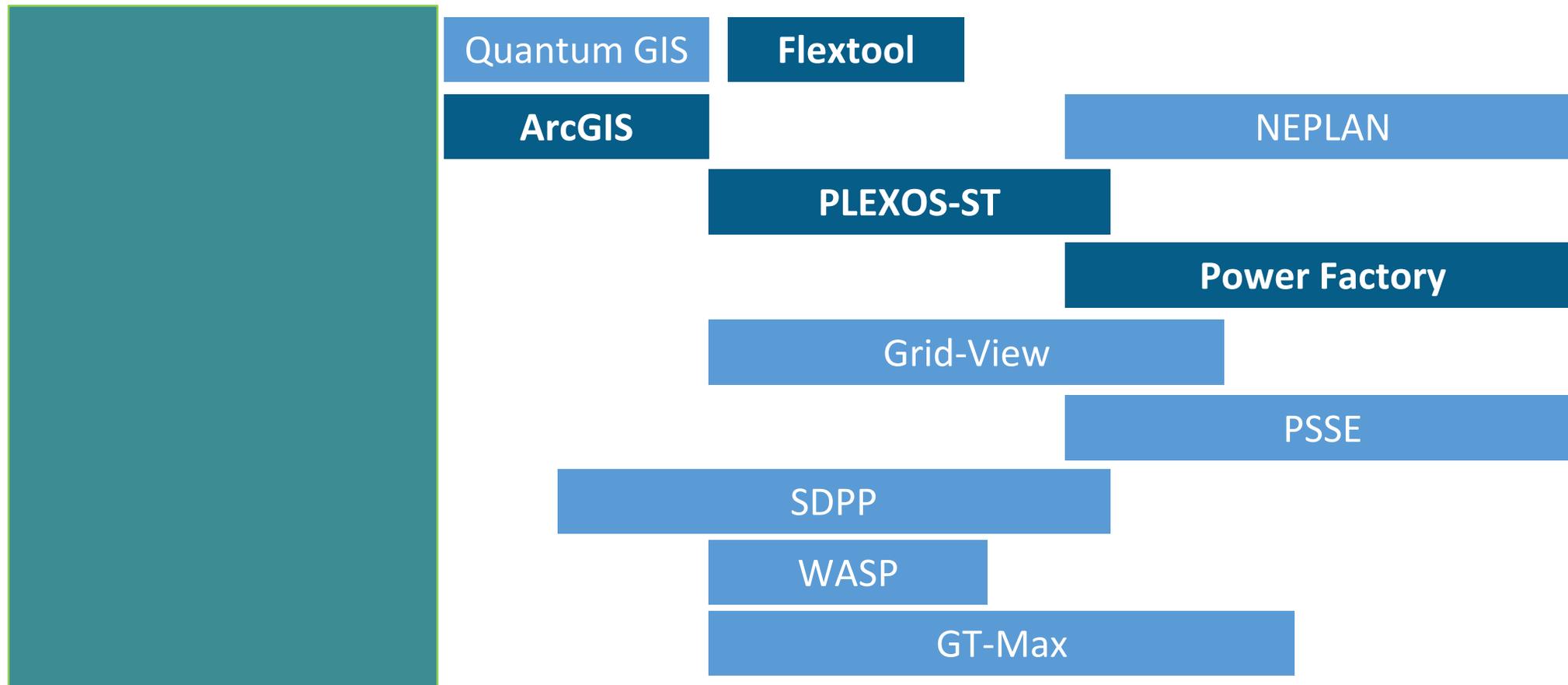
Dispatch simulation

- **PLEXOS-ST**: Barbados, EU
- **Flexibility assessment tool**: Five ongoing case studies
- **Storage evaluation toolkit**
- **HOMER**: Maldives, Kiribati, Samoa, Palau, etc.

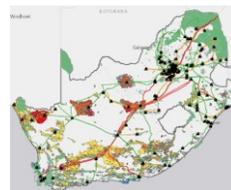
Network studies

- **Power Factory**: Samoa, Antigua, Cook Islands, Fiji, etc.

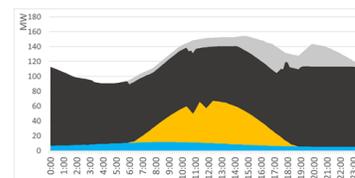
Modelling software: Indicative coverage



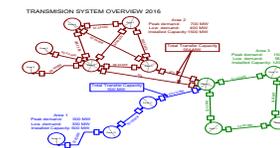
Cap expansion



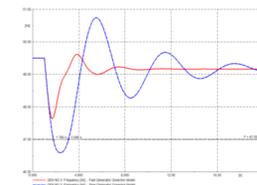
Geo-spatial



Dispatch



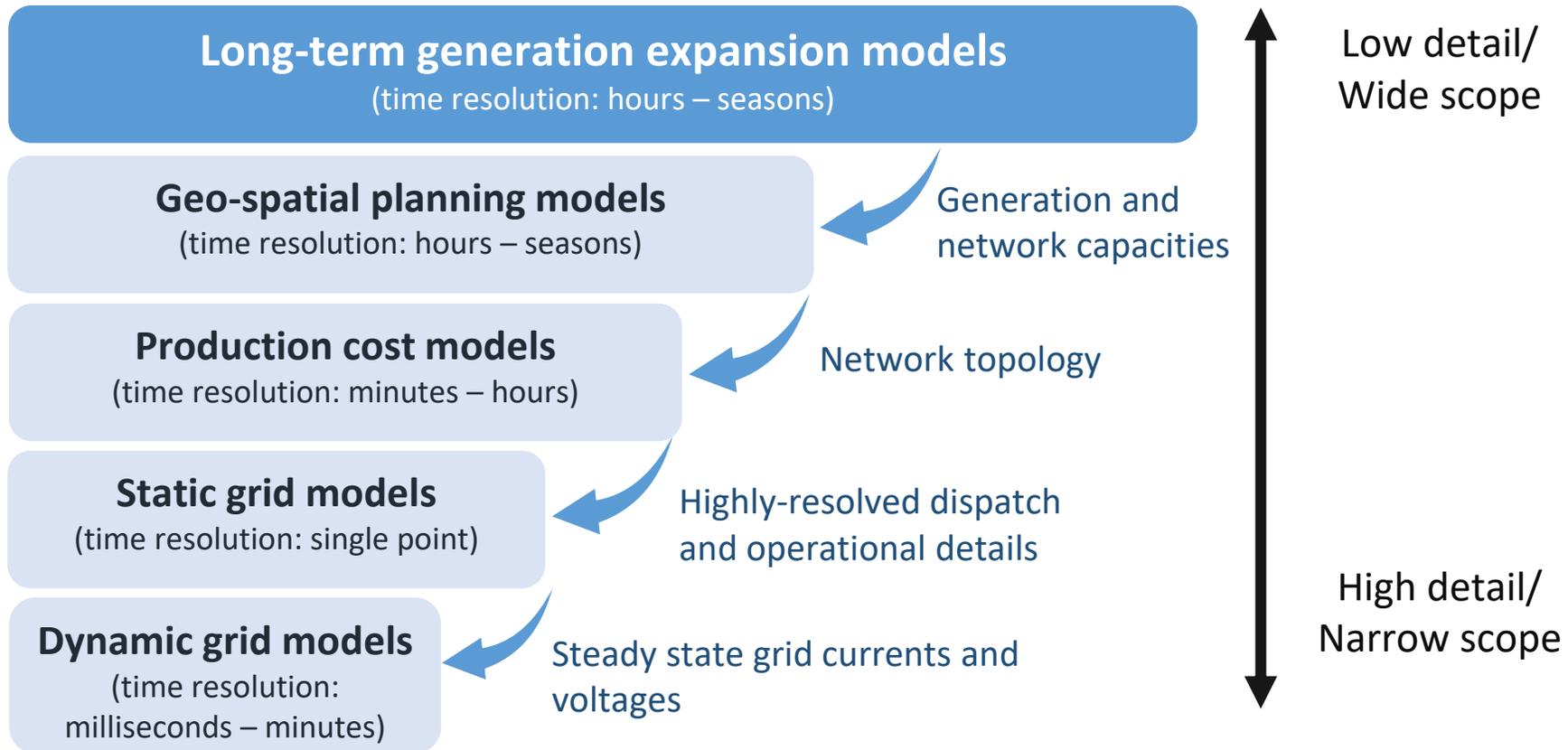
Static



Dynamic

Application of planning tools

... without VRE

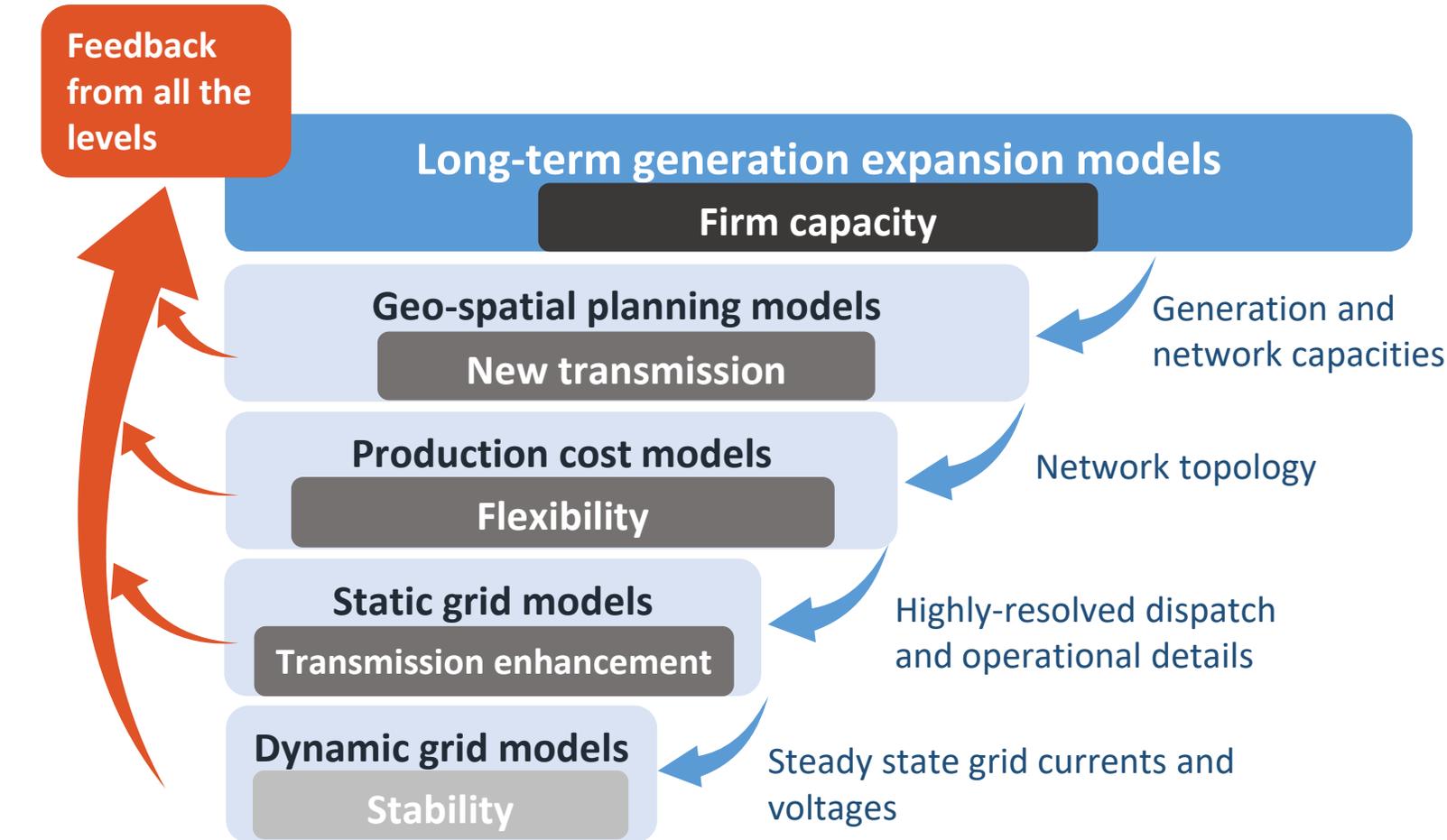


Key features of solar and wind

- Rapid cost reduction
- Firm capacity / capacity credit
- Flexibility
- Transmission investment needs
- Stability consideration



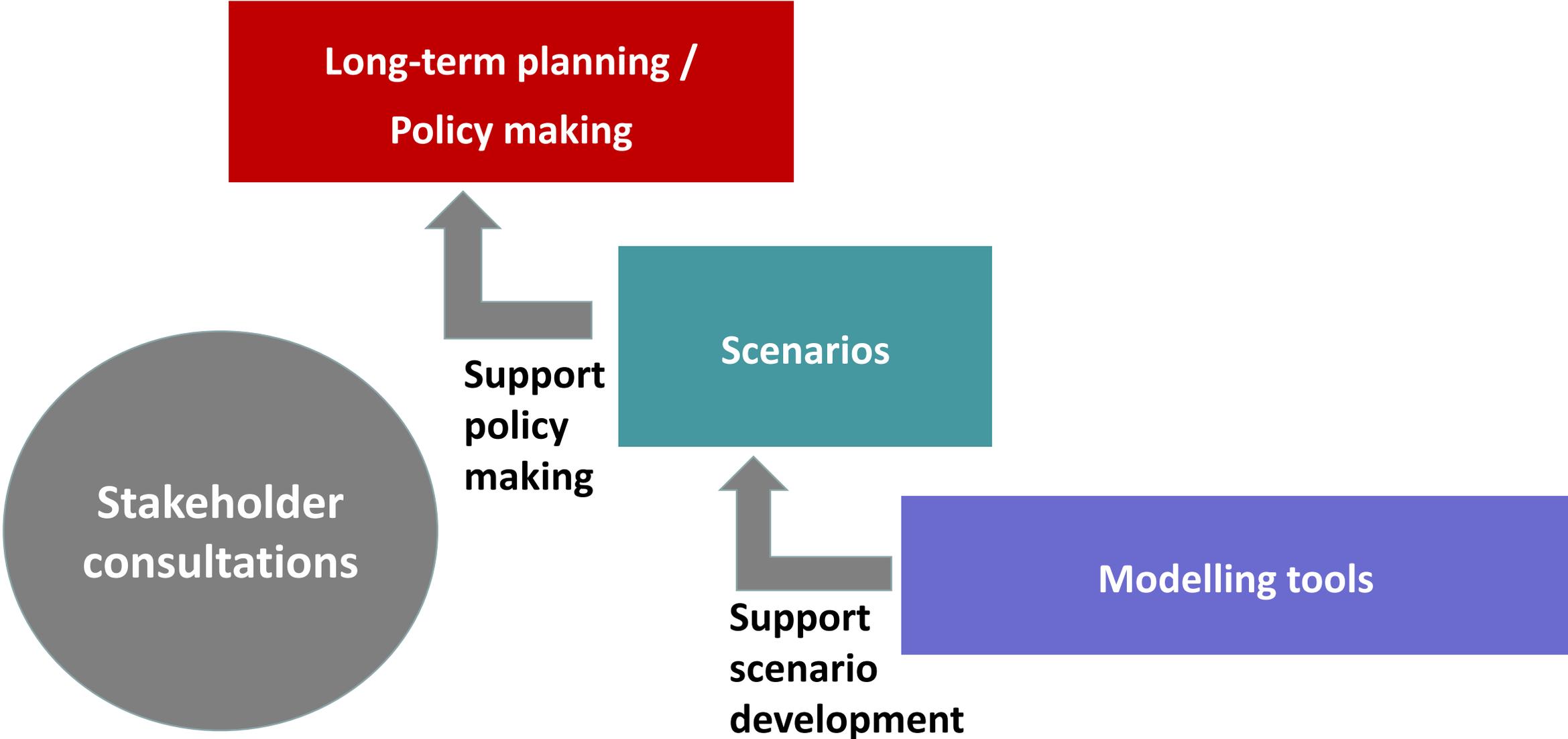
Application of planning tools ... with VRE



Better coordination is required!

Low High
Relevance of VRE impact in long-term planning

How scenarios are used and developed



Summary from “*Planning renewable energy strategies: Africa power sector, Achievements and way forward*”, Abu Dhabi January 2015



Long-term energy planning, if done properly,

- » Creates consensus among stakeholders
- » Can help to avoid costly investment mistakes
- » Reduces uncertainties in policy directions/project selection
- » Sends investors signals on types & quantity of investment needs
- » Accelerate service delivery

Latin American context

Summary from ““Exchanging best practices to incorporate variable renewable energy into long-term energy/power sector planning in South America”



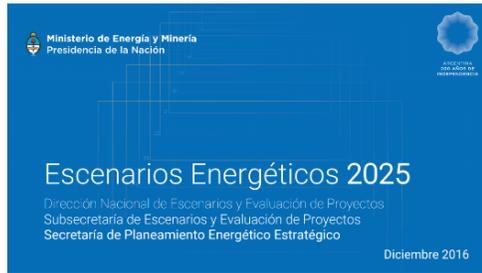
Colombia:
Basis for policy making, establishing **signals for investment** and capacity expansion needs

Brazil:
To be used as a **basis for formulating public policies**

Uruguay:
To design policies to support technologies to promote and **investment needs**

Argentina:
To establish a framework of discussion for the **design of new policies** and for the **discussion with actors of the sector.**

Planning reports from governments in LATAM



Argentina



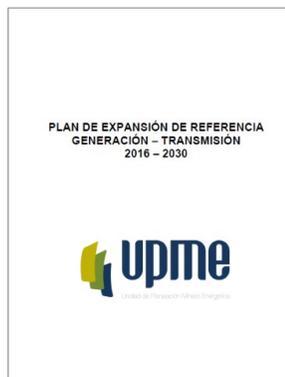
Bolivia



Brazil



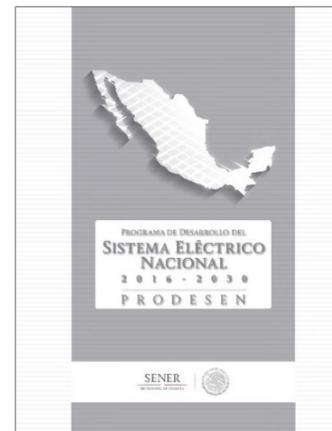
Chile



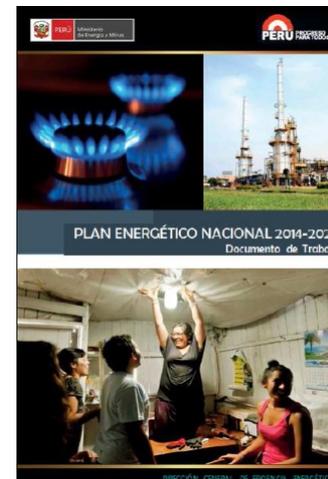
Colombia



Ecuador



Mexico



Peru



Paraguay

Planning scopes in LATAM

Country	Scope	Planning horizon	Update
Argentina	Energy	2025	Annual
Bolivia	Electricity	2025	NA
Brazil	Energy	2050	5 -10 years
Chile	Energy	2046	5 years
Colombia	Electricity	15 years	Annual
Ecuador	Electricity	2025	2 years
Mexico	Electricity	15 years	Annual
Paraguay	Energy / electricity	2040 / 2025	5 / 2 years
Peru	Energy	10 years	2 years
Uruguay	Energy / Electricity	2035 / 2040	Annual

Day 1 – 2

- » Scene-setting presentations
- » Country presentations

Day 2 – 4

- » Presentations on VRE impacts and planning model implications
 - Cost; Generation adequacy; Flexibility; Transmission; Stability
- » Open discussions of the relevance of the concepts and gap identification (based on the survey)

Day 4

- » Prioritization of planning gaps and possible country support

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