

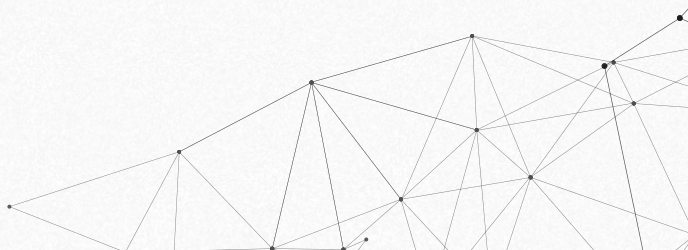
Vanadium Redox Flow Energy Storage Technology Presentation

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2024



**Challenge: Integrating
weather-dependent
production into the
system.**



solution:

ENERGY STORAGE WITH VRFB (Vanadium Redox Flow Battery) TECHNOLOGY

The vanadium redox flow battery operates based on the reduction and oxidation of vanadium in different ionized states. Vanadium is an easily accessible material, found naturally and recoverable from various waste streams.

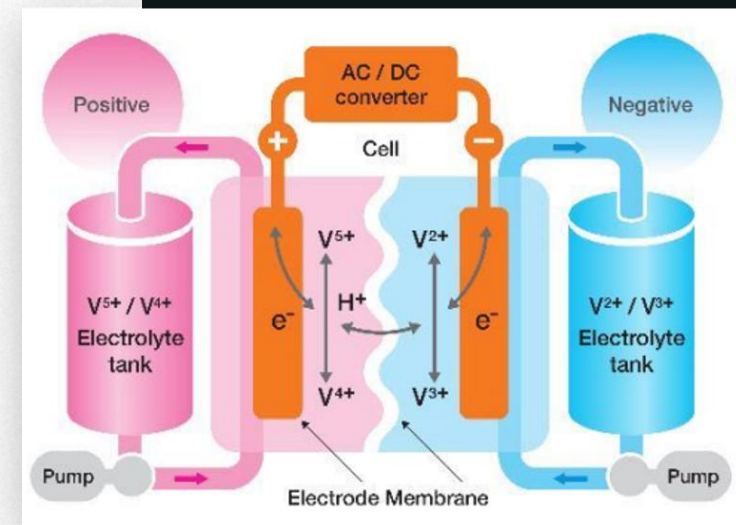


Operating principle

The tanks contain electrolytes, which are liquids capable of conducting electricity. One tank holds positively charged vanadium ions (V^{5+}), while the other contains an electrolyte filled with V^{2+} .

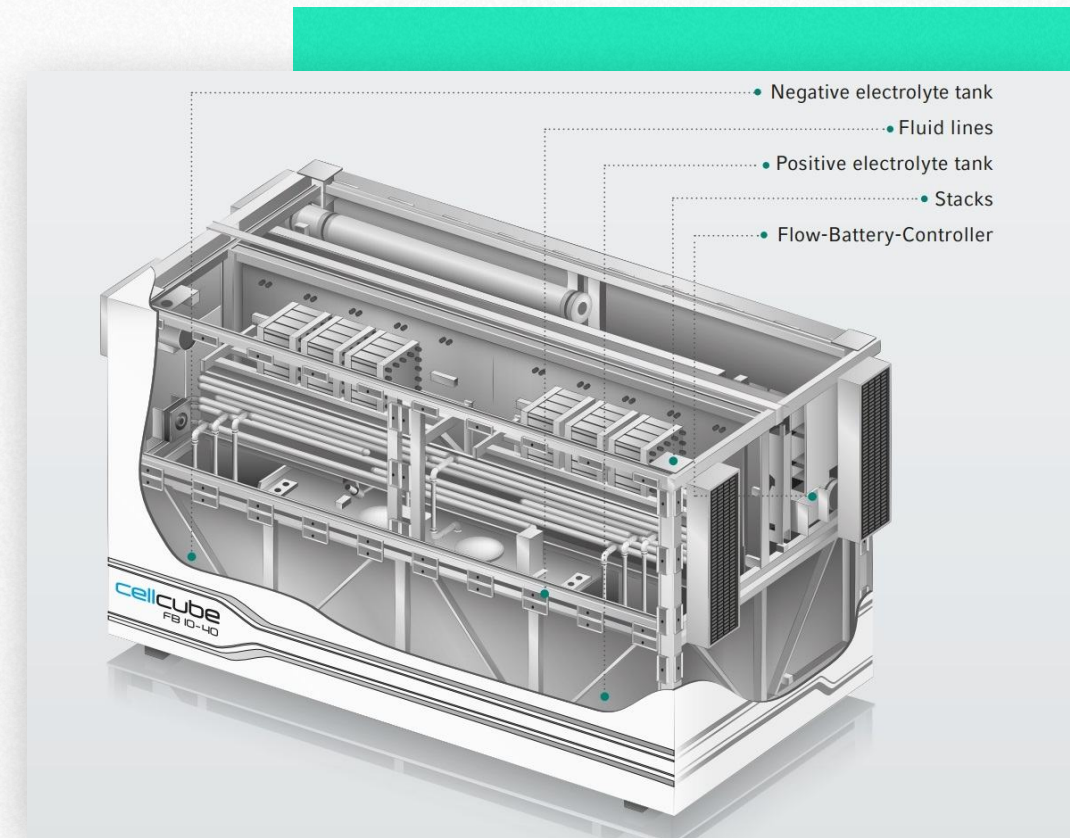
The vanadium battery is a type of flow battery, meaning it generates electricity by pumping liquid from external tanks into a central battery tank where the liquids mix.

Pumps in the containers move the electrolyte filled with ions from both tanks to a third tank. Here, a chemical reaction changes the charge of the ions, generating electricity.



Redox Flow Battery system components

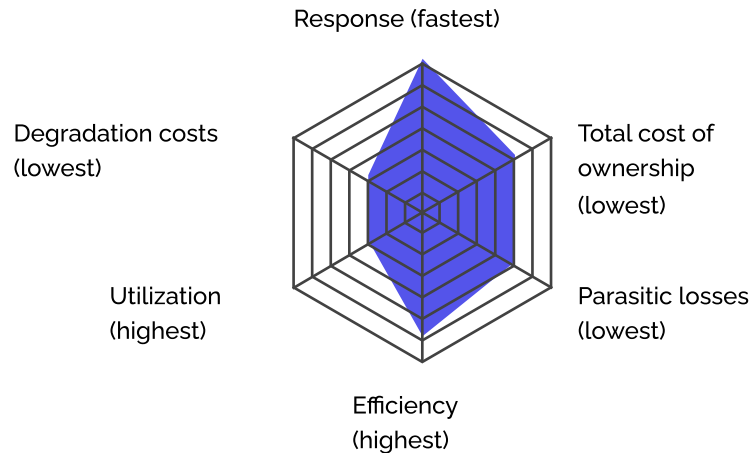
- **Container:** Power Stack, Tanks, Pumps
- **Electrolyte**
- **Control interface for the battery**
(BMS: Battery Management System)
- **PCS:** Inverter
- **EMS:** Energy Management System.
Operational control system linking
the container, BMS, and PCS.



Comparison Between Lithium-Ion and VRFB Technologies

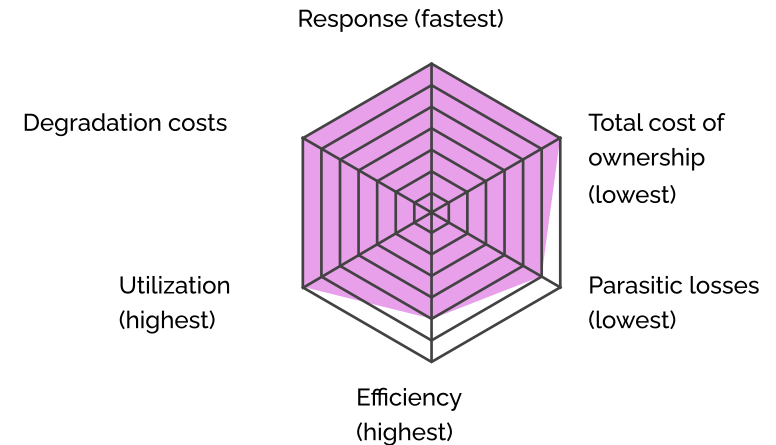
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- Gaining significant traction in international trends (Asia, USA, Australia).
- Multiple times the capacity of competing technologies.
- Outstanding recyclability.
- Exceptional cost efficiency over the lifecycle.
- ESG compliant (truly sustainable technology).



Lithium

- Average discharge duration: 1–2 hours or less.
- Low utilization rate (30–70%) due to performance degradation.
- Short lifespan, with strict warranty conditions.
- High disposal costs.
- Low upfront costs.
- Safety concerns and fire risks.



Redox

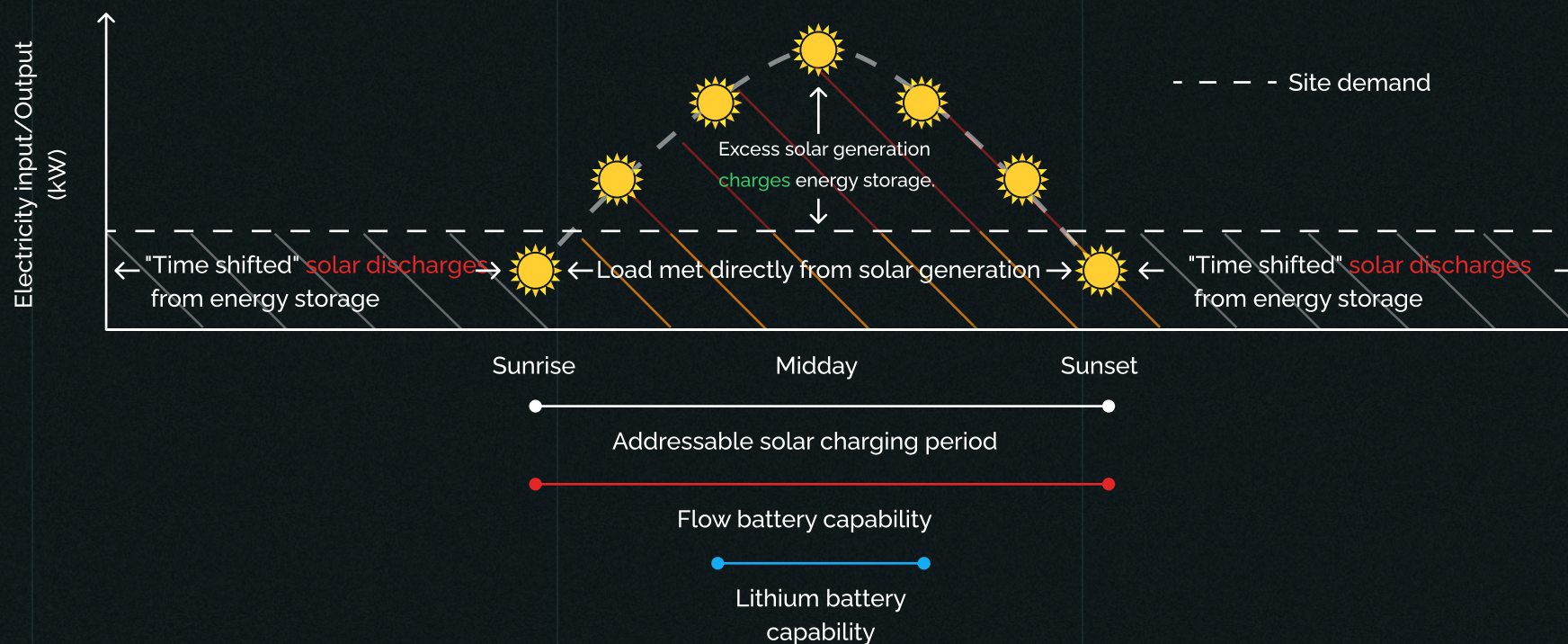
- Discharge duration: 4+ hours.
- 100% utilization, no marginal costs per cycle.
- 25-year lifetime, bankable and financeable (the warranty allows an unlimited number of cycles)
- Fully recyclable, no disposal costs.
- Lowest operating costs.
- Safe, no fire risks.

Energy Storage Technology Comparison

Flow batteries are a safe, economic, and flexible technology for storing renewable energy.

Store more solar power with Vanadium Redox Flow Batteries

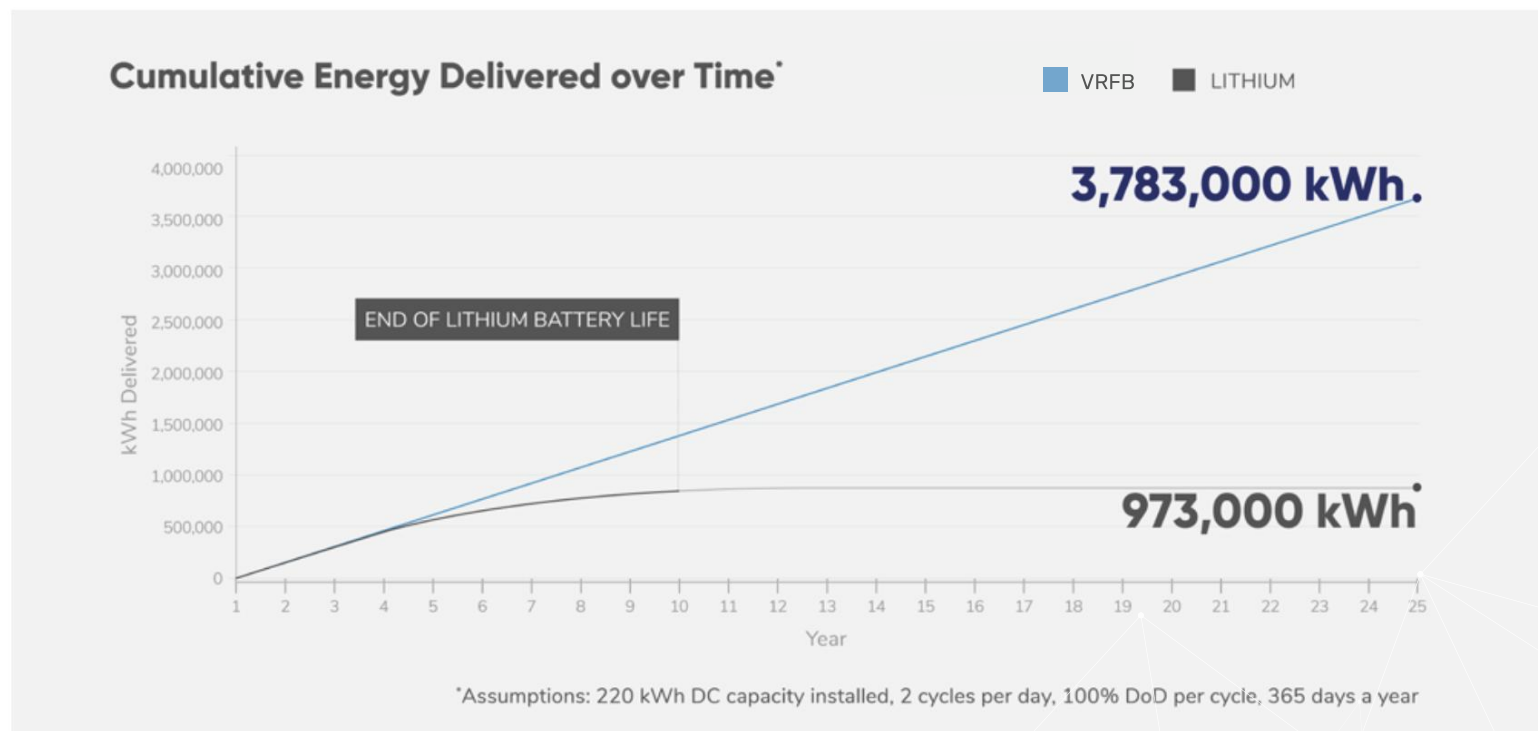
Flow batteries greater storage capacity and longer duration allows more excess solar energy to be captured during daylight hours and discharged to meet site demand after the sun has set.



Comparison Between Lithium-Ion and VRFB Technologies

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Over a long 25-year timeframe, four times the delivered/managed energy.



Comparison Between Lithium-Ion and VRFB Technologies

Li-ion akkumulátor		Vanádium redox akkumulátor
60-120 kWh/m3	Energy density	20-33 kWh / m3
Yes	Risk of fire and explosion	No
No (in practice, it is kept at 80-100% charge for longevity)	Total capacity range available	Yes
1-2 hours	Use for system stabilisation	4+ hours
To a minimal extent	Recyclability	Close to 100 %
100 %	Life-cycle CO2 emissions	~ 85 %
100 %	Life cycle based environmental acidification and toxic effects	~ 50 – 60%
8-10 years (depends on use)	Lifecycle	25 years (with warranty), up to 50 years
~ 6.000 cycles	Charge cycle	~ 20.000 cycles
80%	Cycle efficiency	85 %
973.000 kWh	Electricity stored during its life cycle	3.783.000 kWh
56.250 EUR/MWh/year	Projected over a full life cycle investment cost	37.500 EUR/MWh/year
Lower installation cost, higher life cycle cost	Cost	Higher installation cost, lower life cycle cost

Advantages of Vanadium Redox Flow Storage Technology

- Significantly higher safety levels.
- No degradation.
- Long lifespan, high cycle count.
- Optimized for deep cycles (long duration: 4–12 hours).
- Low lifecycle costs.
- Easy and inexpensive to operate.
- Flexible design, unique scalability (modularity).
- Ideal for peak shaving and peak shifting.



Fields of application

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1. System-wide balancing services (Balancing):

- FRC, aFRR, mFRR, RR:

2. Wholesale energy markets (Wholesale):

- Day-Ahead optimisation
- Intraday Optimization
- Production Optimization

3. Local (off-grid) opportunities

- Time of Use
- Self balancing
- Kw max control
- (Emergency Supply), Blackout source

4. Supporting renewable energy systems:

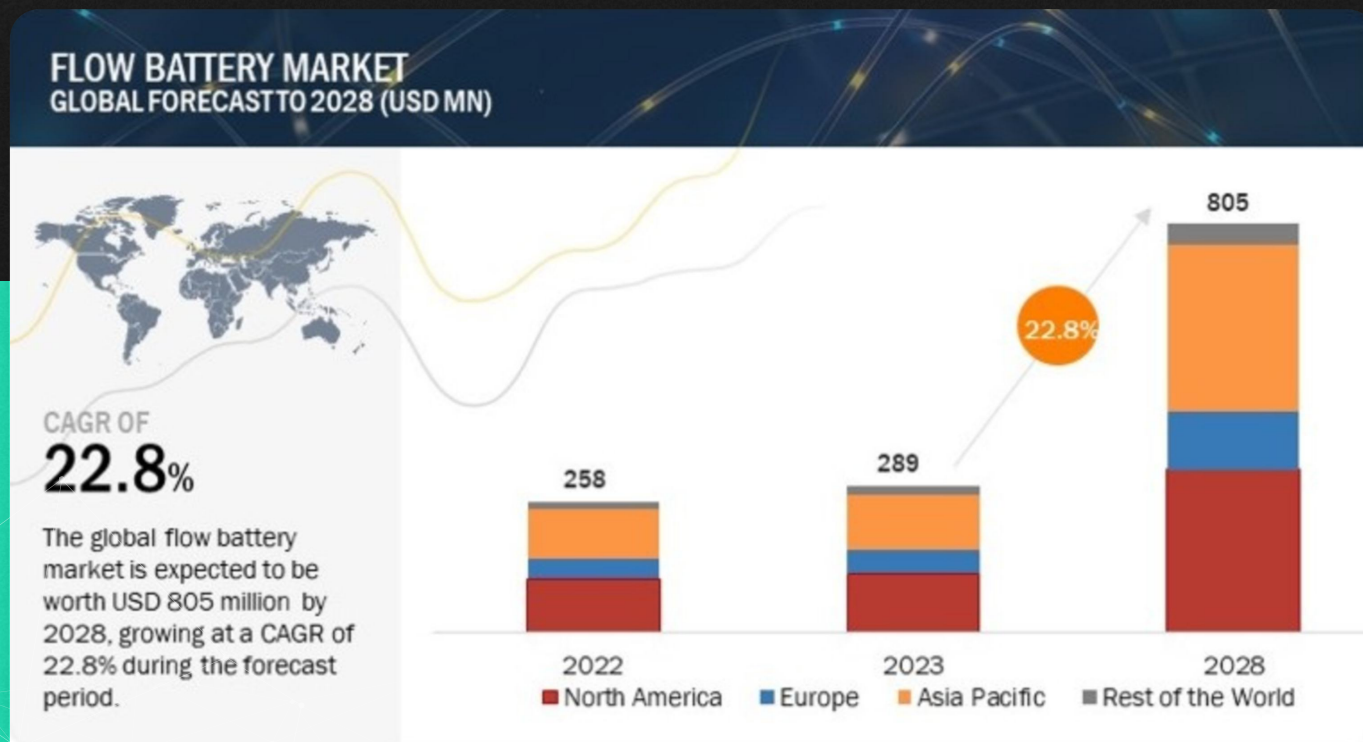
- Load shift, Peak shifting
- Peak-time reduction (peak-shaving)
- Green peak load
- Support for PPA contracts
- Scheduling, balancing support
- Load leveling and emergency power supply system



Market Trends in VRFB:

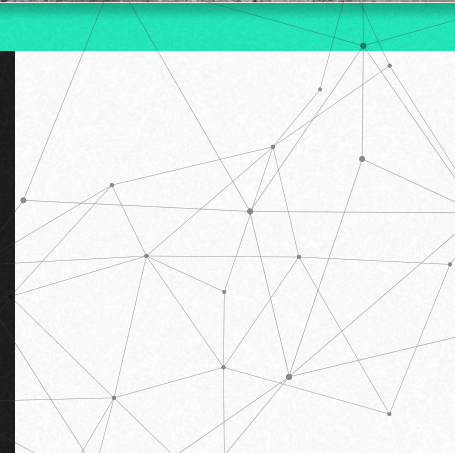
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- Total installed and planned capacity: **1.7 GW**
 - Asia + Australia: ~1600 MW
 - USA: ~60 MW
 - Europe: ~50 MWh
- Forecasted market growth: **110%** in the next 5 years. Expected market value by 2028: **USD 805 million.**
- European breakthrough also expected in the near future.
- Focus on long-duration energy storage (6–12 hours).



Pilot project: Öskü hybrid project

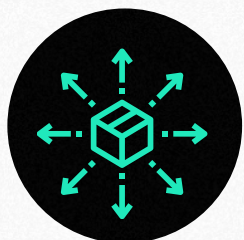
- **Konzorciumi partnerek:** IDEONA Zrt., University of Pannonia, Budapest University of Technology and Economics
- **Project with grant support and grid connection permission.**
- **250 kW solar power capacity.**
- **250 kW, 1.5 MWh (6-hour system) Redox Flow Battery.**
- **Goal: Testing regulation and scheduling of weather-dependent systems in a real environment.**
- **Total project cost: HUF 1.4 billion, CAPEX ~HUF 1.2 billion.**
- **Expected commissioning: Q2 2025**
- **Expected results: the aim of the research is to develop an integrated Vanadium Redox Flow Battery**
- **Investigating the scheduling improvement effect of a flow battery.**



About IDEONA

1. Distribution

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**Exclusive domestic distributor of Redox
Flow Storage solutions**

(Cellcube (A), Invinty (Sco), Sumitomo (JP))

cellcube
BUILDING ENERGY STORAGE INFRASTRUCTURE

 **INVINTY**
ENERGY SYSTEMS

 **SUMITOMO
ELECTRIC**

IDEONA - What do we do?

2. PV+VRFB hybrid/stand-alone storage project development

08 Maintenance

- EPC partner working closely with the technology manufacturer
- Warranty repairs & general maintenance

07 Related aggregators services

- Demand side regulation services to maintain network stability (aFRR+/- services to TSO)
- Profit maximised energy trading

06 Implementation of the investment

- Fixed price EPC implementation.
- EPC partner: service certified and contracted by technology manufacturers

01 Site selection

- Identification of connection point(s)
- Development area design (legal - technical preparation)

02 Planning and authorisation

- Complex planning & authorisation process
- EPC partner reference: 1.5 Gigawatt+ renewable project

03 Business modelling and planning

- Business plan certified by independent experts
- Market volatility modelled

04 Full allocation of resources

- Raising capital through a fund manager
- Commercial bank financing

05 Choosing a technology partner

- TOP 3 technology partnerships

The logo for ideona, featuring the word "ideona" in a white, lowercase, sans-serif font, centered on a black rectangular background.

Contact

ideona

+36 30 637 3797
szilard.kovacs@ideona.hu
ideona.hu

Szilard Kovacs
Board Member