Planning for the renewable energy future with grid investment

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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
• 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

The importance of location for the economic value of VRE: Gujarat province, India: wind zones

Key planning implication:
• Trade-off between resource quality and transmission investment

Source: Lawrence Berkley National Lab, MapRE
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
High-level transmission scenarios to be co-optimized with generation expansion planning

Better coordination is required!
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

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

- Planning across different geographical scopes – GSTIC Nov 2018 in Brussels
Key to access cost-effective flexibility options from the neighboring countries

- Regional studies show benefits of the trade and coordination – with varying degree of political 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: standaralized dataset for planning (Denmark)
- Netherlands: adding up regional plans, standarazlied reference case to allow comparison
Ongoing Energy Transformation: Drivers

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

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

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Time dimensions of power sector planning

**Typical time resolution**

- Seasonally to sub-hourly
  - (Static)

- Hourly to sub-hourly

- Sub-hourly to sub-seconds

**Planning time horizon**

- Near-term
- Long-term

**Typical time frame**

- Generation expansion planning: 20-40 years
- Geo-spatial planning: 5-20 years
- Dispatch simulation: Weeks-years
- Technical network studies: Snapshot

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)*

Energy generation scenarios given

Geo-spatial information

Optimal power flow

Grid enhancement needs to 2030 plan

Check for voltage and stability problem

Fossil & Nuclear scenario 100% RES scenario No-regret investment
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.