



Long-term capacity expansion planning with variable renewable power

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Planning for the Global Energy Transition

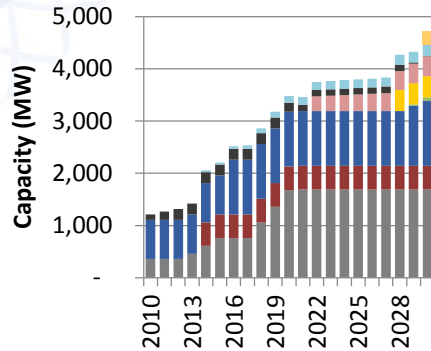
Objective:

To help improve RE representation in global/regional scenarios and national master plans

Three components:

1. Consolidation of data, methodologies, and good practices (guides and manuals)
2. Supporting application of methodologies (country case studies)
3. Capacity building in the use of methodologies

Energy planning: Focus areas for techno-economic analysis

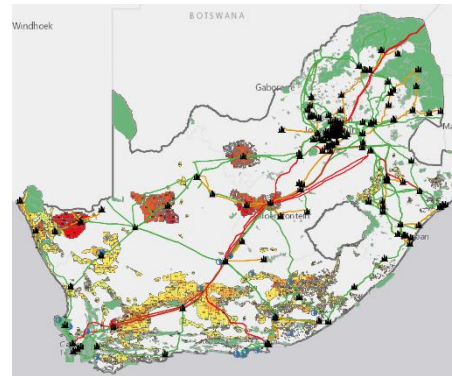


Generation expansion planning

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

Dispatch simulation

- Fuel and operation cost calculation
- Market and regulation design

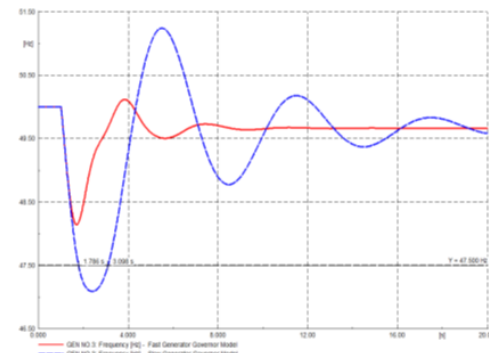
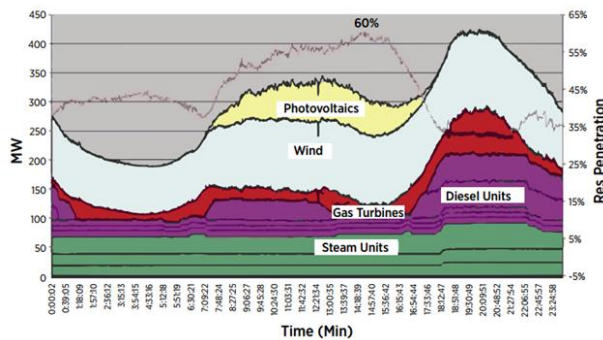


Geo-spatial planning

- Generation siting and long-term transmission development needs

Technical network studies

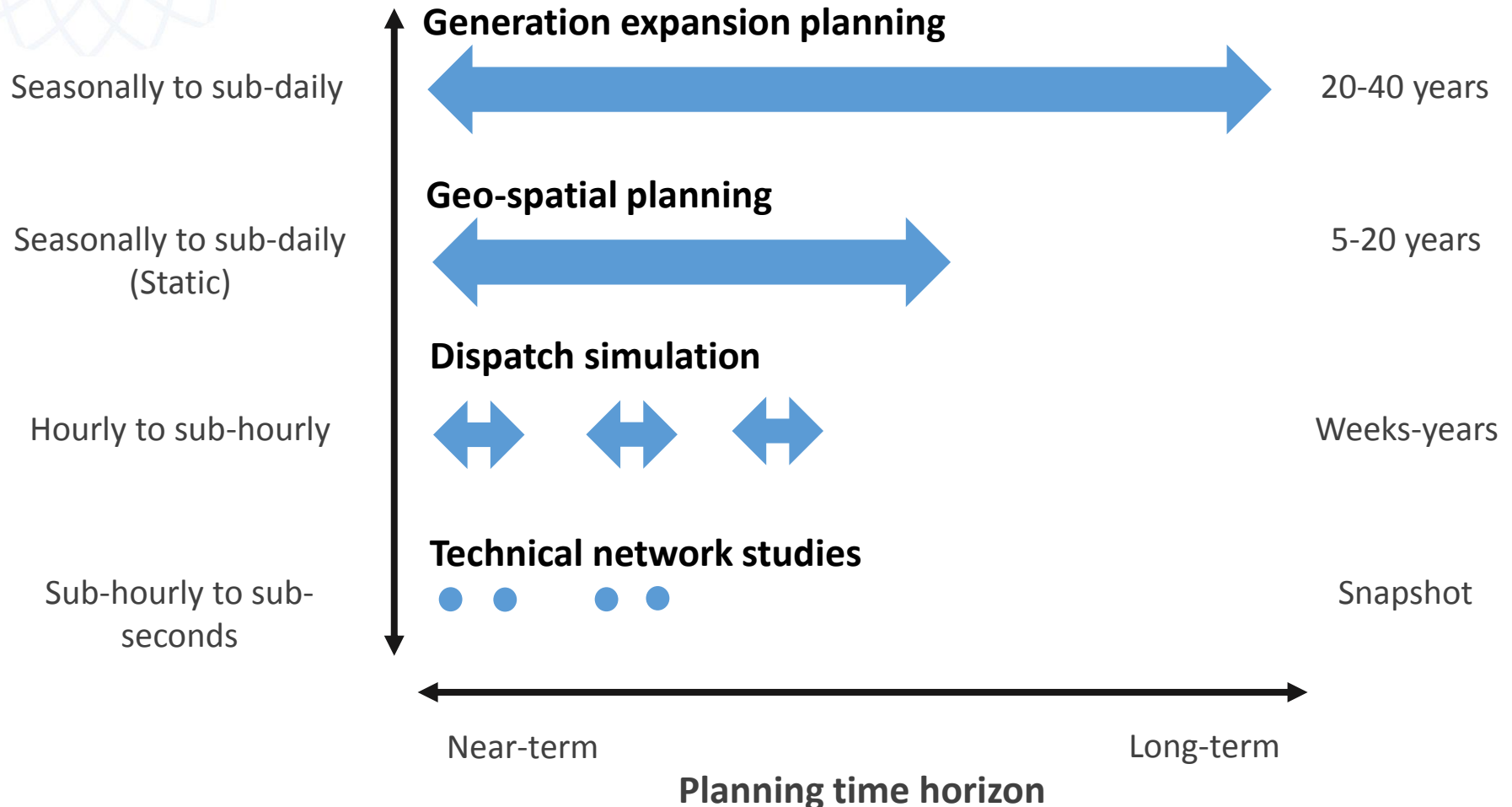
- Static analysis for load flow
- Dynamic analysis for stability



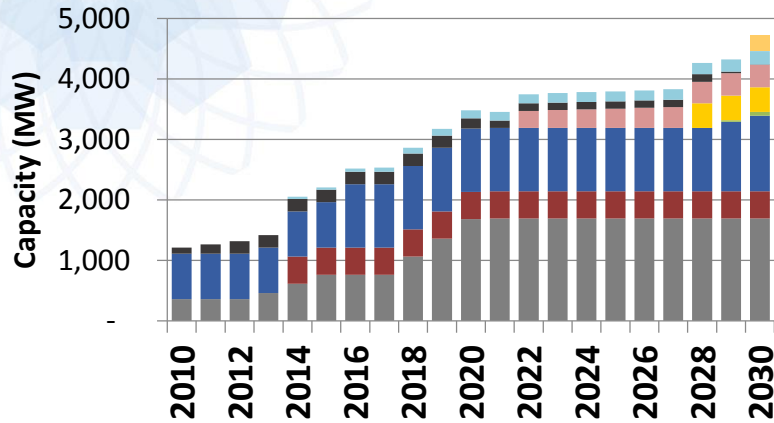
Time dimensions of power sector planning

Typical time resolution

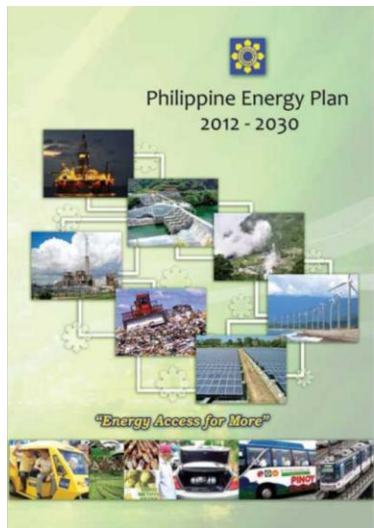
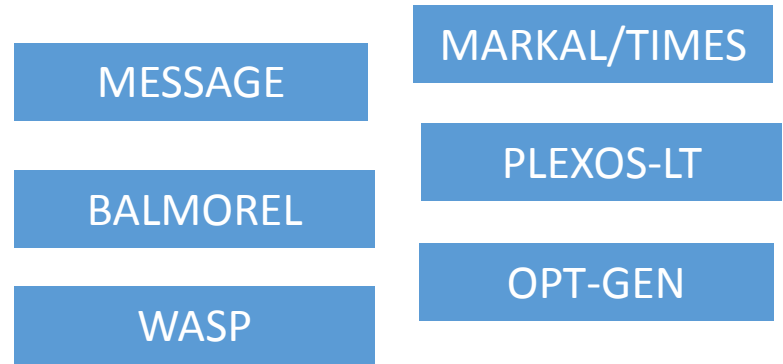
Typical time frame



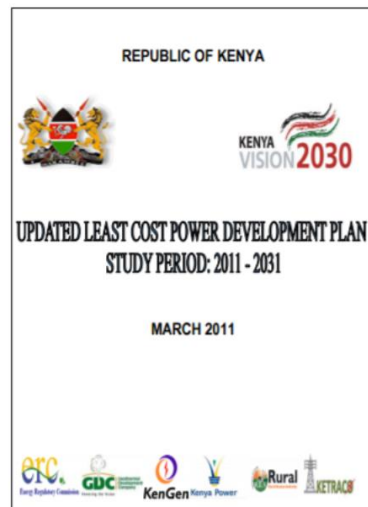
Generation expansion planning



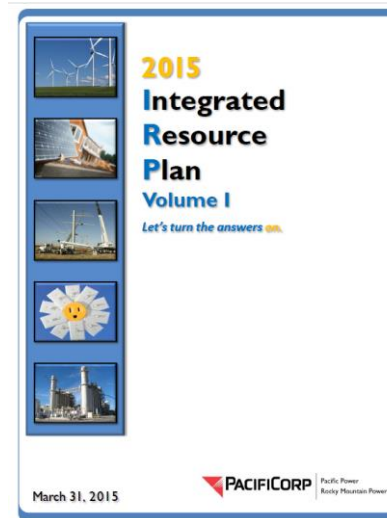
Example of the tools



Department of Energy



Regulatory commission



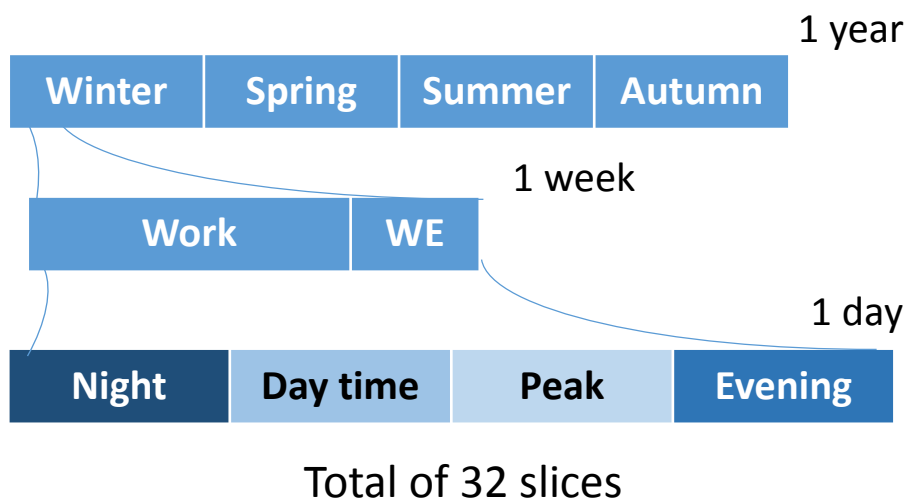
Utility



Specialized agency⁵

Features of generation expansion planning model

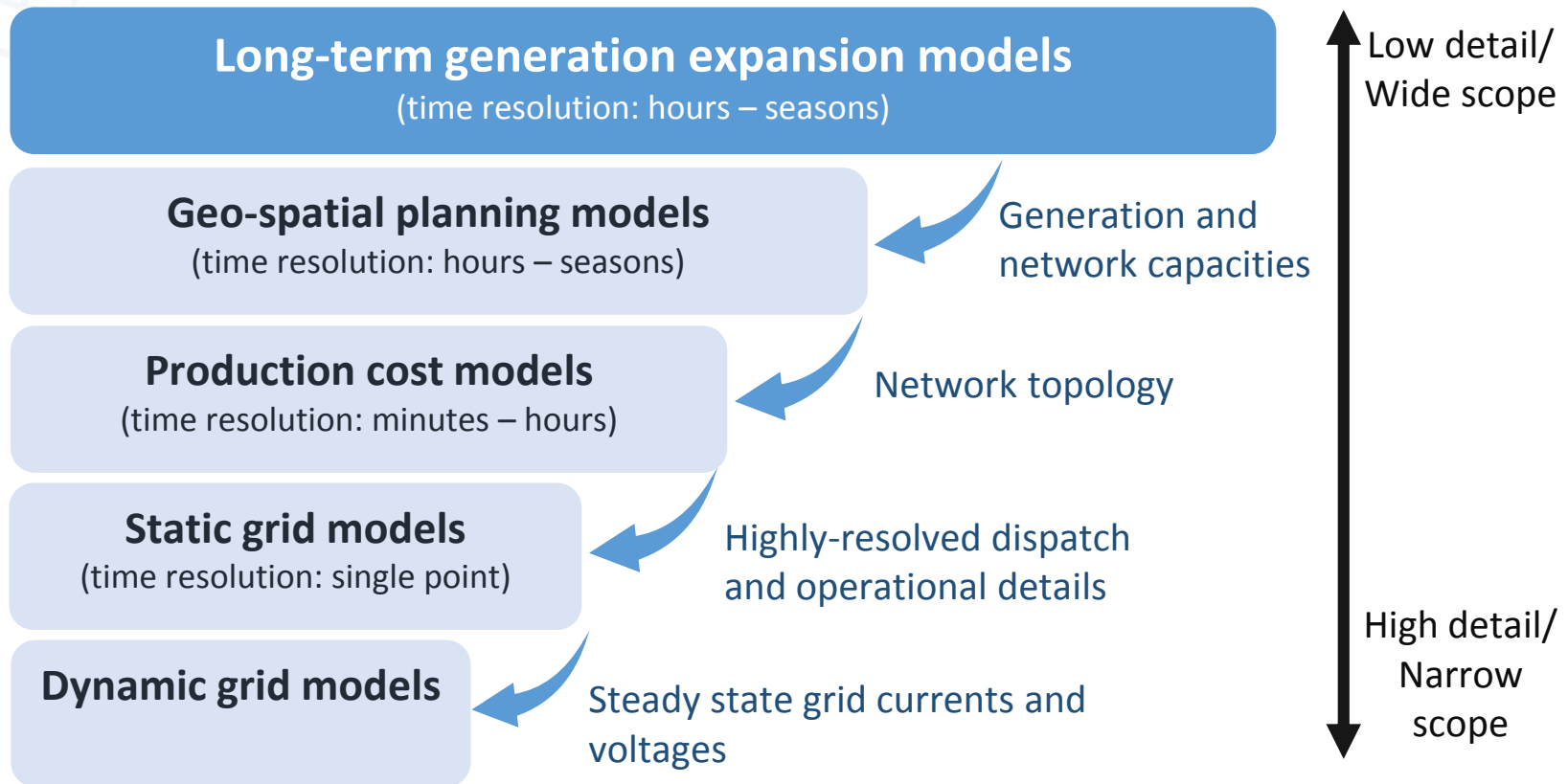
- » Cost minimization over a long-time horizon
- » Capacity build up with time steps of 1-5 years
- » Limited time resolution
- » Limited spatial resolution



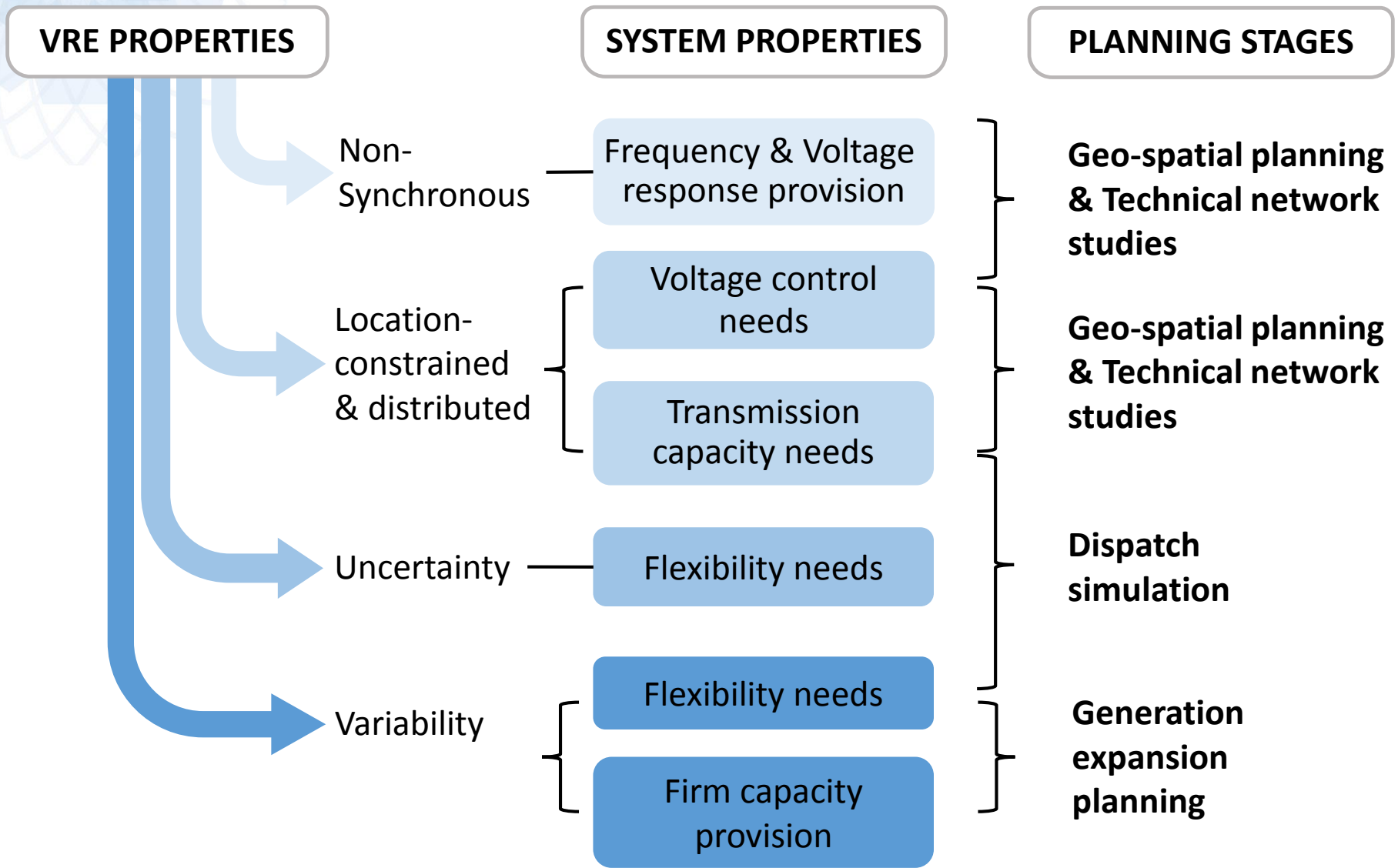
Example of models with advanced approaches

Model name	Region	No. of time slices
GEMS +CEEM	Germany	432
DIMENSION +INTRES	Europe	192
DIMENSION	Europe	7200
US-REGEN	US	50
LIMES-EU+	Europe & Middle East and North Africa	49
URBS-EU	Europe	8064
-	Texas (US)	696

Planning tools



VRE in the planning process



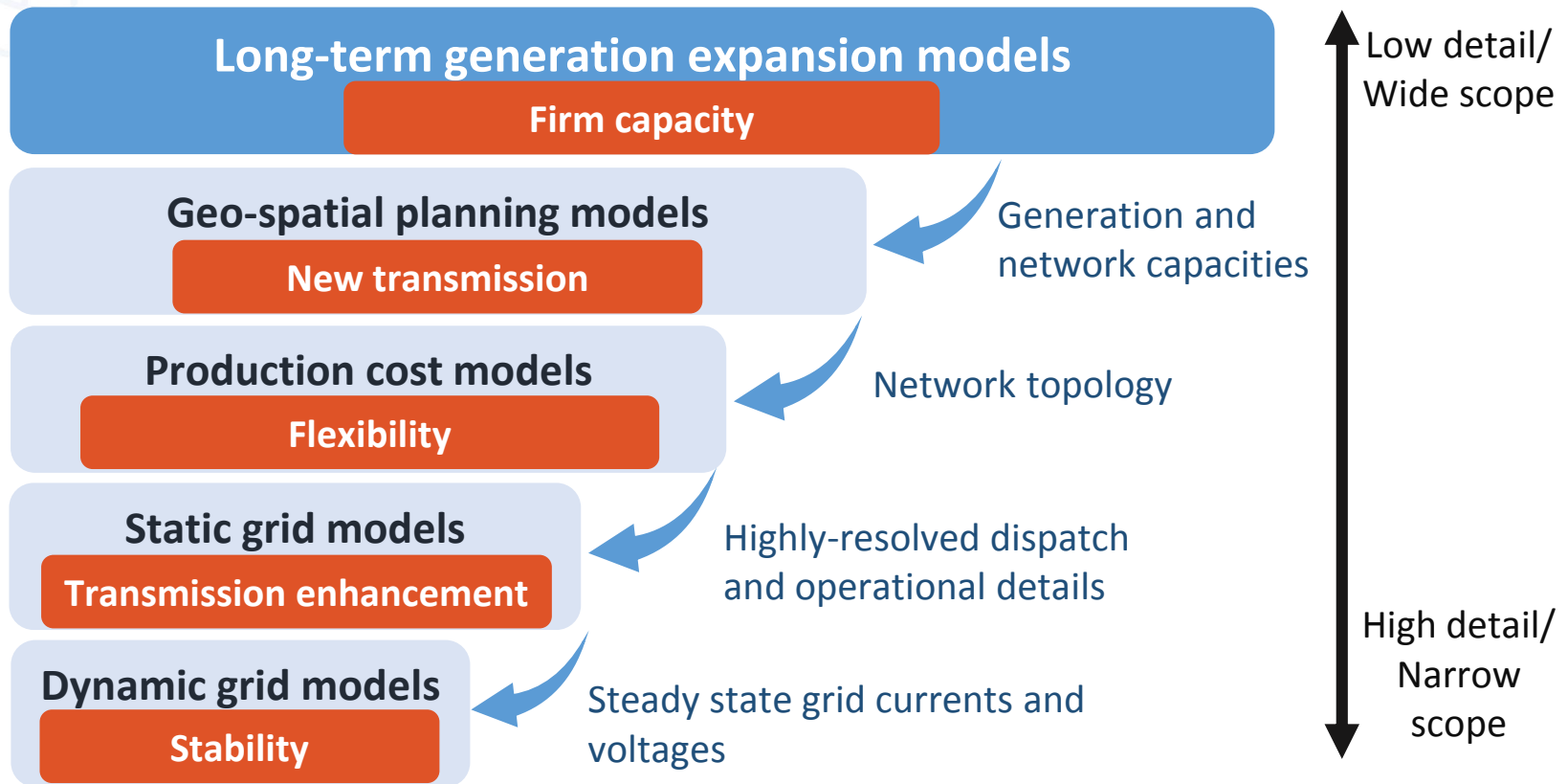
Key features of solar and wind

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

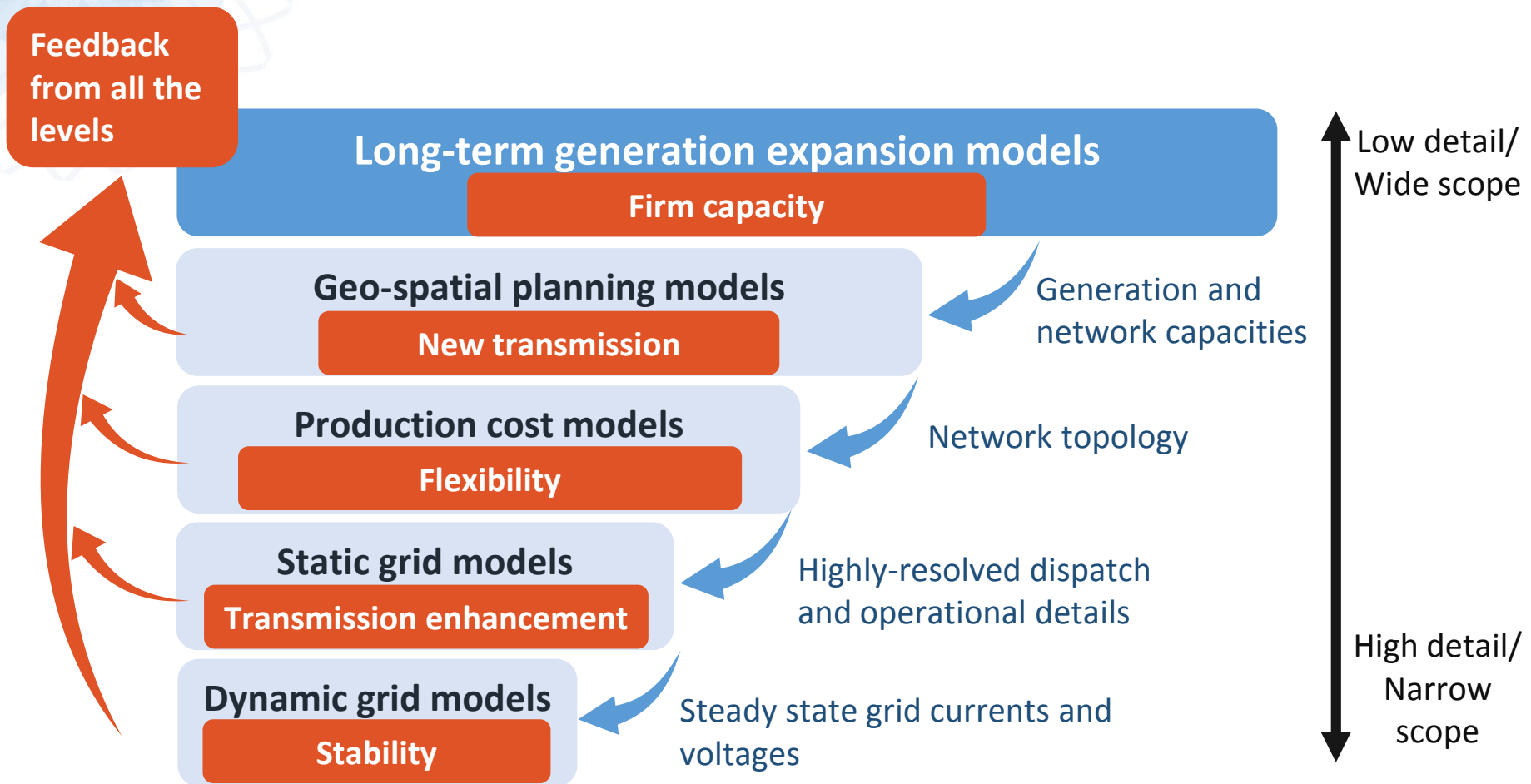


Typically not well covered in “traditional” generation expansion planning models and methodologies

Typical planning sequence



With variable renewable energy...

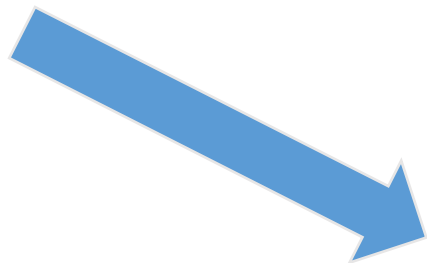


It is important to do it right from the beginning!

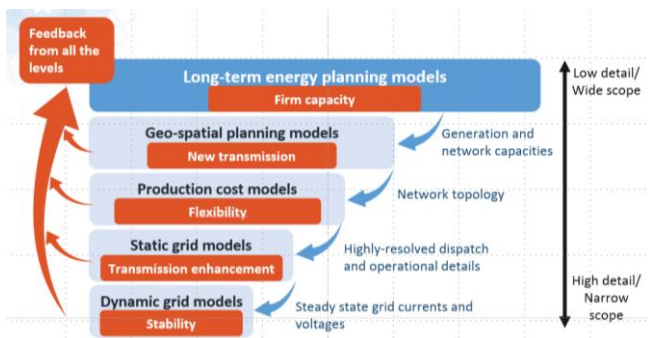
How?



Coordinated planning across planning bodies



Improve long-term energy planning modeling methodologies by incorporating key VRE features

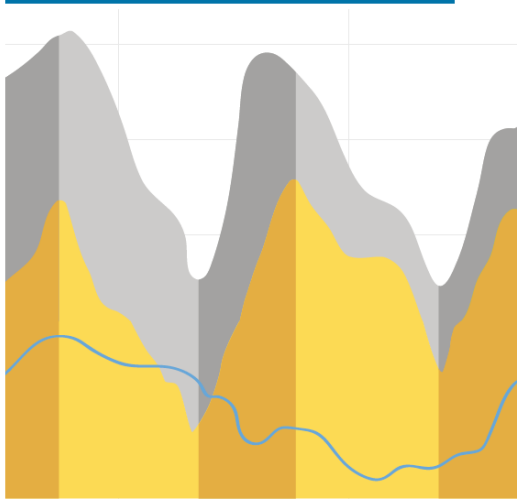


Key elements of the subsequent steps can be pre-analyzed in a simplified manner

Capacity expansion planning

PLANNING FOR THE RENEWABLE FUTURE

LONG-TERM MODELLING AND TOOLS TO EXPAND
VARIABLE RENEWABLE POWER IN EMERGING ECONOMIES



Long-term planning check list – plan for “operability with high VRE”

- » **Firm capacity** (adequate generation fleet)
- » **Flexibility** (balancing for secure operation)
- » **Transmission investment needs** (adequate transmission infrastructure)
- » **Stability** (robustness to withstand contingency)

Best practices to better represent the VRE investment implications in long-term capacity expansion models

IRENA activities in the long-term planning with VRE

Technical workshops to discuss the best practices in long-term planning with VRE

- Key planning concepts
- Practical modelling

Joint long-term planning studies

- Pilot projects on institutional capacity building in developing and updating long-term generation expansion plan

LAC AVRIL follow up meeting

USAID training events

IEW meeting

Swaziland energy planning capacity building

Regional capacity building events with partners (IAEA, UN, etc)

REmap flexibility study

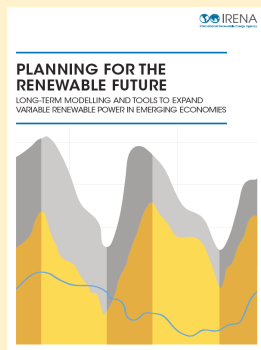
Best practice – VRE integration

Market design, regulation, business models

- Forthcoming Report: **Adapting electricity market design to high shares of VRE** (Q2 2017)
- Country regulatory advice
- **Power sector innovation landscape report** (Q4 2017)

Long term, least cost capacity expansion plan

- Best practices in long-term scenario-based modelling* report, **Planning for the renewable future**
- Recommendations are to be discussed at a **Latin American regional workshop** (2017 Q3)



Unit commitment and economic dispatch

- Production cost modeling
- Developing **flexibility assessment** to be applied to 5 REmap countries
- Developing a **global storage valuation framework**, to assess the value of storage in different markets

Find the optimal pathway for power sector transformation

Grid studies

- Technical network studies
- A guide for **VRE integration studies** is upcoming (2017 Q2)
- Technical assessments for larger systems





IRENA

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