

# The SIT-SP Punggol Campus Microgrid - a platform for education, research and business collaboration



SPgroup

Empowering the Future of Energy



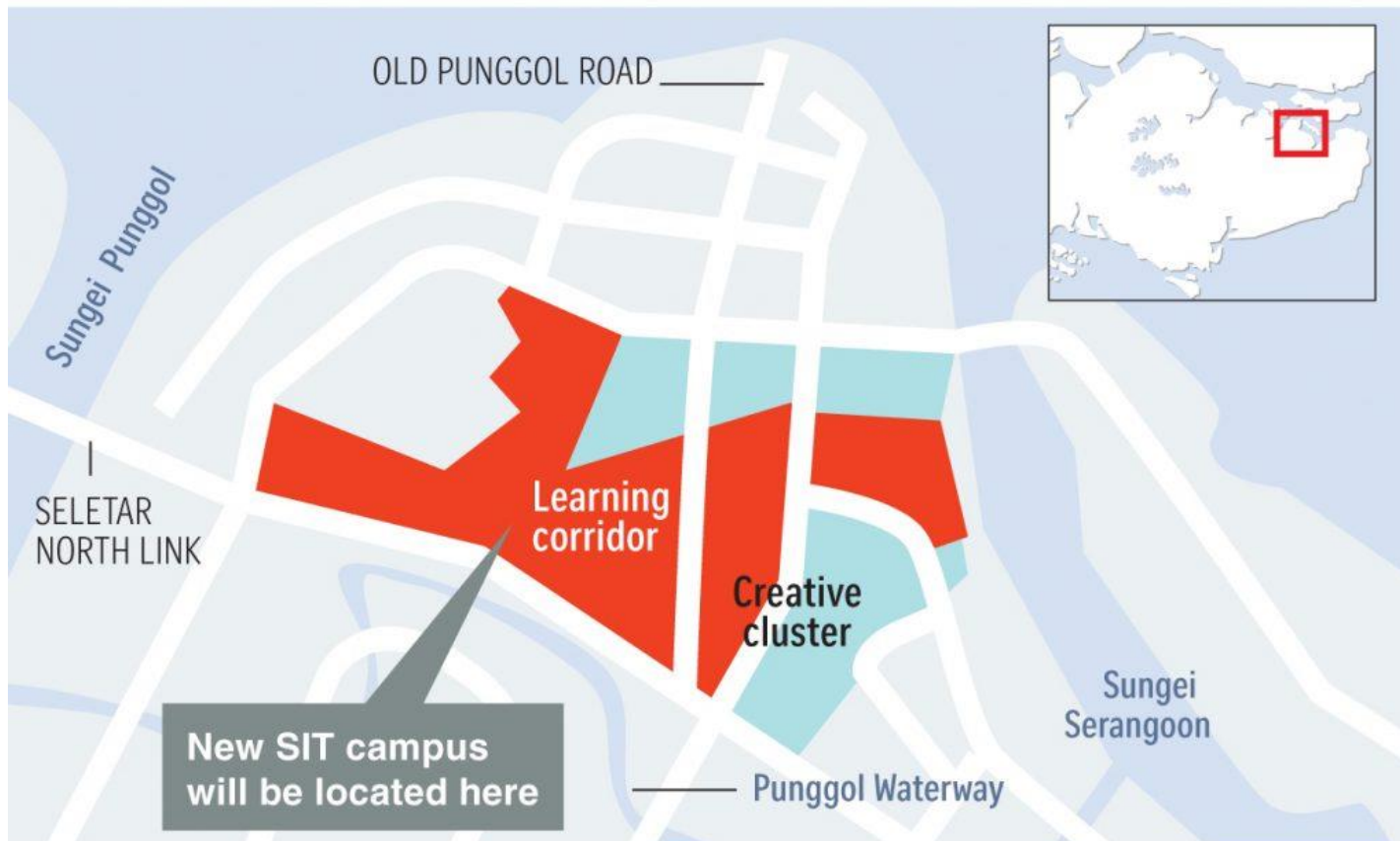
Prof TSENG KingJet, SIT  
Dr Michael Lim Tian, SP

1 Nov 2022

# Planning the SIT-SP Microgrid Concept - 2016



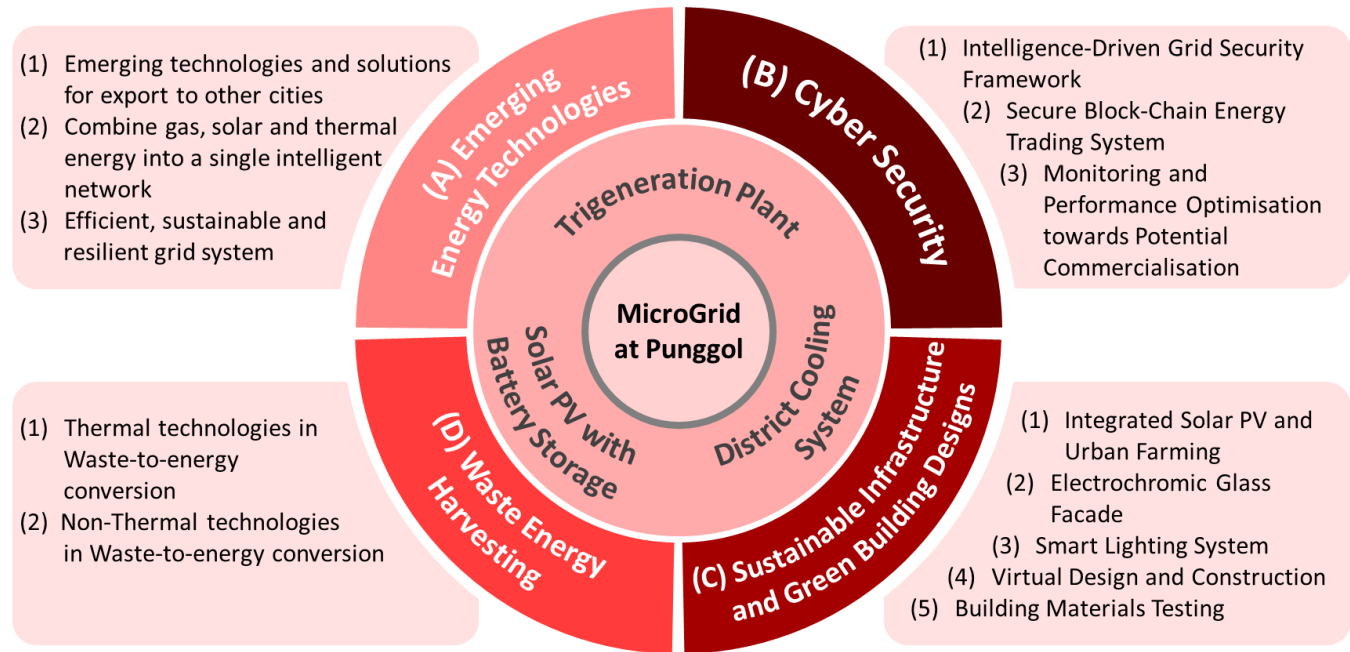
## URA masterplan for Punggol



# A Full-Scale Campus of 15,000 Consumers as Living Laboratory



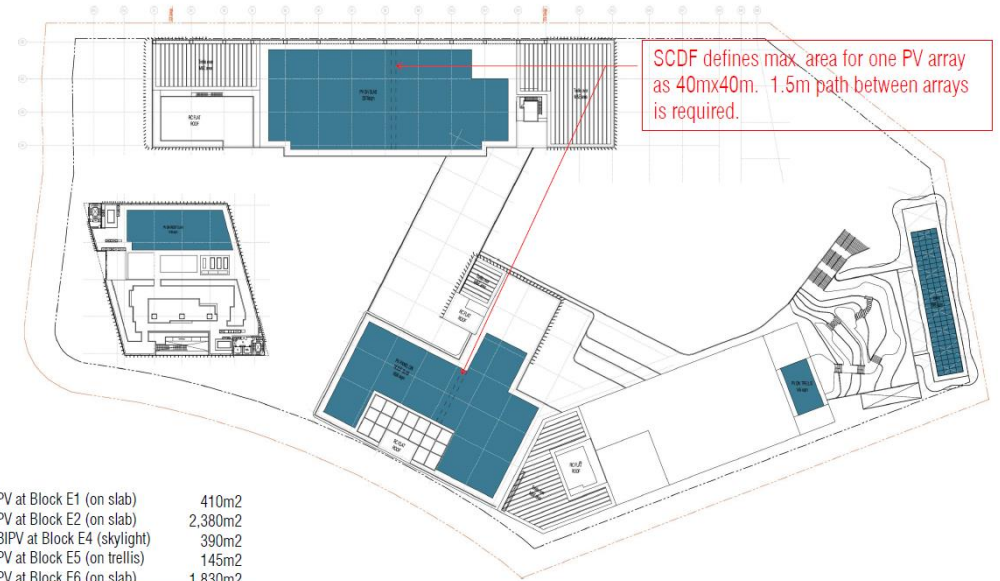
SIT's Future Campus in Punggol



The Microgrid is the crucible of Cross Disciplinary Research Platforms

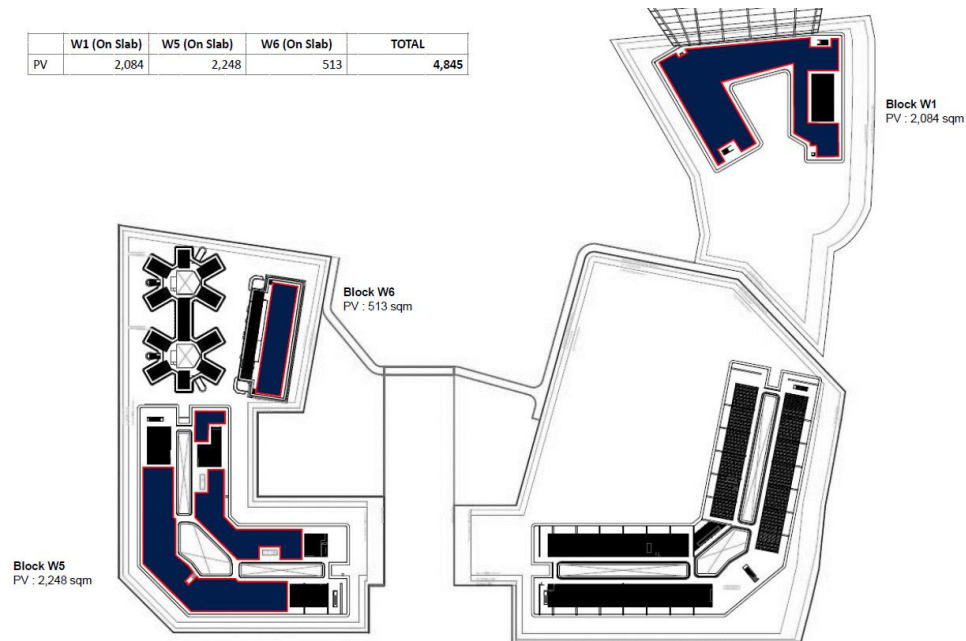
# Rooftop Solar Photovoltaic Systems

- Principal renewable energy source
- Important growth area for Singapore



PV at Block E1 (on slab)	410m <sup>2</sup>
PV at Block E2 (on slab)	2,380m <sup>2</sup>
BIPV at Block E4 (skylight)	390m <sup>2</sup>
PV at Block E5 (on trellis)	145m <sup>2</sup>
PV at Block E6 (on slab)	1,830m <sup>2</sup>
<b>Total</b>	<b>5,155m<sup>2</sup></b>

	W1 (On Slab)	W5 (On Slab)	W6 (On Slab)	TOTAL
PV	2,084	2,248	513	4,845



# Importance of Energy Storage

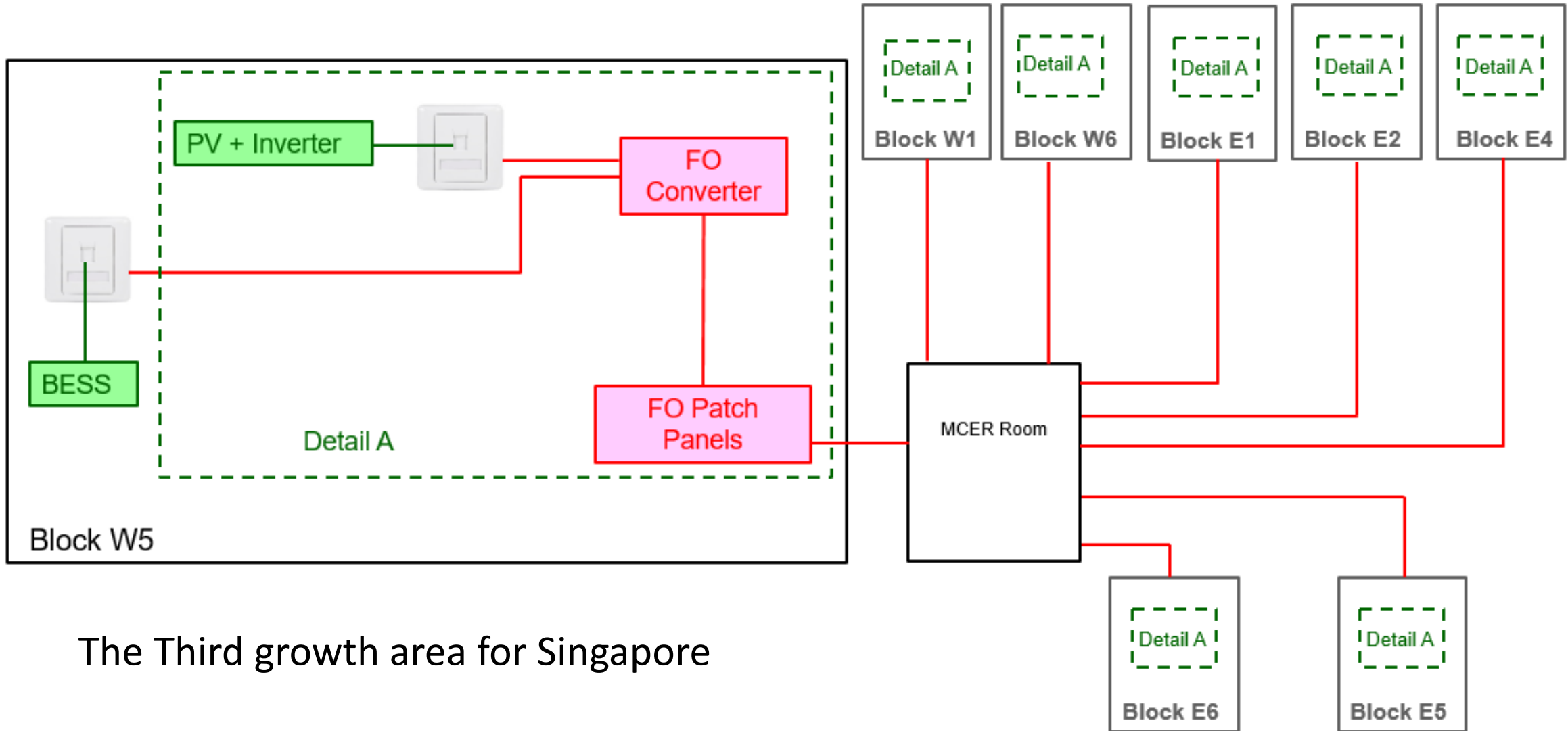


Another important growth area for Singapore

## Energy Storage System (ESS):

- Acts as a battery to store power from the Grid
- Proof of Concept: “Charge at off-peak and discharge at peak period” to manage the load profile
- Serve as a back-up and continuous power supply to critical load of Block W5 during emergency period

# Microgrid Communication Concept – Smart Grid



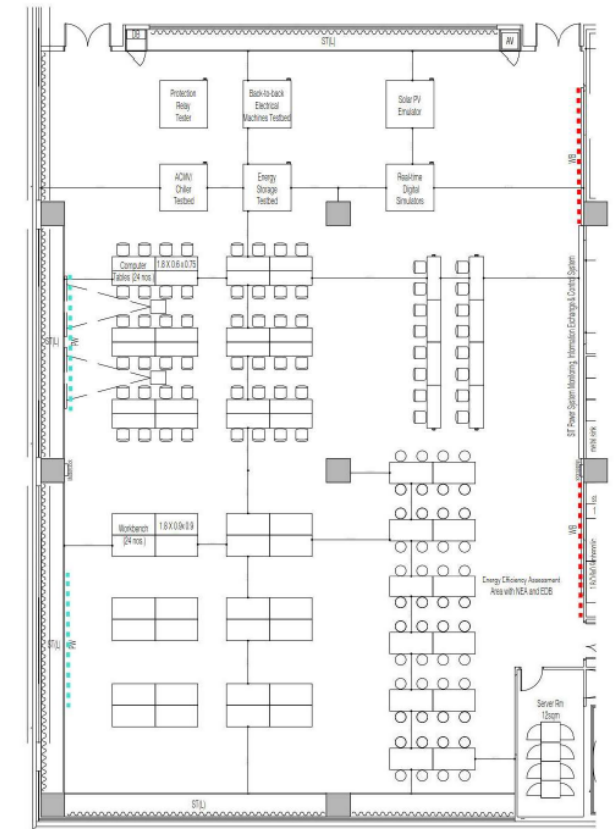
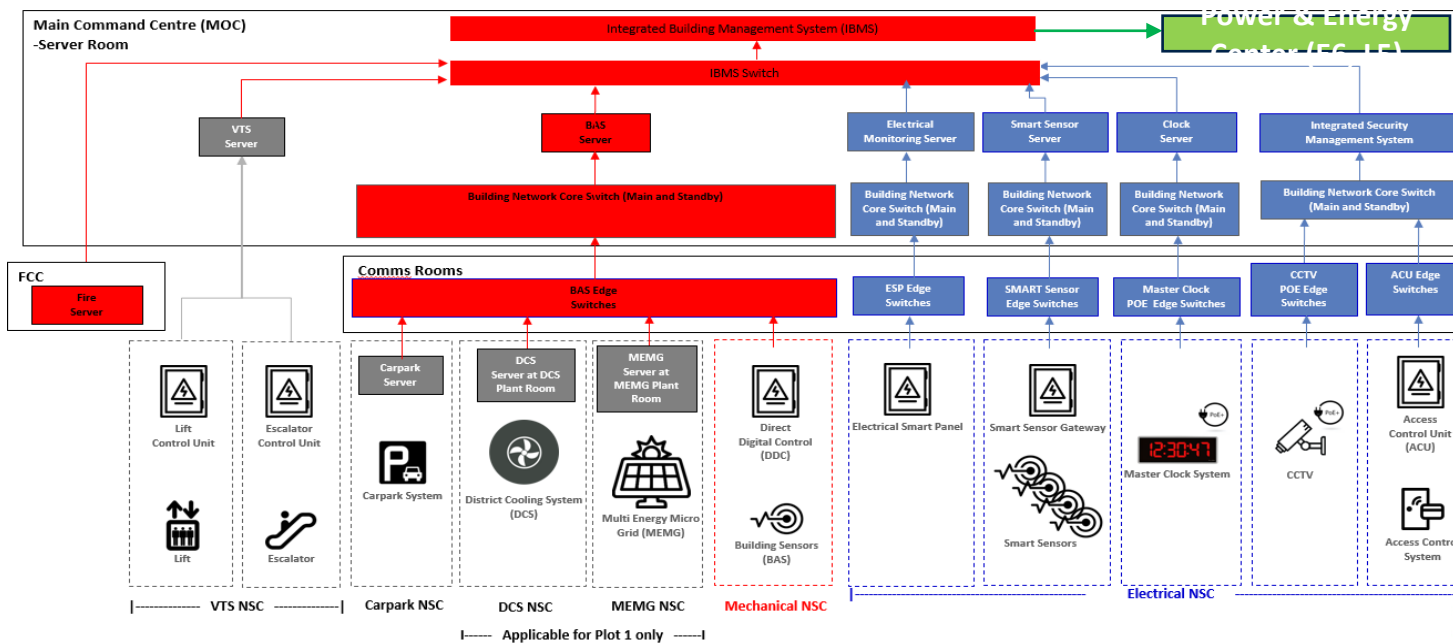
The Third growth area for Singapore

# Information Sharing between IBMS, MEMG and Power & Energy Lab

## Power & Energy Lab

Location: Block E6, Level 5

Requirement: Data provision for future remote monitoring of operation and system status of MEMG via display screens system (provided by user)



# Technologies (explored but not implemented...)



## Natural Gas Generator:

- Not implemented due to gas supply issue
  - Liquefied Natural Gas (LNG) Storage require clearances from Major Hazard Department (FSSD, MOM and NEA), URA, etc.
  - Piped-in Natural Gas may only be available after 2028



## Absorption Chiller:

- Not implemented due to no waste heat from Natural Gas Generator



# Technologies (explored but not implemented...)



## Carbon Dioxide Capture Technology:

Currently no plan for implementation due to lack of fuel combustion (source of CO<sub>2</sub>)



## LNG Regasification with Chill Water Recovery

# Concept of Multi-Energy Microgrid - 2019

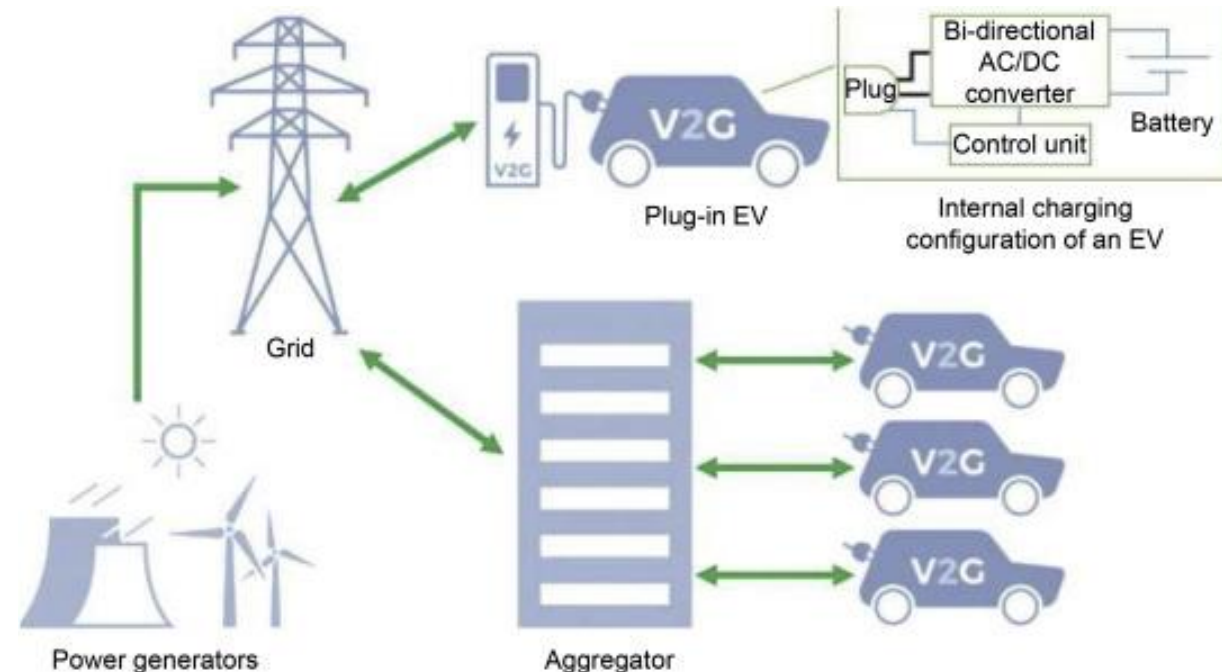


Technology	Location
Photo-Voltaic (PV)	W1, W3, W5, W6, E1, E2 and E6
Building Integrated PV (BIPV)	E4
Solar Thermal PV (STPV)	E6
840kWh Energy Storage System (ESS)	W5
Micro Grid Controller	W3 (Level 1)
EV Charging Lots	8 @ Plot 1 16 @ Plot 2

- Estimated power generation is 1.3 MW ( $\approx 10\%$  of Campus Demand: 12 MW)
- No direct carbon-emitting technologies in Campus

# Then Pandemic came....(2020 to 2021)

- Blessing in disguise?
- Time out to reflect and fine-tune our microgrid concept
- Types of DER most applicable to Built Environment:
  - Solar Photovoltaic Systems
    - Important as ever
  - Battery Energy Storage Systems
    - The more the better
    - Second Life Batteries possibility
  - EV Charging Infrastructure
    - As significant dispatchable loads
    - As mobile BESS
    - As Vehicle-to-Grid



# Enhanced Microgrid Design - 2022



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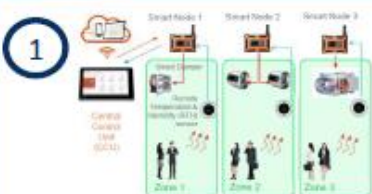
 <p><b>1</b></p>	<p><b>Microgrid Controller</b> (W3, Level 1)</p> <ul style="list-style-type: none"> <li>Monitoring &amp; control of microgrid assets</li> </ul>	 <p><b>2</b></p>	<p><b>EV Charging stations</b> (8 Nos; W3, Level 1)</p>	 <p><b>3</b></p>	<p><b>Roof Top Solar PV</b> (1.8 MWp; entire campus)</p>	 <p><b>4</b></p> <p><b>PV Thermal</b> (26 kWp elec, 54 kW hot water; E6, Roof Top)</p> <ul style="list-style-type: none"> <li>Hot water to reheat pre-cooled air serving labs</li> </ul>
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 <p><b>5</b></p>	<p><b>Energy Storage System</b> (600kWh; W5, Level 10)</p> <ul style="list-style-type: none"> <li>Piloting of ESS to provide emergency supply to explore its potentials to replace standby generator in future</li> <li>SIT to research &amp; develop optimization and frequency regulation algorithms</li> </ul>	 <p><b>6</b></p>	<p><b>BIPV</b> (57 kWp; E4, food court)</p> <p>Public showcase :</p> <ul style="list-style-type: none"> <li>Super Low Energy Building</li> <li>Renewable Energy &amp; Day Lighting</li> <li>Mass Engineered Timbre structure</li> </ul>	 <p><b>7</b></p> <p><b>EV Charging stations</b> (16 Nos; Basement)</p>
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# Enhanced Microgrid Design -2022

**1** **Micro-climate solution**  
(W1, Level 8 & 9)  
- Dynamic Airflow Balancing




**2** **EV Charging stations**  
(additional 12 Nos)  
(W3, Level 1M)



**3** **DC grid including ESS** (600 kWh; E2 Level 1)

- Reliable DC power for ICT servers
- Enabling R&D topics in DC network





**4** **Nano grid including ESS** (2 x 600 kWh; W3 Level 1)

- Building Level microgrid
- Seamless transition between island and Grid-Connected modes



**5** **Pico grid including ESS** (600 kWh; E6 Level 1)

- Riser level microgrid
- To switch, change connection and form different Pico Grid



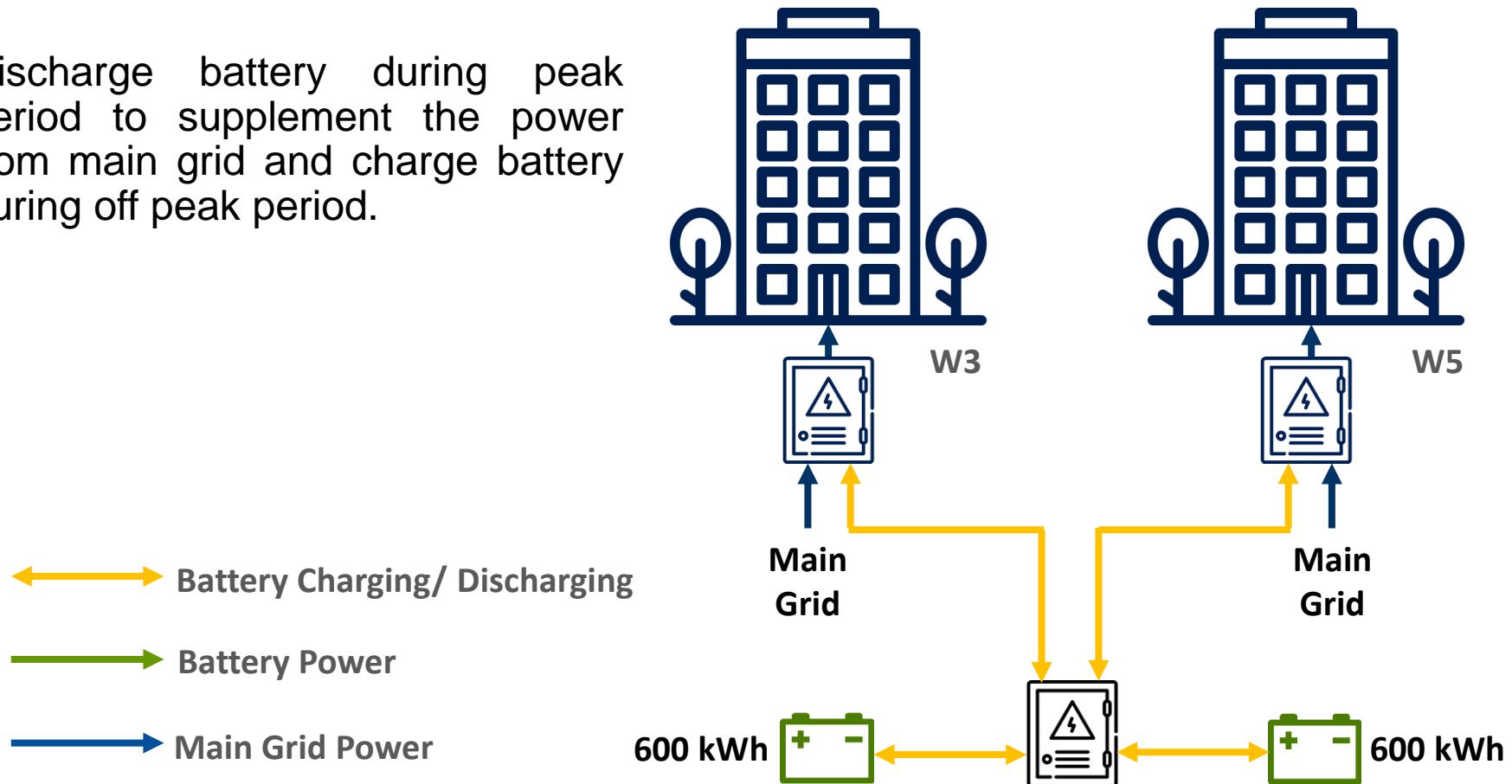
**6** **EV Charging stations**  
(additional 32 Nos; Basement)



# Provision of Heterogeneous Power Quality and Reliability

**Nanogrid** - Electrical network with the capability to **island the building** from the Main Grid

Discharge battery during peak period to supplement the power from main grid and charge battery during off peak period.

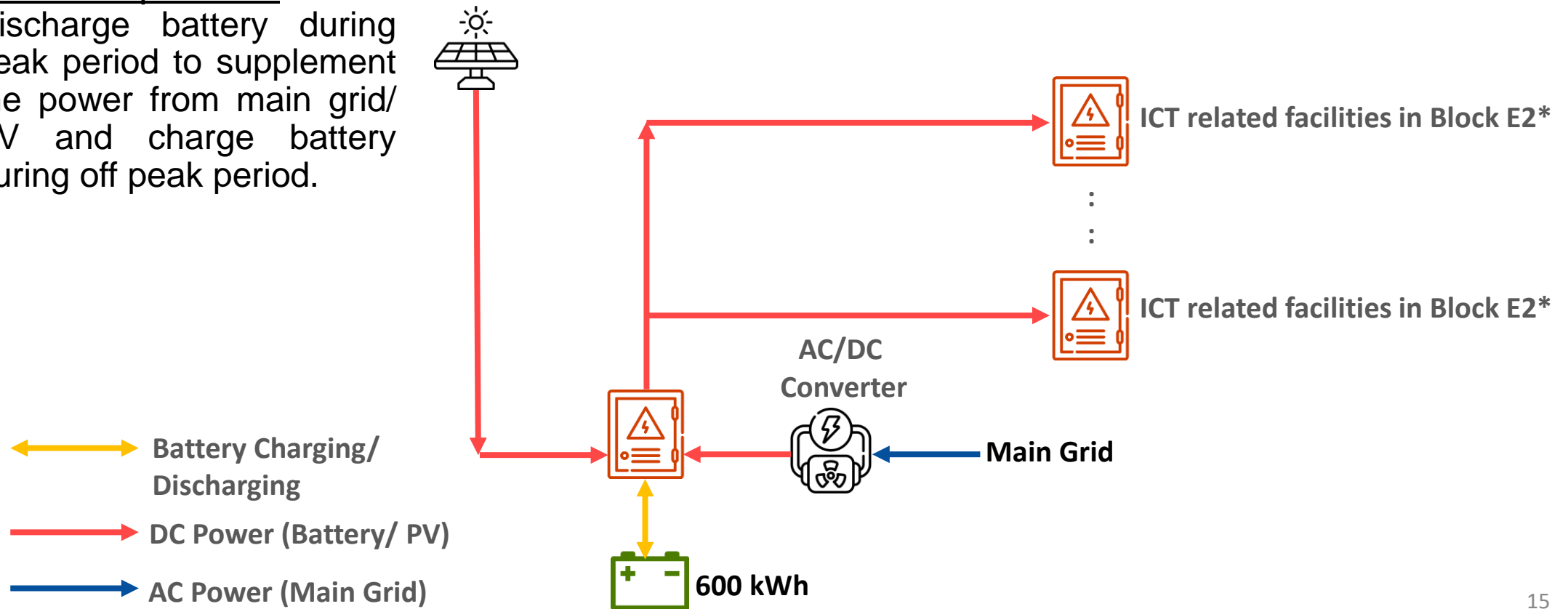


# Provision of Heterogeneous Power Quality and Reliability

DC Grid - Electrical network with **Direct Current (DC)** power from the PV and capability to **island the facilities** from the Main Grid

## Normal Operation

Discharge battery during peak period to supplement the power from main grid/ PV and charge battery during off peak period.

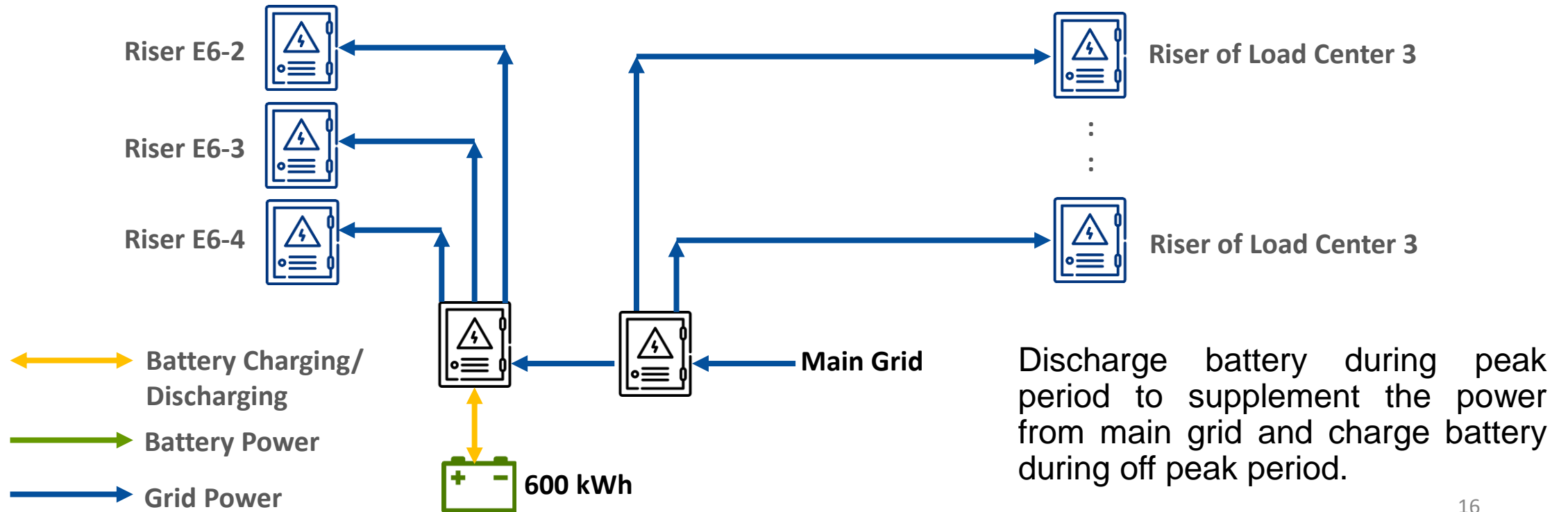


# Provision of Heterogeneous Power Quality and Reliability

Picogrid - Electrical network with the capability to **island certain parts of the building** from the Main Grid

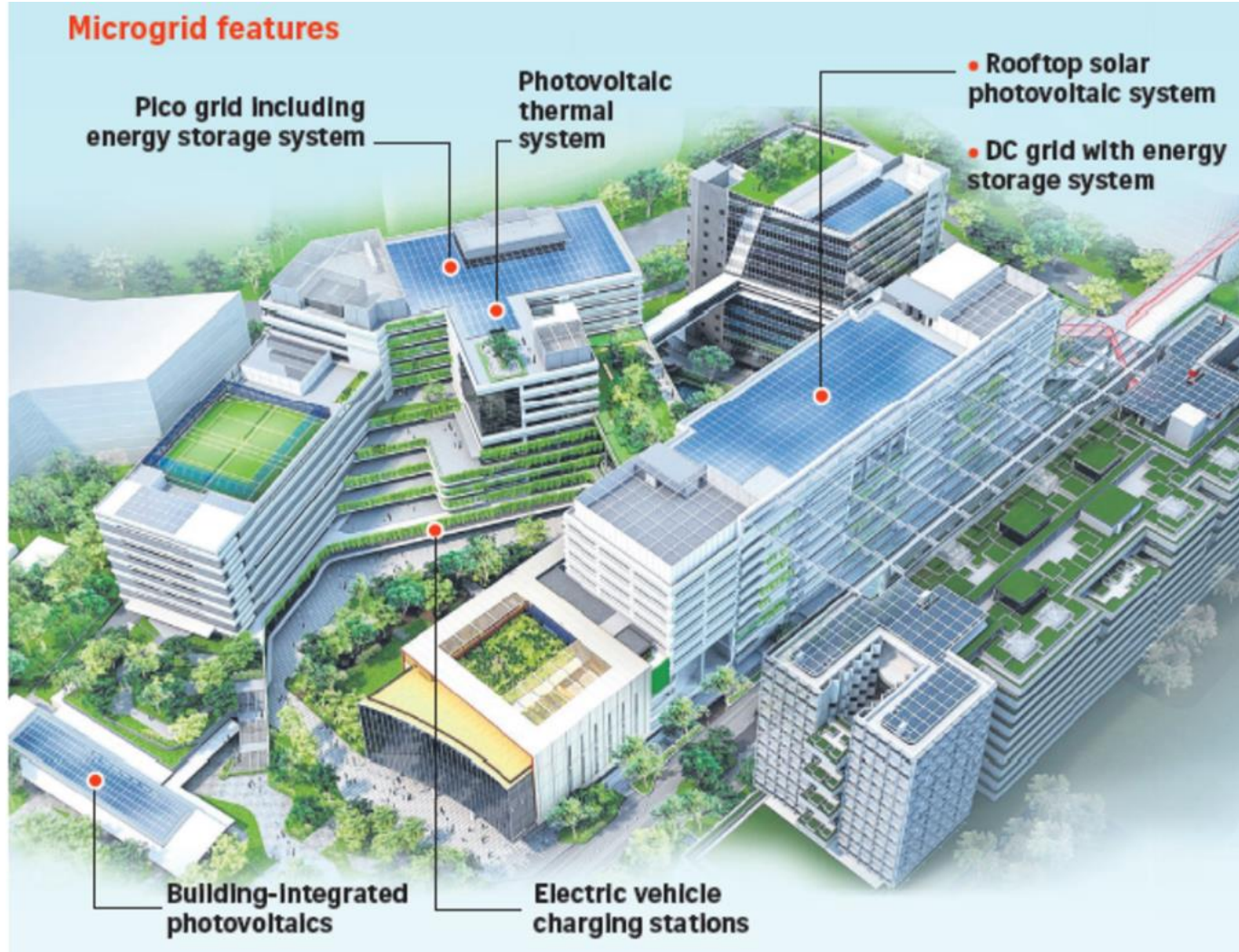
## Normal Operation

TR 25	TR 25	TR25
TR35	TR35	TR35
ACE 60	ACE60	ACE60
ACE 80	ACE 80	PDR Room
ACE100	PDR Room	CSR60 Room
FYP Room	LT160	Pastoral Care Office
PDR Room	Pastoral Care Office	Student Life Support Office
Power & Energy Centre		Admin Office
Combined Lab		





# SIT-SP Microgrid 2022 - Summary



- SIT new campus, be ready in 2024
- Designed and constructed as a cluster of microgrids with various DERs – SP as operator
- V2G Ready Campus
- Aimed to promote study of benefits of heterogeneous PQR type of electricity distribution
- Islandable buildings and load clusters within building
- As Living Lab for our bachelor degree in Electrical Power Engineering
- SIT hosts the EDGE programme funded by EMA to promote innovation and demonstration

**Thank You**

**Q & A**