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Planning long-term transition pathways towards the integration of a high share of VRE

Scaling up Variable Renewable Power
World Future Energy Summit 2017
16 January, 2017, Abu Dhabi

Transition ahead

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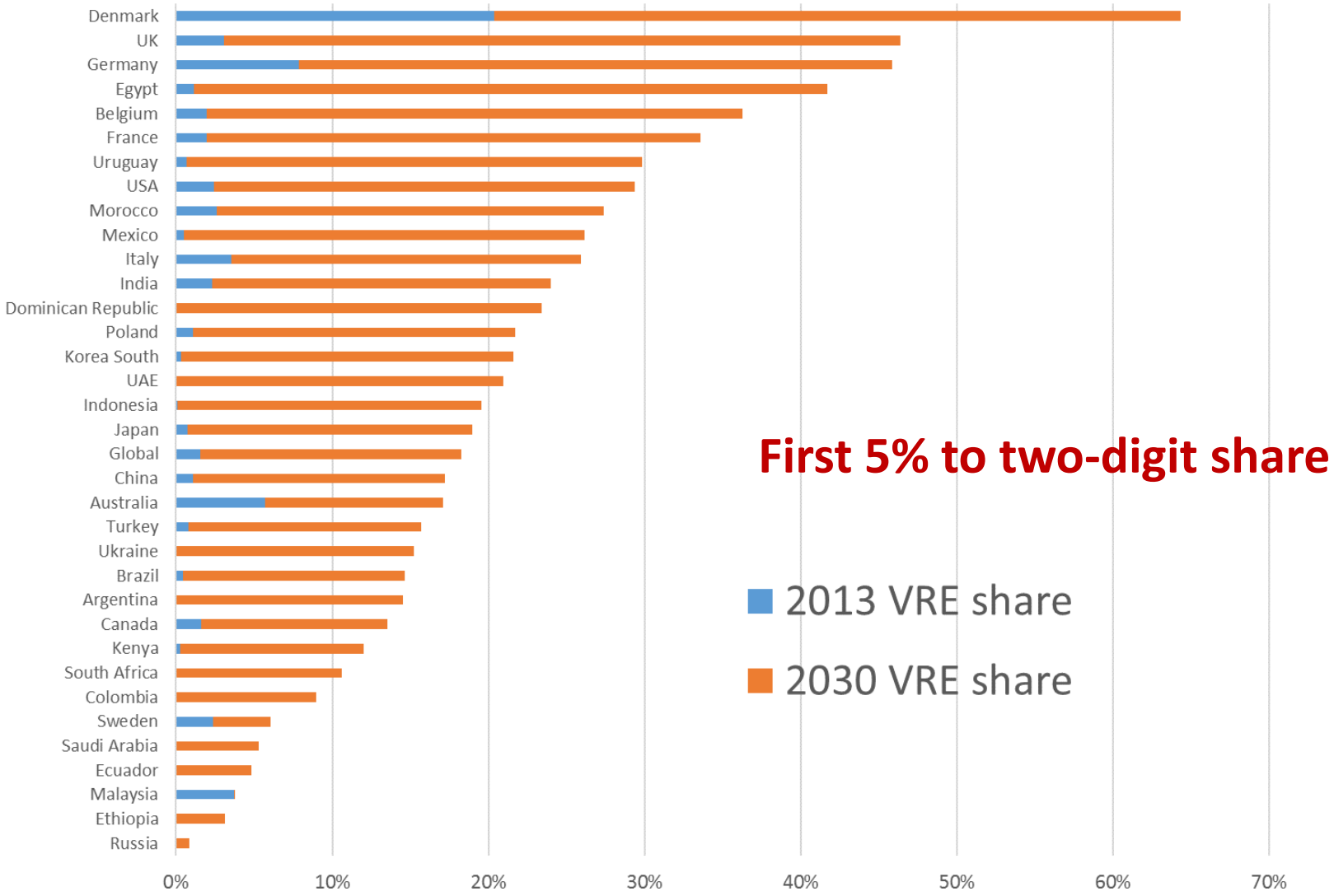
Source: REmap 2030



Planning challenges

Planning challenges with VRE shift as moving towards a higher share of VRE

- Network incidences
- Curtailment
- Transmission grid
- Designing cost-effective capacity mix

Best planning practices are emerging but knowledge is not systematically accessible to the energy planners – looking for ways to produce more credible VRE assessments

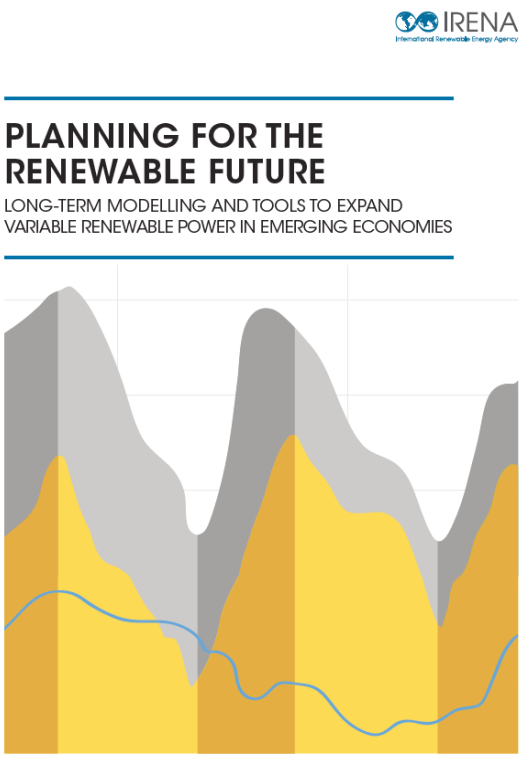
Addressing VRE in long-term planning (AVRIL) project

Based on expert inputs

- International Energy Workshop 2014, 2015
- AVRIL expert meeting
- Interviews

In consultation with energy planners in North Africa and Latin America

Planning check list



A long term energy plan needs to address the **techno-economic implications** of VRE:

- Check how much VRE can contribute to the generation adequacy (**firm capacity**)
- Check for the **flexibility** of the planned system
- Check for the **transmission needs** and possible trade-off with RE sites quality
- Is **stability** an issue?

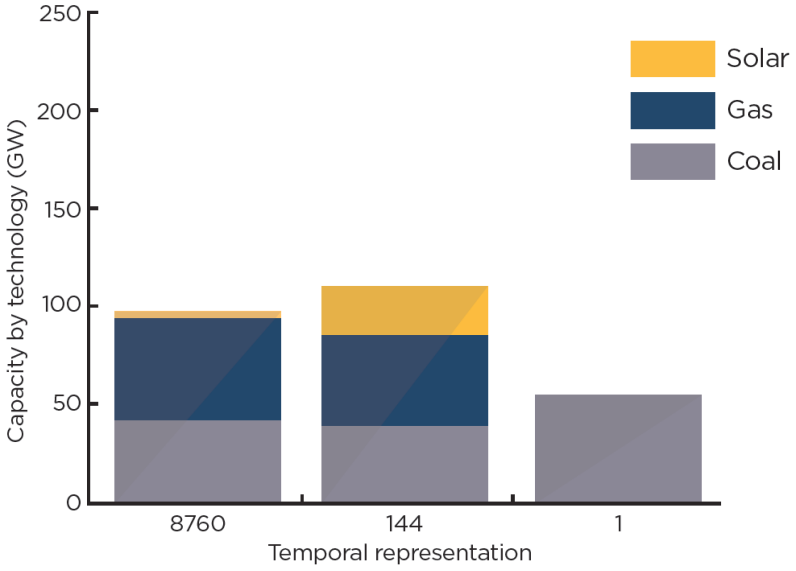
The report guides energy planers through best practices for using modelling tools and available renewable energy data to address these issues

Firm capacity

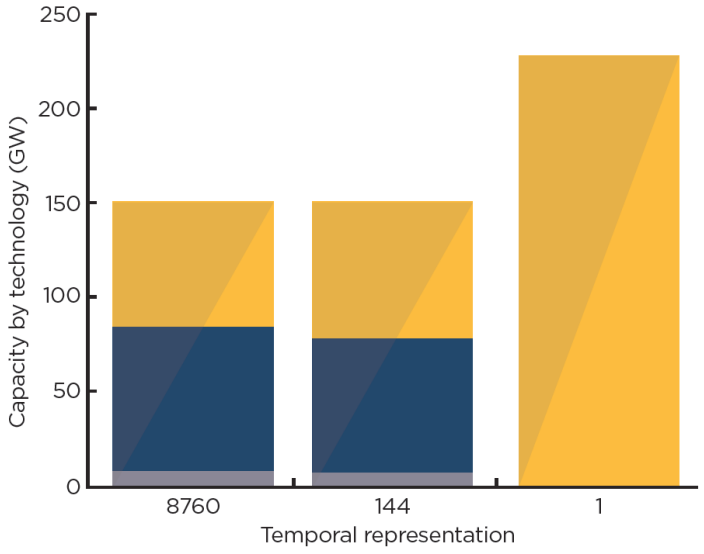
Driven by temporal correlation of VRE and load pattern

→ A system needs to have sufficient generation capacity even during the time of high demand / low VRE availability

→ Utilization rate of non-VRE plants becomes lower



PV cost 1$/KW



PV cost 0.5 $/KW

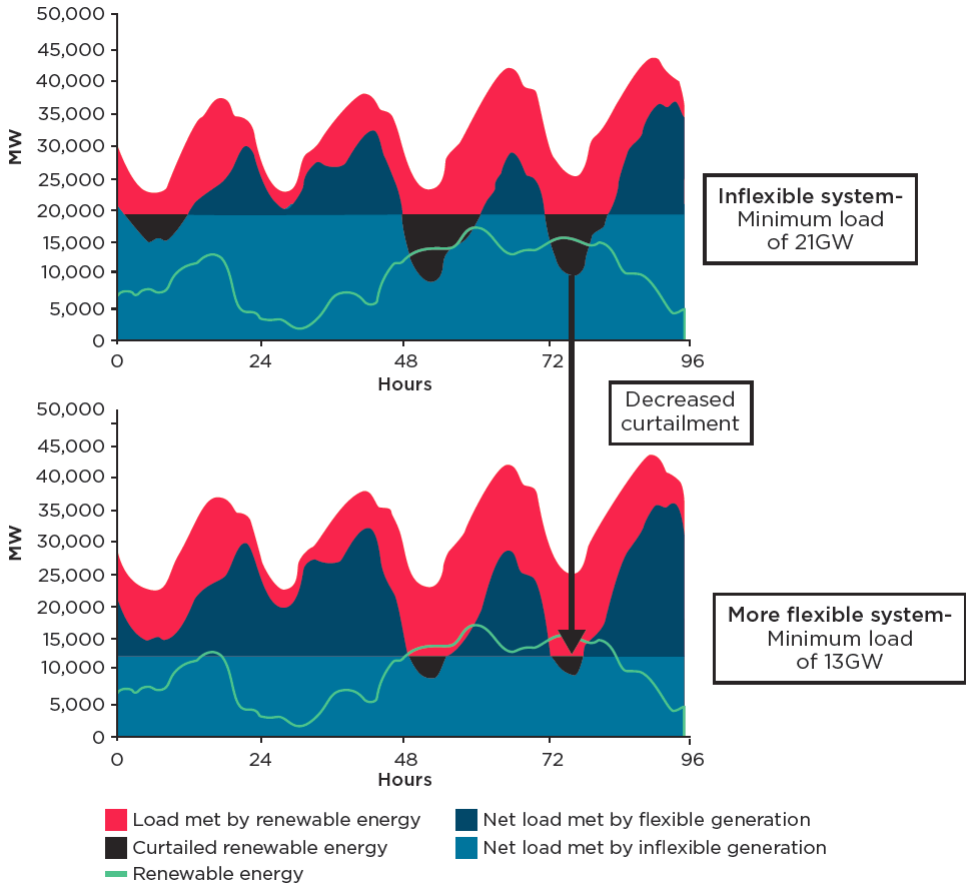
(Source: Merrick, 2016)

Flexibility

Driven by rate of change of VRE

→ The rest of a system needs to have sufficient flexibility to balance (ramping, minimum generation)

→ Curtailments lead to low utilization of VRE plants



(Source: Denholm, P., Hand, M., 2011)

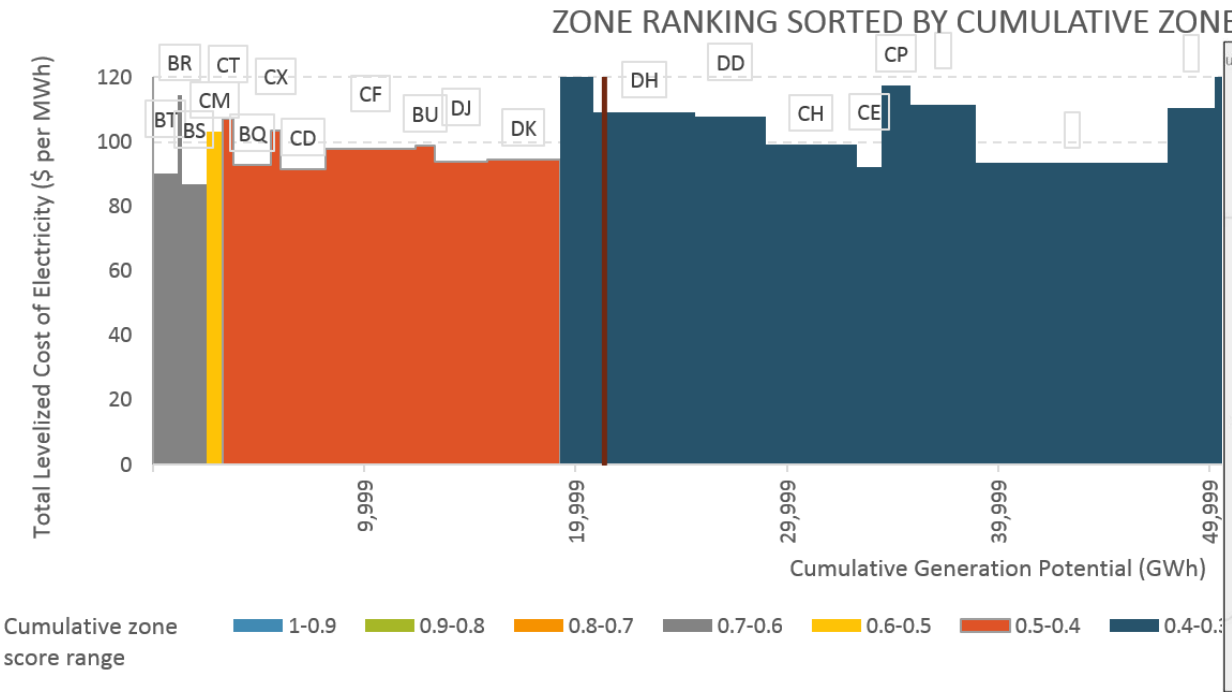
Transmission capacity

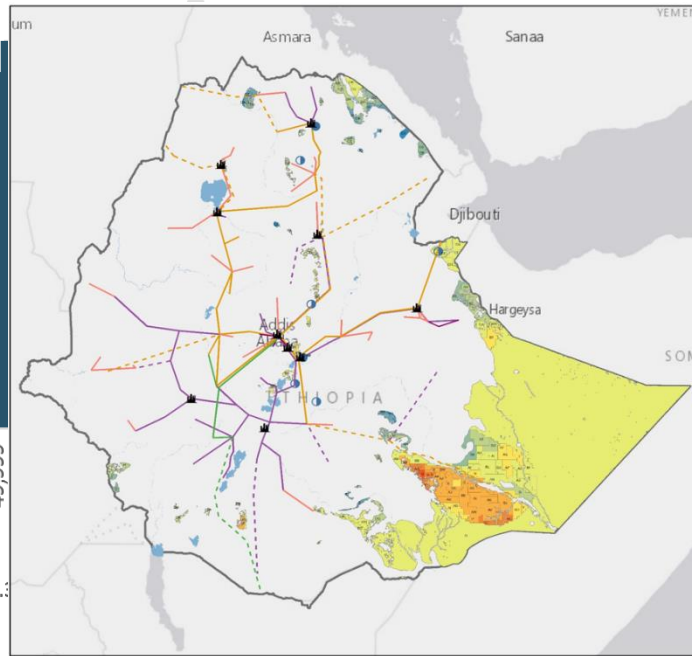
Driven by spatial variability

→ VRE resource availability varies across sites

→ Transmission capacity investment change relative economics of VRE sites

(Source: IRENA and LBNL, 2015)





For better transition planning

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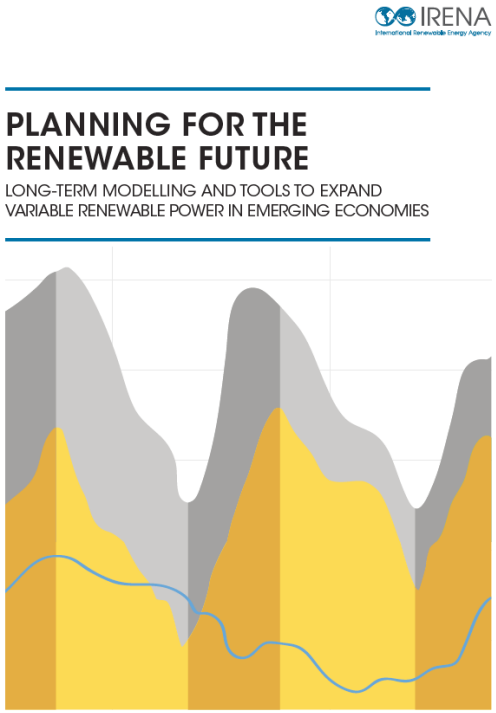

Best practices to better represent the VRE investment implications in long-term capacity expansion models

- Increasing temporal and spatial resolutions of model
- Better calibration of time approximation using VRE generation data
- Incorporating capacity credit
- Incorporating constraints on flexibility provision
- Validating flexibility balance
- Coupling with production cost models
- Linking investment needs with VRE expansion
- Site-specific representation of generation and transmission needs
- Representing stability constraints

Start simple, and advance the scope and quality of the analysis models as planning capacity enhances.

IRENA supports disseminating and exchanging best practices in addressing key VRE planning questions.

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Thank you for your attention

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Long-term transition planning with a high share of VRE

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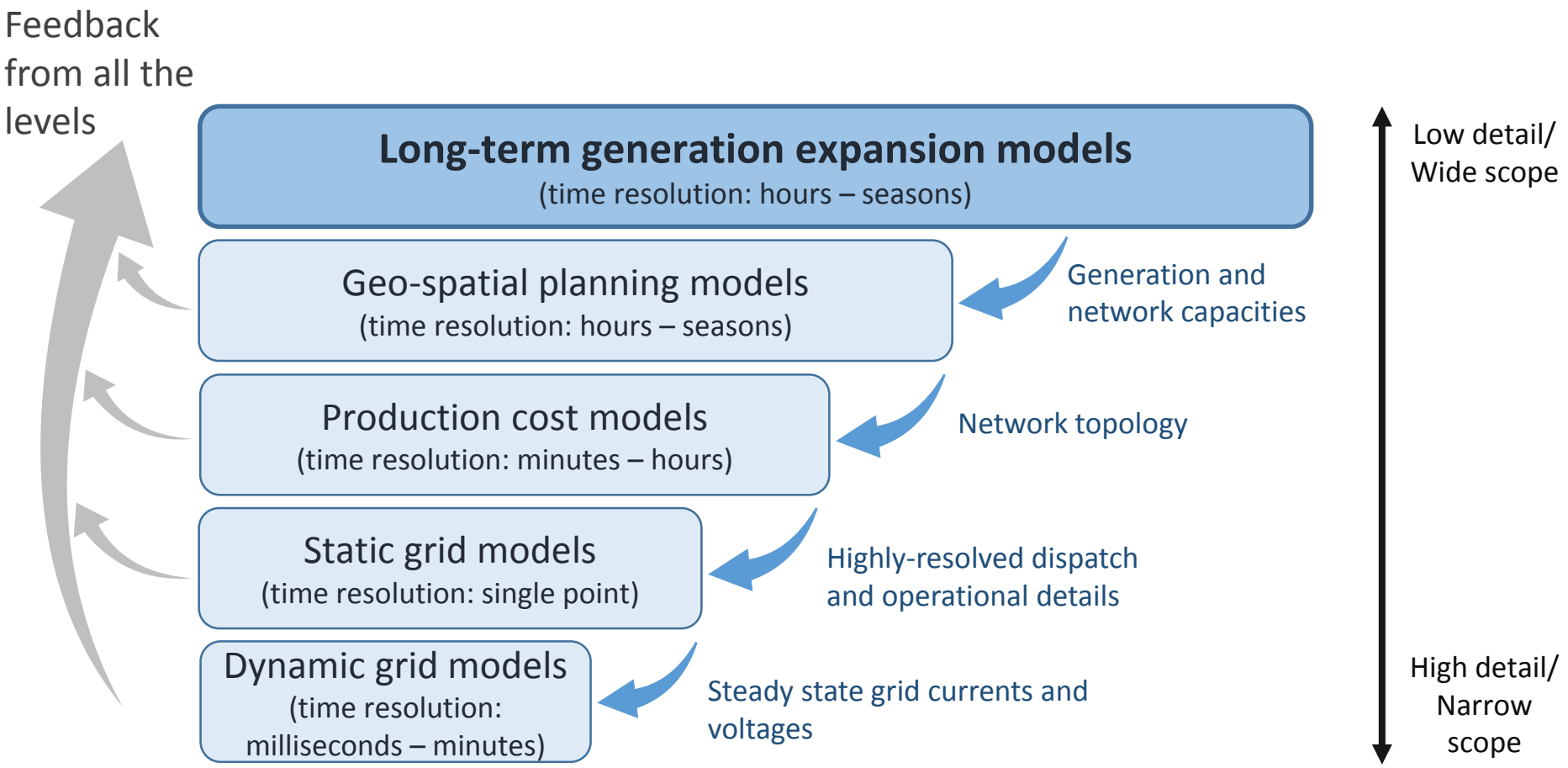
Four key areas to focus

Focus areas for planners	Factors driving
Capacity credit	Temporal alignment between demand and VRE production
Grid investment needs	Trade off between grid investment and resource quality
Flexibility balance	Rate of the change in the mismatch
Stability	Operation with fewer conventional generators

Tools to support planning



For planning transition to a high share of VRE, establishing the feedback loop is critical

Firm capacity

Firm capacity: driven by temporal correlation of VRE and load pattern

→ A system needs to have sufficient generation capacity even during the time of high demand / low VRE availability

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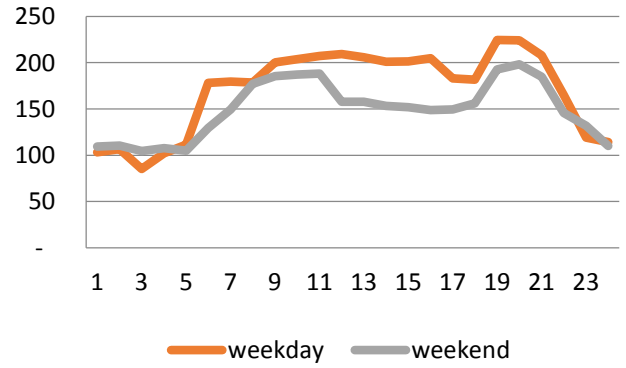
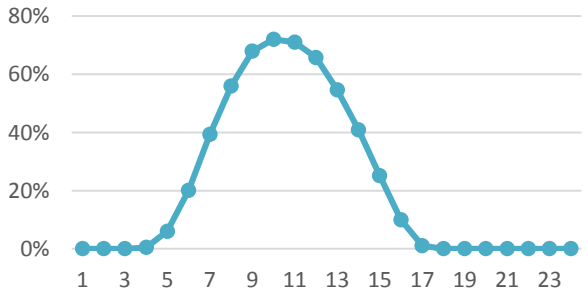
Demand: Average winter day

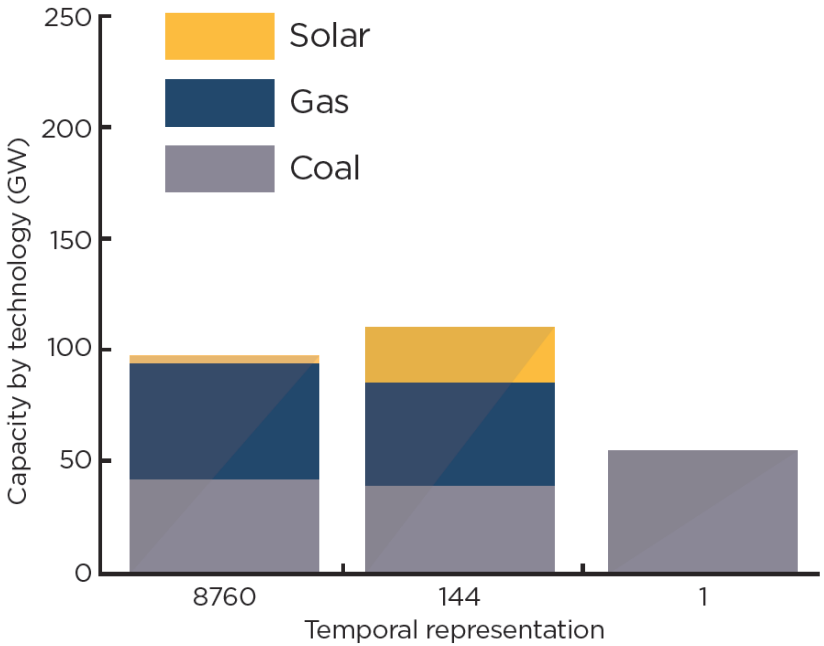


Solar PV: Average winter day
Capacity factor

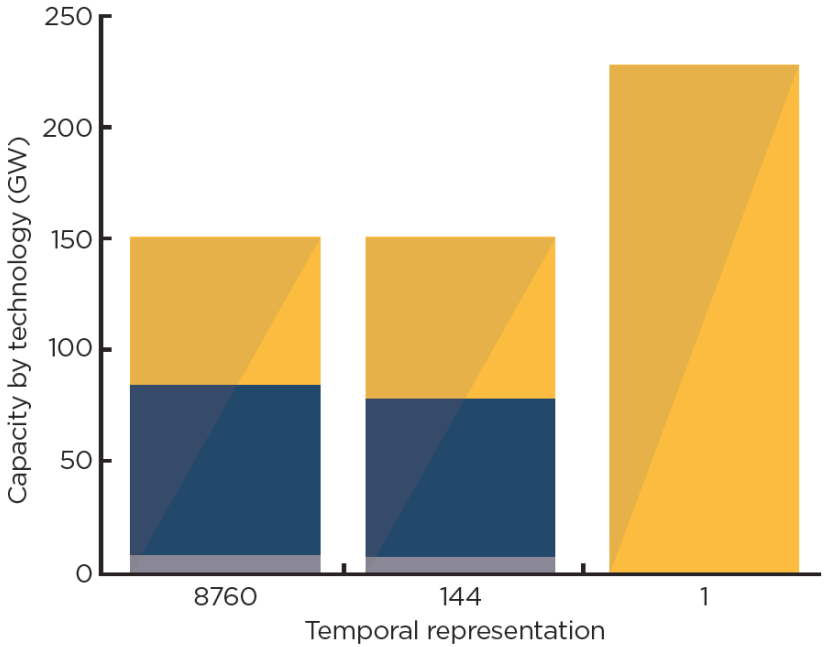


Effects of temporal resolutions

The selection of the temporal resolution influence the results of the techno-economic assessments of VRE



PV cost 1$/KW



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(Source: Merrick, 2016)

Long-term investment impacts

System specific impacts

Stability (contingency response): Operation with fewer conventional generators

- → **VRE can be made to participate in contingency response at modest cost**
- → **At a very high share of VRE in an isolated system, operation with little or non synchronous resource may present technical challenges**
- → There could be a maximum penetration limits due to technical and institutional barriers

Long-term planning with VRE

Government

"Deploying variable renewables (VRE) is beneficial."

"Our country should adopt ambitious long-term VRE targets."

Energy planning officials

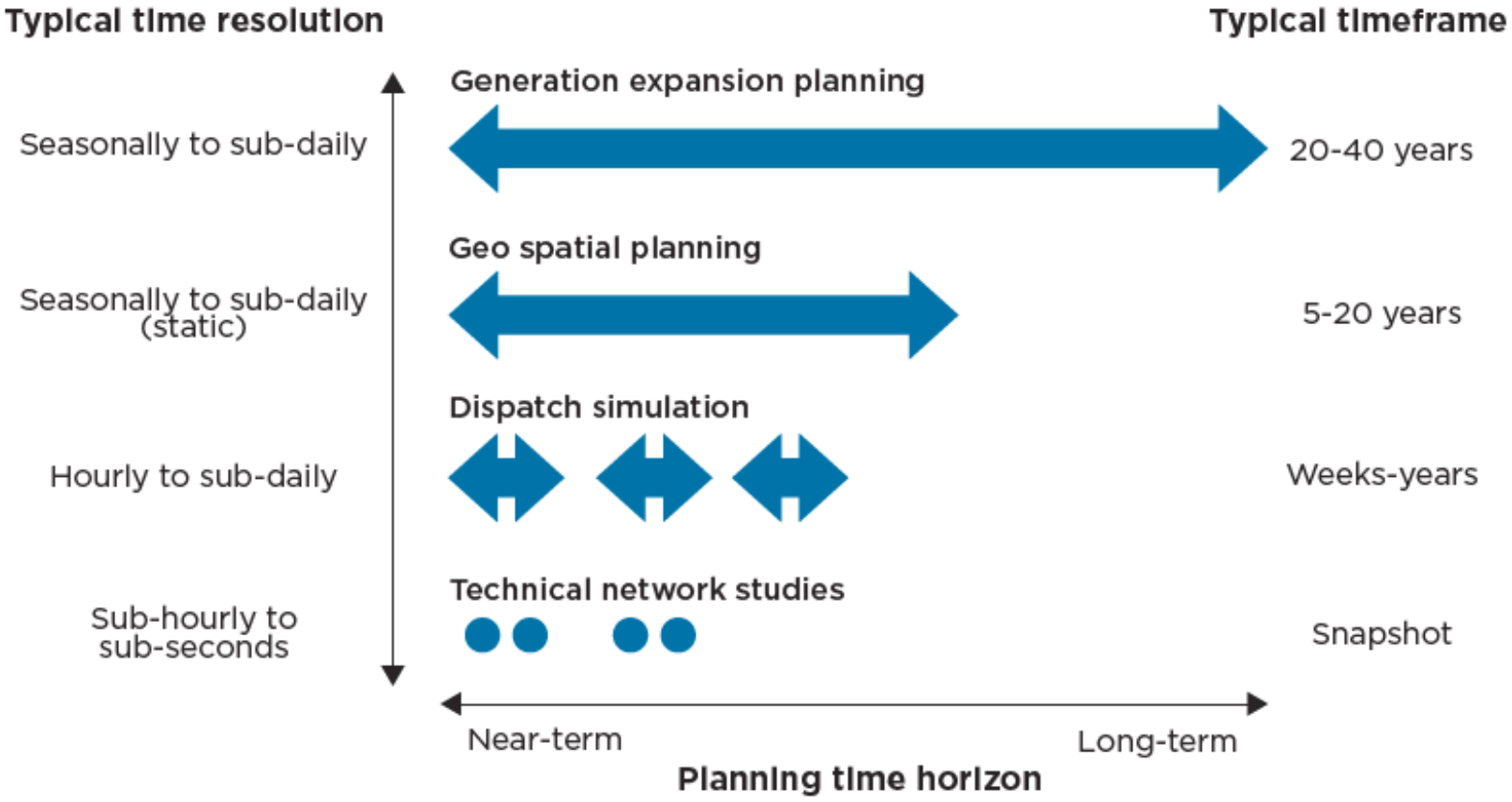
System operators

"VRE's short-term variability endangers power system reliability"

"There is an upper limit of X% VRE"

- Credible assessment of VRE contribution is called for.
- Request received to help improve the planning methodologies used to set and evaluate the future energy mix

Elements of planning



For planning transition to a high share of VRE, more integrated approach is critical for credible assessment of VRE

Long-term planning with VRE

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