

Microgrids for Boosting Power System Resilience

Panel Session: Microgrids for Resilience

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**Besides “common” blackouts,
this can happen too...**



Typical Power System Outages VS Natural Disasters

Typical Power System Outage	Natural Disaster/Extreme Weather
<ul style="list-style-type: none">• Low impact, high probability• More predictable/controllable• Random location and time of occurrence• Supported by contingency analysis tools• Limited number of faults due to component failures• Network remains intact• Quick restoration	<ul style="list-style-type: none">• High impact, low probability• Less predictable/controllable• Spatiotemporal correlation between faults and event• Unforeseen event• Multiple faults• Large portion of the network is damaged/collapsed• More time and resources consuming/longer restoration

Resilience Conceptual Framework

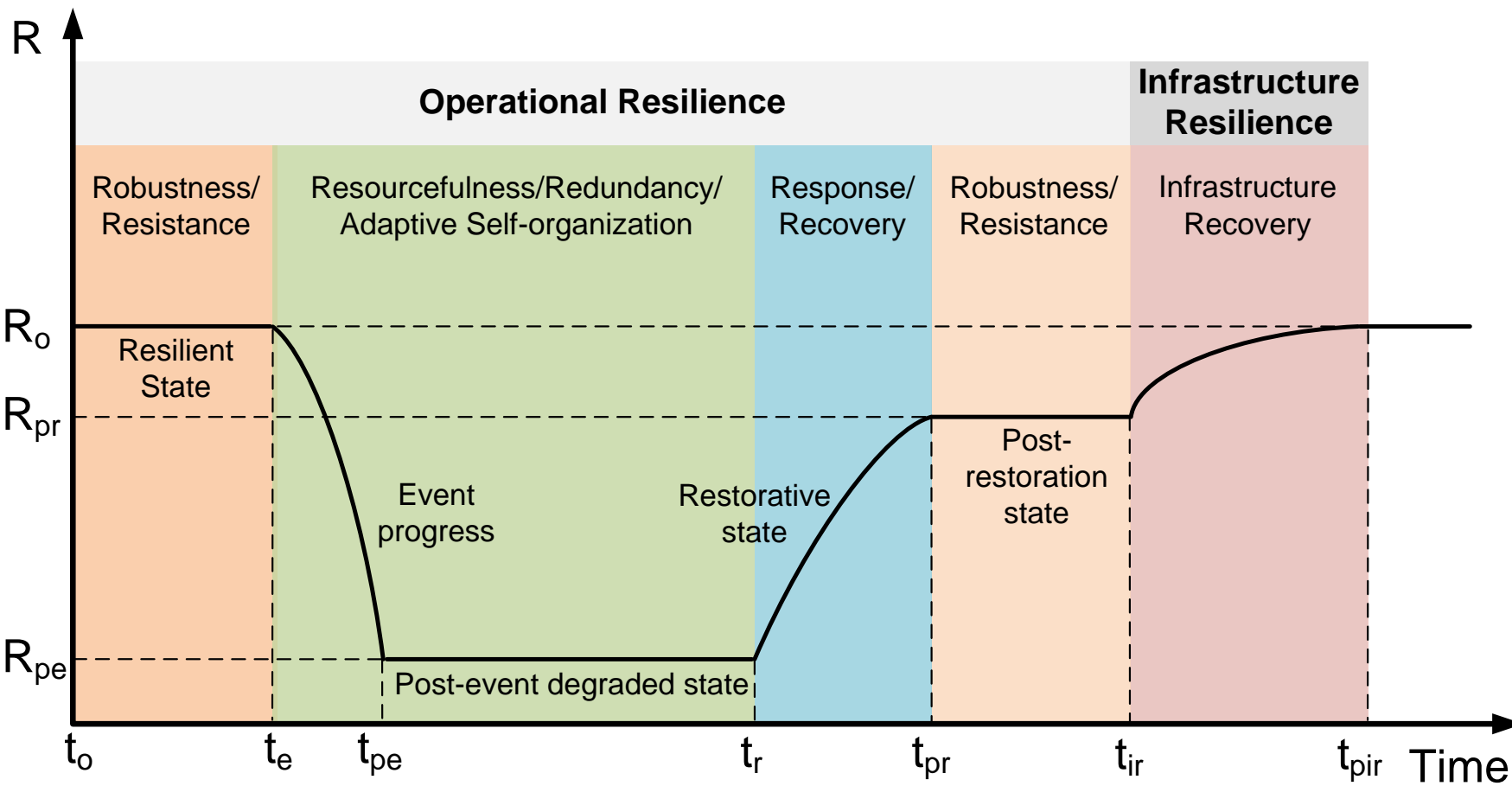


Figure 1. Conceptual Resilience Curve Associated to an Event

Power System Resilience Enhancement

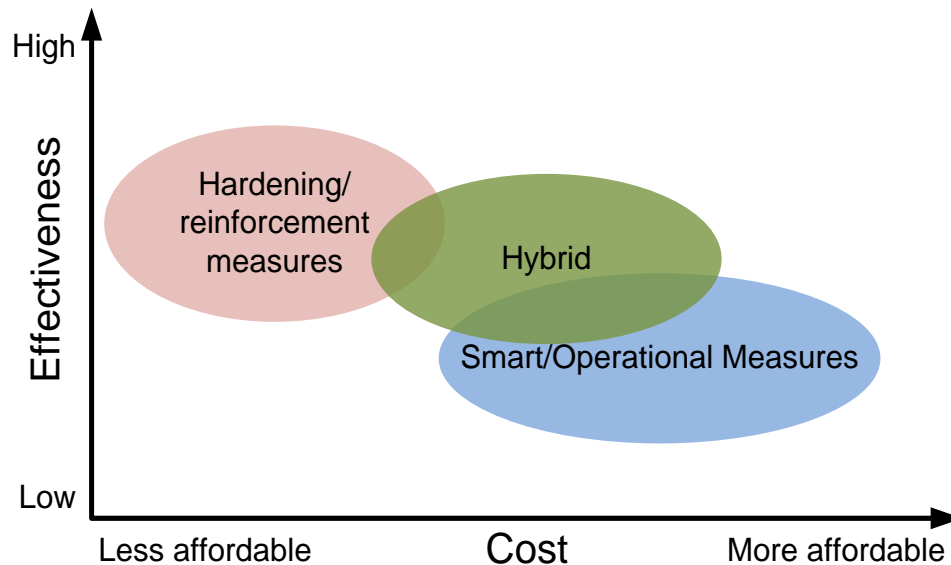


Figure 2. Cost Vs Effectiveness of resilience engineering approaches – Conceptual comparison.

Hardening measures: boosting the infrastructure resilience

- Undergrounding distribution and transmission lines
- Upgrading poles and structures with stronger, more robust materials
- Elevating substations
- Relocating facilities and network elements (e.g. substations and transmission lines) to areas less prone to external shocks
- Redundant transmission routes

Smart/operational measures: boosting the operational resilience

- Distributed energy systems (distributed generation and storage)
- Demand side management
- Decentralized control
- Advanced and accurate weather forecast
- Preventive control (e.g. preventive generation re-scheduling)
- Network reconfiguration
- Microgrids
- Advanced and adaptive restoration
- Adaptive wide-area protection and control schemes (e.g. defensive and controlled islanding of affected areas)
- Advanced visualization and situation awareness systems

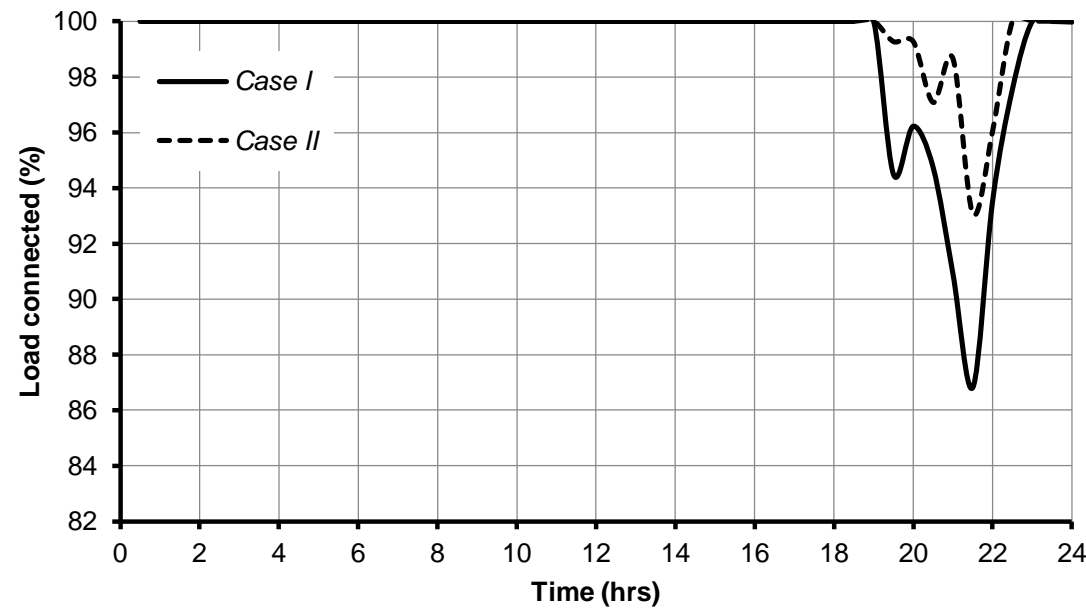
Figure 3. Boosting power systems infrastructure and operational resilience.

Microgrid Operation for Enhancing Power System Resilience

Microgrid consists of:

- Microturbines (MTs)
- Wind Turbines (WTs)
- Photovoltaic (PV)
- Energy Storage Systems (ESSs)

Estimation of unintentional islanding of MG:
Between 19h and 21h



- Case I: Microgrid operation without considering unintentional islanding
- Case II: Microgrid operation considering unintentional islanding

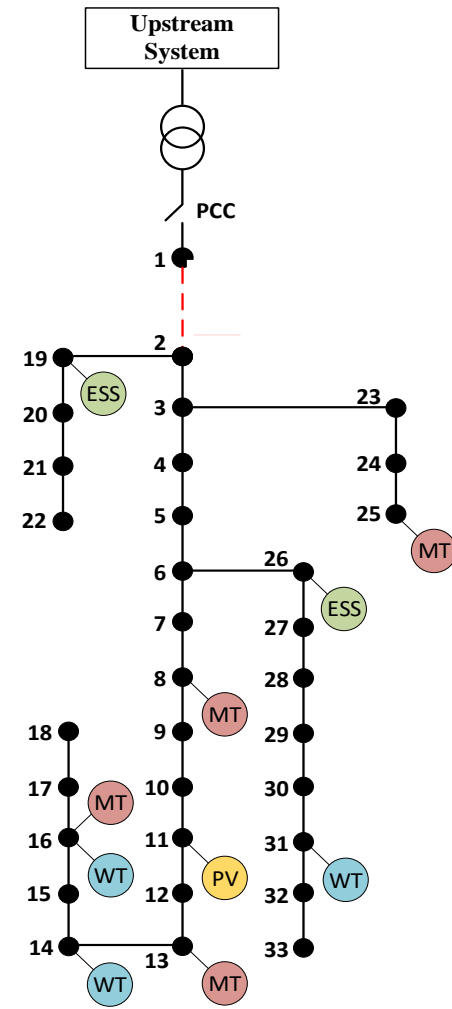


Figure 4. Single line diagram of MG

Microgrid Operation for Enhancing Power System Resilience

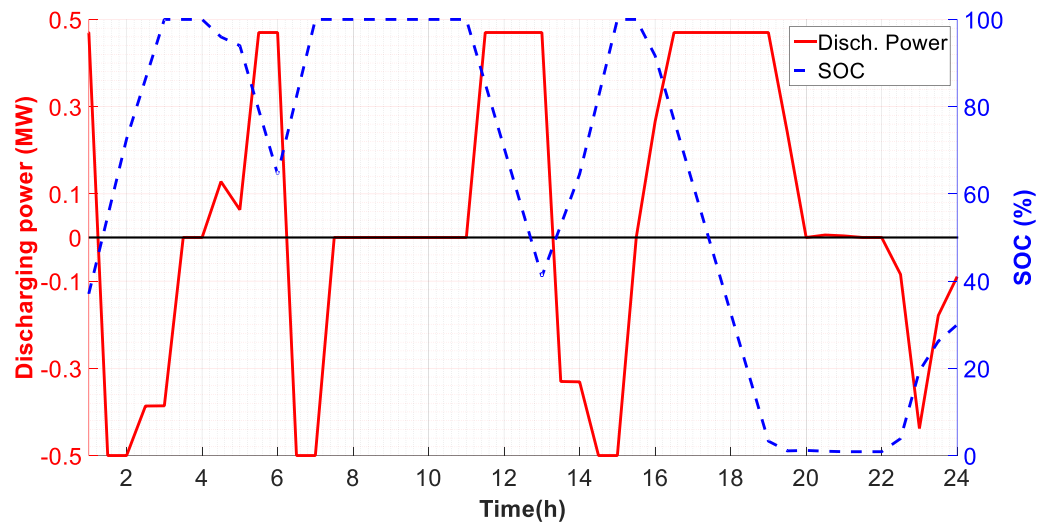


Figure 5. Expected discharging power and SOC of ESS at bus 19 for Case I.

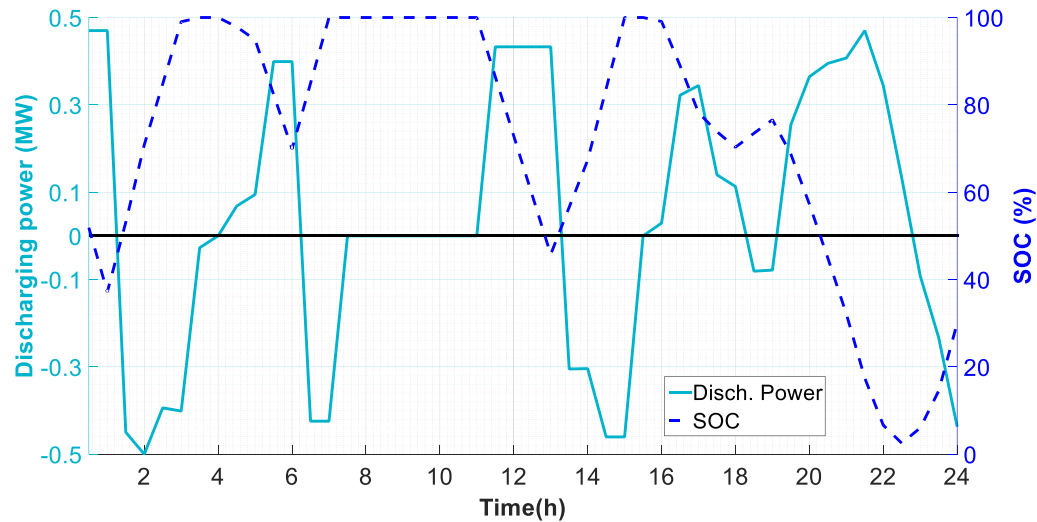


Figure 6. Expected discharging power and SOC of ESS at bus 19 for Case II.

Microgrid Operation for Enhancing Power System Resilience

Needs for enabling resilient operation:

- DERs
 - ❖ Meet demand during unintentional islanding period
- Advanced and accurate weather forecasting tool
 - ❖ Predict RES generation
 - ❖ Estimate unintentional islanding period
- Tools for modeling impact of extreme events on power system components
 - ❖ Estimate unintentional islanding period
- Tools for monitoring and controlling DERs
 - ❖ Apply optimal operation of microgrid.

Thank you for your attention



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