



Energy intelligence Power plant upgrades

WÄRTSILÄ SERVICES BUSINESS WHITE PAPER

Energy intelligence

Power plant upgrades

Energy intelligence is about optimising lifecycle costs and ensuring efficiency. This can be done by using all assets in the most efficient and sensible way. Digital technologies and data intelligence play an important role by enabling continuous monitoring and the optimisation of operations – or even value chains.

The world is changing with ever-increasing speed, and so is the power generation market. Customer needs, environmental regulations, available technologies, optimal ways to run a plant – all this has changed dramatically during the past 10–15 years. This creates a clear need – but also a great opportunity – to improve power plants' energy efficiency.

There are many ways of improving the energy efficiency of a power plant – from the upgrade of a single component to a complete lifecycle solution, including asset performance guarantees and jointly agreed KPIs for measuring success. In today's power generation, the use of renewables as a method of increasing energy efficiency is also increasing.

This Business White Paper illustrates the role and importance of power plant upgrades when considering the ways of improving a power plant's energy efficiency during its whole lifecycle.

CONTENTS

New trends reshaping the energy industry	3
Key benefits of power plant energy efficiency	4
How to improve energy efficiency with power plant upgrades	5
Wärtsilä's energy efficiency offering.....	9

New trends re-shaping the energy industry

NEW TRENDS are re-shaping the energy industry. The importance of energy efficiency continues to increase. An investment in energy efficiency creates significant commercial, operational, and environmental benefits. It decreases fuel costs, increases the efficiency of operations, lengthens the lifecycle of the plant and reduces emissions. It is also a way of future-proofing operations and increasing brand value.



Renewables change industry dynamics and at the same time, flexible power generation enables more renewable energy generation.

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. Load balancing plants are needed for frequency control and for ensuring that the total energy output meets the demand.



Reducing fuel consumption to cut OPEX and increase competitiveness. In an uncertain economic environment, increases in profitability are often sought through tightened cost control. Fuel costs form a major part of a power plant's operating costs – up to 80%.



Environmental regulation calls for emission reduction. Environmental regulation is becoming more stringent. In order to ensure compliance with the latest regulations, emission reductions are often needed.



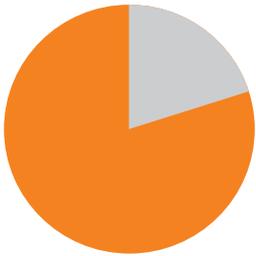
Digitalisation: predicting power demand and maintenance needs. As digitalisation advances, collecting and analysing operating data is becoming the norm. With this information, power demand and plant's maintenance needs can be forecasted more accurately, and operations adjusted accordingly.



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.

Key benefits of power plant energy efficiency



Fuel costs form
up to **80%** of a power
plant's operating costs

INVESTING IN a power plant's energy efficiency can bring significant commercial, operational, and environmental benefits.

Commercial benefits

- Decreased operation costs and good return on investment (ROI) due to decreasing fuel costs and maximised power plant availability
- More sustainable operations and brand image are becoming important business drivers

Operational benefits

- Improved cost-to-output ratio e.g. improves the power plant's ranking in the merit order list when providing energy for a national grid, thus improving its competitive position
- Extending the plant's lifecycle with well-planned maintenance operations

Environmental benefits

- Reduced emissions per produced kWh due to better fuel efficiency
- Regulatory compliance is crucial as emission limits are becoming tighter

How to improve energy efficiency with power plant upgrades

THERE ARE MANY WAYS of improving the energy efficiency of a power plant – from the replacement of a single component to complete modernisation or operation and maintenance solutions.

What is the best course of action? Finding answers to the following questions will help:



What type and quality of fuel is my plant using?

What is the condition of the engines and fuel injection system? Have they been maintained properly?

Is the cooling water system and the quality of the cooling water still at a sufficient level?

Are the systems responsible for charge air and removal of exhaust gases working as they should?

Is my plant still operated according to the original parameters or has the operating profile been changed to match changed needs?

Does the number of engines match my needs and are they run at an optimal load?

Sometimes answering these questions is simple. Often, a site audit conducted by an energy efficiency expert is recommended to define, together with the customer, the business case, scope and timing of the upgrade project. It is also good to evaluate what other maintenance activities could be carried out at the same time to maximise the improvement potential and availability of the plant.

However, there will always be some surprises along the way. Flexibility and adaptability to new circumstances is crucial to ensuring a successful upgrade project. Some of the most common power plant upgrade projects include:

- 1. Rehabilitation**
- 2. Modernisation**
- 3. Gas conversion**
- 4. Combined cycle upgrade – Wärtsilä Flexicycle™ solution**
- 5. Engine performance optimisation**

1. Rehabilitation

In a rehabilitation project, equipment in a power plant is upgraded to meet its original running parameters. In the beginning of the project, the condition of the power plant is analysed and actions are suggested to correct excessive de-rating in order to restore its operating efficiency to its original state or beyond.

Case: Limbe Power Plant – restoring original capacity with a rehabilitation project



ENEO CAMEROON'S Limbe power plant could generate only about 40% of the installed total capacity of 80MW. Wärtsilä's solution was a complete rehabilitation; a total overhaul of four Wärtsilä engines and five alternators. The overhaul covered all critical auxiliaries, including the replacement and upgrade of radiator systems as well as other auxiliaries.

In addition to recovering original capacity, the rehabilitation resulted in savings through reduced fuel and lube oil consumption as well reduced air emissions.

2. Modernisation

In a modernisation project, some components of a power plant and its automation systems are upgraded or replaced to comply with the modern standards. The scope of a modernisation project differs case by case – it may include the replacement of a single part or a complete modernisation of the entire installation. While modern equipment can be more efficient and reduce the own energy consumption, the biggest benefit is the secured availability of spares, thus minimising the risk of forced outage. In order to implement more efficient ways to run the plant, a modernisation of the automation system is also typically required.

3. Gas conversion

When thinking about energy intelligence, conversions of existing engines for gas operation are increasingly being considered. Natural gas is the most efficiently burning fossil fuel and converting an existing engine to operate on gas has an attractive ROI, offering clear benefits both economically and environmentally. Additionally, natural gas has good supply, it is attractively priced, and its emissions are lower.

It is typically a good idea to sync the timing of the gas conversion work with a larger, planned engine overhaul to maximise plant availability and reduce the costs.

Case: Delimara Power Plant 3 – Gas conversion reduces power plant emission levels



SHANGHAI ELECTRIC POWER, one of the major listed companies of China Power Investment Corporation, reduced both electricity production costs and emission levels at their Delimara 3 Power Plant in Malta. Eight Wärtsilä HFO-fuelled engines were converted to run on natural gas and a new UNIC C3 engine control system was installed.

The conversion led to a lower heat rate for the engines, increased efficiency, higher power output capacity, and lower emissions – in other words, reduced operational costs.

4. Combined cycle upgrade – Wärtsilä Flexicycle™ solution

The Wärtsilä Flexicycle™ Upgrade solution combines the advantages of a simple cycle power plant with the efficiency of a combined cycle power plant. The Flexicycle™ concept is based on reciprocating engines equipped with individual heat recovery steam generators producing superheated steam to the steam turbine. The turbine will then generate additional electricity without increasing the fuel consumption. The solution minimises the ecological footprint and maximises the efficiency of existing simple cycle power plant, improving power plant's efficiency by up to 10%.

When planning a power plant upgrade project, identify the areas with highest improvement potential

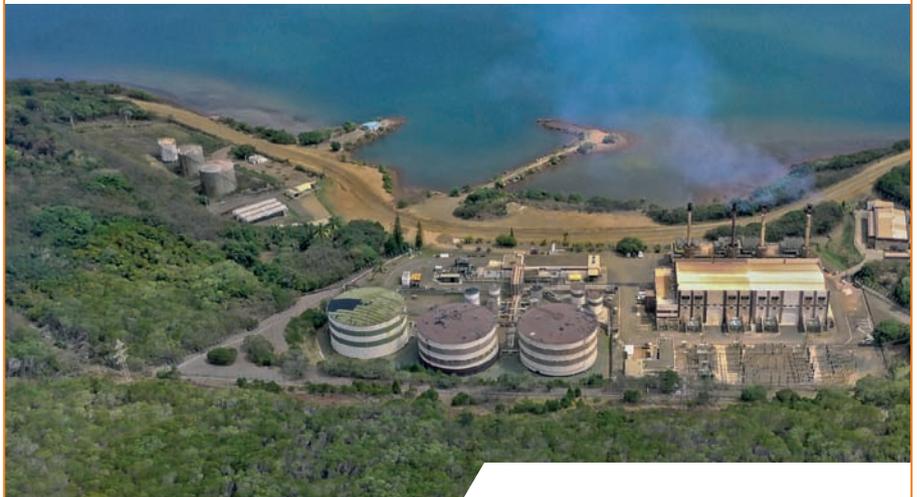
By implementing the Wärtsilä Flexicycle™ Upgrade solution to an existing simple cycle power plant or heavy industries with large amounts of waste heat, high power efficiency can be achieved, while at the same time lowering the emissions per MWe produced. This solution is well suited to base load power plants in which high electrical efficiency is required.

5. Engine performance optimisation

Engine performance upgrades are often based on the latest, state-of-the-art turbocharger with improved efficiency and faster start-up time. Higher pressure ratio capability combined with optimum engine settings improves energy efficiency and can result in an up to 4 percent reduction in fuel consumption. This has a positive impact on operational costs and an attractive ROI.

The fast start-up and loading time is becoming more and more important for frequency regulation in the power grid as flexible, fast-response balancing solutions are used to mitigate the challenges caused by the intermittent nature of renewables like solar and wind.

Case Enercal – Performance optimisation upgrade



NEW CALEDONIAN public utility company ENERCAL wanted to optimise the operational cost and performance of their Nepoui power plant. Before the optimisation project, the fuel consumption of the plant was about 218g/kWh i.e. about 55,000 tons/year.

The project consisted of upgrading the Wärtsilä engines and ABB turbochargers during a scheduled major engine overhaul, thus minimising the overall downtime.

The result was a 5g/kWh improvement for each engine, enabling savings of about USD 400,000 in 2016.

Wärtsilä's energy efficiency offering

As power plants and their equipment age, their efficiency often declines, leading to reduced output and increased fuel consumption – and thereby weaker profitability. However, the energy efficiency of power plants can be improved with various methods, from the replacement of a single part to a full-scale plant lifecycle upgrade project.

Wärtsilä has a broad range of solutions for improving the energy efficiency of a power plant:

- Guaranteed asset performance - a lifecycle solution with performance guarantees
- Power plant lifecycle upgrade
- Power plant gas conversions
- Power plant combined cycle upgrade
- Engine and turbocharger upgrades

For more information, please visit <https://www.wartsila.com/services/services/lifecycle-solutions-for-energy>

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>

[wartsila.com/services](http://www.wartsila.com/services)

© 2018 Wärtsilä Corporation – All rights reserved.

No part of this publication may be reproduced or copied in any form or by any means (electronic, mechanical, graphic, photocopying, recording, taping or other information retrieval systems) without the prior written permission of the copyright holder. Neither Wärtsilä Finland Oy, nor any other Wärtsilä Group Company, makes any representation or warranty (express or implied) in this publication and neither Wärtsilä Finland Oy, nor any other Wärtsilä Group Company, assumes any responsibility for the correctness, errors or omissions of information contained herein. Information in this publication is subject to change without notice.

No liability, whether direct, indirect, special, incidental or consequential, is assumed with respect to the information contained herein. This publication is intended for information purposes only.

