ASIA CLEAN ENERGY FORUM 2026

Beyond Transition: Building Secure, Resilient, Inclusive, and Intelligent Energy Systems

8–11 June | ADB Headquarters, Metro Manila, Philippines

Thailand's Vehicle-to-Grid Development Program

9 June 2026

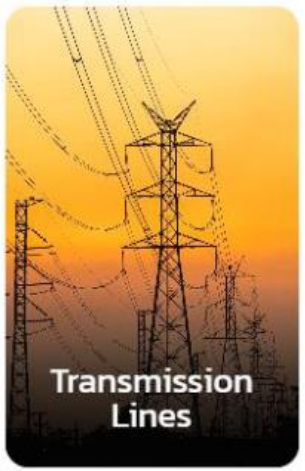
Setthasit Chardgaroon

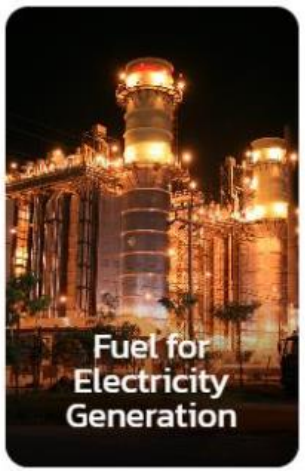
Head of Energy Storage Business Section

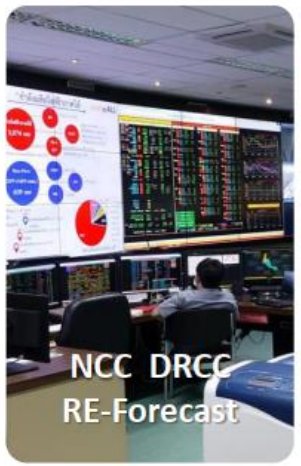
Electricity Generating Authority of Thailand

Who is EGAT

a state-owned enterprise under the supervision of Ministry of Energy and Ministry of Finance.







Subsidiary Companies :

EGCO Group

RATCH Group

DCAP

EGATI

EGAT Diamond Service

InnoSpace

INNOPOWER

PE LNG

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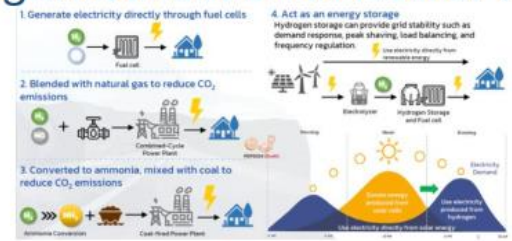
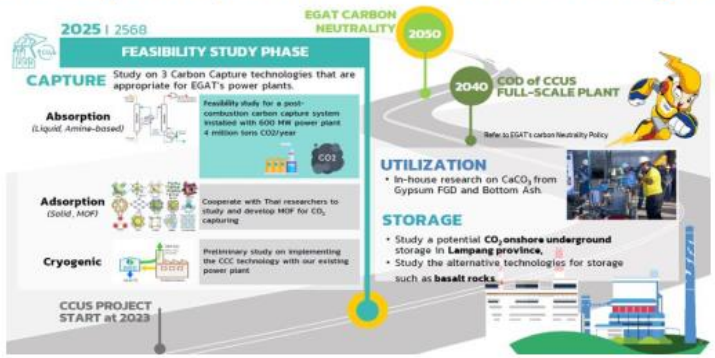
Small Modular Reactor

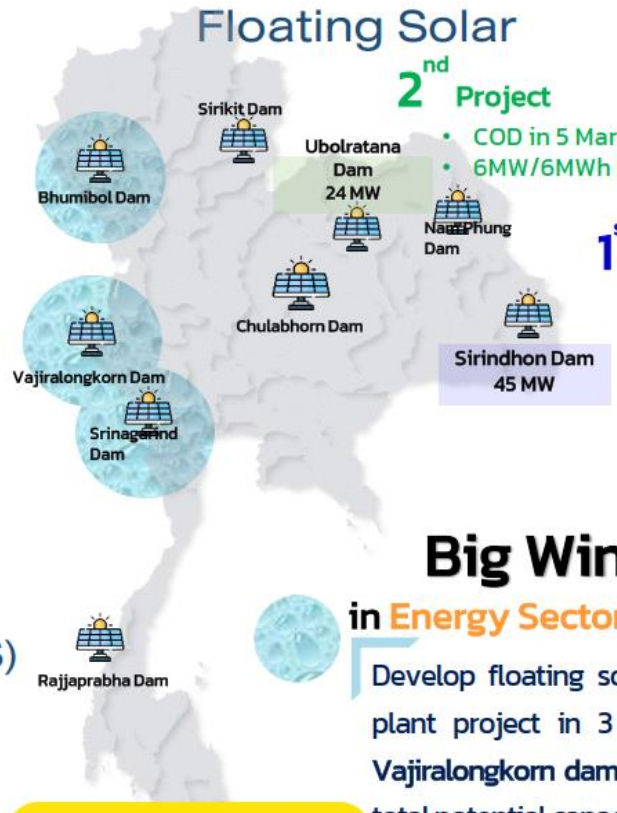
Hydrogen Utilization in Power Sector



Carbon Capture, Utilization and Storage (CCUS)



Floating Solar



2nd Project

- COD in 5 March 2024
- 6MW/6MWh BESS

1st Pilot Project

- COD in 31 October 2021
- Using Energy Management System (EMS) and Weather Forecast System
- Connected with existing 115 kV Substation

Big Win in Energy Sector

Develop floating solar PV with hydro power plant project in 3 areas of **Bhumibol dam, Vajiralongkorn dam** and **Srinagarind dam** with total potential capacity of **1,638 MW**

2,725 MW

Project implementation during 2021–2030
(According to Draft PDP 2024)

EGAT is preparing to implement over 10 GW in 10 potential Dams driving Thailand's goal of sustainable low carbon society

National Energy Plan (NEP) Roadmap

Energy Policy and Planning Office
MINISTRY OF ENERGY

NET ZERO
2050

RE>50% w ESS
Policy to increase RE share in Electricity Generation across Grid Scale / Community / Consumer

EE >30%
Policy and technology innovations to promote energy efficiency

แผนพลังงานชาติ
(NATIONAL ENERGY PLAN: NEP)

On 4th August 2021 :
NEPC considered and approved national energy plan (NEP) framework.
The goal is to support Thailand moving towards clean energy and reduce carbon emissions to net zero (Carbon Neutrality).

4D1E
- Digitalization
- Decarbonization
- Electrification
- Decentralization
- De-regulation

EV 30@30
Development of infrastructure to support an increase in EV adaptation in line with the EV 30@30 target

Gas Plan | **AEDP** | **PDP** | **EEP** | **Oil Plan**

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Concept NEW PDP2026

LOW CARBON TECHNOLOGIES

- SMR / MMR
- Solar PV / Floating
- Wind
- Pumped hydro Storage

CONSIDERATION OF ALL COSTS

CO2

CARBON PRICING

REINTEGRATION COST

DEVELOPMENT OF PROSUMER POWER TRADING MODELS

Residential solar program

MAXIMIZING THE BENEFITS

Repurposing of Retired Power Plant

ENSURE RELIABILITY
Maintain power system security

REDUCING POWER PLANT CONSTRUCTION COSTS

LOWER ELECTRICITY COST
Reduce overall cost of electricity

EVALUATION OF POWER GENERATION CAPACITY TO HANDLE VARIABILITY AND UNCERTAINTY

from IPS Solar Rooftop.

APPROPRIATE CONSIDERATION OF DATA CENTER

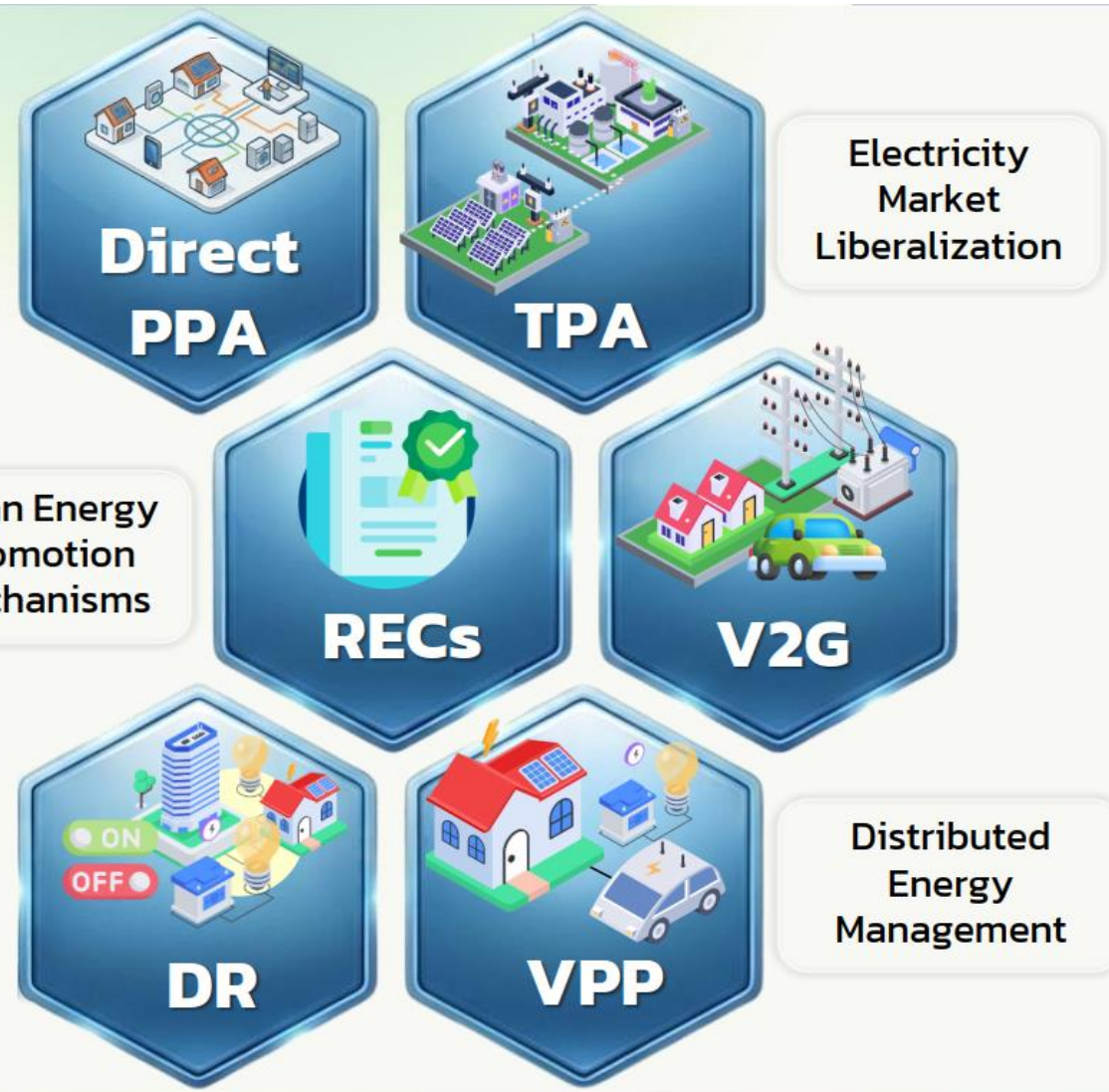
Approximately consider the electricity demand from data centers

Energy Policy and Planning Office
MINISTRY OF ENERG

PROMOTING

ENERGY-RELATED BUSINESSES

in support of the energy transformation



EGAT Development Phase of Variable Renewable Energy Integration

IEA classifies VRE Integration development into 6 phases by different impacts to power system and their corresponding measures and tools for effective management.

VRE Integration Complexity

VRE variability causes longer periods of energy surplus and deficit.	**Phase 6: Seasonal or inter-annual surplus or deficit of VRE supply**
	Phase 5: Growing amounts of VRE surplus (days to weeks)
When Inverter-Based Resources (IBRs) generate over 50% of total generation, System will require **Inertia.**	**Phase 4: VRE makes up almost all generation.**
System Flexibility is needed to manage VRE's variability and uncertainty.	**Phase 3: VRE generation determines the operation pattern.**
VRE influences change of load profile.	**Phase 2: VRE has a minor to moderate impact.**
VRE has no significant impact to load profile	**Phase 1: VRE has no noticeable impact.**

Recommended Flexibility Tools

- Synthetic Fuels or Hydrogen for Power Generation
- Incentivize New Load via Electrification i.e. V2G
- ESS
  - PSH: Real Inertia
  - BESS: Synthetic Inertia
- Inertia Support
  - Gas Turbine
  - Synchronous Condenser
- RE Control Center (Curtailment)
- Revise Commercial Contract
- Flexible Power Plant
- FACTS Device
- Smart Inverter
- ESS (Pumped Storage Hydro Power Plant; PSH and BESS)
- Advanced DR
  - General Consumer
  - Smart Charging
- Forecasting System
- Demand Response (DR) (Large-scale Consumer)
- Data Integration (VRE Registration, Technical Requirements & Connection code)

Completed Tasks

- Power System Security Study (draft of PDP2024 version)
- WN-C4
- STATCOM
- Existing PSH, Pilot Project of BESS (Bamnet Narong & Chai Badan)
- Advanced DRCC
  - RE Forecast Center
  - DR Control Center

National Energy Information Center (NEIC)

" **Power system flexibility** is a critical factor for maximizing the efficiency of VRE integration across the dimensions of energy security, cost-effectiveness and environmental sustainability"

Source: Thailand Renewable Grid Integration Assessment, 2018, IEA

Virtual Power Plant (VPP)

2022–2023

NCC (EGAT)
DRCC (EGAT)
LA (PEA) | LA (MEA)
LAMS Platform | LAMS Platform
DR Participants
C&I

Upgrade DRCC to be VPP Platform

Digital Control Platform

- Improve Security
- Improve Stability
- Improve Reliability
- Improve Flexibility

VPPP to EV Aggregator

VPP Platform → Request (*OpenADR Standard*) → EV Load Aggregator

Request
Charge
Charge/ Discharge

EV Owner (V1G)
EV Owner (V2G)

Observe
Predict
Control

NCC (EGAT)

Predictable
Increase / Decrease Generation

VPP Platform

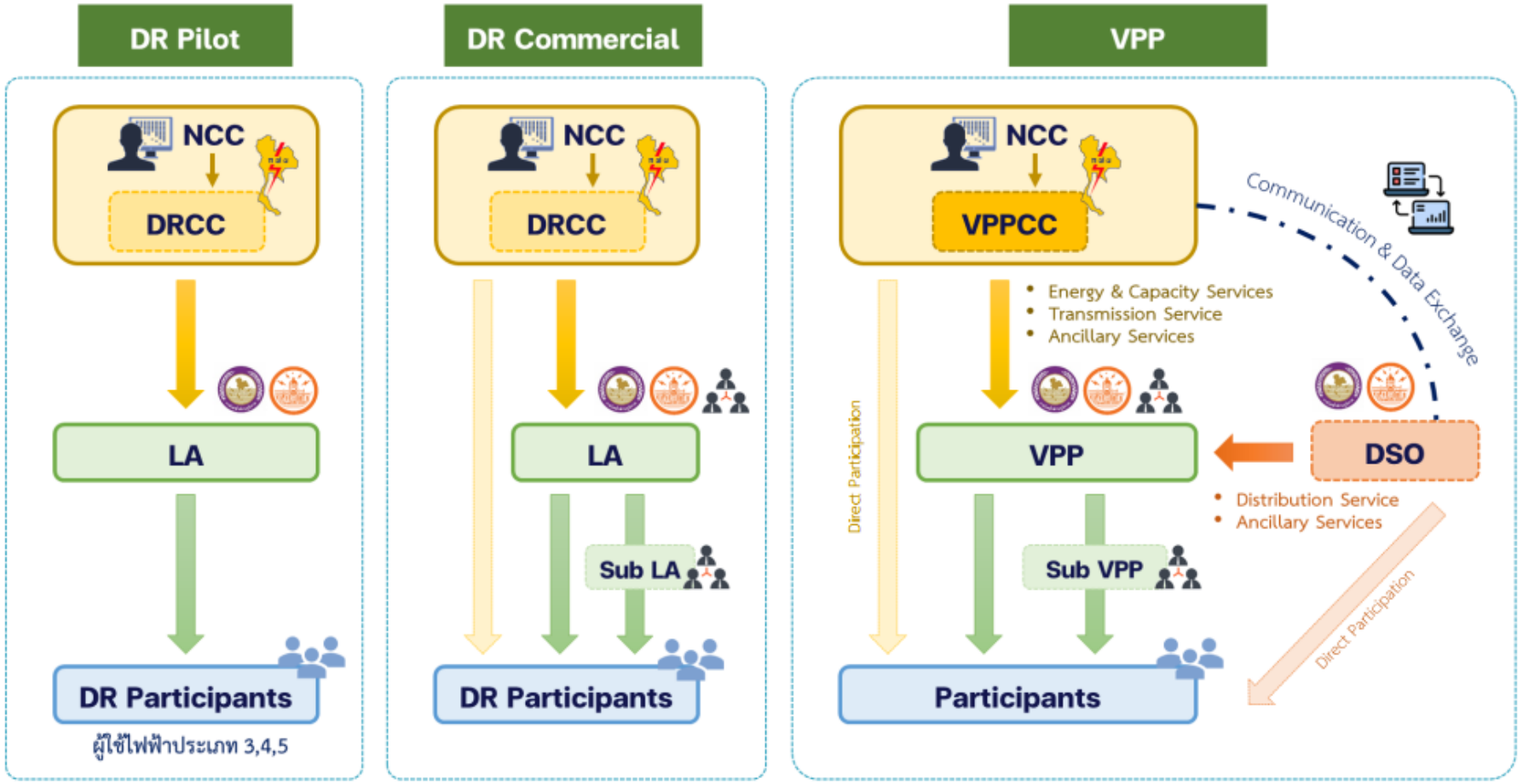
Increase / Decrease Power
Increase / Decrease Power

VPP #1 | VPP #2 | VPP #n

DERs

Solar Farm
Small Hydro Power Plant
VRE + BESS
BESS
Wind Farm
Biomass
Biogas
EV
Flexible Load

Operating Concept for Thai Context



Draft PDP 2024

สรุปกำลังผลิตใหม่ และระบบกักเก็บพลังงาน ในช่วงปี 2567 – 2580

(หน่วย: เมกะวัตต์)

ประเภทโรงไฟฟ้า	กำลังผลิตใหม่
โรงไฟฟ้าพลังงานหมุนเวียน	34,851
โรงไฟฟ้าพลังความร้อนร่วม	6,300
โรงไฟฟ้าพลังความร้อน	600
รับซื้อไฟฟ้าจากต่างประเทศ	3,500
อื่น ๆ (DR, V2G)	2,000
รวม	47,251

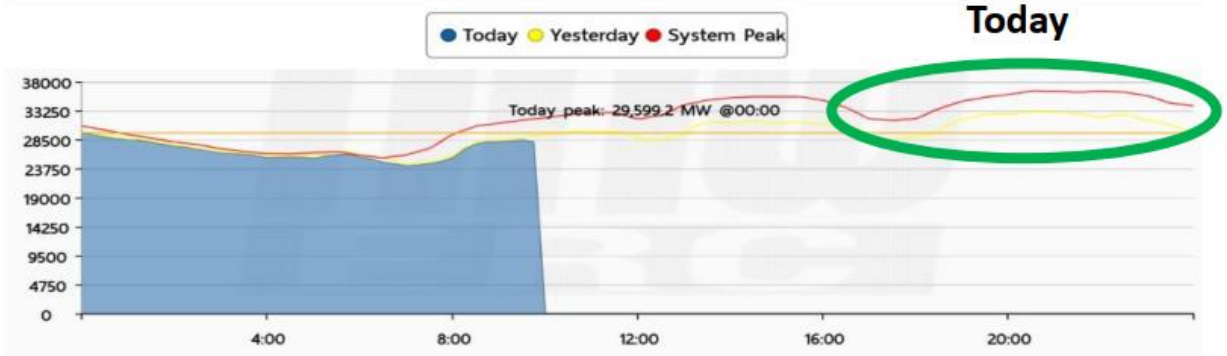
หมายเหตุ : ไม่รวมกำลังผลิตที่ได้ข้อยุติแล้ว

ประเภทโรงไฟฟ้า	MWh	เมกะวัตต์
พลังน้ำแบบสูบกลับ	19,776	2,472
ระบบกักเก็บพลังงานแบบแบตเตอรี่	26,010	10,485
รวม	45,786	12,957

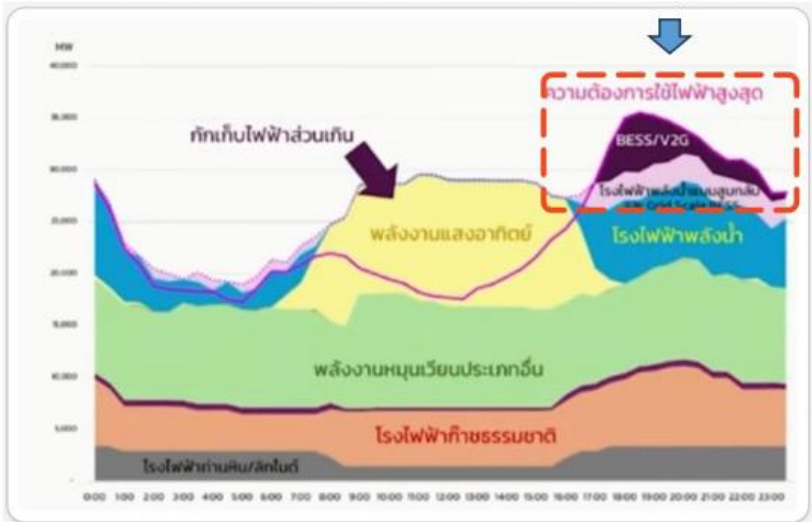
45

ค่าความต้องการพลังไฟฟ้าสูงสุดของระบบไฟฟ้า
(System Peak)

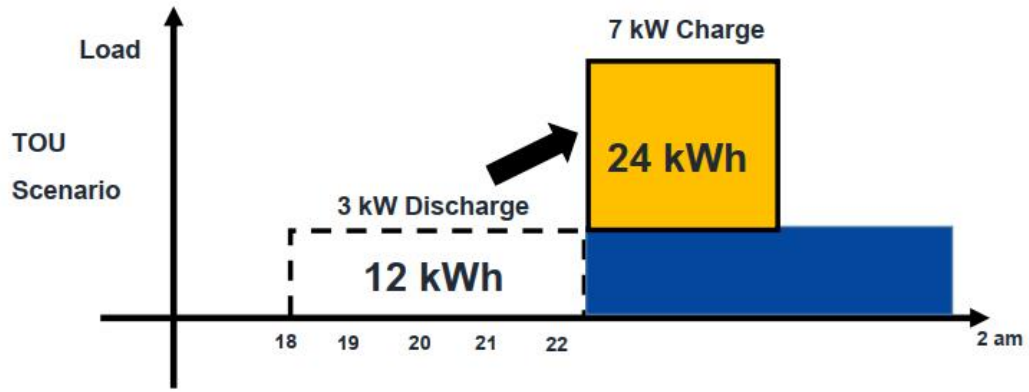
Today

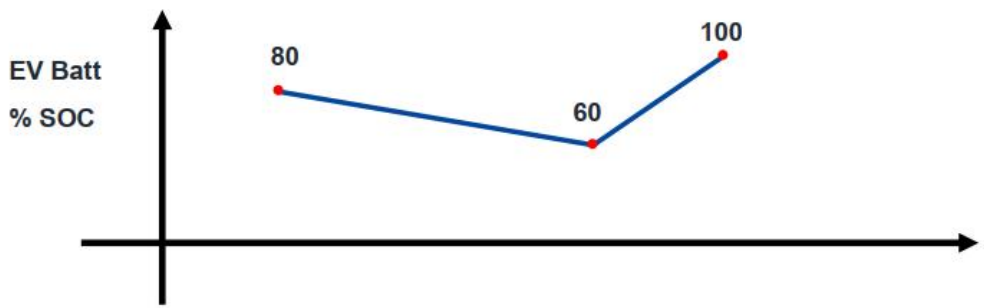


Future
DR + V2G 2,000 MW

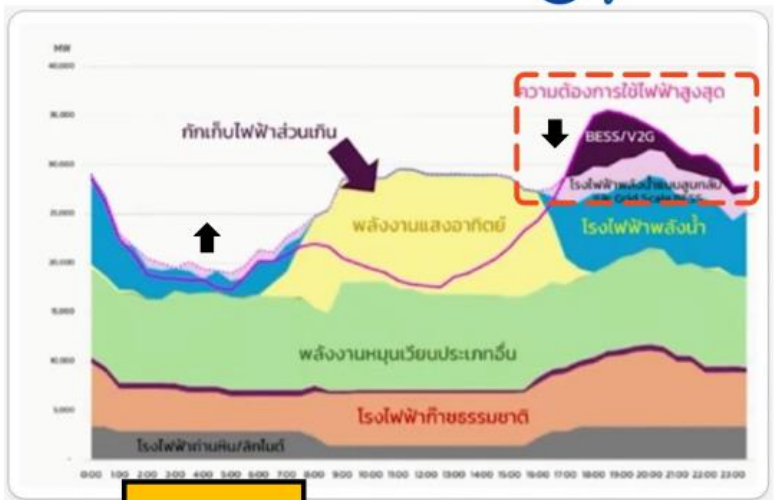


How does it work ?





Each Unit



24 kWh

7 kW charge

x 600,000 units

= 4,200 MW

12 kWh

3 kW Discharge

x 600,000 units

= 1,800 MW

EGAT VGI Sandbox Project Experiences

EGAT
Demand Response Control Center

WATTDRIVE
EGAT

EGAT
Vehicle Grid Integration Platform

CHAdeMO

DC Bi-directional charger

11 Units

NISSAN

Grid code Testing

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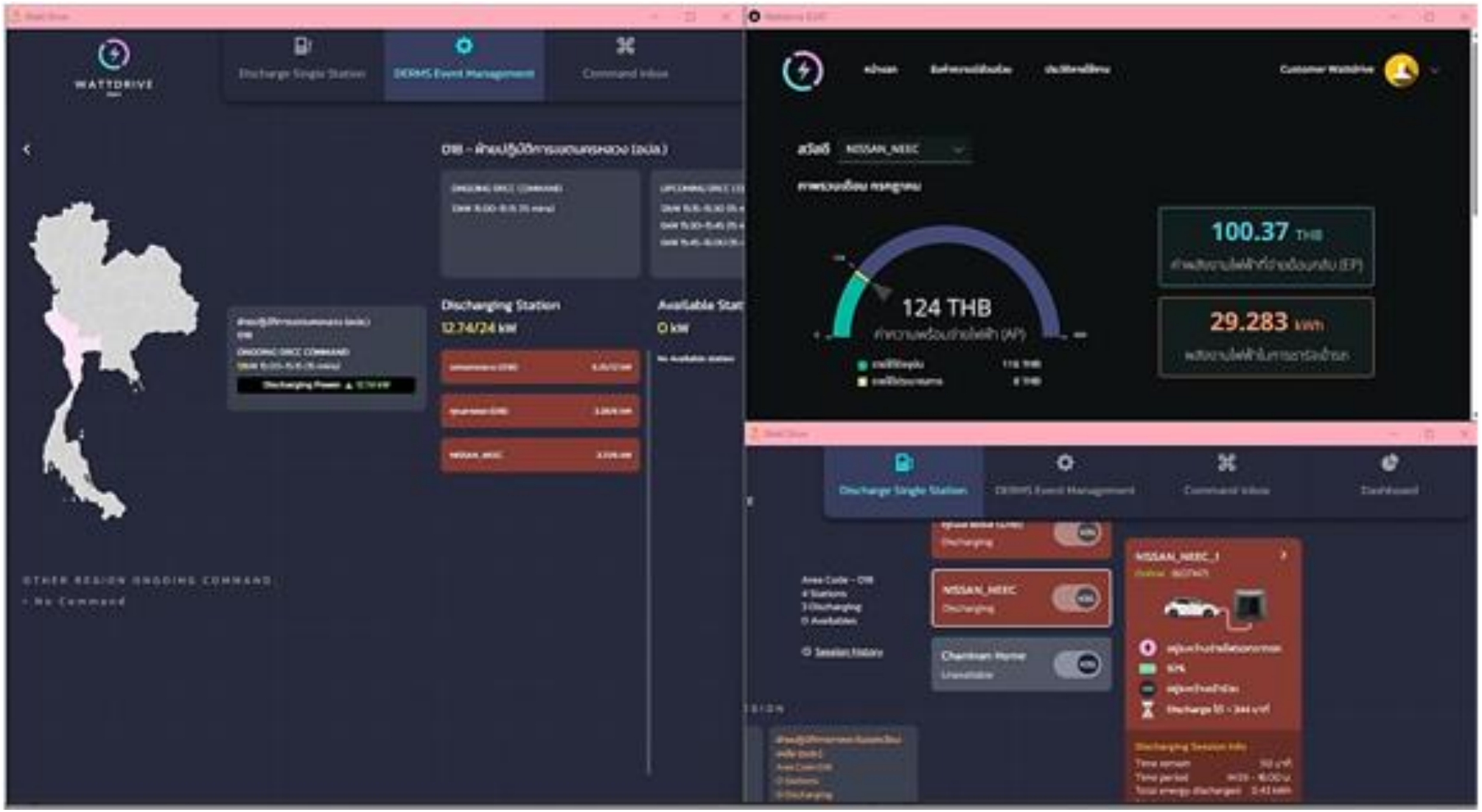
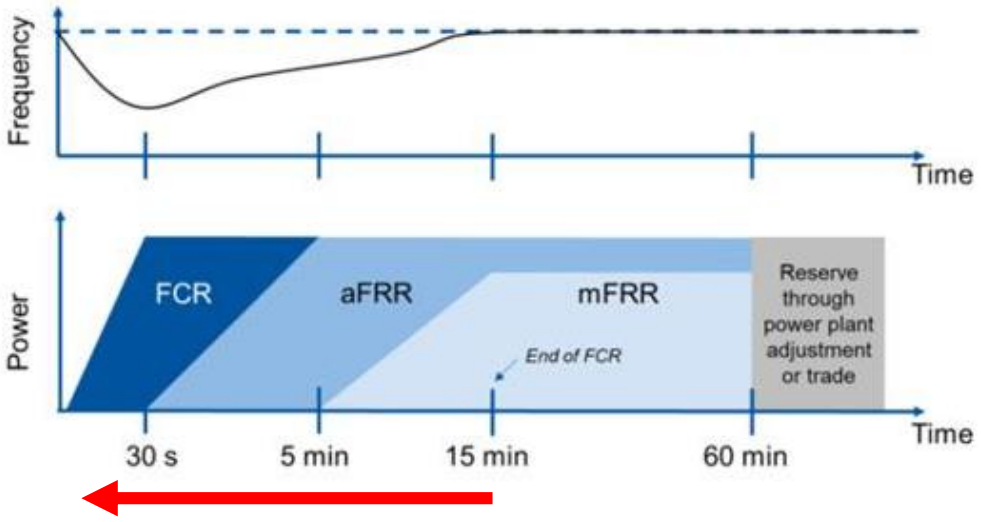


V2G Application

EGAT for ALL



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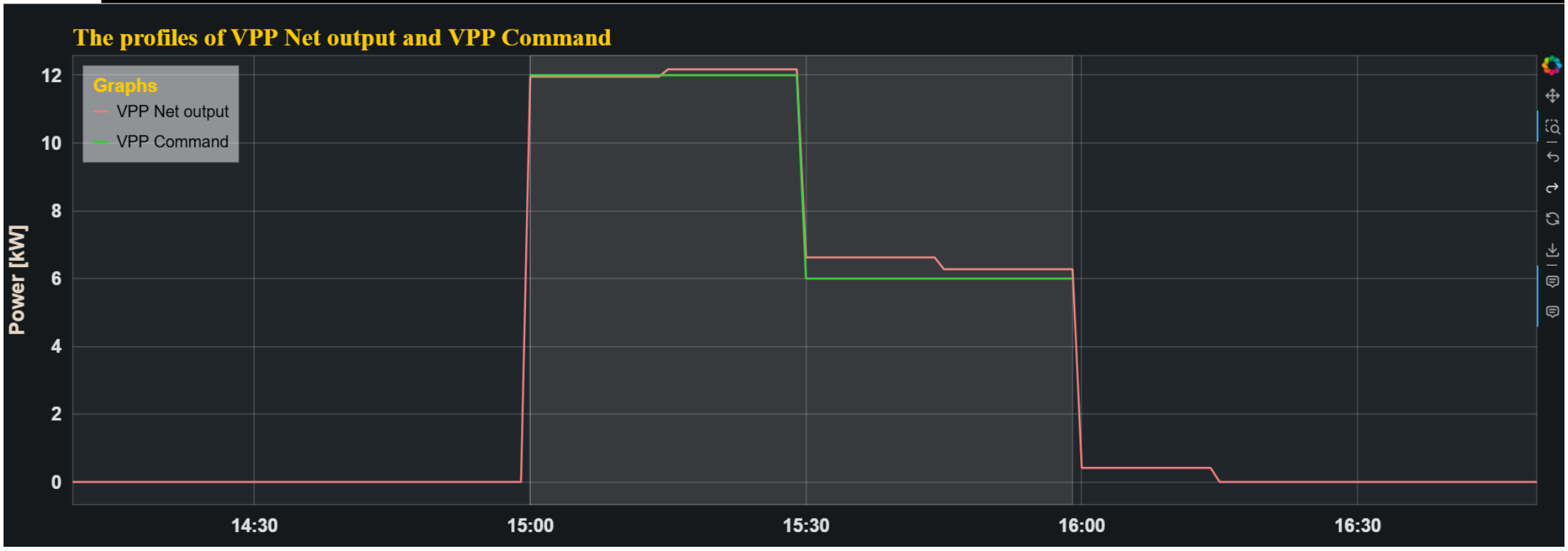
EGAT Virtual Power Plant Platform

EGAT

≡ Menu

Select Program: 15-min ahead Scheduling | Select VPP: Wattdrive | Select Area code: 00: All area codes | Select Date from: 2025-07-07 | Select Date to: 2025-07-07 | Show | Auto-Refresh: OFF

Net output | Generation | Energy Storage | Load | Other



EGAT Demand Response by Vehicle Grid Integration (VGI) Program (New)

EGAT
Demand Response Control Center

EGAT
Vehicle Grid Integration Platform

Type2

AC Bi-directional charger

CCS2

DC Bi-directional charger

ISO15118-2
ISO15118-20
Standard

New Car Brand

1,000 Units

EGAT VGI Large Scale Project

Benefit for All

Customer

- Cost Saving : 8000 THB + Per year
- Incentive from EGAT
- Energy Security

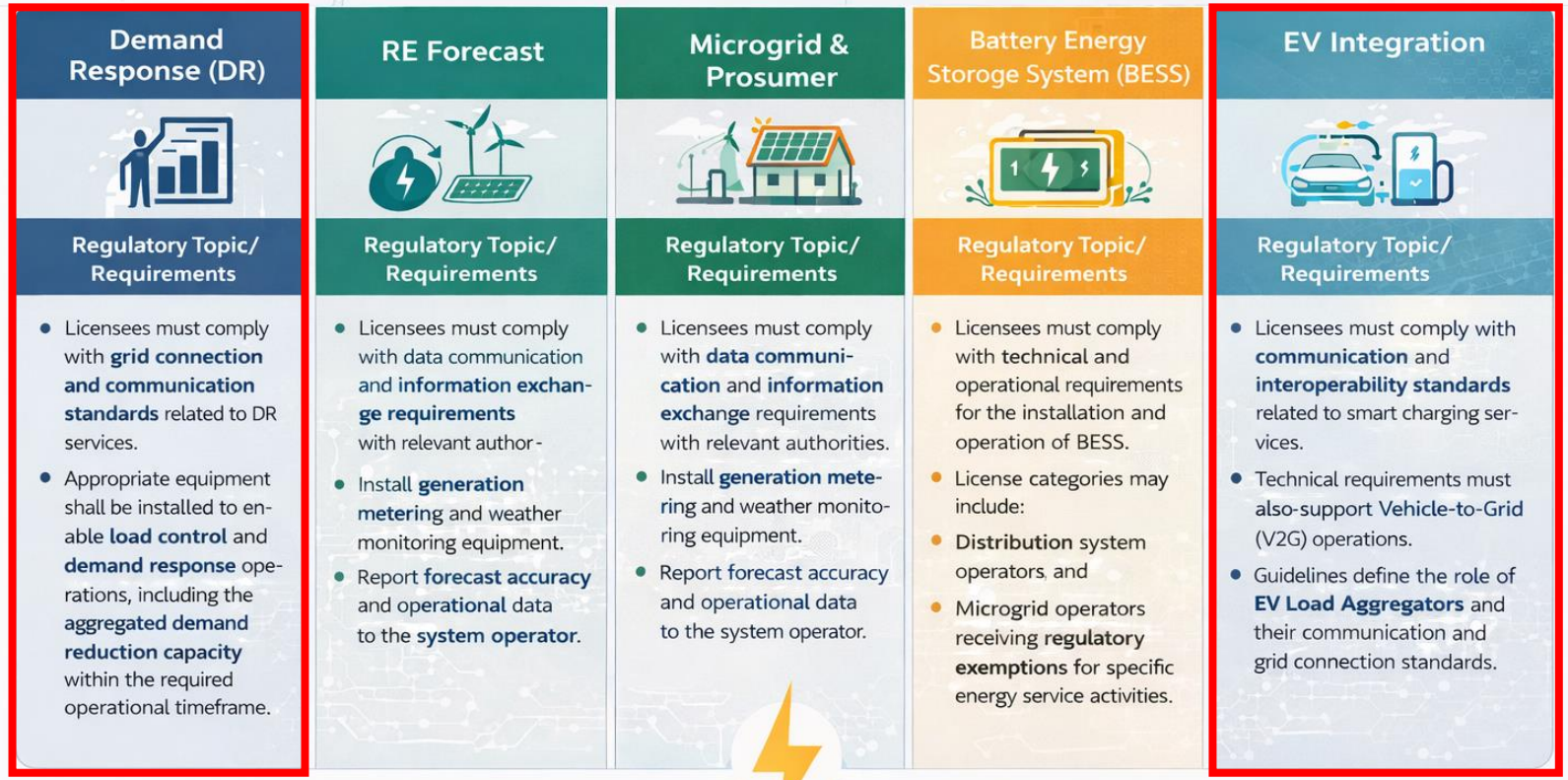
Car Brand

- Value added Branding
- Strong Selling Point
- Product Differentiation

EGAT

- Grid Flexibility
- Supporting Renewable Energy Resources
- Achieving Carbon Neutrality Goal

Regulatory Considerations for Emerging Grid Flexibility Resources in Thailand



Regulatory Framework for Emerging Energy Resources in Thailand

Demand Response (DR)	RE Forecast	Microgrid & Prosumer (>1 MW)	Battery Energy Storage (ERC)	EV Integration
				
Regulation by Other Authorities	**Regulatory Topic/ Requirement**	**Regulaton Topic/ Requirements**	**Regulatery Topic/ Requirements**	**Regulatory Topic/ Requirements**
• TISI standards for related equipment	• TISI standards for related equipment	• TISI standards for related equipment	• To be considered in the future based on ERC policy and regulatory direction of the Energy Regulatory Commission (ERC)	• TISI standards for related equipment
• **Compensation** mechanism for Energy Providers (EP) and calculation of compensation for Aggregators (AP)	• To be considered in the future based on ERC policy and regulatory framework	• To be considered in the future based on ERC policy and regulatory framework.	• **Tarnif** structure determined based on service costs or thr-eugh competitive bidding mechanisms depending on the technology.	• **Tariff structure** may include **TOU tariff, Smart Tariff,** or **V2G incentive tariff** depending on charging demand and grid support services.
• ERC regulations **defining service standards** and penalty mechanisms if the service quality does not meet the specified requirements	• **ERC regulations defining standards for forecasting** centers, including measure-ment indicators, accuracy requirements, and operati-onal responsibilities of licensees.	• **ERC regulations defining standards for forecasting centers**, including measur-ement indicators, accuracy requirements, and operational responsibilities of licensees.	• To be considered in the future based on ERC policy and regulatory direction	• To be considered in the future based on ERC policy and regula-tory direction • To be considered in the future based on ERC policy and reg-ulatory direction.

Demand Response (DR)

Key Success Factor: Access to Smart Meter Data

Pillar 1: Demand Response Implementation

Data Access Principles

1 Customer Consent

- Authorized entities must obtain **consent** from electricity customers before accessing meter data.
- The **scope** and purpose of **data usage** must be clearly defined.

2 Data Security

- Data management must comply with **information security standards**.
- Measures must be implemented to **prevent unauthorized access** or data breaches.

3 Legal Compliance

- All authorized entities **must comply** with **relevant laws** and regulatory frameworks, including data protection regulations.

Data Access Permission Structure

Data Type	TSO / DRCC	DSO	DR Service Provider
Customer Data	Full Access	Partial Access	Access to Own Customers
Customer Contract	Full Access	No Access	Access to Own Customers
Individual Baseline Data	Full Access	No Access	Access to Own Data (Individual DR)
Aggregated Baseline Data	Full Access	Partial Access	Access to Aggregated Data (DR-LA)
DR Activation Data	Full Access	Partial Access	Access to Own DR Data
Actual Load Data	Full Access	Partial Access	Access to Own Data

MEA Grid Code

PTEC ELECTRICAL AND ELECTRONIC PRODUCTS TESTING CENTER
National Science and Technology Development Agency,
Ministry of Science and Technology

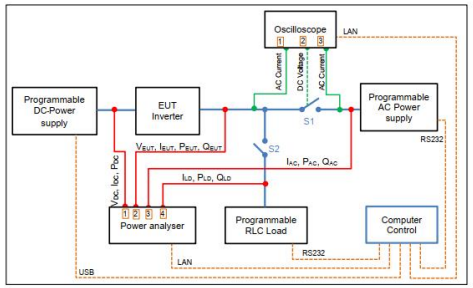
TEST REPORT

Grid-connected Inverter Regulation
Metropolitan Electricity Authority B.E. 2558 (2015)

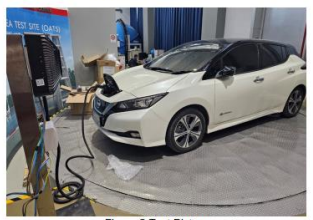
Report Reference No.	**93/66-004**
Equipment Under Test (EUT) No.	**SC-66-0560**
Testing Laboratory Name	**Electrical and Electronic Products Testing Center**
Address	141 Thailand Science Park, Innovation Cluster 2 Tower D, PhahonyothinRd., KhlongNueng, KhlongLuang, PathumThani 12120, Thailand
Applicant's Name	**INNOPOWER Company Limited**
Address	19th Floor, Tipco Tower 2, 118/1 Rama 6 Road, Phaya Thai, Phaya Thai, Bangkok 10400
Test specification	
Standard	IEC 61727-2004, IEC 62116-2008, IEEE 1547-2003 IEEE1547.1-2005 and AS 4777.3-2005.
Non-standard test method	N/A
Test item description	Bidirectional EV charger
Trademark	Wallbox
Model and/or type reference	Quasar
Serial number	607201
Firmware version	5.1.17
Rating	See marking
Date of receipt of test item	23 June 2023
Date(s) of performance of test	23 June 2023
Date of report issue	23 June 2023

Tested by
T.Eakkachai
(Mr.Eakkachai Taesanoo)
Engineer

Approved by
N.Ruengrit
(Mr.Ruengrit Ninae)
Operation manager



Finger 1Test Configuration



Finger 2 Test Picture

PTEC ELECTRICAL AND ELECTRONIC PRODUCTS TESTING CENTER
National Science and Technology Development Agency,
Ministry of Science and Technology

Response to utility recovery under voltage level 1

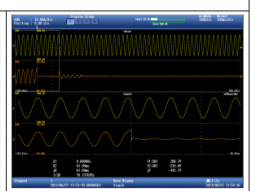
	Trip voltage setting: 203 V Recovery time setting: 120 Sec Voltage 203-5% area: 193 V Test time: **259.99 Sec** Inverter: not reconnected
	Chang Voltage to 230 V Time for Inverter reconnect: **130.83 Sec**

PTEC ELECTRICAL AND ELECTRONIC PRODUCTS TESTING CENTER
National Science and Technology Development Agency,
Ministry of Science and Technology

3.2.2	TABLE: Operating Frequency Range						P
No.	Frequency Range (Hz)	Setting Frequency (Hz)	Setting time (s)	Test Frequency (Hz)	Disconnecting Time (S)	Max. Disconnecting Time (S)	Result
1	< 47	47	0.18	46.8	0.05690	0.1	P
2	< 47	47	0.18	46.8	**0.05699**	0.1	P
3	< 47	47	0.18	46.8	0.05693	0.1	P
4	< 47	47	0.18	46.8	0.05697	0.1	P
5	< 47	47	0.18	46.8	0.05695	0.1	P
6	>52	52	0.1	52.2	0.01697	0.1	P
7	> 52	52	0.1	52.2	0.01693	0.1	P
8	> 52	52	0.1	52.2	**0.01699**	0.1	P
9	> 52	52	0.1	52.2	0.01691	0.1	P
10	> 52	52	0.1	52.2	0.01698	0.1	P

Supplementary information:

Under frequency < 47 Hz



Over frequency> 52 Hz

PTEC ELECTRICAL AND ELECTRONIC PRODUCTS TESTING CENTER
National Science and Technology Development Agency,
Ministry of Science and Technology

3.2.1	TABLE: Operating Voltage Range						P
No.	Voltage Range (V)	Setting Voltage (V)	Setting time (s)	Test Voltage (V)	Disconnecting Time (S)	Max. Disconnecting Time (S)	Result
1	V < 115	114	0.1	113	0.00234	0.1	P
2	V < 115	114	0.1	113	0.00235	0.1	P
3	V < 115	114	0.1	113	0.00232	0.1	P
4	V < 115	114	0.1	113	**0.00239**	0.1	P
5	V < 115	114	0.1	113	0.00232	0.1	P
6	115 ≤ V < 200	203	1.5	198	1.6312	2.0	P
7	115 ≤ V < 200	203	1.5	198	**1.6316**	2.0	P
8	115 ≤ V < 200	203	1.5	198	1.6311	2.0	P
9	115 ≤ V < 200	203	1.5	198	1.6310	2.0	P
10	115 ≤ V < 200	203	1.5	198	1.6313	2.0	P
11	240 < V < 311	241	2.0	242	1.6272	2.0	P
12	240 < V < 311	241	2.0	242	1.6270	2.0	P
13	240 < V < 311	241	2.0	242	**1.6275**	2.0	P
14	240 < V < 311	241	2.0	242	1.6271	2.0	P
15	240 < V < 311	241	2.0	242	1.6272	2.0	P
16	V ≥ 311	285.5	0.1	286.5	**0.01299**	0.05	P
17	V ≥ 311	290	0.05	286.5	0.01291	0.05	P
18	V ≥ 311	290	0.05	286.5	0.01296	0.05	P
19	V ≥ 311	290	0.05	286.5	0.01292	0.05	P
20	V ≥ 311	290	0.05	286.5	0.01294	0.05	P

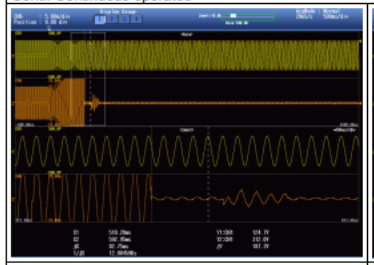
Supplementary information:
-Minimum under voltage trip string of inverter is 114 V
-Maximum over voltage trip string of inverter is 285.5 V

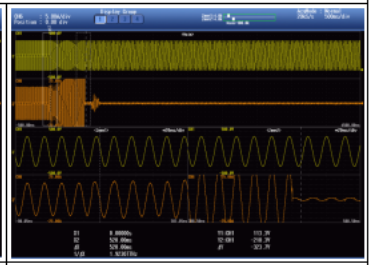
PEA Grid Code

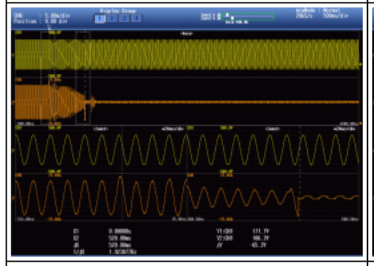
PTEC ELECTRICAL AND ELECTRONIC PRODUCTS TESTING CENTER
National Science and Technology Development Agency,

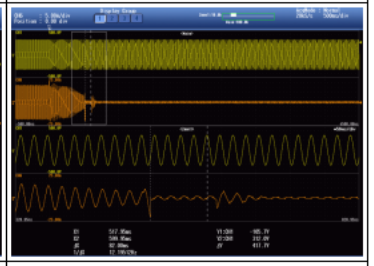
8.2	TABLE: Operating Frequency Range						P
No.	Frequency Range (Hz)	Setting Frequency (Hz)	Setting time (s)	Test Frequency (Hz)	Disconnecting Time (S)	Max. Disconnecting Time (S)	Result
1	99% UFT<TF	47.0	0.10	46.43	0.0828	0.1	P
2	UFT <TF<110%UFT	-	-	47.00	Cont.	Cont.	P
3	90% OFT<TF< OFT	-	-	52.00	Cont.	Cont.	P
4	TF>101%OFT	52.0	0.10	52.63	0.0820	0.1	P

Supplementary information:
TF:Test Frequency
OFT: Over frequency Trip Setting
UFT: Under frequency Trip Setting
Cont.: Continuous operated


Under frequency 46.43 Hz


Under frequency 47.00 Hz


Over frequency 52.00 Hz

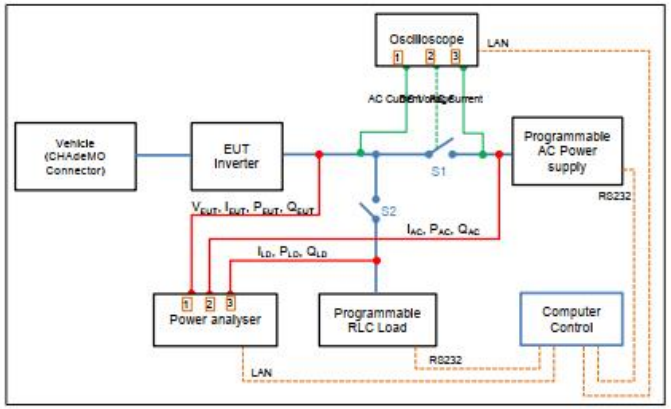

Over frequency 52.63 Hz

8.4	TABLE: Harmonics						P
	Condition of test			Power (kW)			
	supplying power to balance linear loads 33% ±5%			1.950			P
	supplying power to balance linear loads 66 %±5%			3.890			P
	supplying power to balance linear loads 100 %±5%			5.900			P
	Output Current Harmonics Measurement						
Order	33% of rated output current (A)	66% of rated output current (A)	100% of rated output current (A)	Phase	(1) Limit (of output current) (A)	(2) Limit (of output current) (A)	Result
1	9.491	20.924	28.121	L	-	-	-
2	0.024	0.02	0.019	L	2.174	48	P
3	0.032	0.132	0.194	L	5.87	34	P
4	0.017	0.016	0.018	L	1.087	22	P
5	0.025	0.051	0.053	L	2.908	56	P
6	0.015	0.015	0.015	L	0.725	11	P
7	0.013	0.045	0.052	L	1.957	40	P
8	0.016	0.015	0.017	L	0.544	9	P
9	0.014	0.055	0.065	L	1.033	8	P
10	0.013	0.011	0.011	L	0.435	7	P
11	0.014	0.03	0.038	L	0.843	19	P
12	0.012	0.012	0.013	L	0.362	6	P
13	0.008	0.033	0.044	L	0.544	16	P
14	0.011	0.011	0.01	L	-	5	P
15	0.009	0.022	0.033	L	-	5	P
16	0.009	0.009	0.01	L	-	5	P
17	0.007	0.016	0.024	L	-	6	P
18	0.01	0.01	0.011	L	-	4	P
19	0.005	0.014	0.022	L	-	6	P
20	0.008	0.007	0.008	L	-	-	P
21	0.004	0.011	0.017	L	-	-	P
22	0.008	0.009	0.01	L	-	-	P
23	0.004	0.008	0.014	L	-	-	P
24	0.007	0.008	0.009	L	-	-	P
25	0.004	0.006	0.01	L	-	-	P
26	0.006	0.007	0.008	L	-	-	P
27	0.006	0.004	0.006	L	-	-	P
28	0.007	0.008	0.009	L	-	-	P
29	0.005	0.006	0.008	L	-	-	P
30	0.006	0.006	0.007	L	-	-	P
31	0.006	0.005	0.005	L	-	-	P
32	0.007	0.007	0.008	L	-	-	P
33	0.005	0.004	0.006	L	-	-	P
34	0.005	0.006	0.007	L	-	-	P
35	0.004	0.004	0.004	L	-	-	P
36	0.006	0.007	0.007	L	-	-	P
37	0.005	0.006	0.007	L	-	-	P
38	0.005	0.006	0.007	L	-	-	P
39	0.004	0.006	0.007	L	-	-	P
40	0.005	0.006	0.006	L	-	-	P
THDi	0.75%	0.84%	0.84%	L	-	5%	P

Supplementary information:
(1)Limit at IEC 61000-3-12:2011

PTEC ELECTRICAL AND ELECTRONIC PRODUCTS TESTING CENTER
National Science and Technology Development Agency,

Annex I
Test Configuration



Finger 1Test Configuration

Finger 2 Test Picture

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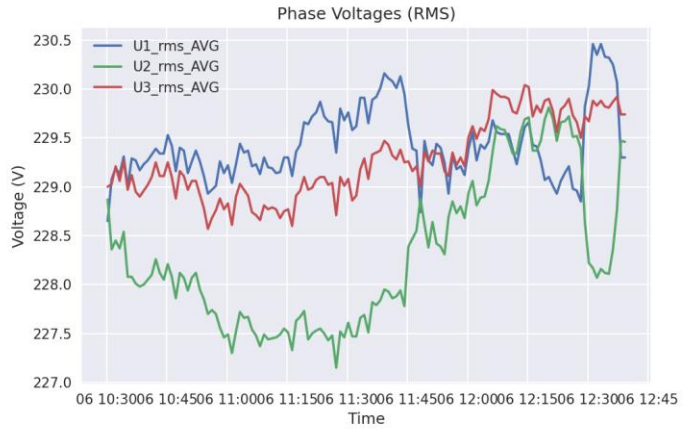
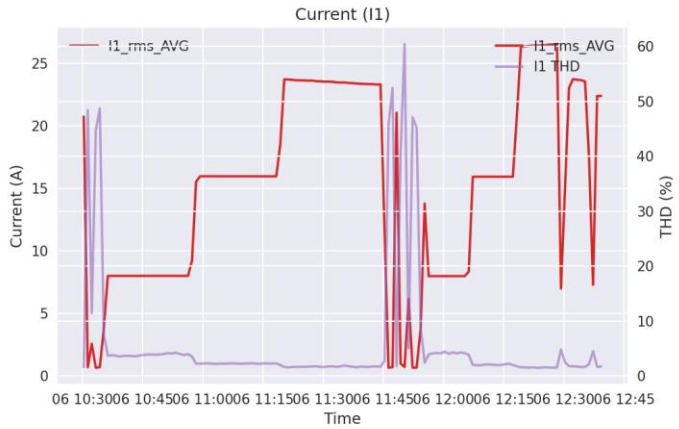
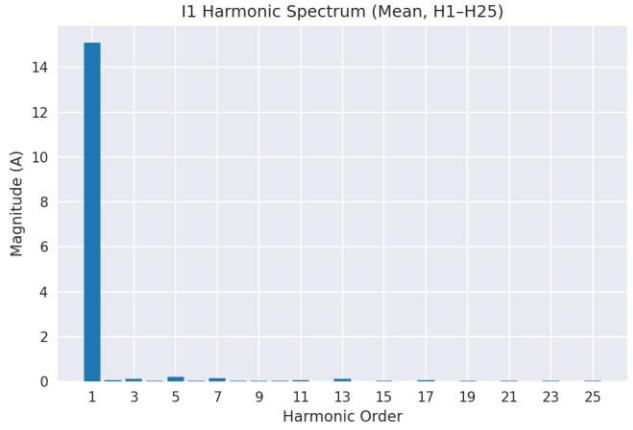
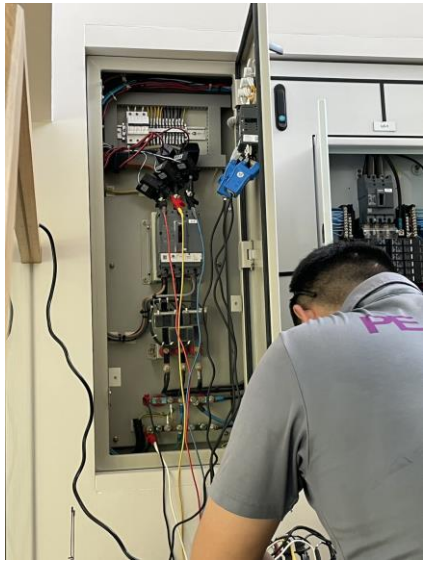


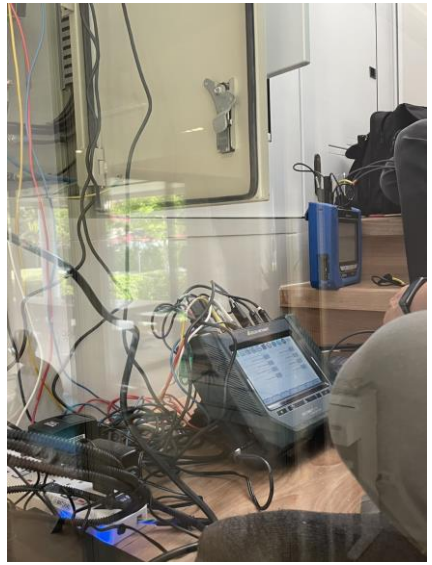




V2G to MEA @ 5.46 kW
To Check Power Quality
In ERC Sandbox

EGAT V2G Testing with PEA





Software & Protocol Standard Readiness

INTERNATIONAL STANDARD **ISO 15118-20**

First edition
2022-04

Road vehicles — Vehicle to grid communication interface —

Part 20:
2nd generation network layer and application layer requirements

Véhicules routiers — Interface de communication entre véhicule et réseau électrique —

Partie 20: Exigences des couches réseau et application de 2ème génération

ISO IEC

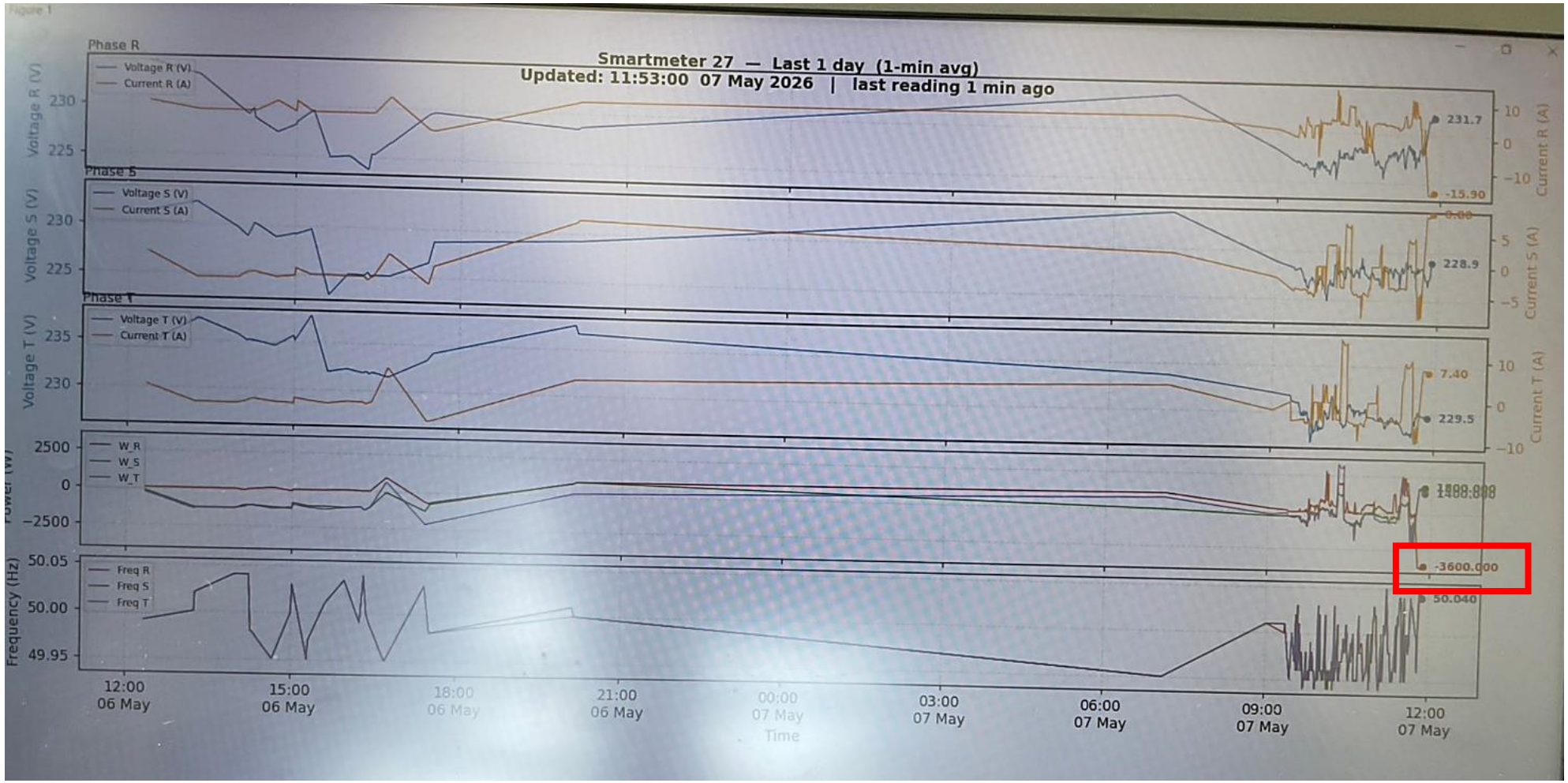
Reference number
ISO 15118-20:2022(E)

OCA Open Charge Alliance

OCPP 2.1 includes improved and added functionalities compared to OCPP 2.0.1:

1. ***Support for ISO 15118-20:*** *Support for ISO 15118-20 with bidirectional power transfer.*
2. ***New Functional Block on Bidirectional Charging:*** *Enablement of bidirectional energy flows (V2X), allowing EVs to act as energy sources.*
3. ***New Functional Block on DER Control:*** *Enhanced integration with distributed energy resources (DER).*
4. ***Improved Smart Charging:*** *Advanced tools for optimized energy distribution across charging stations.*
5. ***Extended Transaction Options:*** *Possibility to perform transactions with fixed costs, energy or time. Possibility to resume transactions after a forced reboot.*
6. ***Battery Swapping:*** *Support for battery swap stations for two- and three-wheelers and electric vehicles.*
7. ***Local Cost Calculation:*** *Support for local cost calculation on the charging station.*
8. ***New Authorization Options:***
   - ***Support for Prepaid Charge Cards:*** *Transaction cost cannot exceed prepaid card balance.*
   - ***Support for Ad Hoc Payment:*** *Pay with credit or debit card via a built-in or a stand-alone credit card terminal.*
   - ***Secure Dynamic QR Codes:*** *Introduction of secure dynamic QR-codes for ad hoc payment.*
9. ***Many Additional Improvements:*** *A variety of updates driven by feedback from the EV charging community.*

EGAT V2G Testing with PEA 3.6 kW Back to the grid



Key Takeaways

- **Grid Codes and Inverter Codes** must be clearly defined and established. Testing and validation should be conducted jointly with the electricity distribution utility to ensure compliance and system compatibility.
- Clear rules and procedures for **accessing data from smart meters** should be jointly developed and agreed upon by all relevant stakeholders.
- The **control and dispatch mechanisms** must be clearly specified, including how commands are issued, communicated, and executed.
- An appropriate **incentive and pricing structure** for dispatchable resources must be established. Ideally, this should be incorporated into the electricity tariff structure to enable these resources to effectively replace **peaking power plants** in the future.
- The **technology is already available and mature**; the remaining challenges lie primarily in **policy development and regulatory frameworks**.

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8–11 June | ADB Headquarters, Metro Manila, Philippines

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EGAT

Thank You

Maraming salamat po!