European Association for Storage of Energy EASE

# Energy Storage: a Key Flexibility Resource

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# 1. Introduction to EASE

## European Association for Storage of Energy…

…is the European **voice** of the energy storage community

…advocates the **role of energy storage** as an indispensable instrument for the energy system

…supports a **sustainable**, **flexible** and **stable** energy system

…**shares** and **disseminates** information

### Strategic objectives:

1. Promotion of the role and benefits of energy storage
2. Fair market design for energy storage
3. Promotion of funding for Energy Storage (mainly RD&D)

# 1. Introduction to EASE

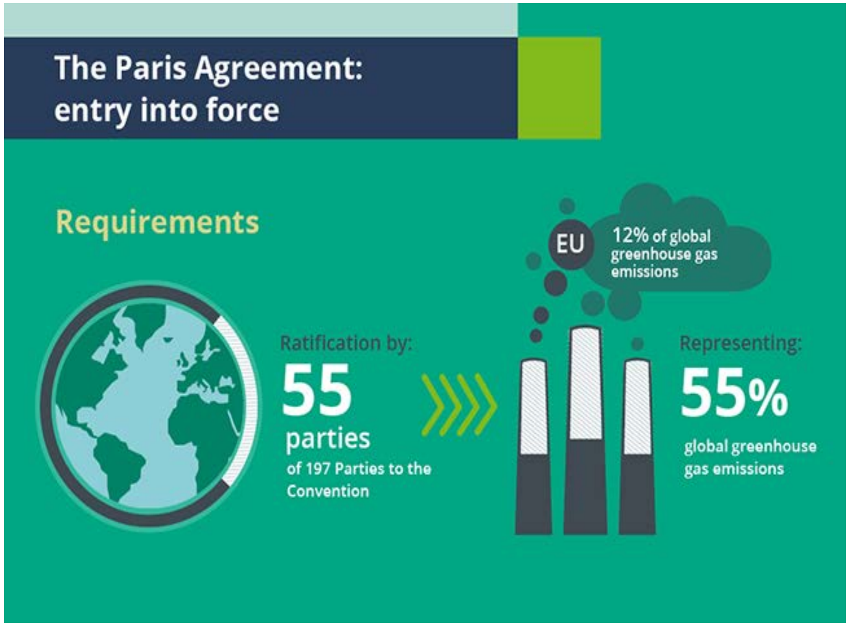
## EASE Members

# 2. Why Do We Need Storage?

## Paris Agreement and Decarbonisation Goals

- At the Paris climate conference (COP21) in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal.
- The agreement sets out a global action plan to put the world on track to avoid dangerous climate change by **limiting global warming to well below 2°C.**

➢ **The Paris Agreement will have long-term effects on governments, citizens and companies.**



# 2. Why Do We Need Storage?

## Decarbonisation and the Energy Union – Example: Germany

ca. 86 GW

**Maximum peak demand**

Source: German TSOs (2016)

ca. 300 GW

RES installed capacity needed to cover peak demand

Source: Sachverständigenrat für Umweltfragen (SRU): Wege zur 100% erneuerbaren Stromversorgung.

**How to maximise the use of RES to meet EU decarbonisation goals?**

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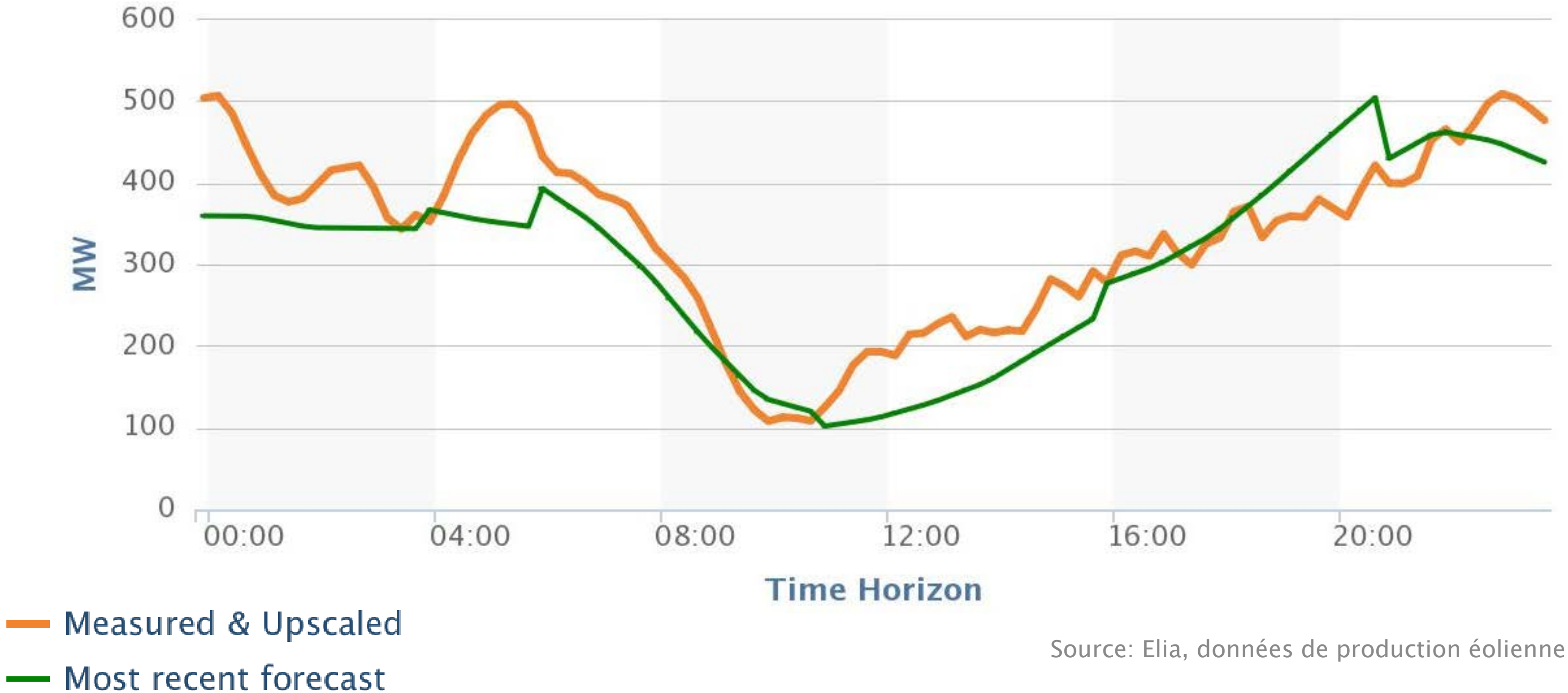
# 2. Why Do We Need Storage?

## Balancing Generation and Consumption at all Times

### Belgian Wind Power Forecasting – 02.09.2018




Source: Elia, données de production éolienne

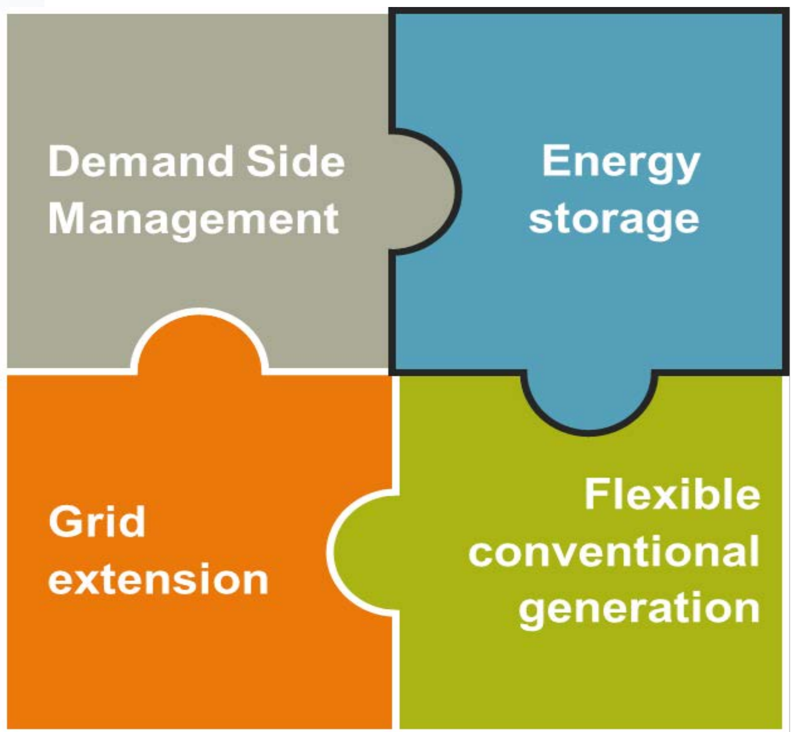
**This challenge becomes more difficult the more variable renewables (vRES) you have in the system.**

# 2. Why Do We Need Storage?

## Available Flexibility Options to Integrate Variable Renewables

Uncertainties about practicability…has yet to demonstrate full potential

Social acceptance becoming increasingly limited




**Many available technologies, value for host of different applications and locations.**

Concerns about the environmental impacts and sustainability

# 3. Technologies and Applications

## Many Energy Storage Technologies on the Market and in R&D

### Chemical

- Ammonia
- Drop-in Fuels
- Hydrogen
- Methanol
- Synthetic Fuels
- Synthetic Natural Gas

### Electrochemical

- Classic Batteries
  - Lead Acid
  - Li-Ion
  - Li-Polymer
  - Li-S
  - Metal Air
  - Na-Ion
  - $Na-NiCl_2$
  - Na-S
  - Ni-Cd
  - Ni-MH
- Flow Batteries
  - Vanadium Red-Ox
  - Zn-Br
  - Zn-Fe
- Hybrid Supercapacitors

### Electrical

- Supercapacitors
- Superconducting Magnetic ES (SMES)

### Mechanical

- Adiabatic Compressed Air
- Diabatic Compressed Air
- Liquid Air Energy Storage
- Flywheels
- Pumped Hydro

### Thermal

- Latent Heat Storage
- Sensible Heat Storage
- Thermochemical Storage

# 3. Technologies and Applications

## Energy Storage can provide many valuable services across the energy system.

| Conventional Generation | Transmission | Distribution | Customers Services |
| --- | --- | --- | --- |
| Black start | Participation to the primary frequency control | Capacity support | End-user peak shaving |
| Arbitrage | Participation to the secondary frequency control | Dynamic, local voltage control | Time-of-use energy cost management |
| Support to conventional generation | Participation to the tertiary frequency control | Contingency grid support | Particular requirements in power quality |
| **Renewable Generation** | Improvement of the frequency stability of weak grids | Intentional islanding | Continuity of energy supply |
| Distributed generation flexibility | Investment deferral | Reactive power compensation | Limitation of upstream disturbances |
| Capacity firming | Participation to angular stability | Distribution power quality | Compensation of the reactive power |
| Limitation of upstream perturbations | | Limitation of upstream perturbations | |
| Curtailment minimisation | | | |

# 3. Technologies and Applications

## Short-term energy storage applications

Today, there are many short-term (second-minutes) energy storage applications for reserve services and frequency regulation:

- **Enhanced frequency response (UK):** providing frequency response in one second or less
- **Frequency containment reserve (EU):** increasing/decreasing power output at very short notice, within 0 to 30 seconds
- **Synthetic inertia:** inertia-like response via super fast active (milliseconds) power injection and import → This is increasingly being considered across Europe

➢ Many of these shorter-term services are tendered on the market.

➢ More needs to be done to clarify possibilities to stack multiple services on one device, allow for long-term contracts, clarify TSO/DSO ownership for provision of infrastructure services.

Seconds and Minutes

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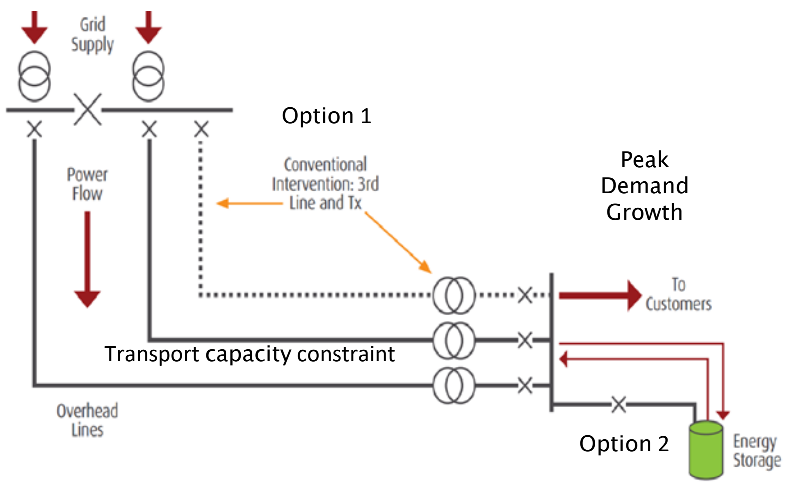
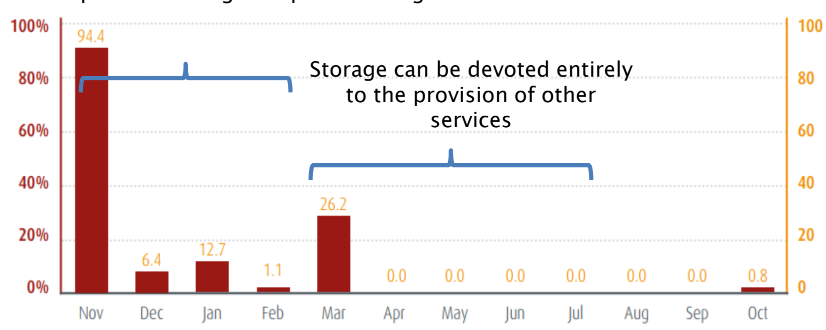
# 3. Technologies and Applications:

## Network reinforcement deferral: peak demand growth triggers power network reinforcements

- Option 1: Traditional network reinforcement (overhead or underground power lines)
- Option 2: Energy storage can be used to provide security of supply when required while providing additional services to the TSO at other times




**Energy capacity allocated to serve peak load at the Leighton Buzzard ESS**




Source : UKPN, 2016. Successful Demonstrations of Storage Value Streams

### Possible Technologies:

- Mechanical: Compressed Air Energy Storage, Liquid Air Energy Storage
- Electrochemical: Lead Acid, Li-Ion, NaS, Flow batteries

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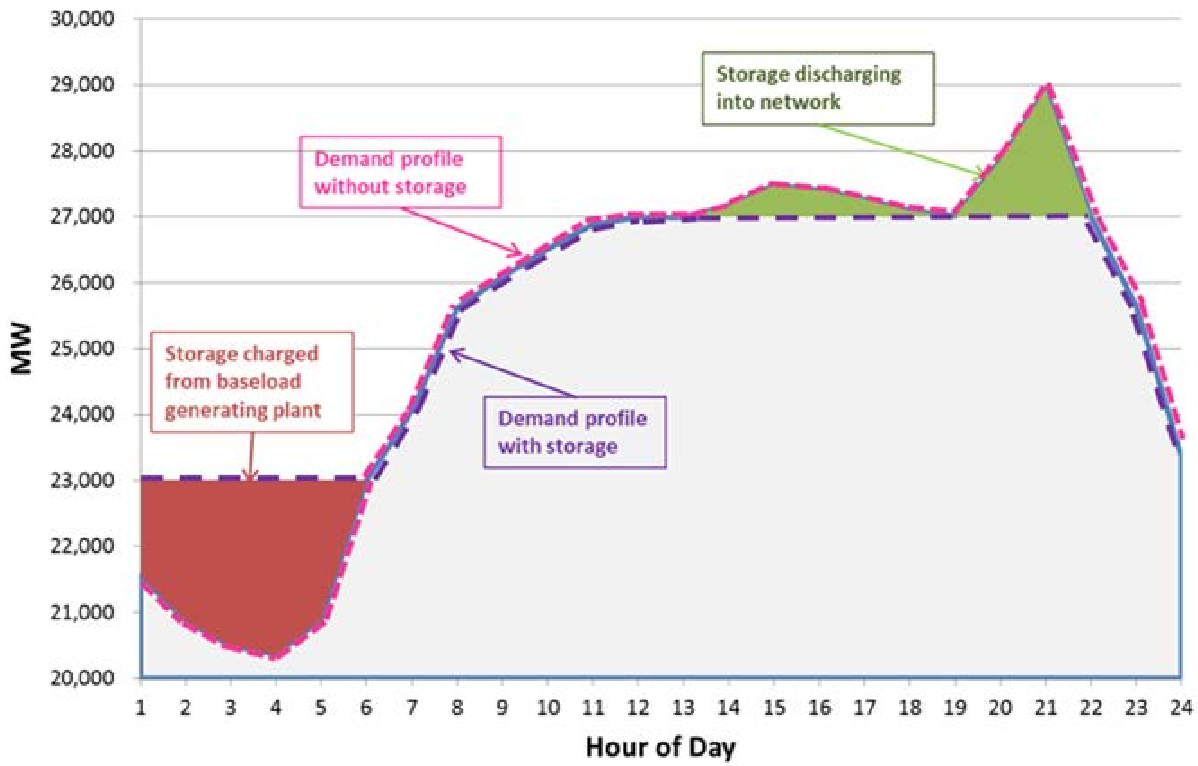
# 3. Technologies and Applications

## Balancing

### Possible Technologies:

- Mechanical: Compressed Air Energy Storage (CAES), Liquid Air Energy Storage (LAES), Pumped Hydro Storage
- Electrochemical: e.g. Lead Acid,  Li-ion, NaS, Flow batteries (e.g. Vanadium, Zinc-Bromine)

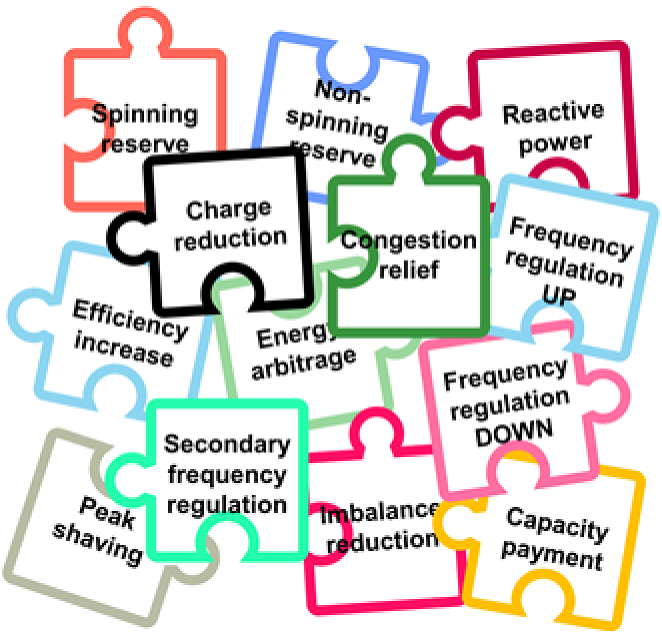



Source : http://energyclub.stanford.edu/wp-content/uploads/2013/06/kavousian-3.png

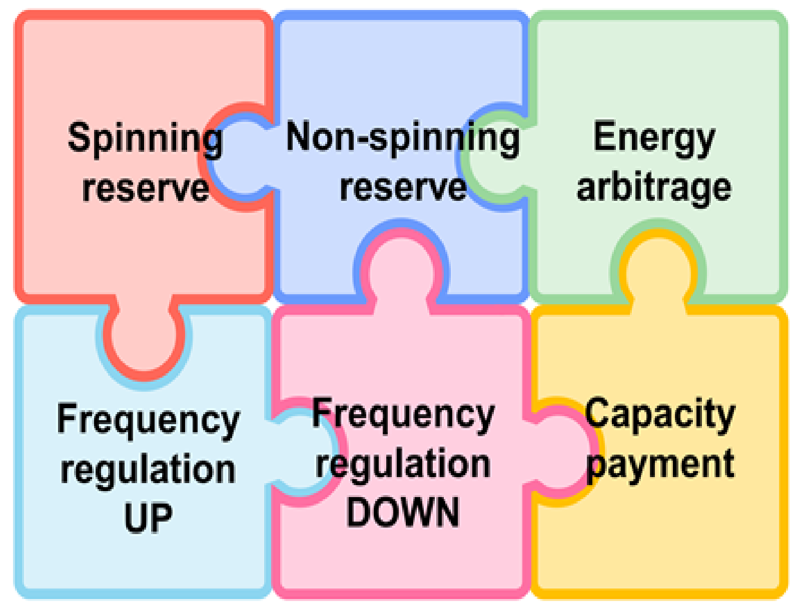
# 4. EU Energy Storage Policy

## Importance of Revenue Stacking

### Applications and revenues




### Applications by ESS in California




*Source: ENEL – EASE Investor Workshop 2017*

- Energy storage technologies have multiple applications and can derive revenue from multiple stacked revenue streams.
- **To implement multi-service business cases, it is paramount to allow storage to provide all services it can deliver and to allow revenue stacking**

# 4. EU Energy Storage Policy

## Example: use of a Li-Ion ESS in Ireland 1/3

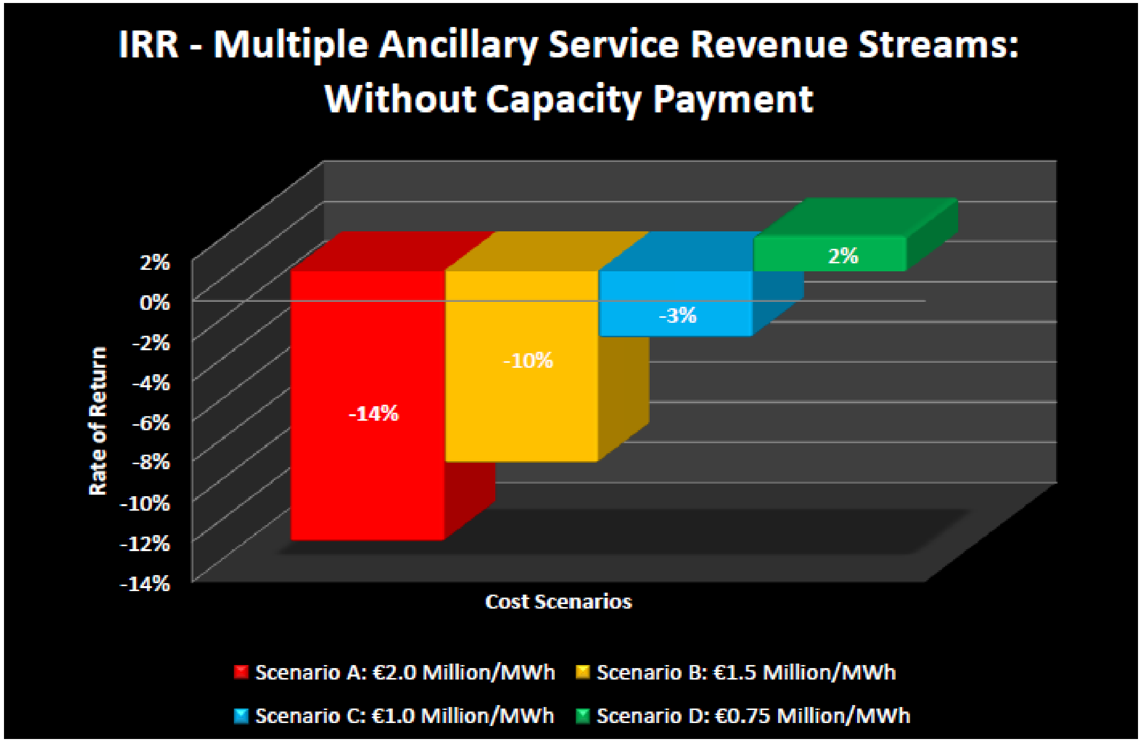
- **Li-Ion Energy Storage System (ESS)**:
  - Energy: 55 MWh or 5*11 MWh
  - Power: 100 MW or 5*20 MW
- **Services provided by ESS**:
  - Ancillary services: operating reserves (POR, SOR & TOR)
  - Capacity services
- **4 scenarios were considered to calculate the total cost of such ESS** :

| Scenario A | Scenario B | Scenario C | Scenario D |
|---|---|---|---|
| Historical Reference Price | High End of the Current Price Range | Low End of the Current Price Range | Indicator of Near Future Price |
| €2.0 Million/MWh | €1.5 Million/MWh | €1.0 Million/MWh | €0.75 Million/MWh |

Source: Financial Viability of Lithium-Ion Based Energy Storage Systems for Ancillary Services in the Secondary Market, Jason Omer, 2015
POR: Primary Operating Reserve
SOR: Secondary Operating Reserve
TOR: Tertiary Operating Reserve

# 4. EU Energy Storage Policy

## Example: use of a Li-Ion ESS in Ireland 2/3

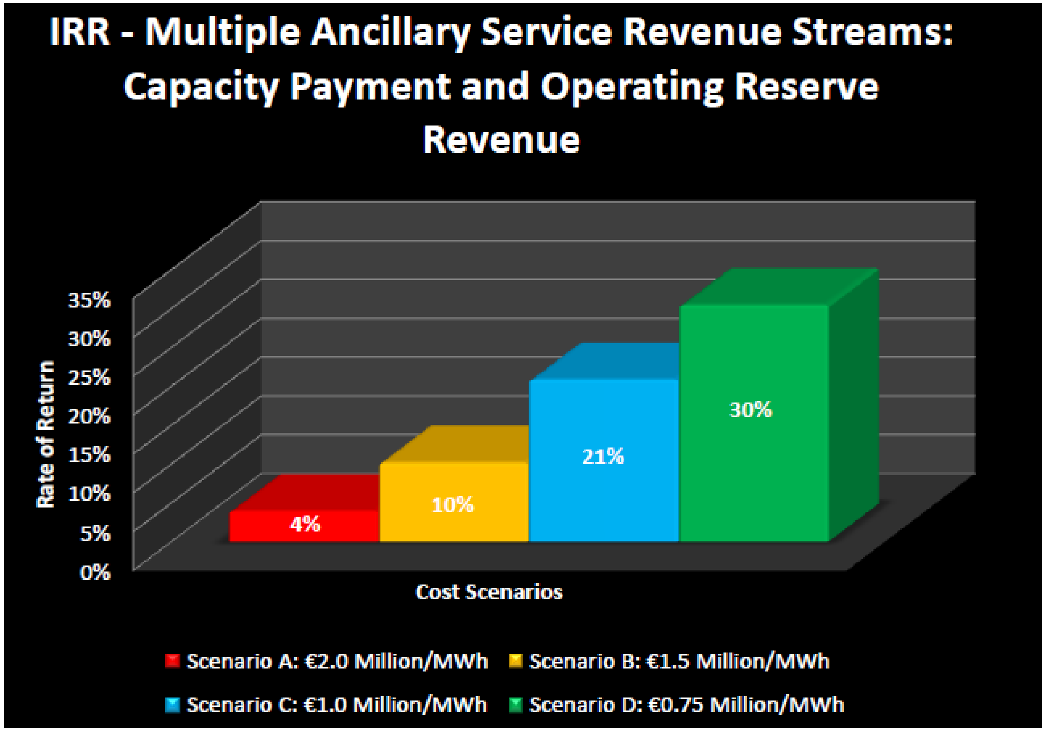



- Profitability analysis for the ESS providing a single service to the market.

Source: Financial Viability of Lithium-Ion Based Energy Storage Systems for Ancillary Services in the Secondary Market, Jason Omer, 2015

# 4. EU Energy Storage Policy

## Example: use of a Li-Ion ESS in Ireland 3/3




- Profitability analysis for the ESS providing several services to the market
- **Revenue stacking is crucial for the profitability of storage projects**

Source: Financial Viability of Lithium-Ion Based Energy Storage Systems for Ancillary Services in the Secondary Market, Jason Omer, 2015

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# 4. EU Energy Storage Policy

## Multi-Service Business Cases

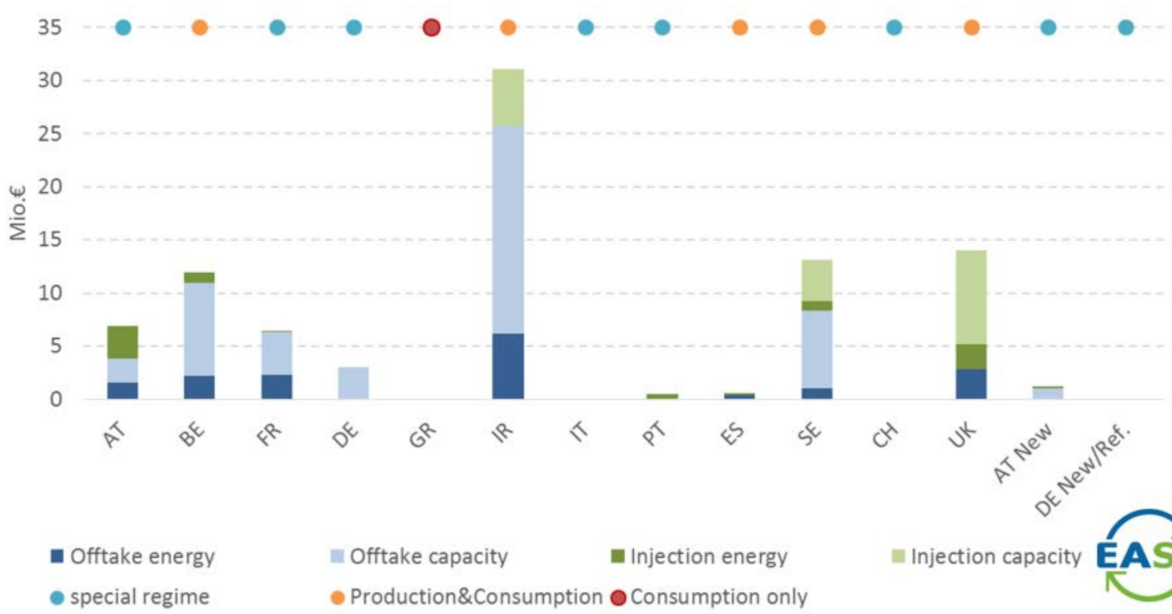
- The EU institutions are currently clarifying the framework under which regulated entities could own, develop, manage and operate energy storage facilities (Articles 36 and 54 of the recast Electricity Directive):
  - Council: derogation for energy storage facilities "which are fully integrated network components"
  - Parliament: exception for the operation of energy storage facilities for "local short-term control of the distribution system"
- It appears that regulated entities will be allowed to own, manage and operate storage facilities in specific, non-market cases
- Therefore it is crucial to explore different ways to maximise the value of the storage facility when a regulated entity will have been allowed to build it, e.g. by looking into multi-service business cases

Multi-service business cases see a regulated entity share operation and/or ownership of one energy storage device with a non-regulated entity

# 4. EU Energy Storage Policy

## Example: Grid Fees for Energy Storage Systems

### Indicative grid charges for a fictive large-scale PHS plant




- **Significant variance between countries creates distortions** in cross-border energy trade: investment in PHS plants not only depends on where they are most needed, but also where grid costs are lower.
- EASE calls for a joint EU approach to grid charges, taking into account the contributions of energy storage to grid stability.

*Source: EASE Position on Energy Storage Deployment Hampered by Grid Charges, 2017*
*PHS: Pumped Hydro Storage*

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