



IRENA

International Renewable Energy Agency

Long-term Planning with a High Share of Variable Renewable Energy

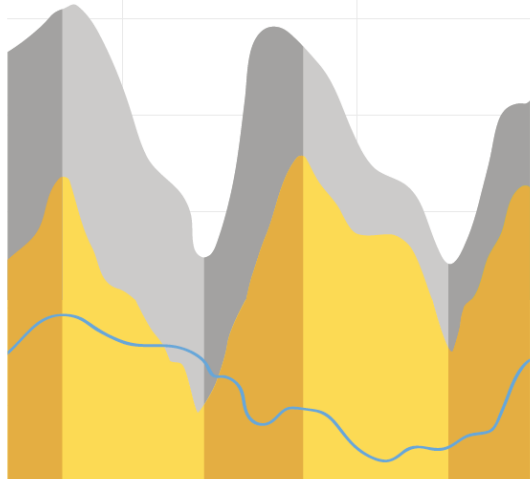
Astana, Kazakhstan

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



PLANNING FOR THE RENEWABLE FUTURE

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





How much electricity demand will there be?



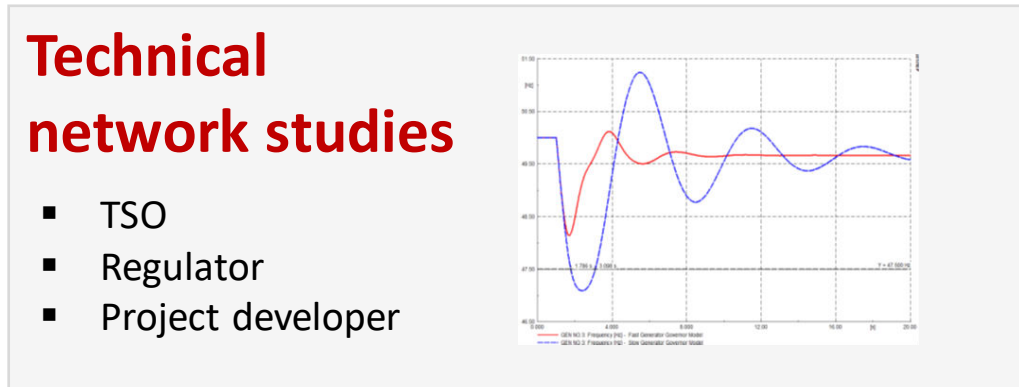
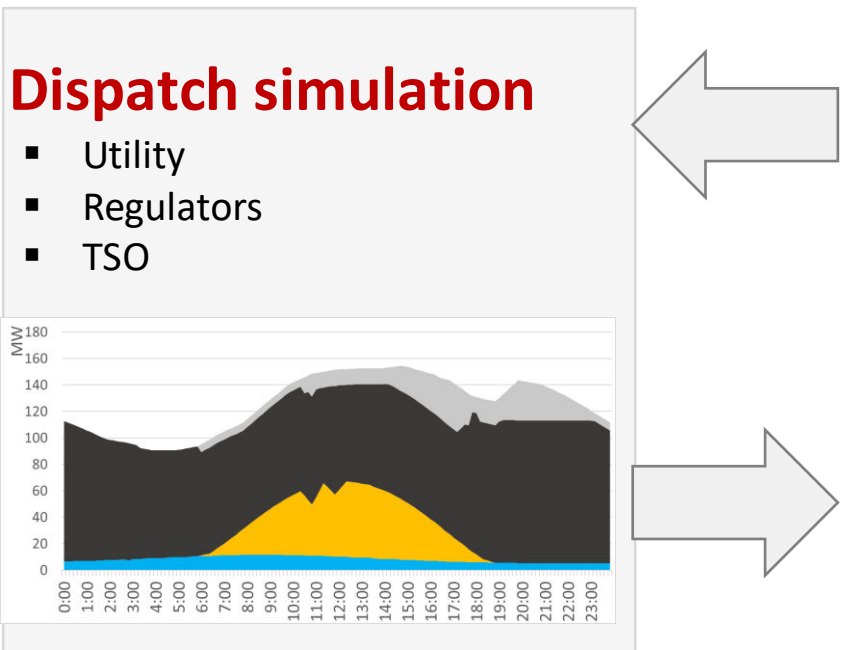
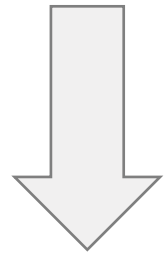
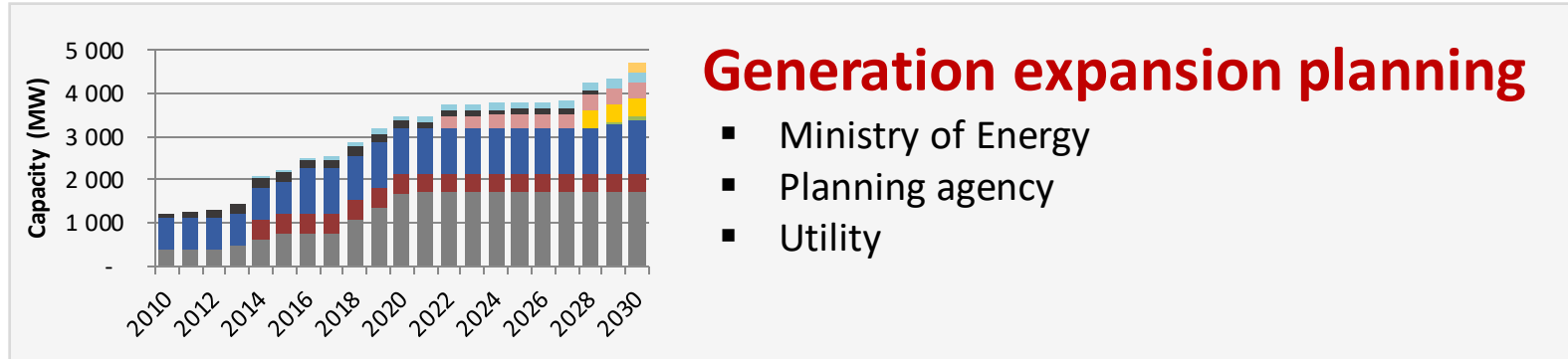
How much and what type of generation is needed to serve this demand?



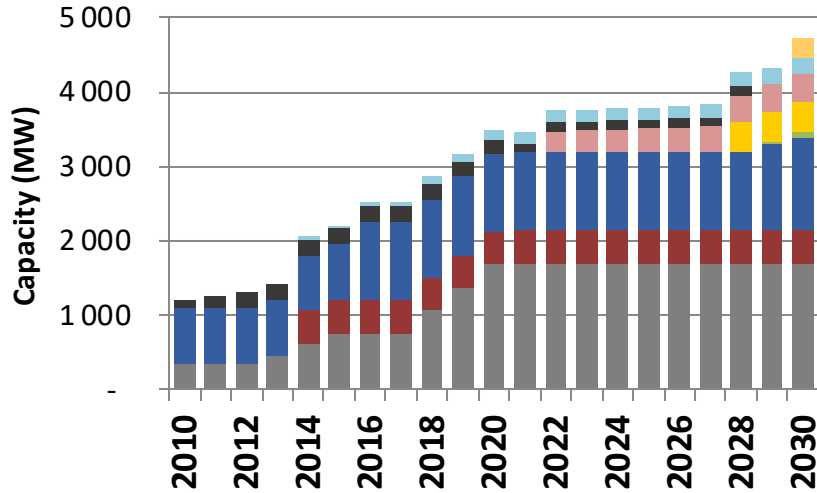
What enhancements to the network are needed to ensure the reliable supply of electricity?

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

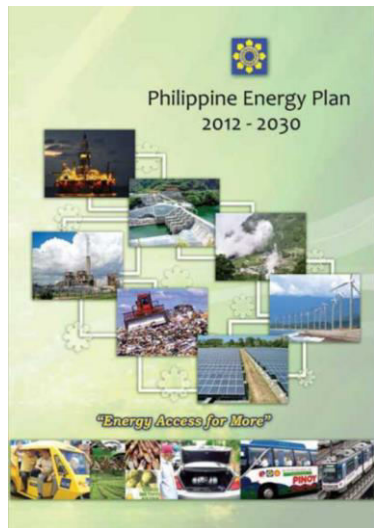
Power sector planning: Planning scopes for techno-economic analysis



1. Generation expansion planning



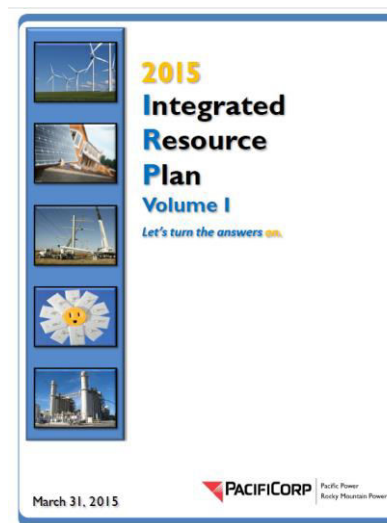
- Future energy mix and investment path
- Compliance with long-term energy policy goals
- Political consensus making
- Linked often with non-power sector planning



Department of Energy



Regulatory commission

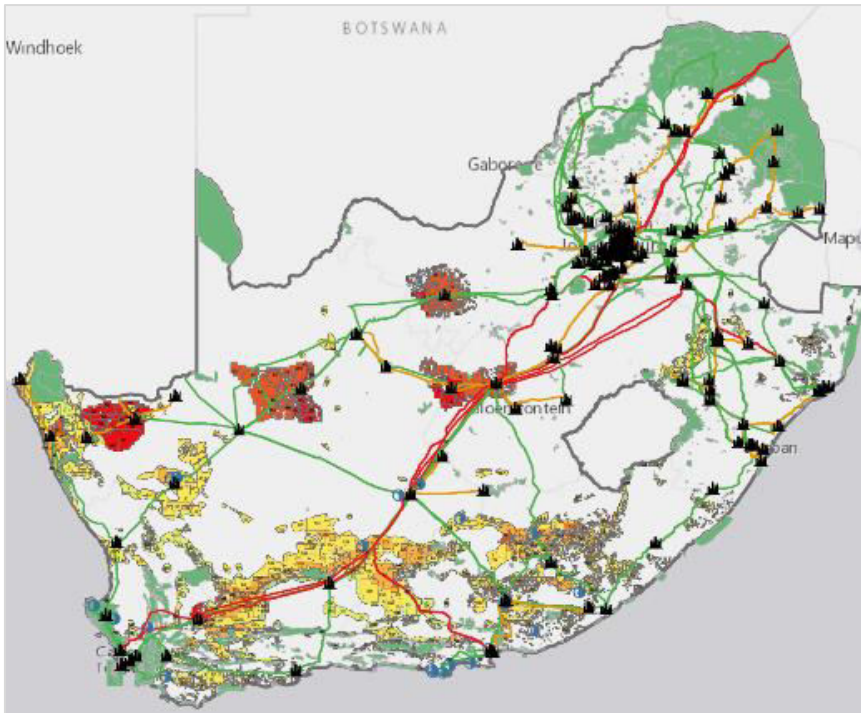


Utility



Specialized agency⁵

2. Geo-spatial planning

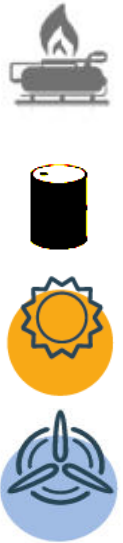
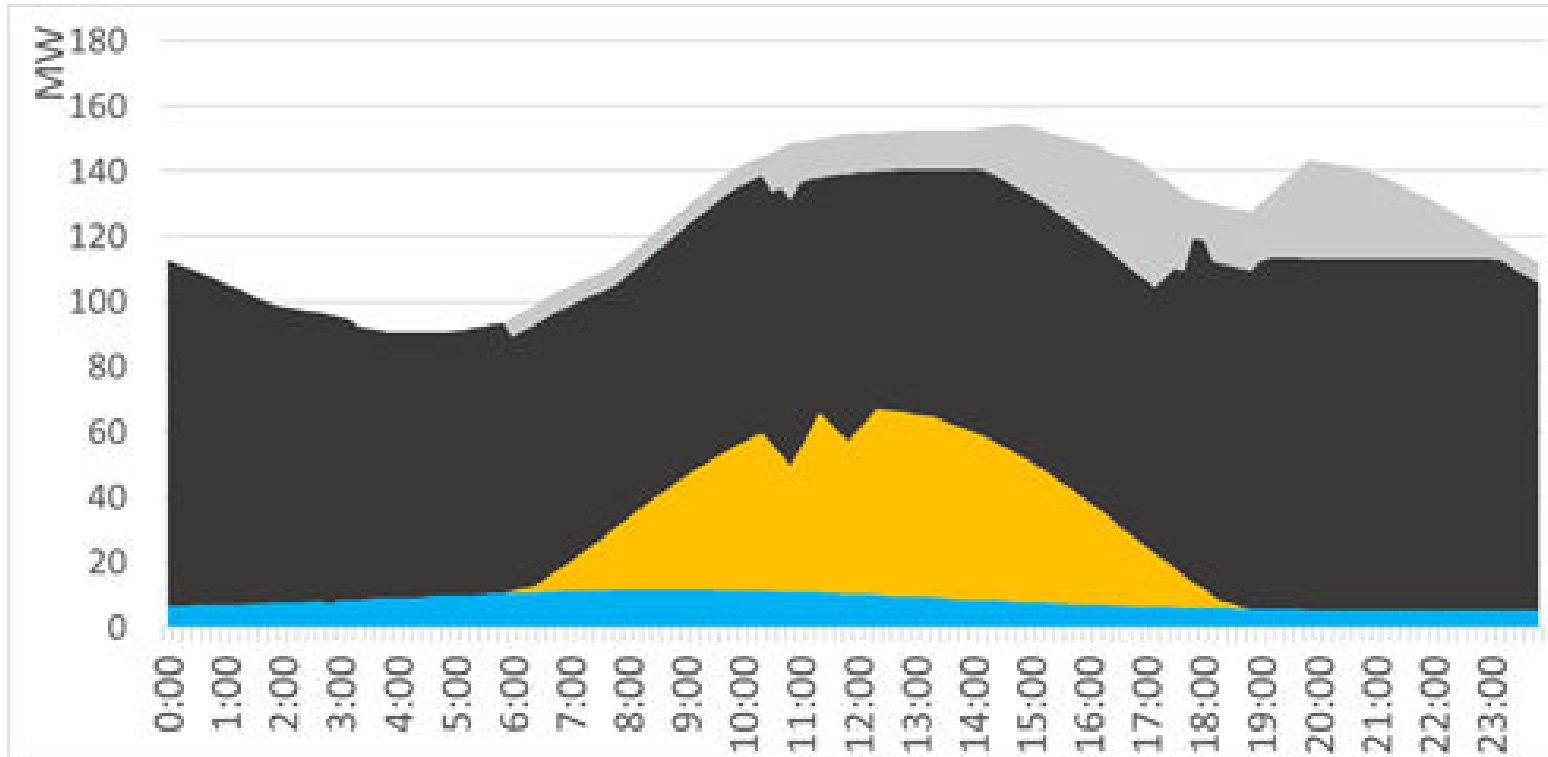


- Generation siting and long-term transmission development needs
- High-level screening scenarios for transmission network development
- Zone identification for investment promotion

Tools:
Maps, Geographical Information System (GIS)



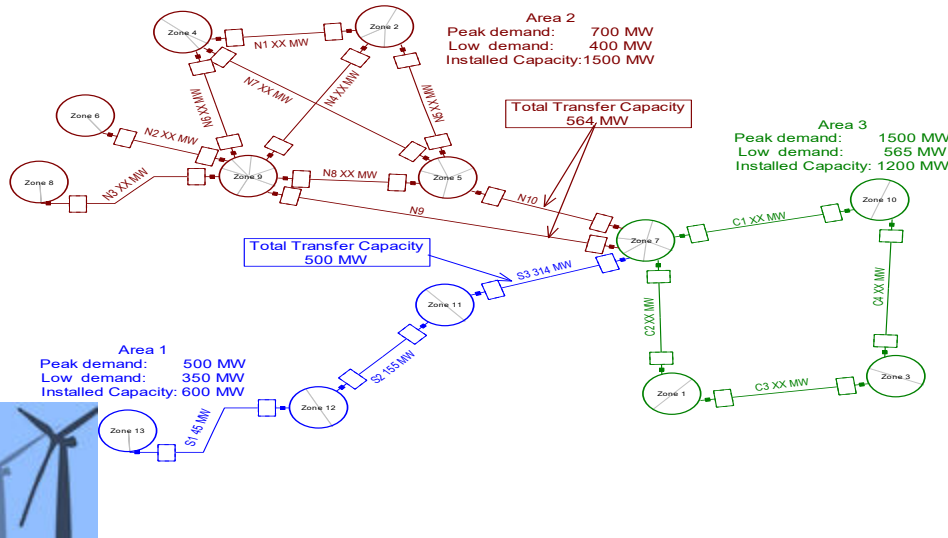
3. Dispatch simulation



- Fuel and operation cost calculation
- Maintenance scheduling
- Economic power flow
- Market and regulation design
- VRE integration study

4. Technical network studies

TRANSMISSION SYSTEM OVERVIEW 2016

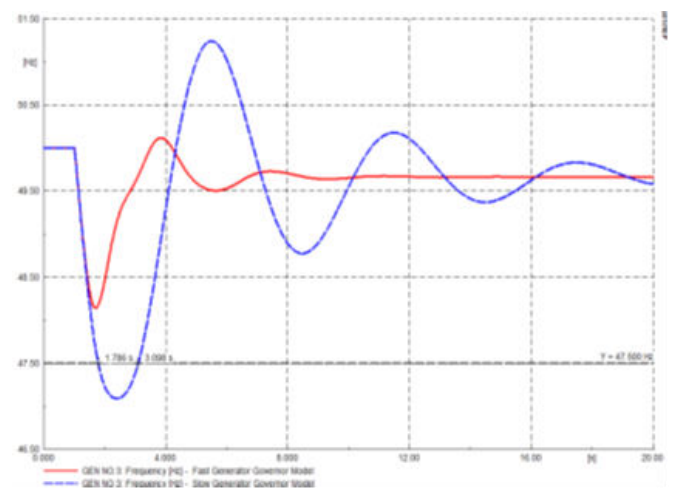


Load flow analysis

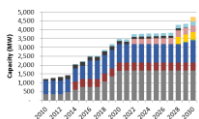
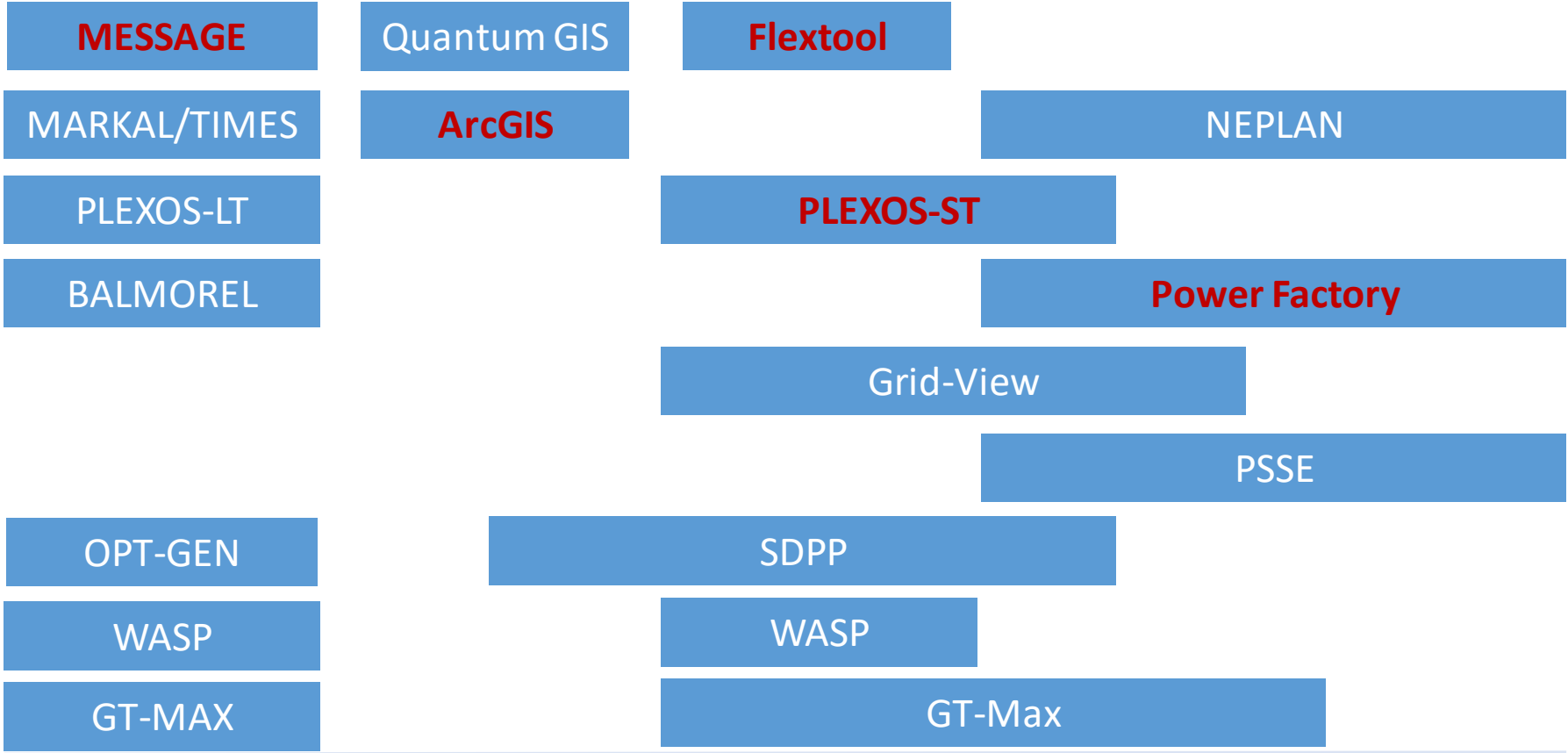
- Simulate power flow of a given network under a challenging situation
- Identify network enhancement needs
- VRE integration study

Stability assessment

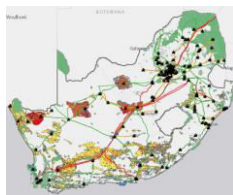
- Simulation of frequency and voltage response in a network to a contingency event
- VRE integration study



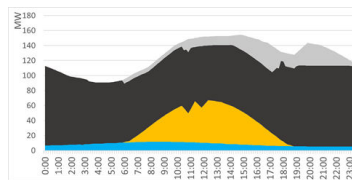
Modelling software – indicative coverage



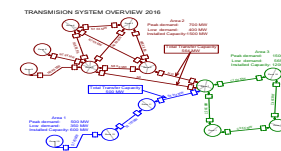
Cap expansion



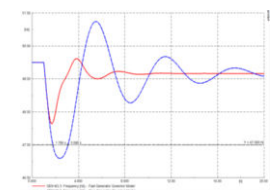
Geo-spatial



Dispatch

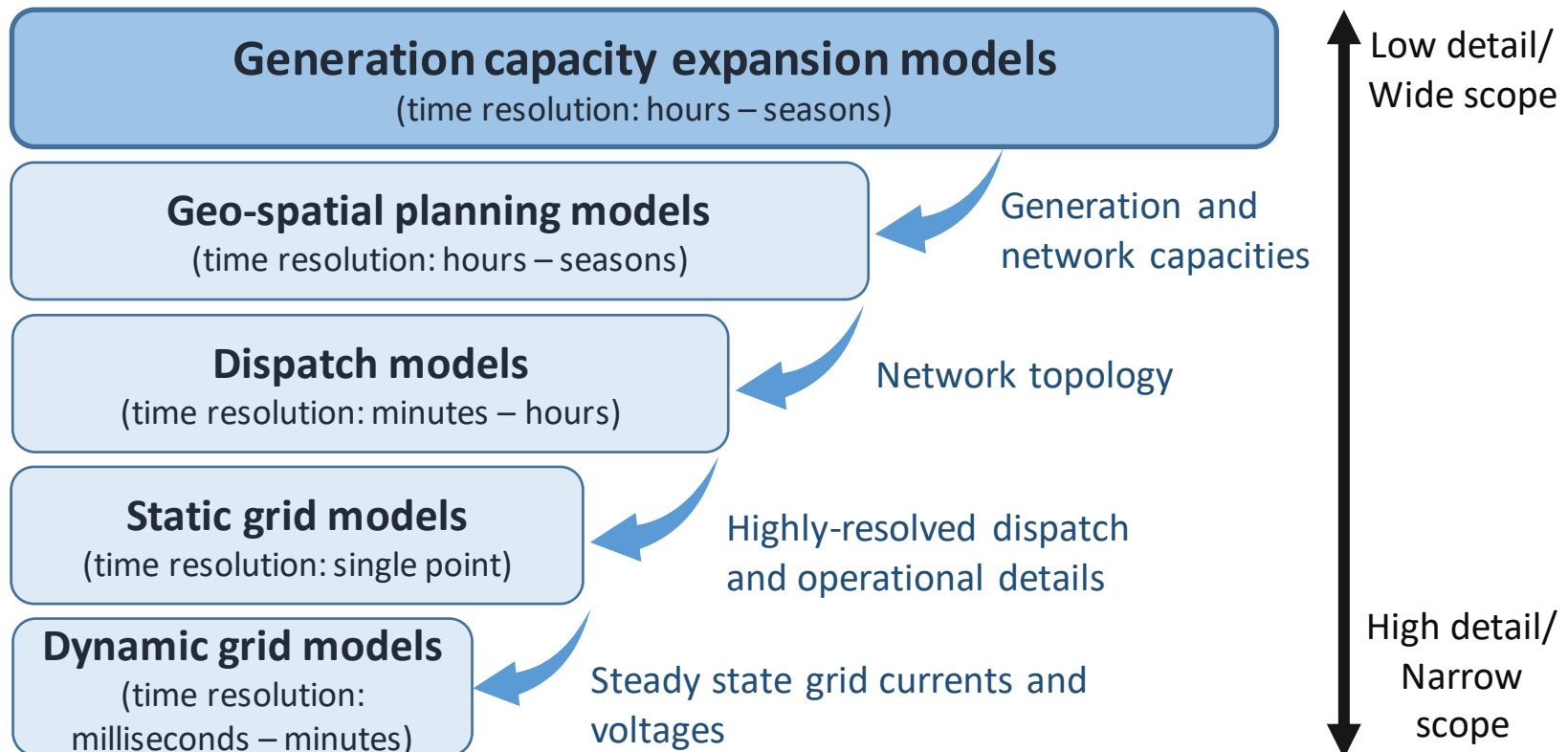


Static



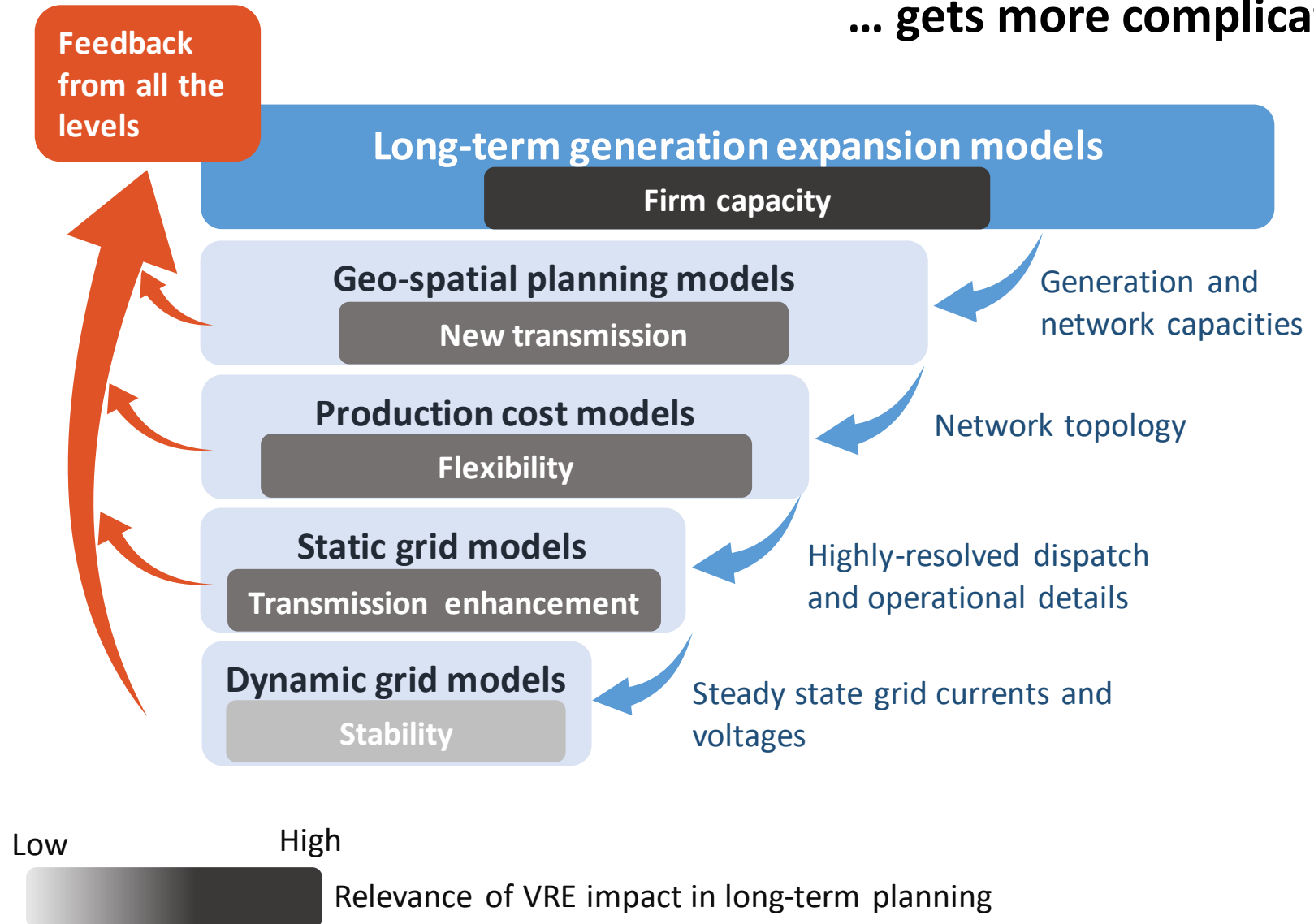
Dynamic

... without VRE



Long-term energy planning with VRE

... gets more complicated



	Generation	Networks
Adequacy	Sufficient firm capacity	Sufficient and reliable transport and distribution capacity
Security	Flexibility of the system Stability (Robustness to contingency)	Voltage control capability Stability (Robustness to contingency)



Generation from VRE generators is variable, uncertain, location-constrained, non-synchronous, and often distributed (connected to distribution grid).

Technical properties of VRE and their impacts to the aspects of reliability

	Generation	Networks
Adequacy	Variability reduces contribution to firm capacity	Location-constraints may require grid extension and reinforcement
Security	Variability and limited predictability requires system to follow residual load Lack of inertia and governor response may pose the technical limit to VRE penetration	Location-constraints may change voltage control requirements Distribution level connection may affect voltages and protection system coordination RE's behavior during fault may affect system stability

	Generation	Networks
Adequacy	Firm capacity	Transmission capacity
Security of operation	Flexibility	Voltage control capability
	Stability (frequency response and voltage response)	

Most relevant 

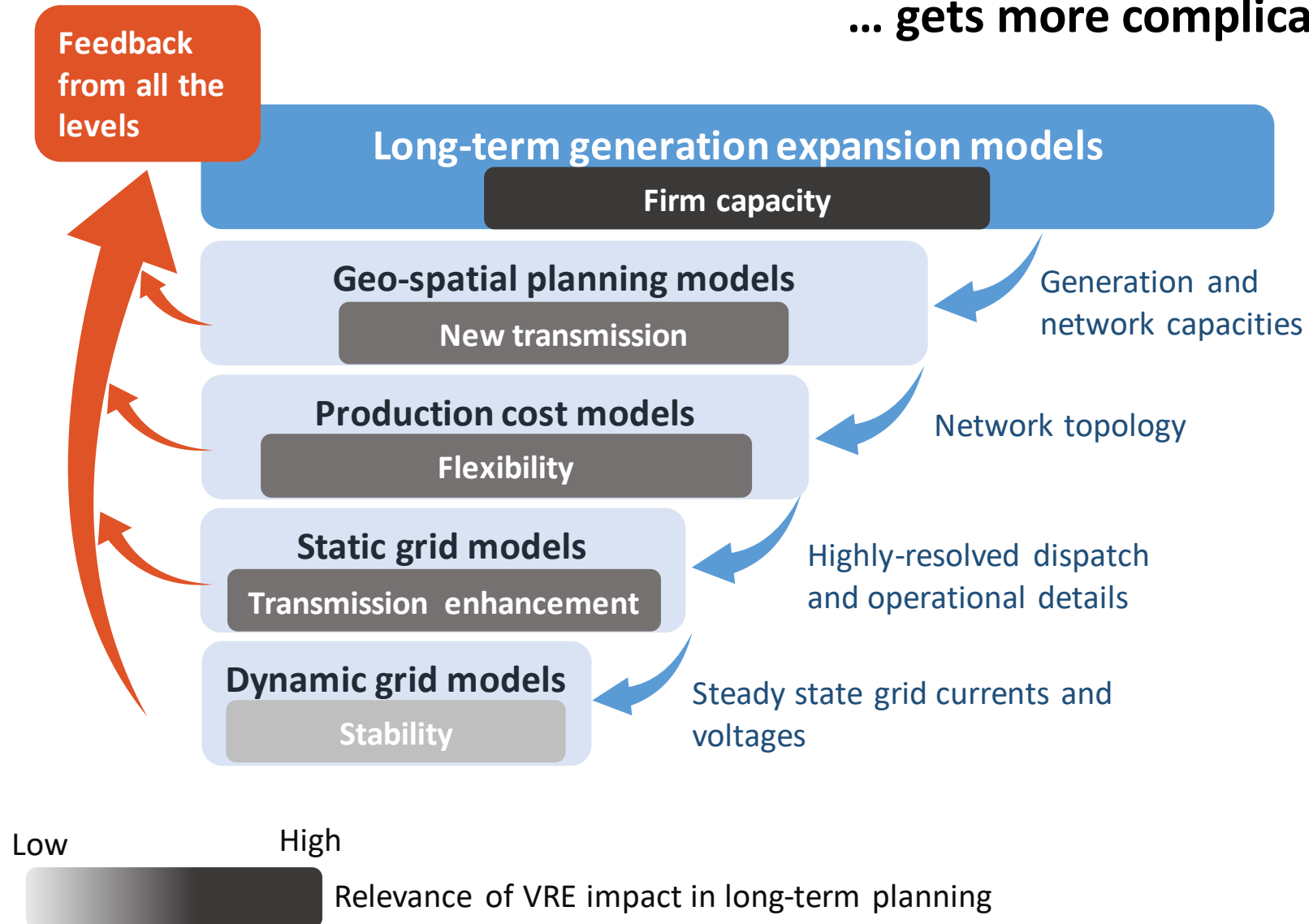
High relevance 

System-specific 

Near-term relevance 

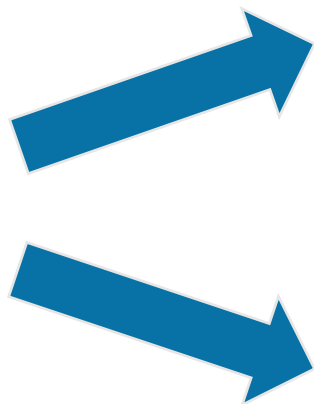
Long-term energy planning with VRE

... gets more complicated



It is important to do it right from the beginning!

How?



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

Coordinated planning across planning bodies

IRENA's country support programme offers country specific planning support





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Thank you

Asami Miketa, Amiketa@irena.org