

AFRY's view on battery storage business cases

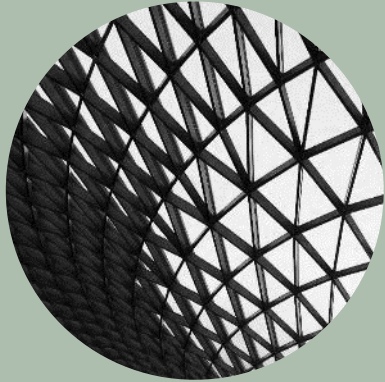
Get inspired!

VIENNA, 08TH NOVEMBER 2022



AFRY AT A GLANCE

AFRY is a global engineering, design, and consulting company based in SWE



ENGINEERING



DESIGN



DIGITALISATION



ADVISORY SERVICES

Locally present in **50+ countries**

Projects in **100+ countries**

Revenue **~2 bn EUR in 2021**

Experts **17,000**

- S** – **Infrastructure**
E – **Energy**
C – **Bioindustry**
T – **Process Industry**
O – **Food and Life Science**
R – **Automotive**
S

AFRY has supported clients in all types of battery storage projects and markets in recent times

Due Diligences

- Commercial
- Technical
- ESG
- Regulatory

Business plans and investment decision support

- Stand-alone systems
- Co-location systems
- Electric vehicle business

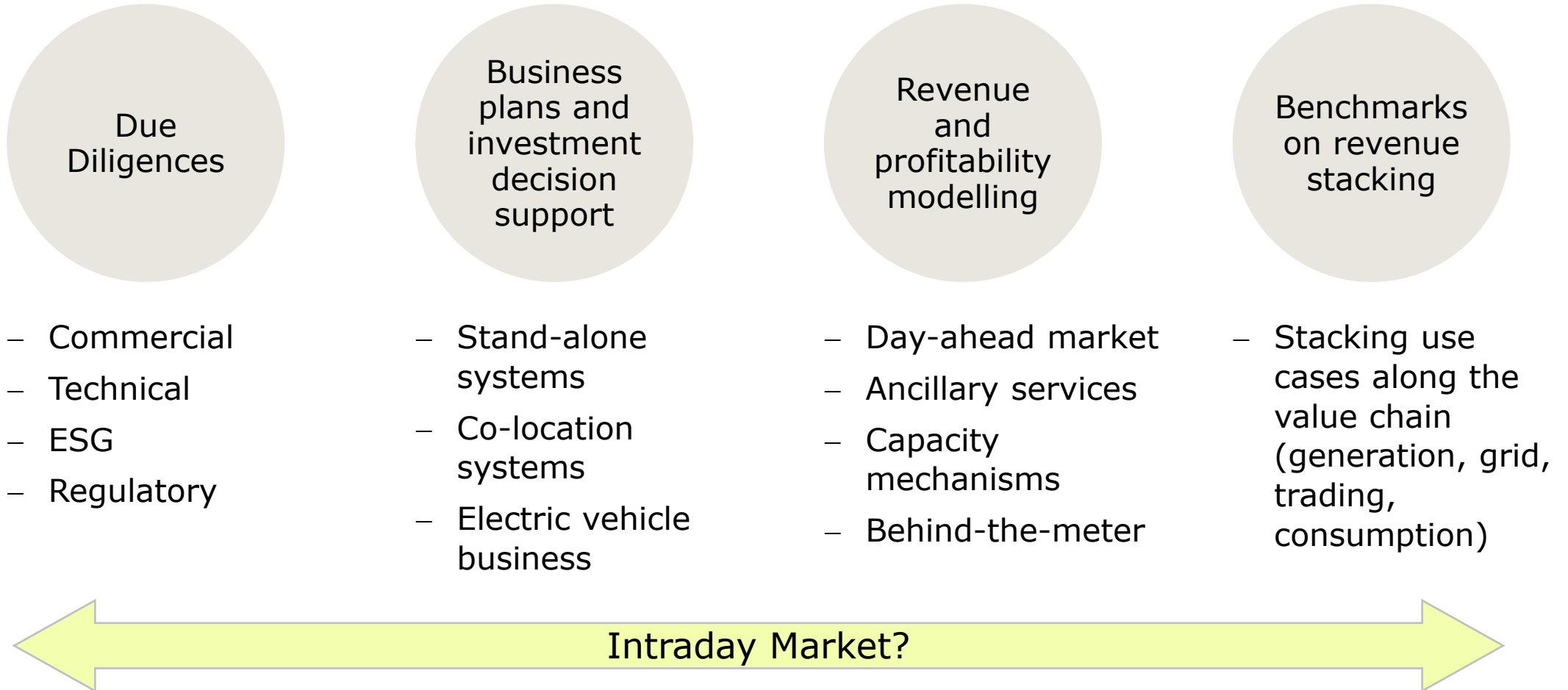
Revenue and profitability modelling

- Day-ahead market
- Ancillary services
- Capacity mechanisms
- Behind-the-meter

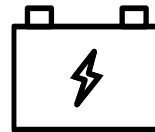
Benchmarks on revenue stacking

- Stacking use cases along the value chain (generation, grid, trading, consumption)

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There are a number of key items to focus on in order to make storage investments fully profitable

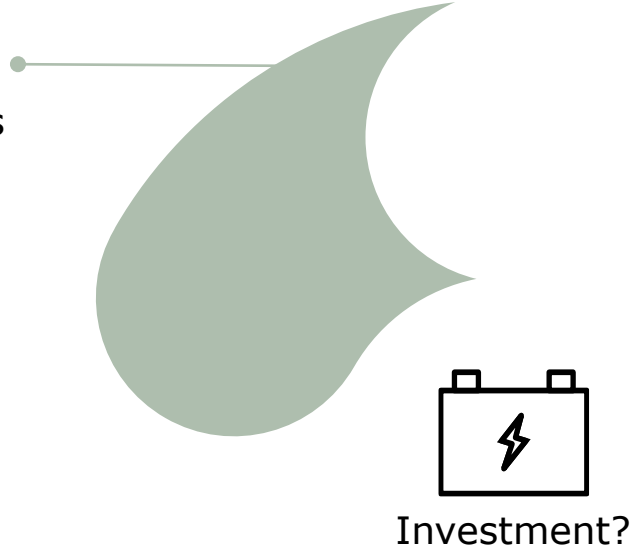


Investment?

There are a number of key items to focus on in order to make storage investments fully profitable

WHICH SIZE?

Trade-off between costs and revenues, optimisation versus use case flexibility



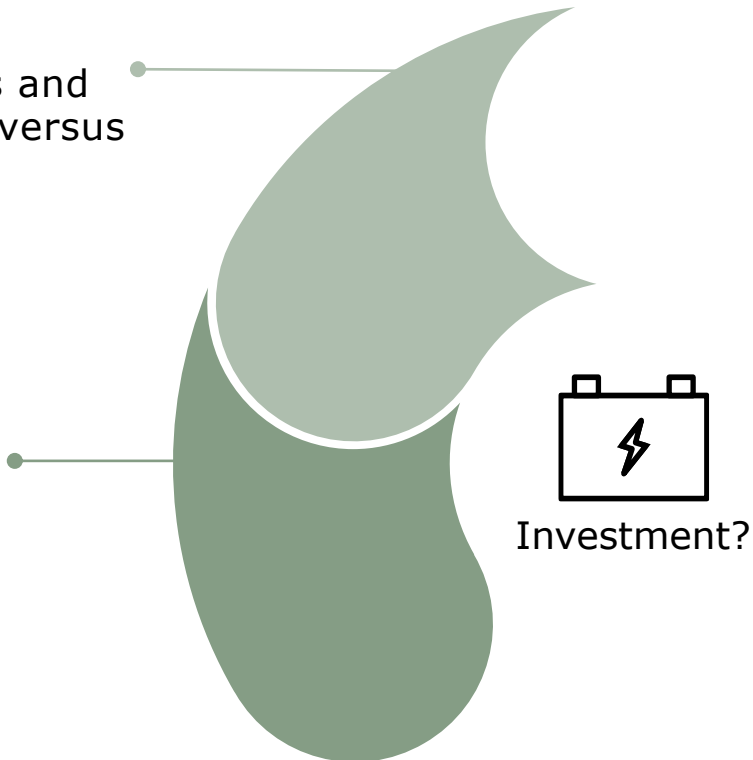
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Technology readiness (lithium-ion, flow batteries, sodium-sulphur, lead-acid, etc.)



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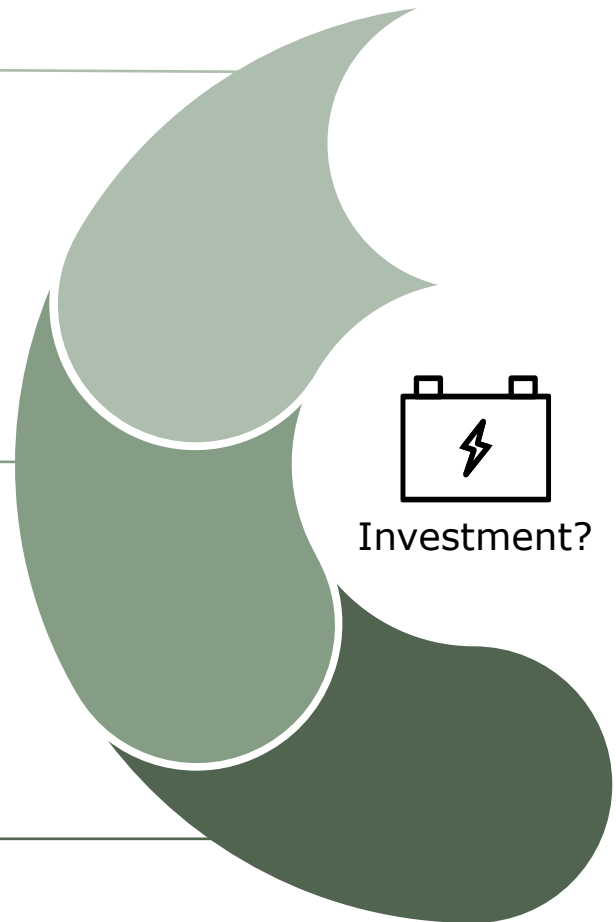
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Locational characteristics, available space, co-location



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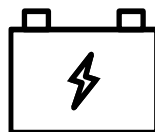
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Investment?

WHEN?

Competitive landscape, regulatory situation and outlook, profitability

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WHICH FORM OF SUPPORT?

Capacity markets, regulatory changes, contract conditions and derating factors

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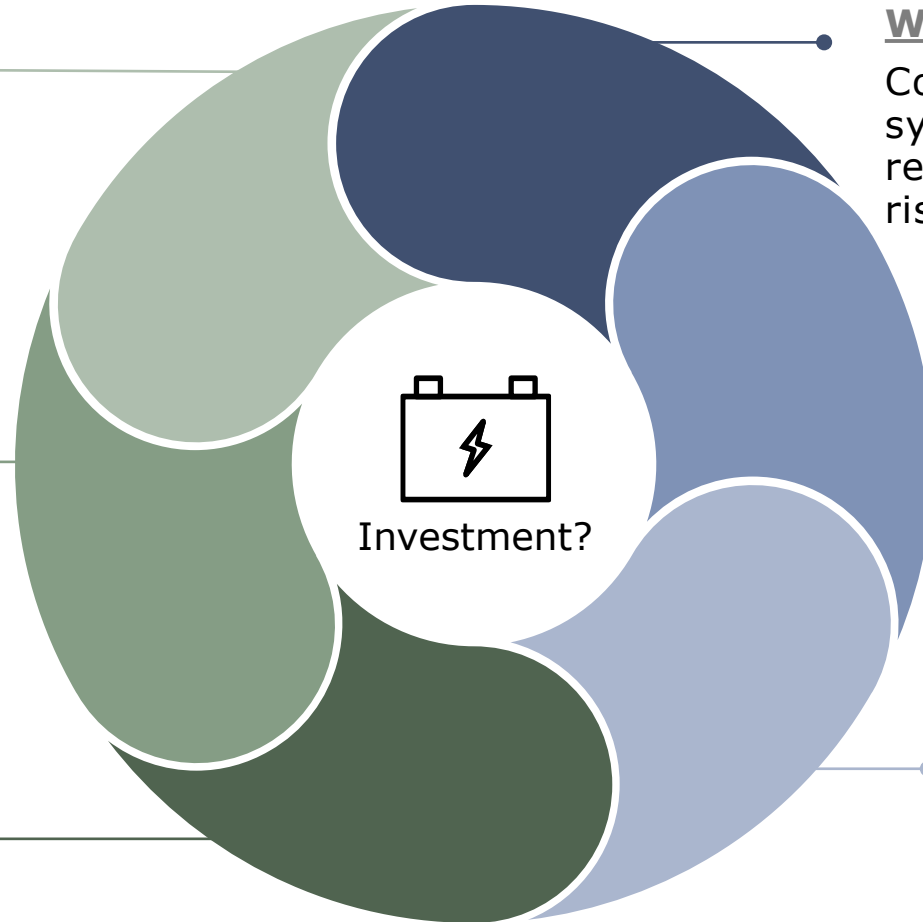
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WHICH TECHNOLOGY?

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WHICH BUSINESS MODEL?

Co-location with RES, infrastructure synergies, imbalance cost reduction, curtailment reduction, risk of conflicting incentives

WHICH FORM OF SUPPORT?

Capacity markets, regulatory changes, contract conditions and derating factors

WHEN?

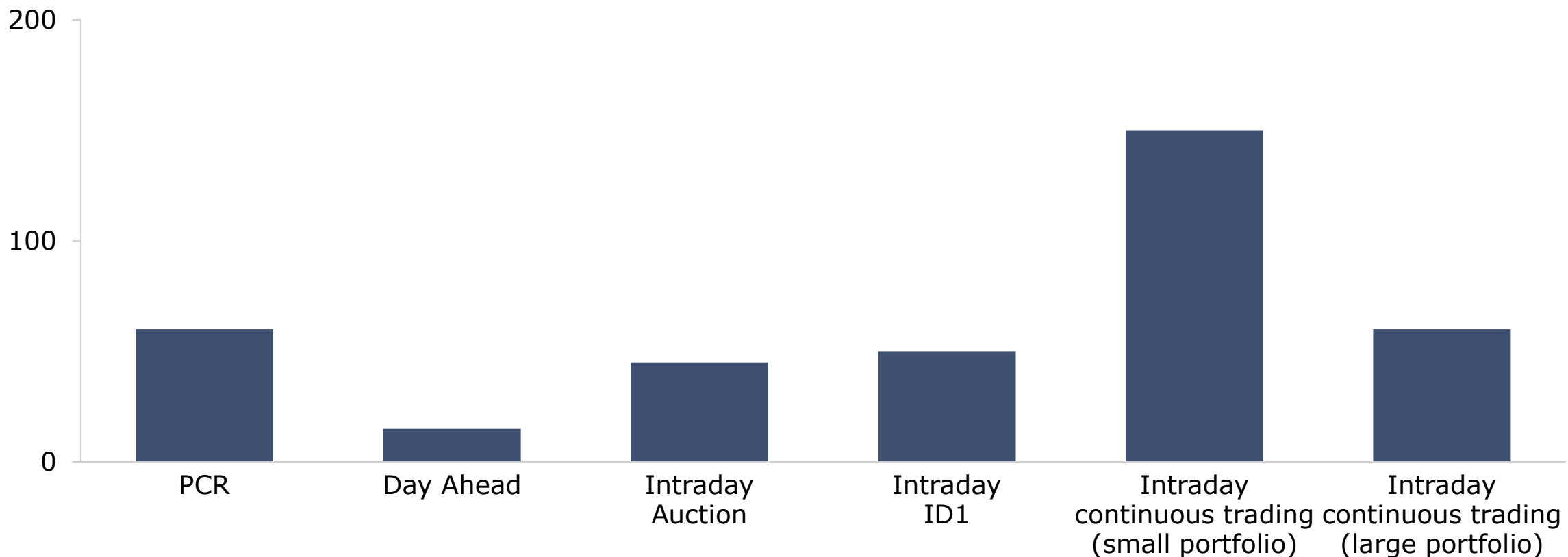
Competitive landscape, regulatory situation and outlook, profitability



We assessed value creation potential for battery electricity storage systems in Germany and concluded that intraday trading is the most attractive

ANNUAL GROSS MARGIN FOR BATTERY TRADING
(NET FROM TAXES, LEVIES, AND TRADING FEES)

kEUR / MW

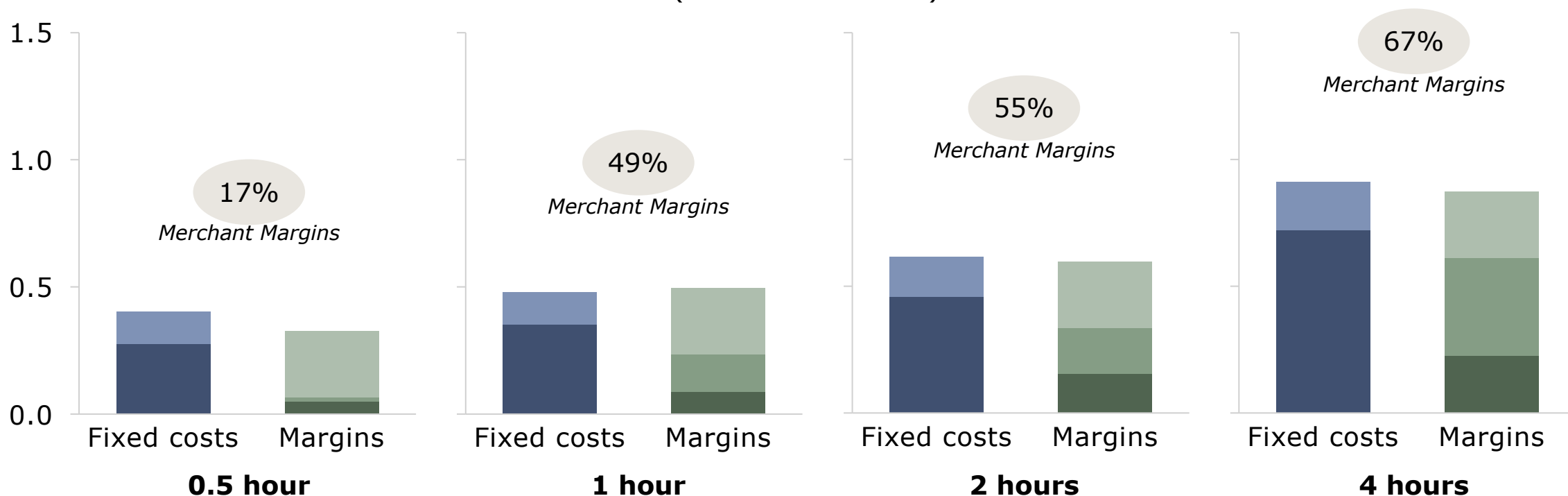




For Italy we compared different types of batteries for fast reserve unit payments, concluding that 4h batteries are the closest to market parity

NPV OF DIFFERENT BATTERY TYPES IN ITALY NORTH ZONE (REAL 2018 MONEY)

kEUR / MW



Capex Opex DA AS FRU xx% weight of merchant margins (DA+AS) on total costs

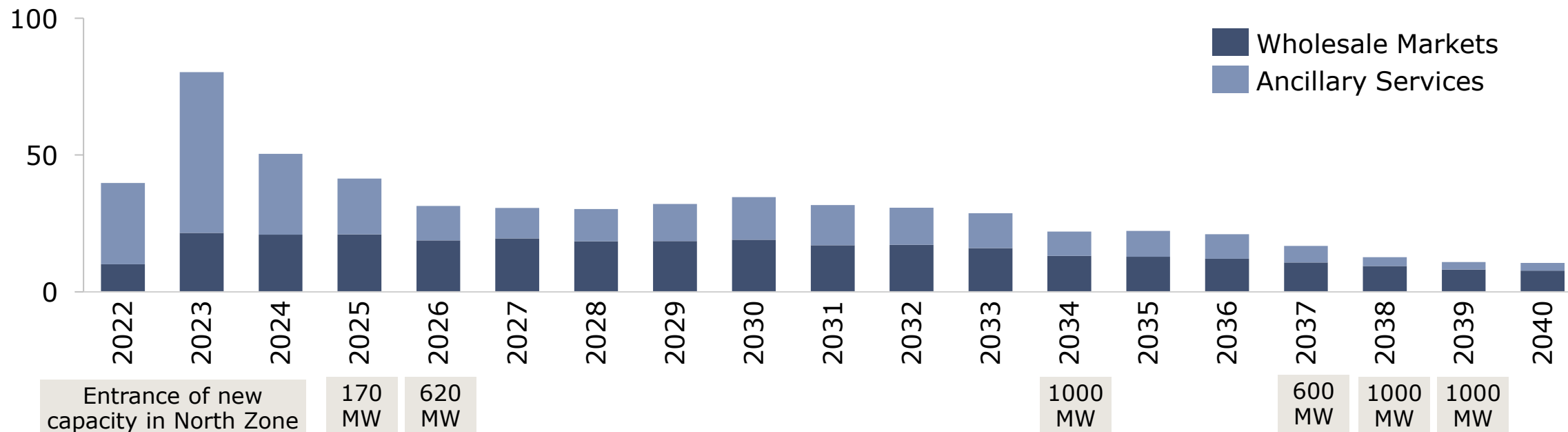
Note: the NPV has been calculated assuming an annual discount rate of 8% and batteries operating in the North zone



Batteries are highly subjected to intra-technology competition and revenue cannibalization will happen quickly

WHOLESALE MARKET AND ANCILLARY SERVICE MARGINS (2H BATTERIES IN ITALY NORTH AREA)

kEUR / MW



Margins show major fluctuations in Ancillary Services Markets:

- "First-mover" benefit at the beginning of lifetime
- Margin reduction due to capacity degradation and new-entrant competitors

Average number of total equivalent cycles per year is approximately 400 considering both Wholesale Markets and Ancillary Services Markets

What if we combine the strength of both – enspired and AFRY?

INTRADAY OPTIMISATION



DAY-AHEAD PRICE PROJECTIONS



What if we...

 Service idea:

Your feedback
is much
appreciated

Intraday Storage Business Case Modelling

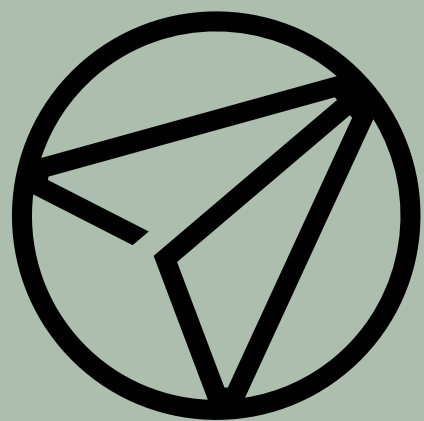
Get inspired, get connected!

My personal LinkedIn
[/thomas-steinberger-83181119b](https://www.linkedin.com/in/thomas-steinberger-83181119b)



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Co-location can be beneficial in particular in terms of infrastructural synergies, but also barriers are in place



SYNERGIES

1 **INFRASTRUCTURAL SYNERGIES**

Already existing infrastructures like connection can be exploited, implying a reduction in Capex

2 **IMBALANCE REDUCTION**

The presence of a battery may partially mitigate the imbalance costs of a wind/solar farm

3 **CURTAILMENT REDUCTION**

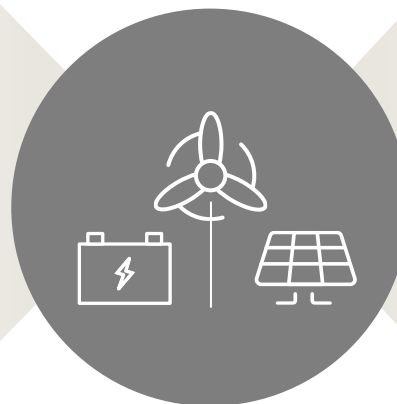
A battery could be useful to recover curtailed energy of the farm. However, the impact of curtailment could be already mitigated by the opening of the ancillary services market to renewable sources



BARRIERS

CONFLICTING INCENTIVES


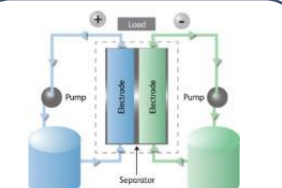


Risk of potential conflict with some incentive schemes for renewables according to current regulation

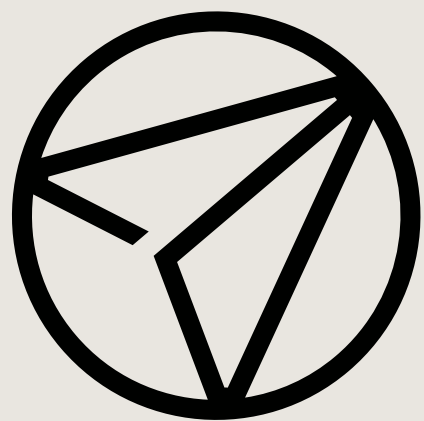


BATTERY CO-LOCATION WITH RES



The most suited technology is to be selected based on the chosen business model, as many technologies each with their own pros and cons exist

<ul style="list-style-type: none"> - High energy & power density - Versatile technology - Fast response <p>Key Features</p> <ul style="list-style-type: none"> - Mature <p>Maturity</p> <ul style="list-style-type: none"> - Electric vehicles, electronics - Utility-scale and consumer-side <p>Application</p>	<p>Lithium-Ion</p> 	<p>Flow Batteries</p>  <p>Key Features</p> <ul style="list-style-type: none"> - Liquid electrolyte stored in tanks and pumped through cell - Low-cost storage capacity <p>Maturity</p> <ul style="list-style-type: none"> - Moderately mature <p>Application</p> <ul style="list-style-type: none"> - Large-scale storage - Load shifting
<ul style="list-style-type: none"> - Operates at high temperature - Warm-up time - Large-scale applications <p>Key Features</p> <ul style="list-style-type: none"> - Moderately mature <p>Maturity</p> <ul style="list-style-type: none"> - Renewables smoothing - Large-scale peak shaving - Large-scale load shifting <p>Application</p>	<p>Sodium-Sulphur</p> 	<p>Lead-Acid</p>  <p>Key Features</p> <ul style="list-style-type: none"> - Low cost - Low energy density - High cycling degradation <p>Maturity</p> <ul style="list-style-type: none"> - Mature <p>Application</p> <ul style="list-style-type: none"> - Stationary standby - Motive power (e.g., forklifts) - High energy, low cycling applications



AFRY

ÅF PÖYRY