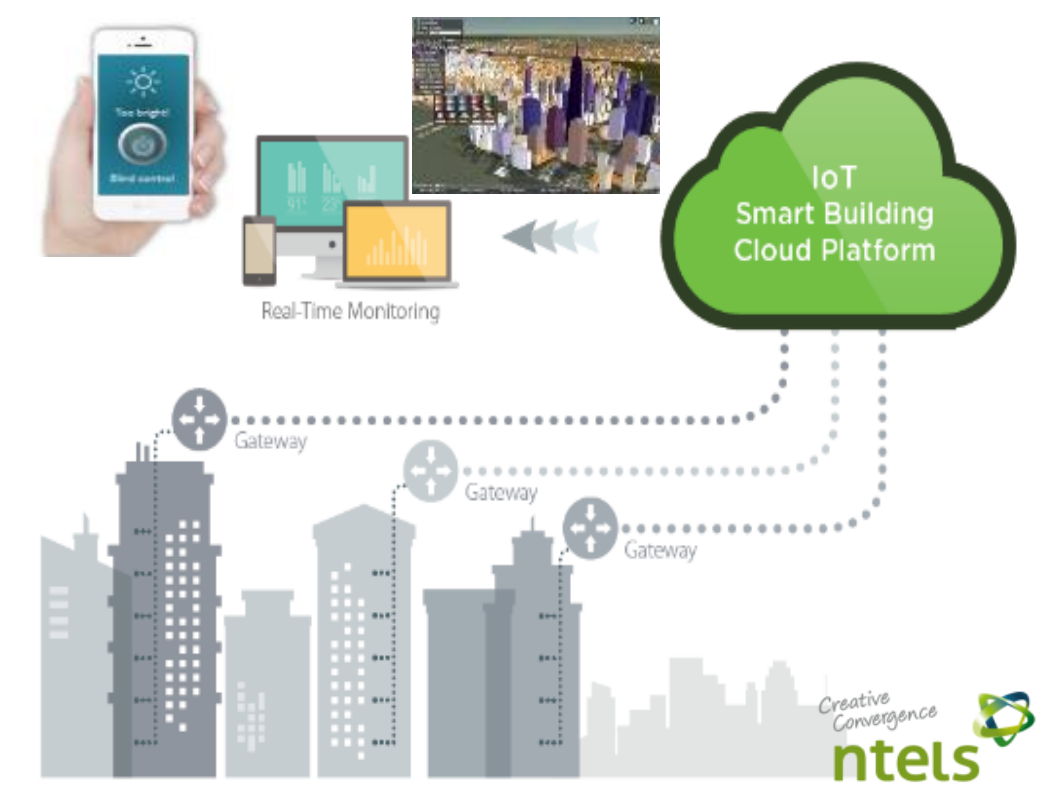Primary Contact : Changsoo Park [cspark11@ntels.com]
Youngjin Lim [young9321@korea.kr]

IoT & AI Smart Building and Energy City Platform in Suwon City
(KOREA Government Project)

2D Map Service
빌딩을 Openlayers3 기반의 2D Map에서 가시화 합니다
바로가기

3D Map Service
빌딩을 Cesium 기반의 3D Map에서 가시화 합니다
바로가기

IoT Smart Building Cloud Platform

Real-Time Monitoring

Gateway
Gateway
Gateway

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Government of KOREA's IoT & AI Smart Buildings and Energy City Initiative

NTELS Smart Building & Energy City Platform was deployed in public buildings in Suwon City to provide optimal management building facilities, environment, and energy using the urban 3D map and 3D spatial modeling. With the M&V engine as well as data intelligence technology with deep-learning, the platform can quickly measure energy performance and determine city energy efficiency.

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과학기술정보통신부
Ministry of Science and ICT

IoT & AI based Smart Energy Management System For Smart City

CREATIVE
CONVERGENCE

INNOVATIVE PLATFORMS FOR BUSINESS INTELLIGENCE

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I. Intro

Smart Energy Management IoTAI Platform & Service for Smart City

*Visual Thinking – Urban 3D Energy MAP

IoT Device

BAS Device

BACnet, Lonworks Modbus KNX, Metasys

*Standardization
(Connectivity)

*Consolidation & Prediction
(Data Integration➔ Analyzing ➔ Learning/Inference)

Building (Dark Data)

Building (Standard Data)

Valuation
(Smart Data)

N ISE™
Smart Gateway

N MAS™
IoT Platform

N BDP™

Data Analyzing & AI(LSTM-RNN)

Energy Management
(Energy ↓ / Energy Demand Prediction & Control/M&V)

Predictive Asset Management

AI

Urban Building Integrated Management
(TCO ↓ /Efficiency ↑)

Smart-Space
(Environment)
Service

Predictive Energy & Asset Management

HUMAN CITY SUWON

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NTELS Smart City Platform & Smart Energy Cloud Service

- We have been offering the smart city platform for local municipalities and smart energy management services for public buildings.

OUT ←

Global Smart City Platform

Capable of connecting with global smart cities like Santander, Spain - globally connected platform and services

IN →

Smart Energy Cloud Service

From a single building, a complex of buildings to an entire city, cloud-based specialized services for smart energy management

UP ↑

Data Intelligence

Through big data-based intelligent analysis, value-up services for sustainable and fast growth

Concept

It's a lot more than simple energy monitoring.
Through customized building energy design, our platform takes energy management to a whole new level.

Energy Design
Versatile and easy-to-modify design to meet various needs

Substantial Energy Savings

ICT
Statistics optimized for big data and system data visualization

Use Case	
	• Cloud BEMS (2011 - 2017)
	• HBEMS (63 Building and Hanwha Life Building in Bucheon) (2014)
	• BEMS for Beijing and Shanghai R&D Center, China (2013)
	• BEMS Certified Seamarq Hotel (2017)
	• Canada ALLIED Cloud IBMS (2016)
	• Cloud IBMS/BEMS for Public Buildings' Energy-Saving Management in Suwon City (2017)

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Introduction to N-ISBCP

" IoT & AI-based *Smart Building Cloud Platform* "

| Key Component | 1 IoT-based **Smart Building Platform** | 2 Building Manager•Tenant **Cloud IoT Service** | 3 LSTM-RNN-based **AI Engine** |

Key Value

IoT Platform-based Cloud Management + AI-based Facility Management + AI-based Energy Management + AI-based Environment Management

Service Domain

| Cloud Building Management Service | Predictive Maintenance Service | Energy Saving Service | Indoor Environment Quality Service |

Service Scope

NTELS ISBCP provides integrated building management services to different BAS-ready buildings (Isolated BAS, Partial BAS and Non-BAS buildings).

ISBCP: IoT Smart Building Cloud Platform
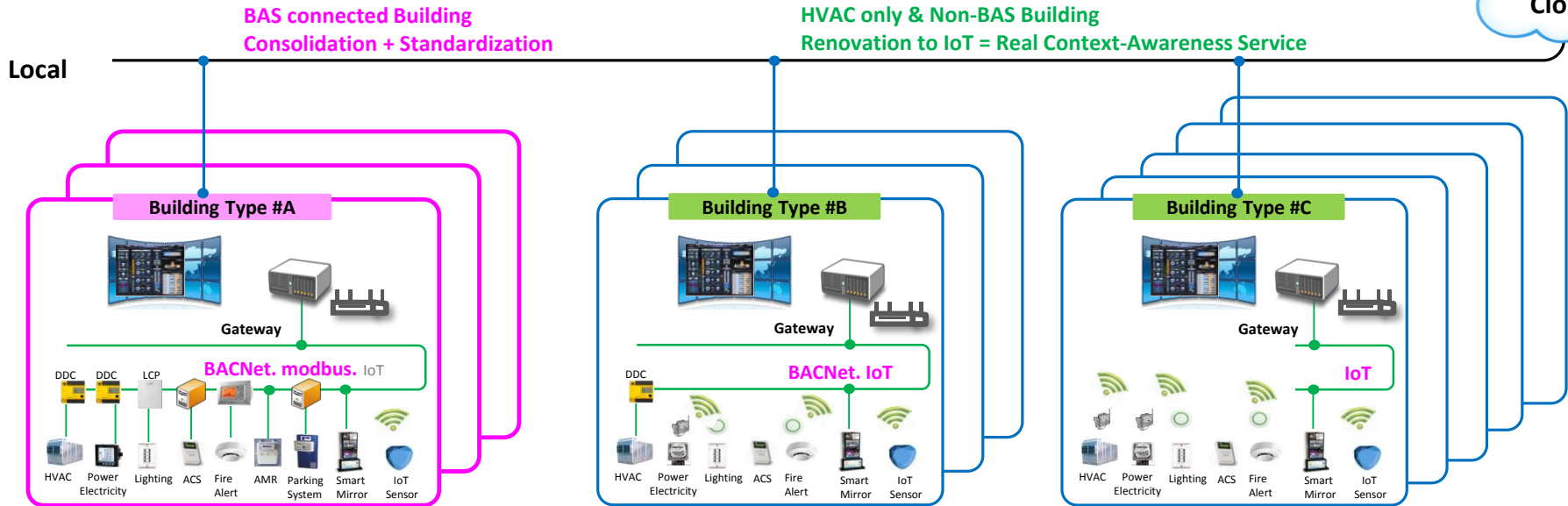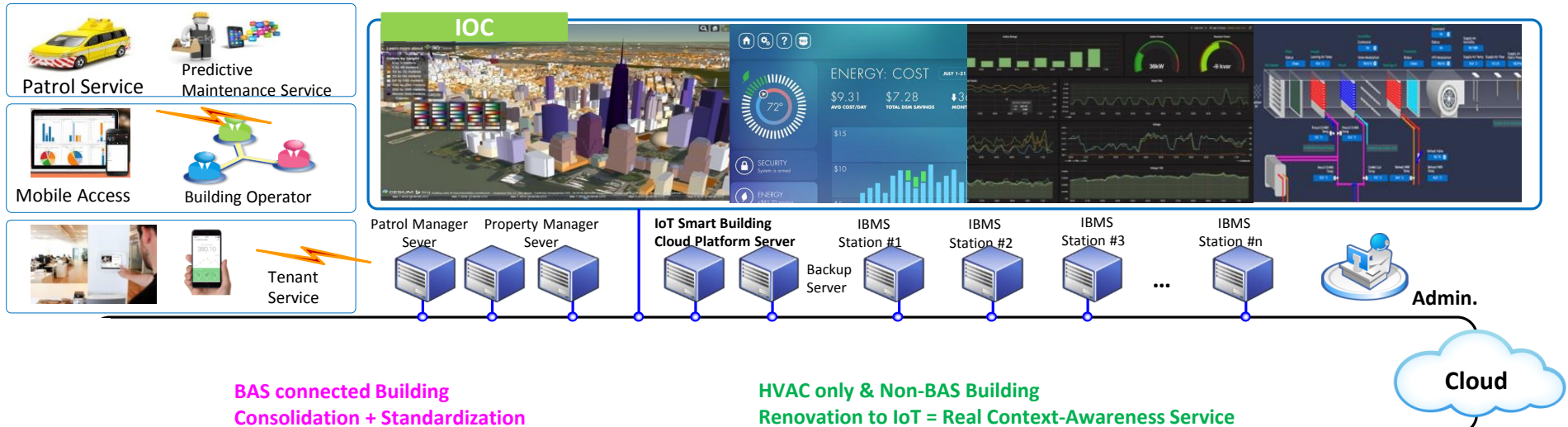
Service Scope – Reference(Suwon City Energy Management)

1 HW구성 - BAS & IoT Hybrid Platform & Service
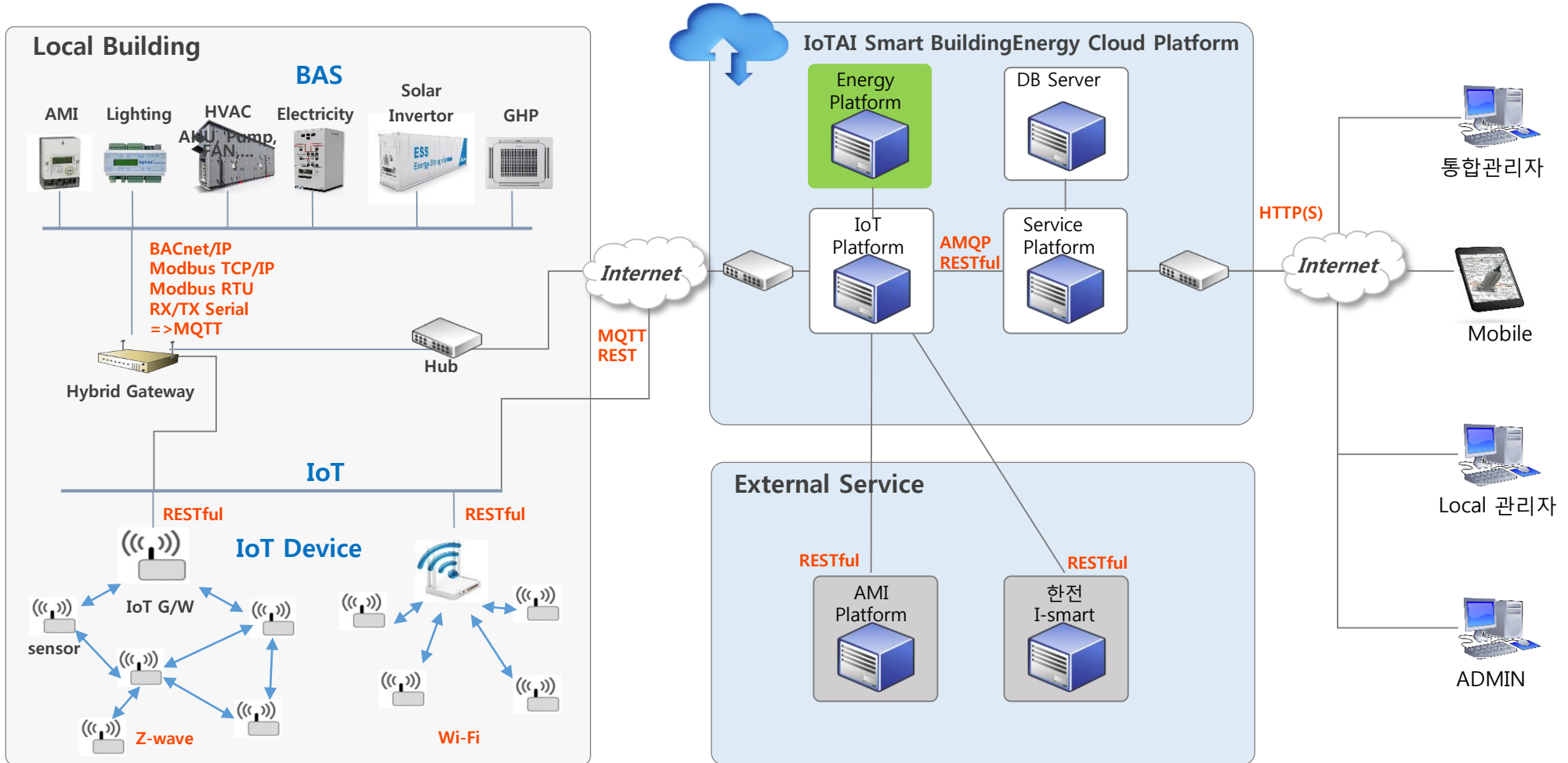
Data Flow

2 **Data Flow**

Data Flow
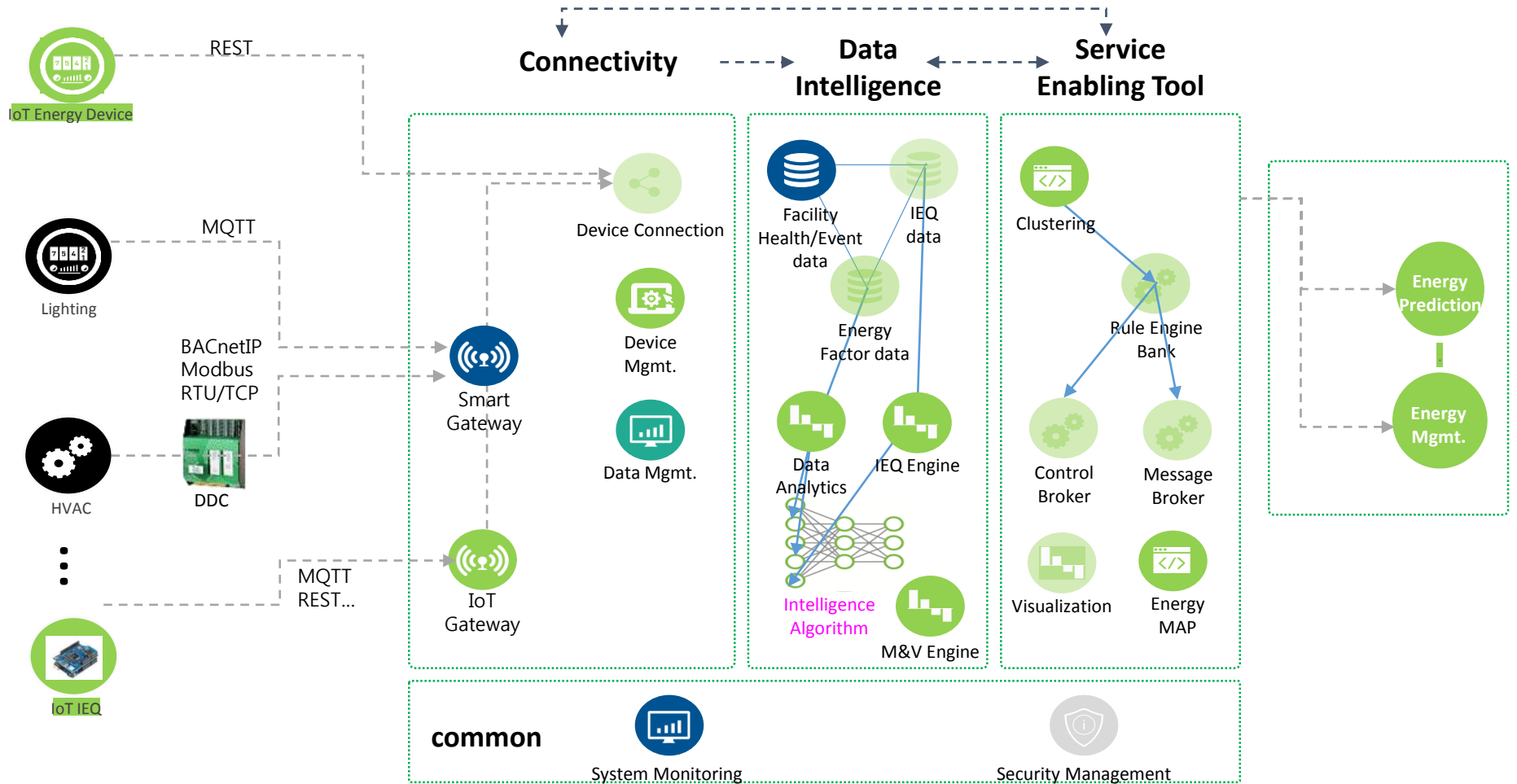
Basic Architecture

3 Cloud-based IoT smart building platform architecture
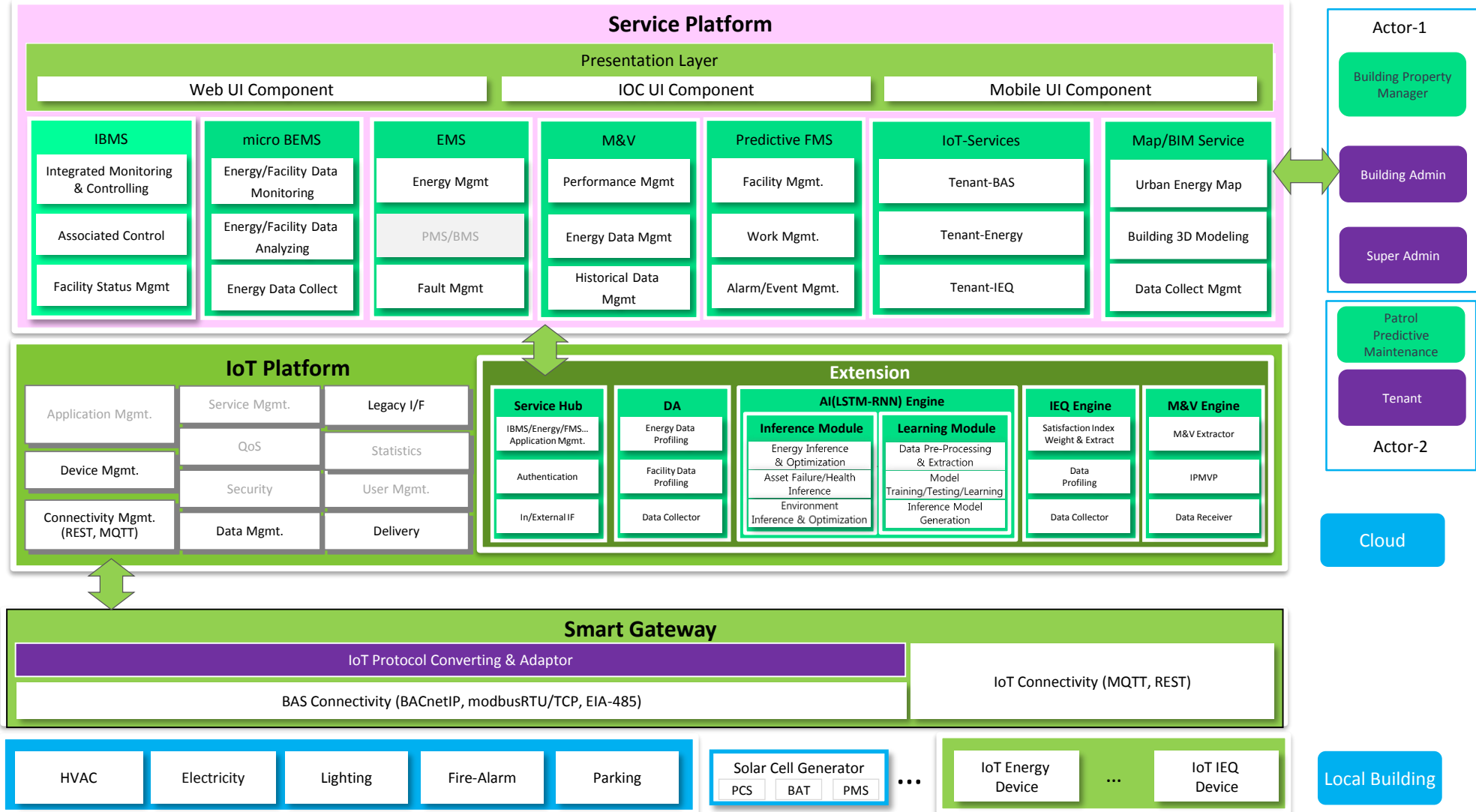
Service Domain

N-ISBCP service domains, effects, and interaction methods from an angle of the stake holders

Stake Holders	Service Domain	Service	Effect	Interaction
Building Owner (landlord, property manager)	Property Management Service	Building Energy Map Service	Energy Saving	Smart Building Platform Web (Landlord) **Landlord Mobile**
		Tenant Energy Tree Service		
	Advertisement Service #1	Advertisement Revenue Manager Service	New Sources of Revenue	
	System Integration Service	Simplification of Building System Infrastructure	Low Cost for Establishing System Infrastructure	
		Building Utility Manage & Reporting Service	- Low Cost - Efficient/Standardized Operation and Service	Smart Building Platform Web (Operator) **Operator Mobile**
Building System Operator		Building System Integration & Control Service		
		Prediction of Power Demand Service		
		Associated Control Service		
		Standardization		
Facility Management Company	Patrol Service	Facility Management Service		Smart Building Platform Web (Patrol) **Patrol Mobile**
		Maintenance Ticket Service		
Neighborhood Commercial Center	Advertisement Service #2	Real-time Advertisement Service	- Low Cost - Profitability - Convenience	Smart Building Platform Digital Signage (Building) Smart Mirror (Tenant) **Tenant Mobile**
		Real-time Rate Information/Coupon/On-line Delivery Service		
	Unified Billing Service	Real-time Usage/Rate Information Service		
Tenant		Online Payment Service		
	Private Service	Context-Awareness Service (Energy, Environment)		
	Information Service	Building Information Service		

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Service Component

Solution	Package	Solution	Function	Description
Package	2D/3D Map	Urban Energy Map	Urban 2D/3D Energy Map	2D/3D-based energy map service for integrated building management
Package	Hyper-Connectivity	IoT Gateway	Connectivity (BACnet, modbus / MQTT, REST / File, DBMS, TCP)	Interface with BAS protocol
				Near real-time data collection in DBMS and CSV
				MQTT and REST interface with IoT sensors
Package		IoT Platform	Connectivity (Restful, CoAP, MQTT, Socket)	Support for various protocols (RESTful, CoAP, MQTT, Socket) to collect data from devices
			Device Management	Device profile management (Manufacturer, Model, Serial Number, Reporting Cycle, F/W Version, S/W Version, H/W Version, etc.)
			Node Management	Node profile management (Manufacturer, Model, Serial Number, Reporting Cycle, F/W Version, S/W Version, H/W Version, etc.)
			Data Management	Sensor data collection (optional)
				Delivery of data collected from devices to applications using polling with RESTful open APIs and real-time push methods via AMQP
Package		Service Hub	N-MAS Interface	Device registration and connection through N-MAS
			Data Management	Raw data storage and management
				Annual, monthly, daily and hourly statistics for floor energy consumption, operation hours, etc.
			Control	Real-time node control
				Scheduled control for specific times and days of the week
Package	IoT Device/Service	IoT Energy	IoT CT Sensor-based Energy Monitoring	Electricity consumption analysis and comparison by purpose, user and period
		IoT IEQ	IoT IEQ Sensor-based Indoor Environment Analysis	Indoor environment analysis and satisfaction monitoring using IoT multi-sensor (temperature, humidity, CO2, PM2.5, brightness)

Service Component

Solution	Package	Solution	Function	Description
Package + SI	Mobile	TVS	BAS, IoT (IEQ, Energy) Interface Control & Monitoring	Mobile services for tenants, including BAS interface, energy monitoring and inquiry handling
		PMS	Building Facility Detection & Maintenance	Mobile maintenance for building facilities
Package	Hyper-Intelligence	M&V	Energy Saving Result Analysis	IPMVP logic-based energy saving result analysis
		AI	Energy Demand Analysis & Forecast	Demand forecast and optimized control through LSTM-RNN algorithm-based energy consumption analysis
			Electricity Peak Demand Forecast	LSTM-RNN Algorithm-based electricity peak demand forecast and energy savings by interfacing with ESS
Package	IBMS	HMI	Dashboard	Energy consumption trend, electricity peak, index/alarm, consumption by energy source, TOE, CO_2
			HVAC	Control & monitoring of cooling, heating, ventilation, hot water systems
			Lighting Monitoring & Control	Lighting monitoring and control by zone and according to schedule
			Power Electricity	Electricity monitoring and alarm generation for electricity peak
Package + SI		Energy	Energy Monitoring	Electricity consumption analysis and comparison by purpose, user and period
			Facility Monitoring	Analysis and comparison of facilities' operation hours, efficiency, performance and energy consumption
			Statistics Analysis, Consumption Forecast & Optimized Control Plan	Energy consumption forecast, facility control and renewable energy use plan establishment
			Energy Target Management	Energy goal setting and accomplishment status view
			Report Creation	Overall reports on building energy consumption
			Baseline Information Management	View, input and modification of baseline information, such as TOE factor, heating value and unit price per energy source
Package + SI	SEM	EMS	Electricity Generation Monitoring	Solar-light power generation monitoring in real time
			Generation Efficiency Monitoring	Monitoring of DC/AC voltage & current, energy conversion efficiency
			Real-Time Trend	Energy trend in charts on a daily, monthly and yearly basis, containing AC/DC power, solar radiation amount and facility generation efficiency

II. Hyper Intelligence Algorithm

AI(LSTM-RNN)

Predictive energy & facility management using LSTM-RNN algorithm

Long Short Term Memory Recurrent Neural Network Algorithm

• **Recurrent Neural Network** : Learn the sequential data to perform classification or prediction
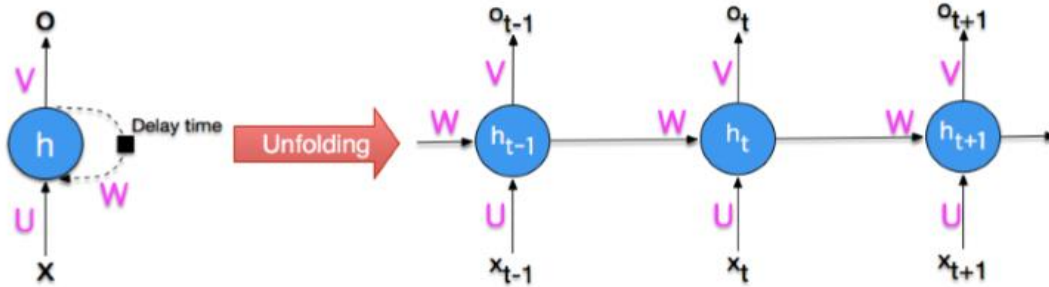
Using the LSTM in H-L for figure out the Vanishing gradient problem

• **LSTM-RNN** : Apply the LSTM to Stacked RNN Structure
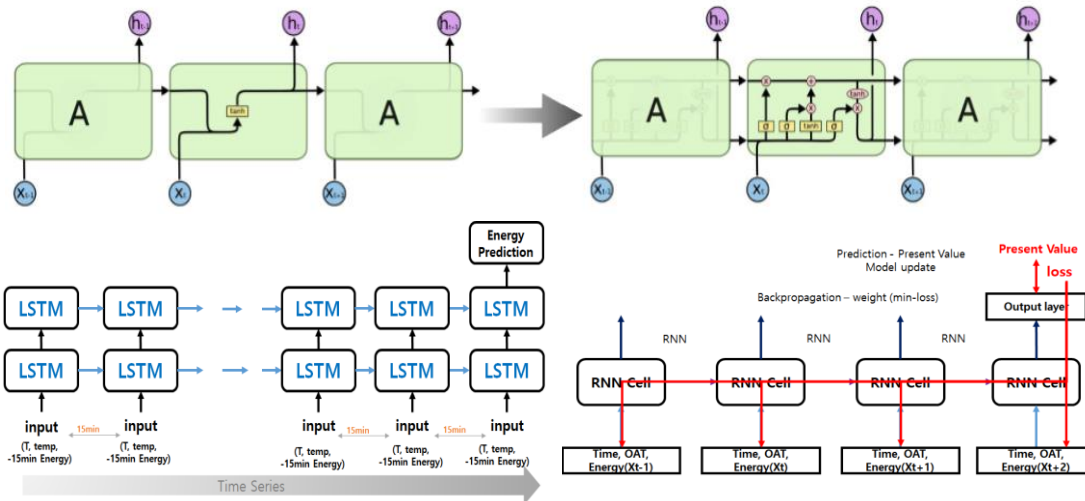
Feature of LSTM-RNN

1 • Predict of the Energy (Peak Elec. Demand, Optimal Control of Power Electricity)

2 • Predict of the Asset/Facility Fault & Health

※ Successful application of AI depends on a sufficient data set

ESS

Peak Control

Energy Data

KECO
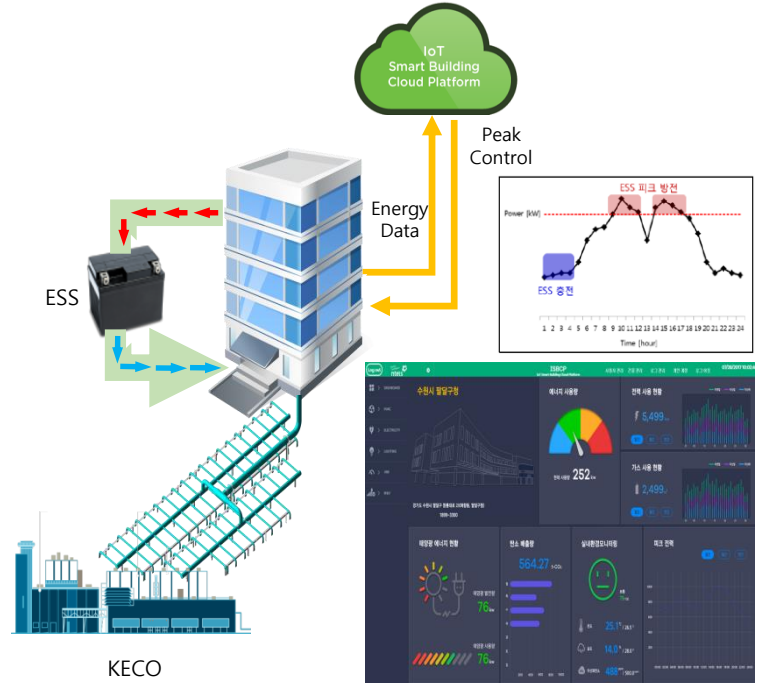
M&V Plan

Energy saving performance estimation by M&V algorithm

M&V Interface
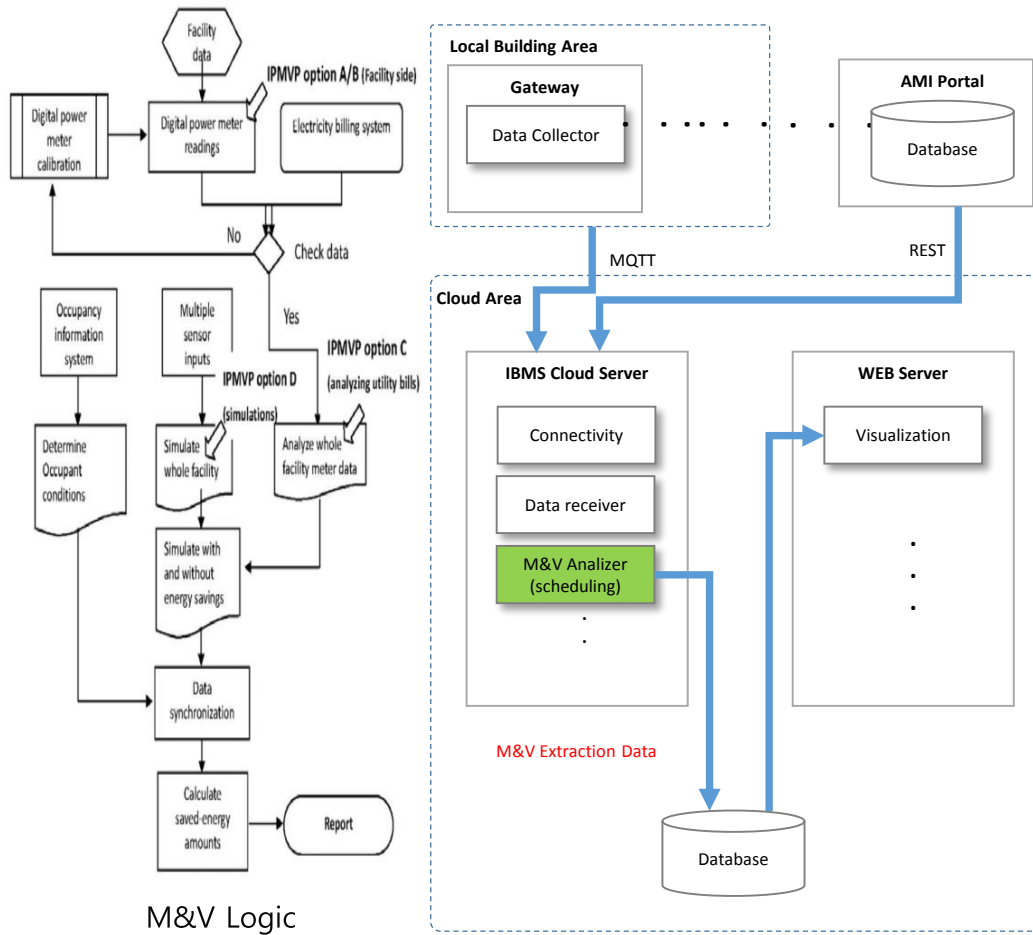
M&V Logic

Feature of M&V

Item	Description
Connectivity	Gateway MQTT, AMQP, REST
Data receiver	Building Energy Data Collect & DB Loading
M&V Analizer	IPMVP based M&V Logic Running & data extraction ✓ Input : JSON ✓ Output : CSV
Visualization	AMR chart/ELK
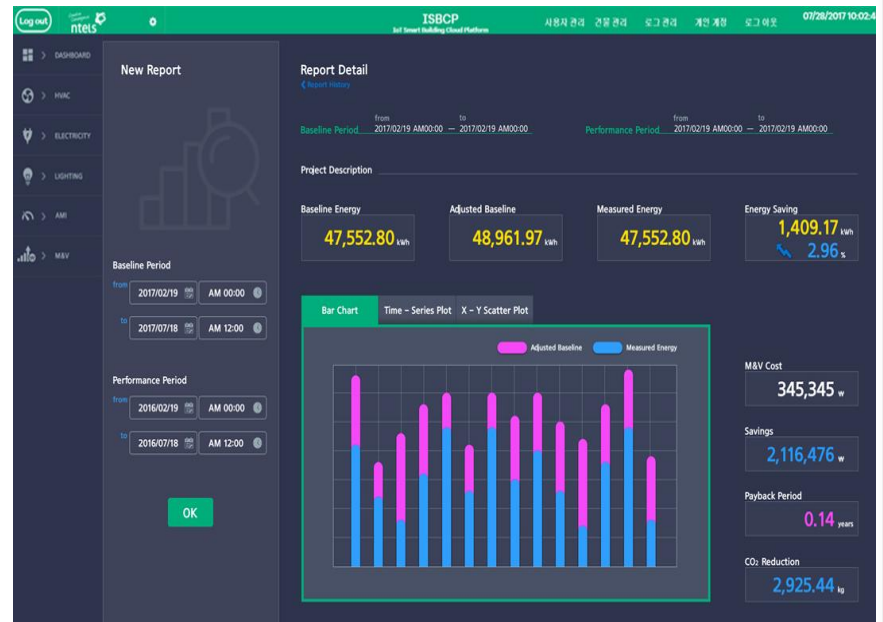
ANN based IEQ

Indoor environment quality improvement using ANN algorithm

IEQ Algorithm

Multi-Sensor

ANN Algorithm

Running the Algorithm with indoor air quality standard index and CMM index

Measure the satisfaction of tenant
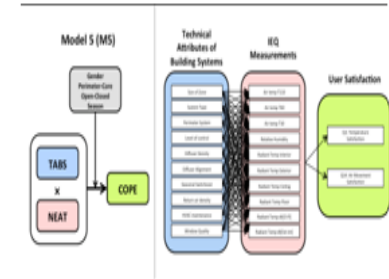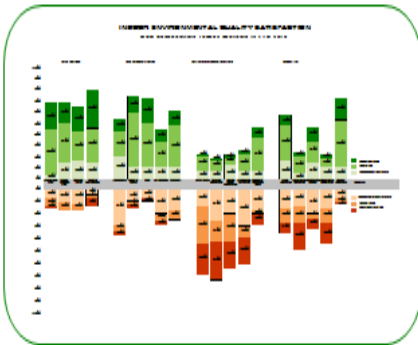
Feature of IEQ
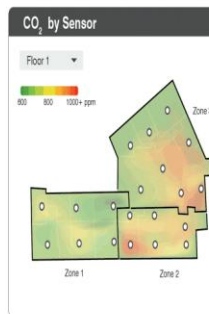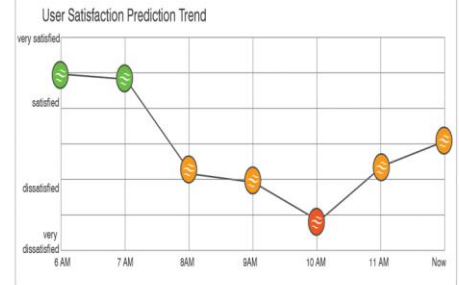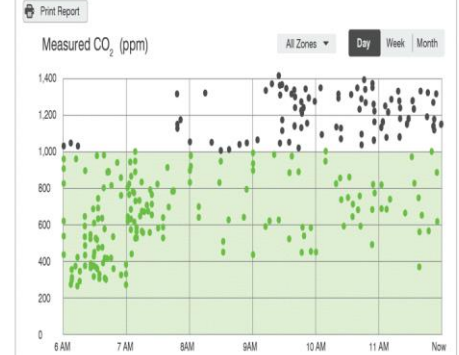
III. UX of Smart Energy & Asset Management System

UX/UI of N-ISBCP

- 3D Urban Energy Map & Building Energy Modeling System's Screen

1 Log-In(SSO)

2 Earth

3 Scroll to Destination Point

4 Managing of Urban Energy Mgmt. MAP

5 Managing of Each Building's Energy Consumption & Trend

6 Managing of Each Building's Energy M&V

n Managing of Building Energy 3D Modeling

20

UX/UI of N-ISBCP

▪ Cloud-based Integrated Building Management System's Screens

1 Management of Group of Buildings with Urban Energy Map
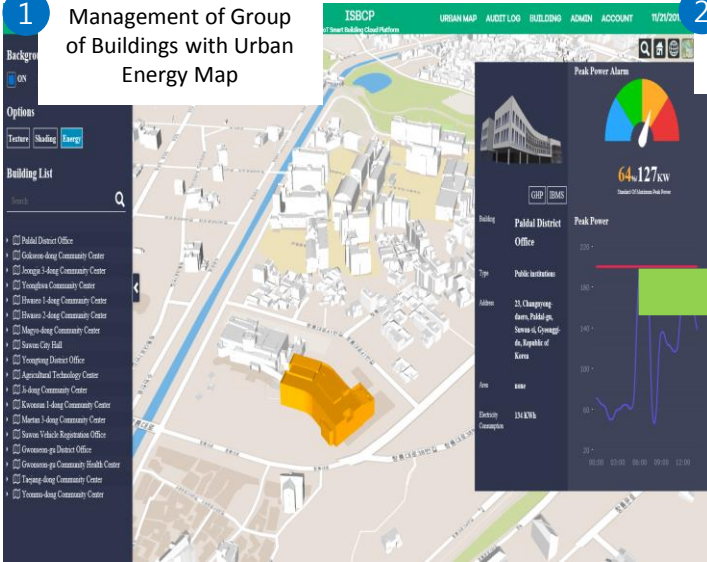
2 View of Specific Building (Dash board)

3 •View of Energy Monitoring (Source)
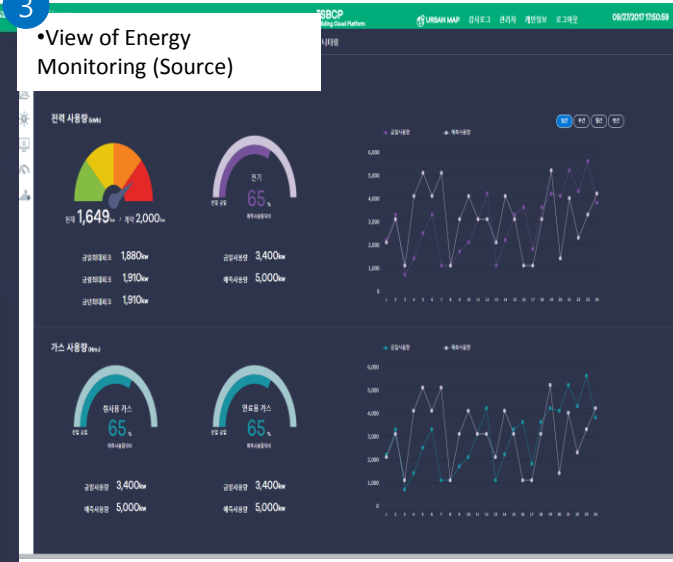
4 Managing of Energy Usage Goal

5 Managing of Facility Status

n View of M&V (Energy)
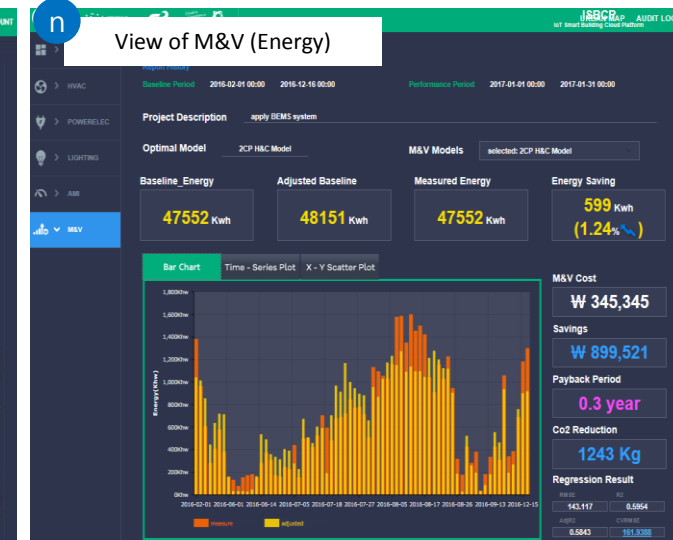
UX/UI of N-ISBCP

■ Cloud-based Building Energy Management System's Screens

1 Dash Board

2 View of Energy Monitoring (Source)

3 View of Energy Analysis

4 View of Energy Usage Source

5 Managing of Energy Usage Goal

n Report
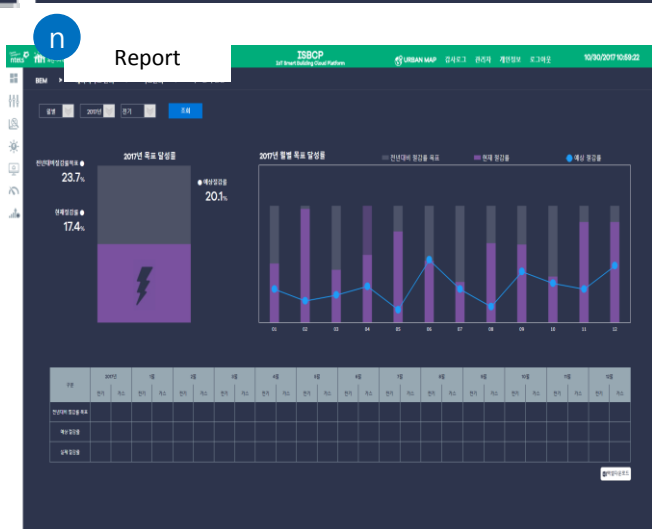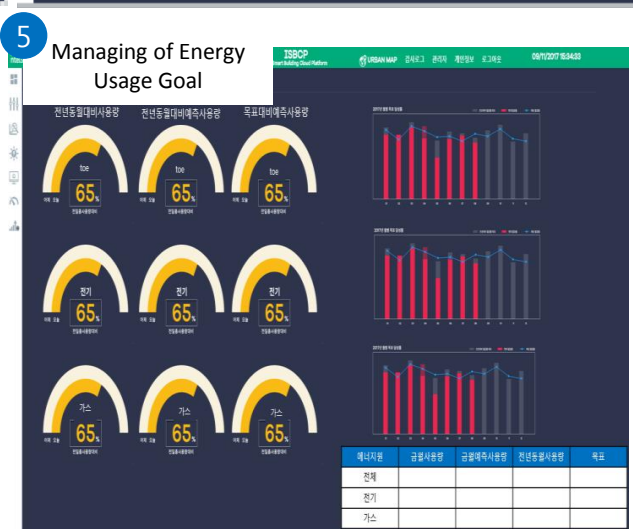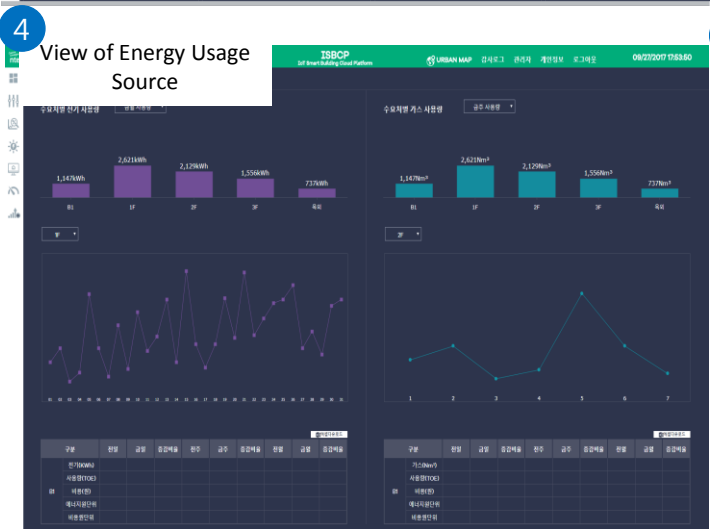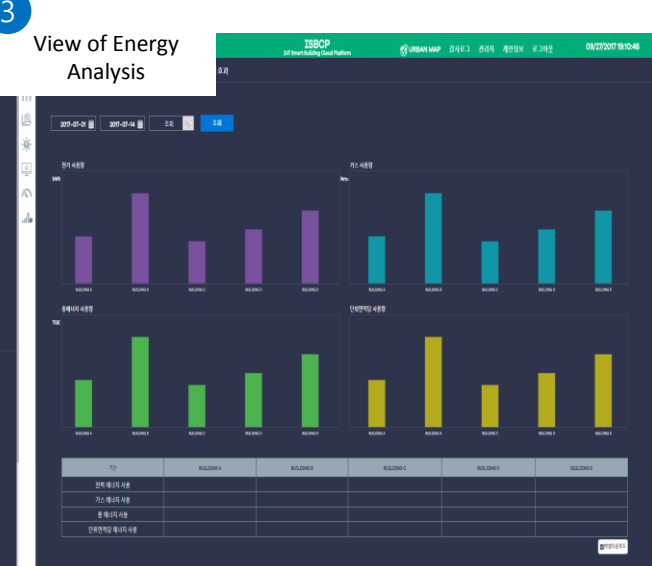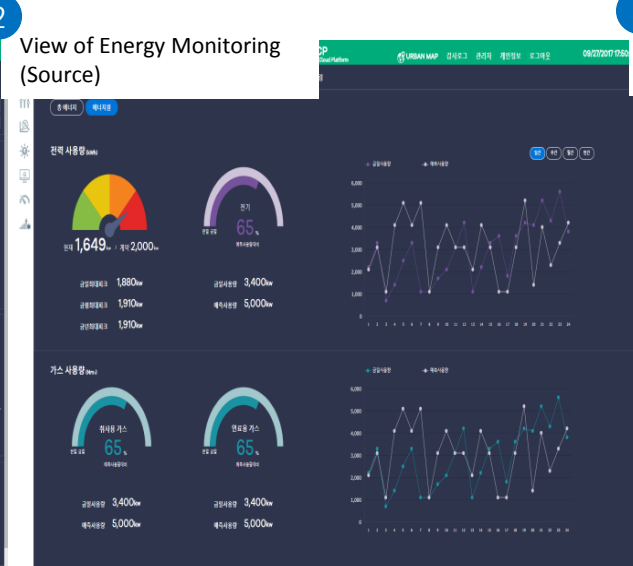
UX/UI of N-ISBCP

▪ Mobile Service Screens

1 Mobile Intro

2 View of Energy Monitoring

3 View of IEQ Monitoring

4 Lighting Scheduling & Management

5 Temperature Scheduling & Management

n M&V & Maintenance

References

References: 2011 - 2017

NTELS Cloud BEMS is an enterprise-level service designed to analyze and manage energy consumption of multiple buildings.

<u>History</u>

- 2011 : Cloud BEMS Prototype Open (3 buildings)
- 2012 : Cloud BEMS 1.0 Commercial Launching
- 2014 : Cloud BEMS 2.0 Launching
- ~Dec., 2017 : 61 Building managed by Cloud BEMS 3.0

[Cloud BEMS Center]

<u>Key Features / Benefits</u>

- Multi-Tennant Service
- Fast Tennant Extension (90 Days per New Building)
- Easy Scale up & Scale out (Cloud-based Service)
- Various Sensor, Meter, and Facility Supporting
- Real-time Data Collecting
- Usage & Pattern Analysis Supporting
- Facilities & Energy Efficiency Report
- Energy Advisory Report

References: 2016

■ **ALLIED REIT** http://alliedreit.com

Allied is a leading owner, manager and development of urban office environments that enrich experience and profitability for business tenants operating in Canada's major cities. (Allied owns more than 150 buildings in Canada, and they has a rental business)

● **Revenue Streams**

- Cost Saving of TCO
- Cost Saving of Energy
- Cost Saving of IBMS(HMI) Infra Solution
- Maintenance Cost Saving
- Tenant Service Profit
- Advertisement profit (Smart Signage)

● **Building Energy & Facility Management on a Cloud Platform**
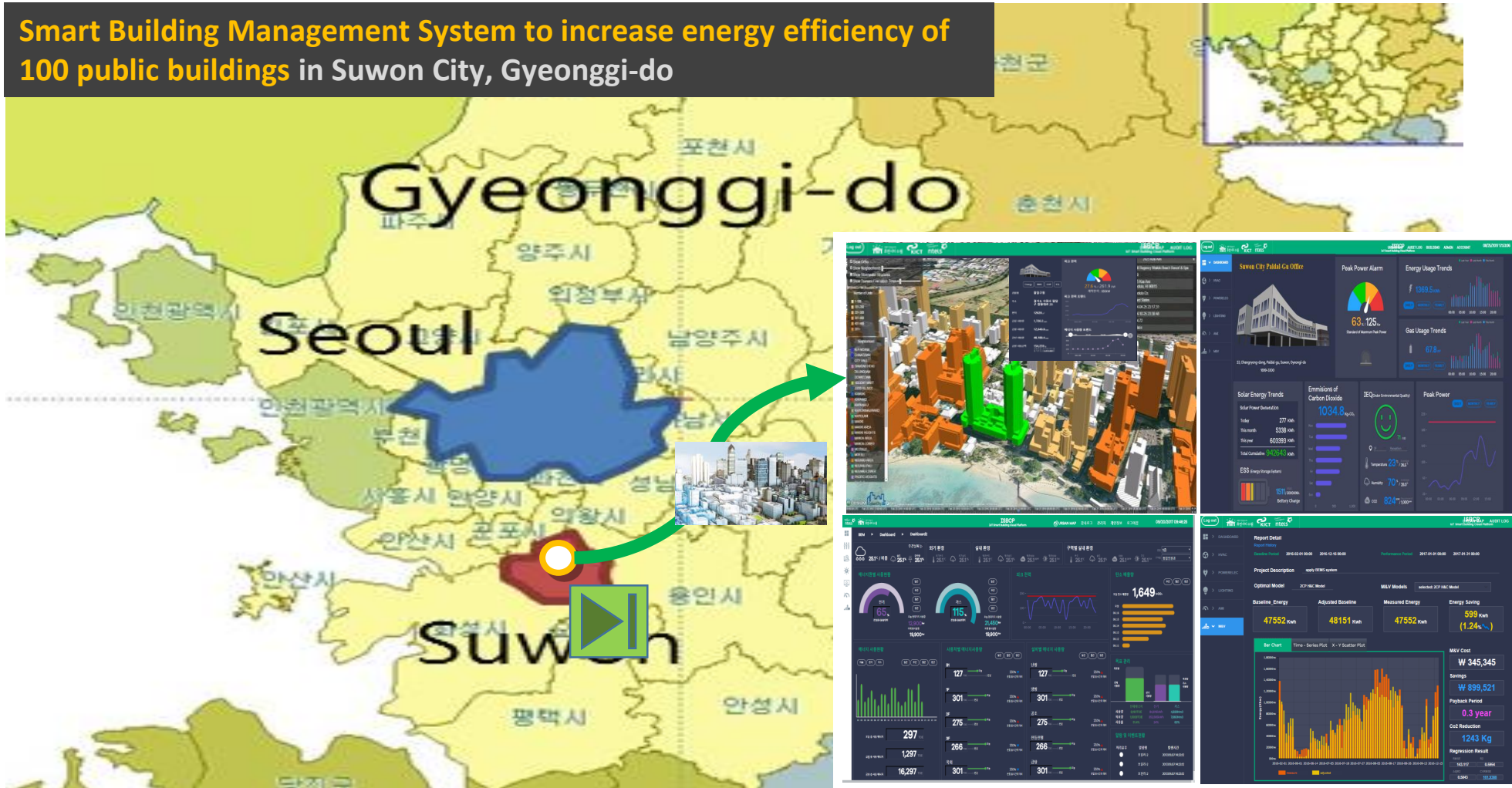
References: 2017.6~2018.12

- **Suwon City in Korea**

As part of national research projects of Ministry of Science and ICT, urban 3D energy map-based Cloud Smart Building Management System was implemented for 100 public buildings in Suwon City

Smart Building Management System to increase energy efficiency of 100 public buildings in Suwon City, Gyeonggi-do

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