Development of Smart Grid in Thailand

5th ASEAN SMART GRID CONGRESS (ASGC 5)

December 4th, 2019

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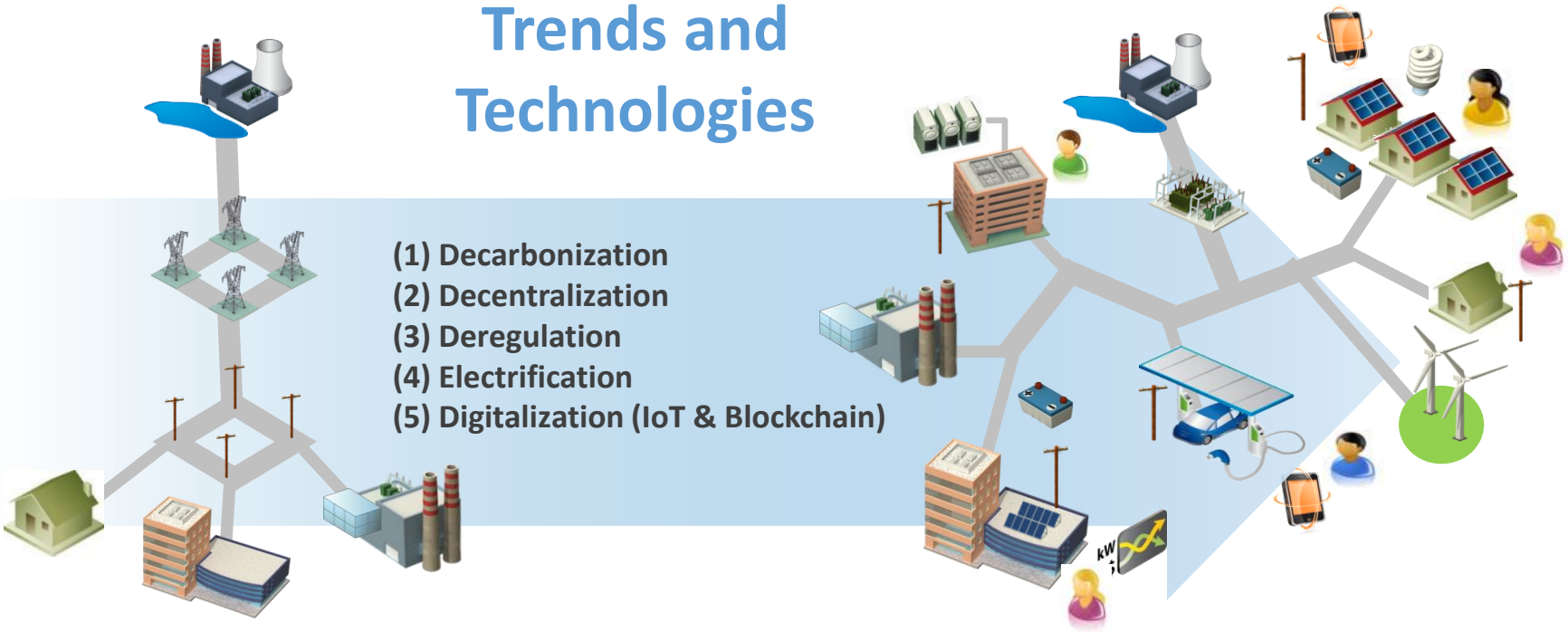
SGtech, Naresuan University

Energy Disruption Trends

5 Disruptive Trends and Technologies

(1) Decarbonization
(2) Decentralization
(3) Deregulation
(4) Electrification
(5) Digitalization (IoT & Blockchain)



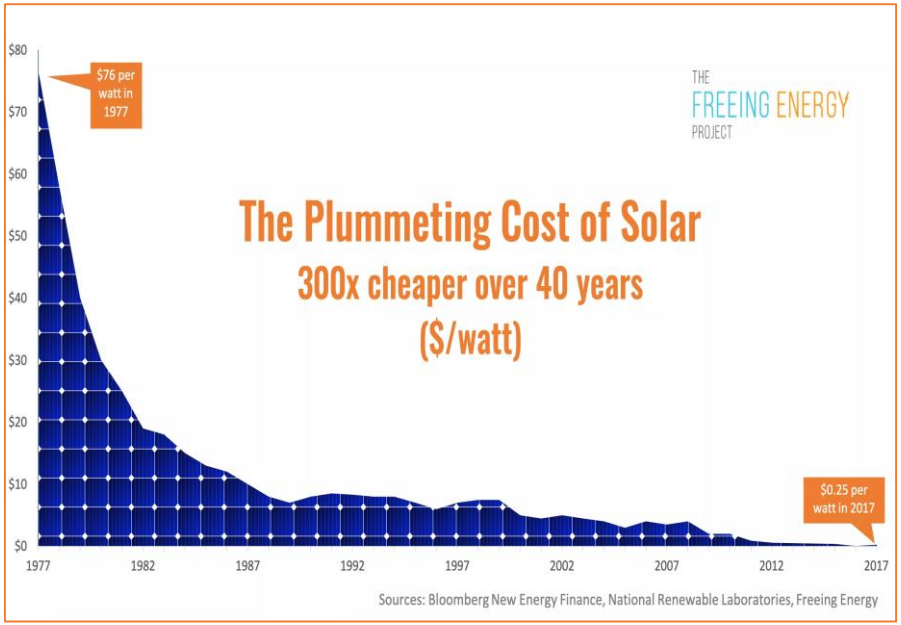
Grid for today

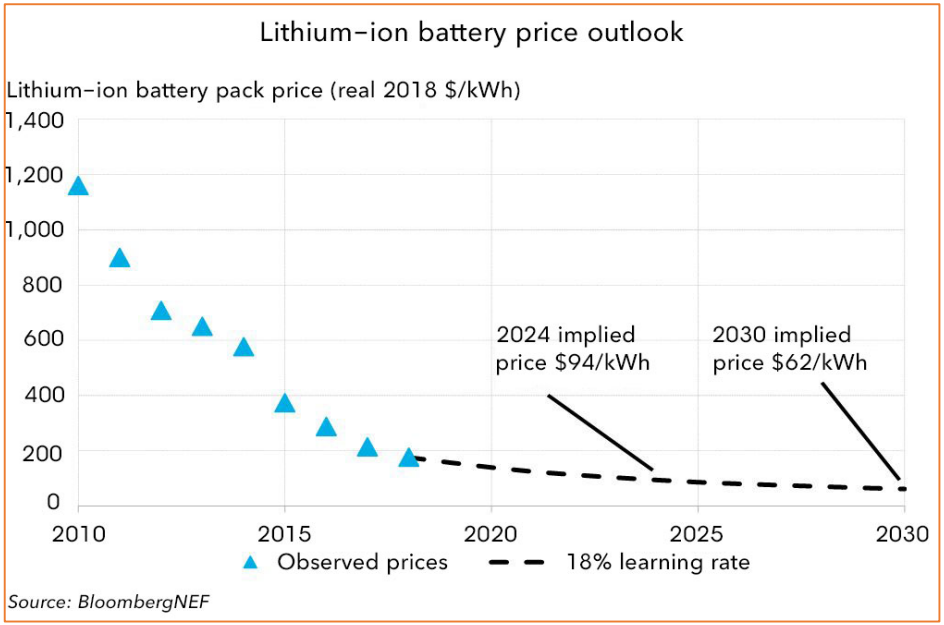
Grid for tomorrow

Energy Disruption Trends

Distributed Generation (DG)

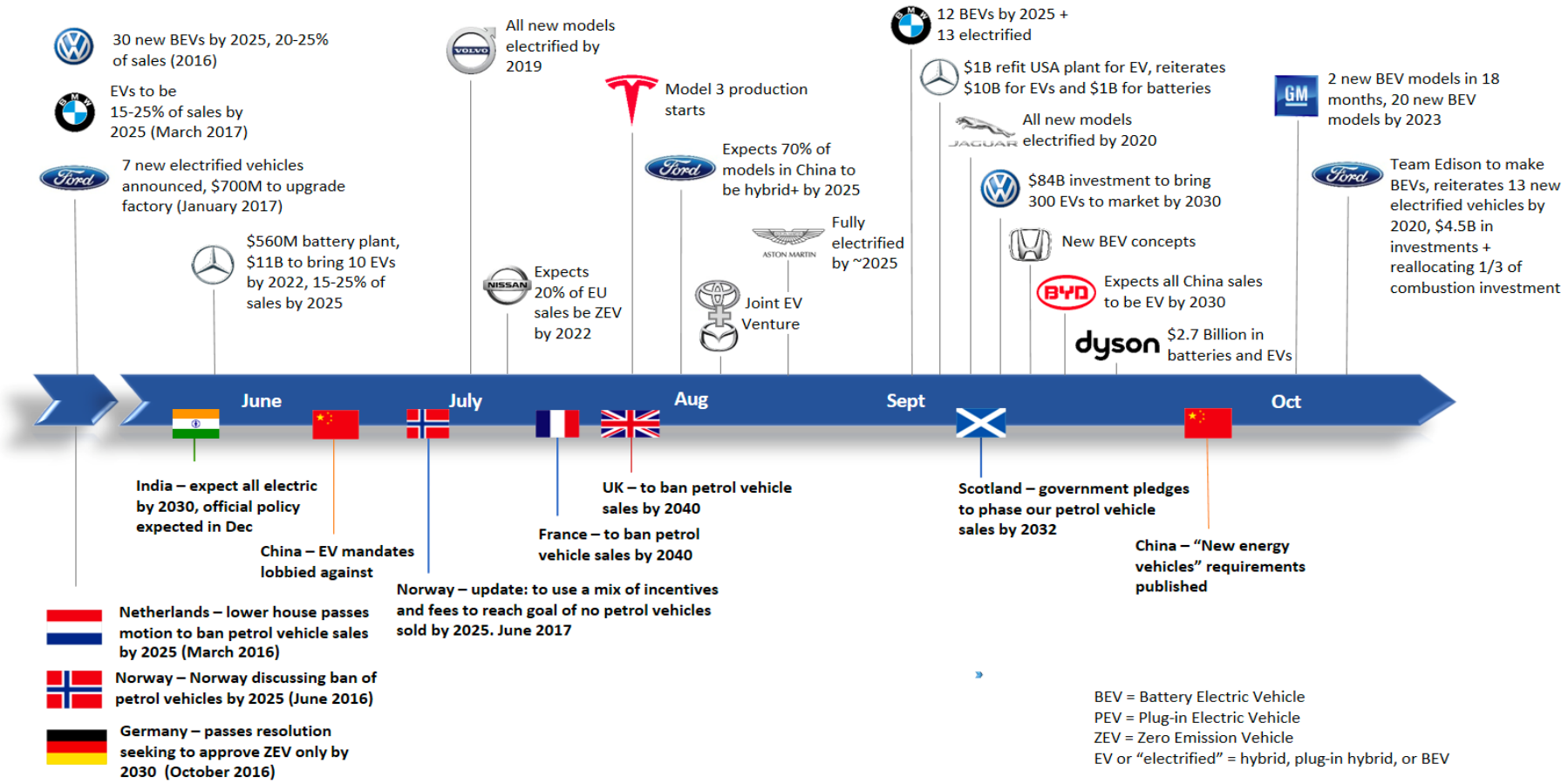
- Increasing of distributed generation (DG)
- Change from centralize to decentralize and two-way power flow
- Rapidly development of Lithium-ion and "**COE decreasing of PV and ESS**"





Energy Disruption Trends

Electrification

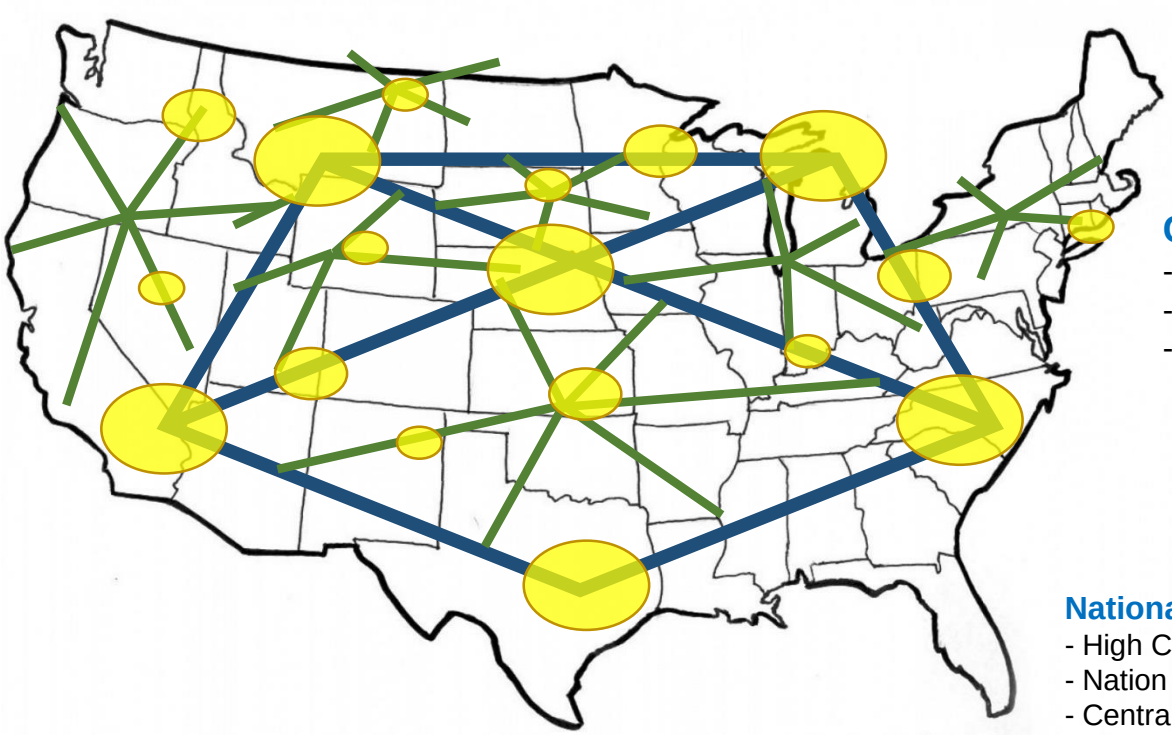


Source: https://www.teslarati.com/automakers-come-acceptance-ev-revolution-begun

Energy trend in the future

Micro-Grid (Low Voltage)

- Distributed Generation (DG)
- Customer Electrification (Prosumer)
- Almost PV on ground and rooftop (< 1 MW)



Community Grid (Medium Voltage)

- Small Power Producer transmission
- Community Electrification (IPP, SPP)
- PV and Wind farm, Waste to Energy
  Biomass Gasification (1 – 90 MW)

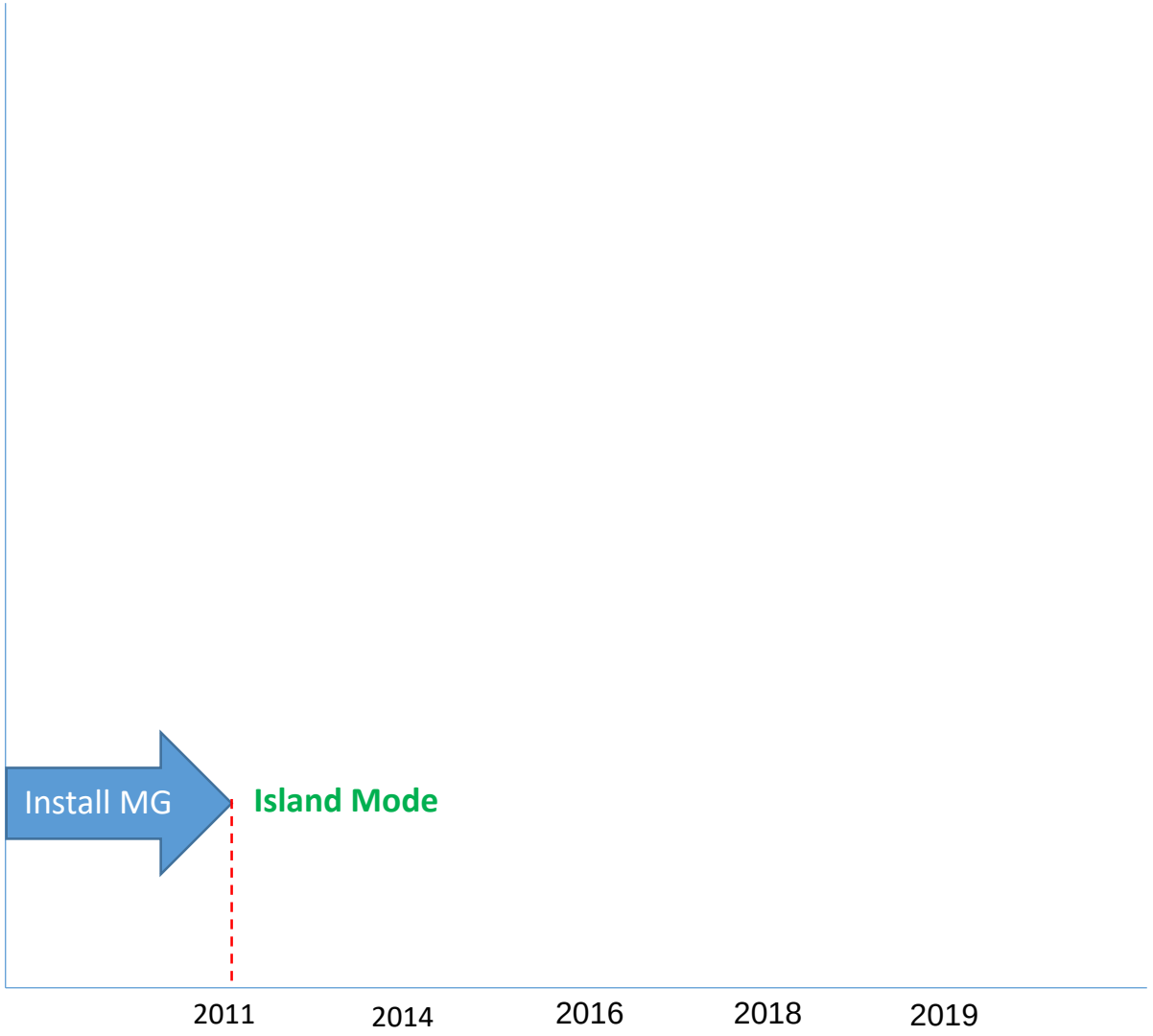
National Grid (High Voltage)

- High Capacity transmission
- Nation balance of supply & Demand
- Centralize Generation (> 100 MW)

Year 2008: Energy Park Project

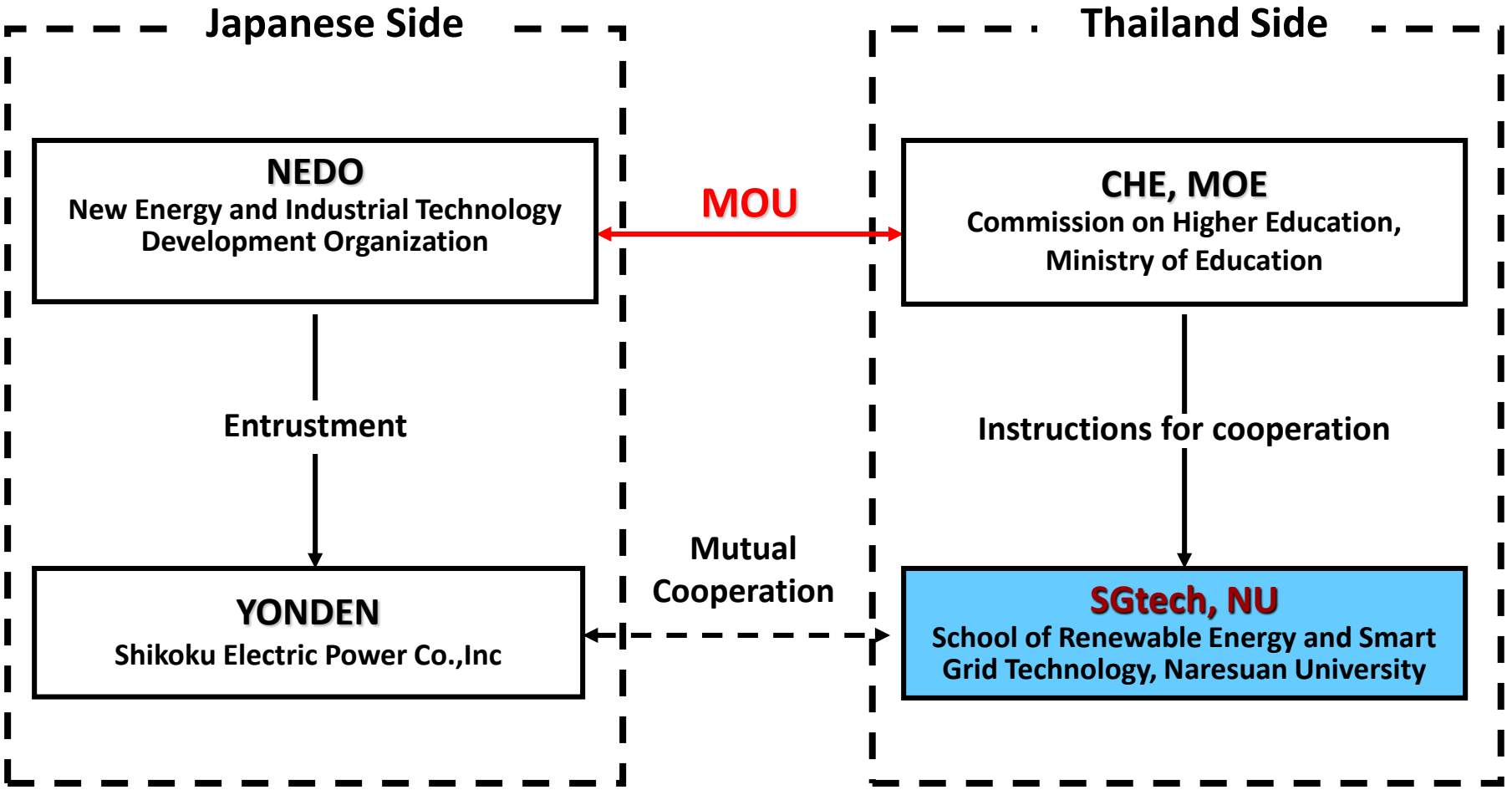
SGtech Smart Grid Development

SERT Micro Grid
(Phase I)



Year 2011: NEDO-Microgrid System

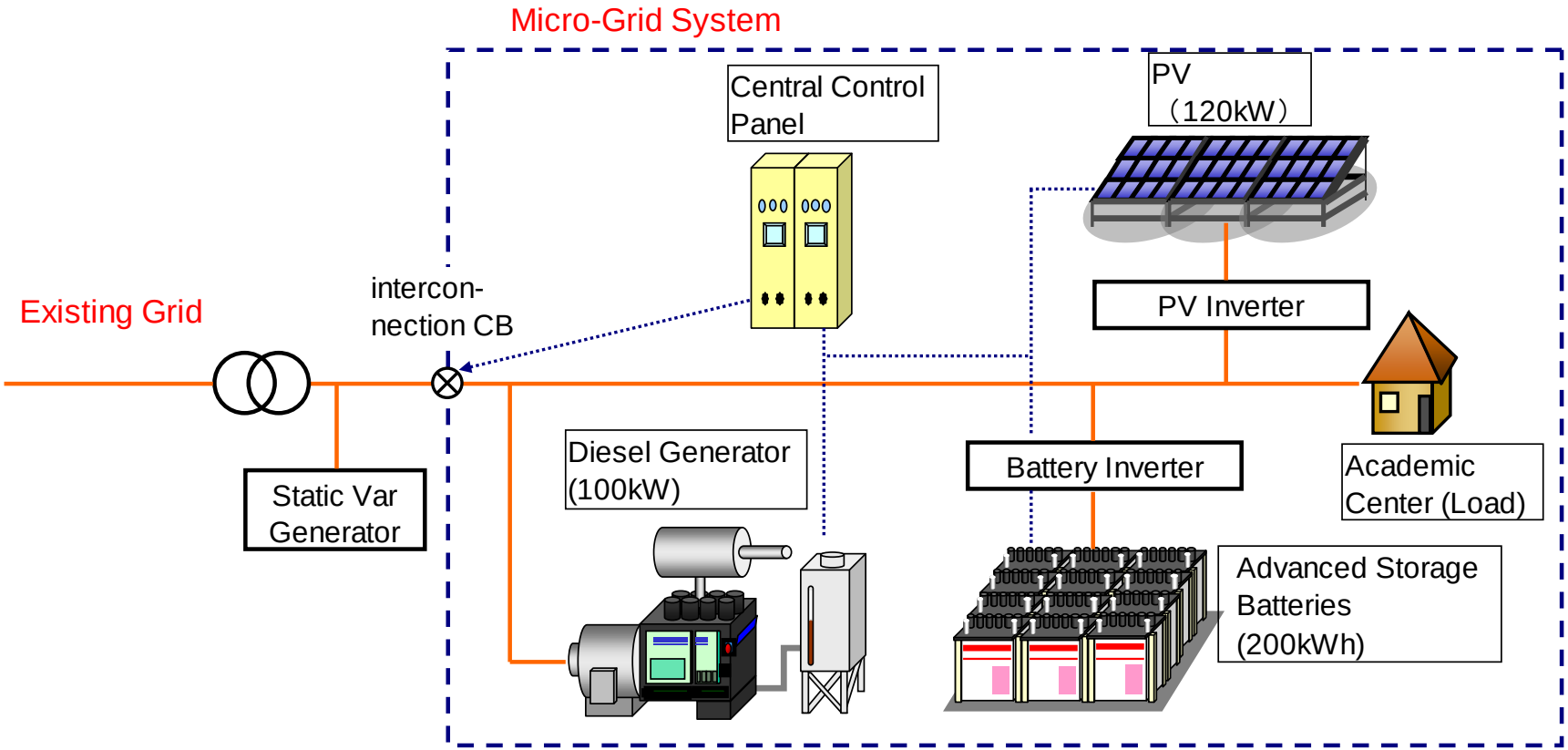
Project Structure



MOU : Memorandum of Understanding

Year 2011: NEDO-Microgrid System

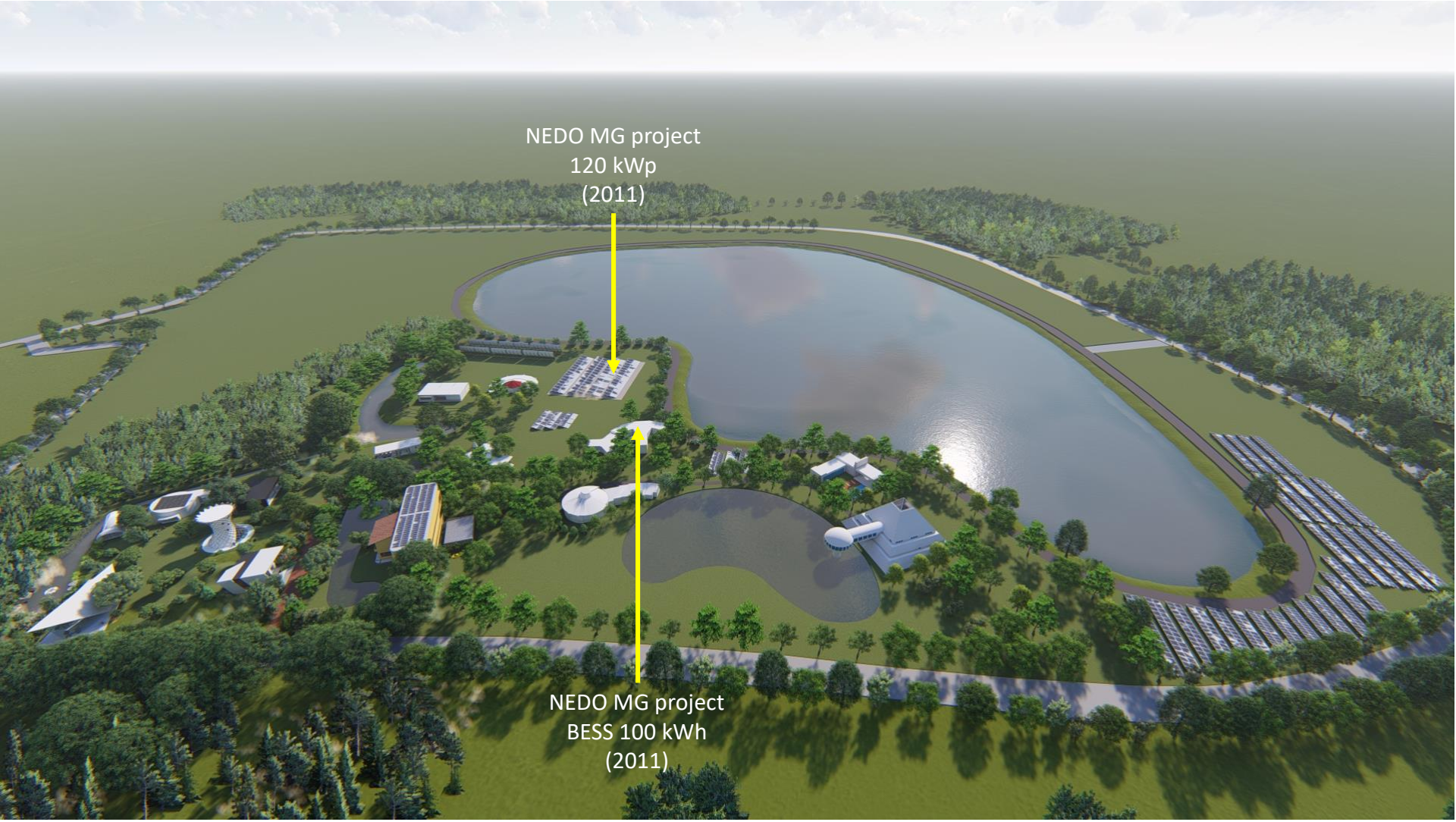
System Overview



* SVG can maintain the voltage by controlling its reactive power very quickly

Year 2011: NEDO-Microgrid System

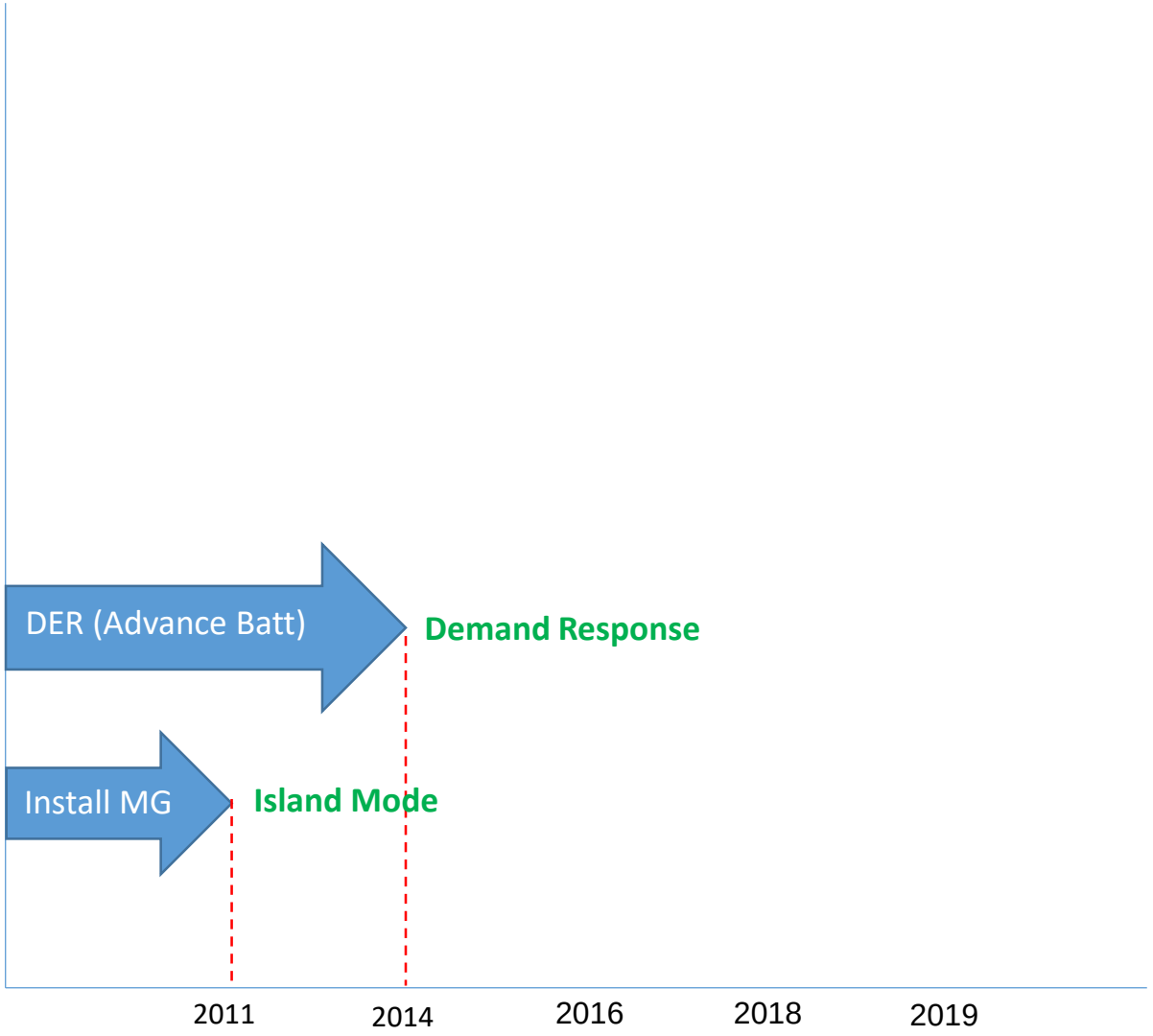
Year 2011: NEDO-Microgrid System



SGtech Smart Grid Development

SERT Smart Grid
(Phase II)

SERT Micro Grid
(Phase I)



Year 2014: Demand Response

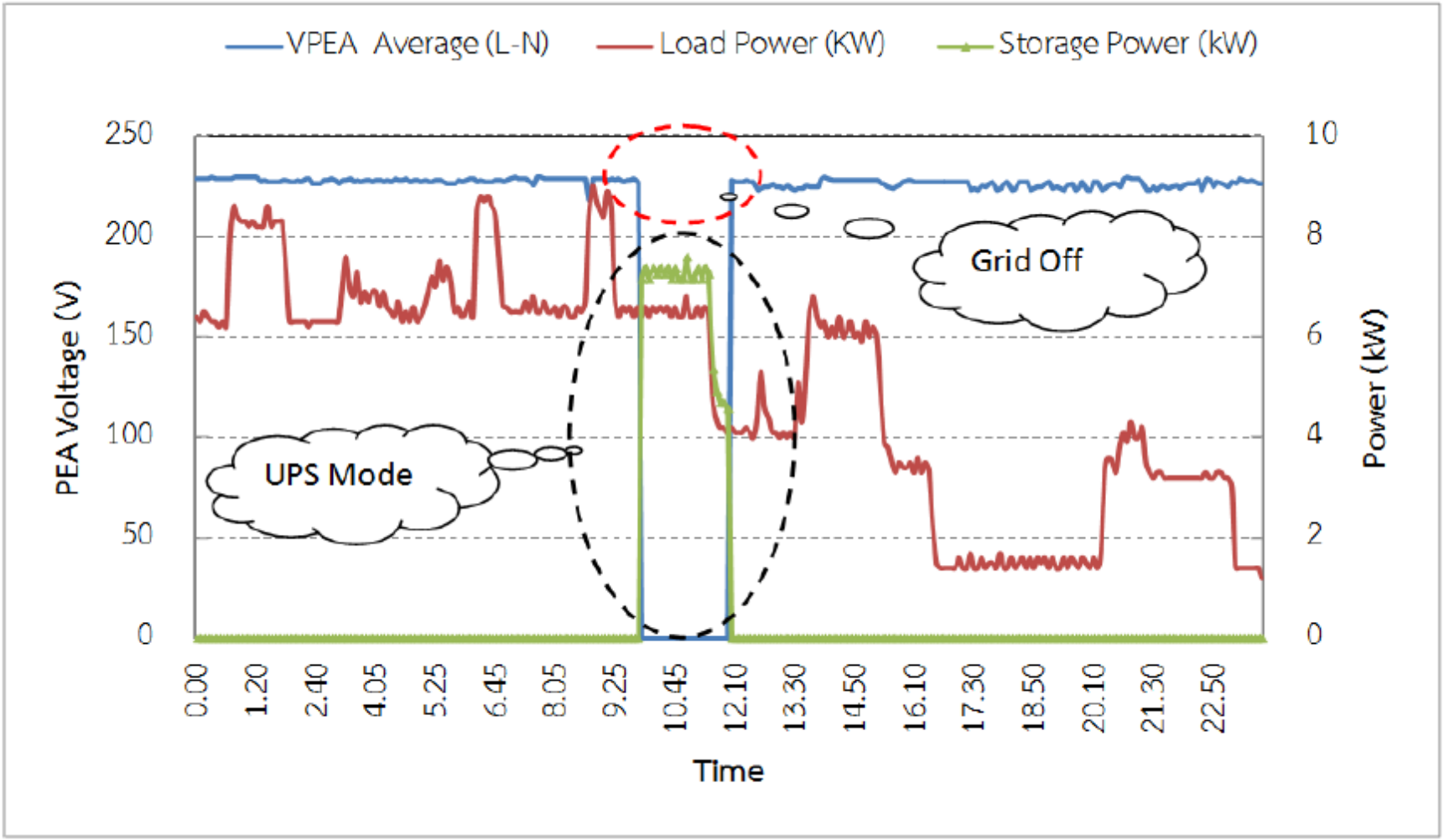
Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

Schneider Electric

Energy Storage System for Smart Grid Technology

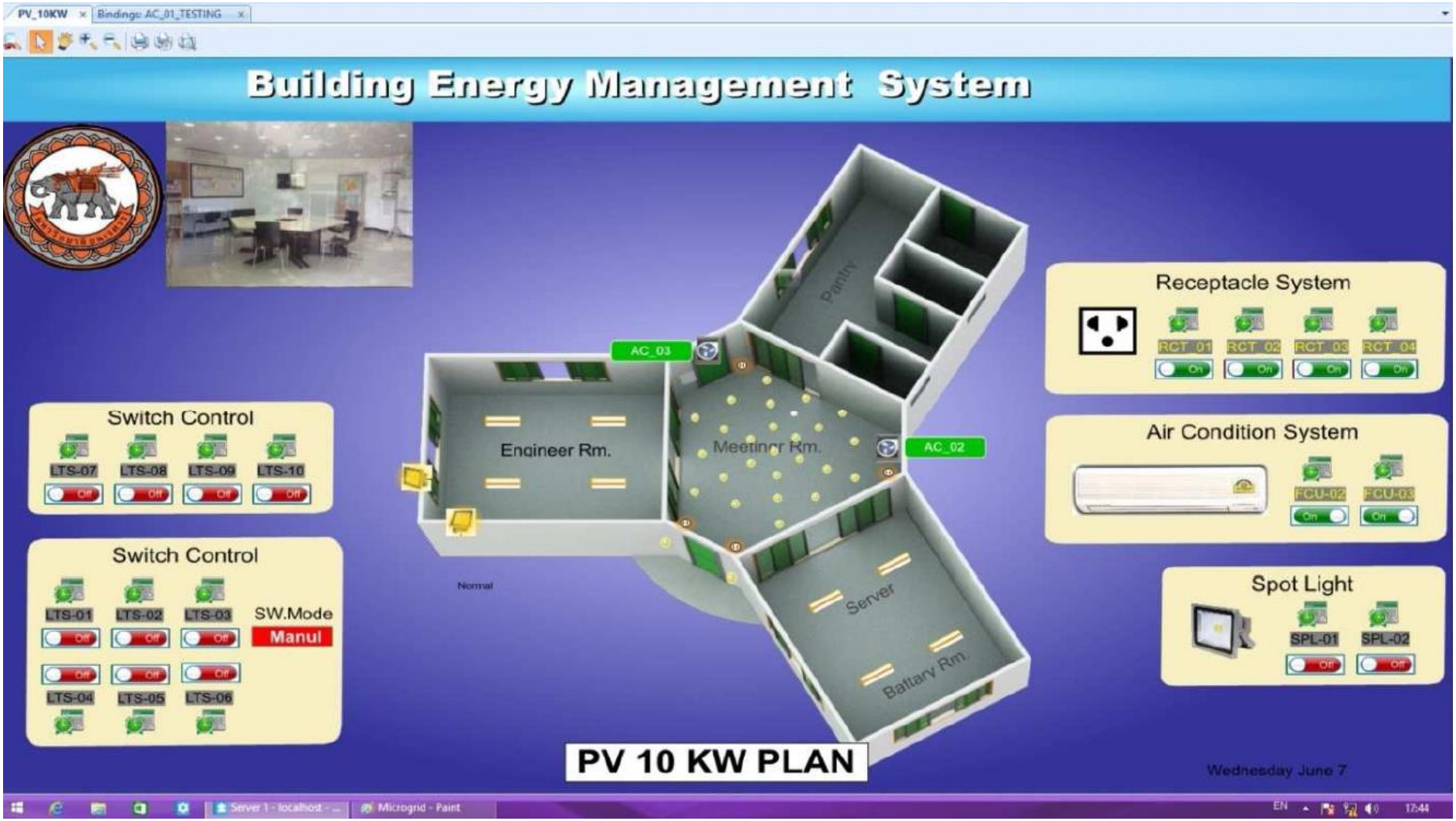
- Virtual Power Plant (VPP)
- Scada System installation
- 300 kWh Storage Battery
  - Power Quality / UPS
  - Bridging Power
  - Energy Management

ESS with UPS mode



Energy Storage System (ESS) working with UPS mode

Year 2014: Demand Response



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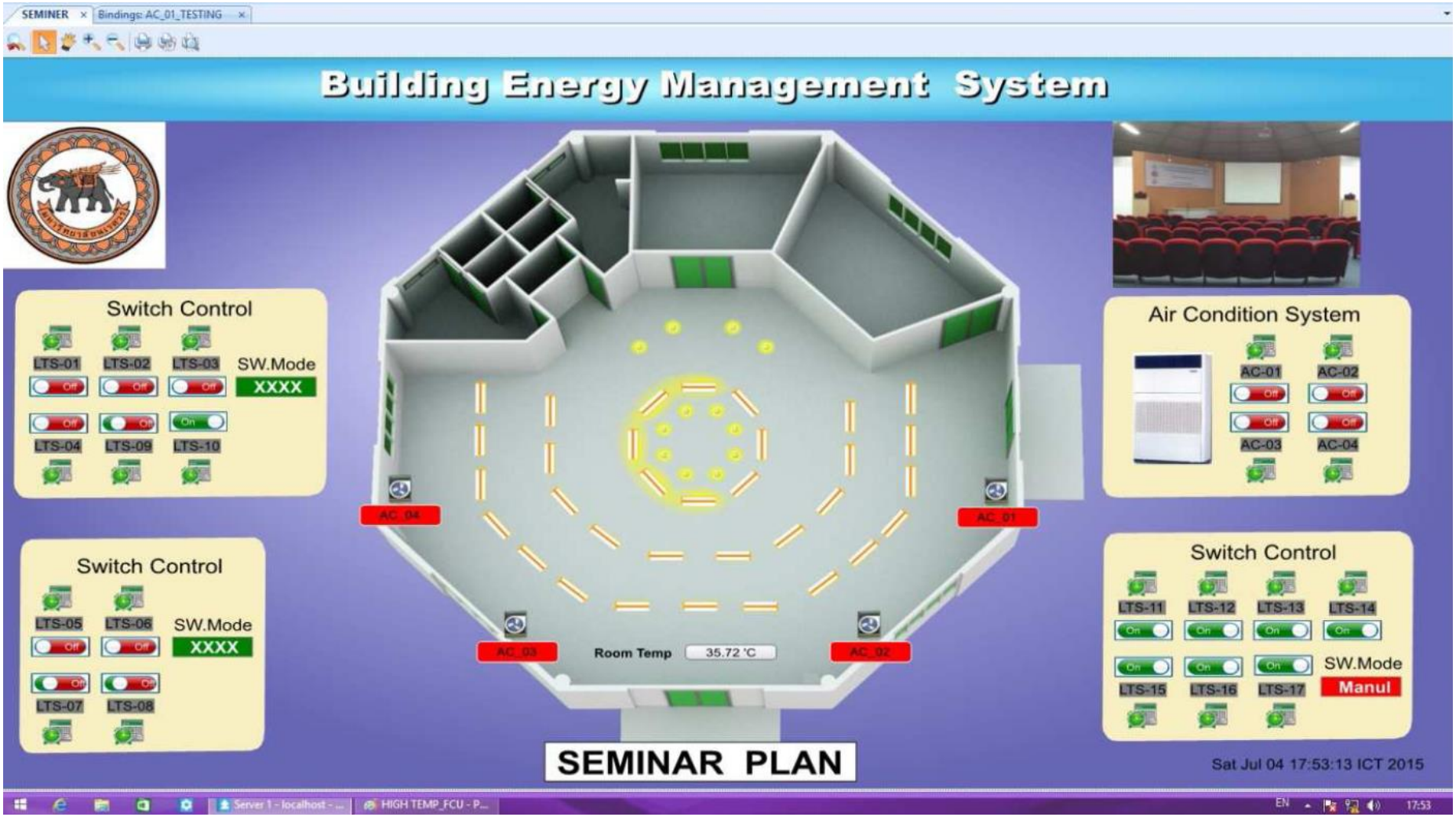

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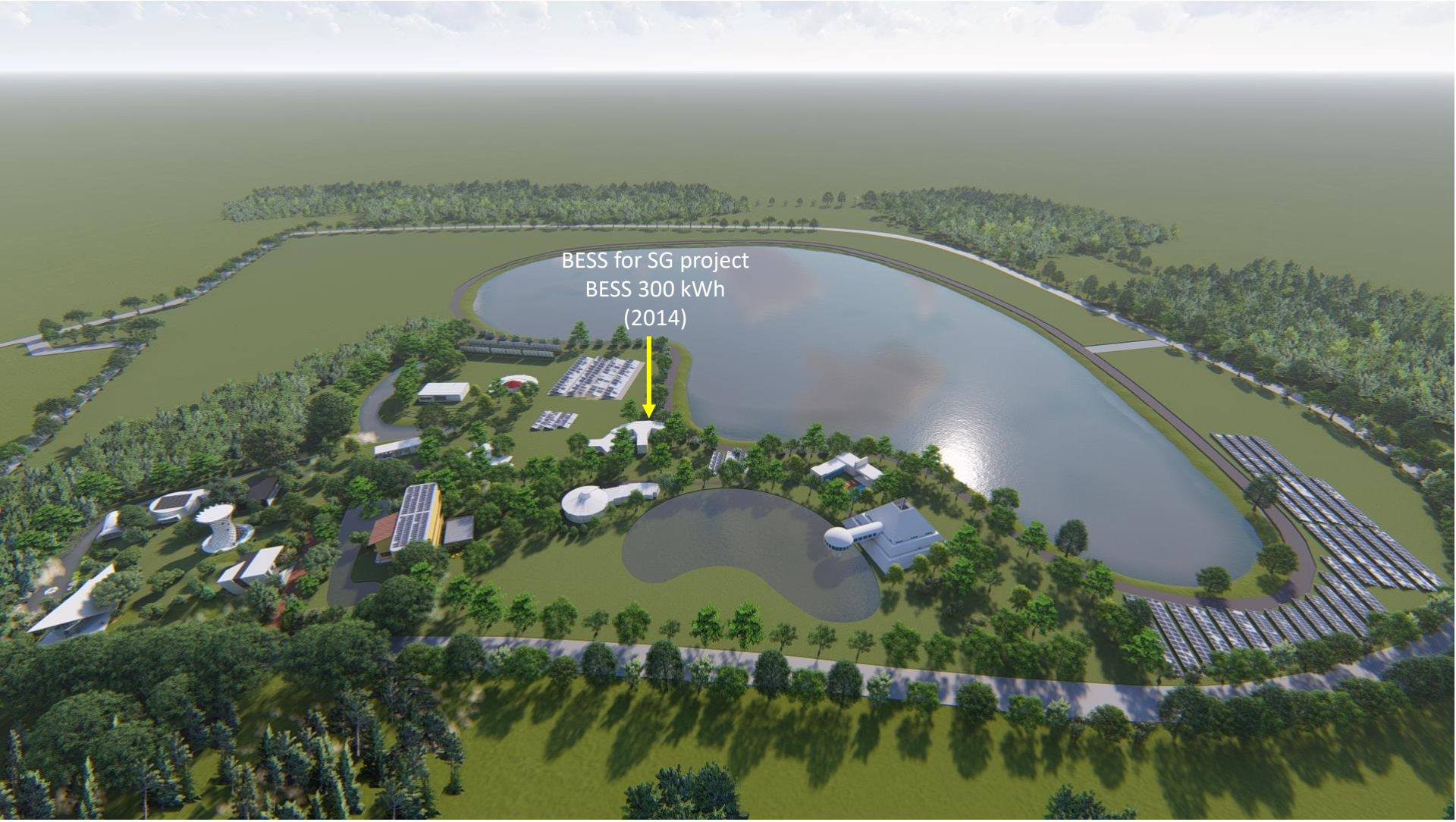
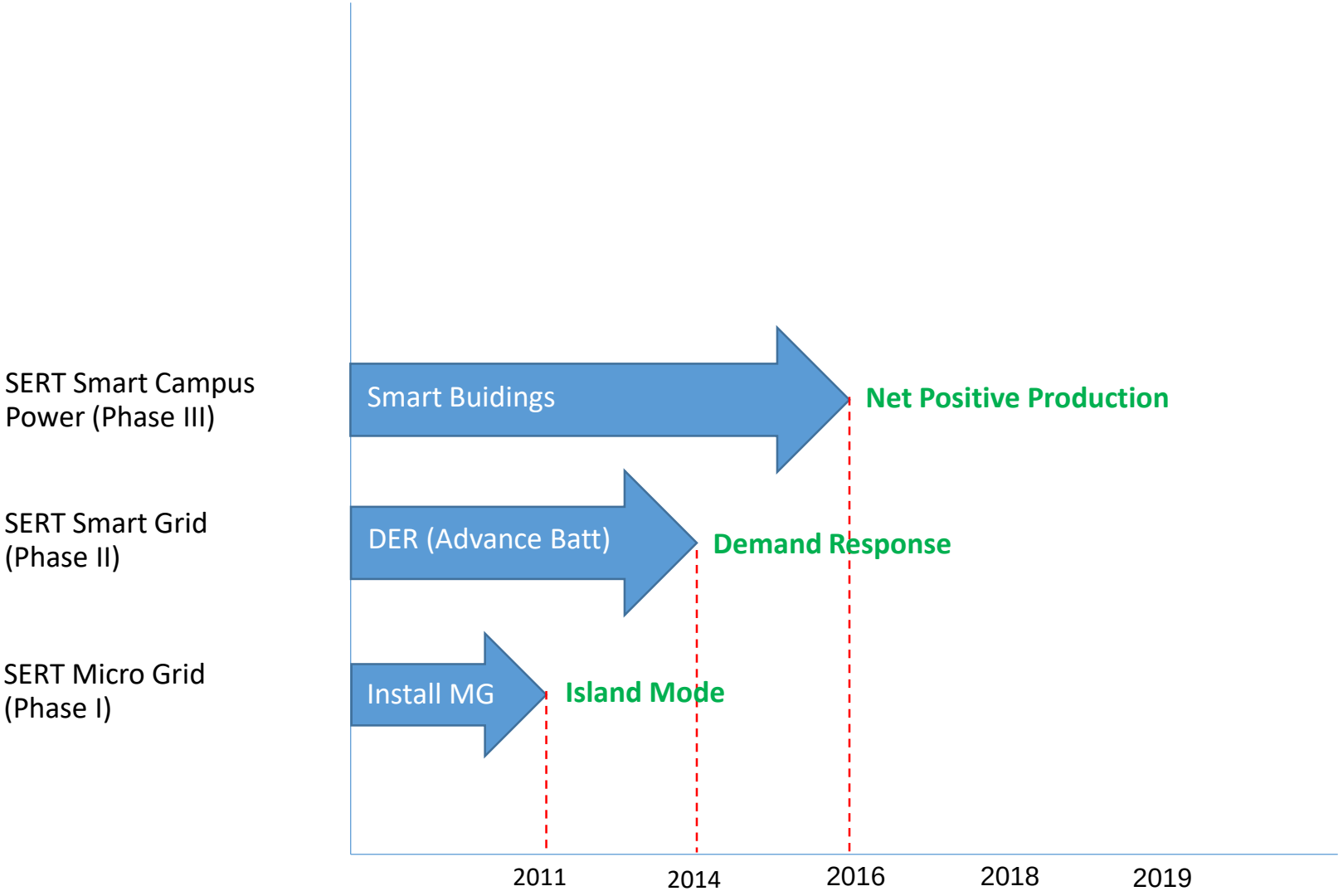


SGtech Smart Grid Development



Year 2016: Net Positive Production

Campus Power Project

Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

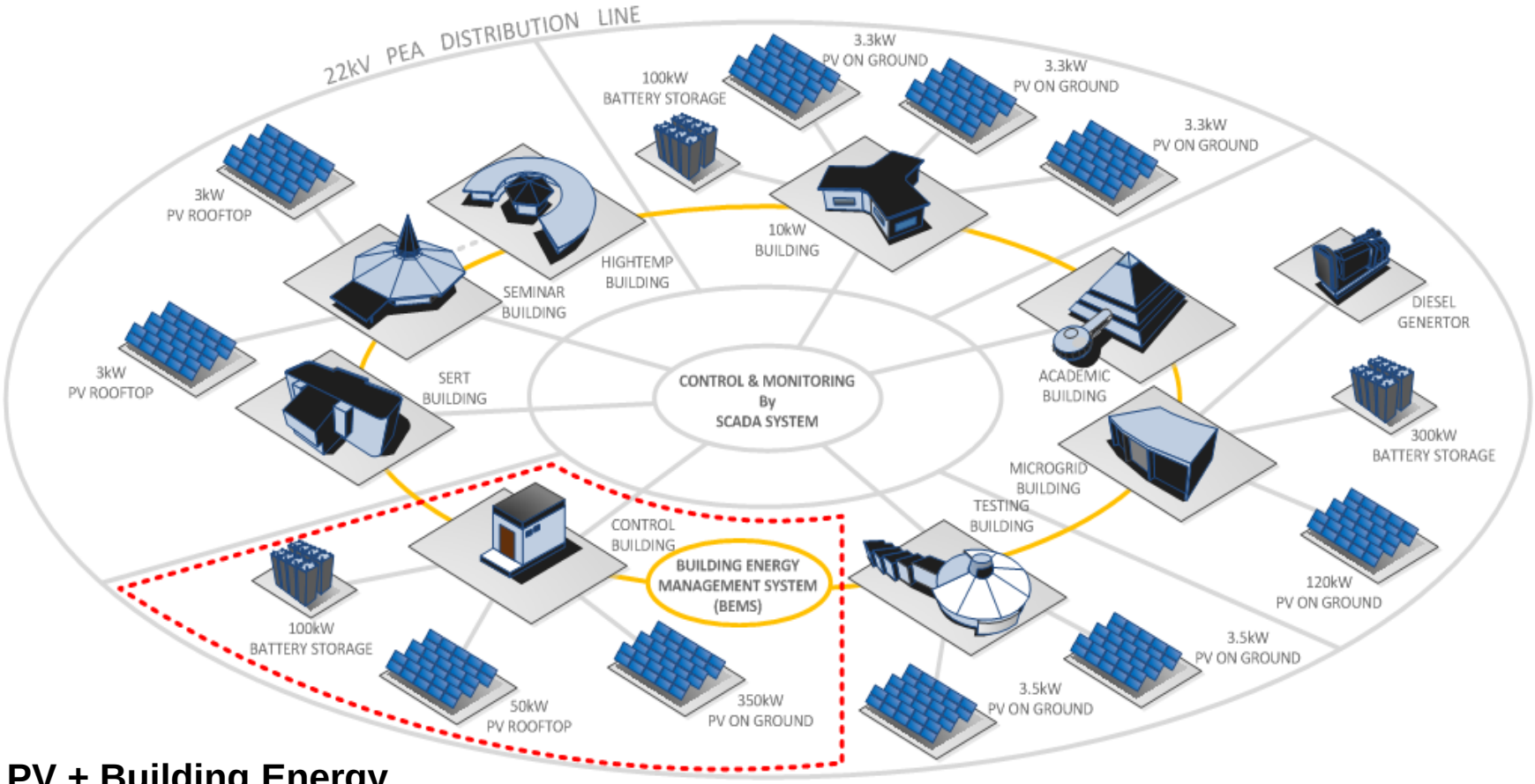
LEONICS®

"To promote the renewable energy for using in the university"

System Components

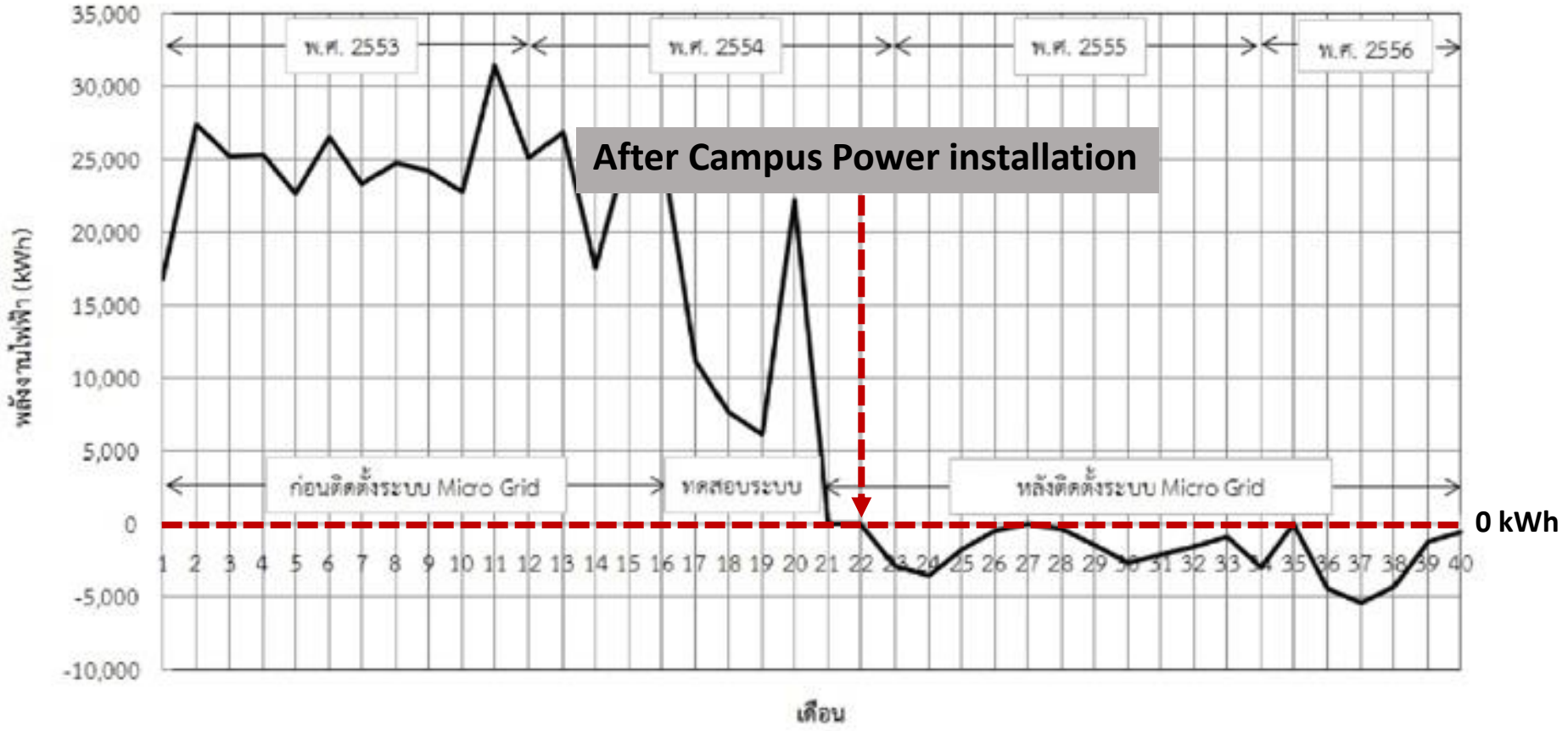
- PV : 400 kW
- Bidirectional Inverter
- Storage Battery: 100kWh
- Energy Management System (EMS)

Year 2016: Net Positive Production



PV + Building Energy Management System (BEMS)

Year 2016: Net Positive Production

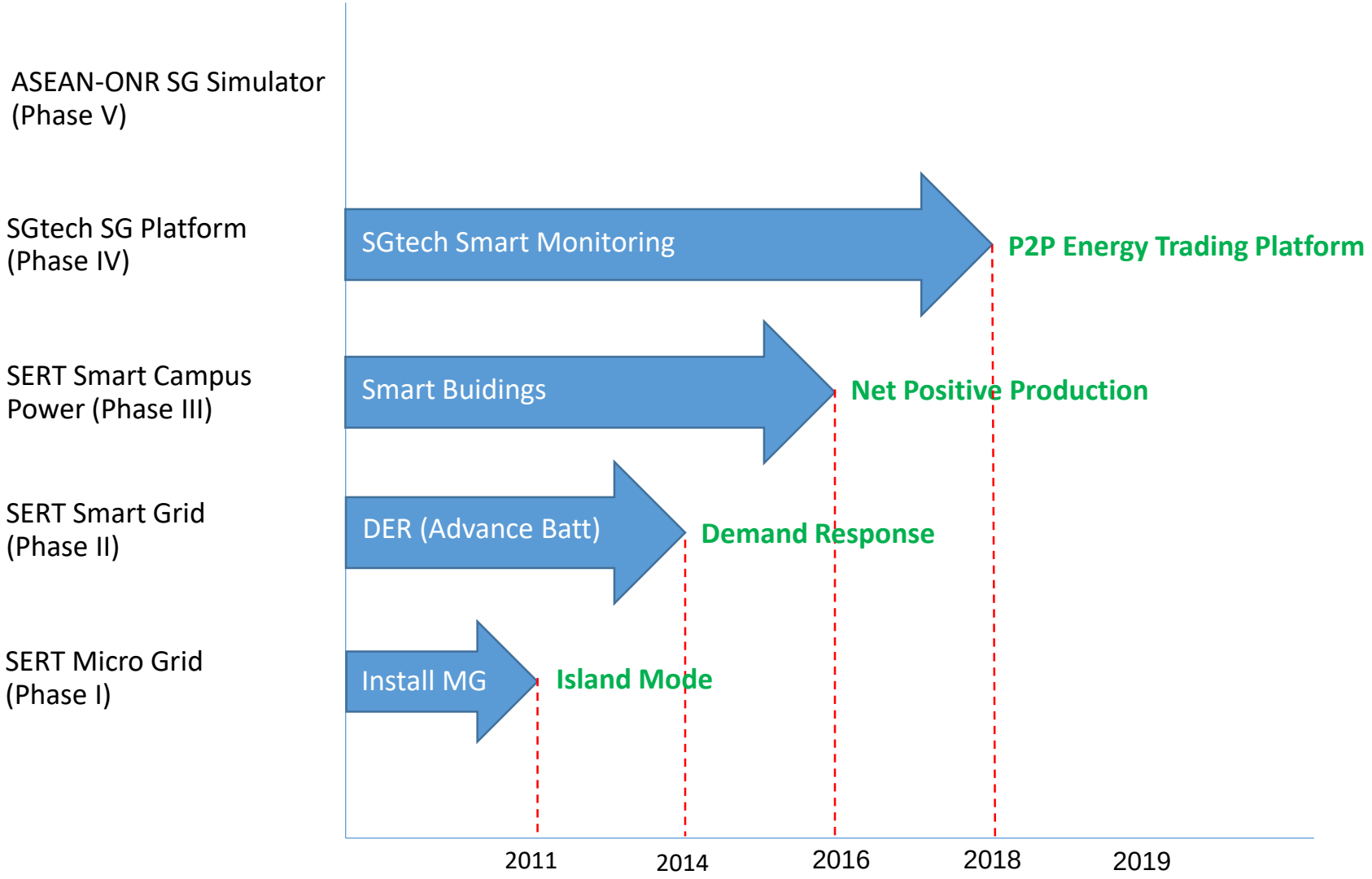


Energy Production (PV) > **Energy Consumption**

(520 kw_p) (200 kw_p)

Year 2016: Net Positive Production

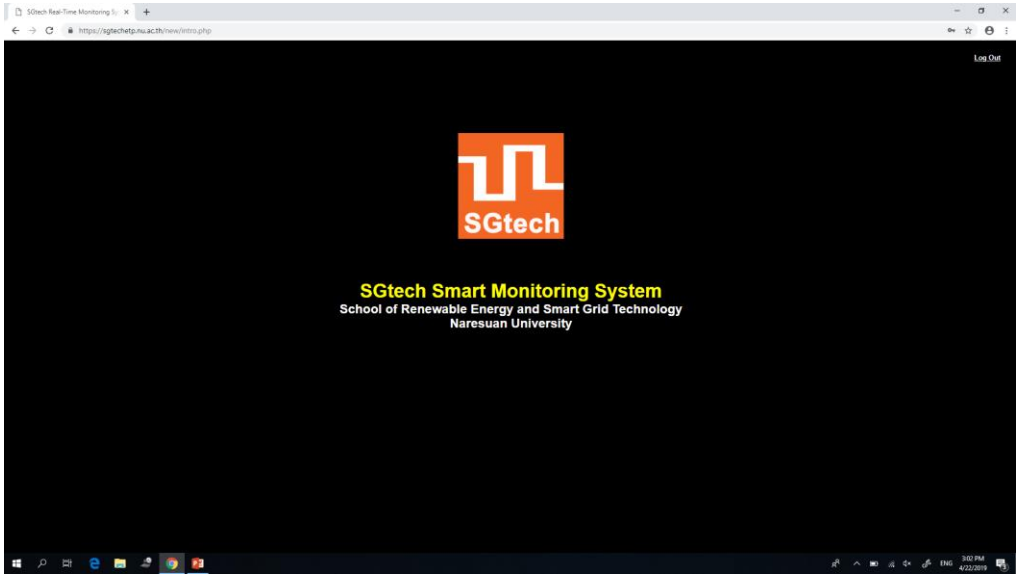
SGtech Smart Grid Development



Year 2018: P2P ETP Platform

What is SGtech smart monitoring concept?

- Real-time two-way power flow concept
- Real-time energy flow
- Electrical exchange identification
- Real-time pricing / costing model for P2P Energy Trading Platform



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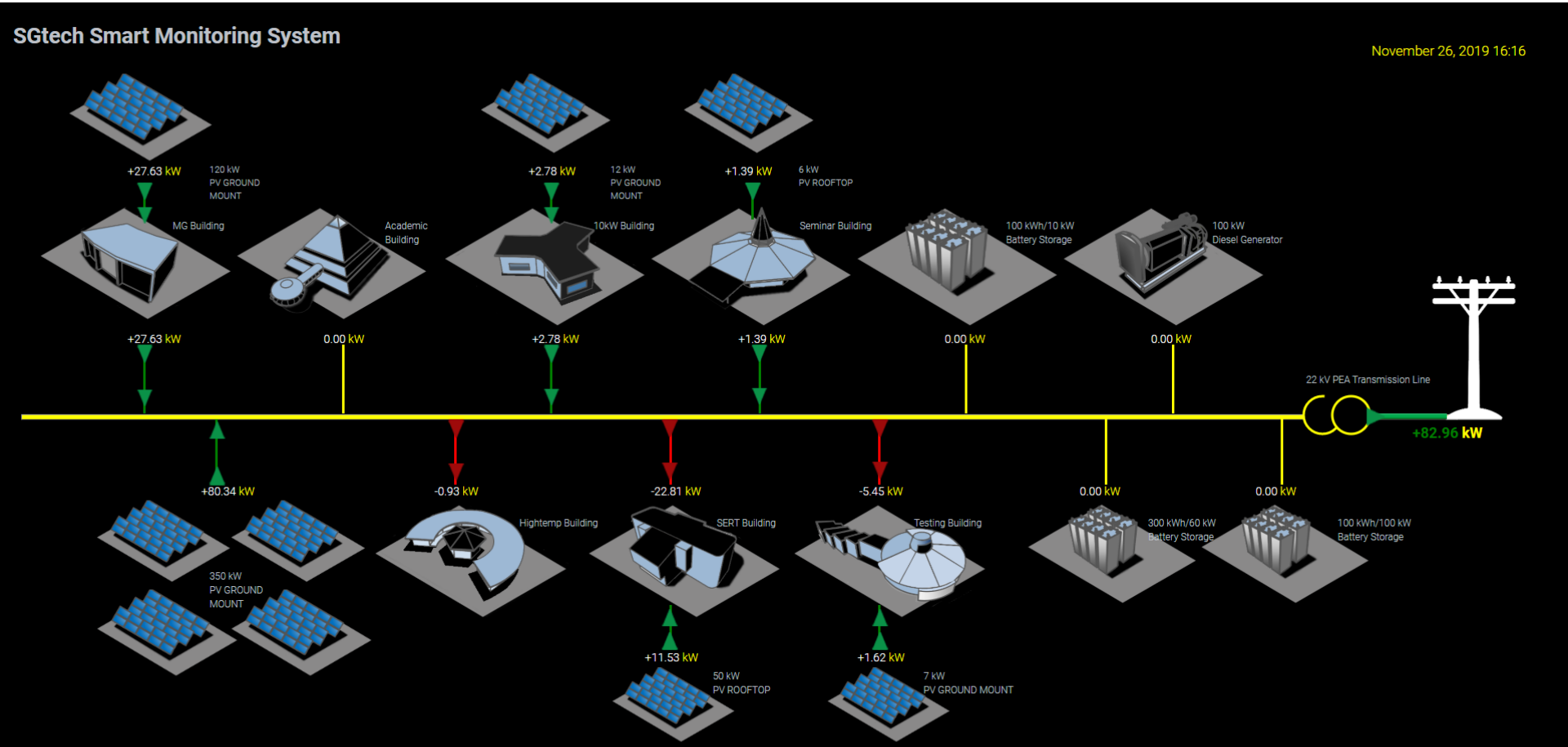
Naresuan University

Year 2018: P2P ETP Platform



Real-Time Power Flow

Power Consumption: -42.34 kW
Power Production: +125.30 kW

Monthly Energy Display

Energy Consumption: -2,956.33 kWh
Energy Production: +49,595.00 kWh
Net Energy: +46,638.67 kWh

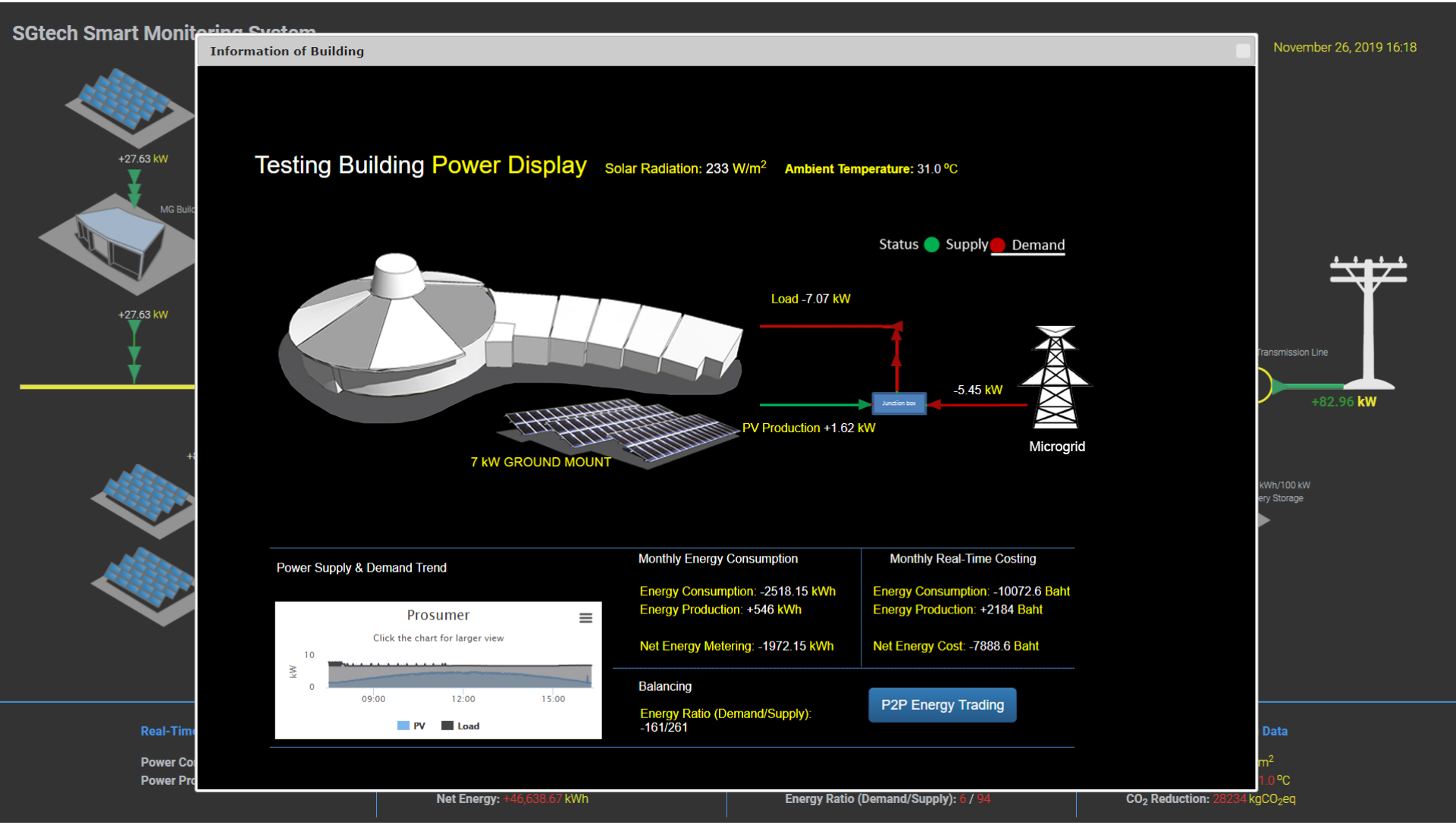
Real-time Costing

P2P Energy Trading (SGtech): 11,825.32 Baht
Excess Energy Trading (NU): 186,554.68 Baht
Energy Ratio (Demand/Supply): 6 / 94

Environment Measuring Data

Solar Irradiance: 233 W/m^2
Ambient Temperature: 31.0 °C
CO_2 Reduction: 28234 $kgCO_2eq$

Year 2018: P2P ETP Platform



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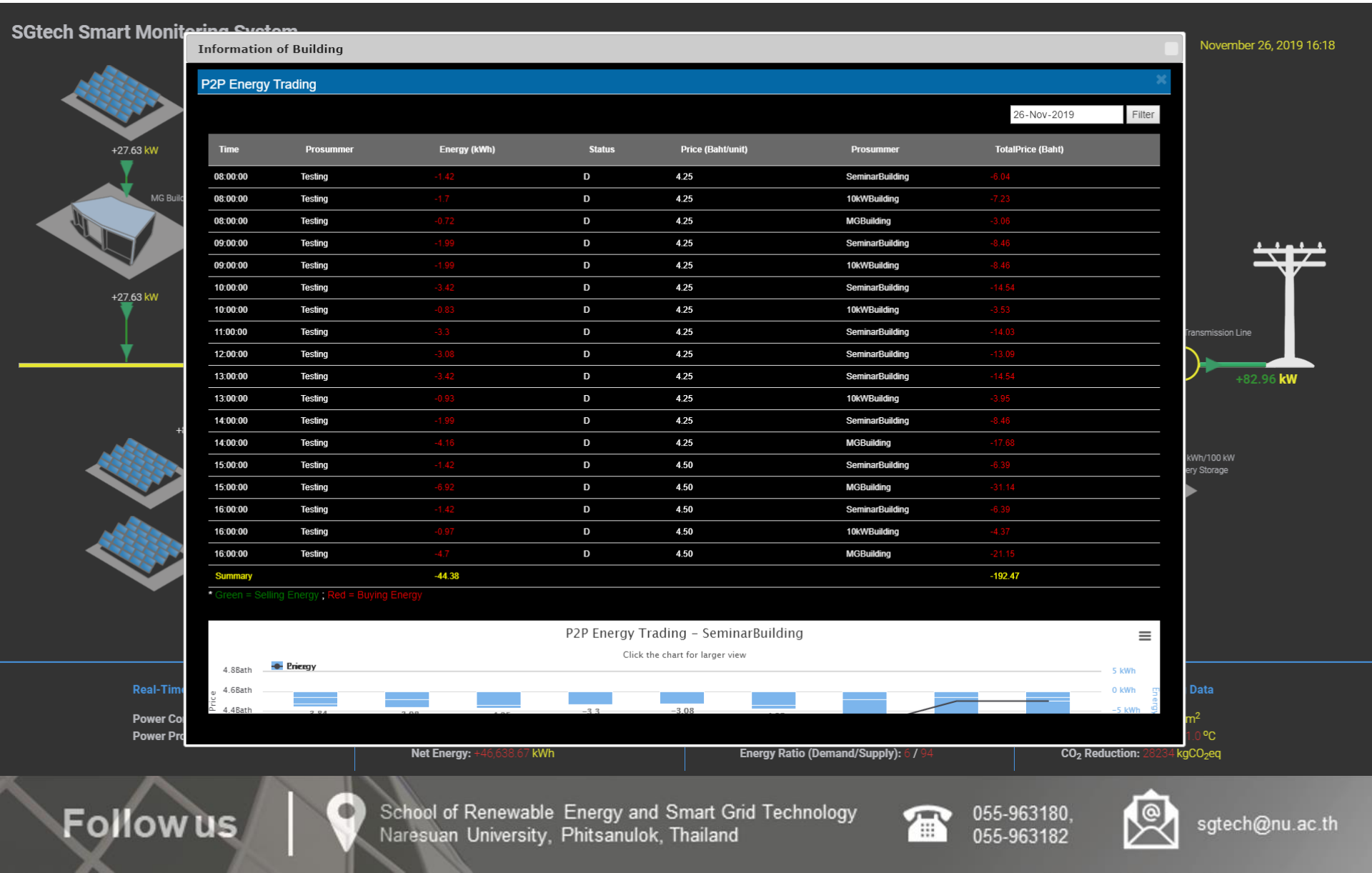

Year 2018: P2P ETP Platform

SGtech Smart Monitoring System

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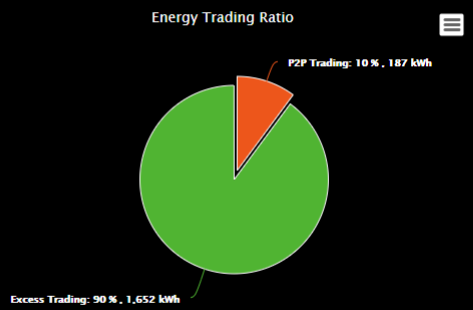
P2P Energy Trading (2019-11-26)

Time	Prosummer	PV Capacity	Energy (kWh)	Status	Price (Baht/unit)	Prosummer	TotalPrice (Baht)
16:00:00	SeminarBuilding	6kW	+1.42	S	4.50	Testing	+6.39
16:00:00	10kWBuilding	12kW	+0.97	S	4.50	Testing	+4.37
16:00:00	MGBuilding	120kW	+4.7	S	4.50	Testing	+21.15
16:00:00	MGBuilding	120kW	+19.3	S	4.50	SertBuilding	+86.85
16:00:00	350kWBuilding	350kW	+4.41	S	4.50	SertBuilding	+19.85
16:00:00	350kWBuilding	350kW	+0.93	S	4.50	HightempBuilding	+4.19
Summary			+31.73				+142.79

Excess Energy Trading (to Grid)

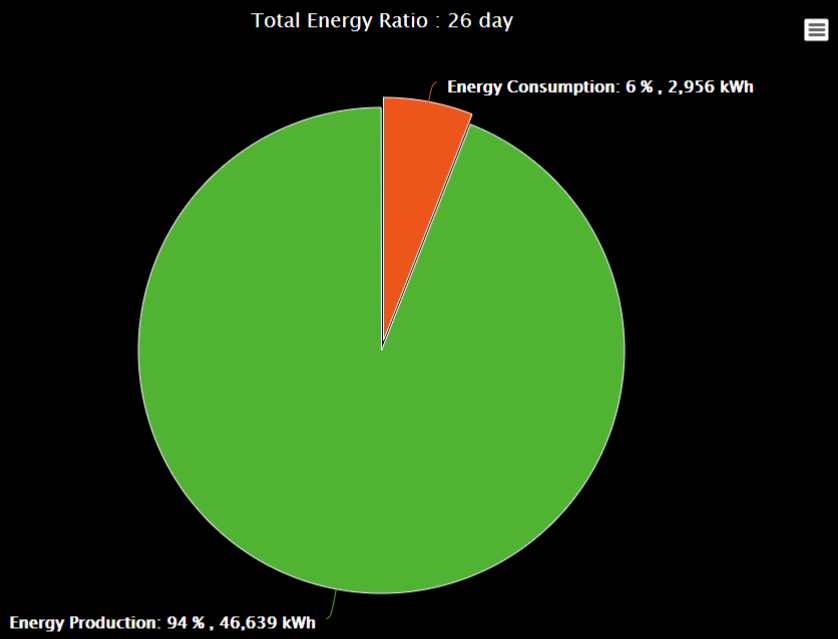
Time	Prosummer	PV Capacity	Energy (kWh)	Status	Price (Baht/unit)	Prosummer	TotalPrice (Baht)
16:00:00	350kWBuilding	350kW	+64.66	S	1.68	Grid	+108.63
Summary			+64.66				+108.63

* Green = Selling Energy



Daily Real-time Costing (2019-11-26)

P2P Energy Trading (SGtech) : 810.25 Baht
Excess Energy Trading (NU): 2,774.77 Baht



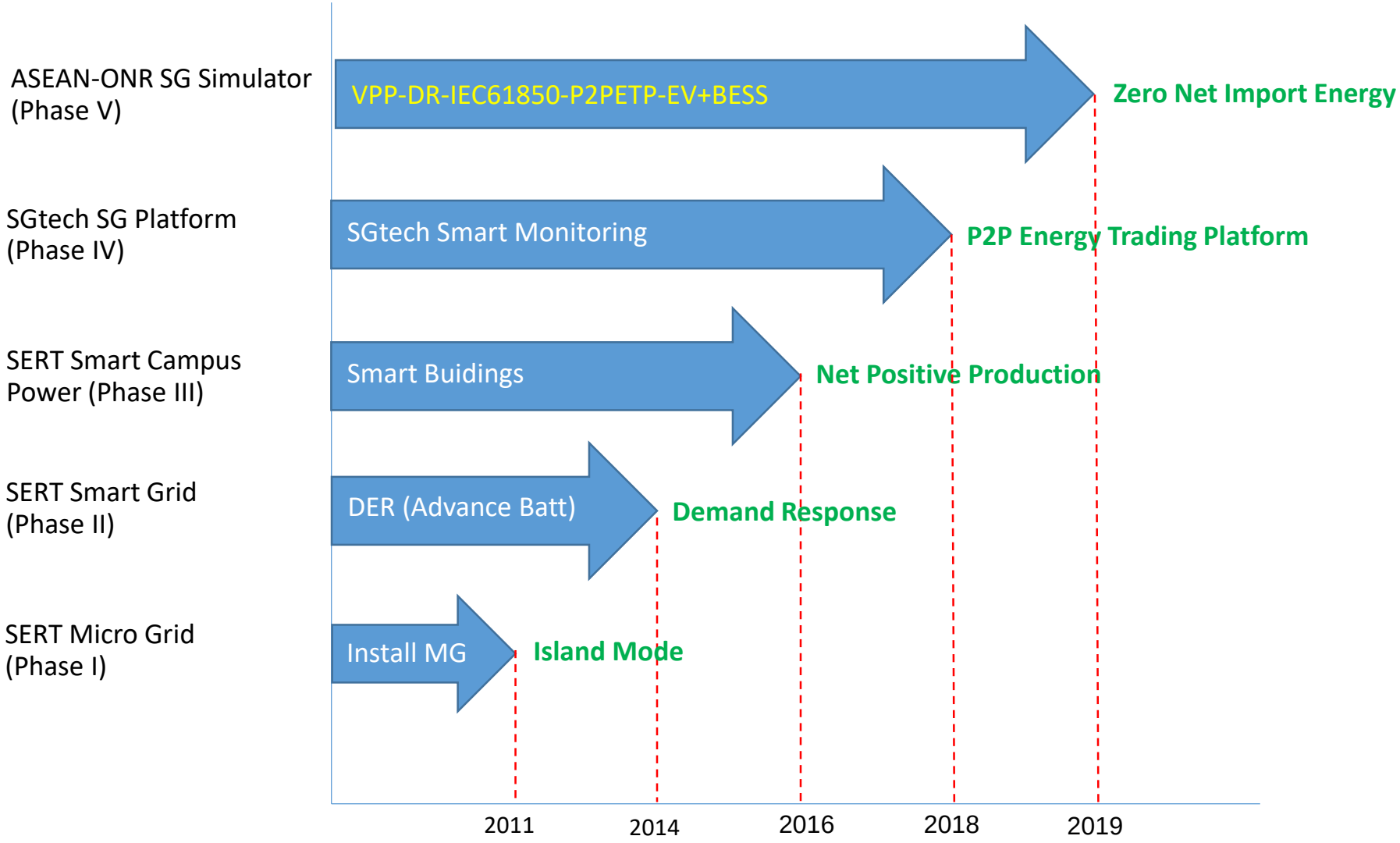
Monthly Real-time Costing (2019-11-01 - 2019-11-26)

P2P Energy Trading (SGtech) : 11,825.32 Baht
Excess Energy Trading (NU): 186,554.68 Baht

Net Energy: +46,638.67 kWh | Energy Ratio (Demand/Supply): 6 / 94 | CO_2 Reduction: 28234 $kgCO_2eq$

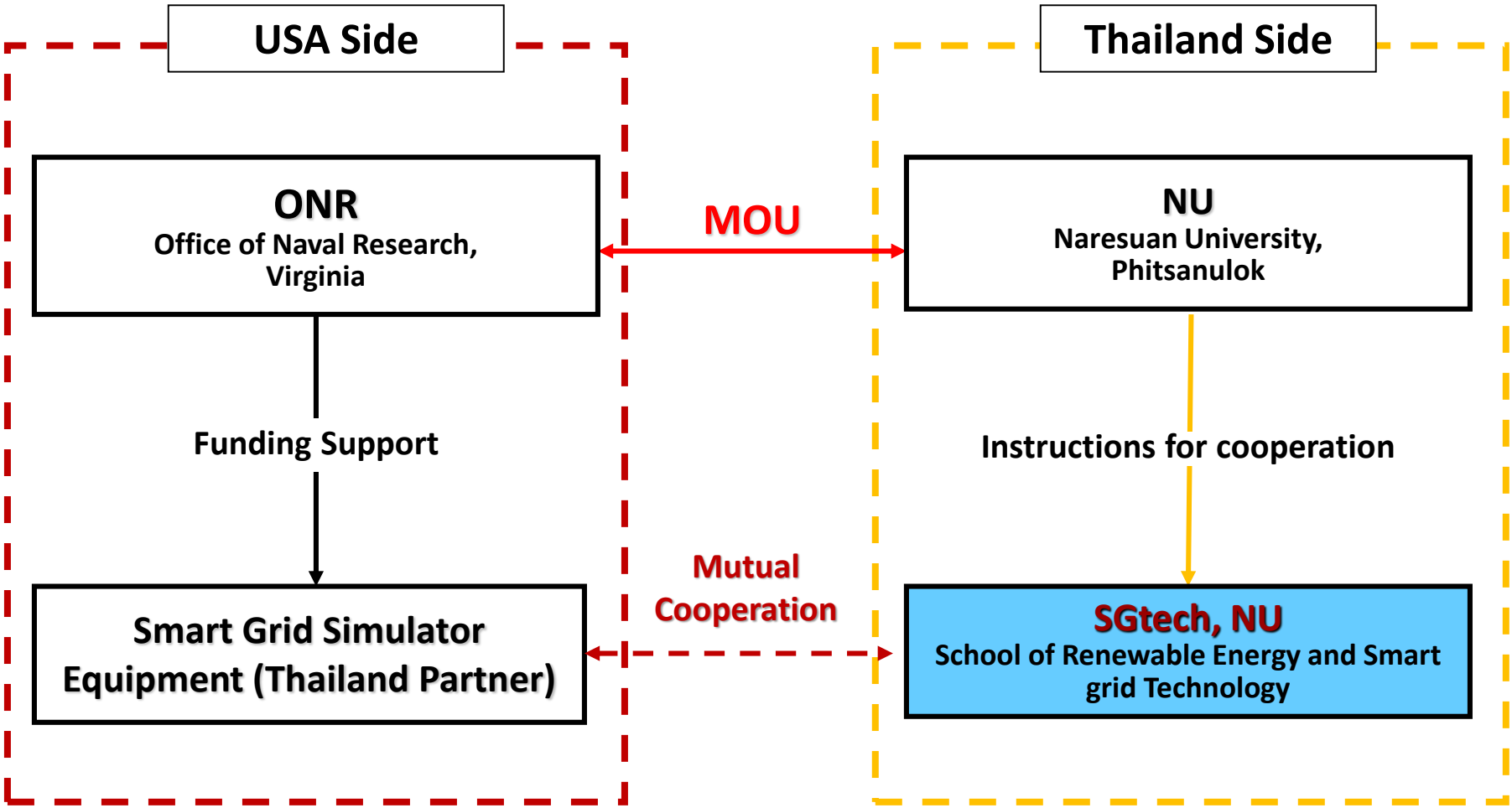
Year 2019: ASEAN-ONR SG Simulator

SGtech Smart Grid Development



Year 2019: ASEAN-ONR SG Simulator

Project Structure



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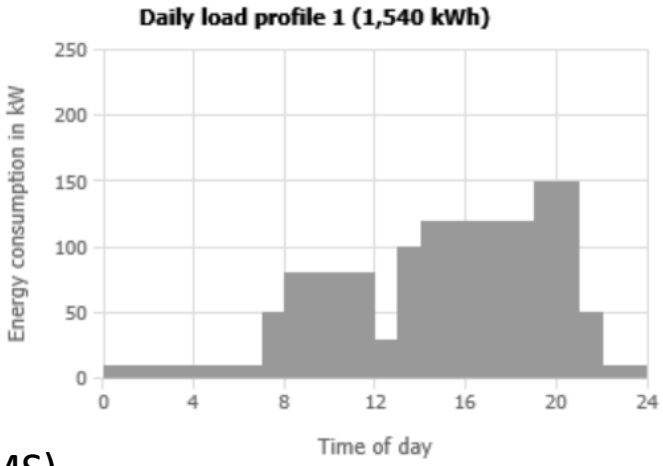


SGtech Microgrid Status

- PV Production 520 kWp and Energy Consumption 200 kWp
  (Excess Power 350 kWp about 2-3 hours)
- Weak of Overall Energy Management System (EMS) for Balancing Power
- Energy Storage Degradation (Lead Acid Battery)

New Smart Microgrid Concept

- Develop the EMS for Balancing Power with **“Net Zero Import Energy Concept”**
  (Daytime: PV+ESS and Nighttime: ESS)
- New Installation of ESS for Islanding Mode
- The First of Completely Microgrid Demonstration Concept for the Future
  (VPP-DR-IEC61850-P2P ETP with V2G + ESS concept)

New System Components

Hardware System

- Advance Metering Infrastructure (NB-IOT Smart Meter with MQTT)
- Feeder & Substation Automation System (IEC 61850)
- Microgrid Component (Micro EMS) with Energy Storage System (300 kW / 300 kWh)
- IOT Sensor for Demand Response (DLC Concept with Open ADR V.2)

Software System

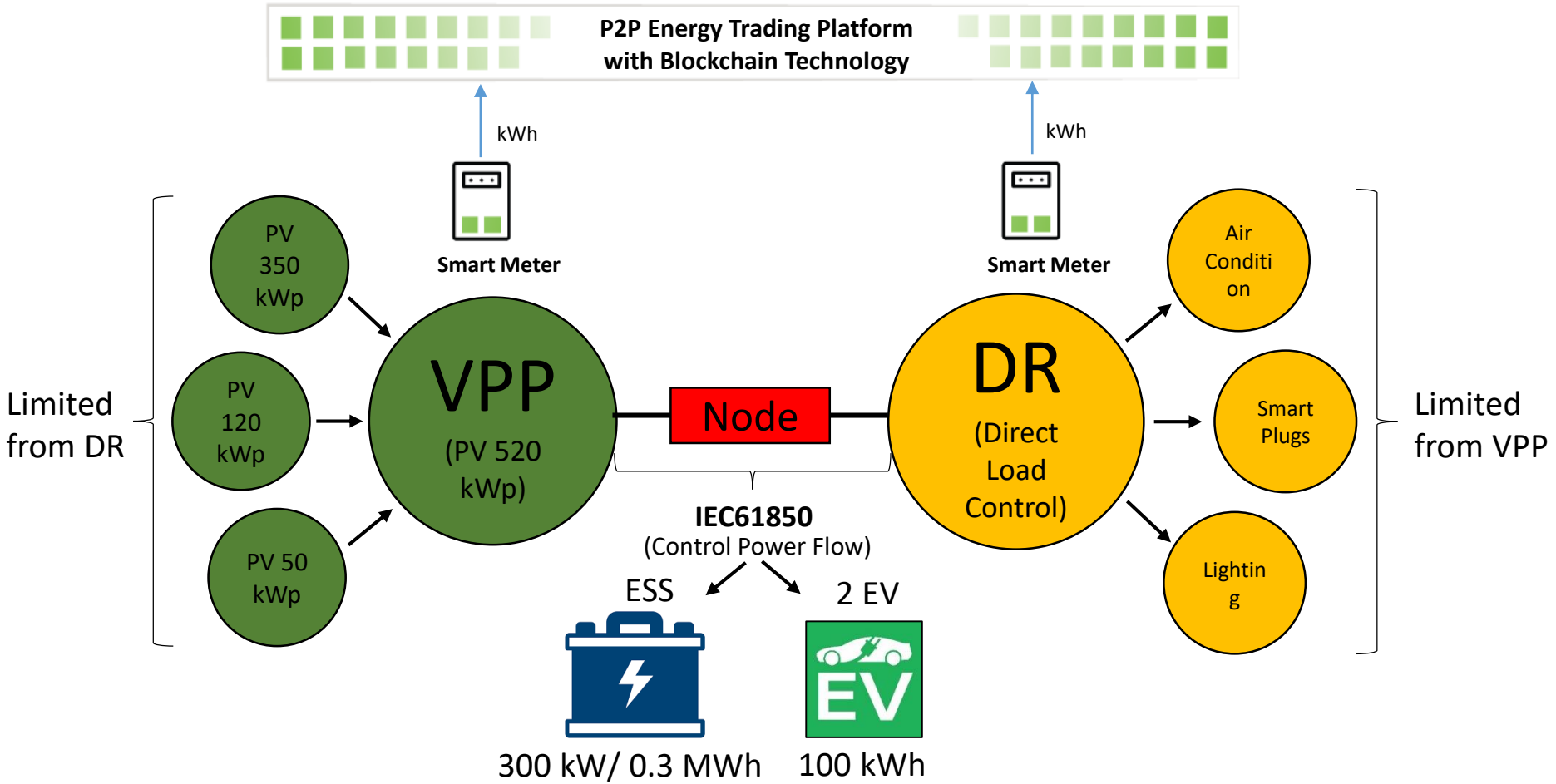
- Renewable Energy Forecasting and Demand Response (Balancing Power)
- Virtual Power Plant (VPP) Monitoring and Control
- P2P Energy Trading Platform (Blockchain Technology (Hyper ledger: IBM))
- Data Center (Private Cloud Server)

Net Zero Import Energy (Smart Microgrid)

Additional System

- 2 EV cars with Charging Stations on P2P ETP (V2G / G2V Concept with OCPP V.2)

ASEAN-ONR Smart Grid Concept



The prototype of future communities (Smart Microgrid) in the ASEAN country

"Net zero import energy from the grid"

Thank You

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