IRENA
International Renewable Energy Agency

Addressing variable renewables in long-term energy planning (AVRIL)

Strommarkttreffen
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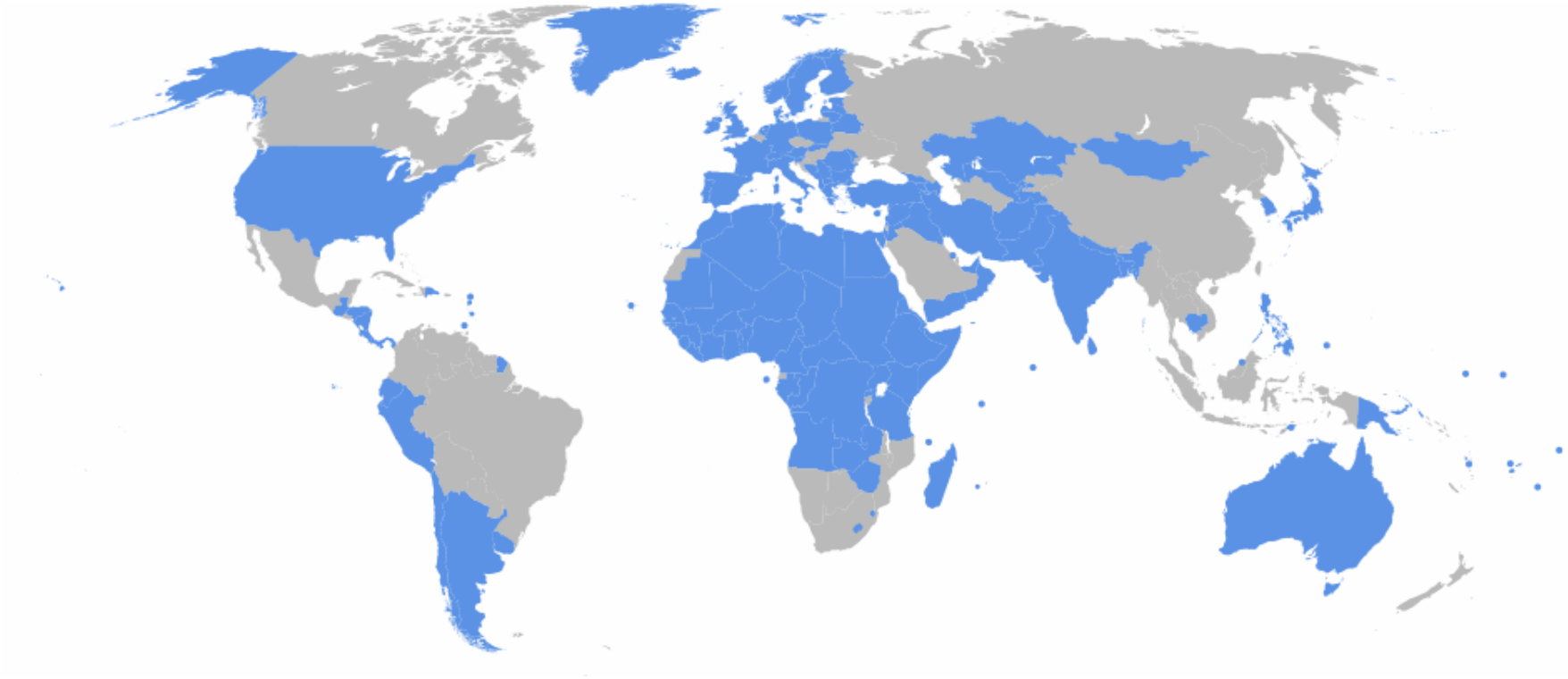
IRENA – an international organization supported by 171 member states



IRENA was founded in 2009 with the mandate of

Supporting sustainable deployment of renewables worldwide

IRENA member states request support for energy planning with variable renewables

Energy planning officials:

"Let's quickly deploy variable renewables (VRE)"

"Adopting ambitious long-term VRE targets is worthwhile"

Barrier to RES deployment

System operators:

"VRE endanger the power system's reliability"

„There is an upper limit of X% VRE"

1. Guideline for how to introduce variable renewables in the short term.
2. Guideline for long-term energy planning with variable renewables.

Guideline for long-term energy planning with variable renewables: key questions

1. Why long-term energy planning?
2. Which VRE system impacts are relevant to long-term planning?
3. Which planning tools are currently used? What do they miss?
4. What are modeling approaches that account for these impacts?

Why does a cost-efficient and reliable power system require long-term energy planning?

1. No markets in many countries (in particular non-OECD)
   → central planner (e.g. state-owned utility)
2. Market based systems: planning needed for policy targets/instruments, transmission grid expansion, private investment decisions

3. Long building times and lifespan of energy infrastructure
4. Inadequate generation&transmission cause „costs of mismatch“ and might endanger system reliability

5. VRE increase the need for long-term planning
   - Transformation & More interaction of system components

   → „costs of mismatch“ increase and addional challenges to reliability

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Which VRE system impacts are relevant to long-term planning?

VRE properties

1. Variability
2. Uncertainty
3. Spatial variability
4. Non-synchronous generation
5. Distributed generation

System impacts

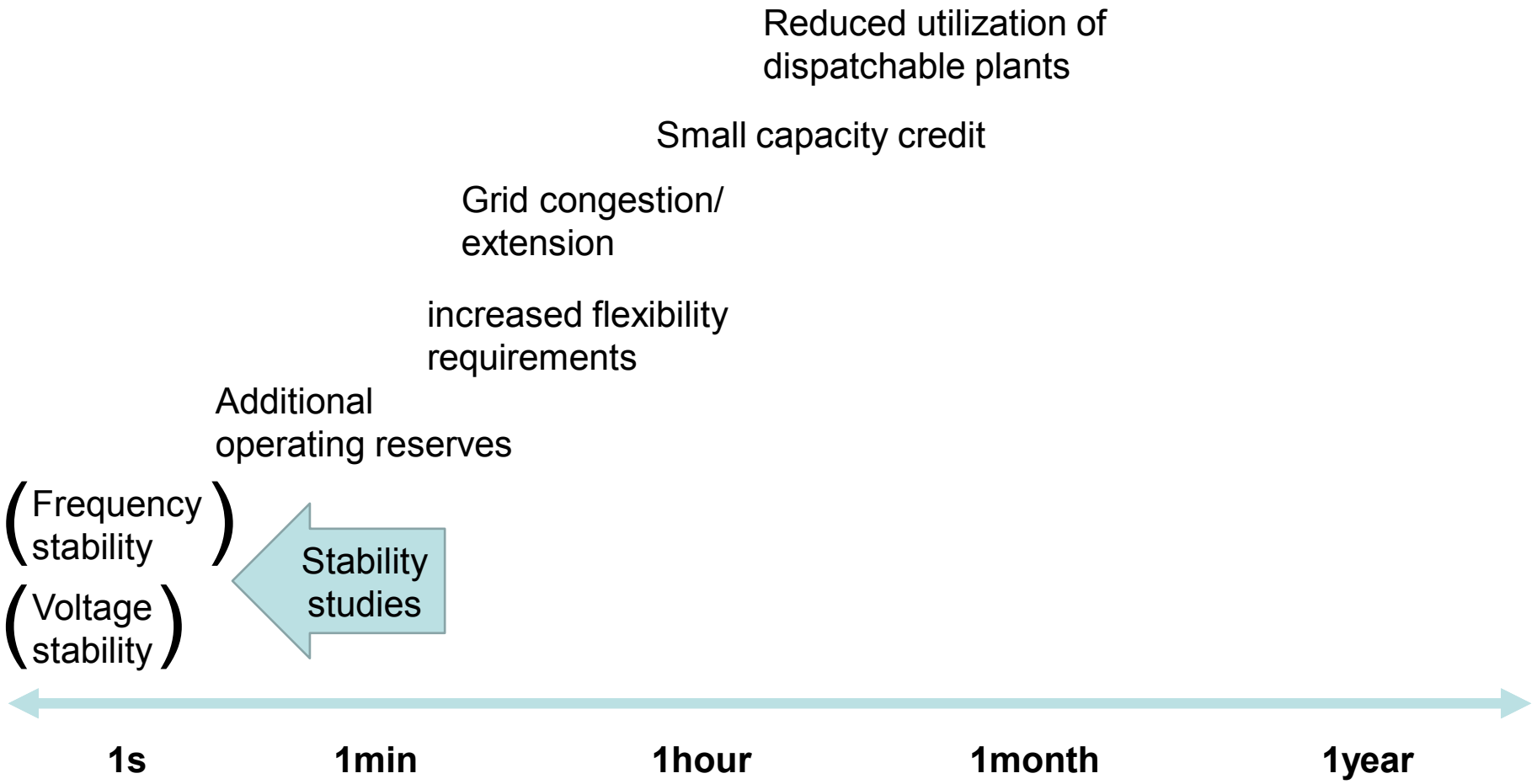
1. Small capacity credit, reduced utilization of dispatchable plants, increased flexibility requirements
2. Higher forecast errors → additional operating reserves
3. Grid congestion, additional transmission grid investments

(4. Decreased frequency stability, power electronic devices required)

(5. Voltage stability, additional distribution grid investments, advanced power devices)

- 2nd order impact: curtailment
- There are more mitigation measures
- more relevant impacts?

What temporal resolution is required to directly address impacts in models?



Challenge: Combining these short-term scales with long-term time horizon of capacity expansion models

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Which planning tools are currently used? What do they miss?

Capacity expansion models used for planning in non-OECD countries:
e.g. MESSAGE, Balmorel, OSeMOSYS, TIMES, WASP, HOMER
…or no model at all

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What are modeling approaches that account for these impacts?

Approach	Merits	Drawbacks
1. Directly increasing the temporal resolution	• One optimization framework. • Straight forward implementation • Could cover all VRE impacts	Numerically demanding or not possible
2. Representative time slices (adhoc/clustering)	• Numerically less demanding. • Captures most VRE impacts.	• What is a good choice? • Temporal order partly lost. • High number necessary to capture wind variability?
3. Residual load duration curves	• Numerically much less demanding. • Captures most important impacts (capacity credit, utilisation)	• Temporal order lost. • Copper plate assumption → no transmission • Linear implementation?
4. Characteristic days/weeks	• Numerically less demanding. • Very high detail possible → capturing all VRE impacts	• How to find a representative choice?
5. Link with a highly resolved model	• Numerically less demanding? • High detail possible→ capturing all VRE impacts	• Separated optimization → Complex iteration to converge? • Harmonize model scope and parameter
6. Parameterizations (e.g. flexibility constraint)	• Numerically less demanding. • Intuitive and easy to implement	• How to find parameterization that is robust over many scenarios? • How to account for interactions?

Danke für die Aufmerksamkeit und das Feedback!