



Power saving and infrastructure cost and sustainability

April 24, 2024



SMALLCELLS
WORLD SUMMIT



Circadian Background

Digitalization to Decarbonize and Decentralize Energy

Energy optimization, analytics, and virtual power platform enabled by edge computing & wireless sensors

End to end solution for Macro & Micro base stations



Pre-Commissioning

Commissioning

Post-Commissioning

Strategic planning to reduce CapEx

> Right-sized solar and storage designs for new sites based on load analysis

Reduce Time to Market

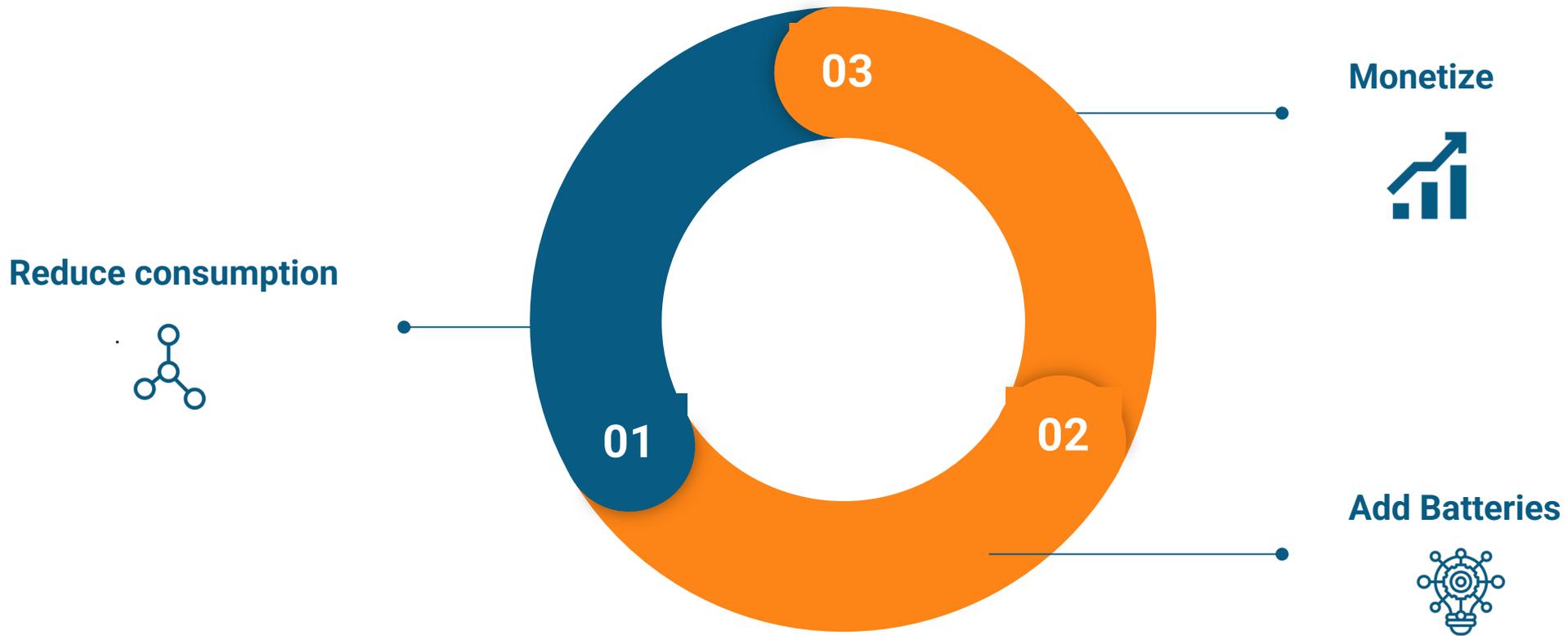
> Enable Interoperability on site

Reduce OpEx, Monetize

> Reduce consumption
> Enable TOU, Peak Shaving
> Aggregate to monetize
> Carbon reporting, RECs



Everything stems from
DES: Distributed Energy Storage



Digitalization drives energy efficiency



1. Traffic Load Monitoring:

- Continuously monitor the traffic load and user demand within the small cell.
- Calculate the average traffic load $L(t)$ over a specific time interval.

2. Determine Power Adjustment Factor:

- Define a threshold T that represents the minimum traffic load below which power savings measures are activated.
- Calculate power adjustment factor $P_{adj}(t)$ based on the traffic load:

$$P_{adj}(t) = \begin{cases} 0.5 & \text{if } L(t) < T \\ 1 & \text{otherwise} \end{cases}$$

- Here, $P_{adj}(t)$ reduces the transmit power by 50% during low traffic periods.

3. Adjust Transmit Power:

- Adjust the transmit power of the small cell based on $P_{adj}(t)$:

$$P_{transmit}(t) = P_{normal} \times P_{adj}(t)$$

- Where P_{normal} is the normal operating transmit power of the small cell.

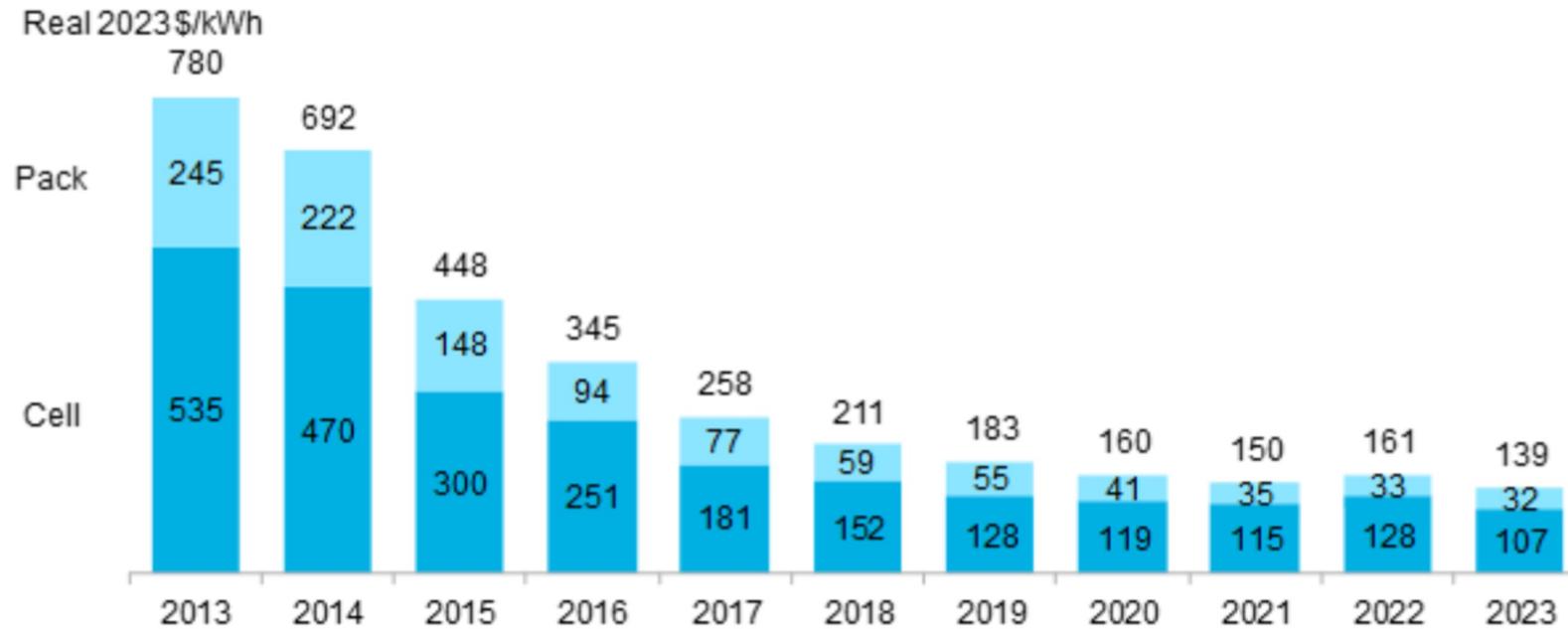
4. Energy Consumption Calculation:

- Calculate the energy consumption during both peak and off-peak hours:

$$E(t) = P_{transmit}(t) \times \text{Operating Hours}$$

Energy storage pricing approaching \$100/kWh

Volume-weighted avg Li-Ion battery pack and cell price split, 2013-2023



BloombergNEF



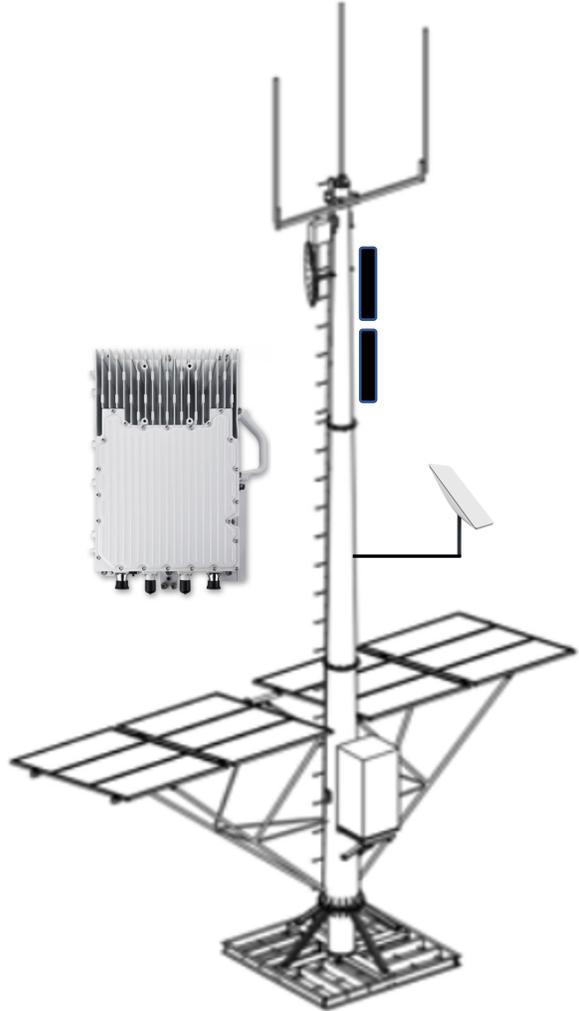
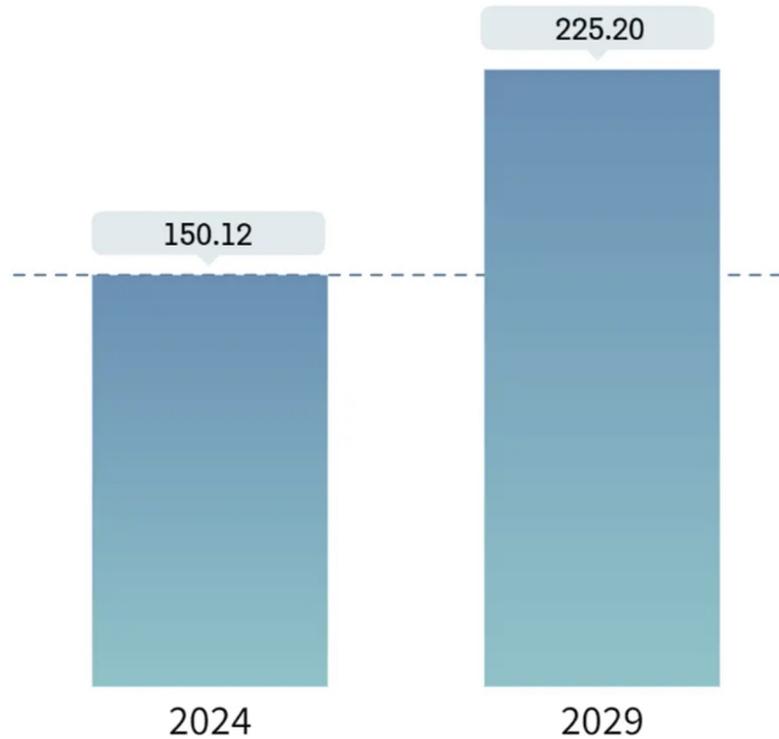
Not just Europe

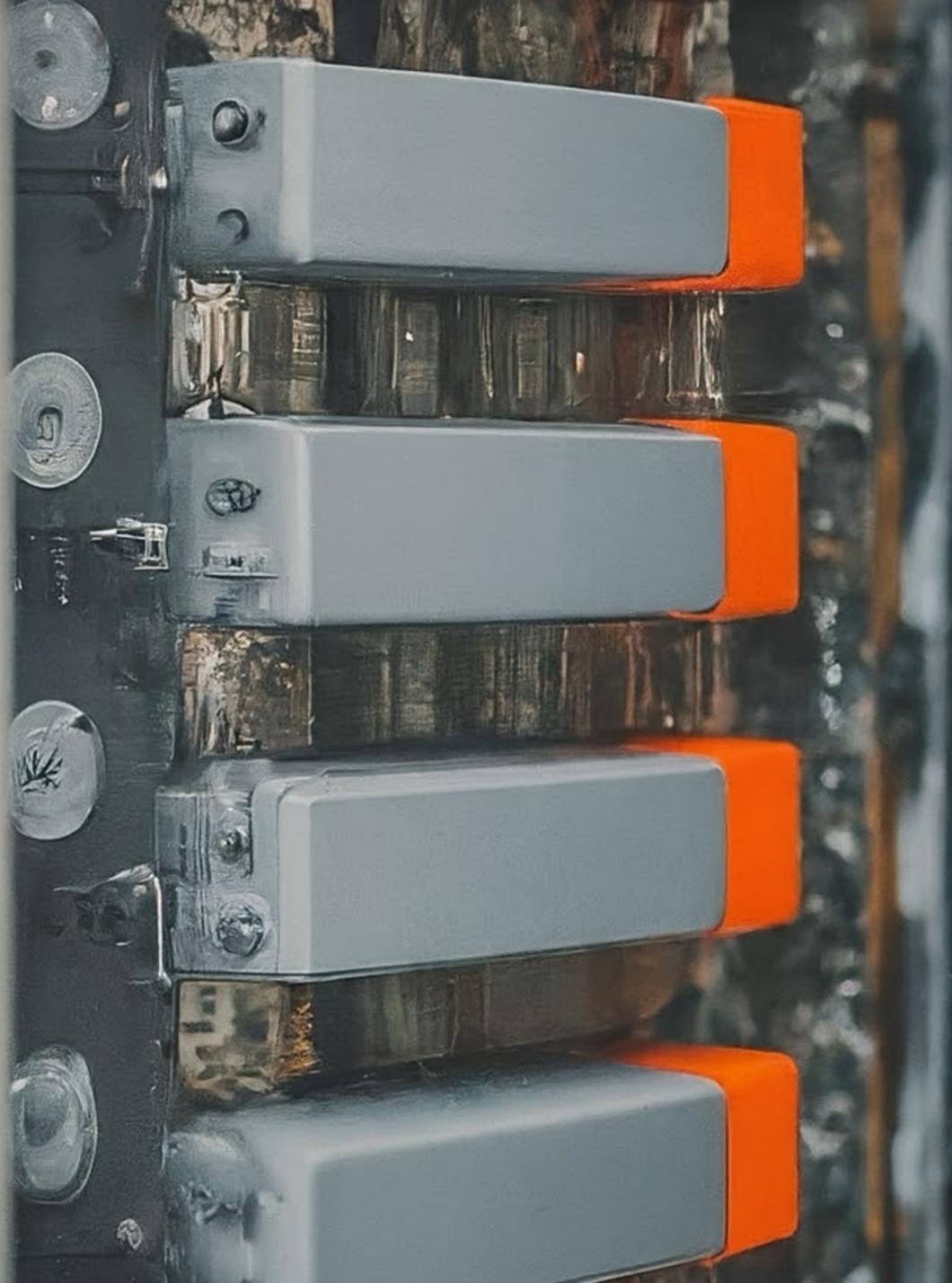
Energy storage for resilience in emerging markets

Africa Small Cell Market

Installed Base in Thousand RUs

CAGR 8.45%





Digitalization Value Chain

Electric energy market

- TOU arbitrage
- Spot: day-ahead, day, and real-time trading
- Medium- and long-term: annual and monthly trading

Ancillary power service market

- Peak shaving market
- Frequency regulation

Capacity market

- Capacity

Smart Management System



Example figures

6kWh, 12hr backup

Small Base Station: 500W Consumption

\$700 CapEx

\$120/kWh x 6kWh

\$438/yr Arbitrage

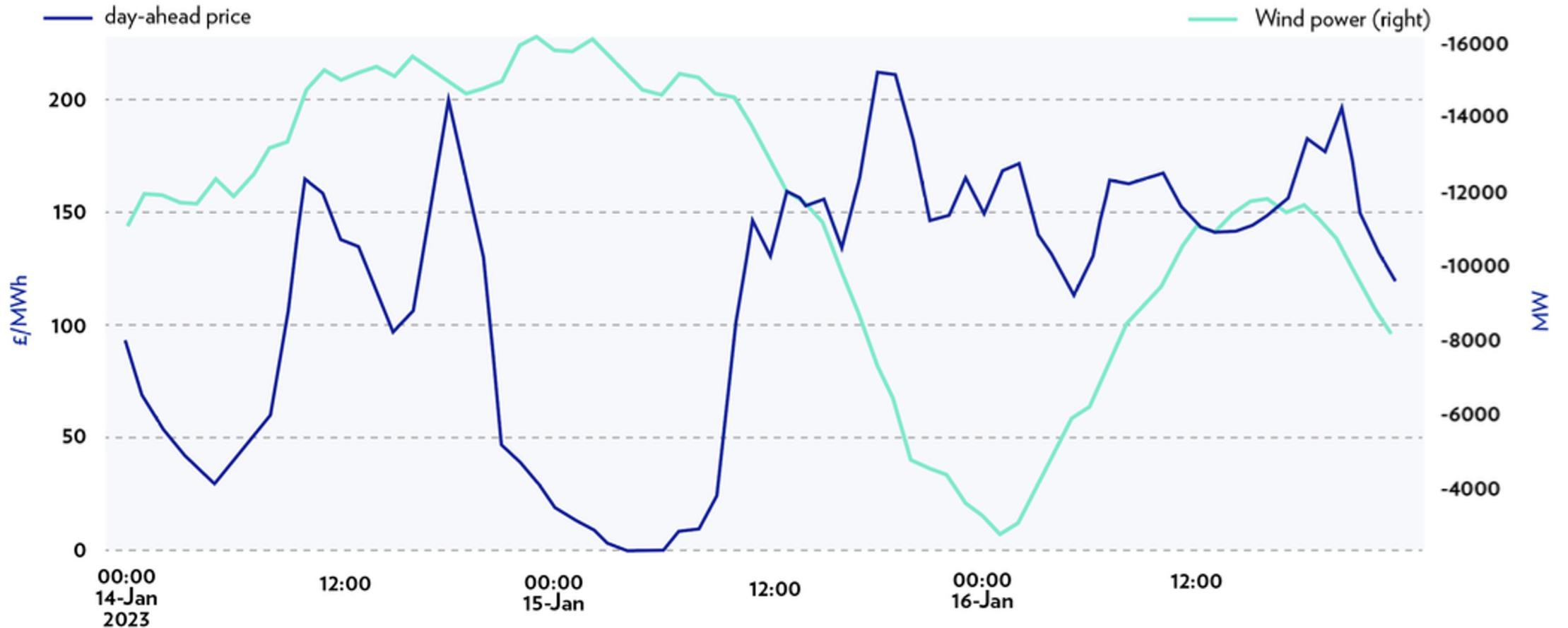
\$0.15 kWh peak shaving & TOU

44% IRR

Annualized over 10 yrs

Arbitrage reduces OPEX
TOU: Time of Use

UK wholesale (day-ahead) prices (£/MWh) and wind power production (MW) in January 2023

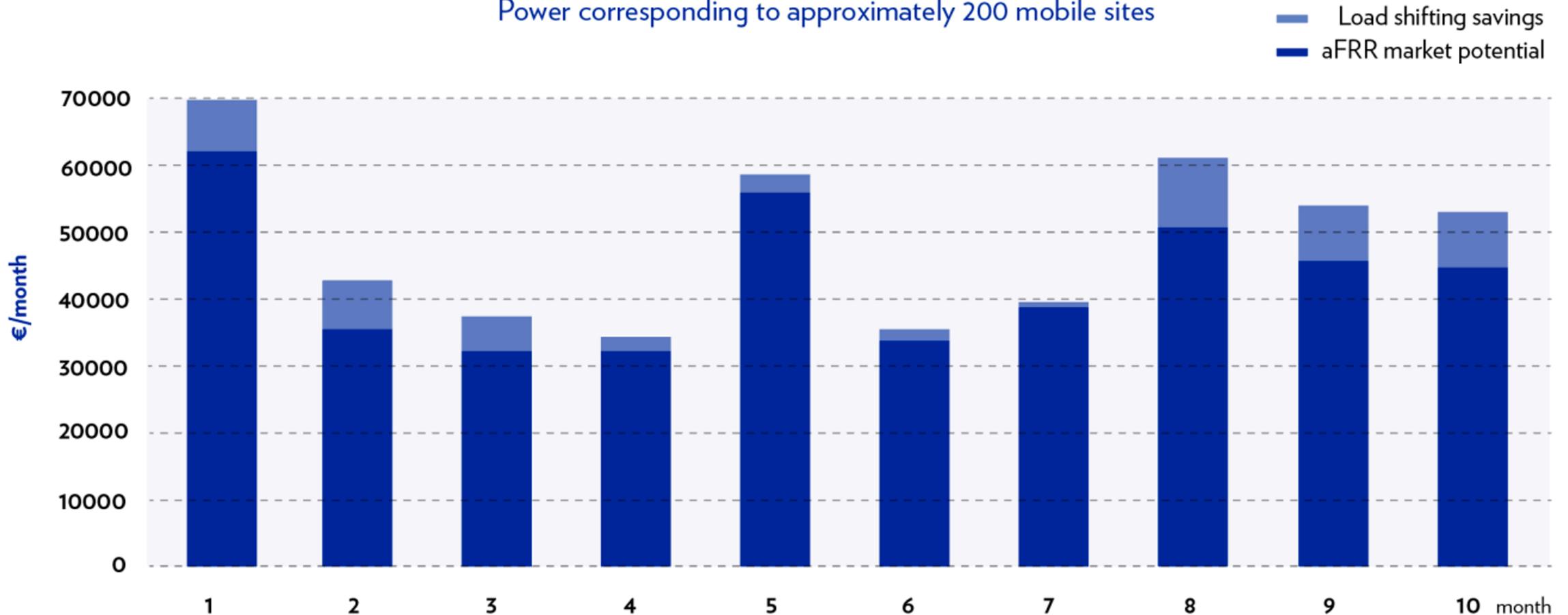


Macro tower reserve market participation
aFFR: automatic frequency restoration services



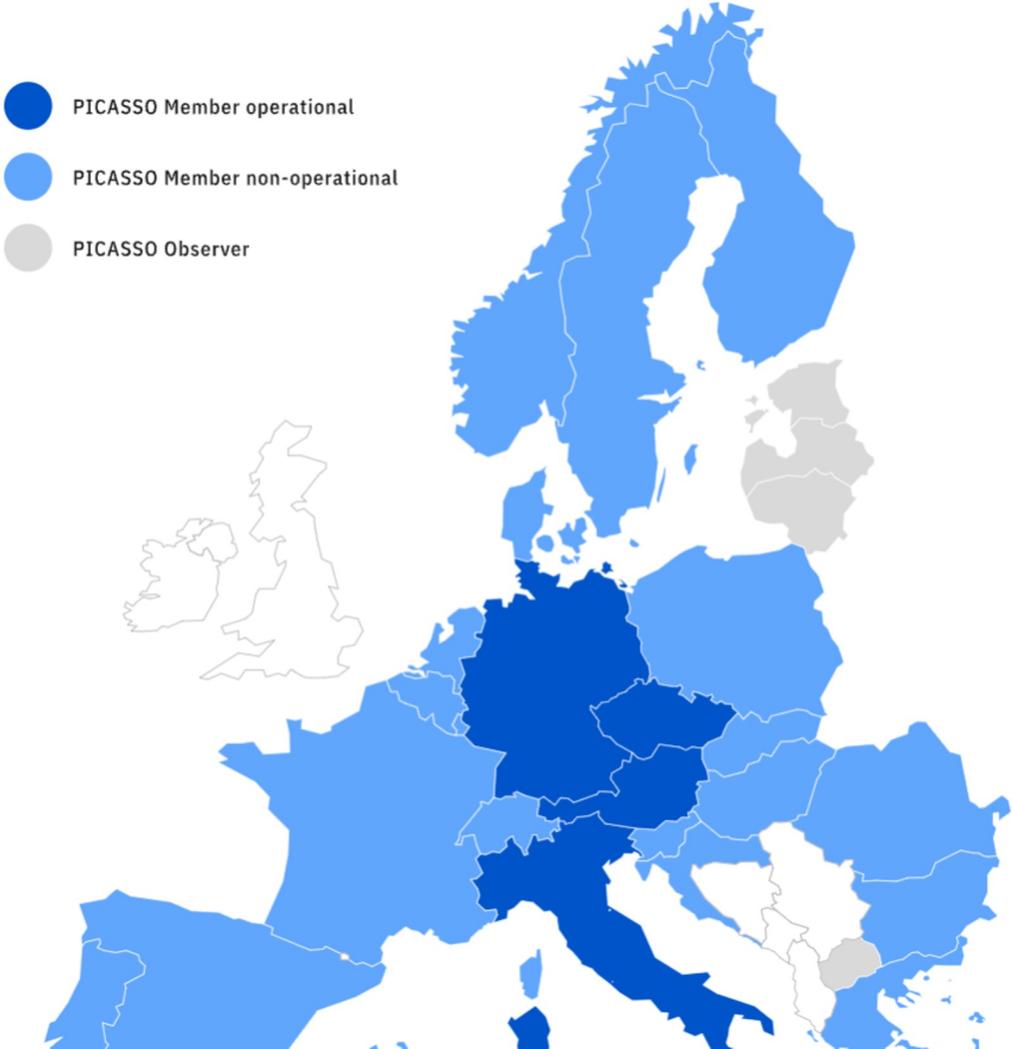
DISTRIBUTED
ENERGY
STORAGE

Monthly revenue potential with 1MW, Finland, 2023
Power corresponding to approximately 200 mobile sites



Enabling negative cost of electricity with Virtual Power Platforms (VPP)

PICASSO



The Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation (PICASSO) is the implementation project endorsed by all TSOs through the ENTSO-E Market Committee to establish the European platform for the exchange of balancing energy from frequency restoration reserves with automatic activation or aFRR-Platform, pursuant to Article 21 of the Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing (EB GL).

Carbon Credits, RECs No longer the wild west



Questions?

Mike Rosenberg | mike@circadian.io

