ENTSO-E RES integration

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Leading practices in RES Integration – a global perspective

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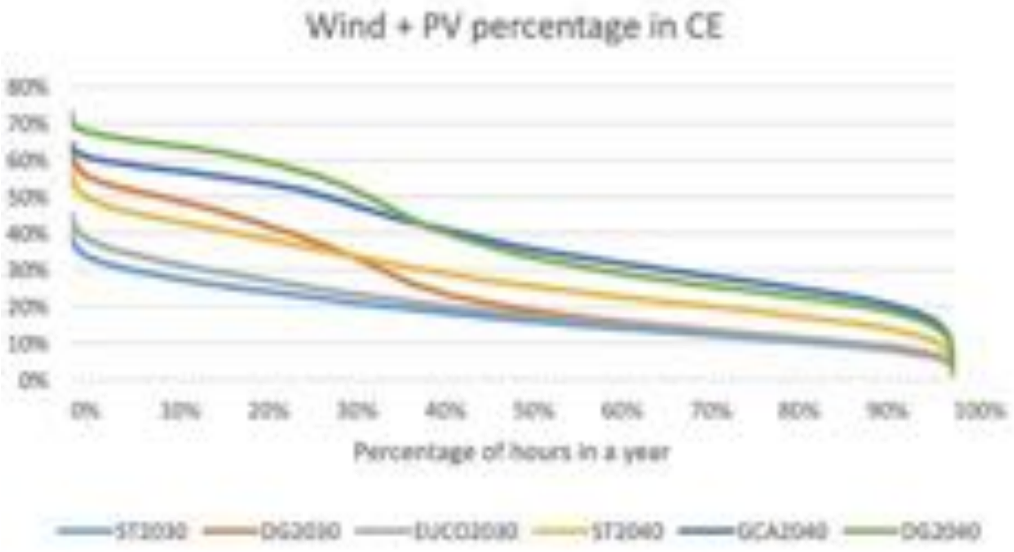
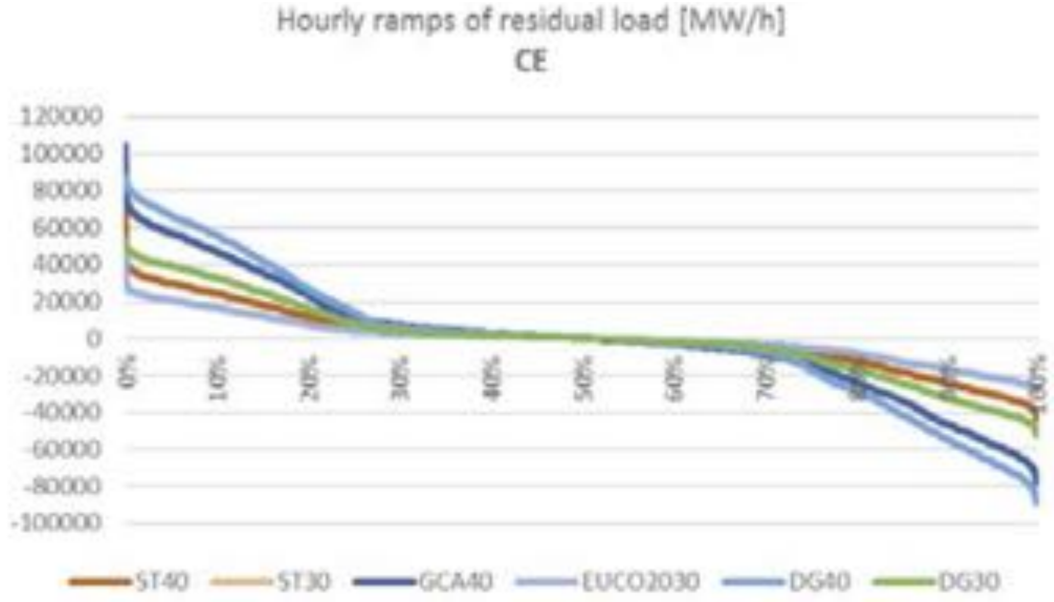
Scenarios to 2040

Flexibility needs

- **Duration curves** : Wind and Solar / Total generation
- **Magnitude of the hourly ramping**
- **Lower inertia trend especially in the small synchronous area**
  - **Use of Interconnectors (VSC and AC)**
  - **Batteries**
  - **Super capacitators**





The evolution of the EU power system confronts TSOs with major challenges but also presents new opportunities

50% Of the generating capacity from intermittent renewable energy sources (wind, solar and hydro run of river) by 2030

14 Countries likely to wind and solar outputs higher than 80% demand already in 2025

5 Countries likely to have significant RES curtailment risks already in 2025

-20% Reduction of dispatchable capacity margin over peak load (in proportion)

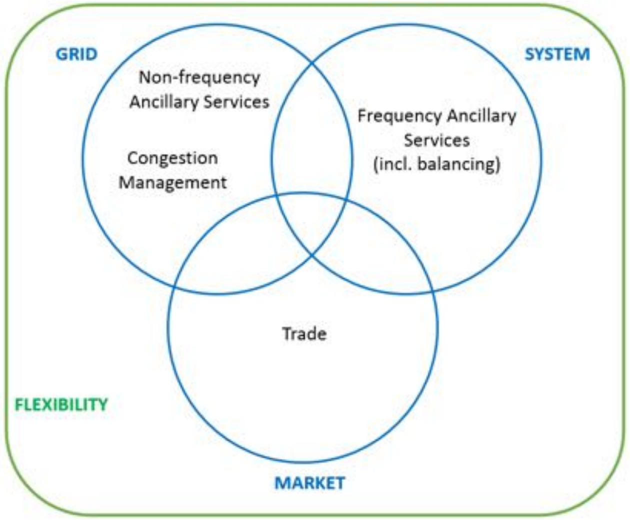
150 Billion euros of transmission investments (of which 70-80 by 2030) to reduce congestion and integrate renewables

1. **Manage variability / uncertainty of intermittent renewable energy sources**
2. **Enable cross-border flows to take advantage of the variety of generation mix and patterns**
3. **Deal with a much higher complexity in operations**
4. **Connect thousands of small units in distribution networks and coordinate with distribution system operators**
5. **Empower consumers, willing to become more active in the power system**

Network codes are key <u>enablers</u> to cope with these challenges and seize new opportunities

TSOs perspective on flexibility sources, services and products

Flexibility services will evolve

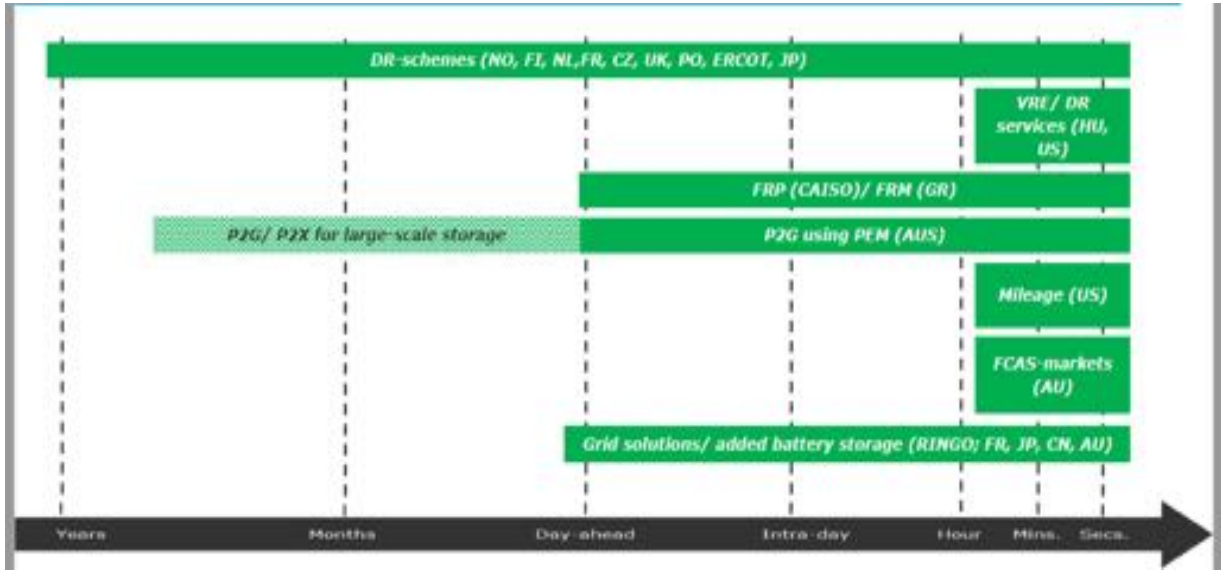


Technology

Storage, DR, IOT, Flexible Gen , Blockchain

Markets

Market and product design



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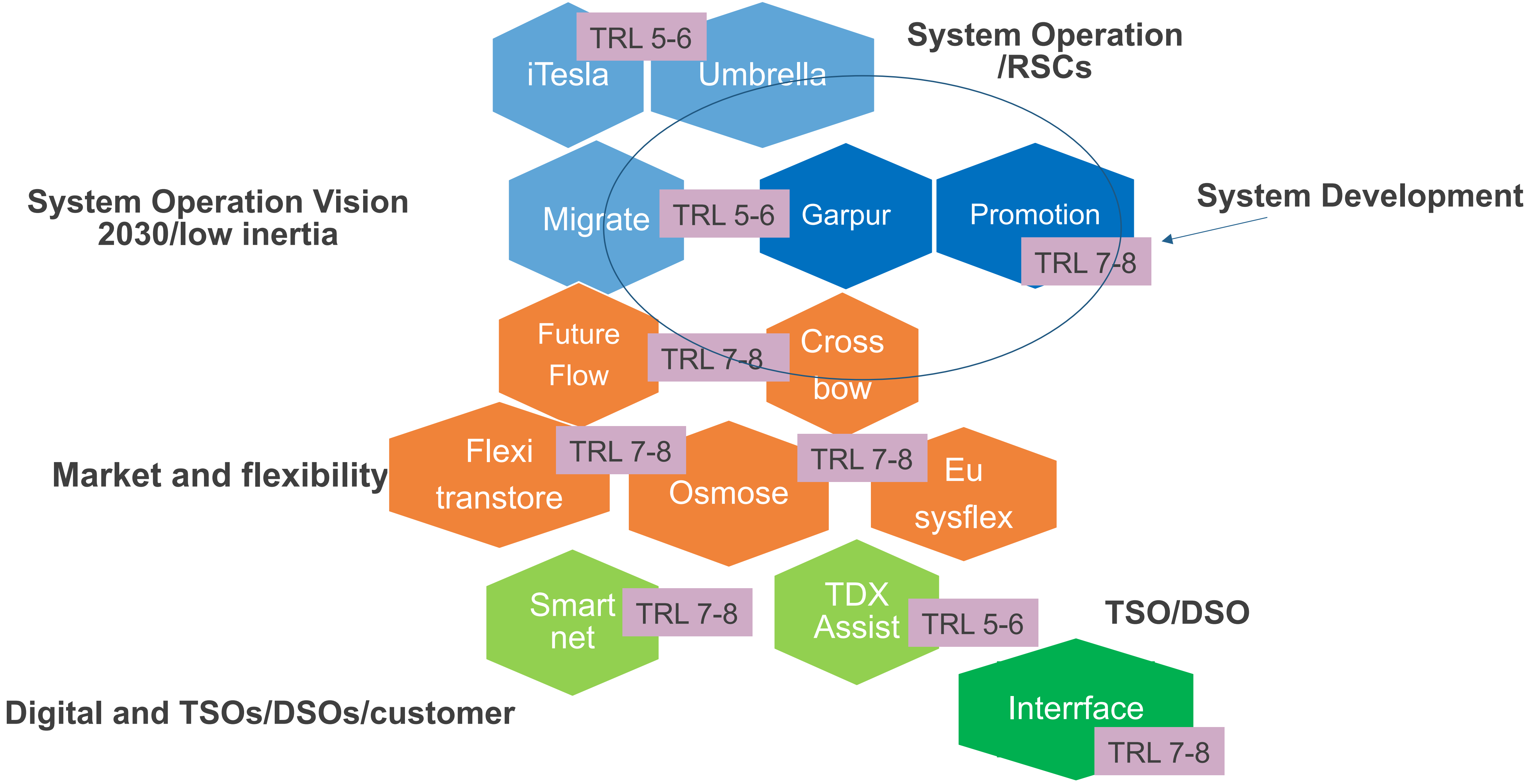
EC funded projects



Thank you for your attention