Accelerating Net Zero Energy Systems with Liquid Air Energy Storage

Jan Andersson
Director, Market Development
5 December 2022

Sumitomo SHI FW

SFW is part of Sumitomo Heavy Industries' Energy & Lifeline segment

Year 2021

Logistics & Construction

€2387M

Industrial Machinery

€1617M

Energy & Lifeline

€1435M

Others

€42M

Mechatronic

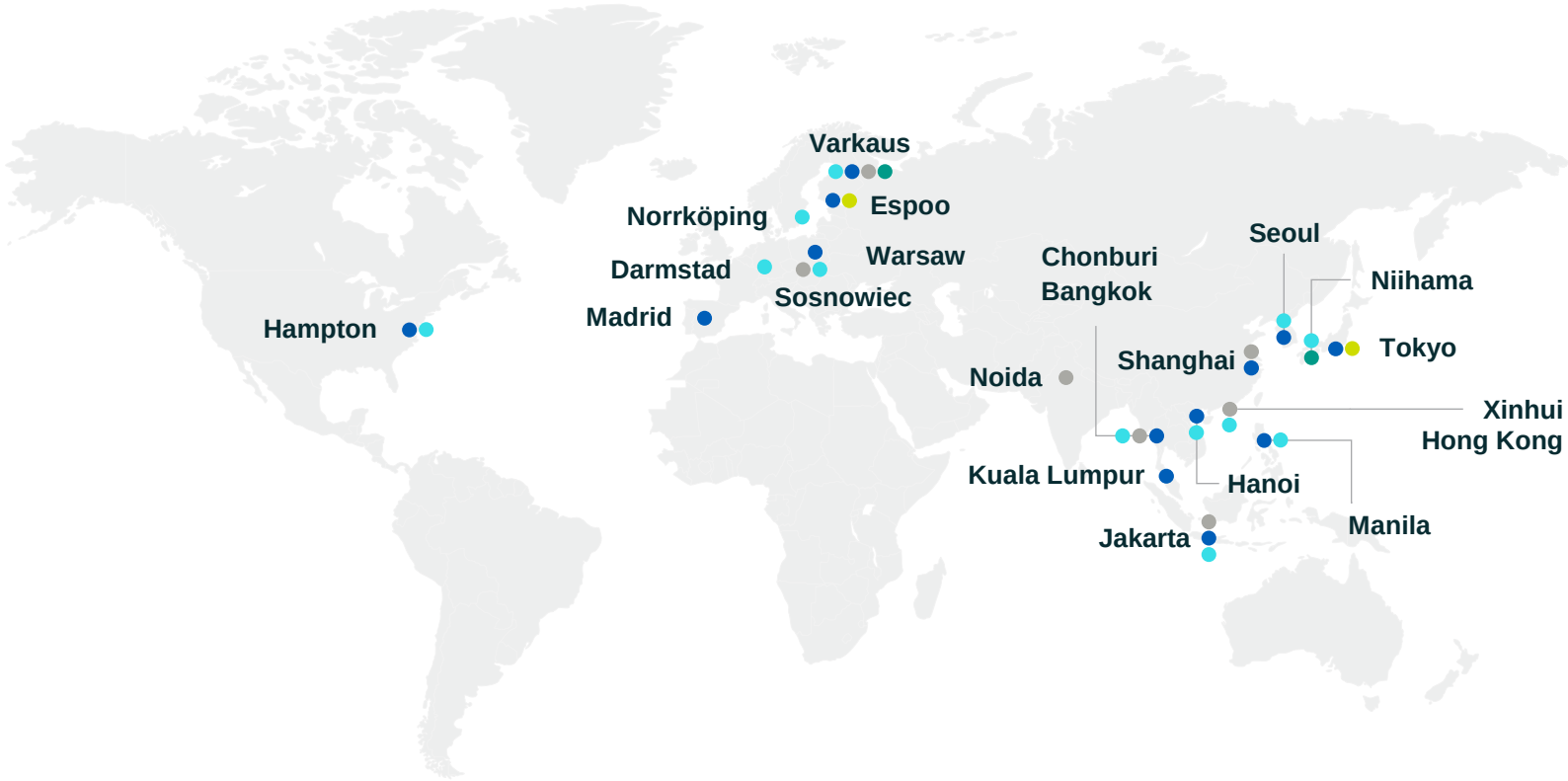
€1127M

Sumitomo SHI FW

Global reach with

1,800

highly skilled people



- Head office
- Engineering centers
- Sales offices
- Factories and after-sales service offices
- Research and development centers

Sumitomo SHI FW

SFW response to decarbonization and climate change mitigation

Helping our customers to reach decarbonization goals

Energy generation

Energy from biomass or waste for carbon neutral or carbon negative heat & power applications

Carbon capture

Carbon neutral traditional energy generation and integration with production of renewable fuels

Services

Life cycle solutions enabling high plant availability and efficiency

Waste to value

Solid waste into syngas, biofuels & chemicals, or plastics recycling

Energy storage

Long Duration - Enabling net zero grid systems to limit the climate change

Sumitomo SHI FW

Liquid Air Energy Storage (LAES)

The technology uses an easily available resource, **clean air** which is cooled and **stored as a liquid**. It is subsequently converted back into pressurised gas which drives a turbine to generate electricity. There are **no harmful emissions** in the process.

The process is optimized to deliver storage solutions targeting a wide range of services i.e. grid ancillary, energy shifting, peaking, base load (round-the-clock) renewable power.

“We integrate and optimize long duration energy storage systems to provide flexible, sustainable and secure energy infrastructure”

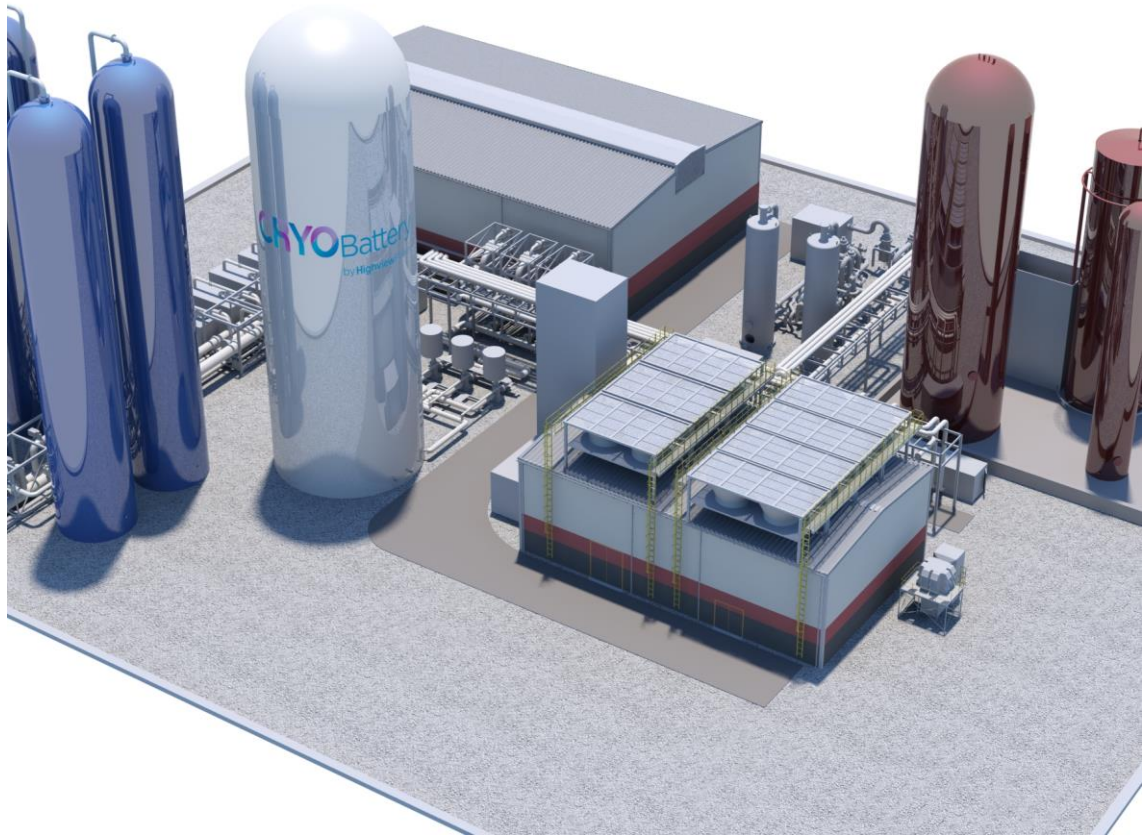
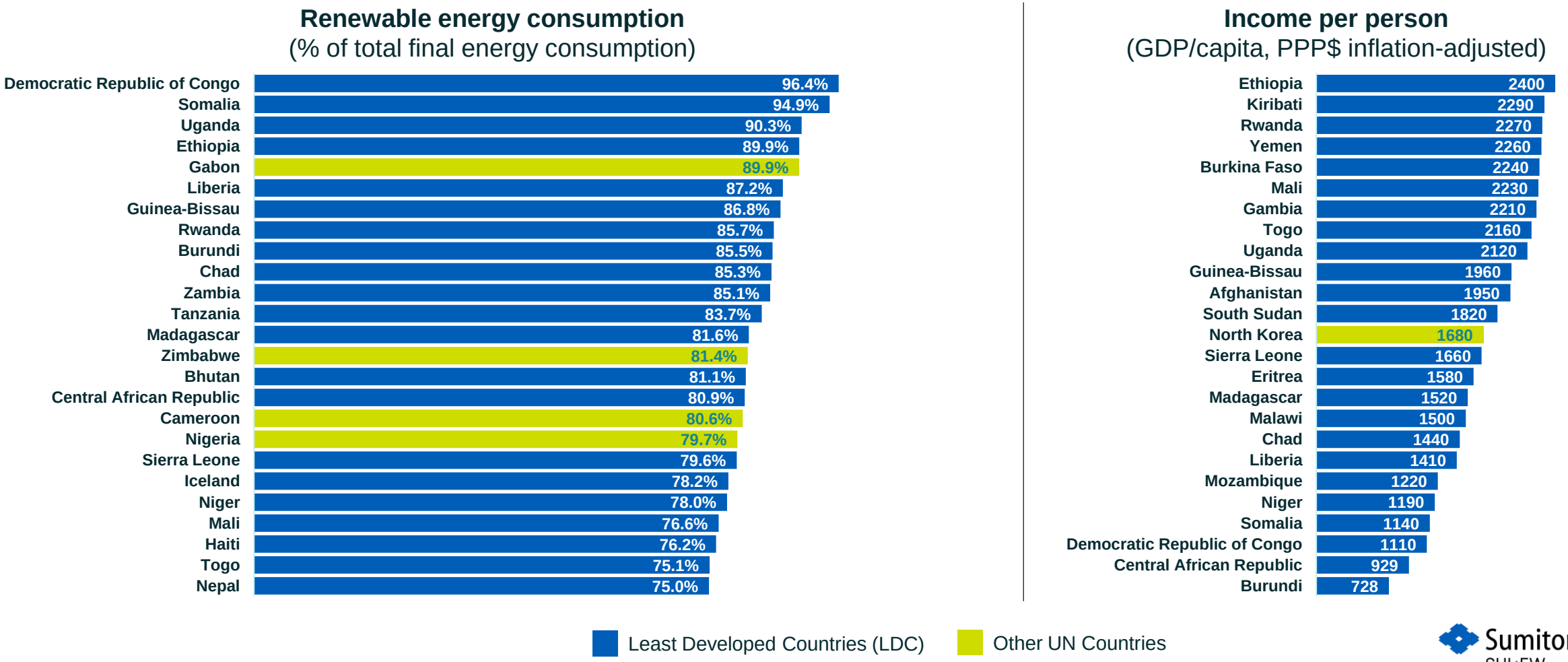


Image of Highview Power’s CRYOBattery™

Sumitomo SHI FW

Liquid Air Energy Storage allow developing countries to by-pass the fossil fuel era

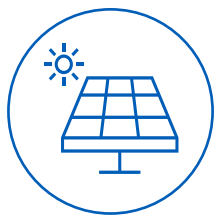
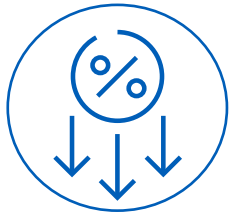
- Many of the Least Developed Countries (LDC) have a very high share of renewable energy, relying on sources such as hydro and biomass
- With LAES countries can have 24/7 reliable renewable power

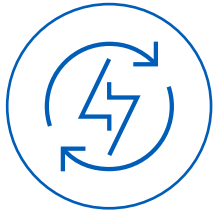


Source: WDI tables, Gapminder

100% carbon free electricity – always!

LAES systems provide crucial services for the power grid and support electrification of rural areas in a sustainable way




Energy Shifting
- Intra-day
- Inter-day
- Weekly storage

Net zero eco system
- Integration with external sources of heat or cold such as LNG plants

Grid ancillary services
- Rotational inertia
- Frequency support
- Voltage support
- Reactive power
- Spinning reserve

Islands and off-grid mining
- Decarbonizing smelting operations
- Reducing fuel consumption
- Enhancing security of energy supply

Future proofed asset
- Lifetime >30 years
- Decoupled charging and discharging powers
- Flexible charging and discharging ratios
- Negligible capacity degradation
- Highly scalable
- End of life recycling
- Circular economy
- Low supply chain risks

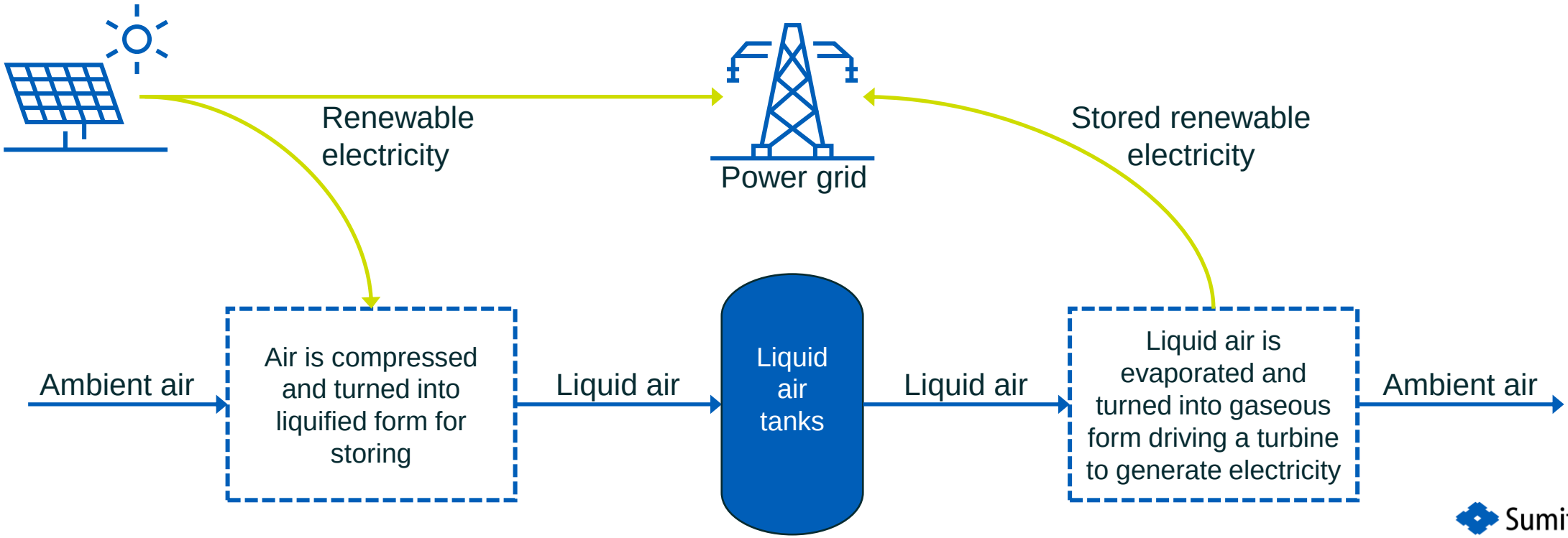
LAES is a scalable, ultra-flexible, location agnostic long duration energy storage system

Sumitomo SHI FW

Liquid Air Energy Storage (LAES)

Utilizing established process and equipment from industry in a novel way to store energy

- **Zero emissions** – uses ambient air turned into liquide to store energy
- **Location agnostic** – can be colocated with renewable energy farms or at critital nodes in the power grid
- **Round Trip Efficiency** (RTE) is improved by utilization of heat storages in the process



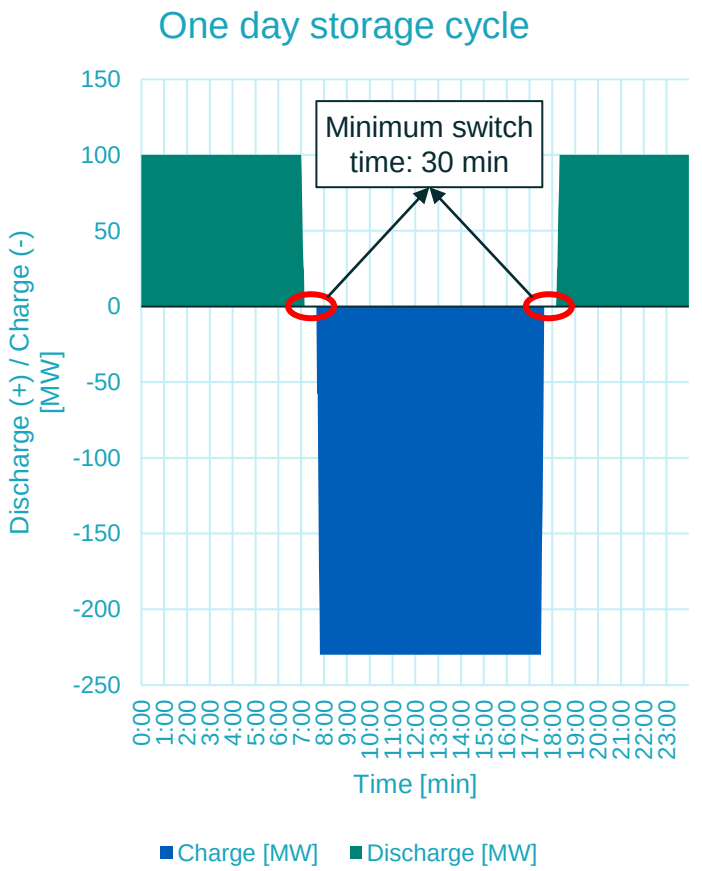
Sumitomo SHI FW

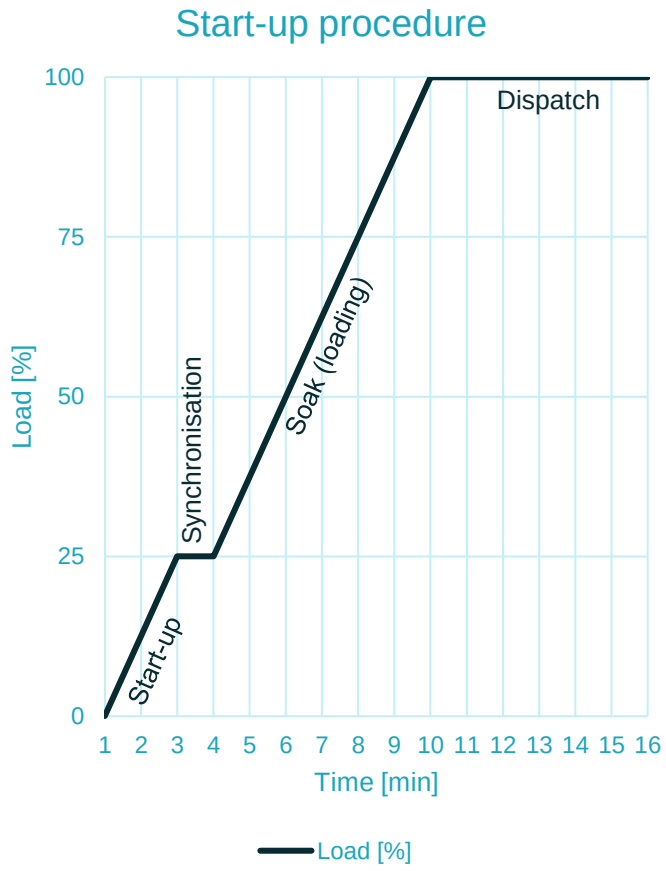
Optimisation and standardisation ongoing to improve customer value

LAES plant characteristics

- Parameters are still being optimized in cooperation with suppliers and partners
- Minimum load 25% in 2 minutes
- Synchronisation done at minumum load
- Full charging power reached in 10 minutes from start
- Round-trip-efficiency 50-55%. Development ongoing to increase RTE

Charge MW	Storage h / MWh	Discharge MW	Footprint m^2
50	8 / 400	50	15 000
200	8 / 1600	200	30 000



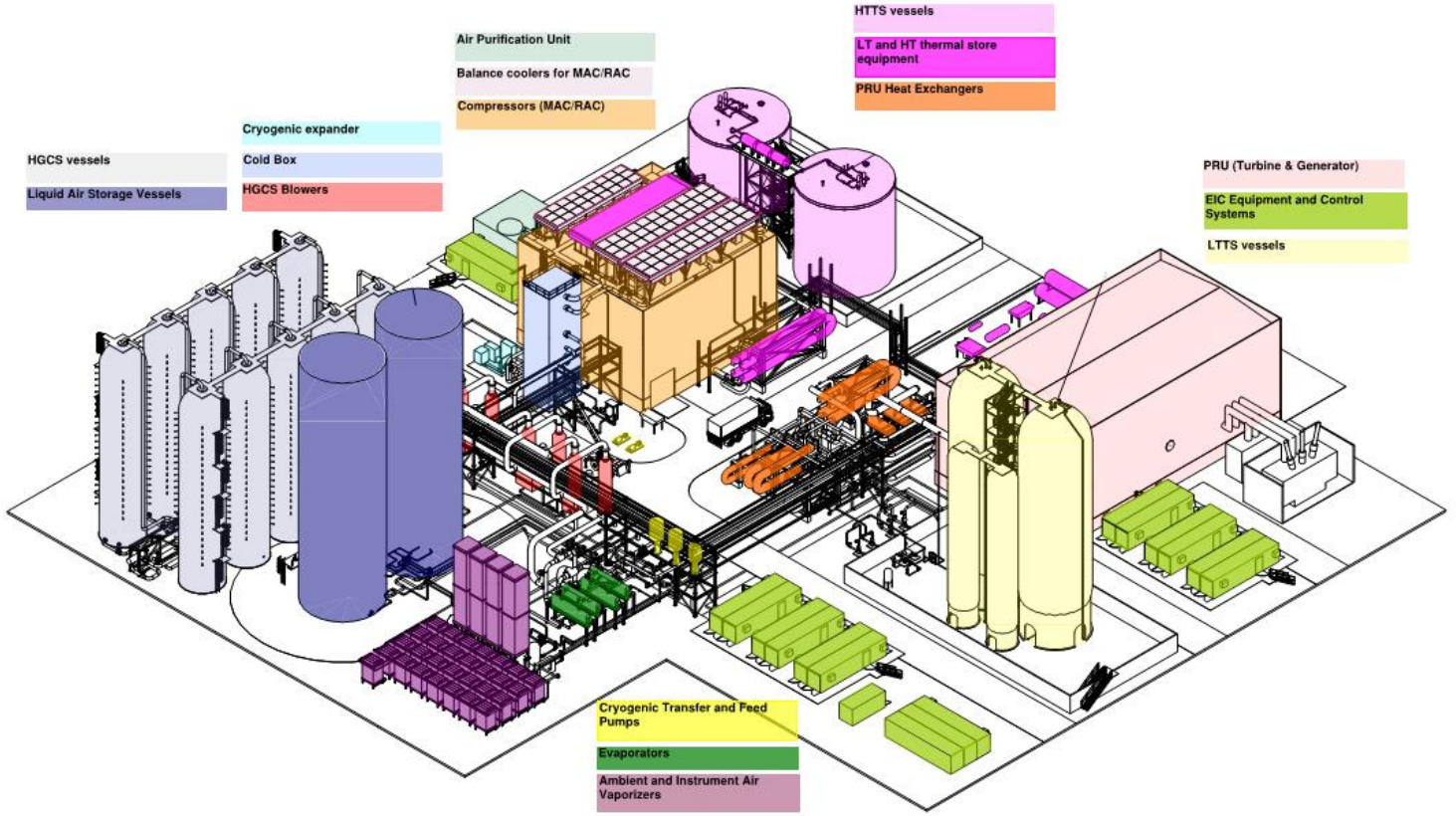


Sumitomo SHI FW

Reference plant layout

No explosive classification (e.g. ATEX) requirements

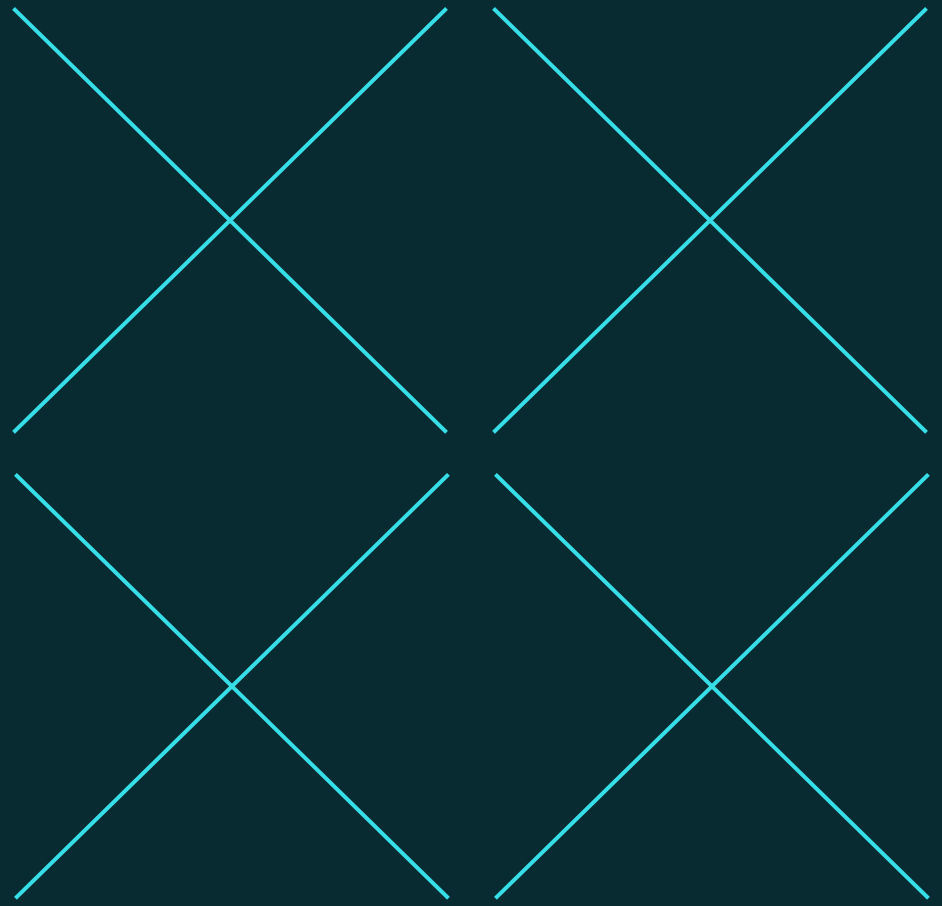
Oxygen-service compatibility required. International codes such EIGA and/or AIGA followed



Note: The lay-out shown is a template, not customized for a specific case.

Sumitomo SHI FW

Case study: Optimisation of island system with LAES



Sumitomo SHI FW

Optimization model details

Input Details

Dynamic parameters and system constraints

1. Minimum stable output power, minimum up/down times
2. Only renewable energy sources (RES) are used to charge the LAES
3. Inertia – Sum of thermal generation and LAES discharge capacity must be at least 10% of the system hourly load demand
4. CO_2 emission cost – 90 EUR/tonne
5. Part-load efficiencies were taken into account for the thermal generators
6. Hot, warm and cold start-up profiles were taken into account where applicable for the thermal generators

System data

- 1 transmission node (copper plate)
- Thermal generators – Vasilikos, Dhekelia, Mari, Moni. Full data available at https://www.iene.eu/
- LAES configuration – 200MW charging, 1.6GWh storage capacity, 200MW discharging, 55% RTE, 30 minutes switch time from liquefaction to power recovery and vice versa
- Aggregated solar and wind power plants

Simulation scenario

- **Comparing the system with and without LAES when the RES penetration level is 60%**

Model formulation and optimization

- Using the input data, the power system optimization problem is formulated and solved using PLEXOS

PLEXOS

- PLEXOS uses Gurobi in the background to solve the formulated mixed integer linear programming problem. All the constraints and inputs are taken into consideration while solving the problem

Sumitomo SHI FW

Liquid air storage will provide significant benefits for the power system

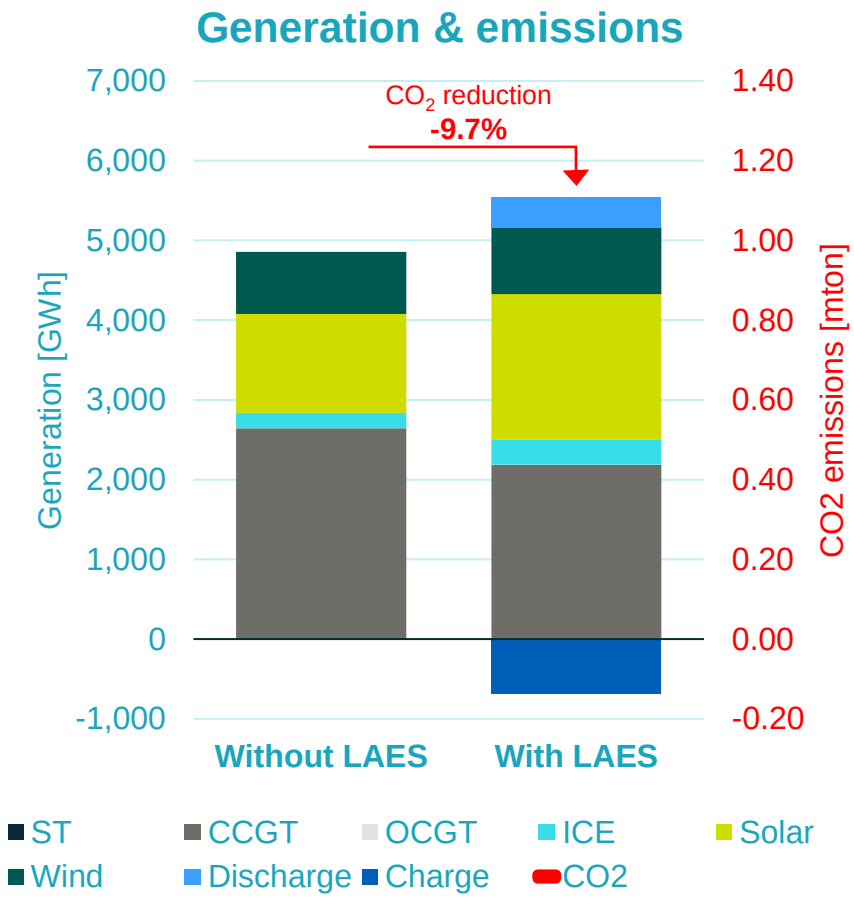
LAES allows the system to better utilize renewable energy and maintain grid stability

Reduced CO_2 emissions
-9.7%

Increased utilisation of wind power
8.0%

Increased utilisation of solar power
46.6%

Reduced fuel consumption
-17.3%



Sumitomo SHI FW

THREE TAKE AWAYS

1. LAES is a proven long duration energy storage technology
2. LAES increases the utilization of renewable energy and accelerate the net zero journey
3. Give developing countries opportunity to by-pass fossil fuel era

Sumitomo SHI FW

Thank you

Jan Andersson
Director, Market Development
jan.andersson@shi-g.com

Connect on LinkedIn