Flexibility means for power grid Resilience

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Content

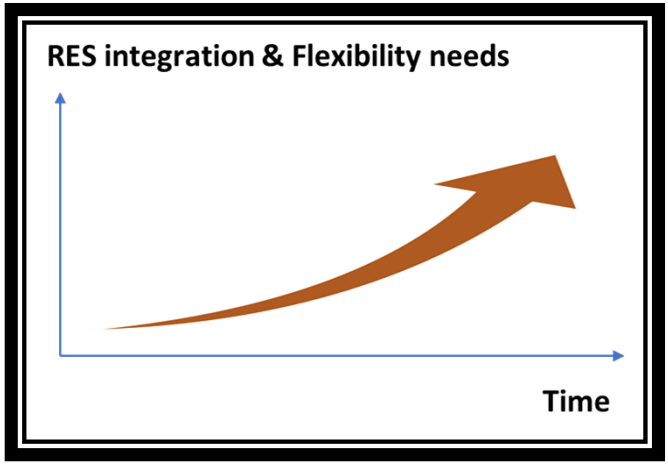
- Flexibility meets Resilience
- Flexibility categorization & needs
- Resilience needs & solutions
- Examples of Flexibility benefits for Resilience
- Conclusions

Flexibility meets Resilience

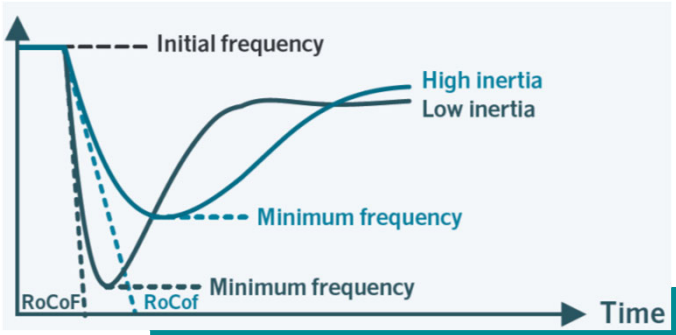
- Flexibility in normal operation to enable massive VRES penetration
  - Values: decrease overall costs & overcome challenges
- Resilience for extreme situations to prevent severe events (n-x, blackout, HILP)
  - Threats: instability, cybersecurity, climate change, …
- **How do they meet???**

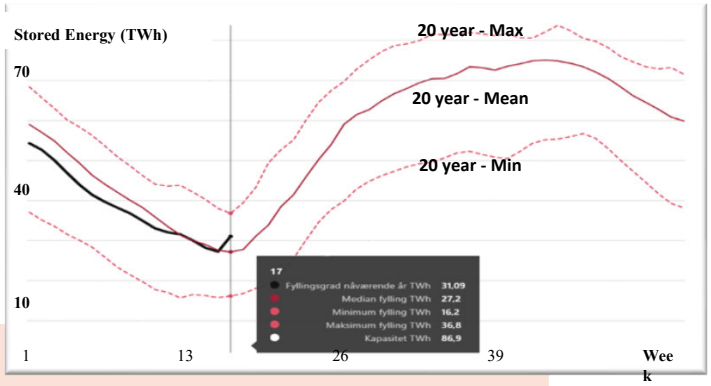
Flexibility needs

- **Flexibility relates to the ability of the power system to manage changes** (ISGAN, 2020)
- Many variations, incl.:
  - “the capacity of the electricity system to respond to changes that may affect the balance of supply and demand at all times” (CEER 2018)
- Flexibility needs foreseen to increase, due to:
  - Variable RES integration
  - Increased grid utilization & fast societal developments



Categorisation of Flexibility needs

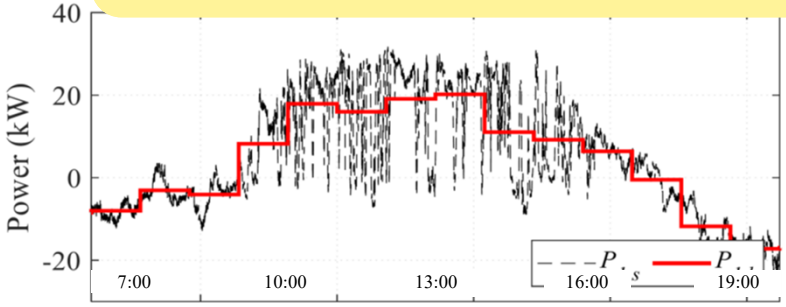




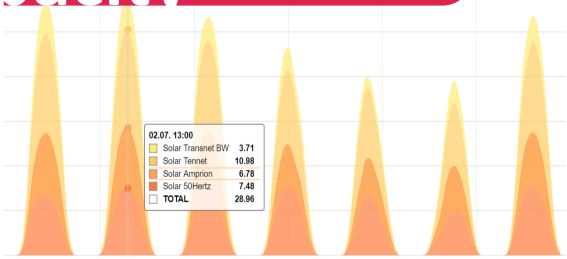
Flexibility for Power

Flexibility for Energy

Flexibility for Voltage



Flexibility for Transfer Capacity



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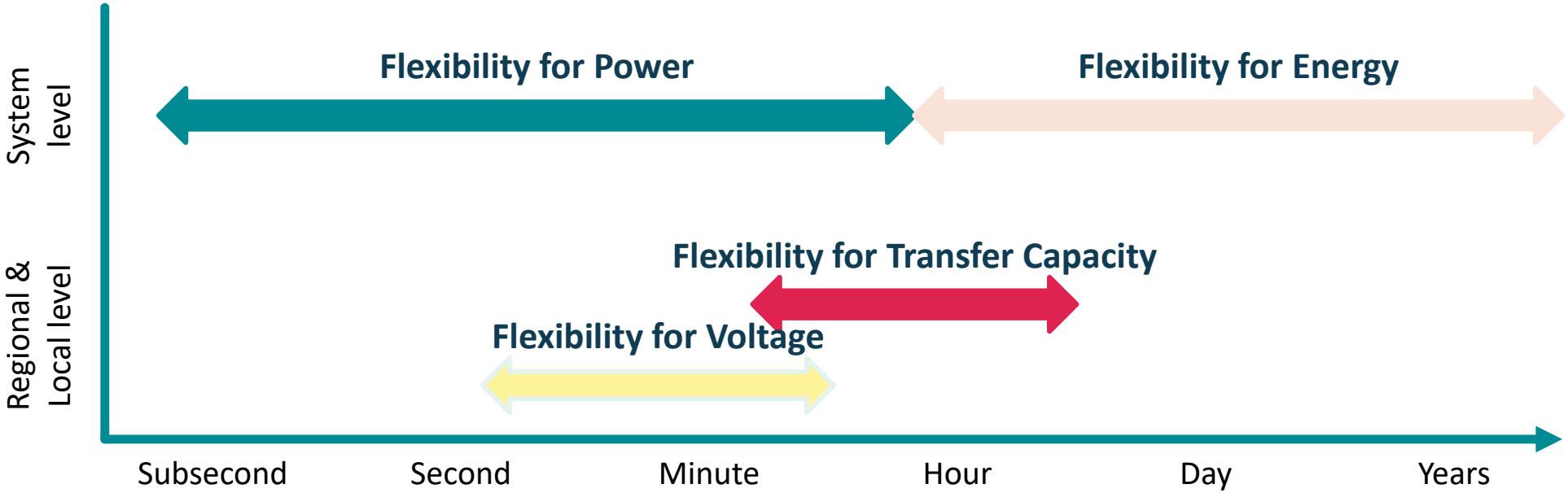
Categorisation of Flexibility needs



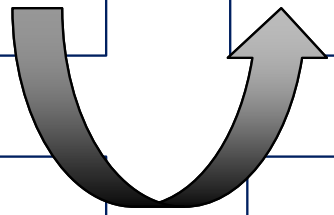
iea-isgan.org/flexibility-in-future-power-systems/

Resilience needs

- **Power system resilience reflects the ability of the power system to cope with severe events**
- Many variations, incl.:
  - “the ability to limit the extent, severity, and duration of system degradation following an extreme event” (CIGRE 2019)
- Resilience needs foreseen to increase due to several reasons, including:
  - Increased electrification and sectorial integration

Resilience solutions

Resilience areas: Anticipation, Preparation, Containment, Mitigation, Rapid recovery, & Adaptation



Novel Resilience solutions: increased possibilities with integration of DER & controllable assets

Resilience solutions (*conventional containment and restoration*): diminish with decommissioning of primary energy reserves

Resilience requirements: increase with grid utilization, climate change/ severe weather, data handling/cybersecurity

Flexibility benefits for Resilience

- Four identified areas:
    1. New/improved System Integrity Protection Schemes
    2. Improving System Technical Performance
    3. Alternative grid development
    4. Financial values

Flexibility benefits for Resilience

1. **System Integrity Protection Schemes (SIPS)**
    - Improving existing and enabling new solutions, including:
        - Controlled load-shedding
        - Islanding and island operation
        - Distributed recovery / black-start
        - Emergency controls

Flexibility benefits for Resilience

2. **System Technical Performance**
    - Flexible capacities and controllable assets providing resilience support for
        - Increased no of mitigating measures
        - Improved performance (congestion, voltage, stability, loss-reduction, etc.)
        - Simplified maintenance & operation processes

Flexibility benefits for Resilience

3. **Alternative Grid Development:**
    - Optimise investments vs. operation
    - Investment deferral, more efficient planning
    - Moving towards TOTEX regulation

Flexibility benefits for Resilience

4. **Financial Values:**
    - Decrease cost of resilient solutions
    - Reduce cost for security measures (e.g. redispatch)
    - Provide incentives for resilience-enhancing investments

Conclusions

- Even tough Flexibility and Resilience are stemming from different situational needs, it is obvious that these areas are related
  - They have a common foundation in the basis of the increased needs, originating largely from the increase in RES integration and grid utilization
- The future holds increased possibilities for Flexibility and Resilience to provide added benefit to the power system, where:
  - Flexibility solutions become fully deployed and utilized for operation and planning of the power system
  - Advanced system protective, as well as monitoring & control solutions become integrated in the daily operation

Thank you!

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