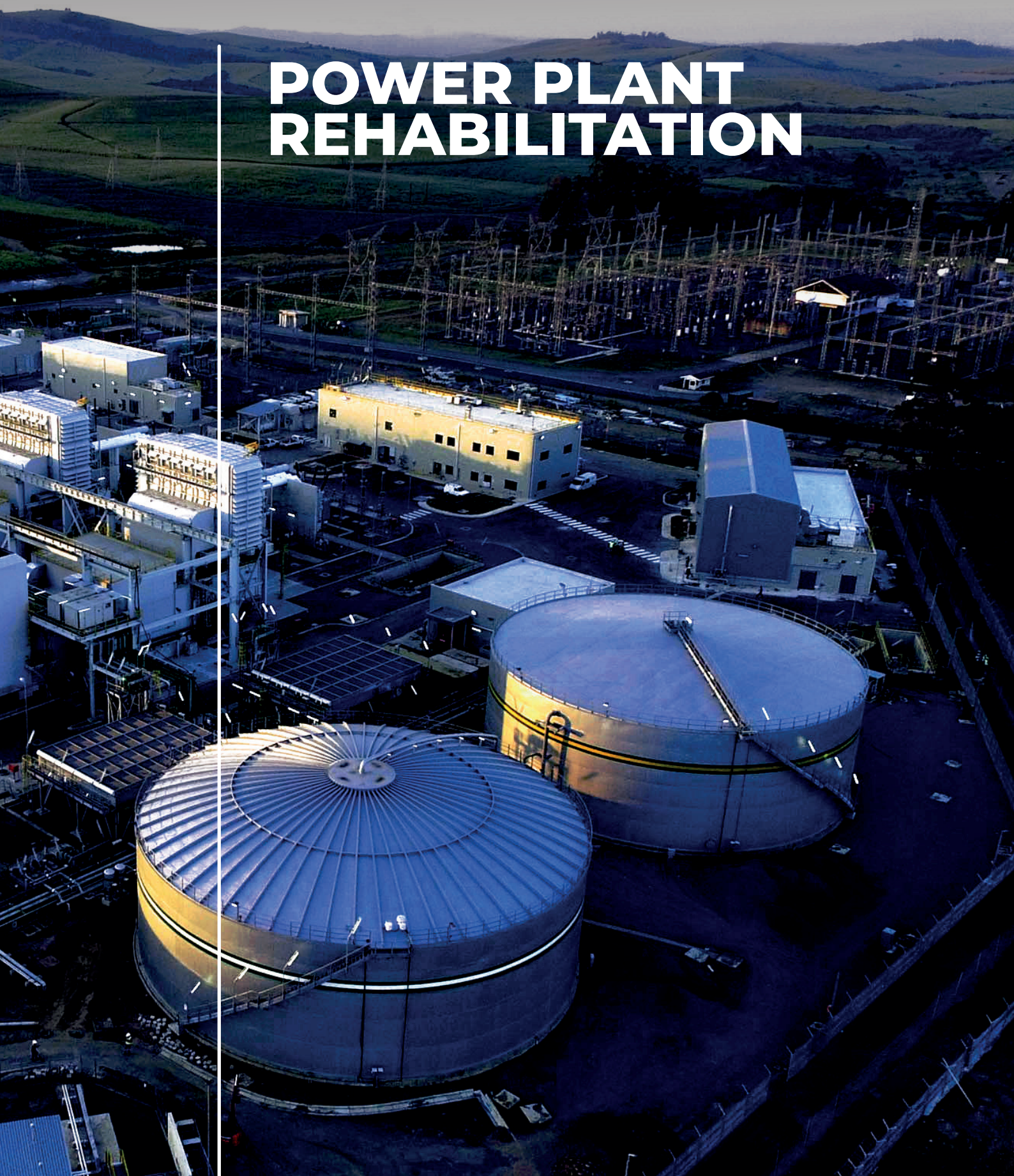


POWER PLANT REHABILITATION



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Make your power plant fit for the future

To meet the fast-changing demands of today's power generation industry, Customers often need to maximise their power systems' performance at the lowest possible cost.

Technological advances, new energy efficiency regulatory requirements, health & safety and/or environmental concerns are just a few of the many reasons why energy businesses are increasingly faced with the need to make changes to existing facilities.

Many power generation infrastructures have already been in operation for several decades, therefore requiring modernization to sustain their functionality



Ansaldo Energia's range of services includes:

- Plant general assessment from initial site survey up to detailed report with recommended solutions
- Repowering of conventional steam plants with the installation of gas turbines
- Add on of steam turbines in existing open cycles
- Replacement of existing equipment
- Plant recommissioning/relocations
- Hybridisation with addition of storage/ integration with renewables
- Modernisation: modifications to improve old equipment's performance and/or reliability and/or extend lifecycle
- Retrofit solutions for equipment upgrades (e.g. emissions compliance, flexibility upgrades)
- Cyber security
- Integrated plant support through remote monitoring
- Customised training

Ansaldo Energia provides a broad spectrum of services designed to bring existing power plant assets back to original state and/or upgrade them to the latest technology. In addition to enhancing service reliability and overall performance, our rehabilitation and/or upgrading measures will help minimize forced outages and cut comprehensive downtime costs (e.g. revenue losses, emergency maintenance, emergency freight surcharges for critical spare parts).

Moreover, in-depth site analysis offers an opportunity to identify possible safety issues affecting the original systems and tackle them in the context of the project, resulting in enhanced safety compliance among personnel. Rehabilitation measures can also include all necessary upgrades to reduce vulnerabilities in IT and IIoT/OT (Industrial Internet of Things/Operational Technology) and improve cyber security to better respond to potential threats.

Alongside equipment life extension and reduced shutdown frequency, therefore, retrofitting and modernisation measures will bring additional benefits at lower investment costs.

How you can benefit

Our strategy is rooted in our belief that Customers should be provided comprehensive, wide-ranging support to achieve full operational reliability, from each single piece of equipment up to their power plant as a whole. Our Service and Retrofit offering is designed to achieve optimised asset management throughout the entire plant lifespan.

A tailored approach is the foundation of every project we undertake: thanks to their extensive knowledge of power plant equipment and to our

Boasting a proven track record in the power generation industry, Ansaldo Energia has been providing a huge variety of engineering solutions to power plants for decades

partnerships with key component suppliers, our experienced teams can handle projects involving Ansaldo Energia's proprietary technology as well as components from other manufacturers.

Our highly qualified staff work in synergy with our Customers to provide all-round assistance with every aspect of the rehabilitation process, from initial site survey through to project completion.

Commitment and competence are core practices in our interaction with customers as well as in the services we offer. Ensuring a successful delivery of each project through a customer-focused, highly-specialised approach is our guiding philosophy as we work towards enabling our Customers achieve their goals.

Our approach

Upgrades can have a significant impact on power plant assets including gas turbines, steam turbines, generators, boilers and/or heat recovery steam generators, emission control systems and balance of plant equipment.

Effective rehabilitation assessments are organized into the following analysis stages:

Initial Plant Survey

This is the first step of site analysis. It is aimed to collect all available technical information, including reports on malfunction conditions and recurring problems, maintenance and outage records. The survey must include interviews with operation and maintenance staff.

Hot Inspection

It consists in a plant walkthrough during normal operation to carry out visual inspections including with measuring instruments. This stage of analysis should also include a performance test establishing a baseline to set the scope of any possible Performance Guarantee and Upgrade Contract.

Cold Inspection

Its main purpose is to perform an assessment of Plant Conditions and Residual Life by means of NDT, visual/functional/dimensional checks of the equipment involved in the Rehabilitation project.

Every project must start from an integrated assessment of critical power plant components and systems to provide:

- Comparison between design and upgraded performance
- Knowledge of equipment limitations and solutions
- Guidance for operational improvements
- Evaluation of emission compliance and other regulatory concerns

Ansaldo Energia's plant assessment covers all of the following areas:

COMPONENT EVALUATION

Gas Turbine

- Ansaldo Energia upgrade applications
- Output and efficiency gains
- Exhaust flow and temperature

Heat Recovery Steam Generator and Conventional Boiler

- Pressure parts design limitations
- Flow-accelerated corrosion areas
- Increased operational flexibility/availability/efficiency

Steam Turbine

- Steam path analysis
- Thermal and mechanical stress limits
- Output and efficiency gains

Generator

- Operation during maximum output
- Capability curves and cooling limitations
- Magnetic saturation limits Condenser

Condenser

- Vacuum upgrades
- Steam flow improvement
- Alignment with BoP new conditions

Balance of Plant

- Performance of environmental controls
- Plant layout assessment for integration of new components and equipment
- Process upgrading
- Extension, refurbishment and replacement of the electrical auxiliaries of the power plant
- Fitness for service
- Steam trap & safety valves monitoring solution

I&C - Digital Solutions

- Instrument monitoring & maintenance solutions
- Control systems upgrading & cybersecurity
- Digitalisation

MODELING & ANALYSIS

Ansaldo Energia can carry out a detailed power plant analysis under multiple operational and ambient conditions, incorporating the following elements:

- Original design and upgraded heat balances
- Model calibration to as-is equipment condition
- OEM and model-based upgrade potential for major equipment
- Balance of plant systems and components capability
- Real-time performance monitoring and operational optimization of power plants

PLANT ASSESSMENT REPORT

The plant assessment report provides the following evaluations:

- Current vs. upgraded plant thermal performance
- Emissions summary and environmental impact
- Equipment and operational limitations/recommendations
- Business case development support
- Safety assessment
- Plant residual life assessment

Detailed descriptions of project examples from our service portfolio can be found in the following specific sections:

Steam Turbine
Retrofit

Geothermal
Retrofit

Add on

Gas Turbine
Replacement

Landmark project

MARSAT EL HADJADJ (Algeria)



Rehabilitation of Unit 1, completed in 2014

Customer: SONELGAZ Production d'électricité

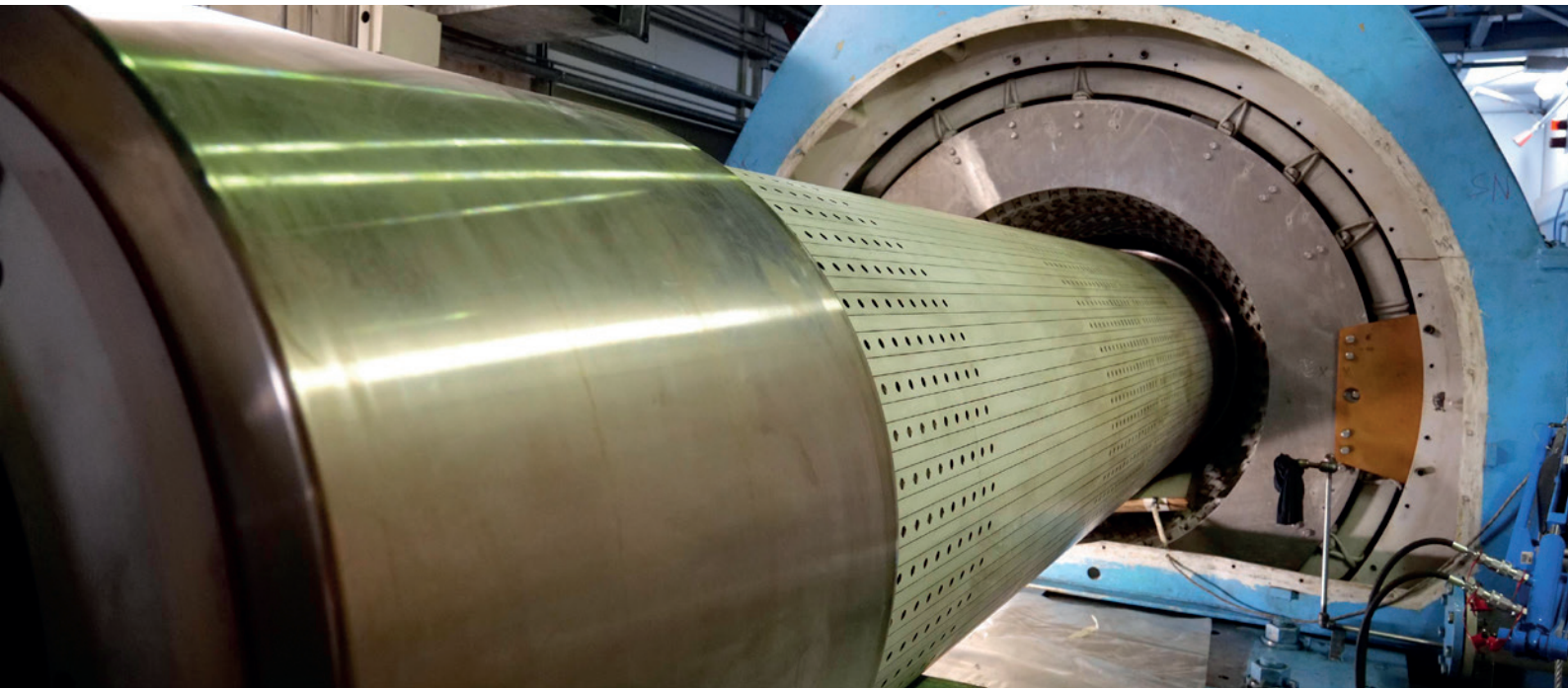
Site Type: Brownfield/Rehabilitation

Type of Contract: EPC Contract

PROJECT MAIN CHARACTERISTICS

- Marsat el Hadjadj is a conventional power plant heavy oil-fired block.
- The Customer requested rehabilitation of Unit 1 to improve performance (power output and efficiency), preserving most of the remaining parts of the existing plant and extending lifetime.
- The contract was awarded to a Consortium made up of Ansaldo Energia, ACB, ABB Energy Automation.
- Alongside the Consortium, Ansaldo Energia carried out Hot Inspection and Cold Inspection on the main equipment during dismantling to define the final scope of work in order to fulfil the Performance Improvement Plan that successfully achieved increases in:
 - Power Output
 - Efficiency
 - Availability
- All of the plant Equipment was overhauled and refurbished for Power Plant Lifetime Extension.
Rehabilitation works mainly involved:
 - ST & Generator
 - Boiler (by ACB)
 - Balance of Plant
 - Electrical and automation part (by ABB)





STEAM TURBINE & GENERATOR

Steam Turbine, 168 MW

- Major overhaul
- Replacement of Kingsbury bearing and other minor components of the auxiliary system
- Spare parts supply

Generator, 220 MVA

- Major Overhaul
- Installation of new excitation system
- Spare parts supply

BOILER (ACB)

The main activities carried out on the Boiler were:

- NDT, Hydraulic tests
- Supply and installation of super-heater 1, reheater and rehabilitation of 2 Ljungström heat exchangers
- Supply of boiler outlet damper and bypass

BALANCE OF PLANT

Preheaters, pumps, valves:

- Supply and installation of tube bundle, water box and LP1 preheater plates
- Installation of new LP2&3 e HP1&2 supplied by the Customer
- Replacement of control valves and valve overhaul

SEAWATER INTAKE AND FILTRATION SYSTEMS:

- Supply of seawater condenser tube plates
- Overhaul of seawater circulation pumps
- Rehabilitation of seawater intake
- Installation of new seawater filtration system

ELECTRICAL AND AUTOMATION EQUIPMENT (ABB)

Electrical components:

- Excitation transformer replacement
- Machine switch replacement
- Installation of Bus-bar protection 6.6 kV
- AT cable replacement

General main and unit transformer overhaul

Automation components:

- Supply of a new control system: Distributed Control System (DCS), Boiler Monitoring System (BMS), Digital Electronic Hydraulic Control (DEHC) of the steam turbine.



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