



Energy Storage Summit 2024

Grid-Forming – The Keystone of Transition to Renewables.

Friedrich Piontek-Helms, Head of Global Business Development Large Scale

SMA Solar Technology AG

London, 20/02/2024

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Quick survey



Agenda



- 1 Short introduction SMA
- 2 Grid Forming: Drivers, Definition, References
- 3 Grid Modeling Support
- 4 Summary



“Energy transition company” and pioneer for decarbonization & decentralization since 1981.

SMA Solar Technology AG (2024)

>130 GW installed solar inverters **1,700** patents & utility models
>10 GW installed battery inverters **3,600** employees
86 MT/a CO₂e avoided **20** countries (sales & service)

"Made in Germany" & European Supply Chain:

Main production facilities & HQ @ Kassel (Germany)

Magnetic component manufacturing @ Krakow (Poland)

Assembly and shipping of MV systems @ Sicily (Italy)



Key financials 2022

Sales: MEUR 1,066
EBITDA: MEUR 70
Inverter power sold: 12,2 GW

Guidance 2023

Sales: MEUR 1,800 to 1,900
EBITDA: MEUR 285 to 325

Second **SMA GIGAWATT-FACTORY** will almost double today's production capacity at HQ in Germany to **40 GW/a** in 2025.¹

SMA will **expand manufacturing into the US** that will add additional **3.5 GW/a** of production capacity in 2025.²



Business Segments

SMA Solar Technology AG



Home Solutions



Commercial & Industrial Solutions



Large Scale & Project Solutions





Home Solutions



Commercial & Industrial Solutions

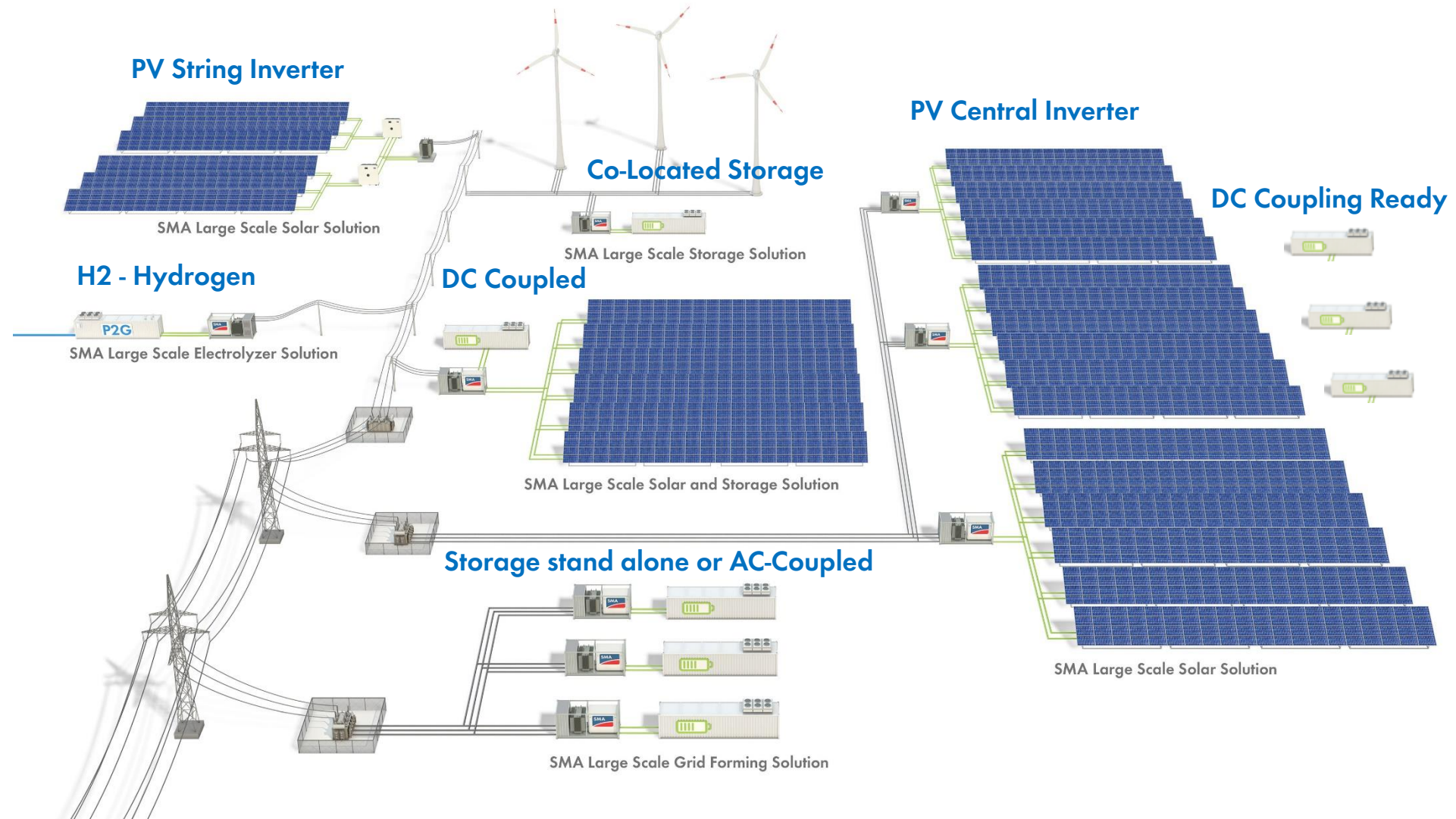


Large Scale & Project Solutions

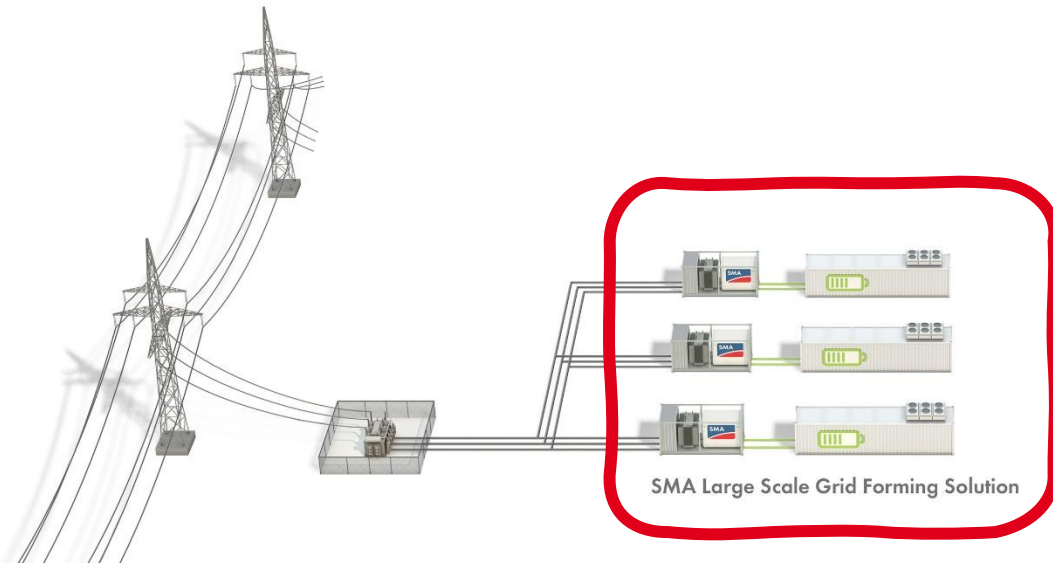
SMA Large Scale Energy Solutions (2000+)



SMA Large Scale Energy Solutions (2024) = PV/STORAGE/P2G



Today's focus: **Standalone Storage**



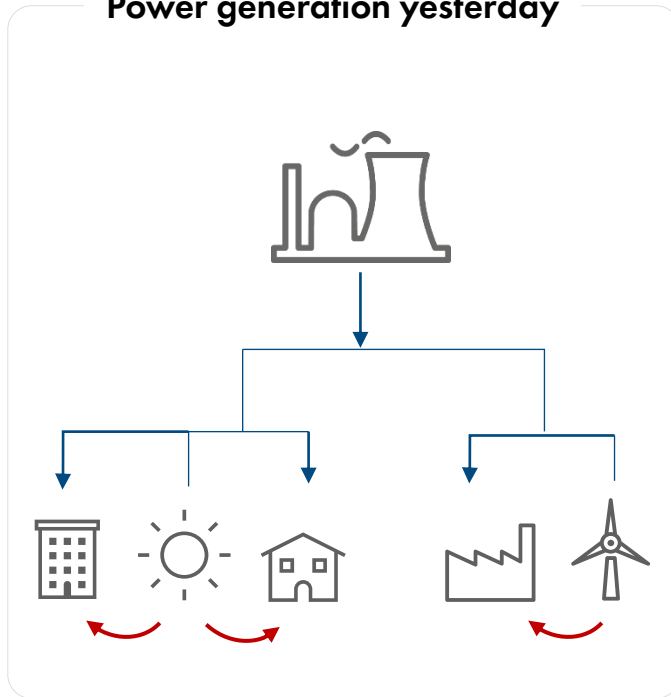


Why Grid Forming?

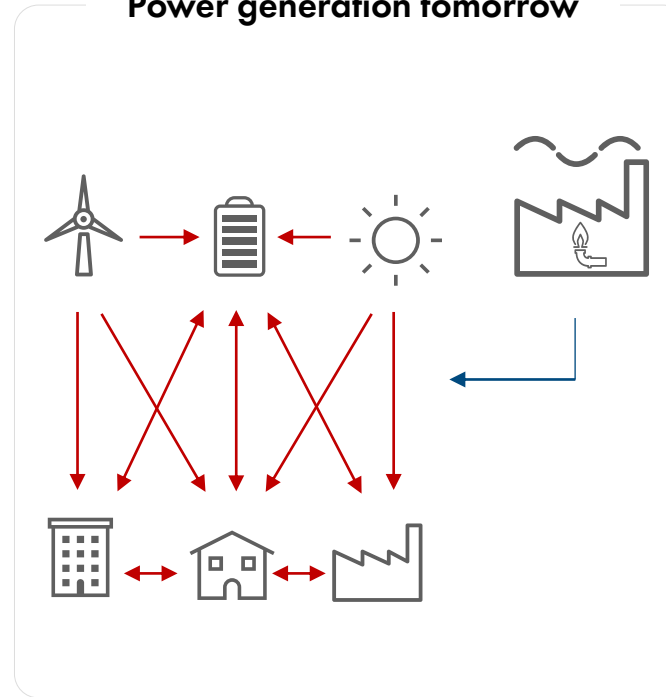
Energy transition = With increasing decentralization and decarbonization, the power system is becoming more complex.



Power generation yesterday



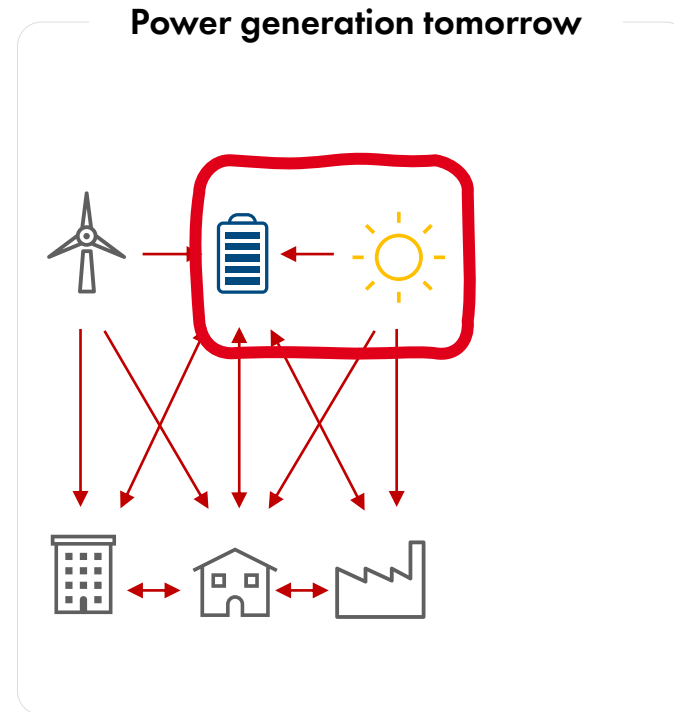
Power generation tomorrow



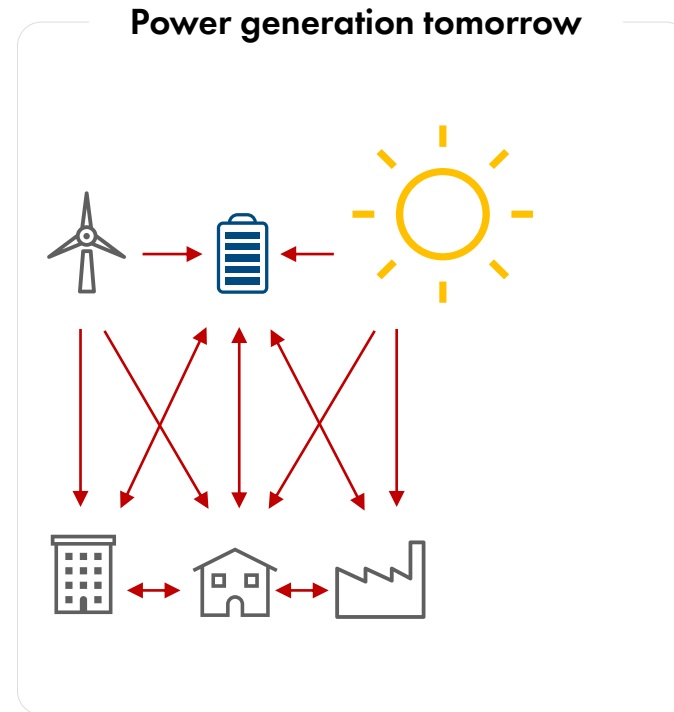
- Increasing share of RES, while **phase-out** of synchronous thermal power plants.
- Renewable energies and storage systems form the backbone of future energy supply.
- In order to integrate more renewable energy into the grid, **inverters need to support the grid via Grid Forming.**

- › In the future, the majority of grid stabilization will come from inverter-based resources (IBR), not rotating machines.
- › RES itself are in transition from “being part of the **problem** for the grid” (GFL) to “becoming the **solution** via IBR with Grid Forming capabilities” (GFM).

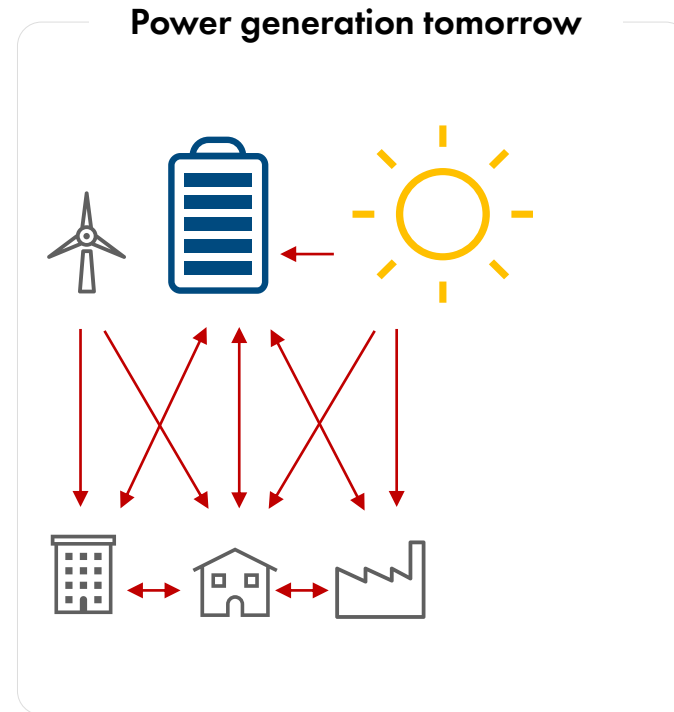
Zoom in on the “renewable resilience loop” or the “perpetuum mobile of **PV plus STORAGE**”:



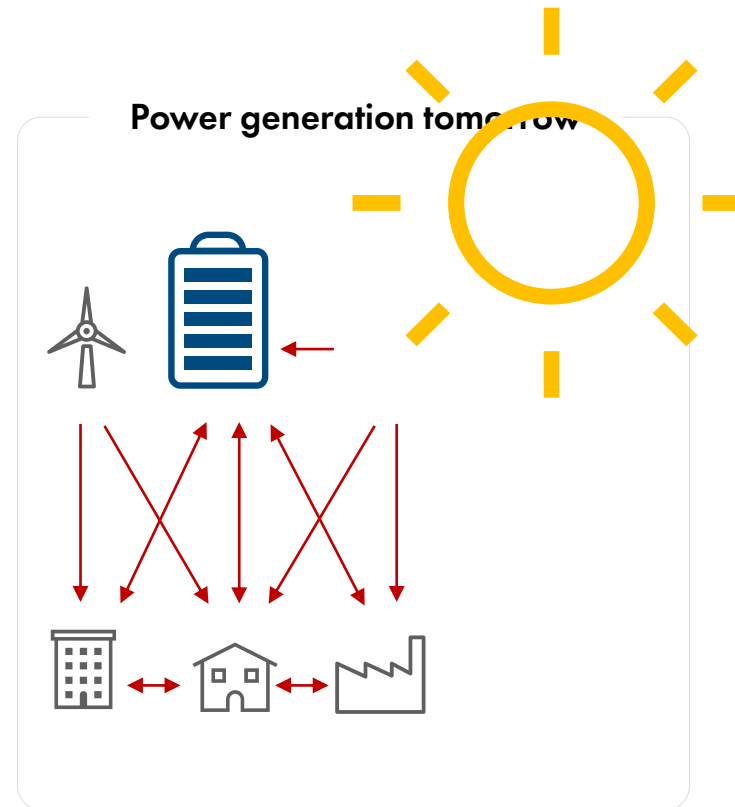
The “renewable resilience loop” of **PV plus STORAGE**:



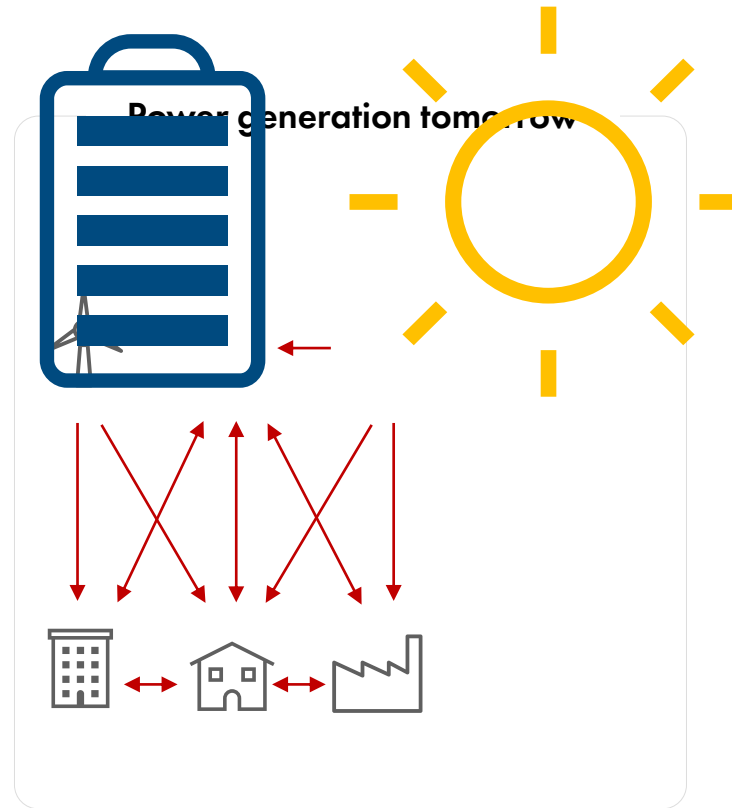
The “renewable resilience loop” of **PV plus STORAGE**:



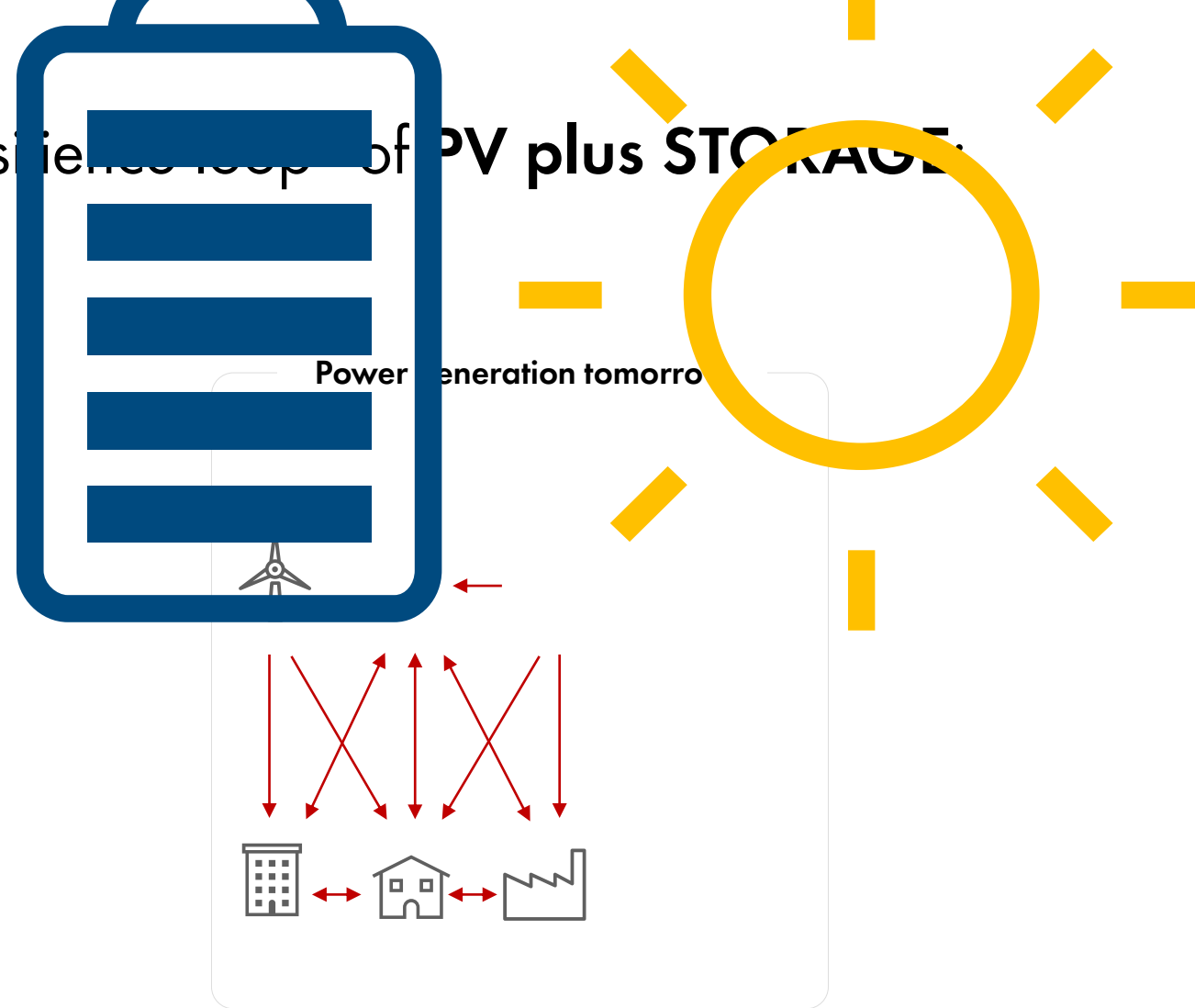
The “renewable resilience loop” of **PV plus STORAGE**:



The “renewable resilience loop” of **PV plus STORAGE**:



The “renewable resilience loop” of PV plus STORAGE



We are right in the middle of the transition from small shares of RES based on (just) grid following IBR, towards stabilized grids via inverter-based grid forming assets and real chance for 100% RES.

Grid Forming: What is system stability and which inverter functions can increase system strength?



CIGRE Definition of power system stability:

The **ability** of power system equipment to operate in a **stable manner** and for the system as a whole **to recover intact from major disturbances**, is influenced by the electrical 'strength' of the system at the point where equipment connects.

1) Islanding capability

The ability to continue operation when interconnected system is not available.

2) System Restoration

Blackstart – The ability of the plant to re-start itself and serve for system restoration.

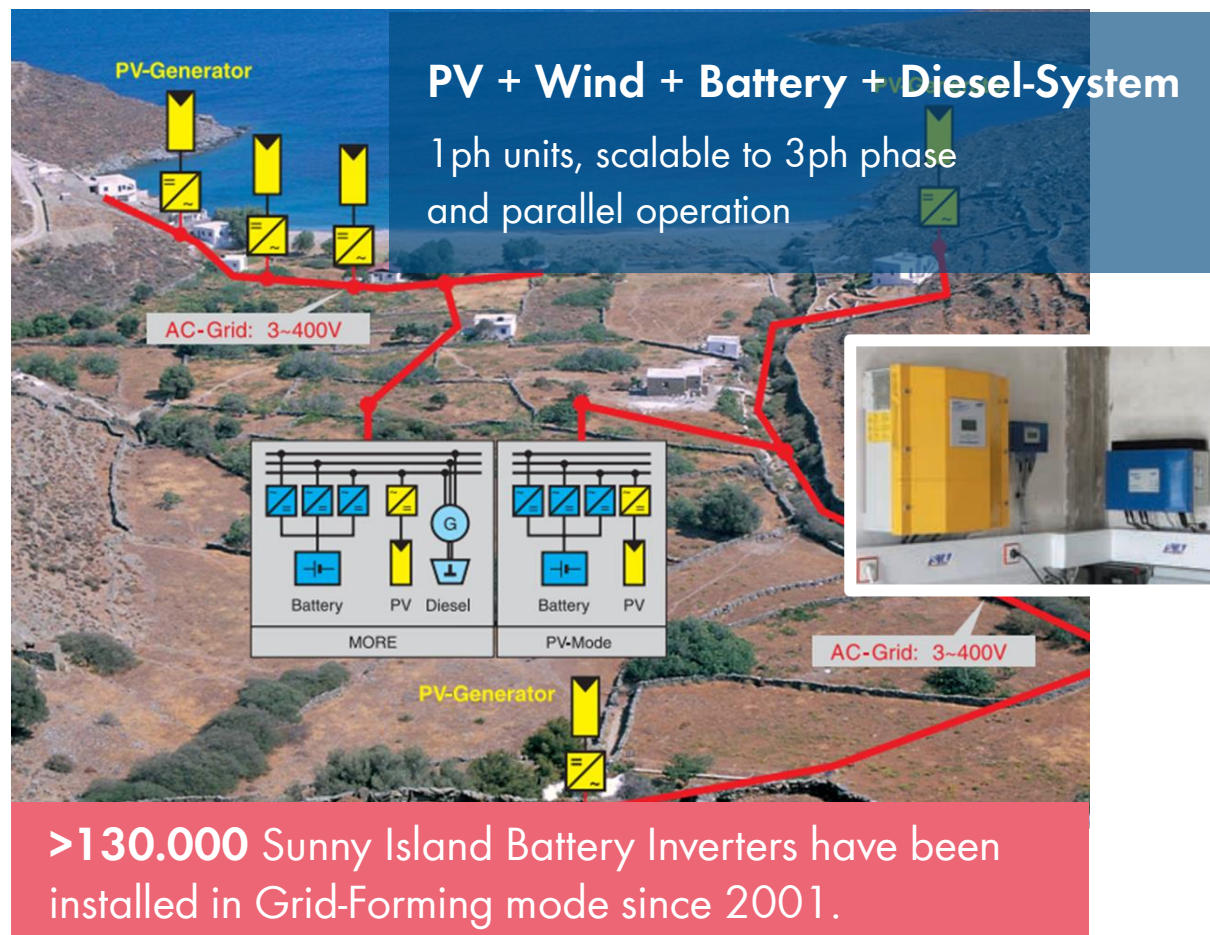
3) Short Circuit Current

The ability to clear system faults and increase system strength by increasing the short circuit ratio (SCR) at point of interconnection.

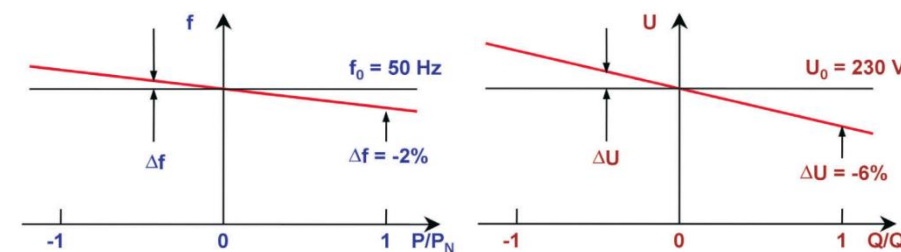
4) Inertia

The ability to instantaneously support during frequency deviations, i.e. phase jumps or RoCoF events.

1) Islanding capability: Modular Grid Forming Hybrid-Power Supply based on AC-coupling - Kythnos Island in Greece 1982 - 2001

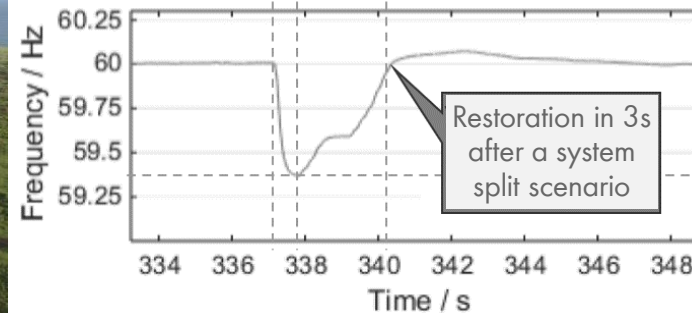


Kythnos Island – 20 Years' Experience of System Technology for Renewable Energies (sma.de)



- **First wind-diesel hybrid system in Europe** featuring a central control unit built by SMA goes into operation.
- **kW showcase for high renewable grid integration.**
- **Droop-based Grid Forming control** of Sunny Island battery storage inverters enables simple design and stabilization of island grids due to connection of all components on the AC side.

1) Islanding capability: MW-Scale Power Supply with 100% Renewable Generation from PV and Battery Storage for >10.5 hours per day - St. Eustatius Island, 2017



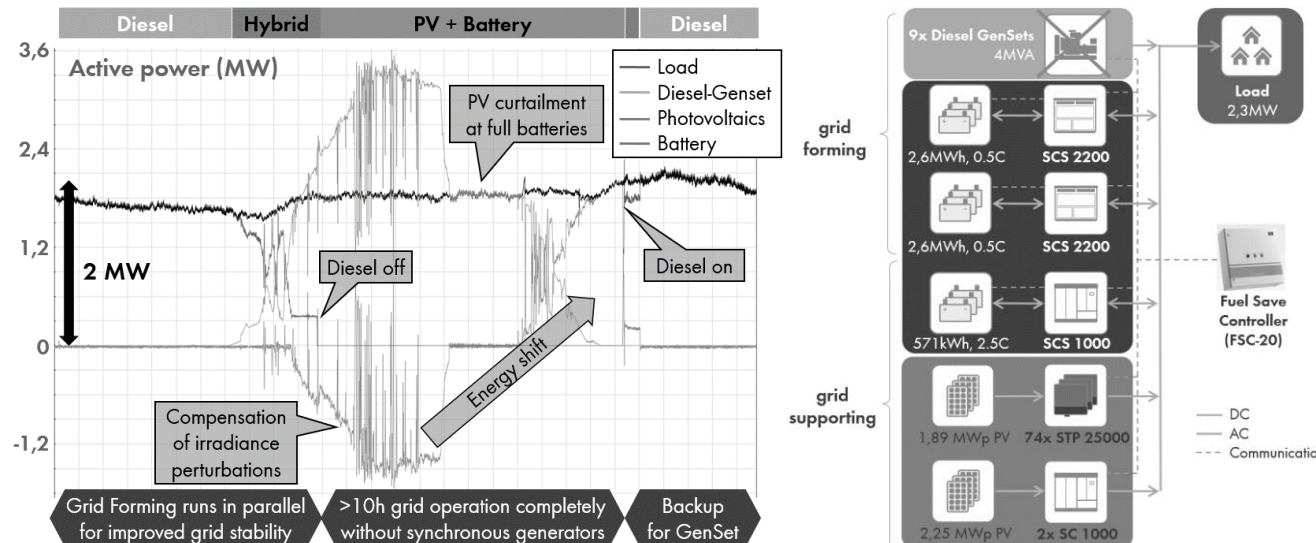
[St. Eustatius: 100 Percent Caribbean Solar Power - YouTube](#)

Services:

- **Power & energy management:** energy shifting, ramp-rate control, reverse power protection, min. genset load
- **GFM services:** frequency & voltage regulation, power quality, full backup with UPS

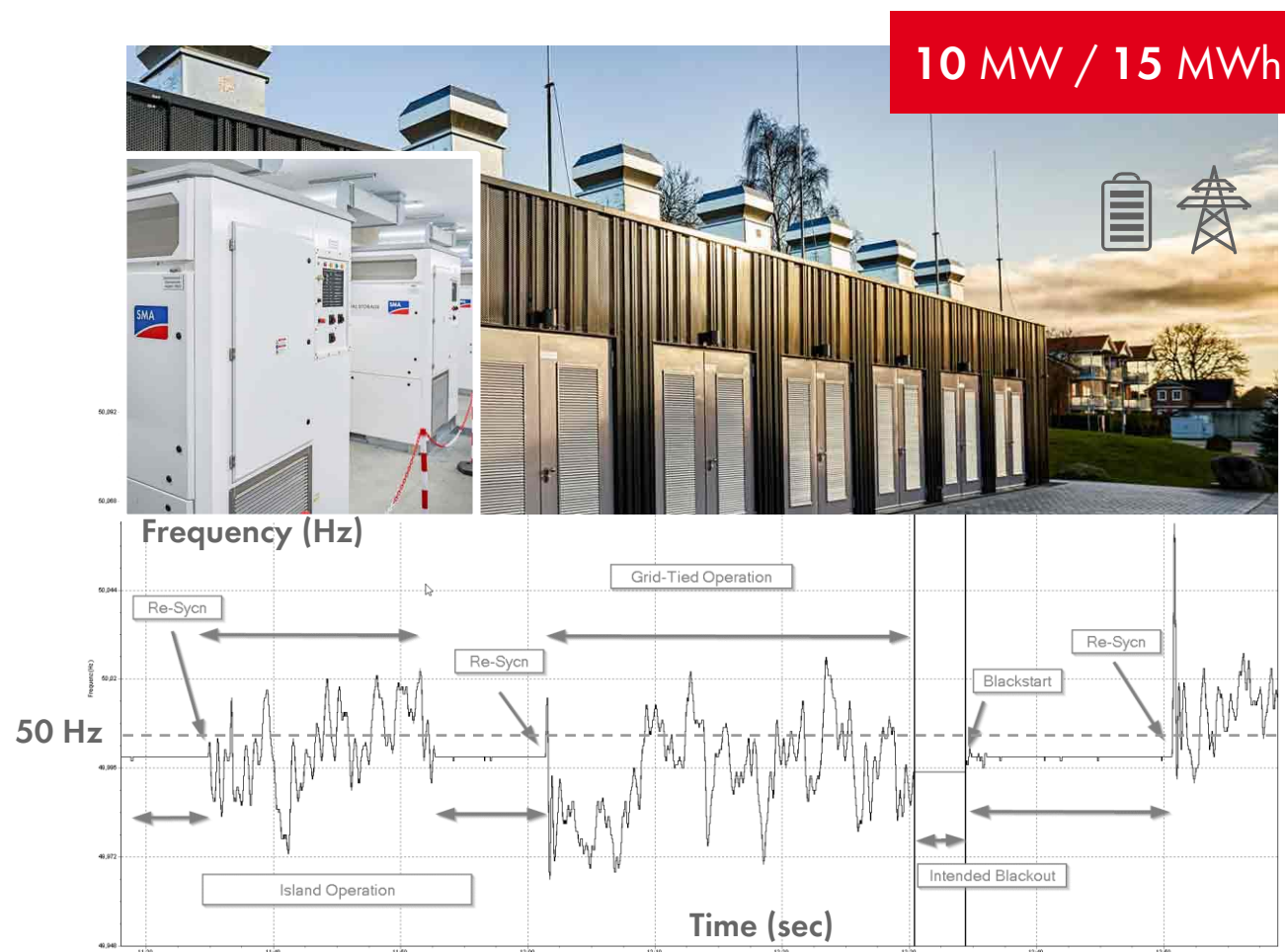
Key findings:

- Inverters-based resources enable a **stable power system operation** with and completely **without rotating machine technology** also at MW scale.
- **Superior restoration dynamics** after significant grid events like system splits and grid faults can be achieved with IBR.



1) Islanding capability: Disconnection of a small city (7500 inhabitants) from utility grid and its supply with 100% renewable energy for an hour before reconnection -

Bordesholm, Germany in 2019



The Bordesholm stand-alone grid ensures power supply even in the event of a grid failure - YouTube

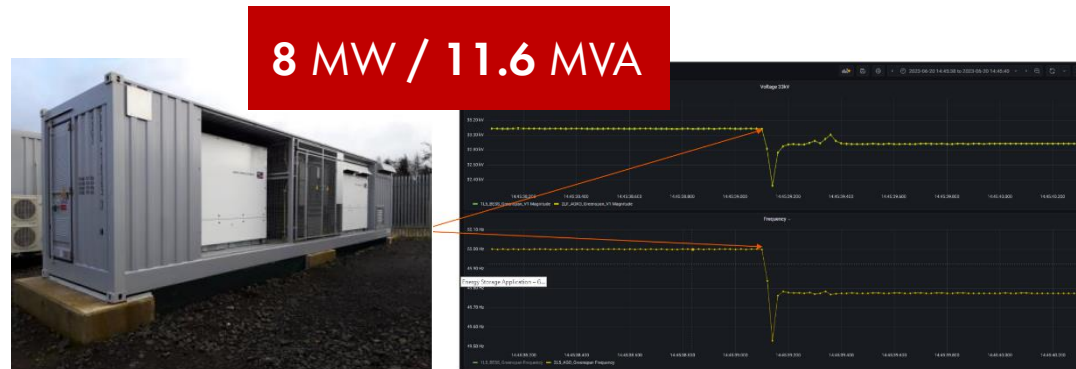
Services:

- **Typical (GFL):** primary control market participation, intraday energy trading, direct marketing
- **GFM:** community backup, black start, grid resynchronization, frequency & voltage regulation

Key findings:

- **Superior frequency & voltage quality in microgrid operation** compared to grid-tied operation
- **Seamless intended transition** from interconnected grid operation and back-synchronization, without customers & renewable generators being able to notice the transitions
→ **GFM in distribution grids can impact on islanding detection of IBRs!**

2) “Distributed ReStart”: World’s first live trial of utility-scale battery for system restoration (black start) of T&D grid in practice - Redhouse, Scotland, 2023

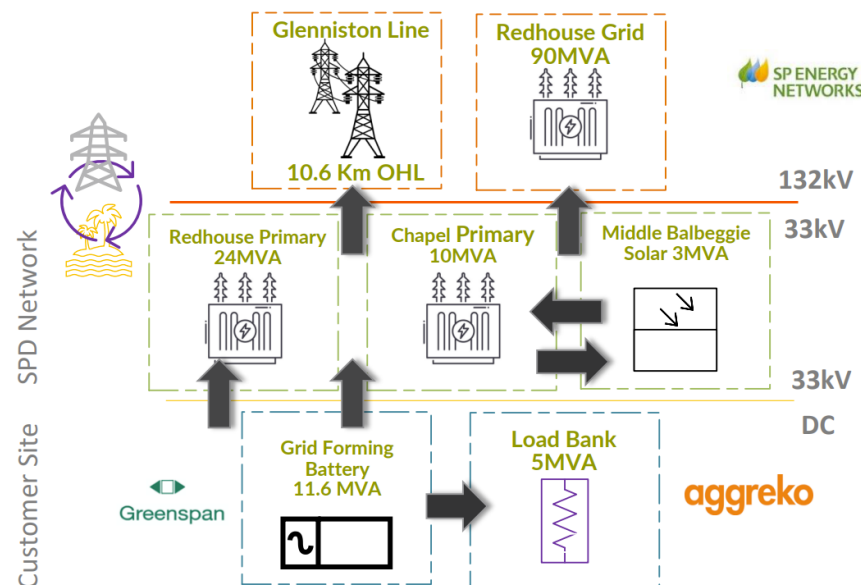


Technical goals of the live trial & the project:

- Demonstrate a “non-synchronous” BESS to **restart** the distribution restoration zone (DRZ).
- **Reduce grid restoration timeframe** from days to hours.

Key findings:

- BESS can **blackstart** itself.
- BESS **can be used as anchor** to start, maintain and control power islands with or without diesel.
- BESS **can energize distribution & transmission transformers & lines** (Point on Wave switching recommended)
- **Block load pickup capability of BESS is far superior** compared to synchronous generators (no must-run).



3+4) Inertia + SCL: World's first Large Scale Grid Forming Asset to provide New Commercial Stability Services for the Transmission System – Blackhillock, Scotland, 2024



Zenobē breaks ground on pioneering 300MW battery in Blackhillock



Contracted Stability Services (Phase 1):

- Inertia: 380 MWs | Short Circuit Level: 120 MVA
- Compensation interval: 10 years

Stability Pathfinder 2 tender outcome:

- Inertia + SCL specific cost is lower for BESS!

Ingredients for successful stability planning:

- System planning with **demand-oriented** procurement ensures availability of the right amount of stability service in the right location in time.
- Market design with **predictable** incentives for **firm** stability service provision in combination with energy shifting is a key contribution to a **cost-efficient** energy transition.
- **Technology agnostic, voluntary** specification defines service quality and enables market participation for IBR.

Pathfinder 2 Request:

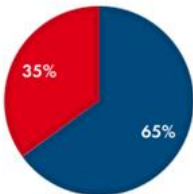
- SCL: 11.5 GVA
- Inertia: 6.7 GWs

Winners (out of 225):

5x SynCon + 5x BESS

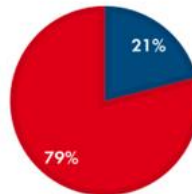
6.7 GVAs INERTIA

■ BESS ■ SynCon



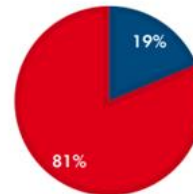
11.5 GVA SCL

■ BESS ■ SynCon



ANNUAL COST

■ BESS ■ SynCon



3+4) Inertia + SCL: Zenobē's second Stability Pathfinder Phase 2 project "Kilmarnock South" 300MW / 600MWh breaks ground – Kilmarnock, Scotland, 2024



ZENOBĒ

Zenobē commences construction of its Kilmarnock South battery project, in drive to maximise renewables and reduce the cost of wasted wind



Kilmarnock South

A 300MW/600MWh battery storage project in Kilmarnock, supporting the uptake of renewable power.

Thursday 25th January 2024

- Zenobē reaches financial close and begins construction of its Kilmarnock South battery project, a transformative 300MW/600MWh asset to reduce wasted wind energy and power Scotland's renewable energy future.
- As part of Zenobē's £750 million commitment to doubling Scotland's battery storage capacity in just three years, the operation is due online in late 2025, propelling the nation towards energy autonomy.
- The company's 1.2GW battery storage portfolio in Scotland aims to decrease energy bills by an estimated £1 billion through reduced curtailment costs over a period of 15 years.
- SMA Solar Technology AG, EDF, Wärtsilä, Omexom and GE Grid Solutions are appointed as suppliers to the project.



More grid stability projects to come...



29 AUG, 2023

Construction commences at Neilston Greener Grid Park

Statkraft has commenced construction at Neilston Greener Grid Park. In April 2022 our planning application for Neilston Greener Grid Park was consented by the Scottish Government's Department of Planning and Environmental Appeals Division.

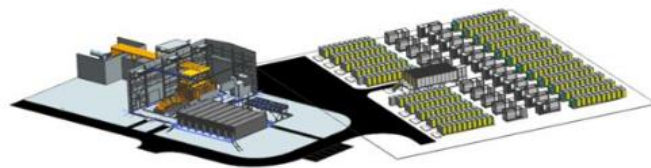
[Show more +](#)

9 DEC, 2022

Statkraft awarded National Grid Stability Pathfinder contract for Neilston Greener Grid Park

Following planning consent for the project, we are pleased to report that Statkraft now have a contract in place for Neilston Greener Grid Park to provide stability services to the operator of the National Grid, NGESO.

[Show more +](#)



Project Sponsors: Hanwha Energy Corporation, Lumcloon Energy

Project Capacity: 63.2MW

Equipment: Siemens Energy Ltd.

Design and Build Contractor:

Owners Engineer: Fichtner Consulting Engineers Ltd.

Construction Commencement:

Construction Completion:

Security of supply

Building 250MW 'Grid Booster' storage system for German TSO BW

Technology, Business

Twitter

Reddit

Facebook

Email



Source / TransnetBW.

energy storage system for
announced in Germany.

two grid boosters for Tennet

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the help of DeepL, original version: [More...](#)



Project in Audorf could look when it is completed in 2025. (Image: Tennet)



What we offer, additionally to hard-/
software for power conversion and
grid connection:

Grid Modeling Support

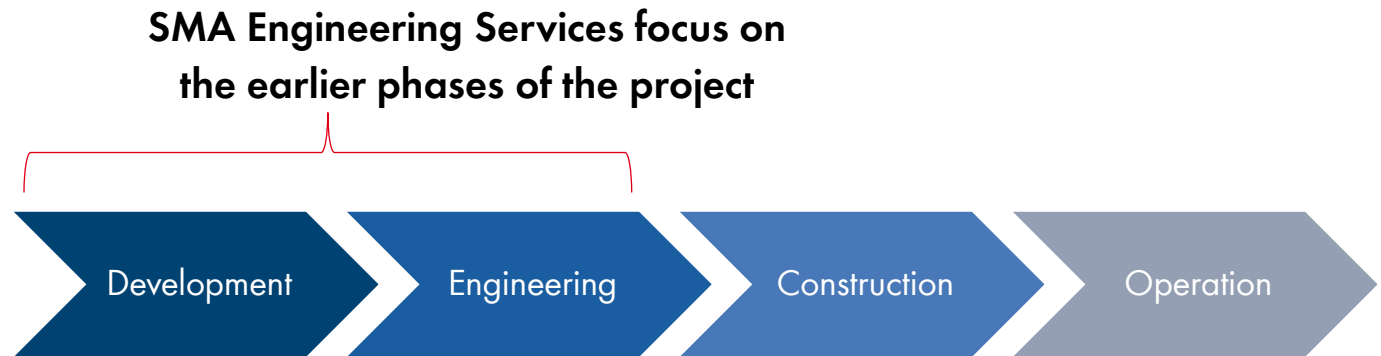
via "SMA Engineering Services" (LS)
during Plant Development Phase

Future proofing your BESS: Ease of mind in times of changing energy markets and grid requirements.



The higher complexity of systems requires **advanced engineering support**.

Having **a comprehensive service offering** represents the best financial backing and long-term plan for the PV and storage industries to maximize system performance.



Working with the right PARTNER is essential to get the support during the whole project life.

SMA offers Advanced Engineering Services to reduce the complexity of the challenging requirements.



SMA experts supporting your projects in the following areas:



GRID STUDIES

- GRID MODELING SUPPORT
- SPECIFIC GRID STUDIES



BATTERY STORAGE DESIGN

- BATTERY SIZING, TECHNICAL AND ECONOMICAL CALCULATION
- EMS SIMULATION (FOR MOPO)



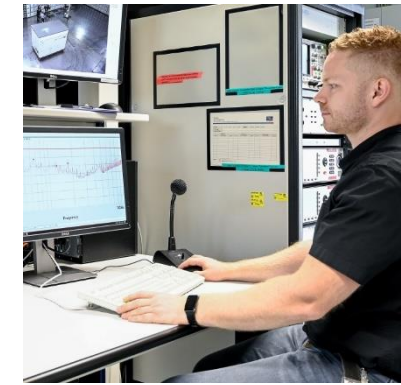
SPECIALIZED ENGINEERING SUPPORT

- BATTERY INTERFACE INTEGRATION
- FACTORY INTEGRATION TESTS
- CONTROL SYSTEM ASSESSMENT – FUNCTIONAL DESCRIPTION
- OTHER SPECIAL REQUIREMENTS



GRID FORMING TECHNOLOGY PERFORMANCE

- GRID MODELING SUPPORT FOR GRID FORMING PROJECTS (INCLUDING INERTIA, BLACKSTART...)



PROTOCOL CONVERTER CONFIGURATION

- PROTOCOL CONFIGURATION IN THE PPM: IEC60870-5-101/-104, IEC61850, DNP3...

Success Story in Australia: Proven Grid Management know-how



Australia is one of the most challenging markets worldwide when it comes to grid integration: low system strength, low SCR, solar plants far from consumption areas.

Challenging local requirements from AEMO and Network Service Providers:

- PSSE and PSCAD models are always required for both inverter and PPM
- NER (National Electricity Rules) constantly changing.
- The parameters used in the Grid Modeling studies are then configured during commissioning.
- Onsite testing (R2 Hold point testing) is required to show the behavior in the modeling studies matches real plant behavior.



- SMA is the **market leader** having sold 5GW+ inverter power into Utility projects in Australia.
- **95 % of all projects are supported by SMA Grid Modeling team.**
- **Top 8** performing solar assets in Australia are connected to the grid via SMA power conversion systems.

Summary

The background of the slide features a photograph of a high-voltage power line tower and its associated cables. The scene is captured during sunset or sunrise, with a warm orange glow on the left side of the frame. The sky transitions from a deep blue at the top to a lighter hue near the horizon. In the foreground, there is a dark silhouette of a line of trees. A semi-transparent blue rectangular overlay is positioned on the left side of the image, partially covering the tower and the sky. The word "Summary" is written in a white, sans-serif font within this blue area.

SMA Grid Forming Technology

- Grid forming technology for large-scale IBR is **available today** and proven for years.
- BESS will solve two major challenges: grid **stability** and **energy shifting** for RES.
- Key to a 100% green, **stable and resilient power supply**.
- Future-proofing BESS = Ability to **meet** market-specific **requirements** with system design flexibility and state-of-the-art hard- and software.
- By choosing the right (grid forming) inverter, you are enabling **multiple revenue streams**, today and in the future.

The background of the slide is a long-exposure aerial photograph of a highway at night. The lights from the cars create bright, flowing trails of orange and yellow, curving through a dark landscape. In the distance, city lights are visible under a dark sky.

*Emerging technologies need
pioneers who set the standards.*

SMA Solar Technology AG

Large Scale projects: (shipped or in operation)

- **> 39.500 MW** of solar inverters in the field (PV)
- **> 10.000 MW** of battery inverters in the field (BESS)
- **> 600 MW** of electrolyzer converters (P2G)

More than 3.900 LS projects executed since 2017:

- 72x PV-projects >100MW
- **25x BESS-projects >100MW**

...LS-assets in operation in **99** countries in the world.

The background of the slide is a long-exposure photograph of a multi-lane highway at night. The lights from the cars create a continuous, flowing orange and yellow streak that curves through the frame. The surrounding landscape is dark, with some greenery visible on the sides of the road.

*Emerging technologies need
pioneers who set the standards.*



Come to our booth!

Let's talk BESS, PV or P2G or ...

"renewable resilience loop".

The background of the slide is a photograph of a lush green field with yellow wildflowers in the foreground. In the background, there are trees and a bright sunset or sunrise sky with long, soft rays of light filtering through the foliage.

Thank you for your attention!

SMA Solar Technology AG

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