POLYCITY

SIXTH FRAMEWORK PROGRAMME

SUSTAINABLE ENERGY SYSTEMS

Report on gas co-generation unit implementation

Organisation name of lead contractor for this deliverable: **ATC**

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1 Summary

The new thermal station placed in the second floor underground of ATC building is able to supply heat and hot water both to ATC building and the Arquata district (trough the district heating network).
The new heating system comprehends:

- Three new gas boilers that have been installed
  two heat generators with 2600 kW thermal power each and a condensation boiler with 978 kW power
- A Combined Heat and Power (CHP) unit (~1 MWel, ~1.2 MWth), that will be installed within the end of 2006

In normal working conditions the cogenerator plant will work in parallel with the local electric energy distribution network. It will be also thermally coupled with an absorption chiller, so to produce refrigerated water for the cooling system (fan coils) of ATC building.
Its main features are:

- Electric power: ~ 960 kW
- Thermal power coming from hot water recovery (70/85 °C) on the engine block: ~ 500 kW
- Thermal power coming from hot exhaust gas recovery (95/80 °C): ~ 650 kW
- ηel (guaranteed minimum at full load in ISO 3046 conditions): > 0.38
- ηth (guaranteed minimum at full load in ISO 3046 conditions): > 0.45
- Esteemed methane gas consumption: ~ 265 Sm3/h
- NOx emissions (5% O2): < 250 mg/Nm3
- CO emissions (5% O2): < 300 mg/Nm3
- NNHC emissions (5% O2): < 150 mg/Nm3
- Noise level at 10m: < 50 dB

2 Deliverable objectives and starting point at the beginning of reporting period

This document is a part of the Workpackage DE1 (“Implementation of demand side efficiency measures”). It aims at describing the scheme of the heating system in the ATC (Agenzia Territoriale per la Casa) building in Torino and the main features of the heating plants, with particular attention to the cogeneration plant.
By now, only a part of the new configuration of the thermal station has been completed: the installation of three new gas boilers (and an electric chiller). The new CHP plant’s technical features and constraints have been defined; a call for tender for the construction and implementation of the cogenerator is foreseen in the month of may 2006; the start of working will be in the first months of 2007.

3 The new ATC thermal station

The thermal plant in the ATC headquarters was in the past years used only for supplying heat to the building itself. The boilers had the following characteristics:

two NAVAL boilers with overheat water, 800000 kcal/h, 688 kW each
one NAVAL boiler with overheat water, 350000 kcal/h, 301 kW

In conditions of normal work only the first boiler with bigger size was active. The smallest size boiler was active only in the week-ends in order to provide the heating to the night-watchman apartment.

Since September 2004 the thermal plant has been completely changed. With the new configuration the thermal plant is able to supply both ATC building and the Arquata district trough a new district heating network.
The new system comprehends:

- Three new gas boilers that have been installed in 2004:
  two Viessmann heat generators, model Vitomax 200, 2600 kW each
  one Viessmann condensation boiler, model Vitocrossal 300, 978 kW
- A Combined Heat and Power (CHP) unit (~1 MWel, ~1.2 MWth), that will be installed in the first months of 2007
- An absorption chiller, thermally coupled to the CHP unit, that will provide cold water for the air-conditioning of ATC building. This signifies that a *Tri-generation* system will be present (i.e. a combined production of electricity, heat and cool)
- A compressor chiller.

The complete scheme of ATC building's new thermal station is represented in Figure 1**.**

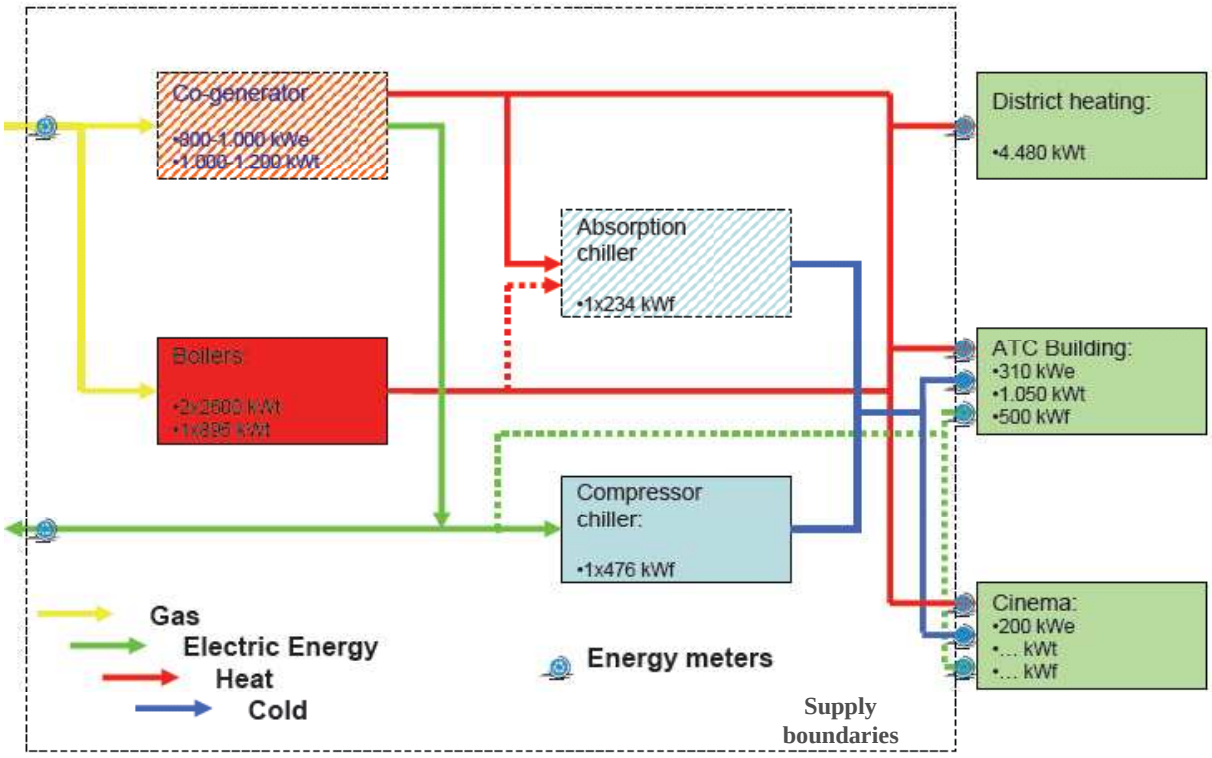

Figure 1 - ATC building Tri-generation scheme

4 Description of ATC cogenerator

The new cogeneration plant (CHP) will be placed in the basement of ATC building. By now the final accurate definition of the system is not available, since the tender for the construction and implementation is foreseen for the month of may 2006. However, the general features of the system and its technical constraints have already been drawn and are described in this chapter.

The installation of a cogenerator concurs on one hand to have a source of internal electric power independent from the distribution network, and on the other hand to realise a series of advantages in environmental and economic matter. In fact, the heat recovered from the cogenerator in the cycle of electric power production and poured on the heating system, reduces the power that must be supplied from other sources with consequent fuel saving.

The future cogeneration group will be able to produce hot water from the heat recovery system, which will be destined to the heating network of the Arquata district and the ATC building. A dedicated line of hot water to the concentrator of the absorption chiller will be also realised; so to produce refrigerated water for the cooling system (fan coils) of ATC building.

4.1 Components and features of the cogenerator

In normal working conditions the cogenerator will have to work in parallel with the local electric energy distribution network.
The gas methane engine will be coupled to a three-phase synchronous alternator and placed on a chassis in a rigid way and with appropriate covering. Vibrations are removed by use of suitable high absorption elastic supports of spring type, opportunely dimensioned for the load to be supported, positioned among the frame group and the bearing face of the group itself.

The produced electric energy will be transformed in MV and subsequently convoyed to the “MV boards” in the adjacent room. From “MV boards” room part of the produced electric energy will be put in the grid at MV and part will be re-transformed in LV to supply the users in the building.

The cogenerator will work only according to precise selections defined by the command and control system, on the base of predefined and programmable time, thermal demand and electric logic. The whole plant management has therefore to be committed to a central supervisor, who will ensure its control and correct functioning, together with all the other auxiliary services of the thermal station.

4.1.1 Engine

Four-stroke Otto cycle engine with supercharging of the air-gas fuel mixture and related intercooler, system of electronic ignition controlled by a microprocessor with coil for every single cylinder, preparation of the thin mixture of combustion by continuos electronic optimisation system for the reduction of polluting emissions, even without external catalyst help.

Main features:

- Electric power: ~ 960 kW
- Thermal power coming from hot water recovery (70/85 °C) on the engine block: ~ 500 kW

- Thermal power coming from hot exhaust gas recovery (95/80 °C): ~ 650 kW
- η_{el} (guaranteed minimum at full load in ISO 3046 conditions): > 0.38
- η_{th} (guaranteed minimum at full load in ISO 3046 conditions): > 0.45
- Esteemed methane gas consumption: ~ 265 Sm3/h
- NOx emissions (5% O_2): < 250 mg/Nm3
- CO emissions (5% O_2): < 300 mg/Nm3
- NNHC emissions (5% O_2): < 150 mg/Nm3
- Noise level at 10m: < 50 dB
- Work cycle: Otto
- Cooling fluid: water
- Lubrication system: forced
- Lubrication oil consumption: < 0.4 g/kWh$_e$
- Electric starting system: electric engine at 24 Volts DC

4.1.2 Three-phase synchronous generator

Complete of automatic voltage regulation system and, in case of working in parallel with the external net, of automatic power factor regulator. The alternator consists in a main generator with internal poles, an outside pole excitement generator, a regulator of tension whose power supply is guaranteed by an auxiliary permanent magnetic exciter.

Main features:

- Tension	400/231 V
- Frequency	50 Hz
- Rounds	1500 rpm
- Power factor	0.8 - 1
- Efficiency (cosφ = 1)	0.965
- Efficiency (cosφ = 0.8)	0.955
- N. of poles	4
- Constructive type	B3/B14
- Phases connection	Star
- Exciter	Brushless
- Tension regulator	Automatic with transistors
- Grade of protection	IP 23
- Insulation class	H
- Over-temperature class	F
- Max air temperature	40 °C
- Service	Continuous

4.1.3 Gas fuel supply line

It is a pre-assembled regulation line composed by:
- Manual interception valve
- Gas filter
- Gauge indicating gas fuel pressure
- Pressure switch
- Interception solenoid valve
- Flexible tube connection to the engine

- Pressure regulator

4.1.4 Starting system

- Starting batteries opportunely sized for the group, with lead elements at 24 Volts and linking clamps
- Battery chargers inserted in the auxiliary control board

4.1.5 Electric pre-heating

This device maintains the motor cooling water at a temperature between 55 °C and 60 °C when the cogenerator isn't working to assure a quick operational start.

4.1.6 Dissipation radiator for the engine heat

The heat produced from the module (cooling water and fuel mixture) and not used is dissipated through a system of cooling (radiator) arranged on the external.
The electro-radiator intervenes on the warm water circuit through a temperature controlled valve.
The dissipation system consists of:

- two electro-radiator respectively for motor cooling water and intercooler mixture cooling, 400 Volt, 50 Hz
- two expansion tanks and safety valves
- accessories for command and surveillance

4.1.7 Oxidant catalyst

Catalytic oxidant purifier for the containment of carbon oxides and unburned hydrocarbons till these maximum levels:

- CO < 300 mg/m^3
- NMHC < 150 mg/m^3

4.1.8 By-pass valve on exhaust side

It allows the deviation of exhaust flows directly in the atmosphere, in case the heat of the recovery circuit is not used. The valve is three ways and is commanded by a small electrical motor.

4.1.9 Other components

- Soundproofed covering (max. 50 dB at 10 meters and 70 dB at 1 meter)
- Exhaust gas silencer
- Control switchboard, TEM type (Total Electronic Management)
- Compensators and flexible connections
- Gas interception valve
- Module equipments (filters, oil tanks, chassis, joints, ...)