The Potential for a Fully European Flow Battery Supply Chain

FLOW BATTERIES EUROPE
A united voice for flow batteries

Decarbonisation has become not only and environmental obligation, but also a security and affordability priority for the EU. In the past few years, the EU has accelerated the implementation of the Green Deal and REPowerEU to phase out Russian fossil fuels imports by 2027, diversify its energy sources and achieve its 2030 and 2050 climate targets, while reducing its dependencies for energy resources. To deliver this transition, Battery Energy Storage Systems (BESS) play a pivotal role as they stabilise the grid enabling rapid expansion of variable renewable energy. However, **most BESS rely on critical raw materials which Europe lacks**: for instance, the **EU imports almost 90% of LFP batteries used for energy storage from China**[1]. With security and strategic autonomy as key focuses of the European Commission's mandate, this represents a serious risk to EU energy security.

Flow batteries offer a solution on various fronts: they have **high environmental, recyclability and safety features**, are used for Long Duration Energy Storage (LDES) with capacities from 6 hour to multiple days, and crucially, flow batteries are made from **materials abundantly available in Europe**. This gives the opportunity for the EU to scale up LDES while developing a fully European flow batteries supply chain, without any dependencies.

Locally-sourced Raw Materials – Vanadium, other metals, and organics

The wide range of existing flow batteries are categorised in two groups: organic-based and metal-based flow batteries. **For organic-based ones**, flow batteries are produced with **readily available and sustainable materials**, such as iron sulphates, lignin or biopolymers. For **metal-based flow batteries, chemistries such as iron, zinc, bromide and vanadium** have been developed, although vanadium flow batteries are the most deployed on the market. Of these metals, iron, zinc and vanadium are widely available in Europe. **Vanadium** specifically, which is classified as a critical raw material under the Critical Raw Materials Act (CRMA), can be produced **through mining or via recovery from industrial by-products**. European countries like **Finland, Estonia, Poland, Sweden, and Norway have untapped vanadium resources**[2] that could support production in the medium and long term. In the short term, other circular economy approaches offer a viable European vanadium supply, such as the extraction from steel-plant slags and recovery from coal and petroleum fly ashes. Given their availability and sustainable production processes, both metal-based and organic-based flow batteries could potentially support the EU reducing LDES-related import dependencies and achieve the objectives of the CRMA.

European Manufacturing for Flow Batteries' Components

Europe is becoming one of the key global markets for vanadium flow batteries[3]. The EU not only has access to metals and organic materials in-house, but it also possesses the **manufacturing capabilities** to produce flow batteries' **electrolytes and other components domestically,** such as stacks, tanks, pumps and piping. European

Contact Us +32 2 743 29 86 www.flowbatterieseurope.eu

companies like Volterion, CellCube, KEMIWATT and Vanevo already produce different locally-sourced components for flow batteries and have installed capacities across Europe. This includes the production of vanadium electrolytes, for which several European companies are increasingly developing production facilities on the continent, such as AMG Advanced Metallurgical Group[4] and Phoenix Metals[5].

From Industrial Applications to Data Centres and Defence Installations

Flow batteries can be used for a wide variety of stationary energy storage applications. Besides providing **grid services**, they are well suited for **industrial applications** with high energy demands (such as for the chemical, telecommunications and metal industries), and for infrastructure such as data centres and hospitals, thanks to their capacity and non-flammability. They can also be employed as a grid-scale energy storage solution, storing excess energy generated by renewables and providing homes, businesses and microgrids with reliable backup power. Flow batteries are also increasingly being **installed in military bases**, as a safe, and secure form of back up power for long durations.

Overall, flow batteries offer greater **flexibility** than other storage options, like lithium batteries. With their long lifespan (~20.000 cycles), wide operating temperature range (-20 to 50 °C)[6] and sustainable, adaptable design, they provide reliable energy storage that supports clean and secure energy systems, even **under challenging climate conditions**. In addition, their non-flammable chemistry ensures **higher safety standards**, while their potential to diversify and localise supply chains in Europe further strengthens energy security.

Conclusion

Flow batteries' production and manufacturing in Europe is growing, thanks to the increasing demand for alternative sustainable and non-flammable LDES that can support the integration of renewables and for energy solutions that foster the EU's energy self-sufficiency. However, flow batteries face some challenges that limit their widespread deployment in the EU market:

1. **Scale up is needed:** while many **European startups** have succeeded in developing local flow battery projects, **scale up is needed** for production capacity to meet the needs of the EU energy system.
2. **Limited vanadium refining capacities:** Europe's current **vanadium mining and refining capacities are limited**, causing supply risks and current imports of materials which could otherwise be sourced from Europe.
3. **Lack of consistent business case:** the **lack of a consistent business case**, driven by the fragmentation of the EU energy market and lack of incentive for LDES, creates uncertainty for project developers and investors.

The development of the supply chain which already exists within Europe can help to develop this market, and enhance European energy security by giving grid operators the option of European made, safe, and sustainable solutions for long duration storage.

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[4] AMG (2023). AMG Advanced Metallurgical Group N.V. Announces Approval for Vanadium Electrolyte Plant at AMG Titanium. https://amg-nv.com/investors/press-release/amg-advanced-metallurgical-group-n-v-announces-approval-for-vanadium-electrolyte-plant-at-amg-titanium/
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