



E2S
P O W E R

**TURNING FOSSIL FUEL POWER PLANTS INTO
CLEAN ENERGY STORAGE**

INTRODUCTION TO E2S POWER

E2S Power AG was incorporated as a joint venture between SS&A Power Development and WIKA Group. SS&A Power Development is part of the SS&A Power Group, a company composed of professionals with experience in senior positions in some of the world's major power companies.

SS&A Power Group has provided services and collaborated with global electric utilities, power generators, investors, and equipment suppliers. SS&A Power's partner WIKA is a global leader in the field of measurements technology founded in 1946.

With a strong power industry DNA, SS&A Power has set a goal to make an impact in the energy transition and founded E2S Power to offer a near term cost effective long duration energy storage solution that provides a way to repurpose fossil fuel power plants.

OUR MISSION

Our mission at E2S Power is to accelerate the energy transition by cutting our dependence on fossil fuels, enabling greater utilization of renewable energy, and contributing to net zero carbon. By utilizing existing power plant infrastructure, equipment, and personnel, we offer a way for regions that have been economically dependent on fossil fuels to move toward clean, reliable power.

THE QUEST FOR CARBON NEUTRALITY

As we strive to cut our dependence on fossil fuels, the share of global power generation from intermittent renewable sources is increasing rapidly. Renewable energy today represents over 40% of the share of power generation in several countries with a target over 50% in the coming years.

This growth will drive the need to address intermittency, security of supply, and grid stability with energy storage solutions. The large-scale storage market has been estimated to grow over 10 times in the coming years.

At the same time, at COP 26, more than 40 countries have agreed to phase out their use of coal-fired power. Several countries have already committed to a phase out program of coal power plants by 2030.

This means that hundreds of GW of fossil fuel power plants will be decommissioned, and the key questions are: **How are we going to repurpose these power plants? How do we ensure security of supply? How do we transition economies where these plants are located to a carbon free future?**

E2S Power is aiming to address these challenges with our thermal energy storage solution.

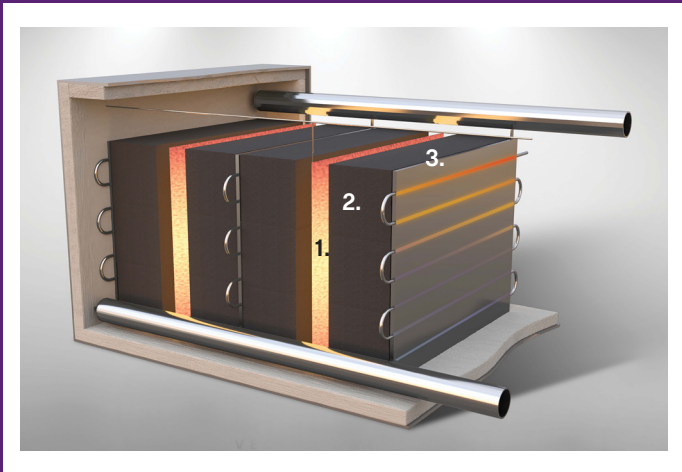


OUR PRODUCT

Our product is a novel energy storage system, TWEST, which constitutes the building block at the heart of our power plant conversion solution. TWEST is a compact “all in” standardized module that does not require any additional auxiliary equipment, external heat exchangers or working fluids. The compact, modular design allows scaling up to match the required storage capacity of a project. The use of existing equipment and infrastructure, particularly in plants scheduled for decommissioning, minimizes investment cost. The modular approach makes our solution very adaptable to different configurations.

TWEST consists of three key components in an insulated enclosure:

- 1) Electric Radiant heaters
- 2) MGA storage blocks
- 3) Steam Generators



The electrical heaters are designed for temperatures over 1,000°C and facilitate the heat transfer to the storage blocks during charging. The storage blocks utilized are made of high energy density and high thermal conductivity materials.

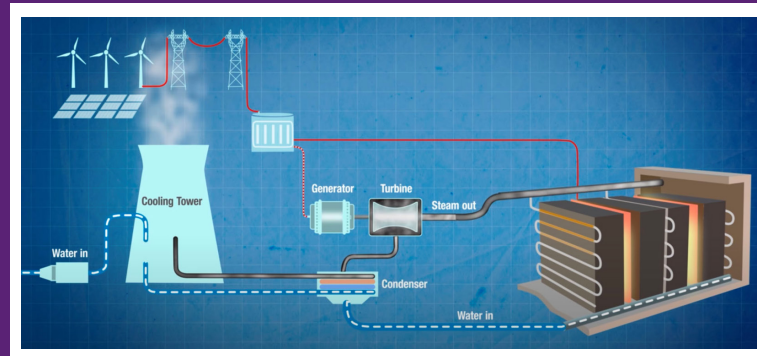
The steam generators are made of advanced high temperature resistant alloys and are mounted in the storage blocks. Our proprietary “traveling wave” technology ensures that a constant steam temperature is delivered to the host plant. Our system is packaged in a standard module that allows stacking up, as required, to meet storage requirements and plant footprint and can adapt to a variety of power-plant sizes and configurations. The superior energy density makes it a more compact solution requiring less space.

The TWEST thermal energy storage is designed to easily integrate into an existing power plant with three main interfaces: electric supply for charging the system, feedwater input and steam supply into the existing steam cycle.

HOW IT WORKS

Our concept can be applied to convert fossil fuel power plants into energy storage facilities by substituting the boiler with the E2S thermal energy storage system and integrating with existing infrastructure, thus eliminating emissions of CO₂ while utilizing an otherwise stranded asset. In our system, electricity from renewable sources powers the electrical heaters which heat up the storage blocks to a temperature near 700 C.

During the discharge process, heat stored in the blocks is then transferred to feedwater in incorporated steam generators which then supply steam with properties matching the requirement of existing steam turbines to generate electricity. The system is designed to maximize the use of existing non-polluting plant infrastructure to minimize costs, including high voltage switchyard, existing steam turbines and associated balance of plant equipment (condensers, cooling towers, generators, transformers, etc.).



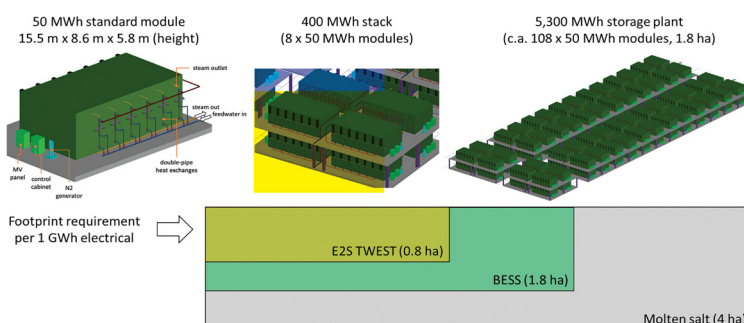
WHY CHOOSE TWEST?

E2S Power offers a cost-effective and easy to operate solution for transforming fossil fuel power stations into thermal storage systems for renewable energy.

Key advantages include the following:

- ✓ **Compact design with high energy density.** This makes it the most suitable utility scale storage with a footprint 2 to 5 times smaller compared to all other storage systems
- ✓ **Scalable modular design.** All-in modular design without the need for additional external equipment such as heat exchangers. Easy integration and minimum disruption to existing plant. Can be easily scaled up thanks to modularization concept
- ✓ **Lower capital cost.** Our system maximizes use of existing equipment and infrastructure (all but the boiler and fuel related equipment)
- ✓ **Environmentally Benign.** Made of abundant, safe and recyclable materials.
- ✓ **Safe.** The design is inherently fail-safe, with maximum temperature limited. The process is not chemically active and poses no fire risk.
- ✓ **Long life.** Our system is designed for 30 years. No issues related to degradation or depth of charge. Storage material is safe and remains stable throughout their life cycle.
- ✓ **Supports grid stability.** By using synchronous generators, our system is better able to provide inertia and grid stability compared to batteries.
- ✓ **Socio-Economic Benefit.** By using existing, potentially stranded assets, and by retaining jobs, our technology can help local economies transition to clean energy.
- ✓ **Fast implementation.** Due to the simple, easy to integrate technology, our technology allows faster deployment. A typical time to market (from order to commercial operation) is estimated to be less than 18 months.

Modular Storage Plant Approach



FREQUENTLY ASKED QUESTIONS

1. Why is it important to have alternative storage technologies to Li-ion Batteries?

While Li-ion batteries are a proven solution and commercially available, it will be important to consider other storage technologies, complementary to batteries, and encourage their development. Li-ion batteries may be a solution in the near term for short duration in a smaller scale, but they have some serious limitations as we consider a larger scale use in the future.

We have seen that, in applications requiring a lot of cycling, li-ion batteries degrade rapidly, requiring the replacement of the battery pack. In addition, there will be increased competition from the electric vehicle market expansion for the key raw materials required. From an environmental point of view, the problem of large-scale battery recycling has not been fully solved. One of the key aspects of the thermal energy storage technology developed by E2S Power is that the storage system doesn't degrade substantially over time, and the materials required are readily available and recyclable.

2. How does the thermal energy storage technology developed by E2S compare with other storage technologies?

The total LCOS cost of TWEST for utility scale applications is very competitive compared to batteries and other storage solutions as we are taking advantage of valuable existing equipment and assets. Our design is a compact "all in one" unit and, unlike other energy storage solutions, does not require additional equipment, separate storage, or auxiliary systems. One key aspect of our design approach is simple plant integration and project execution. Some of the other energy storage technologies have additional project complexities due to the amount of additional equipment, auxiliary systems, materials, and special working fluids.

We believe that total costs should be considered on an equal basis for a true comparison. When looking at the cost of Li-ion batteries, for example, the complete project cost needs to be included, not just the battery pack. This includes inverters, power electronics equipment, required housing and climate control, in addition to construction costs and the interconnection to the grid.

By utilizing existing power plant equipment, infrastructure, and sites, we are able to keep our costs down. If you consider a 25-year life and taking into account capital costs and the degradation and replacement cost of batteries, the levelized cost of storage of the E2S Power storage system is estimated to be one third of Li-ion batteries.

3. Can your system provide ancillary services such as frequency response, load following, reactive power?

Yes, by using the existing synchronous steam turbine generator, we are better equipped to provide grid support and ancillary services compared to batteries. Furthermore, the advantage that we bring to existing plants is that we do not have boiler drums which limit the start-up times and cycling capabilities. Our system is much more flexible than most of existing coal-fired plants and can be started or shut down very rapidly if needed without any life penalty.

4. What is the long-term performance degradation of the system?

We expect to have less than 1% of recoverable performance loss within the 2,000 cycles interval. The storage material and the steam generator are designed to have negligible degradation over time. The recoverable degradation is mainly expected to be due to electrical connectors and typical auxiliary and balance of plant equipment.

5. When you store the energy how much is the daily energy loss?

We expect to have less than 1% of loss per day – which can easily be recovered during off peak hours to maintain the full system charge.

6. What is the roundtrip efficiency of your system?

The storing efficiency which is defined as conversion of electrical energy into heat is very high, about 99% as we have efficient heat transfer through radiation and therefore very low losses in this process. The roundtrip efficiency depends on the existing steam cycle efficiency, typically around 40%. As mentioned, when looking at life cycle costs, there are also other factors that need to be considered, such capital costs, lifetime degradation, need for replacement, and opportunity to use existing infrastructure.

7. What is the maintenance schedule for TWEST?

We have designed the key components for 30-year life. However, as with any power plant equipment regular inspections are needed and we recommend to have visual and borescope inspection yearly and a major inspection every 6 years or 2,000 cycles.

8. Can you use the TWEST for gas-fired plants?

Yes, in fact our system can be used to generate steam for steam cycles in coal plants and combined cycle plants.



OUR TEAM



Dr. Sasha Savic
Chief Executive Officer

Sasha has professional experience in the power industry spanning twenty years, primarily in gas-fired power generation. He holds a Master's in mechanical engineering and PhD in experimental combustion. Sasha joined Alstom in 2000 and led several important development programmes in the gas turbine R&D division and held roles in gas turbine service and product management. He has an MBA from the HWZ Zurich.

Dr. Savic is an author of more than 15 patents, mainly in the field of gas turbines and combined cycle power plants design and operation with the most recent ones on thermal energy storage solutions. After 13 years working at Alstom, Sasha founded SS&A Power Group and most recently the E2S Power company with the focus on Energy Storage. In addition to this, he was one of the principal founders of S2P Electric a company focused on developing solar power plants.



Fabrizio de Candia
Chief Operating Officer

Fabrizio has over 30 years of experience in the energy industry, including development, investment, operations, and engineering and construction in Europe, North America and India. He was a founding member of IPP InterGen and his senior management experience includes roles such as General Manager Gas Power Plants at Alstom in Italy and North America, and Group Vice President at Circor International. He currently serves on the Investment Advisory Committee for NTR, Plc, a leading renewable energy company. He holds a MS in Mechanical Engineering from the University of Michigan, Ann Arbor and has attended the INSEAD Advance Management program at INSEAD Fontainebleau and Singapore.



Zoran Nenadic
Chief Designer and Head of Belgrade Office

Zoran has more than 17 years of professional engineering experience in various industries such as oil&gas and thermal power generation. Before joining E2S Power, he built his career in several companies starting as a mechanical design engineer and progressing to project leadership roles. His primary expertise is in the field of design, modeling, and documentation relating to complex piping systems, steam boilers, and other types of pressurized industrial equipment. Zoran holds an M.Sc. degree from Belgrade University, Faculty of Mechanical Engineering.



Dr. Sergey Pancheshnyi
Chief Technology Officer

Sergey has over 25 years of industrial and academic R&D experience in energy and environment sectors, having held a variety of technical and leadership positions in companies of different sizes across Europe. He supports engineering organizations and high-tech companies in the domain of medium- and high-voltage apparatus and systems, plasma physics and applications. Sergey received advanced degrees in plasma physics and chemistry from Moscow Institute of Physics and Technology, Russia and University Paul Sabatier, France.



Ratko Vukadinovic
Head of Thermal Engineering

Ratko brings over 15 years of industrial engineering experience in the field of thermal power systems, boilers, pipelines and pressure equipment. His international work assignments brought him to manufacturing and assembly facilities in a number of countries like Serbia, Germany, Brazil, and Australia. His main expertise is in all forms of technical documentation, design calculations, the production of assembly drawings and detailed documentation for technical support. Ratko graduated from Belgrade University with an M.Sc. degree in Mechanical Engineering.



Dr. Vladimir Vassiliev
Senior Advisor

Vladimir's international career in power systems technologies stretches over 25 years, primarily in the gas-turbine and aircraft-engine sectors. His R&D expertise is in fluid dynamics, thermodynamics, heat transfer, as well as in integration of thermal power systems. At E2S Power, Vladimir directs and oversees all R&D efforts and interfaces with external technology partners and suppliers. He received his Master's degree from Moscow Physical-Technical University and a doctoral degree from Moscow's Central Institute of Aviation Motors.




Djordje Kascelan
Systems Engineer

Djordje obtained his M.Sc. degree in Mechanical Engineering from the University of Belgrade, Faculty of Mechanical Engineering. He completed his thesis at the Department of Automatic Control, where he worked on the implementation of system identification and controller synthesis in industrial automation. He graduated at the top of his class, earning a prestigious best-in-class award. Djordje started his professional career with E2S Power team, in the field of advanced storage technologies. He is responsible for technical project management and development of the TWEST technology demonstrator, including supervision and design of electrical and mechanical control systems.

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