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A New Model to Perform Preliminary Evaluations of Complex Systems for the Production of Energy for Buildings: Case Study

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Abstract : The building sector is responsible, in many industrialized countries, for about 40% of the total energy requirements, so it seems necessary to devote some efforts in this area in order to achieve a significant reduction of energy consumption and of greenhouse gases emissions. The paper presents a study aiming at providing a design methodology able to identify the best configuration of the system building/plant, from a technical, economic and environmentally point of view. Normally, the classical approach involves a building's energy loads analysis under steady state conditions, and subsequent selection of measures aimed at improving the energy performance, based on previous experience made by architects and engineers in the design team. Instead, the proposed approach uses a sequence of two well known scientifically validated calculation methods (TRNSYS and RETScreen), that allow quite a detailed feasibility analysis. To assess the validity of the calculation model, an existing, historical building in Central Italy, that will be the object of restoration and preservative redevelopment, was selected as a case-study. The building is made of a basement and three floors, with a total floor area of about 3,000 square meters. The first step has been the determination of the heating and cooling energy loads of the building in a dynamic regime by means of TRNSYS, which allows to simulate the real energy needs of the building in function of its use. Traditional methodologies, based as they are on steady-state conditions, cannot faithfully reproduce the effects of varying climatic conditions and of inertial properties of the structure. With TRNSYS it is possible to obtain quite accurate and reliable results, that allow to identify effective combinations building-HVAC system. The second step has consisted of using output data obtained with TRNSYS as input to the calculation model RETScreen, which enables to compare different system configurations from the energy, environmental and financial point of view, with an analysis of investment, and operation and maintenance costs, so allowing to determine the economic benefit of possible interventions. The classical methodology often leads to the choice of conventional plant systems, while RETScreen provides a financial-economic assessment for innovative energy systems and low environmental impact. Computational analysis can help in the design phase, particularly in the case of complex structures with centralized plant systems, by comparing the data returned by the calculation model RETScreen for different design options. For example, the analysis performed on the building, taken as a case study, found that the most suitable plant solution, taking into account technical, economic and environmental aspects, is the one based on a CCHP system (Combined Cooling, Heating, and Power) using an internal combustion engine.

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