

Cooperative Operation of Chemical-free Energy Storage System with Solar Photovoltaic for Efficient and Resilient Power Distribution in Buildings

Presented by:

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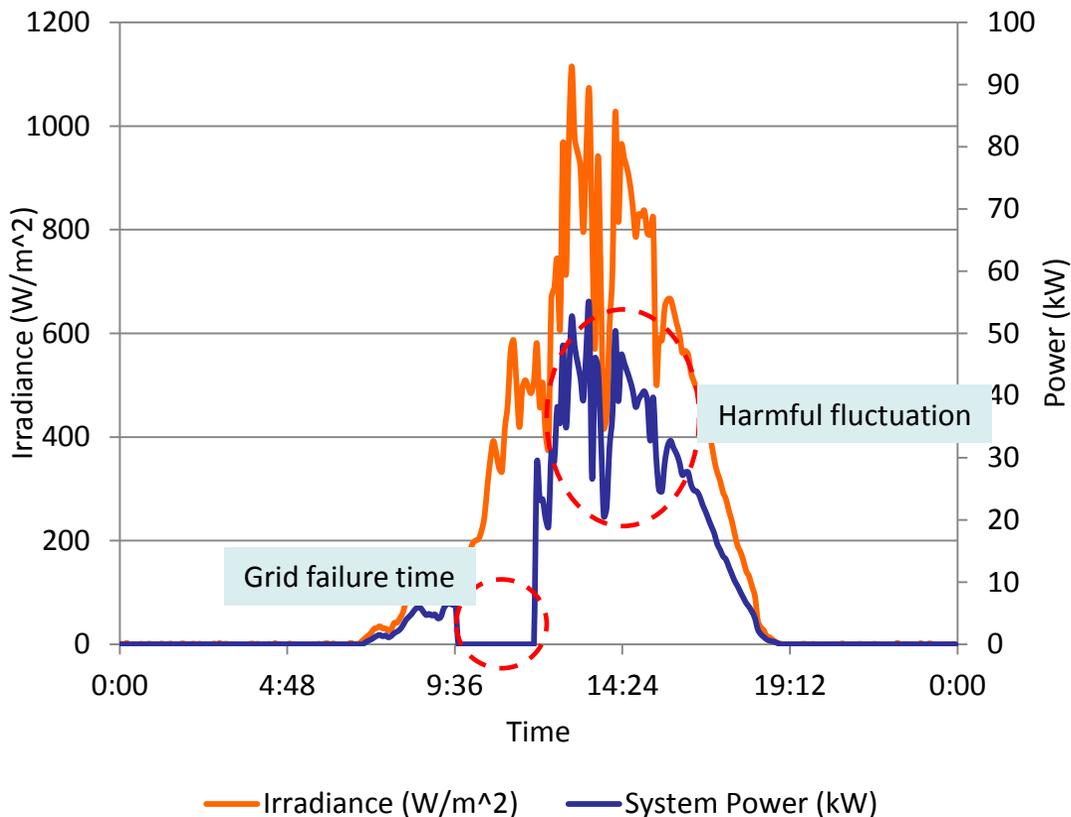
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Options of renewable energy for Singapore	Potential & Limitation
Ocean energy	Limited potential, much of the coastal areas are used for ports, anchorage and shipping lanes
Hydropower	Limited potential due to the unfavourable geographic conditions
Offshore wind energy	Limited potential due to the unfavorable low average wind speed of 2-3 m/s.
Land-based wind energy	Limited potential due to the low wind speed and expansive land cost
Land-based solar energy	Limited potential due to the expansive land cost
Biofuel energy	High potential
Building integrated PV (BIPV)	High potential <ul style="list-style-type: none">• Use the “useless” roof top or building façade• Coming down installation cost of the W/\$• 50% more solar irradiation than temperate countries• Associated infrastructure is ready

Issues

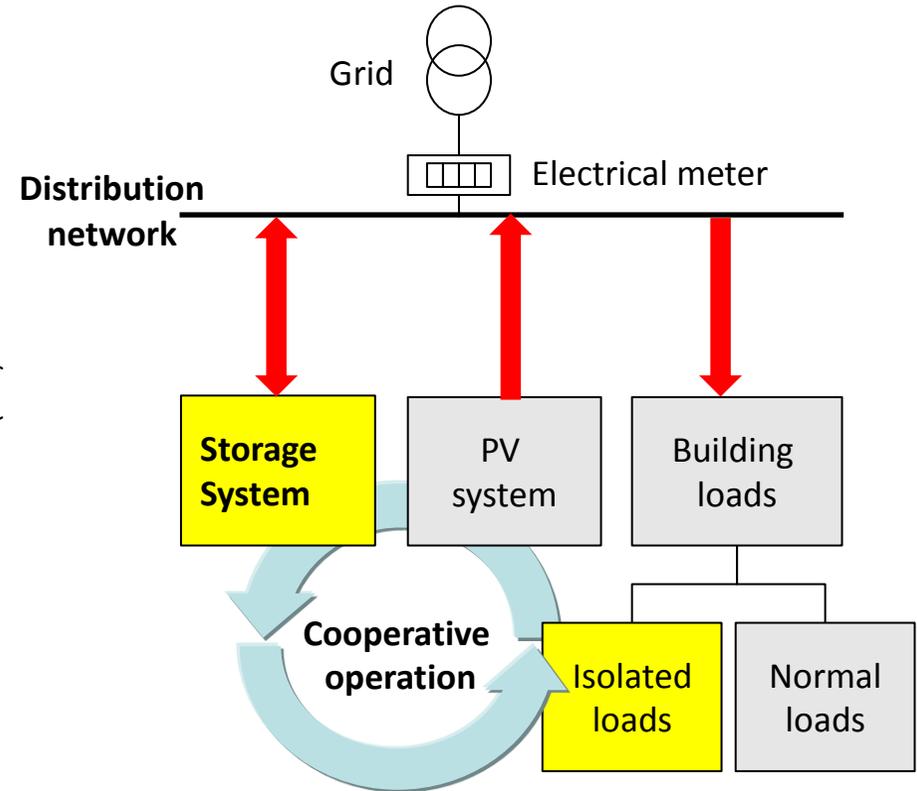
- Intermittent & wildly fluctuating solar power
- Interruption of solar generation caused by grid failure

Daily solar irradiance and power output (Oct 02)



Solutions

- High performance storage system
- Redesign of the power distribution network
- Cooperative control

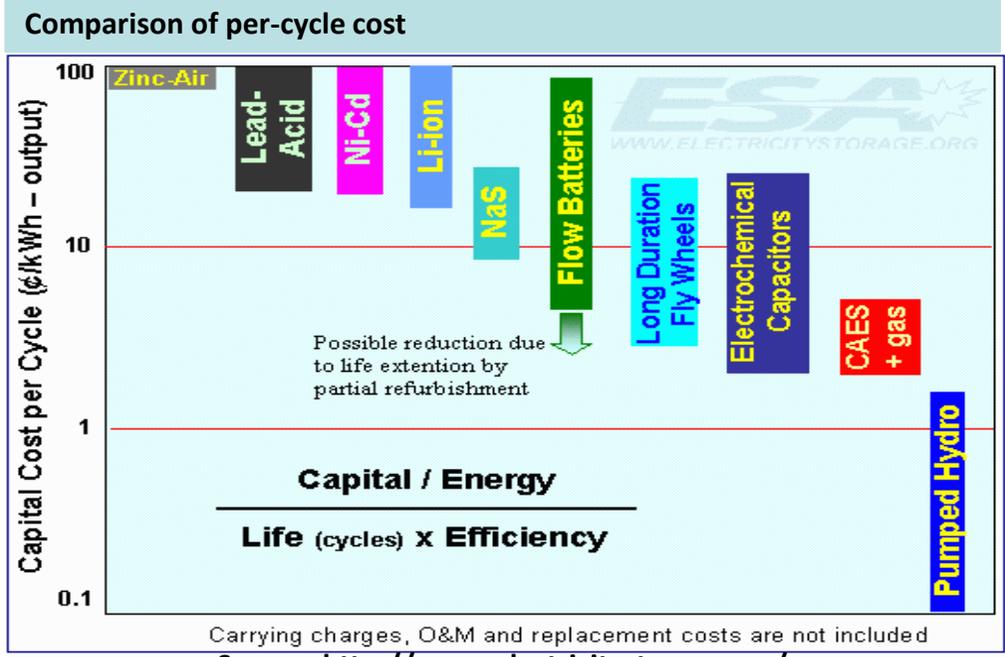
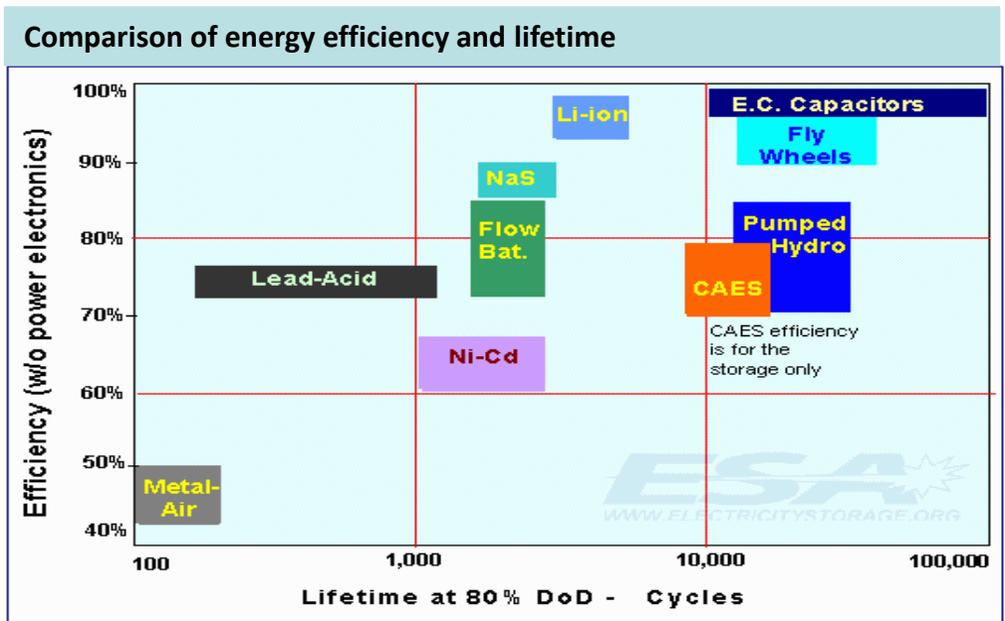


Targets

- Minimum impact to the grid
- Resilient & efficient power distribution network

Compare FEES with other Energy Storage & FR technologies

	Chemical battery	Fly wheel storage system (FEES)
Form of storage energy	chemical	kinetic
Life span	3~10 Yr	>20 Yr
Operating temperature range	narrow	wide
Energy density	high	high (200 Wh/kg for carbon fibre)
Power density	high	10 times higher
Impact to environment	Harmful	Harmless
Maintenance	moderate	minimum
Recharge time	10* charge time	Seconds or minutes
Number of deep charge and discharge cycles	Up to 3,000 times	unlimited



Carrying charges, O&M and replacement costs are not included

Isolated network

- Commercial/industrial buildings: emergency network with red on/off button
- Singapore HDB residential buildings: common area network

The total backup power load of HDB common area network is 22 kW (source: Panasonic)

Lift A



Service road lightings



Landscape and pergola lightings



Footpath lightings



Night Lightings



24hrs Lighting @ Basement



Booster Pump



Void deck, block signage and corridor lightings.



Emergency and Exit Lighting





Level 11 SinBerBest (11th floor, 1723 gsm)

Building attributes

Sector: University

Type: Offices & Laboratories

Size: 16-story with 2-level basement, 34,000 gsm

Roof top PV system

Capacity: 252x 230 Wp = 57.96 kWp

Inverter: SMA Sunny TriPower STP15000TL-10

Application: grid connected generation

BMS

Provider: Schneider

Systems under monitoring and control:

- PV system,
- lighting systems,
- HVAC systems,
- electrical metering systems

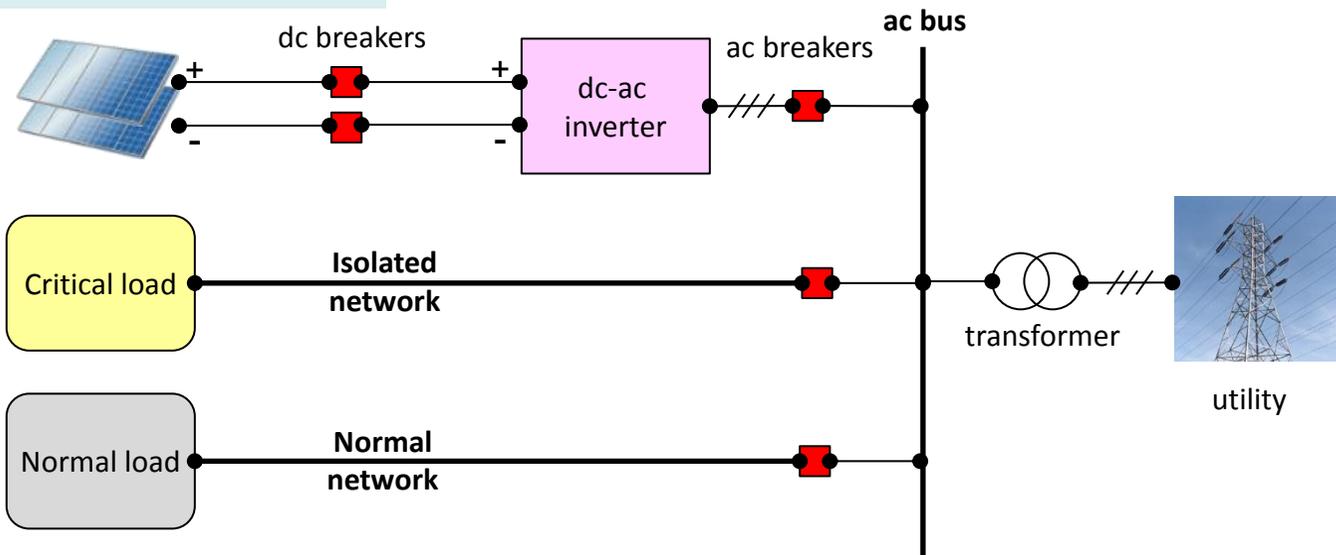
Load structure

Select loads: emergency loads, backup loads

Normal loads: lights, plug loads, etc.

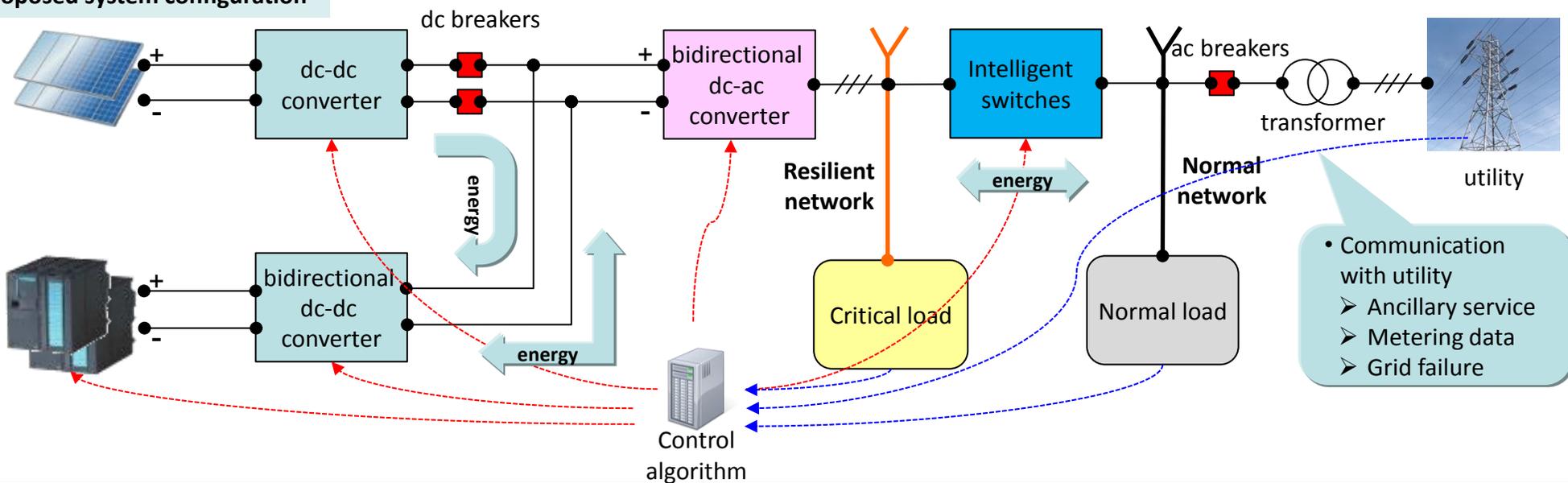
Current and Proposed System Configurations

Current system configuration



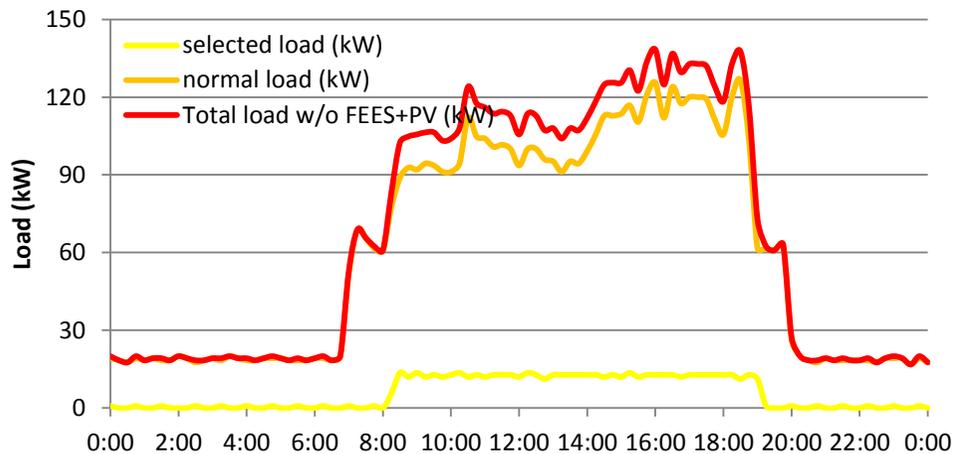
Advantage	Disadvantage
Straightforward design & control	No coordination between local PV and loads
	PV's production can be interrupted by the failure of the utility grid
	Transmission energy loss
	Risk of over-voltage which lead to grid failure
	Harmful fluctuations of the feed in power

Proposed system configuration



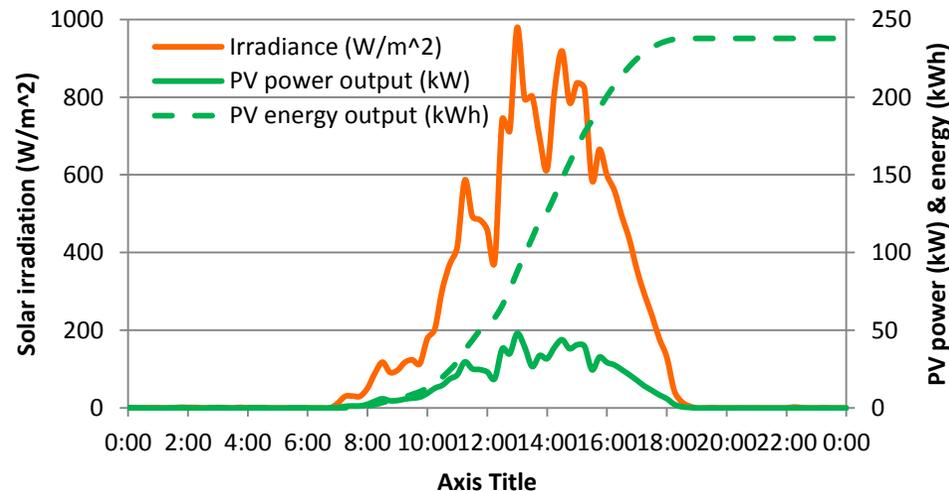
- Communication with utility
 - Ancillary service
 - Metering data
 - Grid failure

Daily load profiles

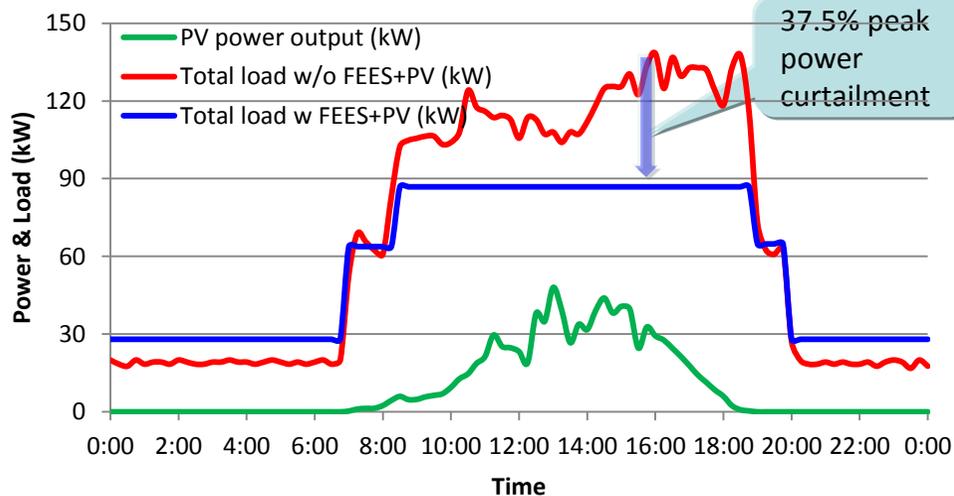


*Building daily load profiles are estimated based on the measurement data of SinBerBest

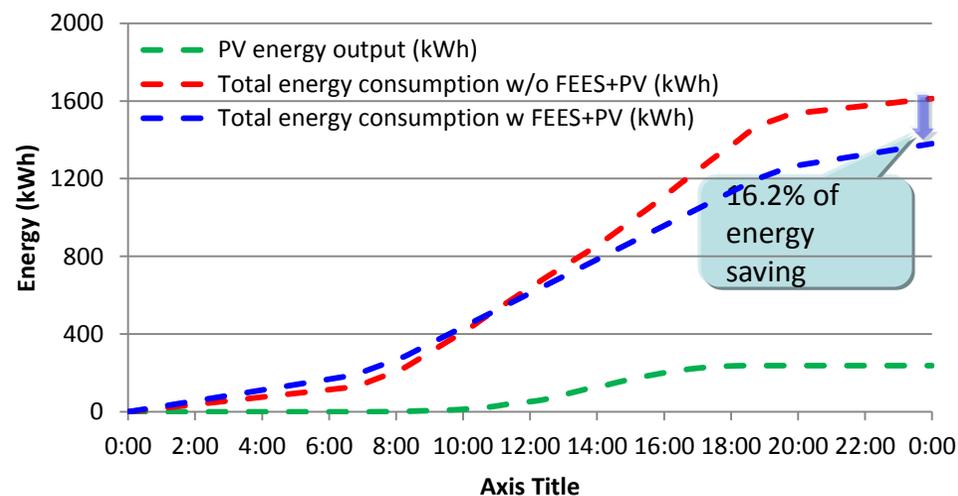
Solar irradiation & PV performance



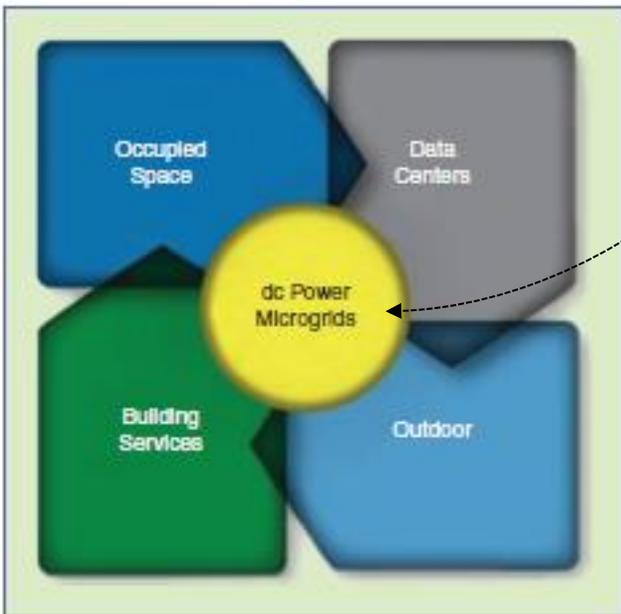
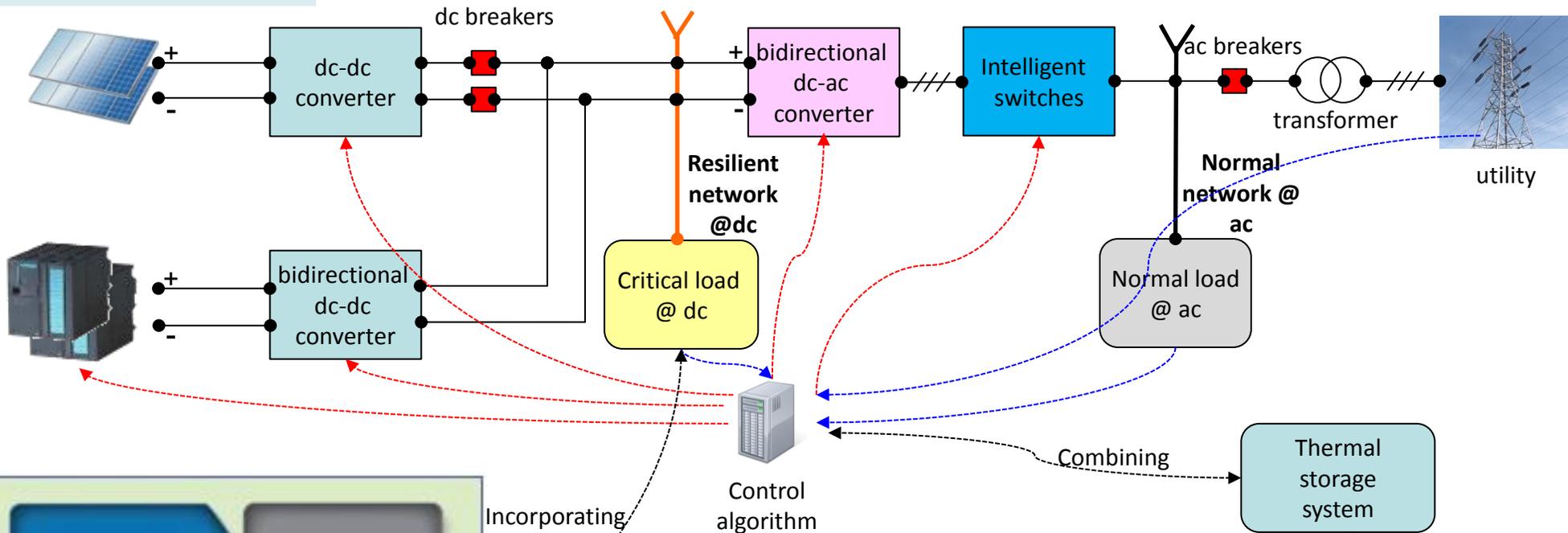
Comparison of daily load profiles (kW)



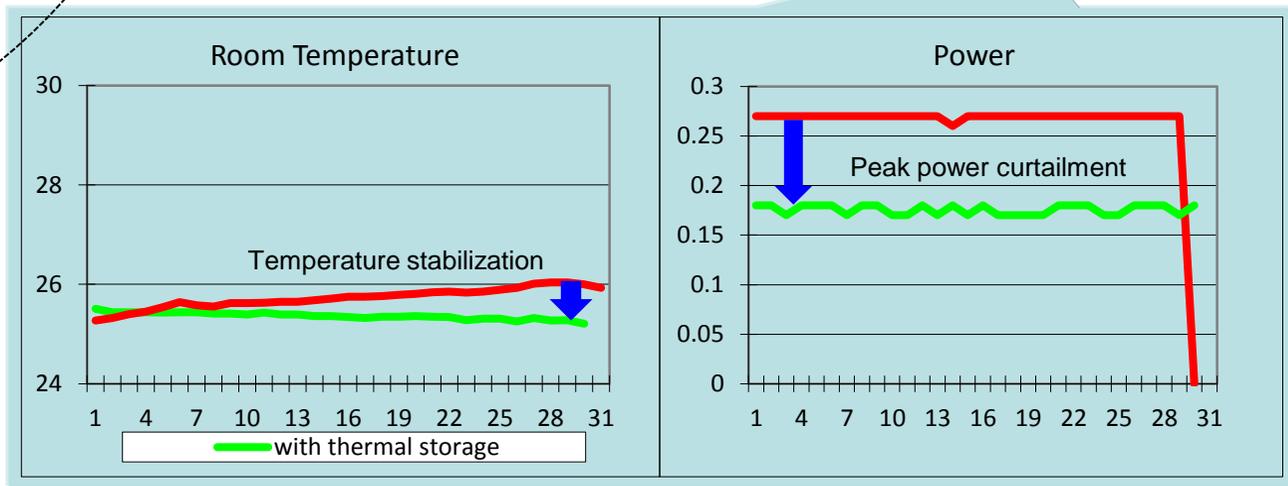
Energy consumption & production (kWh)



Future system configuration



Incorporating



Thank You