

2022 Energy Exemplar User Group Meeting

Modelling battery energy storage revenues -
Lessons from the Greek Power Market

15th September 2022

Agenda

1. **Introducing ECA**
2. **Introducing the project context**
3. **Revenue streams for BESS (DAM, AS, BM, CRM)**
4. **Using Plexos to model the operation of BESS in the Greek market**
5. **Key results for the operation of BESS**
6. **Concluding remarks**



Economic consultants specialised in the energy and water sectors operating worldwide

Specialised economic and regulatory consultancy

Focus on electricity, natural gas and water sectors

28 professional staff members, based in offices in **London, Athens and Berlin**

Solutions to **generation optimisation, net zero targets** and energy transition challenges

International footprint with focus on UK, Ireland, southeast Europe, sub-Saharan Africa and southeast Asia

20+ years
in business

60
assignments
annually

10+ years
average
experience

28
Economists and
Engineers

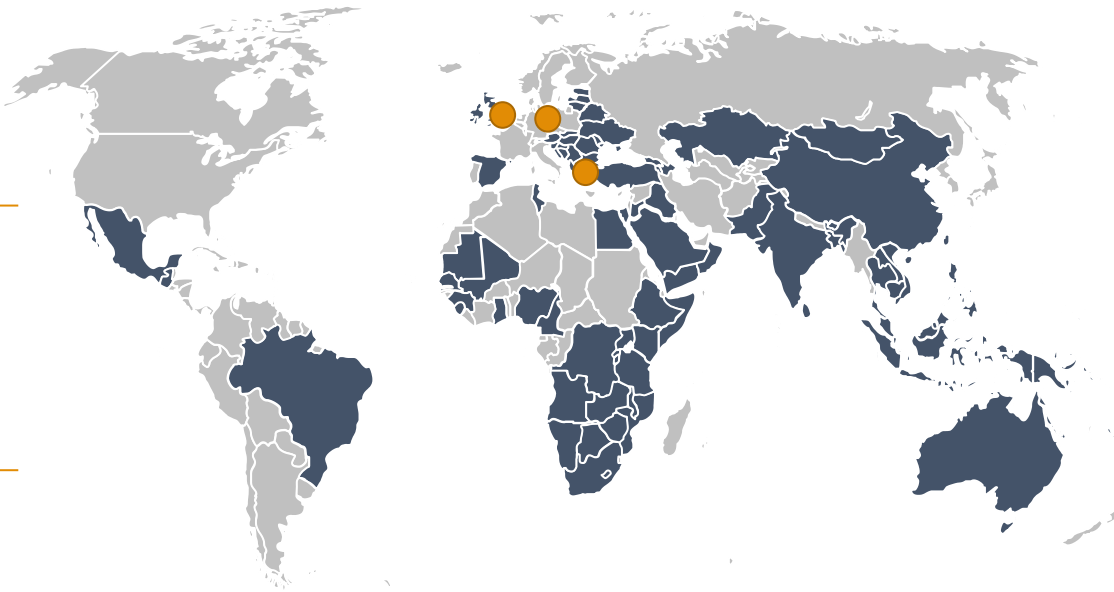
100%
Employee owned

45
Regulators advised

3
Locations
London, Athens, Berlin





70
Countries worked
in

25
National utilities
advised



“ECA combines the application of economic principles and industry knowledge with best international practice to deliver implementable recommendations”

Our experts support clients across four service areas covering economic regulation, markets, decarbonisation and investment planning

Economic Regulation		<ul style="list-style-type: none">• Network and retail tariff design• Cost of capital advice• Allowed revenue determination• Design of regulatory frameworks and incentive mechanisms• Regulatory due diligence
Decarbonisation Strategy		<ul style="list-style-type: none">• RE market integration mechanisms• Energy efficiency regulation and policy• Hydrogen strategies and integration• Low carbon strategy and policy• Energy storage investments
Markets & Commercial		<ul style="list-style-type: none">• Market due diligence• Asset valuation• Generation and storage revenue projections• Wholesale power market design• Ancillary service remuneration mechanisms
Investment Planning		<ul style="list-style-type: none">• Least cost development plans• Investment strategy• Electricity load forecasting• Energy and water sector masterplans• PPP policy and regulation frameworks

Electricity market modelling in Greece to assess the business case for Battery Energy Storage Systems (BESS)

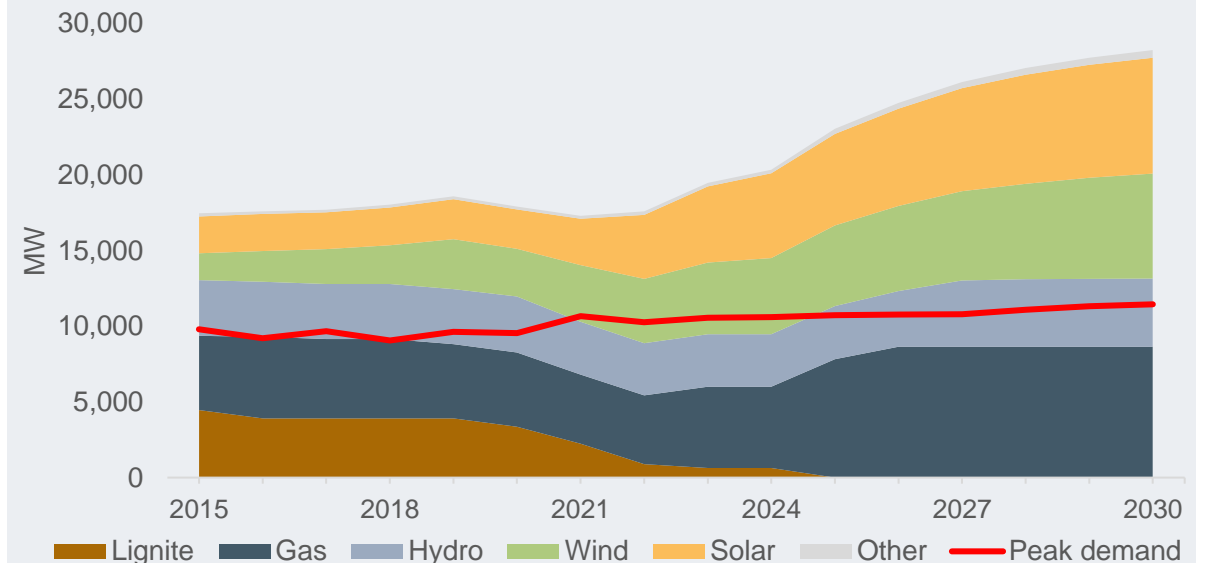
Objective

The objective of the engagement was to **develop a strategy for BESS investments** in Greece and assessing the commercial viability of BESS.

Approach

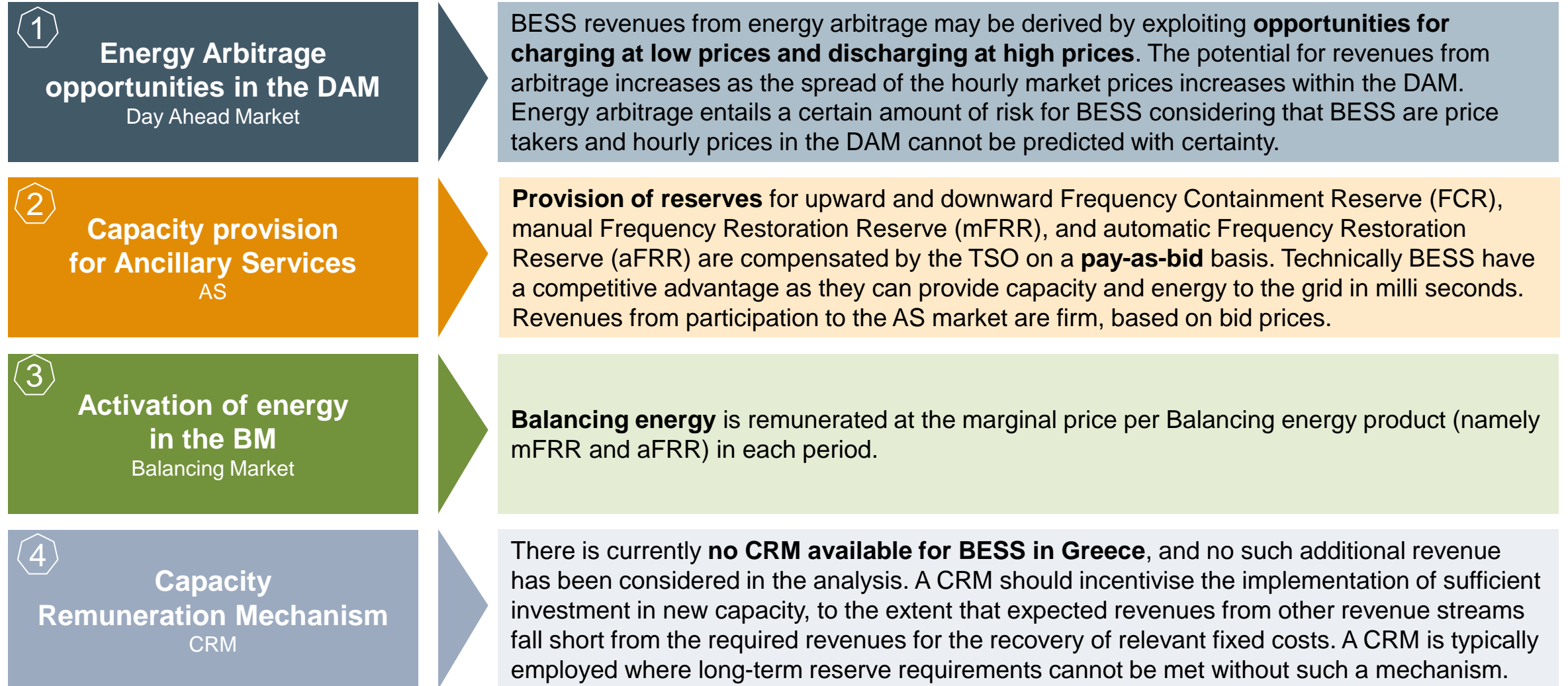
- ▶ The evaluation of storage assets was analysed in **4 scenarios** that cover a breadth of potential evolutions of the electricity market in Greece.
- ▶ The electricity market was **modelled in Plexos** software.
- ▶ The modelling analysis conducted included the electricity market in **Greece and the power systems in interconnected neighbouring countries** to capture the impact of imports/exports on market prices and on the dispatch of power plants.
- ▶ The results were then applied into a **BESS financial model** to analyse the commercial viability of storage assets.

NECP Capacity plan (2022-2030)



- ▶ Greece's **renewable energy contribution** to the EU target for 2030 is **35%**.
- ▶ The National Energy and Climate Plan (NECP) foresees the development of 1,200 MW of battery from 2024 to 2030.
- ▶ On November 2020 Greece reached a significant milestone by launching the European Target Model.

We quantified and modelled the four key revenue streams for BESS : energy arbitrage, ancillary services, balancing energy and capacity remuneration



The Greek electricity market was simulated in Plexos applying a two-step approach

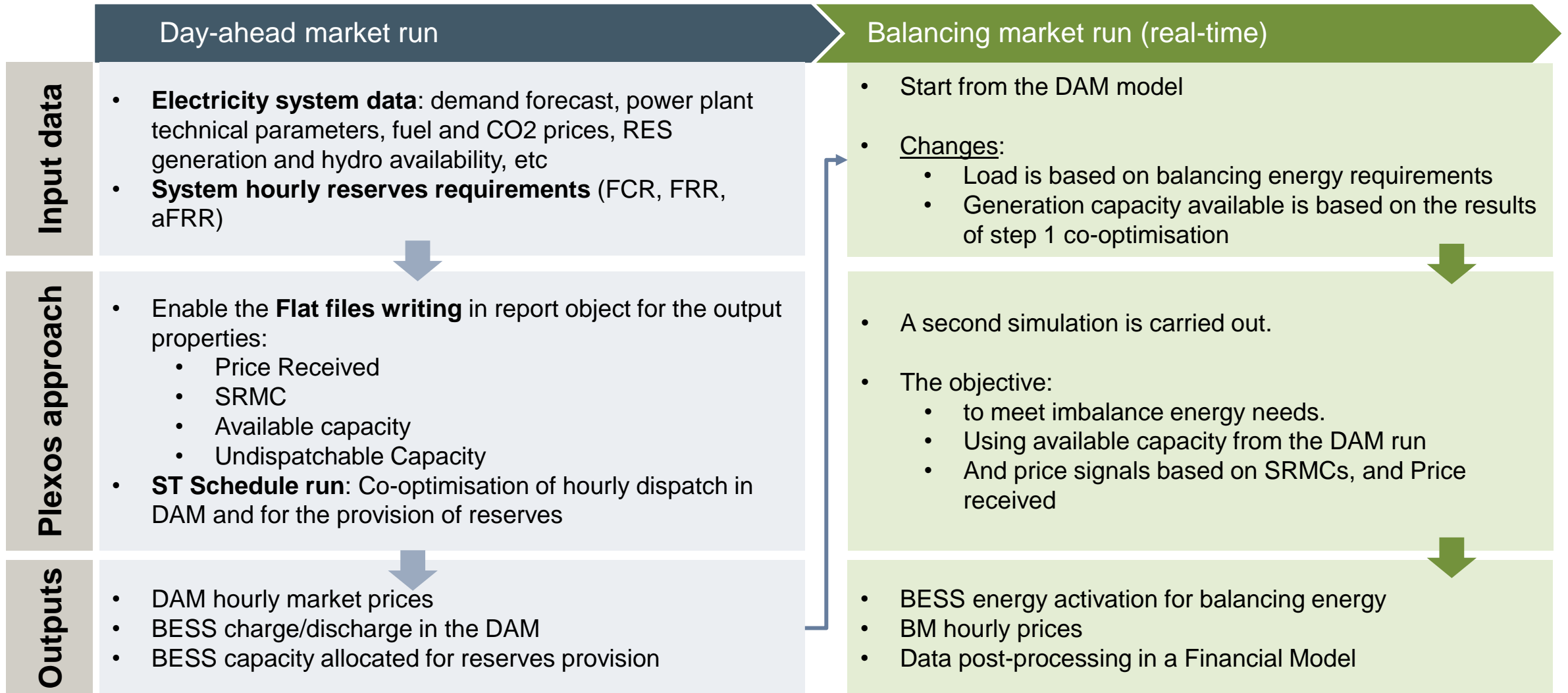
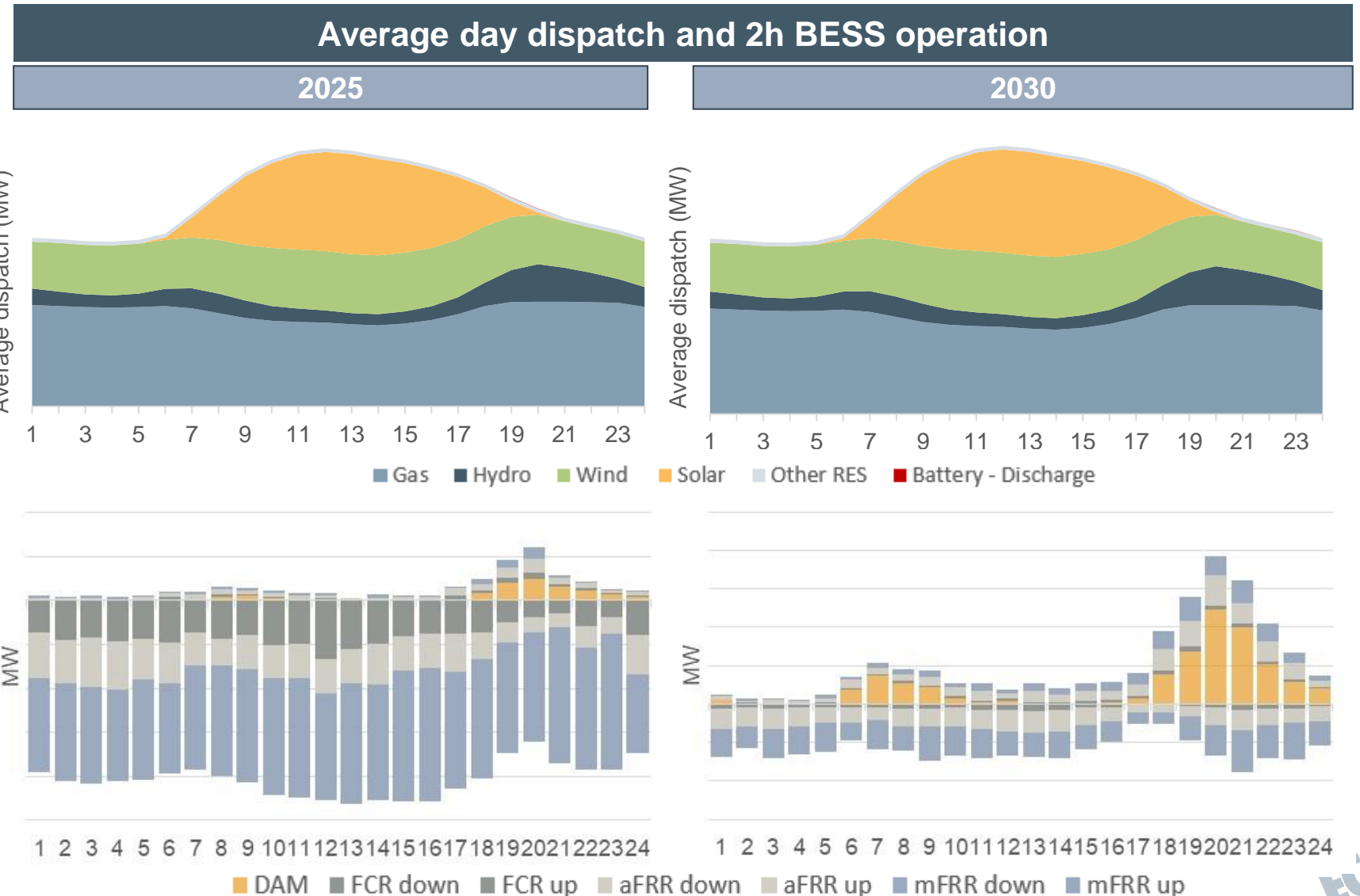


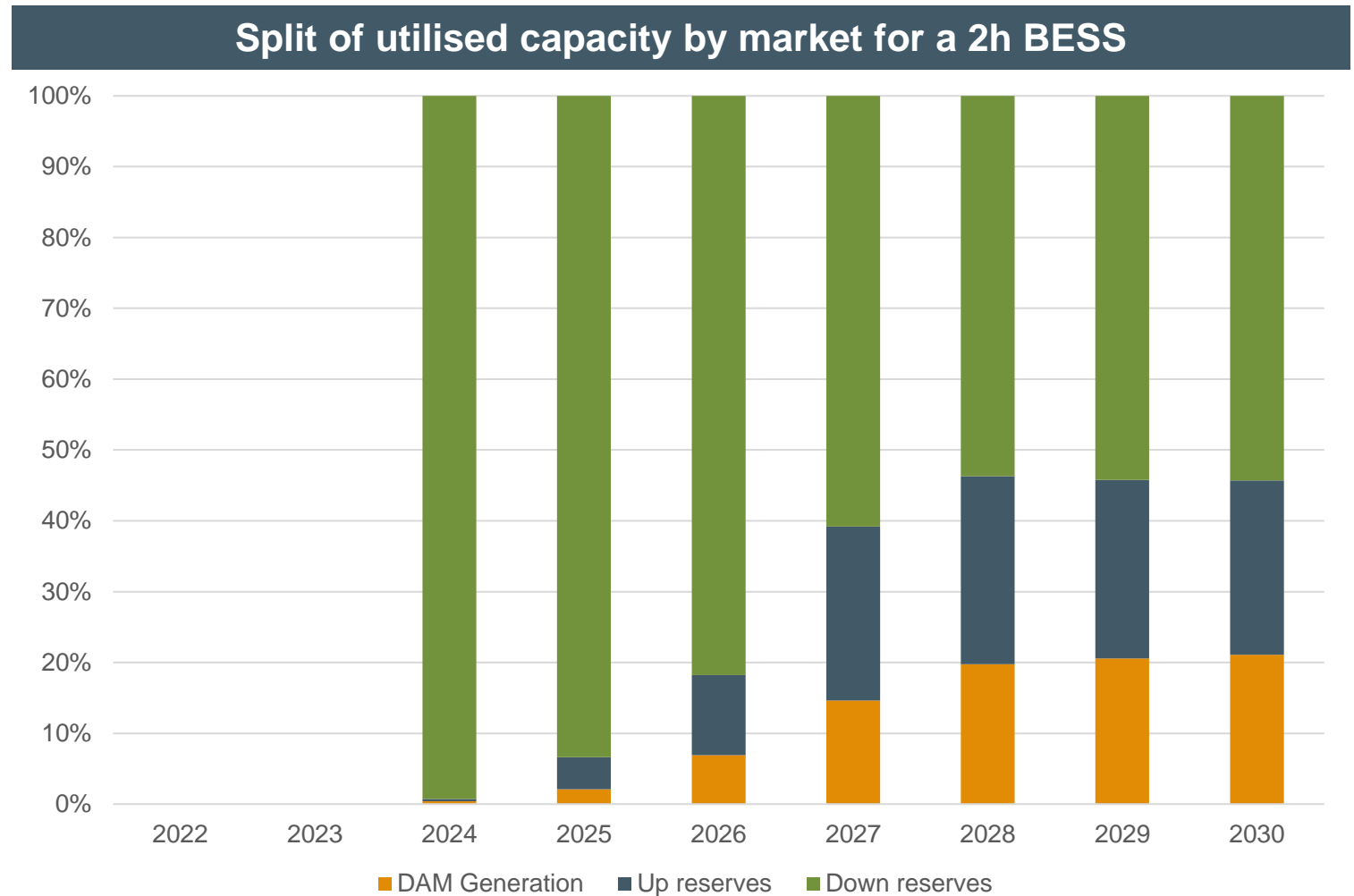
Illustration of results – operation of 2h BESS in 2025 and 2030 highlights the importance of reserve markets

- ▶ **Plexos** offers the capability to co-optimize energy and ancillary service provision.
- ▶ In 2025 most of BESS capacity is allocated for the provision of **down reserves** throughout the day.
- ▶ In 2030 most of BESS capacity is allocated for the provision of both **up and down reserves**.
- ▶ Most of the **up reserves** provision is concentrated early morning and, in the evening, when there is need for fast response to balance phasing out (or in) Solar PV generation.
- ▶ In the DAM, **BESS mainly charge during the daytime** and discharge in the evening



For BESS, the reserves market makes up the large majority of BESS utilisation and therefore defines the business case

- ▶ The majority (48%-100% depending on year and scenario) is selected to provide down reserves
- ▶ Low capacity utilised is selected for energy arbitrage in the DAM
- ▶ The utilisation of BESS in the DAM increases over time but remains low at close to 20%



Plexos as a flexible tool to accommodate the complexities of markets

Wider project BESS investment case conclusions		Plexos as a flexible tool
Revenue streams	<p>Using PLEXOS we were able to optimise the operation of BESS in the DAM, for AS provision and in the Balancing Market:</p> <ul style="list-style-type: none"> The modelling results revealed that energy arbitrage in the DAM was not enough to bring profitability for BESS projects. This constitutes the modelling of AS provision and the BM as extremely important to evaluate properly BESS projects. Capacity provision for Ancillary services was predominant for BESS - revenues from AS provision was the most important revenue stream for BESS under all scenarios. 	<ul style="list-style-type: none"> Using PLEXOS Software, we were able to model the complexities of the co-optimisation between day-ahead and reserve markets as well as the real time unit commitment of the balancing market. Worked together with EE staff to overcome modelling issues. Plexos as an intuitive and versatile tool in many markets ECA works in
BESS duration	<p>Within PLEXOS we modelled alternative duration types for BESS investments (1h, 2h and 4h). We evaluated the utilisation and profitability of alternative duration types for BESS to inform investment decisions.</p>	
Timing of investment	<p>We were also able provide insights regarding the optimum year (in terms of profitability) for the investments of BESS given that capital costs are forecast to decline.</p>	
CRM	<p>Using Plexos outputs we were able to determine required level of prices for CRM to make BESS projects profitable.</p>	

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