



COMBINED CYCLES



AnsaldoEnergia
A Finmeccanica Company

Combined Cycles

The new world energy market is leading more and more toward highly efficient power plants together with the necessity of fulfil new stringent limits for the environmental emissions.

Combined Cycle Power Plants show peculiar advantages in this way allowing fuel economization, a large range of flexibility strategies for power production, an optimisation of the whole plant efficiency and a limited environmental impact.

Ansaldo Energia, a Finmeccanica company, banking on more than one century and a half of experience in power generation, with a total capacity over 176,000 MW, is a distinguished player in the energy industry, providing reliable and flexible solutions across a complete and innovative products portfolio in the power generation field: equipment and plant designs, engineering, manufacturing, contracting, service and customers assistance.

Ansaldo Energia is the main supplier for power plants in Italy and deals with international local agencies, Independent Power Producers, Industrial Customers.

The company is an international turn-key power plants provider: Ansaldo Energia designs and manufactures several plants types: thermal, geothermal, combined cycle, cogeneration and many activities for nuclear power plants.

According to the market demand, the core business focuses on combined cycle power plants supplied in a wide range of generating capacities from 100 to 1,600 MW.

A distinctive feature of Ansaldo Energia is its in-house manufacturing capability for all major plant components, such as generators, steam and gas turbines, the other plant components, such as HRSGs, condensers and plant auxiliaries are purchased from selected suppliers.

Ansaldo Energia offers multiple choices: the turboset package can be supplied as a standalone system together with the electrical generator, the turboset auxiliaries and the control system; it can be integrated with thermal cycle equipment to form a complete power island; or it can be extended to include all the components and systems in a complete turnkey plant.

Ansaldo Energia modular approach integrates the benefits of a pre-engineered combined cycle design with the flexibility needed for customisation according to specific site or Client requirements, as well as allowing to adapt the offered solutions to maximise customer satisfaction.



Typology

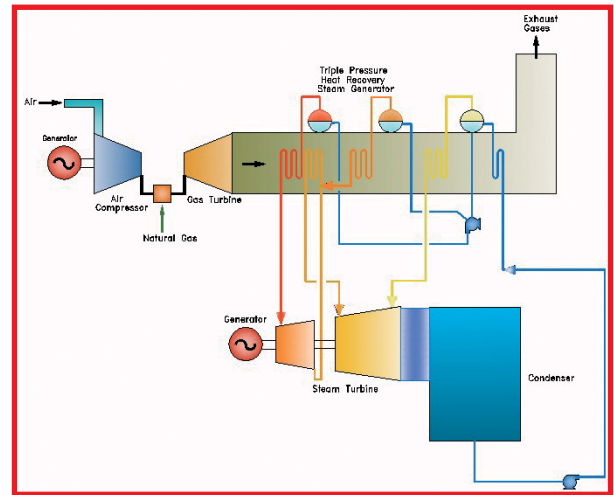
Ansaldo Energia supplies combined cycles in different configurations:

Configuration 1+1, both in multi shaft and single shaft arrangement

In multi shaft arrangement both the gas turbine and the steam turbine are connected to a dedicated generator. In single shaft arrangement the gas turbine and steam turbine drive the same generator, with the advantage of many common auxiliary systems.

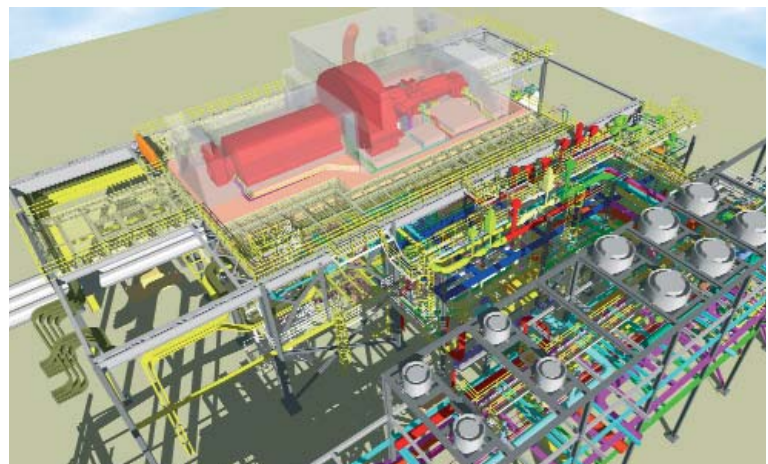
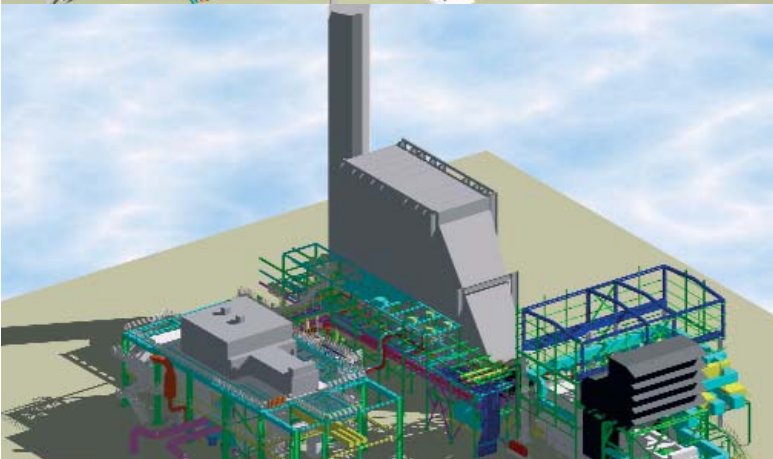
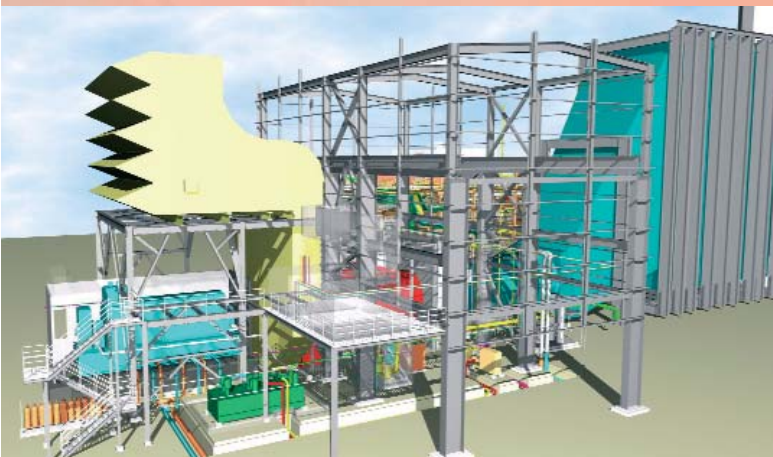
Configuration 2+1

This configuration is composed by two gas turbines, each with its own HRSG, one steam turbine and the steam condenser. This solution allows more flexibility during the operation, because in case of low power demand, a gas turbine and its associated HRSG can be excluded while the other group operates at full power keeping an overall high efficiency.



These configurations can be combined together to reach different aims following clients requirements:

- **combined cycle for electrical energy production only**
- **combined cycle for both electrical and heat power production** for cogeneration for industrial purposes or district heating applications using controlled or uncontrolled steam extractions from steam turbine or from HRSG
- **combined cycle solutions can be also adopted when low LHV gas are available from an industrial park**, as blast furnace gas (BFG), refinery off-gas, synthesis gas (syngas).



Plant Performance

Combined Cycle	Plant Configuration	No. & Type of GT	Net Plant Power Output [MW]	Net Plant Efficiency [%]	Net Plant Heat Rate [kJ/kWh]	Grid Frequency [Hz]
1AE643-CC1M	1 + 1	1 x AE64.3A	112	53,8	6698	50/60
2AE643-CC1M	2 + 1	2 x AE64.3A	224	53,8	6689	50/60
1AE643-CC1S	Single Shaft	1 x AE64.3A	112	53,8	6698	50/60
1AE942-CC1M	1 + 1	1 x AE94.2	251	52,1	6904	50
2AE942-CC1M	2 + 1	2 x AE94.2	507	52,6	6843	50
1AE943-CC1M	1 + 1	1 x AE94.3A	427	58,2	6190	50
2AE943-CC1M	2 + 1	2 x AE94.3A	855	58,2	6188	50
1AE943-CC1S	Single Shaft	1 x AE94.3A	427	58,2	6190	50

Note:

ISO conditions with:

- condenser vacuum = 0.035 bar, except 0,050 bar for AE64.3A
- GT inlet pressure loss = 10 mbar ISO
- GT exhaust pressure loss = 30 / 30 / 35 mbar ISO resp. for AE64.3A / AE94.2 / AE94.3A gas turbines.



Environmental Impact

More and more stringent environmental constraints set by international and local regulators have induced combined cycles manufacturers to develop innovative solutions to reduce the plant environmental impact:

Lower flue gas emissions

Ansaldo Energia gas turbines models, fuelled by fuel gas and equipped with Hybrid Burner combustion system, achieve less than 50 mg/Nm³ NO_x emissions and less than 30 mg/Nm³ CO emissions.

Ansaldo Energia has successfully designed upgraded burners that reduce emissions significantly and guarantee the same reliability and availability, achieving guaranteed NO_x emissions lower than 30 mg/Nm³.

Thanks to its Centre of Excellence dedicated to combustion technologies, Ansaldo Energia has developed VeLoNO_x[™] burners (Very Low NO_x), the new combustion system.

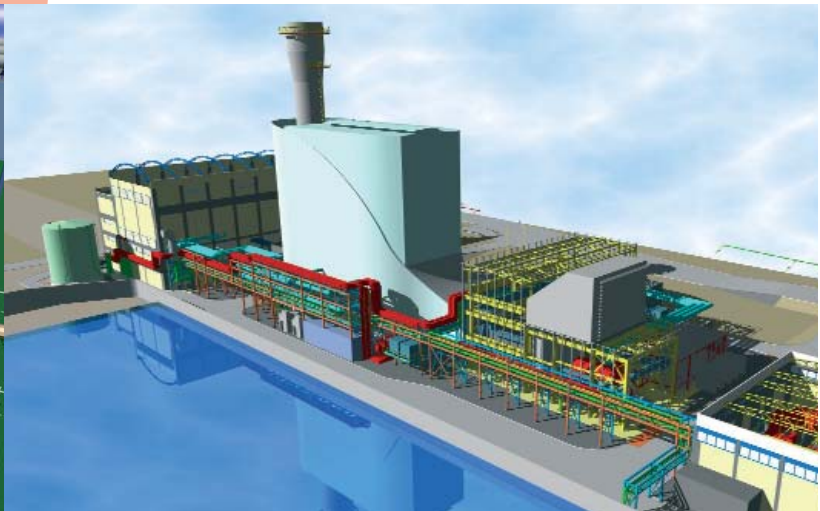
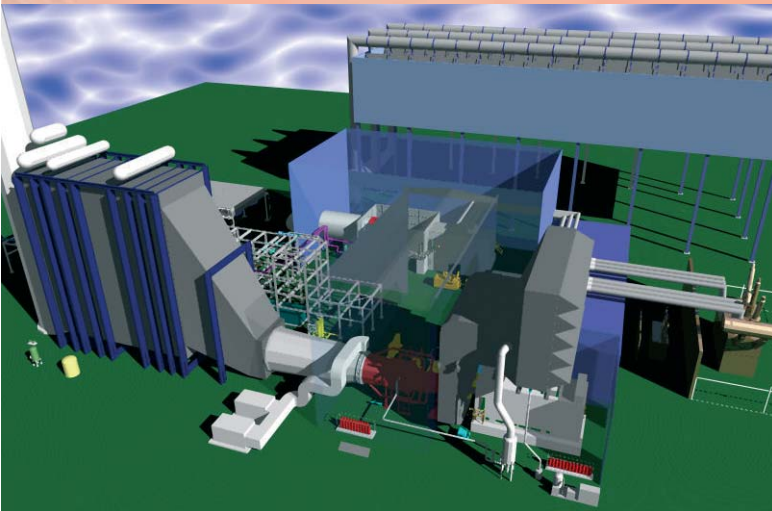
Noise

An evolving issue in power plant design and siting is the noise control.

Ansaldo Energia takes care of plant acoustic design, providing innovative engineered solutions to noise problems at the lowest disposable costs. Plant acoustic balance is constantly checked during the whole design process, in order to satisfy law requirements and customers' needs.

Zero liquid discharge

Ansaldo Energia, respecting the most stringent environmental laws and as an active part in the research against water resources pollution, has conceived CRIOS, the proprietary ZLD system to reduce the needs of fresh water consumption and to comply with the local regulation that prohibits any liquid effluents emission from the industrial sites. The system allows a total recovery of the industrial discharge water. The system is composed by the following sections: biological treatment, oily water treatment, neutralisation treatment, demineralisation system and brine treatment.



Architectural solutions

Ansaldo Energia implements architectural solutions using a suitable and flexible approach to meet client's distinctive character and expectations.

Ansaldo Energia takes care of the land social-cultural framework in order to promote plant acceptance and territorial integration.

Integrated plant engineering

Ansaldo Energia proposes to its Clients a wide range of configurations on thermoeconomical optimisation basis:

Combined cycle with HRSG from one pressure level, mainly used for desalination plants, to three pressure levels with reheating. HRSG can be also designed with:

- post-firing to improve the steam production/electrical power
- fresh air system particularly for the application with low LHV gases

Steam turbines: full condensing type, condensing with controlled or un-controlled steam extraction type, back-pressure type

Main Condenser: air cooling condenser, Heller system, surface condenser in open cycle, surface condenser in closed cycle with a cooling tower

Dual fuel: different kind of fuels can be burned in the gas turbine apart from natural gas such as: fuel oil, LNG, bio-fuel, blast furnace gas (BFG), refinery off-gas, synthesis gas (syngas)

Plant optimising

Flexibility

To meet the requirements of the new free electric market, new power plants should have long lifetime and high flexibility to hold heavy and continuous load cycles with frequent daily start-up and shut-down.

Ansaldo Energia designs plants from base load to reliable daily start up and shut down with its proper features.



Automation

Another significant feature is the automation/supervision system. Field bus technology has been adopted both for field connections and the electric power interface. Ansaldo has chosen ABB AC 800 technology to develop plant automation for the steam generators, the thermal cycle, all turbine auxiliary systems and electric power sub-distribution, including SART automatic voltage control system. The use of field bus technology is particularly interesting as it reduced wired interconnections and improves signal diagnostics, optimising maintenance activities as a result.

Layout

Layout optimisation is achieved using a flexible approach to cope standard plant solutions, specifically applicable to power block, with customer and site requirements. Each plant layout is personalized and optimised; the following main criteria will be the base of the plant layout design: safety, operability, maintainability, standardization.

Repowering of existing conventional units

Ansaldo Energia has acquired many skills in repowering from ageing conventional coal/oil fired plants to modern and efficient combined cycles. In the new electricity market it has become mandatory to have in operation very competitive power stations with high efficiency, high flexibility and low investment cost: the reduction in emissions deriving from the use of natural gas in latest generation technology gas turbines plus the superior efficiency and the expanding capacity of combined cycle are decisive factors in this choice, together with the economic advantages in recovering the existing steam cycle and services, main components, such as the steam turbine, the steam condenser and also the auxiliaries and piping still standing.

Ansaldo Energia combined cycle design approach responds to new market requirements deriving from the privatisation of the energy market with the key design factors in achieving a swift return on invested capital, minimizing capital cost, fuel consumption, operation and maintenance activities, as well as meeting the consumer demand profile or grid regulations.

Other Ansaldo Energia capabilities, including specific engineering subjects like RAM (Reliability, Availability, Maintainability) analysis, plant dynamic analysis and remote control, are also used during configuration design to define plant behaviour in transient conditions, optimise the maintenance program, increase availability and improve net dependable capacity.

Additionally, Ansaldo Energia is improving, with a great effort in research and development, combined cycle main components design, such as gas turbine upgrading, study on blades new materials/coatings, new low emissions burners, steam turbine new last stage blades and construction of air cooled generators up to 350 MVA, to better satisfy clients' requirements.



Ansaldo Energia has over 150 years experience in the electrical and mechanical engineering business.

It is a global player in the power generation sector with an installed capacity of over 176,000 MW.

Ansaldo Energia offers the full range of manufacturing, engineering, contracting and service activities, as well as a flexible approach to power projects.

Steam fossil fired, gas turbine and combined cycle, hydroelectric, geothermal and nuclear power plants, supplied turnkey, in separate lots or by components.

The Quality Systems, certified as complying with ISO 9001 by a recognised certification society, cover all aspects including, design, planning, manufacture, testing, inspection, installation and servicing.



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