



Energy intelligence Optimising lifecycle efficiency with renewables

WÄRTSILÄ SERVICES BUSINESS WHITE PAPER

Energy intelligence Renewables

Energy intelligence of operating a power plant is about optimising its lifecycle costs and ensuring efficiency. A power plant's lifecycle has different stages, and its maintenance needs vary between these stages. As general environmental awareness increases and environmental regulations become more stringent, the role of renewables in optimising costs and ensuring lifecycle efficiency become more important.

Already today, renewables are often financially the most attractive energy source. Energy storage systems, transmission networks, data analytics, and flexible, fast-responding balancing power plants play an important role in paving the way to a 100% renewable energy future - also for the existing power plants. This journey towards more intelligent and sustainable operations should be taken one step at a time, utilising the technologies and expertise we have today and being agile in adopting new solutions as they become available.

Wärtsilä's lifecycle solutions for the energy industry offer guaranteed operational reliability and efficiency, backed up by expert advice on optimising power plant's operation and maintenance. This Business White Paper illustrates this journey towards energy intelligence and the role of **renewables and energy storage systems** when operating a power plant and optimising its lifecycle efficiency.

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New trends re-shaping the energy industry

NEW TRENDS are reshaping the energy industry. These trends strongly support the growth of renewable energy like solar and wind power and encourage the owners of traditional power plants to take advantage of the opportunities offered by renewables.



Renewable energy is gaining popularity because it is often financially the most attractive option. This changes industry dynamics and creates demand for flexible power generation that enables more renewable energy generation. Combining renewable energy and traditional power generation can also improve the plant's efficiency and sustainability and help to optimise its lifecycle costs.



Load balancing power plants are needed to ensure that energy output meets demand. Renewable energy is gaining popularity because it is often the cheapest form of energy. However, it is still subject to weather conditions, resulting in fluctuation in energy production. Energy storage systems and fast-response, load balancing plants are needed for frequency control and for ensuring that the total energy output meets the demand. Energy storage systems and load-balancing power plants can also be built as an addition to an existing plant, helping to improve its lifecycle efficiency.



More stringent environmental regulations and an increasing focus on people's health call for emission reduction and stimulate the growth of renewables. The climate change and the increase of more extreme weather conditions are putting pressure on reducing CO₂ emissions globally. More and more, also societies are putting pressure on power plant owners and operators to improve their existing power plants to make them more sustainable.



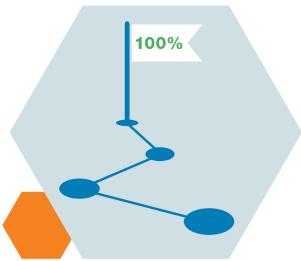
Digitalisation: predicting power demand and maintenance needs. As digitalisation advances, collecting and analysing data is becoming the norm. With this information, power demand and plant's maintenance needs can be forecasted more accurately, and their operations adjusted accordingly. A powerful software platform is needed to control, monitor and optimise multiple generation assets.



The role of consumers in energy production grows. Consumers are already showing interest in producing their own electricity and selling the surplus, becoming "prosumers". This trend will only strengthen as new small-scale solar and wind technology becomes more easily available and affordable. Also communities are influencing their energy mix via policies and putting pressure on the status-quo.



The adoption of electric cars could create demand peaks when a large number of cars are charged simultaneously. This can be avoided via programs that allow vehicle owners to opt into delayed charging and other grid services, enabling participation of electric cars in the grid operation.



The journey to a
100% renewable
energy future is taken
one step at a time

Even though renewables are an increasingly important source of energy, the jump to a 100% renewable energy world does not happen overnight.

But there are already solutions out there that can pave the way. Combining renewables, energy storage systems and fast-response, load-balancing power plants with more traditional power generation helps increase the usage of renewable energy and ensures more sustainable operations.

Many powerful energy storage systems are already in the market and the technology is constantly developing – mainly in incremental steps, but sometimes through big, technological breakthroughs. The more technology-neutral the energy storage operating system is, the more flexibility it brings, enabling the agile adoption of the latest innovations, such as a hydro storage, as they become available.

In order to fully harness the power of renewable energy, there is a need for more robust transmission systems that reach across continents and help in coping with the annual and daily seasonality of renewable energy. However, building this kind of global transmission systems is politically challenging.

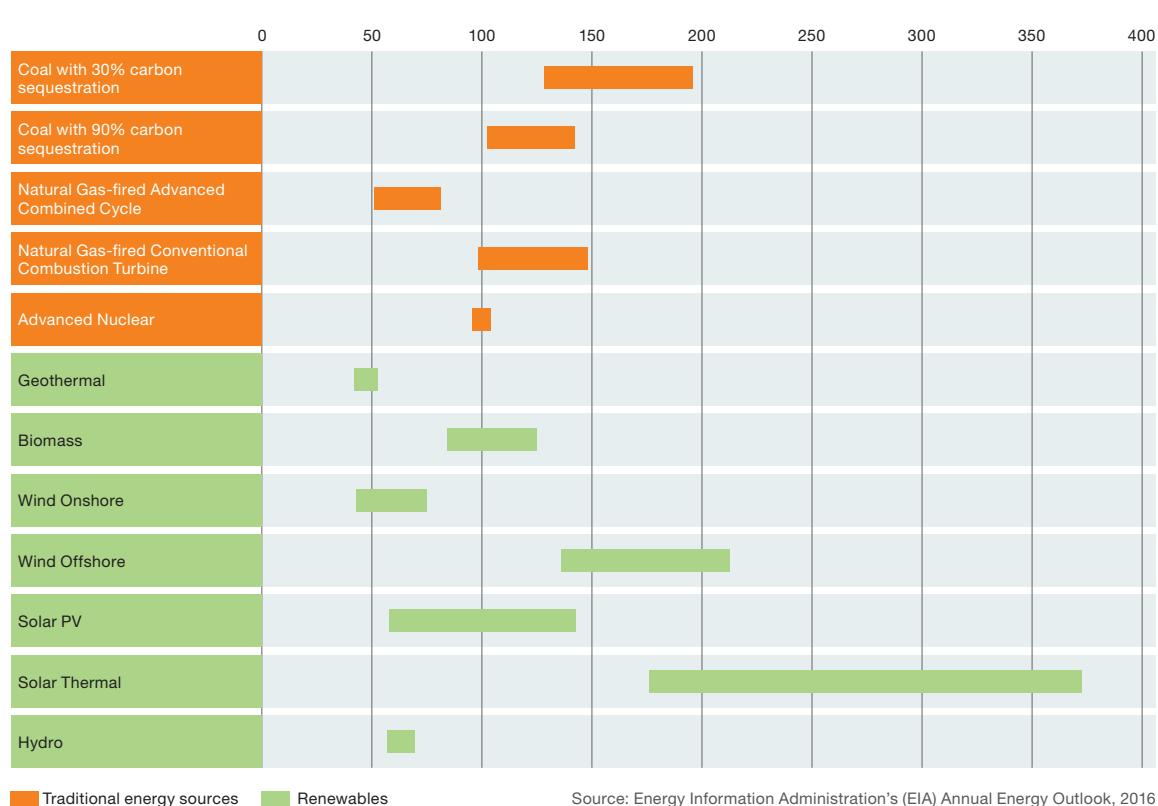
Improving the lifecycle efficiency with renewables

A POWER PLANT OWNER has various options for improving the lifecycle efficiency and extending the lifecycle of a power plant. Traditional methods include equipment upgrades, fuel conversions or changing the operating profile of the power plant. However, improving the efficiency of a traditional power plant by taking advantage of the renewable energy sources is becoming more attractive.

Combining traditional and renewable energy can bring significant commercial, operational, and environmental benefits throughout the lifecycle of the power plant.

- **Renewables are often financially the most attractive option.** When adding up the costs of being compliant with environmental regulations and considering how close to urban areas you can build a plant, renewables are often the most cost-effective form of power generation and offer the best return on investment.
- **Flexible engine technology** enables vast integration of renewables while ensuring high reliability in power systems.
- **Regulatory compliance** is crucial as emission limits are becoming tighter. Optimal usage of various assets is achieved with energy management systems, which also help decrease CO₂ emissions and lower fuel consumption.
- **More sustainable operations and brand image** are becoming more important business drivers.

Projected LCOE in the U.S. by 2022 \$/MWh



The steps for improving the lifecycle efficiency of a power plant with renewables are as follows

1. **Selecting** the right type of renewables
2. **Planning** the efficiency improvement project
3. **Guaranteeing** the asset performance

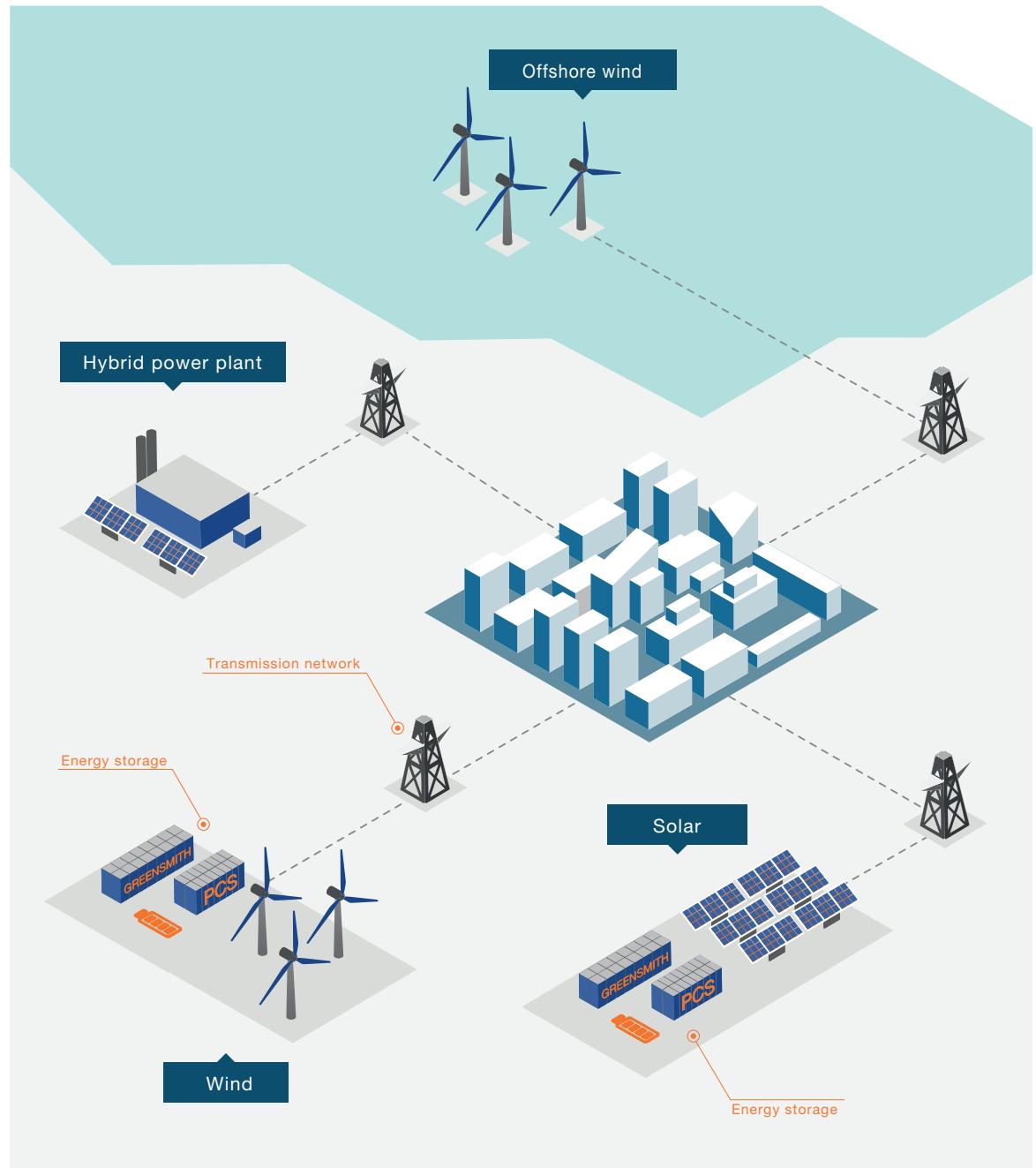
1. Selecting the right type of renewables

Each form of renewable energy has its place. A careful, holistic assessment of the customer's needs with an expert helps to select the most suitable renewable energy source for each specific case.

When selecting the most suitable form of renewable energy in each specific case, the answer is not always straightforward. Finding answers to the following questions can help:



Different type of renewables



2. Planning the efficiency improvement project

The first priority of power plant owners and operators is to produce energy for their customers efficiently and reliably, while creating business value and a good return on their investments. The operating profile of the power plant is determined to serve these business needs and, together with the power plant owner's value proposition, it defines the best ways to organise the operations and maintenance of the facility.

It also has a big impact on the decision concerning the most suitable renewable energy source. Comparing the different renewable energy sources is not always straightforward. For example, wind has a higher capacity factor than solar. Thus, in theory, a 100MW wind plant generates more energy than a 100MW solar plant. However, if the location of the plant is not windy enough, a solar plant can be a better choice. On the other hand, a hydro electric power plant is more constant and can adapt very fast to fluctuating demand. While tidal and wave power seems attractive, in some cases the corrosive nature of ocean makes it more viable to install an off-shore wind farm instead.

Having a mix of different renewable energy sources is sometimes the best solution. Combining wind and solar power or spreading the plants to different geographical locations helps to mitigate the volatility and intermittency of renewables, improving system efficiency.

Energy storage is also a good and cost-efficient way of dealing with the intermittent nature of renewables and improving system efficiency. Energy storage enables thermal generation power plants to operate at their most efficient loading point, quickly picking up any fluctuations in the power supply. This gives enough time to turn on backup units, so they do not have to be run in an inefficient standby mode. In solar plants, batteries can be used for 'DC coupled energy storage' to reduce efficiency losses, resulting in an increase in annual energy generation that is proportional to the energy that would otherwise be lost in PV systems that have high DC/AC ratios.

Case: Pomona – one of the largest energy storage facilities in North America



ALTAGAS LTD. selected Greensmith Energy, a Wärtsilä company, as the software provider and system integrator for a 20 MW/80MWh energy storage system in Pomona, California. Greensmith Energy's solution was selected as it delivered the best financial results and an attractive payback time. The energy storage system was installed at an existing AltaGas natural gas-fired power plant. The whole project was designed, built, and made operational in under four months. The installed system is among the largest energy storage facilities in North America, being able to provide 80 MWh of electricity over a continuous four-hour period.

The energy storage system in Pomona increases reliability and helps the resource-constrained Southern California grid to cope with the energy consumption peaks during hot summer days, short term power imbalances in the grid, and the ramping constraints described by the 'duck curve' from high renewable energy penetration in the region.

"AltaGas has significant experience in developing, owning and operating clean energy assets across North America. Adding battery storage to our California power portfolio and having Greensmith as our partner, proved the versatility of our asset base and greatly enhanced the value of what we could offer the California and desert southwest markets," says David Harris, President and Chief Executive Officer of AltaGas.

Greensmith Energy and AltaGas were recognized with a Grid Edge 2017 Award for the Pomona energy storage facility project. The award recognises leading companies and projects that incorporate distributed energy resources, energy-enabled customers, and emerging trends in energy delivery.

The combination of traditional and renewable energy generation provides an opportunity to control and optimise the usage of engines and renewable power sources. Among other things, it enables a reduced fuel consumption, thus increasing cost efficiency and more sustainable operations.

Case: Essakane gold mine – powered by Africa's largest engine-solar PV hybrid power plant



IN 2017, Wärtsilä supplied a 15 MWp solar PV power plant to Essakane Solar SAS in Burkina Faso. The solar PV plant was built next to a 55 MW Wärtsilä power plant running on heavy fuel oil. The solar PV plant and the engine power plant are controlled and operated in synchronization, thus forming the largest engine-solar PV hybrid power plant in Africa. Combining the solar PV power plant and an existing power plant running on heavy fuel oil, improved the energy efficiency of the existing plant and optimised its lifecycle costs.

Wärtsilä's scope covered the engineering, procurement & construction (EPC) for the solar PV power plant. It also included the critical Energy Management Software (EMS) and integrated controls. The EMS software is an essential component in avoiding operator errors and ensuring that a customer is getting the full value out of their investment.

The ability to control and optimise the usage of engines and solar power will enable the mine to decrease its fuel consumption by approximately 6 million litres per year and to reduce its annual CO₂ emissions by 18,500 tons.

The duration of the project was about one year, and it represented a major breakthrough in the industry. Hybrid solar PV-engine solutions will allow energy-intensive industries to enter an era of more climate-friendly operations, improve business and increase resilience to oil price fluctuations.

3. Guaranteeing the asset performance

When the right source of renewable energy has been selected and implemented to complement an existing power plant, the last step is to ensure and guarantee the performance of the plant and its energy storage systems.

Wärtsilä offers an availability and performance guarantee as standard to ensure that the required capacity and performance is available. When Wärtsilä manages the operations of a power plant and energy storage system, the owner of the plant can count on optimal efficiency, financial performance and energy turnaround as well as maximised availability and performance. Fuel savings and lifecycle cost guarantees can also be part of the agreement.

For more information, please visit

<https://www.wartsila.com/services/services/lifecycle-solutions-for-energy>
<http://www.greensmithenergy.com/solutions>

Wärtsilä Services in brief

Wärtsilä Services provides high-quality lifecycle services that enhance customers' business. Its broad range of services supports both shipping and power generation companies, whenever and wherever needed. Solutions range from spare parts and basic support to ensuring the maximised lifetime, increased efficiency and guaranteed performance of the customer's equipment or installation – in a safe, reliable, and environmentally sustainable way.

<http://www.wartsila.com/services>