



Large-scale Stationary Energy Storage

Roadmap report

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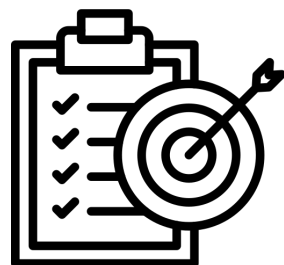
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Introduction

Introduction and objectives of the Roadmap report

This report was developed as part of a broader initiative to identify and capitalize on market opportunities within the **Large-scale Stationary Energy Storage** sector. The report serves as a guide that maps out the market potential, challenges, and strategic actions necessary for the successful scaling of businesses in this sector.



The primary goal of the Large-scale Stationary Energy Storage Roadmap Report is to equip companies and stakeholders within the energy industry with the knowledge and tools needed to navigate the transition **towards more efficient, sustainable, and competitive market positions**.



Main function of the report is to highlight opportunities that the participating startups may have not recognised. It provides a structured approach to understanding market dynamics, customer needs, and emerging trends, thereby helping businesses position themselves effectively in the evolving marketplace.

Overview of the Participants

Ventures

Following the evaluations by the selection panel, 10 of the most promising European ventures in Large-scale Stationary Energy Storage were chosen through a competitive process. Companies were selected based on leadership potential, product/technology strength, market opportunity, go-to-market strategy, and business clarity.



Geyser Batteries offers sustainable high-power heavy-duty energy storage solutions based on novel proprietary water-based electrolyte and unique engineering and manufacturing know-how.



FuseBox Energy provides energy companies with their Virtual Power Plant (VPP) and advanced Energy Management Software (EMS) solutions, giving their customers a competitive edge in energy management.



Electriq is a hydrogen carrier that acts like coffee powder for a coffee machine - simplifying storage, transport, and use of hydrogen in off-grid applications and long-term storage.



KiteRise Technologies, based in Graz, Austria, specializes in advanced engineering and battery development, particularly in sodium-ion technology.



PowerUP revolutionises clean energy solutions with their smart electric generators, powered by hydrogen fuel cell technology. Reliable backup power with zero emissions, contributing to a greener, more resilient future.



STOFF2 develops and builds electrolyzers for the production of green hydrogen. In this way, they combine hydrogen production and energy storage function in one system, and thus offer the perfect solution for the efficient grid-serving use of renewable energies.



Floating Power Plant develops hybrid platforms that combine wind and wave energy to provide reliable renewable energy offshore.



Haliogen Power specializes in developing a membraneless flow battery for long-term energy storage.



Silbat develops disruptive electricity storage technology that can turn intermittent renewable energies into fully dispatchable electricity sources.



Initiation Energy is creating the next generation of technologies to decarbonise battery production and make it accessible to all levels of industry.

Market opportunity Stakeholders

European
Innovation
Council



Funded by
the European Union

Investors



www.d2xcel.eu

Lead Customers



Market opportunity Stakeholders

European
Innovation
Council



Funded by
the European Union

Network partners



Market opportunity Mentors

European
Innovation
Council



Funded by
the European Union



Prof. Dr. Jens Bockstette
HSD University



Christophe Bodin
CBO Consulting



Lars Boehnisch
Evonik Venture Capital



Michael French
Independent Energy Advisor



Tobias Grün
BRYCK



Dr. Christian Stumpf
TenneT PowerLab



Dietrich Sümmermann
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Methodology

We state here some of the underlying assumptions and 'facts' about the Large-scale Stationary Energy Storage industry that serve as the basis and context of this analysis.

- Energy storage market in Europe is on the rise as the need for effective solutions to manage unpredictability of renewable energy sources grows. Based on the market data as well as the insights collected for this roadmap both the storage capacity and the overall market value will see considerable increases by 2030 and beyond.
- The large-scale stationary energy storage sector is rapidly evolving, driven by decentralization, technical advancements, and significant investments, aiming to enhance flexibility and cost reduction.
- The comprehensive review shows that, from the electrochemical storage category, the lithium-ion battery fits both low and medium-size applications with high power and energy density requirements.
- Energy Storage regulations may vary between countries, but nevertheless the industry could be considered quite regulated. Regulations often focus on ensuring the safe installation, operation, and maintenance of energy storage systems to protect both people and properties.
- According to the European Association for Storage of Energy (EASE), energy storage capacity in Europe is expected to reach approximately 200 GW by 2030 and 600 GW by 2050.

Methodology

- 6 in-depth interviews were conducted with industry stakeholders to extract expert opinions across the following categories:

1. *Market trends and impact*
2. *Competitive advantage and uniqueness (value proposition)*
3. *Customer segments and relevance*
4. *Channels and delivery*
5. *Revenue streams and financial viability*
6. *Risks and challenges*
7. *Competition*

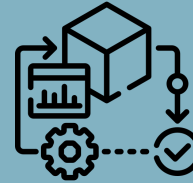
- Surveys: Collected 12 survey responses to validate and quantify the insights gathered from interviews. The survey included 13 structured questions.
- Business Model Analysis: 10 venture business model canvases evaluated to assess strategic approaches and innovation in the sector.
- Validation process involved the engagement of D2XCEL stakeholders, to ensure the accuracy of the findings. Stakeholders, mainly interview participants, provided the feedback on the final version of the report. This step ensured that report information, as well as the analysis, is aligned with experts opinion.
- The gathered data was analyzed by focusing on key categories, identifying strategic opportunities and potential barriers. The analysis provided a comprehensive view of the sector, enabling the development of targeted insights for growth and scalability.



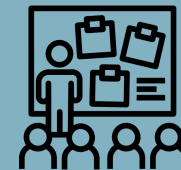
6 Stakeholder interviews



12 Survey responses



10 Venture Business Model Canvases analyzed



Validation through stakeholder feedback

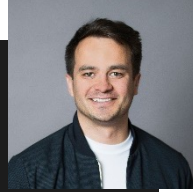
Total of 20+ Participants

Results, Insights, Roadmap

Opportunities, Market trends: Decentralization, data consolidation, and the expanded use of new renewable sources of energy (1)

Johannes Weber

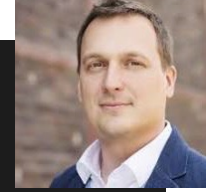
Principal, HGTF Investment Fund



" **The environment** for climate tech, energy, and deep tech startups **is very favorable**. Compared to other verticals like Fintech, these sectors have better opportunities... **Markets with a high proportion of renewables** and fluctuating energy production, such as Germany and Central Europe, **offer significant growth opportunities**. "

Tobias Gruen

Technology and Innovation Management expert.



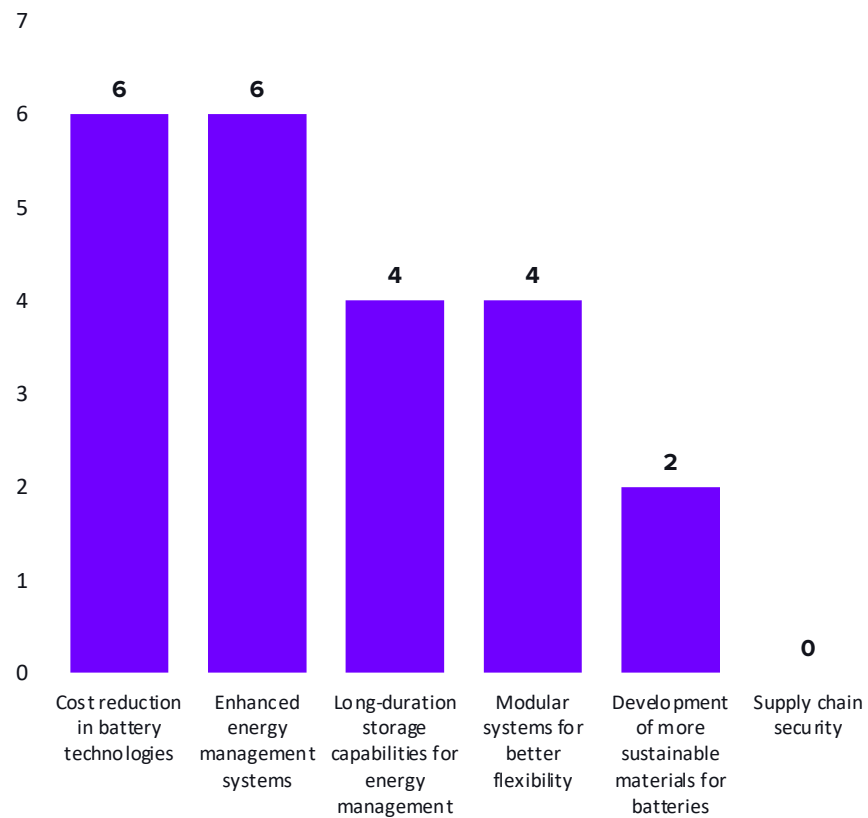
" **The market is still in its early stages**, driven by the rising demand for storage due to increased investments in renewables. **The necessity for large-scale energy storage has become more apparent recently**, and the **market is expected to evolve rapidly in the next five years**, with significant scaling opportunities thereafter. "

The **energy sector overall is undergoing a transition period**, and part of that are the changes that pertain the Large-scale Stationary Energy sector. **Decentralization of energy towards more localized energy systems is a major trend**. Coupled with that are some technical advancements, such as **data platform solutions** that facilitate integrating the different elements of the whole energy ecosystem into one, as well as **green hydrogen**, and **advances in Lithium-ion and other new battery technologies**. These and other such changes are expected to result in more **flexibility, potentially reduced pricing, and a more secure supply chain**, which appears to be a lower priority according to survey responses, while noted in market reports and interviews as a trend. One of the **main objectives in these developments is to facilitate the shift from fossil fuels to renewable forms of energy sources**.

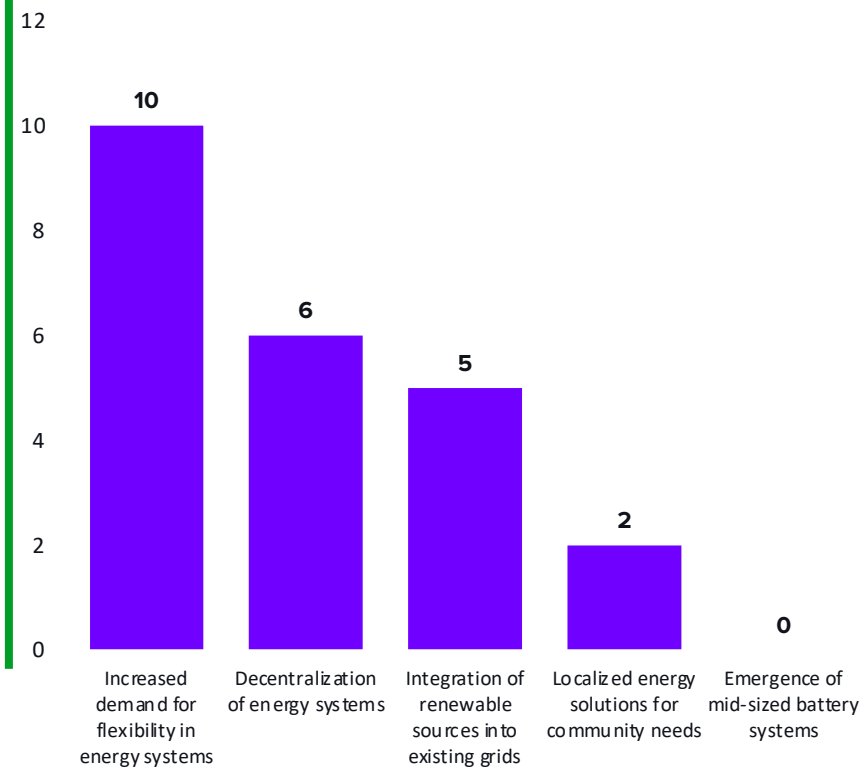


Opportunities, Market trends: Decentralization, data consolidation, and the expanded use of new renewable sources of energy (2)

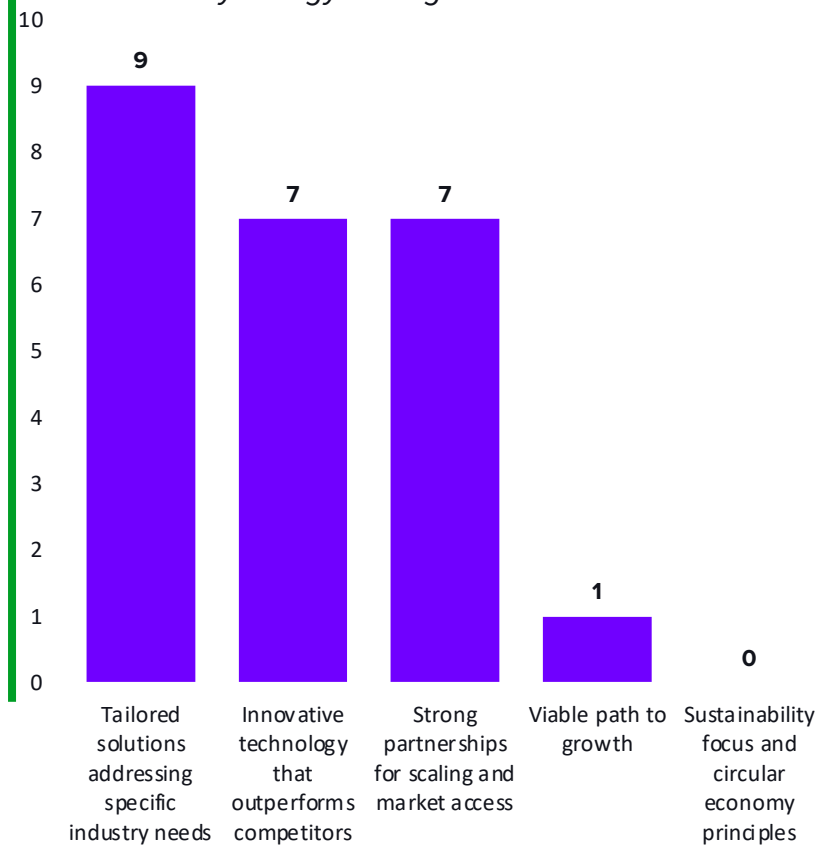
The areas of technology that will be most needed in the Large-Scale Stationary Energy Storage sector:



Market trends believed to be most important for start-ups in the Large-Scale Stationary Energy Storage sector:



Factors that make a startup's value proposition unique and compelling in the Large-Scale Stationary Energy Storage sector:



Technology: New technical solutions are developed in energy and in storage especially, but the capital intensity tends to slow the development in the sector

*These technologies address a broad range of needs, from **cost reduction and scalability to sustainability and security**, making them central to the growth and adoption of large-scale stationary energy storage solutions.*

Following market reports and survey data, **lithium-ion batteries** are broadly recognized as one of the most prominent technologies in the energy storage landscape. However, it is important to note that their scalability faces significant challenges.

Magnesium-based batteries, and thermal storage are solutions with much growth potential, for use cases where Lithium-ion is less applicable.

Green hydrogen, synthetic fuels, and high-temperature storage are critical for long-term sustainability in the energy storage sector, as highlighted by market reports for their potential to provide clean alternatives and efficient energy solutions. Green hydrogen plays a vital role in energy storage, helping to balance the grid by storing excess renewable energy generated during periods of low demand and releasing it when demand is high.

Decentralized systems and 100-hour storage cycles are systemic concepts that considered important to facilitate flexibility in energy production and consumption, while **recycling of batteries** is important in supporting our environmental objectives.



Michael Bez

*Portfolio Manager, EnBW
Innovation*

*“ (The most critical needs from technology perspective are) **lowering the cost of battery technologies... (and) supply chain security**, i.e. ensuring a stable supply of batteries and materials, with a focus on manufacturing in Europe.”*



Juho Risku

Partner, Butterfly Ventures

*“ Balancing power production cycle counts, energy density, cost, and materials. **Technologies that can scale gradually and prove business fundamentals without massive initial investments are crucial.** “*

Scaling: Accelerating growth by moving fast in a specialized area, with a strong customer focus (1)

How to position as a start-up for rapid growth in an industry that is increasingly focused on sustainability and innovation?



Capital Efficiency and Proof of Concept: strong unit economics to prove business case



Leverage Partnerships: integrate into existing ecosystem for validation and access to partners



Develop a Compelling Value Proposition: cost-effective solutions and profitability



Target Specific Niche Markets: create advantage in underserved segments



Adopt Scalable and Flexible Technologies: faster growth with many use cases



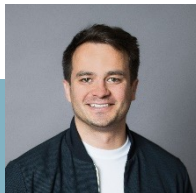
Strong Customer Understanding: engage directly and iterate upon feedback



Janet Würpel

Head of Digital at Iqony

*"**Cost efficiency** is definitely a **critical need**. There could be the greatest technology out there, but if it doesn't meet the necessary cost structures to ensure a return on investment, it won't be viable. **Accurate cost efficiency is essential.**"*



Johannes Weber

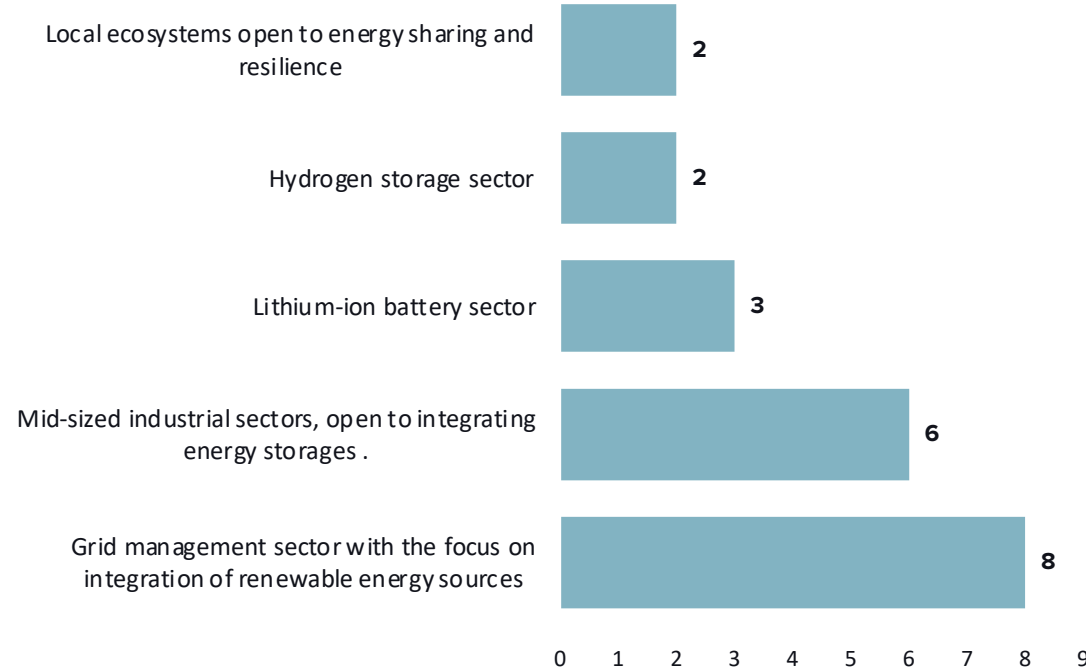
Principal, HGTF Investment Fund

*"**Established technologies like lithium-ion batteries have ample funding for scaling from venture capital and private equity.** Less de-risked technologies, such as **thermal storage, face more challenges** in bridging development phases and scaling."*

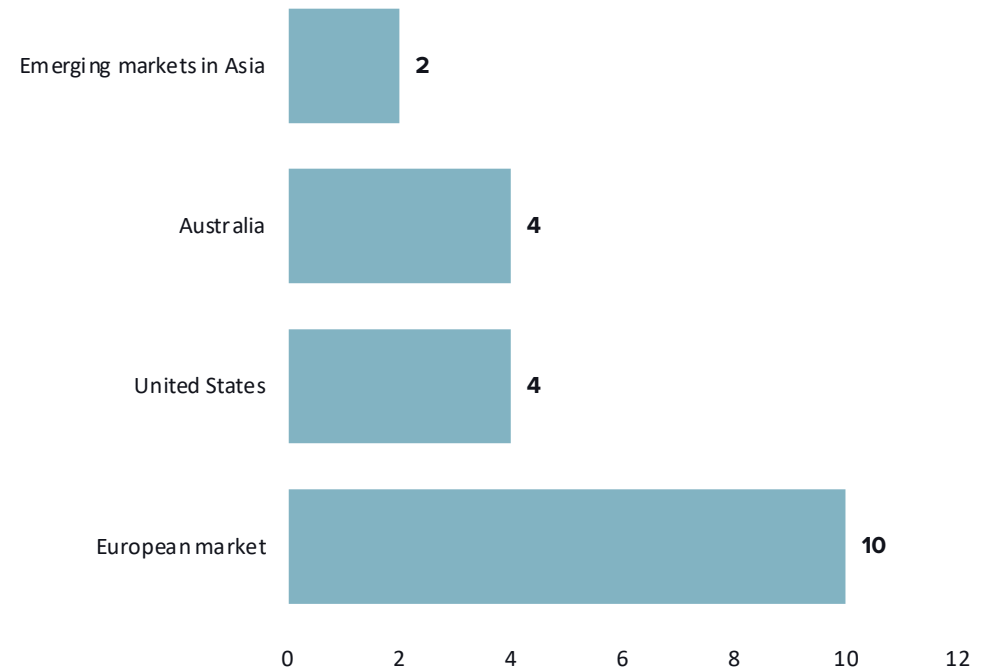


Scaling: Accelerating growth by moving fast in a specialized area, with a strong customer focus (2)

Sectors that hold the most promise for growth in the large-scale stationary energy storage:



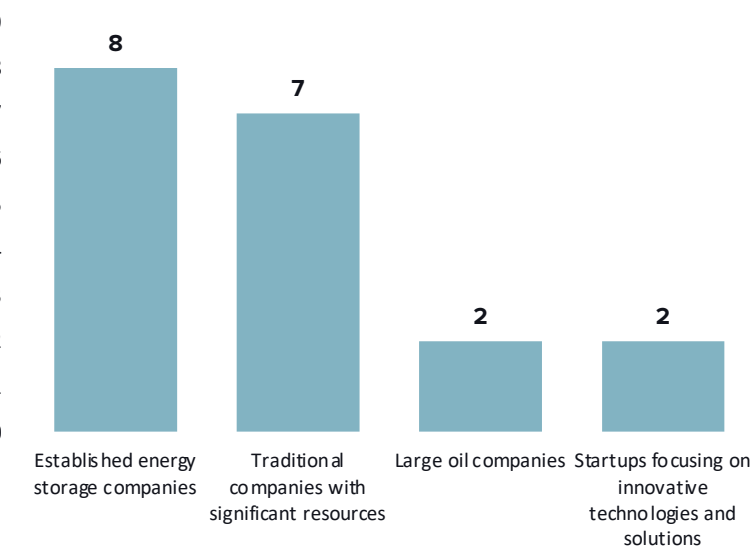
Geographic markets perceived to offer the greatest opportunities for growth in the large-scale stationary energy storage sector.



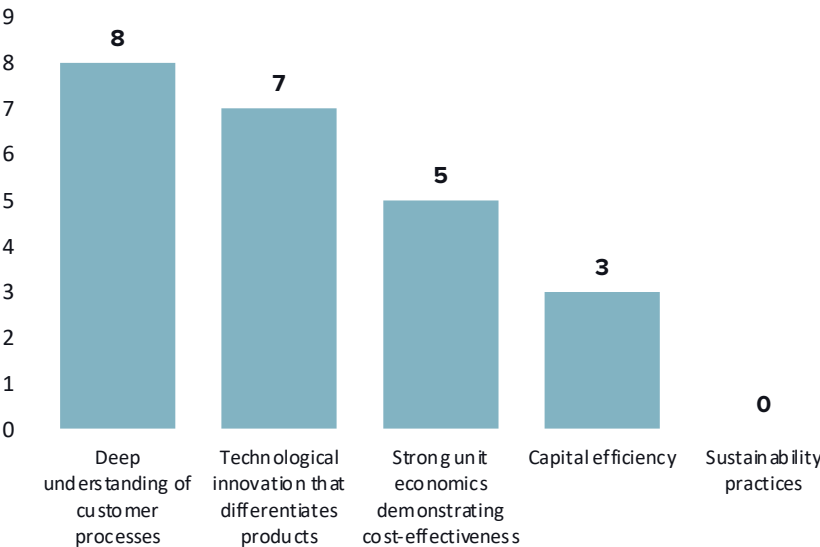
Competition: The sector is dominated by large firms, but start-up opportunities lie in faster adoption of new technologies

Large-scale stationary energy sector requires by definition large investments, and thus is dominated by large companies, such as large utilities, big oil companies, and classical energy companies and integrators. These enjoy many competitive advantages, e.g. large scale, significant resources, and already established market position.

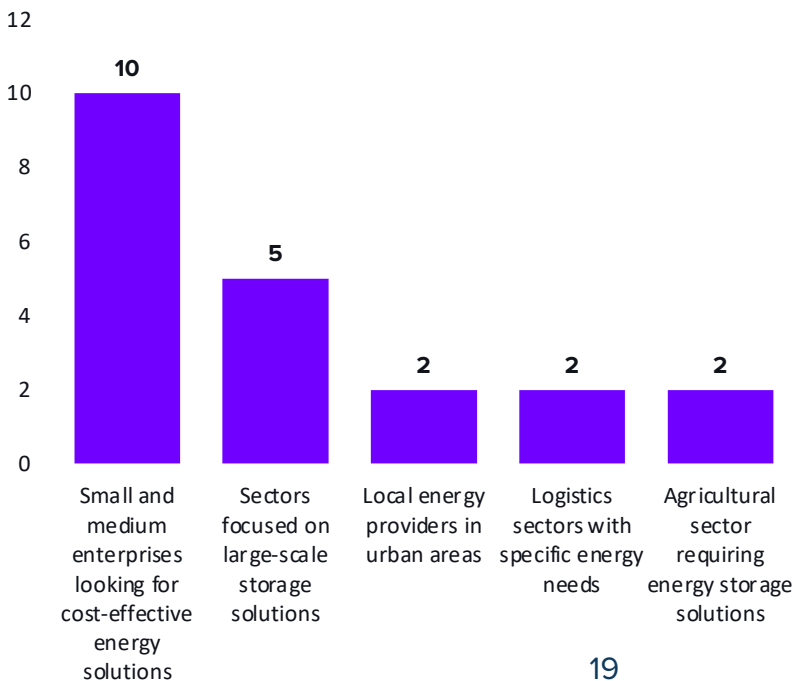
Main competitors for growth companies in the large-scale stationary energy sector according to survey respondents:



Attributes or capabilities to indicate competitive advantage in the large-scale stationary energy sector:



Customer segments that are underserved in the large-scale stationary energy sector:



Tobias Gruen

Technology and Innovation Management expert.



“Competition is a sign of a healthy market. Look for markets with existing competition to validate market demand. Focus on technological advancements and differentiation within specific market segments to gain a competitive edge”

Challenges for start-ups in Large-Scale Stationary Energy Storage: Technological, operational, financial and regulatory obstacles

Sector challenges are considerable, creating high barriers for start-ups to compete.

Technological

- ❏ Technical de-risking needed, for scaling mature solutions (e.g. L-ion), while others are unproven (e.g. hydrogen or thermal storage).

Financial

- ❏ High capital needs and long development cycles mean that cost efficiency is critical yet difficult to achieve soon enough. There are uncertainties in pricing.

Operational

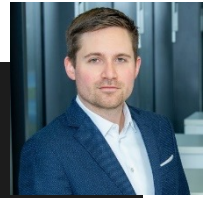
- ❏ Security of supply chain for key materials is challenging. Waste management and recycling are important requirements. Customer understanding and market fit is not always easy.

Regulatory

- ❏ Long approval processes, potential for regulatory changes, and public concerns about safety create uncertainties in the sector.

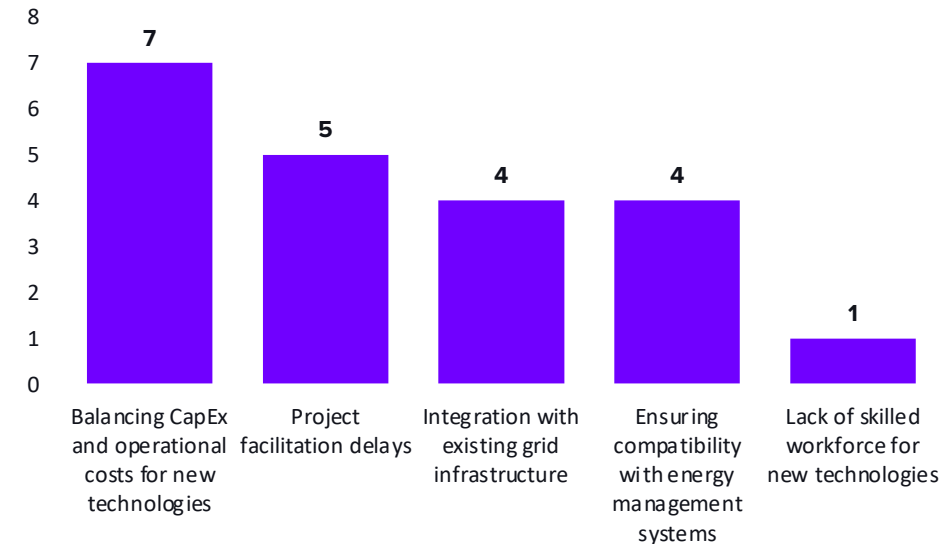
Michael Bez

Portfolio Manager, EnBW Innovation



“(Challenges that can impact the sector:) Time to asset, i.e. the ability to plan, build, and facilitate projects quickly. Also, supply chain, i.e. managing supply chain risks and price stability. And finally, market risk, i.e. ensuring sufficient demand for flexibility services at viable prices.”

Main technological and operational challenges
hindering advances in large-scale stationary energy storage



Risks for start-ups: Capital intensity, technical uncertainty, regulatory and policy changes

Start-ups face several risks in the large-scale stationary energy storage sector, requiring careful risk management strategies.

Capital and funding risks

The high capital requirements, coupled with long development cycles to prove the technology, make it difficult for startups to attract sufficient investment.

Technological risks and de-risking

The uncertainty surrounding the maturity and viability of newer technologies poses a substantial risk.

Regulatory and Policy risks

Changes in regulations or policies related to energy storage, renewables, and CO2 pricing can significantly impact business models and project feasibility.

Market and competitive risks

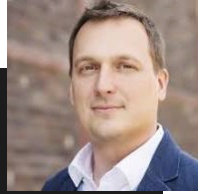
Risk of market saturation as new technologies emerge, and price competition from established players can undermine financial viability of a start-up.

Operational and supply chain risks

Securing a reliable supply of materials and components, risks related to project execution and integration with existing energy systems, can affect start-up's ability to deliver.

Tobias Gruen

Technology and Innovation Management expert.



*“(One key risk potentially to impact the sector is) market saturation with inferior technologies that flood the market. Also, **there are regulatory and political challenges that could impact the adoption and scaling of energy storage solutions.**”*

Juho Risku

Partner, Butterfly Ventures



*“(One key risk potentially to impact the sector is) **the time and capital required to prove the technology to customers. The process often takes too long and costs too much, creating significant hurdles for startups.**”*

Customer segments and distribution channels: The sector is distinguished by customers that are typically large-scale organisations

The most important customer segments in the large-scale stationary energy storage, and their marketing channels are indicative of a well-established sector, with many strategic options open to pursue for start-ups.

Utilities

- Engaging utilities often involves direct partnerships and collaborative projects.
- Personal sales and networking via industry groups are crucial to reach decision-makers

Project Developers and Energy Service Companies

- Targeted marketing campaigns and networking at industry events
- Participating in consortiums

Industrial Customers

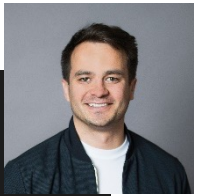
- Targeting requires B2B direct sales strategies
- Build strategic partnerships within industry supply chains, participation in sector-specific trade shows

Commercial and Institutional Customers

- Educational webinars and content marketing
- Direct sales efforts, combined with case studies

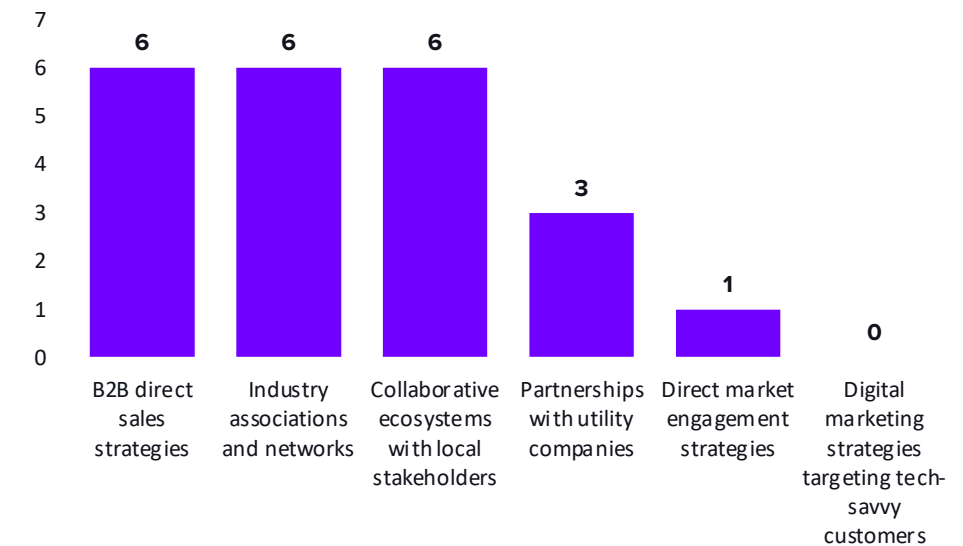
Johannes Weber

Principal, HGTF Investment Fund



“Industrial customers, especially energy-intensive sectors like chemical and pharmaceutical industries, are underserved compared to utilities and private households.”

*Most effective **channels to reach and engage customers** in large-scale stationary energy storage*



Roadmap: The evolution of the Large-Scale Stationary Energy Storage

Before

- **Technology Development:** Traditional energy storage technologies, e.g. lead-acid and early lithium-ion batteries.
- **Market Understanding:** limited awareness of importance of energy storage, not yet recognized need to integrate renewables with storage.
- **Investment Landscape:** Funding for energy storage technologies was scarce, market characterised by high risk and uncertainty.
- **Regulatory Environment:** Regulatory frameworks for energy storage were often inadequate or nonexistent

Now

- **Technological Advancements:** Significant advancements in lithium-ion battery technology. Alternative storage technologies start to emerge.
- **Market Demand:** New awareness of climate change. Utilities recognize importance of storage.
- **Investment Surge:** Increase in VC and PE investments, and government initiatives.
- **Regulatory Support:** Introduction of supportive policies and frameworks for energy storage. Incentives for deployment and integration into existing energy systems.

Next years

- **Focus on Scalability:** Startups will prioritize demonstrating the economic viability and scalability of their technologies to attract investment.
- **Market Competition:** Increased competition, leading to intensified pressure on pricing and cost structures.
- **Emerging Technologies:** R&D into new storage technologies, e.g. green hydrogen and thermal storage, will gain momentum.
- **Regulatory and Policy Challenges:** Complex regulatory landscape will remain a challenge.

Beyond next years

- **Technological Maturity:** Likely the maturation of various storage technologies - will enhance overall system efficiency.
- **Widespread Adoption:** Storage to be integrated as a standard in energy systems globally
- **Decentralized Energy Systems:** Localized energy storage solutions becoming more common, e.g. growth of microgrids.
- **Sustainability and Circular Economy:** E.g. second life of batteries, supply chain security for materials
- **Regulatory Framework Evolution:** better support to integrate energy storage into the grid

References



Aalto University
Startup Center

www.d2xcel.eu

References

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2. [Geothermal Energy](#)
3. [The Role of Critical Minerals in Clean Energy Transitions](#)
4. [The Energy Storage Report](#)
5. [The Rise of Green Hydrogen: Stats, Trends, and Future Projections](#)
6. [Energy Storage Targets 2030 and 2050](#)

Other Market Opportunity Roadmaps



Logistics Market Opportunity roadmap



*Sustainable Freight Transportation
Market Opportunity roadmap*



*Sustainable and Circular Construction
Market Opportunity roadmap*



*AI-Powered Digital Services for
Sustainable and Smart Cities Market
Opportunity roadmap*

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THANK YOU!



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