Grid-scale electricity storage development in APEC

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Outline

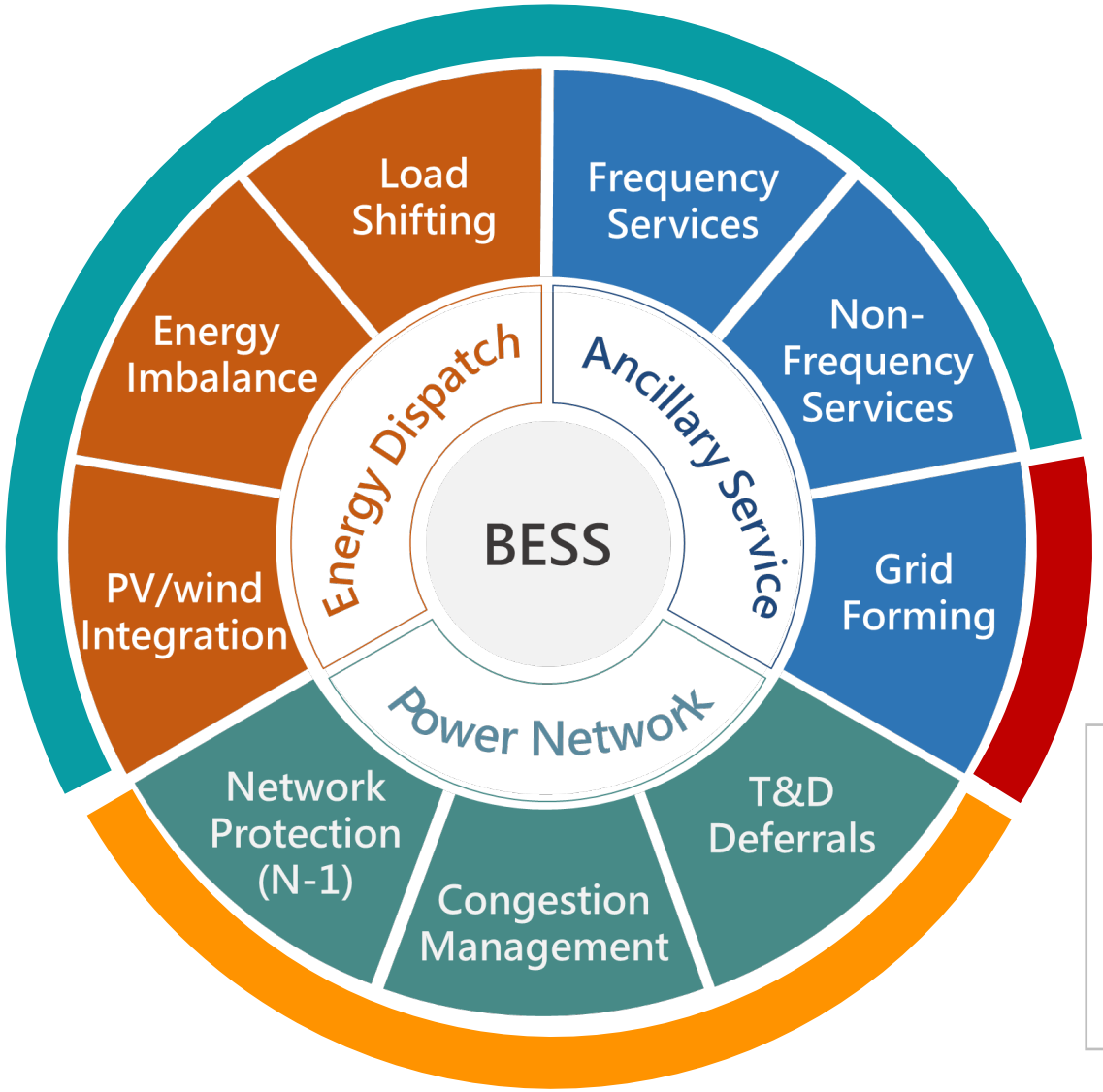
1	**Introduction**	• BESS development in APEC
2	**BESS in Chinese Taipei (CT)**	• Development targets • Challenges & solutions • Operation & Data communication
3	**Conclusion**	• Prospects & future BESS application

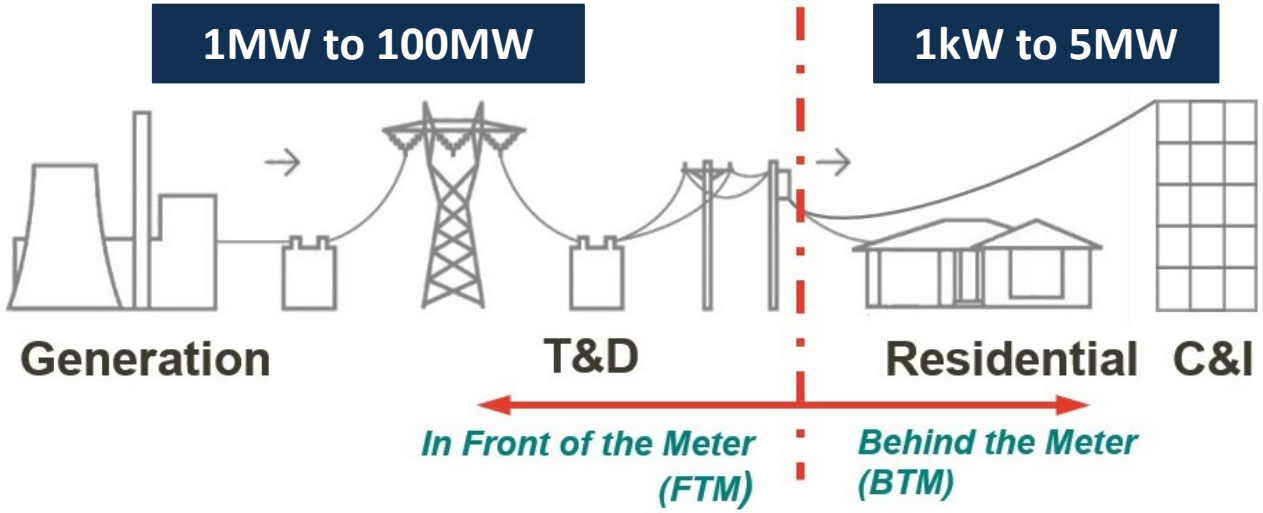
1 Introduction

1.1 Main applications of BESS

1.2 Use cases in APEC member economies

1.1. Main applications of grid-scale BESS





Popularity

- High
- Mid
- Low

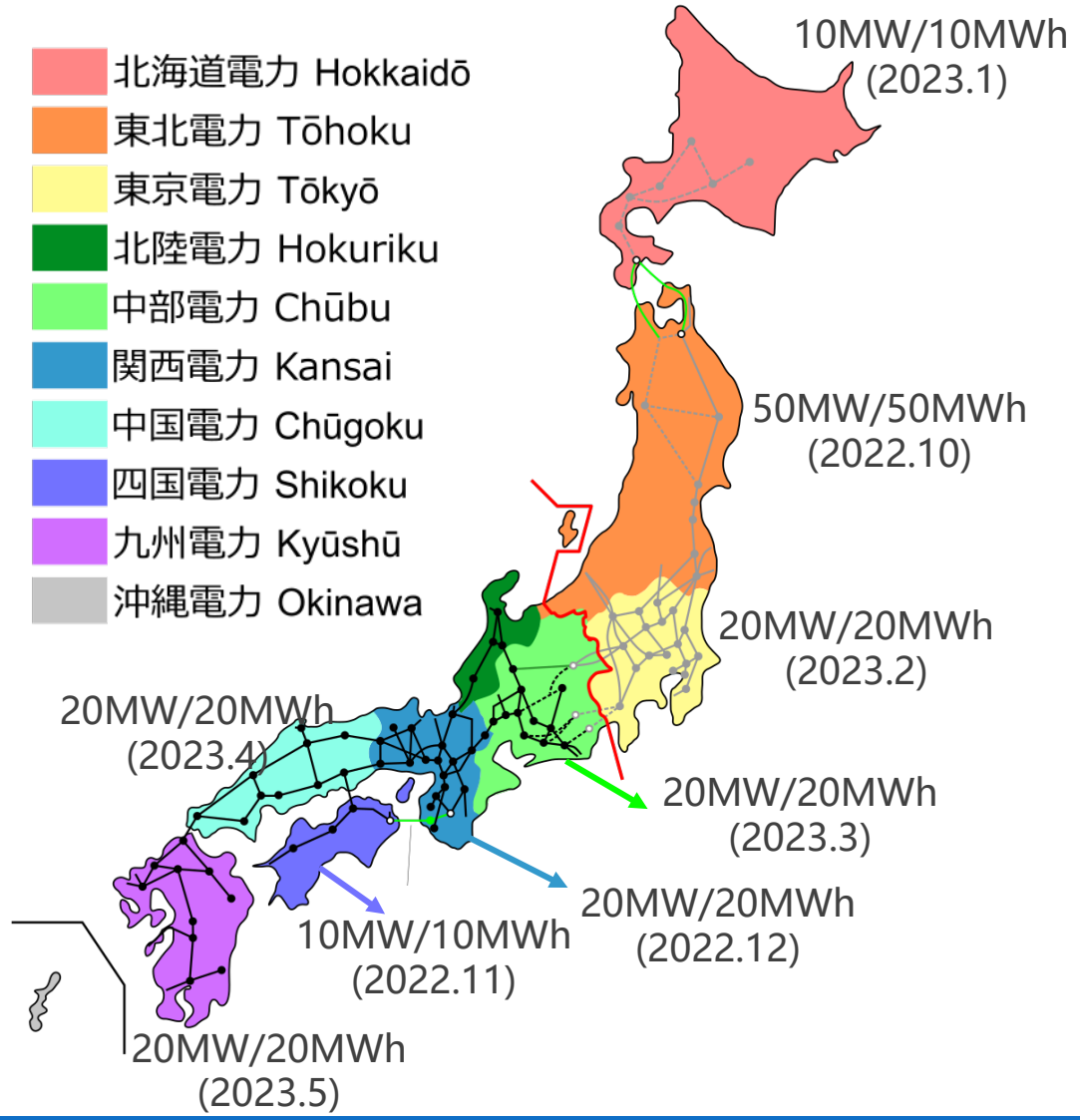
1.2. Use cases in APEC member economies

Australia

Installed capacity	1,011 MW (2023)
Registered capacity	4 GW
	• FCAS (Frequency Service) • SIPS (Network protection) • NEM market (Energy dispatch)
Main Applications	• T&D deferrals • Congestion management • Renewable energy integration
	• Inertia (Grid forming)

Source:
NEM Generation Information July 2023
AEMO Annual Report 2022
ESB Post-2025 Market Design Final advice to Energy Ministers
https://reneweconomy.com.au/

1.2. Use cases in APEC member economies

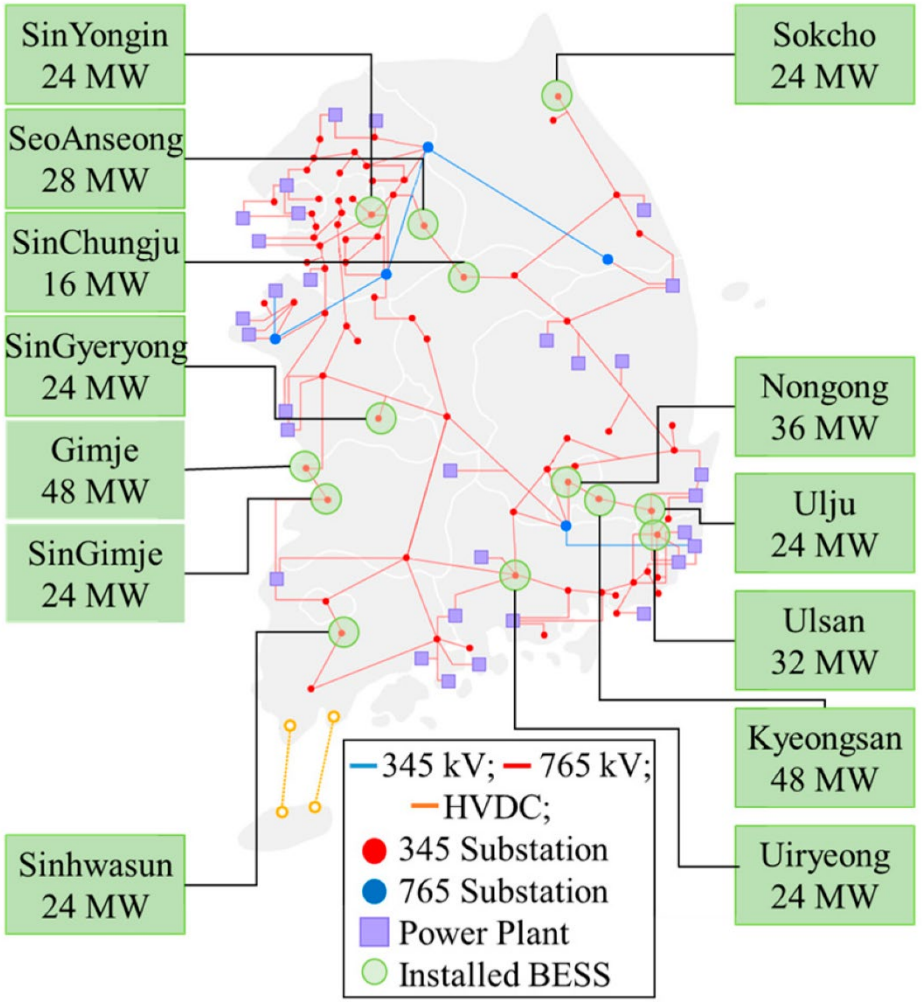


Japan

Installed capacity	160 MW (2022)
Registered capacity	-
Main Applications	• 電源I' (Frequency Service) • 三次調整力 (Frequency Service) • Wholesale market (Energy dispatch)

Source:
OCCTO - 蓄電設備・需要設備のグリッドコード検討会での取扱い 2023

1.2. Use cases in APEC member economies

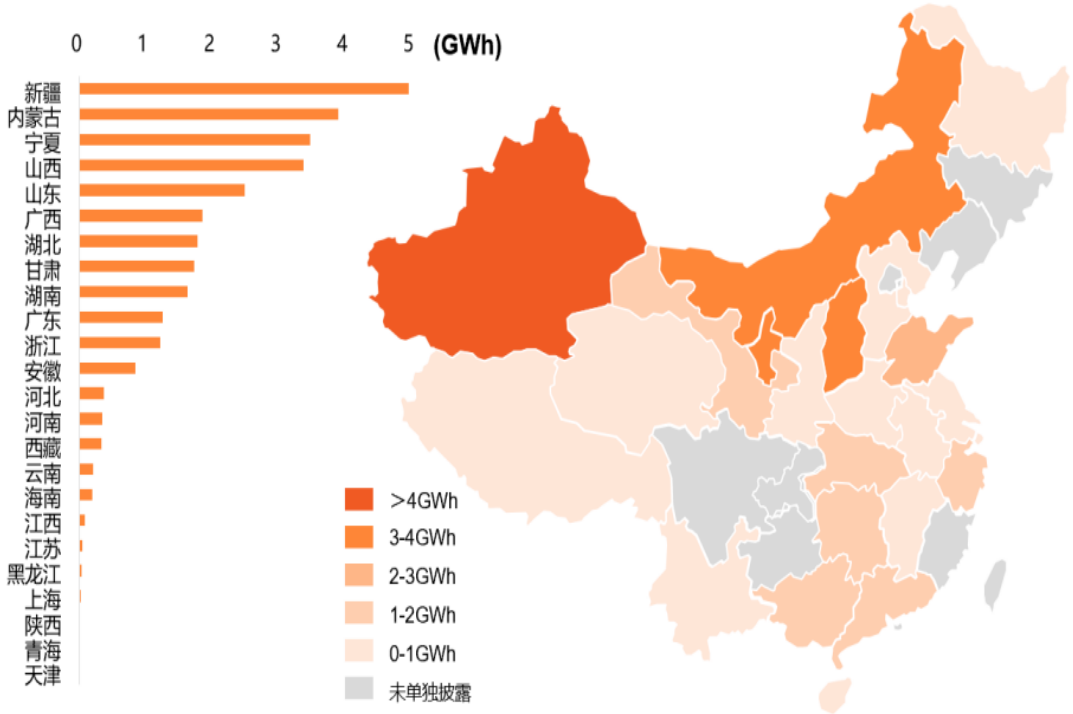


Korea

Installed capacity	426 MW (2023)
Registered capacity	-
Main Applications	• Frequency regulation (Frequency Service) • Substation operation optimization (Network protection)

Source:
828Form 20-FFY22 KEPCO's Form 20-F as filed with the U.S. SEC
https://www.mdpi.com/1996-1073/12/21/4060

1.2. Use cases in APEC member economies



China

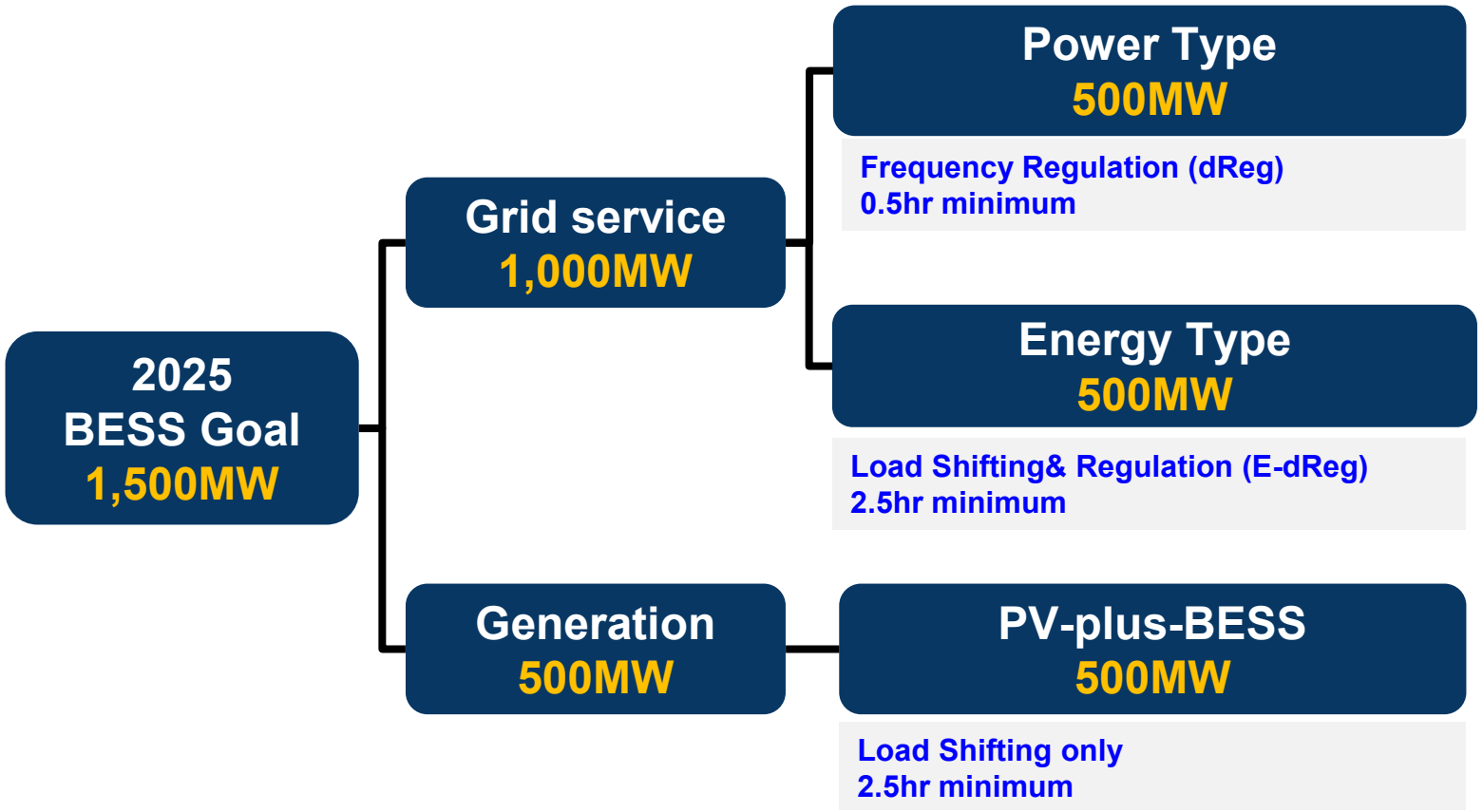
Installed capacity	13,100 MW (2022)
Registered capacity	-
Main Applications	• Current: Renewable energy, electricity markets, tariffs, and subsidies • Upcoming: Market and dispatch mechanisms

Source:
China Energy Storage Alliance - Energy Storage Industry White Paper 2023
https://pdf.dfcfw.com/pdf/H3_AP202302101583001313_1.pdf?1676042740000.pdf

2 BESS in Chinese Taipei(CT)

2.1 Development Targets & Trajectory
2.2 Challenges & Solutions
2.3 Operation & Data Communication

2.1. BESS in CT - 2025 Development Target



Deployed **MW** (end of 2023)

500+ **MW**

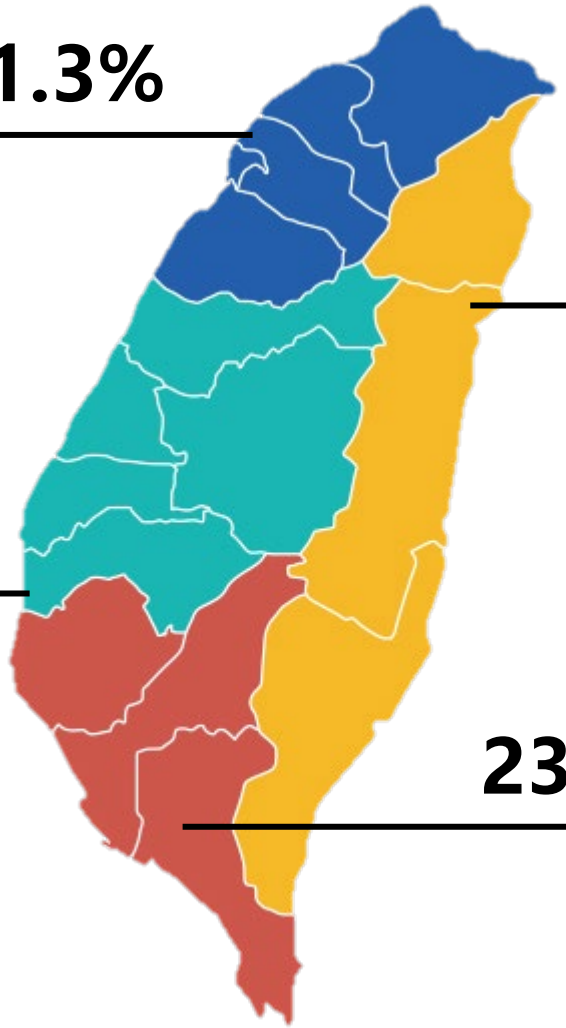
100+ **MW**

70+ **MW**
(awarded)

2.1. Distribution of BESS implementation by 2023

North
75.5MW
*(32.3MW)

21.3%



36.2%

East
128.2MW
*(157MW)

18.6%

Mid
65.7MW
*(46.7MW)

23.8%

South
84.3MW
*(46.7MW)

*(MW expected to finish by end of 2023)

2.1. BESS in CT - Development Trajectory

2018

1

Research & Pilot Project

Proof of concept by research project conducted by ITRI

- Modelling and simulation
- Telemetry and technical specs
- 1 MW pilot project

2019

2

Demonstration Procurement

Proof of commercial feasibility

- Frequency containment product
- 6 years bilateral contract
- 15 MW procured (60MW bids received)

2020

3

Ancillary Services Market

Day-ahead hourly capacity bidding

- Frequency regulation product
- 350 MW commissioned

2022

4

Load Shifting Trading Product

Day-ahead capacity and energy bidding

- Load shifting + Frequency regulation
- 500 MW market size

2 BESS in Chinese Taipei(CT)

2.1 Development Targets & Trajectory

2.2 Challenges & Solutions

2.3 Operation & Data Communication

2.2. Main development challenge

Who builds the BESSs?

EPC by TaiPower* Itself		Unbundle Electricity Market
Tender based	Business model	Market based
Ownership; authority	Benefits	Efficiency; cost; reliability
Low	Policy barriers	High
Simple	IT integration	Complex

VS

*TaiPower as a state-owned, vertical-integrated power company

2.2. BESS in CT - Various aspects of challenges

		Challenges
Grid Connection	■ Grid Code ■ Capacity	• Tech-specs for BESS were missing • LV feeder preliminary for PV
Dedicated Regulations	■ Market Rules ■ Safety Standards	• Not ready for BESS • High complexity of standards integration
Stakeholders	■ Developers ■ Banks	• Unfamiliar with power market • Lack of investment & loan confidence
IT Integration	■ Distributed communication ■ CDCC monitoring	• Unable to dispatch small resources • Rather conventional and inefficient

2.2. BESS in CT - Various aspects of challenges

Grid Connection

Dedicated Regulations

Stakeholders

IT Integration

- Grid Code
- Capacity
- Market Rules
- Safety Standards
- Developers
- Banks
- Distributed communication
- CDCC monitoring

Challenges	Solution	Current Situation
• Tech-specs for BESS were missing • LV feeder preliminary for PV	• Grid code revision within 1 year • Unleash LV feeder for BESS	2021: 1GW approved 2023: 6GW approved

2.2. BESS in CT - Systematic transformation

Grid Connection

Dedicated Regulations

Stakeholders

IT Integration

- Grid Code
- Capacity
- Market Rules
- Safety Standards
- Developers
- Banks
- Distributed communication
- CDCC monitoring

Item	Approved Capacity
Distribution Level	845.6MW
Transmission Level	5441.2MW
Total	6286.8MW

2.2. BESS in CT - Various aspects of challenges

Grid Connection

Dedicated Regulations

Stakeholders

IT Integration

- Grid Code
- Capacity
- **Market Rules**
- **Safety Standards**
- Developers
- Banks
- Distributed communication
- CDCC monitoring

Challenges	Solution	Current Situation
Not ready for BESS	Amendments to Electricity Act + Launch AS market	300MW BESS commissioned
High complexity of standards integration	Set IEC, UL9540 as national standard	

2.2. BESS in CT - Various aspects of challenges

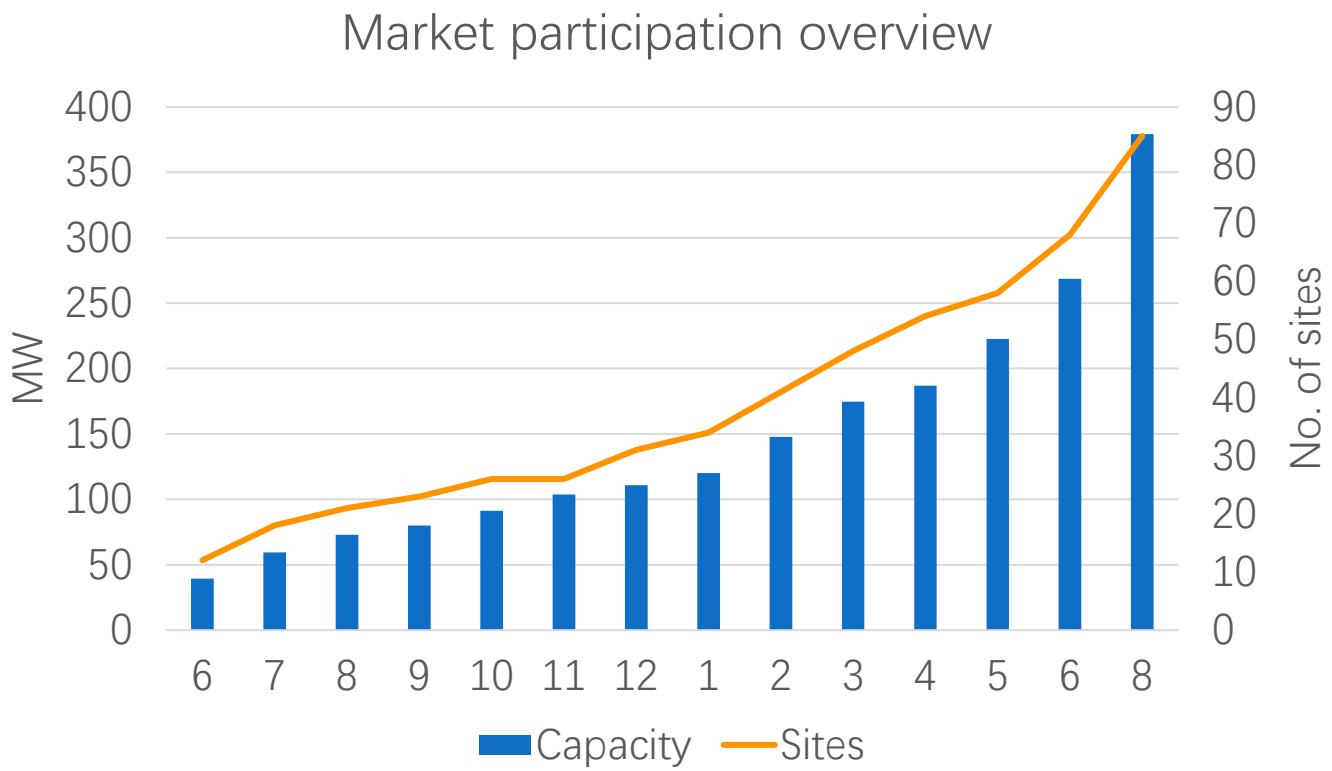
Grid Connection

Dedicated Regulations

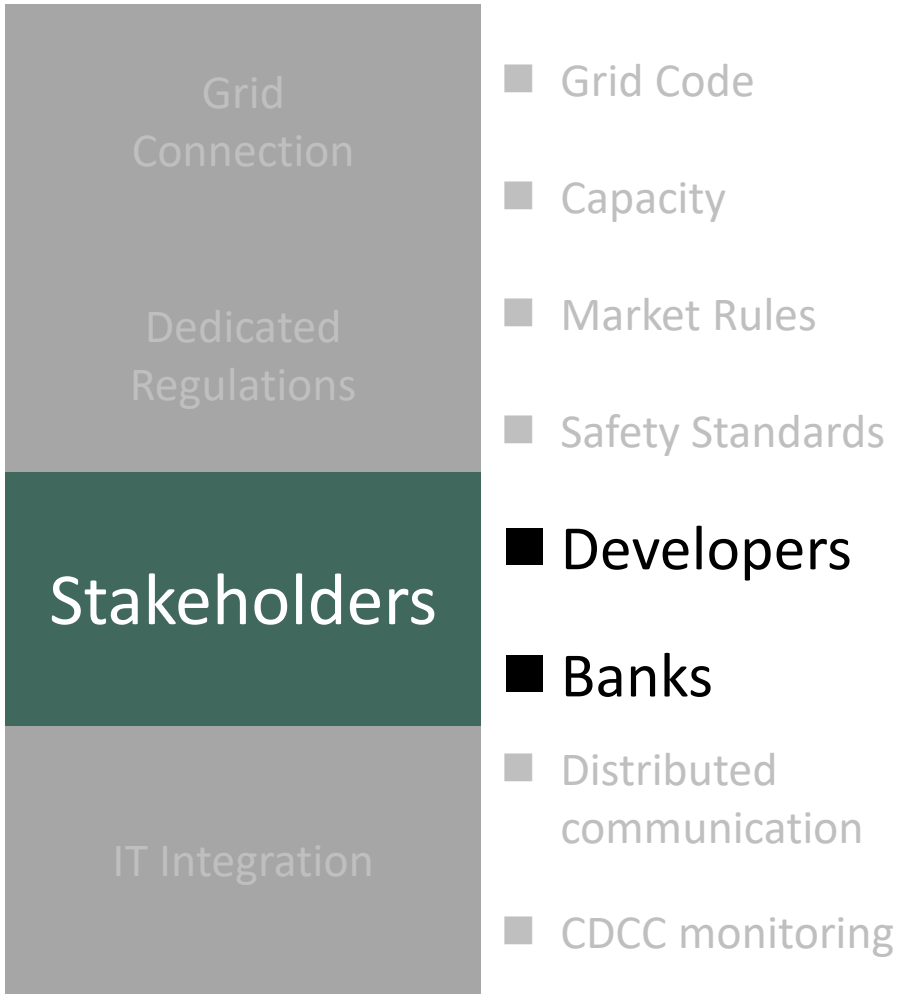
Stakeholders

IT Integration

- Grid Code
- Capacity
- **Market Rules**
- **Safety Standards**
- Developers
- Banks
- Distributed communication
- CDCC monitoring



2.2. BESS in CT - Various aspects of challenges



Challenges	Solution	Current Situation
• Unfamiliar with power market • Lack of investment & loan confidence	• 7 public hearings • Online power market tutorial • Transparent market rules & information	• Over 42 active BESS developers • BESS loans up to 70% in major banks

2.2. BESS in CT - Various aspects of challenges

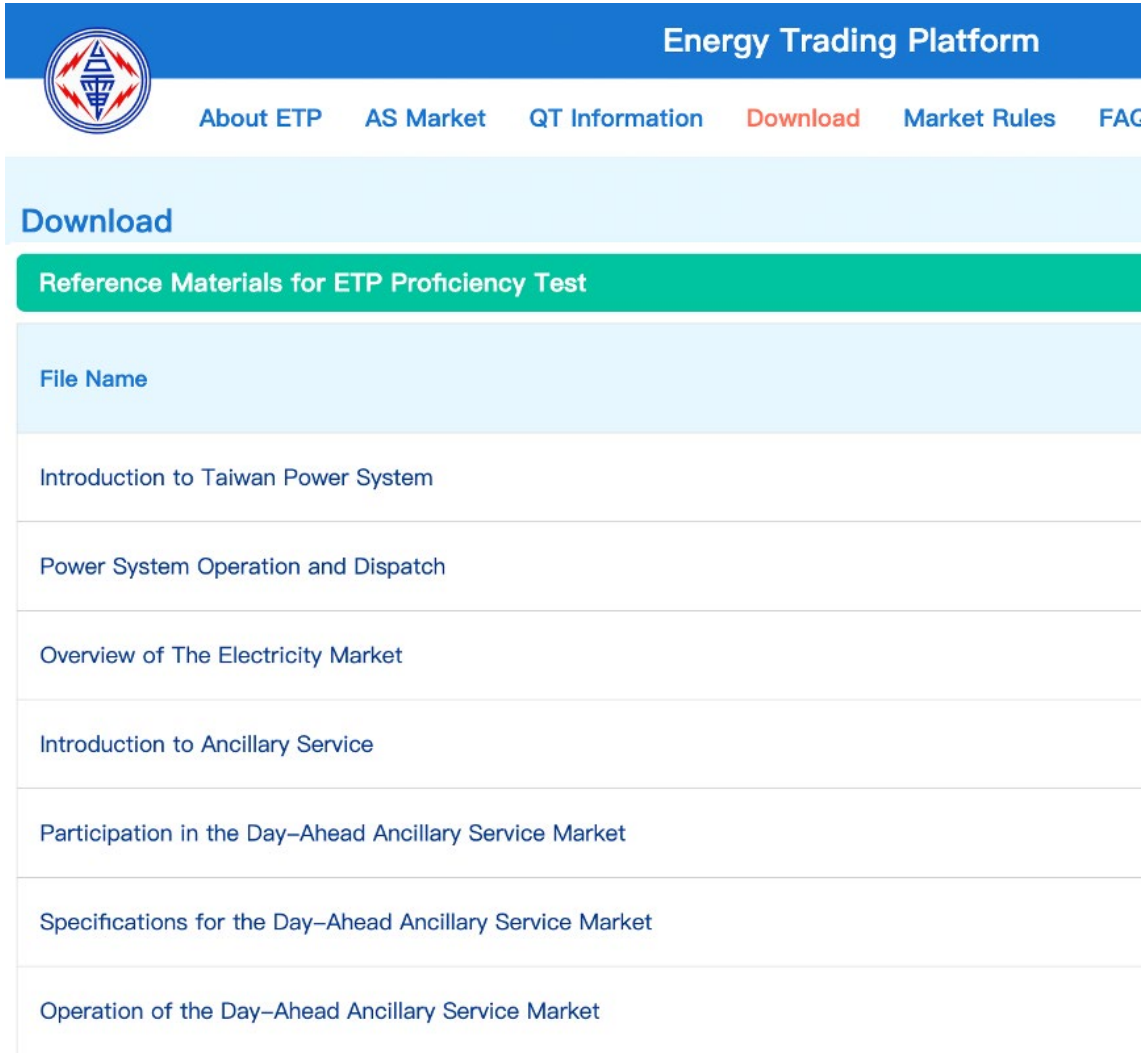
Grid Connection

Dedicated Regulations

Stakeholders

IT Integration

- Grid Code
- Capacity
- Market Rules
- Safety Standards
- **Developers**
- **Banks**
- Distributed communication
- CDCC monitoring



2.2. BESS in CT - Various aspects of challenges

Grid Connection

Dedicated Regulations

Stakeholders

- Grid Code
- Capacity
- Market Rules
- Safety Standards
- Developers
- Banks

IT Integration

- **Distributed communication**
- **CDCC monitoring**

Challenges	Solution	Current Situation
• Unable to dispatch DER resources	• SDWAN + IEC61850	• DER aggregation to 100kW
• Rather conventional and inefficient	• MMS system	• ETP up & running

2.2. BESS in CT - Various aspects of challenges

Grid Connection

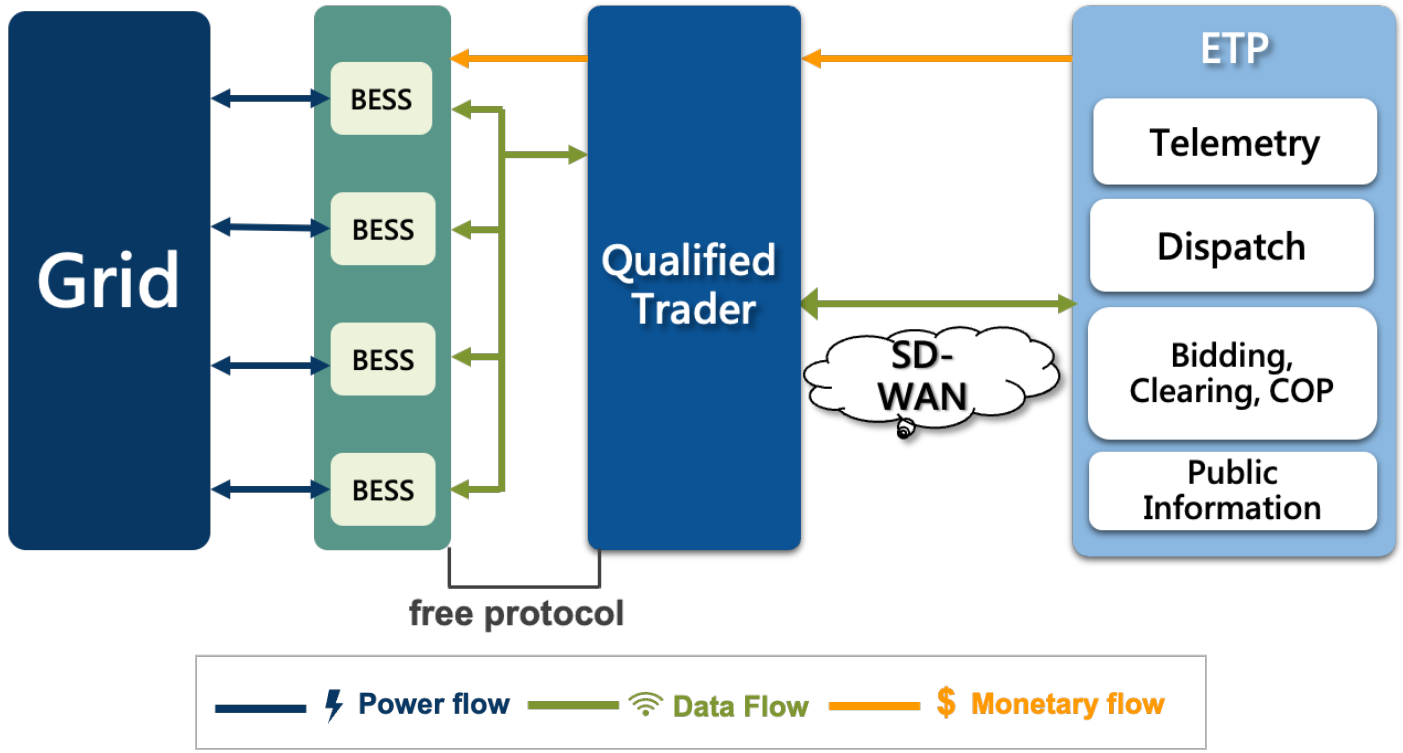
Dedicated Regulations

Stakeholders

- Grid Code
- Capacity
- Market Rules
- Safety Standards
- Developers
- Banks

IT Integration

- Distributed communication
- CDCC monitoring



2.2. BESS in CT - Then vs Now

		Challenges		Current Situation
Grid Connection	■ Grid Code ■ Capacity	• Tech-specs for BESS was missing • LV feeder preliminary for PV		2021: 1GW approved 2023: 5GW approved
Dedicated Regulations	■ Market Rules ■ Safety Standards	• Not ready for BESS • High complexity of standards integration	4 years	300MW commissioned
Stakeholders	■ Developers ■ Banks	• Unfamiliar with power market • Lack of investment & loan confidence		• Over 42 active BESS developers • BESS loans up to 70% in banks
IT Integration	■ Distributed communication ■ CDCC monitoring	• Unable to dispatch small resources • Rather conventional and inefficient		• DER aggregation to 100kW • ETP up & running

2 BESS in Chinese Taipei(CT)

2.1 Development Targets & Trajectory

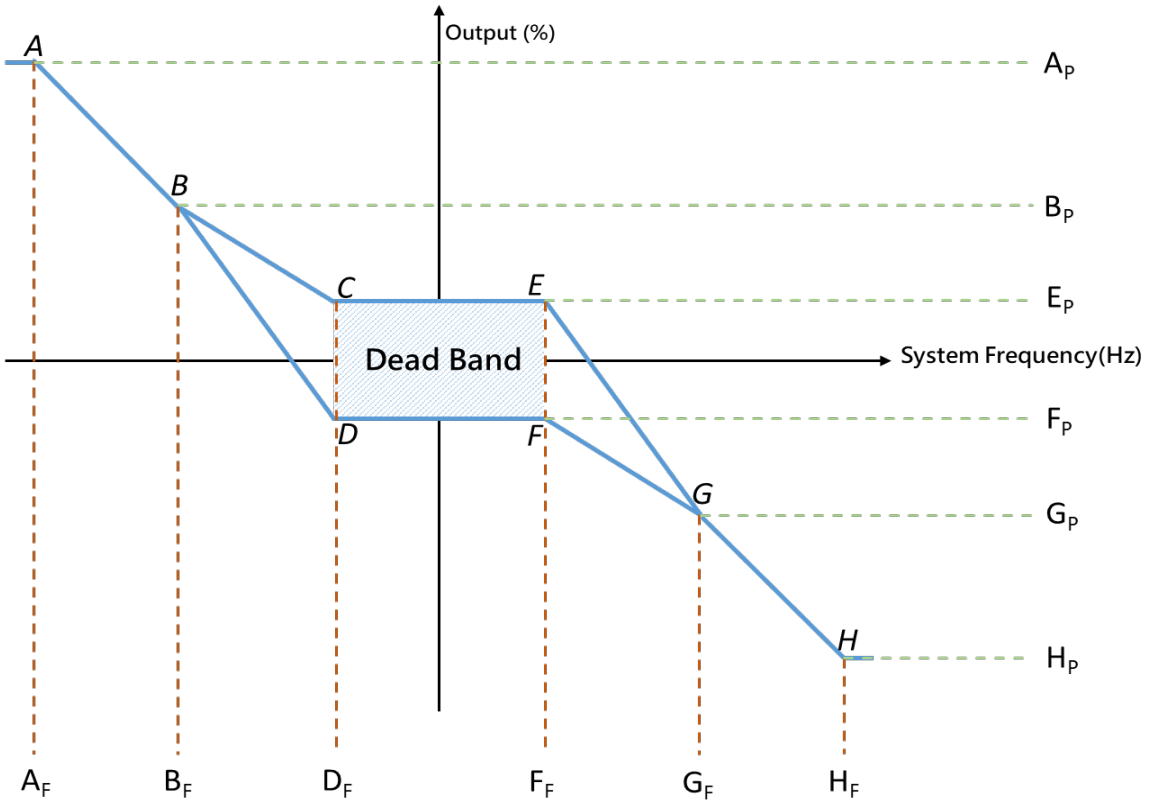
2.2 Challenges & Solutions

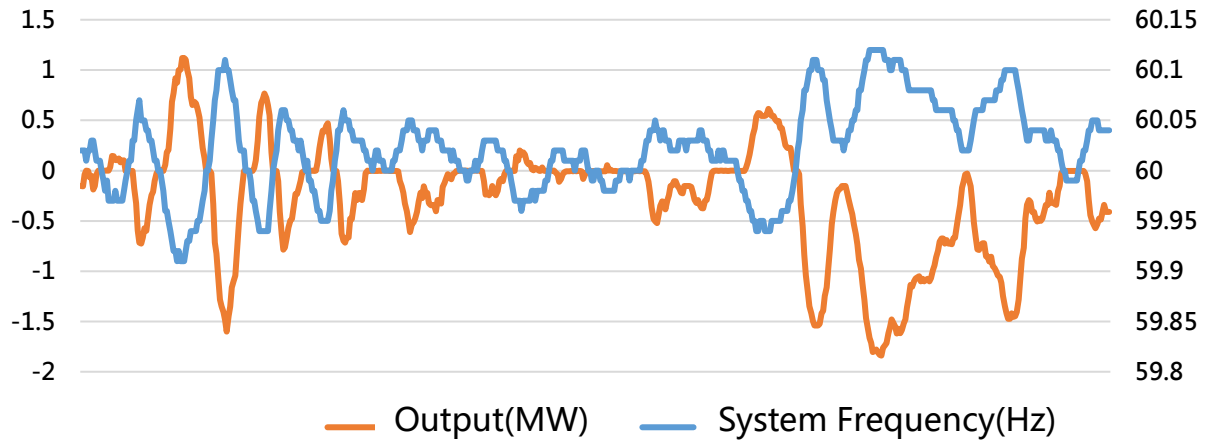
2.3 Operation & Data Communication

2.3 Technical Specifications of A/S Products

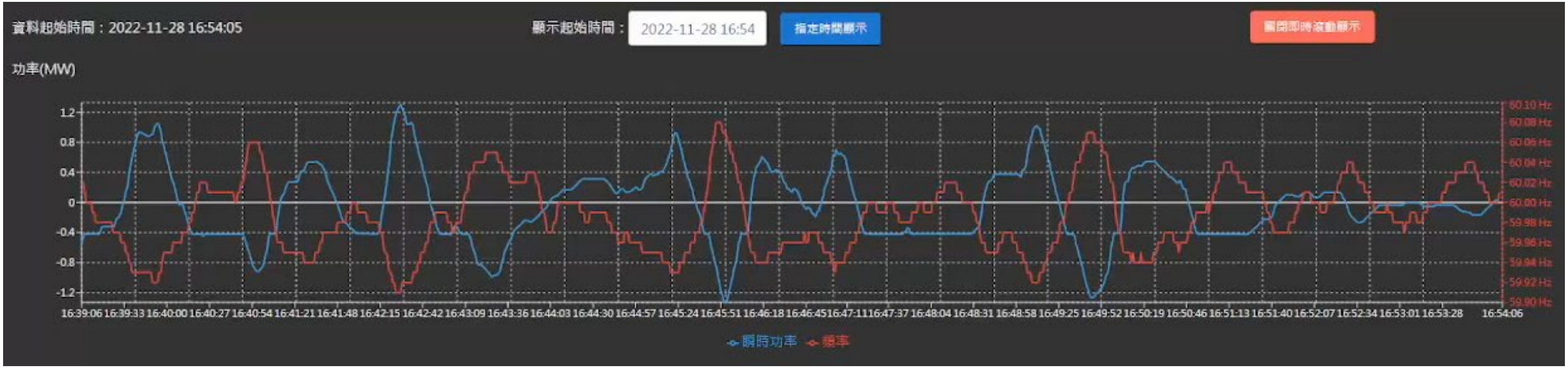
Day-Ahead Ancillary Service Market				
	Frequency Regulation Reserve		Spinning Reserve	Supplemental Reserve
	Dynamic (dReg)	Enhanced (E-dReg)		
Objective	Automatedly change output power in response to system frequency deviation	Simultaneously provide dReg and follow DA dispatch instruction for load shifting	Currently not provided by BESS	
Response Time	≤ 1s	≤ 1s		
Required energy level	0.5hr	2.5hr		

2.3 Example of dReg operation





2.3 Example of dReg operation - low frequency

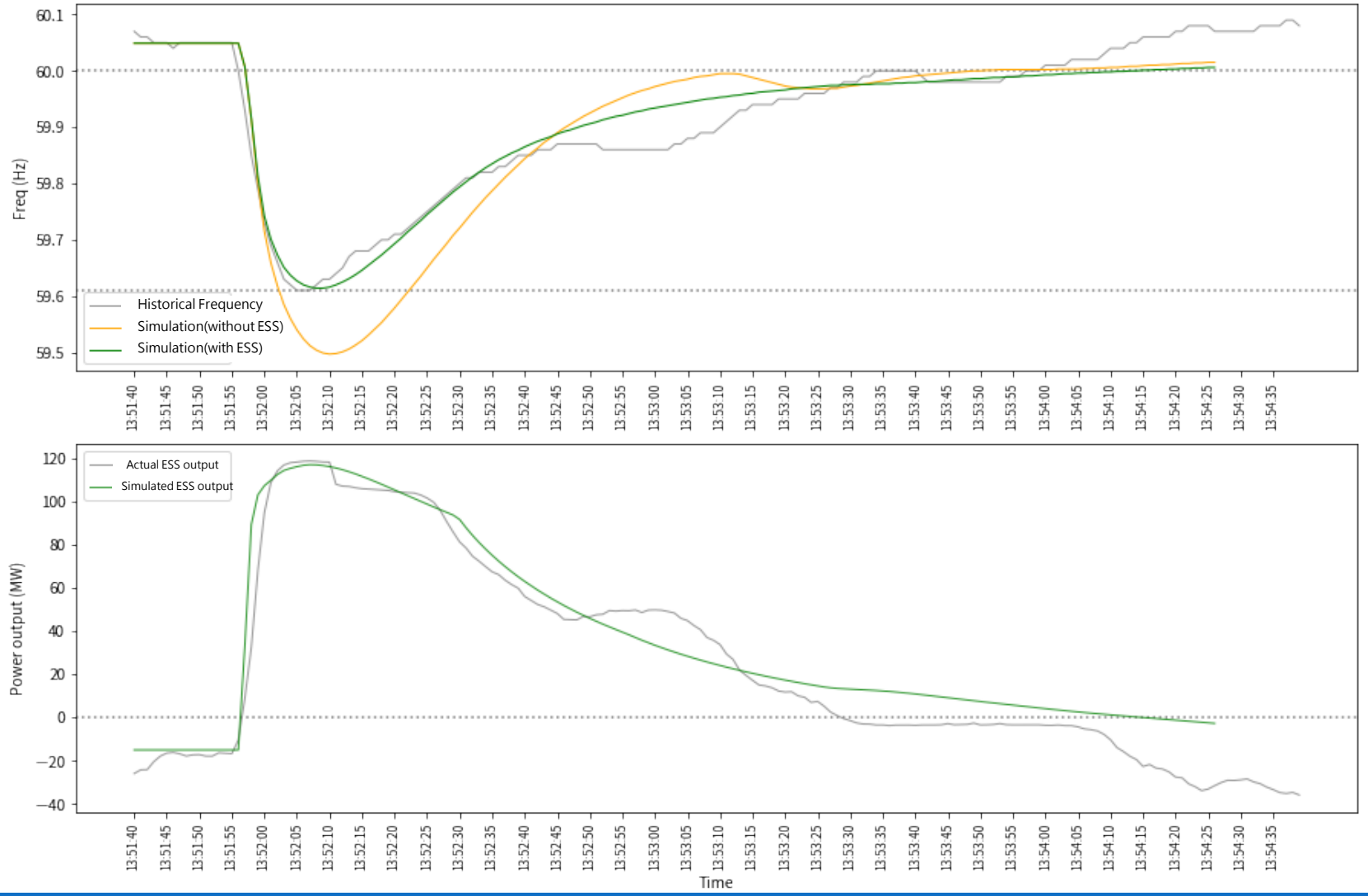


- **Contingency event: Coal power plant tripped**
- **Nadir frequency: 59.75**
- **Max output power of a single BESS site: 5MW**

2.3 Example of dReg operation - high frequency

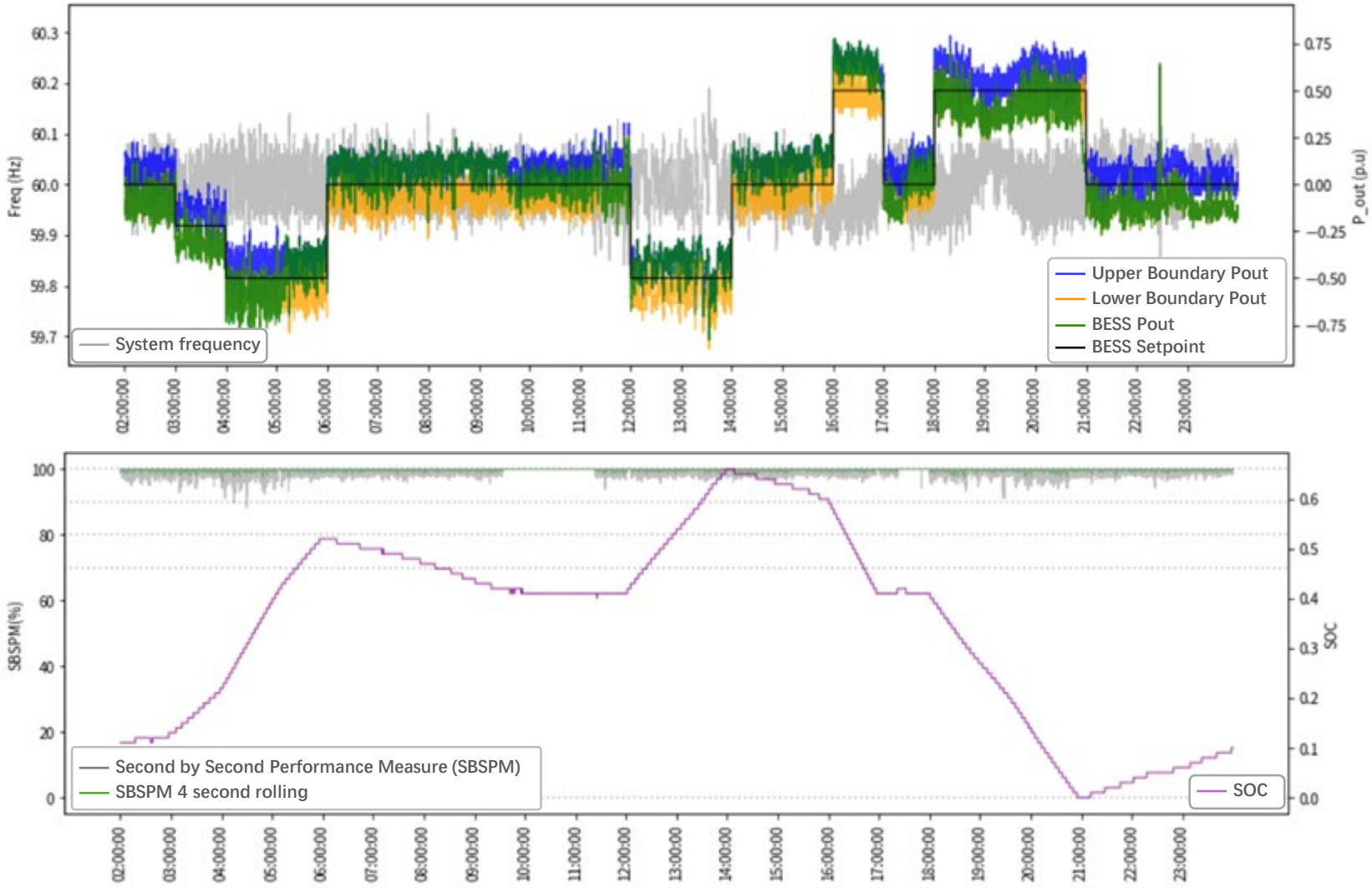
- **Before** and **after** contingency: **Frequency regulation**
- **Upon** a contingency: **Frequency containment**

2.3 Quantified contribution of nadir frequency

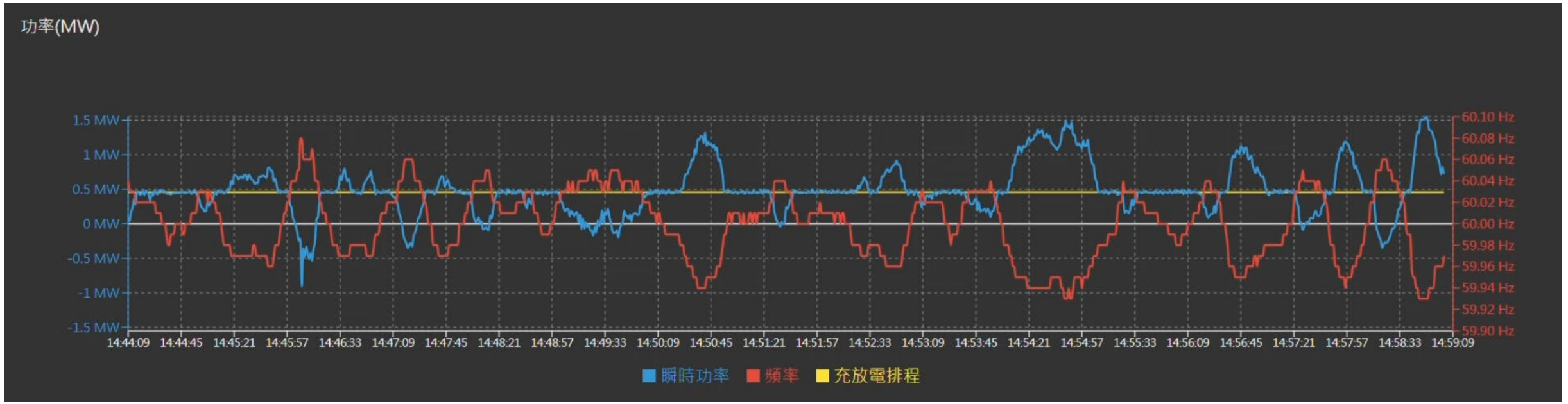


Item	Parameter
Date of event	2023/3/3
Tripped generator	Coal power unit
Tripped capacity	780 MW
BESS Installed capacity	140MW
BESS response power	120MW
Nadir Frequency (With BESS)	59.61 Hz
Nadir Frequency (Without BESS)	59.50 Hz

2.3 Dispatch example of E-dReg(load shifting)



2.3 Dispatch example of E-dReg(load shifting)



- **BESS operation in this clip:**
  1. **Frequency regulation**
  2. **Frequency containment**
  3. **Load shifting + frequency regulation**

2.3 Telemetry and data communication

Market Products：
- ✓ AFC
- ✓ dReg
- ✓ sReg
- ✓ E-dReg
- ✓ PV+BESS generation units

SDWAN

VPN / ~~IPSec~~

- IEC61850
- DNP3
- RESTful API (HTTP)

Electricity Trading Platform

- Bidding
- Performance Monitoring
- Dispatch Instruction (E-dReg only)
- Settlement

3 Conclusion

Conclusion

- Due to the high cost of battery energy storage, after establishing foundational technical capabilities (**Level1**, **Level** 2), BESS development should follow international experience to explore more complex applications. Focusing on the current dispatch requirements from 2023 to 2030, the following outlines **Level** 3 **Level** 4 dispatch technologies and pathways:

Dev. Level	Schedule	Frequency regulation	Voltage	Daily Schedule (Load shifting)	Real Time Dispatch	Congestion + Grid Forming
Level1	2021 (achieved)	v	v			
Level2	2023 (achieved)	v	v	v		
Level3*	2025 (Planed)	v	v	v	v	
Level4**	2026 (Planed)	V	v	v	v	v

Thank You!
Questions?