

Overview of Microgrids in Asia

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on Microgrids
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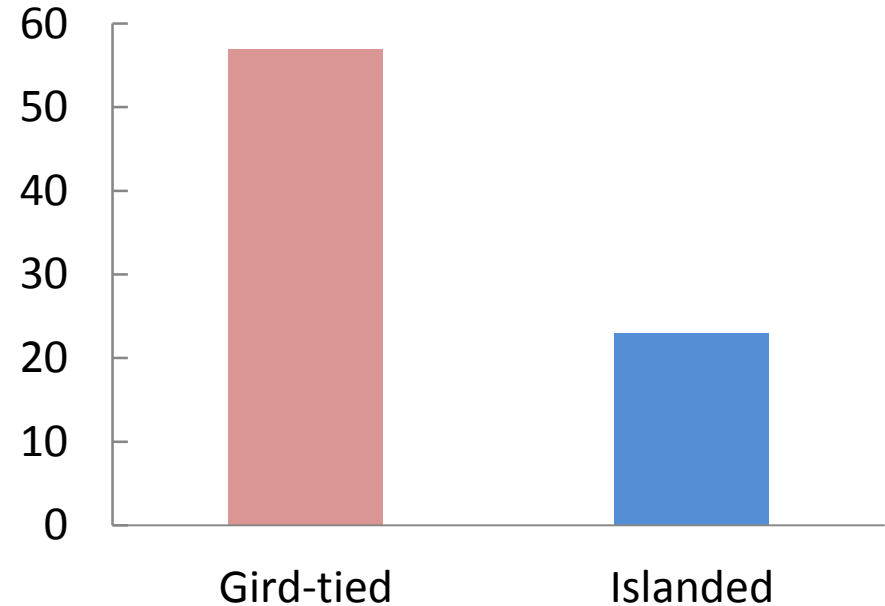
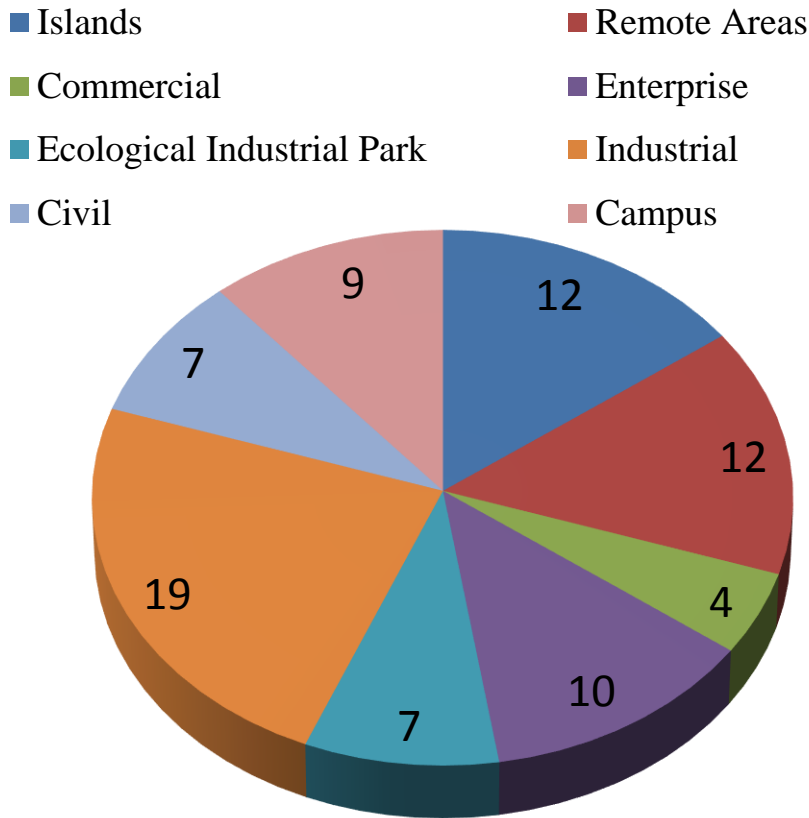
HEFEI UNIVERSITY OF TECHNOLOGY

Key Contributors

Country	Name	Organisation
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Australia	Pierluigi MANCARELLA	University of Melbourne

Microgrid Activities in China

- It is estimated that there are over **80** demonstration microgrids or multi-microgrid groups built in China up to 2017.



Microgrids by applications or types

Locations of Part Microgrids in China



Grid-tied Microgrid



Islanded Microgrid

China's Government's Activities on Microgrid

- In **Dec. 2016**, the 13th five-year plan for energy technology innovation & the 13th five-year plan for renewable energy development are announced by NDRC. **New-energy microgrid demonstration project** is identified as one of three innovation renewable energy development technologies, **Intelligent distribution network and microgrids** are also identified as one of key technologies in the field of new-energy power systems.

T21) Multi-energy complementary distributed generation and microgrid application

Objective: Achieve the project demonstration and popularization & application on intelligent distributed PV application, Interconnection of PV microgrids, AC-DC hybrid microgrid and unified energy management of multi-energy complementary microgrid.

Contents: Integration of regional high-penetration distributed PV, DC grid integration, Power forecast & its intelligent application, Standard communication interaction model of various DGs, Communication network architecture and mode of microgrid, Standardization & modularization of microgrids, etc.

Duration: From 2016 to 2020.

China's Government's Activities on Microgrid

- In **April 2017**, Microgrid energy storage application technology is listed in the “Promotion directory of the National key energy-saving and low-carbon technologies” .

It is estimated that there will be over **300** microgrids to be built in China for next five years, the total investment will be **500 million CNY**, reducing the CO₂ **by 200 thousand of tones per year**.

- In **May 2017**, 28 demonstration projects of microgrids were announced by NDRC.

Locations of 28 New Microgrid Projects in China, 2017



Grid-tied Microgrid

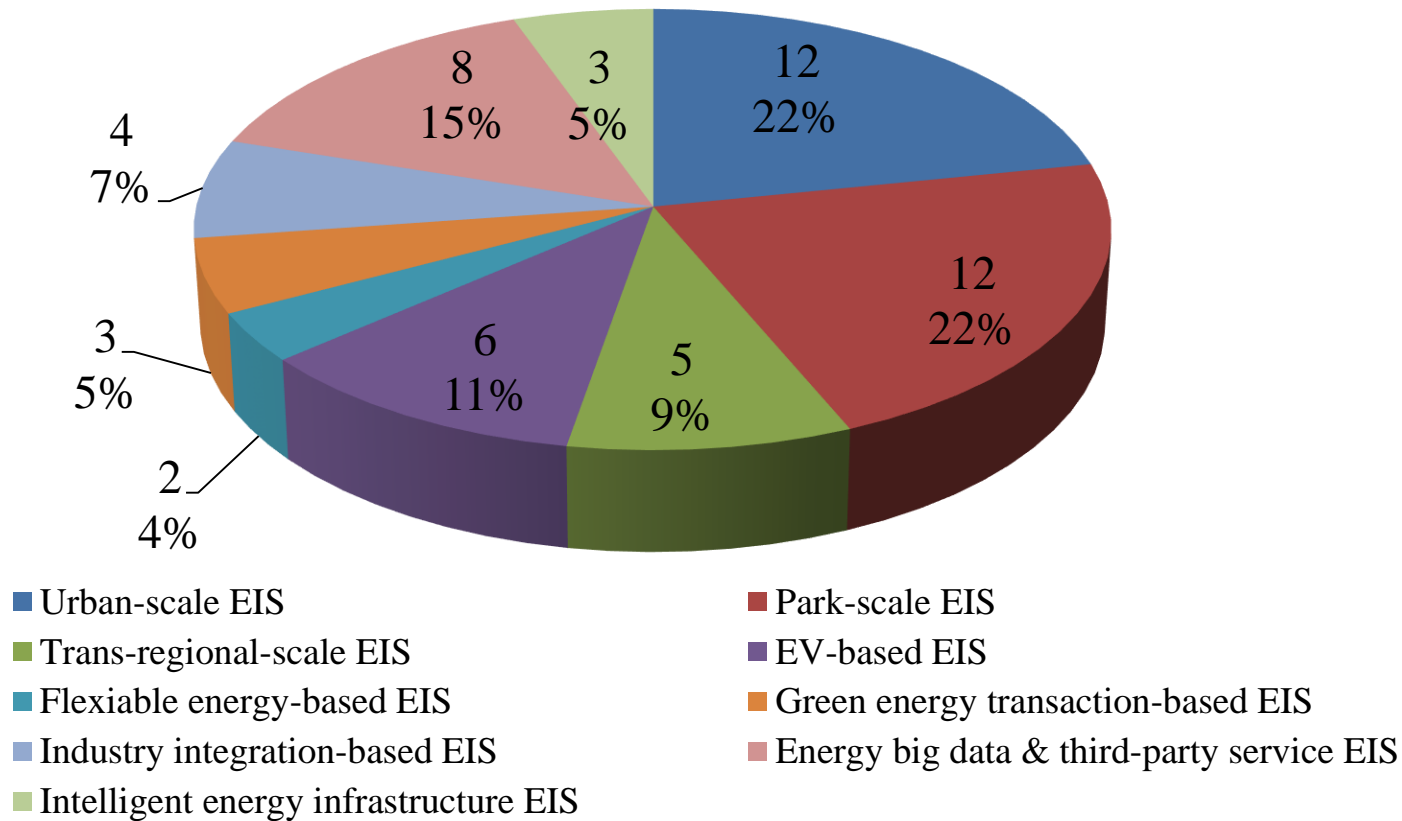


Islanded Microgrid

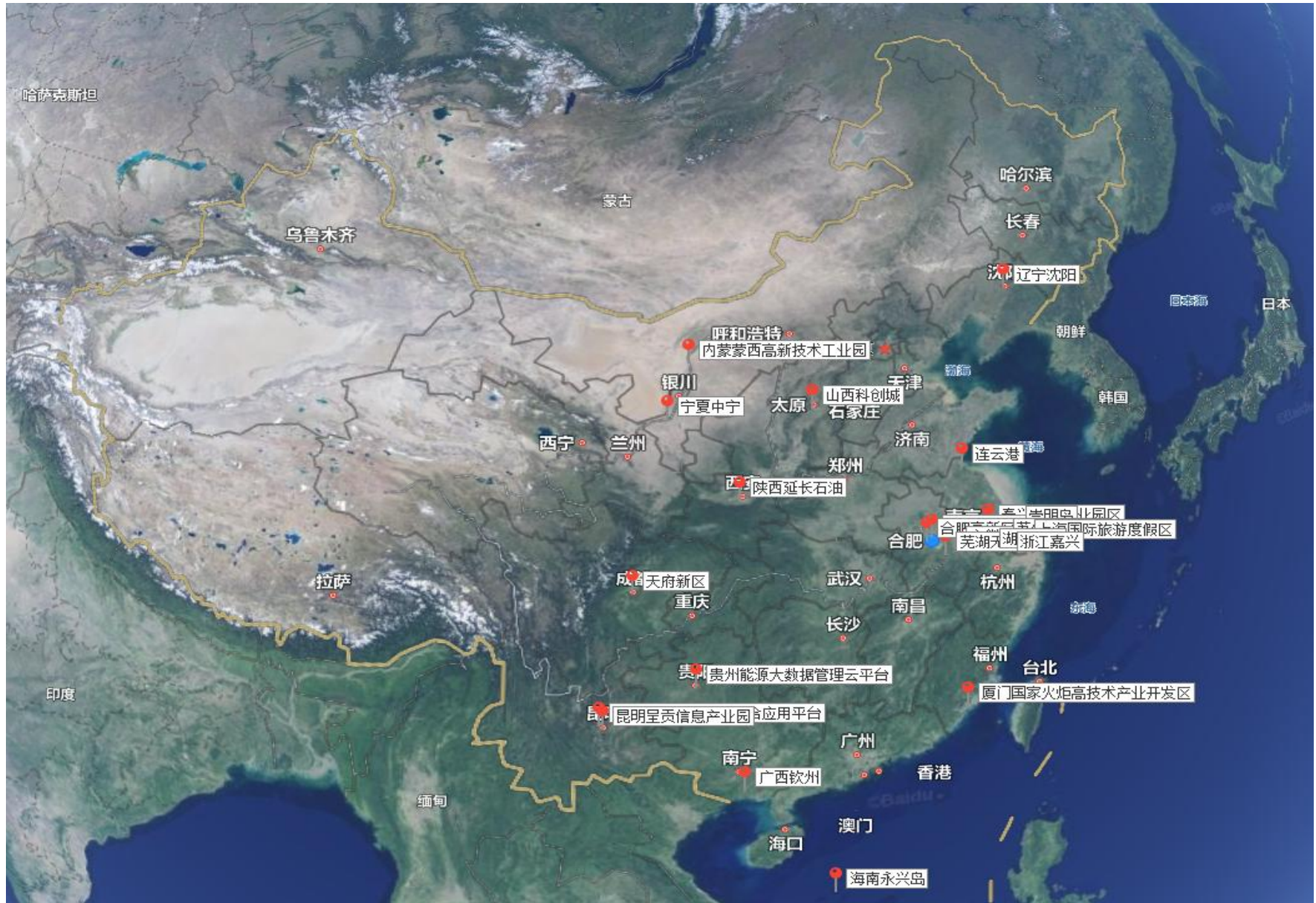
China's Government's Activities on Microgrid

- In **July 2017**, 55 “Internet +” Intelligent energy (energy interconnection system, EIS) projects are announced by NEA.

“Internet +” Intelligent energy concept is initially proposed in the official file “Guidance on promoting the development of “Internet +” Intelligent energy ”in Feb. 2016. It is defined as an emerging and promising energy industry development form to deeply integrate the Internet technology and Energy Generation, Transmission, Storage, Consumption and energy market. **The EIS is the higher level of microgrid development.**



Locations of Some EISs Demonstration Projects in China



Part Key Microgrid-related Projects Supported by China's Government in 2018

Project	Key Objectives	Funds (CNY)	Duration
Key technology & equipment of multi-port distributed PV integration into DC distribution network	<ul style="list-style-type: none"> • Topology, parameter of multi-port distributed PV DC converter and its interaction with DC system; • Design medium or low voltage distributed PV DC integration method ; • Develop medium or low voltage PV DC converter; • Control, protection & operation of High-penetration distributed PV DC distribution network; • Demonstrate MW-scale system. 	17.64 million	3 Years
Technology & application of wind/PV generation prediction to promote renewable energy utilization	<ul style="list-style-type: none"> • Generation prediction for medium/long term scheduling and monthly/annually dispatch method considering the volatility and randomness of wind/PV generation; • Short-term probabilistic prediction for daily scheduling & multispatial scale prediction; • Ultra-short-term prediction method; • Backup capacity allocation and emergency control . 	20.49 million	3 Years

Part Key Microgrid-related Projects Supported by China's Government in 2018

Project	Key Objectives	Funds (CNY)	Duration
Key technology & application on medium/low DC distribution system	<ul style="list-style-type: none"> • Voltage class series & typical supply modes for different application scenario; • Develop DC breaker, DC metering and Protective sensor for medium/low DC distribution system ; • Control and operation strategy for multi-converter and multi DC voltage level DC distribution system; • Technology Demonstration. 	20.98 million	3 Years
Key technology of distributed supply based on multi-energy complement & gradient utilization	<ul style="list-style-type: none"> • Design technology of distributed energy system with renewable energy complement; • Clean energy production based on solar energy and its application in electricity generation; • Combined cooling and power driven by waste heat; • Combined heater and power considering multi-energy complement & electric heating and heat pump; • Active control method and performance in all operating states. 	23.64 million	3 Years

National Standards Related Microgrids in China

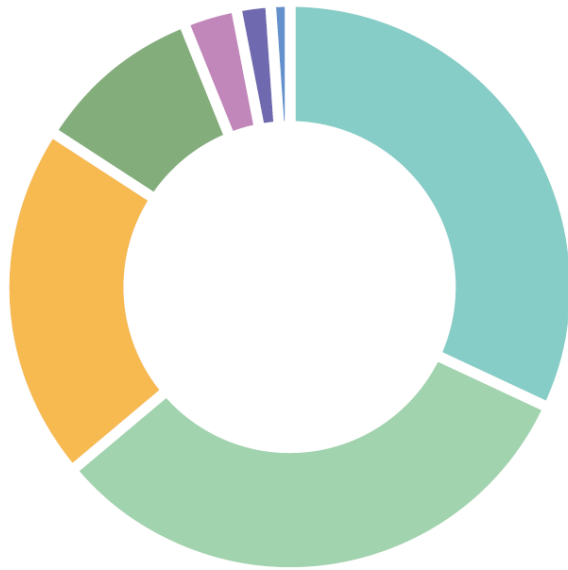
Title	Date	Status
Technical Specification For Energy Management Of Microgrid	2018 Jun.	In force in 2019
Technical Specification For Monitoring And Control System Of Microgrid	2018 Jun.	In force in 2019
Code For The Commissioning And Acceptance Of Microgrid Interconnected With Distribution Network	2017 Dec	In force
Operation And Control Specification For Microgrids Connected To Distribution Network	2017 Nov	In force
Specification For Test Of Microgrid Connected To Distribution Network	2017 Aug	In force
Technical Requirements For Connecting Microgrid To Power System	2017 May	In force
Technical Requirements For Grid Connection Of Distributed Resources	2017 May	In force

Microgrid Activities in Australia

- Key projects are associated with:
 - *Fringe of the grid*, typically to:
 - Avoid reinforcement costs due to long and network connection
 - Improve reliability, again especially in those cases of long, unreliable network connections
 - *Isolated communities and islands*, where network connection may be too costly or infeasible
 - *Community energy systems*, especially based on solar PV and batteries
 - *Demonstration projects* to test new technologies, equipment and control strategies

Renewables in Australia

**RENEWABLE GENERATION
BY TECHNOLOGY TYPE²**



Hydro	33.9%
Wind	33.8%
Small-scale solar PV	20.3%
Bioenergy	9.7%
Large-scale solar PV	1.8%
Medium-scale solar PV	0.5%
Solar thermal	0.1%

**ANNUAL ELECTRICITY
GENERATION IN 2017²**



Renewables	17%
Fossil fuels	83%

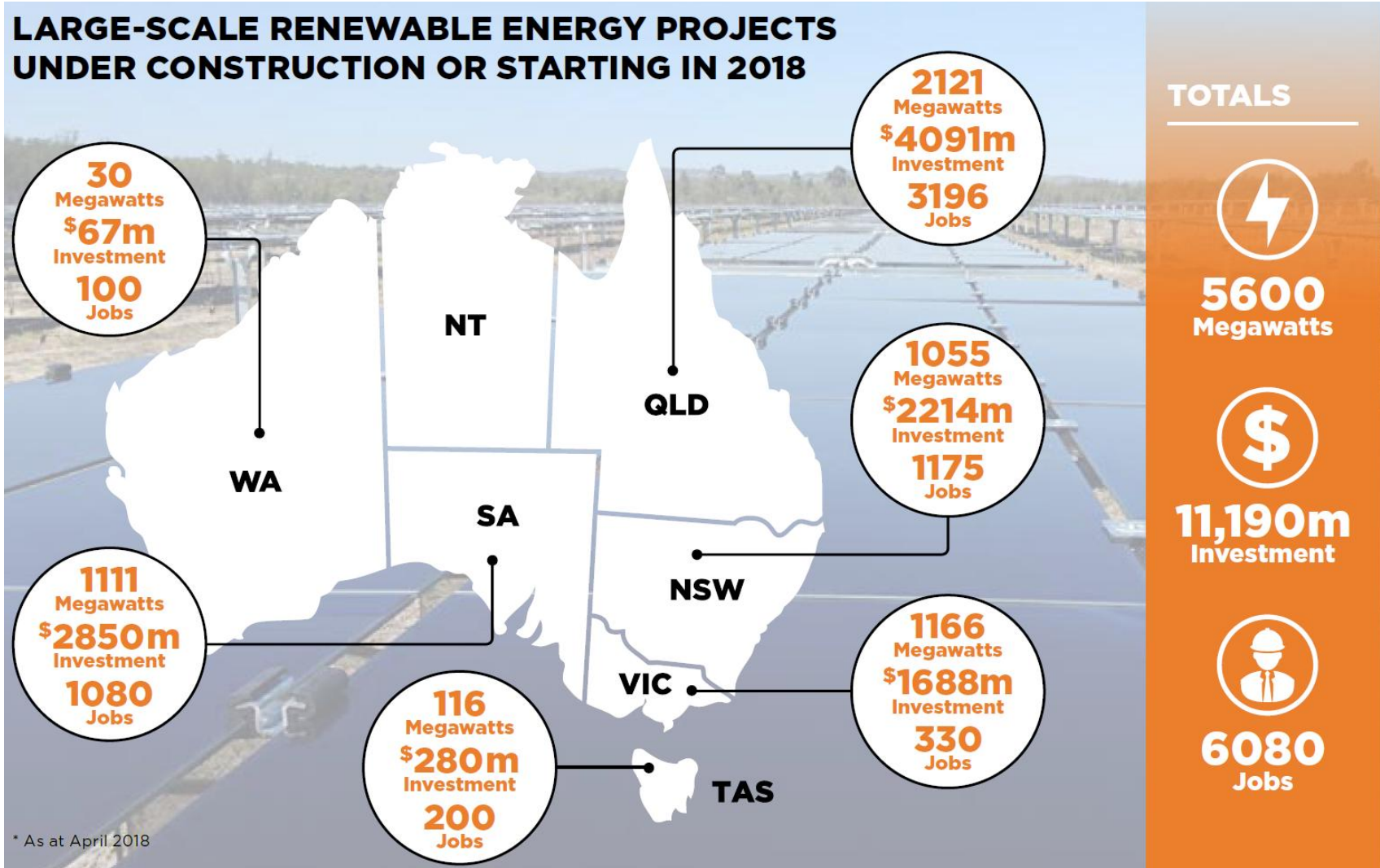
**RENEWABLE ENERGY
PENETRATION BY STATE³**



TAS	88%
SA	45%
VIC	16%
WA	14%
NSW	11%
QLD	8%

Source: Clean Energy Australia Report 2018

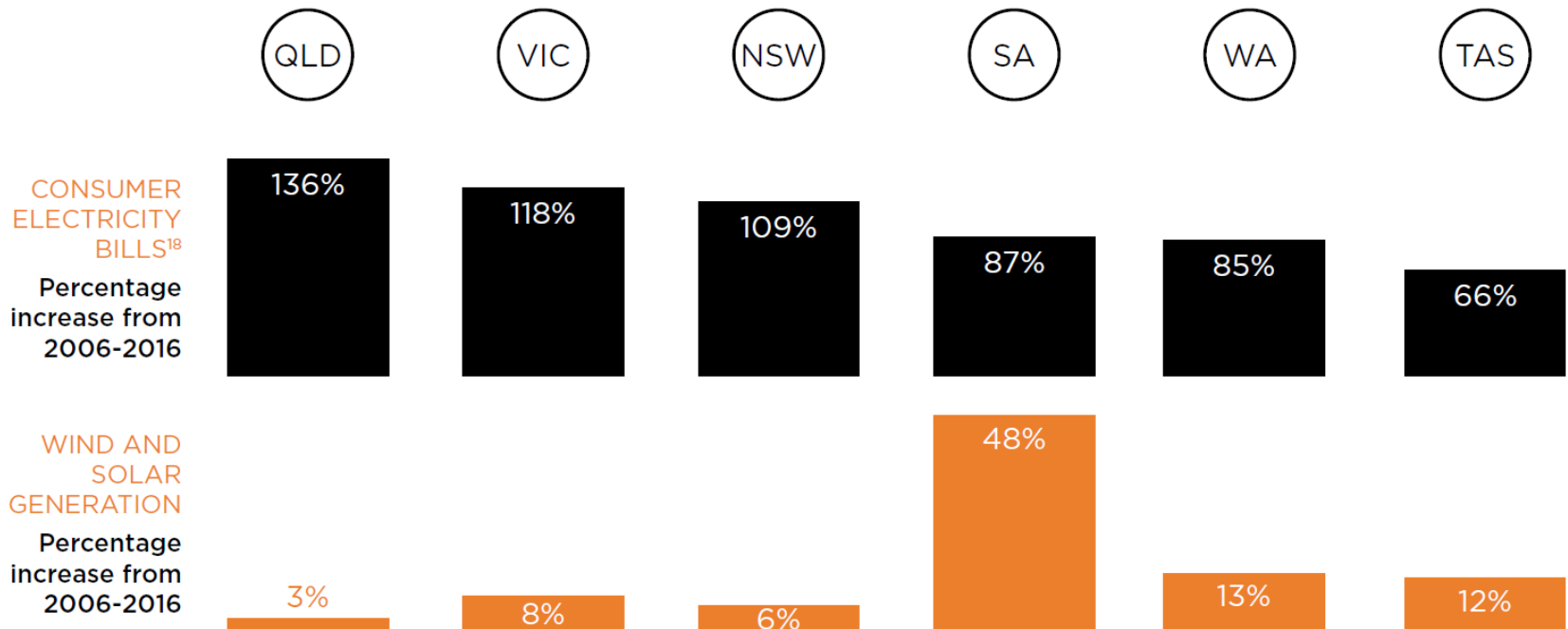
Renewables in Australia



Source: Clean Energy Australia Report 2018

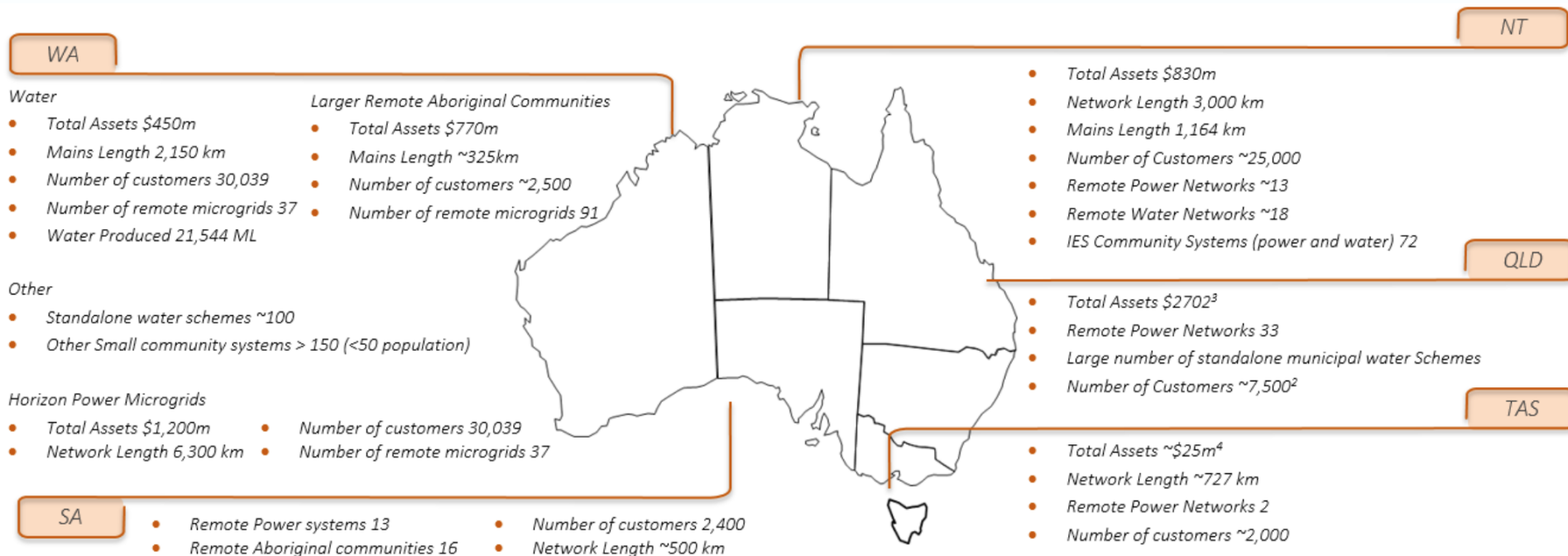
Renewables in Australia

POWER PRICE INCREASES VS POWER FROM WIND AND SOLAR



Source: Clean Energy Australia Report 2018

Highlights of Microgrids in Australia



Various examples will be presented throughout the Symposium



Microgrid trial in Victoria

CASE STUDY

MOOROOLBARK COMMUNITY MINI-GRID



To the casual observer, the Melbourne suburb of Mooroolbark is just like any other middle-class commuter region, but something unique is happening in one tree-lined street.

In a ground-breaking trial, AusNet Services worked with Greensync – who built, operated and maintain the smart solar-storage home systems – and PowerTec – who manage the smooth

separation and stabilisation of the system – on a community mini-grid using solar panels and batteries.

The trial included a series of scenarios to test how renewable and community energy projects can be efficiently integrated into the network, and the benefits they can bring to both consumers and the electricity grid.

The first test was conducted in May 2017 and involved successfully separating eight homes from the grid – six with solar and storage, two without – and operating them as a stand-alone solar and battery storage powered mini-grid.

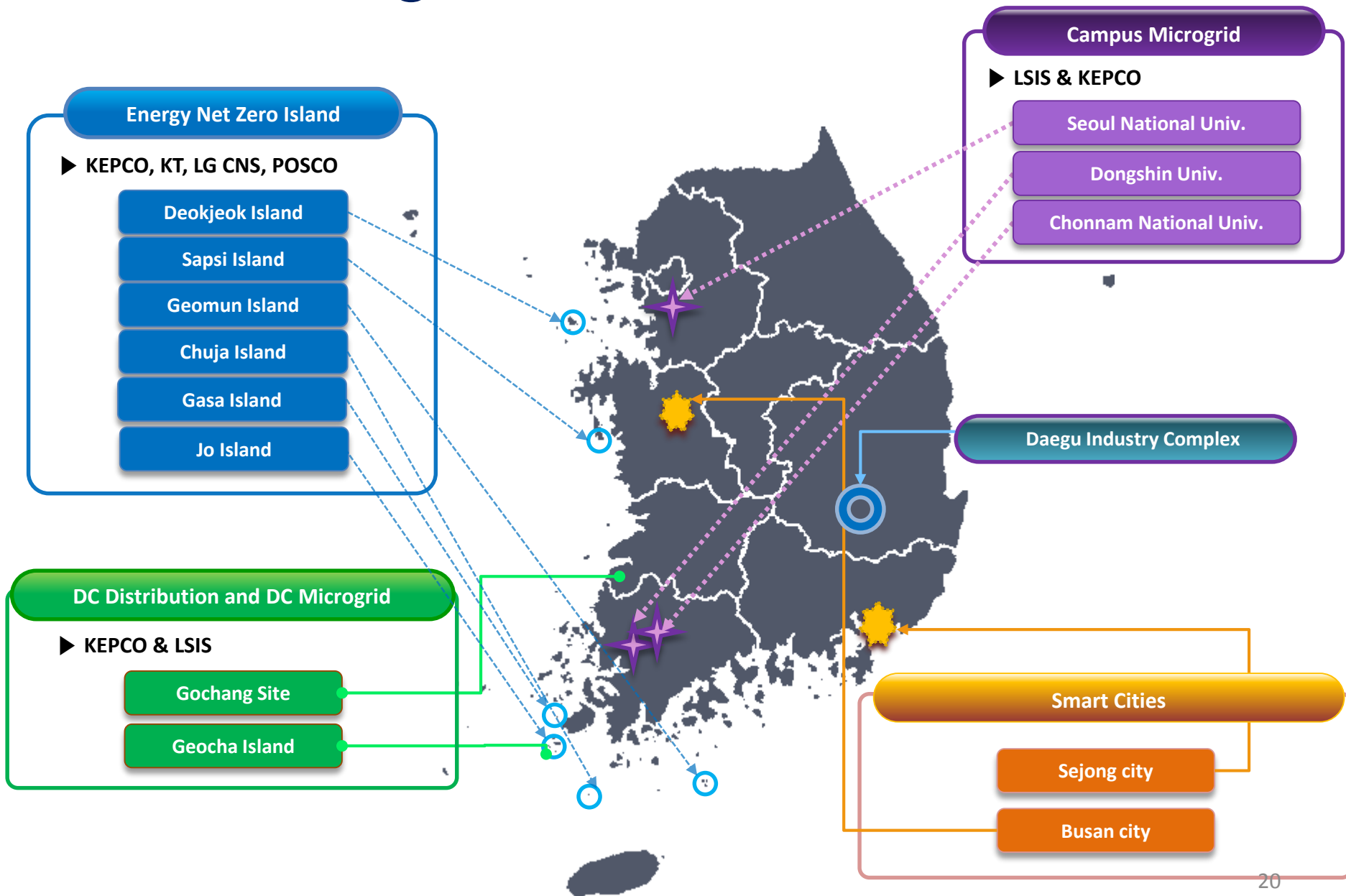
Towards the end of 2017, AusNet took a group of 17 houses off-grid for a total of nine hours, powered only by the collective solar and battery storage systems installed on 14 of the homes.

The project not only demonstrated the effectiveness of residential renewable power, but it could also lead to considerable savings for consumers.

The Mooroolbark mini-grid trial was a joint winner of the 2017 Clean Energy Council Innovation Award.

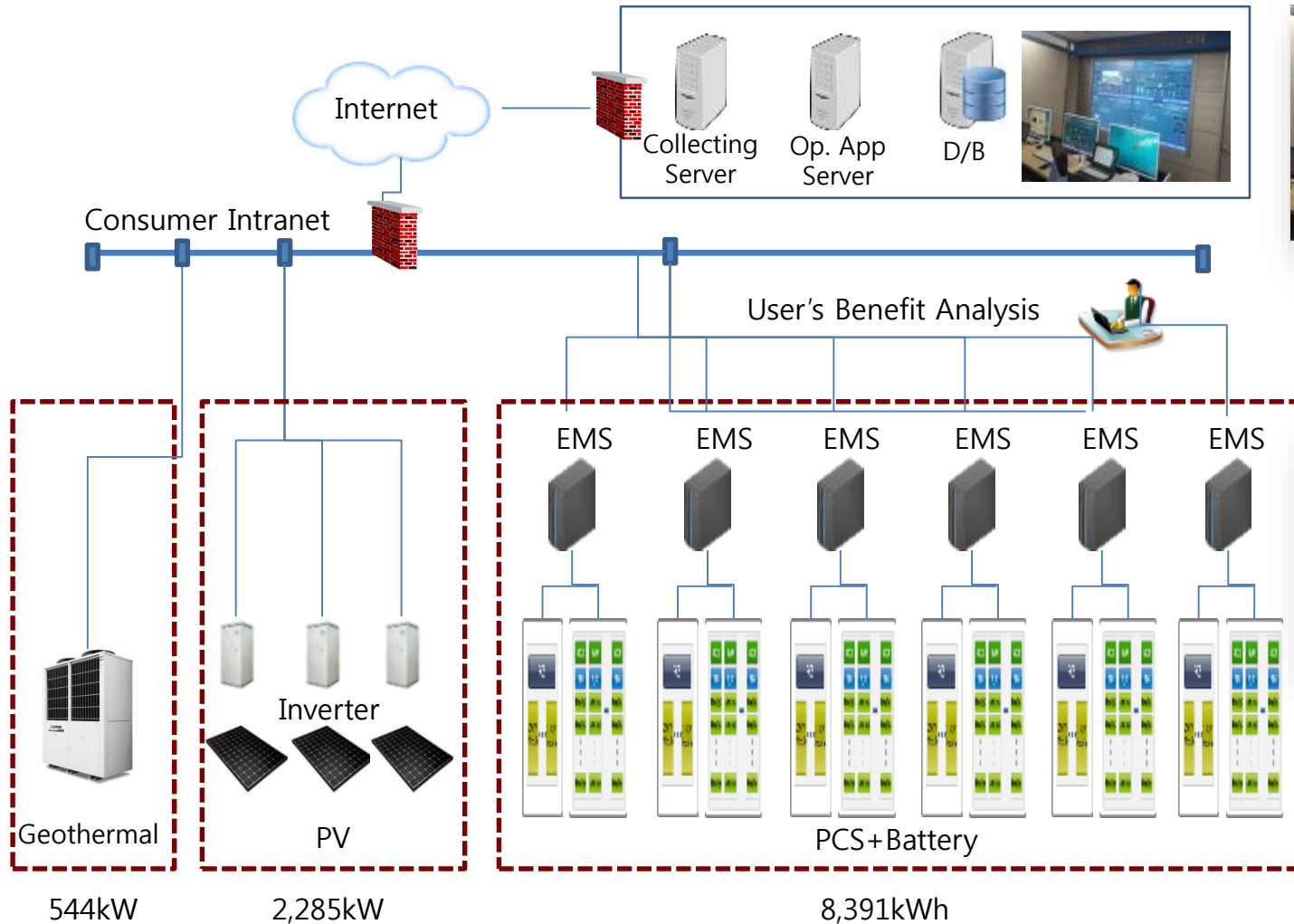
Source: Clean Energy Australia Report 2018

Microgrid Activities in Korea



Daegu Industrial Complex LEGO-Type Microgrid

- Total Operation Center (TOC), Renewable Energy (2,285kW PV/ 544kW Geothermal), Battery (8,391kW)



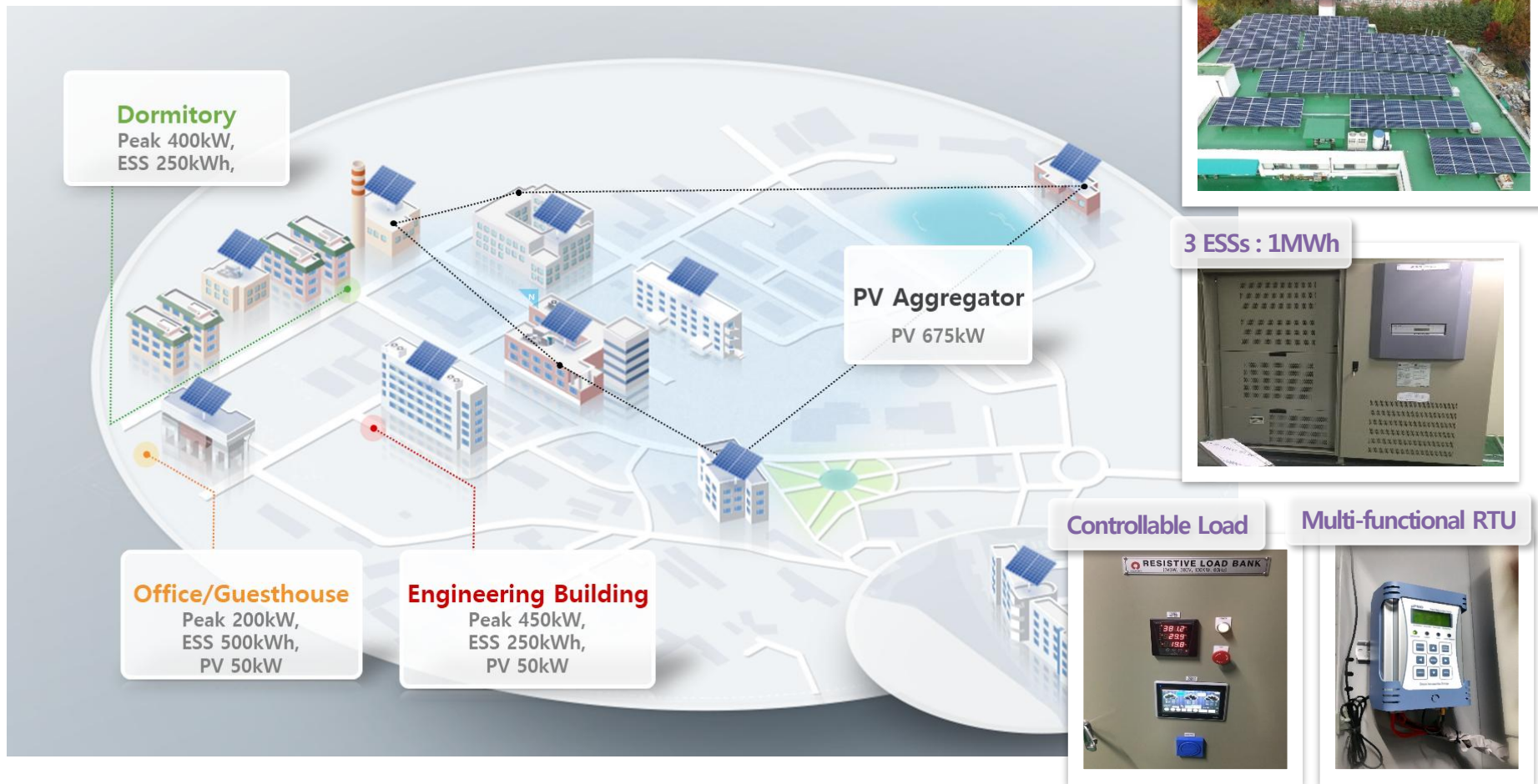
System Configuration



Total Operation Center (TOC)

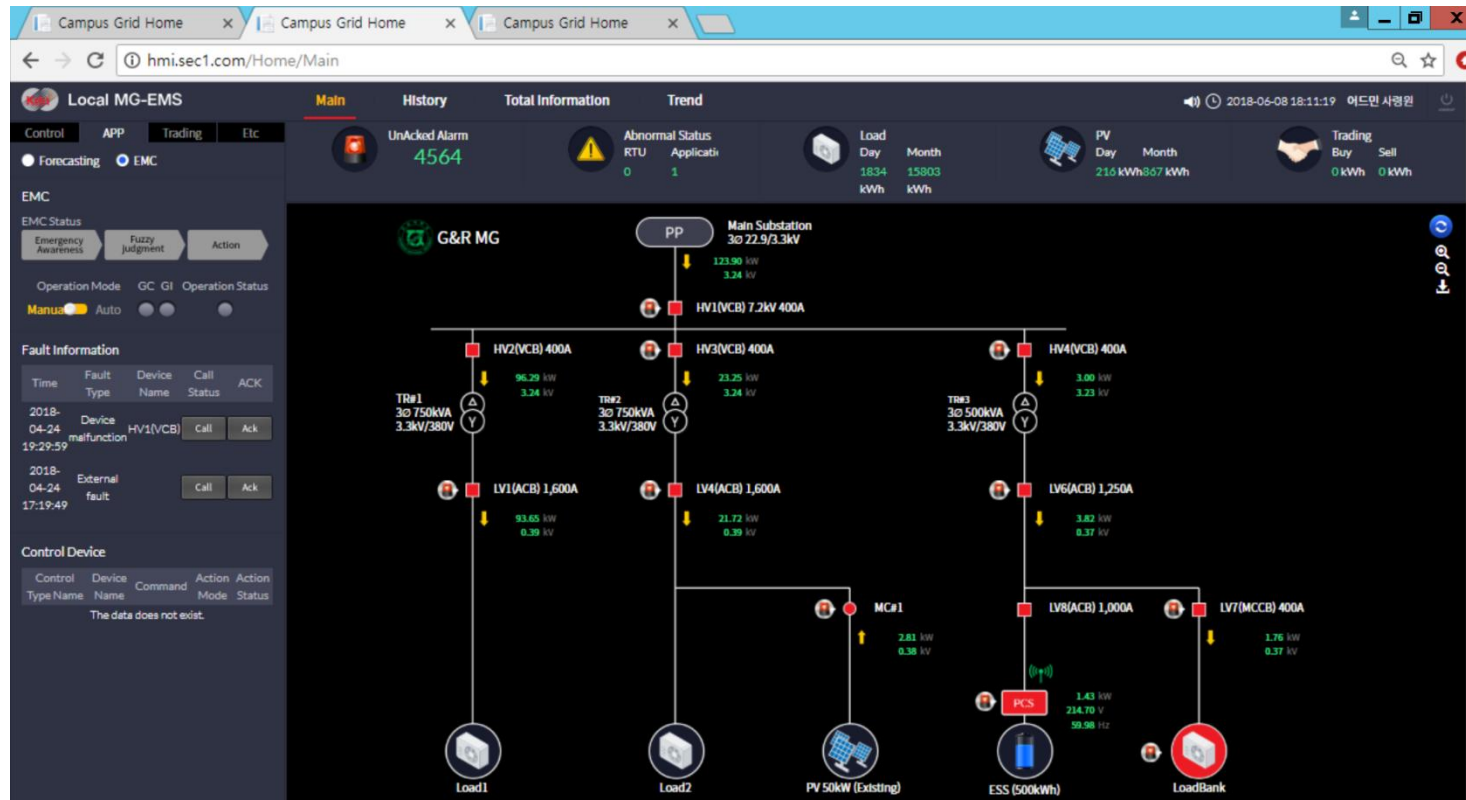
Smart Energy Campus: KEPCO, Korea

- MG Site Construction
 - 4 MG Cells: PV(675kW), ESS(1MWh), RTUs, Controllable Loads
 - Site acceptance test (SAT) completed



Smart Energy Campus: KEPCO, Korea

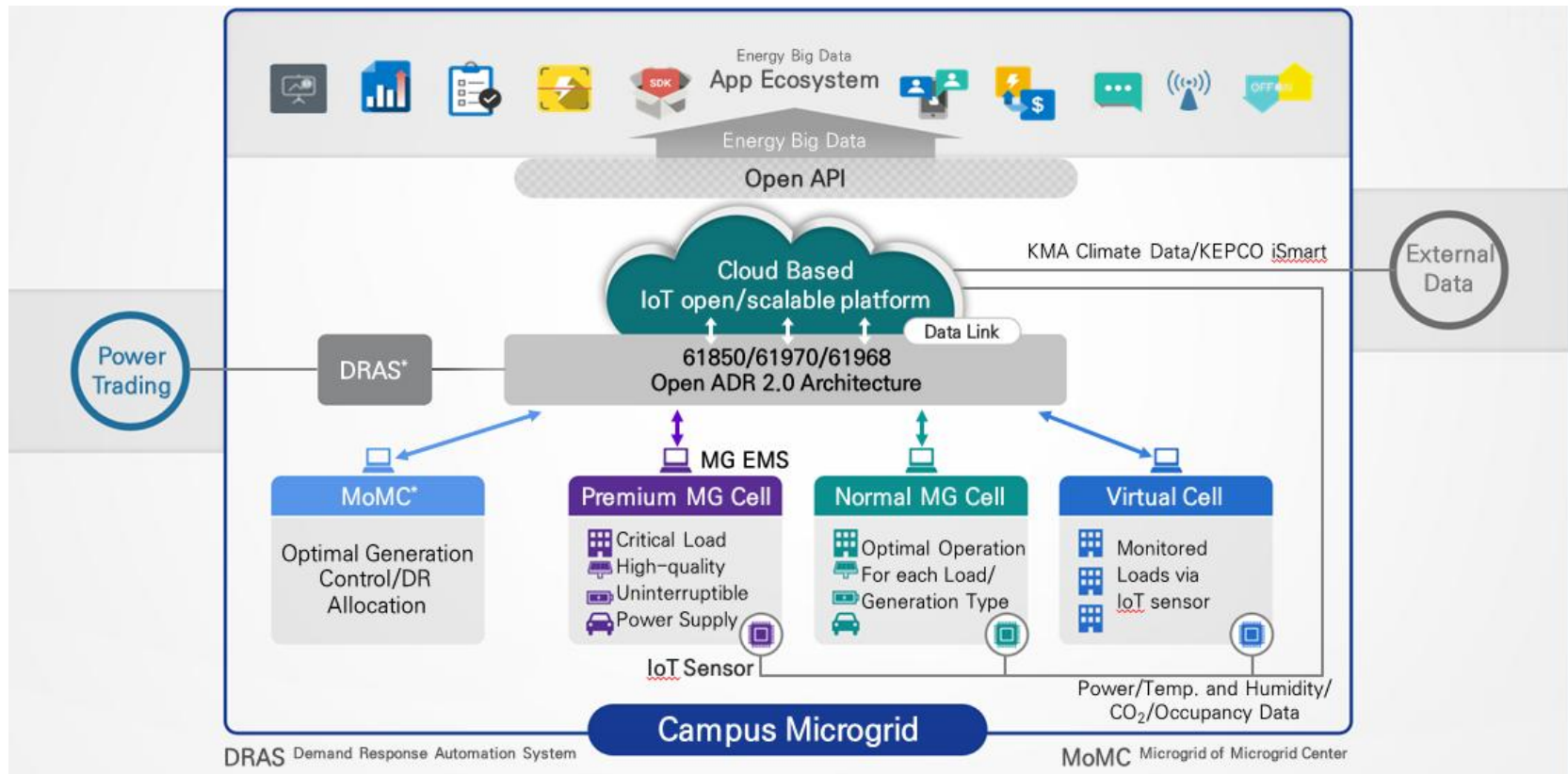
- Web-based EMS
 - Compact platform, user-friendly interface
 - Schedule based Applications: PV and Load forecasting, ESS scheduling
 - Alarm/Event driven Application : Emergency autonomous control



- [Web발신] Operation mode of MG has been changed to GI mode.
- [Web발신] An external fault has occurred. please check and clear. 오후 9:32
- [Web발신] The MG has been re-connected to the main system.
- [Web발신] [Location : G/R Hub] Device malfunction occurs at HV4(VCB) please check and clear. 오후 9:33
- 2018년 4월 24일 화요일
- [Web발신] [Location : G/R Hub] Device malfunction occurs at HV4(VCB) please check and clear. 오전 11:29
- [Web발신] Operation mode of MG has been changed to GI mode.
- [Web발신] An external fault has occurred. please check and clear.
- [Web발신] The MG has been re-connected to the main system. 오후 7:33

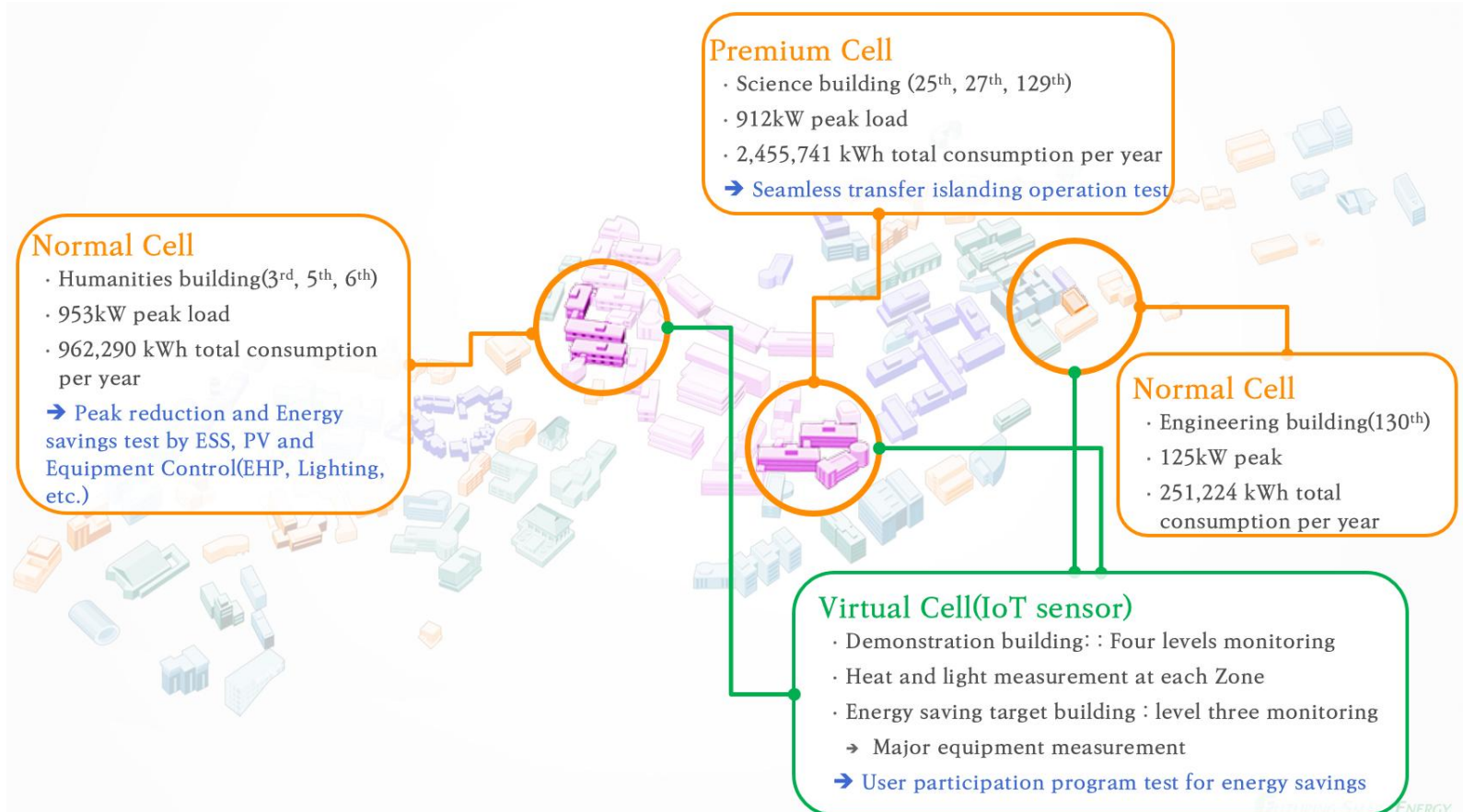
Seoul National University Campus Microgrid, Korea

- Project Goal
 - 4 hour islanding operation to critical loads
 - 20% peak load reduction and energy cost saving based on campus operating model
 - Consumer participative energy saving services by employing big-data platform

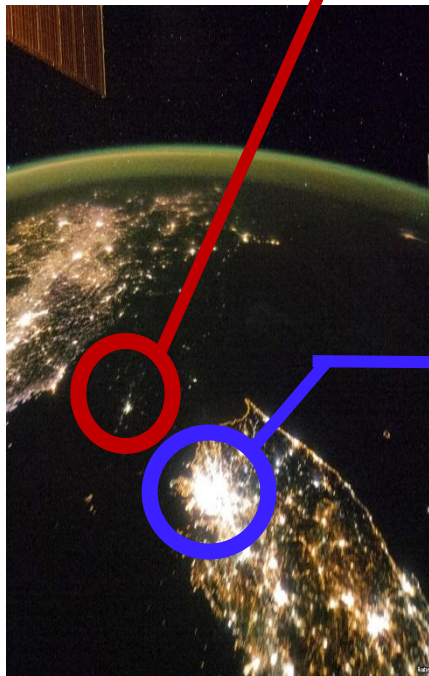


Seoul National University Campus Microgrid, Korea

- SNU System for Demonstration
 - Premium Cell : Critical load with seamless transfer islanding operation and high power quality
 - Normal Cell : Normal load with DERs(PV and ESS)
 - Virtual Cell : Normal load with IoT Sensor(without DERs)



Microgrid Cooperation of SEPRI and PUST



The satellite picture of Korea (NASA)

Pyongyang University of Science and Technology (Energy Supply Oriented)

- Poor energy facilities due to aging
 - Requirement of transmission expansion planning (Cost & Time)
- Rapid energy facilities expansion (Renewables + ESS + IoT Sensor)



Seoul National University (SNU) (Energy Saving Oriented)

- On the constructing of IoT-based campus microgrid in SNU
- Goal : 4 hours islanded operation and 20% energy saving
- Microgrid of Microgrid Center (MoMC)
- Securing best practice in campus microgrid demonstration



Preliminary Study for Microgrid in North Korea

Reality of North Korea



- Poor and aging energy facilities
- Requirement of transmission expansion planning

Experience of Failure : KEDO



- Official suspension at 8 January 2006 (34.5%)

Need for Energy Cluster

• Candidate Selection

Positive Factor

1. Coastal city
2. Urban development potential after South & North cooperation
3. Willingness of development

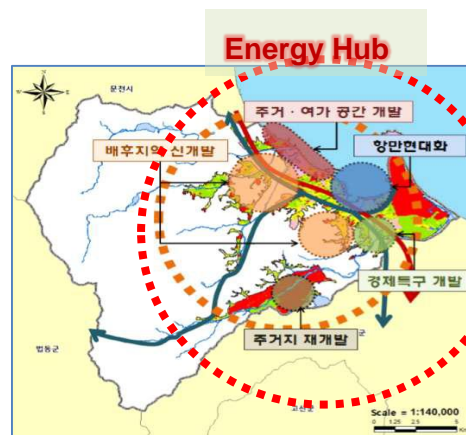


Candidates

Nam-po
Sin-uiju
Na-seon
Cheong-jin
Won-san

• Candidate : Wonsan

- Maximizing trade between South & North Korea
- Less military facilities
- Large development prospects



Microgrid Activities in Singapore **REIDS**

Renewable Energy Integration Demonstrator – Singapore

| An ERI@N Flagship Project |

Low Voltage Microgrid Testbed and Demonstration

{ Research Leader }



**NANYANG
TECHNOLOGICAL
UNIVERSITY**
SINGAPORE

Energy Research Institute @ NTU

{ Supporting Agencies }



**National
Environment
Agency**

Safeguard • Nurture • Cherish



**ENERGY
MARKET
AUTHORITY**

Smart Energy, Sustainable Future

**NATIONAL
RESEARCH
FOUNDATION**

Semakau Island – Singapore REIDS Microgrid Testbed & Demonstration

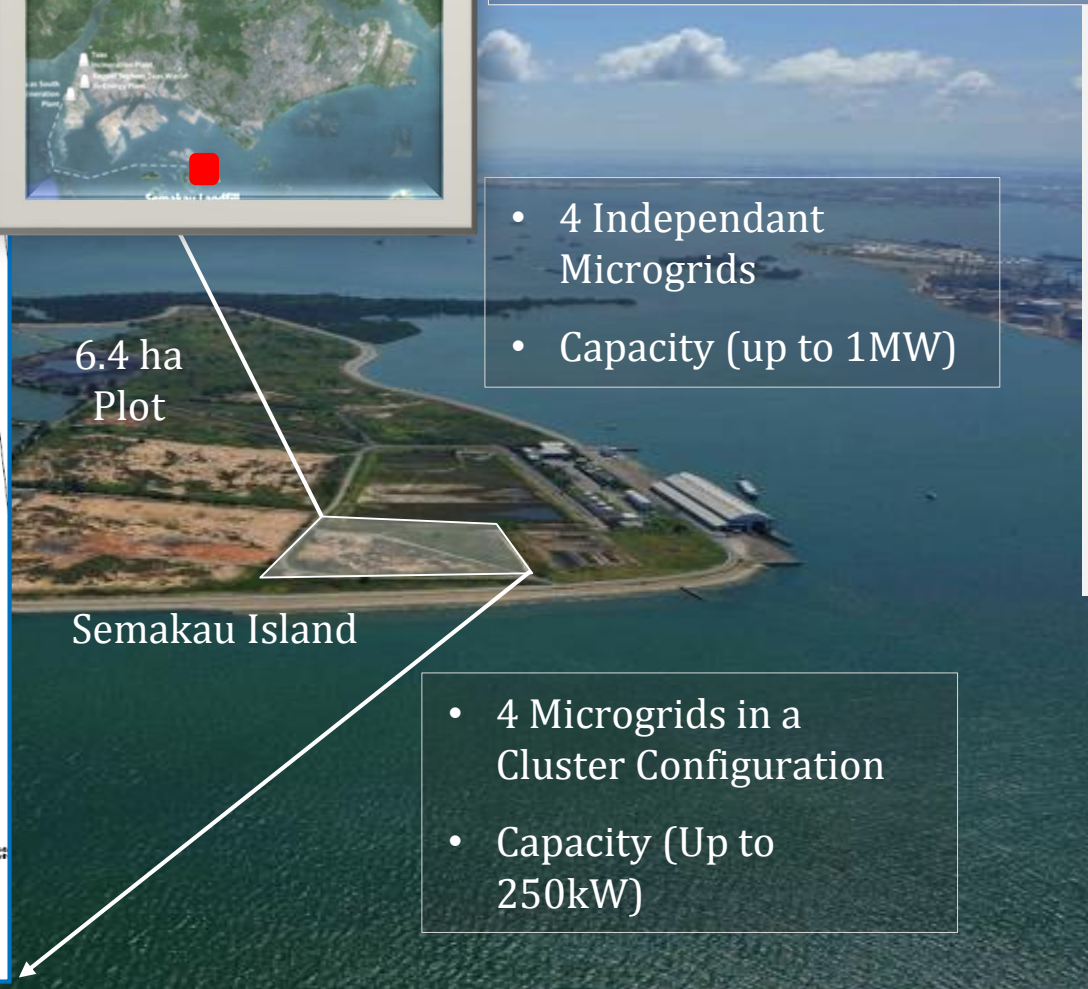
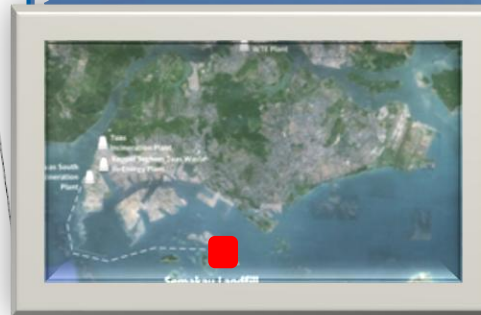
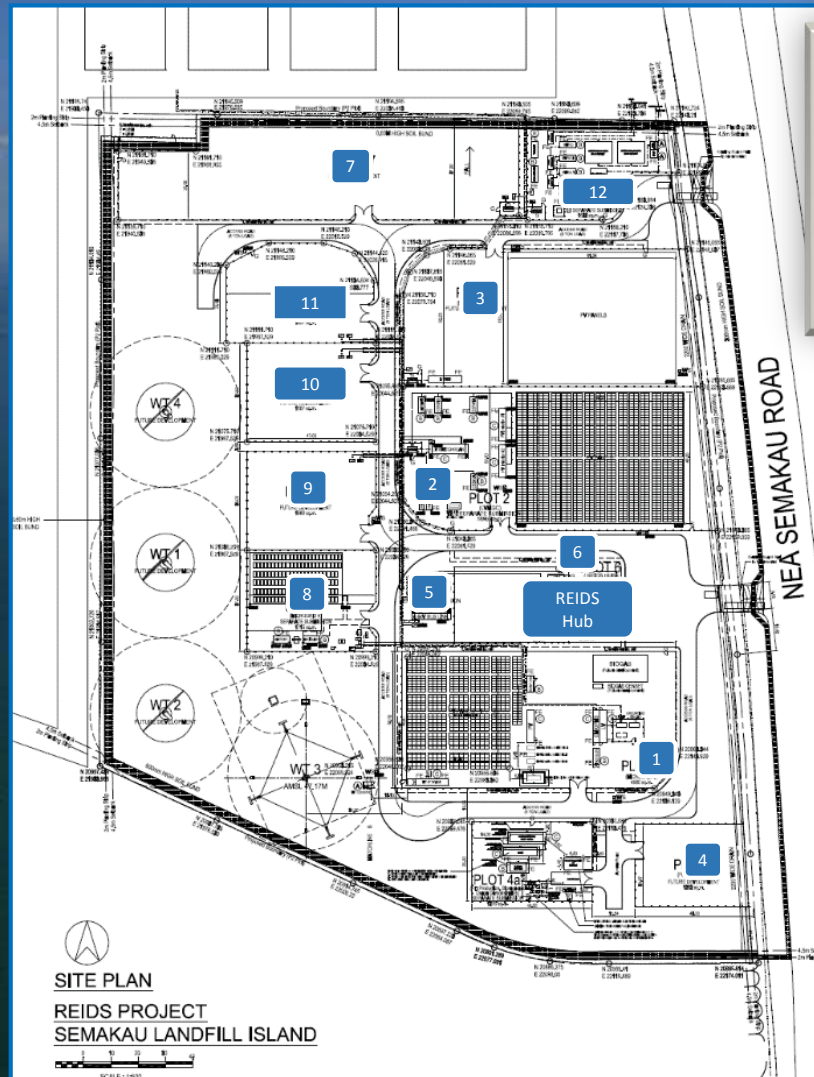
REIDS Microgrid Projects

- 4 Independent Microgrids
- Capacity (up to 1MW)

6.4 ha Plot

Semakau Island

- 4 Microgrids in a Cluster Configuration
- Capacity (Up to 250kW)



Programme Update 2018

MG1

- Murata BESS commissioned
- Testing of PV, BESS, and Smart Investor
- Testing of Wind Turbine and Load Bench

MG4

- Completed containerized design, electrical architecture
- Upcoming installation of PV, Genset and integration

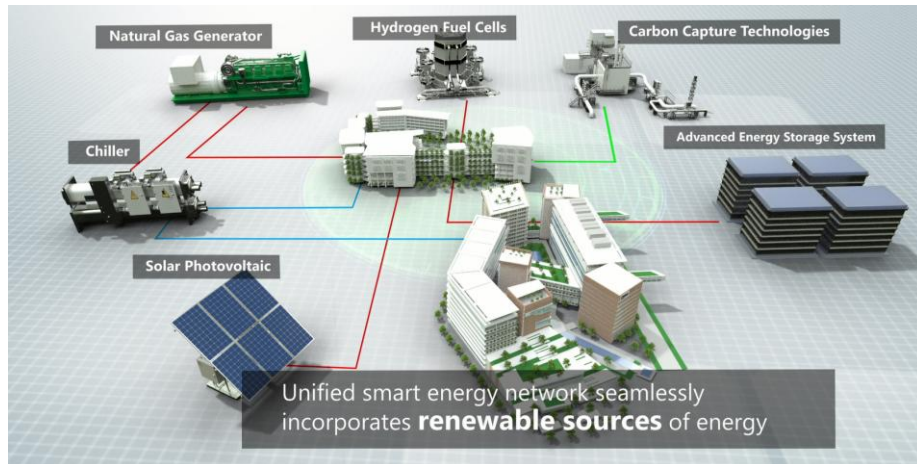
REIDS
Hub

- REIDS Hub Inverter Integration Test
- REIDS Hub Upgrade Design Completed
- Retrofitting to complete 1Qtr 2019

Upcoming

- Design of MG5
- Installation of 2 x 500KWh Shared Assets

SINGAPORE INSTITUTE OF TECHNOLOGY MULTI ENERGY MICROGRID



FEATURES:

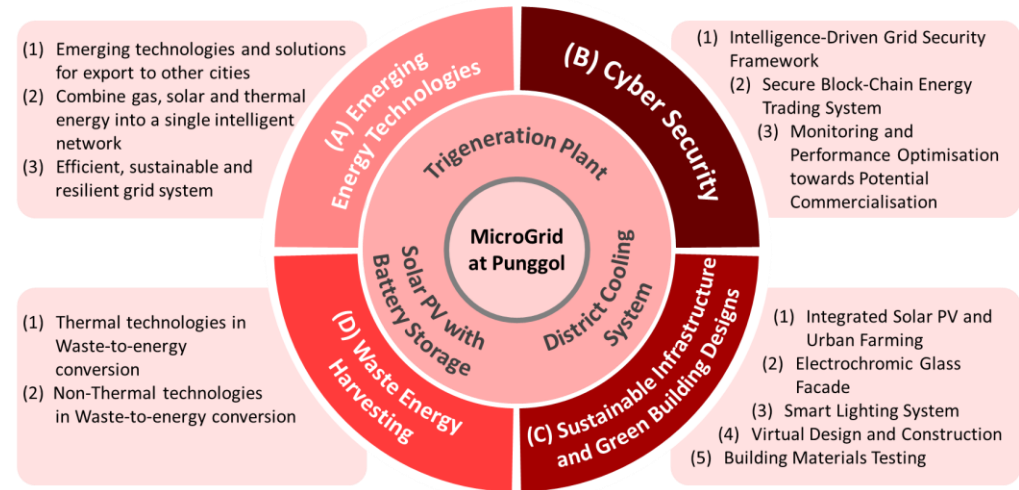
- Use of renewable multi-energy resources
- Recycle waste energy
- Towards zero carbon emission
- Islanding capability
- Teaching, applied learning and research platform

Target completion in 2022

SINGAPORE INSTITUTE OF TECHNOLOGY FUTURE CAMPUS: Beyond the microgrid



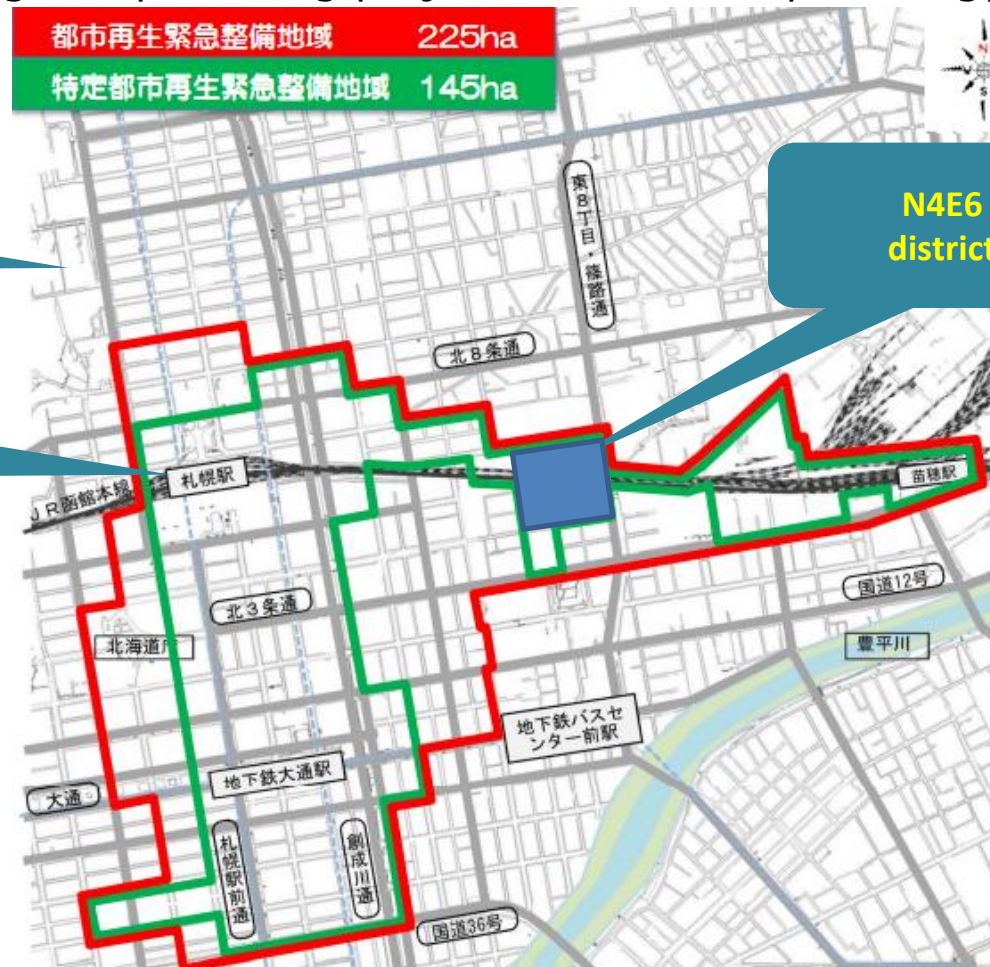
SIT's Future Campus in Punggol



The Microgrid is the crucible of Cross Disciplinary Research Platforms

Microgrid Activities in Japan

- located at east-side of central area in Sapporo, old-factory site of Hokkaido Gas Co., Ltd. (4.1ha)
- Designated as one of the governmental emergency development areas, especially targeting on “construction of Distributed and Autonomous Energy Supply Hub”
- regarded as a leading and promising project in the municipal energy vision



Purposes

Energy saving and Resiliency Improvement by Areal Introduction and Usage of CHP / RE generation

- Aiming at load leveling effects by combining the energy supply for different type of demands
- Total energy efficiency improvement by CHP (CGS) and renewables

Advanced and bilateral energy management

- Energy supply based on the sophisticated electricity / heat demands forecast
- Promotion of demand-side contribution for energy savings / peak shift

Active cooperation btwn distributed generations and PPS company

- Flexible and bilateral energy trading between N4E6-dist. and PPS (Hokkaido Gas), considering the electrical / thermal energy balance in the district to utilize the distributed generations

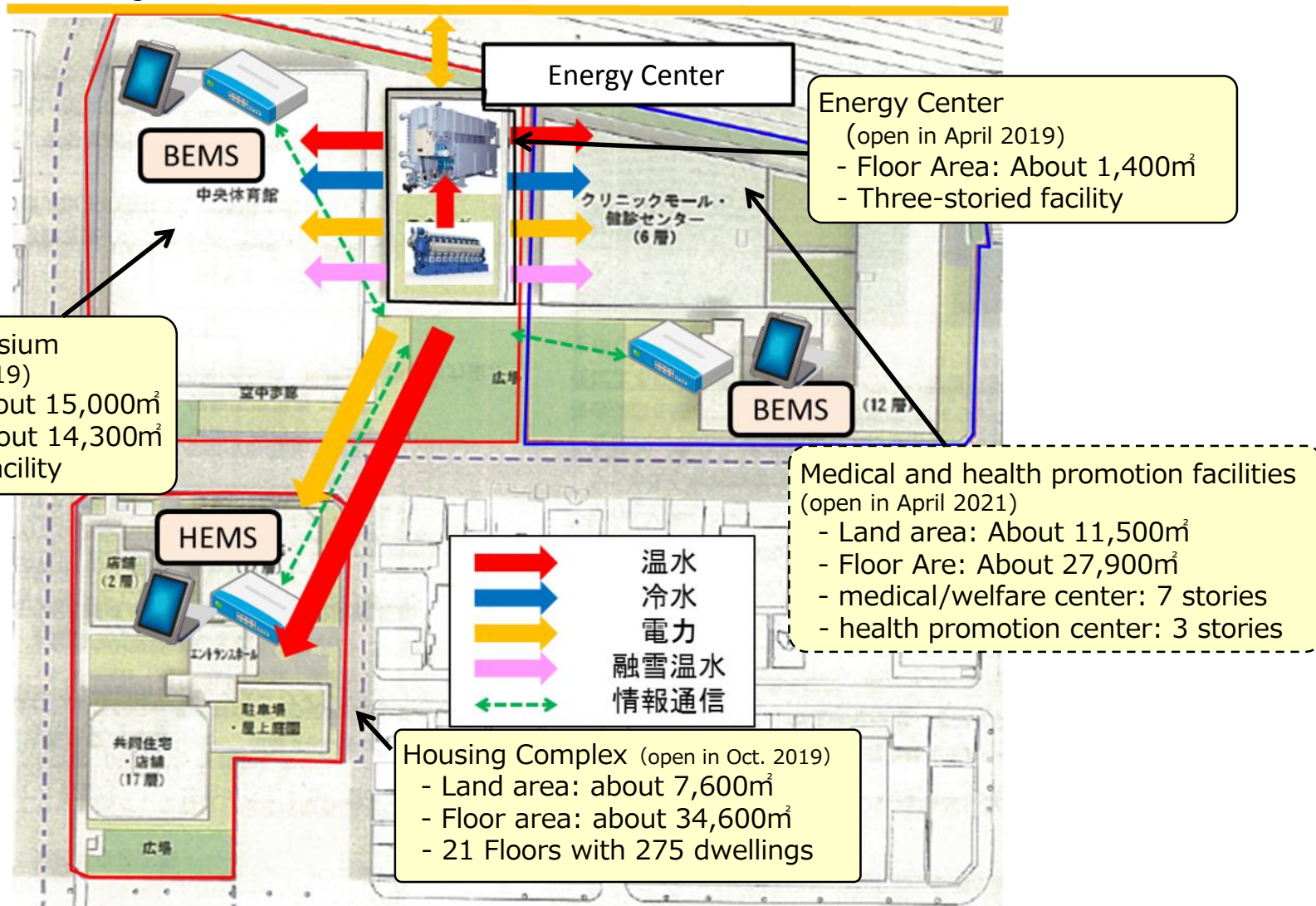


Demonstration of total energy supply service for a specific area

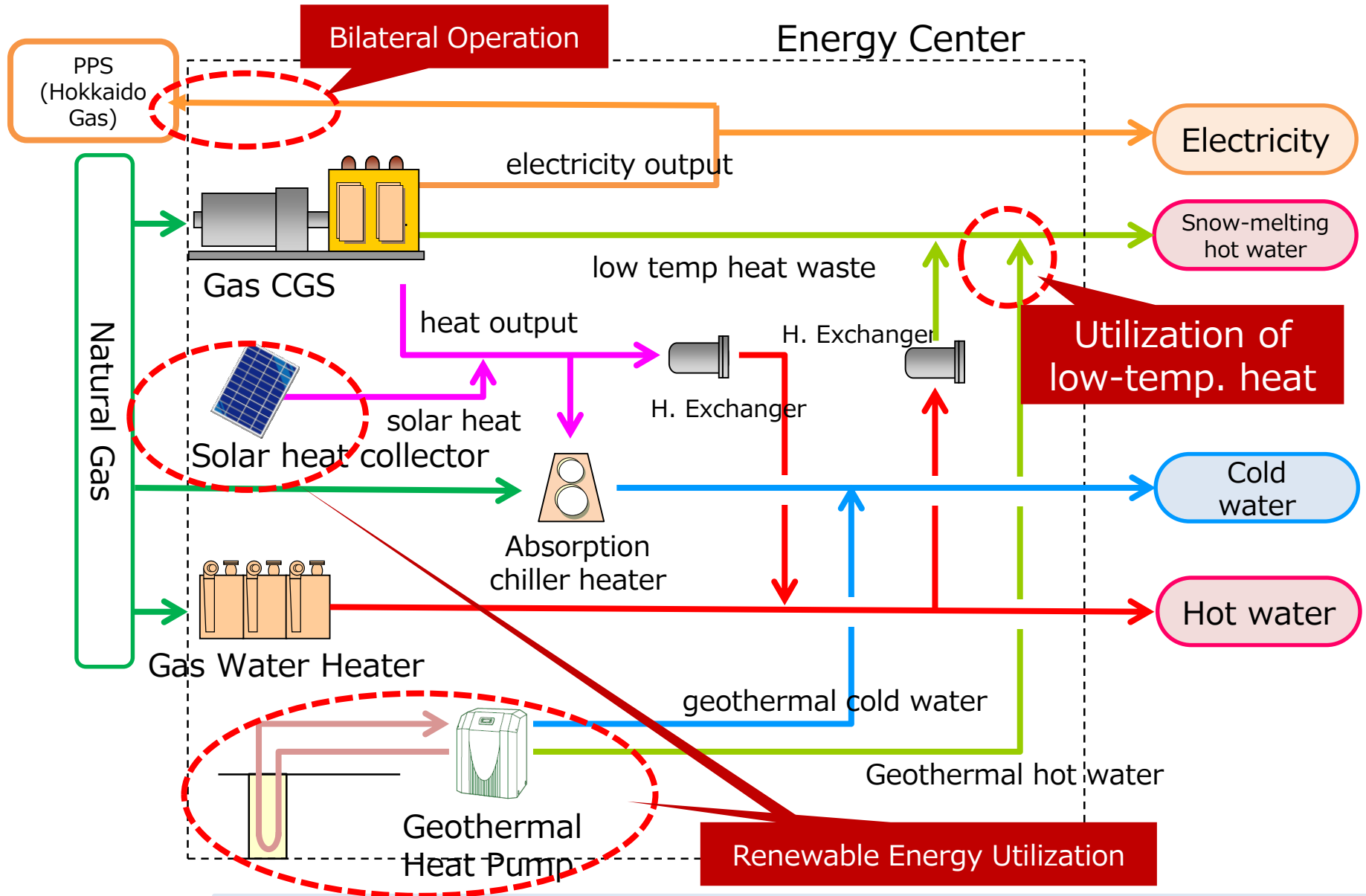
Overview of N4E6 District

The Energy Center supplies electricity and heats (hot/cold) for gymnasium, housing complex, medical facilities, and health promotion center

Existing Electric Power Grid



Adopted Energy Flow



Specifications of major devices

Device	Detail	Capacity	# of Units
CHP unit	Gas-engine driven Exhaust heat emission (hot water)	315kWe	2
Solar heat collector	Vacuum grass-tube heat pipe	77kW	1
Geothermal heat pump	Water-cooling HP chiller	34kW	1
Absorption chiller heater	Exhaust heat driven Gas absorption	270USRT 150USRT	1 2
Water heater	Gas-fired vacuum heater	930kW	10