Newcastle 2017 Symposium on Microgrids


# Construction of IoT-based Campus Microgrid in Seoul National University

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SEOUL NATIONAL UNIVERSITY

INHA UNIVERSITY

LSIS FUTURING SMART ENERGY

# IoT-based Campus MG Project Overview

## SNU Campus MG Demonstration Project Overview

**Project Budget:** **15.7 million USD (Government 10.3M, Private 5.4M)**

**Project Period:** **2015. 06 ~ 2019. 05 (for 4 years)**

**Project Site:** **Seoul National University**

## Project Goal:

Development of a customized SNU Campus MG model to provide

1) 4 hours islanding operation to critical loads

2) 20% peak load reduction and energy cost saving by cell MG model

3) Consumer participative energy-saving by IoT based Bigdata platform

4) Multi-Microgrid operation with different cell types

* SNU: Seoul National University
* MG: Microgrid

Leading Companies :

LSIS, KEPCO, NARA

LG Electronics, ENCORED

(16 Industry-academia

-research institutions)


## Best Team of best organizations in each field

| | |
|---|---|
| Solution/ Services | LSIS, ENCORED, LG Electronics |
| Operation | KEPRI, ktl Korea Testing Laboratory |
| Analysis/ Design | KSGI Korea Smart Grid Institute, EDISON(주)에디슨전기 EDISON Electrical Engineering CO., LTD |
| Component technologies | INHA UNIVERSITY, KETI Korea Electronics Technology Institute |
| Development/Manufacturing | WOOAM, NARA, GREEN INFO, DAE KYUNG, FLK, NEOPIS |

Leading a New Energy Industry Era

Campus Micr... ...es in Seoul National University

MOTIE MINISTRY OF TRADE, INDUSTRY & ENERGY

SEOUL NATIONAL UNIVERSITY

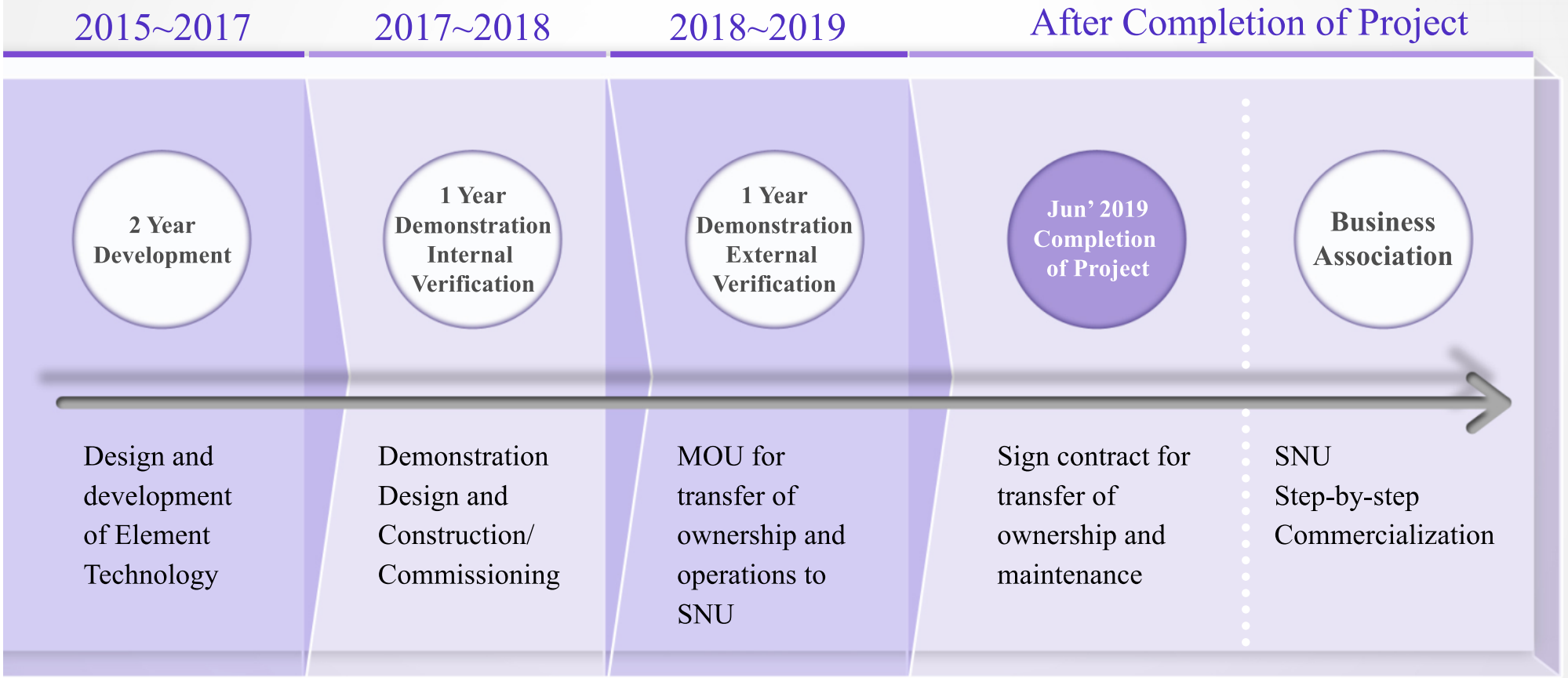


LSIS

# Demonstration Plan

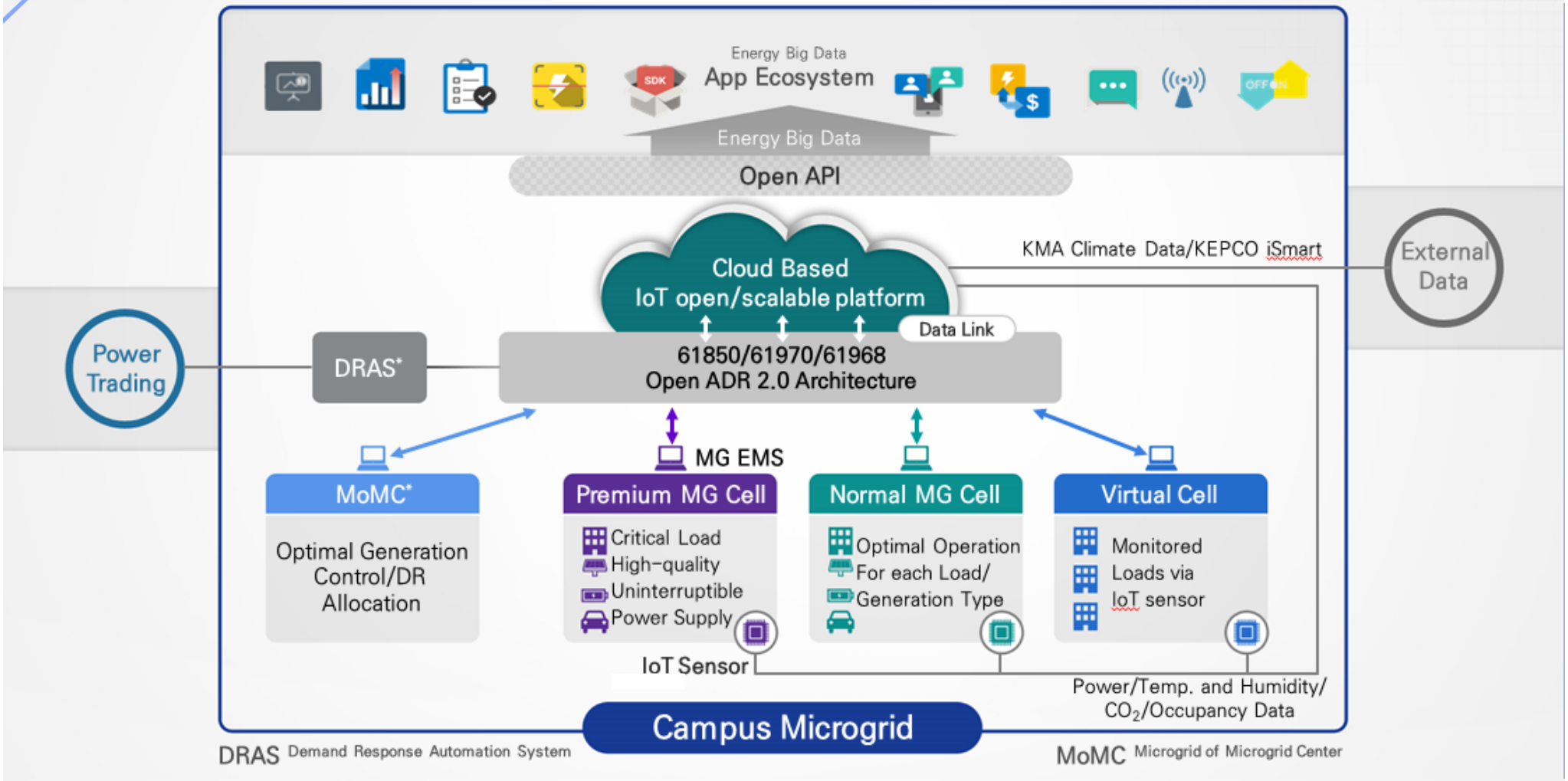
## Achieve early commercialization by 2 years of development and 2 years of demonstration

- Derive best demonstration strategy through in-depth analysis of campus system
- Analysis of the effect of the demonstration results and confirmation of results by external verification organization



# SNU Campus MG Conceptual Model

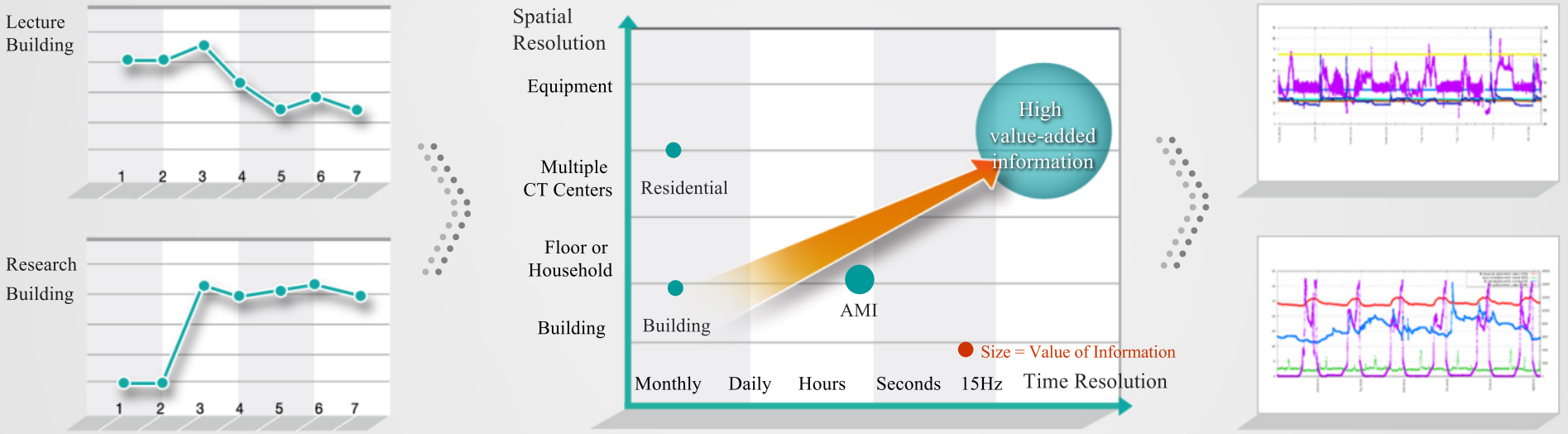
Cell region: Efficient energy operation  Cloud region: Providing variety of IoT based services



# Development of Each Type Building Model

## Model considering energy consumption characteristics and energy saving methods

- Develop accurate model (Lecture, Research, Hospital, Dormitory, and etc.) for each building types
- The accurate model will be designed by enhanced time-spatial resolution from IoT-based big data technology.



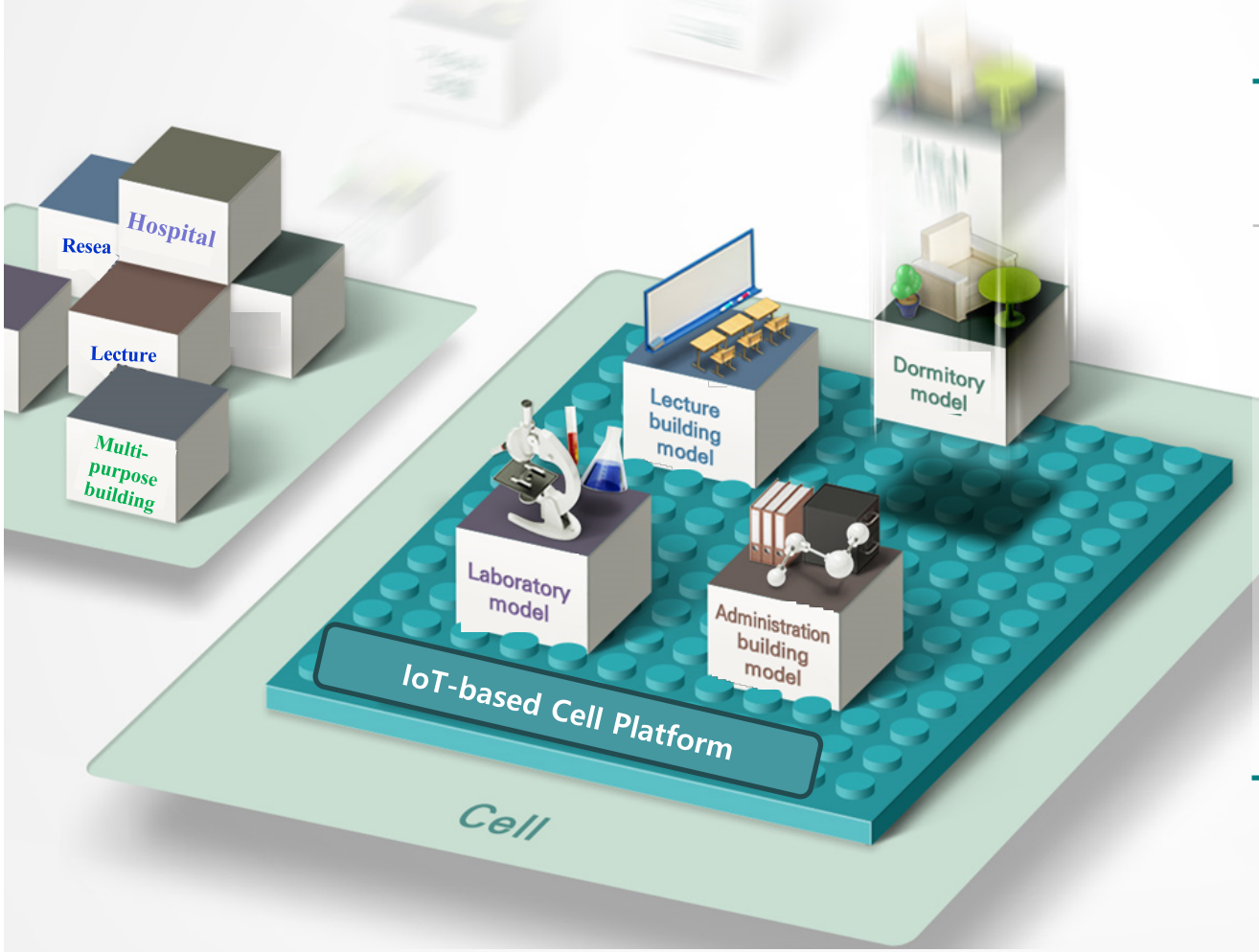

**Build and secure accurate model**
through time and space resolution improvement
by IoT based Big Data technology

◆

Standardization of energy-saving technologies and engineering methods for
**Reuse in Future Projects**

# SNU Campus MG Characteristics

**Lego style Campus MG Customized Model** taking flexible configuration change depending on customer demand




## Lego-style Campus Microgrid Customized Solution

**Campus Model Development**

Build campus model according to different energy consumption characteristics of campus buildings

**IoT based Cell Platform Development**

Platform for combining the required models through the Open API

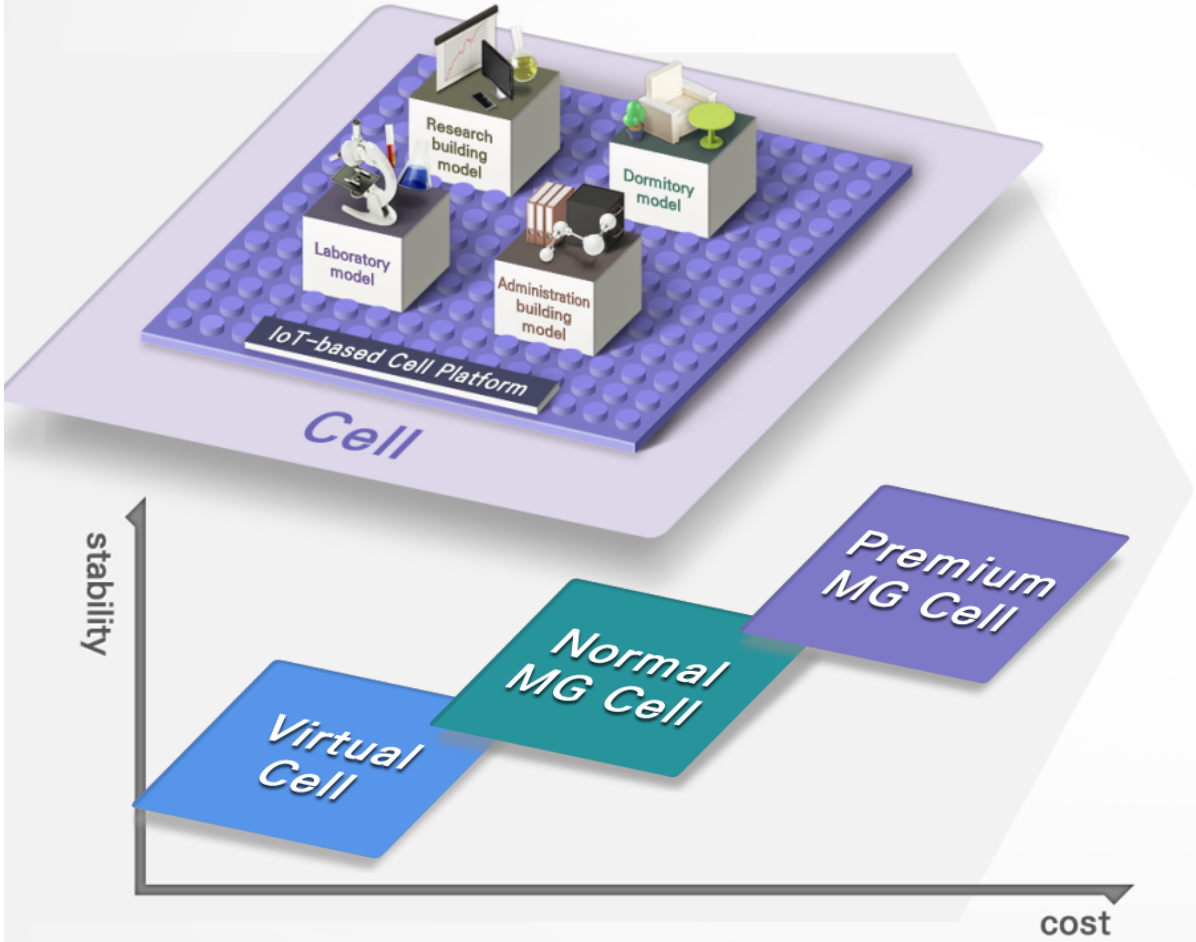
**Flexible solution by model combination**

**Cell** IoT Based Cell Platform + Campus Model
➡ Minimum sales unit of customized solutions

# Cell Solution Type

Cell : IoT-based Cell Platform + Campus building model for each type ⇒ Minimum unit of customized solutions

- Cell divided into 3 categories based on stability/cost




## Premium MG Cell

- Cell model for critical loads (research buildings, hospitals, etc.) requiring islanding operation and power quality
- 4 hours islanding operation and 20% energy savings

## Normal MG Cell

- Cell model for general loads (lecture halls, dormitories etc.) with DGs considering energy efficiency
- 20% saving of energy costs by peak load reduction

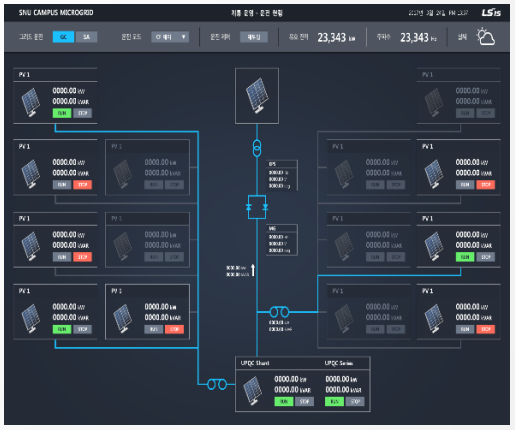
## Virtual Cell

- Cell model for general loads without DGs that provides energy saving service based on the analysis of information from IoT system
- 10% energy saving through IoT based user participative energy service platform

# Microgrid of Microgrid Center (MoMC)

## MoMC HMI Layout

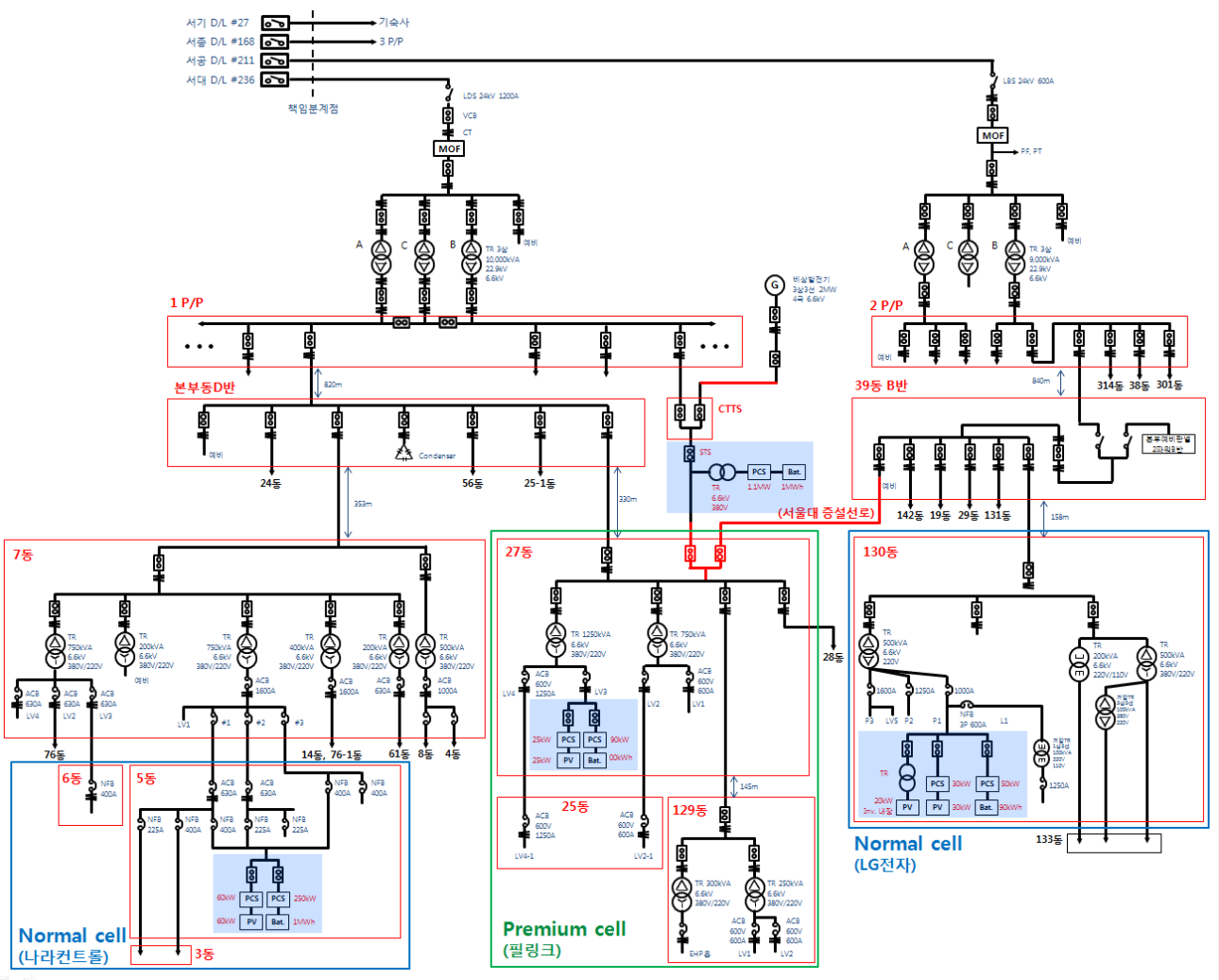
- Overall SNU campus monitoring and control (over 225 buildings)
- Hierarchy : MoMC - MG Cell EMS - BEMS

# Campus Microgrid Power System Network

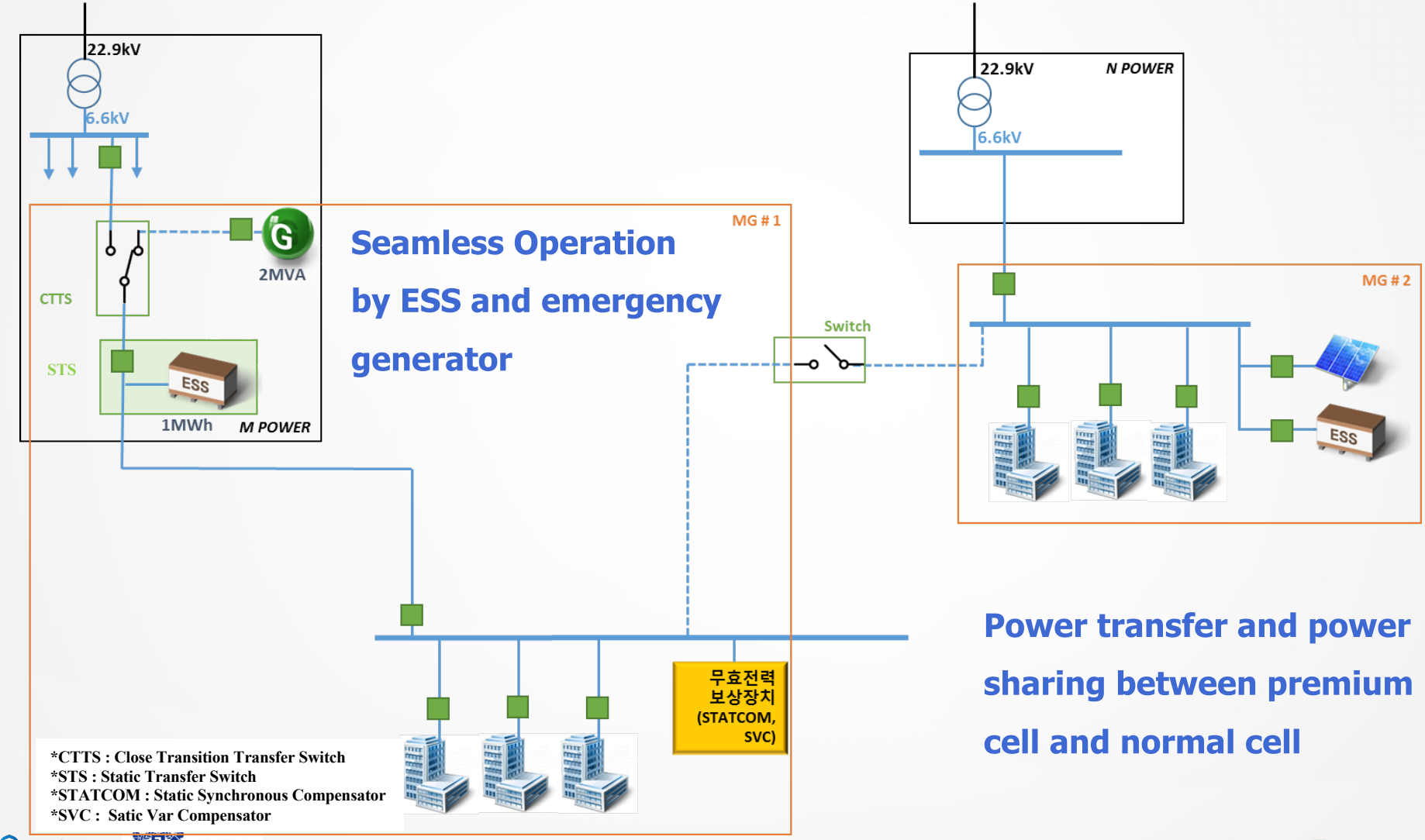
## One line diagram

- **Premium Cell**
  - ESS for islanding: 1MW/1MWh
  - Emergency Gen. : 2MW
  - ESS for energy saving: 50kW/100kWh, 50kW/150kWh
  - PV : 80kW
- **Normal Cell #1**
  - Energy saving
    - ESS : 2 * 250kW/500kWh
    - PV : 60kW
- **Normal Cell #2**
  - Energy saving
    - ESS : 50kW/90kWh
    - PV : 50kW



# Premium Cell Islanding Operation

## Premium Cell Islanding Operation for 4 hours




**Power transfer and power sharing between premium cell and normal cell**

# Normal Cell Energy Saving

## Normal Cell Equipments : IoT Sensors, ESS, MG-EMS

Normal Cell IoT Sensors

- Temperature, Humidity, $CO_2$, Presence etc.
- Mesh network

ESS

(PCS +

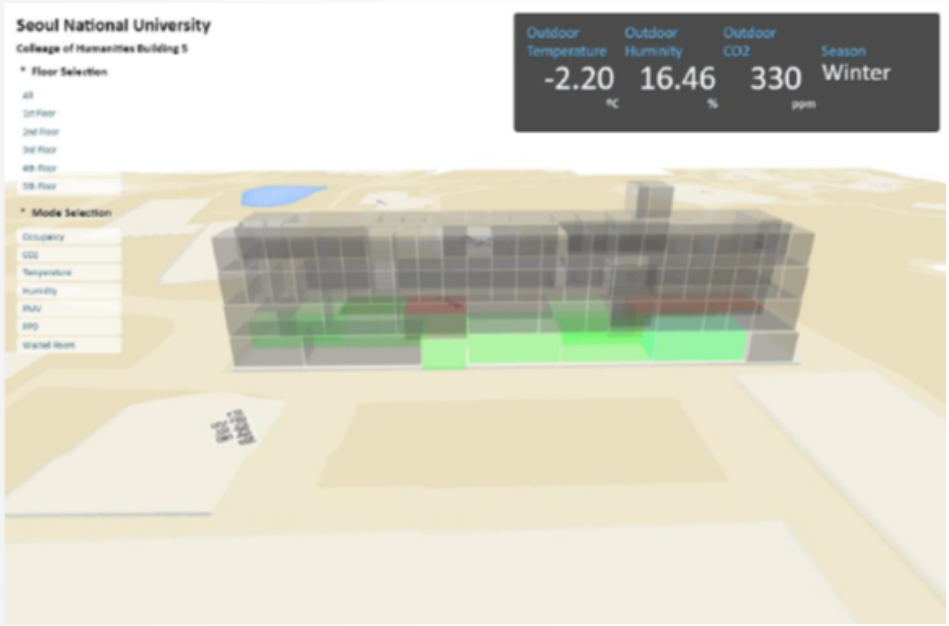
Li-ion Battery)

MG-EMS Server

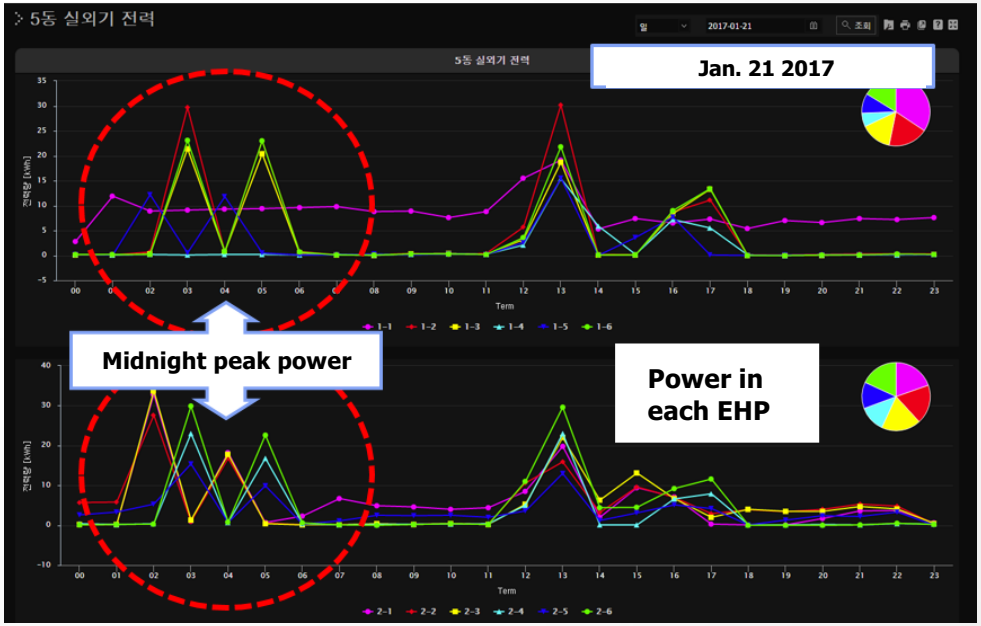
# Normal Cell Energy Saving

## Analysis on IoT sensor data and energy data

- 3D Visualization of IoT Sensor data
- Mapping with Geographic data



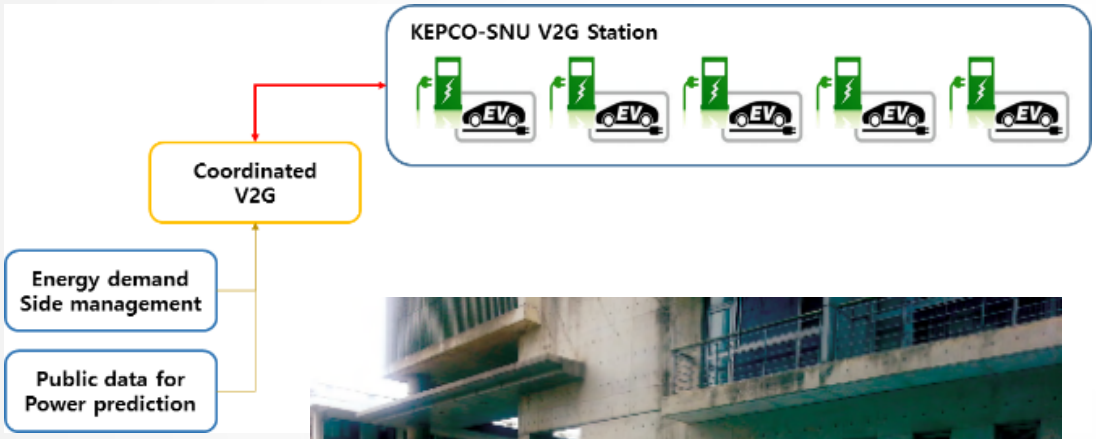

- By combining energy data with IoT data, useful information on energy consumption come out.



# Electric Vehicle C-EMS

## V2G Service Demonstration

- EV Cell EMS is connected to MoMC and manages the charging stations

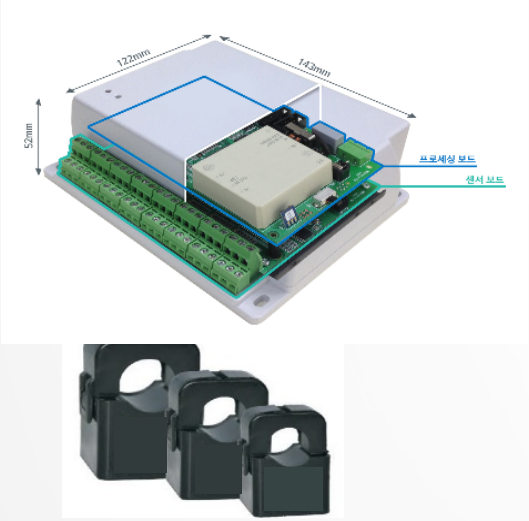



# Virtual Cell Energy Saving

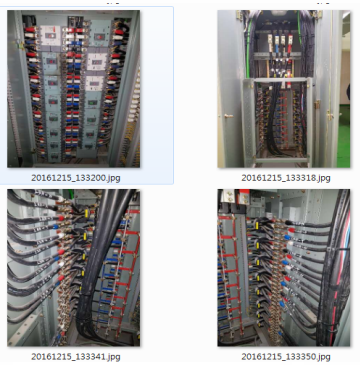
## IoT Power Sensor

- **IoT power sensor : Premium cell, Normal cell, Virtual cell**
- **High resolution : 1 sec. power monitoring**

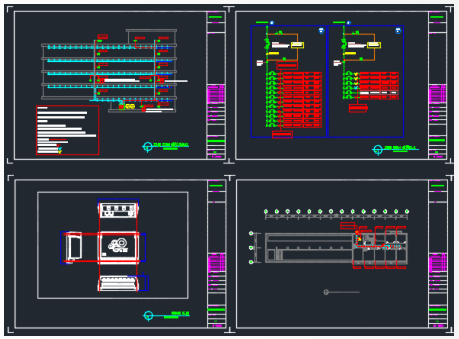
Product




Investigation




Mapping

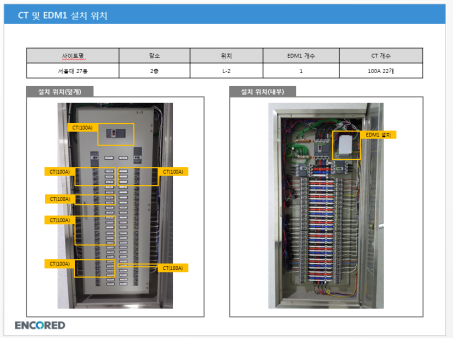


Installation

Comm.

Elec.

Testing

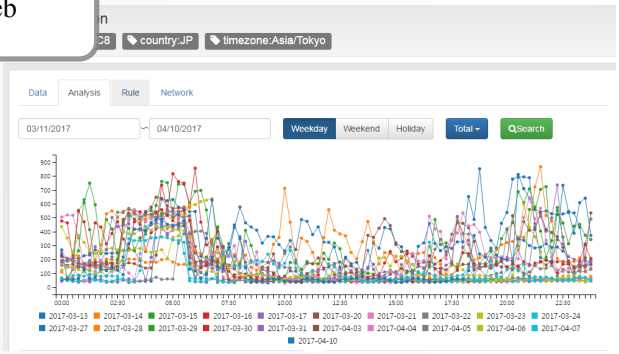


# Virtual Cell Energy Saving

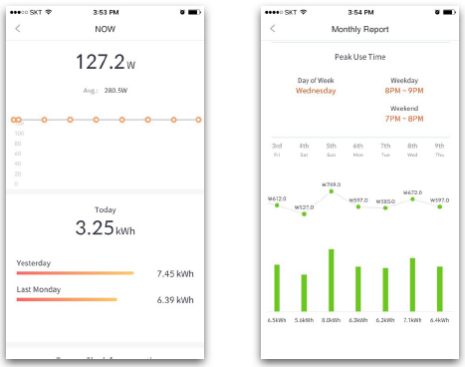
## Big data Platform Development

- Big data platform by ENCORED
  - Energy data visualization and analysis
  - Mobile application for customer engagement

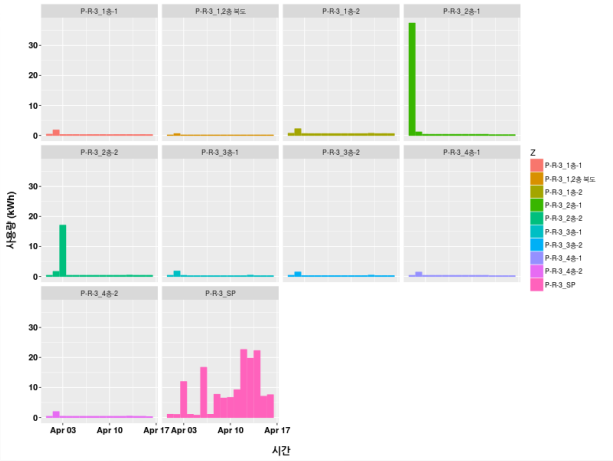
PC Web



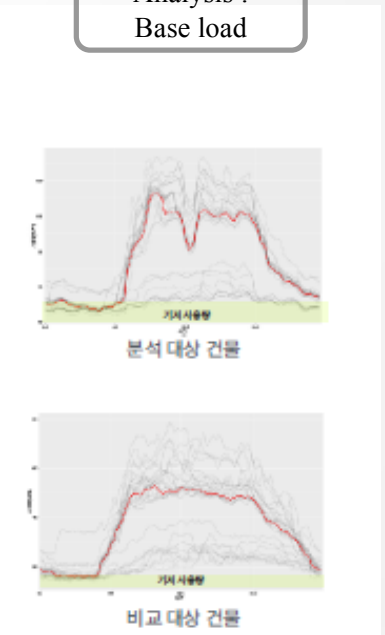

Mobile App.




Analysis : Night




Analysis : Base load

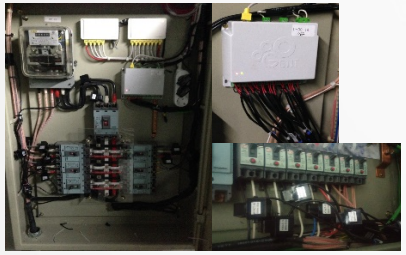


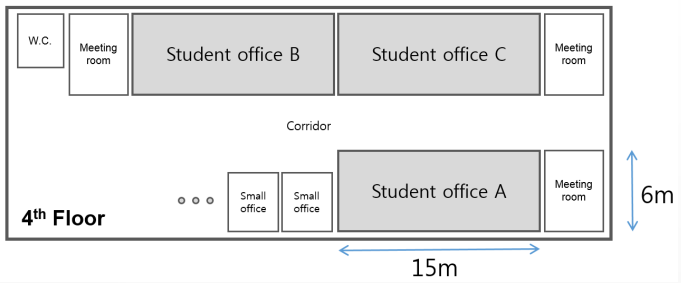
# Virtual Cell Energy Saving

## Customer Participation

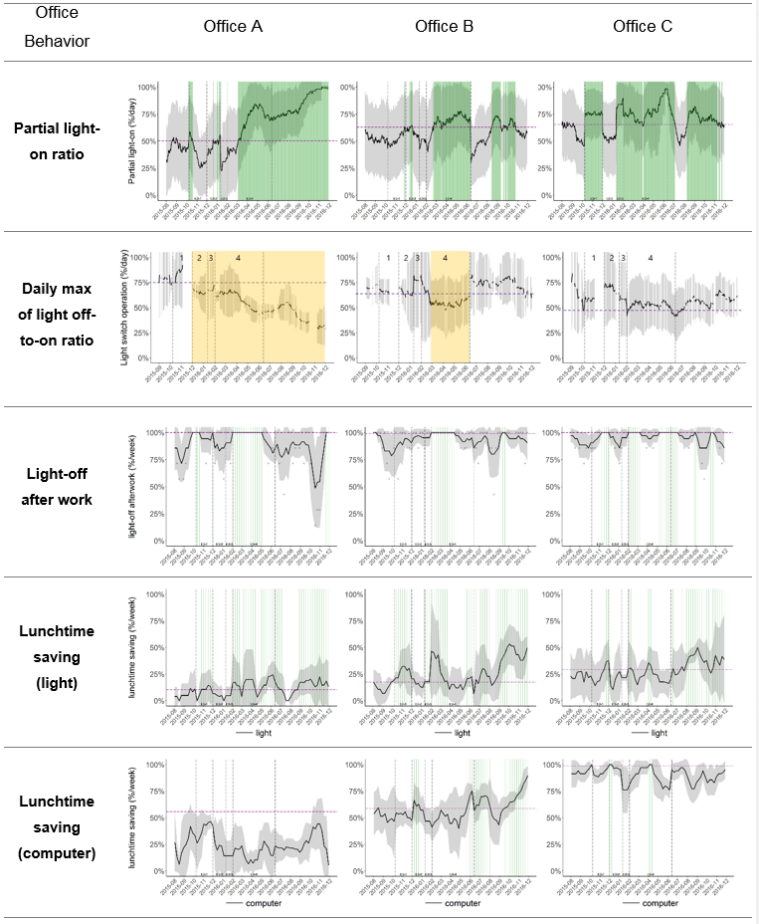
- Campus people participate in energy saving
  - Test site : Graduate student laboratory
  - Provide energy information and rewards

Test site





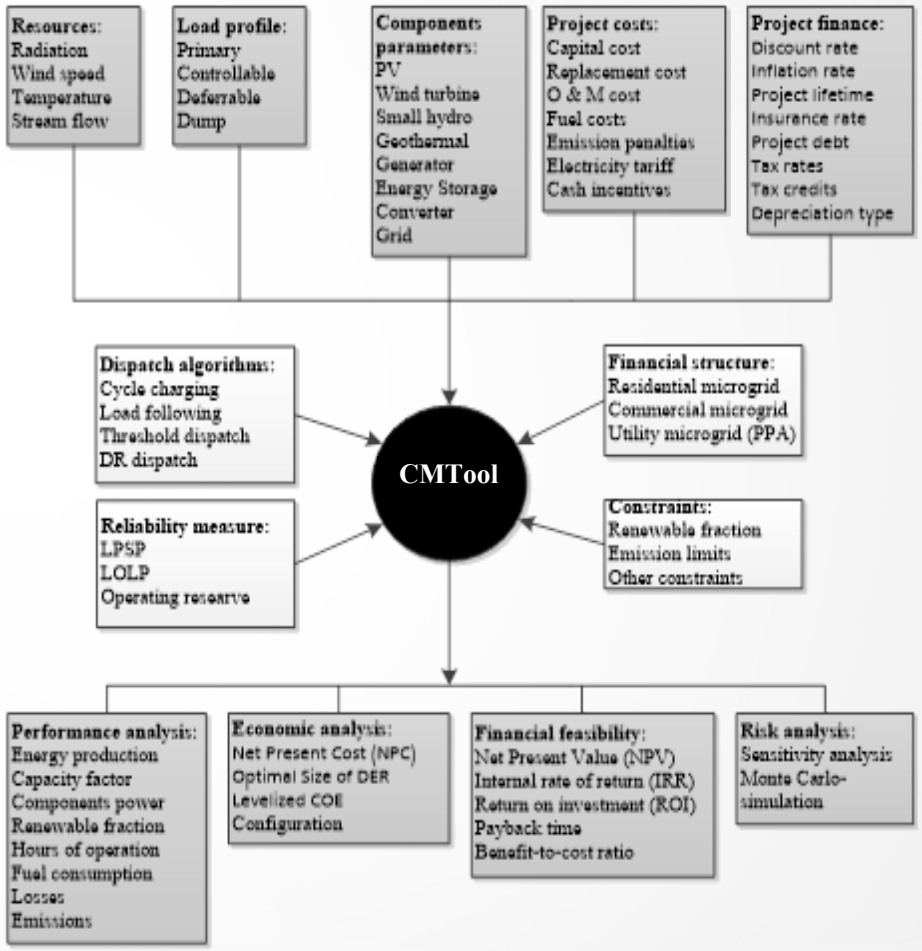

Results



# Campus Microgrid Design Tool

## CMTool (Campus Microgrid optimal design Tool)

- **CMTool**
  - **Performance Analysis Model**
  - **Economic Analysis Model**
  - **Financial Analysis Model**




**Economic Analysis Results**

| | Case 1: Base case (Grid-only) | Case 2: Threshold dispatch | Case 3: Peak shaving dispatch | Case 4: MGTool advanced dispatch |
|---|---|---|---|---|
| NPC | 3,181,600.00 | 3,339,270.00 | 3,051,800.15 | 3,00,230.00 |
| Annual energy charge ($/year) | 177,790.45 | 166,380.43 | 173,054.93 | 163,112.36 |
| Annual demand charge ($/year) | 54,456.00 | 20,733.56 | 20,207.22 | 13,879.00 |
| Annual electricity savings ($/year) | - | 49,881 | 61,843 | 70,207.00 |

| Metric | Threshold | Peak shaving | MGTool optimal |
|---|---|---|---|
| Net present value ($) | -54,238.00 | -30,238.00 | 16,374 |
| Payback period (years) | NA | 10.9 | 8.9 |
| LCOE ($/kWh) | 0.1003 | 0.089 | 0.0871 |
| Net capital cost ($) | 380,000 | 500,000.00 | 612,500 |

[ MATLAB 기반의 프로그래밍]

# Conclusions

Develop the most economic solutions and sustainable business models

- Characteristics of Campus Microgrid
  - Single owned microgrid
  - High possibility for energy saving
  - Various load types
- Purpose of SNU campus microgrid
  - 4 hours islanding operation to critical loads
  - 20% peak load reduction and energy cost saving by cell MG model
  - Consumer participative energy-saving by IoT based Bigdata platform
  - Multi-Microgrid operation with different cell types
- Business model development
  - Premium cell, normal cell, virtual cell model
  - Lego style campus MG model