



# Reliable life cycle management for turbine generators with Long-Term Service Agreements

The purpose of this paper is to describe the essential elements of the life cycle management of turbine generators and present efficient solutions to allow power plant owners to concentrate on fulfilling their core tasks in the rapidly changing business environment.

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## Introduction

Today's turbine generators are inherently reliable. A breakdown can, therefore, come as an unexpected and unwelcome surprise for the operator. What's more, if the right spare parts are not readily available, the resulting downtime can be significantly prolonged. In the worst case, the failure of high-speed rotating parts can have severe consequences for both equipment and personnel.

Turbine generators are special equipment whose maintenance requires special competence – which internal maintenance staff at thermal power plants rarely possess. However, even insurance companies nowadays require that more emphasis be placed on the maintenance of the life cycle of high-value and high-risk turbomachinery.

Having a strong service partner gives plant owners a solid basis and guidance for updating their maintenance plans and planning for future investments. With the help of a knowledgeable partner, the risk levels for the main rotating equipment can be optimised to an acceptable level.

A long-term partnership with an experienced and specialised service provider, such as Fortum eNext, really pays off. The continuity of the turbine island operations will be ensured and the results can be seen clearly in reduced maintenance downtime as well as costs.

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## 1. Background

Working practices have changed in power generating companies over the years. In the past, power plants used to have dedicated personnel who knew the equipment, such as turbines and generators, inside-out and who most likely had been taking care of it since the plant was built and commissioned. Often, the original equipment manufacturer (OEM) was responsible for servicing the equipment, and afterwards presented test results to the plant operation staff. It was then up to the plant staff to analyse and decide on the state of their equipment, and to make their own recommendations for necessary service and upgrades in the future.

Today, the power plants have less and less in-house equipment expertise. At many older plants, in conjunction with generational renewal, experienced staff has retired and been replaced by younger, less experienced personnel. Additionally, the number of maintenance staff may have been reduced, and turbine generators are typically just one of their many areas of responsibility. Consequently, there is less time to dedicate to each equipment type, making it difficult to gain in-depth expertise in all areas.

As a result, there has been a decline in the in-house capability to analyse and assess necessary measures, and power plant staff must increasingly rely on the analysis and recommendations given by service providers. However, service providers typically present results from overhauls only in terms of what was done during an outage and how – but not why.

**It is important to know WHAT was done. However, even more important is to know WHY something was done.**

## 2. Lack of systematic equipment life cycle management

In today's operating environment, a long-term approach to equipment life cycle management and maintenance is often missing. One-off services are typically ordered as needed and only after something has already gone wrong and repairs are urgently required.

Larger overhauls are conducted according to a predefined schedule: when the equivalent operating hours in a maintenance interval, as defined by the equipment manufacturer, are reached. A service provider for a larger overhaul is then selected through competitive bidding. This may mean each service is conducted by a different party, giving no continuity to maintenance planning or visibility in the service history. Furthermore, power plants in different locations, even if these are part of the same company with equipment from one or more providers, often make independent decisions on maintenance and service providers, spreading the services and knowledge even wider.

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**In nearly all industries, turbine generators require very special maintenance expertise, which differs from basic maintenance competence.**

However, deviations to planned service schedules and decisions to postpone maintenance activities can sometimes be made purely based on desired costs savings, or due to the fact that there is no budget for the scheduled service. There is rarely systematic data collection and analysis available to support these decisions.

Nowadays, there is also more and more discussion around the life cycle of steam and gas turbine generators. The economic trend in the rapidly transforming energy market is increasingly driving companies to avoid new investments to replace old equipment. Instead, the life cycles of existing machines are extended beyond their designed lifetime. Predicting the feasible lifetime is however very challenging, and operating the equipment must naturally be reliable – and above all safe – during the extended life cycle. Paradoxically, the quality of new equipment has, in parallel, been declining. According to studies, new generators often have considerably shorter operational times until the first failure, compared to older models.

## 3. Supporting energy producers through a long-term approach

Today, a large share of power plant maintenance activities are being outsourced. Through outsourcing, the owner relies completely on the selected partner, to guarantee the availability of critical main equipment. In long-term partnerships, the goal of the owner is to make the outsourcing partner shoulder greater responsibility for its activities, to include a longer term perspective into maintenance planning and ensure continuity and security beyond the original warranty period.

In some cases, the contract terms between the owner and the maintenance partner are so strict that this will eventually drive the need for expert service providers, specialised in maintaining specific equipment areas, whose competence and expertise can be trusted. In the end, what the plant maintenance staff needs are analyses and results from outages, that offer staff tangible advice and help in planning for the future.



**The key benefits of a long-term partnership with a sole supplier include savings in terms of both time and money** – as there is no need to first start the process by choosing supplier, and the overhaul and maintenance work can begin immediately.

It is also easier to have one partner who is familiar with the equipment history and can foresee the need for repairs well in advance.

Another incentive for more systematic lifetime management is the stricter requirements set by insurance companies. Insurance companies are increasingly demanding focused efforts in actively managing the life cycle of high-value and high-risk turbomachinery.



**Efficient and systematic condition monitoring is a major part of responsible power plant maintenance, and naturally contributes to fulfilling the insurance requirements.**

#### 4. Selecting your service partner

When facing a need for equipment upgrades and maintenance, power producers typically have the following alternatives:

	 Maintenance	 Upgrades and modernizations
Typical service approach by OEMs	Follow the standard maintenance plan given by the equipment manufacturer	Replace old equipment or parts of it with completely new ones
Typical service approach by independent service providers	Strive for a more optimized maintenance plan, customize for the environment and equipment in question	Maintain and upgrade the existing equipment

Original equipment manufacturers (OEMs) naturally tend to service and provide solutions for the technology originally provided by themselves. Due to the nature of their business model, the offered approach is often standardised, including a standard set of spare parts for each delivery.

Independent service providers have a different approach, as they do not have their own technology. **The broader knowledge they have means a wider range of equipment from different providers can be serviced and upgraded.** The aim is also to offer the best technical and most economical solution to each specific customer environment and need in question, tailoring the service and delivery as much as required.

## 5. Introducing Fortum eNext

**Service can be provided from a wide range of equipment manufacturers:**

### Turbine brands

ABB • Alstom • Ansaldo  
• Blohm & Voss  
• Fincantieri • General Electric • MAN • Lang  
• LMZ • Tuthill • Siemens  
• Skoda • Stal-Laval  
• Zamech

### Generator brands

ABB • AEG • Alstom  
• Andaldo • ASEA • AVK  
• BBC • Brush  
• Elektrosila • ELIN  
• English Electric  
• Leroy Sommer • LDW  
• Siemens • Skoda

Fortum Corporation (listed on Nasdaq Helsinki) is a leading clean-energy company that develops and offers solutions for customers in electricity, heating, cooling, as well as for improving resource efficiency. Furthermore, Fortum provides services for the power generation industry and consumers, to enable smarter choices in energy matters. Fortum is the third largest power generator and the largest electricity retailer in the Nordic countries. In 2018, the corporation employed around 9,000 energy sector professionals globally and sales amounted to EUR 5.2 billion.

Fortum eNext – part of Fortum Corporation – serves thermal power plant customers globally. Fortum eNext's offering includes highly specialised expert services throughout the life cycle of a thermal power plant, including turbine and generator repairs and overhauls, combustion solutions for emission reduction, co-firing with biomass, as well as many other services to improve power plant performance and optimise regional energy systems. Additionally, Fortum eNext provides full-scope operation and maintenance services, specialising in new waste-to-energy and biofuel fired plants.

With more than 30 years of experience in providing turbine and generator services, Fortum eNext occupies a unique position to cost efficiently support thermal power producers with its turbine generator maintenance management. Operating as an independent service provider for equipment originally supplied by a wide selection of different OEMs, Fortum provides services that include turbine relocation, generator stator and rotor rewinding, turbine rotor re-blading, turbine casing erosion corrosion repair, turbine automation and control and protection system modernisation. Services are typically delivered under tight time pressure during standard minor and major overhauls, which requires agility, first-rate project management and an extensive and specialised partner network.

A strong geographical presence in Scandinavia ensures smooth and quick response times when service is needed. Fortum eNext has two dedicated workshops, in Naantali, Finland and Västerås, Sweden, ready to support turbine generator owners.

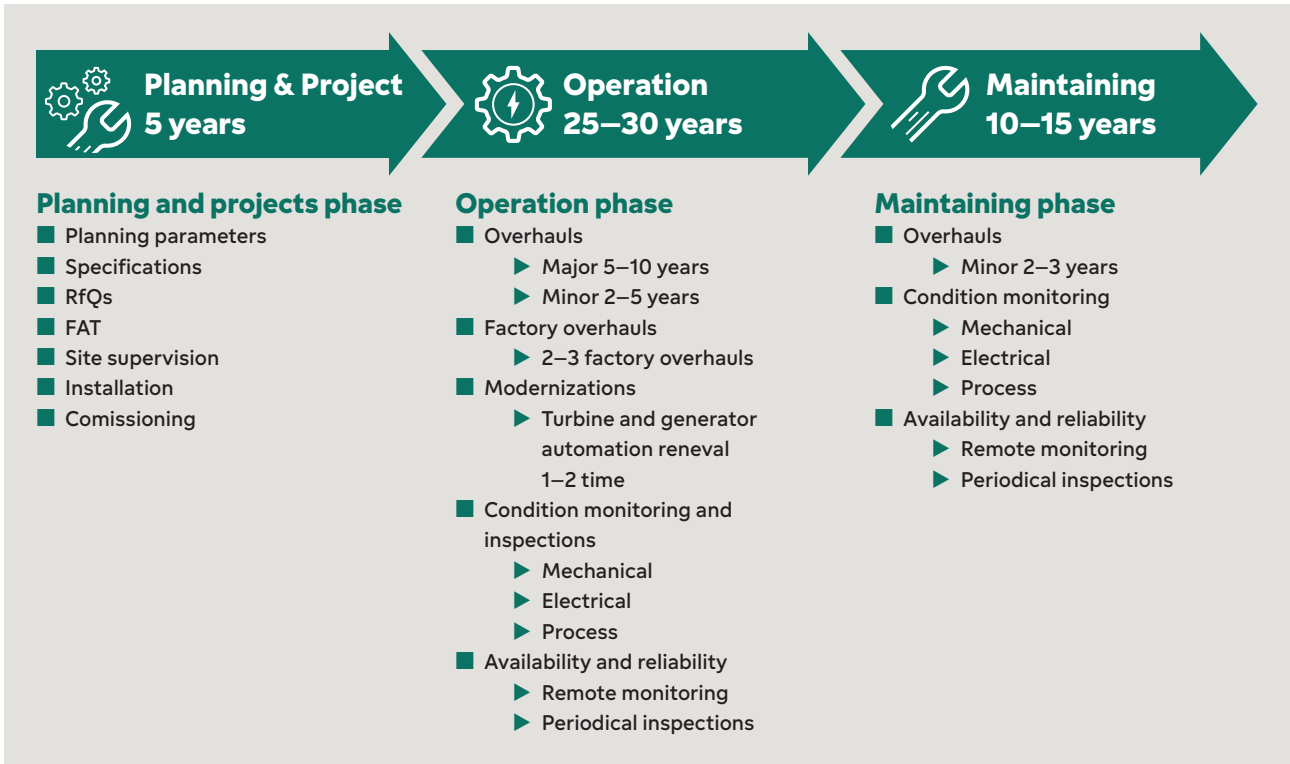
The workshop in Naantali is designed for full-scope turbine maintenance services, and is also equipped with servomotor testing and service facilities. Logistically, the workshop is in an excellent location near Naantali harbour by the Baltic Sea and near the road network.

For more than 130 years, generators have been produced in Västerås, Sweden. This experience, know-how and commitment now lives on in Fortum eNext's workshop, designed for full-scope generator maintenance services. The workshop is fully equipped to repair and rewind both rotors and stators. Next to the workshop facilities, Fortum eNext also operates the only independent high-speed rotor balancing facility in the Nordic countries, expanding the service capabilities even further.

Altogether, Fortum has served more than 200 customers with turbine and generator services, in more than 20 countries globally, and is highly rated by its customers for the expertise and quality of the support provided.

## 6 . Long-term service agreements by Fortum eNext

Long-Term Service Agreement for turbine generators offered by Fortum eNext covers the entire equipment life cycle from the beginning of operation until the end of the life cycle. The typical life cycle phases of a turbine generator are described below:



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Based on decades of experience of working with rotating main equipment, we understand that after several years in operation it is increasingly relevant to base maintenance activities on the actual condition of critical components. In practice, this means partly switching from time-based maintenance to planned, condition-based maintenance.



**For today's turbine generators, the best approach is to mix both time-based and condition-based maintenance.**

The foundation for this strategy is a maintenance plan with activities planned according to schedule, but where inspection findings and measurements from monitoring equipment are used to update the intervals and the scope of the maintenance plan.



## OPTIMIZING LIFETIME PERFORMANCE AND COST

### Diagnostics • What? + Why? + How?

- Identifying and understanding risks
- Giving recommendations how to manage the risks
- Providing expertise to implement improvements and solve issues



#### Inspections

based on reports, available data and visual evaluation as well as minor inspections and testing

**CONTINUOUS  
NEEDS BASED**



#### Overhauls

including more extensive inspections, testing and dismantling of components

**EVERY 3–8 YEARS  
OR EQUIVALENT  
OPERATING HOURS**



#### Modernizations

including machine or system specific upgrades and lifetime extensions

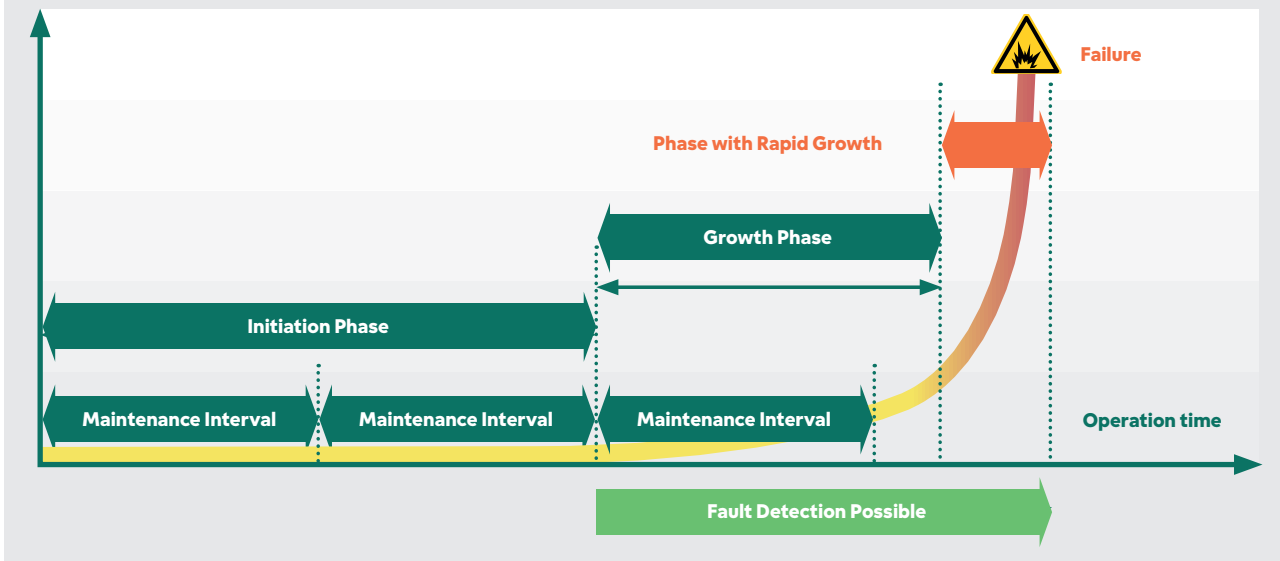
**1–3 TIMES DURING THE  
EQUIPMENT'S LIFETIME**

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Conducting systematic analyses and introducing condition-based maintenance require greater awareness of the anomalies that may occur with your equipment, as well as how these are diagnosed and how often measurements are needed. Fortum eNext's philosophy is to identify the turbine generator condition from a risk perspective in terms of downtime. For a new turbine generator, the maintenance plan is drawn up as an accrual activity at fixed intervals. For an older turbine generator with a higher overall risk level, the maintenance interval must be adjusted in line with the results from diagnostic tools that detect failure modes, and to the growth rate of these failure modes.

The earliest point at which a fault can be detected is when the growth phase of a fault begins, as shown in the figure below. The phase of rapid growth before a failure occurs may be very short. This means that it is during the growth phase that we can and should find the active failure mode.

## Faults can only be detected when the Growth Phase begins



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For this reason, the maintenance plan must be designed with short enough intervals to detect active failure modes. If the interval is too long, a fault may go from undetectable to failure in the interval between two diagnostic inspections.

Fortum eNext's approach gives plant owners a solid basis for updating their maintenance plans and guides future investments in order to maintain or reduce risk to an acceptable level. The inspection reports always include recommendations for measures that can reduce the risk of operational disturbance and/or reduce the consequences of such an outage.

Fortum eNext's service includes remote monitoring of all turbine island equipment: from main equipment to auxiliary systems vital to turbine generator operation.



**When equipment condition is continuously monitored, there will be fewer surprises. Potential faults can be detected in time, which yields clear savings in maintenance costs.**

Working in a long-term partnership with a service provider such as Fortum eNext offers further clear benefits: when maintenance staff is familiar with the equipment history from a longer time horizon, all technical support can be better targeted to fit the actual need. Also, spare parts can be chosen to meet the exact need. All of this reduces downtime and offers cost savings.



## 7. Conclusions

A long-term service agreement with a competent service provider yields clear savings for the power plant owner, in terms of familiarity with the equipment history, performing continuous monitoring of equipment condition, and being able to take precise corrective action before major failures occur. If issues nonetheless occur, no time is lost in selecting a service provider – instead, knowledgeable, specialised technical support and experienced maintenance staff is always available at short notice, and focus is on quickly solving the problem.

Fortum eNext has expertise in a wide range of turbine generators from several different equipment manufacturers, and can cover the owner's whole fleet even with equipment from many different brands.



**Having a strong service partner gives plant owners an excellent basis for updating their maintenance plans, provides an insight into why certain maintenance activities are needed, and offers clear guidance in planning future investments.**

This is a powerful tool to manage and maintain turbine generator-related risks at the desired level – even when the plant's own staff no longer possess specialist competence in high-value and high-risk turbomachinery.



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