



# Why Greece is becoming a key energy storage market hub for Europe

## PRESENTED BY:



**Michael Salomon**  
CEO  
Clean Horizon



**Konstantinos Petsinis**  
Director of Branch Market  
Design & Monitoring  
Greek Transmission System Operator



**Dr. George Loizos**  
Head of Electricity Networks and  
New Technologies  
Regulatory Authority for Energy

## MODERATED BY:



**Andy Colthorpe**  
Editor  
Energy-Storage.news



**CLEANHORIZON**  
The Energy Storage Experts

## Why is Greece becoming a key energy storage market hub for Europe ?

## **Introduction & the opportunities set by the Recovery and Resilience Facility**

### **1. The Greek electricity context**

- 1.1 Greece's electricity context (electricity supply chain and electricity mix)
- 1.2 The goals of the NECP
- 1.3 BESS projects licensed

### **2. Revenue streams available in Greece for storage systems**

- 2.1 The Balancing Market
- 2.3 Other revenue streams
- 2.4 Business case for storage in Greece

## **Conclusion**

## **Introduction & the opportunities set by the Recovery and Resilience Facility**

### **1. The Greek electricity context**

- 1.1 Greece's electricity context (electricity supply chain and electricity mix)
- 1.2 The goals of the NECP
- 1.3 BESS projects licensed

### **2. Revenue streams available in Greece for storage systems**

- 2.1 The Balancing Market
- 2.3 Other revenue streams
- 2.4 Business case for storage in Greece

## **Conclusion**

**In its Recovery and Resilience Facility (RRF), Greece targets 6 pillars. The main pillar is the green transition which has been allotted 38% of the RRP total allocation.** The Greek Recovery and Resilience Plan has been positively assessed by the European Commission and it is a first step toward disbursing 17.8 billion in grants and €12.7 billion in loans under the Recovery and Resilience Facility (RRF) over the period 2021-2026.

**450 million euros** will be invested to support the installation of **1,380 MW** of energy storage in the electricity system.

These investments will :

- Allow the system integration of new RES capacities to reach the National Energy Climate Plan goals,
- Alleviate network congestion,
- Increase the flexibility of the electricity system and liquidity of the balancing market,
- Enhance system adequacy,
- Enable energy efficiency.

The **450 million euros** are for **both batteries and pump storage** and **will cover up to 40% of the cost of the storage system** according to Secretary General of Energy Alexandra Sdoukou.

The 700 MW energy storage tender announced by the Minister of Environment and Energy (Kostas Skrekas) in June 2021 for Q4 2021 will be postponed to Q1 2022. By Q2 2023, selected projects for a total of up to 700MW of capacity (and minimum capacity of 500MW) should be notified of the award of the contracts and projects should be completed by the end of 2025.



## Introduction & the opportunities set by the Recovery and Resilience Facility

### 1. The Greek electricity context

#### 1.1 Greece's electricity context (electricity supply chain and electricity mix)

#### 1.2 The goals of the NECP

#### 1.3 BESS projects licensed

### 2. Revenue streams available in Greece for storage systems

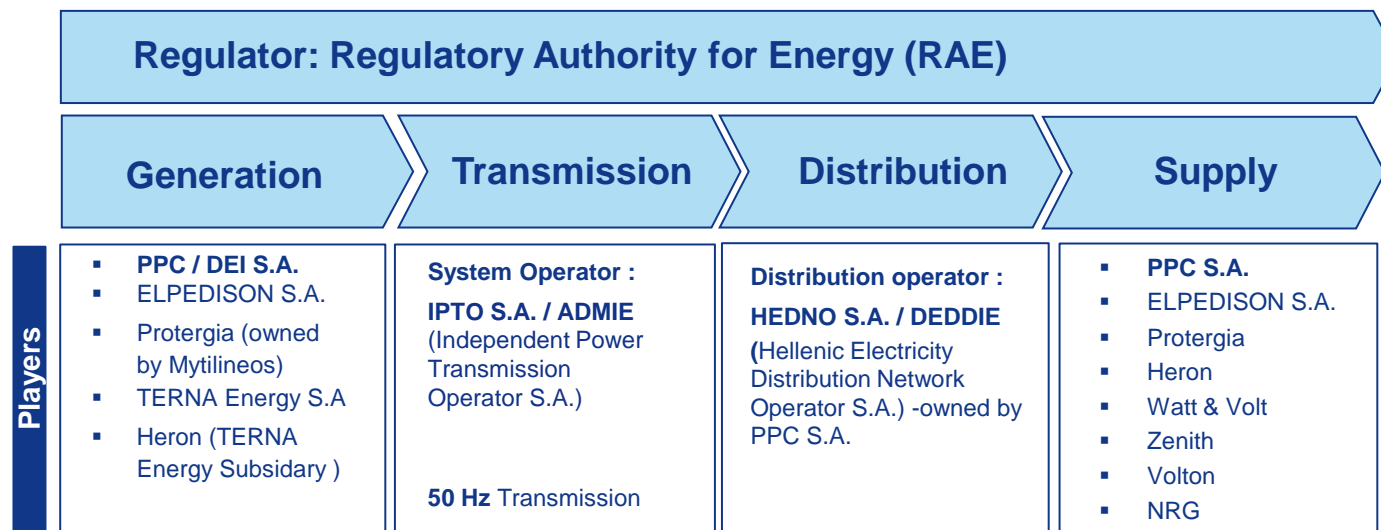
#### 2.1 The Balancing Market

#### 2.3 Other revenue streams

#### 2.4 Business case for storage in Greece

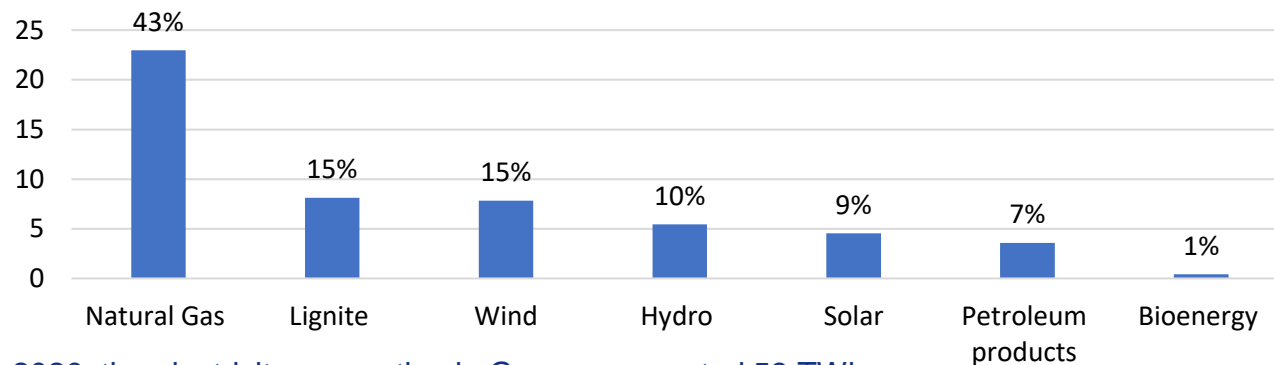
## Conclusion

## Greece's electricity supply chain



## Electricity generation in Greece in 2020 by source

In TWh



In 2020, the electricity generation in Greece amounted 53 TWh.

Source: National Energy Climate Plan (NECP) – Hellenic Republic, Ministry of Environment and Energy, December 2019

- PPC S.A. holds 51 % of the installed power generation capacity. The supply is also dominated by PPC S.A., yet the competition for supply is growing as the number of independent suppliers rises.
- Greece's electricity generation mix is dominated by natural gas.
- Lignite still represents an important share.
- Renewables represent **35 % of the total generation mix.**



## **Introduction & the opportunities set by the Recovery and Resilience Facility**

### **1. The Greek electricity context**

1.1 Greece's electricity context (electricity supply chain and electricity mix)

#### **1.2 The goals of the NECP**

1.3 BESS projects licensed

### **2. Revenue streams available in Greece for storage systems**

2.1 The Balancing Market

2.3 Other revenue streams

2.4 Business case for storage in Greece

## **Conclusion**



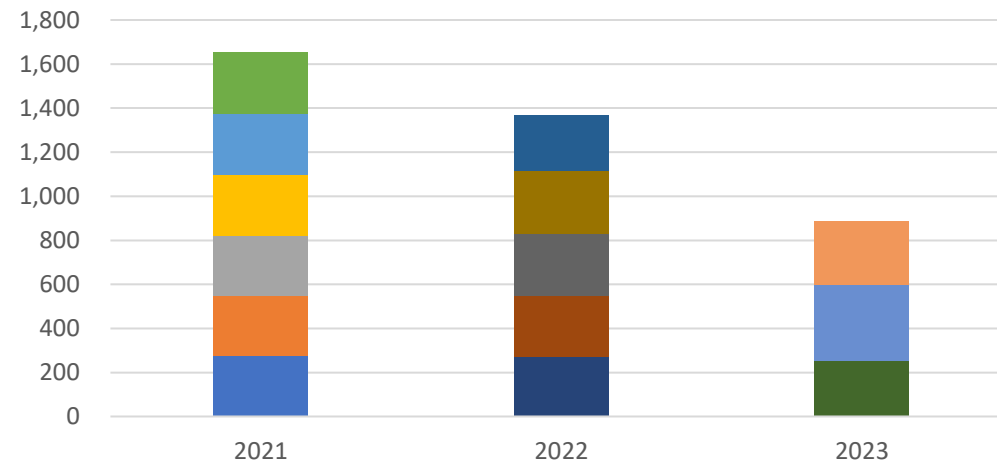


# The goals set by the National Energy Climate Plan (NECP)

- The National Energy Climate Plan is the strategic plan developed by the government with a roadmap to solve energy and climate issues by 2030. It is backed up by Europe's Recovery and Resilience Facility which supports reforms and investments implemented by the EU countries.
- The investments should allow the penetration of new RES capacity and alleviate the network congestion as well as increase the flexibility of the electric system and the liquidity of the balancing market.
- Greece plans on putting a **complete end to the use of lignite for power generation by 2028.**
- Greece intends to **increase the renewables share up to 61% of the electricity generation mix by 2030.**

Planned shutdown of lignite-fired plants in Greece

In MW

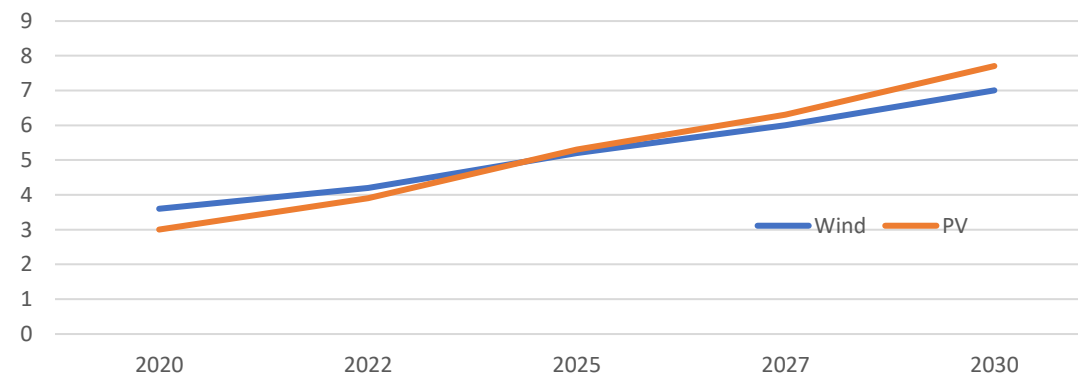


Florina/Meliti  
Agios Dimitrios 5  
Megalopolis 4  
Megalopolis 3  
Agios Dimitrios 4  
Agios Dimitrios 3  
Agios Dimitrios 2  
Agios Dimitrios 1  
Kardia 4  
Kardia 3  
Amyntaio 2  
Amyntaio 1  
Kardia 2  
Kardia 1

- The lignite set out frame aims at **closing 3,912 MW of lignite rated capacity by 2023.**

Planned evolution of wind and PV capacity according to the National Energy Climate Plan

In GW



- Greece plans on **more than doubling the Wind and PV capacity over the next ten years.**

Source: National Energy Climate Plan (NECP) – Hellenic Republic, Ministry of Environment and Energy, December 2019



## Introduction & the opportunities set by the Recovery and Resilience Facility

### 1. The Greek electricity context

1.1 Greece's electricity context (electricity supply chain and electricity mix)

1.2 The goals of the NECP

**1.3 BESS projects licensed**

### 2. Revenue streams available in Greece for storage systems

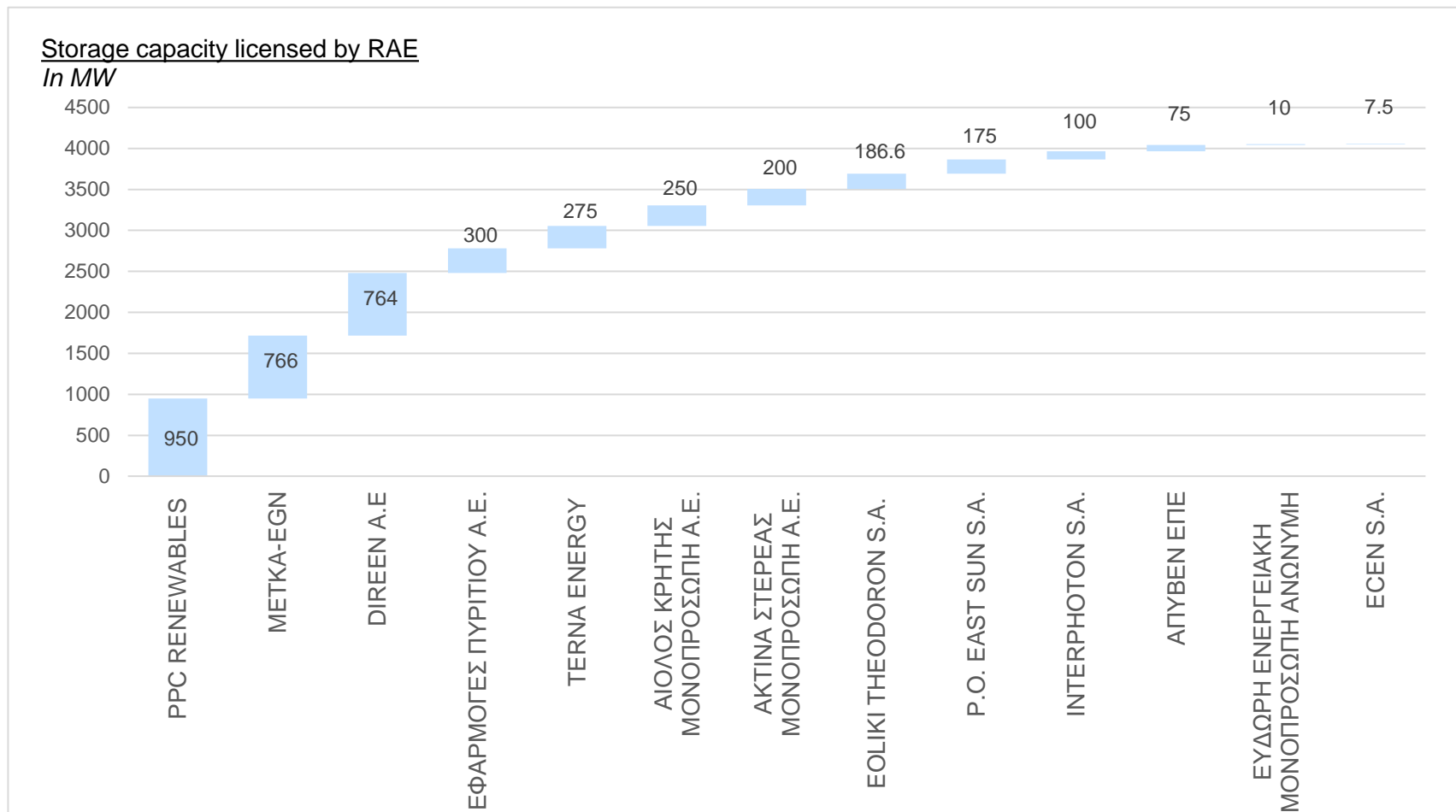
2.1 The Balancing Market

2.3 Other revenue streams

2.4 Business case for storage in Greece

## Conclusion

In July 2021, there were more than 4 GW of licenses granted by RAE to storage projects. The overall capacity that is licensed keeps growing considerably with each passing month.



- The numbers are evolving and have largely increased since July! The regulator has **licensed more than 7 GW of storage projects**. (Batteries 5,27 GW + Hybrid 0.15 GW + Pump Hydro Storage 1.64 GW)
- PPC Renewables (a PPC S.A. Subsidiary), MEKTA-EGN and DIREEN have the majority of licensed capacity.

Source: RAE geoportal - <https://geo.rae.gr/>



## Introduction & the opportunities set by the Recovery and Resilience Facility

### 1. The Greek electricity context

- 1.1 Greece's electricity context (electricity supply chain and electricity mix)
- 1.2 The goals of the NECP
- 1.3 BESS projects licensed

### 2. Revenue streams available in Greece for storage systems

#### 2.1 The Balancing Market

- 2.3 Other revenue streams
- 2.4 Business case for storage in Greece

## Conclusion

# Greek Balancing Market

***Konstantinos Petsinis***

Head of Branch

Market Design & Monitoring

IPTO

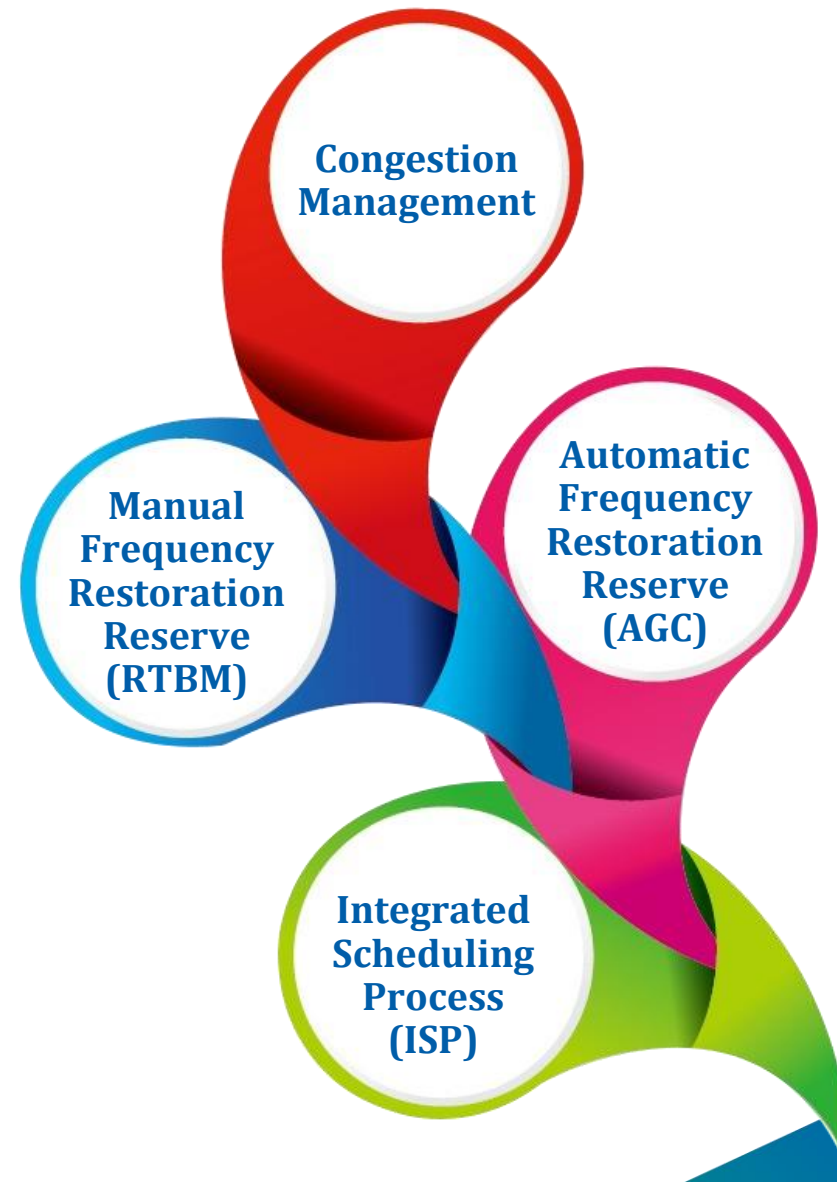
# Balancing Market in Greece

## Central Dispatch – Unit Based

- Units are scheduled by the TSO day-ahead and intraday.
- The integrated scheduling process co-optimizes balancing capacity and balancing energy taking into account the technical characteristics of the units and system constraints.

## Pricing

- Marginal pricing for mFRR balancing energy
- Hybrid for aFRR balancing energy
- Pay-as-bid pricing for FCR, mFRR & aFRR balancing capacity
- Pay-as-bid for other than balancing activations (e.g. redispatch)



# Market Participation for storage

## Integrated Scheduling Process

### Balancing Capacity

- Voluntary participation
- Mandatory participation in case of state subsidy according to the relevant obligations

Right to submit upward and downward offers for the following balancing capacity products:

- Frequency Containment Reserve (FCR),
- Automatic Replacement Reserve (aFRR),
- Manual Replacement Reserve (mFRR)

### Balancing Energy

- Voluntary participation
- Mandatory participation in case of state subsidy according to the relevant obligations

Right to submit upward and downward offers for balancing energy

## RTBM/AGC

### Balancing Energy

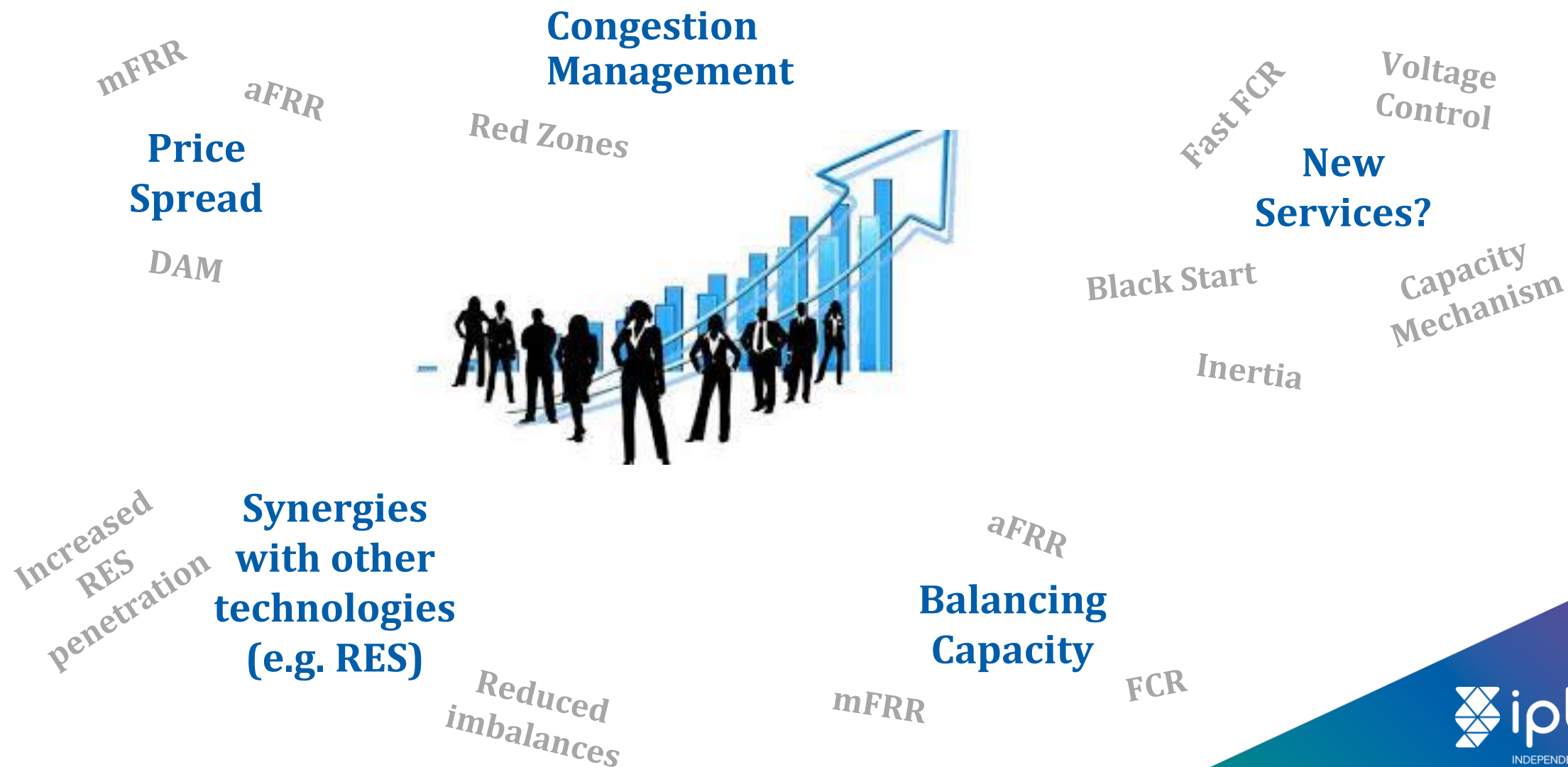
- Voluntary participation
- Mandatory participation in case of state subsidy according to the relevant obligations

Right to submit upward and downward offers for the mFRR and aFRR balancing energy.

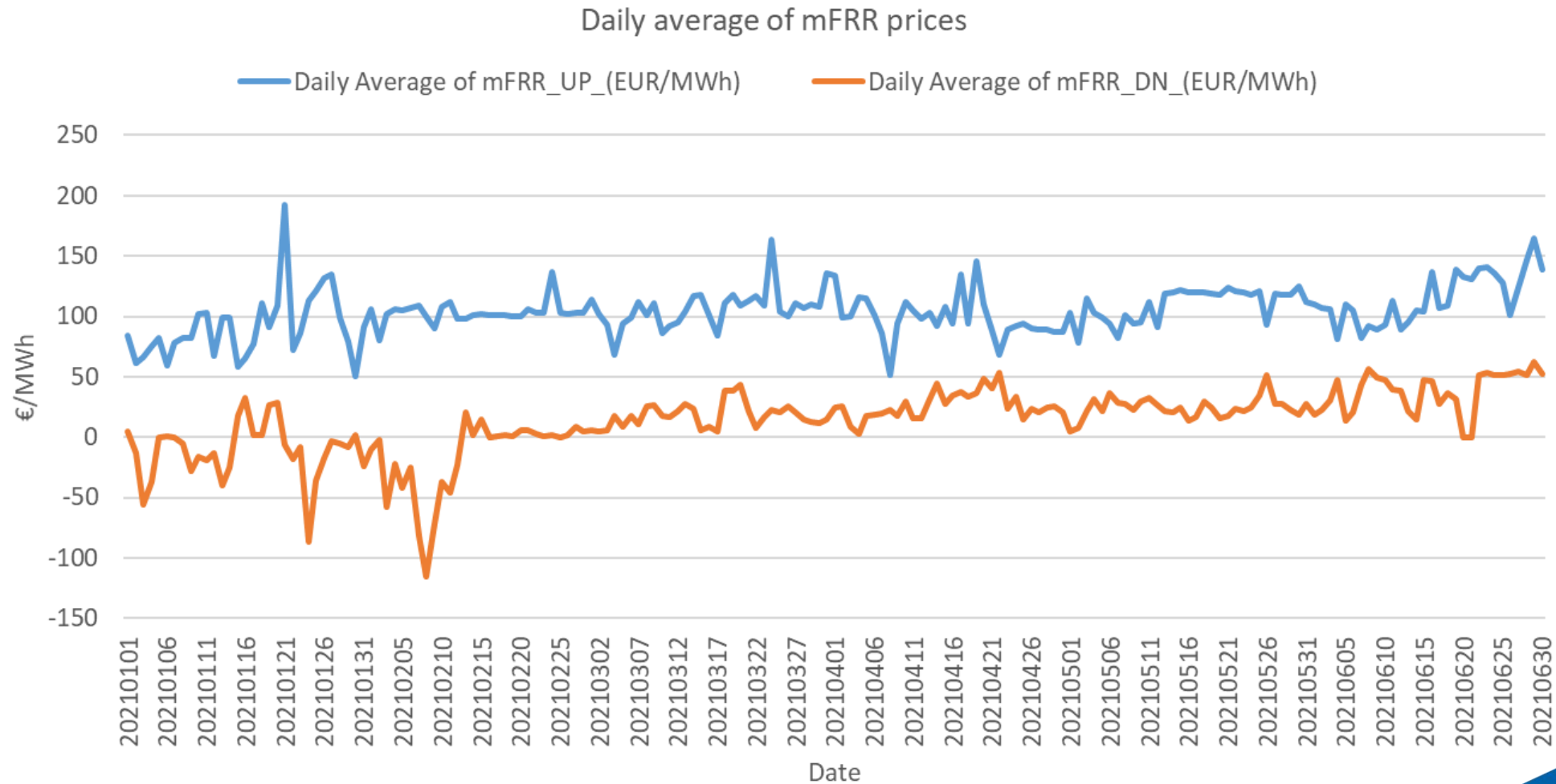
Obligation to submit the relevant balancing energy offers in case balancing capacity has been awarded.



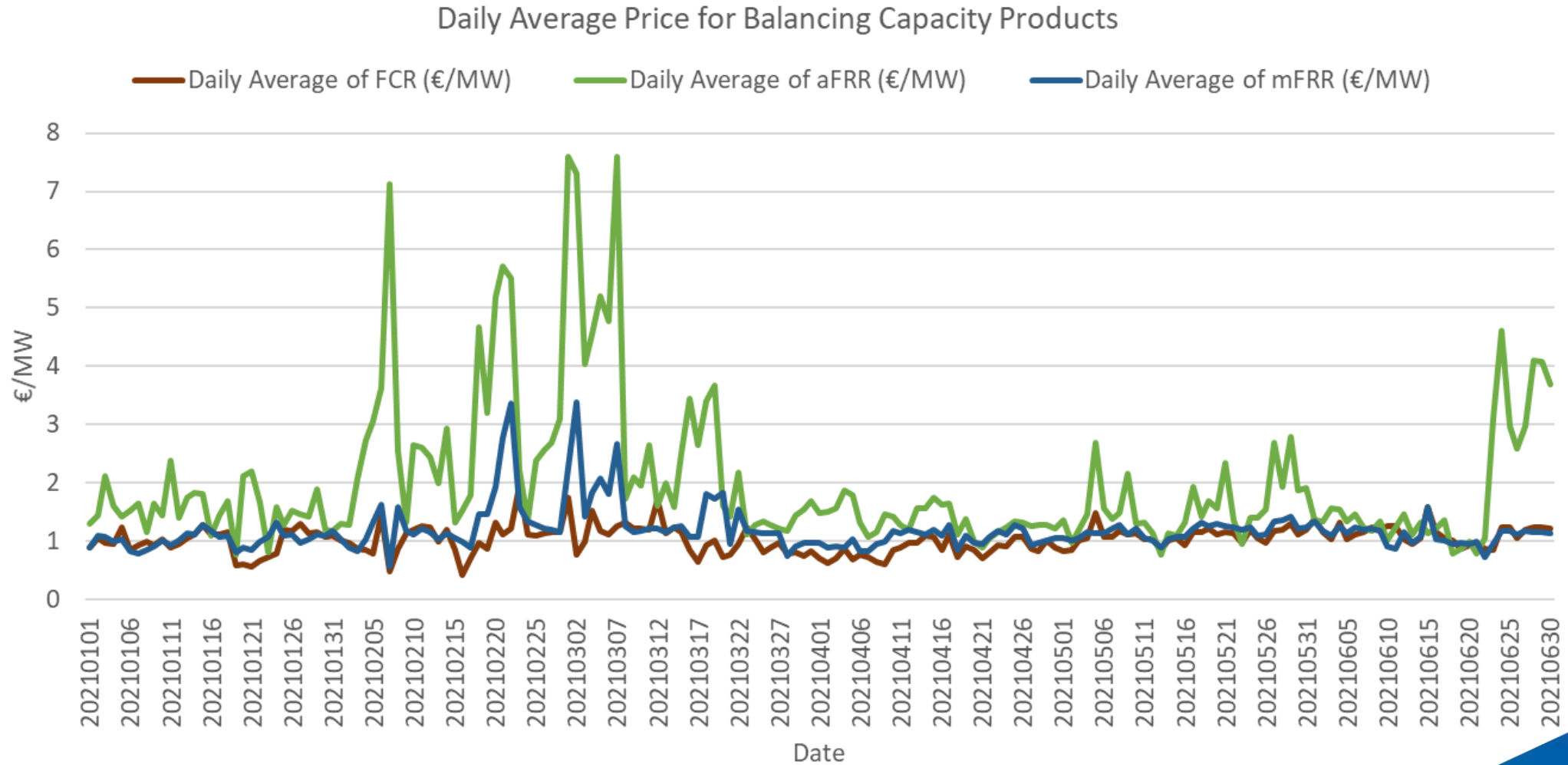
# Revenue streams for storage



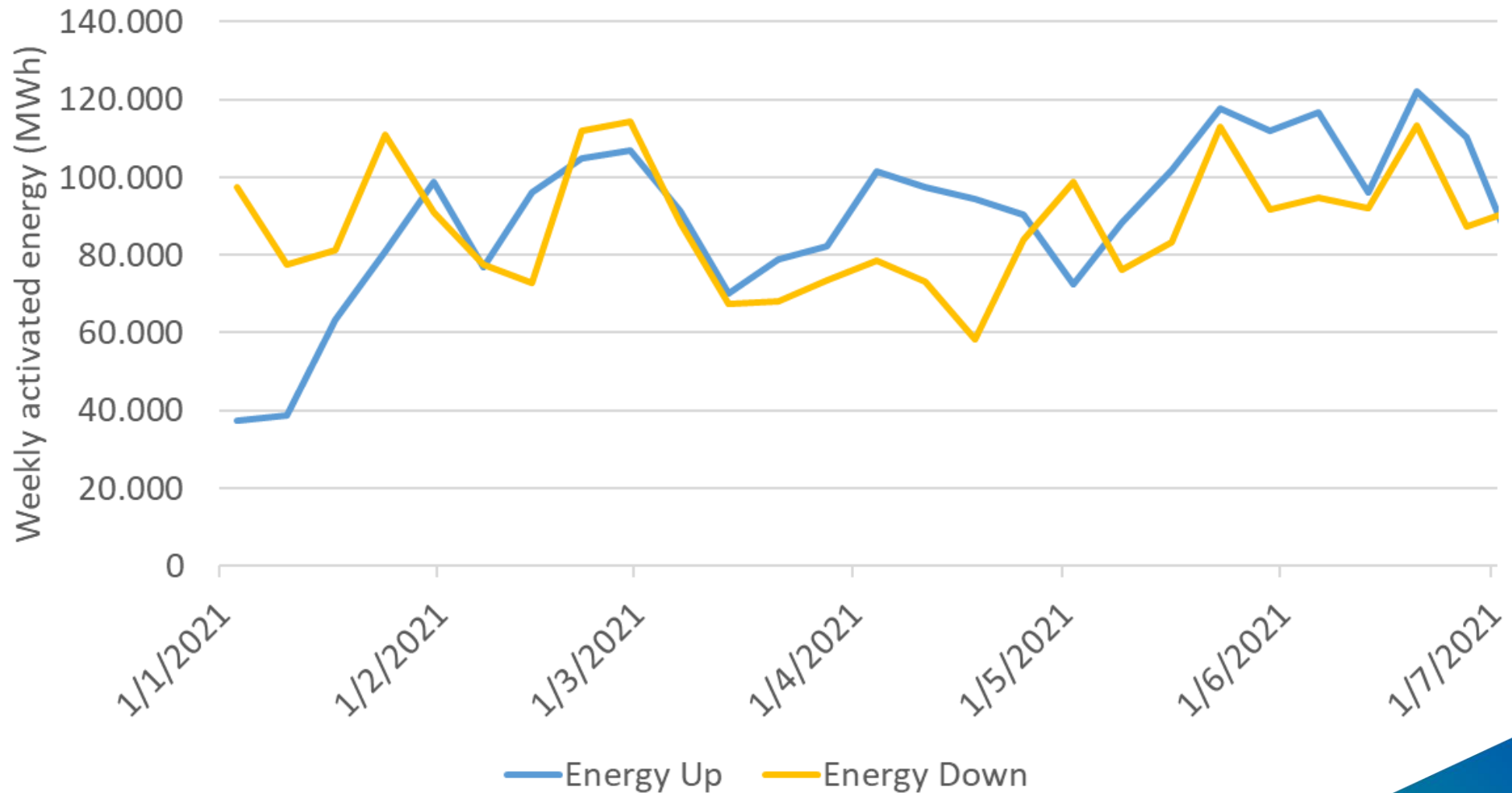
# Spread between upward & downward Balancing Energy Prices



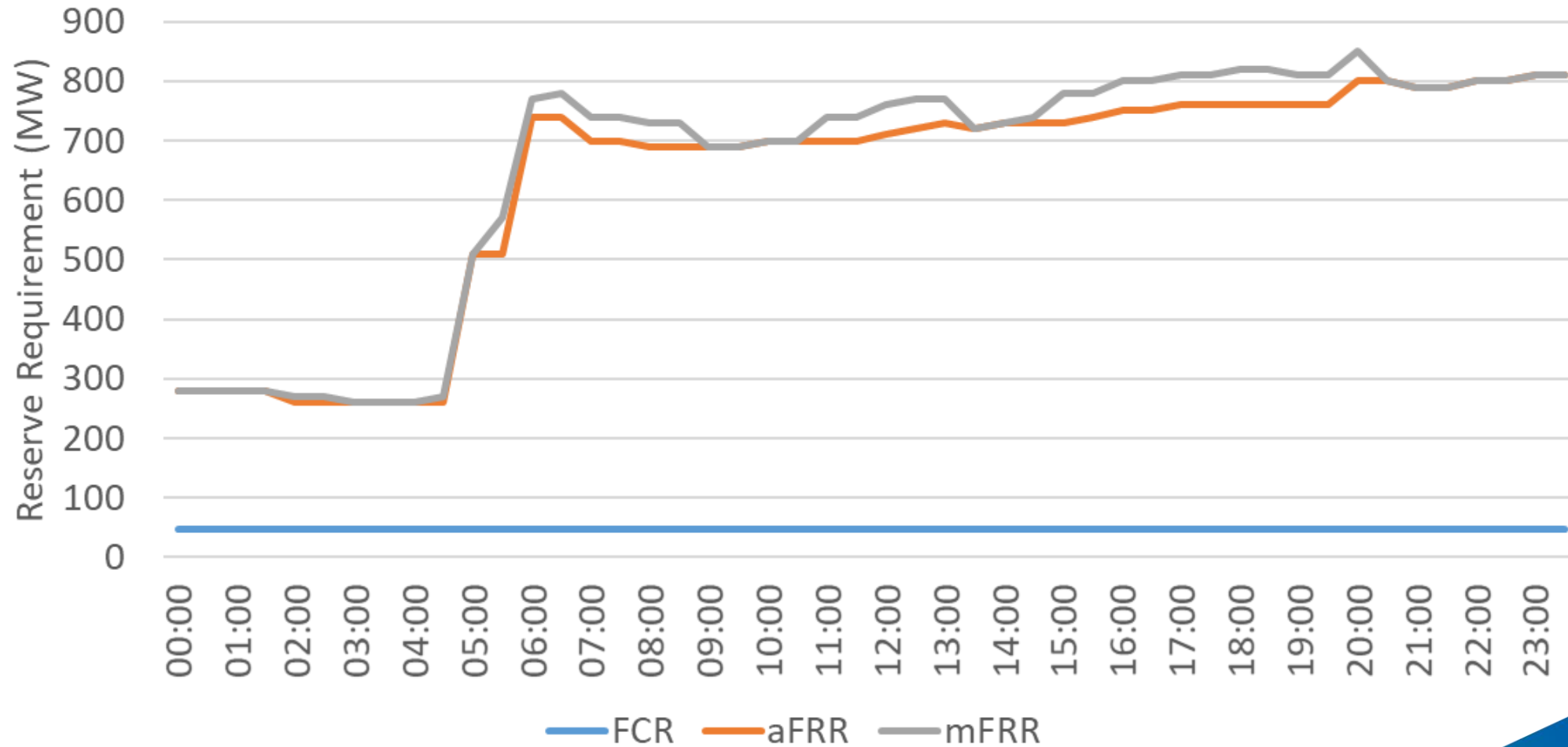
# Average Balancing Capacity Prices



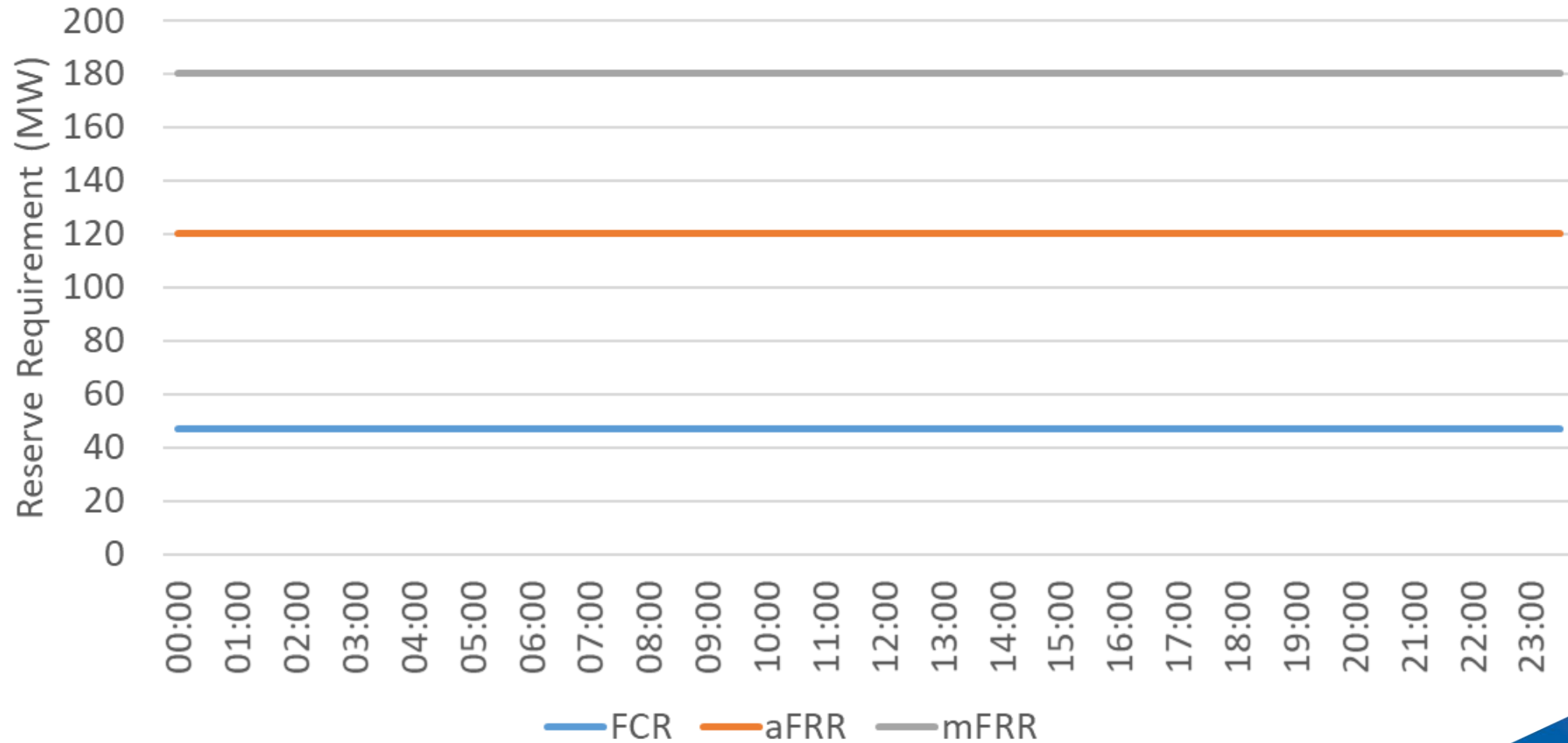
## Weekly activated energy volumes (MWh)



# Upward balancing capacity need profile (7/7/2021)



## Downward balancing capacity need profile (7/7/2021)



## **Introduction & the opportunities set by the Recovery and Resilience Facility**

### **1. The Greek electricity context**

- 1.1 Greece's electricity context (electricity supply chain and electricity mix)
- 1.2 The goals of the NECP
- 1.3 BESS projects licensed

### **2. Revenue streams available in Greece for storage systems**

- 2.1 The Balancing Market
- 2.3 Other revenue streams**
- 2.4 Business case for storage in Greece

## **Conclusion**



Summary table of the interesting revenue streams for storage in Greece

Service	Current regulation	Remuneration structure	Maximum revenues for a 1-hour battery storage system	Volume
Day ahead market	Regulatory framework under establishment	Difference between high and low energy prices in €/MWh	37.7 €/MWh	
Intraday market		Difference between high and low energy prices in €/MWh	65€/MWh	
Primary reserve (FCR)		30 min pay-as-bid auctions for up and down products	100 k€/MW/year (if awarded marginal pricing)	47 MW
Tertiary reserve (mFRR)		15 min offers activated at marginal price	249 k€/MWh/year (assuming one cycle per day based on max spread between up and down price – Using 2021 data)	242 MWh/ 30 min upward 241MWh/30min downward
Transmission system congestion management	Pilot projects for now (Thebes and Naxos)			

Legend:



Interesting revenue for storage



Interesting as a secondary revenue

- FCR and mFRR could represent a great revenue for storage.
- Day ahead and intraday market are not that remunerative.



## Introduction & the opportunities set by the Recovery and Resilience Facility

### 1. The Greek electricity context

- 1.1 Greece's electricity context (electricity supply chain and electricity mix)
- 1.2 The goals of the NECP
- 1.3 BESS projects licensed

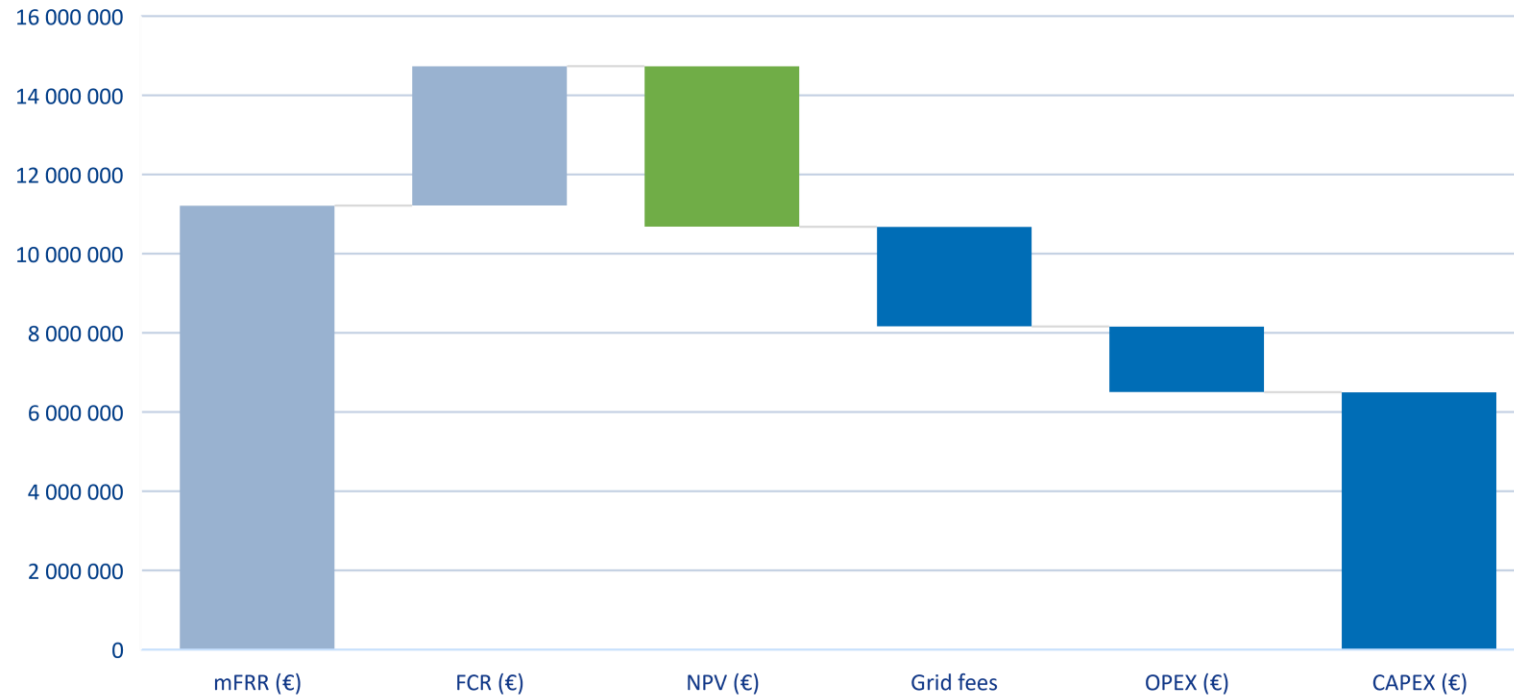
### 2. Revenue streams available in Greece for storage systems

- 2.1 The Balancing Market
- 2.3 Other revenue streams
- 2.4 Business case for storage in Greece**

## Conclusion

## 5-year business case for a 10 MW /20 MWh battery

In euros (€)



### Assumptions:

- **mFRR:** The average daily spread for mFRR has been calculated over 6.5 months (from November 2020 to May 2021). It is considered that the batteries do 2 cycles a day to provide mFRR (which takes about 4h/day).
- **FCR:** The FCR prices for up and down mFRR were averaged for the month of June 2021. The hourly remuneration for providing symmetric FCR product was calculated. It was considered that the battery provides FCR 20h/day. It is considered that the FCR volume is of 400 MWh/MW/year.
- **Grid fees and taxes:** Were taken into account, the transmission and distribution fees for MW customers (source: RAE) as well as the ETMEAR (Special Duty of Greenhouse Gas Emissions Reduction) and the SGI (Services of General interest) from the Γ23 Business Tariff form PPC S.A.
- The actualization rate is 8%.

- The Net Present Value (NPV) is positive. The Internal Rate of Return (IRR) is therefore higher than the targeted 8%. **The obtained IRR is of 29% over 5 years (!)**
- The Business considers full investment in **CAPEX**. No subsidies have been considered (which could mount up to 40% of the cost of the storage system).



**CLEANHORIZON**

The Energy Storage Experts

**Thanks for your attention!**

**Michael Salomon**

**ms@cleanhorizon.com**

12 rue de la Chaussée d'Antin

75009 Paris, France

**contact@cleanhorizon.com**

Tél : +33 (0)1 78 76 57 04

**www.cleanhorizon.com**

Clean Horizon Americas

1200 BRICKELL AVE, SUITE 1960

MIAMI, FL33131, USA

**reports@cleanhorizon.com**

# WEBINAR

Sponsored by:



**CLEANHORIZON**  
The Energy Storage Experts

**28** SEPT  
2021

# Why Greece is becoming a key energy storage market hub for Europe

**FOR ANY ENQUIRIES:**

[contact@cleanhorizon.com](mailto:contact@cleanhorizon.com)