SMHYLES

SAFE, SUSTAINABLE AND MODULAR HYBRID SYSTEMS FOR LONG-DURATION ENERGY STORAGE AND GRID SERVICES

SMHYLES NEWS

November 2026
Issue 02

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Welcome to our latest newsletter!

Renewable energy is only as reliable as the storage that backs it up. Solar and wind are, by nature, intermittent – the sun does not always shine when we need power, and the wind does not always blow on demand.

The SMHYLES project is tackling this challenge by developing Hybrid Energy Storage Systems (HESSs) that combine two very different technologies in one package: batteries that store large amounts of energy for long periods, and supercapacitors that can charge and discharge almost instantly. Together, they promise the best of both worlds – steady, long-duration power plus a rapid response to sudden spikes in supply or demand.

Visit Us at Battery Innovation Days 2026

Authored by BayFOR

At this year's **Battery Innovation Days 2026 in Stockholm**, SMHYLES and BayFOR will welcome visitors to their **joint exhibition booth T:01**.

The booth will offer an opportunity to learn more about SMHYLES and its work on innovative hybrid energy storage systems using salt- and water-based technologies. Visitors will gain insights into the project's objectives, ongoing activities and its contribution to the development of sustainable energy storage solutions.

Beyond presenting the project, we look forward to engaging with researchers, industry representatives and other stakeholders, exchanging ideas and exploring opportunities for future collaboration.

Come and visit us at booth T:01! We look forward to meeting you, discussing the latest developments in energy storage and sharing more about SMHYLES.

Date: 11–12 November 2026
Location: Stockholmsmässan, Stockholm, Sweden
Booth: T:01 – SMHYLES & BayFOR
More information



How Big Should a Hybrid Battery Be?

Authored by FBK

What we learned by sizing hybrid storage systems for four cases studies

Deliverable D2.3 looks for the right size for the SMHYLES hybrid storage systems, which combine a salt-based or a flow battery with a supercapacitor that reacts in a split second.

Using the computer models from our last newsletter, the project teams from Fondazione Bruno Kessler, RINA Consulting S.p.A, and Comete Engineering tested four case studies: Graciosa Island in Portugal, a research centre in Landshut in Germany, a large solar plant in Italy, and an industrial site in Tunisia all utilizing battery and supercapacitor units. Each place has different electricity prices, rules, and energy needs, so each one gets a different answer.

Graciosa Island (Portugal): a battery that works hardest in winter

Graciosa is a small off-grid island. Its wind and solar plants sometimes make more power than the island needs, and diesel generators fill the gaps. For example, in January 2024, a salt-based battery of 1200 kW/4800 kWh would have saved 41 MWh of diesel and used 74 MWh of wind and solar power that would otherwise have been wasted. Over the whole year it would save 223 MWh of diesel, about 3.7 % of what the island burns. In summer there is little spare power, and the battery, which must stay very hot (about 265 °C), spends much of it keeping warm.

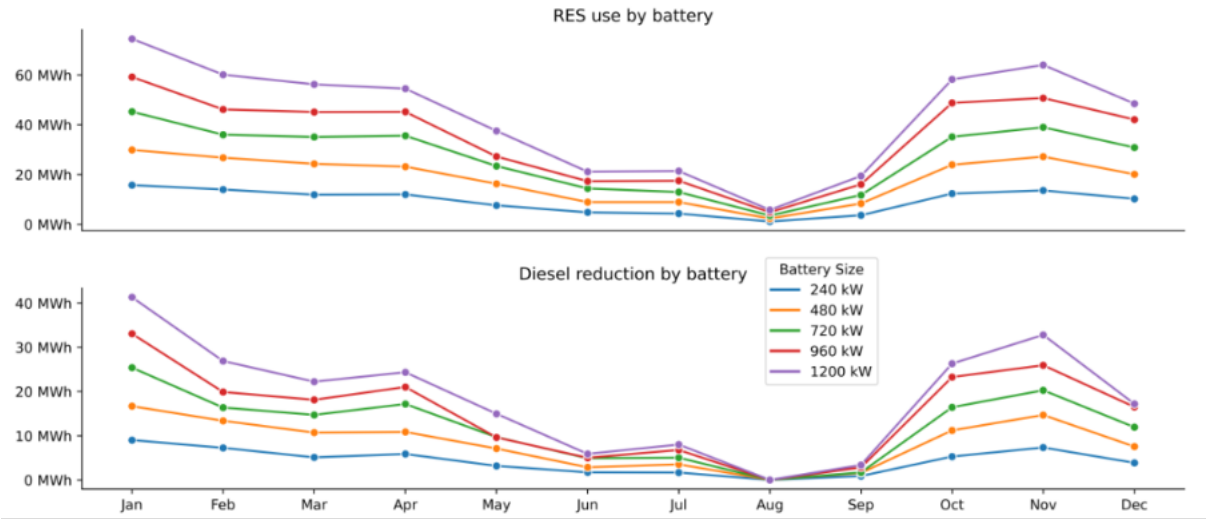

Figure – Monthly wind and solar power use and diesel reduction by salt-based batteries of different sizes.

Supercapacitors made the power smoother, by up to about 12 %, but at today's prices they cost more than they earn. No setup paid for itself within one year. Over 20 years it can work, but only if winter-level savings continue all year, the price of CO2 emissions is high, and batteries become cheaper. In the best case, the return is about 7 % a year.

Landshut (Germany): it works, but the money is not there yet

The Technology Center for Energy at Landshut University already has solar panels on its roofs and carports. The team tested a flow battery with a supercapacitor to use more of that solar power and to cut the electricity bill. Technically, it worked. The flow battery charged when electricity was cheap and discharged when it was expensive, while the supercapacitor handled sudden power peaks. But the savings were small: the batteries (12.5–25 kW) earned only €164–512 a year. Over 10 to 20 years, every tested setup ended with a loss of about €47,000 to €90,000. Cheaper flow batteries and bigger price swings would change this.

Italy: earning from several markets at once

Here the team modelled a large solar plant with a 3000 kW / 12,000 kWh flow battery and a small supercapacitor. The system sells its services in four electricity markets (Day-ahead, Intraday, Balancing, and Fast Reserve) at the same time. A short test period suggested a net profit of about €1.09 million a year. A fairer test, using one week from every month, lowered this to about €0.47 million. That is still positive, and it shows why a full year of data matters. The best battery size was 2500–3000 kW. A bigger one (5000 kW) earned far less.

Tunisia: storage that earns its keep

At an industrial site with a 1200 kWp solar plant, the rules favour storage. Only 30 % of the solar power may be sold to the grid, and at just 20 % of the price the site pays. So it is better to store it and use it later. After testing over 6,000 combinations, the best choice was a 1536 kWh vanadium flow battery. Over 25 years it had a slightly lower total cost than the same site without a battery (€7.48 million against €7.59 million), a return of about 11 % a year and a payback of about five years. The supercapacitor helped with short peaks but did not pay off.

Four sites, four answers

Site	*Storage tested*	*Main message*
Graciosa (PT)	*Salt-based battery + supercapacitor*	*Saves diesel, mostly in winter. Pays off only in the best case.*
Landshut (DE)	*Flow battery + supercapacitor*	*Works well technically. Costs are higher than savings today.*
Italy	*Flow battery + supercapacitor*	*Profit from several markets: about €0.47 million a year after a full-year check.*
Tunisia	*Flow battery (+ supercapacitor tested)*	*Flow battery is slightly cheaper over 25 years. Supercapacitor not yet worth it.*

The common lesson is clear. Hybrid storage works technically everywhere, but the money depends on local prices, market rules and battery costs. Supercapacitors are very good at fast changes, yet current market rules rarely pay for that.

What comes next

The next step is to move from design to daily operation. The team will build smart controls that decide, in real time, when each part of the system should charge or discharge. The power systems regulators and operators' insights are also important, so that fast-reacting technologies like supercapacitors are properly rewarded in the electricity market to help with system stability and ancillary services.

If you are interested, you can find more in D2.3_SMHYLES_Report_on_techno-economic_sizing_analysis_20250523_FBK.pdf

References

- *Deliverable D2.3 "Report on techno-economic sizing analysis", SMHYLES Project, GA #101138029, 23 May 2025.*
- *Buchajczyk, Marcin, et al. "Dual-timeframe optimization of hybrid salt-based battery–supercapacitor systems—A techno-economic sizing framework." Journal of Energy Storage 154 (2026): 121347.*
- *Deliverable D2.2 "Digital twins for HESSs design", SMHYLES Project, GA #101138029*

Simulating The Physics of Vanadium Redox Flow Batteries

Authored by FBK

How SMHYLES exploits numerical computing to assist and improve stack design

Battery behavior at the fundamental level is the result of a complex interplay between well-known processes governed by the laws of physics. When properly formulated in a mathematical way, these laws have the form of Partial Differential Equations (PDEs) whose solutions yield, in principle, the knowledge of the battery control parameters and their time evolution: reactants concentrations, voltages, electric currents, pressures, etc. This knowledge is of paramount importance for design and predictive purposes, even at large scale after suitable rescaling of the models.

Given that getting solutions in the conventional mathematical way, i.e., analytic solutions, is impossible due mainly to the complex geometries involved, the SMHYLES team exploits numerical computing as a tool to obtain approximate but reliable solutions to the PDEs. Finite Element Method (FEM) or Finite Volume Method (FVM) are well established methods of

numerical analysis for reformulating the search for a PDEs solution in a computer affordable task, by means of the discretization of the computational domain and the equations themselves. Using a computer of suitable computational power in terms of memory (RAM) and CPU speed, it is then possible to emulate the physics of batteries using virtual replicas of them.

Vanadium Redox Flow Battery (VRFB) three-dimensional (3D) modeling

SMHYLES simulations performed by FBK team in Trento (Italy) concerned the modeling of realistic cell batteries geometries, in which the electrochemical reactions take place inside porous electrodes wet by the liquid electrolyte containing the specific vanadium reactants in a supporting solution. Feeding manifolds convey and distribute the liquid directly through the electrode ("flow-through", left) or wet it at a grazing incidence ("flow-by", right).

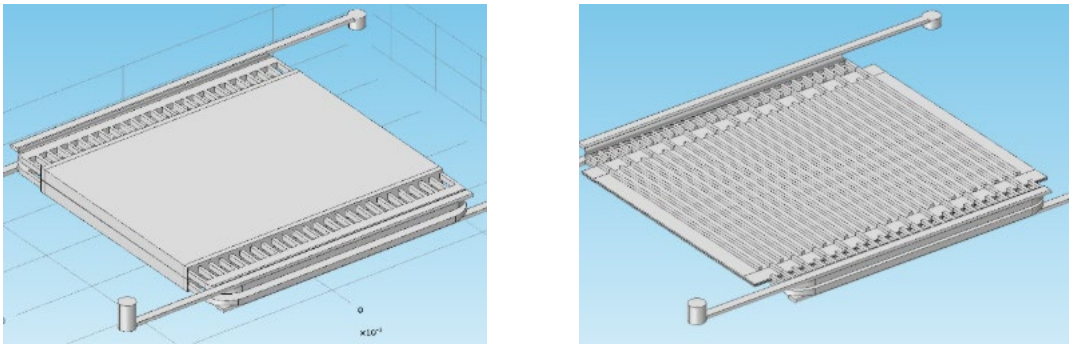

Figure – Battery cells geometries considered for numerical simulations: "flow-through" (left) and "flow-by" (right).

Finite Element analysis is performed after meshing the computational domain, i.e., splitting the space volume corresponding to the cell battery in a discrete finite number of sub-volumes, thus making possible the numerical treatment of the governing PDEs.

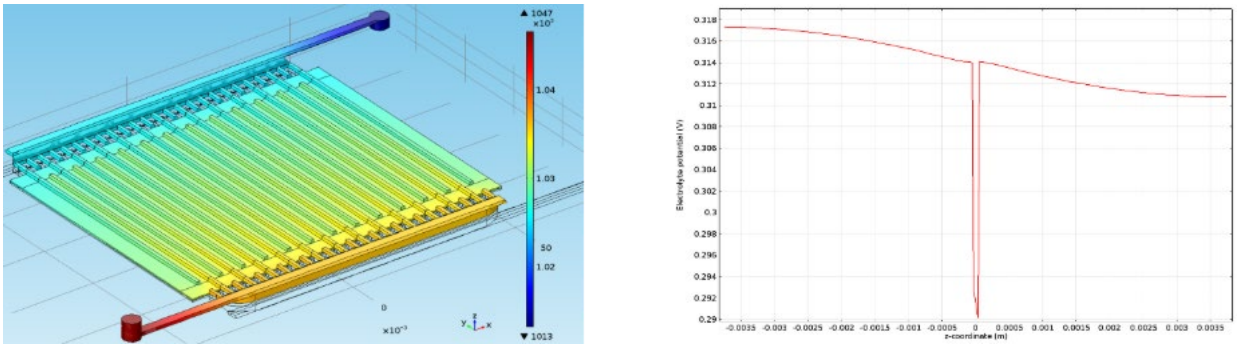

Figure – Excerpts of numerical results: pressure distribution color map (left), electrolyte voltage (right).

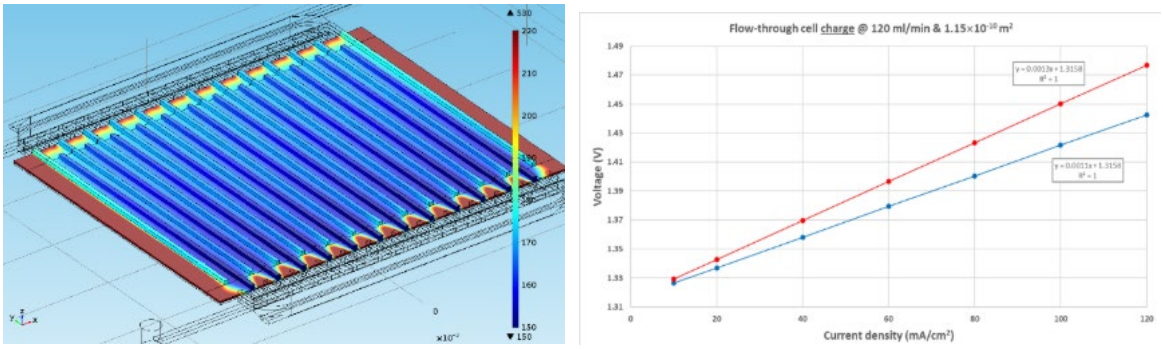

Figure – Excerpt of numerical results: vanadium concentration distribution color map (right), battery charge loading curve.

The numerical results of the simulations give access to the knowledge of the relevant parameters involved in the battery cell operation and permit a performance analysis and how it can be improved by varying the geometries and/or the inner/external operating conditions.

Extending the range of numerical simulations: vanadium recycling

In SMHYLES project, FBK employed numerical simulations to also support electrolyte recycling. This process is composed by several stages (see our first newsletter article, p.10 "Test rig for vanadium recycling"). After the regeneration of "exhausted" electrolyte, vanadium catholyte/anolyte concentrations must be restored, and this is obtained thanks to an electrochemical reactor. The FBK team evaluated the performance of this reactor, which is composed by ten conversion cells stacked in an electrical series. These cells works exactly like the flow battery ones, being governed by the same equations, and they can be simulated with very similar same models. In this way, the team predicted the reactor conversion rate and its further optimization will be guided by the point-to-point knowledge of control parameters.

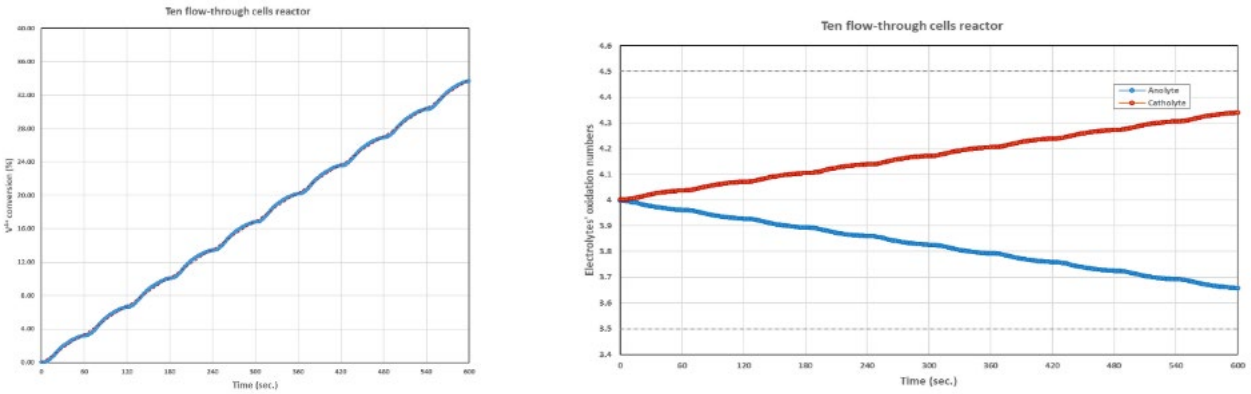

Figure – Simulated vanadium IV regeneration as a function of time.

What comes next

Numerical simulations have fruitful applications in guiding and aiding the experimental activity. They allow the virtualization of complex systems, on which they can operate in an immaterial way, without the strong effort of prototyping. These tools can provide the reasonable confidence of the effectiveness of a given choice before even building it.

If you are interested, you can find more in Deliverable D3.1 "Report on test rig and prototype cascading stack for vanadium recycling"

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- N. Poli, M. Schäffer, A. Trovò, J. Noack, M. Guarnieri, P. Fischer, *Novel electrolyte rebalancing method for vanadium redox flow batteries*, Chemical Engineering Journal, **405** (2021) 126583, https://doi.org/10.1016/j.cej.2020.126583
- Deliverable D3.1 "Report on test rig and prototype cascading stack for vanadium recycling", SMHYLES Project, GA #101138029

Flexible and Modular Energy Storage with Vanadium Redox Flow Batteries

Authored by SCHMID Group

As part of the SMHYLES consortium and building on the long-standing industrial experience of the SCHMID Group combined with more than a decade of product development in Vanadium Redox Flow Battery (VRFB) technology, Schmid has developed a flexible and modular 10-foot container EverFlow VRFB system.

The modular design allows energy storage capacity to be adapted to individual application requirements. A standard module, housed in a 10-foot shipping container, provides up to 125 kWh of energy capacity at 15 kW of nominal power. Designed for fast and easy installation, the system offers a convenient plug-and-play solution, with the inverter already integrated into the container. This significantly simplifies system deployment and reduces the complexity of installation.

The modular concept also makes it possible to increase the storage capacity as requirements grow. By adding a second container for only electrolyte tanks, the system's energy capacity can be more than doubled without the need to duplicate the complete power and auxiliary infrastructure. This provides a high degree of flexibility while allowing the system to be tailored to different energy storage needs.

The system uses an aqueous vanadium electrolyte, making the battery inherently non-flammable. The vanadium redox flow battery chemistry also offers several important advantages for stationary energy storage. Unlike conventional battery technologies, the electrolyte is not susceptible to self-discharge while it is stored in the tanks, and the system can be deeply discharged without compromising it.

Another key benefit is the essentially unlimited lifetime and retained value of the electrolyte, providing an important advantage from both a sustainability and long-term economic perspective.

Thanks to its modular design, scalability, safety and long service life, the VRFB system is suitable for a wide range of applications. These include EV charging, energy arbitrage, load shifting and levelling, as well as backup power for telecommunications systems.

Beyond individual applications, technology can play an important role in the broader energy transition. By storing electricity when renewable generation is abundant and making it available when it is needed, VRFB systems can help increase the integration of renewable energy sources and support a more flexible and resilient energy system.

With its combination of proven vanadium flow battery chemistry, modular containerized design and integrated power electronics, the system developed by Schmid provides a flexible solution for today's growing demand for safe, durable and scalable stationary energy storage.

Within the **SMHYLES project**, SCHMID's EverFlow VRFB will be demonstrated as part of a **hybrid energy storage system** combined with a supercapacitor. This innovative combination leverages the strengths of both technologies, delivering multi-hour energy supply from the VRFB while enabling the supercapacitor to handle short-duration power peaks and rapid response events.

The demonstration will showcase how hybrid energy storage solutions can address demanding real-world applications while supporting a more sustainable and reliable energy infrastructure.

The result is a safe, scalable and durable energy storage solution designed for the challenges of the energy transition.



How Sustainable Are Hybrid Energy Storage Systems?

Authored by TBU

SMHYLES Deliverable D2.5 evaluates the environmental, economic and social sustainability of vanadium redox flow batteries (VRFB), sodium–nickel chloride (ZEBRA) batteries and aqueous supercapacitors, both individually and within hybrid energy storage systems.

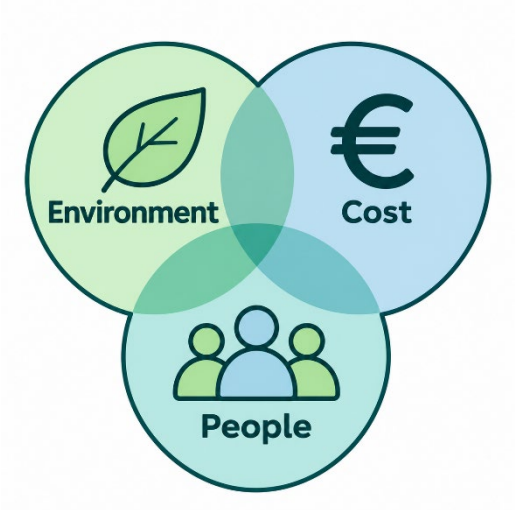
The environmental assessment identifies material production and manufacturing as major hotspots. Vanadium electrolyte accounts for around 90% of manufacturing emissions for the assessed VRFB. Using 81.6% recycled electrolyte could reduce these manufacturing emissions by approximately 43%. For ZEBRA batteries, combining recycled nickel with cleaner energy could lower manufacturing emissions by nearly 40%.

At system level, modelling indicates that the VRFB–supercapacitor hybrid at Demo Site 1 has approximately 40% lower greenhouse gas emissions than its state-of-the-art reference. The ZEBRA–supercapacitor hybrid at Demo Site 2 achieves a reduction of around 62%.

Economic modelling, supported by 10,000 Monte Carlo simulations, estimates median levelized storage costs of approximately €0.12/kWh for VRFB, €0.075/kWh for ZEBRA and €0.07/kWh for supercapacitors. Costs depend on investment, efficiency, cycling, lifetime and material recovery.

The social assessment highlights risks in raw-material extraction and processing, including child and forced labour, corruption, community safety and indigenous rights.

These findings highlight the potential of hybrid storage and the importance of recycled materials, low-carbon electricity, responsible sourcing and stronger supply-chain due diligence.



Upcoming Joint Webinar on Hybrid Energy Storage

Authored by BayFOR

The SMHYLES project is joining forces once again with the European research projects **HAVEN and HiHELIOS** for another webinar in our joint series on hybrid energy storage technologies.

Taking place on **20 November 2026, from 10:00 to 11:30 CET**, the free webinar, entitled **"Making Hybrid Energy Storage Work – System Integration and Management in Practice"**, will explore how hybrid energy storage systems can be integrated and managed effectively.

Experts from the three projects will share insights into their approaches, experiences and practical examples from their demonstration sites. The session will also provide an opportunity to discuss common challenges and exchange knowledge across the projects.

Stay tuned! The registration link will be available soon. We look forward to welcoming you to the webinar!



Impressum

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About SMHYLES

SMHYLES is a Horizon Europe project developing innovative Hybrid Energy Storage Systems that combine batteries and supercapacitors to support renewable energy integration and grid flexibility.

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