



THE UNIVERSITY OF  
**AUCKLAND**  
Te Whare Wānanga o Tāmaki Makaurau  
**NEW ZEALAND**

# Role of Microgrids in Resilience of Electric Power Distribution Systems

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# Overview

- **Introduction**
- **Power System**
  - **Distribution system & Microgrids**
- **Applications of Microgrid**
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- **Role of Microgrid in Distribution Power System Resilience**
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    - **Power System Restoration**
    - **Critical Loads Supply**
  - **Midterm Response**
    - **Communication, Control and Operation**
  - **Future Planning (A different Investment Model)**

# Introduction

## **Electricity Distribution Resilience Framework through West Coast Alpine Fault Scenario (Nirmal Nair)**

Leo Yang Liu

Defining and quantifying the resilience of electric distribution networks to natural hazards

Andrew Austin

Investigating resilience of communication systems to natural disasters

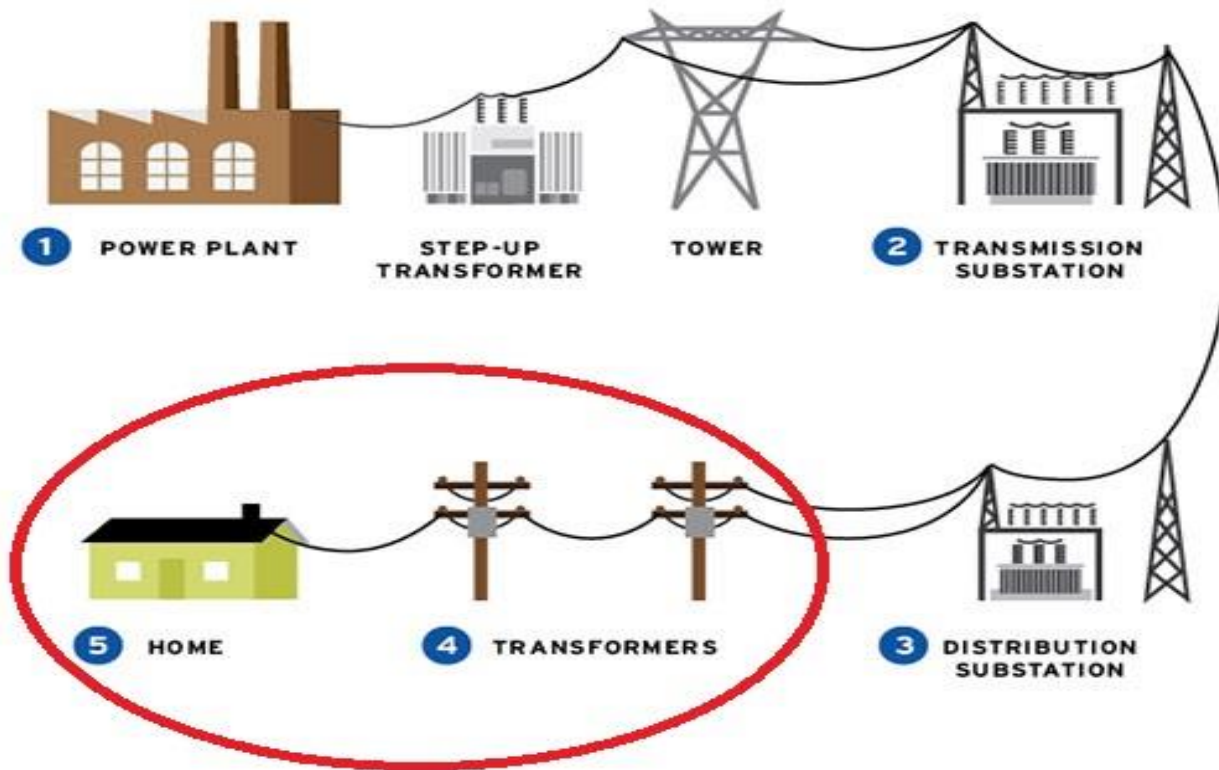
Duncan Maina

Disaster related recovery of electrical power networks

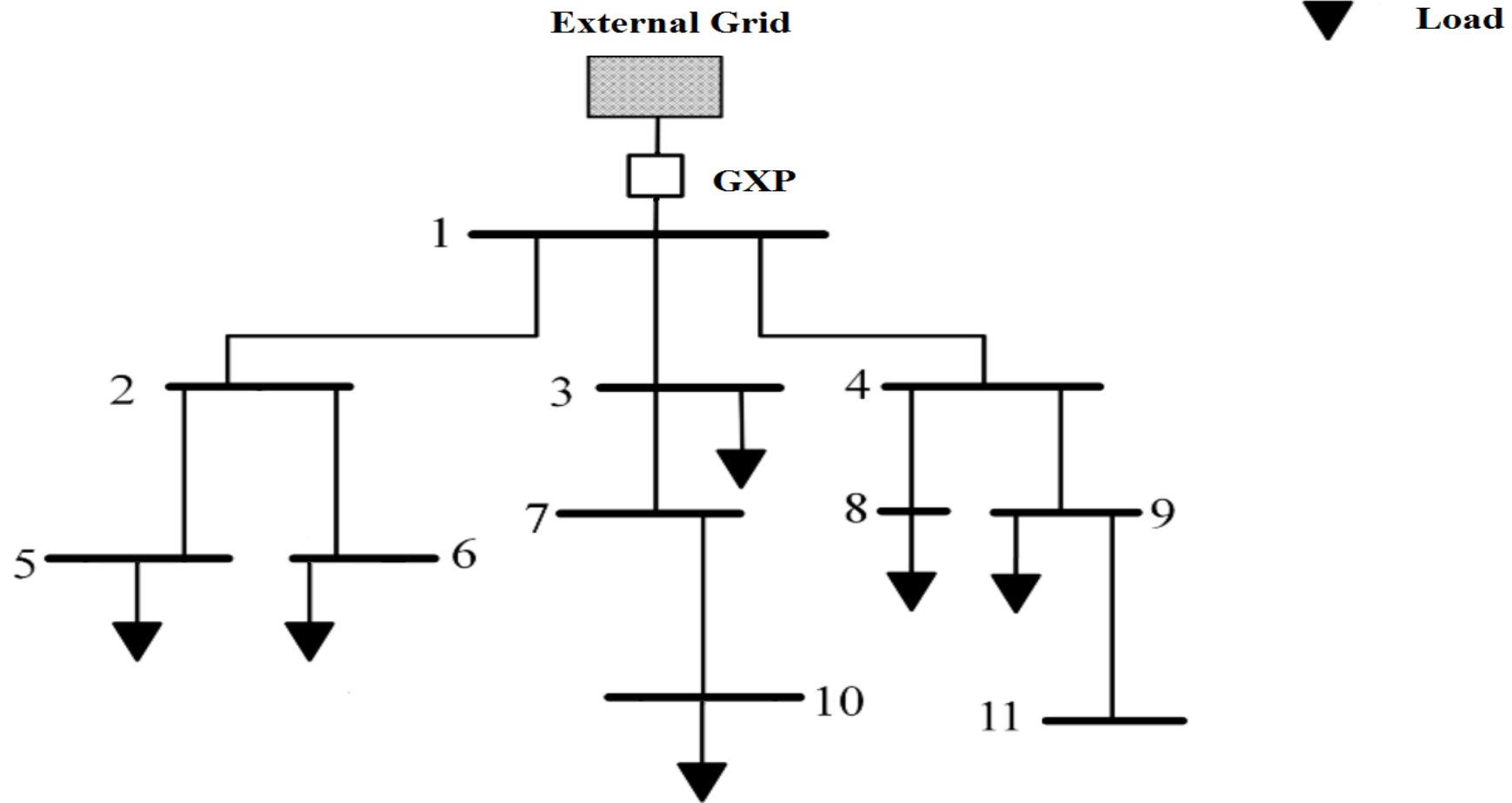
**Samad Shirzadi**

**Role of Microgrids in Resilience of Electric Power Distribution Systems**

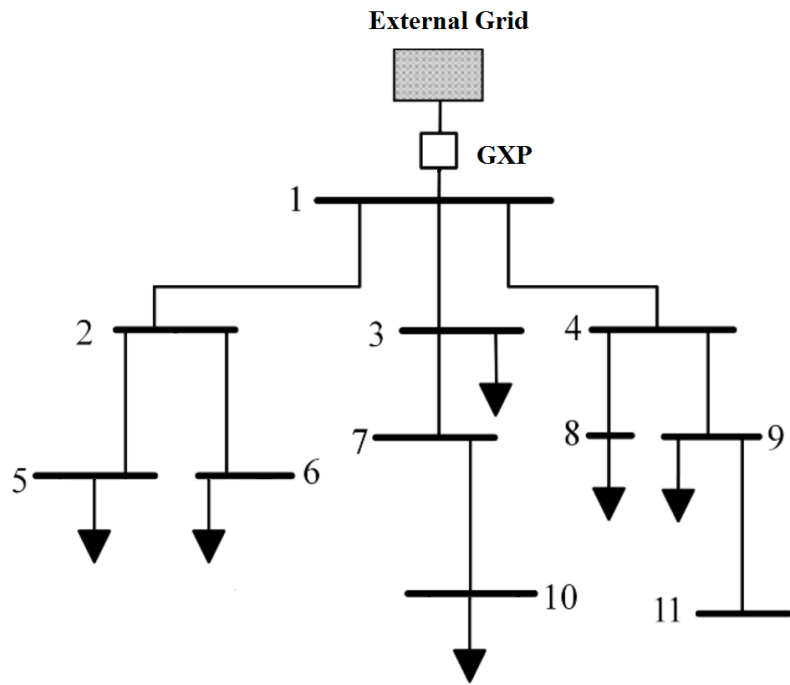
# Power System



# Distribution System

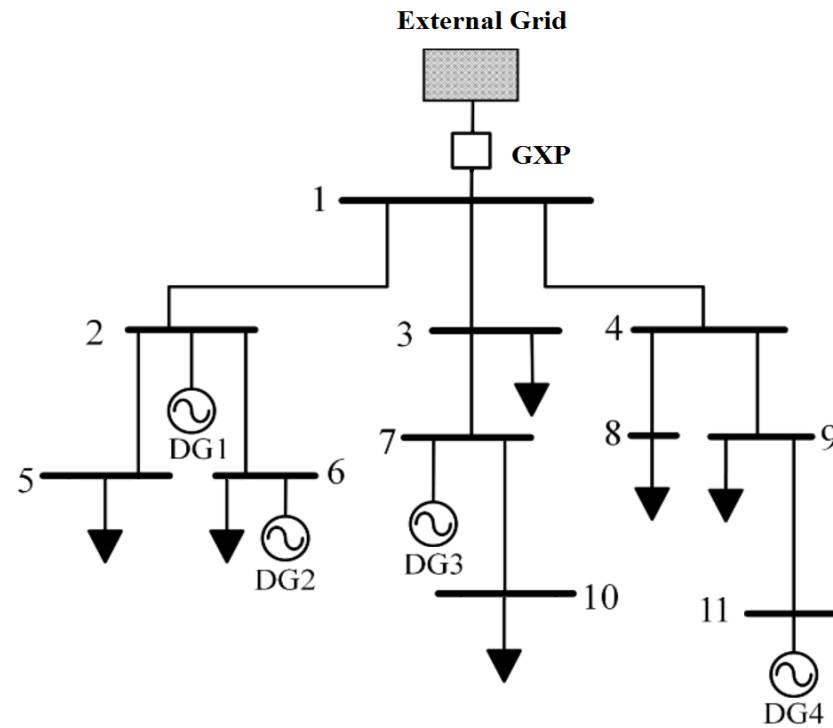


# Distribution System



▼ Load

# Microgrid



▼ Load

⊗ Distributed Generation

# Applications of Microgrid

- Environmental Concerns and Sustainability



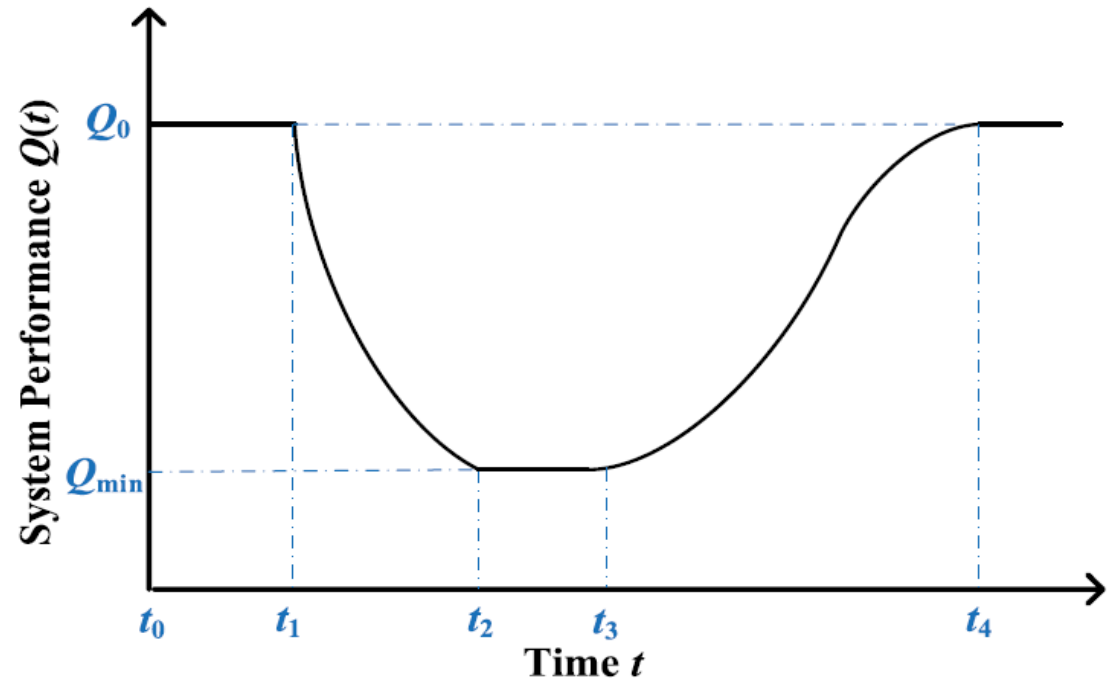
- Power System Resilience



# Resilience Metrics (Leo)

$$Resilience = \frac{1}{loss}$$

$$Loss = \frac{1}{t_4 - t_1} \int_{t_1}^{t_4} \left[ \frac{Q_0 - Q(t)}{Q(t)} \right] dt$$

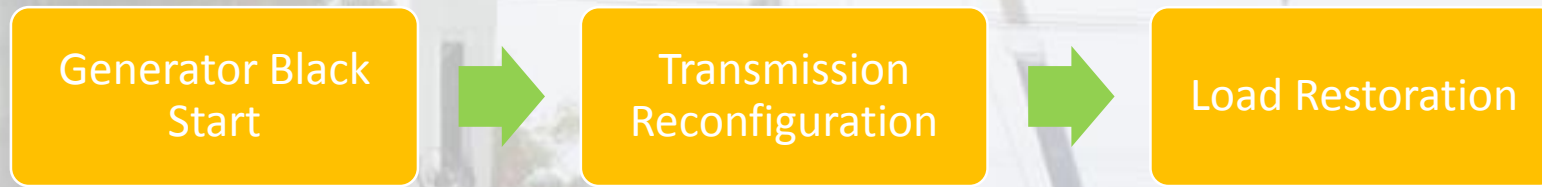


Networked Microgrids for Enhancing the Power System Resilience

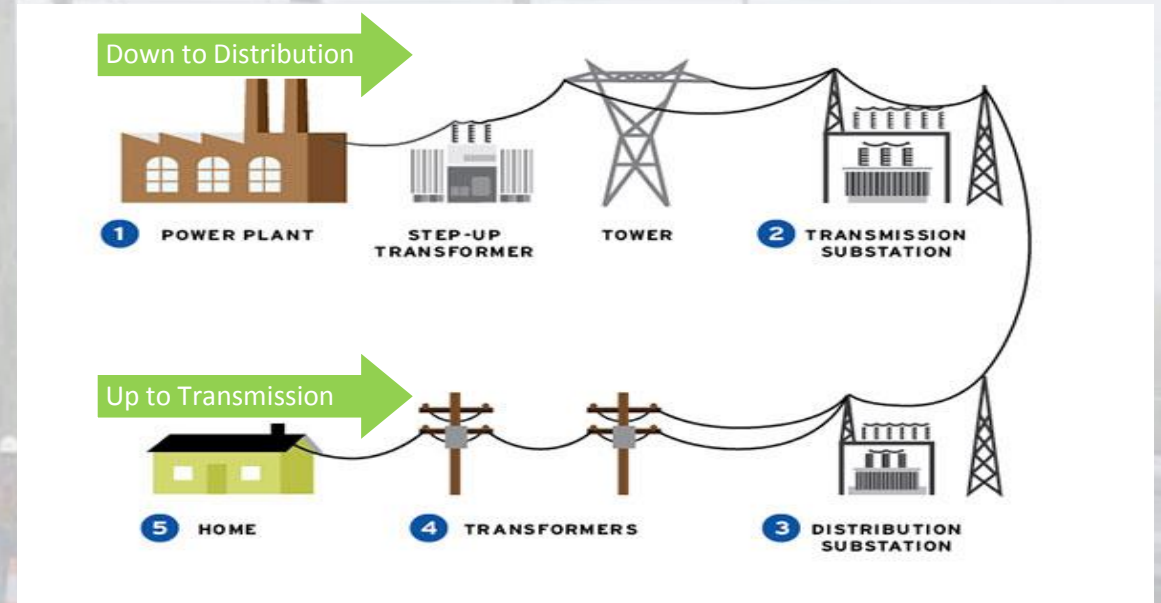
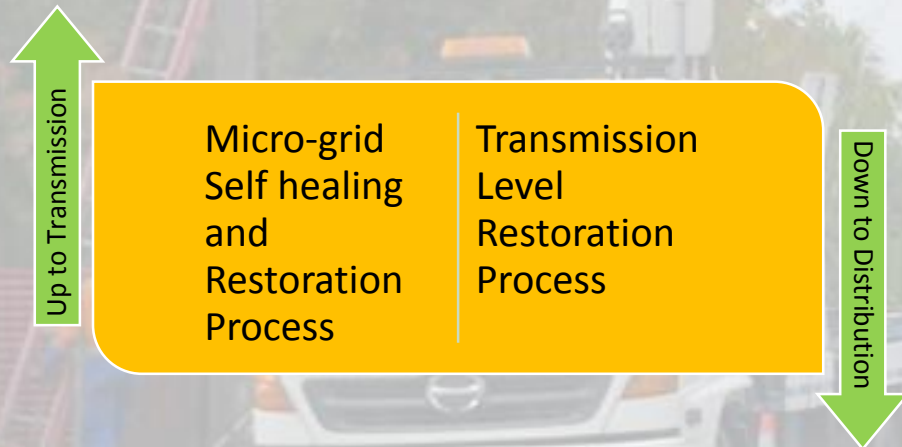


# Immediate Response (Restoration)<sub>(Duncan)</sub>

- Traditional Method

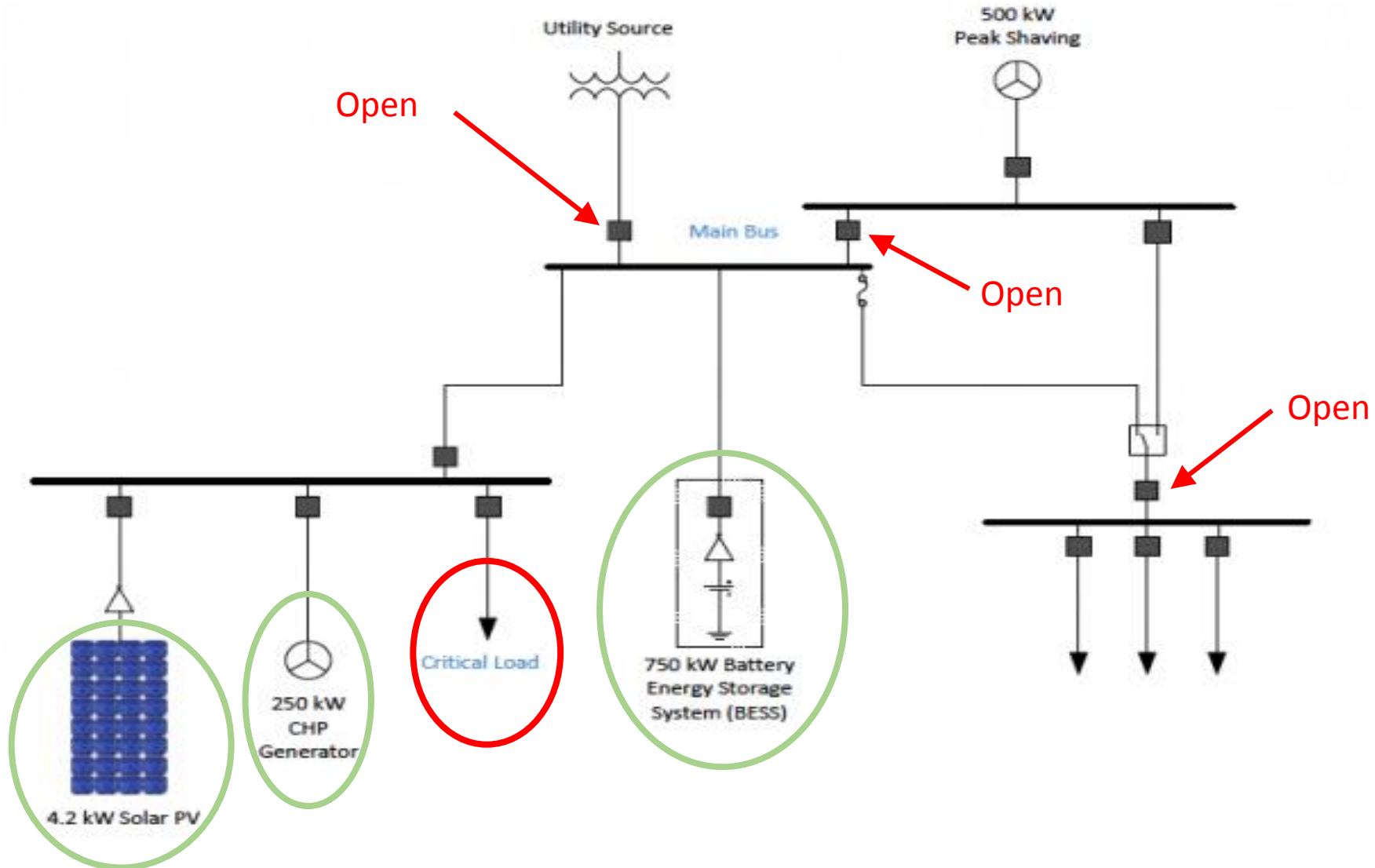


- Modern Method



Enhancing the resilience of the electricity grid through microgrid facilities

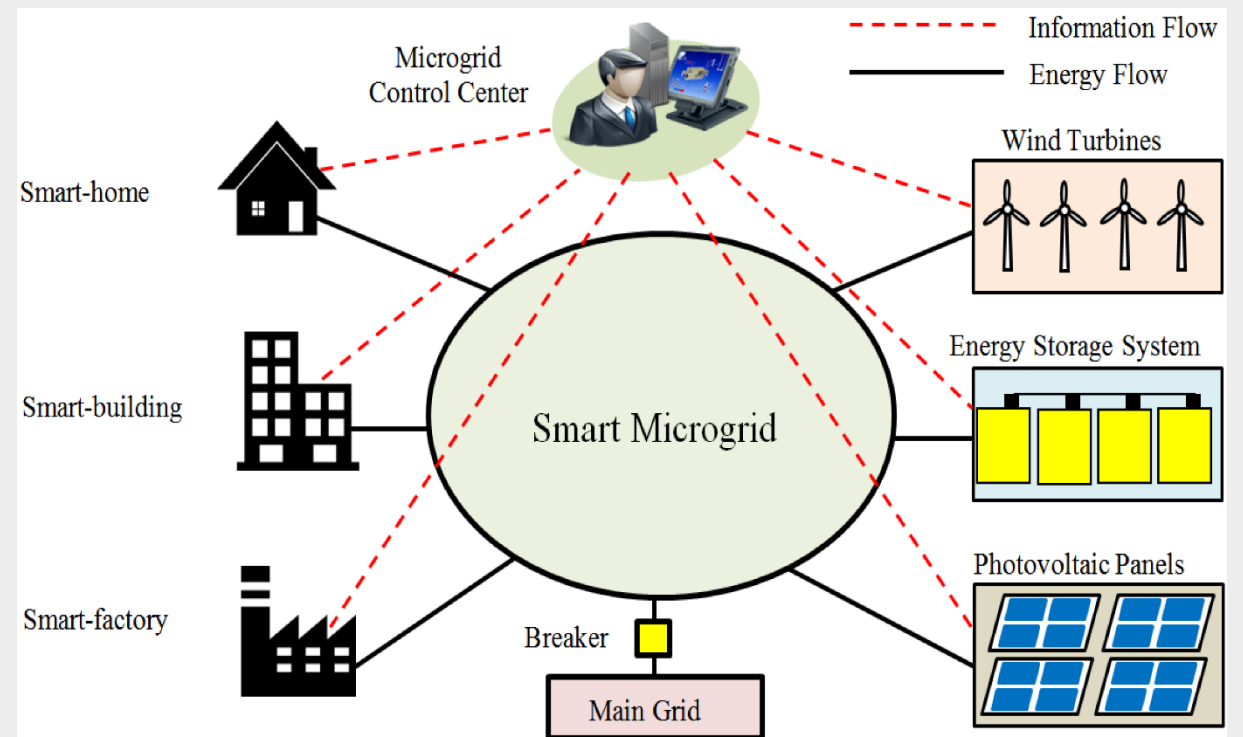
# Immediate Response (Critical Loads Supply)



# Midterm Response (Communication, Control and Operation)

## Operating a microgrid as an Island

- Communication (Andrew)
  - Communication medium
  - Communication resilience
- Control strategies
  - Centralized
  - Decentralized
  - **Distributed (multi MCCs, delay)**



# Future Planning (A Different Investment Objectives)

## Optimal Microgrid Placement for Enhancing Power System Resilience

*min* Cost of unserved energy

$$\min \sum_t \sum_s \sum_b v_b LS_{bts}$$

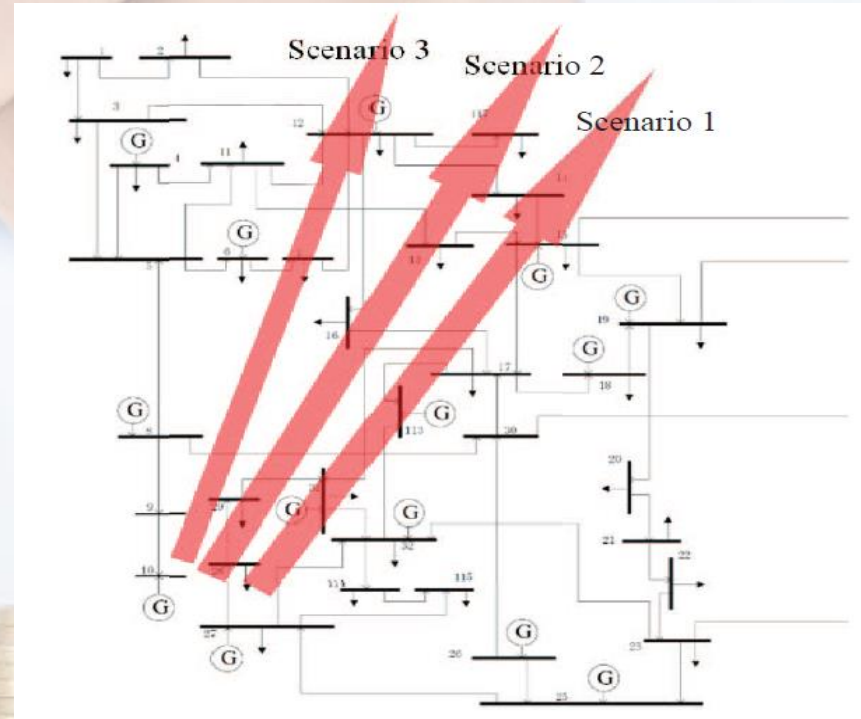
*b.* Index for buses.

*s.* Index for scenarios.

*v.* Value of lost load (VOLL).

*LS.* Load shedding.

*t.* Index for time.



Optimal Microgrid Placement for Enhancing Power System Resilience in Response to Weather Events

# Conclusion

		Time		
		Short Term	Midterm	Long-term
Strategy	System Reinforcement	-	-	Investment & Future Planning
	System Operation & Control	Critical Load Supply	Microgrid Islanding Operation	Investment & Future Planning

Different Strategies → - Different System Assessment  
- Different Requirements

A 3D maze with a person standing in a central opening. The maze is composed of white walls and a central path that leads to a person standing with their back to the camera. The text "Thanks Q&A" is overlaid on the scene.

Thanks  
Q&A