

ansaldo | green tech

ANSALDO GREEN TECH

Speaker: *Bartolomeo* Gianni Marcenaro

CUSTOMER DAY - October 4th 2023

Your partner for the energy transition

Incorporated in 2021 with the mission to develop new business opportunities in the energy transition market.

Ansaldo Green Tech is the All-Round Italian player for the energy transition.



**ENERGY
STORAGE**

- **Innovative Electrochemical Storage solutions** for Utility Scale



**TRANSITION
READY**

- **Multi-fuel Microturbines** (H₂, Biogas, Methanol, etc.)



**GREEN
HYDROGEN**

- **Electrolysers Manufacturing**
- **Hydrogen Production Plants**
- **Hydrogen Plant Maintenance**

Electrolysers for Green H₂ production



Hydrogen Global Market

Forecast of Global Hydrogen Capacity Yearly Additions:



2016



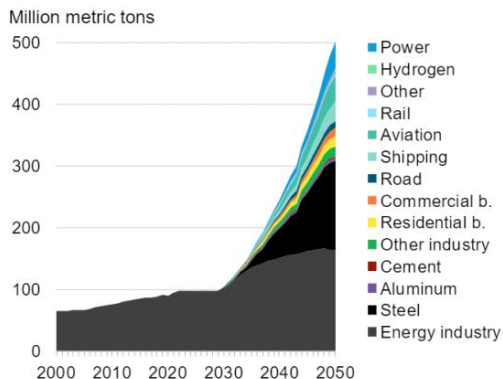
78 countries all over the world

with an H₂ strategy **already in place** or **in preparation**

Hydrogen Global Market

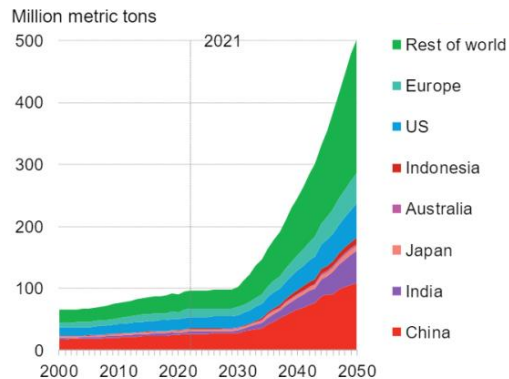
- Green H₂ utilization is the only **decarbonization way** for some hard to abate sectors such as ironmaking and chemical industry.
- Green H₂ market** is expected to grow significantly starting from 2028/2030.

By sector



Source: BloombergNEF. Note: "Energy industry" includes legacy uses as well as own use for energy-producing industries. Net Zero Scenario is from BNEF's New Energy Outlook.

By region



Source: BloombergNEF

Ansaldo and Hydrogen



1990-2010

Ansaldo Fuel Cell

MCFC technology
development and
factory set-up



2006-TODAY

Ansaldo Energia

H2 combustion:
Brindisi Power Plant
AE94.3A



Today & Tomorrow

Ansaldo Green Tech

AEM electrolyser
development

Ansaldo Green Tech approach:

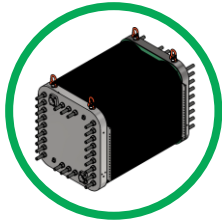
- Proprietary Design
- R&D and IP development
→ first patent applications
in 2023
- Strong R&D network

Today & Tomorrow

Ansaldo Green Tech

AEM electrolyser development

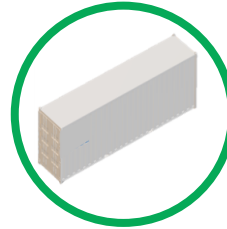
H2 2023



Short Stack Validation

1st step Technology Validation Process.

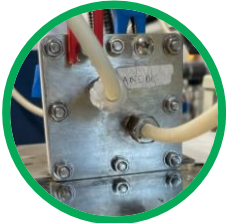
H1 2025



System

Finalize BoP engineering.
Ex Work of First MW-class AEM electrolyzers.

H1 2023



Component Test

Membrane Validation.

H1 2024

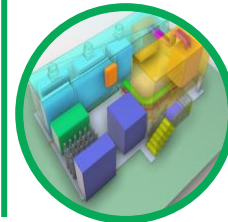


Sub-Scale Stack Validation

2nd step Technology Validation:

Assembly and Test of short stacks with more cells.

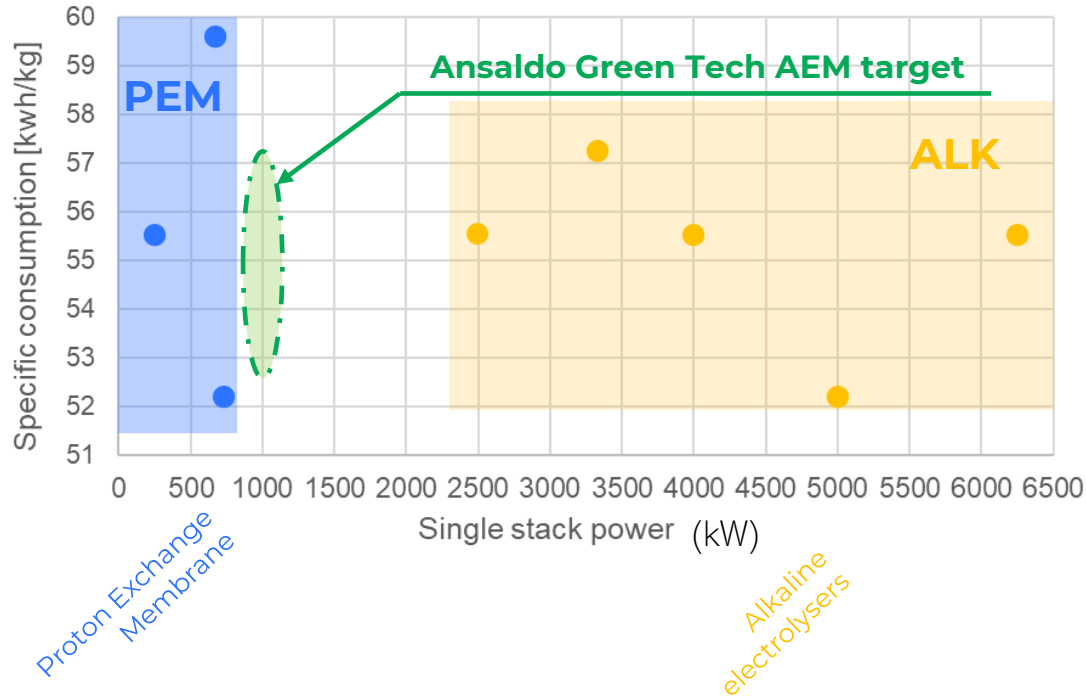
H1 2026



Plant

Integration of several MW-class systems.
Turnkey plant commissioning.

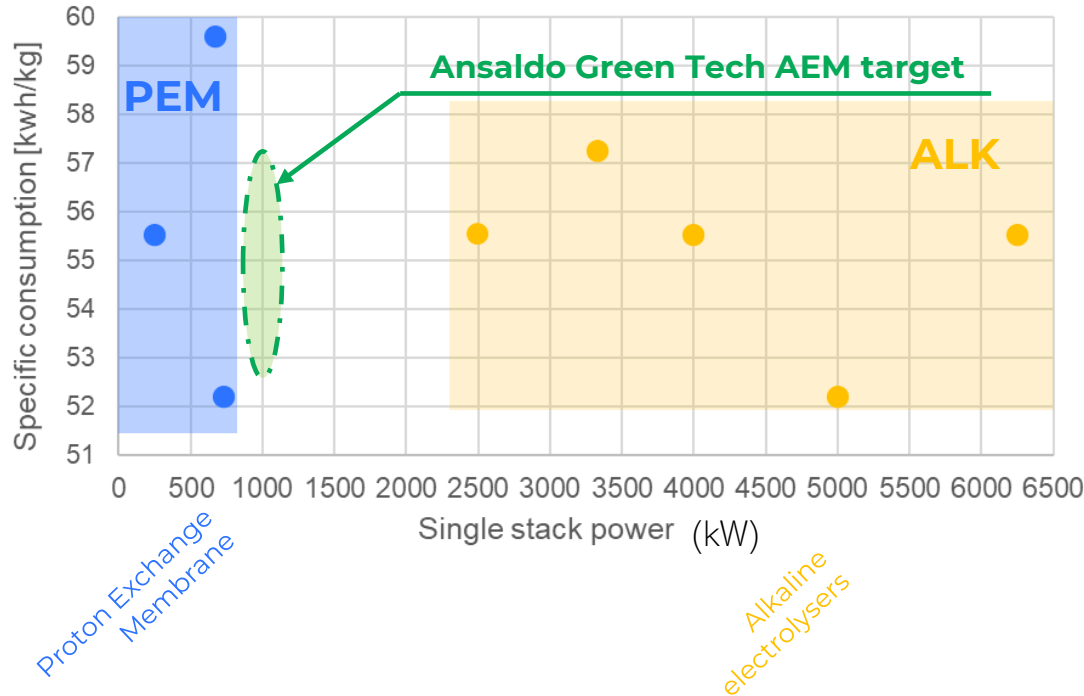
AEM Electrolysers



Anion Exchange Membrane (AEM)

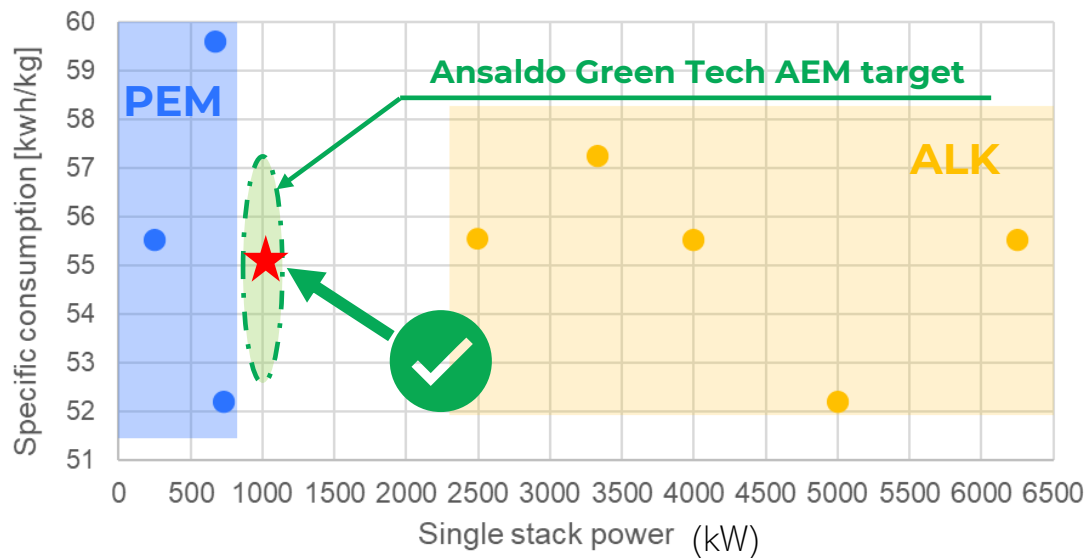
is a low temperature water electrolyser that overcomes the main disadvantages of competing technologies in terms of flexibility and dependency on critical raw materials

AEM Electrolysers



- **System Specific Consumption**
<58 kWh/kg H₂
- Fast response and flexible operation
→ **synergies with RES**
- Low rare materials use
- **High purity** of pressurized H₂ and O₂
- No ultra-pure water
- No strong alkaline solution: **more** eco-friendly, **less** maintenance
- Containerized solution **1-4 MW**

AEM Electrolysers



1st experimental campaign August 2023
results in line with expectations



AE-T100 Microturbine



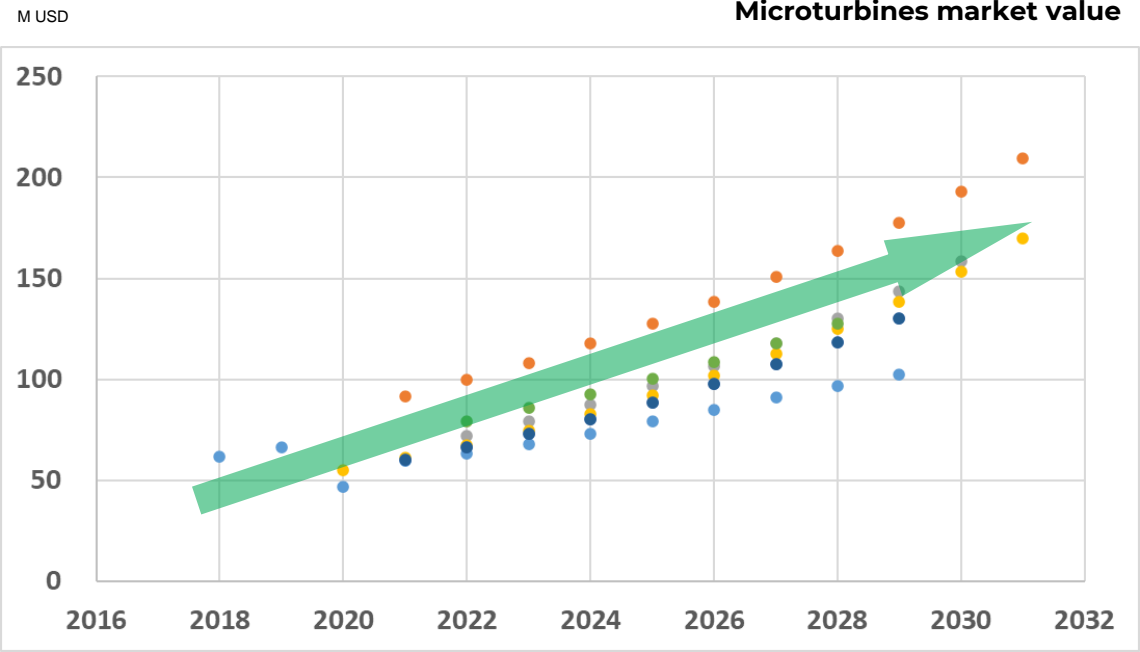
Microturbines Market Outlook



Energy Transition is bringing **new complexity** to the electrical grids:

→ distributed energy systems are a **new opportunity for decentralized power production solutions**

Microturbines Market Outlook



Among others decentralized technologies, **microturbines are expected to play a key role** due to fuel flexibility and operational rangeability

Multi-fuel Microturbines

100kWe



NATURAL GAS

167kWth



BIOGAS

30% Eff.



15 ppm NOx
CO



INTERNAL
FUEL BOOSTER



INDOOR-OUTDOOR



MICROTURBINE
AE-T100 CHP



SOLAR e Micro grids

Multi-fuel Microturbines

100kWe

167kWth

30% Eff.

15 ppm NOx
CO

INTERNAL
FUEL BOOSTER

INDOOR-OUTDOOR

NATURAL GAS

BIOGAS

HYDROGEN

SOLAR e Micro grids



MICROTURBINE
AE-T100 CHP

100% H₂ since 05/2022

@Stavanger University
(Norway)

Multi-fuel Microturbines

100kWe

167kWth

30% Eff.

15 ppm NOx
CO

INTERNAL
FUEL BOOSTER

INDOOR-OUTDOOR



MICROTURBINE
AE-T100 CHP

NATURAL GAS

BIOGAS

HYDROGEN

METHANOL

SOLAR e Micro grids

100% synthetic CH₃OH
in commercial operation
since 11/2022

@Sprüngli (Switzerland)

Multi-fuel Microturbines

100kWe

167kWth

30% Eff.

15 ppm NOx
CO

INTERNAL
FUEL BOOSTER

INDOOR-OUTDOOR



MICROTURBINE
AE-T100 CHP

NATURAL GAS

BIOGAS

HYDROGEN

METHANOL

AMMONIA

SOLAR e Micro grids

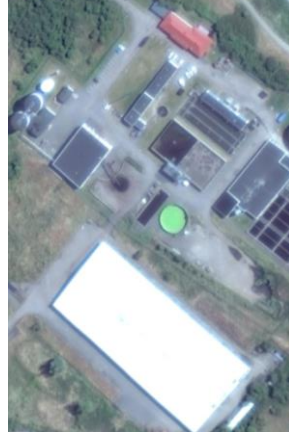
Tested up to 30% NH₃
target 100% <2023

@Saudi Aramco and
KAUST- King Abdullah
University of Science and
Technology



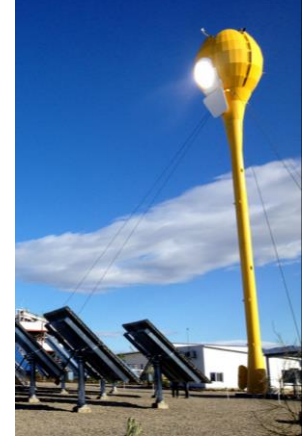
Civil/Industrial applications





Biogas application (Landfill, Wastewater)





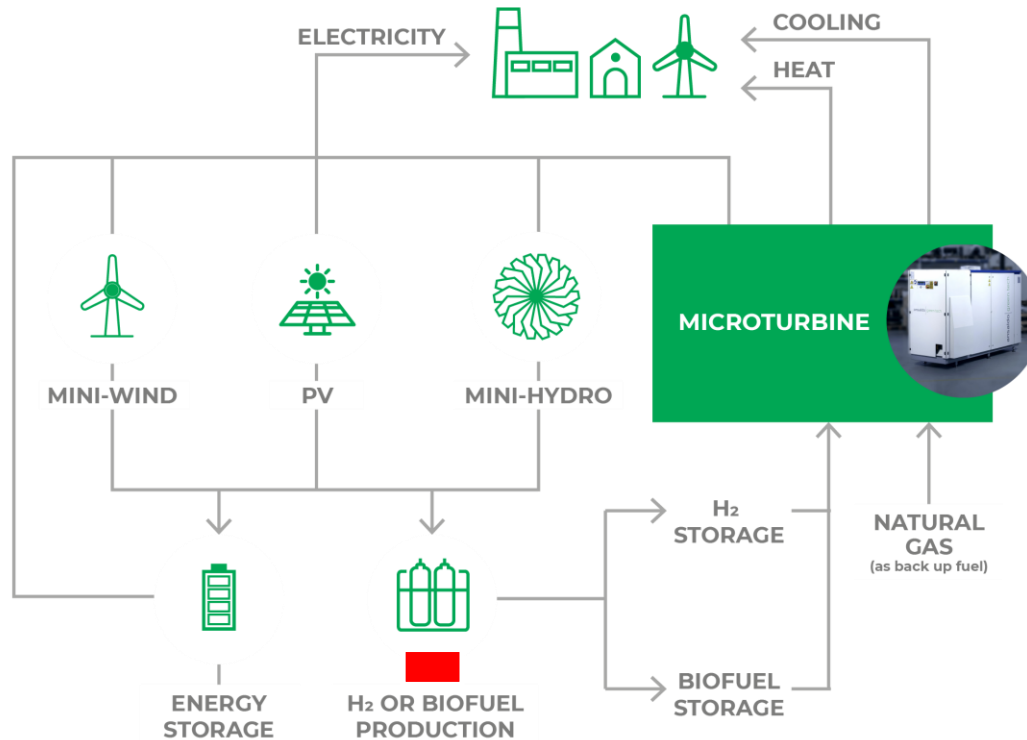
Solar and Biomass applications



Microturbine for Energy Transition

Development, validation and testing within a microgrid of a new version of a 100kW microturbine, capable of using zero-carbon footprint "e-fuels."

Microturbines evolution



Microturbines evolution

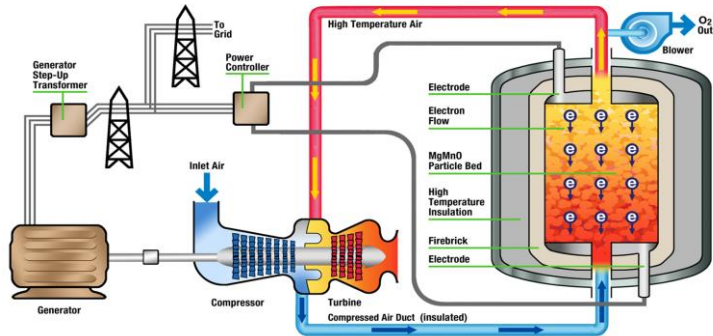
Long Duration Energy Storage Applications (in collaboration with Redox Blox)

- AT-100 coupled with innovative thermo-chemical energy storage technology



magnesium-manganese oxide (MgMnO_2)

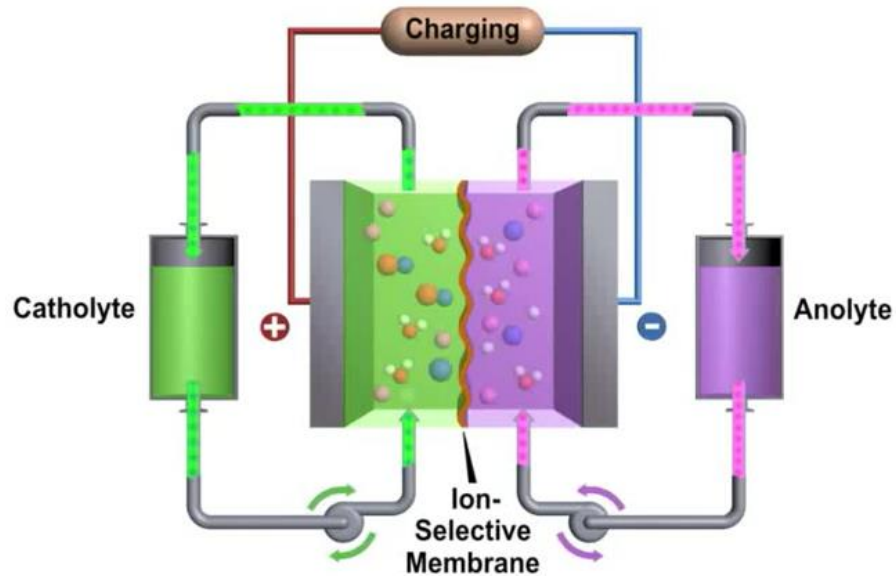
- Project funded by USA Department of Energy
- Thermal storage capacity: 2 MWh /Electrical power output: 100 kW/Storage duration: 15 h



Vanadium Redox Flow Batteries

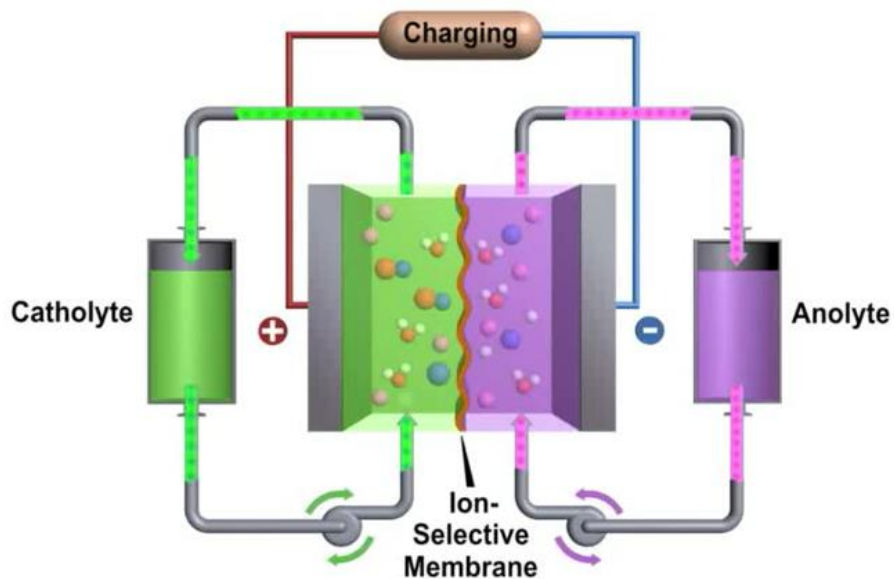


Vanadium Redox Flow Batteries



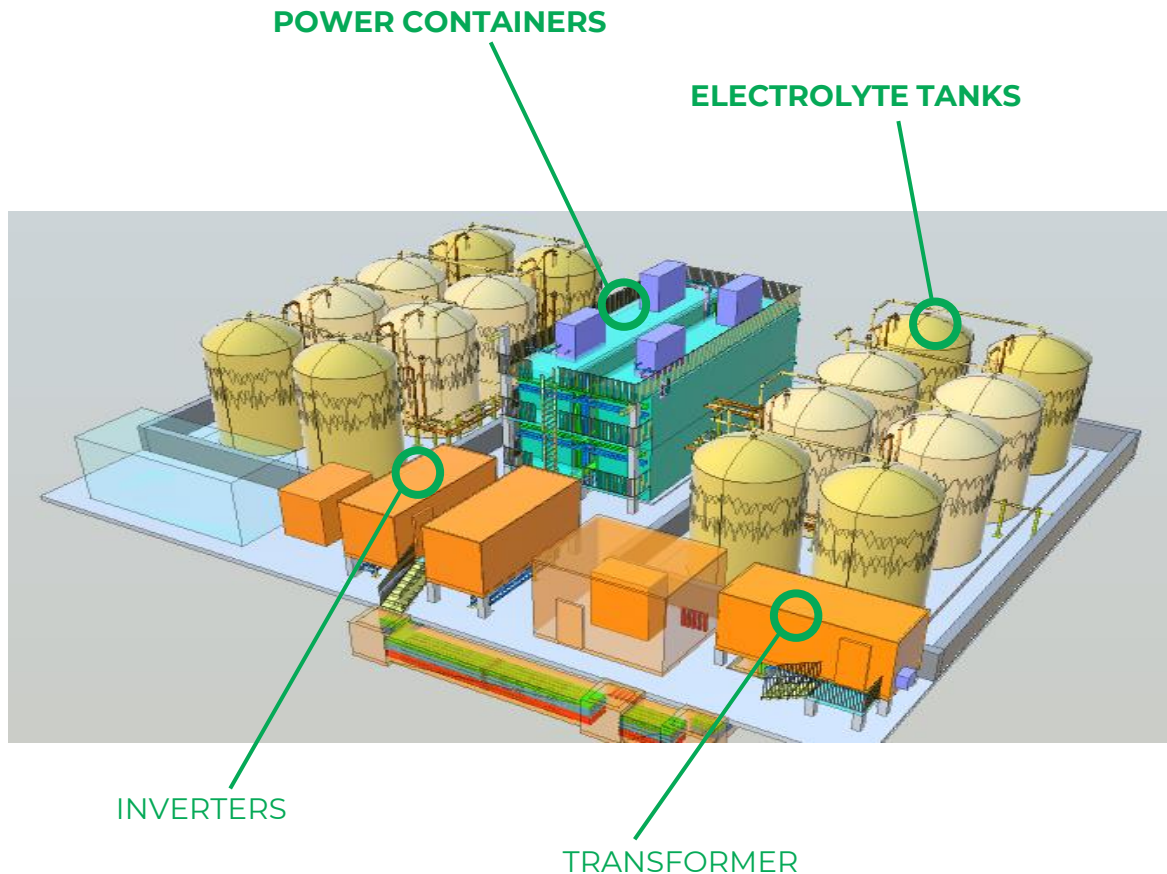
- Liquid **electrolytes (Energy)** are stored in separate tanks and pumped through the **electrochemical stack (Power)** during charge/discharge operation.
- The electrochemical active element is **Vanadium in an aqueous solution**

Vanadium Redox Flow Batteries



- **Power and Energy decoupled:**
scalable storage capacity independent from power (>4 hours charge cycle for Energy Shifting)
- **Longer lifespan:**
20+ years, unlimited cycles
- **No capacity degradation**
after cumulative cycling
- **100% depth of discharge**
- **No self-discharge**
- **Safe:**
no fire risk from thermal runaway
- **Sustainable:**
upon plant decommissioning, 100% of electrolyte is reused in a new plant. Also, no critical raw materials are used

Ansaldo VRFB concept



Product features

Discharge duration:

5-10 hours

Efficiency:

78% DC/DC, 68% AC/AC

Response time:

<1sec (pumps on)

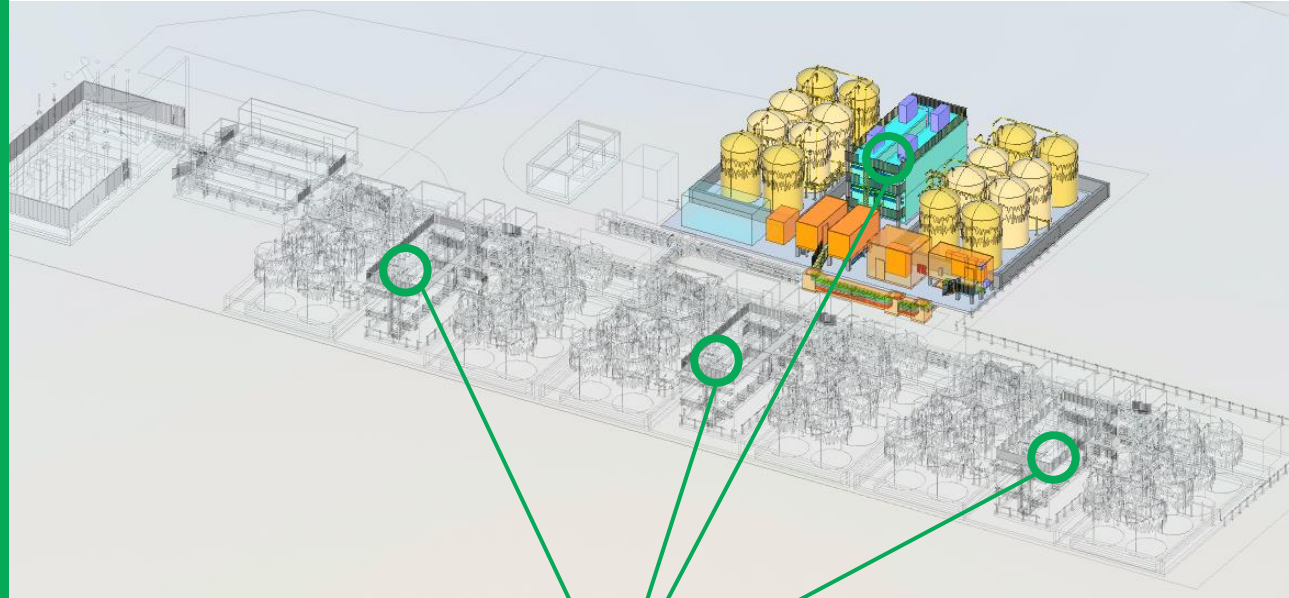
Lifetime confirmed:

20+ years, unlimited cycles

Ansaldo VRFB

Modular design

Integration of several modular systems for energy shifting utility scale application



**INTEGRATED MODULAR
SYSTEMS**

Attitudes ...



1908 “...I therefore ask permission to also deal with airplanes, which are manufactured here in the same workshop...”

Eng. Luzzatti appointed by Ansaldo CEO to discover the industrial secrets of airships



1914/15 “...this device seems destined to give great results in distant reconnaissance...”

Eng. Brezzi, general director of the Ansaldo aeronautical shipyards



1918 **250 airplanes/y capacity**

THANK YOU FOR YOUR ATTENTION

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