Above SAT

Introduction of SAT's ESS

2018. 01. 26 Ver.04

Contents

Overview _ Company Introduction

SAT, founded in 2004, manufactures and sells Energy Storage System, LED Lighting, Semi-conductor equipment and Battery material. Since its flotation on the stock market, SAT has reinforced investment in eco-friendly and renewable energy. Based on proven technology and wide experience, SAT has developed an excellent reputation not only in Korea, but globally across the world.

Overview _ Field of Business

ESS

Energy Storage System

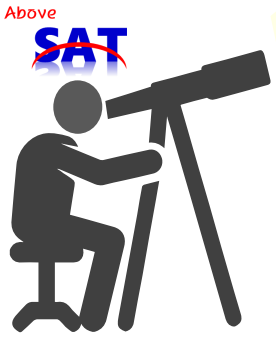
LED

LED Lighting

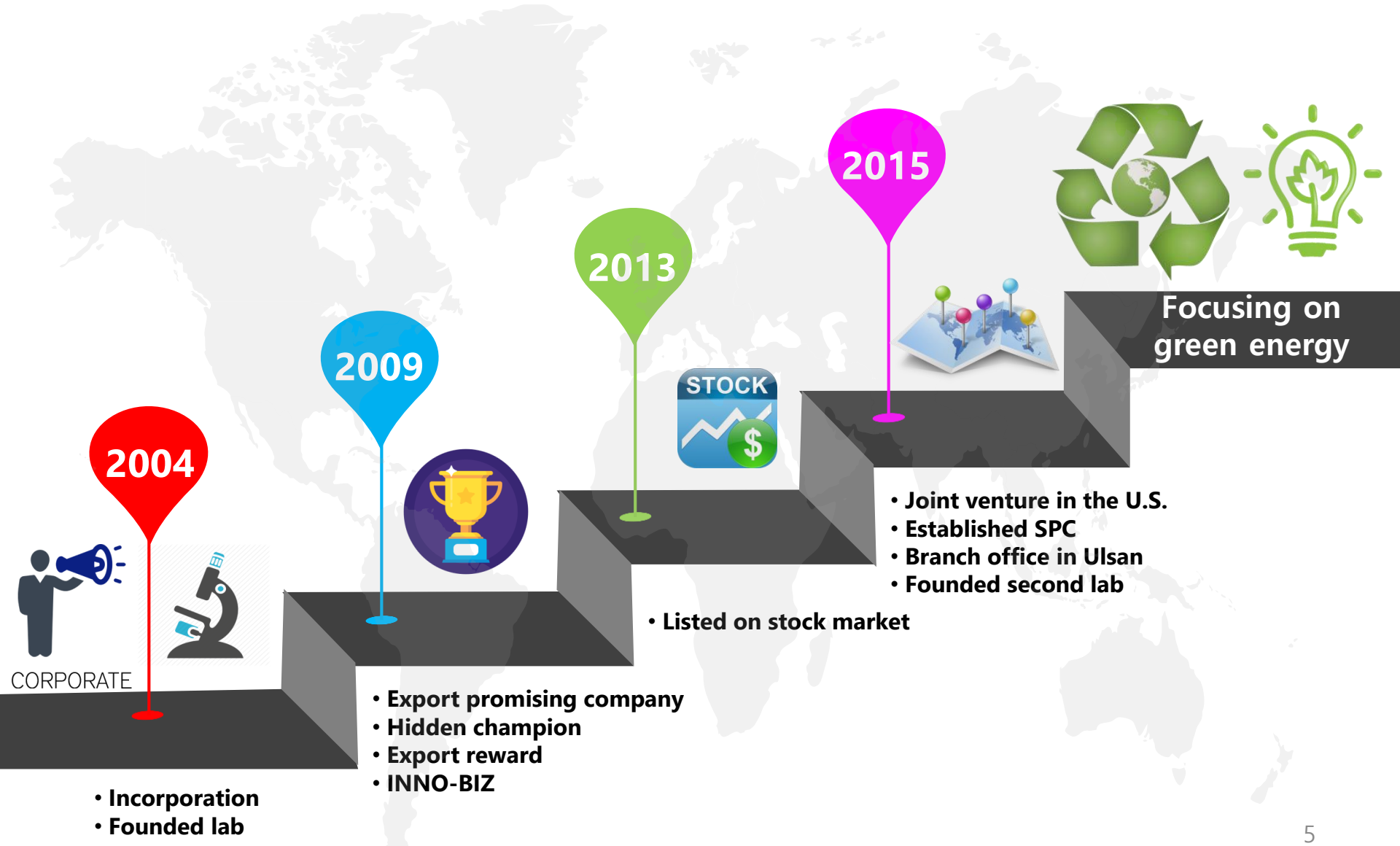
Battery Material

LCD

Semi-conductor Equipment



Overview _ History of SAT



Why ESS _ Issues with existing grid system

Inefficiency

- About 60% of electricity losses during the power transmission
- Centralized generation and simplex transmission
- Inefficient power supply by passive distribution network

Air Pollution

- Excessive Co2 emission
- Serious air pollution

Emergency Situation

- Damage and Loss due to power outage
- Safety problems related to medical equipment failure, program loss, elevator stoppage

Why ESS _ Issues with existing grid system

Environmental Disaster

- A danger from natural disaster like earthquake or flooding
- Serious damage to human life and eco system

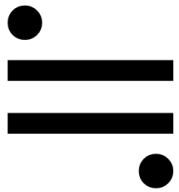
Site Limitation

- Limitation on a construction site for large scale power plant
- Transmission congestion occurred by uneven distribution

Why ESS _ Definition of ESS

-ESS(Energy Storage System) : Energy Storage system is the set of methods and technologies used to store electricity which is being consistently produced to meet consumer demand

Battery for electric devices



Battery for home and building

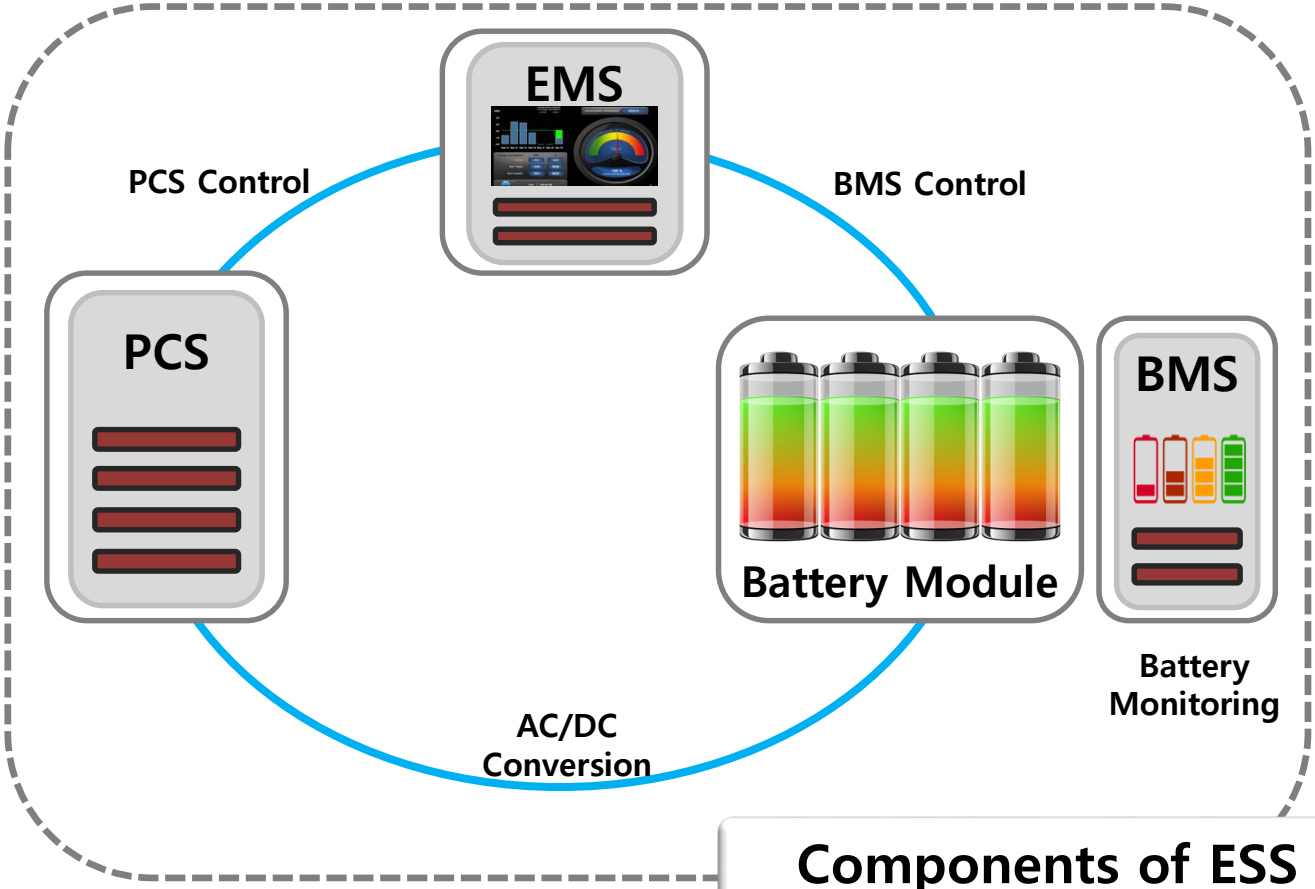
Home with ESS is an independent power plant

Why ESS_ ESS Concept and Configuration

-ESS is an integrated system which consists of Battery(Battery module +BMS), PCS(Power Conversion System), EMS(Energy Management System)

Renewable Energy

Transmission
(Charging)



Components of ESS

Why ESS _ ESS Solutions

Electricity Bill Reduction

- Reduction of electricity charges by lowering the peak power
- Storing energy when the electrical cost is low, discharging energy when it is high

Renewable Energy Integration

- A booming trend of expanding renewable energy
- Unstable power supply caused by specific situations like climate change
- Improved power quality by using ESS

Emergency Backup

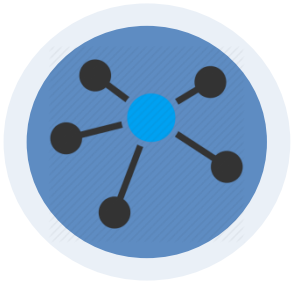
- Stable power supply in an emergency situation
- Backup power during power outage
- Replacement of existing emergency power like UPS(Uninterrupted Power Supply)

Why ESS _ ESS Solutions

Power Supply Management

- Charging during high supply and discharging during high demand -> efficient balance between supply and demand
- Power quality improvement by FR (frequency regulation)

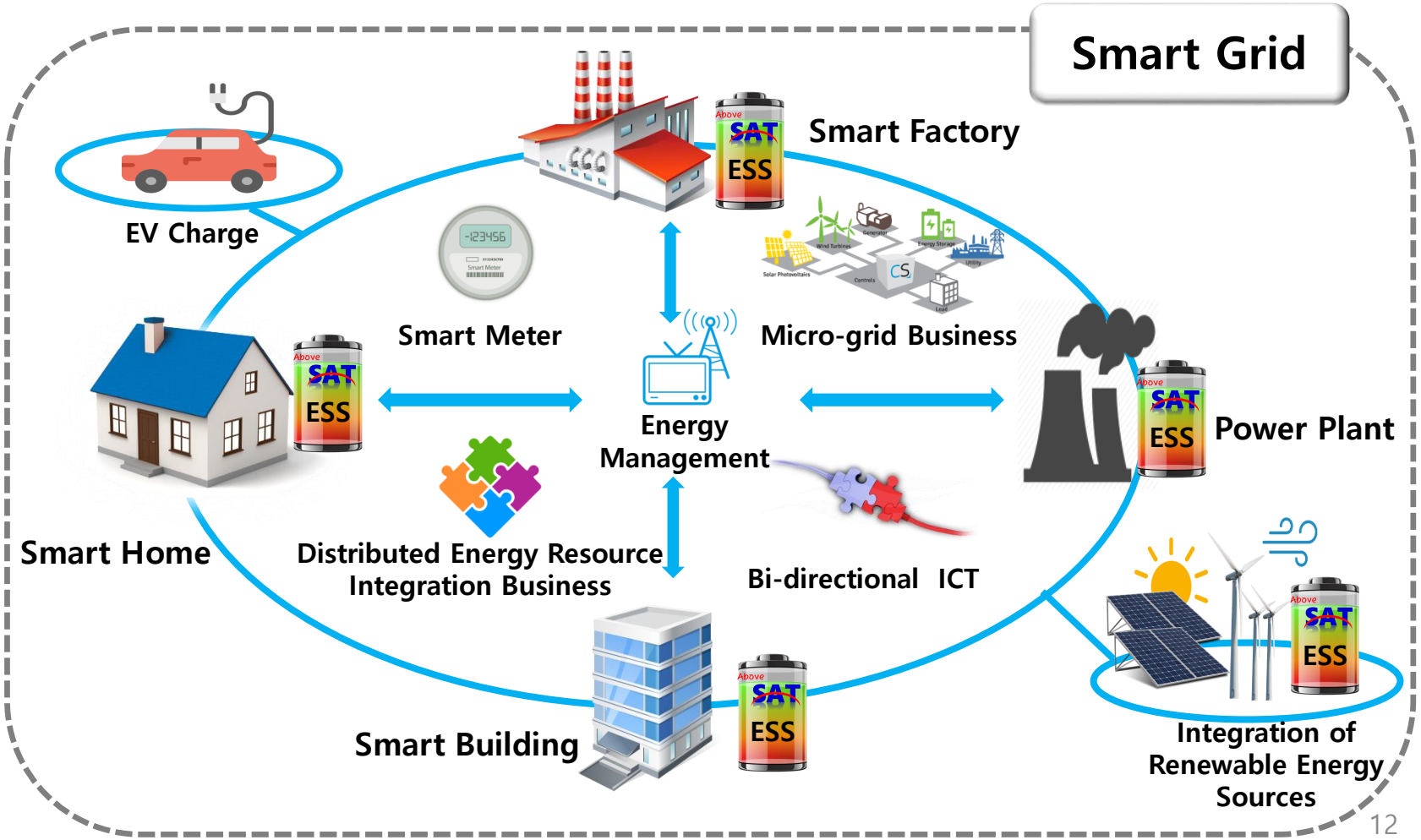
Smart Business Links



- Smart integration of home, factory and building based on IoT
- Realization of independent power system by Micro-grid concept

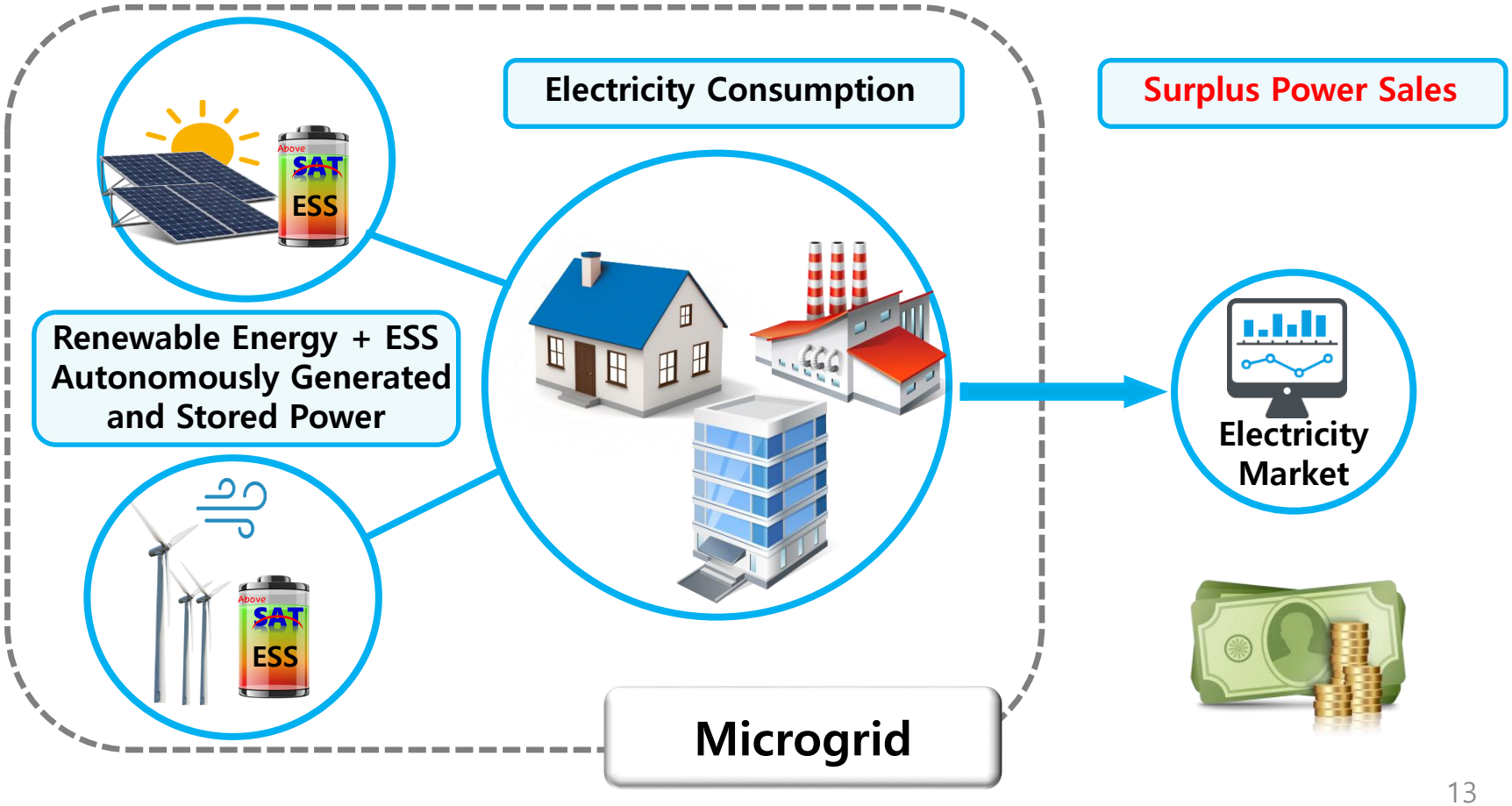
Why ESS _ Smart Grid

-Smart Grid : A smart grid is an electrical grid which includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficient resources. ESS plays a key role in Smart Grid



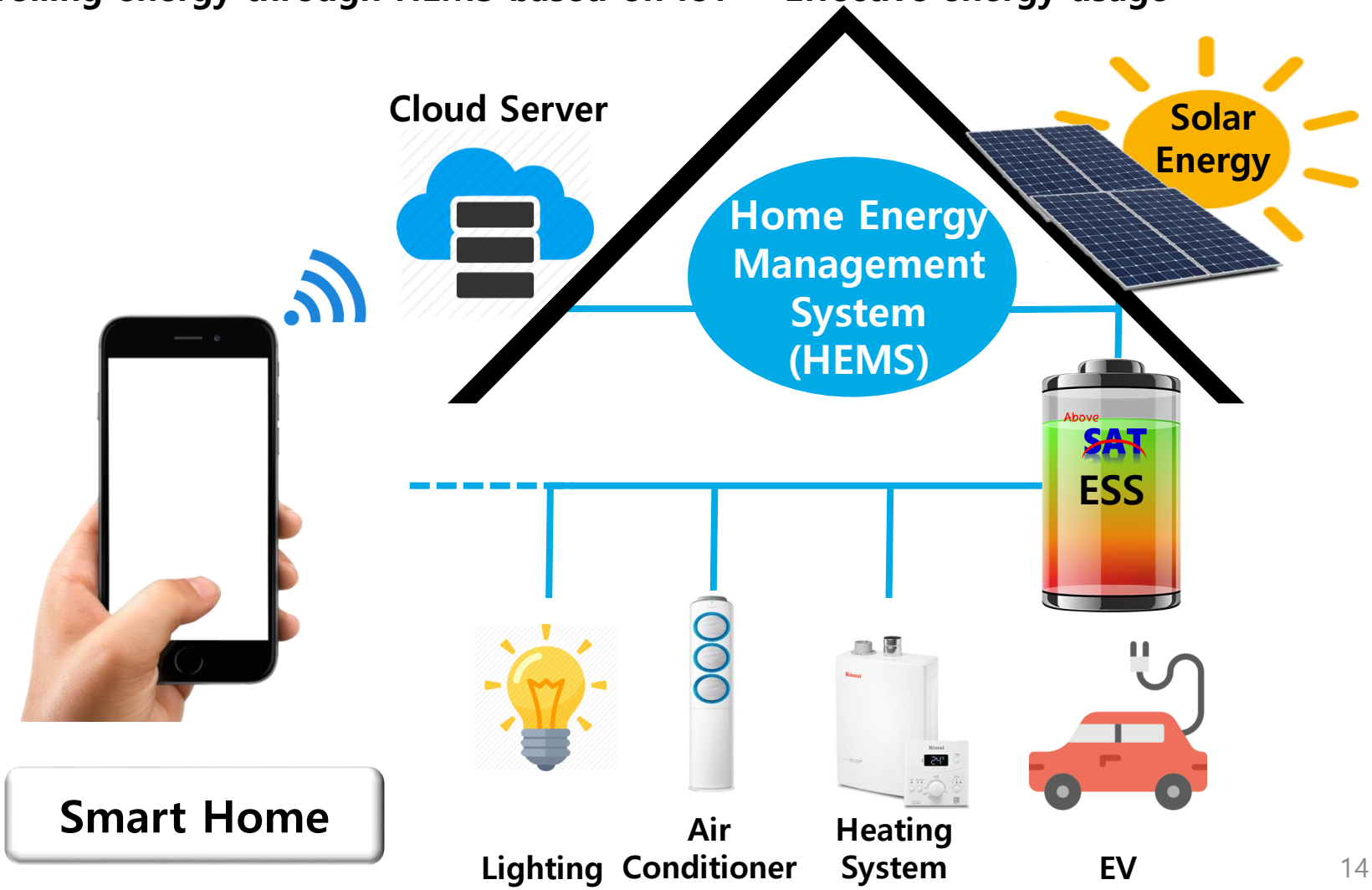
Why ESS _ Micro-grid

-Microgrid : A microgrid is a small-scale power grid that can operate independently or in conjunction with the area's main electrical grid. Any small-scale localized station with its own power resources, generation and loads and definable boundaries qualifies as a micro-grid.

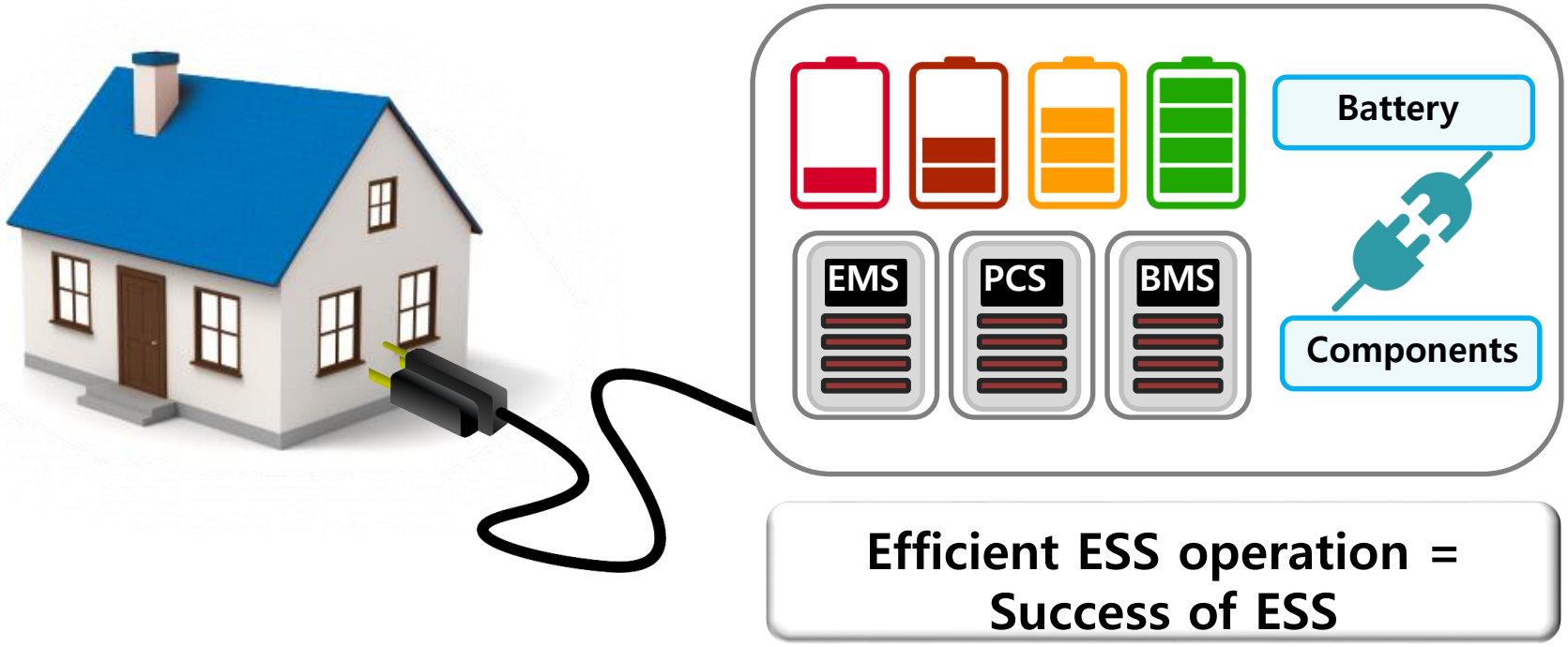


Why ESS _ Smart Home Solution

- After Setting up ESS which is connected to renewable energy, managing and controlling energy through HEMS based on IoT-> Effective energy usage

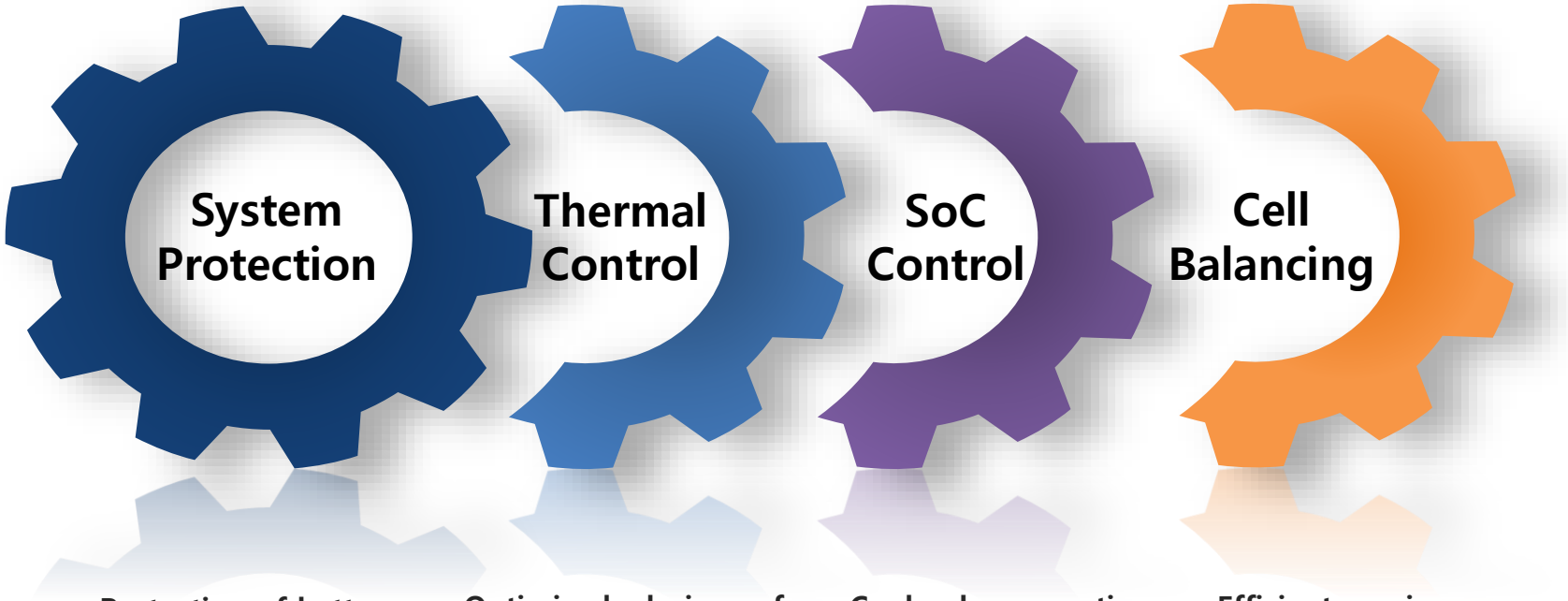


SAT Competency _ Successful ESS Solution



▪ ESS is not the only one product, it is a system which consists of batteries and other components.
-> The performance and technology of each parts in a ESS determine the good quality of ESS

SAT Competency _ Total ESS Solution



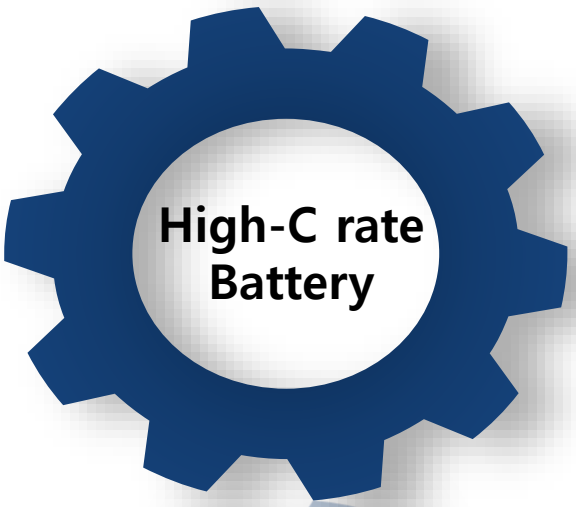
- Protection of battery packs from the danger of overcharging /discharging
- Extension of battery life

- Optimized design of HVAC system (Heating, Ventilating, and Air Conditioning) and cooling fan
- Maintenance of proper temperatures

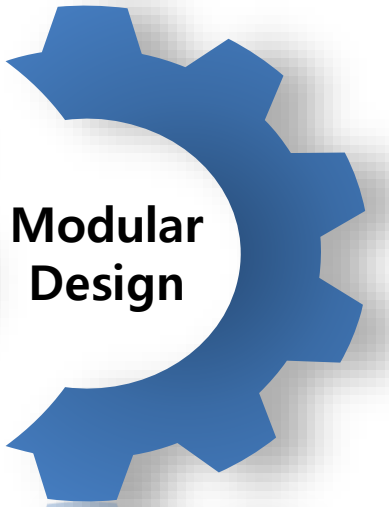
- Coulomb counting and dynamic drift correction
- Precise SoC (State of Charge) measurement

- Efficient passive battery cell balancing to optimize the cell properties & cell capacity
- Measurement of battery capacity & each cell's IR (internal resistance)

SAT Competency _ Total ESS Solution



- C-rate optimization depending on use cases
- Divers usage from peak shift to FR

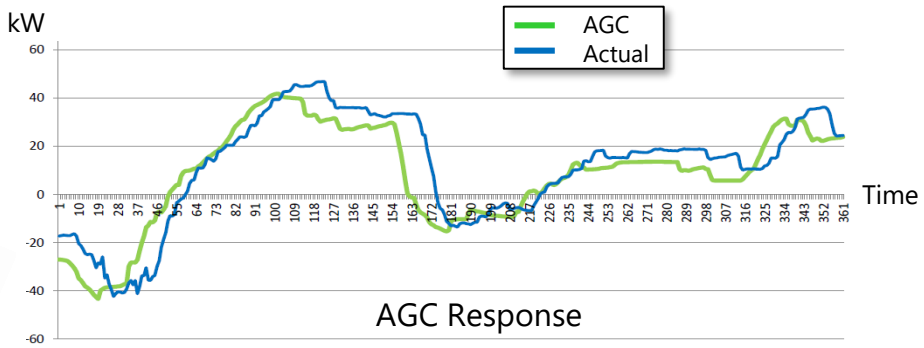


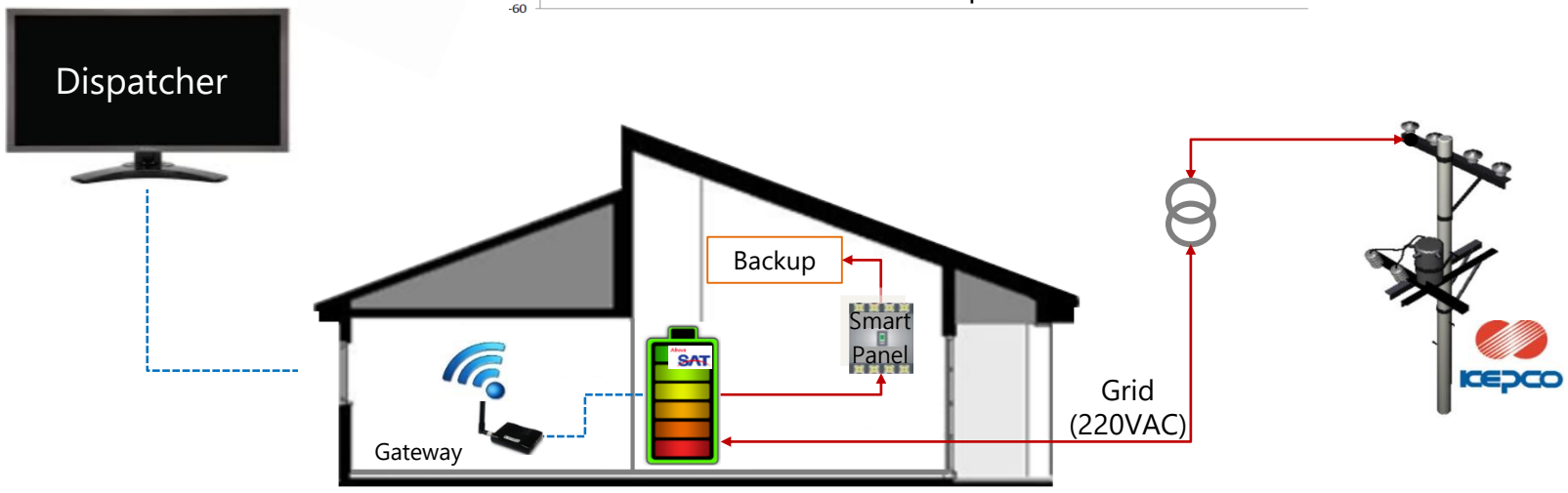
- Plug & Play technique (New hardware can be automatically detected and configured with little or no setting up by the user)
- Increasing/Decreasing battery capacity in an easy way-> up to MW
- Better manufacturability

- Remotely controlling and managing all programs
- Versatile protocol support

SAT Competency _ Total ESS Solution

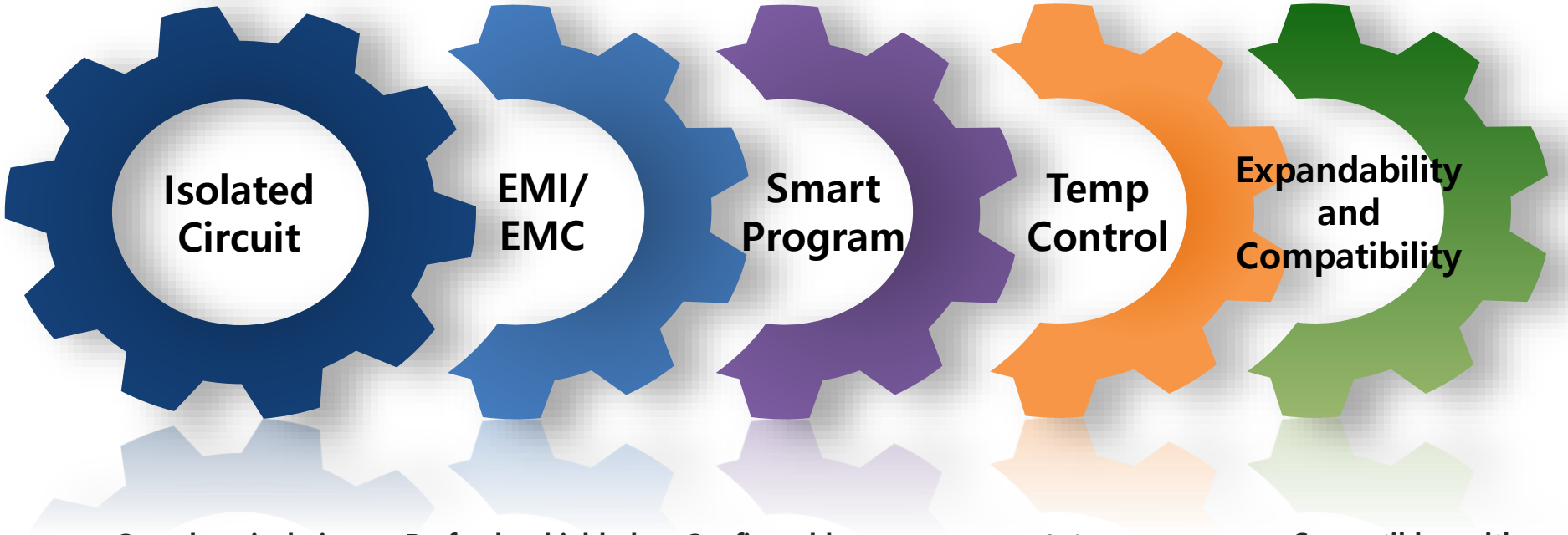
Optimized Algorithm for AGC Signal to achieve High Performance Score





- **Wireless Network**
- **Designed for optimized FR application**
- **Supply Backup power during blackout**

SAT Competency _ Proprietary BMS Technology



- Complete isolation between battery and circuit
- Error-free performance when the data is monitored

- Perfectly shielded noise and EMI

- Configurable up to 50 conditions
- Monitoring cells and battery packs in real time
- Adjusting charge/ discharge control according to battery environment

- Real-time adjustment of electrical current according to SoC and cell temp for optimum conditions /SoH

- Compatible with pack voltage in the wide range of 48V to 1,000V

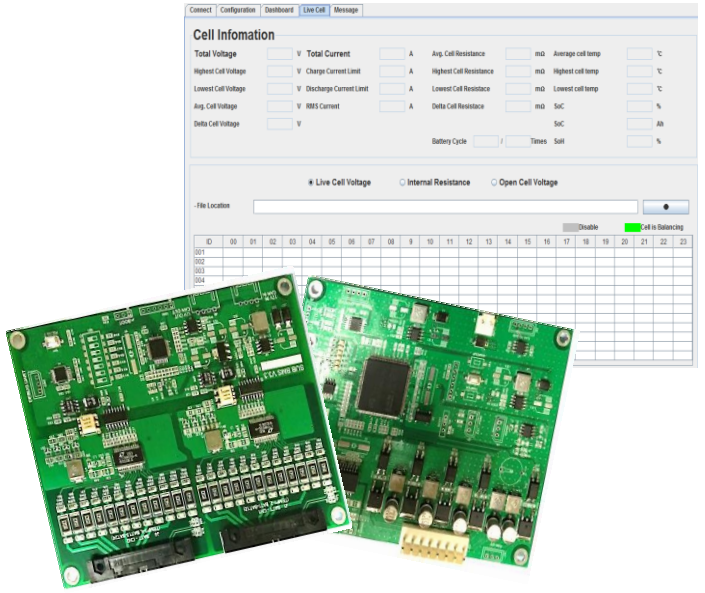
SAT Competency _ Proprietary BMS Technology

- SAT provides reasonable price by applying software which has been developed by our own superior technology.

- SATBMS is well featured for diverse types of Lithium Ion Battery.

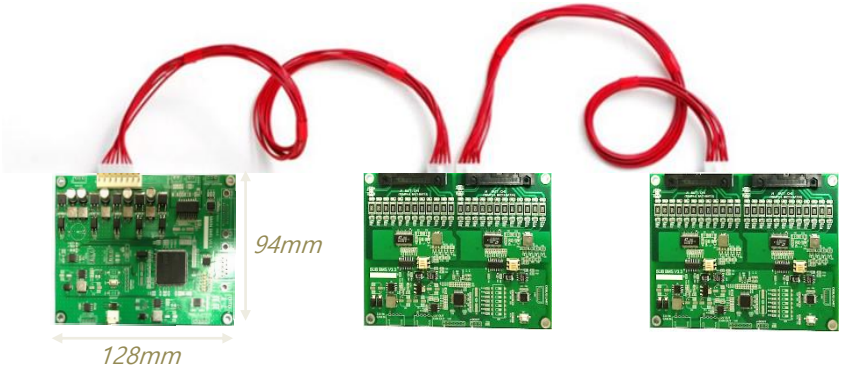
- SAT developed compact size BMS which is compatible even with MW scale.

- SATBMS technology has been verified in U.S. market for the fastest responding Frequency Regulation.



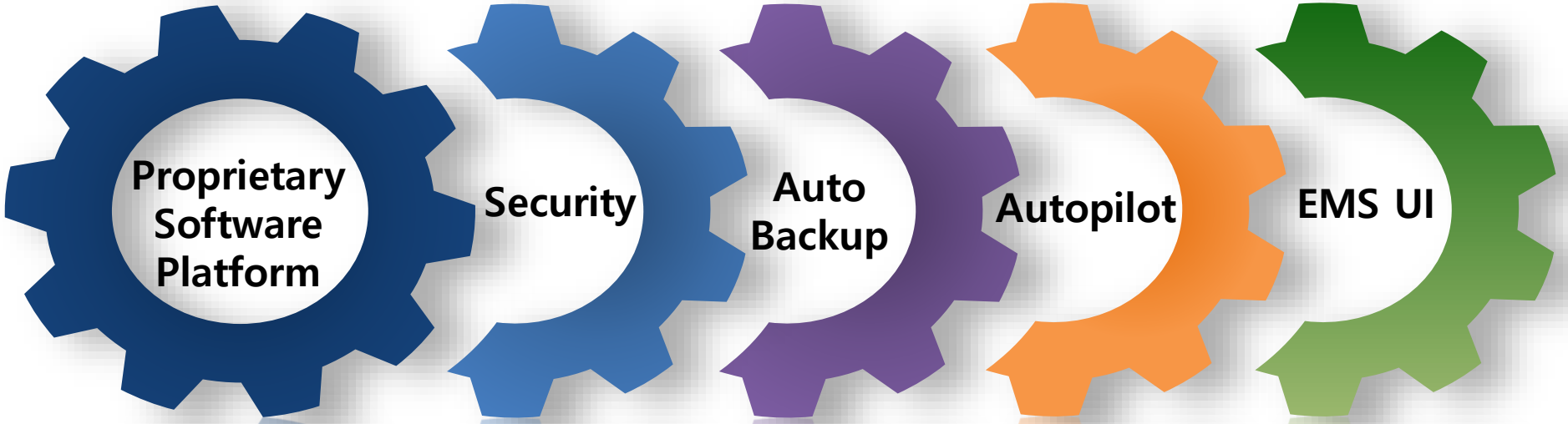
Product

Model	Vdc	Max Connectivity
BMS-S	1,000	1MBMS/12SBMS
BMS-R	1,000*5	1MBMS/7RBMS/84SBMS



SAT Competency _ Proprietary BMS Technology

- SAT EMS technology has been proven by several global companies such as LS, PPS, and Ideal Power.



- Software Platform with a well-customized algorithm
- Integrated Control /Management of Battery System and various types of distributed resources

- Applying cryptography technology
- Efficiency management according to different level of access authority

- Automatic restoration to backup during grid outage

- Automatic safe operation according to preset mode

- Providing operation UI for customers to control and manage the system by themselves
- Easy editing with an algorithm based on Windows

SAT Competency _ a Proven ESS Solution Provider

a Checklist on ESS Supplier Selection

SAT Competency _ a Proven ESS Solution Provider

Total Solution

pjm®

- SAT entered PJM which is the largest FR market in U.S..
- SAT established SPC ; holds a 86% stake.

Competitors

ESS manufacturing company

SAT

+

Above SAT NOC
(Integrated Operation of DES*)

Total solution company handling both manufacturing and software operation

DES* : Distributed Energy Sources

SAT Competency _ a Proven ESS Solution Provider

Expert & Specialist

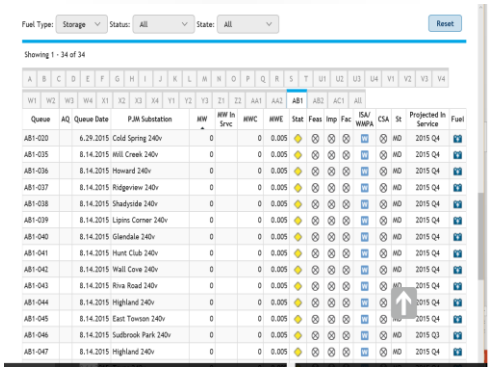
- SAT set up a joint venture(JV) with AFM in U.S., which is the first company specializing in distributed FR.
- SAT JV is composed of a lot of experts and developed 100kW ESS with the largest electricity company, First Energy.



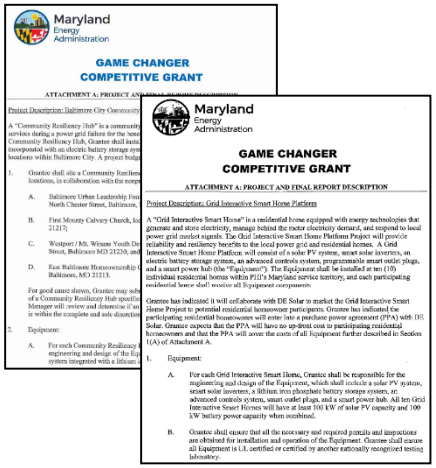

SAT Competency _ a Proven ESS Solution Provider

Ample Experience in Fields

- SAT has accomplished various ESS development business models in the fields of ESS integrated with solar PV and wind power , cooperating with major companies such as PSEG, First Energy and PEPCO in New Jersey, Ohio, Maryland and Delaware.
- SAT has acquired U.S. government projects.



PJM homepage
(SAT ESS installation status)



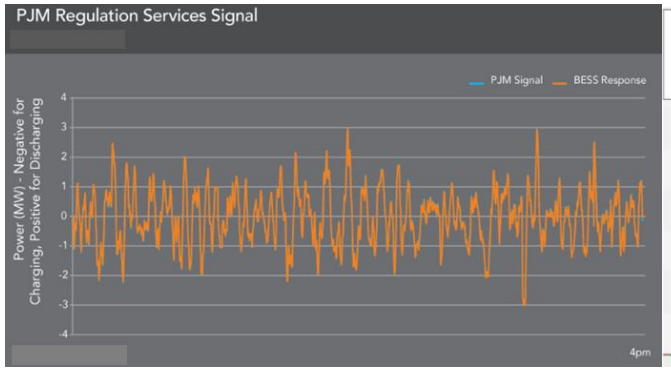
Collaboration with Maryland state government

PV Integration for residential premises in Maryland
and Wind integration in Ohio University

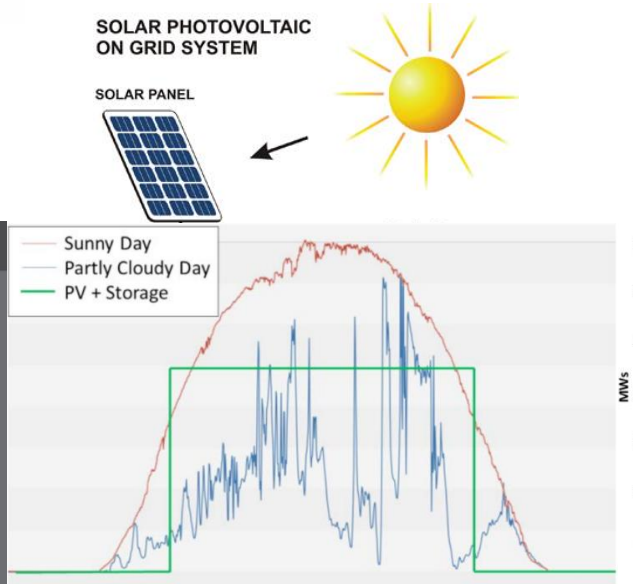
SAT Competency _ a Proven ESS Solution Provider

Various Application

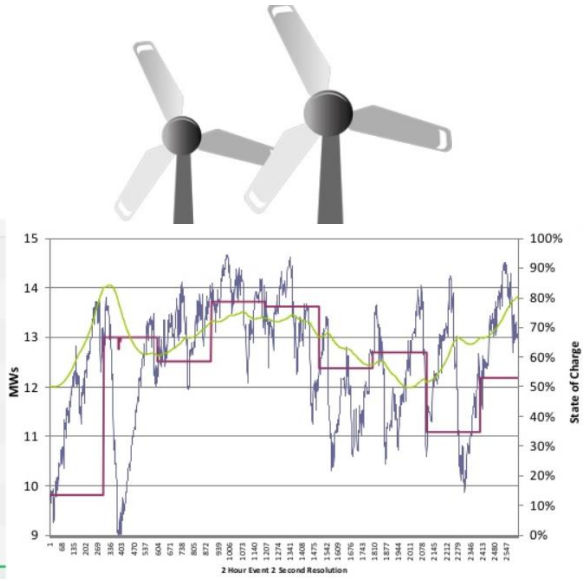
- After the installation of ESS, the business model has been well proven in U.S., showing excellent performance score.
- SAT has been developing new applications with local major utility companies like PSEG and First Energy



Frequency Regulation in PJM



Solar Integration in New Jersey



Wind Integration in Ohio

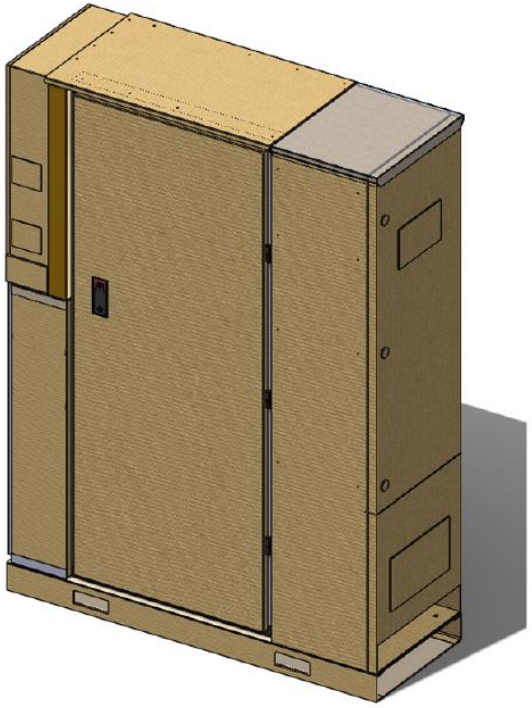
Product _ 5kW

Dimension(H*D*W) : 910*790*610(mm)

Product Specification

General Specification	
Inverter Technology	Bi-directional
Enclosure	Indoor use only
Grid Port Specification	
Rated Output Voltage	120/240VAC 1 Split Phase
Maximum Input Current	~20.8A AC
Normal Line Frequency	50Hz or 60Hz
DC Port Specification	
Capacity	5kW/5.12kWh
Charge and Discharge Duration (Continuous)	1hr
Application	
Frequency Regulation, Emergency Backup	

Product _ 30kW



Dimension(H*D*W) : 1,980*610*1,520(mm)

Product Specification

General Specification	
Inverter Technology	Bi-directional
Enclosure	NEMA-3R (Outdoor)
Grid Port Specification	
Rated Output Voltage	208VAC 3Phase
Maximum Input Current	~20.8A AC
Normal Line Frequency	50Hz or 60Hz
DC Port Specification	
Capacity	30kW/34.5kWh
Charge and Discharge Duration (Continuous)	1hr
Application	
Peak Cut, Load Shifting, FR, PQ control, Power Smoothing, Emergency Backup, others	

Product _ 100kW

Dimension (H*D*W) : 2,000*1,000*1,200~2,800(mm)

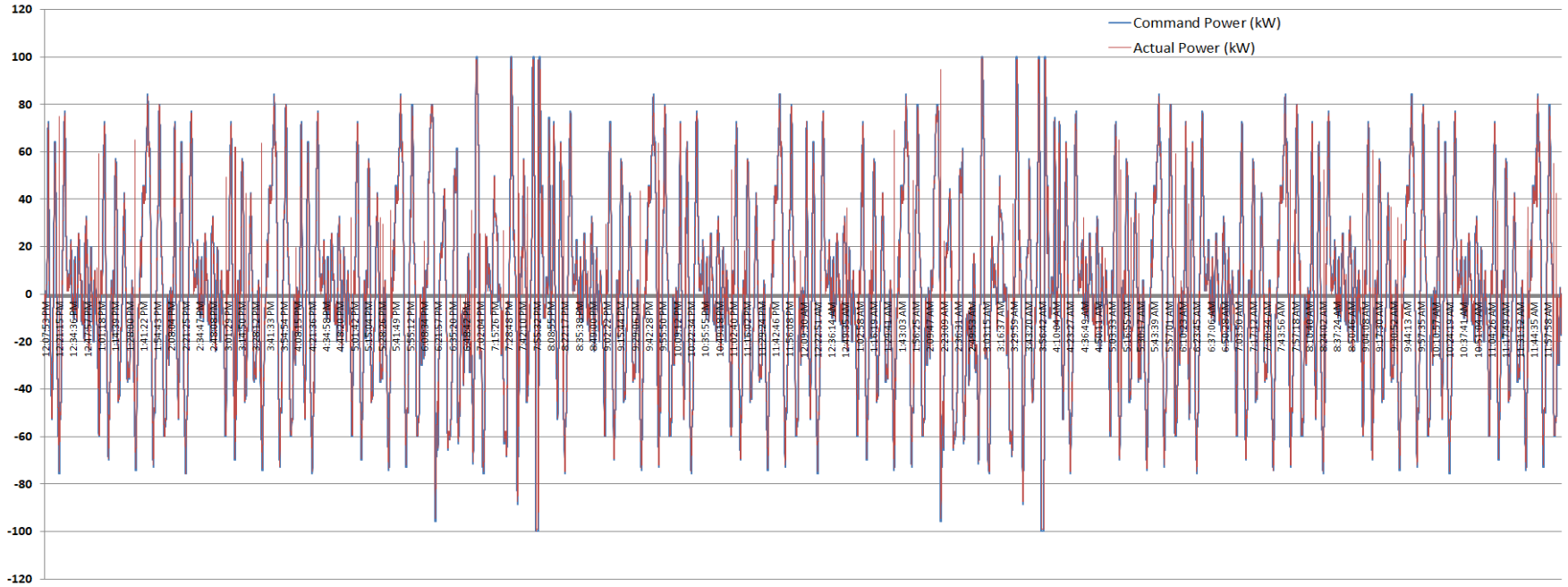
Product Specification

General Specification	
Inverter Technology	Bi-directional
Enclosure	Indoor only
Grid Port Specification	
Rated Output Voltage	380~480VAC, 3Phase
Maximum Input Current	~225A AC [variable]
Normal Line Frequency	50Hz or 60Hz
DC Port Specification	
Capacity	100kW / 42.2 ~ 200kWh
Charge and Discharge Duration (Continuous)	0.5 ~ 2hrs
Application	
Peak Cut, Load Shifting, FR, PQ control, Power Smoothing, Emergency Backup, others	

Product _ 100kW

Duty Cycle for FR

Battery	PCS	EMS Simulation	Test Signal
SAT Power Module	*L*-100*	*SAT EMS*	*DOE PNNL-22010 REV1, 100kW / 24hrs*



Performance Score of FR achieves 97%
The higher the performance score is, The more the profit is
Duty Cycle test using 100kW ESS system has been performed at SAT Lab at Aug 25. 2016

Track Record _ Full Capacity Range

ESS Market Segment

Residential	Commercial	Utility
5~30kW	30~500kW	MW


[House]


[A.P.T]


[School]


[Building]

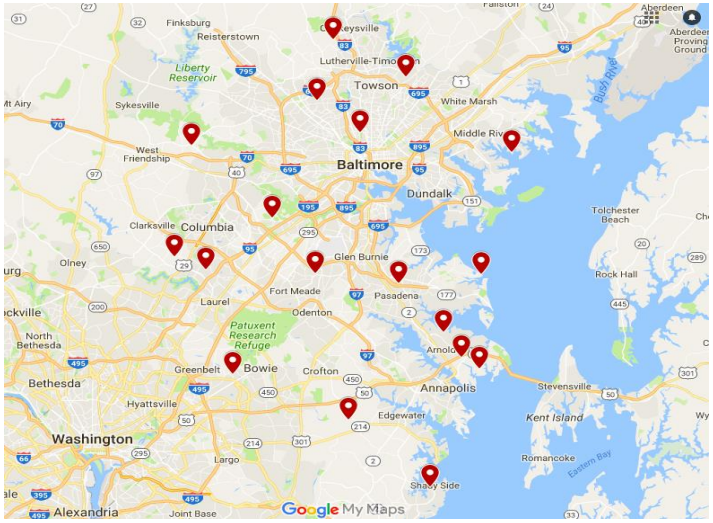

[Factory]


[Distribution]


[Power Plant]

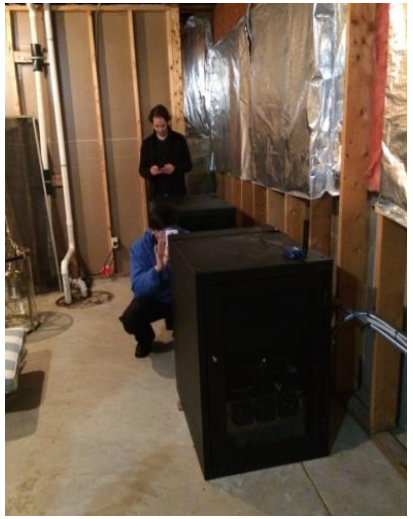
- Full experience from residential capacity to C&I market
- SAT performed pilot project on utility-scale wind farms with the largest utility company in Ohio.
- After conducting an analysis of the customers' electricity usage patterns and calculating battery capacity, SAT offers optimized ESS.

Track Record_ Residential VPP Pilot in Maryland



20 installations at homes near Baltimore city in Maryland

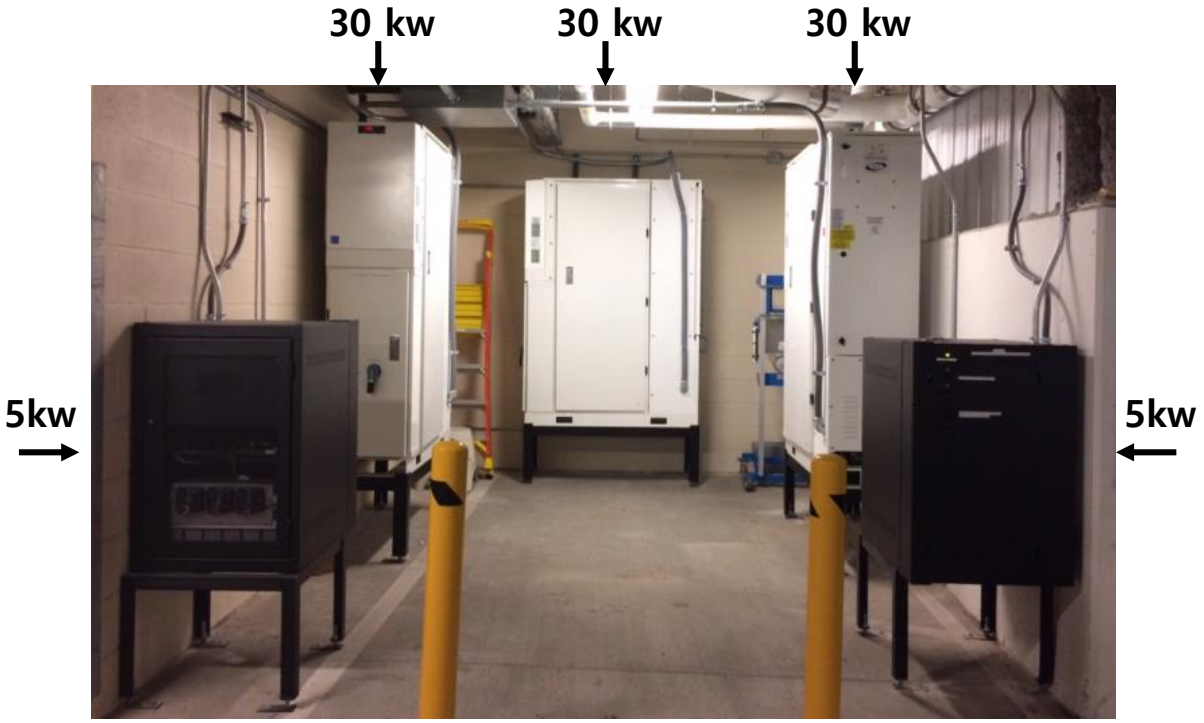
Garage



Basement

- The world's first residential level Frequency Regulation VPP pilot project integrating 20 units of 5kW ESS into a 100kW ESS with wireless communication technology
- Backup power supply during power outage

Track Record_ Commercial FR in Ohio



At the parking lot of IGS(ESCO company) in Ohio

- The world's first integration of 5 units ESS into a 100kW- 5 units of ESS were configured with a Behind Meter which is under commercial operation
- SAT supplied it to an energy company in Ohio, which shows more than 90% Performance Score when it is running

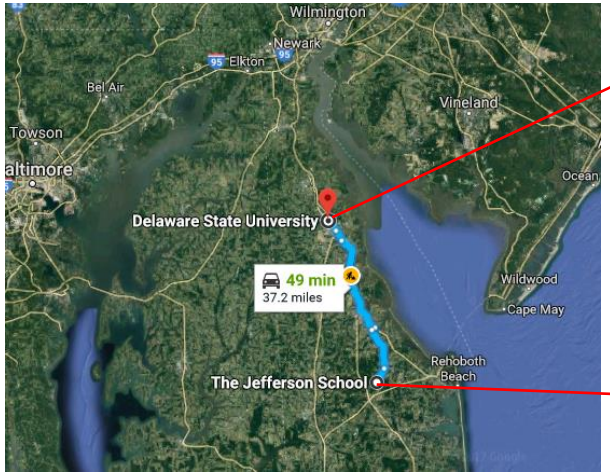
Track Record_ Utility Wind Farm Pilot in Ohio

Pilot Site in C* University in Ohio

100kW ESS Product

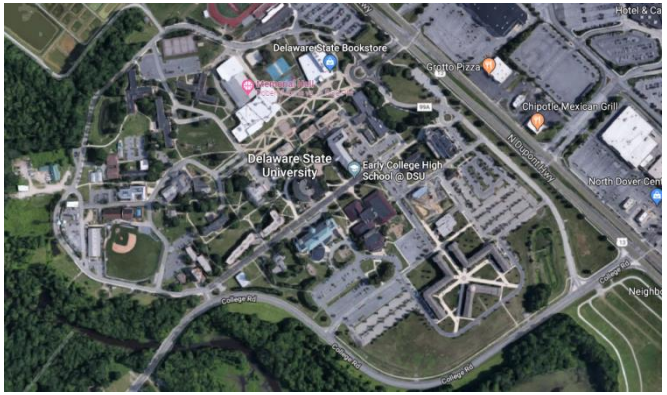
- SAT supplied a new 100kW ESS connected to wind power system to Ohio State University that is a site of pilot project for wind farm business model improvement performed by First Energy, the largest utility company in Ohio
- Our 100kW ESS product can be used for various uses and technology

Track Record_ C&I FR in Delaware



FR + Backup

[Site-2]
: University of Delaware
300kW



[Site-1]
: The Jefferson School
200kW

- Delaware State government funded renewable energy program installing 200kW and 300kW at 2 sites, respectively, in Delaware
- Edison Power owned property, SAT-AFM has rights of manufacturing/ installing/maintaining/managing

Thank you

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