



# Design and Operation of Provisional Microgrids

---

Abdullah Albaker & Amin Khodaei  
University of Denver  
USA

Liuxi Zhang  
Commonwealth Edison  
USA

# Introduction

---

- Microgrids are considered as part of distribution systems with distributed energy resources (DERs), controllable loads, and storage devices which can operate both in grid-connected and islanded mode, in a controlled and coordinated fashion.
- DERs include dispatchable and nondispatchable units:
  - Dispatchable: fuel cell, micro-turbine, and combined heat and power units.
  - Nondispatchable: renewable energy resources (PV and wind units).
- Islanding is the most important characteristics of the microgrid which enables disconnection from the utility grid.

# Introduction

---

- The deployments of microgrids provide significant advantages:
  - improving local system resilience and reliability.
  - higher power quality and efficiency.
  - increasing economic benefits.
- Notwithstanding their numerous benefits, development of microgrids faces several challenges:
  - ❖ microgrids require substantial investments (costly DER installations, distribution network upgrade, etc.); thus not all end-use consumers are capable of this investment.
  - ❖ islanding feature requires that the installed dispatchable DGs capacity be larger than the critical loads (reduce the deployment of renewable DGs).
  - ❖ the installed DERs will potentially be underutilized (as microgrids frequently import low-price power from the utility grid).

# Provisional Microgrids

---

- The concept of provisional microgrid is introduced to support the use of renewable energy resources in the distribution systems.
- Provisional microgrid holds similarities with microgrids as it contains :
  - Interconnected loads and DERs.
  - A master controller that controls and regulates the operation of the provisional microgrid.
- Nevertheless, the difference here is that provisional microgrids are unable to operate in islanded mode without relying on a microgrid

# Provisional Microgrids

---

- The advantages of the provisional microgrid can be summarized as:
  - Liveability in communities by ensuring a cost-effective operation.
  - Workability by collaborating with existing microgrids and enabling a viable response in emergency operations.
  - Sustainability by advancing the deployment of emission-free renewable energy resources.

# Provisional Microgrids

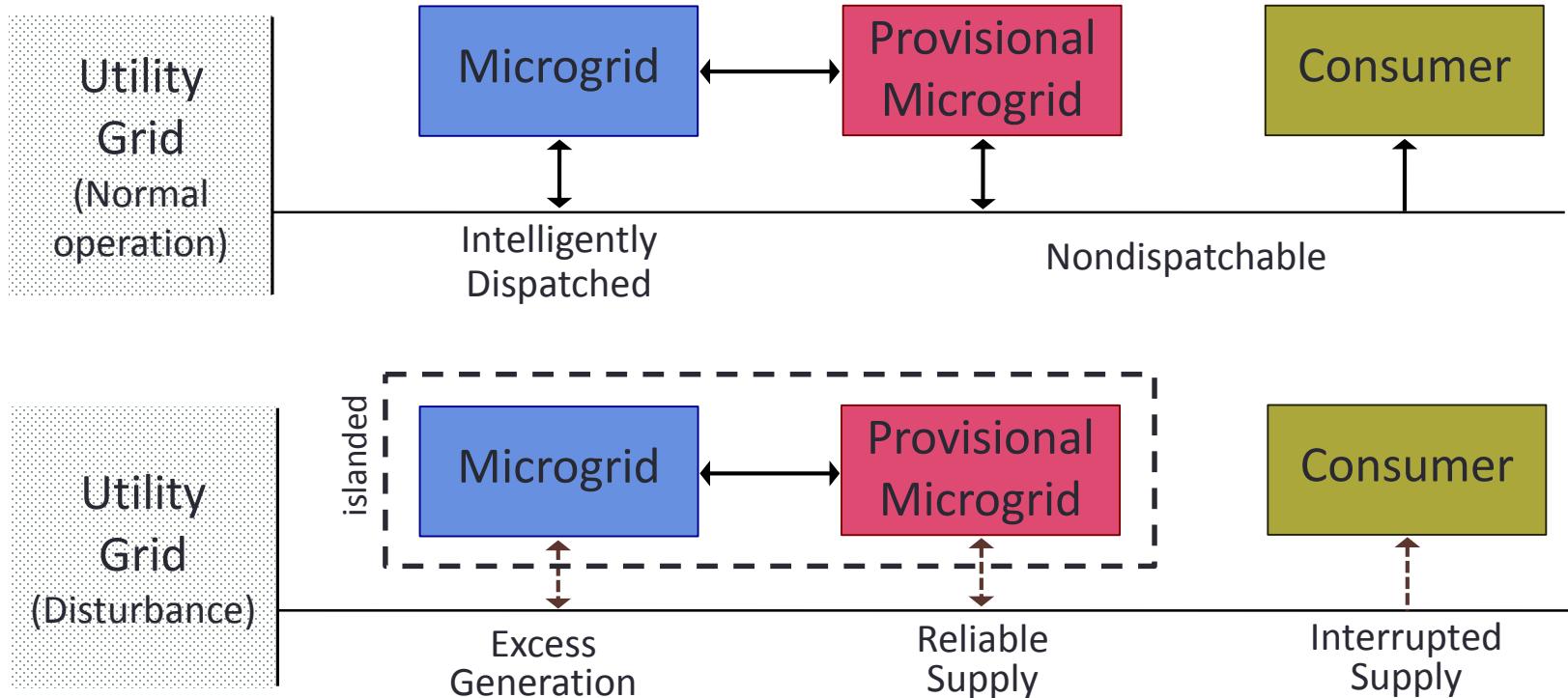


Illustration of the operation modes of a provisional microgrid.

# Rational, Relevance, and Features

---

- Eliminating the islanding requirement
  - facilitates the deployment of any generation mix and in particular high penetration levels of renewable energy resources can be installed.
  - the underutilization concern of the installed capacity alleviates.
- The provisional microgrid would benefit from the connection to the coupled microgrid through:
  - ❖ obtaining the required flexibility.
  - ❖ importing additional power as needed.
- Mutual benefits include:
  - ❖ Coupled microgrid maximizes its economic benefits.
  - ❖ Provisional microgrid achieves the required reliability.

# Rational, Relevance, and Features

---

- The characteristics of the proposed provisional microgrid include:
  1. It can operate when connected to the utility grid, but has the capability to synergistically operate with the coupled microgrid for reliability and resilience purposes.
  2. It mainly consists of renewable energy resources and energy storage.
  3. It makes smart decisions to connect/disconnect to/from the utility grid and the coupled microgrid to reach desired objectives.
  4. It is capable of optimally operating smart appliances such as HVAC systems.
  5. It is interoperable externally and internally using standard protocols that meet control and communication potentials as desired by the utility.

# Operation Modes

---

- Within the scheduling horizon, the provisional microgrid master controller must ensure:
  - Load-supply balance (local generated power + exchanged power with the utility grid + exchanged power with the coupled microgrid = load demand).
- Two operation modes:
  - a. Grid-connected operation: the provisional microgrid coordinates local generations and the exchanged power with the utility grid and the coupled microgrid.
  - b. Islanded operation: the provisional microgrid would be disconnected from the utility grid, and import its energy requirements from the coupled microgrid to supply the local loads.

# Operation Modes

---

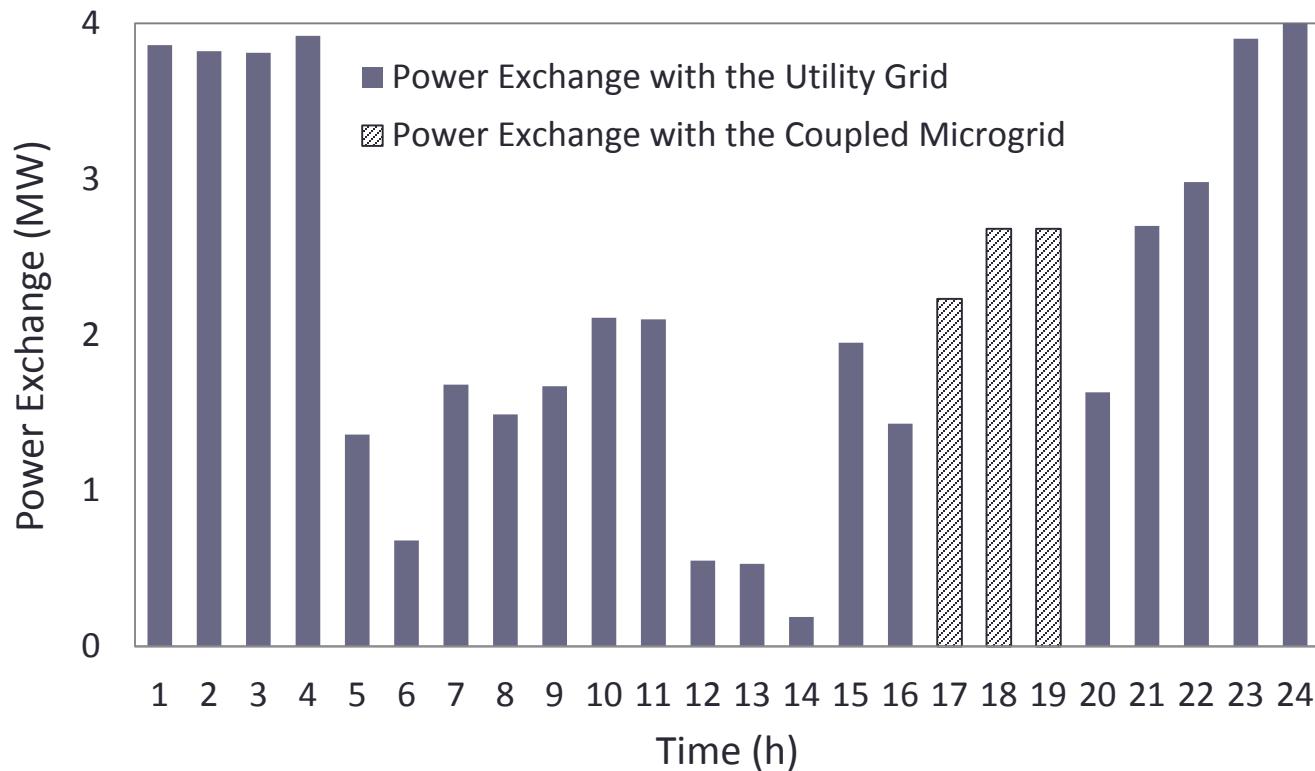
- The islanding is implemented to promptly disconnect the provisional microgrid and the coupled microgrid from the faulty upstream network, and protect the local DGs and voltage sensitive loads from the disturbances.
- The operation modes (OM) of the provisional microgrid include:
  - ❖ OM1: Normal operation (grid-connected and microgrid-coupled).
  - ❖ OM2: Normal operation (grid-connected only).
  - ❖ OM3: Emergency operation (microgrid-coupled).

# Illustrative Study

---

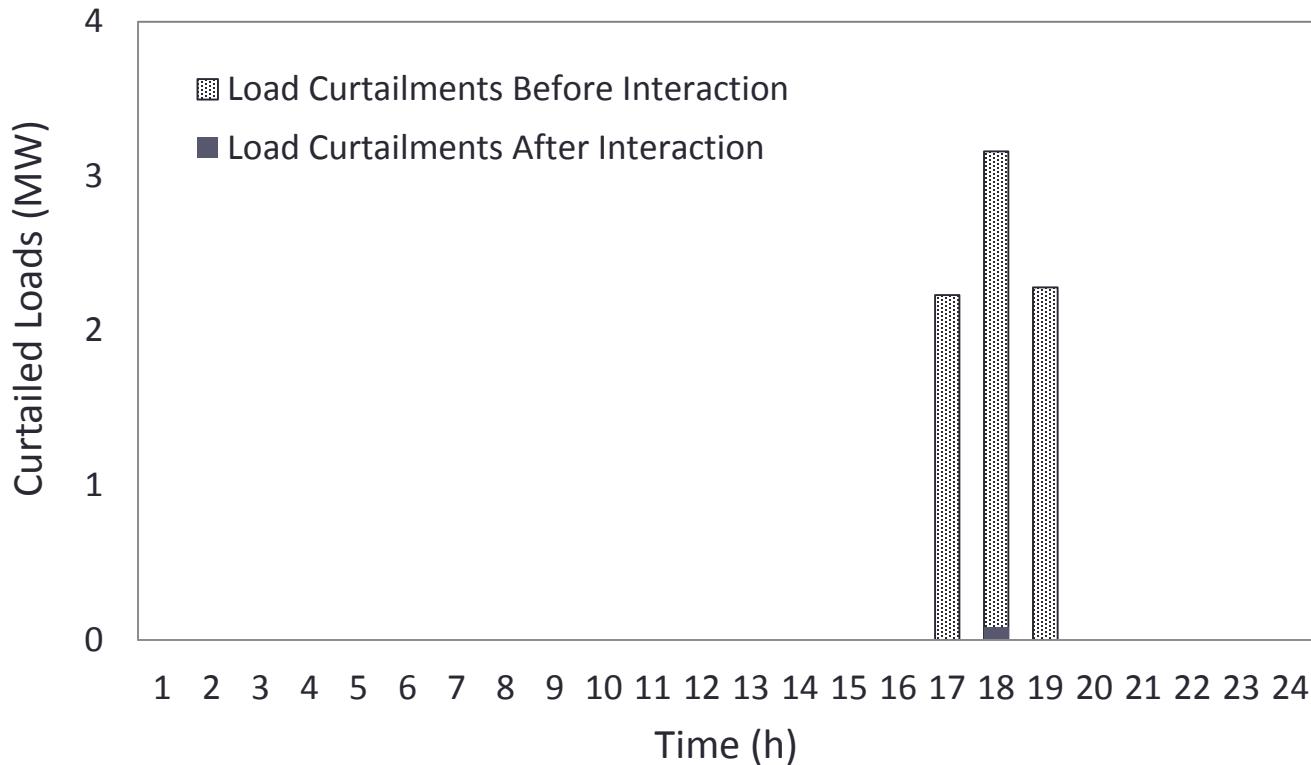
- A provisional microgrid is utilized to investigate the effectiveness and the impact of this technology on the total operation cost and the amount of the load curtailments.
- ❑ based on a certain 3 MW transfer limit with the coupled microgrid.
- ❑ a certain 10 MW transfer limit with the utility grid.
- ❑ and an arbitrary 3-hour islanding (hours 17:00, 18:00, and 19:00).

# Illustrative Study



Provisional microgrid imported power from the utility grid and the coupled microgrid during the selected scheduling horizon.

# Illustrative Study



The corresponding prosumer (before being elevated to a provisional microgrid) and Provisional microgrid load curtailments during the islanded mode.

# Conclusion

---

- The concept of provisional microgrid is introduced
- It is shown that the penetration levels of renewable energy resources can be increased using provisional microgrids
- The efficiency and economics of microgrids can be enhanced using provisional microgrids

---

Thank you  
**amir.abirijahromi@du.edu**