

# Workshop

*Innovative solutions for achieving 100% renewable power systems by mid-century*

## Session II – Technical feasibility of a 100% renewable power system by 2050

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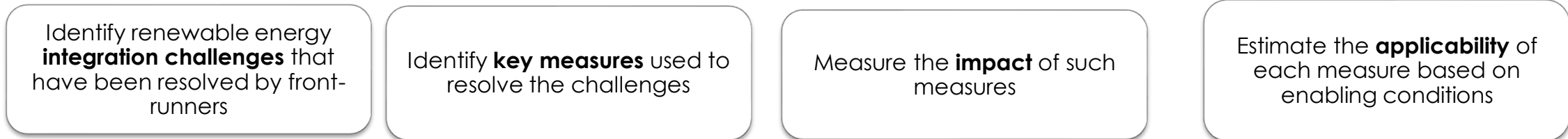
## 1. Knowledge Framework

- Best practices
- Chinese example
- Measures & indicators

## 2. Power sector flexibility assessment

- Definitions, sources of flexibility, FlexTool
- Flexibility analysis for Uruguay's 2030 power system

## Best practices



- Line congestion
- Frequency and voltage deviation
- Lack of system Inertia
- Insufficient flexibility
- Insufficient storage

- Dynamic Line rating
- VRE to provide frequency reserves
- Synchronous condensers
- Retrofit powerplants
- Increase Interconnection

- Curtailment variations
- Redispatch costs
- Negative prices

- Measures filtering:
  - ✓ "Manually" (now)
  - ✓ Statistical Inference



### Integration challenges in China

- **Flexibility:** Keep on providing incentives for generators to operate flexibly
- **Transmission:** Energy congestion throughout the grid
- **Operation:** Address current grid stability concerns and plan ahead in time for future issues



### Key measures applied in countries



## Keeping pace with the Chinese transition

	Implemented in China	Suggestions from countries experience		
Flexibility	<p><b>Ancillary services and spot market pilot</b></p> <ul style="list-style-type: none"> <li>- Released 3 000 MW down-regulation capability</li> </ul>	<p><b>Flexibility and heat storage in CHP-coal units</b></p> <ul style="list-style-type: none"> <li>-Engineering (technical enabler)</li> <li>-Ancillary and Spot Market Pilots (Financial enabler)</li> </ul>	<p><b>Keep on providing incentives for a flexible and efficient operation</b></p> <ul style="list-style-type: none"> <li>- Shorten clearance time-scale in spot market</li> <li>- Make market national</li> </ul>	<p><b>Incentives to DR resources</b></p> <ul style="list-style-type: none"> <li>-To electric boilers and heat pumps</li> </ul>
Transmission	<p><b>Expansion of transmission lines</b></p> <ul style="list-style-type: none"> <li>- Started UHV pilot projects since 2009</li> <li>- Many other projects on its way to integrate renewables</li> </ul>	<p><b>VRE to have dispatch priority</b></p> <ul style="list-style-type: none"> <li>- Until a predefined capacity</li> </ul> <p><b>Investment Grid Alert Platform</b></p> <ul style="list-style-type: none"> <li>- Regions ranked by current hosting capacity</li> </ul>	<p><b>Dynamic line rating</b></p> <ul style="list-style-type: none"> <li>-<b>Increase line ampacity</b> in VRE exp/imp AC regional grids (Less suitable for DC)</li> <li>-<b>Lower investment costs</b> by using smaller-size cables for a same project capacity</li> </ul>	<p><b>Grid Long-term strategy</b></p> <ul style="list-style-type: none"> <li>-Identify VRE regions based on studies and developers interest</li> <li>- Detailed grid study for different integration scenarios</li> <li>-Detect from the beginning problematic stability spots that may limit development</li> </ul>
Operation	<p><b>Regional reserve sharing mechanism</b></p> <ul style="list-style-type: none"> <li>- decreased reserve requirements in China</li> </ul> <p><b>Frequency services provision from Storage facilities</b></p>	<p><b>Wind farms are required to provide active and reactive control</b> (frequency and voltage) as well as LVRT</p>	<p><b>Voltage stability in real time</b> at VRE exporting regions</p> <p><b>Power ramp limits</b> in VRE units</p>	<p><b>Plan ahead for upcoming inertia and voltage issues</b></p> <ul style="list-style-type: none"> <li>- Real-time inertia monitoring</li> <li>- Reserve requirements as function of system inertia</li> <li>- Synchronous condensers at strategic spots of the grid</li> </ul>

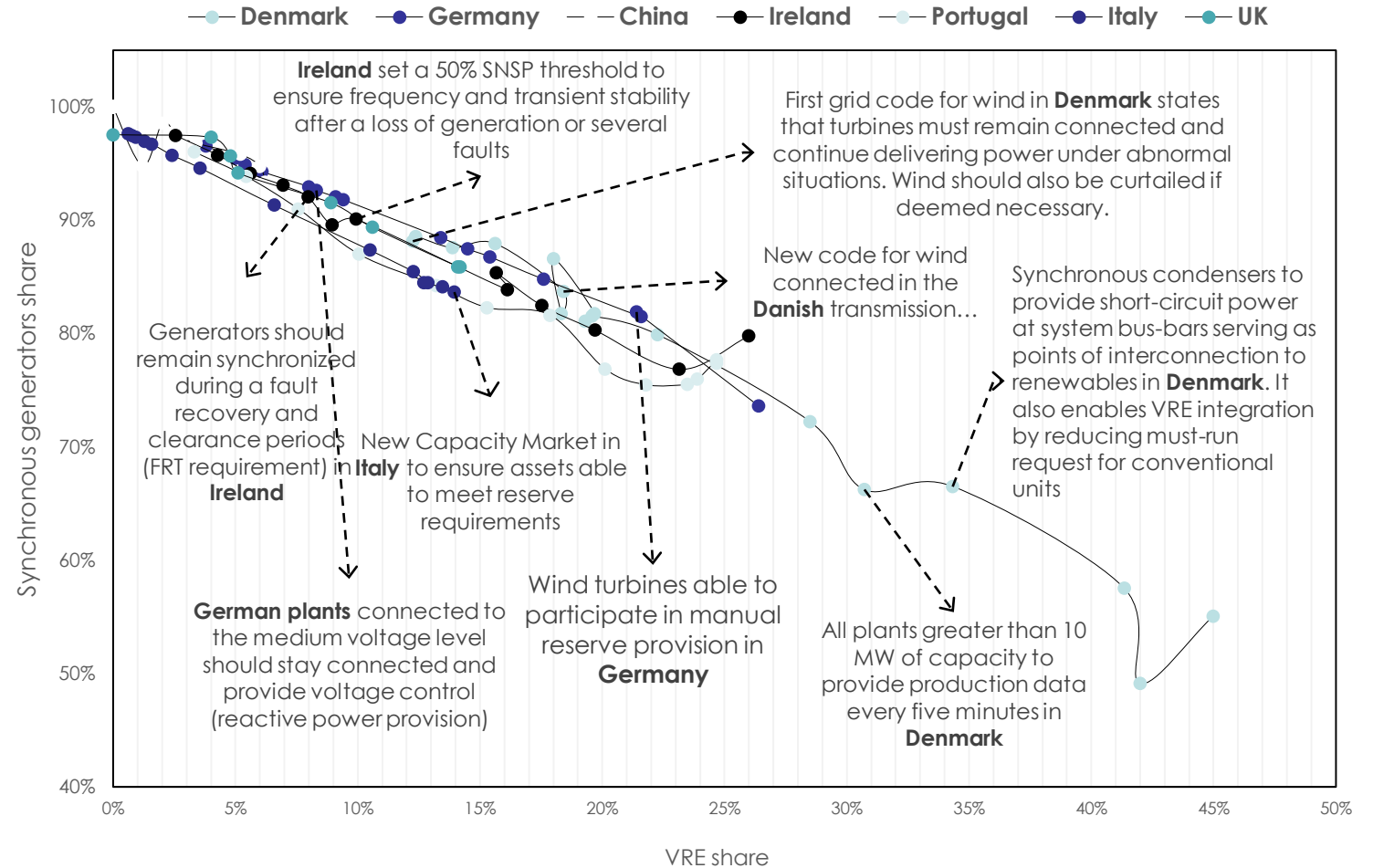
## Measures-Indicators link

- Measure applied in a given year



- Indicators (country profile) for the same particular year

- Flexibility share
- Synchronous generation
- CHP share
- Distributed generation
- Storage availability
- Supply-load mismatch
- Flexibility and storage availability in neighboring countries
- Reserve requirements
- Market information
- Others



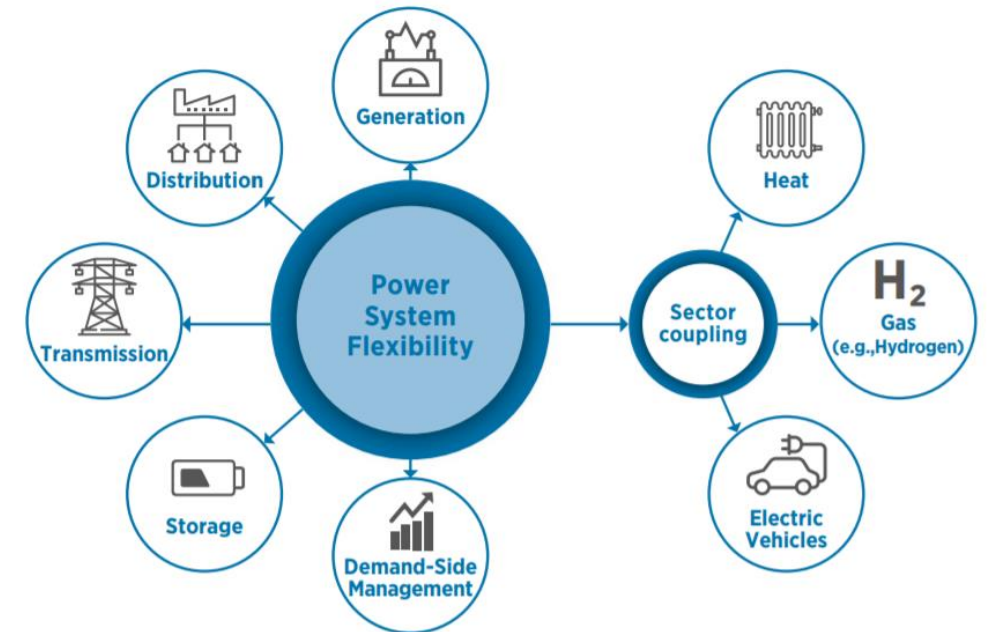
## Definitions

**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

- ✓ **Variability** is the fluctuating nature of solar and wind resources, which translates into potentially rapid changes in electricity output.
- ✓ **Uncertainty** is the inability to predict perfectly the future output of solar and wind power sources.

## Main flexibility sources

- **Generation:** Hydro, gas
- **Grid:** Dynamic line rating, T&D grid enhancement, smart grids
- **Storage:** Pumped hydro, batteries, V2G
- **Demand:** conventional (DSM, aggregation), sector coupling (heat pumps, boilers, H<sub>2</sub>)
- **Market/Institutional:** unlock flexibility/remove barriers, regulation needs to support flexibility



## URUGUAY POWER SYSTEM FLEXIBILITY ASSESSMENT

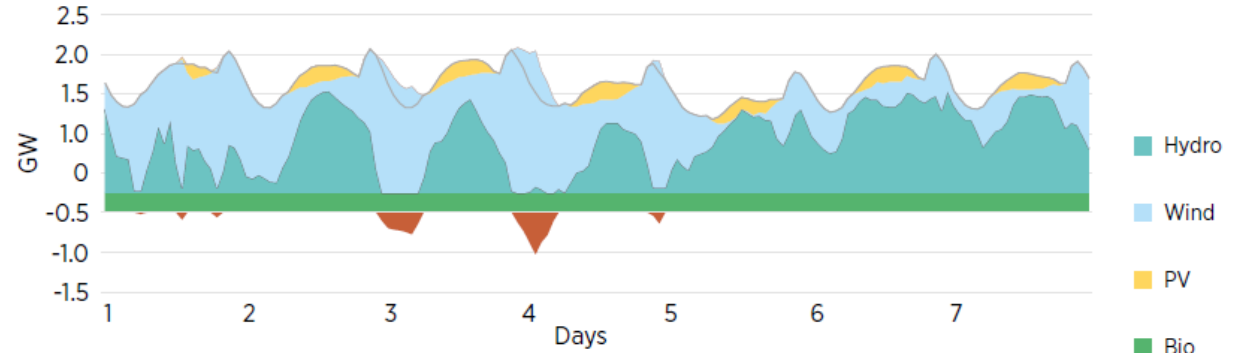
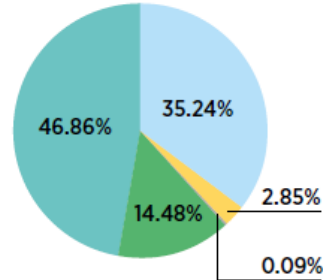
IRENA FLEXTOOL



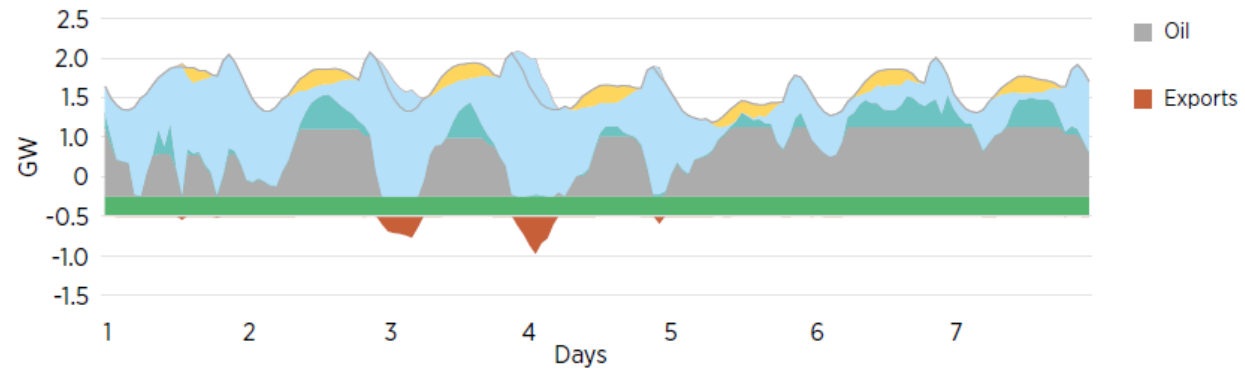
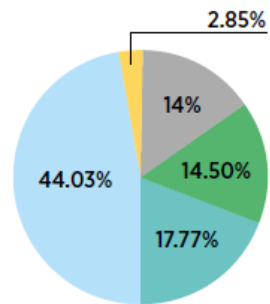


# Flextool, Uruguay, 2030

2030 Reference



2030 Dry-year



	2030 Reference		2030 Dry Year	
	Total (GWh)	Peak (MW)	Total (GWh)	Peak (MW)
Curtailment*	1 920	2 397	609	1 102.7
Loss of load	0	0	0	0
Spillage	0	0	0	0
Reserves inadequacy	0	0	0	0



**Thank you for your attention!**