

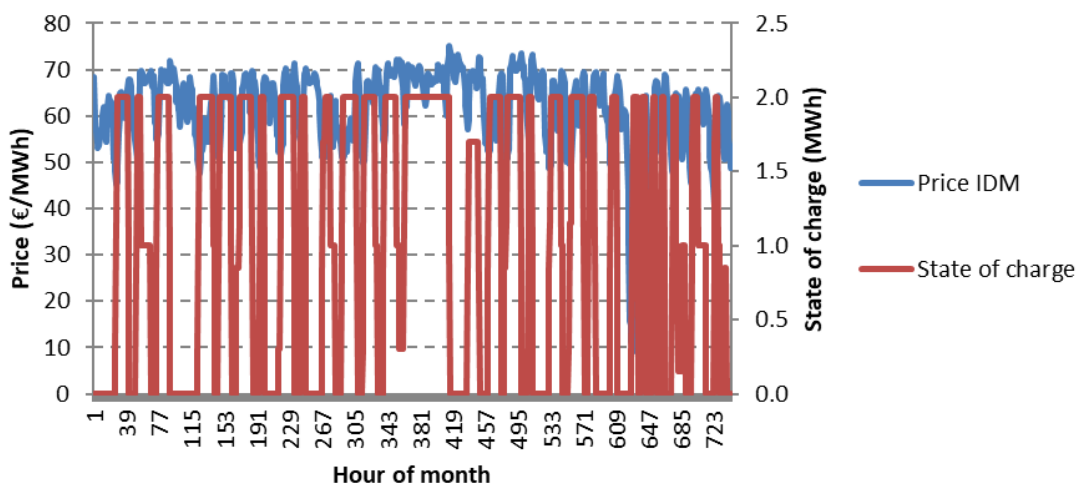


Food4Thought:

Continuing to demystify BESS (Battery Energy Storage Systems) – Part 2

On 17 November 2023, I published an article that assessed the arbitrage opportunities of four hypothetical 1MW batteries with 1, 2, 4 and 12-hours of storage, namely 1MWh, 2MWh, 4MWh, and 12MWh. The analysis assumed a cycling loss of 15% and applied a variable cost to reflect degradation of 1€/MWh whenever one charged or discharged the battery. There was no limit to the number of cycles. An optimisation model identified hourly charge and discharge cycles that maximised net income across the year using only the hourly Day-Ahead Market (“DAM”) prices in the Spanish electricity wholesale market operated by OMIE (Operador del Mercado Ibérico de Energía - Polo Español) for the period between 1 January 2018 to 31 October 2023. Since then, I have periodically updated the analysis in my “BESS Tracker”. However, I did wonder whether the BESS would do better if, instead of arbitraging in the DAM, the analysis was based on the potentially more volatile prices from the European continuous Intra-Day Market (“IDM”). The simple answer is no. The result of this analysis is explored in this article.

Figure 1: Hypothetical optimised operation of a 2-hour battery in January 2019 (IDM)

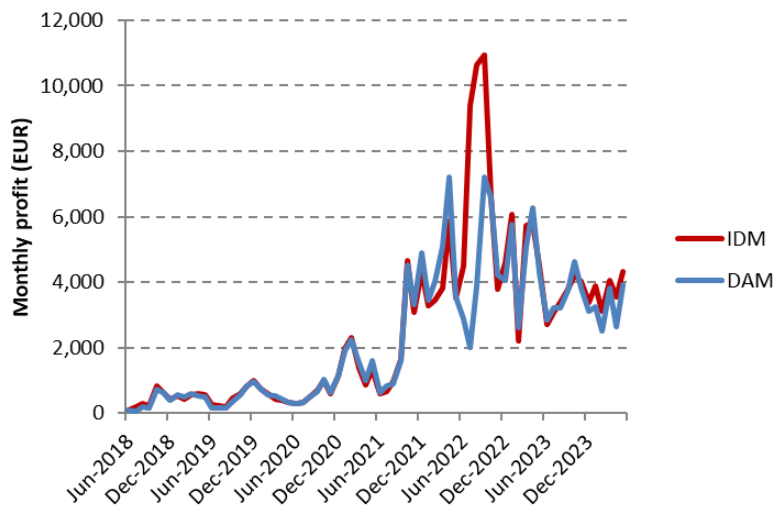


Source: REE ESIOs and K4K calcs.

Figure 1 above shows the state of charge and hourly prices for the first month of 2019 for the 2-hour battery option. For January 2019, the net income achieved from arbitrage would have been €518. The evolution of monthly net income since then is shown in Figure 2 below. For comparison, this also shows the arbitrage opportunity from DAM prices. There is an anomaly in July and August 2022 when IDM prices and

arbitrage margins were noticeably higher than in the DAM, a period that coincided with the implementation of the “Iberian Exception” introduced by the Spanish and Portuguese governments to limit the impact of gas-fired plant on Iberian spot market prices. During this period, the significant difference in DAM prices between Spain and France was used by some market participants to game the allocation of capacity on the France-Spain interconnection leading to the separation of DAM and IDM prices. A revision in the operating procedures by Red Eléctrica de España (“REE”), the system operator, resolved this imbalance. Outside this two-month window, arbitrage profits in DAM and IDM prove to be quite similar.

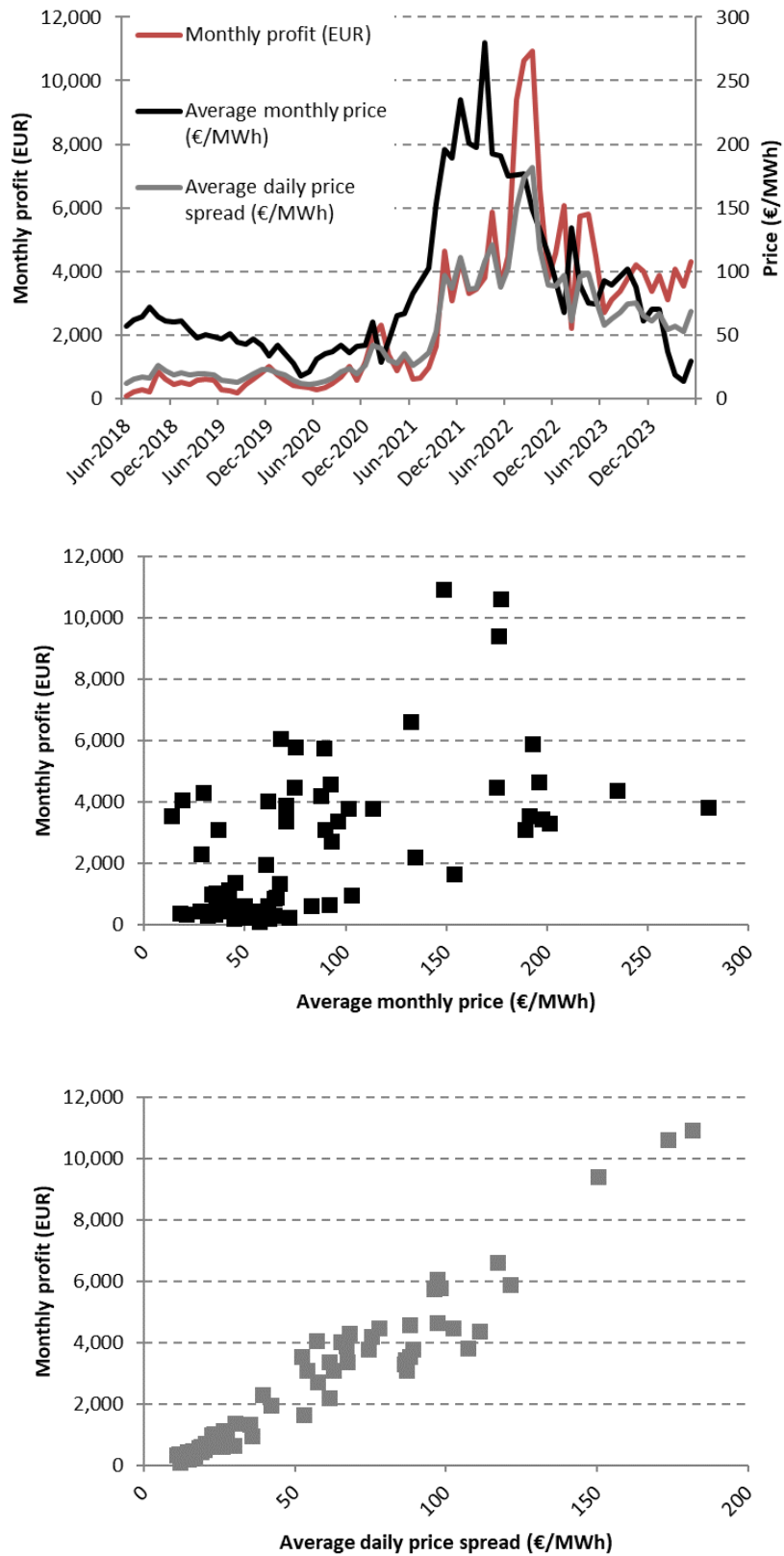
Figure 2: Monthly net income for hypothetical 2-hour battery



Source: OMIE, REE ESIOS and K4K calcs.

For both IDM and DAM, there is a noticeable change in results from mid-2021 which coincides with the rise in gas and electricity prices introduced by the growing tension with Russia. However, as shown in Figure 3 below, whilst higher prices certainly help, the evolution in net incomes is best explained by the increase in the daily difference between maximum and minimum hourly prices.

Figure 3: Main drivers of monthly net income for hypothetical 2-hour battery (IDM only)

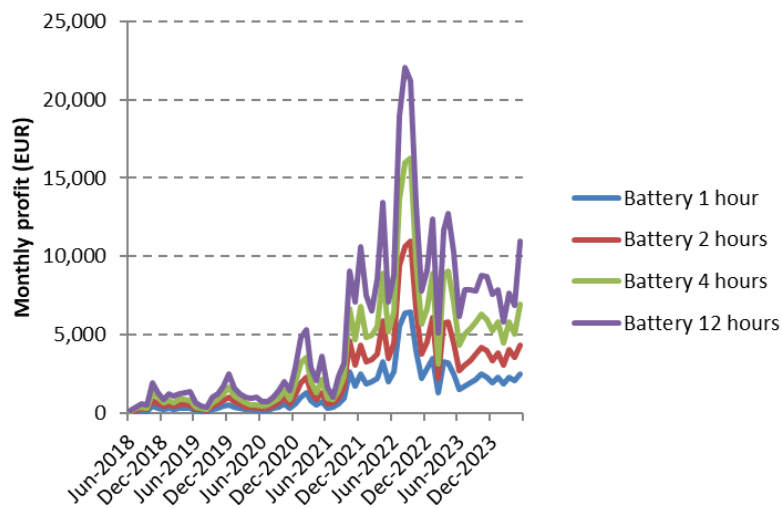


Source: REE ESIOS and K4K calcs.

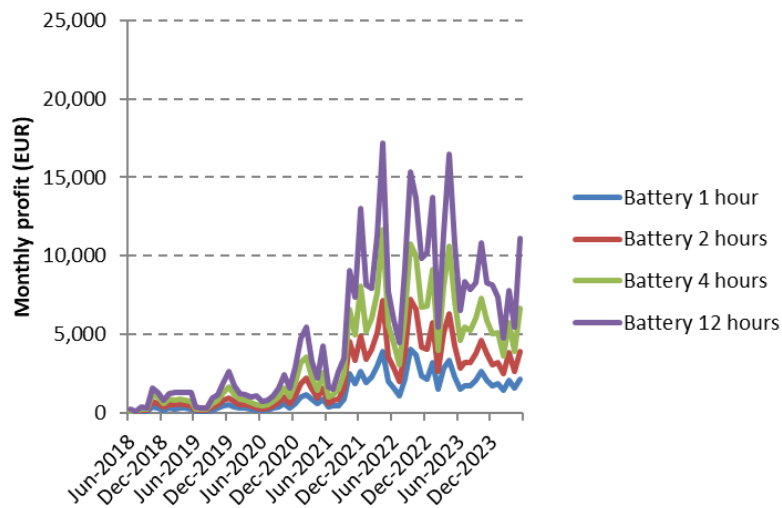
The same calculations can be done for the other battery configurations as shown in Figure 4. We also include the updated DAM results for comparison. In both cases, more storage capability results in higher net incomes. However, when we normalise using 2019 as the base year, whether we refer to the IDM or DAM results, the four indices are remarkably similar as shown in Figure 5 below. Currently the arbitrage opportunity in the IDM is worth more than seven times what it was in 2019, not dissimilar to that in the DAM. If one ignores the anomaly of higher arbitrage profits from the IDM in July and August 2022, arbitrage opportunities across both markets are very similar.

Figure 4: Monthly net income for batteries with different storage capabilities

IDM prices



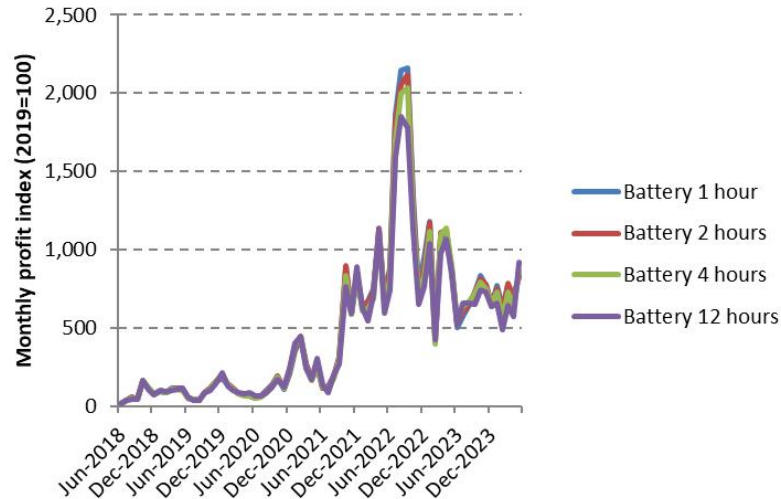
DAM prices



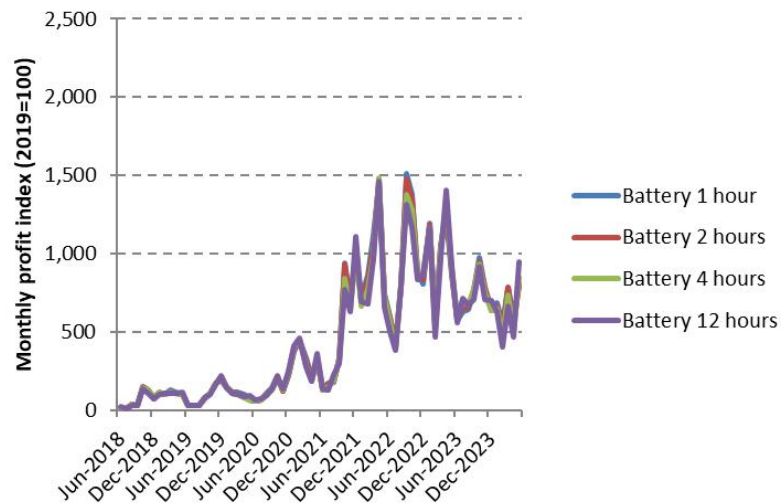
Source: OMIE, REE ESIOS and K₄K calcs.

Figure 5: Index of monthly net income (2019=100)

IDM prices



DAM prices

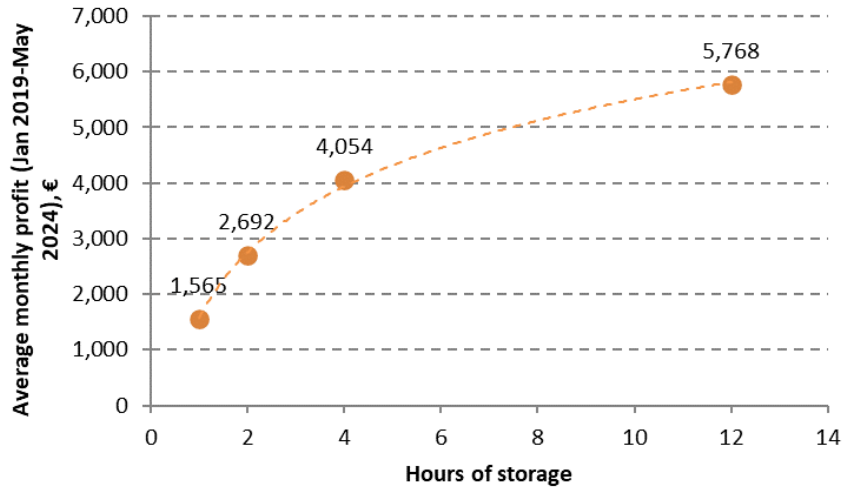


Source: OMIE, REE ESIOS and K₄K calcs.

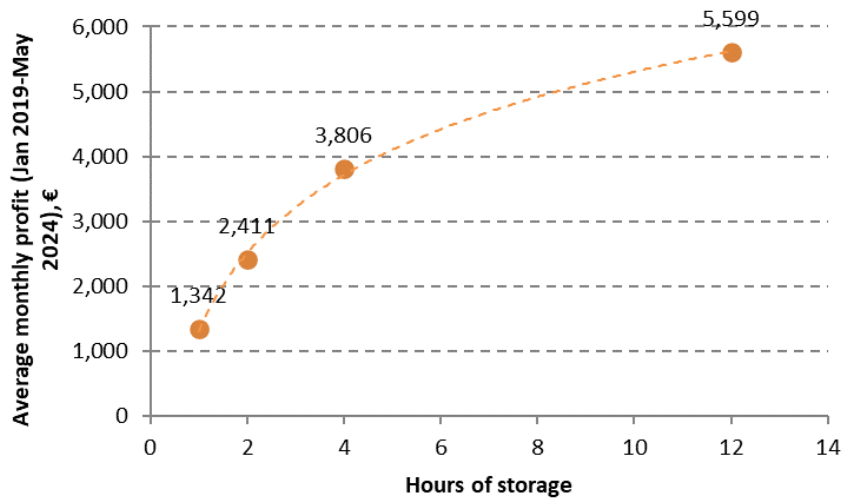
Finally, as was done in the November 2023 BESS article, we calculate the average monthly net income for each of the battery configuration for the period January 2019 to May 2024. This is shown in Figure 6 below for both IDM and DAM results. In both cases, whilst net income rises with storage capability, it suffers from diminishing returns. In other words, the increase in net income drops with every hour's worth of storage that is added. That said, IDM results are slightly better than DAM, an improvement of more than €200 per month. However, this is mainly due to the inclusion of better IDM results from July and August 2022.

Figure 6: Average monthly net income by battery configuration (Jan 2019-May 2024)

IDM prices



DAM prices



Source: OMIE, REE ESIOS and K₄K calcs.

In summary, with the exception of results in July and August 2022, the analysis shows that arbitrage opportunities in the IDM and DAM are quite similar. Of course the past is not a predictor of the future and more volatile prices resulting from, say, excess renewable generation can be expected to lead to wider intraday price spreads. And any “missing money” problem could also be overcome if batteries can layer additional income from ancillary services or future capacity market.

Mr. Kim Keats Martínez

Madrid, 28 June 2024.