



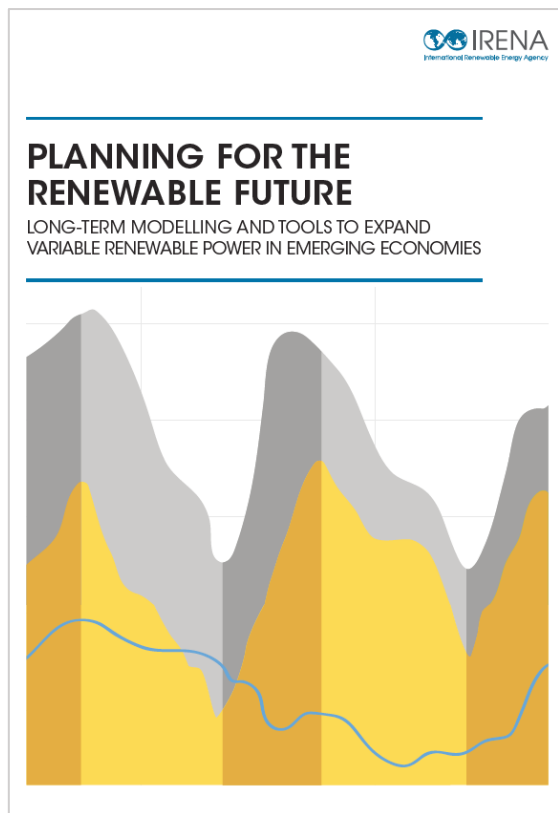
IRENA

International Renewable Energy Agency

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

May 2022

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





How much electricity demand will there be?



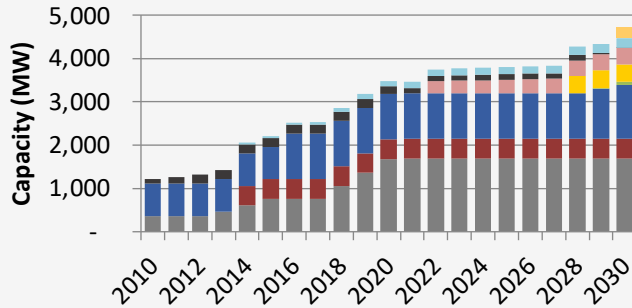
How much and what type of generation is needed to serve this demand?



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

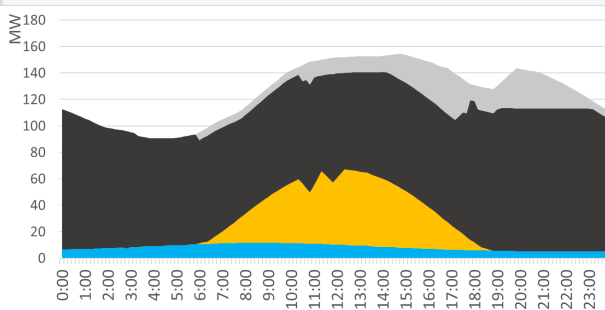


Generation expansion planning

- Ministry of Energy
- Planning agency
- Utility

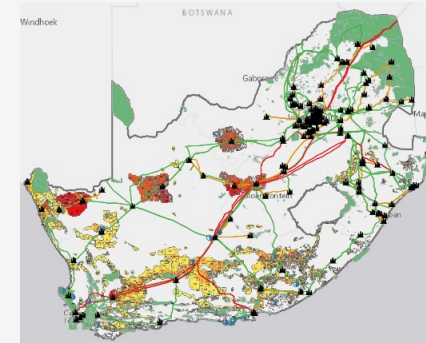
Dispatch simulation

- Utility
- Regulators
- TSO



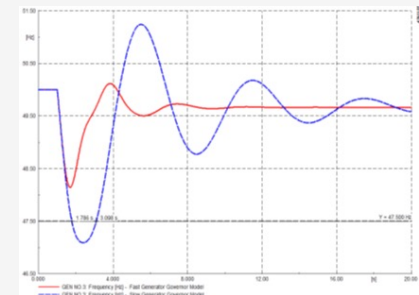
Geo-spatial planning

- Ministry of Energy
- Planning agency
- Utility
- TSO

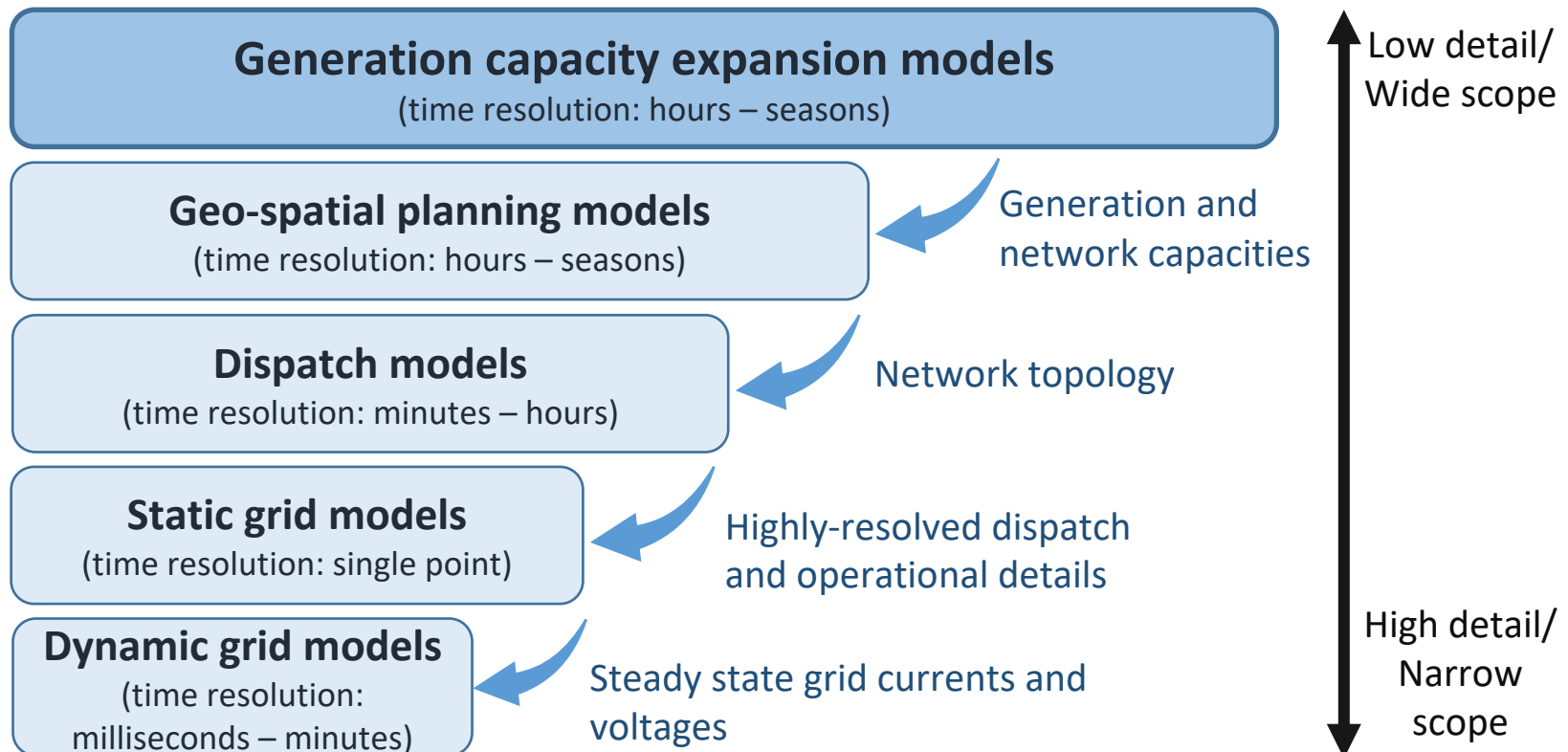


Technical network studies

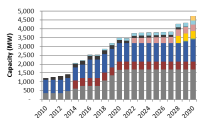
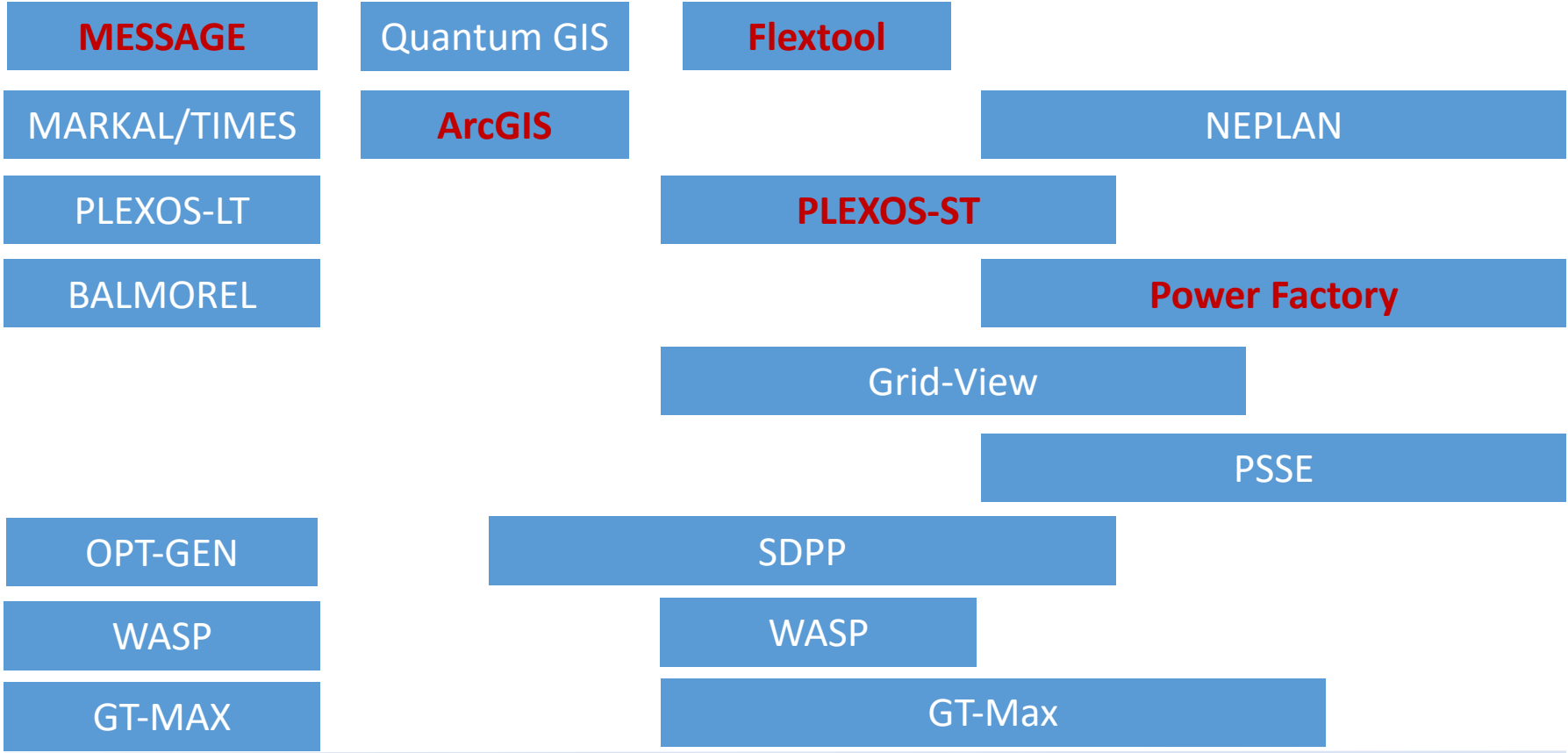
- TSO
- Regulator
- Project developer



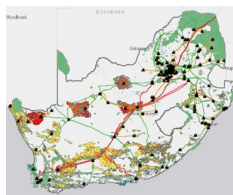
... without VRE



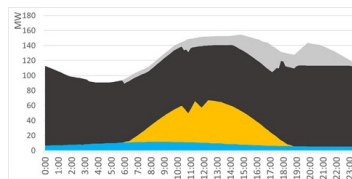
Modelling software – indicative coverage



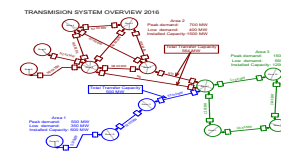
Gen. expansion



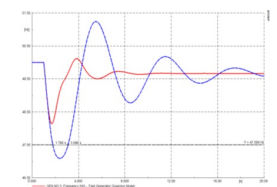
Geo-spatial



Dispatch



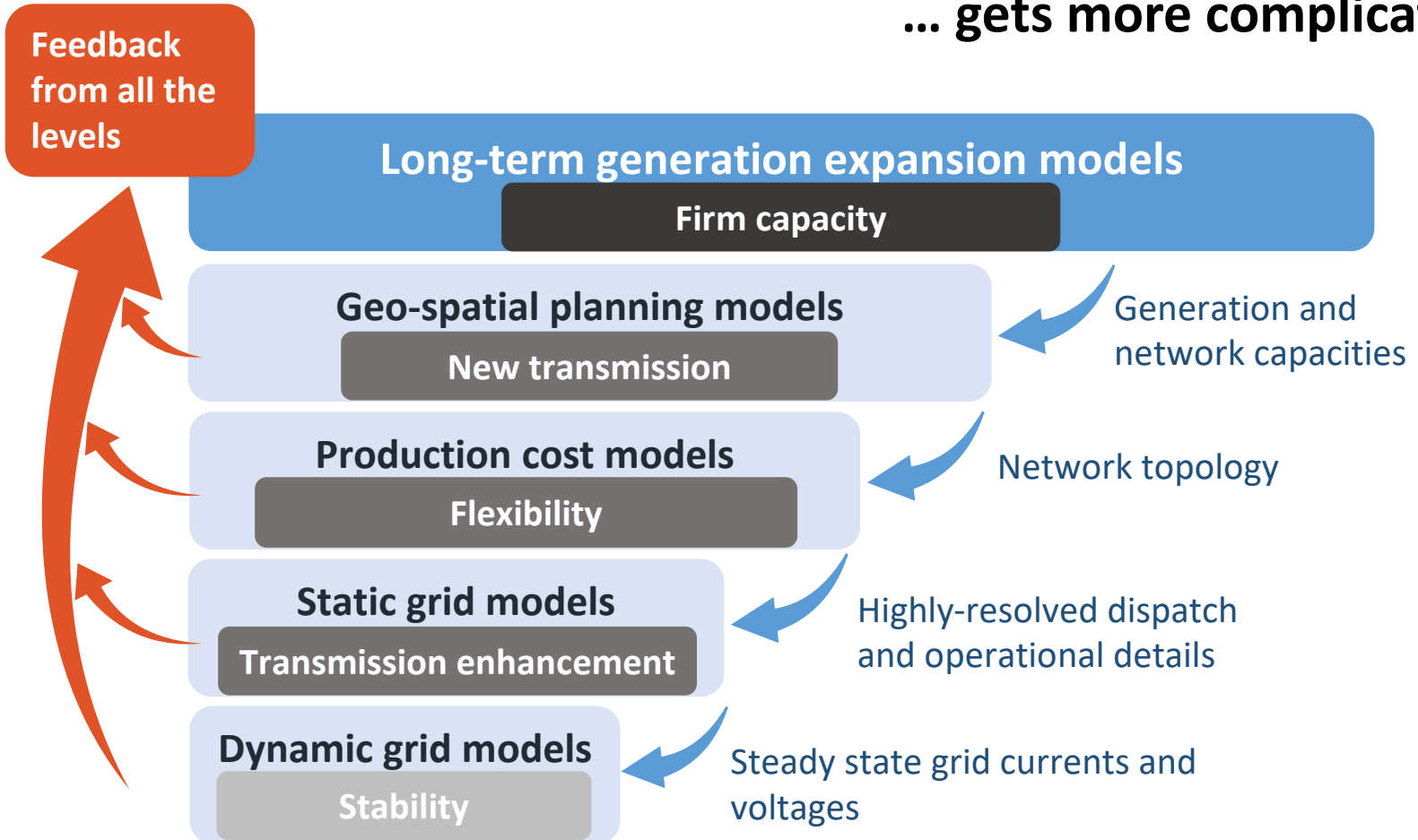
Static



Dynamic

Long-term energy planning with VRE

... gets more complicated



Low

High



Relevance of VRE impact in long-term planning

Aspects of reliability

	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)	

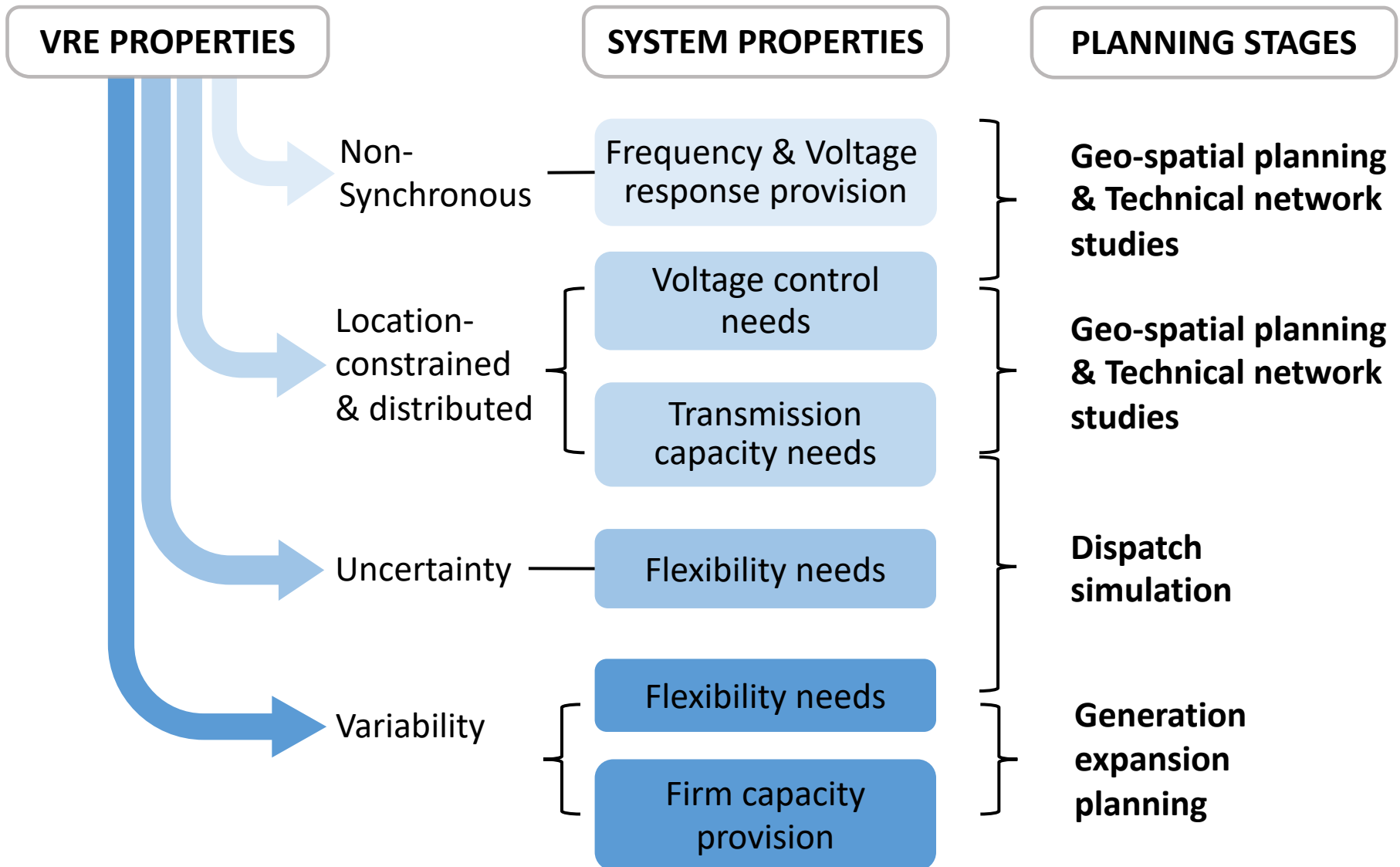
Most relevant 

High relevance 

System-specific 

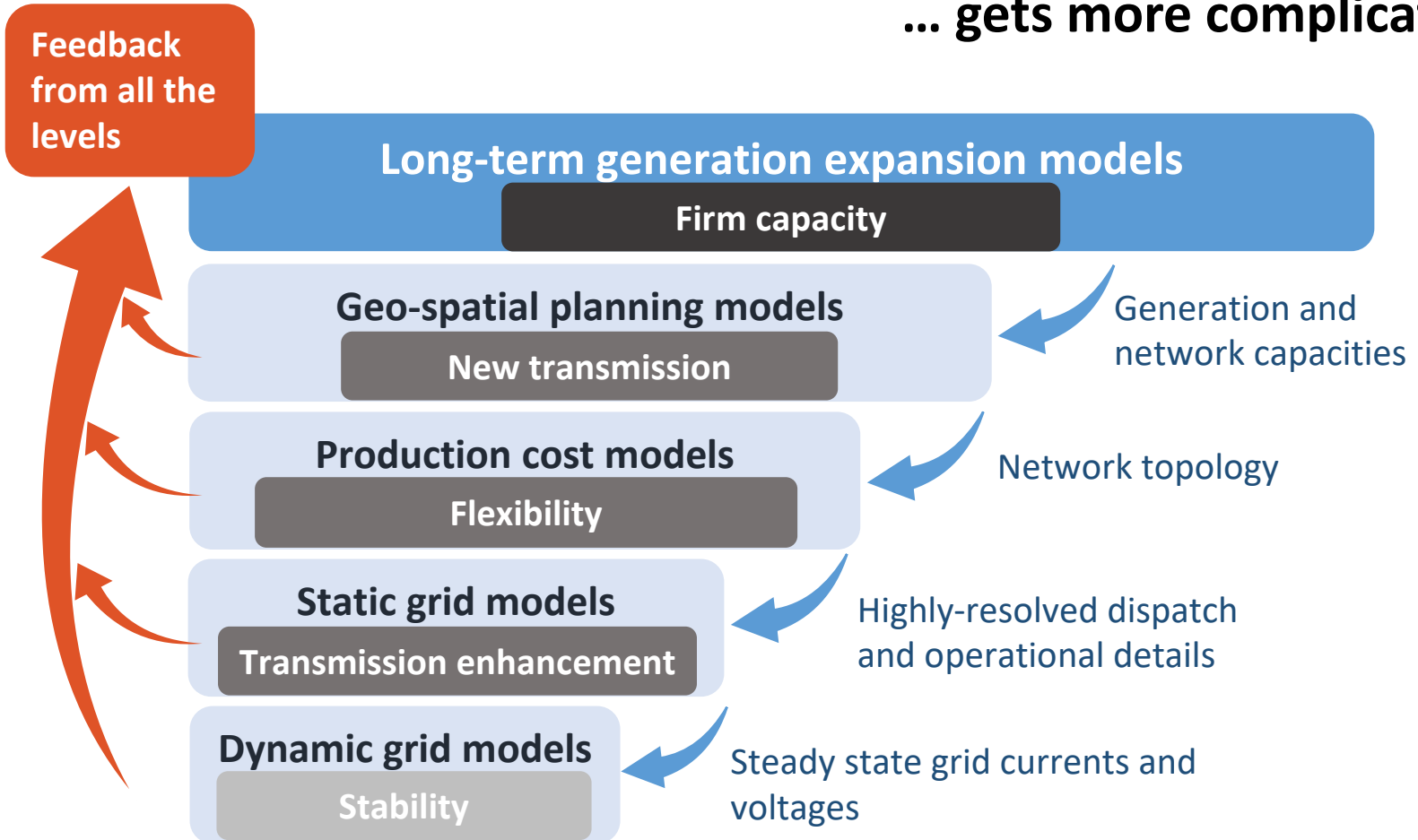
Near-term relevance 

VRE features and planning stages



Long-term energy planning with VRE

... gets more complicated



Low

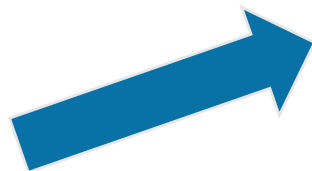
High



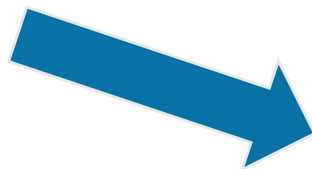
Relevance of VRE impact in long-term planning

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

International Renewable Energy Agency

Thank you

Asami Miketa, Amiketa@irena.org