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Impact of Climate Conditions and Energy Prices on Museums Refurbishments in Different European Countries Based on Geothermal Energy, Electrical Power or Natural Gas Systems

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Abstract

Museum buildings are often subject to architectural protection when belonging to the historical heritage. This limits retrofit solutions and actions. However, they need to be refurbished in order to allow their reuse or to continue to be used according to current quality standards, while retaining their heritage significance.

The usual intervention strategies of verified effectiveness for common buildings can often hardly ever be applied on listed historical buildings, because these could lead to architectural alterations. A viable and acceptable solution respecting the conservation needs can be achieved by implementing the geothermal energy, and installing the ground source heat pump systems. Such systems are almost invisible contrary to the solar thermal collectors and photo-voltaic panels for example. Besides that, geothermal energy assures the continuity of operation of the heating and cooling system, which is another important factor for the conservation of the works of art.

Any refurbishment has to be designed aiming at the best result between the energy costs and indoor environmental conditions, which are strictly connected with the conservation requirements of the art collections in the museum on one hand (i.e. microclimate/thermo-hygrometric requirements, depending on the specific heritage materials), and on the other to the thermal comfort standards for visitors, if possible.

Many aspects which have an impact on the economic attractiveness of the refurbishment depend on the specific country: the climate, the building characteristics, the energy requirements for heating and for cooling, the soil conditions, the installation costs, and the cost of the primary energy. Considering the operational phase only, paramount factors are the cost of energy and the heating and cooling requirements, which are depending on the climate and on the building characteristics.

A comparative study between different refurbishment solutions (ground source heat pumps, electric heaters or natural gas boilers) has been performed considering hypothetical museums around Europe. An energy simulation software has been used to obtain quantitative information about the energy consumption, the operating costs and carbon dioxide emissions savings.