How can microgrids with EVs enhance urban energy resilience?

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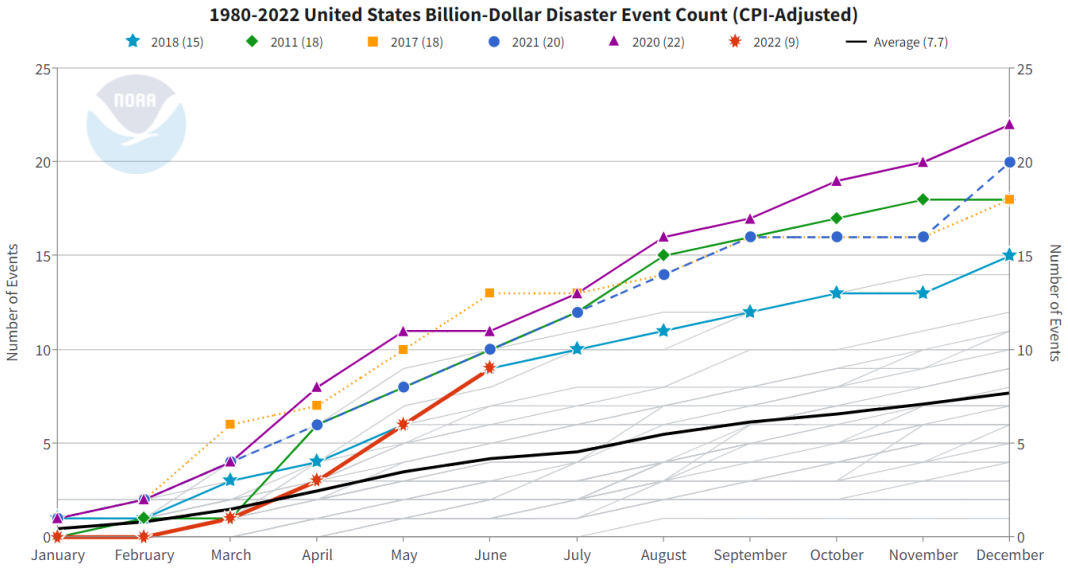
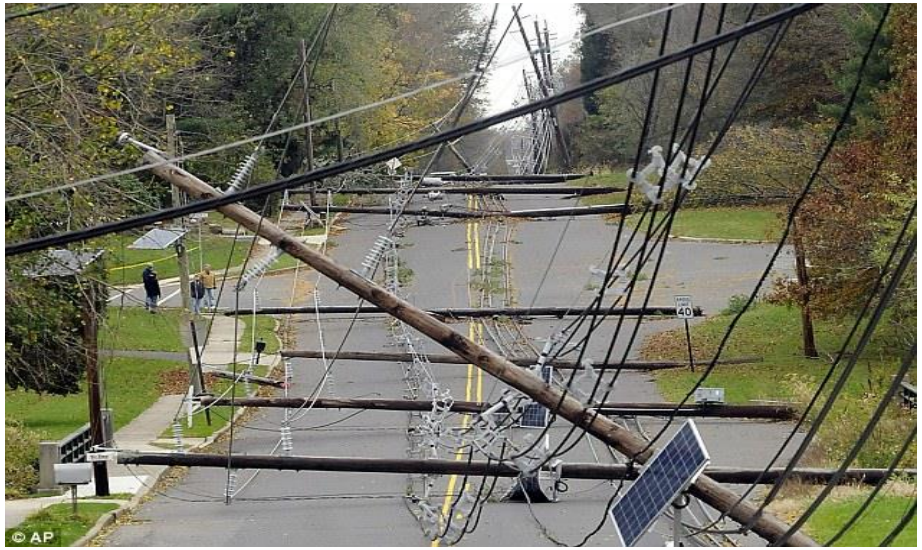
Background

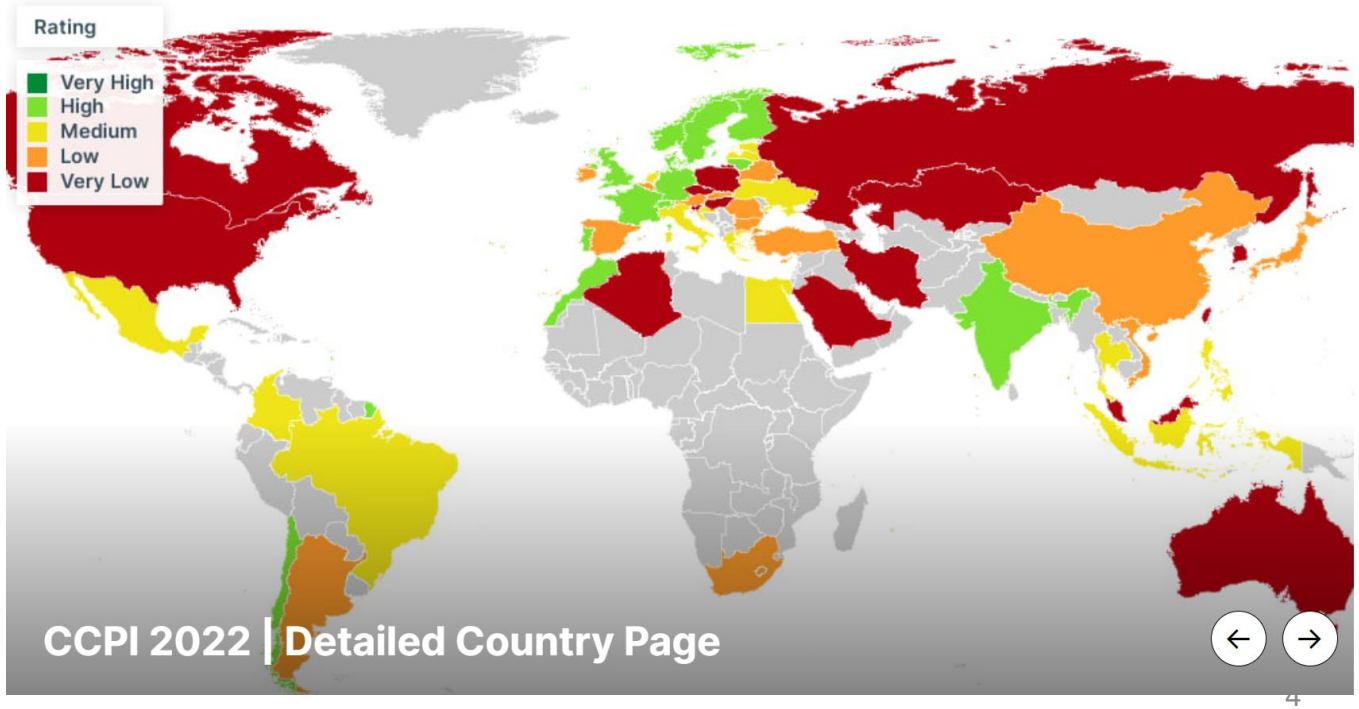
Challenges, Urban system, Resilience concept and promoting strategies

1. Extreme Weather Events and Impacts

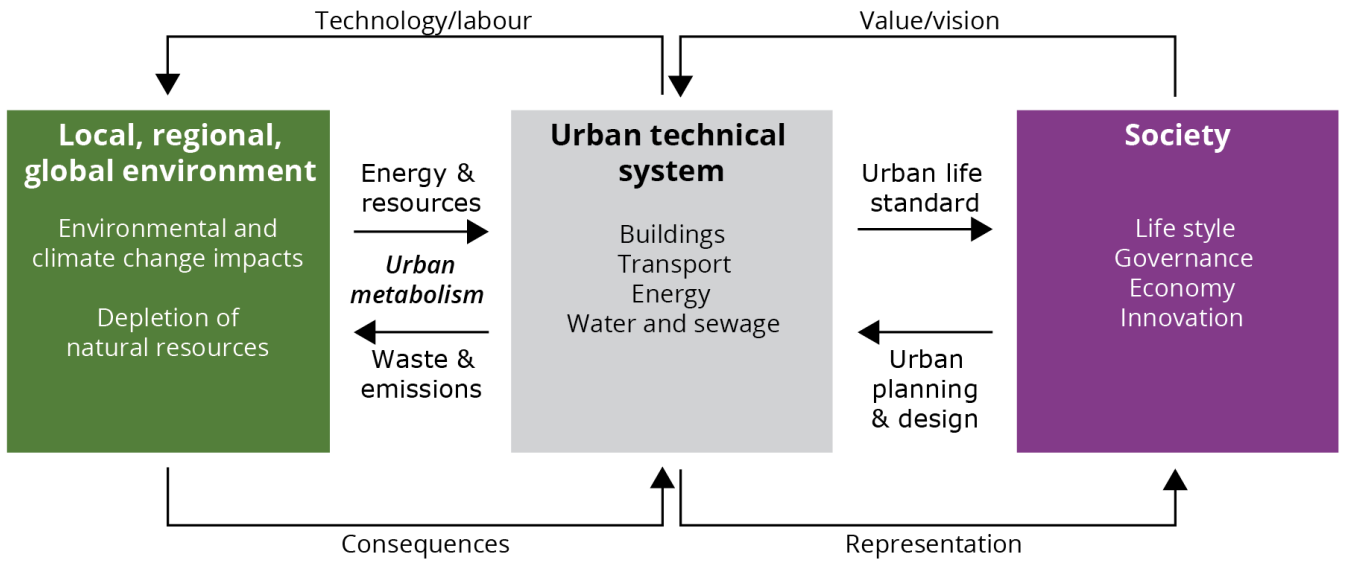




- Disastrous consequences due to threats from Extreme Weather Events together with interdependence
- Climate change supercharges the increasing frequency and intensity of extreme weather related disasters.

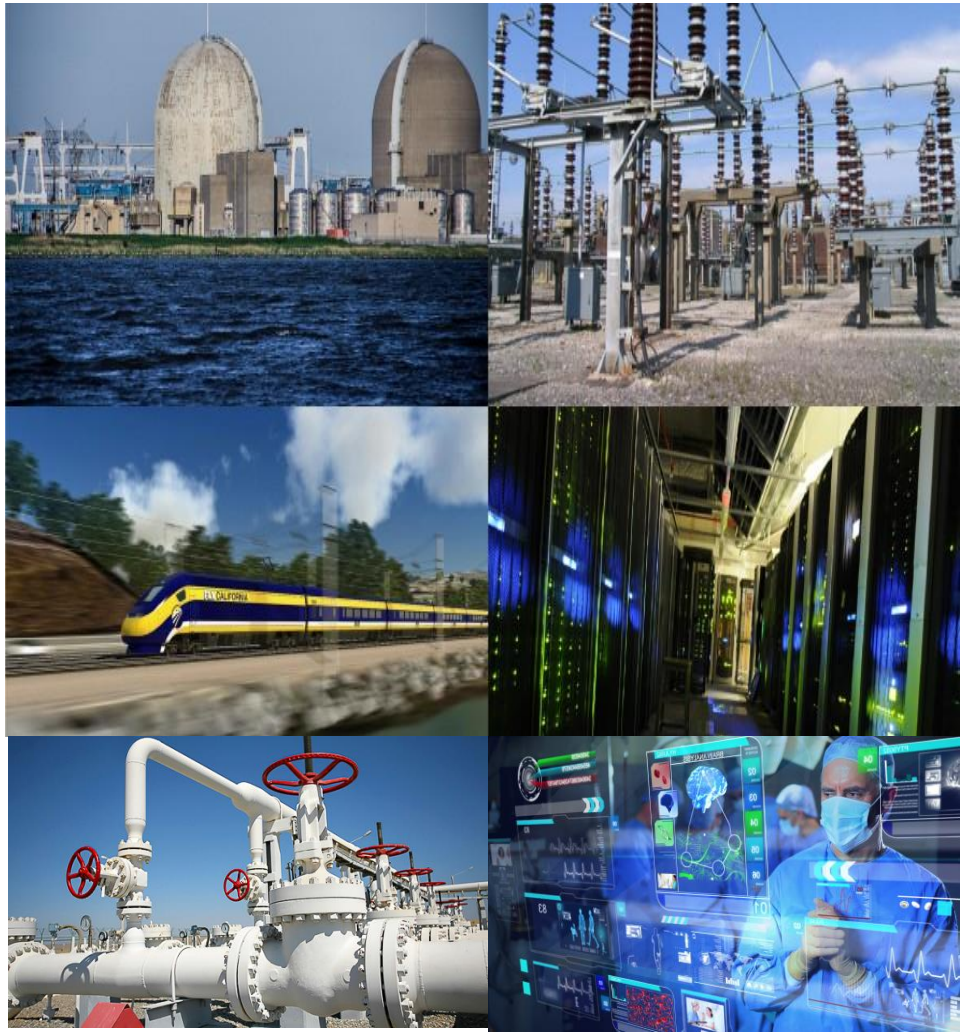


2. Urban System



Adapted from: Bai X, Schandl H: Urban ecology and industrial ecology. In The Routledge Handbook of Urban Ecology. Edited by Douglas I, Goode D, Houck M, Wang R. Routledge; 2011:26-37.

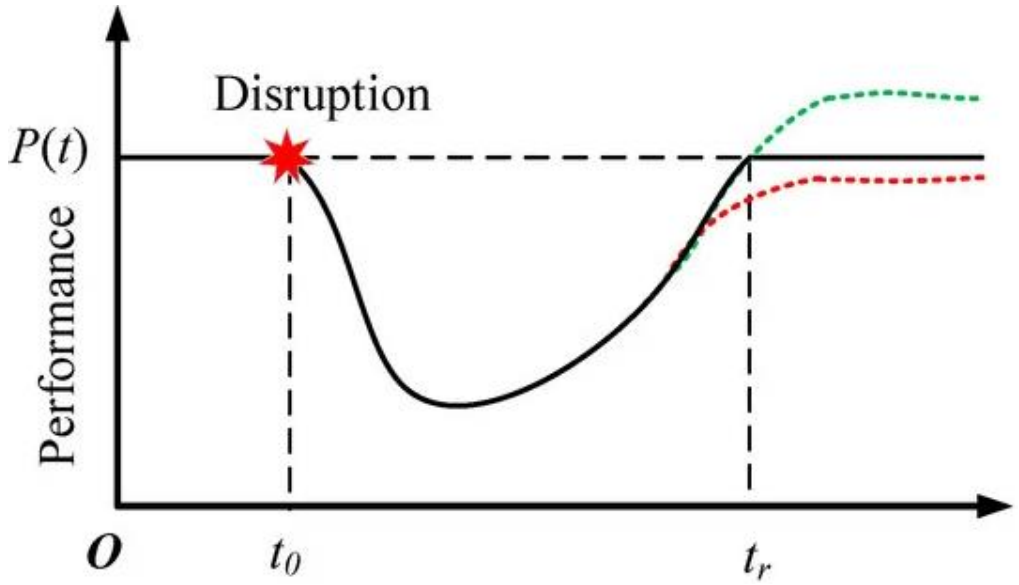
European Environment Agency



- Urban technical system provides service for the society function and development.
- Energy systems, such as **power systems** supply primary and second energy to all other sectors.

3. Resilience Concept and Promoting Strategies

- Comes from Latin language
- First introduced into ecology by the Canadian ecologist, C.S. Holling
- Different interpretations in specific disciplines
- Generally refers to the ability of a system to recover quickly following a disaster



Grid Modernization Technologies

01

03

Microgrid, Energy Storage.

Distributed Generation Technologies

Hardening of Critical Physical Infrastructure

02

04

Enhanced Damage Prediction Models

Source: Q. Dong, R. Li, and R. Kang, "System Resilience Evaluation and Optimization Considering Epistemic Uncertainty," Symmetry, vol. 14, no. 6, p. 1182, Jun. 2022, doi: 10.3390/sym14061182.

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Microgrids with EVs to Enhance Urban Energy Resilience

MG with EVs for Long-term and short-term resilience

1. Microgrids with EVs for Long-Term Urban Energy Resilience

I. Reduce carbon emission

- EV in MG with renewable to optimize the usage of renewable energy

II. Reduce stress on main power system

- Distributed renewable energy in MG to reduce power delivery with long distance
- EVs as compensation of intermittent renewable energy
- EVs for peak-load shifting, reducing concerns for grid overload

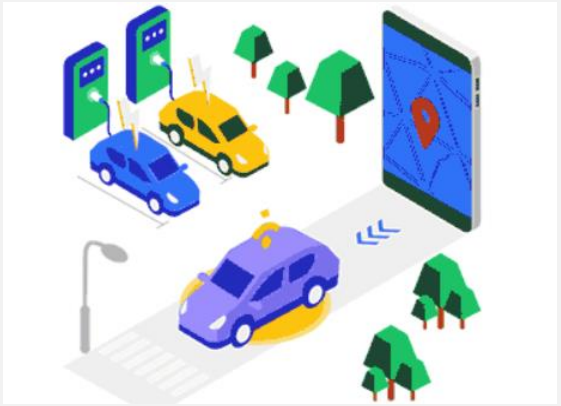
III. Avoid or delay investments in power plants using fossil fuels

- EVs in MG help to maximize renewable energy utilization
- EVs to provide ancillary service
- EVs for peak-load shifting

2. Microgrids with EVs for Short-Term Urban Energy Resilience

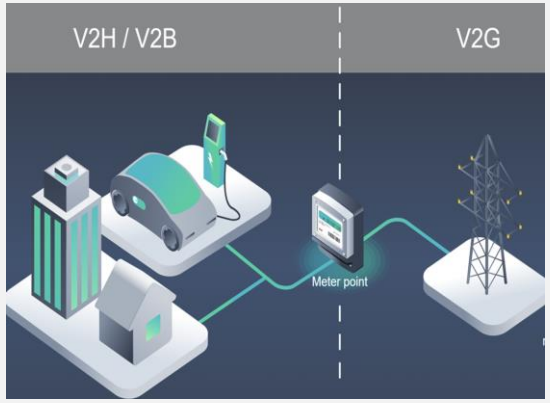
I. Before Disaster Event

- Evs to store energy to prepare for the event
- Optimal dispatch of available Evs in coordination with other resources in power system



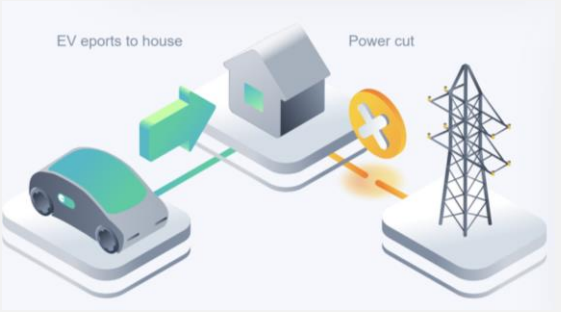
II. During Disaster Event

- Active islanding of MG
- V2G (vehicle-to-grid) to balance generation and demand
- V2H (vehicle-to-home), V2B (vehicle-to-building), V2L (vehicle-to-load) in areas with blackout



III. After Disaster Event

- Islanded MG to reduce disaster event impact
- V2H, V2B, V2L for emergency power supply
- MG or EV for blackstart



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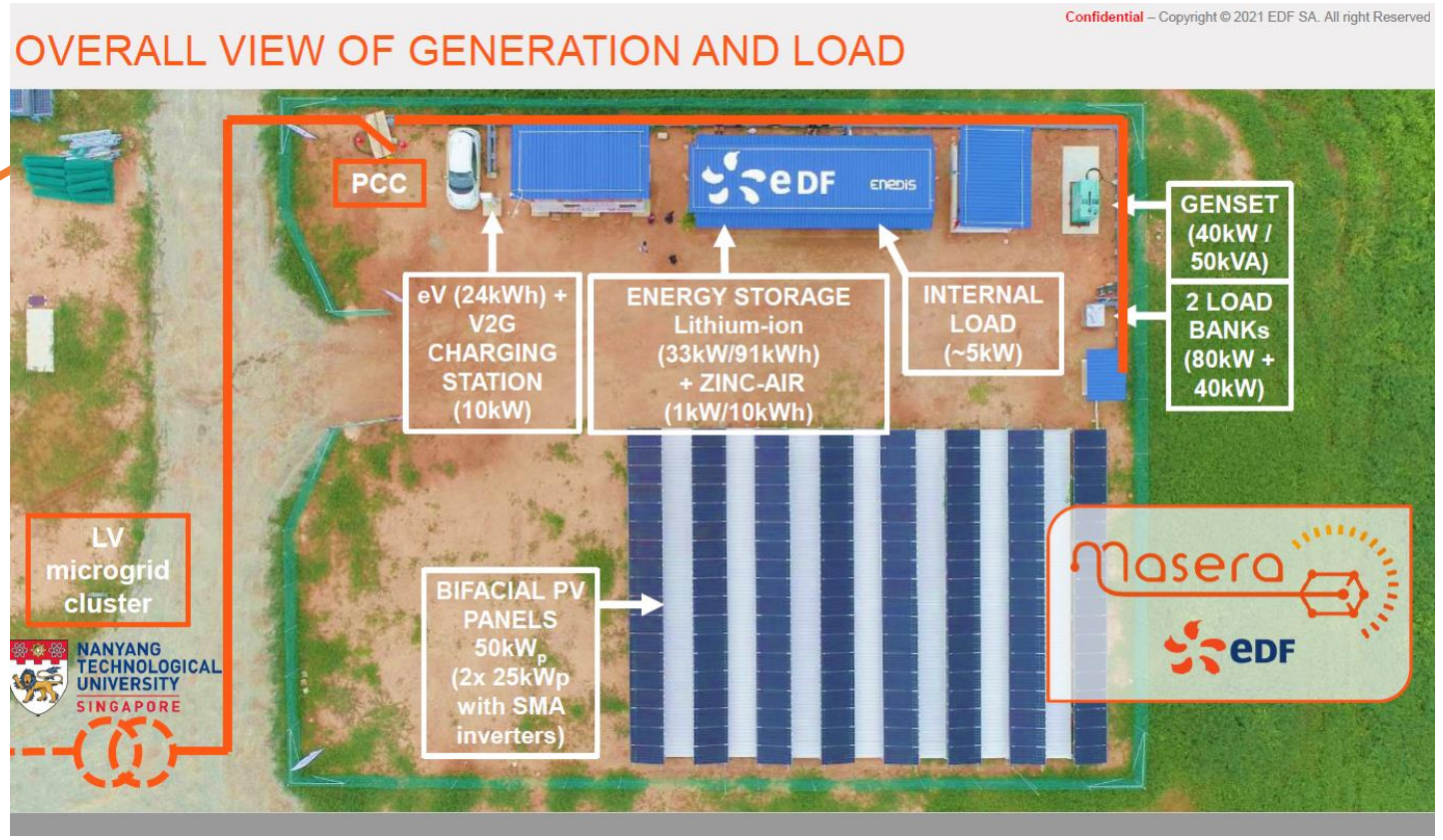
Project Examples in EDF

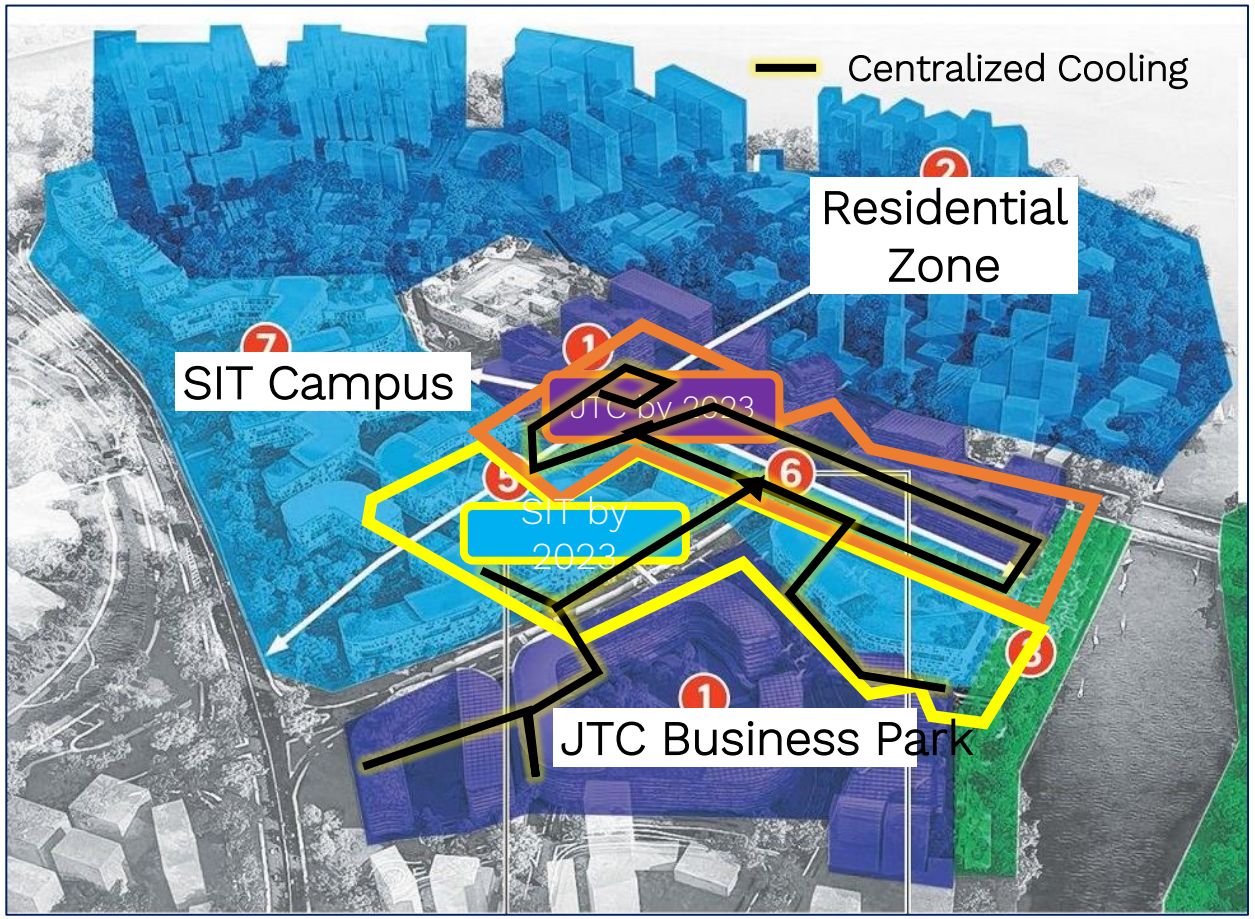
Project Examples overview

1. MASERA



- Two EVSEs: V1G, V2G
- Start to looking connect with neighbor MGs

2. PRIMO - Platform for Interconnected Microgrid Operation



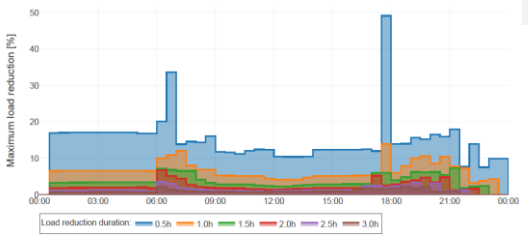
Punggol Digital District (PDD)

Energy-demand mix

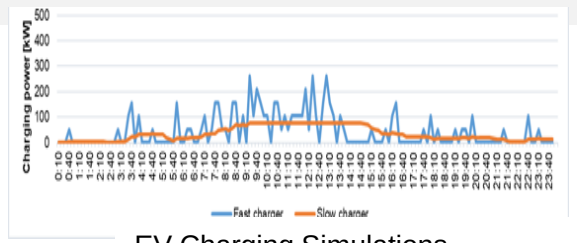
PV | Waste to energy | Demand | Stationary Storage | Mobile Storage

Research objectives

- Estimation of demand side flexibility potentials
- Optimization of energy and demand flexibilities in the microgrid
- Optimal coordination between neighboring microgrids in the muti-microgrid framework
- Market participation for energy and reserve provision

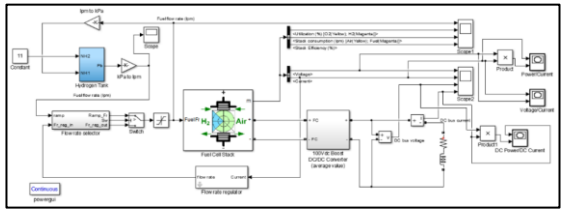


Demand Shifting potential



EV Charging Simulations

DER control modeling



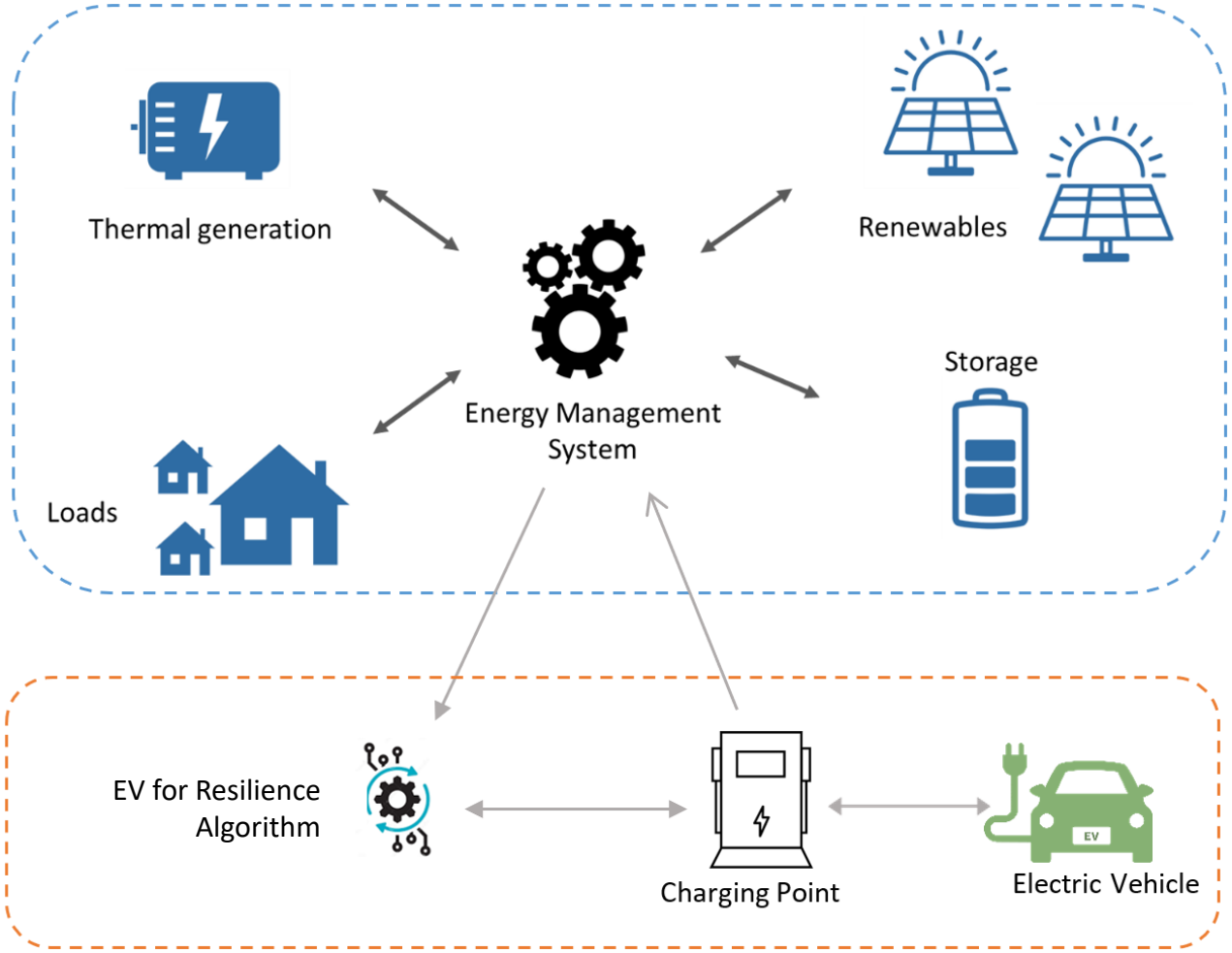
3. Resilient Microgrid with EVs

Normal Operation

- Frequency Regulation with EV
- V2H

MG Blackout

- V2H
- Blackstart with EV



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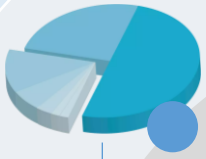
Discussion

Other relevant projects

1. EcoTrust : fractionable hourly REC solution

fREC from Wh scale

Fractionable



Hourly

Matching nearly real-time production and consumption

EDF

ECOTRUST

THE RELIABLE GREEN ELECTRICITY FOR ALL

A solution developed by EDF Lab Singapore for EV users

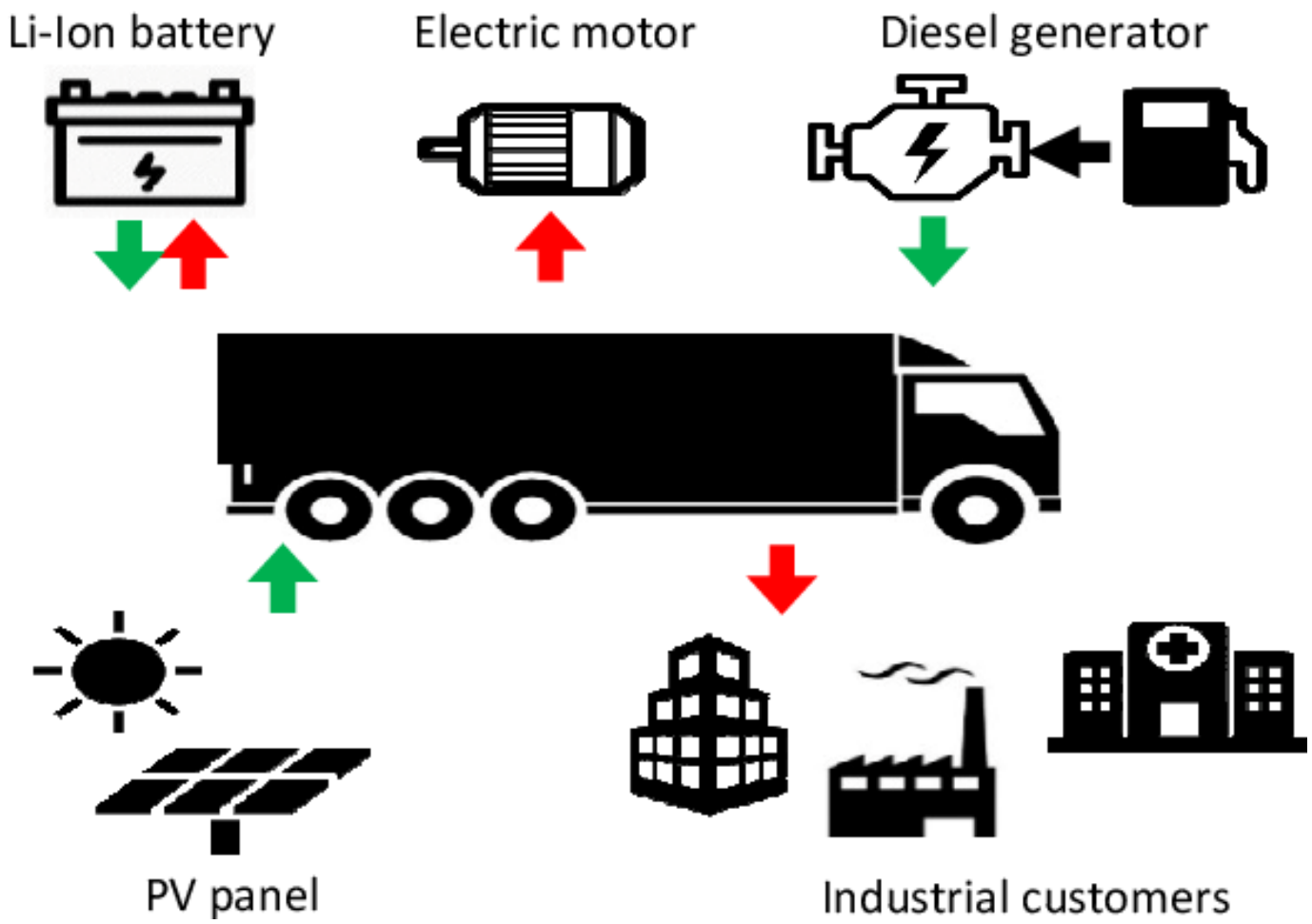
Reliable

Based on blockchain and REC

Digital

Automated Web dashboard solution developed

2. Mobile Storage for Blackstart



Source: S. M. Samara, M. F. Shaaban and A. Osman, "Management of Mobile Energy Generation and Storage System," 2019 IEEE PES GTD Grand International Conference and Exposition Asia (GTD Asia), 2019, pp. 450-454, doi: 10.1109/GTDAsia.2019.8716012.


Thank you