IRENA FlexTool
Assessing power system flexibility to integrate a higher share of renewables

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Wind power would be a major electricity generation source, supplying more than one-third of total electricity demand. Solar PV power would follow, supplying 25% of total electricity demand.

Power system capacity would need to grow to **20 000 GW by 2050**, with over **70% of it coming from solar PV and wind**.
The need for power system flexibility

- Flexibility in power systems is a key enabler for the integration of high shares of variable renewable electricity – the backbone of the electricity system of the future.

- Power systems must achieve maximum flexibility, based on current and ongoing innovations in enabling technologies, business models, market design and system operation.

- On a technology level, both long-term and short-term storage will be important for adding flexibility.
Hourly electricity dispatch in 2050: no major flexibility issues

One-week dispatch of the UK power systems showing how selected technologies balance demand and supply with large shares of solar and wind in 2050

- There are no macroscopic flexibility issues that lead to significant unserved energy in the power system in any country or region, and curtailments of variable renewable wind and solar power are limited.
Flexibility needs to be harnessed in all sectors of the energy system

Flexibility according to IRENA (2018):

“Flexibility is the capability of a power system to cope with the variability and uncertainty that VRE generation introduces into the system at different time scales, from very short to the long term, avoiding curtailment of VRE and reliably supplying all the demanded energy to customers”

Source: Power System Flexibility for the Energy Transition, IRENA, 2018
IRENA’s flexibility workstream

IRENA supports its member countries in planning for flexibility with:

1. An overview of flexibility for policy makers
2. A methodology to assess flexibility
3. The FlexTool to perform analytical work
4. Joint development of case studies in cooperation with member countries

Launched at the 16th IRENA Council (Abu Dhabi, November 2018):

- Part 1: Overview for policy makers
- Part 2: Methodology report

Case studies developed:
- Colombia
- Uruguay
- Panama
- Thailand

Ongoing regional analysis in:
- Central America
- ASEAN
Introduction to the FlexTool

IRENA FlexTool

- Publicly and freely available optimization tool that performs capacity expansion and dispatch with a focus on power system flexibility
- Developed by the VTT Technical Research Centre of Finland Ltd
- Version 2.0 released in April 2020 together with training materials

Flexibility issues identified by FlexTool:
- Non-supplied energy (loss of load)
- Reserve inadequacy
- Insufficient ramp
- VRE curtailment
- Spilled water from hydro reservoirs
- Transmission congestion
FlexTool in the planning process

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<th>Optimal Capacity Expansion</th>
<th>FlexTool Expansion</th>
<th>Capacity Expansion Models (PLEXOS-LT³, Opt-Gen⁴)</th>
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<td>Grid Studies</td>
<td>Dispatch Models</td>
<td>Energy Planning Models (Message⁵, MARKAL/TIMES⁶)</td>
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<tr>
<td>(Power Factory⁷, PSS/E2)</td>
<td>(PLEXOS-ST², SDDP⁴)</td>
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Time Horizon Analysed

1 Second       1 Hour       1 Year       10 Years      50 Years

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2 Copyright of Siemens PTI
3 Copyright of Drayton Analytics Pty Ltd, Australia and Energy Exemplar Pty Ltd, Australia
4 Copyright of PSR
5 Developed by the International Institute for Applied Systems Analysis (IIASA)
6 Developed by the Programme of Energy Technology Systems Analysis (ETSAP)
Engagement options and objectives of the studies

» Engagement options

» Option 1: Engagement with IRENA to develop a flexibility analysis
  » Through relevant stakeholders such as the Ministry of Energy or TSOs
  » IRENA performs the analysis in collaboration with the counterpart nominated by the government

» Option 2: Organisation of a (virtual) training on the IRENA FlexTool
  » The tool is user friendly and the basics can be learnt in one day
  » Preferably done on a regional basis (e.g., South America)

» Objectives of the flexibility studies:

[Diagram showing objectives of the flexibility studies]

- Primary: assessing flexibility of capacity expansion plans
  - Identify potential flexibility shortages in national electricity plans.
  - Study operations during non-average years, e.g., dry years.
  - Capacity expansion plans from national authorities and from IRENA REMap are the ideal starting point

- Secondary: cost-efficient additional investments
  - Identify the least-cost mix of solutions to flexibility shortages.
  - Study additional investments that can minimise total system cost (CAPEX + OPEX)

- Tertiary: higher VRE shares
  - Run sensitivity analysis to see the effect of additional VRE deployment on flexibility.
  - Identify threshold after which flexibility shortages start appearing (and solutions)
IRENA launched in April 2020 a new version of the tool, FlexTool 2.0, with several enhancements that have been developed based on the feedback from experts.

### Technical enhancements

1. Node groups to define properties for a country or region (e.g., reserves)
2. Units groups for investments
3. Minimum inertia constraint
4. Minimum time between shutdown and start-up constraint
5. Storage self-discharge constraint
6. Efficiency time series
7. Max and min generation, must-run constraints using time series
8. Detailed modelling of CHP units

### GUI enhancements

1. Possibility to specify the colors of each node and technology in the input data
2. Possibility to select a specific time period to show in the dispatch, in the results file
3. Results file contains more explanations of each of the parameters
4. New logo of the tool
Ongoing and future work

1. Analysing the value of regional integration
   a) Central America (Panama completed)
   b) ASEAN region (Thailand completed)

2. Capacity building
   a) Latin America (19 May 2020)
   b) ASEAN (2 June 2020)
   c) MENA (July 2020)
   d) Cuba (November 2019)
Other relevant work from IRENA’s PST team

- Electricity Storage
- Demand-side flexibility
- Renewable Hydrogen
- Renewable Minigrids
Questions & Answers

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