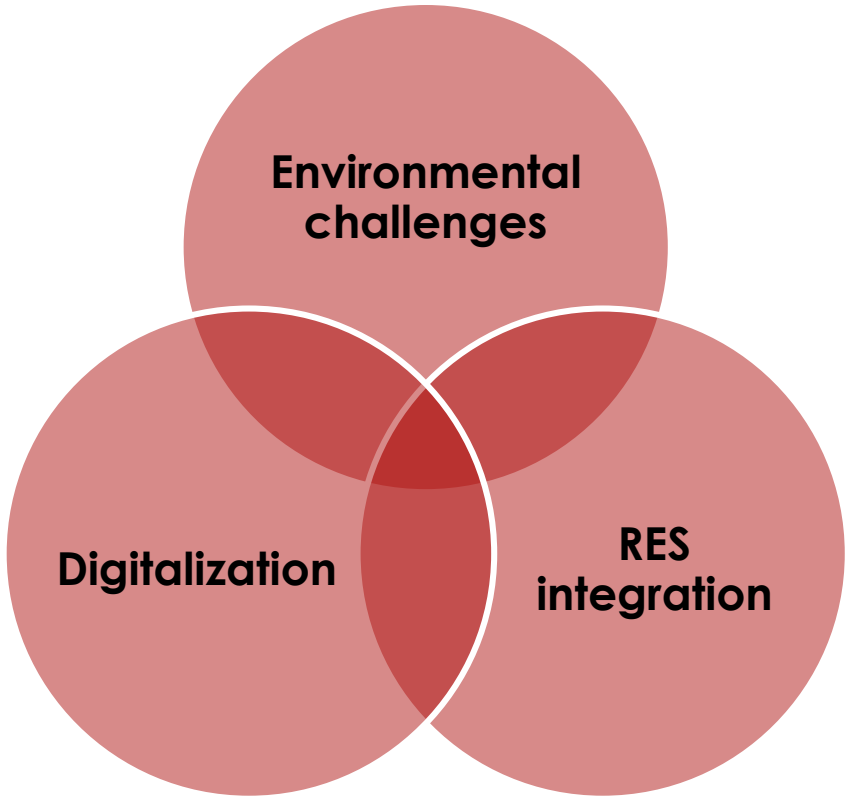
The future challenges of reliability and resilience in modern power systems

PAŠIĆ LEJLA

Structure

1. Motivation
2. Concepts
3. Challenges
4. Summary

Motivation


Environmental challenges
Digitalization
RES integration

Reliability and Resilience

Reliability

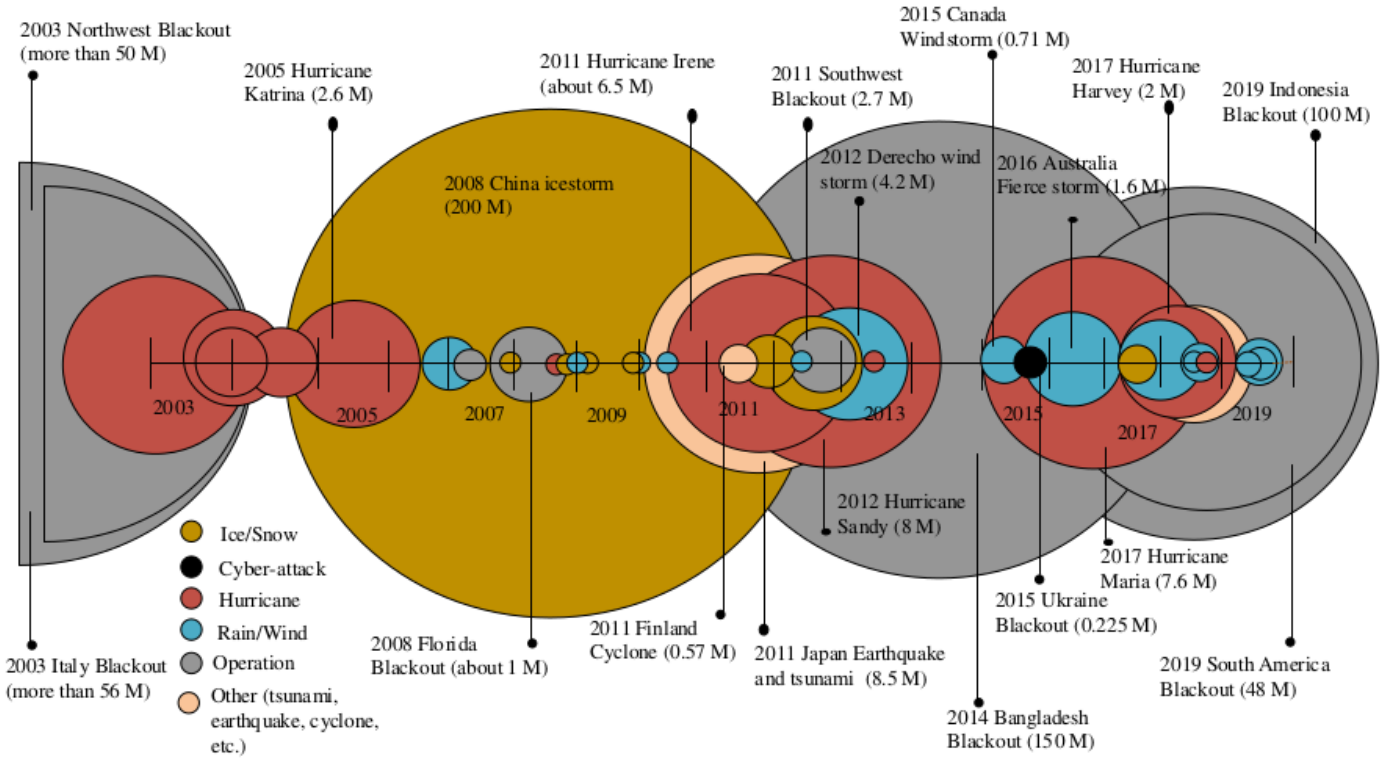
- Ability of meeting consumer quality and quantity requirements
- High probability, low impact events
- Well defined using SAIFI, SAIDI etc.

Resilience

- The ability to predict, absorb, and quickly recover from disasters
- Low probability, high impact events
- Needs to be defined using comprehensive metrics

Extreme Weather Events

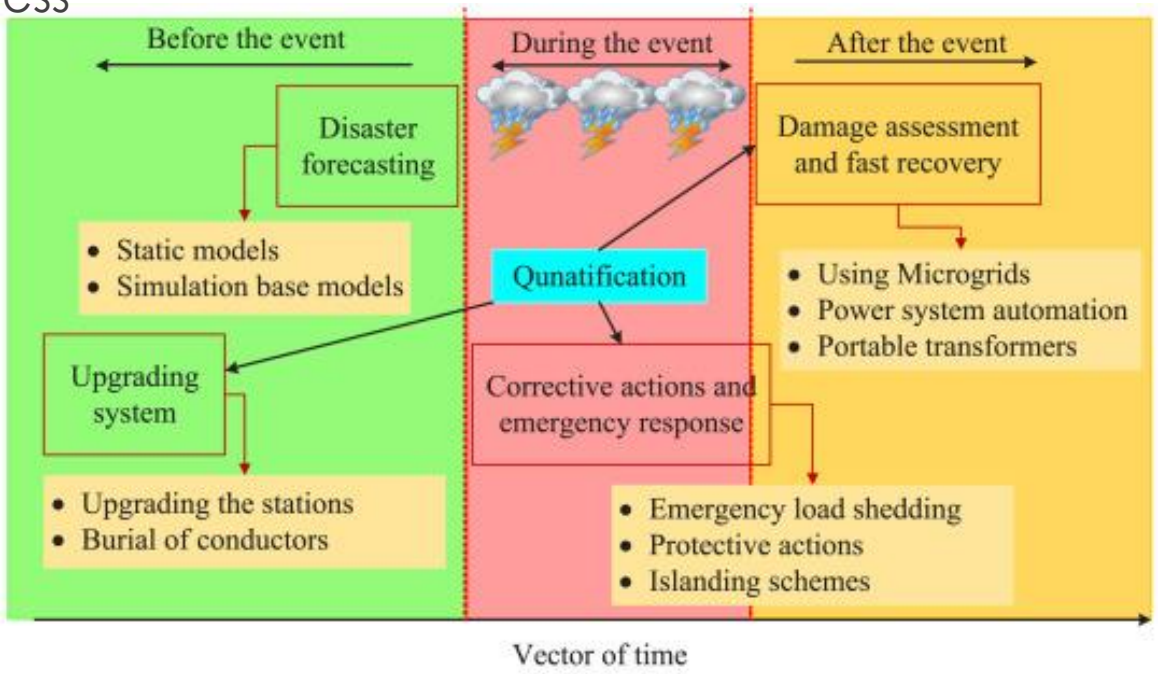
- Increased frequency and intensity
- Increased number of weather related outages
- Power system resilience comes into focus



Narayan Bhusal, Michael Abdelmalak, Md Kamruzzaman, and Mohammed Benidris. Power system resilience: Current practices, challenges, and future directions. IEEE Access, 8:18064–18086, 2020.

Extreme Weather Events

- Upgrading system equipment and hardware, disaster forecasting ⟶ improved System preparedness
- Improving resilience against natural disasters
  - disaster forecasting and estimation
  - upgrading system equipment and hardware
  - corrective actions and emergency response
  - damage assessment, fast recovery
  - resilience quantification

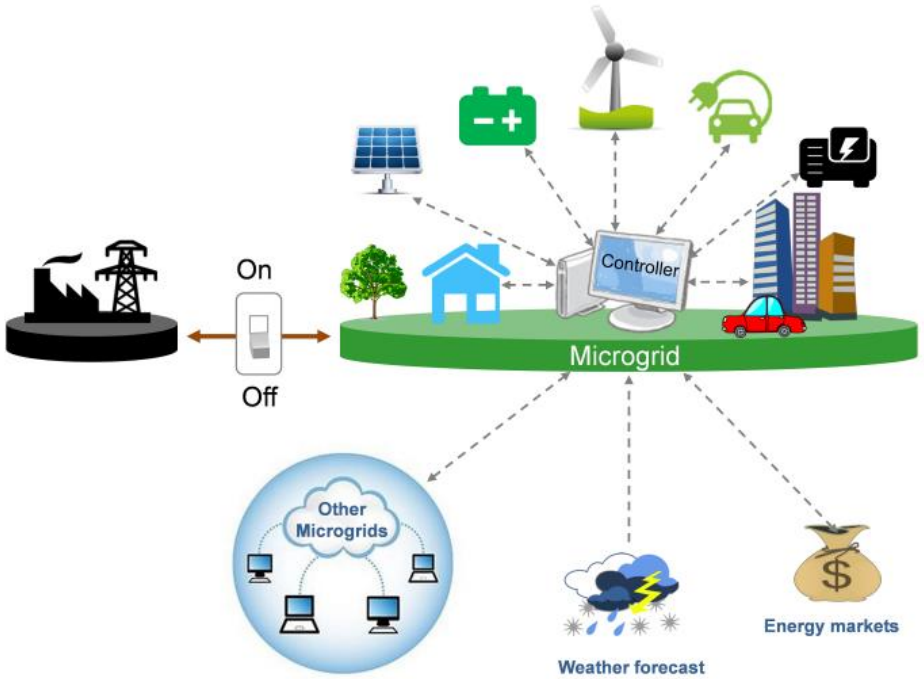


Abdollah Younesi, Hossein Shayeghi, Zongjie Wang, Pierluigi Siano, Ali Mehrizi-Sani, and Amin Safari. Trends in modern power systems resilience: State-of-the-art review. Renewable and Sustainable Energy Reviews, 162:112397, 2022.

Extreme Weather Events

- Microgrids: bringing energy sources closer to load centers, and reducing the grid dependence on transmission lines (most vulnerable equipment)

- Microgrids for resilience enhancement:
  - converting power systems into microgrids
  - deployment of dynamic microgrids
  - networked microgrids



https://nsci.ca/2019/11/08/microgrids-what-are-they-and-how-do-they-work/ 2022.09.15.

Information and Communication Technologies

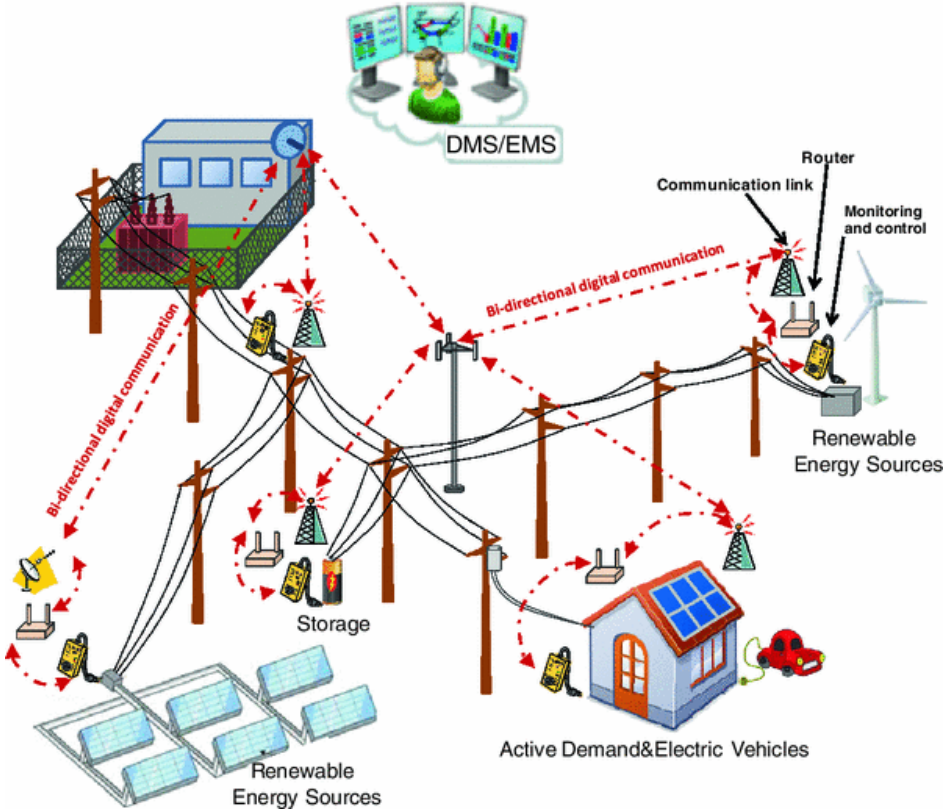
- Digital transformation → increase of ICTs integration
- System reliability can be significantly enhanced
- More cost effective and sustainable power
  - intelligent monitoring and control (increased situational awareness)
  - two-way real-time communication
  - security and safety of supply and self-healing qualities
- Challenges: element failure, failures due to interdependencies and vulnerabilities to cyber-attacks
- Adequate attention to ICT factors in the planning stages

Integration of Renewable Energy Sources

- Intermittent nature of solar and wind resources
- Operational challenges
- Additional and complex balancing actions
- Difficult to maintain the production-consumption balance
- Forecasting, energy storage and demand response systems (more costly) for countering reliability effects

Integration of Renewable Energy Sources

- Resilience enhancement: diverse portfolio of power generation
- At low levels of net generation negative impact and at high levels of net generation statistically significant positive impact on reliability



Di Fazio, Anna Rita, et al. "Integration of renewable energy sources, energy storage systems, and electrical vehicles with smart power distribution networks." *Journal of Ambient Intelligence and Humanized Computing* 4.6 (2013): 663-671.

Summary

- Challenges, but with great possibilities
- Proper integration and utilization
- Transform power systems into a more distributed, decentralized, autonomous system

Thank you for your attention!

pasic.lejla@edu.bme.hu