

Resilience Models for Large Hydropower Diversions

Insights from Calcinere, Italy

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Abstract

Against the backdrop of the growth of renewable energy, this research project aims to study and map the **complex hydropower system** in detail from multiple perspectives. The history and characteristics of these plants, most of which were built in the early 20th century, must be carefully evaluated, as they possess significant architectural and historical heritage value while simultaneously suffering from technological and structural obsolescence. Additionally, the management of these structures in the context of climate change must be considered, along with the potential and feasibility of renovation interventions and the complex regulatory framework. The challenge lies in achieving production and energy efficiency targets through an integrated approach that considers not only the technical modernization of interventions but also climate adaptation, environmental protection, and **sustainable regional development**.

To this end, forward-looking methods and tools were tested to support the digitalization and systemic study of **Calcinere**, a large hydropower diversion, which has been selected as a representative case study and industrial partner for this research project. In this context, an integrated approach was used, combining a **digital model** enabling BIM-FM integration to optimize operational workflows and maintenance scheduling, and a **mental model** as a design framework guiding interventions with positive social and economic impacts in a complex process such as the renewal of a concession. These models provide a graphic and informational basis for an integrated model that could be useful for various applications, including project communication and virtual accessibility to plant facilities.

The proposed methodology aims to develop **resilience models** for the Calcinere hydropower plant, with the ultimate goal of demonstrating how digital infrastructure management can serve as a catalyst for territorial resilience and socio-economic revitalization of mountain communities, and to provide a replicable, scalable approach for similar contexts.