RINNO: Transforming Deep Renovation through an Open Renovation Platform

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***Abstract*—Building stock accounts for a major portion of worldwide energy consumption and greenhouse gas emissions. Integrating resources, information and automation systems in a proper manner to achieve the required outcomes and meet the relevant regulatory standards for deep renovation and emerging energy efficiency is a significant challenge. RINNO is a Horizon 2020 project that aims to deliver a set of processes that, when working together, provide a system, repository, marketplace, and enabling workflow process for managing deep renovation projects from inception to implementation. This paper presents an overview of the RINNO project and, specifically, RINNO's design for an open renovation platform for managing and delivering deep renovation projects for residential buildings based on seven design principles. The proposed platform will be developed, implemented and evaluated at four pilot sites with varying construction, regulatory, market and climate contexts.**

***Keywords*—Deep renovation; open renovation; energy efficiency; residential buildings; renovation management platform.**

I. Introduction

Despite pledges and public sector efforts to curb global warming, carbon dioxide emissions from the energy sector and industry have increased by 60% since the signing of the UN Framework Convention on Climate Change in 1992 [1]. As such, de-carbonising energy sources and implementing sustainable development and circular economy principles in industry has become a key international effort as evidenced in the UN 2030 Agenda for Sustainable Development, the 2015 Paris Climate Agreement, the EU climate action, and the European Green Deal.

Meeting 2030 targets requires reduction in greenhouse gas emissions in excess of 50% [2]. The EU building stock currently accounts for 40% of the EU's energy consumption and 36% of greenhouse gas emissions [2]. Reducing the energy impact of these building is a significant challenge. Most buildings in Europe have substantially longer lifetimes than those built in less developed countries, many of which were built before thermal standards were introduced or required [3]. By 2050, more than 85% of the EU building stock will still be in use, albeit in need of significant renovation [3].

Deep renovation is defined as a form of renovation that "captures the full economic energy efficiency potential of improvement works, with a main focus on the building shell, of existing buildings that leads to a very high energy performance" [4]. This includes improving heating and cooling demand through a more efficient building envelope, the use of low-energy consuming equipment, increasing renewable energy sources and implementing *smart building* principles [2]. RINNO, a four-year Horizon 2020 project, aims to introduce significant improvements in (i) the efficiency of the deep renovation process, both in terms of cost and time, and (ii) the energy performance and stakeholder satisfaction of deep renovation projects [5]. This will be achieved through a novel open renovation platform for the deep renovation of residential buildings - ranging from planning and design, to retrofitting, operation and monitoring - and implementing emerging technologies including new materials, prefabrication, artificial intelligence, amongst others. In Section II, we introduce the RINNO Open Renovation Platform Renovation Framework. Section III provides a brief overview of how the RINNO platform will be tested in real-life implementations. Section IV presents some concluding remarks.

II. The RINNO Open Renovation Platform & Renovation Framework

RINNO aims to develop a new open renovation software platform. It is designed against seven principles [5]:

1) Full-Lifecycle: implementing the best available technological solutions and construction practices across the renovation project lifecycle;
2) Multi-Stakeholder: taking into account multiple concurrent stakeholder perspectives and requirements;
3) Modularity: capitalising on independently designed systems which, when integrated, function as a whole;
4) Open & interoperable: making data, processes and renovation-specific functionalities available in an ecosystem of building stakeholders;

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5) Algorithmic: using machine learning and other, more generic algorithmic systems based on data generated from buildings to enable *augmented building intelligence* in support of planning, design, and building operations;
6) Scalable: using (green) cloud computing to accommodate the massive range of data structure types, algorithms and communication mechanisms inherent in smart buildings; and,
7) Secure: integrating security considerations into all aspects of the open renovation platform from the cloud to the edge.

The RINNO Operational Platform (Figure 1) comprises five layers building on cloud computing Infrastructure-as-a-Service (IaaS) to enable scalability, algorithmic approaches, and data management [5]. The Core RINNO Operational Platform comprises the platform's primary architecture, middleware, orchestration, and analytics systems. The RINNO API (Application Programming Interface) Management Platform supports design, security, publishing, monitoring, analysis, consumption, and monetisation APIs in support of open collaboration standards and data exchange [5]. On top of the underlying infrastructure sits a number of renovation-specific components, which may comprise one or more modules. These include lifecycle-specific modules, e.g., a renovation repository, a planning & design assistant, a retrofitting manager, a building lifecycle renovation manager, and a renovation workflow & transactions manager, finance, and training, as well as more general user administration & support modules. On-site data about the building and its use are gathered through a multi-sensor network. Finally, users and devices can access the platform and data through a variety of interfaces, facilitating multi-stakeholder interactions.

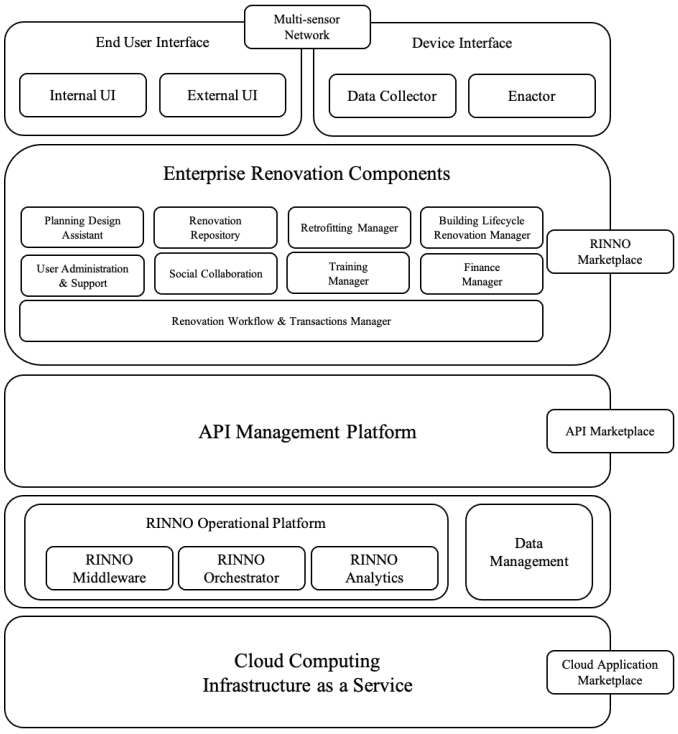

Fig. 1. High level conceptual RINNO Open Renovation Platform with illustrative components [5].

III. RINNO Pilot Sites and Evaluation

The RINNO platform will be used in the renovation of buildings at four pilot sites in Greece, Poland, France and Denmark. These buildings are all multi-unit social housing buildings situated in different climatic regions, with diverse local building codes and regulations. Furthermore, each building features different construction materials and elements and is equipped with different heating, ventilation, and air conditioning (HVAC) systems and other related building systems and features. The project will be evaluated based on a wide range of key performance indicators including reduced energy consumption, the adoption and use of renewable energy sources (RES), thermal performance, renovation time and effort and comparative cost, as well as stakeholder satisfaction measures [5].

IV. Conclusions

This extended abstract provides a short overview of the Horizon 2020 RINNO project. Upon delivery, all processes will work as a system, repository and integrated workflow for the initiation and implementation of deep renovation ventures. This will result in optimised renovation design, reduced renovation time, effort, energy consumption and cost, increased energy efficiency, improved thermal performance, and increased stakeholder satisfaction [5].

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