Dynamic simulations for the optimum management of HVAC and DHW system in a multifamily building

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Aim of the present work was the analysis of an integrated system for the heating and the DHW production for 30 apartments. The system consists of a gas modulating condensing boiler (220 kW) for heating and DHW, a heat pump (130 kW), and 18 evacuated tube solar thermal collectors. Solar energy contribution is used both for heating and for DHW generation. Three thermal storage tanks are installed: a puffer for the heating demand (800 l) and the other two (2000 l each) dedicated to DHW production. The aim of the analysis is to evaluate the optimum design of the plant and of the management system, in order to maximize the exploitation of the solar energy, to increase the load factor of the heat pump and to manage the boiler operation for achieving the highest efficiency at partial loads.

Dynamic simulations have been run first to analyze the management of the solar system, and subsequently to evaluate the overall efficiency of the plant, as it has been managed with different set of controls and different priorities among devices, and the operation of the boiler has been split into two modules dedicated respectively to heating and to the DHW generation.

To identify the best configuration of the solar system, acting on the solar circuit flow management, it was investigated how to divide the total flow among the three storage tanks to optimizing the energy contribution provided by the solar collectors. A small contribution was found with respect to the heating demand and it has questioned whether to maintain or not this connection. However, the overall performance analysis on the system showed a solar contribution of about 23% of the total energy demand, due to the contribution to DHW production, always greater than the 50% required by Italian regulation. Compared to a traditional system(only condensing boiler) the analyzed solution provides a primary energy saving of 36%. The split management of the boilers allows a further saving of 6% of primary energy [Tab.1].

Main research topics:

- Performance analysis of HVAC system by the means of experimental measures and dynamic simulations
- Analysis of indoor environmental quality (thermal comfort and air quality)
- Modeling and analysis of heating radiant system
- Natural and mechanical ventilation
- Geothermal heat pumps
- Screen walls and efficient enclosures
- Energy and temperature analyzes in large environments
- Energy and plant consulting
- Study and optimization of the interventions for the renovation of existing buildings
- Fluid dynamic simulations
- Thermo graphic surveys
- Detailed thermal analysis of thermal bridges
- Measurements of air permeability of building envelopes
- Hygrothermal behavior of the envelope components

	BOILER	HP	SOLAR SYSTEM	TOTAL INPUT
	Thermal energy [MWh] Primary energy [toe]	Thermal energy [MWh] Primary energy [toe]	Thermal energy [MWh] Primary energy [toe]	Thermal energy [MWh] Primary energy [toe]
Integrated system unique boiler	45.4 3.9	16.1 3.0	30.3 -	91.8 6.9
Integrated system split boilers	34.3 2.9	18.8 3.5	30.3 -	83.4 6.4
Traditional system only boiler	126.0 10.8	- -	- -	126.0 10.8