Unlocking the future of flexibility!

Bangkok Climate Action Week

5 October 2026

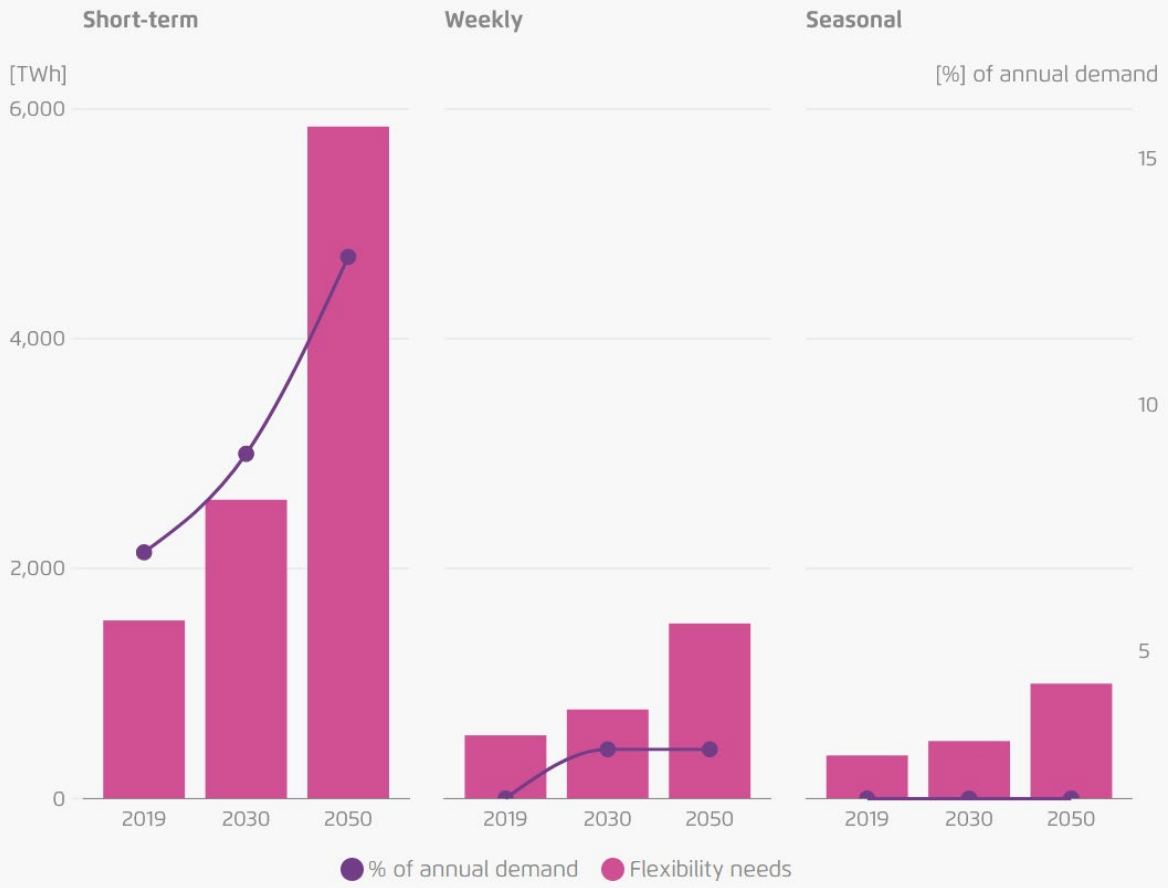
Agora Energiewende

Scaling up Battery Storage

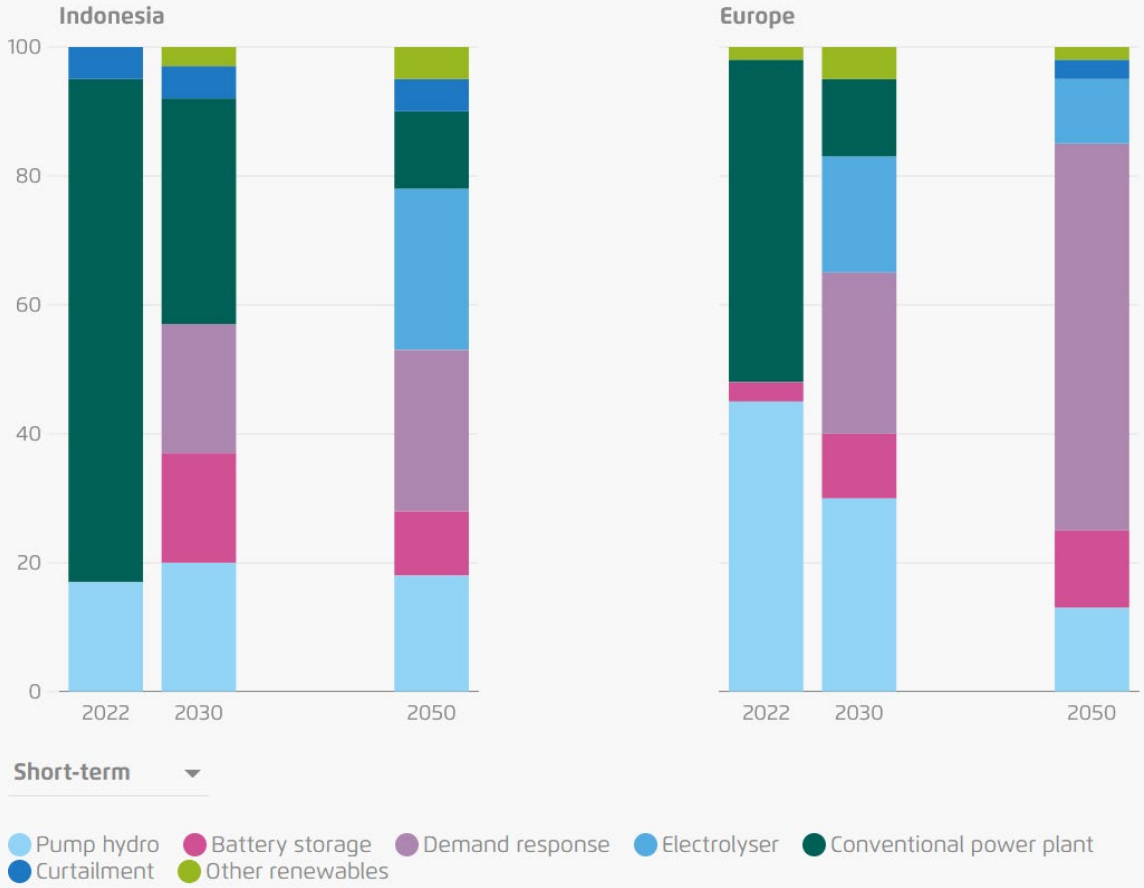
Mentari Pujantoro
Project Lead Flexible Electrification, Agora Energiewende

Large share of the flexibility needs are for short-term/daily, where battery storage plays key role

Estimated global flexibility needs*



Short term flexibility supply by technology



 *IRENA Planned Energy Scenario. Source: IRENA (2026), IEA (2023)

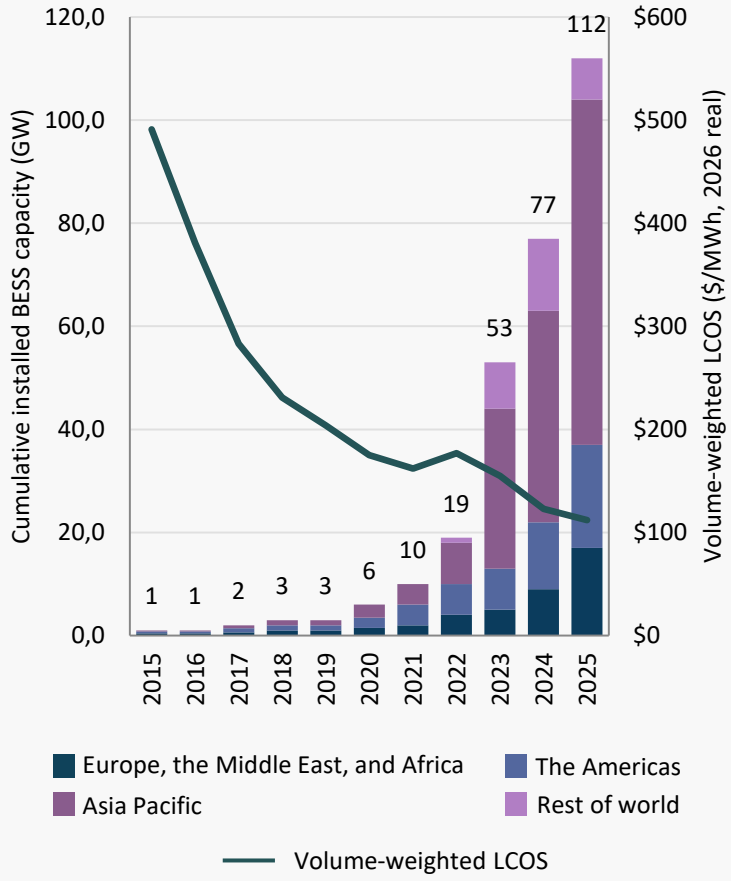
Agora Energiewende

Battery storage emerges as the fastest growing technology. The versatility of BESS makes it suitable for most applications in the power sector

Suitability of different energy storage technologies for selected applications

Application	Battery storage	Pumped hydro	Compressed air energy storage	Flow batteries	Flywheel/ capacitor	Hydrogen storage
VRE integration	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable
Energy shifting	Suitable	Suitable	Suitable	Suitable	Not suitable	Limited suitability
Congestion Management	Suitable	Suitable	Suitable	Suitable	Not suitable	Not suitable
Ancillary services	Suitable	Suitable	Limited suitability	Suitable	Limited suitability	Not suitable
Other system services	Suitable	Limited suitability	Limited suitability	Suitable	Not suitable	Limited suitability
Behind-the-meter	Suitable	Not suitable	Not suitable	Limited suitability	Not suitable	Not suitable
Long-term duration storage	Limited suitability	Suitable	Suitable	Limited suitability	Not suitable	Suitable

Global BESS installed capacity vs LCOS



Battery storage projects around the world

Hornsdale Power Reserve, South Australia – Pioneer for Grid Services

World's biggest battery at the time of installation

Phase 1 of 100 MW/129 MWh completed in 2017

- Saved consumers $150 million in first two years of operation confirming benefits of grid-scale storage for RE integration

Phase 2 of 50 MW/65 MWh completed in 2020

- Upgrade from grid following to grid forming battery
- Support the need for faster frequency control ancillary services

Huanghe Hydropower Hainan Solar Park, Qinghai, China – Policy-mandated Renewable Co-location

2.2 GW solar power park co-located with a 210MW/MWh battery storage system

- Part of a planned 16GW renewable power complex
- Delivers power to densely populated Eastern provinces through an 800kV utlra high voltage transmission line
- Construction began in November 2019 and was completed in September 2020
- Equipped with sub-array energy management system capable of ensuring smooth power output

AES Alamitos BESS, California, USA – Storage Replaces Fossil Peaker Plants

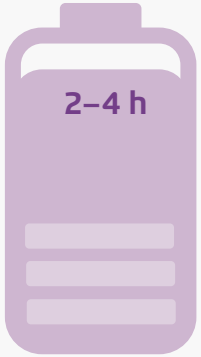
100MW/400MWh standalone battery storage system

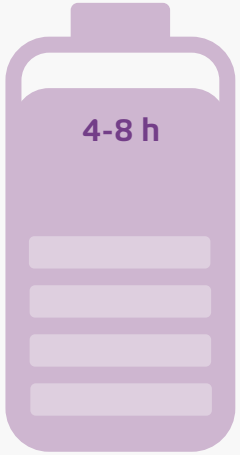
- World's first grid-scale battery to recieve a long term power purchase agreement and capacity contract
- Developed revenue contracting frameworks that accelerated deployment of future projects
- Chosen from all-source procurement in 2014 to provide local capacity after retirement of San Onofre nuclear plant
- Will allow state to set aside capacity for use during peak periods and reduce reliance on fossil fuels

Hornsdale Power Reserve, South Australia's Big Battery (2026)
PV Magazine, Chinese 202 MW/MWh solar-plus-storage project (2026)
AES Dominicana, The AES Alamitos Battery Energy Storage System made history. Here's why it matters. (2026)

Battery market evolution: From grid stability to long-duration value.

The battery business model has evolved in distinct stages as markets mature and renewable penetration increases:





1

Ancillary Services

Focused on supporting grid stability through frequency regulation and reserve services

2

Energy Arbitrage

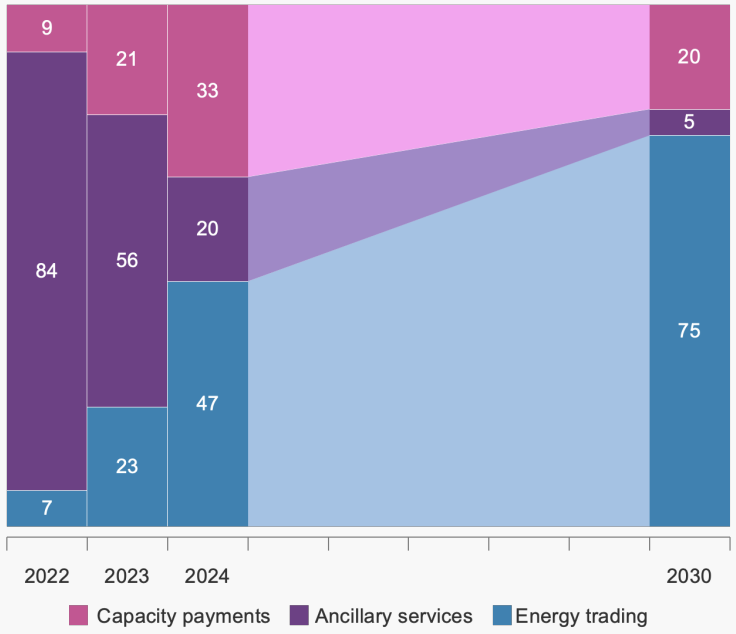
Batteries shift electricity from low-price periods (e.g. midday solar surplus) to high-price evening demand hours

3

Resource Adequacy

Batteries increasingly provide reliability during peak demand events, ensuring power availability when the grid is most stressed

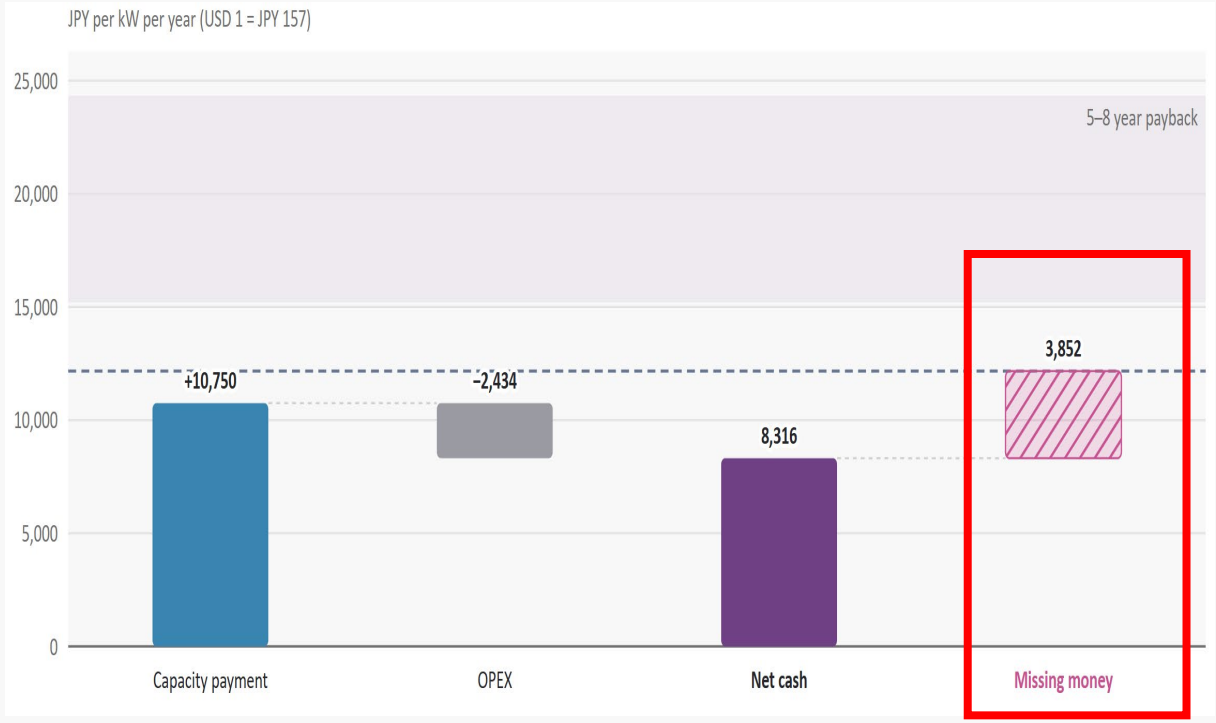
By 2030, energy arbitrage could account for about 75% of BESS revenue in the UK



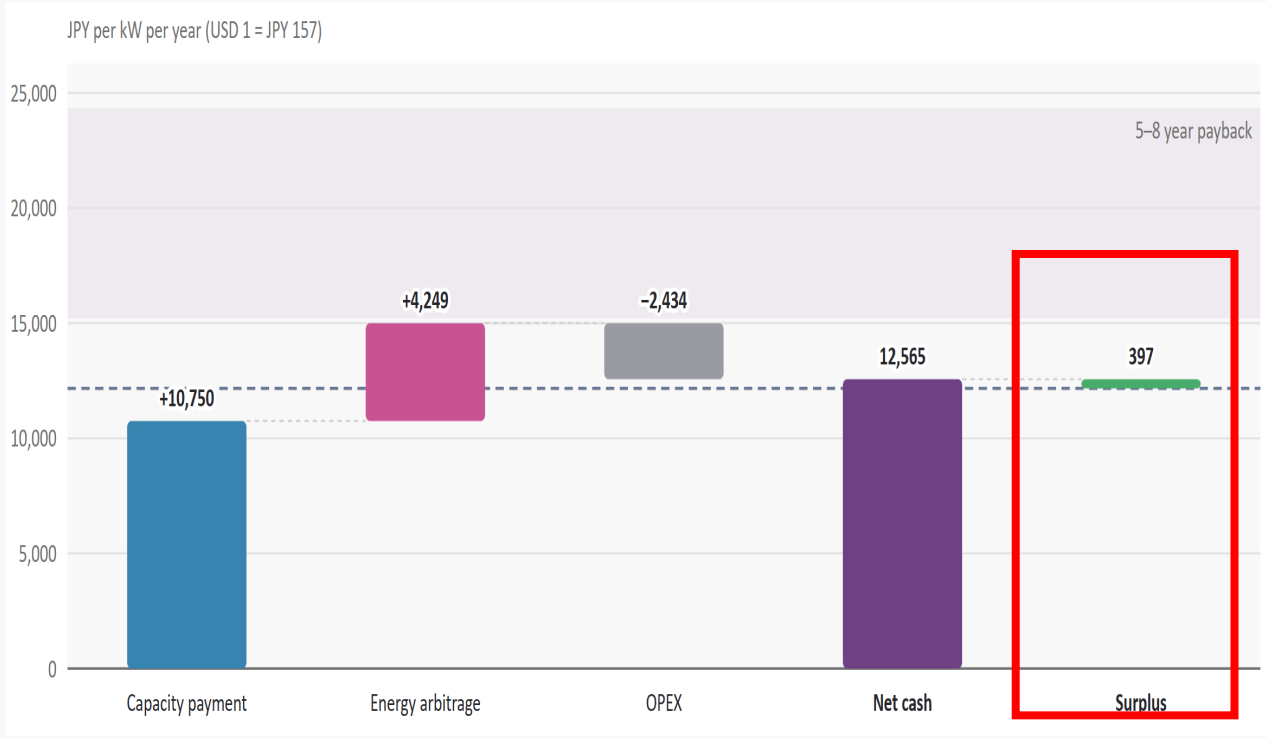
Agora Energiewende

Regulation should allow BESS to stack value, otherwise the potential is underutilized

Example of BESS revenue if only through capacity payment



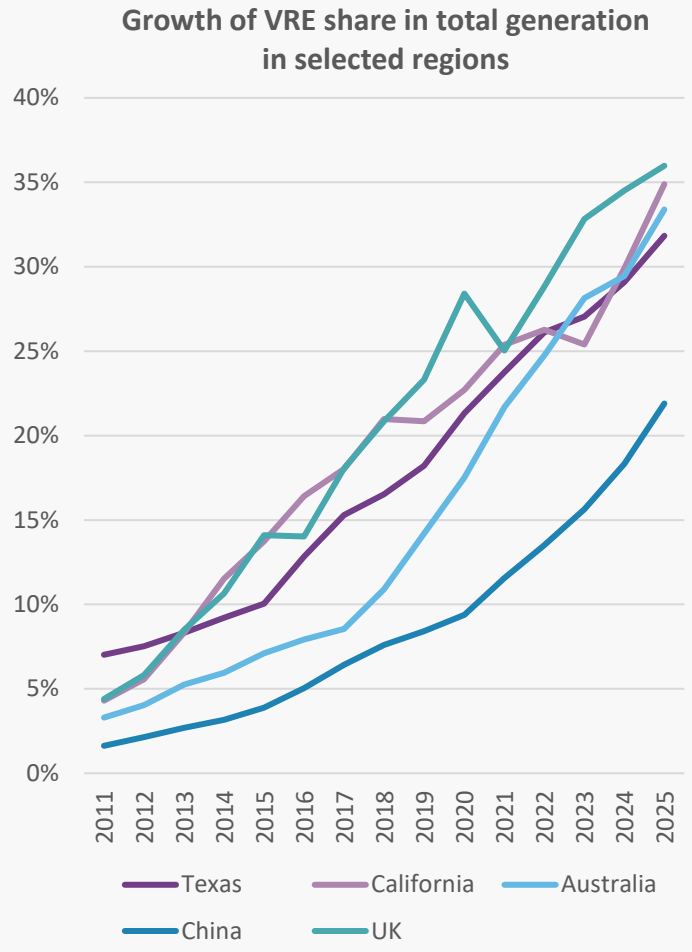
Example of BESS revenue if combining both capacity payment and arbitrage



Needed for a 10-year payback: **12,168 JPY/kW/yr (USD 78/kW/yr)** | 5–8 year payback: financeable for utility-scale (ToR) | Surplus over a 10-year payback | Missing money: what any instrument would have to add

Agora Energiewende

Unlocking battery storage deployment requires a clear and supportive regulatory environment



Examples of BESS policy support in markets with high BESS deployment

Texas

- **2023:** Interconnection process updated to formally include co-located resources
- **2021:** Legislation passed to allow utilities to contract for battery storage
- **2019:** Task force created to develop market rules to integrate grid-scale storage

California

- **2024:** Rules for bidding, dispatch, and state of charge management strengthened
- **2019:** Integration of hybrid storage projects into wholesale market
- **2013:** 2020 energy storage procurement target of 1.3GW set

Australia

- **2025:** Long term revenue underwriting introduced to reduce risk
- **2021:** Market reform enables battery storage participation as two-way resources
- **2017:** First battery storage tenders demonstrate strong investor interest

UK

- **2025:** Provision of eligibility, application rules, and investment support for LDES
- **2021:** Strategy to clarify legal status, enable co-location, and reform network charges
- **2016:** Frequency response and capacity contracts awarded to battery storage

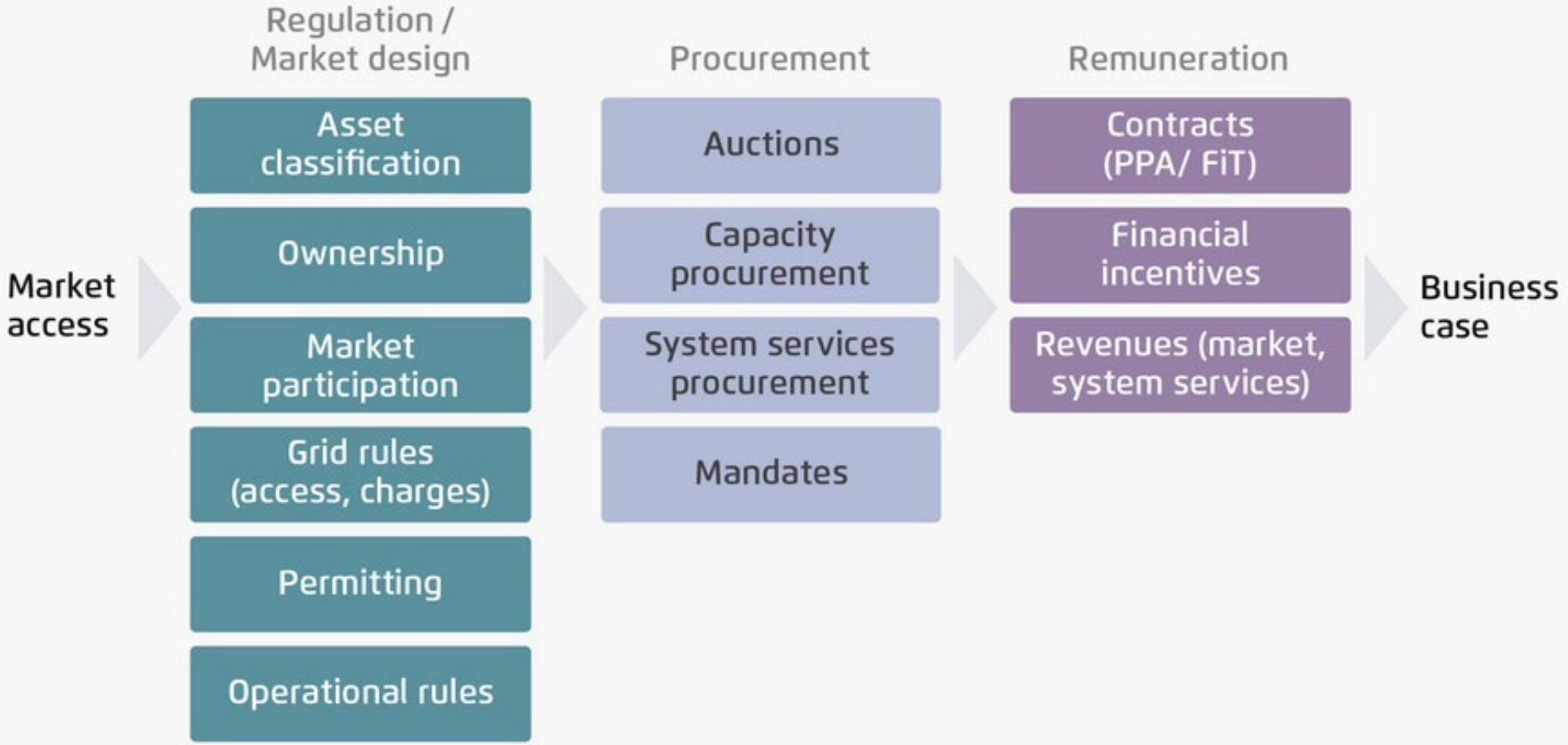
China

- **2025:** Co-location mandate dropped and capacity remuneration expanded
- **2022:** Legal clarification and participation enabled in electricity markets
- **2017:** Provinces begin co-location mandates for renewable projects

Non-Market Mechanisms Market Mechanisms

Agora Energiewende

Implementing policy and regulatory enablers and addressing common regulatory challenges reduces investment risk and enhances the cost-effectiveness of BESS



Agora Energiewende

Key messages

1 **Flexibility is the cornerstone of modern power system**, and with rapidly falling costs and high scalability, batteries are emerging as a key option for providing renewables integration, energy shifting, fast-response ancillary services, congestion management, and other system services such as black start.

2 **Regulation should allow BESS to stack value, otherwise the potential is underutilized.** Examples from various jurisdictions for power systems with high shares of variable renewables and declining thermal generation shows that demand for ancillary services increase. Overtime, however these market begin to saturate and value creation then moves towards energy shifting and then towards resource adequacy. By combining services such as frequency response, energy arbitrage, and renewable integration, operators can optimise asset utilisation while mitigating risks from market volatility and regulatory changes.

3 **Unlocking battery storage deployment requires a clear and supportive regulatory environment.** This includes well defined asset classification and ownership rules, fair remuneration across services, grid codes and market design.

Thank you!

Contact: mentari.pujantoro@agora-energiewende.de

Key takeaways

1. Types of energy storage
2. Renewables and storage
3. Energy storage grid services
4. Difference between LCOE and LCOS
5. Battery costs
6. Revenue models
7. Global battery leaders
8. Unlocking battery potential
9. Safety and sustainability
10. Future outlook for batteries

Battery storage

Visit our **FAQ**

on battery storage

Flexibility

Visit our **FAQ**

on flexibility

Key takeaways

1. Power system flexibility
2. Why flexibility matters
3. Systems with high renewables
4. Benefits of a flexible power system
5. Types of flexibility services
6. Flexible technologies
7. Cost-effective solutions
8. Flexibility planning
9. Procurement and market mechanisms
10. Key elements to scale up flexibility