With well over a hundred years of experience across more than 90 OEM brands, we customize solutions around:

- Planning and installation
- Long-term operation and maintenance
- Performance upgrades and improvement
- Asset/plant repowering and repurposing

Power Services brings GE’s digital industrial culture to life by blending advanced hardware and software technologies to help you achieve productive outcomes for your operational and business goals.

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Heat Recovery Steam Generators
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Thought leadership for today’s energy challenges:
This is Power Services

Power Services offers advanced technology installation, maintenance and upgrade solutions across total plant assets to more than 2,800 customers in 150+ countries spanning six continents.

Turn Knowledge into Power

- 230+ Years in Power Services
- 150+ Terabytes Engineering Data
- 150 Million Hours Asset Operating Data
- Reduce Risk, Meet Business Goals
  - ~2,500 Outages per Year
  - 6+ Million Parts Shipped Per Year
  - 50+ Parts and Repair Centers Worldwide

Improve Performance

- 26,000+ Patents
- ~4,000 Engineers
- 1,100 Plant O&M Specialists

Manage Total Lifecycle Cost

- ~300 GW Capacity Under 750+ Multi-Year Agreements (MYAs) Worldwide
- 50 Power Plant O&M Contracts
- ~$350 Million Investment
- Power Services New Product Introduction

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POWER

- 9 power generation product lines
- 28,000 power generation assets – one of the world’s largest installed bases
- Servicing 40% of the world’s thermal power
- 1,600 GW of installed capacity

PEOPLE

- 25,000+ global power generation experts
- 3,500+ highly skilled repair employees
- 230+ years of experience

TECHNOLOGY

- Monitoring data from 8,400+ global assets
- Hardware & software blended solutions
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Fleet360* Total Plant Solutions

Power producers around the world face growing pressure to drive their plants' performance to new levels—enhancing reliability, efficiency, output and flexibility while lowering life cycle costs. In this increasingly competitive marketplace, you deserve a trusted partner with the expertise, technology and resources to help you achieve your desired outcomes. Through GE’s Fleet360 portfolio, we can deliver solutions for total power plant assets across 90+ OEM brands, including:

- Gas turbine: heavy duty and aeroderivative
- Steam turbine
- Generator
- Heat recovery steam generator (HRSG)
- Boiler
- Environmental controls
- Repairs
- Asset/plant-level software, controls and data analytics
- Balance-of-plant systems
- Parts programs
- Operations and maintenance (O&M) management
- Service agreements

*Trademark of General Electric Company.
Whether you have a simple-cycle or combined cycle gas plant, you are facing a rapidly changing industry. Integration of renewable generation into the grid, plant reliability and regulatory requirements are just a few of the key areas where Power Services’ Fleet360* portfolio can help you find an excellent solution for your plant.

- Simple-cycle
- Combined cycle
- Cogeneration gas plant
Gas Power Plant Solutions

- 230+ years of "plant-as-a-system" expertise
- 90+ OEM brands serviced
- 120+ million hours of operating data analyzed
- 1 partner to deliver all of your plant solutions

Click each icon below to see specific outcomes.

- Generator
  GE services ALL generator OEM brands (30+)
- Steam Turbine
  ~40% of steam turbine solutions are performed on cross-fleet assets
- Gas Turbine
  GE supports a global fleet of nearly 6,000 gas turbines
- Balance of Plant
  - Water and steam cycle systems
  - Electrical/mechanical auxiliaries
  - Steam quality and handling systems

Multi-Year Agreements
Performance-based strategies that evolve through your plant life cycle

Operations & Maintenance (O&M) Services
GE manages 30+ O&M sites globally that produce 15 GW of total power

Digital Solutions
Outcome-based solutions that transform knowledge into power

Output Efficiency Availability/Reliability Flexibility Emissions

Total Plant Solutions

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HRSG
Installations completed on 30+% of the world’s fleet

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- Combined cycle
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OUTCOMES

Output
Efficiency
Availability/Reliability
Flexibility
Emissions

TOTAL PLANT SOLUTIONS

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*Trademark of General Electric Company.
Steam Power Plant Solutions

- 230+ years of "plant-as-a-system" expertise
- 90+ OEM brands serviced
- 120+ million hours of operating data analyzed
- 1 partner to deliver all of your plant solutions

Whether you're operating a large fossil steam plant, nuclear plant or mechanical drive plant, you need flexible and creative solutions. Power Services can work with you to develop a "no-regrets" strategy that enhances your current performance, while protecting you against future uncertainty.

- Large fossil steam plant ... operating cost reduction
- Industrial and cogeneration ... reliability and operating flexibility

Click each icon below to see specific outcomes.

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**Solutions**

**Outage Services**

**Upgrades**

**Digital**

**MYA and O&M**

**Field Services**

**RePower & Rehab/Relocation**

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**Outcomes**

- Output
- Efficiency
- Availability/Reliability
- Flexibility
- Emissions

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**TOTAL PLANT SOLUTIONS**

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Outcomes
- Output
- Efficiency
- Availability/Reliability
- Flexibility
- Emissions

Click icon to view video.

Steam Turbine
- ~40% of steam turbine solutions are performed on cross-fleet assets

Generator
- ALL OEM brands supported (30+)

Air Quality Control System
- 2,800+ industrial systems implemented

Boiler
- GE installations represent 30+% of the world’s fleet

Balance of Plant
- Water and steam cycle systems
- Electrical/mechanical auxiliaries
- Plant cooling water system

Multi-Year Agreements
- Performance-based strategies that evolve through your plant life cycle

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Product Lines

Steam Turbine

Cross-Fleet

Boiler

Generator

Environmental Control Solutions (ECS)
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Outcome-based solutions that transform knowledge into power

**Video**
STEAM POWER PLANTS

**Outcomes**
- Output
- Efficiency
- Flexibility
- Availability/Reliability
- Emissions
Outage Services

PARTS
GE uses advanced engineering techniques and high-quality materials to manufacture spare parts that help you get more out of your assets. Every part is thoroughly tested and backed by our OEM warranty, leading to improved output, increased efficiency and extended maintenance intervals.

REPAIRS
Our advanced repair solutions are cost-effective, properly scoped to your operational needs and enhanced to reduce your downtime. Our vision is to support one of the world’s best-running fleets, and we do this by delivering new capabilities and programs, all of which are driven by a culture of accountability and a commitment to your organization’s desired outcomes.

MAINTENANCE
Make the right decisions about repairs, replacement and appropriate upgrades for performance improvements with help from GE’s outage services team. Proper planning and expert support are essential to slashing the length of your outages and decreasing downtime.

Aeroderivative Gas Turbines
- HDGT – B/E
- HDGT – F
- Steam
- HRSG
- Generator
- Boiler
- ECS
Adapting to a Changing Industry

The global power industry is changing rapidly. Today’s power plants are required to operate in new ways that differ from their original concept. GE’s comprehensive suite of plant upgrades provides the capability and flexibility to position your plant for a successful future.

Whether you need more output, improved emissions, extended asset life or enhanced operational flexibility to run at lower loads or on a non-traditional fuel, we can customize a solution to meet your commitments.

**GE’s Fleet360* solutions portfolio can:**

- Improve plant heat rate as much as 13%
- Increase output by up to 27%
- Reduce emissions to as low as 5 ppm NOx
- Help achieve part-load operation as low as 10% load with emissions compliance
- Extend asset life up to 200,000 hours
- Harness digital insights to drive plant improvement and scenario evaluation

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*A Trademark of General Electric Company.*
Digital Solutions

Industry in Transition

The electricity industry is undergoing a transformation. Old approaches and techniques are no longer viable—triggering the need for widespread change from power generation to the grid to consumers. By embracing digitalization, companies can apply unprecedented insights, new capabilities and innovative business models to capture enormous opportunities across the entire Electricity Value Network.
Multi-Year Service Agreements

In today’s dynamic industry, power producers are challenged to deliver more flexibility and improved profitability. Through our multi-year service agreements, we continue to demonstrate our commitment to adding value to your operations as a long-term partner. Now, GE is revolutionizing and enhancing our offerings by providing a new type of multi-year agreement (MYA).

Our MYAs are tailored to yield specific outcomes that are important to your business by utilizing new technology and digital solutions while mitigating operational risks. These MYAs extend beyond providing parts, services and repairs to focus on delivering your key outcomes—from enhancing availability and operational flexibility to improving variable output and efficiency.

They provide the financial certainty, simplification, flexible scope, customized solutions, risk management, and substantial performance guarantees your business needs in today’s challenging environment.

Through GE’s portfolio of Fleet360* solutions, our MYAs look beyond the power island to increase value and make your plant more competitive in your operating space.

*Trademark of General Electric Company.
Operations & Maintenance

A long-term partnership

Let us take your plant to the next level with our customizable O&M services options.

Whether you're seeking advisory services to enhance your own operation or looking for a full service operator to perform all of the daily activities associated with operating your site, we can customize an operational partnership with solutions to meet your business goals.

By combining an O&M partnership with our expanded MYA and plant capabilities, we provide you with the expertise you need to increase your productivity and lower your cost.

Our Capabilities:

**Experience** – 50+ years of global O&M services experience applied by a dedicated team of up to 1,400 plant O&M specialists

**Expertise** – Proven capability across B, E, F, H, aeroderivatives, steam, solar and balance-of-plant for GE and Cross-Fleet equipment

**Scale** – O&M contracts totaling about 35 GW of generation at more than 50 customer sites spanning 22 countries

Your Results:

**Increased productivity** – Increased reliability, availability, fuel efficiency, output and flexibility via our cutting-edge Digital Power Plant solutions

**Asset improvement** – Total lifecycle approach from the initial plant design review through the full operating life of your asset. Our experiences from nearly 28,000 equipment assets in operation allow us to identify what you need to ensure greater financial predictability, reduce your risks and increase your profit.

**Lower operating costs** – Access to the latest training, technology, tools and cost-effective practices to help ensure safe, compliant and economic performance. Robust maintenance strategies, anomaly detection and equipment health analytics all drive lower maintenance costs.
Field Services
A Global Field Services Powerhouse

GE’s expert team of field services personnel has deep technical knowledge and cutting-edge tools to deliver the outcomes you need. Our technical field advisors, craft personnel and on-site services teams are highly regarded across the industry for their ability to create customized solutions to virtually any power generation challenge, when and where you need it.

In 2017, Power Services announced the creation of FieldCore – a new, independent industrial field services company with a vision to deliver the highest standard of field services excellence and capabilities. A GE company, FieldCore will unite the best field expertise and people from Granite Services and GE’s Power Services businesses into one unified team.

FieldCore will deliver:

• More productive, reliable, outcomes
• Greater communication and collaboration with you and within our team
• One team of technical field advisors, craft personnel and other field services experts
• Standardized processes and consistency in field service methods and practices
• Operational excellence in all we do
• A structure offering you the right mix of GE’s Fleet360* total plant capabilities

*Trademark of General Electric Company

Power Services in Europe has now completed its evaluation of its existing field services model and organization design. A proposal to transfer its field services fulfillment activities and related support functions in Europe to FieldCore on a phased country by country basis with effect from 1st January 2018 is being discussed with the ILE. A period of consultation with employee representatives will take place across Europe as appropriate and where required by law before any final decisions are taken. This process is likely to take some months.
RePower and Relocation Services

RePower

Achieve significant performance improvements in output and fuel efficiency to restart the clock on your plant's life with GE's RePower service. This flange-to-flange upgrade can improve your existing gas turbine's performance and add years of profitability and life to your power plant. With more than 100 successfully completed flange-to-flange replacement projects across all frame sizes and on five continents, GE has the proven capability and experience to craft the right solution to keep your plant running at its peak potential. GE can RePower existing GE assets or non-GE assets to gain significant performance improvements for your plant. With GE's RePower and relocation services, you can:

• Address multiple asset improvements in one simple upgrade
• Reduce emissions to comply with new regulations
• Increase profitability by improving your gas turbine, plant efficiency, reliability, availability and output
• Lower lifecycle maintenance costs

Plant Rehabilitation and Relocation

Plant rehabilitation and relocation provides operators with a fast track to reliable power supply, combining our plant integration expertise with the proven performance of GE equipment.

Rehabilitating plants that are currently in standstill mode, partially dismantled or damaged offers operators a quick path to power recovery and an opportunity to inject technology for more competitive operation.

Plant relocation is an option to not only revitalize an underutilized asset, but also move it to a more advantageous location. Through this program, we help you return standstill units to operation.
Outcomes
Solutions Developed To Meet Your Needs

Click the links below for more information

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<td>Is your plant providing the information and insights you need to proactively manage key performance metrics?</td>
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Outcomes

Output: Is your plant ready to increase return on current capacity

Rapid changes in the power industry are making capacity management an increasingly critical operational challenge for power producers in today's volatile conditions, particularly plants providing reserve capacity during periods of high demand. GE can deliver an integrated view at the plant level and across all of your assets.

• Operations Optimization
• 7F AGP Portfolio
• 7F Enhanced Compressor
• 6F AGP
• GT24/26 Compressor Upgrade

• LM25/LM6 RePower
• OpFlex* Peak Performance
• Steam Injection
• Compressor Fouling Mitigation (HFWW/Super Polish Blades)
• LMS100 PA+ Upgrade

• ASP upgrades for large fossil LP
• ASP upgrades for D11 HP/IP
• SEC/DEC 600MW ASP solutions
• ASP upgrades for Industrial ST OEM

• 9E AGP
• 9EMax
• 13E MXL2
• 6B AGP

• Stator Rewind
• Rotor Rewind
• Replacement Generator

*Trademark of General Electric Company.
Efficiency: Is your plant delivering on your desired business outcomes through enhanced efficiency?

The growing mix of renewables, volatile fuel prices and emergence of competitive applications globally requires today’s power generation fleet to run more efficiently than ever before. Plants facing variable fuel prices, fuel quality and load levels are adopting new approaches to improve efficiency and reduce operating costs. GE’s Fleet360* solutions can help your plant achieve better efficiency results with more frequent dispatch, more attractive margins and lower fuel costs.
Outcomes

**Flexibility:** Is your plant configured and controlled for enhanced cyclic operation?

Improved plant and fleet flexibility is essential when responding to the challenges of increased renewables, grid fluctuations and fuel price volatility. Plants are increasingly focused on increasing revenue during high demand while decreasing costs when demand is low. With cutting-edge tools and data-driven insights, GE can unlock new opportunities to increase your plant’s flexibility.

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**TOTAL PLANT SOLUTIONS**

- **OpFlex** package
- **Shell Warming System**
- **Low Load District Heating**
- **Steam Turbines Subject to Flexible Operation**
- **Digital ASP**
- **Hybrid EGT**
- **OpFlex Fast Start**
- **Alternative/Dual Fuel Systems Conversion**
- **Synchronous Condensing Upgrade**
- **LM25/LM6 RePower**
- **DLN2.6+**
- **7F AGP Turndown**
- **GT24/26 LPL30**
- **GT26 EV LPL20**
- **OpFlex** package
- **Shell Warming System**
- **Low Load District Heating**
- **Steam Turbines Subject to Flexible Operation**
- **Digital ASP**
- **DLN1+ LPL30**
- **EV Alpha with LPL50**
- **AEV with LPL10**
- **Fuel Flexibility**

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*Trademark of General Electric Company.*
Outcomes

**Availability/Reliability:** Is your plant providing the information and insights you need to proactively manage key performance metrics?

As the power industry faces a complex set of new dynamics and emerging disruptive forces to the operating environment, the expectation to maintain high reliability and availability benchmarks remains. Incentive and penalty levels associated with achieving these benchmarks are increasing in many regions. GE’s proven technologies can help your plant meet rising performance expectations.

CUSTOMER STORIES

Go back to KPI Page

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**Digital Solutions**
- Asset Performance Management (APM)

**Aeroderivative**
- Xtend*
- Rad-Rad Combustor
- Core Software & Controls Upgrades
- Compressor Fouling Mitigation (HFWW/Super Polish Blades)
- Asset Performance Management

**Steam Turbines**
- Valve Upgrades for extended maintenance interval
- Control System Upgrades
- ASP Upgrades for AEG KANIS and Wesel
- Lifetime Assessment and life extension

**HDG - B/E**
- 9E AGP
- 9EMax
- 13E MXL2
- Rotor Life Extension
- 32K Extendor

**HDG - F**
- Rotor Life Management (RLM)
- Enhanced Compressor
- 7F AGP Portfolio
- 9F AGP Portfolio

**Generators**
- Stator Rewind
- Rotor Rewind
- Replacement Generator

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*Trademark of General Electric Company.*
Outcomes

**Emissions:** Is your plant prepared to increase returns within emissions regulations?

Power plants that rely on fossil fuels to generate electricity will play a significant role in producing the world's electricity long into the future. For example, coal-based power is expected to contribute 30% of the world’s electricity through 2025. Changing regulations and developing emissions standards have created the need for active management of emissions levels. GE understands how to navigate evolving conditions and deliver tailored solutions to help your plant comply with stringent emissions regulations.
Product Offerings

Click the tabs below for more information

Cross-Fleet
Aeroderivative Gas Turbines
HDGT - F
HDGT - B/E
Digital Solutions
Steam
HRSG
Boilers
Generators
Environmental Control Solutions
Cross-Fleet Solutions

230 years of power generation services experience

Plant solutions for 90+ OEM brands

4,000+ engineers globally

50+ repair shops in 25 countries

3,200+ monitored gas plant assets across numerous OEMs

24/7 monitoring and diagnostics

With the largest services portfolio in the industry, Power Services can support more than 90 OEM brands across all major plant assets.

80+ steam turbine OEM brands, including: Siemens, KWU, Westinghouse, Toshiba, MHI, and LMZ

~40% of steam turbine upgrade solutions are performed on cross-fleet brand equipment

Gas turbine solutions for several OEM brands

Maintenance and repair solutions for steam turbine brands, including: Siemens, LMZ, SEC, Ansaldo, Brush, and Electrosila

Capabilities to service ANY type of generator (over 30 OEM brands), including: Siemens, Ansaldo, BHEL, Brush, Dongfeng, MHI, and Hitachi

60% of our HRSG solutions are performed on cross-fleet brand equipment

Additionally, our robust portfolio of digital solutions features breakthrough power generation capabilities that bridge assets across your plant and fleet infrastructures, delivering turnkey solutions regardless of configuration or OEM asset mix.
Our cross-fleet portfolio spans supply, repairs, multi-year agreements (MYAs), inspections, upgrades and digital solutions, while applying patented technologies to help extend maintenance intervals and improve asset performance for over 90 OEM brands across major plant assets.

**Gas Turbine Solutions**

**Our portfolio includes:**
- Expert maintenance and repair services using our global network of repair facilities and dedicated cross-fleet field resources
- Patented GE technology that increases intervals, efficiency, and flexibility adopted for non-GE machines
- Digital monitoring, diagnostic, and analysis capabilities at the turbine and plant level
- Dedicated and experienced engineering and field support teams for Siemens and MHI turbines

**Generator Solutions**

**Our portfolio includes:**
- Sensor monitoring of equipment operation to support condition-based maintenance
- Robotic inspections not requiring field removal to reduce outage time and lower maintenance costs
- Rewinds for all conventionally cooled gas turbine generators within a C-inspection
- Zero cycle time maintenance with off-the-shelf parts
- Large stator upgrades for steam nuclear and coal plants to extend output and operating life

**Steam Turbine Solutions**

**Our portfolio includes:**
- Technical support through lifetime assessments and MYAs
- Field service for minor and major overhauls
- Parts solutions, including reverse engineering, design improvement, and supply
- Simple and complex repairs and mobile machining
- Balance of plant services, including component improvements and auxiliary systems upgrades
- Steam path and condenser upgrades

Additionally, our Powering Efficiency Center of Excellence (COE) brings together cross-business experts applying a total plant hardware and software approach to significantly boost efficiency and reduce emissions at the world’s new and existing steam plants.

**Heat Recovery Steam Generator (HRSG) and Boiler Solutions**

GE’s HRSG and boiler solutions support all OEM brands, including Babcock Borsig (now Balfour), AC Boilers, Nooter Eriksen, HRST, NES, Stark, Vogt, and CMI.

**Our portfolio includes:**
- Comprehensive parts replacement
- Advanced technology upgrades to digital solutions
- MYA coverage

By harnessing GE’s MYAs, you not only have access to our numerous commercial and operational offerings, but also benefit from outcome-based solutions warranted by our unprecedented digital capabilities.

**1000+ cross-fleet assets** now being monitored (including Siemens gas turbines)

**MYA contracts** on gas plants and steam plants with other OEM equipment that guarantee improvements in asset performance and customer service over the life of the contract.
Digital Solutions

Built on Predix* to Empower the Electricity Value Network (EVN)

- **Key Programs:**
  - **Profitability**
    - Business Optimization: Up to 1% reduction in fuel costs and higher revenues with optimal dispatch and streamlined communications
  - **Operations Optimization**
    - Operations Optimization: Up to 20% reduction in NOx and 4% reduction in other greenhouse gas (GHG) emissions
    - Operations Optimization: Up to 4% increase in MW output
    - Operations Optimization: Up to $500,000 in fuel savings; 0.5-2% heat rate improvement
  - **Efficiency**
    - Asset Performance Management: Up to 5% reduction in unplanned downtime and as much as $2,000/MW annual reduction
    - Asset Performance Management: Up to 2% improvement in total plant readiness
  - **Flexibility**
    - Operations Optimization: Faster start times, better ramp rate, lower turndowns
  - **Security**
    - Cyber: From avoidance of $1 million per NERC infraction to reduction of lost production due to a catastrophic cyber event
  - **Digital Worker**
    - Digital Worker: Up to 8% reduction in service costs

- Up to **15% IT cost reduction**

- Up to **30% application acceleration:** millions in benefits from cross-EVN data sharing

- **More than $1 billion annual investment** by GE

- **~ 30% of the world’s generation capacity**

- **20,000+ developers** using GE’s Predix solution

- **5,000+ electricity sector patents**

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*Trademark of General Electric Company.*
**APM** software enables the improvement of asset reliability and availability while reducing risk and maintenance costs. It connects historical data, real-time machine data, and other disparate data sources and applies advanced analytics, including physics-guided machine and deep learning, to deliver actionable insights. By predicting potential equipment failures and quickly diagnosing related issues, APM reduces unplanned downtime and improves availability. Additionally, the software helps develop customized maintenance strategies that enhance plant reliability while reducing overall maintenance needs.

Built on Predix, APM offers a cloud-based solution that provides a unified and accurate view of assets and full asset histories. This adaptable and extraordinary scalable solution gives you the flexibility to develop or adopt new analytics, capabilities, and applications as needed.

**Learn More about APM**

APM Case Studies:
- Discover how [Bord Gáis Energy](#) is using GE’s APM software at its Whitegate power plant in Ireland.
- See how [SSE’s](#) Equipment Performance Monitoring Centre is using APM to improve reliability, reduce downtime, maintain uptime, and realize operational savings.

This solution offers four key functional components:

**Machine and Equipment Health:** The foundation of APM, this component provides a unified, complete, and accurate view of assets along with their operating state, status, and health. It functions as a visual reference of the status of an asset, plant, and fleet. The software lets you drill down into the data to perform your own analyses—including root cause—as well as to configure dashboards for various roles and to benchmark performance. It improves asset performance, availability, reliability, and time-to-value while reducing maintenance costs.

**Reliability Management:** APM enables prediction and accurate diagnoses of issues, responding before they negatively impact assets for improved operational reliability and availability. The software’s reliability management functionality layers advanced, predictive analytics to anticipate potential failures earlier and with unprecedented accuracy. It uses a single point of management for anomalies, advisories, alerts, and cases, capturing the complete detail of each case or incident for root cause, reliability, or future analysis.

**Asset Strategy Optimization:** This feature balances reliability, availability, performance, and costs against risk to enhance the value of the asset and reduce maintenance costs. It lets you optimize your approach to performing maintenance, inspection, or redesign activities and enables intelligent asset strategies to help manage it all.

**Compliance and Integrity Management:** APM provides insights into and management of environmental, health, and safety issues while managing regulatory compliance. To help you reduce incidents and increase availability, this APM functionality allows you to calculate the risk and remaining useful life of assets as well as evaluate compliance strategies as equipment conditions change.
**Operations Optimization** is a digital solution that provides critical decision support and improves productivity by pushing the operating envelope to capitalize on more economic operations for every plant in the fleet. Enabled by edge-to-cloud technology and built on Predix, the solution analyzes historical, plant, and other data sources to deliver executable advice or close the loop and drive desired outcomes for better efficiency, flexibility, availability, capacity, and emissions.

The solution allows power generators to directly align operational priorities to business strategy—at scale—across their fleet, regardless of original equipment manufacturer (OEM).

This solution has two functional components:

**Strategic Planning:** This component helps your central operations, fleet managers, and power plant managers create production plans across many planning horizons for the power generation assets in your fleet. The solution leverages key performance indicators (KPIs), advisors, and scorecards along with scenario analysis to determine the best plant configurations to meet desired production schedules and achieve target results. The production schedule generates a runbook that has more granular operational detail in the short term and automatically updates operational plans based on actual plant activity, events, and results.

**Plant Optimization:** Operations Optimization software provides the visibility, insights, advanced analytics, and decision-making support to help optimize your portfolio and improve KPIs. With automation and sophisticated optimizers, our plant optimization functionality can close the loop to help achieve your desired results. This solution gives your plant managers the help they need to achieve production targets, keep the plant running longer, and improve your overall return on assets.

**Plant optimization benefits include:**

- **Greater efficiency:** Helps your central operations and plant managers improve heat rate and better manage operating margins across your fleet.

- **Enhanced flexibility:** Provides insights and recommendations to help your plant managers identify enhanced configuration, process, or operational settings to achieve faster startup, lower fuel consumption, quicker ramp up, and lower turndown.

- **Increased capacity:** Offers more accurate dispatch forecasting (given ambient conditions) as well as the ability to raise baseload output with power reserve or achieve peak capacity at lower operating costs.

- **Higher total plant availability:** Helps optimize operational configurations to reduce the number of trips, cut operational risk, offer more reliable starts, and more seamlessly manage transients or variations in fuel quality.

- **Reduced emission rates:** Establishes operating thresholds during startup, turndown, full load, and part load to help comply with regulatory guidelines and emissions goals for NOx, SOx, and CO2.

**Learn More about Operations Optimization**

Gas Power Plant Case Study: Learn how A2A is using GE’s Operations Optimization software at its Chivasso power plant in Northern Italy.

Steam Power Plant Case Study: Watch how OMU in Kentucky reduces emissions and improves heat rate with GE’s Operations Optimization.
Business Optimization combines physical asset capability, contractual commitment, and essential market data to enable energy marketing and trading teams to succeed in the complex modern power industry. This software revolutionizes energy trading and risk assessment with visibility and insight into financials and transparency into operations.

Our Business Optimization software alerts power generation businesses about profitable trading opportunities—often highly profitable short-term opportunities—and provides utilities with valuable market bidding information. It helps utilities engage in new profit pools such as the market for ancillary services to help manage grid stability, and new market opportunities such as cross-border trading.

Built on Predix, Business Optimization is a cloud-based software solution that enhances portfolio profitability, unit commitment, and economic dispatch in real time. It also supports portfolio planning in the short term and for up to 30 years into the future. Business Optimization comprises the following functional components:

**Market Intelligence and Forecasting**: This component forecasts plant capability and market behavior to increase revenue. It accurately predicts megawatt capacity—accounting for a rigorous set of operational and market factors—as well as market pricing. It also provides effective load forecasting and more dynamic pricing in response to change.

**Portfolio Management**: The software includes portfolio scheduling and planning to increase profits. Its enhanced production scheduling capability helps meet demand set by load or market pricing to reduce total production costs and boost revenue. On an hourly basis, the software uses operational data to recommend optimal bids/offers for energy and ancillary services. Its analytics improve portfolio structuring to enable faster and more efficient transactions, better fuel management, and enhanced maintenance timing.

**Business Communication**: This component efficiently communicates and transfers data with independent system operators (ISOs) and both internal and external parties, including gas nominations and fuel tracking. It delivers efficient, streamlined, and automated communications with ISOs, generation dispatchers, and other key stakeholders. It also provides greater transparency through detailed tracking of transported fuel and electronic tagging of transaction flows.

**Financials**: The software’s functionality includes complete financial forecasts, settlements, and post analysis. It forecasts financials from different market instruments, supports settlement with ISOs and third parties for traded energy, and provides KPIs. This component also manages meter reads for consolidation and provides an interface to General Ledger. It delivers more detailed and effective financial management processes while enhancing clarity, granularity, and insight into financial performance.

See how Digital drives bottom-line success, gathering real-time generation data, grid demand, fuel pricing, and other factors into an optimization equation that drives more refined trading and portfolio decisions. Read eBook.
Workers in the power industry are expected to maximize reliability, productivity, safety, and compliance while controlling operating expenses—all while managing the challenges of complex assets, remote locations, aging infrastructure, generational workforce turnover, and the growth of new generation technologies. Never has the need and opportunity been greater to empower workers with the digital technologies to help deliver exceptional service.

GE’s Predix-based **Digital Worker solutions** augment the abilities of workers at every skill level. Mobile service delivery solutions—paired with predictive analytics—give your remote or onsite workers the information they need, when they need it, and enable greater collaboration with other workers to accelerate knowledge sharing.

GE’s Digital Worker solutions include our **ServiceMax Field Service Management (FSM)**—an industry-leading, cloud-based, mobile solution for field service delivery. The comprehensive ServiceMax solution helps your service workers track assets, leverage analytics from connected devices, collaborate with other workers, schedule the right engineer for the right job, stay in regulatory compliance, and track performance. And when integrated with APM analytics, ServiceMax enables more predictive maintenance to reduce unplanned downtime and drive reliability.

**ServiceMax includes the following functionality:**

- **APM/IoT Integration:** Connects to APM to drive connected field service by executing analytics-driven work requests before a failure occurs. Enables more proactive, predictive maintenance to reduce unplanned downtime, improve reliability, and extend asset lifetime.

- **Work Planning and Scheduling:** Enables you to manage field service teams, their territories, and the corresponding field activities for all service models: break-fix, preventative, condition-based, and predictive maintenance. Improves reliability, availability, and productivity with enhanced scheduling and dispatch so that the right worker is sent to the right task at the right time.

- **Mobile Technician Enablement:** Increases productivity with a mobile app that empowers field workers to successfully complete complex work orders, present service reports for customer signature, and provide dynamic pricing of labor, parts, and products in the field. Allows for offline synchronization, using a standard mobile framework for the field-ready functionality needed to improve productivity with any device.

- **Work Order Debrief:** Allows your engineers to complete work order debriefs, account for time and material costs, collect data and surveys, and capture digital signatures while onsite, significantly reducing the need for additional back office processing.

- **Entitlements and Logistics:** Drives revenue and customer loyalty by helping to ensure maintenance of warranty plans and service contracts. Provides parts visibility across locations, in vans and at depots.

- **Installed Base Management:** Keeps track of every asset and provides visibility into assets, their location, configuration, and service history. Provides workers—including managers, dispatchers, service technicians, and engineers—with instant access to accurate asset information and connected devices data through an intuitive mobile app.

- **Service Performance Metrics:** Tracks critical service KPIs, including utilization, first time fix-rate, and mean time to repair so companies can achieve performance, reliability, and productivity objectives.

**The Service Delivery Effect**

**ServiceMax customers report:**

- **18%** increase in technician productivity
- **8%** reduction in service costs
- **13%** boost in machine uptime
- **12%** decrease in repair time
- **15%** fewer safety incidents
- **13%** increase in service revenue
Traditional risk management is focused on factors like fluctuation in renewables dispatch priority and dynamic fuel costs. Today, cyberattack and security breaches are equally prominent issues that can quickly cascade into serious financial damage or impact human safety.

GE’s expertise in operational technology cyber security can help power companies and utilities plan, design and build operational resilience into people, processes, and technology. Our cohesive risk management approach addresses cyber security challenges throughout the evolution of a company’s security maturity. We develop your security strategy using our three-stage cyber-security maturity model:

- **Stage 1** - Assess: Identify immediate security issues that can impact operations even if the environment is thought to be air-gapped.
- **Stage 2** - Protect: Implement security monitoring and defensive layers to comply with standards and strengthen the security posture of your company.
- **Stage 3** - Prevent: For sophisticated organizations, pursue proactive and predictive security measures such as running attack scenarios on cloud-collected data.

Across all stages, it is critical to maintain a constant vigilance to ensure basic security hygiene is implemented and cyber security policies are enforced. GE offers solutions that work at any stage of security maturity to bring greater control, less risk, and increased reliability to your power business. GE Power’s Cyber Security solutions include:

- **Security Assessment Services**: Consisting of a site security assessment, this in-depth, comprehensive evaluation of an operational site facility is based on industry standards and best practices, resulting in an individualized report with prioritized mitigation recommendations and strategies. The assessment consists of:
  - Site Security Health Check: Provides a rapid overview of your operational site facility, including a baseline of cyber strategy with recommendations on further analysis as well as economic justifications for remediation.
  - NERC CIP Cyber Vulnerability Assessment: Delivers an in-depth evaluation for electric utilities following the requirements prescribed by NERC CIP. The report includes mitigation plans aligned to NERC CIP as well as other industry best practices.
  - IEC Security Practices Certification: Provides certification for system supplier compliance with industry standard security best practices (IEC62443-2-4), covering areas such as hardening, anti-malware, patch management, network, and data security.
  - IEC 62443 GAP Assessment: Helps industrial automation manufacturers and system integrators understand potential security gaps in their software development, and aligns their practices to IEC 62443-2-4. Specialists are highly qualified to perform both onsite and remote assessments.

- **Baseline Security Center**: This risk management platform provides a set of tools, configurations, and services focused on reducing cyber risk that follows the Center for Internet Security’s 20 Critical Security Controls (CIS Controls). CIS Controls are a concise, prioritized set of 20 cyber practices created to stop today’s most pervasive and dangerous cyberattacks. Organizations that implement just the first five CIS Controls can reduce their risk of cyberattack by around 85%.

Unlike typical vendor products, Baseline Security Center is platform agnostic, providing a single pane of glass for a site or fleet. It uses a modular approach with a flexible design, scales from site to fleet, supports Predix integration, can be deployed quickly, and includes extended OS support to address vulnerable legacy operating systems.

- **OpShield**: This purpose-built intrusion detection and intrusion prevention security solution helps protect your critical infrastructure, control systems, and operation technology (OT) assets. OpShield monitors and blocks malicious activity and reduces disruptions to enable highly available operations and secure productivity. This solution includes the following capabilities:
  - Virtual Patching: Protects unpatched systems with strong field and perimeter defense capabilities.
  - Patch Validation Program (PVP): This program includes the Patch Update Service—a monthly subscription service that provides vendor-approved software security patches, validated to work on customer HMI hosts. PVP scheduled updates help protect critical assets from known vulnerabilities by facilitating critical software updates.
  - Intrusion Prevention System/Intrusion Detection System (IPS/IDS): Accurately detects and prevents cyberattacks to the industrial network. By drawing upon our Wurldtech® OT and IT signature set, OpShield offers specific and customized, industrial protection for your industrial control systems (ICS)/SCADA systems and industrial networks. Built for industrial control systems, the inspection engine supports most existing industrial protocols, with the flexibility to easily support emerging proprietary protocols.
  - Centralized Management: Provides a single graphical interface to build and deploy security policy and protection profiles. It also offers a network-wide view of alerts and attacks on the industrial network.

- **Graphical Network Topology**: Provides a real-time graphical representation of the controls network, including unknown device discovery as well as alerting and SIEM integration.

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- **Virtual Zoning**: Creates logical security policy zones without physically rewiring the network (VLAN).

- **Virtual Patching**: Protects unpatched systems with strong field and perimeter defense capabilities.

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A comprehensive, modern platform, Predix spans from the machine to the cloud to enable industrial use cases. The four primary components of Predix are:

**Predix Machine**: The software layer responsible for communicating with the industrial asset and the Predix Cloud, as well as running local applications, like edge analytics. This component can be installed on your gateways, industrial controllers, and sensors. It includes the following features:

- **File and Data Transfer**: Allows data to be pushed to the cloud by continuous streaming, scheduled batches, or file uploads.
- **Store and Forward**: Provides support for intermittent connectivity loss (for example, when a locomotive travels through a tunnel). Data must be collected locally, and then forwarded to the cloud once connectivity is reestablished.
- **Local Data Store and Access**: Allows data about machines to be stored on the device. This capability is particularly useful to provide a service technician with direct access to the data.
- **Sensor Data Aggregation**: Can be connected to multiple sensors and then an aggregated “fingerprint”—that reflects the data gathered from all of the sensors—can be pushed to the cloud.
- **Edge Analytics**: Enables computational algorithms to be run directly on the data that is streaming off the machine.
- **Certificate Management**: Supports certificate management that provides SSL-based connections to the Predix Cloud for end-to-end security.
- **Device Provisioning**: When installed on an edge device, Predix Machine can ‘phone home’ to the Predix Cloud to register itself for further management and software upgrades.
- **Device Decommissioning**: When Predix Machine is taken offline, it can notify the Predix Cloud that it no longer needs to be managed.
- **Configuration Management**: Allows remote configuration of the Predix Machine and the tracking of configuration changes over the lifetime of the machine.

**Predix Connectivity**: Designed for scenarios in which a direct Internet connection is not readily available. The service enables machines to talk to the Predix Cloud via a virtual network containing cellular, fixed line, and satellite technologies.

**Predix Cloud**: Provides a global secure cloud infrastructure created to support industrial workloads and meet regulatory needs.

**Predix Services**: Includes a variety of industrial services to help you build, test, and run Industrial Internet applications. It also provides a microservices marketplace where developers can publish their own services as well as consume third-party services.
CUSTOMER STORY
See how GE is helping Bio-PAPPEL improve reliability, availability, and capacity through a multi-year agreement.

Aeroderivative Gas Turbines

Based on aviation technology with over 400 MM flight hours and 5,000 engines in operation

40+ year aeroderivative product legacy

1,500+ active power generation units and more than 60 GW of installed capacity

More than 6 million annual operating hours and 100 million total operating hours of experience

Operating in more than 60 countries with product reliability exceeding 99%

Outages as short as 2 days with module and engine exchanges

Key Programs:

- LM25/LM6 RePower
- OpFlex* Peak Performance
- Steam Injection
- Compressor Fouling Mitigation (HFWW/Super Polish Blades)
- LMS100 PA+ Upgrade

- DLE Conversion
- OpFlex Automapping
- Hybrid EGT*
- OpFlex Auto NO, Biasing
- Water or Steam Injection for NO.

- Hybrid EGT*
- OpFlex Fast Start
- Alternative/Dual Fuel Systems Conversion
- Synchronous Condensing Upgrade
- LM25/LM6 RePower

- Xtend*
- Rad-Rad Combustor
- Core Software & Controls Upgrades
- Compressor Fouling Mitigation (HFWW/Super Polish Blades)
- Asset Performance Management

*Trademark of General Electric Company.
Asset Management Solutions
FAST ASSET TURNAROUND TIME, PREDICTABLE REPAIR COSTS, INCREASED ASSET AVAILABILITY

GE's aeroderivative asset management solutions provide you with fast turnaround and true fixed-price maintenance with GE warranty. By delivering asset flexibility, speed, efficiency, and improvement, GE helps you benefit from improved outcomes: better output and performance, cost saving, and enhanced maintenance and availability.

Benefits of Repair by Engine Exchange
- New, fully refurbished and partial-life engines to meet your diverse operation cycle requirements
- Reduced engine downtime with one 2-3 day outage
- Buyback value offered on exchanged unit
- Elimination of spare engine and lease engine

Benefits of Fast Turnaround Depot Repair by Module Exchange
- 50-day major overhaul and quick turnaround repair by exchange modules
- Fast return to service
- No change to engine serial number
- GE assumes cost risk for large engine parts and flow path airfoil replacement

Benefits of Onsite Repair by Rotable Exchange
- Enables onsite repair for your hot section, HPT rotor, HPT rotor, HPT S3 and S2 nozzle, combustor and turbine mid-frame modules
- Eliminates the need for a depot visit
- Reduces your engine downtime to one 1-3 day outage
- Eliminates the need to stock spare module assembly

Benefits of Flexible Lease Program
- Lease membership: Use of lease assets during major repair and unplanned outages
- Backup lease membership: Use of lease assets as a stand-in for spare engines
- Long-term lease: Long-term use of lease assets with option to buy at the end of the lease
- Benefits of a spare or operating engine without the capital investment
- Reduced engine downtime with two 2-3 day outages
- Payment tailored to your operations: Fired-hour-based lease-asset usage fees

Outage Applicability
- Major Overhaul ✔
- Hot Section ✔

Benefits of Repair
by Engine Exchange

Benefits of Fast Turnaround Depot Repair by Module Exchange

Benefits of Onsite Repair by Rotable Exchange

Benefits of Flexible Lease Program

Service Center Overhauls and Repairs
LOCAL CAPABILITIES BUILT ON OUR AVIATION LEGACY

Offering unmatched industry support, our worldwide network of service centers offers convenience and quick turnarounds. Our Centers of Excellence have the capability to overhaul and repair GE units with quick turnarounds and are certified with aerospace quality standard AS9100. We provide:

- High quality with low turn times
- Wide range of alternatives to suit your needs
- Used parts to reduce cost and turn times
- Reduced downtime and lease fees
- Technology and intellectual investments
- Industry leadership in quality, including process control stability and supplier certification programs
- Level 4 service depots with engine overhaul capability
- LM2500, LM6000 and LM100 – all models
- Overhauls, repairs, and hot-section events
- Multi-product line test capabilities (all LM2500/LM6000 models)
- Serviceable rotatable assets in the event of extended repair cycles
- Engine mapping

Brindisi, Italy
- LM2500 – all models
- Overhauls, repairs and hot-section events
- Met Lab for detailed analysis

Outage Applicability

Benefits of Repair
by Engine Exchange

Benefits of Fast Turnaround Depot Repair by Module Exchange

Benefits of Onsite Repair by Rotable Exchange

Benefits of Flexible Lease Program

Outage Applicability

TOTAL PLANT SOLUTIONS

TABLE OF CONTENTS
AERODERIVATIVE GAS TURBINES

GE's Xtend Hot Section for LM2500 base SAC/DLE engines increases engine availability to help reduce your overall maintenance and life-cycle costs. The LM2500 Base Xtend hardware was developed from technology improvements made within the LM2500 Plus G4 engines. These improvements include improved materials, coatings and enhanced secondary cooling.

The Xtend DLE 1.0 combustor and fuel nozzle kit is available as an option for gas-only DLE combustion applications. The Xtend SAC combustor and fuel nozzle kit is available as an option for gas/dry applications. It is also available for SAC water-injected and steam-injected units without a combustor/fuel nozzle guarantee. The Xtend DLE 1.0 combustor and fuel nozzle kit offers the following benefits:

- Doubles LM2500 base SAC/DLE hot section life up to 25,000 hours of additional life
- Reduces your life-cycle costs by eliminating one entire hot section repair or exchange
- Provides you with greater availability by avoiding hot section replacement downtime
- Provides you with an OEM-approved life extension

LM2500 models can be updated to the current LM2500+ or LM2500+G4 configuration for enhanced output and improved thermal efficiency. The upgrade can be performed according to the following options:

- Convert the existing engine with a modification kit so that it exhibits the same performance as the production +/-G4 model
- Replace the existing engine with a production LM2500 +/-G4
- Upgrade the combustion system to Dry Low-NOx Emissions (DLE) to reduce water usage and improve emissions capability and combustor life over existing SAC combustion technology.

Benefits include:

- Allows you to increase total output up to 36 MW (or an additional 13 MW)
- Provides 2.5 pts of efficiency improvement
- Uses new single-crystal materials and improved cooling technology to increase life at higher temperatures
- Lowers emissions for environmental friendliness and regulatory compliance, including 15 PPM NOx/CO for LM2500+ and 25PPM NOx/CO for LM2500+G4 without water injection via the DLE 1.5 technology

LM2500 RePower

REFRESH YOUR GAS TURBINE WITH AERODERIVATIVE TECHNOLOGY

<table>
<thead>
<tr>
<th>Model</th>
<th>Output (MW)</th>
<th>Heat Rate (BTU/kW hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base SAC</td>
<td>23</td>
<td>9,813</td>
</tr>
<tr>
<td>Base DLE</td>
<td>22</td>
<td>9,447</td>
</tr>
<tr>
<td>+ SAC</td>
<td>30</td>
<td>9,377</td>
</tr>
<tr>
<td>+ DLE</td>
<td>30</td>
<td>8,948</td>
</tr>
<tr>
<td>+G4 SAC</td>
<td>36</td>
<td>9,253</td>
</tr>
<tr>
<td>+G4 DLE</td>
<td>32</td>
<td>8,863</td>
</tr>
</tbody>
</table>

Platform: LM2500
LM2500 and LM6000 DLE
REDUCE EMISSIONS, ELIMINATE WATER USE FOR NO, ABATEMENT, AND IMPROVE EFFICIENCY

Convert your LM2500 or LM6000 SAC gas turbine to Dry Low Emissions (DLE) technology and reach NOx levels as low as 15 ppm for some models, eliminate water consumption for NOx control, improve heat rate, and improve combustor life over SAC. Benefits include:

- Allows the combustor premix to operate over the entire power range, reducing emissions at lower power
- Because the DLE system does not require water injection to lower NOx emissions, eliminates the possible maintenance impact of water and enhances thermal efficiency compared to water-injected systems
- Leads to increased plant operations savings with absence of water or steam injection
- Guarantees NOx emissions not to exceed 25 ppm when using natural gas fuel at full load and down to 15 ppm on certain LM2500 and LM6000 models
- Guarantees CO emissions not to exceed 25 ppm on natural gas fuel and at full load

LM6000 models can be updated to the current PC through PH configurations for enhanced output and improved thermal efficiency. The upgrade can be performed according to the following options:

- Convert existing engine with a modification kit
- Replace the existing engine with a production LM6000 PC-PH engine

Our LM600 model updates offer the following benefits:

- Allow you to increase total output up to 57 MW
- Improve the efficiency, availability, flexibility, reliability, life and emissions
AERODERIVATIVE GAS TURBINES

The Hybrid Electric Gas Turbine (EGT) upgrade offers reduced system operating costs to create value for power providers and ratepayers. The upgrade enables contingency (spinning) reserve without fuel-burn between demand events. This also enables high-speed regulation, primary frequency response, and voltage support with the combined response of the gas turbine and battery storage system.

The upgrade can be applied to the LM6000, LM2500, and LMS100. Representative values for the LM6000 Hybrid EGT are shown below.

**Without Fuel Burn Attributes:**
- Instant response/always ready technology
- 50 MWs of operating reserve
- Primary frequency response
- -8 to +5 MVAR voltage support
- 134 MW-secs inertia with synch cond
- Black-start technology
- Demand charge savings

**With Fuel Burn Attributes:**
- 50 MW peaking energy for local contingency
- 25 MW of high-speed frequency regulation
- Self-managed BESS SOC
- BESS peaking power capability

**Key Features:**
- 10 MW Li-ion battery
- GE’s Brilliance inverters
- OpFlex* hybrid upgrade package
- GE’s proprietary hybrid turbine controls

GE’s Radial-Radial (Rad-Rad) combustor design for the LM6000. The new combustor features redesigned primary and secondary swirlers to alleviate potential issues with the anti-rotation tabs and coating loss, thereby extending the life of your combustor and downstream components. Benefits of the latest SAC technology include:

- Increase combustor life
- Increase high-pressure stage 1 and stage 2 turbine blade life
- Maintain current guaranteed NOx, and CO emissions

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- OpFlex* hybrid upgrade package
- GE’s proprietary hybrid turbine controls

GE’s Radial-Radial (Rad-Rad) combustor design for the LM6000. The new combustor features redesigned primary and secondary swirlers to alleviate potential issues with the anti-rotation tabs and coating loss, thereby extending the life of your combustor and downstream components. Benefits of the latest SAC technology include:

- Increase combustor life
- Increase high-pressure stage 1 and stage 2 turbine blade life
- Maintain current guaranteed NOx, and CO emissions

**Outage Applicability**

<table>
<thead>
<tr>
<th>Major Overhaul</th>
<th>Hot Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
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</table>
LMS100 PA+ Upgrade
INCREASE OUTPUT AND EFFICIENCY WITH THE LATEST LMS100 TECHNOLOGY

The LMS100PA+ upgrade brings the output and efficiency gains of the LMS100PA+ to the LMS100PA fleet. This upgrade may include conversion from a low-flow power turbine to a high-flow power turbine, IGV rigging modifications, and software upgrades to increase performance across the ambient range. Benefits include:

- Achieves the same expected output performance as new production LMS100PA+ units
- Provides up to 116 MW total output
- Increases efficiency up to 0.4%
- Increases gas turbine air flow up to 3.4%
- Includes upgrade to the latest controls software

Aeroderivative RePower Upgrade
REFRESH YOUR GAS TURBINE WITH AERODERIVATIVE TECHNOLOGY

Add years of profitability and life to your existing power plant with a flange-to-flange upgrade of your existing gas turbine to an aeroderivative gas turbine, including the Fr6B to LM6000, Fr5 to LM2500, FA/8 to LM2500/LM6000, Westinghouse to LM2500/LM6000, and Rolls Royce Olympus and Avon to LM2500. This upgrade has multiple options, depending on your existing configuration and power demands, including: replacing the existing gas turbine with an aeroderivative turbine within the existing package; replacing the turbine-driven package with a newly built aeroderivative gas turbine driver package (re-using the existing driven equipment); and completely replacing the entire gas turbine package—turbine and driven equipment—with a completely new aeroderivative gas turbine. Our aeroderivative gas turbine upgrade offers the following benefits:

- Match your gas turbine output and exhaust energy to the needs of your existing plant.
- Increase profitability by improving your gas turbine and plant efficiency, reliability, availability, and output.
- Lower your life cycle maintenance costs.
- Upgrade to the latest GE turbine controls technology.
Other Upgrade Options

<table>
<thead>
<tr>
<th>Upgrade Offering</th>
<th>Applicable Turbines</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpFlex* Automapping: DLE combustors are continuously and automatically mapped during operation to help ensure emissions compliance at all ambient conditions.</td>
<td>LM6000</td>
<td></td>
</tr>
<tr>
<td>OpFlex Auto NOx Biasing: Upgrade control logic to closed loop control NOx.</td>
<td>LM6000</td>
<td></td>
</tr>
<tr>
<td>OpFlex Fast Start: Go from 0 to baseload in 5 minutes.</td>
<td>LM6000</td>
<td></td>
</tr>
<tr>
<td>Alternative/Dual Fuel Systems Conversion:</td>
<td>LM2500/LM6000/LMS100</td>
<td></td>
</tr>
<tr>
<td>Synchronous Condensing Upgrade: Allows the generator to work as a sync condenser while still maintaining the ability to have a hot start back to creating power.</td>
<td>LM2500</td>
<td></td>
</tr>
<tr>
<td>Water Injection for NOx: Add water injection for NOx control.</td>
<td>LM2500/LM6000/LMS100</td>
<td></td>
</tr>
</tbody>
</table>

Compressor Fouling Mitigation (HFWW/Super Polish Blades): This product introduces new polished compressor blades and vanes along with an enhanced online high flow water wash (HFWW) system to improve compressor performance and extend water wash intervals.

OpFlex* Peak Performance: Increase hot day performance by adjusting engine parameters to improve power while taking a slight hit on life. Output is increased up to 10 MW.

OpFlex VIGV Schedule Improvement: Adjust VIGV schedules to provide more air flow into the LPC when engine has degraded, providing increased power and efficiency under certain operating conditions.

Steam Injection: The LM6000 upgrade provides emissions control with the addition of steam through the fuel nozzles.

Core Software & Controls Upgrades: With these products, you can upgrade software to the latest version.

Asset Performance Management: Identify the impact of each critical failure mode on total plant reliability, mitigate each with digital solutions to the extent possible, and measure the effect of the solution as a reliability improvement.

See our full list of upgrade offerings for aeroderivative gas turbines.
B/E-Class Gas Turbines

More than **217 million** hours of operation

More than **2.5 million** starts

3,700+ units in **99 countries**

Largest installed base in the world with **257+ GW** of capacity—twice our nearest competitor

**Unmatched reliability** at >98.5%

46 years of proven performance in **power generation**, **cogeneration**, and **mechanical drive**

GE’s first unit was COD in **1971**, and still in commercial operation today

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**Key Programs:**

**OUTPUT**
- 9E AGP
- 9E Max
- 13E MXL2
- 6B AGP

**EMISSIONS**
- DLN1+
- AEV
- EV Alpha

**EFFICIENCY**
- 9E AGP
- 9E Max
- 13E MXL2
- 6B AGP

**FLEXIBILITY**
- DLN1+ LPL30
- EV Alpha with LPL50
- AEV with LPL10
- Fuel Flexibility

**AVAILABILITY**
- 9E AGP
- 9E Max
- 13E MXL2
- Rotor Life Extension
- 32K Extendor
Customizable Outage Solutions
SHORTEN OUTAGE TIMES AND REDUCE COSTS

Make the right decisions about repairs, replacement, and appropriate upgrades for performance improvements with help from GE’s outage services team. Proper planning and expert support are essential to slashing the length of your outages and decreasing downtime. With more than 1,500 outages completed each year, our team has broad experience handling both planned and unplanned outages. We can work with you to address your specific needs and create an integrated plan that includes processes, resources, parts, and repairs. Additionally, our Outage Advantage* program enhances execution through a tailored selection of technologies and service options focused on performance and maintenance management.

Our outage solutions offer the following key benefits:
• **Shorter gas turbine outages**: Detailed planning helps ensure that parts, upgrades, repairs, and experts are in place when you need them.
• **Reduced costs**: By limiting emergent maintenance needs, our outage services keep your costs down.
• **Increased performance**: We help you increase overall value and performance by focusing on upgrades that work with your whole system.
• **Increased safety**: Our services help ensure the safety of your people, your plant, and the environment.
• **Broad service range**: Rely on the same GE expertise and capabilities you know and trust for repairs on select non-GE turbines as well.

Transporting turbine components off-site for repair can increase your outage time by days or weeks, while the additional handling required exposes the equipment to risk of further damage.

GE’s On-site Services (OSS) offers highly technical onsite inspections and premium repairs globally. We help ensure adherence to strict environment, health and safety (EHS), quality, technical, and operational standards while meeting and exceeding your scheduling and budgeting requirements. We bring the inspection and repairs directly to your location to help you reduce outage time and achieve substantial cost savings. Our On-Site Inspection and Repair teams offer:

**Comprehensive services**: We provide a full range of services—from typical inspections, repair, and machining to highly specialized services only offered by GE.

**Extensive tooling**: GE’s OSS is one of the largest onsite service organizations, with more than 500 pieces of portable equipment and an extensive tooling inventory.

**Experience**: Our team of qualified GE specialists includes machining supervisors, engineers, and technicians with an average experience level of more than 20 years.

**Global responsiveness**: All equipment is completely mobile and can be enroute to required destinations around the world within hours of notification.

**Non-destructive Testing (NDT)**
- Eddy-current Testing (ET) Blade Attachments (GT Wheel Dovetails)
- Penetrant Testing (PT)/Replication for Spacer Rubs
- Full Unit Compressor Blade PT (Casing Off)
- In-Situ TO/SO/R1 (PT-Ulrasonic Testing (UT))
- In-Situ Fwd Stub (TL 1907)
- Post Repair/Blend PT (GT Compressor)
- End of Life (Full Teardown)

**Welded Gas Turbine Rotor NDT**
- Based on periodic creep and LCF monitoring schedule
- Maximize your specific rotor lifetime with information gained from NDT
- An OEM solution built upon decades of rotor fleet experience
- Dedicated on-site team of GE NDT specialists

**Repairs/NDT**
- Robotic RD Blending (7F)
- EMT
- Torsional Testing
- Rotor/Bucket Instrumentation

**Borescope**
- Standard Borescope Inspection
- Enhanced Borescope Inspection (eBI)

Help ensure the integrity of your insulation and mechanical support systems with inspections from GE. Each unit requires specific tests and analysis:

- Borescope inspections of the compressor and turbine
- Smart borescope inspection for longer inspection intervals
- Compressor blade R0/R1 penetrant inspection, in-situ or case off
- Gas turbine wheel dovetail eddy current inspections, rotor removed
- Ping test to determine resonant frequency and response of stator compressor vanes in stages S0 to S5
- Forward stub shaft UT
- Inspections to support rotor life extension—customized per rotor model
Outage Applicability

<table>
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<th>CI</th>
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<th>MI</th>
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</table>

Repair capabilities by region:

**Americas: 3 Locations**
- Rotor: F5, 6B, 7E, 7F/FA/FB
- Turbine Blade: 6B, 7E, 7FA/FB, 7F AGP
- Power Nozzle: 6B, 7E, 7FA/FB, 7F AGP
- Shroud: B/E/F All Frames
- Fuel Nozzle: 6B, 7E, 6FA, 7FA/FB, 9E
- Combustion: 6B, 7E, 9E

**Europe: 6 Locations**
- Rotor: All Frames (excluding Fr7)
- Turbine Blade: GT8, GT9, GT11, GT13D, GT13E1, GT13E2, GT24, GT26, 701F
- Power Nozzle: 6F, 9F, 7F
- Fuel Nozzle: 6B, 6F, 9F, HDGT
- Combustion: 6F, 7F, 9F, GT9, GT11, GT13D, GT13E1, GT13E2, GT24, GT26, 701F

**Middle East/Africa: 5 Locations**
- Rotor: All Frames
- Turbine Blade: F5, F5, 6B, 7E, 7E, 9E, GT8, GT9, GT11, GT13D, GT13E2
- Power Nozzle: F5, F5, 6B, 7E, 7E, 7F
- Shroud: 6B, 7E, 9E, 7F S2 and S3
- Fuel Nozzle: 6B, 7E, 9E, HDGT
- Combustion: 6B, 6F, 6FA, 7E, 9E, GT9, GT11D

**Asia: 6 Locations**
- Rotor: All Frames
- Turbine Blade: F5, 6B, 7E, 7E, 7F, 9E, 9F, 9F, GT13E2, 701F
- Power Nozzle: F5, 6B, 6FA, 7E, 9E, 9FA/FB
- Shroud: B/E/F All Frames, GT13E2
- Fuel Nozzle: 6B, 6FA, 7E, 7F, 9E, 9E, 9F
- Combustion: F5, 6B, 6FA, 7E, 7E, 7F, 9E, 9F, 9F, GT13E2, 701F
Reduce costs by extending the lifetime and recovering the performance of your gas turbine components through our innovative reconditioning services. The reconditioning portfolio covers the full range of parts:

- **Turbine components**: Nozzles, blades, buckets, and shrouds
- **Compressor components**: Blades and vanes
- **Structural parts**: Shells, casings, and bearings
- **Combustion components**: Fuel nozzles, burners, liners, and transition pieces

Standardized repair processes help make every customer-specific job efficient and well-suited to meet your operational needs. Backed by our Repair Development Centers and our Repair Technology CoE, GE invests $40 million annually to draw upon our design experience and the world’s largest fleet and inspection database to continuously improve our repairs technology and lower your total cost of ownership.

**Flexibility and Expertise to Meet Your Repair Needs:**
- SMART repairs for customizable light/medium/heavy repair scopes
- Repair capability to service non-GE turbines, non-GE parts, and GE components previously repaired by a third party
- Global repair network

**Zero Cycle Repair Options:**
- Reduce repair cycle time to zero with refurbished parts
- Eliminate inventory costs
- Backed by GE’s warranty for peace of mind

**Technical Data**
- More than 60% cost reduction through reconditioning – compared with new parts
- More than 30 years of reconditioning experience on well over 50,000 parts
- Delivery of full sets including replacement of fallout parts and assembly material
- Emergency stock for fast responses component history tracking

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**B/E/F-Class Reconditioning and Repairs**

**REDUCE LIFE CYCLE COSTS**

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**OUTAGE SERVICES**

**TABLE OF CONTENTS**

**TOTAL PLANT SOLUTIONS**
The DLN1+ combustion system provides superior capability across a wide range of requirements, allowing you to operate your B/E-class gas turbine with enhanced performance. This solution provides the following key features and benefits:

- **Ultra-low NOx configuration**: Controls to 3.5 ppm NOx to meet the strictest regulatory requirements without the use of water, steam, or ammonia.

- **Low part load 30 (LPL 30)**: Uses axial fuel staging to allow for NOx/CO compliance across a 200°F firing temperature range, as low as 35% of baseload, in addition to improving heat rate across all load ranges by as much as 3%.

- **Capacity performance package**: Employs an alternative version of an axial fuel staging configuration to increase simple cycle output up to 76% by peak firing up to 100°F higher with no impact on NOx emissions and CO levels 70% lower than baseload.

- **Fuel flexibility**: Reduces fuel costs with customized solutions that enable higher concentrations of process gas to be blended and burned diluent-free with natural gas in a DLN combustor.

### Emission-compliant Load Flexibility with Axial Fuel Staging

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Min. Load</th>
<th>Max. Load</th>
<th>NOx (ppm)</th>
<th>CO (ppm)</th>
<th>Heat Rate @ 70% of Load</th>
<th>Capacity Performance Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLN1+ with LPL 30</td>
<td>37%</td>
<td>102%</td>
<td>as low as 9</td>
<td>25</td>
<td>-3%</td>
<td>+7.6%</td>
</tr>
<tr>
<td>Capacity Performance Package (+100°F Tfire)</td>
<td>60%</td>
<td>107%</td>
<td>as low as 9</td>
<td>25</td>
<td>-1%</td>
<td>+7.6%</td>
</tr>
</tbody>
</table>

### Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
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<td>✔</td>
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</table>

### New Quoting Limits

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen (H2)</td>
<td>Up to 32%</td>
</tr>
<tr>
<td>Ethane (C2H6)</td>
<td>Up to 100%</td>
</tr>
<tr>
<td>Ethylene (C2H4)</td>
<td>Up to 49%</td>
</tr>
<tr>
<td>Propane (C3H8)</td>
<td>Up to 100%</td>
</tr>
<tr>
<td>Propylene (C3H6)</td>
<td>Up to 35%</td>
</tr>
<tr>
<td>Butane (C4H10)</td>
<td>Up to 100%</td>
</tr>
</tbody>
</table>

You can accommodate a full range of fuel alternatives, as well as switch from one fuel to another while running under load or during shutdown, with GE’s B/E-class combustion systems.

**Standard Combustion and Multi-Nozzle Quiet Combustor (MNQC)**
Operate on more than 50 types of fuels—across nearly the entire fuel spectrum—including gaseous fuels ranging from traditional natural gas to hydrogen to syngas, and liquid fuels ranging from light distillates to heavy fuel oil (HFO).

**Dry Low NOx (DLN)**
Reduce fuel costs with customized solutions that enable higher concentrations of process gas to be blended and burned diluent-free with natural gas in a DLN combustor.

**Dual Fuel Conversions**

- **Liquid conversion kits**: Operate on liquid fuels, providing startup fuel when you want to use non-standard fuels. Increase plant availability via emergency automatic fuel transfers when gas fuel becomes unavailable.

- **Gas conversion kits**: Switch to natural gas or liquid natural gas (LNG), resulting in lower emissions, longer inspection intervals, and longer hardware life compared to liquid fuels.
Reduce component wear and combustion repair costs with Advanced Extendor. Built on proven, proprietary technology from the DLN1+ combustion system, and data-driven insights from extensive fleet experience, our B/E-class standard combustor components are durable and long lasting. You will experience increased availability based on extended maintenance intervals between combustion inspections of up to 32,000 hours when operating on natural gas.

For operation on Heavy Fuel Oil (HFO), GE’s new proprietary LifeMax TBC coating for HFO offers unparalleled protection against vanadium attack and hot corrosion. Available on new components or as part of a repair on your existing Standard Combustor, LifeMax TBC coating for HFO extends maintenance inspection intervals to up to 24,000 factored fired hours (FFH), eliminating inspections and reducing maintenance downtime.

Combine the durability of our Advanced Extendor hardware with GE’s Advanced Gas Path (AGP) solution or Performance Improvement Package (PIP), and you can extend and align your gas path and combustion maintenance intervals to up to 32,000 hours—providing up to four years of continuous operation between inspections.

Modernize the performance of your assets by uprating the base firing temperature of any vintage 6B unit up to 2084°F or the latest PG6581B PIP configuration up to 2114°F, and any vintage 7E and 9E up to 2053°F with hot gas path and controls modifications.

Significantly increase output, efficiency, reliability, and availability with advanced materials and improved cooling features that can withstand higher firing temperatures and increase component durability and inspection intervals.
GE has developed a drop-in replacement for repowering the 6B fleet, the 6F.01 F2F (flange-to-flange). This solution maintains the proven reliability and flexibility of your 6B with its current footprint and auxiliary systems intact, while benefiting from advanced F-class technology, efficiencies, and extended maintenance intervals for power generation and industrial applications. With 6F.01 F2F, you benefit from:

- **Drop-in simplicity:** Retrofit within your current 6B footprint and continue to use most of your existing auxiliary systems.
- **Similar exhaust energy:** The operation of your combined heat and power (CHP) and combined cycle (CC) applications will not be impacted.
- **Improved output:** Expect a greater than 18% boost in output above a 6B unit.
- **Reduced outage durations:** Our field-replaceable compressor airfoils translate to quicker replacement times.

### Technical Data

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.6 MW output for CC</td>
<td>(compared to 43 MW for 6B - 6,581 PIP)</td>
</tr>
<tr>
<td>+18% increase in GT MW</td>
<td>+15% for CC MW</td>
</tr>
<tr>
<td>9,031 BTU/MWhr heat rate</td>
<td>(compared to 10,180 for 6B - 6,541 PIP)</td>
</tr>
<tr>
<td>+5 pts improved efficiency for SC and CC applications</td>
<td></td>
</tr>
<tr>
<td>40% turndown capability for ISO Day conditions using Inlet Bleed Heat</td>
<td></td>
</tr>
<tr>
<td>Extended maintenance intervals with 32% CI and HGP hardware components</td>
<td></td>
</tr>
<tr>
<td>Emissions as low as 25 ppm NOx and as low as 9 ppm CO</td>
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</tbody>
</table>

### Outage Applicability

<table>
<thead>
<tr>
<th>Category</th>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
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Increase power and slash operating costs—without sacrificing reliability—with GE’s 9EMax four-stage turbine module. The 9EMax solution can help you cut annual fuel costs by as much as $5 million, while creating the potential for up to $6 million in additional revenue—all within the same footprint as your existing 9E gas turbine. Key upgrade benefits include:

- **Increased output:** Achieve up to 145 MW (simple cycle) and 208 MW (combined cycle).
- **Reduced fuel costs:** Experience efficiency of up to 37.3% (simple cycle) and 54.5% (combined cycle).
- **Upgrade simplicity:** The turbine module allows for use of the existing compressor and combustion sections and combustion capital spares.
- **Reduced end-of-life concern:** Available as a flange-to-flange unit replacement to address any 9E unit end-of-life concerns.
- **Reduced installation time:** Our modular design supports quick installation.
- **Equivalent exhaust energy:** The operation of your combined heat and power (CHP) and combined cycle (CC) applications will not be impacted compared to your current 9E unit.
- **Offset performance degradation:** In extreme ambient operating conditions, you can offset as much as 2–3% of normal performance degradation between maintenance intervals.
- **Extended availability:** Achieve longer hours-based maintenance intervals of up to 32,000 hours between hot gas path inspections when operating on natural gas.
Increase output, efficiency, and availability while reducing fuel consumption and extending your gas turbine asset life with GE’s 9E Advanced Gas Path (AGP) solution. Developed from data insights and operational experience on proven F-class AGP upgrade technology, this solution blends hardware innovations with our advanced OpFlex® software to deliver customizable, industry-leading performance and operational flexibility. Key AGP benefits include:

- Increased output by up to 6.9% for simple cycle or up to 6.2% for combined cycle configurations
- Reduced fuel costs with heat rate improvements up to 2.6% for simple cycle or 1.7% for combined cycle configurations
- Extended availability with the industry’s longest gas path maintenance interval of up to 32,000 factored fired hours (FFH)
- Improved heat rate (+0.6%) and extended hot gas path intervals (to 24,000 hours) with heavy fuel oil (HFO) option delivering a 1.7 MW increase
- Expanded operating window provided by the faster startup and lower turndown of OpFlex advanced control solutions
- Flexibility to implement as a complete system or a single stage at a time to balance performance

### Technical Data

<table>
<thead>
<tr>
<th></th>
<th>Simple Cycle</th>
<th>Combined Cycle</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Output</td>
<td>Efficiency</td>
<td>Output</td>
</tr>
<tr>
<td>Baseline 9E non-PIP</td>
<td>125 MW</td>
<td>33.6%</td>
<td>190 MW</td>
</tr>
<tr>
<td>AGP</td>
<td>130 MW (+4%)</td>
<td>34.5%</td>
<td>197 MW (+3.7%)</td>
</tr>
<tr>
<td>AGP with Max Output</td>
<td>133 MW (+6.9%)</td>
<td>34.54%</td>
<td>202 MW (+6.2%)</td>
</tr>
</tbody>
</table>

### Example Components

- HPP Brush Seals
- #2 Bearing Brush Seal
- S15 Abradable Coating
- S2S and S3S Honeycomb Seals
- S2N Diaphragm Brush Seal
- Advanced Aero S3B and S3N

Improvement of your B/E-class gas turbine units with GE’s Performance Improvement Package (PIP). This package delivers the following benefits:

- Increased output and enhanced heat rate through improved materials and airflows that reduce clearances/leakages and enable firing temperature increases
- Increased availability and lower maintenance costs by extending maintenance intervals between hot gas path inspections to as much as 32,000 hours
- Increased parts life to up to 96,000 hours

Combine the durability of DLN1+ or Advanced Extendor hardware with a PIP upgrade to extend and align your gas path and combustion maintenance intervals up to 32,000 hours—providing up to four years of continuous operation between inspections.
Extend the life of your gas turbine with GE’s rotor life extension solution. By focusing on repair and replacement of individual components, this cost-effective solution helps you tap into additional value compared to more extensive refurbishment options.

GER-3620 defines E-class rotor life at 200,000 factored fired hours (FFH) or 5,000 factored fired starts (FFS). GE draws on extensive field experience and accumulated OEM knowledge to create a customized solution for rotor assets that helps ensure reliable performance for up to an additional 100,000 FFH for all 6B, 7E, and 9E units, and up to an additional 2,400 FFS for 7E units. With a rotor life extension, you will benefit from:

- Cost-effective life extension for your gas turbine
- Reliable operation through the economic life of your unit
- Manageable operational and maintenance costs with this alternative to full rotor replacement

Every power plant owner understands the challenges of complying with stricter emissions regulations as well as the need for operational flexibility. The new EV-α burner for GT8, GT11N, and GT13D gas turbines is the result of our continuing research and investment in burner technology.

The EV-α burner benefits from the features of the proven EnVironmental (EV) burner while using the latest innovative combustion technology. Additionally, it brings NOx performance down to single digit parts per million (ppm) under baseload conditions. Advantages of this solution include:

- Significantly reduced emissions down to low gas turbine relative loads
- Reduced NOx emissions at upper part load by up to 40%
- Unchanged or improved pulsation behavior during steady-state and transient operations
- Dry operation (no water/steam injection needed)
- Unaffected dual fuel capability
- Enhanced combustion reliability due to improved pulsation behavior

### Outage Applicability

<table>
<thead>
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<th>CI</th>
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### Technical Data

<table>
<thead>
<tr>
<th>NOx Emissions at Base Load</th>
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<tbody>
<tr>
<td>GT11N</td>
</tr>
<tr>
<td>GT13D</td>
</tr>
<tr>
<td>GT8</td>
</tr>
</tbody>
</table>
GT11DM Turbine Upgrade
OPTIMAL PERFORMANCE IMPROVEMENT

To significantly improve the efficiency, power output, availability, and maintainability of your GT11D gas turbine, GE offers the GT11DM turbine upgrade. As the technology continues to evolve, this upgrade boosts performance and helps ensure plant competitiveness. The result is a new, more efficient turbine based on advanced aerodynamics, cooling, and sealing technology. This upgrade was designed specifically to increase power output and efficiency for fuel cost savings and reduced CO₂ emissions per MWh. Benefits include:

- Increased gas turbine performance of up to 4.2 MW
- Increased gas turbine efficiency of up to 3% (multiplicative)

The DM turbine upgrade can be combined with the DxC compressor upgrade to further improve power output.

GT11DxC Compressor Upgrade
ENHANCE POWER OUTPUT

GE’s GT11DxC compressor upgrade delivers more power for increased generation revenues and additional capacity. This boost in power won’t raise the turbine inlet temperature or increase the thermal stress on components. By using an improved aerodynamic design, the compressor blades have been further optimized. A large part of the existing compressor hardware remains unchanged—in particular the vanes, casings, channel heights, and number of stages. The implementation can be fully retrofit, and can be installed at the site during a scheduled inspection to reduce overall replacement downtime. Additional benefits include:

- Increased gas turbine performance of up to 3.3 MW
- Greater operational range due to permanently available additional output
- Consistently high reliability, availability, and maintainability of the unit
GT11N2 M Upgrade
ENHANCE PERFORMANCE AND OPERATIONAL FLEXIBILITY

The new GT11N2 M upgrade bridges the gap between the latest technological developments and existing proven gas turbine designs to keep your plant competitive. Featuring completely redesigned turbine blading, it is successfully operating in multiple units worldwide.

The upgrade allows the engine to be operated in three different modes, depending on specific requirements. All three modes can be selected on demand and online. This flexibility allows electricity costs to be continuously optimized. With the GT11N2 upgrade, you benefit from:

- **Enhanced flexibility**: Three switchable operating modes offer extended lifetime or extra power output and efficiency.
- **Reduced maintenance costs**: Attain extended service intervals of up to 48,000 equivalent operating hours (EOH).
- **Enhanced performance**: Achieve a power output increase of up to 14 MW and as much as 5.8% improvement in gas turbine efficiency.

### Technical Data

<table>
<thead>
<tr>
<th>Benefits</th>
<th>MCL-mode</th>
<th>P-mode</th>
<th>L-Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Output Increase (MW)</td>
<td>+14.3</td>
<td>+10.2</td>
<td>+8.2</td>
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<tr>
<td>Efficiency Increase (%)</td>
<td>+5.8%</td>
<td>+5.6%</td>
<td>+5.0%</td>
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<tr>
<td>Interval Extension (EOH)</td>
<td>0</td>
<td>+12</td>
<td>+24</td>
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</tbody>
</table>

Basis: GT11N2 3VGV EV
All values at ISO conditions, baseload, gas operation, GT only specific benefits in power output and efficiency are dependent on the status and limitations of the existing plant.

GT11NM XL/XP Turbine Upgrade
ENHANCE PERFORMANCE AND OPERATIONAL FLEXIBILITY

The GT11NM XL/XP upgrade is an evolutionary product that combines recent technological advances and many years of operational experience into a single attractive upgrade package for GE’s GT11N gas turbines. Upgrade package options let you choose to either increase your plant’s power output or extend inspection intervals. Both modes help secure the sustainable future competitiveness of your plant and enhance the plant’s cost of electricity. With this upgrade, you benefit from:

- **Greater flexibility**: Choose from two operating modes to gain either extra performance or extended lifetime.
- **Lower cost of electricity**: Gas turbine performance is improved by up to 3.4 MW power output and 0.9% (multiplicative) increase in efficiency.
- **Reduced maintenance costs**: Service intervals can be extended up to 32,000 EOH.

The XL/XP turbine upgrade can be combined with the NMC compressor upgrade, which provides additional power output and increased operational flexibility as well as improved combined cycle performance and emission reduction in part load.
The GT11N gas turbine has proven to be both efficient and reliable. To meet demands and provide value-added lifetime extension options, GE developed a fully stage-optimized compressor airfoil design that increases the mass flow through the unit to deliver a substantial power increase at unchanged firing temperature. The NMC compressor achieves this performance improvement purely based on advanced aerodynamic blading and without increasing component thermal stress, thus retaining the unit’s consistently high reliability, availability, and maintainability. Improved variable inlet guide vane operation translates to extended unit flexibility in part load operation as well as improved combined cycle efficiency and reduced CO emissions at these conditions. Field-proven since 2004, this upgrade delivers the following key benefits:

- Lower cost of electricity
- Demonstrated reliability
- Improved flexibility and combined cycle part load efficiency, based on an advanced variable inlet guide vane concept for increased temperature after turbine
- Increased gas turbine power output by 7.3% due to the advanced compressor airfoil design

The GT11NMC compressor upgrade can be combined with the XL/XP turbine upgrades for increased flexibility with additional power output or extended inspection intervals.

The GT13DC compressor upgrade was designed specifically for the GT13D original turbine to increase the performance and improve the surge margin under severe ambient conditions, making it particularly beneficial for plants in hot countries. With this upgrade you retain the GT13D’s excellent maintainability while gaining the ability to apply further modular upgrades (GT13DMC). Additional benefits include:

- Increased gas turbine performance by up to 7%
- Improved gas turbine efficiency by as much as 0.9% (multiplicative)
- Improved surge margin (approximately 10° C)
- Increased availability and reliability

Sustain the future competitiveness of your GT13D turbine with the modular GT13DMC turbine and compressor upgrade package. Thanks to two different operation modes, one for more power output and efficiency (P-mode) and the other for longer inspection intervals (L-mode), the upgrade provides an additional performance and availability boost. Key advantages include:

- Increased gas turbine performance by up to 19 MW (P-mode)
- Improved gas turbine efficiency by as much as 2.2% (P-mode)
- Enhanced flexibility due to switchable operating modes for enhanced extended lifetime or extra power output and efficiency
- Reduced maintenance costs due to extended C-inspection intervals of 32,000 EOH (L-mode)

### Outage Applicability

A-Visual | B-Minor | C-Major
---|---|---
✔ | | |

### Technical Data

<table>
<thead>
<tr>
<th></th>
<th>GT Original</th>
<th>GT13DC Compressor Upgrade</th>
<th>GT13DMC Turbine Upgrade</th>
<th>GT13DMC Compressor Upgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT Power (MW)</td>
<td>(1975)</td>
<td>88.1</td>
<td>103.5</td>
<td>110.0</td>
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<tr>
<td>GT Efficiency (%)</td>
<td>29.1</td>
<td>30.3</td>
<td>33.8</td>
<td>34.0</td>
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<tr>
<td>C Inspection Extension (EOH)</td>
<td>N.A.</td>
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<td>16,000</td>
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<tr>
<td>C Inspection Interval (EOH)</td>
<td>16,000</td>
<td>32,000</td>
<td>24,000</td>
<td>24,000</td>
</tr>
</tbody>
</table>

Figures based on: ISO / Fuel: Gas / Base load operation

Outage Applicability

A-Visual | B-Minor | C-Major
---|---|---
✔ | | |
In today’s competitive environment, reducing power plant maintenance costs is a key requirement of power producers. The GT8C XL turbine upgrade is an evolutionary improvement, based on extensive field experience and proven concepts. The upgrade features improved blading as well as additional coatings that offer extended C-inspection intervals from 24,000 to 32,000 EOH. These improvements and optimizations help ensure that the hot gas path components’ lifetimes are extended, and enable operators to reduce maintenance intervals and associated costs without compromising performance. Key benefits include:

- Same excellent performance
- Extended inspection intervals by 8,000 EOH

GE’s modular GT9D1x Performance Improvement Package addresses your specific requirements for increased performance and reduced maintenance costs. The package consists of a compressor upgrade that applies high-tech controlled diffusion airfoil profiles for improved performance. Additionally, advanced materials and coating systems offer a maintenance interval extension or allow an increase in firing temperature to further enhance performance.

With the GT9D1C+ upgrade, the operator can either use the full performance benefit with an extended C-inspection interval of 24,000 EOH (GT9D1C+ XP) or, with a slightly reduced turbine inlet temperature, increase the service interval to 32,000 EOH (GT9D1C+ XL). With the extended inspection intervals, plant owners can reduce maintenance costs and increase unit availability. For the XP option, the upgrade increases efficiency and power output, potentially leading to higher overall plant performance. Key benefits include:

- Extended C-inspection intervals by as much as 16,000 EOH
- Increased power output by up to 4.4 MW
- Improved efficiency by 3.3%
The need for operational flexibility and the challenge of complying with stricter emissions regulations top the agenda of every power plant owner. Our ongoing investment in burner technology has culminated in the new EV-α burner for the GT13E2.

Building on the proven features of our standard EnVironmental (EV) burner, the EV-α burner employs the latest innovative combustion technology and reduces NOx emissions by about 35%. With this burner technology, you benefit from:

- Reduced NOx emissions in upper part load range by up to 35%
- 15 ppm NOx emissions at baseload
- Emissions compliance down to 50% low part load operation (provided by EV-α with LPL 50)
- Unchanged or improved pulsation behavior during steady-state and transient operations
- Enhanced combustion reliability due to improved pulsation behavior
- Unaffected dual fuel capability

The GT13E2 EV-α Burner
INNOVATIVE COMBUSTION TECHNOLOGY

The GT13E1 MC2 upgrade combines a host of fully validated, revolutionary improvements for the turbine, compressor, and combustor parts into one package to deliver significantly improved performance and 50% longer lifetime between inspections. Compatible with all installed GT13E1 units, the MC2 upgrade combines the latest GT13E1/GT13E2 technology, which was based on more than 13 million operating hours of combined GT13E1 and GT13E2 fleet experience to bring immediate performance gains and long-term maintenance cost savings. Upgrade advantages include:

- Increased performance with as much as 10 MW of additional power output
- Improved combined cycle efficiency by as much as 0.7%
- Extended lifetime with inspection intervals of 36,000 EOH
- Increased parts life up to 96,000 hours
- Improved availability with fewer C-Major inspections

The GT13E1 MC2 Turbine and Compressor Upgrade
RENEW PERFORMANCE, LIFETIME AND AVAILABILITY

Outage Applicability
A-Visual   B-Minor   C-Major

Outage Applicability
A-Visual   B-Minor   C-Major
The GT13E2 MXL2 upgrade allows operators to benefit from increased efficiency, improved power output, and significantly extended service intervals. Designed for compatibility with all installed GT13E2 units, the GT13E2 MXL2 upgrade combines GE’s latest technology developments based on more than 10 million operating hours of GT13E2 fleet experience.

The unique modular upgrade program lets you select the best-fit upgrade for your GT13E2 machines, and strike the ideal balance in terms of budget, inventory, and the remaining lifetime of your existing turbine components, while taking advantage of the performance and lifetime benefits of MXL2 technology.

This upgrade provides the following key advantages:

- Increased performance with a boost of 15 MW in power output and 1.5% in combined cycle efficiency (absolute)
- Extended lifetime with inspection intervals of up to 48,000 EOH
- Improved availability with fewer C-Major inspections

Outage Applicability

A-Visual | B-Minor | C-Major


Increasing Performance and Lifetime

- Scope of the upgrade can be tailored to the scheduled standard CIN scope
- Specific performance benefits to be calculated on a site-specific basis
F-Class Gas Turbines

- More than **64 million** hours of operation
- More than **1 million** starts
- **1,600+** units in **58 countries**
- Largest installed **base** in the world with **260+ GW** of capacity
- **99%** annual reliability
- Over **25 years of proven performance**, growing from **135 MW** to **359 MW**
- GE's first unit was COD in **1990**, and still in commercial operation today

**Key Programs:**

**OUTPUT:**
- 7F AGP Portfolio
- 9F AGP Portfolio
- 7F Enhanced Compressor
- 6F AGP
- GT24/26 Compressor Upgrade

**EMISSIONS:**
- DLN2.6+
- DLN2.6

**EFFICIENCY:**
- GT26 HE
- 7F AGP Portfolio
- 9F AGP Portfolio
- 6F AGP

**FLEXIBILITY:**
- DLN2.6+
- 7F AGP Turndown
- GT24/26 LPL30
- GT26 EV LPL20

**AVAILABILITY:**
- Rotor Life Management (RLM)
- Enhanced Compressor
- 7F AGP Portfolio
- 9F AGP Portfolio
Customizable Outage Solutions

SHORTEN OUTAGE TIMES AND REDUCE COSTS

Make the right decisions about repairs, replacement, and appropriate upgrades for performance improvements with help from GE’s outage services team. Proper planning and expert support are essential to slashing the length of your outages and decreasing downtime. With more than 1,500 outages completed each year, our team has broad experience handling both planned and unplanned outages. We can work with you to address your specific needs and create an integrated plan that includes processes, resources, parts, and repairs. Additionally, our Outage Advantage program enhances execution through a tailored selection of technologies and service options focused on performance and maintenance management.

Our outage solutions offer the following key benefits:

- **Shorter gas turbine outages**: Detailed planning helps ensure that parts, upgrades, repairs, and experts are in place when you need them.
- **Reduced costs**: By limiting emergent maintenance needs, our outage services keep your costs down.
- **Increased performance**: We help you increase overall value and performance by focusing on upgrades that work with your whole system.
- **Increased safety**: Our services help ensure the safety of your people, your plant, and the environment.
- **Broad service range**: Rely on the same GE expertise and capabilities you know and trust for repairs on select non-GE turbines as well.

Transporting turbine components off-site for repair can increase your outage time by days or weeks, while the additional handling required exposes the equipment to risk of further damage.

GE’s On-site Services (OSS) offers highly technical onsite inspections and premium repairs globally. We help ensure adherence to strict environment, health and safety (EHS), quality, technical, and operational standards while meeting and exceeding your scheduling and budgeting requirements. We bring the inspection and repairs directly to your location to help you reduce outage time and achieve substantial cost savings. Our On-Site Inspection and Repair teams offer:

**Comprehensive services**: We provide a full range of services—from typical inspections, repair, and machining to highly specialized services only offered by GE.

**Extensive tooling**: GE’s OSS is one of the largest onsite service organizations, with more than 500 pieces of portable equipment and an extensive tooling inventory.

**Experience**: Our team of qualified GE specialists includes machining supervisors, engineers, and technicians with an average experience level of more than 20 years.

**Global responsiveness**: All equipment is completely mobile and can be enroute to required destinations around the world within hours of notification.

**Non-destructive Testing (NDT)**

- Eddy-current Testing (ET) Blade Attachments (GT Wheel Dovetails)
- Penetrant Testing (PT)/Replication for Spacer Rubs
- Full Unit Compressor Blade PT (Casing Off)
- In-Situ TO/SO/R1 (PT-Ultrasonic Testing (UT))
- In-Situ Fwd Stub (TL 1907)
- Post Repair/Blend PT (GT Compressor)
- End of Life (Full Teardown)

**Welded Gas Turbine Rotor NDT**

- Based on periodic creep and LCF monitoring schedule
- Maximize your specific rotor lifetime with information gained from NDT
- An OEM solution built on decades of rotor fleet experience
- Dedicated on-site team of GE’s NDT specialists

**Repairs/NDT**

- Robotic RD Blending (7F)
- EMT
- Torsional Testing
- Rotor/Bucket Instrumentation

**Borescope**

- Standard Borescope Inspection
- Enhanced Borescope Inspection (eBI)

Help ensure the integrity of your insulation and mechanical support systems with inspections from GE. Each unit requires specific tests and analysis:

- Borescope inspections of the compressor and turbine
- Smart borescope inspection for longer inspection intervals
- Compressor blade R0/R1 penetrant inspection, in-situ or case off
- Gas turbine wheel dovetail eddy current inspections, rotor removed
- Ping test to determine resonant frequency and response of stator compressor vanes in stages 50 to 55
- Forward stub shaft UT
- Inspections to support rotor life extension—customized per rotor model
Rotor-In Major Inspection
B/E/F-CLASS MAJOR INSPECTIONS WITHOUT ROTOR REMOVAL

Save time, reduce costs and alleviate safety concerns with GE's rotor-in major inspection. Specialized tooling and techniques allow B/E/F-class major inspections to be performed without removing the turbine's rotor. Benefit from:

- Decreased outage durations—up to seven days shorter
- Reduced costs due to eliminating the crane, platform, and trucks required for loading and unloading parts, and the scaffolding needed for accessing bolted flanges
- Reduced labor and reworks that can occur during dismantling and installation
- Lower EHS risk due to fewer exposure opportunities associated with reduced work scope
- Simpler logistics due to fewer interfaces with other contractors, and a smaller footprint to store parts

Singular concentration produces standardized processes that increase efficiency, improve quality and cycle time, and result in better repairs. With GE's Center of Excellence (CoE) approach for repair services, we can concentrate our repair resources to achieve consistent, high-quality results. At each CoE, our technicians receive specialized training, and we invest in specialized tooling and equipment. Each Repair Service Center then can focus on specific areas of expertise, such as gas turbine power nozzles, turbine blades, shrouds, combustion, fuel nozzles, and rotor hardware.

Repair capabilities by region:

**Americas: 3 Locations**

- **Rotor**: Fr5, 6B, 7E, 7FA/FB
- **Turbine Blade**: 6B, 7E, 7FA/FB, 7F AGP
- **Power Nozzle**: 6B, 7E, 7FA/FB, 7F AGP
- **Shroud**: B/E/F-All Frames
- **Fuel Nozzle**: 6B, 7E, 6FA, 7FA/FB, 9E
- **Combustion**: 6B, 7E, 9E

**Europe: 6 Locations**

- **Rotor**: All Frames (excluding Fr7)
- **Turbine Blade**: GT9, GT11, GT13D, GT13E1, GT13E2, GT24, GT26, 701F
- **Power Nozzle**: 6F, 9F, 7F
- **Fuel Nozzle**: 6B, 6F, 9F, HDGT
- **Combustion**: 6F, 7F, 9F, GT9, GT11, GT13D, GT13E1, GT13E2, GT24, GT26

**Middle East/Africa: 5 Locations**

- **Rotor**: All Frames
- **Turbine Blade**: Fr3, Fr5, 6B, 7E, 9E, GT8, GT9, GT11, GT13D, GT13E1
- **Power Nozzle**: Fr3, Fr5, 6B, 7E, 9E, 7F
- **Shroud**: 6B, 7E, 9E, 7F 52 and 53
- **Fuel Nozzle**: 6B, 7E, 9E, HDGT
- **Combustion**: 6B, 6F, 6FA, 7E, 9E, GT9, GT11D

**Asia: 6 Locations**

- **Rotor**: All Frames
- **Turbine Blade**: Fr5, 6B, 7E, 7F, 9E, 9F, 9H, GT13E2, 701F
- **Power Nozzle**: Fr5, 6B, 6FA, 7E, 9E, 9F/7F/FB
- **Shroud**: B/E/F All Frames, GT13E2
- **Fuel Nozzle**: 6B, 6FA, 7E, 7F, 9E, 9H, 9F
- **Combustion**: Fr5, 6B, 6FA, 7E, 7F, 9E, 9F, 9H, GT13E2, 701F
B/E/F-Class Reconditioning and Repairs
REDUCE LIFE CYCLE COSTS

Reduce costs by extending the lifetime and recovering the performance of your gas turbine components through our innovative reconditioning services. The reconditioning portfolio covers the full range of parts:

- **Turbine components**: Nozzles, blades, buckets, and shrouds
- **Compressor components**: Blades and vanes
- **Structural parts**: Shells, casings, and bearings
- **Combustion components**: Fuel nozzles, burners, liners, and transition pieces

Standardized repair processes help make every customer-specific job efficient and well-suited to meet your operational needs. Backed by our Repair Development Centers and our Repair Technology CoE, GE invests $40 million annually to draw upon our design experience and the world’s largest fleet and inspection database to continuously improve our repairs technology and lower your total cost of ownership.

**Flexibility and Expertise to Meet Your Repair Needs:**
- SMART repairs for customizable light/medium/heavy repair scopes
- Repair capability to service non-GE turbines, non-GE parts, and GE components previously repaired by a third party
- Global repair network

**Zero Cycle Repair Options:**
- Reduce repair cycle time to zero with refurbished parts
- Eliminate inventory costs
- Backed by GE’s warranty for peace of mind

**Technical Data**
- More than 60% cost reduction through reconditioning – compared with new parts
- More than 30 years of reconditioning experience on well over 50,000 parts
- Delivery of full sets including replacement of fallout parts and assembly material
- Emergency stock for fast responses component history tracking
6F.03 and 7F DLN 2.6 Combustion Solution
PROVEN DEPENDABLE TECHNOLOGY

Increase maintenance intervals while providing operational flexibility at reduced emissions with GE’s Dry Low NOx (DLN) 2.6 combustion system. With more than 26 million hours of operation, the hardware is proven to extend service intervals up to 24,000 factored fired hours (FFH). DLN 2.6 also provides plants adjusting to increased cyclic operations with extended turndown as low as 42% of baseload. Benefits include:

- Increased availability and lower maintenance costs due to 24,000 factored fired hour (FFH) and 900 factored fired start (FFS) combustion intervals
- Extended turndown to as low as 42% of baseload for off-peak fuel savings and fast dispatch
- Improved flexibility when combined with OpFlex* controls software, including AutoTune, Fast Start, Cold-Day Performance, and Extended Turndown

- Operating flexibility over a wide range of natural gas or distillate fuel compositions
- Reduced NOx and CO to as low as 9 ppm across large load and an ambient temperature range of 0°F–120°F
- Reduced costs due to elimination of diluent injection or Selective Catalytic Reduction (SCR) systems

Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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</tbody>
</table>

F-CLASS GAS TURBINES

6F.03, 7F, and 9F DLN 2.6+ Combustion Solution
THE NEXT GENERATION OF TECHNOLOGY LEADERSHIP

Extend your outage intervals and flexibility with GE’s Dry Low NOx (DLN) 2.6+ combustion system. Building on a rich heritage of combustion leadership, the DLN2.6+ delivers industry-leading low emissions. Introduced in 2005 on 9F gas turbines, the DLN2.6+ is now available for 7F units (DLN2.6+ for 6F units is set to be released in 2018). Key advantages of this system include:

- Reduced NOx emissions to as low as 5 ppm for the 7F, 10 ppm for 9F.03, and 15 ppm for 9F.04—across large load and an ambient temperature range of 0°F–120°F
- Increased availability and lower maintenance costs due to 32,000 FFH and 1,200 FFS 9F combustion intervals and 1,250 FFS for 7F combustion intervals
- Broadened fuel flexibility for gas fuels with up to 30% Modified Wobbe Index (MWI), 25% ethane/propane, 20% hydrogen, and a wide range of distillate fuels
- Extended turndown to as low as 37%(7F) and 32% (9F) of baseload for off-peak fuel savings and fast dispatch
- Improved flexibility when combined with OpFlex controls software, including AutoTune, Fast Start, Cold-Day Performance, and Extended Turndown
- Reduced costs due to the elimination of diluent injection or Selective Catalytic Reduction (SCR) systems and the drawbacks associated with ammonia utilization

Outage Applicability

<table>
<thead>
<tr>
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</tr>
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Technical Data

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<tr>
<th>Fuel</th>
<th>NOx</th>
<th>CO</th>
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<tbody>
<tr>
<td>Natural Gas</td>
<td>as low as 5 ppm</td>
<td>~0—9 ppm</td>
</tr>
<tr>
<td>Distillate Oil</td>
<td>as low as 42 ppm</td>
<td>20 ppm</td>
</tr>
</tbody>
</table>

* 15% O2 with gas fuel, water injection for liquid fuel
**Fuel Flexibility Conversions**

**FOR A CHANGING ENERGY ENVIRONMENT**

Enhance your fuel use, reduce fuel costs, and grow new revenue opportunities with GE's F-class combustion system conversions. Price fluctuations and fuel availability present continuous challenges and opportunities for plant owners and operators. These system conversions use a wide range of liquid and gas fuels—including steel mill gases, syngas, lean methane, natural gas, higher order hydrocarbons, and high hydrogen fuels—allowing you to switch from one fuel to another while running under load or during shutdown.

**Multi-Nozzle Quiet Combustor (MNQC):** Operate on syngas, higher hydrocarbon, and high hydrogen fuels

**Liquid Fuel Conversions:**
- Enable distillate fuel operation to increase availability when gas fuel becomes unavailable
- Increase reliability with water- or air-cooled check valves, liquid fuel recirculation, and auto-N2 purge options

**DLN2.6/2.6+:** Enable diluent-free operation in this custom solution with higher concentrations of process gas; up to 25% ethane/propane and 20% hydrogen when blended with natural gas

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### Outage Applicability

<table>
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<tr>
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<th>HGPI</th>
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### Outage Applicability

<table>
<thead>
<tr>
<th>A-Inspection</th>
<th>B-Inspection</th>
<th>C-Inspection</th>
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### Technical Data

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<thead>
<tr>
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<th>Gas Only</th>
<th>Liquid Only</th>
<th>Dual Fuel</th>
<th>Fuel Blending</th>
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<td>Standard/MNQC</td>
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<td>✔</td>
<td>✔</td>
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<tr>
<td>Dry Low NOx</td>
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<td>✔</td>
<td>✔</td>
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</tbody>
</table>

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### GT24/GT26 Low Part Load

**IMPROVE TURNDOWN CAPABILITY**

The Low Part Load concept builds upon GE’s unique advantage of the GT24/GT26 sequential combustion engine architecture to allow the combined cycle plant to achieve excellent turndown while maintaining low emissions and very high efficiency compared to single combustor engine architectures. LPL advantages include:

- Increased load flexibility
- Ability to operate as low as 30% combined cycle load while maintaining CO emissions as low as 100 ppm
- Reduced fuel costs at minimum environmental load
- Larger spinning reserve
- Frequency response capability

---

### GT24

- **Fuel:** Natural Gas
- **CO (mg/m³):** As low as 100
- **Outage Outcome:** Lower CC Turndown to 30% at 100 mg/m³ CO (80ppm)

### GT26

- **Fuel:** Natural Gas
- **CO (mg/m³):** As low as 100
- **Outage Outcome:** Lower CC Turndown to 20% at 100 mg/m³ CO (80ppm)

*Assumes no CO catalyst installed*
KA24/KA26 Low Load Operation
EMISSION-COMPLIANT ENHANCED TURNDOWN CAPABILITY

LLO for the KA24/KA26 allows you to park your GT26-fired combined cycle plant at very low load while staying emission-compliant. This is achieved by completely switching off the SEV combustor and maintaining the Environmental (EV) combustor in low emission operation. The water steam cycle remains in operation, so the plant can quickly be returned to full load. The benefits are:
- Increased load flexibility
- Reduced fuel costs at lowest minimum environmental load
- Larger spinning reserve

Technical Data

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Emission-compliant GTCC relative load of as little as 20% at about 35% efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LLO to baseload in as little as 20 minutes</td>
</tr>
<tr>
<td></td>
<td>Spinning reserve of &gt;550 MW in as low as 20 minutes (&gt;650 MW for KA26-2)</td>
</tr>
<tr>
<td></td>
<td>Spinning reserve of &gt;220 MW in &lt;20 minutes (&gt;440 MW for KA24-2)</td>
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</tbody>
</table>

Outage Applicability

A-Inspection  B-Inspection  C-Inspection

6F Advanced Gas Path
INDUSTRY-LEADING UPGRADE PERFORMANCE

Increase output, efficiency, and availability while reducing fuel consumption and extending your 6FA.01 or 6FA.03 gas turbine components with GE’s Advanced Gas Path (AGP). This offering also qualifies for GE’s ecomagination™ portfolio by helping you meet growing power demands while maintaining low emissions footprints. The next generation AGP, after AGP Lite, will be released early 2019. Key AGP benefits include:
- Increased combined cycle gas turbine output by up to 4.2%
- Improved combined cycle gas turbine heat rate by as much as 1.2%
- Increased availability and lower maintenance costs due to 32,000 factored fired hour (FFH) and 900 factored fired start (FFS) intervals
- Reduced emissions with less fuel needed to generate the same megawatts on an absolute basis

Outage Applicability

<table>
<thead>
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<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Technical Data

<table>
<thead>
<tr>
<th>AGP Offering</th>
<th>Combustor</th>
<th>Customer Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGP Lite</td>
<td>DLN2.6*</td>
<td>Up to +3.8% MW, +1.1% heat rate reduction, 32K FFH</td>
</tr>
<tr>
<td>AGP</td>
<td>DLN2.6 or 2.6+</td>
<td>Up to +8.2% MW, +1.8% heat rate reduction, 32K FFH</td>
</tr>
</tbody>
</table>

*Max performance with 2.6, other combustion systems by request
**Values are relative to 6FA.03, even higher benefits with most 6FA.01
GE’s 7F Advanced Gas Path (AGP) portfolio is a collection of evolved hot gas path upgrades that delivers industry-leading performance and operational flexibility driven by increased output, efficiency, availability, and improved turndown. AGP technology allows you to benefit from increased gas turbine performance and one of the industry’s longest gas path maintenance intervals, which extend gas turbine assets and parts life. The AGP portfolio has been developed to meet the needs of a wide variety of operating profiles. Whether you are running at baseload throughout the year or as a load-balancing plant, there is an AGP that can improve your business outcome.

Products within the 7F AGP portfolio are:

- **AGP Performance**: Achieve an increase in output of up to 20 MW along with improved efficiency and turndown.
- **AGP Standard**: Gain as much as 10 MW in output and improved efficiency.
- **AGP Flex**: Get a boost of as much as 10 MW along with improved efficiency across both full and part load operations.
- **AGP Peaker**: This fusion of AGP and 7F.03 technology delivers up to 7 MW of increased capacity.
- **AGP Turndown**: DLN 2.6+ with dilution adds as much as 24 MW of turndown capability.
- **AGP Cold Day**: Provides up to 10 MW shaft limit increase to 207 MW during peak demands in the winter.

Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

*AGP Peaker can provide up to 1,350 FFS HGPI intervals

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GE’s 9F Advanced Gas Path (AGP) Portfolio is a collection of evolved hot gas path upgrades that delivers industry-leading performance and operational flexibility driven by increased output, efficiency, availability and improved turndown. AGP technology enables GE customers to benefit from increased gas turbine performance and one of the industry’s longest gas path maintenance intervals that extend gas turbine assets and parts life. These solutions were adapted from GE’s proven 7F AGP upgrade technology and improved upon by incorporating GE’s latest HA gas turbine technical innovations. Products within the portfolio:

<table>
<thead>
<tr>
<th>AGP Offering</th>
<th>Combustor</th>
<th>Customer Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>9F.01, .02, .03 AGP</td>
<td>DLN 2.6+</td>
<td>Up to +8% CC output, 2% HR reduction, and improved turndown</td>
</tr>
<tr>
<td>9F.03 AGP Flex</td>
<td>DLN 2.0/2.6+</td>
<td>Fusion of AGP &amp; .03 technology offering up to 0.6% HR reduction for customers running primarily at part-load</td>
</tr>
<tr>
<td>9F.05 AGP</td>
<td>DLN 2.6+</td>
<td>Up to +6% CC output, 1% HR reduction, and improved turndown</td>
</tr>
</tbody>
</table>

Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

*AGP Flex will incur reduced HGPI hour intervals if run primarily at full-load

---

*Values are relative to a 7F.03 gas turbine
GE's GT26 Advanced Performance Package (APP) builds on the platform's unique flexibility advantages to deliver improved competitiveness that will help you stay relevant. Whether your business model profits most from reduced maintenance costs, increased plant availability, increased power output or reduced fuel costs, the GT26 APP helps deliver in all these areas.

The GT26 APP features three operating modes conceived to turn today's evolving power industry segment challenges into profitable opportunities:

- **XL-mode (eXtended Lifetime mode):** Extend your C-Inspection cycle by up to 33% to save on maintenance costs and increase availability.

- **PK-mode (PeaK load mode):** Boost your profit at times of increased power demand by benefiting from up to 6% additional capacity at a balanced maintenance factor.

- **F-mode (Flex mode):** Reduce start contribution to your maintenance costs at times of flexible generation demand.

The additional advantage of being able to either pre-select or choose on-line operation modes provides you the flexibility to exploit the most suitable operation mode to match your requirements cost effectively.

By introducing the latest sealing and coating technologies and cooling improvements, and blending proven 9F and 7F gas turbine technology with unmatched GT26 sequential combustor operational capabilities, the GT26 APP delivers increased baseload and part-load efficiency and enhanced lifetime capabilities. This translates into fuel savings which, depending on your operating regime, could amount up to 0.6% of your yearly spend and up to 8000+ operating hours in major inspection interval extension.

The GT26 APP proves GE’s commitment to continue exploiting the intrinsic GT26 platform advantages by progressively adding value when required by changing power industry segment conditions.

### Combined Cycle Technical Data

<table>
<thead>
<tr>
<th>Delta output</th>
<th>GT26 Rating 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>APP - XL</td>
<td>2.0%</td>
</tr>
<tr>
<td>APP - PK</td>
<td>6.0%</td>
</tr>
</tbody>
</table>

### Outage Applicability

<table>
<thead>
<tr>
<th>Mode</th>
<th>A-Inspection</th>
<th>B-Inspection</th>
<th>C-Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>XL (Extended Lifetime)</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M (Power)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PK (Peak)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Technical Data

<table>
<thead>
<tr>
<th>Mode (Extended Lifetime)</th>
<th>Combined Cycle Heat Rate</th>
<th>Combined Cycle Output</th>
<th>Interval [WOH]</th>
</tr>
</thead>
<tbody>
<tr>
<td>XL</td>
<td>0.8%</td>
<td>+10 MW</td>
<td>32,000</td>
</tr>
<tr>
<td>M (Power)</td>
<td>1.5%</td>
<td>+17 MW</td>
<td>27,300</td>
</tr>
</tbody>
</table>
F-Class CMC Stage 1 Shroud
BOUNDARY-BREAKING AVIATION-BASED TECHNOLOGY

Reduce gas turbine cooling flow and increase performance with GE’s Ceramic Matrix Composite (CMC) upgrade. By combining unique strength and durability characteristics with the high temperature capability of ceramic, CMC represents a pinnacle of material capability for 7F gas turbines. This composite material is molded to form the stage 1 shroud used in the AGP solution, and represents the first-of-its-kind use on heavy duty gas turbine hardware. Benefits of this upgrade include:

- Increased gas turbine output by 0.61 percent
- Improved gas turbine heat rate by as much as 0.21%

Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Technical Data

<table>
<thead>
<tr>
<th>GT Output†</th>
<th>GT Heat Rate (× better)</th>
<th>Interval (FFH/FFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+0.6%</td>
<td>-0.2%</td>
<td>12K/1250</td>
</tr>
</tbody>
</table>

As the flagship Rotor Life Management (RLM) offering, our RotorUp Exchange Program delivers increased plant availability and reliability by transforming rotor life decisions into an adaptable asset management strategy. Customers will benefit from improved cashflows, cost avoidance and continued modernization when providing GE with the flexibility to effectively manage their rotor through a long-term commercial arrangement. At each major inspection, a just-in-time GE certified rotor with the latest GE standards/recommendations (TILs) is placed into operation, while your existing rotor is placed into a GE shop to be updated and placed in the rotor pool. This proactive program eliminates the rotor as a life-limiting component and ensures you are provided with the latest technology improvements such as our 3-Step Age material which improves the hold-time fatigue capability and increases hot day performance.

Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key Features

- GE certified exchange rotor at each Major Inspection
- Full-term warranty
- Major Inspection outage duration reduction
- Member of the GE Rotor Pool

For customers that prefer a new rotor, refurbished rotor, or want to extend the life of their existing rotor, our Rotor Life Management portfolio has solutions to meet those business needs.
6FA.03 Unflared Compressor

In the past, owners of a 6FA.01 with an unflared compressor had only one option to get the benefits of a .03 flared compressor. But now, GE has developed the 6FA.01 to .03 unflared compressor, which significantly reduces the scope and migration costs with the same benefits of the flared compressor. On top of the performance improvement benefits, this offering resets the clock on the life of your gas turbine compressor rotor back to 144,000 hours or 5,000 starts. Operational flexibility also is improved, with faster ramping and elimination of the 10-minute hold time. Benefits include:

- Increased performance, including degradation recovery
- Extended gas turbine asset life: 144,000 hours/5,000 starts
- Enabled for latest 6F technology, including AGP and DLN 2.6+
- Proven reliability, shared technology with 7FA/9FA
- Improved flexibility with faster ramping and eliminated 30-minute hold time
- Improved configuration management and parts availability

Performance Summary

<table>
<thead>
<tr>
<th></th>
<th>SC</th>
<th>CC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>+1.5%</td>
<td>+1.4%</td>
</tr>
<tr>
<td>Heat Rate</td>
<td>-0.6%</td>
<td>-0.5%*</td>
</tr>
</tbody>
</table>

Efficiency Optimizer can further reduce heat rate by -0.5%

Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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</tbody>
</table>

7F Flared Enhanced Compressor

GE offers a suite of compressor enhancements, packaged according to unit and site-level requirements.

The High Output Compressor for flared 7F units includes re-configured R0 rotating blades together with 50 stator vanes and an update to the SpeedTronic control system. The full solution provides up to 1% additional output at both ISO and hot day ambient temperatures. This option complements Enhanced Packages 3-5.

The High Output Compressor can be installed during any typical maintenance inspection when complementing a unit previously uprated to Enhanced Packages 3-5.

The full R0/S0 package will deliver 1% output improvement at ISO conditions as well as at higher inlet temperatures up to 95°F.

Technical Data

<table>
<thead>
<tr>
<th>Enhanced Comp Package</th>
<th>Features</th>
<th>Expected Outage Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Output Option -a</td>
<td>RD Replacement</td>
<td>Long Weekend</td>
</tr>
<tr>
<td>High Output Option -b</td>
<td>R0/S0 Replacement</td>
<td>CI/HGP/MI</td>
</tr>
<tr>
<td>Option a/b + Package 2</td>
<td>R0 and Forward Stators</td>
<td>HGP/MI</td>
</tr>
<tr>
<td>Option a/b + Package 3</td>
<td>IGV, R0, and Forward Stators</td>
<td>HGP/MI</td>
</tr>
<tr>
<td>Option a/b + Package 4</td>
<td>IGV, R0, Forward and Aft Stators</td>
<td>MI</td>
</tr>
<tr>
<td>Option a/b + Package 5</td>
<td>IGV, Forward and Aft Stators, Forward Blades</td>
<td>MI &quot;Pre-staged Rotor&quot;</td>
</tr>
</tbody>
</table>

Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
Increase performance and maintainability with the new Advanced Compressor, which offers four stages of variable stators, field-removable blades, and improved flow capability. This upgrade can fit in the same footprint as current 7F.01/02/03/04 compressors, and can be replaced as either a module or a full flange-to-flange upgrade. The upgrade’s significant benefits help you:

- Improve output by more than 10% above an Advanced Gas Path (AGP)-equipped unit, and boost efficiency by as much as 2%
- Achieve substantial hot day output improvements—up to 65 MW at 95˚ F for a typical 2x1 combined cycle plant, as part of a total plant solution
- Achieve ~200 MW at ISO conditions and improve hot day and high altitude performance
- Displace HRSG duct-fired generation at a far better incremental heat rate
- Displace inlet chiller operation for reduced O&M costs

Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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</tbody>
</table>

† Actual improvement depends on the original configuration of the unit and choice of optional hardware

Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Technical Data as compared to a 7F.03 AGP

<table>
<thead>
<tr>
<th>Output</th>
<th>Heat Rate ((\leq) better)</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>+10%</td>
<td>-1%</td>
<td>32K FH/1250 starts</td>
</tr>
</tbody>
</table>

Enhanced Comp Pkg | Features | Expected Outage Duration |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Package 1</td>
<td>Controls Change</td>
<td>1 day</td>
</tr>
<tr>
<td>Package 2</td>
<td>R0 Replacement</td>
<td>Long weekend</td>
</tr>
<tr>
<td>Package 3</td>
<td>IGV, R0, and Fwd Stators</td>
<td>HGPI/M</td>
</tr>
<tr>
<td>Package 4</td>
<td>IGV, R0, Fwd and Aft Stators</td>
<td>MI</td>
</tr>
<tr>
<td>Package 5</td>
<td>IGV, Fwd and Aft Stators, Fwd Blades</td>
<td>MI &quot;Pre-staged Rotor&quot;</td>
</tr>
</tbody>
</table>

9F.03, 7F.03, 6F.03 Frames
Blade Health Monitoring System

**ANALYTICS FOR COMPRESSOR PROTECTION**

Help ensure safe compressor operation with GE’s Blade Health Monitoring system. This remote system monitors the forward stages of your compressor to detect anomalies, such as damage to a blade or other changes in component behavior that could pose concerns, and monitors the progression of those situations.

GE collects and analyzes the data on a daily basis, providing trending reports and long-term monitoring to help ensure that the unit is performing as intended. In addition, you can receive advanced notice of any evidence of an anomaly—potentially saving you millions of dollars in lost revenue and outage expenses associated with a forward compressor event. Key features of the system are:

- Non-contacting blade monitoring system
- Sensors installed over airfoils
- Real-time monitoring of R0-R2 condition

### Technical Data

<table>
<thead>
<tr>
<th>System Components</th>
<th>Function</th>
<th>System Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensors for R0-R2</td>
<td>Monitor airfoil passing frequency</td>
<td>Trending reports</td>
</tr>
<tr>
<td>Onsite data acquisition</td>
<td>Record and transmit data</td>
<td>Start health monitoring</td>
</tr>
<tr>
<td>Connecting cables</td>
<td>Tie sensors to DAQ system</td>
<td>Steady state health monitoring</td>
</tr>
</tbody>
</table>

### Outage Applicability

<table>
<thead>
<tr>
<th>CI</th>
<th>HGPI</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

GT24/GT26 Compressor Upgrade

**INCREASE PLANT CAPACITY BY AS MUCH AS 10%**

Increase GT24 or GT26 output by implementing the latest compressor upgrade. Using 3D aerodynamic designed airfoils with stage-by-stage aero-profiling, the upgrade delivers a substantial increase in mass-flow while the essential engine architecture is unaffected.

Benefit from our extensive OEM experience in this compressor upgrade, which was introduced in 2002 and is today the predominant compressor in the GT24/GT26 fleet. The numbers speak for themselves: more than 80 in operation, more than 2.8 million operating hours, and more than 30,000 starts.

### Technical Data

<table>
<thead>
<tr>
<th>GT24</th>
<th>GT26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 20 MW power output increase in combined cycle</td>
<td>Up to 38 MW power output increase in combined cycle</td>
</tr>
</tbody>
</table>

### Outage Applicability

<table>
<thead>
<tr>
<th>A-Inspection</th>
<th>B-Inspection</th>
<th>C-Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>
Leverage proven GE F-class turbine technology made to enable rapid deployment and improved reliability. Utilizing OEM-compatible components and material enhancements, GE allows you to get the most out of your 501F machine. Benefits include:

**Performance Package:**
- Significant performance improvement (efficiency and output)
- Operational flexibility including improved turndown and fuel flexibility
- Interval extension

**Lifecycle Package:**
- Interval extension
- Emissions reduction
- Efficiency improvements
Steam Turbines

6,100+ installed units, more than 900 GW

Up to 1,700 MW configurations

More than 110 years of steam turbine experience
- 1,300+ steam turbine upgrades from all major OEM fleets

Strategic outage planning for rapid response to emergent needs
- Experienced steam turbine specialists in every region
- Fulfillment process aligned to support long-lead critical parts
- Commercial process to support your inquiries

Wide variety of offerings to meet your key needs

Key Programs:

- ASP upgrades for large fossil LP
- ASP upgrades for D11 HP/IP
- SEC/DEC 600MW ASP solutions
- ASP upgrades for Industrial ST OEM
- Dense Pack Advanced Steam Path upgrade
- Full Shaft line package for Chinese OEM
- Fossil Plant Solution for Regulatory Compliance
- Hitachi/Toshiba Steam Turbine ASP
- Valve Upgrades for extended maintenance interval
- Control System Upgrades
- ASP Upgrades for AEG KANIS and Wesel
- Lifetime Assessment and life extension
- OpFlex package
- Shell Warming System
- Low Load District Heating
- Steam Turbines Subject to Flexible Operation
- Digital ASP
Through our continual investment in local resource development, GE is well-positioned to deliver repair services where and when you need them. Critical to managing our global presence, GE has mastered the logistics necessary to maintain reliable supply chains, coordinate resources, and comply with regional regulations.

Our specialized tests help you detect unusual situations before they become serious problems. The following tests and activities are typically recommended by PGE’s Product Services team to improve unit performance:

- **Torsional testing**: Determines resonant frequencies for torsional vibration. This test supports engineering to help ensure adequate separation between the rotor train and grid frequency.

- **Acoustic testing**: Measures sound pressure levels and analyzes spectral content to identify root causes of excessive machinery noise.

- **Operational deflection shape (ODS) modeling**: Deduces the cause of excessive vibration and develops recommendations for resolution. A vibration survey is conducted to build a three-dimensional “forced running shape” model of the unit.

- **Improved tenon stress relief**: Greatly reduces environmental health and safety (EHS) and quality concerns with the salt bath process for relieving welded tenons through this self-contained induction stress relief system.

- **Portable vertical boring mills**: Offers increased onsite machining capabilities that allow for diametrical machining and horizontal milling for circumferential cuts, joint facing and much more.

- **Enhanced bore plug removal**: Provides the ability to mount and drill bore plugs on any size unit and for any coupling hole pattern, with guaranteed straight and true drilling.

- **Gang milling dovetail pins**: Transforms the time-consuming process of cross-pin removal. With this gang milling procedure, all pins are removed at the same time.

### Repair capabilities by region:

#### Americas (6 Service Centers)

<table>
<thead>
<tr>
<th>Capability</th>
<th>Repair</th>
<th>New Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotor/Compressor Inspection</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Bucket Replacement</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Shell/Casing Machining</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Rotor Welding</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Value Repair/New</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Diaphragm Repair/New</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Steam Turbine Manufacturing</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Steam Turbine Blades</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Steam Turbine Spare Parts</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

#### Europe (6 Service Centers)

<table>
<thead>
<tr>
<th>Capability</th>
<th>Repair</th>
<th>New Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotor/Compressor Inspection</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Bucket Replacement</td>
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<td></td>
</tr>
<tr>
<td>Shell/Casing Machining</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Value Repair/New</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Diaphragm Repair/New</td>
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<td>✔</td>
</tr>
<tr>
<td>Pump &amp; Gearbox Overhauls</td>
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<td></td>
</tr>
<tr>
<td>Turbine Manufacturing</td>
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<tr>
<td>Turbine Blades</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Turbine Spare Parts</td>
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<td></td>
</tr>
<tr>
<td>Auxiliaries</td>
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<td>✔</td>
</tr>
<tr>
<td>ST Rotor</td>
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</table>

#### Asia (2 Service Centers)

<table>
<thead>
<tr>
<th>Capability</th>
<th>Repair</th>
<th>New Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotor/Compressor Inspection</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Shell/Casing Machining</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Pump &amp; Gearbox Overhauls</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Diaphragm Repair/New</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Bucket replacements</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Spare parts</td>
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#### Middle East/Africa (1 Service Center)

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<th>New Parts</th>
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<td>Bucket Replacement</td>
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<td>Value Repair/New</td>
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<td>Diaphragm Repair/New</td>
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**TOTAL PLANT SOLUTIONS**
Transporting turbine components off site for repair can increase your outage time by days or weeks, while the additional handling requirements can expose the equipment to risk of further damage.

GE’s On-site Services (OSS) offers highly technical onsite inspections and premium repairs for global power generation customers through our EHS, quality, technical, and operational excellence. We work hard to meet and exceed your expectations, on budget, every time. We bring the inspection and repairs directly to your location to help you reduce outage time and achieve substantial cost savings. Our On-site Inspection and Repair teams offer:

- **Comprehensive services:** We provide a full range of services—from typical inspections, repair and machining to highly specialized services offered by GE Power.
- **Extensive tooling:** GE’s OSS is one of the largest onsite service organizations, with more than 500 pieces of portable equipment and an extensive tooling inventory.
- **Experience:** Our team of qualified GE specialists includes machining supervisors, engineers and technicians with an average experience level of more than 20 years.
- **Global responsiveness:** All equipment is completely mobile and can be transported to any required destination around the world within hours of notification.

**Steam Turbine Inspections**

GE’s inspection services help prevent catastrophic high-speed rotor issues. Each configuration requires the following rotor-specific tests and analysis:

- Boresonic inspection of older bored rotors looks for indications of deterioration from the inside to the outside.
- Periphery ultrasonic testing for solid rotors examines the outside of the rotor for indications of potential issues.
- Phased array wheel dovetail testing looks for indications of stress corrosion cracking (SCC) in time to repair the wheel and prevent bucket liberation.
- Wheelsonic inspections employ a series of tests to evaluate the integrity of wheels on a built-up, low-pressure rotor.
- Finger bucket dovetail inspections provide a comprehensive look that includes:
  - **Non-destructive Testing (NDT)**
    - Boresonic inspection system
    - UT blade attachments (STG wheel dovetails)
    - MT blade attachments (STG wheel dovetails)
    - Wheelbore
    - Solid rotor volumetric
  - **Electromagnetic Testing (EMT)**
    - Rotor/bucket instrumentation
  - **Borescope**
    - Hot borescope

**Steam Turbine Repairs**

- **Machining**
  - Collector ring grinding
  - Stud drilling and tapping
  - Bore plug removal/installation
  - Valve bore and chest repair
- **Welding**
  - Diaphragm repairs
  - Faro arm inspections
  - Shell and joint repairs
  - Valve seat replacements
- **Bucket Repair**
  - Bucket replacement/repair
  - Cover installation and machining
  - Finger-dovetail pin replacements
  - Tie wire brazing and repair
  - Tenon welding and cover foxholing
- **On-site Machining**
  - Diaphragm fit machining
  - Computer numerical control (CNC) dovetail/longshank machining
  - Dense pack upgrades
  - Coupling line and mirror boring
  - Horizontal joint machining
  - Large rotor machining
  - Journal machining
  - Low-speed balance
GE performs a comprehensive range of overhaul and field services, and has a wealth of experience covering all GE and non-GE machine types, including impulse and reaction. These machines include 3,000 rpm and 3,600 rpm fossil units, nuclear units (including half-speed, wet machines) and high-speed industrial turbines.

With a global network and mobile workshops in a variety of strategic areas, GE is able to provide quick and effective engineering services at any location. These services include manufacturing and specialist repair of any part, from individual blades to a new rotor.

We also provide a full range of outage planning, management and execution activities. Unplanned work is significantly reduced, thanks to our extensive fleet management experience. We achieve this by working with you to ensure that maintenance is properly targeted and spare parts are always ready.

To save the cost and lead times associated with replacement parts, GE offers a range of complex repair techniques. Many of these relate to weld repairs, as follows:

- **Rotor repairs**: With more than 80 years of welded rotor technology experience, GE provides joining of new forged sections, shaft buttering, disc repair, and disc head buildup with new material. We also offer a number of techniques for straightening rotors.

- **Blading repairs**: With experience across the range of impulse and reaction blading, GE provides dressing and weld repairs for all types of fixed and moving blades, including linking and attachment features. For last stage blades (LSBs), we also offer leading edge hardening and shielding options.

- **Casing repair**: GE can correct minor cracking and change the geometry of highly stressed areas. We can also re-round distorted casings and add new weld material.
Blade Stocking Program
QUICK RESPONSE TO YOUR DEMANDS

To meet the needs of a growing generation industry, GE is focused on quickly responding to your demands. Our blade stocking program is one example. It employs a cross-departmental process to support emergent blade requests for the following blade types:

- Fossil last-stage and L-1 blades of a broad range of sizes
- D-11 margin stage blades
- Industrial margin stage blades
- Blades for several other GE and legacy Alstom steam turbines

Parts for Non-GE Turbines
QUALITY REPLACEMENTS FOR ALMOST ANY TURBINE

With a broad technology legacy and extensive experience with other manufacturers’ machines, GE can provide replacements for almost any turbine. When drawings and data are not available, we use our established laser scanning and re-engineering process. In addition to providing manufacturing data, the CAD model provides the basis for an engineering analysis. This allows us to offer technology improvements, including advanced materials and standard part replacements.
Steam turbines generally have a working life of 30 years or more. During this time, improvements in technology enable designs of greater efficiency, reliability and flexibility. However, because large generation assets are difficult to replace, operation often is extended, and additional reliability issues arise.

Many of the advantages of new technology can be applied by replacing major components on an existing machine. This alleviates plant changes, as well as related civil engineering work. Upgrades involving a new rotor, known as retrofits, can be applied to individual cylinders, or the entire turbine. The following projects can be executed within a typical major outage period:

- Efficiency improvement
- Output improvement
- Life extension
- Reliability and availability improvement
- Reduced maintenance

We also provide a full range of outage planning, management and execution activities. We can implement the above improvements on steam turbines from GE or from other OEMs.

Outage Applicability

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<th>Efficiency improvement</th>
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<td>Output improvement</td>
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Expand the output and efficiency capabilities of your GE steam turbine equipment without sacrificing reliability or asset life.

In addition to improving reliability and extending asset life, we provide a complete range of cost-effective steam turbine solutions spanning inspections to complete flange-to-flange upgrades for industrial, combined cycle, fossil, and nuclear steam turbines from 5 MW to 1,700 MW. With more than 110 years of experience in the manufacturing, installation and maintenance of steam turbines, GE has a global installed base of 6,100 steam turbines. Our team has performed more than 1,000 conversions, modifications, and uprates while responding to thousands of planned and emergent outages.

Regardless of your needs, GE has the capability to support planned and unplanned outages. Understanding the criticality of reducing downtime, our team can help you extend equipment running time between planned maintenance outages; eliminate unplanned outages with our digital solutions for monitoring and diagnostics; and reduce the duration of necessary outages. Our steam turbine services offer the following benefits:

- Short cycle (less than 10 days)
- Advanced thermal balance capability
- Execution of services onsite or at a regional certified GE repair shop
D11 HP/IP ASP Upgrade
RECAPTURE PERFORMANCE WITHOUT FULL REPLACEMENT

Address open technical information letter (TIL) needs while improving both initial and sustained performance with a steam path upgrade from GE. A cost-effective alternative to a complete section replacement in cases where HP/IP shell condition is not a concern, this upgrade delivers up to a 2% increase in steam turbine output (in the same bottoming cycle) through the recovery of aging losses and improved technology.

Phase 2 Solution
Major components include a new HP section that uses reaction technology, a 10Cr welded rotor, improved IP section buckets and diaphragms, and a modern N2 packing head. These components fit inside the existing HP/IP shell, and the upgrade can be installed within the normal cycle of a major maintenance outage. Available for D11 steam turbines operating at 60 Hz, this solution:

- Addresses all outstanding D11 HP/IP-related TILs with operability improvements
- Offers advanced singlet, high-efficiency diaphragms
- Includes integral covered blades
- Provides enhanced sealing technology and brush seals where applicable
- Accommodates uprate of the combined cycle plant with certain configurations
- Improves operational reliability and performance
- Offers advanced reaction technology with high-efficiency 3D blading in the HP

Outage Applicability

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D11 HEAT* HP/IP ASP Upgrade
INCREASE STEAM TURBINE OUTPUT

Enhance the initial and sustained performance and reliability of your steam turbine with a HEAT section replacement. Ideal for reliability when major shell cracking is prevalent, this complete HP/IP section replacement delivers up to a 2% increase in steam turbine output (in the same bottoming cycle) through recovery of aging losses and improved technology. This "drop in" turbine can be installed on the existing standards—requiring no modifications to the turbine foundation—and is available for D10 and D11 steam turbines operating at 50 and 60 Hz. The HEAT upgrade:

- Addresses all outstanding D11 HP/IP related technical information letters (TILs)
- Provides HEAT reaction steam path
- Delivers advanced sealing technology
- Accommodates uprate of the combined cycle plant with new section configuration
- Offers rugged, double shell construction with separate outer and inner shells

Outage Applicability

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Dense Pack* Advanced Steam Path (ASP) Upgrade

IMPROVE EFFICIENCY ON MATURE ASSETS

Improve the efficiency of your mature steam turbines, enhance plant profitability and competitiveness, and extend the life of your assets with Dense Pack steam path re-configuration technology. This upgrade solution can help decrease aerodynamic losses and leakages within the steam path to help drive better efficiency across your entire power plant cycle. These upgrades are available for high-pressure (HP) or high-pressure/intermediate-pressure (HP/IP) sections of fossil units—typically 300 MW or larger—that are scheduled for an outage within the next three or more years, or that have extensive maintenance needs. Our upgrades provide:

- Advanced aerodynamic blades and nozzles
- Various coatings that help your steam turbine last longer between outages, with less damage caused by solid particle erosion (SPE)
- Advanced sealing technologies (such as brush seals, elliptical packing, and improved clearances)
- Modern mechanical technology (such as rugged control stage buckets and Gen2 integral covered buckets)

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TOTAL PLANT SOLUTIONS

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ASP Upgrade for Fossil LP Rotor
IMPROVE TURBINE OUTPUT AND PARTS RELIABILITY

Extend your parts and component reliability, even as your steam turbine experiences different load levels, with GE’s fossil LP rotor replacement and upgrade. Delivering up to a 2.5% improvement in turbine output—due to recovered aging losses, increased annulus area, and better steam path flow—this upgrade can reduce outage duration by 21 days compared to rotor FineLine® weld repairs during unplanned outages. This upgrade is available for large fossil steam turbines with a double-flow LP that would benefit from an increased annulus area.

The LP rotor replacement is applicable to all units that are experiencing reliability issues due to SCC or other similar phenomena. The upgraded LP rotor mentioned above makes reference to a larger annulus. This LP rotor has limited application space if not replacing the LP inner casing. The fossil LP rotor upgrade:

- Offers advanced steam path technology
- Provides longer latter stage blades and diaphragms
- Includes advanced brush seals
- Provides integral cover blades
- Increases annulus area
- Provides improved reliability to mitigate SCC

Fossil Plant Solutions for Regulatory Compliance
IMPROVE EFFICIENCY AND OPERABILITY

In August 2015, the US Environmental Protection Agency implemented section 111 (d) of the Clean Air Act, which focuses on reducing greenhouse gas emissions from existing coal-fired plants. The regulation will drive coal-fired plants to achieve a 2-4% total plant heat rate improvement. To extend asset life, GE has developed a suite of offerings to meet your fossil unit needs.

**Efficiency solutions:**

- The Heat Rate Improvement Package offers an LP section upgrade with advanced last-stage blade technology, providing up to 2% improved heat rate.
- The Horizontal Joint Leak Mitigation applies an abradable coating to the horizontal joints to minimize leakage, providing up to 0.5% improved heat rate.
- The Dense Pack Cylinder Retrofit—applicable to medium-sized units—offers ASP technology to improve HP/IP turbine efficiency.

**Environmentally friendly solutions**

Our environmental solutions allow for asset reapplication for units with remaining life.

**Operability solutions:**

- The Fossil ST Agility provides operational flexibility for starting and stopping.
- The Shell Warming System improves start time by maintaining a desirable shell temperature.
ASP Upgrade for Small Steam Turbines

IMPROVE EFFICIENCY AND OUTPUT

Improve the efficiency and output of your boiler and reactor feed pump turbines with advanced steam path technology. Our small steam turbine upgrade:

- Addresses pump degradation or replacement
- Sustains performance
- Increases reliability and availability by addressing TIL 1206

ASP Upgrade for Nuclear Steam Turbine

ENHANCE EFFICIENCY AND RELIABILITY

A number of “built-up” rotors have experienced SCC in key ways in nuclear and supercritical steam environments. To address these SCC issues, GE offers LP monoblock rotors and LP section upgrades. Both of these solutions increase reliability by eliminating shaft and wheel bore crevices where harmful SCC contaminants can concentrate, and by reducing wheel stresses. The LP section upgrade offers incremental performance benefits by applying high-efficiency blades and diaphragms, an advanced steam guide, enhanced sealing, low-stress dovetails, integral covered buckets, and a modern 43-inch last stage blade.

The LP Monoblock Rotor offers the following benefits:

- Significantly reduces SCC susceptibility in the wheel dovetails
- Reduces rotor in-service inspection scope due to boreless rotor
- Improves output and heat rate for units with the 43-inch L-0, resulting in up to 1% improvement in output

The LP section upgrade offers the following benefits:

- Significantly reduces SCC issues through new low-stress dovetail configuration
- Improves turbine output and heat rate:
  - 38- to 43-inch L-0 stage blade delivers up to 4.5% in output improvement
  - L-0 stage blade delivers up to 3.5% in output improvement
- Delivers reduced inspection requirements and an extended rotor inspection interval of 10 years
Today’s power industry has placed increased importance on generation from combined cycle power plants. Unit availability and component reliability of the steam turbine fleet are key focus areas for owners. Based on GE’s D11 fleet experience, reducing top-to-bottom shell temperature differentials greatly lessens the likelihood of rub-induced vibration events. GE has developed a robust system that delivers startup flexibility by ensuring temperature uniformity across shells. This upgrade is intended for the HP/IP shell (single-shell configuration), and enables the unit to maintain a set temperature for the turbine shell while reducing transient shell deflections. These deflections target reduced seal wear, which corresponds to longer sustained HP/IP section efficiencies. When combined with GE’s Agility* offering, start times (cold, warm, and hot) are reduced. Our shell warming system:

- Provides faster steam turbine start times; helps eliminate cold starts
- Delivers improved cyclic life expenditure improvements. Cold starts have the potential to incur largest cyclic life debits
- Provides better sustained performance. There are fewer vibrations/rubs, and less seal wear during starts and stops
- Further improves start time when combined with Agility software

To maintain proper steam turbine function, expert operators must adjust control settings to meet original configuration limits. A well-integrated system control approach provides automation to reach optimal conditions and reduce operator involvement and variability. GE’s Back End Optimization upgrade is a comprehensive system solution made to take advantage of an increased operating space, based on years of operating experience and test programs. The new alarm and trip limits expand the safe operating space, particularly for sites that have experienced operating limitations on hot summer days due to limitations of air cooled condensers. The upgrade includes custom control setting changes based on the operating data from your plant. Our Back End Optimization upgrade:

- Allows the steam turbine/gas turbines to maintain higher loads
- Increases operating space prior to backpressure alarm
  - 38- to 43-inch L-0 stage blade delivers up to 4.5% in output improvement
  - L-0 stage blade delivers up to 3.5% in output improvement
- Delivers reduced inspection requirements and an extended rotor inspection interval of 10 years
ASP Upgrade for LMZ/BHEL LP
SIMPLIFY AND IMPROVE AN OLD TECHNOLOGY

The LMZ 200 MW (and its derivatives) was produced under license by BHEL of India. The low pressure (LP) cylinder of this machine is relatively inefficient due to its dual-flow exhaust, which was made to allow for the historic size limitations of last-stage blades. Additionally, there are noted maintenance problems associated with this technology.

GE’s solution replaces the last two stages with a single stage, which is both more efficient and more robust. The installation can be executed within the period of a major overhaul. Our LMZ/BHEL LP upgrade offers:

- Output improvement (generally > 1.8MW)
- Reliability improvement
- Lifetime extension

Valve Upgrades
IMPROVE LIFE, EFFICIENCY AND CONTROL FLEXIBILITY

After many years of operation, steam chests and valves begin to suffer from end-of-life issues such as thermal cycling damage and the interaction of creep and fatigue. These problems may be compounded by demands for more flexible operation. Older valve technologies may also feature less than optimum flow paths and poor control precision. GE has a wealth of experience in upgrading valves on many fleets and machine types. The most common way to achieve significant benefits is to upgrade the parts to improved, modern technologies. These can be adapted to the geometry, layout and interfacing systems of the unit under consideration. Our valve upgrades offer the following benefits:

- Lifetime extension
- Efficiency improvement
- Control improvement
Control System Upgrades
RELIABILITY AND PRECISION TO MEET MODERN EXPECTATIONS

Steam turbines depend on the reliability, accuracy and flexibility of their control systems. Modern electricity grids demand ever more stringent levels of control that cannot be met by older systems, particularly those that preceded modern digital electronics.

Based on many years of experience in turbine manufacturing and servicing, GE has developed a range of control upgrade solutions, both for our own machines and those of other manufacturers. These solutions are tailored to meet your specific requirements and may incorporate other plant areas or improvements to valve actuators. Our control system upgrades offer:

- Operational flexibility
- Lifetime extension
- Improved reliability and availability
- Reduced O&M costs

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TOTAL PLANT SOLUTIONS
Heat Recovery Steam Generators (HRSGs)

GE has more than 100 years of boiler experience.

We can service all HRSG makes and models.

Typical HRSG operating life is 25–30 years.

PressureWave Plus* cleaning can remove 19 tons of debris from a typical HRSG during one cleaning session.

Gas turbine performance upgrades can affect HRSG units.

HRSG installations can require about 19 miles (30 km) of tubing, depending on the configuration.
Operational Flexibility Improvements
INCREASED OPERATIONAL CONFIDENCE

As a total plant service provider and HRSG original equipment manufacturer (OEM), GE offers modular service packages to review and improve the flexible operation of your HRSG. The first step in the process involves identifying the highest risk areas for your particular configuration. We systematically assess the current design and identify areas that are prone to accelerated damage as a result of more frequent startups and shutdowns.

GE offers the following services to enhance performance and lifetime profitability while making safety, reliability and environmental compatibility top priorities:

- High-level, onsite, collaborative risk assessment
- Cyclic life impact calculation
- Drain system review
- Corrosion risk review
- Addition of a final stage desuperheater and/or steam sparging/make warm system for faster startup
- HRSG operation concept modification definition
- Environmental compliance for CO catalyst retrofit-emission in a larger load range

Outage Applicability

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Replacement Parts
COMPREHENSIVE PERFORMANCE IMPROVEMENTS

Supplying parts for HRSG units requires large-scale facilities and extensive engineering, procurement and construction (EPC) experience. As an OEM with a global workshop network, GE can offer standard and tailor-made parts for all major HRSG brands. No matter how large the part or how complex the installation, we have a solution to streamline your maintenance and improve your unit availability.

Pressure parts and assemblies
- Harp assemblies
- Tubing
- Dissimilar metal weld inserts
- Spacers, attachments, hardware
- Drum internals, liners, nozzles

Fabricated parts and boiler mountings
- Access doors
- Ducts, dampers
- Baffles, expansion joints
- Liner systems
- Casing, structural steel, platforming
- Drain lines, drains, vents

Control products
- Safety valves
- Silencers
- Desuperheaters
- Instrumentation and controls
HRSG Upgrades
COMPREHENSIVE PERFORMANCE IMPROVEMENTS

To increase flexibility, reliability, and availability, GE offers performance-enhancing modifications for your HRSG.

- Piping and pressure parts systems
- Material upgrades in corrosion-sensitive areas
- Desuperheater repair, replacement or re-engineer
- OCC* single row harp technology for reduced thermal stresses

Repairs, Replacements and Outage Support
HOLISTIC APPROACH FOR PEAK PERFORMANCE

With our knowledge, extensive experience, and commitment to safety, GE offers time-saving and value-added repairs, replacements and outage support services for your HRSG and auxiliary systems, helping you increase availability and save costs before, during, and after your outage.

Planning
- Objectives, work scope, and priorities
- Material and parts requirements and logistics

Execution
- Detailed inspections, onsite modifications and repairs
- Condition assessments and remaining life assessments
- Flue gas-side cleaning
- Performance-based testing
- Construction services and supervision

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*OCC: OCCURRENCE OF CORROSION
Combined cycle power plant operators typically implement gas turbine (GT) performance upgrades to improve competitiveness and profitability over the life cycle of a plant. GT upgrades typically lead to changes in exhaust gas temperature and mass flow at the inlet of the HRSG. If not properly managed, these changes may have an adverse impact on HRSG safety, reliability or performance. With an HRSG Upgrade Package, GE will review various areas of the unit to assess the impact of a GT upgrade and provide the products and services necessary for continued reliable operation of the HRSG.

To assess the impact of a GT performance upgrade, GE employs proprietary software and creates a performance prediction model for the HRSG design. This software is capable of modeling any HRSG OEM design configuration and evaluating the critical parameters of performance and life for the HRSG components. Based on the software output, further analysis could be necessary to assess HRSG performance, pressure part materials, sound levels, piping design, environmental control equipment, attemperators, valves, and instrumentation.

In addition to proprietary software, GE draws on our service and operation experience from more than 900 HRSGs installed and operating worldwide. Our product and service expertise, combined with the latest monitoring and analytics capabilities, helps ensure that an HRSG Upgrade Package will provide continued reliable operation of your HRSG over its lifetime.

**HRSG Upgrade Package Features**

**Basic Scope**
- Performance calculations
- Pressure part design review
- Review and provision of safety valves and silencers
- Review and provision of attemperators and control valves
- Code compliance assessment

**Expanded Scope**
- Feedwater/condensate pumps
- Environmental control equipment
- Pressure part lifetime assessment
- Acoustic analysis

HRSGs must endure significant cyclic and long-term high temperature operation that can result in fatigue and creep damage to certain components, potentially leading to cracking and failure. Certain events such as rapid cooling, improper drain operation, low load operation, or inadequate maintenance can produce significant temperature differentials and very high thermal stresses that are not detectable with normal plant DCS instrumentation. GE’s HRSG remote monitoring and diagnostics service provides a significant value to the plant owner, delivering information that can be used to improve the life expectancy of the HRSG, or enhance the maintenance program.
Deposits of iron oxide and ammonium bisulfate on the flue gas side can lead to tube fouling. This reduces the heat transfer efficiency and increases backpressure on an adjoining gas turbine. Additionally, it lowers the boiler and turbine efficiency, which can lead to higher operating costs.

GE offers innovative boiler cleaning tools such as PressureWave Plus*, developed by BANG&CLEAN* Technologies AG, that uses pressure waves to penetrate deep into the tube bundle for a more effective and efficient boiler cleaning. Pressure wave cleaning is done with a special lance, which is inserted into the spaces between the tube bundles. A bag at the end of the lance then is inflated with a mixture of combustible gases that are ignited remotely. The resulting pressure wave and ultrasonic tube vibrations dislodge and clean the deposits from the boiler without damaging the boiler tubing.

Pressure wave cleaning is much faster than the traditional method of CO₂ blasting—it can be done in about half the time—and it requires no internal scaffolding. This tube cleaning technology is also much more effective at removing corrosion, as the pressure wave cleaning can reverberate into areas previously unreachable by other boiler cleaning methods.

**Benefits include:**
- Applies to all HRSG types
- Requires no scaffolding
- Cleans deeper into the tube bundle, even in areas that cannot be reached by other technologies
- Is more effective than traditional CO₂/dry ice blasting methods
- Cleans in half the time compared to other methods, without damage to boiler tubing
- Mobilizes quickly
- Reduces gas turbine backpressure
- Improves heat transfer and increases plant performance
- Is cost-competitive

**Outage Applicability**

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Generators

100+ years of experience
- 700+ rewinds over the last decade
- 1.7+ MW of generator uprates

World-class response time for emergent needs
- Strategically placed inventory of long lead critical parts
- Large pool of highly trained, safe, and experienced generator specialists and winders

Continuous investment in upgrade and repair technology

Comprehensive portfolio of solutions built around critical needs of any type or make of generator

Leading online monitoring solutions to support condition-based maintenance

Key Programs:
- Stator Rewind
- Rotor Rewind
- Replacement Generator

- Auxiliary Systems Upgrades
- Flexibilization Package
- Stator Rewind
- Rotor Rewind
- Replacement Generator
GE's remote Generator Health Monitoring provides a comprehensive service to any operator to assess the health of the generator by supplying key information for condition-based maintenance and to help prevent unplanned downtime and losses.

For the highest level of assurance, opt for remote continuous online monitoring and benefit from weekly checks and in-depth reports from our experts.

GE's Generator Health Monitoring provides the following benefits:

- Early fault identification
- Extended outage intervals
- Fewer unplanned outages
- More accurate planning and execution of outage work

GE’s periodic online monitoring service allows you to cost-effectively assess the condition of your generator, for any original equipment manufacturer (OEM). It involves the installation of permanent sensors, followed by twice-yearly measurements and an expert report, allowing you to make informed decisions about your planned maintenance.

GOLD Service benefits include:

- Extended outage intervals
- Fewer unplanned outages
- More accurate planning and execution of outage work

**Technical Data**

Available Modules:

- Partial Discharge
- Rotor Flux
- Rotor Shaft Voltage
- End Winding Vibration
- Stand-alone Boxes
- Collector Health Monitor
- Stator Leakage Monitoring System
GE’s offline inspection solutions include the latest robotic tool technology that can perform a complete air gap inspection program with the rotor installed.

Combining GE’s robotic inspection technology and field service expertise, we can help provide an increased level of operational confidence between major outages. In-situ offline inspections are fully embedded in GE’s modular condition assessment portfolio, and can enhance outage duration and reduce risks related to rotor removal. Combine the air gap inspection with an in-situ retaining ring inspection to get even more from your outage time.

Benefit from:

- Reduced downtime
- Reduced risk—rotor stays in place
- Lower workforce costs due to reduced dismantling requirements

GE’s retaining ring scanner is a robotic inspection tool made for detecting stress corrosion cracks without the need to remove the retaining rings. The dismantling requirements are reduced and the inspection can be carried out with the rotor in-situ or removed.

Enhance your outage time and increase the level of assurance between major outages by carrying out an air gap inspection in parallel with your retaining ring offline inspection.

Benefit from:

- Reduced downtime
- Lower workforce costs due to reduced dismantling requirements
- Enhanced accuracy related to characterization and location of defects

### Technical Data

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<th>Base Scope</th>
<th>Extended Scope</th>
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<tbody>
<tr>
<td>Visual Inspection</td>
<td>DC High Voltage Test</td>
</tr>
<tr>
<td>Robotic Slot Wedge Assessment</td>
<td>Leakage Current Measurement</td>
</tr>
<tr>
<td>Robotic Low Flux</td>
<td>Up to 60% Time Savings with In-Situ Inspections</td>
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<tr>
<td>Insulation Resistance Measurement</td>
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*Up to 40% Time Savings with In-Situ Inspections*
GE’s Test and Inspection Program is a set of modular solutions to thoroughly assess the condition of your generator during a major outage. Based on decades of experience across one of the largest installed fleets, our diagnostic experts will provide you with a detailed analysis and recommendations for reliable operation.

Example tests include:

- Generator endwinding vibration testing (Bump Test): Determines if additional support is required for the endwindings.
- Generator stator cooling water flow test (UT Flow): Pinpoints individual bars with rates that are lower than average low flow that can lead to higher stator bar temperature and accelerated ground wall insulation aging and an eventual forced outage. This test is performed during a major outage.

CUPROPLEX is a proven service to remove copper oxide build-up from stator bars and the cooling water system to restore cooling efficiency and avoid overheating damage.

It is the only process that can be applied while the generator is online and in normal operation.

For heavily flow restricted bars we have developed CUPROPLEX-S.

Benefits of this service include:

- No disassembly requirements
- Controlled process
- Reduced environmental impact—no hazardous liquid waste
- Return to full output in as little as two days
Onsite Repairs
A REPAIR PORTFOLIO BUILT AROUND YOUR CRITICAL NEEDS

By drawing on decades of design and repair experience, we developed a wide range of onsite repair solutions to increase the reliability of your generator asset.

GE’s onsite repair solutions include:

- **APLETEC® – Stator water box leakage repair**
  Seal leaking water boxes by exposed coating, with only disconnecting the hydraulic hoses (no bar removal)

- **Metal spraying – Onsite rotor repair**
  Rotor seal oil journals repair – Low coefficient of friction of sprayed metal, reducing rubbing effects between and oil seal rings

- **On-site stator core repair**
  Prosthesis - Alternative technology to partial core ends restacking

<table>
<thead>
<tr>
<th>Outage Applicability</th>
<th>Generator Closed - Visual</th>
<th>Generator Open Rotor In - Minor</th>
<th>Generator Open Rotor Out - Major</th>
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</table>
Workshop Repairs
A GLOBAL NETWORK OF FACILITIES FOR ANY KIND OF REPAIR

GE is at the forefront of continuous improvements. Our leading workshop facilities are equipped with the latest tools and equipment technology to repair any type and make of generator to restore full operational confidence.

GE is well positioned to deliver repair services where and when you need us by continually investing to develop local resources. Critical to managing this global presence, we've mastered the logistics to maintain reliable supply chains, coordinate resources, and comply with regional regulations.

Repair capabilities by region:

**Americas** (7 Service Centers)
- Capability
  - Stator Bar Manufacturing
  - Stator Winding
  - Rotor Winding
  - Motor/Hydro Repair
  - Generator Inspections
  - Rotor High Speed Balancing
- Repair
- New Parts

**Middle East/Africa** (3 Service Centers)
- Capability
  - Stator Winding
  - Rotor Winding
  - Motor/Hydro Repair
  - Generator Inspections
  - Exciter Inspection & Rewind
  - Rotor High Speed Balancing
- Repair
- New Parts

**Europe** (9 Service Centers)
- Capability
  - Stator Bar Manufacturing
  - Stator Winding
  - Rotor Winding
  - Motor/Hydro Repair
  - Generator Inspections
  - Exciter Inspection & Rewind
  - Rotor Manufacturing
  - Coil Manufacturing
  - StatorStacking
  - Rotor High Speed Balancing
- Repair
- New Parts

**Asia** (3 Service Centers)
- Capability
  - Rotor Winding
  - Motor/Hydro Repair
  - Generator Inspections
  - Stator Winding
- Repair
- New Parts
Select the best solution for you with help from GE’s generator experts. Our investment into developing upgrade solutions—including electrical power systems, full train rotor dynamics, controls and heat exchangers—can have a big impact on your aging systems. GE’s generator upgrade solutions include:

- **Capacity Uprates**: Choose from options to uprate your generator up to 20% of current capacity.
- **Generator Replacements**: High-power density replacement generators can be tailored to meet your needs, with reduced plant impact. These solutions use the latest technologies to provide higher efficiency and reliability.
- **Generator to Condenser Conversion**: GE now offers engineered solutions that convert existing synchronous generators, powered by gas or steam turbines, into synchronous condensers.

* Depending on generator type

No matter the type of generator you own, GE provides a comprehensive portfolio of stator upgrades including rewinds, midsections, and core restacks and replacements for any make of generator to improve reliability and availability. Our stator upgrades deliver the following key advantages:

- Increased output is achieved through the implementation of the latest technology insulation material and improved end-winding support systems.
- Reduced downtime results from the use of high-tech manufacturing processes, advanced tools, and standardized methods.

**Technical Data**

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<thead>
<tr>
<th>Advantages</th>
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<tr>
<td>Up to 20% Output Increase†</td>
</tr>
<tr>
<td>18-day Stator Rewind†</td>
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</tbody>
</table>

* Depending on generator type
Field Upgrades
EXTEND LIFE AND INCREASE OUTPUT

GE provides a comprehensive portfolio of field upgrades for any make of generator to provide the fastest return to service. Depending on your preference, we will rewind your field at site or in a workshop. For selected types we can provide you with an exchange field to reduce downtime.

Technical Data

<table>
<thead>
<tr>
<th>Advantages</th>
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<tbody>
<tr>
<td>18-day Rotor Rewind†</td>
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<tr>
<td>Up to 42 Days Time Saving†</td>
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</tbody>
</table>

† Depending on generator and upgrade type

Outage Applicability

Generator

- Closed - Visual
- Open Rotor In - Minor
- Open Rotor Out - Major

Auxiliary Systems Upgrades
COMPLIANCE WITH TODAY’S SAFETY REGULATIONS

GE offers upgrades for generator auxiliary systems, including electrical systems from static excitation to brushless exciters.

From assessments to identify upgrade potentials, through partial modernizations, to replacements of complete systems, we address parts obsolescence, safety regulations, and redundancy or reliability requirements with our technology-driven solutions.

Outage Applicability

Generator

- Closed - Visual
- Open Rotor In - Minor
- Open Rotor Out - Major

WEBINAR
Generators built in the 90s were designed to be operated at base load. The industry shift to cycling operation has multiple implications for machine operation, like frequent starts/stops, peak operation, and turning gear operation, leading to additional stress and an increased risk for forced outages.

GE’s Flex Packs—including integrated stator and rotor upgrades—support your cycling operation needs, greatly reducing the risk of critical component failure.

### Outage Applicability

<table>
<thead>
<tr>
<th>Generator</th>
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<tbody>
<tr>
<td>Closed - Visual</td>
<td>Open Rotor In - Minor</td>
<td>Open Rotor Out - Major</td>
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</tbody>
</table>

### Technical Data

**Lifetime Extension of Critical Components Configured for Base Load**

- **5,000 Start-stop cycles with old copper**
- **10,000 Start-stop cycles with new copper**

* Depending on generator type
Boilers

A coal-fired tower boiler can be 550 ft. (167 m) tall.

GE has installed more than 1,000 fossil-fired utility boilers globally, not including HRSGs.

The U.S. boiler team executes more than 40,000 replacement part line items each year.

A 600 MW unit’s boiler contains about 130 miles of boiler tubing.

Some boilers weigh 40,000 tons, equal to the weight of about 20,000 cars.

Depending on the unit, water and steam saturate at 680°F (360°C) and then are superheated to 1,000°F (538°C) before they enter the steam turbine.
GE offers a one-stop solution for all your boiler service needs. For GE, every part replacement is an opportunity to help keep your plant competitive and extend the service life of your equipment.

We serve the full spectrum of customer needs. Our in-kind replacements or upgraded parts include the latest technologies and materials for improved performance and extended time between outages. Or, should your operating strategy require end-of-life planning, we offer a range of economical solutions to cater to unit retirement needs.

To improve equipment reliability and reduce outage duration and frequency, we offer the following parts-related services for all major boiler manufacturers:

- Inventory management
- Equipment rebuild programs (US)
- Technical support
- Outage kits
- 24/7 emergency support and expedited components

**PULVERIZER AUXILIARY EQUIPMENT**
- Gearboxes • feeders • stokers

**PRESSURE PARTS**
- All boiler makes and models for small & large scale projects • boiler tubing • straight or fabricated • superheater • reheater • economizers • headers • panels • desuperheaters • drum internals • sootblowers • attachments

**FUEL DELIVERY SYSTEMS**
- Oil guns • coal piping and elbows • riffle distributors • tips
- nozzles • low NOx burner upgrades • windboxes
- dampers • tangential- and wall-fired burners

**ELECTRONICS AND CONTROLS**
- LIMELIGHT® boiler electronic products • ignitors • flame spectrometers and scanners • control cabinets • process instruments • burner management systems

**BOTTOM ASH AND FLY ASH SYSTEMS**
- Products and services for UCC, A-S-H and GE’s bottom ash and fly ash systems • clinker grinder rebuilds • hoppers • seal skirts • waterboxes with weir piping • front enclosures • ash gates • E valves • airlocks • dry drag conveyors • pugmills • submerged scraper conveyors

We enhance the performance of your boilers, pulverizers, air pollution control systems, ash handling systems, and auxiliary equipment.

Our expertise has been built over many years, with many customers, at many plant sites. We have solved common problems, and we have solved unique ones. Our experience has been gained across a variety of equipment types and brands, including service in utility, waste-to-energy, petrochemical, pulp and paper, and industrial sectors, and with all fuel types.

- Outage planning and inspections
- Commissioning
- Instruction/training/E-learning
- Reliability troubleshooting
- Root cause determination
- Equipment/systems testing
- Systems evaluations
- Operational reviews
- Condition assessment
- Performance improvement
- Dedicated engineer program
- Thermal spray claddings
AmStar Thermal Spray Cladding

DEPENDABLE AND PREDICTABLE WATERWALL PROTECTION

AmStar 888 thermal spray cladding provides dependable and predictable waterwall protection in boilers where high temperature gaseous corrosion and/or erosion may occur. Our proprietary metallurgy, surface preparation and high velocity continuous combustion (HVCC) application process resists cracking, spalling, and stress.

Benefits include:
- Cost effective method of extending life of tubes
- Significantly reduced equivalent forced outage rate (EFOR)
- Dependable and predictable tube protection
- Measurable and scalable
- Heat absorption of the tube not affected
- Reduced generation cost
- Corrosion prevented
- Repairable
- Applicable for any fuel type

Maintenance and Repair Services

BOILER EQUIPMENT REPAIR NETWORK

As a leading supplier of quality power plant equipment and replacement parts, GE offers one complete and cost-effective solution for maintaining and repairing boiler equipment. Our Global Repair Centers (GRC) combine our extensive experience and proven processes.

Benefits include:
- All work done in a controlled environment using the latest technology
- All work done to engineering specifications
- Shorter lead times
- All work backed by GE’s engineering experience and quality
- Certified rebuild technicians
- Documented procedures
- Inspection reports
- Warranty included

Repair capabilities by region:

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<thead>
<tr>
<th>Capability</th>
<th>Americas</th>
<th>Europe</th>
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<tr>
<td>Boiler Component Rebuild &amp; Overhaul</td>
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<tr>
<td>Pulverizer Roll Hard Facing</td>
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<tr>
<td>Pressure Part Fabrication &amp; Welding</td>
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Americas

Europe

TABLE OF CONTENTS
Natural Gas Conversions and Co-Firing

Our installed base is one of the industry’s largest, and we have more than 60 years of proven experience firing natural gas in utility and industrial fossil steam units. This experience includes firing natural gas as the main fuel, co-firing natural gas with multiple fuels, and adding gas firing to existing units. We have extensive experience converting both tangential-fired units as well as wall-fired units, for both GE and non-GE technologies.

Benefits include:
- Lower SOx, mercury, particulate, NOx, and ash. In the case of 100% conversion, no SOx, particulate or ash
- Higher turndown ratio (up to 10:1), depending on gas supply pressure at the burner front and equipment configuration
- Ability to balance fuel usage and leverage fuel suppliers

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<thead>
<tr>
<th>Outage Applicability</th>
<th>Major</th>
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<th>Reduction O&amp;M Costs</th>
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NOx Solutions

When a conventional SCR NOx reduction system is not practical due to space requirements, installation logistics or cost efficiencies, we offer a unique combination of technologies and engineering for cost-effective in-boiler NOx compliance.

Primary low NOx measures include our portfolio of cutting-edge low NOx burners. The low NOx concentric firing system (LNCFS*) for our OEM boilers and RSFC* and RoBTAS* burners for other manufacturers’ boilers are commercially proven and cost-effective solutions for achieving significant NOx reductions, especially when combined with our overfire air systems.

A secondary reduction of up to 30 percent of NOx can be achieved with a selective non-catalytic converter (SNCR) system. This works by injecting urea or ammonia in the upper part of the furnace. At temperatures of 1500° to 2010°F, the NOx is reduced without the need for a catalyst. GE’s Umbrella-SNCR (U-SNCR) is unique because the urea is sprayed within the furnace with a nozzle that is adjustable in height. The process uses cooled lances to carry flexible hoses arranged in the furnace. There are no boiler size constraints, and the technology is easy to control.
**T-PRO* Fuel Firing System**

**REDUCE EROSION AND EXTEND COMPONENT LIFE**

The T-PRO Fuel Firing System reduces erosion and thermal stresses on units firing abrasive coal that can cause coal compartment components to fail. The T-PRO Fuel Firing System’s innovative configuration and material selection ensures equipment reliability, longer operation between outages, and shorter outage durations.

- Increases coal nozzle and nozzle tip wear life
- Improves reliability and availability
- Increases operation time between outages and reduces outage duration
- Reduces maintenance and repair labor costs

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**FlexSuite for Boiler**

**LOW LOAD AND RAMP RATE PACKAGES**

Today’s steam plants must operate differently than in the past, and differently than they were designed for. As a total plant service provider and boiler original equipment manufacturer (OEM), GE offers packages that can improve the flexible operation of your boiler. The first step is to systematically assess the design and identify areas that would hinder operating the unit per your new operating parameters.

For improved ramp rate, areas that are prone to accelerated damage as a result of more frequent startups and shutdowns are identified and addressed. For low load, solutions allowing stable operations customized to your system design are identified and addressed. These solutions are applicable to all boilers, whether made by GE or other manufacturers.

Typical packages that GE offers to enhance performance and lifetime profitability while making safety, reliability and environmental compatibility top priorities include a combination of the following solutions:

- Flame scanners
- Plasma burner
- Burner upgrade
- Smart mill
- Stability monitor
- Low load boiler package
- Auto tune

**Benefits include:**

- Increased flexibility
- Greater availability

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**Outage Applicability**

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Mer-Cure*
ADVANCED MERCURY CONTROL TECHNOLOGY

GE has developed an advanced, patented mercury control technology capable of high removal efficiencies. Mer-Cure* is an enhanced activated carbon injection system with unique attributes that improve mercury oxidation and subsequent mercury capture. The sorbent is injected into the duct upstream of the air heater, allowing enhanced use of the effective temperature range for oxidation and providing longer residence time for optimal mercury capture.

For additional mercury capture and reduced sorbent consumption, our patented activated carbon milling technology can add even greater mercury capture and reduced sorbent consumption.

Benefits include:
- Enhanced mercury (Hg) capture by up to 90%
- Reduced sorbent consumption by up to 50%
- Lowered OPEX
- Wider range of potential sorbent suppliers

Boiler Tuning
ACHIEVE ADVANCED BOILER PERFORMANCE

GE is one of the world’s largest power service providers, and our boiler specialists travel from plant to plant, troubleshooting issues and improving performance. Let us document and report the critical operating data necessary to help your plant go beyond tune-up compliance (NOx, CO) to achieve advanced boiler performance. Beyond tuning, services can include inspections and maintenance, performance testing, engineering, parts supply, and document storage.
Economizer Outlet Gas Temperature (EOGT) Control

UNIT FLEXIBILITY WITH EFFECTIVE SCR OPERATION

GE offers advanced boiler modifications and systems to control the gas temperature to the SCR so your plant can operate at low load and still comply with environmental restrictions. These systems are fully integrated with your boiler’s control system (DCS) and are tailored to meet your plant’s demands.

Based on your unit, we can customize the right solution to meet your operating requirements. Two examples for controlling gas temperatures are:

- **Subcritical boiler**: Our patented hot water recirculation system (HWRS) controls the EOGT by extracting a portion of the hot water from the boiler downcomers and mixing it with feedwater upstream of the economizer inlet.

- **Supercritical boiler**: Our patented economizer recirculation system (ERS) recirculates waterwall outlet fluid.

**Benefits include:**
- Easy to control gas temperatures to SCR at low loads
- Operation only during required loads; no parasitic power used at high loads
- Increased boiler flexibility
- Reduced wear and tear on boiler, since operating SCR at low loads avoids increased startup/shutdown cycles

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>Major</th>
<th>Minor</th>
<th>Reduction O&amp;M Costs</th>
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<tbody>
<tr>
<td>Avoids increased startup/shutdown cycles by operating SCR at low loads</td>
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PV-PRO® System

FININESS, CAPACITY, AND OPERATIONAL FLEXIBILITY FOR COAL PULVERIZERS

We are the milling system experts, with a deep understanding of the industry and a full range of offerings across many mill types, including those from our legacy companies (including CE, EVT, Stein, and Alstom), B&W, BPI, Riley, Hitachi, and Foster Wheeler.

The PV-PRO® system is an integrated performance, recovery and optimization (PRO) system. Depending on your mill type, it includes an improved throat/air port, upgraded grinding zone, and an adjustable static or dynamic classifier.

**Benefits include:**
- Less pressure drop
- Improved efficiency and coal transport
- Reduced pulverizer wear for extended operations
- Better control of coal fineness

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**Technical Data**

- Down to 18% lower mill motor power consumption with PV-PRO system installation (at a U.S. power plant)
- Down to 39% lower mill differential pressure due to PV-PRO system installation
Environmental Control Solutions (ECS)

Comprehensive product portfolio of ECS technologies

Abating of at least **155,000 tons** of particulates and **52 tons** of SO₂ through technologies such as our electronic precipitator and flue gas desulfurization

The largest **electronic precipitator** built at a plant in India

**PTFE (polytetrafluoroethylene)** fabric filter bags operated in continuous mode up to temperatures of **500 °F (260 °C)**

Experience with lime/limestone wet flue gas desulfurization, beginning with pilot studies in the mid-1960s, followed by the first commercial installations at **Union Electric’s Meramec station** and **Kansas Power & Light’s Lawrence station** in 1968
Replacement Parts

For original and custom-designed components such as electrostatic precipitators (ESP), fabric filters (FF) and dry and wet flue gas desulfurization (FGD), GE supplies a wide range of replacement parts and control systems. Our extensive original equipment manufacturer (OEM) knowledge and experience enables us to deliver high-quality and innovative components across the entire ECS system.

With our responsive and competitive spare parts management, you can benefit from our quick distribution, spare parts pooling and inventory programs. Based on more than 100 years of experience, GE’s global supply chain responds to stringent quality requirements.

The benefits of using GE’s spare parts include:

- Many years of operational experience with life cycle cost models and enhanced parts (ESP, FF, and wet and dry FGD)
- Dedicated research and development that delivers new technologies with increased performance
- Ability to build an appropriate and reactive supply chain for speed and cost savings
- Global sourcing with stringent quality requirements

Inspections and Maintenance

Field Services
GE’s global field service network has a strong local presence that supports you with the latest tools, technology, and engineering capabilities. We provide inspection services, maintenance management, field repairs, commissioning, construction, and supervision. Our vast technical and outage management experience allows us to service, retrofit, and upgrade your plant to improve the performance of both our equipment and other manufacturers’ systems. With an absolute commitment to quality and EHS, GE’s operational processes cover both planning and execution for on-time delivery.

Advice and Operational Support
GE’s dedicated and experienced technical service and process engineers can provide excellent technical assistance and support to any equipment design. We help you choose the right solution to maximize your ECS performance, availability, and reliability. Our large range of innovative services includes inspections, condition and lifetime assessments, outage management, ERP, monitoring and diagnostics, remote control and optimization (via proprietary systems ProMo and Predix*), and training.

Servicing other manufacturers’ equipment
Following a series of acquisitions and mergers over the last century, GE provides expertise to a broad technical product portfolio, and we can service, upgrade, or retrofit a wide range of ECS systems.
ESP operators can benefit from upgrade solutions to extend lifetime and lower particulate matter (PM) emissions, parasitic losses, and maintenance costs. This enables you to increase the output of your plant while maintaining your ECS equipment. As a one-stop shop, we work with you to conduct a thorough evaluation of your plant’s technical and economic conditions and then help you select the right renovation and upgrade solutions.

Our patented SIR technology reduces the particulate emission level and improves overall ESP performance without the need for costly extensions. With more than 3,500 SIR units in operation around the world, we offer a wide range of advanced high voltage power supplies for ESPs to meet your plant’s requirements.

Benefits include:
- Reduces up to 70% particulate emissions compared to conventional technology, and reduces emissions levels down to below 20mg/Nm³ particulate emissions, when required
- Installs on new or existing ESPs from GE and other manufacturers
- Applies to ESPs in power and industrial applications, such as cement and pulp and paper
- Offers more than 95% electrical efficiency
- Avoids cost-intensive retrofit and longer outages
GE’s electrostatic precipitator integrated controller (EPIC) is an ESP bus-section controller for transformer rectifier sets (T/Rs), which includes basic functionalities, energy savings, current control, spark detection, and rapping efficiency. It uses software algorithms like electrostatic precipitator optimizing of charge (EPOQ) and opacity optimization (OpOpt) to obtain optimum performance from the ESP.

With EPIC well below 20mg/Nm³ particulate emissions can be achieved.

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Building on proven process experience in particulate matter control, GE’s electrostatic precipitator optimizing of charge (EPOQ) software is an intelligent solution for improved ESP performance. Thanks to self-adjusting algorithms and individual bus-control, emissions can be decreased and power consumption improved when handling highly resistive fly ashes.
Fabric Filter (FF) UPGRADES

FF upgrades, with higher removal efficiencies, are required to allow for further reductions in particulate matter (PM) emissions as well as to maintain the performance and availability of the entire plant throughout its life cycle. Operational costs also are optimized for a quick return of investment for the FF upgrade.

Electronic Fabric Filter Integrated Control (EFFIC) ADVANCED FF INTEGRATED CONTROLLER

A powerful controller, the electronic fabric filter integrated controller (EFFIC) can modernize control systems on new or existing units. This intelligent controller drives the pulse jet FF by using actual process conditions instead of traditional pressure drop methods.

Traditionally, the pulse control system must be programmed into the distributed control system (DCS) system. If an EFFIC is used as an interlink between the FF and DCS, the DCS programming is simplified, requiring the addition of only the most commonly used functions. The DCS simply will send a signal to the EFFIC, and the EFFIC automatically will control the entire array of FF functions and alarms.

The benefits are:
- Longer bag life
- Less emissions
- Controlled absorbent consumption
More stringent environmental regulations require improved solutions for flue gases. GE offers a full set of wet or dry FGD service solutions to upgrade your equipment to a high-tech configuration for high performance, low energy consumption and reduced operating costs.

GE is committed to finding innovative solutions to existing FGD systems with upgrades for increased performance and energy savings. As every FGD system is unique, GE takes a tailored approach to determining the solution you need.

FGD upgrade options include:

- Spray headers for improved design for uniform flue gas coverage
- Nozzle types for optimal droplet diameter and dispersion
- Mist eliminators to prevent droplets carryover at reduced pressure loss
- Performance enhancing plates to increase gas-to-liquid contact
- Tray upgrades for optimal velocity with additional perforated tray
- Slurry preparation equipment of ball mills, mixers and pumps

Outage Applicability

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Sulfitrac® Sulfite Analyzer

REDUCE POWER CONSUMPTION AND MERCURY RE-EMISSION IN REAL TIME WITH IMPROVEMENT OF WET FLUE GAS DESULFURIZATION

GE is a global leader with 100 years of experience in ECS. Our patented new SulfiTrac sulfite analyzer is the first online solution for continuous improvement of energy consumption while reducing mercury emissions. This is accomplished by measuring and controlling the sulfite ion concentrations within the wet flue gas desulfurization (WFGD) slurry.

Conventional WFGD systems operate their oxidation air blowers using settings established for worst-case conditions. Blowers set for worst-case parameters, rather than real-time conditions, consume excessive quantities of power. Furthermore, when too much air is pumped into the WFGD slurry, there is a higher risk of mercury re-emission, undesirable selenium speciation, and increased corrosion. The problem becomes especially severe for plants operating at variable load or with different coal compositions.

With GE’s sulfite analyzer hardware and software, you can reduce the power consumption of the oxidation air blowers by injecting only as much air as needed while maintaining gypsum purity.

Configured to cope with harsh environments in heavy industrial applications, the sulfite analyzer is suitable for most power plants or industrial processes with a WFGD.

Key benefits

- Reduce power consumption and costs
- Improves air input rate according to boiler load and coal sulfur conditions
- Reduces mercury re-emissions and dissolved mercury in WFGD purge stream
- Eliminates the need for chemical additives for mercury re-emissions control
- Prevents sulfite blinding and maintains high gypsum quality
- Improves manganese solubility to reduce corrosion potential
- Maintains proper speciation of selenium in WFGD purge stream
- Installs easily with low maintenance

Outage Applicability

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Customer Training

Meeting your continuous learning needs
A continuous path of learning helps plant personnel gain the knowledge and skills needed to run an efficient, successful plant. GE’s Power Services Customer Training can suggest the right mix of training options to align with your plant configuration, equipment technology, employee audience, and time constraints.

- **Site-Specific Courses.** Our high value training service offers a variety of 200 courses that are tailored to your specific site by your assigned GE instructor and dedicated training project manager. Courses are delivered either at your site or at one of our Power Services global learning centers in the language of your choice, and on a schedule that works for you. Courses may contain a mix of classroom learning, site walkdowns, and hands-on training.

- **Open Enrollment Courses.** With technology-specific content, our Open Enrollment training offers a comprehensive selection of more than 75 English-language courses for small staff or new team member training, or to expand the skills of select employees. Your employees train at one of our Power Services learning centers with students from around the world. Courses offer a mix of classroom learning techniques, and may contain walkdowns and/or hands-on training.

- **Online Courses.** A cost-effective solution for a broad range of employees, our 25-plus Online English-language courses let you train your personnel anytime, anywhere, and at their own pace. Each course ranges in duration from one to four consecutive hours, and can be started and stopped at the student’s discretion.

- **Multi-Year Training Agreements.** Simplify your training, budgeting, and planning efforts with our long-term flexible training offering. This agreement entitles you to a fixed number of annual training days for GE’s Site-Specific and/or Open Enrollment courses, unlimited use of all our available Online courses, plus exclusive access to our Remote Turbine Operations Simulator. We partner with you throughout your plant’s lifecycle to help you select the training solutions that best meet your evolving needs.

www.geenergytechnicaltraining.com