European Association for Storage of Energy

Services to Support Generation and Services to Support Bulk Storage

Energy Storage Applications Forms

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Introduction

This overview provides a summary of the different energy storage applications, focused mainly on the electricity system, in order to illustrate the many services that energy storage can provide. The forms are organised according to the segment of the energy system that benefits from a given service; this categorisation does not necessarily reflect the location in which the storage device is installed. The terms for individual services, as well as their maturity (existing service vs emerging or future service) varies across different EU Member States.

The services to support generation and bulk storage are the ones that can ensure a vast and clean energy generation from renewable sources: these are divided into seven categories, among which there are energy arbitrage, system electricity supply capacity, support to conventional generation, ancillary services RES support, capacity firming, RES curtailment minimisation and seasonal arbitrage.

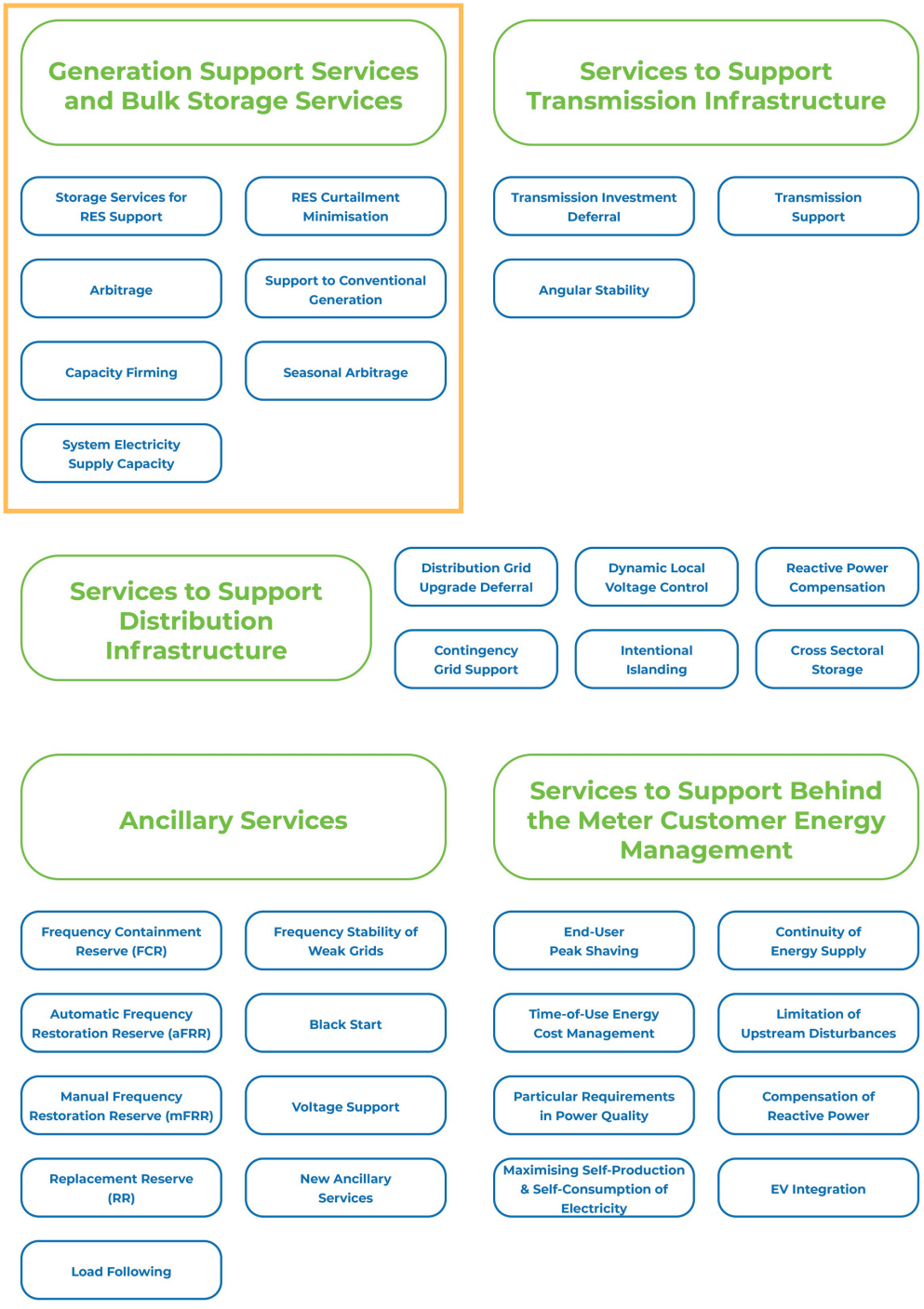


Table of Contents

Abbreviations

List of abbreviations used in this form:

- **RES**: Renewable Energy Sources
- **PHS**: Pumped-Hydro Storage
- **CAES**: Compressed-Air Energy Storage
- **LAES**: Liquid Air Energy Storage
- **PHES**: Pumped Heat Electrical Storage
- **CSP**: Concentrated Solar Power
- **T&D**: Transmission and Distribution
- **P2G**: Power-to-Gas
- **P2L**: Power-to-Liquid
- **P2H**: Power-to-Heat
- **SHS**: Sensible Heat Storage
- **ThCES**: Thermochemical Energy Storage
- **P2H2P**: Power-to-Heat-to-Power
- **ECR**: Electrochemical Recuperator

1. Storage Services for RES Support

Emerging Application

1. Definition

The use of energy storage to help variable renewable generation contribute to ancillary services by providing some reserve power.

2. Technical characteristics

These parameters generally depend on the size of the RES plant and may be determined based on the new grid codes. Below are indicative ranges:

- ES size range: 100 kW → 2 MW
- Target discharge duration range: 20 min → 1h 30 min
- Minimum cycles/year: continuous
- Ramp-up: 15 sec → 30 sec

3. Application providers

- Energy storage operator

4. Application beneficiaries

- RES operator that is able to provide ancillary services such as reserve power for example

5. Value of the application

- Ancillary services purchasing prices defined by each national TSO for each individual service (only when there is a market to remunerate).
- Different tariffs (in some markets) for energy from dispatchable vs non-dispatchable RES
- Deviations penalties avoidance

6. Application synergies for stacking

- Arbitrage
- Capacity firming
- System electricity supply capacity
- Transmission congestion relief

7. Potential energy storage technologies

- Chemical: H2 (fuel cell)
- Electrochemical: Classical and flow batteries, ECRs
- Mechanical[1]: PHS, CAES and LAES
- Thermal: SHS and THS

[1] Note that for these technologies, the ramp-up time is only 15-30 seconds when the plants are in a ready state; otherwise if ramping up from 0 to full capacity, these plants will require 5-10 min.

2. Arbitrage

Existing Application

1. Definition

Arbitrage is the practice of taking advantage of an electricity price difference in the wholesale electricity market. It is the use of storage to buy energy at low price and sell it at high price.

2. Technical characteristics

- ES size range: 1 → 500 MW
- Target discharge duration range: 1 → 10 h
- Minimum cycles/year: > 250
- Ramp-up: < 10 min

3. Application providers

- ES operator
- Generator operator that includes energy storage possibility

4. Application beneficiaries

- Electricity market
- Electricity system due to the decrease of expensive emitting peaking capacity
- Broader society due to environmental benefits related to CO2 emission reduction as a result of the decrease of CO2 emitting peaking capacity

5. Value of the application

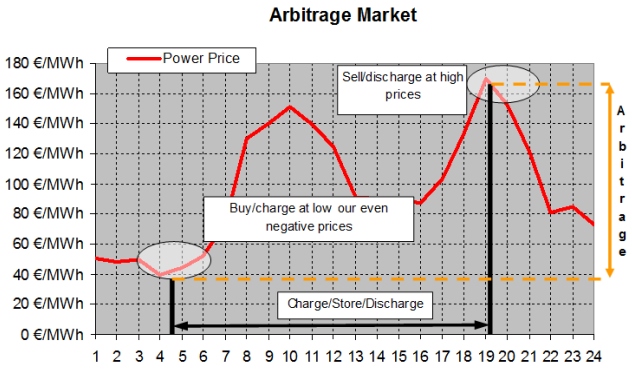
- Wholesale electricity price spread

6. Application synergies for stacking

- System electric supply capacity
- Ancillary services
- Load following
- Transmission investment deferral
- Transmission congestion relief

7. Potential energy storage technologies

- Chemical: H2 (fuel cell)
- Electrochemical: Classical and flow batteries, ECRs
- Mechanical: PHS, CAES and LAES
- Thermal: SHS and ThCES



Source: EASE - The European Association for Storage of Energy, 2013

3. Capacity Firming

Emerging Application

1. Definition

The use of energy storage to render variable RES output more constant during a given period of time. Energy storage is used to store variable energy production (wind or solar) during hours of peak production regardless of demand. This energy is then discharged to supplement generation when the variable energy unexpectedly reduces its output.

2. Technical characteristics

- ES size range: 1 → 400 MW
- Target discharge duration range: 2-4 hours
- Minimum cycles/year: continuous
- Ramp-up: < 10 seconds

3. Application providers

- ES operator
- RES + ES operator

4. Application beneficiaries

- Electricity market
- Electricity system due to the preservation of supply and demand balancing
- RES operator

5. Value of the application

- Reduced imbalance settlement
- Requested feature by some system operators
- Electricity capacity market: Capacity Remuneration Mechanism (CRM)
- Other situations: deferred generation capacity investment

6. Application synergies for stacking

- Arbitrage
- Electric supply capacity
- Ancillary service RES support
- Voltage support
- Transmission congestion relief
- T&D investment deferral

7. Potential energy storage technologies

- Electrochemical: Classical and flow batteries, ECRs
- Mechanical: PHS, CAES and LAES[2]
- Thermal: SHS and ThCES

[2] Note that for these technologies, the ramp-up time is only less than 10 seconds when the plants are in a ready state; otherwise if ramping up from 0 to full capacity, these plants will require 5-10 min.

4. System Electric Supply Capacity

Emerging Application

1. Definition

System electric supply capacity is the use of energy storage in place of combustion turbine (CT) to provide the system with peak generation capacity.

2. Technical characteristics

- ES size range: 1 → 500 MW
- Target discharge duration range: 2 → 10h (For example, in the UK the current duration for this service is 4.5 hours, which will increase as more storage is deployed)
- Minimum cycles/year: 50 → 365
- Ramp-up: < 10 min

3. Application providers

- ES operator

4. Application beneficiaries

- Electricity market
- Electricity system due to the preservation of supply and demand balancing

5. Value of the application

- Electricity capacity market: Capacity Remuneration Mechanism (CRM)
- No electricity capacity market: wholesale electricity price spread between peak period and off-peak period

6. Application synergies for stacking

- Arbitrage
- Load following
- Capacity firming
- Ancillary services
- Voltage support
- Transmission congestion relief
- T&D investment deferral

7. Potential energy storage technologies

- Chemical: H2
- Electrochemical: Classical and flow batteries
- Mechanical: PHS, CAES and LAES
- Thermal: SHS and ThCES

5. RES Curtailment Minimisation

Emerging Application

1. Definition

Use of energy storage to absorb variable RES (wind or solar) that cannot be injected into the electricity grid due to lack of demand, either delivering it to the electricity grid when needed or converting it into another energy vector (gas, fuel or heat) to be delivered to the relevant grid

2. Technical characteristics

- ES size range: 1 kW → 1 GW
- Target discharge duration range: 1 h → 10 h
- Minimum cycles/year: 300 → 500
- Ramp-up: < 5 min

3. Application providers

- ES operator – if there is no compensation scheme for the curtailed energy
- RES + ES operator – if there is no compensation scheme for the curtailed energy
- TSO – if the curtailed RES generation is compensated

4. Application beneficiaries

- Electricity market
- Environment as low carbon electricity displaces other forms of more polluting generation
- Electricity system due to the preservation of the supply and demand balancing.
- Other energy vector markets: gas, fuel, heat

5. Value of the application

- Power to Power: sales of the curtailed RES electricity on the wholesale electricity market
- Power to Hydrogen: sales of the converted curtailed RES electricity on the wholesale gas or fuel markets
- Power to Heat: sales of the curtailed RES electricity to “heat” operators

6. Application synergies for stacking

- Arbitrage
- Capacity firming (P2P)
- Electric supply capacity (P2P)

7. Potential energy storage technologies

- Chemical: H2, P2G, P2L
- Electrochemical: Classical and flow batteries, ECRs
- Mechanical: PHS, CAES and LAES
- Thermal: SHS and ThCES

6. Support to Conventional Generation

Emerging Application

1. Definition

Support to conventional generation is related to optimising operation of conventional generation assets:

- Generator bridging: the ability of energy storage systems (ESS) to pick up a generator load while the generator is stopping, until a new generator starts up or the same generator is restarted. ESS can also avoid stopping the unit (and the associated starting costs) by charging in moments of low load.
- Generator ramping: the ability of ESS to pick up strong and fast load variations, giving enough time for a given generator to ramp up or down its production level according to the optimal technical recommendations to meet load variation at stake.

2. Technical characteristics

- ES size range: depends on the generator size
- Target discharge duration range: up to 700 seconds
- Minimum cycles/year: depends on the application
- Ramp-up: < 1 min

3. Application providers

- Generator operator that includes energy storage possibility

4. Application beneficiaries

- Electricity market, electricity system due to the preservation of supply and demand balancing

5. Value of the application

- Wholesale electricity price spread
- Hedging imbalance: charges due to deviations of final physical notifications.
- Provision of mandatory services (e.g. frequency control), but also apply for bids in the market.

6. Application synergies for stacking

- Ancillary services

7. Potential energy storage technologies

- Electrochemical: Classical and flow batteries, ECRs
- Mechanical: PHS, CAES and LAES[3]
- Thermal: SHS and ThCES

[3] Note that for these technologies, the ramp-up time is only less than 10 seconds when the plants are in a ready state; otherwise if ramping up from 0 to full capacity, these plants will require 5-10 min.

7. Seasonal Arbitrage

Future Application

1. Definition

Seasonal Arbitrage is the practice of taking advantage of an electricity price difference in the wholesale electricity market between 2 seasons: Use of storage to charge energy at low price in summer and discharge it at high price in winter.

2. Technical characteristics

- ES size range: >10 MWel /decentralized), >100MWel (centralized)
- Target discharge duration range: weeks → months
- Minimum cycles/year: 1→5
- Ramp-up: < 10 min

3. Application providers

- ES operator – if there is no compensation scheme for the curtailed energy
- Generator operator that includes ES possibility

4. Application beneficiaries

- Electricity market
- Electricity System due to the decrease of expensive peaking capacity.
- Environment due to the CO2 emission decrease resulting from the decrease of CO2 emitting peaking capacity

5. Value of the application

- Wholesale electricity price spread between Winter and Summer time

6. Application synergies for stacking

- System Electric supply capacity
- T&D investment deferral

7. Potential energy storage technologies

- Chemical: H2, P2G, P2L
- Mechanical: PHS, PHS combined with impoundment plants, CAES and LAES
- Thermal: P2H (in particular large-scale technologies such as ATES)
- Thermal: ThCES

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About EASE:

The European Association for Storage of Energy (EASE) is the leading member - supported association representing organisations active across the entire energy storage value chain. EASE supports the deployment of energy storage to further the cost-effective transition to a resilient, carbon-neutral, and secure energy system. Together, EASE members have significant expertise across all major storage technologies and applications. This allows us to generate new ideas and policy recommendations that are essential to build a regulatory framework that is supportive of storage.

For more information please visit www.ease-storage.eu

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Disclaimer:

This content was elaborated by EASE and reflects a consolidated view of its members from an energy storage point of view. Individual EASE members may adopt different positions on certain topics from their corporate standpoint.

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