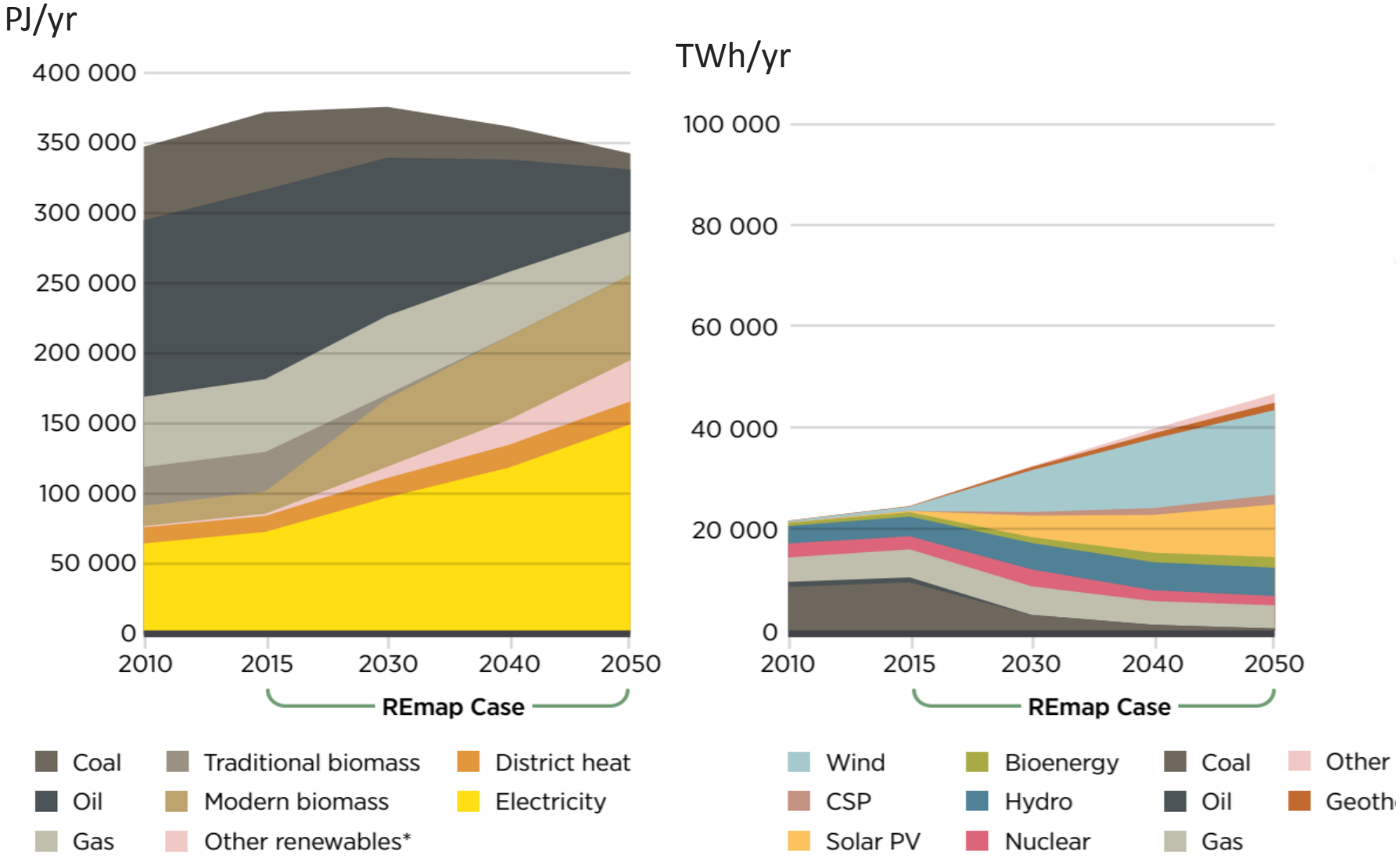
Planning for the renewable energy future with grid investment

Asami Miketa
IRENA Innovation and Technology Centre
Sixth Annual Expert Workshop: Challenges in Electricity Decarbonisation, 18 October 2019, Paris

Increasing role of electricity in the decarbonized world



By 2050:

The share of electricity in the final energy demand reaches to 49%

VRE (Solar PV + wind) 60%

- Implications of a high share of VRE to long-term transmission planning

- Regional coordination in the context of clean energy transition – roles of planning scenarios

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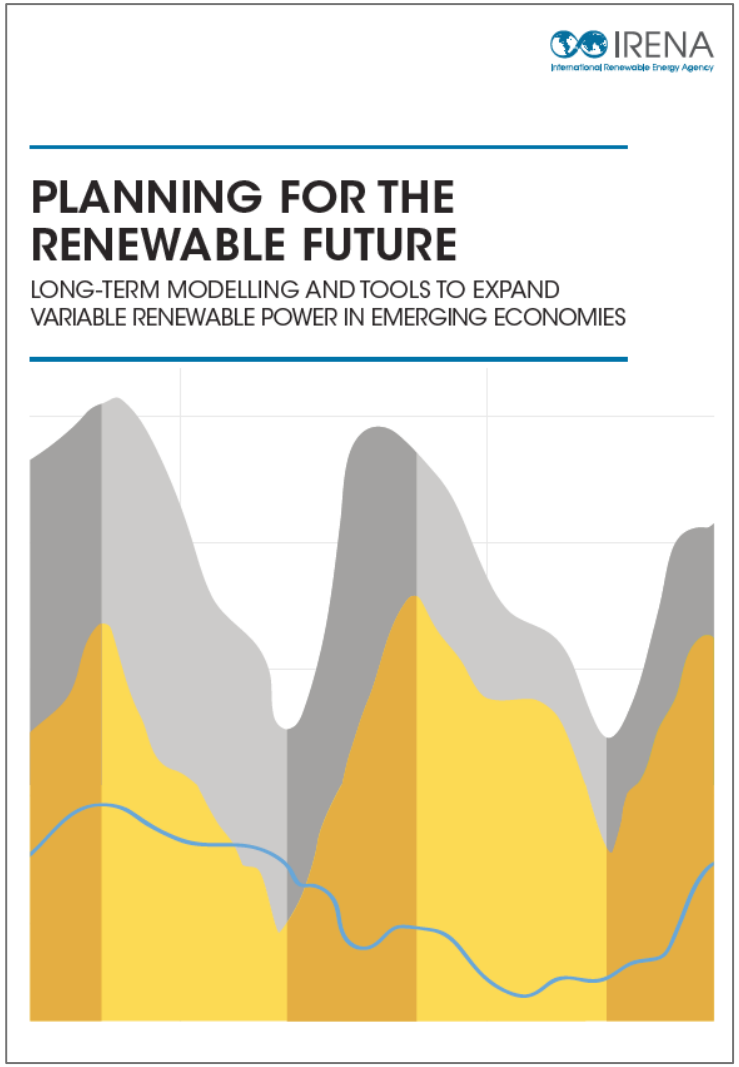
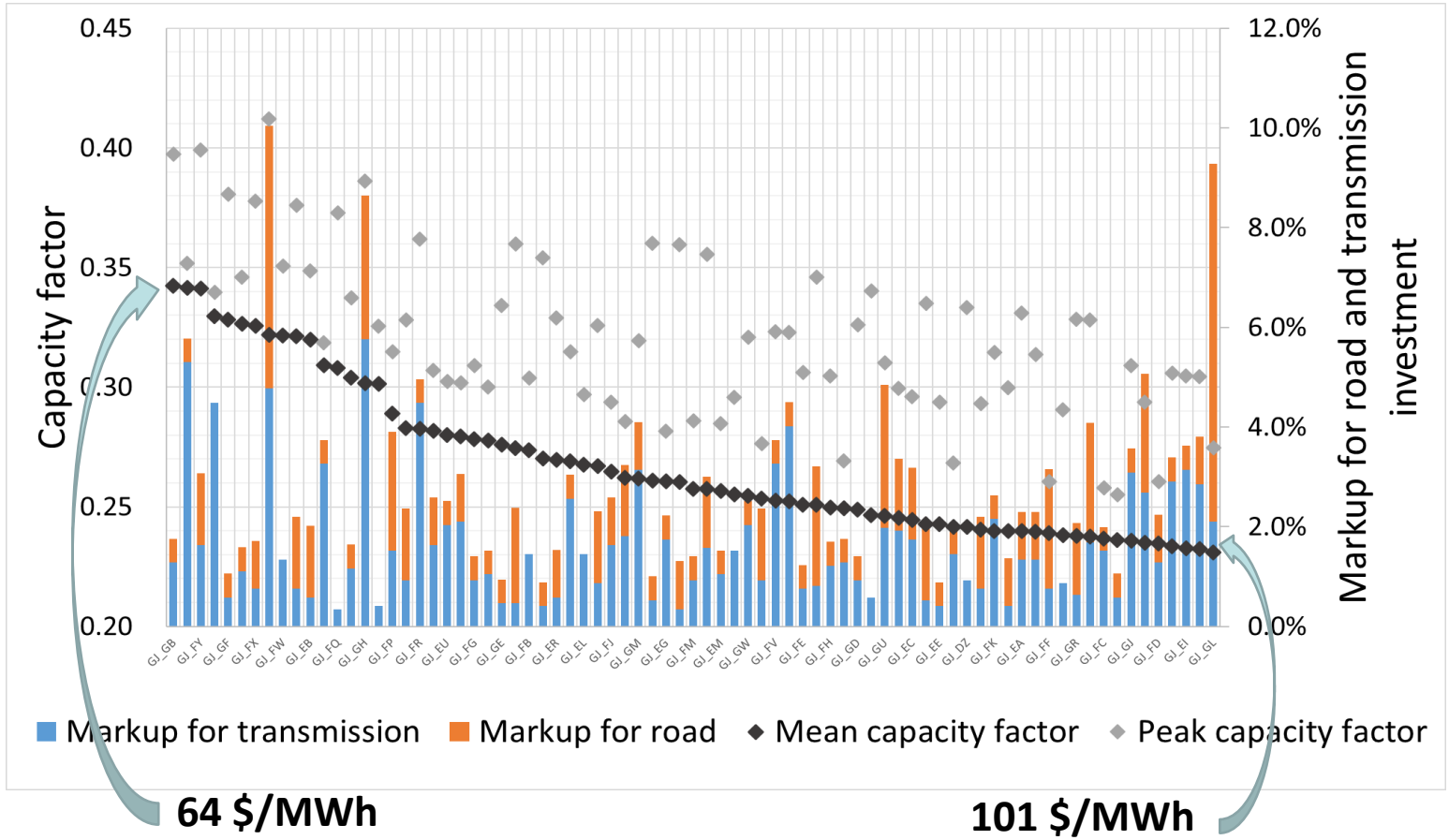
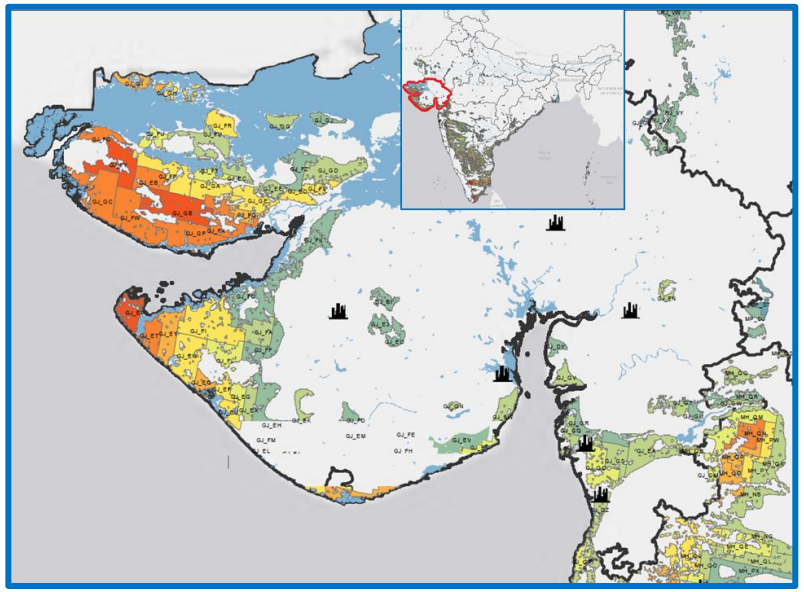


https://www.irena.org/publications/2017/Jan/Planning-for-the-renewable-future-Long-term-modelling-and-tools-to-expand-variable-renewable-power

The importance of location for the economic value of VRE



Gujarat province, India: wind zones

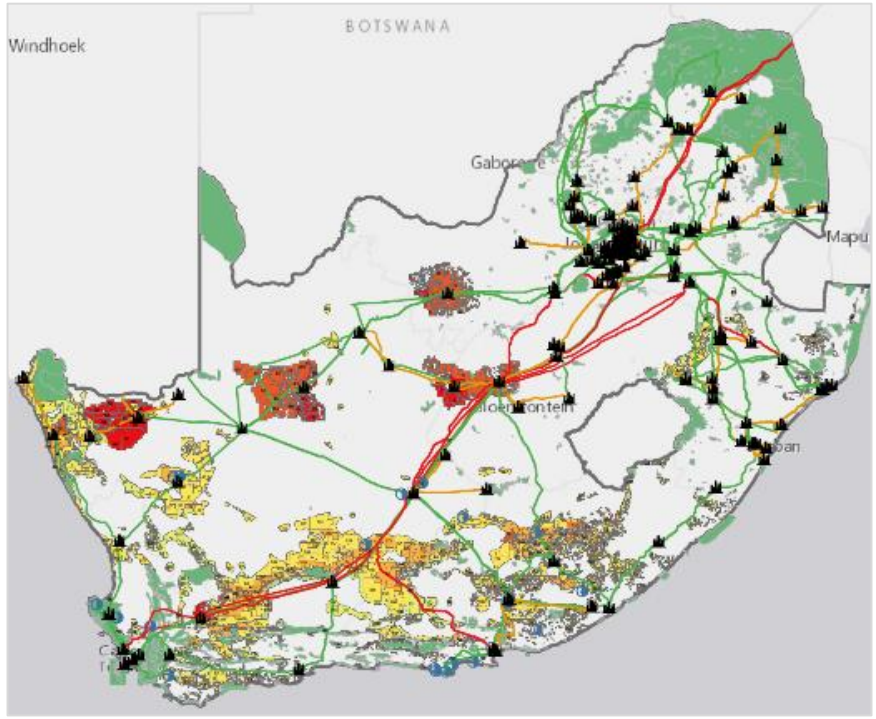


Source: Lawrence Berkley National Lab, MapRE

Key planning implication:

- **Trade-off between resource quality and transmission investment**

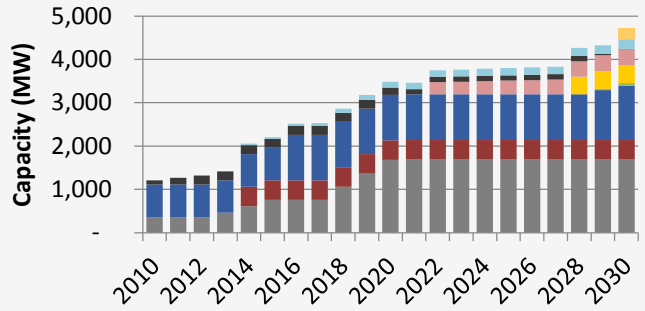
Geo-spatial planning



- Generation siting and long-term transmission development needs
- High-level screening scenarios for transmission network development
- Geographical dispersion of temporal variability

Tools:
Geographical Information System (GIS), Maps

Planning scopes for techno-economic analysis

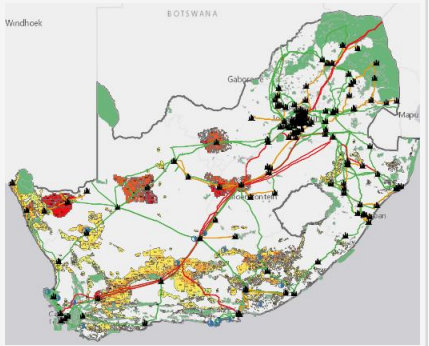


Generation expansion planning

- Ministry of Energy
- Planning agency
- Utility

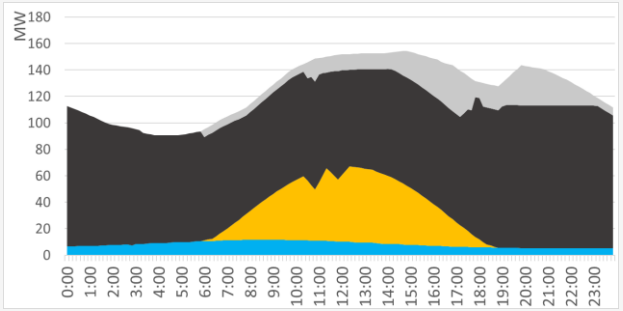
Geo-spatial planning

- Ministry of Energy
- Planning agency
- Utility
- TSO



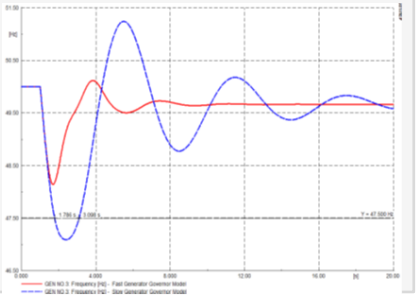
Dispatch simulation

- Utility
- Regulators
- TSO

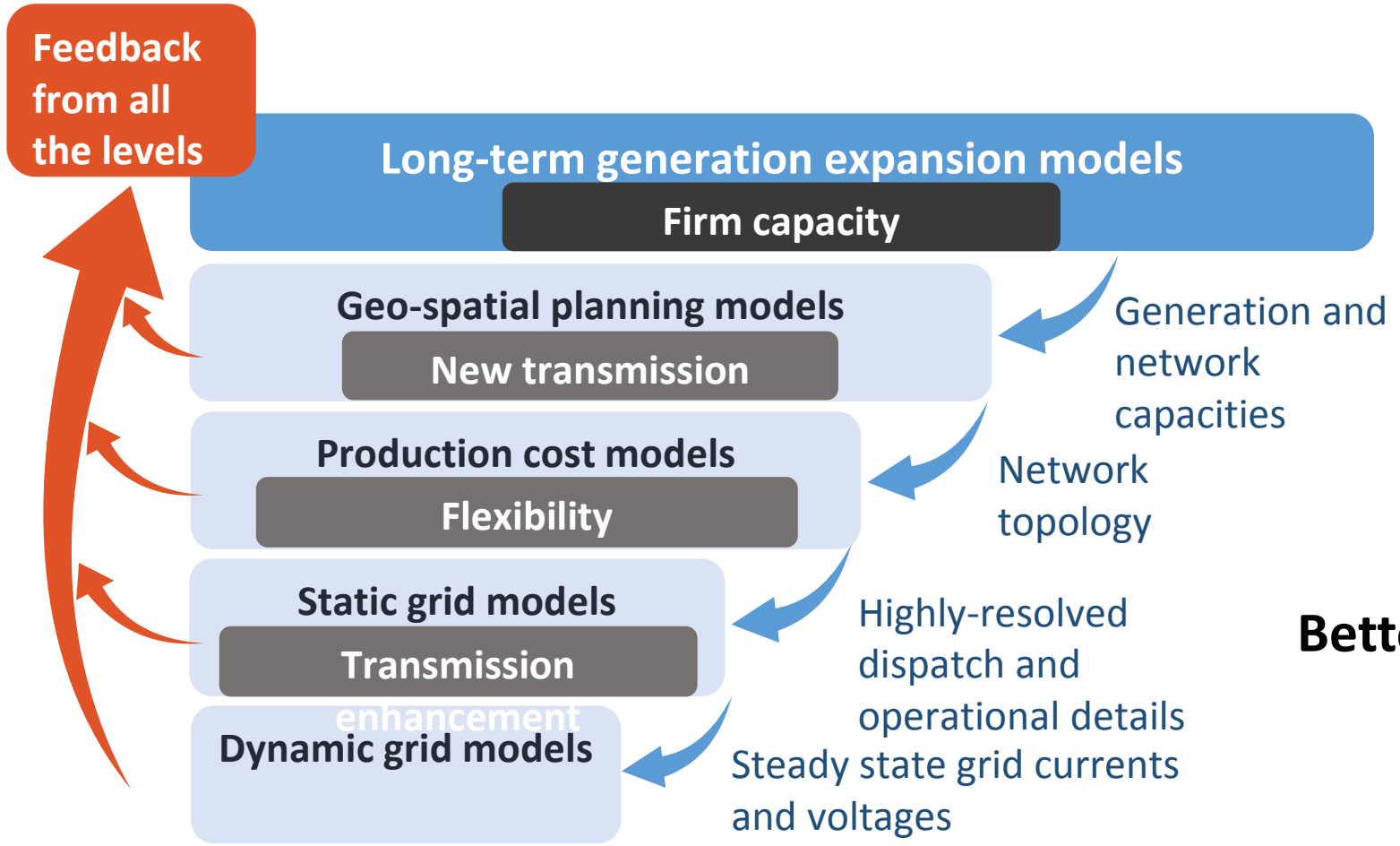


Technical network studies

- TSO
- Regulator
- Project developer



Application of planning tools … with VRE



Better coordination is required!

High-level transmission scenarios to be co-optimized with generation expansion planning

Latin American context

Summary from ""*Exchanging best practices to incorporate variable renewable energy into long-term energy/power sector planning in South America*" - *10 countries*

- Most countries have **developed solar and wind resource maps** to define renewable energy zones, with some adding multiple nodes and/or map layers of further technical and non-technical information to aid model representation of transmission expansion
- Important to note that **investment and construction costs, and not only resource quality**, can also be based on location
- The general **co-optimisation of generation and transmission expansion planning** processes remains a challenge in many cases
- The regional representation in long-term models is sometimes based on characteristics of other resources, such as hydro (in Brazil) or gas (in Argentina), and it is important to analyse whether **different regional representations** could have a material impact on model results

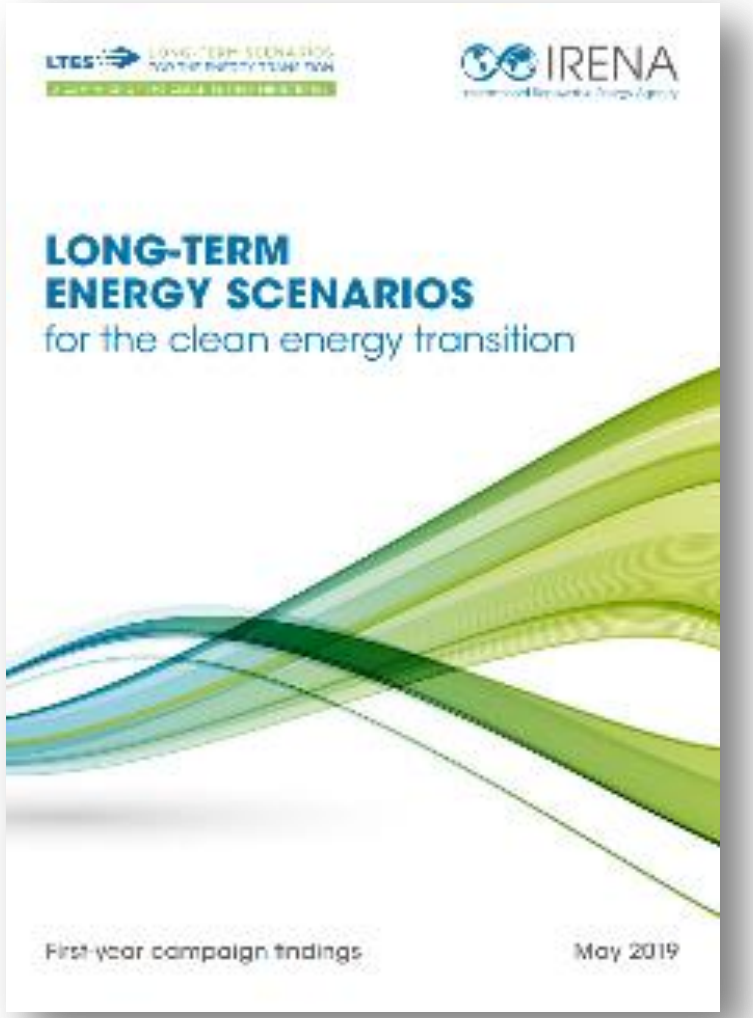
MENA context

Summary from ""*Exchanging best practices to incorporate variable renewable energy into long-term energy/power sector planning in MENA*" - *15 countries*

- There are **established power sector planning practices** in only some of the countries.
- Application of **simplified models of the grid at generation planning level is widely used**, especially for countries that have clearly separated operating areas, such as Saudi Arabia.
- Using the development of a large-scale VRE plant in a remote area to interconnect two previously separated systems is being studied, notably by Saudi Arabia and Algeria.
- For most of the countries, **the development of a VRE project** is preceded by a detailed grid integration study, which can lead to a revision of the siting of the plant based on the hosting capacity of the different possible substations.

- Implications of a high share of VRE to long-term transmission planning

- Regional coordination in the context of clean energy transition – roles of planning scenarios



https://www.irena.org/publications/2019/May/LTES-First-year-campaign-findings

Two events on the regional planning

- Planning across different geographical scopes – GSTIC Nov 2018 in Brussels

- Regional coordination of planning in the context of clean energy transition – WEC Congress September 2019 in Abu Dhabi

Trans-national planning

Key to access cost-effective flexibility options from the neighboring countries

- Regional studies show benefits of the trade and coordination – with varying degree of pollical implications
- Government long-term plans rarely factor in the regional aspects
  - Use domestic resources for internal use
  - Plan to be exporters
- Bilateral agreements have been functioning well - but many are based on contracts
- Need an interface between bottom up plan (driven by private sector) and top-down approach (driven by government leadership)

National-sub-regional coordination

- Denmark: standarlized dataset for planning (Denmark)
- Netherlands: adding up regional plans, standarazlied reference case to allow comparison

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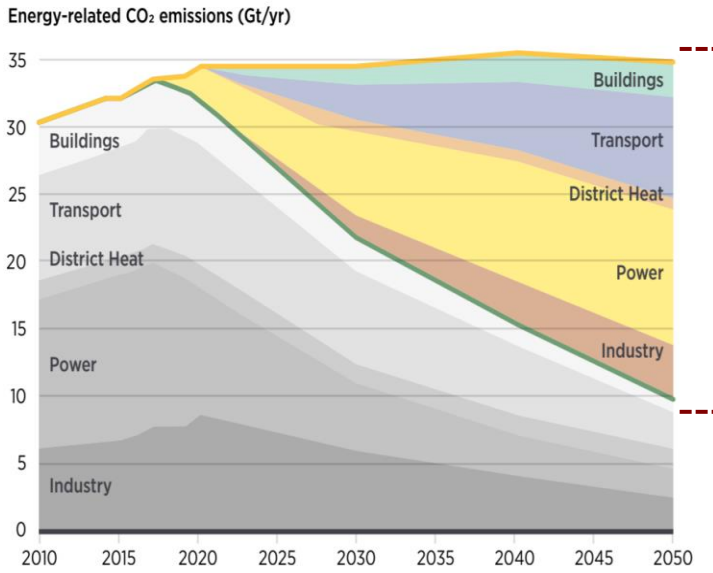
IRENA

International Renewable Energy Agency

Ongoing Energy Transformation: Drivers

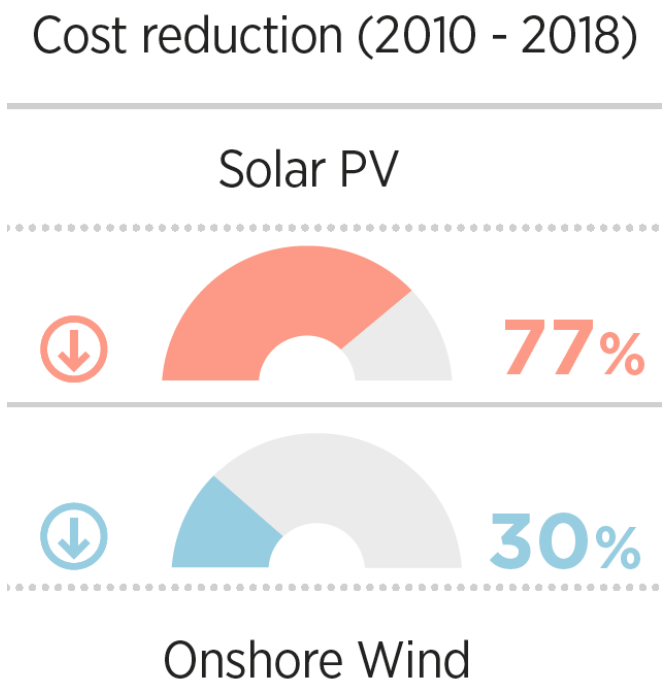
- **Policy imperatives**
  - Sustainable Development and Economic Growth (SDGs)
  - Climate and Environmental agenda (Paris Agreement)

Annual energy-related CO_2 emissions and reductions, 2015-2050 (Gt/yr)



94% of needed emission reductions from RE and EE

- **RE Strong Business case**
  - Policy frameworks, business and technology innovation
  - Dramatic cost reduction



Source: IRENA (2018), Global Energy Transformation: Roadmap to 2050

VRE: Long-term investment implications

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

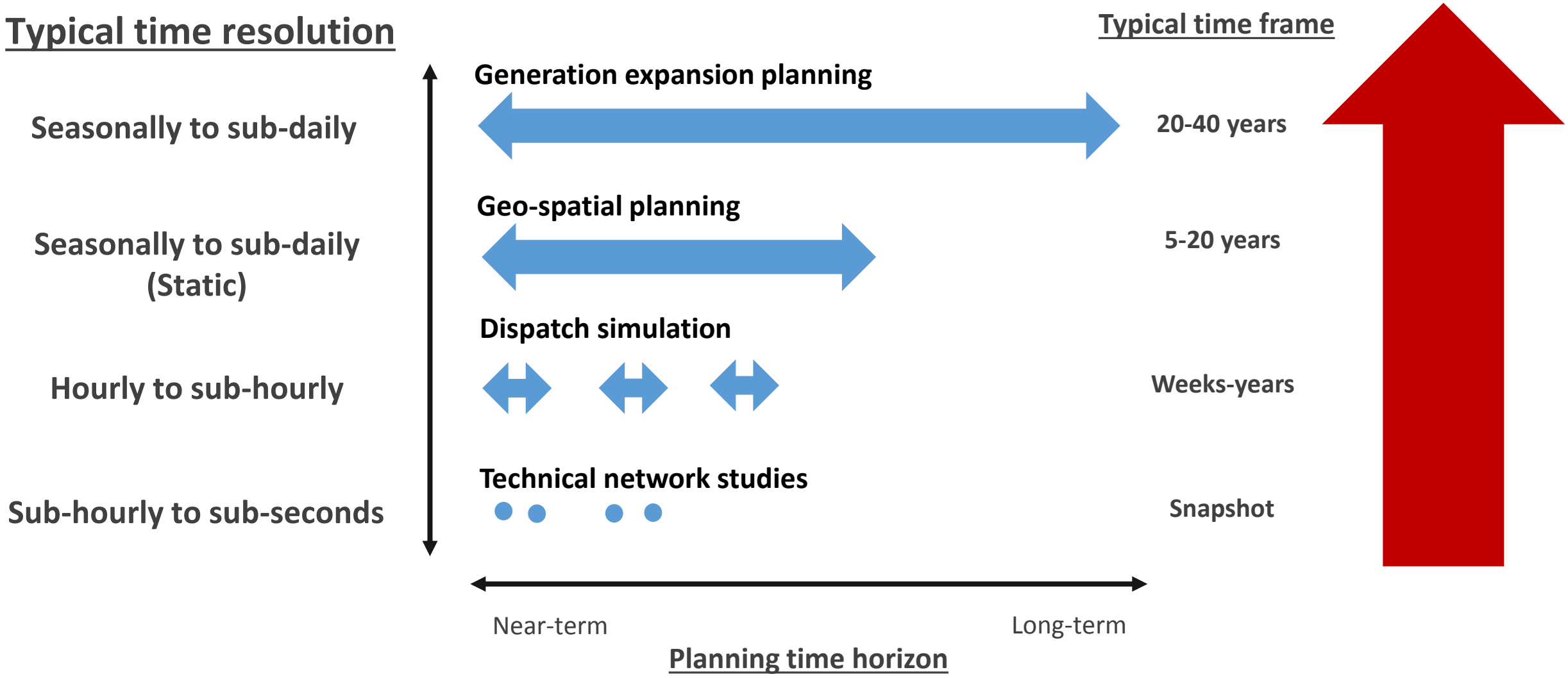
Most relevant

High relevance

System-specific

Near-term relevance

Time dimensions of power sector planning



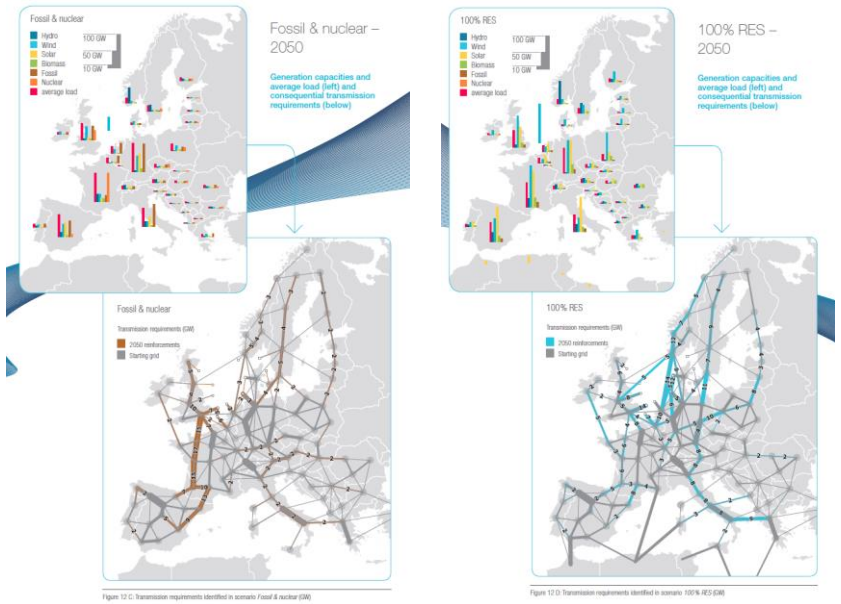
Source: IRENA

Geo-spatial planning

Inputs to other planning steps

- Co-optimization with generation expansion
- A part of technical network studies

Modular Development Plan of the Pan-European Transmission System 2050 (E-highway by ENTSO-E)



Fossil&Nuclear scenario

100% RES scenario

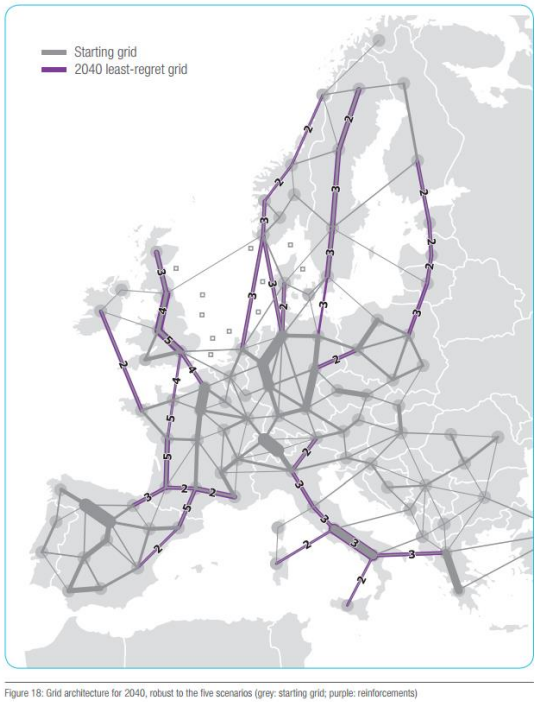


Figure 18: Grid architecture for 2040, robust to the five scenarios (grey: starting grid; purple: reinforcements)

No-regret investment

Energy generation scenarios given

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Geo-spatial information

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Optimal power flow

↓

Grid enhancement needs to 2030 plan

↓

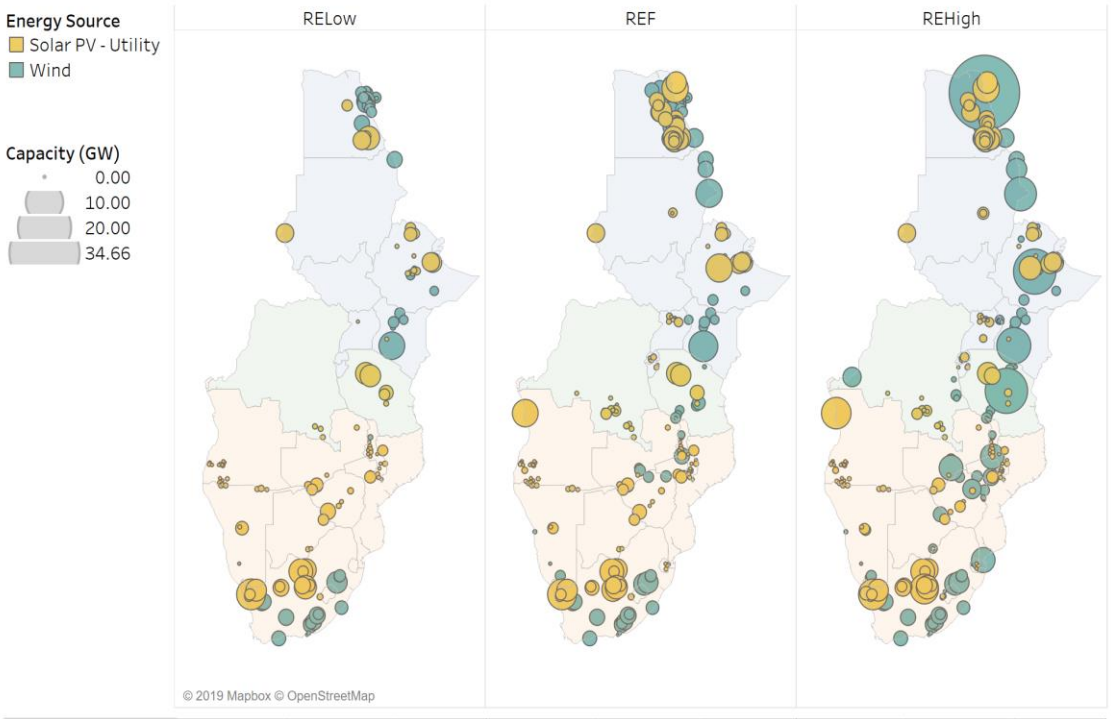
Check for voltage and stability problem

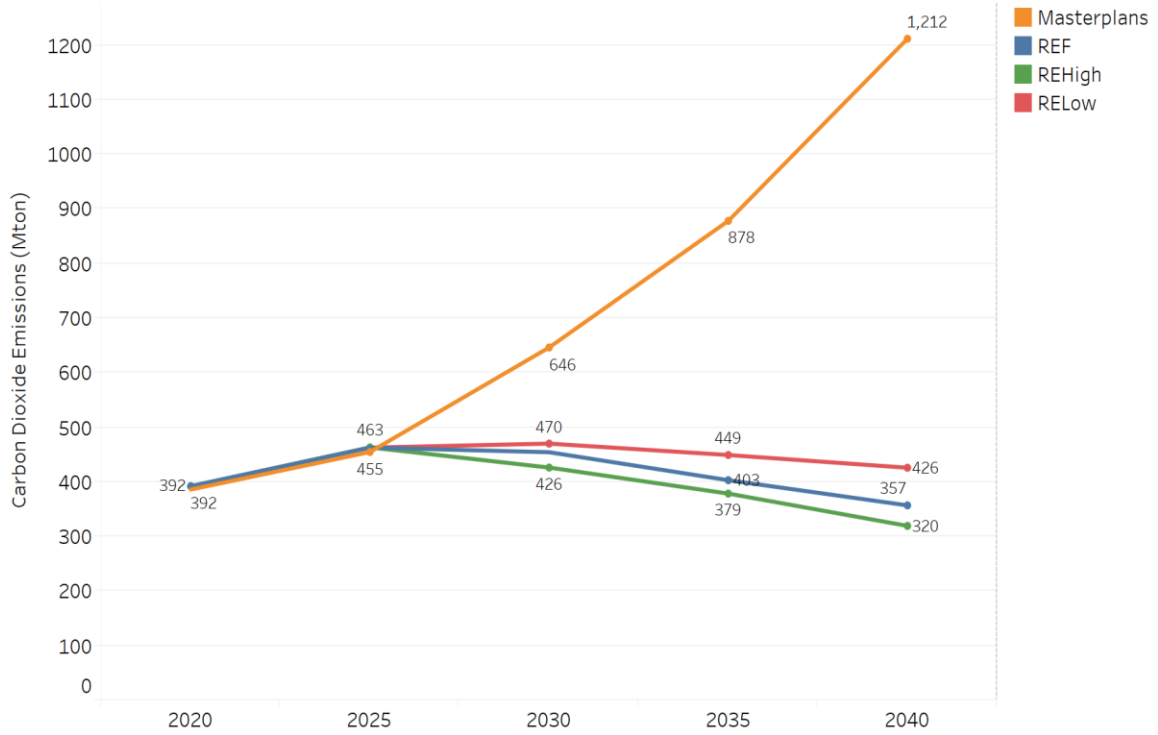
Southern/Eastern Africa regional integration study

Analyzed with IRENA's power system investment model for the region, combined with the zoning analysis

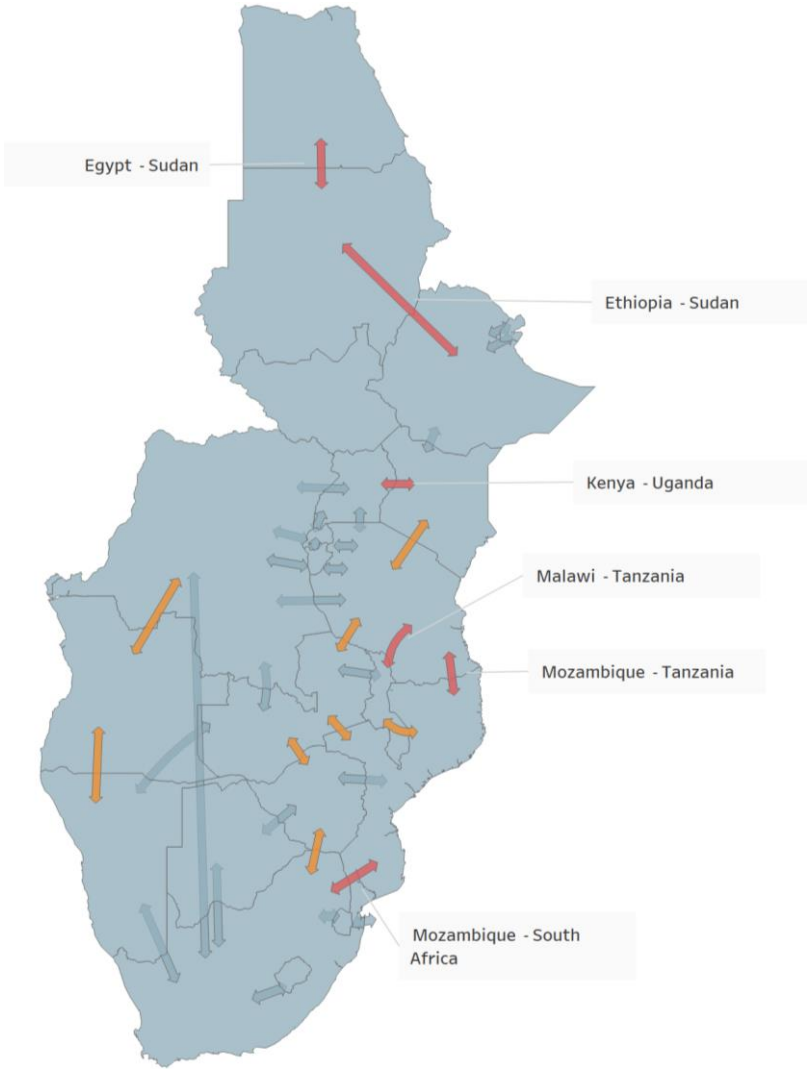
Vast opportunities of VRE :

- **36% VRE penetration** under the reference scenario





The benefits of the regional trade

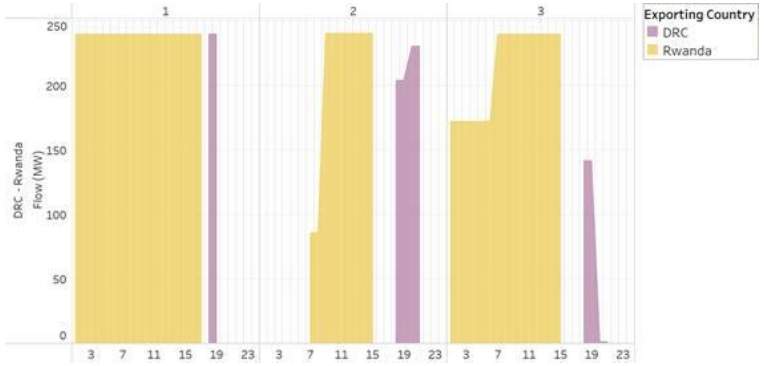


System cost reductions associated with greater integration

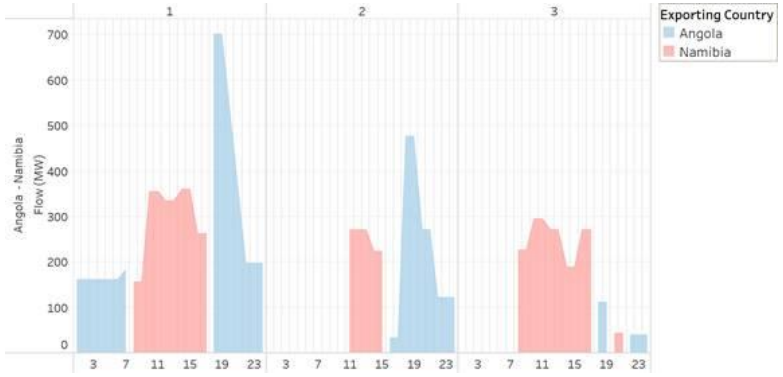
Complementary generation patterns

Rwanda – DRC example:

High volumes of hydropower production at night can be exported to Rwanda, when there is a supply gap in Rwanda from the absence of domestic solar power generation.



Rwanda-DRC



Angola-Namibia