



HEART

Simulation and energy retrofits: tools for better decision-making

Energy performance

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Management, Conservation of Buildings of Historical Value
Vienna, 16th October



TASK 59
RENOVATING HISTORIC BUILDINGS
TOWARDS ZERO ENERGY

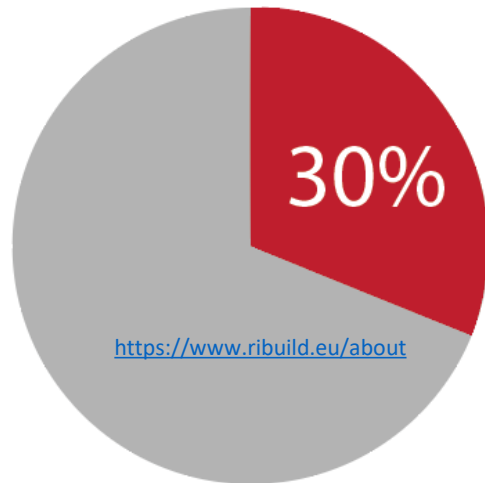
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Energy simulation of historical buildings: framework

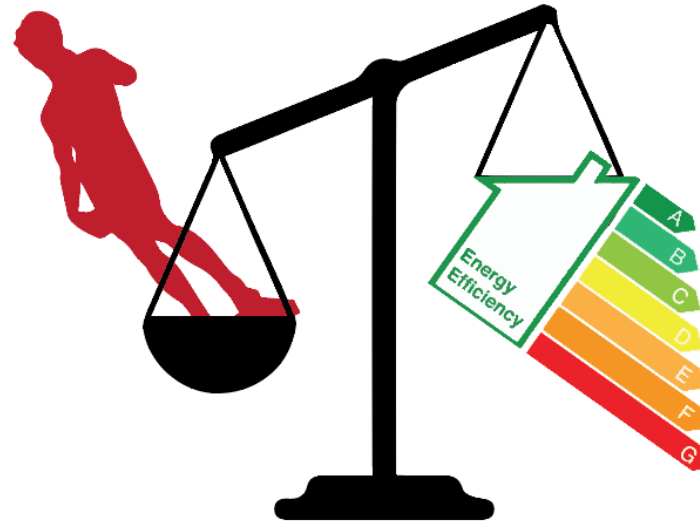
The popularity of the energy simulation in historical buildings is due to many factors:



the amount of buildings considered as historical, which is equal to 30% of the total amount of the existing stock



the need to balance energy efficiency improvement with the requirements of preservation, and



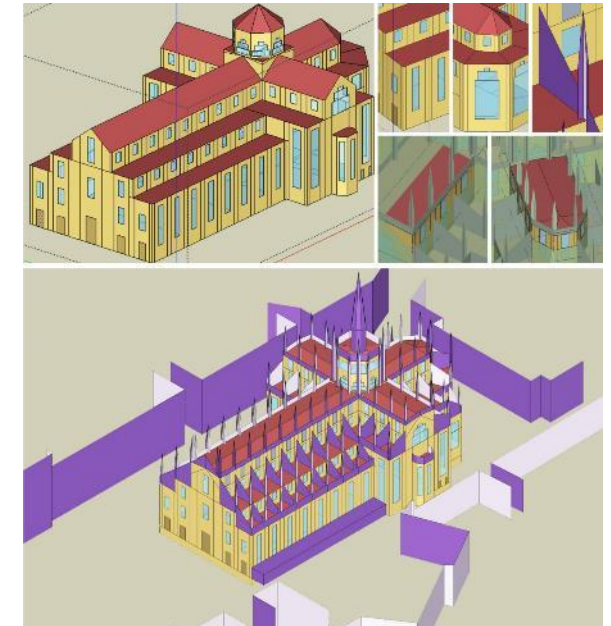
the scarce knowledge about their thermal behaviour.



Energy simulation of historical buildings: aims

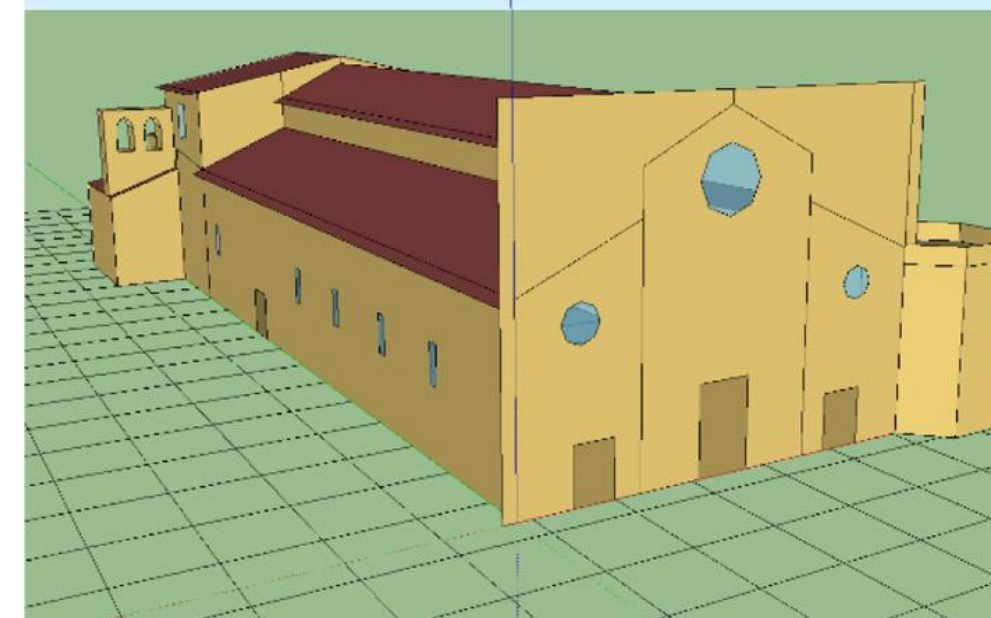
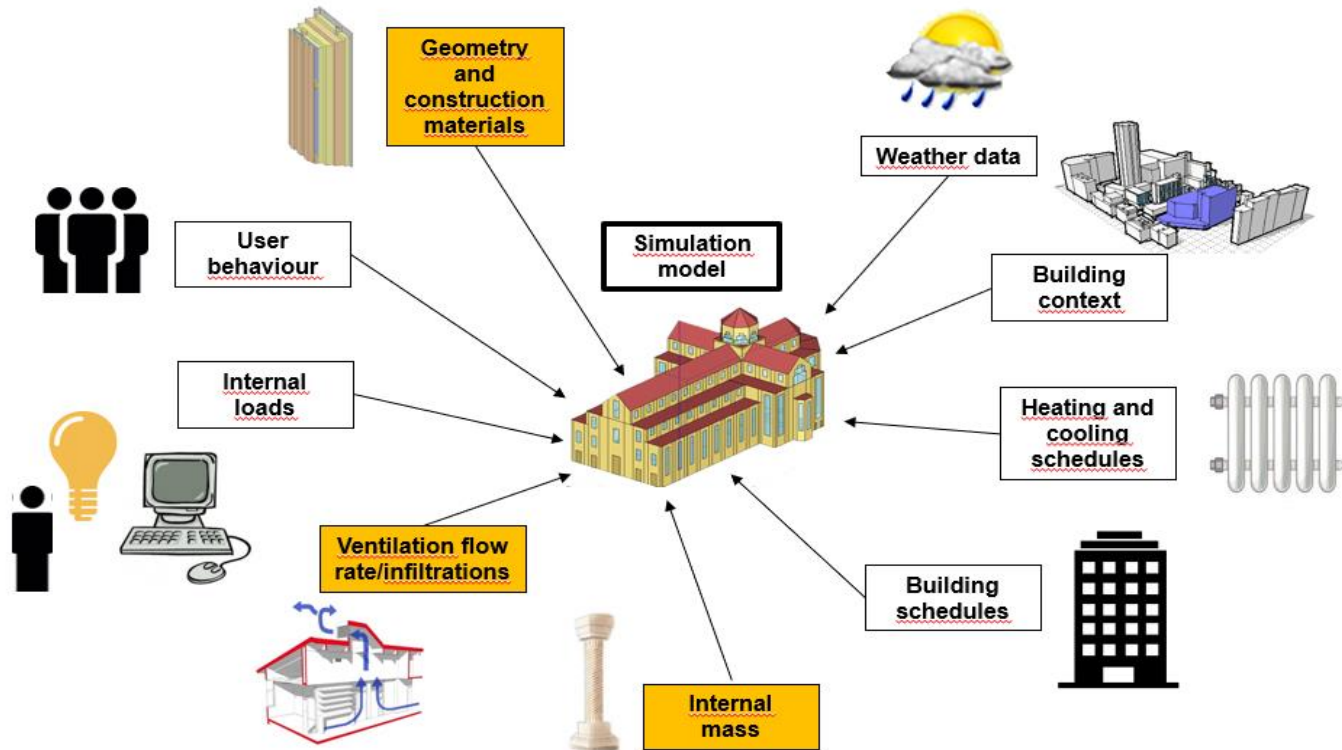
Dynamic simulation tools must be used in the field of historical buildings in order to:

- (i) analyse the possible degradation risks to materials, determined by specific environmental temperature and relative humidity ranges;
- (ii) estimate some phenomena that cannot be easily evaluated, such as the verification of surface condensation;
- (iii) assess multiple energy retrofit scenarios.



Energy simulation of historical buildings: Limitations

1. the lack of reliable information about input parameters
2. calculation's limits of the tools used to describe the geometric features
3. the adoption of wrong models of certain physical phenomena

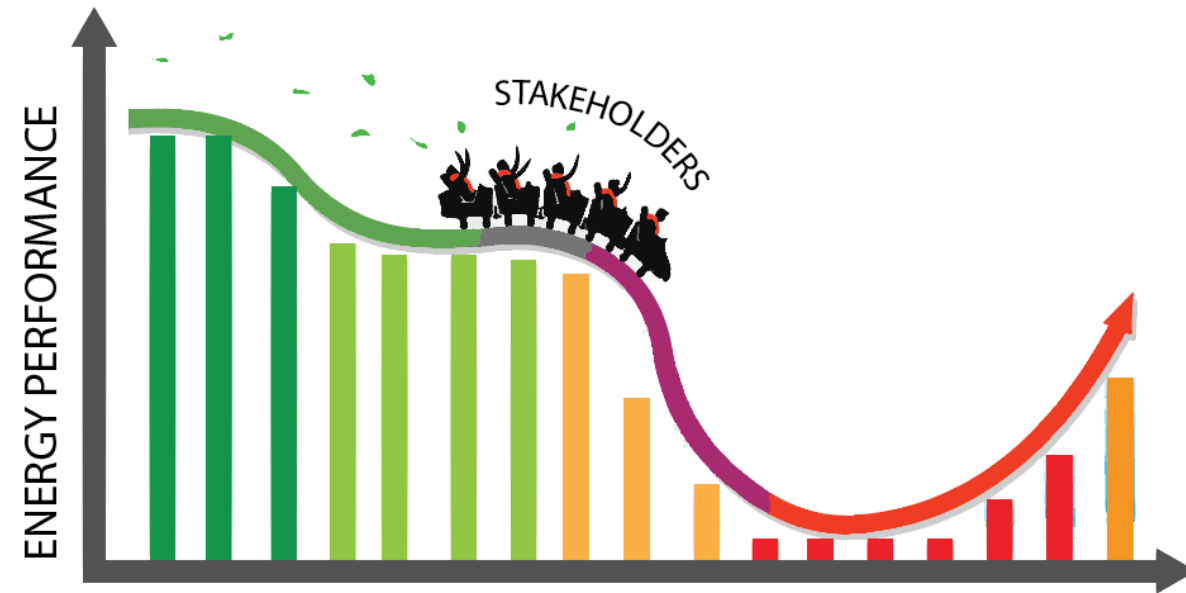


Energy simulation reliability?

In such respect, bridging the gap between predicted and measured performance is pivotal in order to **provide serious and reliable advice to designers, architects, buildings' owners and policy makers, on the real performances of the buildings.**

This will **increase the awareness amongst clients and design teams** on the energy behaviour and performances of the building, estimating the effectiveness of different energy efficient solutions and ensuring the achievement of the forecasted energy performance.

Moreover, such information can be adopted to **plan and to schedule effective interventions and maintenance programs** as well as **to reduce the risk for owners and investors** (i.e. damage, structural problems, and so on). The enforcement of energy performance guarantee, in fact, allow the decreasing of the uncertainty about the final outcome. This latter factor can offer a significant contribution to the development of new rules and strategies for real estate and energy finance, innovating the traditional conservative approaches (i.e. restoration or planned conservation).



HEART Project General information

- **OFFICIAL TITLE:** HEART - Holistic Energy and Architectural Retrofit Toolkit
- **RELEVANT KEYWORDS:** Renovation, Energy efficient buildings, Internet of Things, Interoperability, Integrated design
- **DURATION:** 48 months (01/10/2017 – 30/09/2021)
- **EU CONTRIBUTION:** 5,669,012.50 €
- **PROJECT COORDINATOR:** prof. Niccolò Aste, Politecnico Di Milano, niccolo.aste@polimi.it
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HEART

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Consortium

N°	PARTICIPANT ORGANISATION NAME	SHORT NAME	COUNTRY
1	Politecnico di Milano	POLIMI	Italy
2	ENTPE Lyon	ENTPE	France
3	University of Ljubljana	UL	Slovenia
4	Accademia Europea di Bolzano	EURAC	Italy
5	Turbo Power Systems	TPS	UK
6	Heliotherm	HT	Austria
7	ZH	ZH	Italy
8	VyzVoice	VV	Luxembourg
9	STILLE	ST	Croatia
10	Revolve Water	RW	Belgium
11	Quantis	QT	Swiss
12	GarciaRama	GR	Spain
13	Housing Europe	HE	Belgium
14	ACER RE	ACER	Italy
15	Est Métropole Habitat	EMH	France
16	CTIC Technology Centre	CTIC	Spain

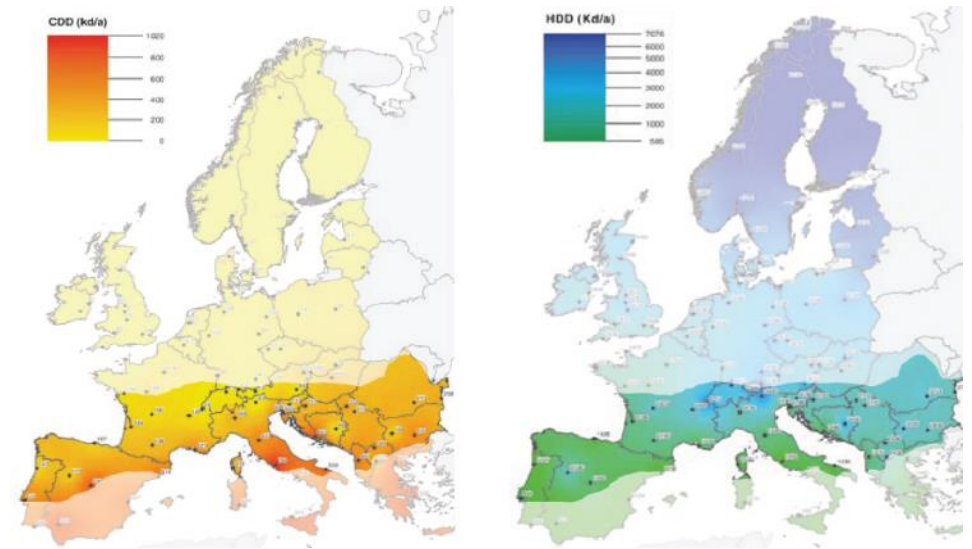


University of Ljubljana
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Application context and target

The project's geographical focus is **Central and Southern Europe**, where the moderate climate requires building energy performance to relate as much as to **heating, overheating and cooling**.



The application target are existing **multi-storey residential buildings**. Within this category, the most common types are **4-5 floors linear condominium buildings**.



Objectives

OBJECTIVE – To support and improve the **decision-making process**

By means of an iterative simulation of various feasible solutions, **HEART selects and sizes the most effective one**, providing a detailed prediction of the achievable cost-performance-benefit ratio.

In addition to strengthening the economic and energy-related benefits **HEART can support and facilitate decision-making**, reducing the choices' processing time by at least 30% and decreasing final outcome uncertainty of the decision-making phase.

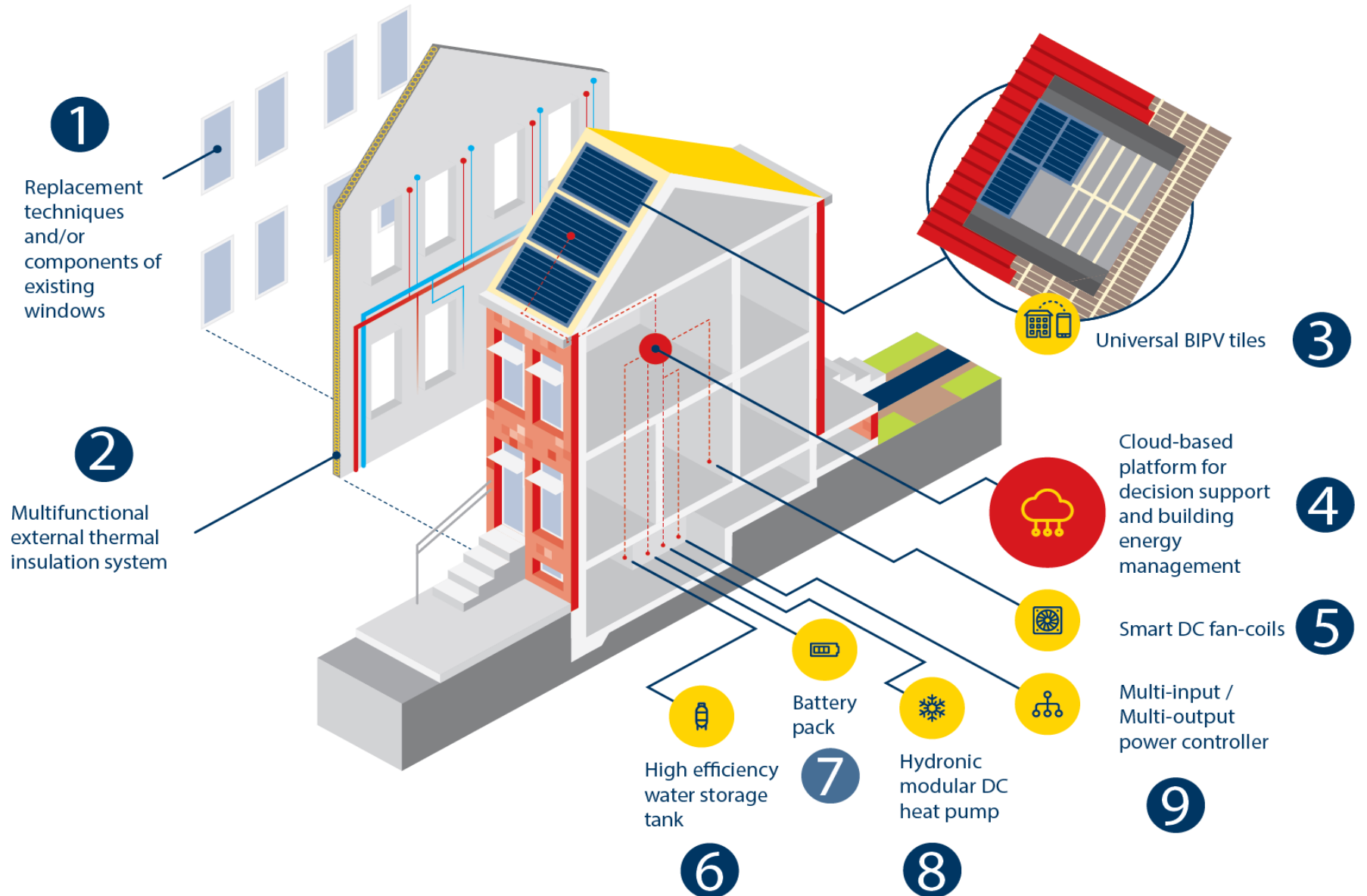
OBJECTIVE – To promote **energy efficient financing**

HEART reduces energy consumption, optimizes overall performance and, through a continuous monitoring and makes a building's operating transparent. This aspect translates into an effective conduct of a retrofit intervention and a constant documentation of its performance.

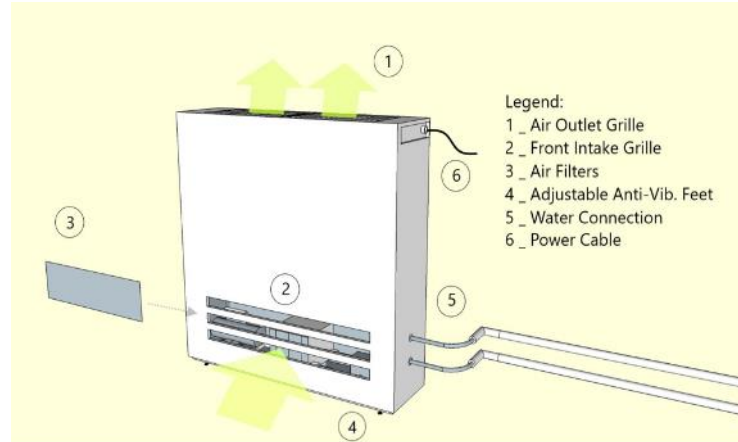
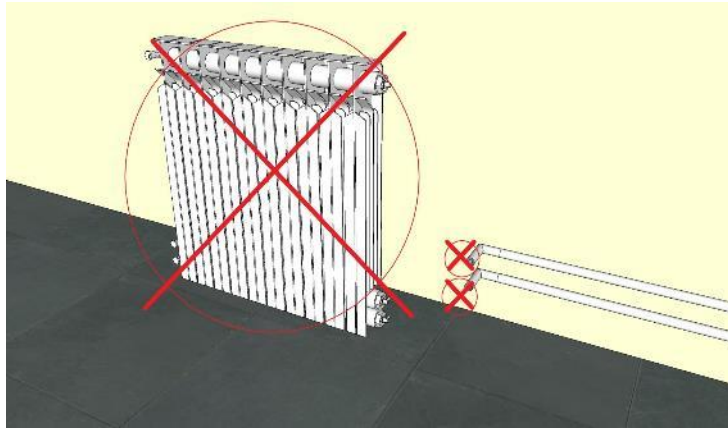
HEART will develop innovative business models to support energy efficiency financing, oriented both at private investments and at public incentives. It can be estimated that these tools, breaking down risks and uncertainties, will increase by 20% the attractiveness of energy retrofit investments.

HEART Toolkit

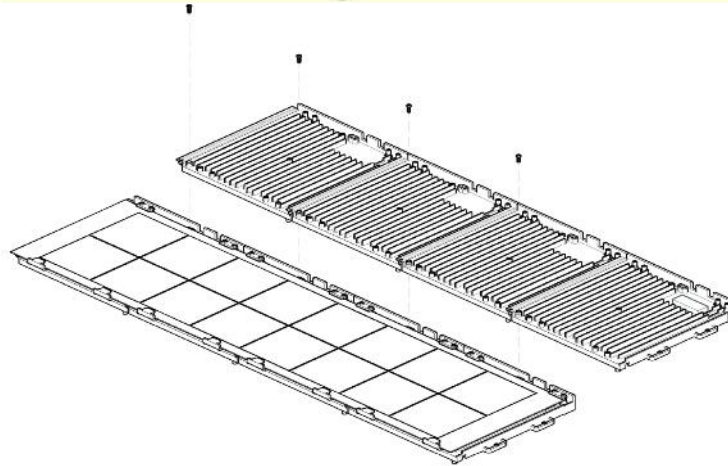
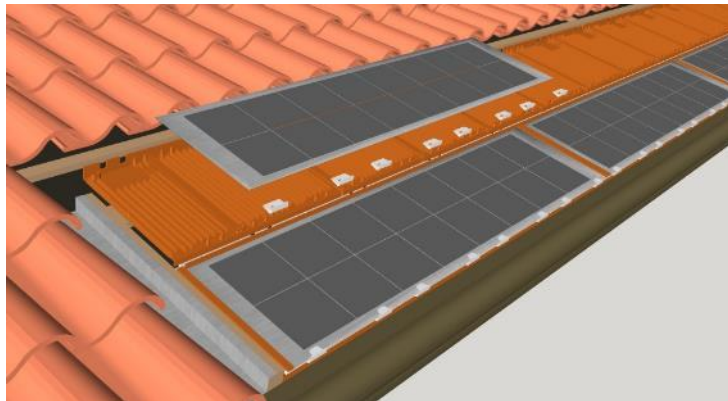
- 1) Retrofit components/techniques for existing windows;
- 2) Multifunctional external thermal insulation;
- 3) Universal PV tiles;
- 4) Cloud-platform;
- 5) DC Smart fan coils;
- 6) Thermal storage;
- 7) Battery pack;
- 8) DC heat pump;
- 9) Multi-Input/Multi-Output converter (MIMO);



HEART subcomponent - non intrusive component



Smart fan-coil



PV Tiles

Current state-of-the-art

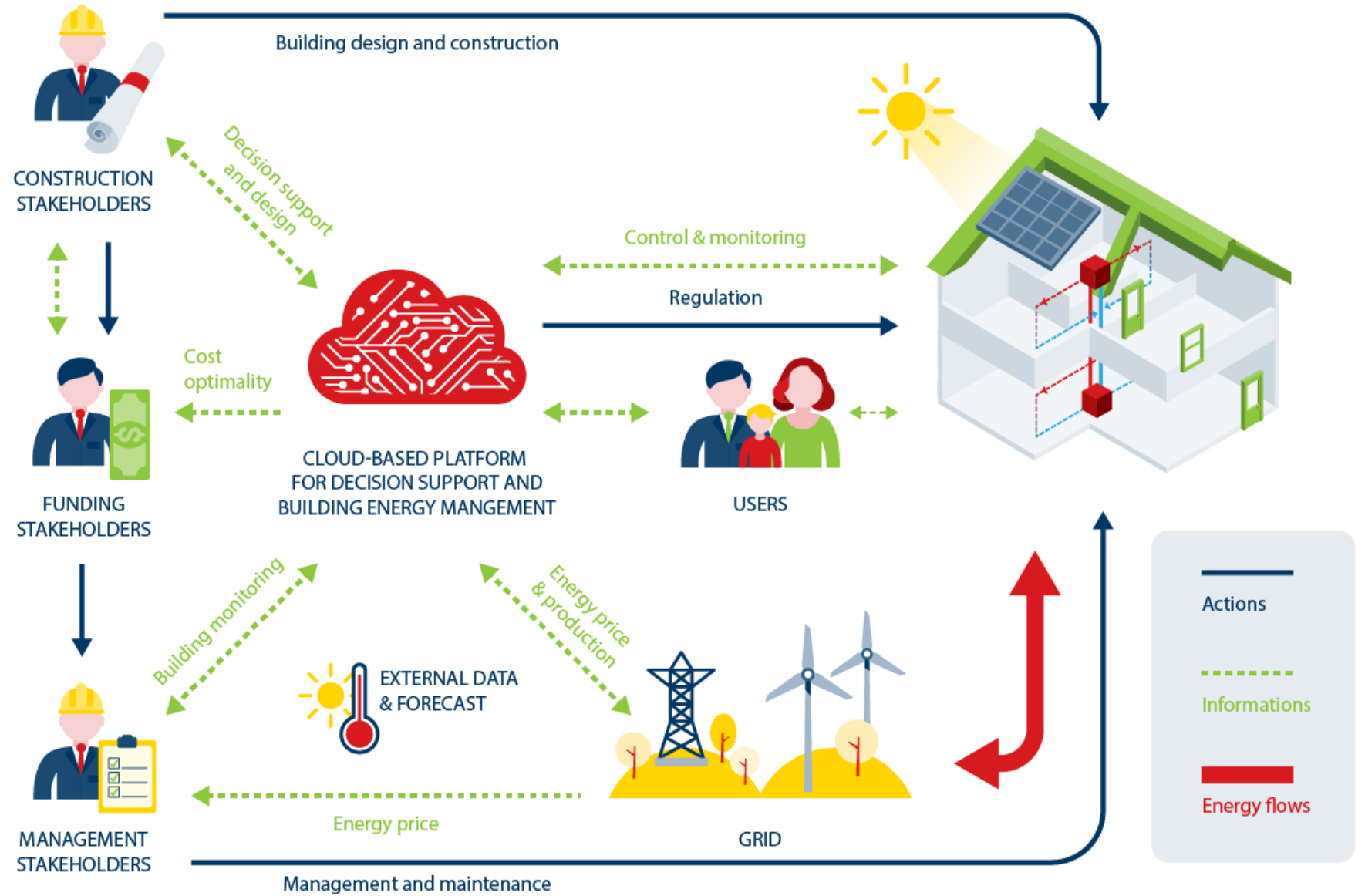
From an operational point of view, computation tools are not generally oriented to give a direct feedback, based on measured data, to improve system design and technologies, because they require model calibration, which can be time consuming and should be automated accordingly. In terms of occupant experience, the feedback to improve design and operation with respect to incidence of user behavior, acceptance and comfort, is limited in most of the cases, determining a relevant component of the performance gap. Finally, in terms of financial management, tailored instruments are already available on the market, but their reference to generic and inaccurate performance data does not guarantee sufficient reliability in the calculation of the investment risk.

Beyond the state-of-the-art

HEART's cloud-based platform guarantees to the different stakeholders both accessibility to low-level measured data and also to high-level analytics. This double level of information distinguishes the knowledge acquired by HEART users from those using other commercial systems. Analytics is made available through an evolution of the web platform which encompasses personalized visualization and communication strategies, working in synergy with MBS gateways. The gateways guarantee support for data acquisition and communication among multiple types of devices (via Narrowband IoT), with the electric grid (enabling Smart Grid interaction) and external monitoring services (e.g. weather forecasting).

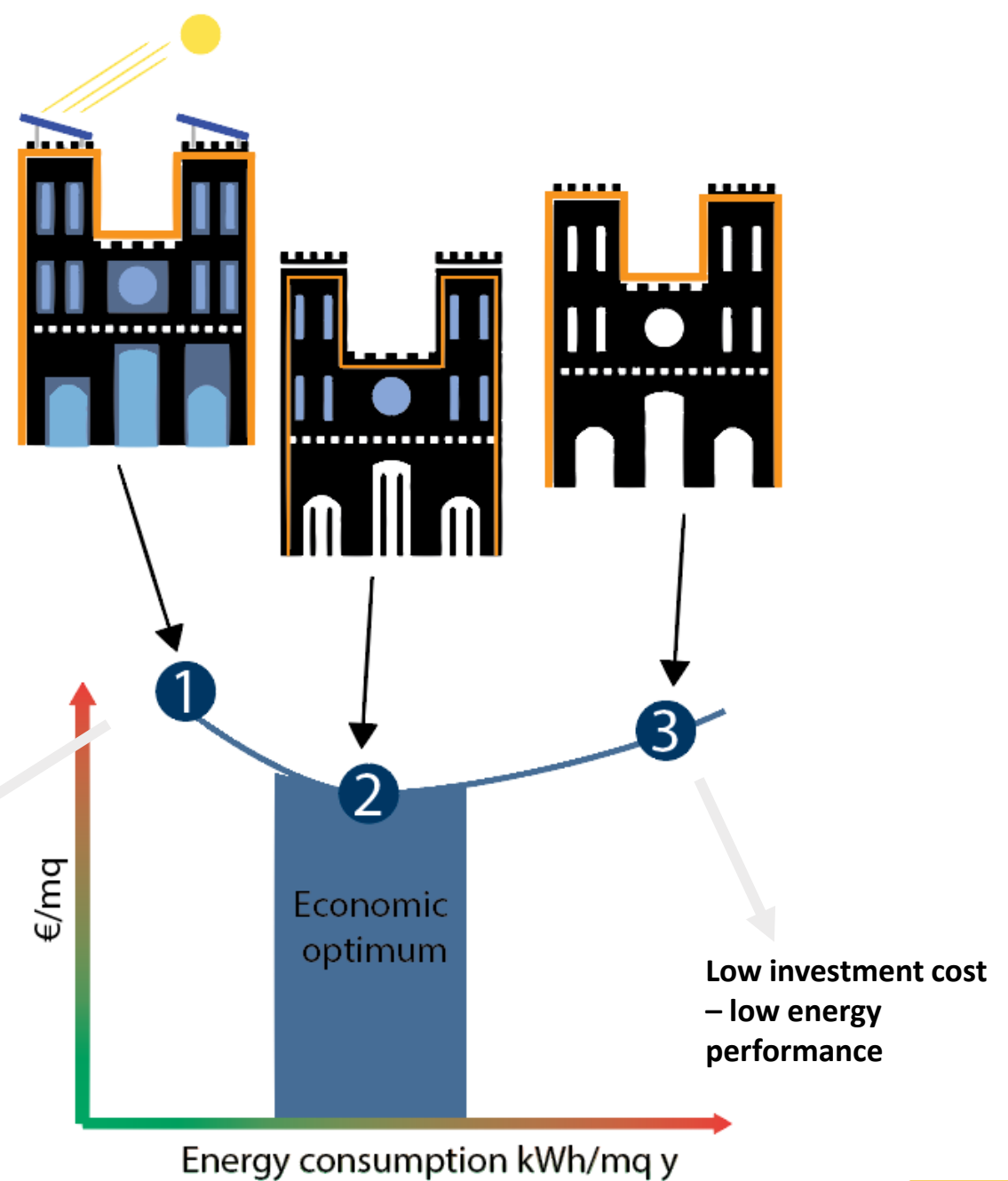
Being cloud-based, HEART's DSS and BEMS avoid expensive computing hardware installation in the building. Above state-of-the-art.

HEART Cloud-Based Structure



The decision-making phase

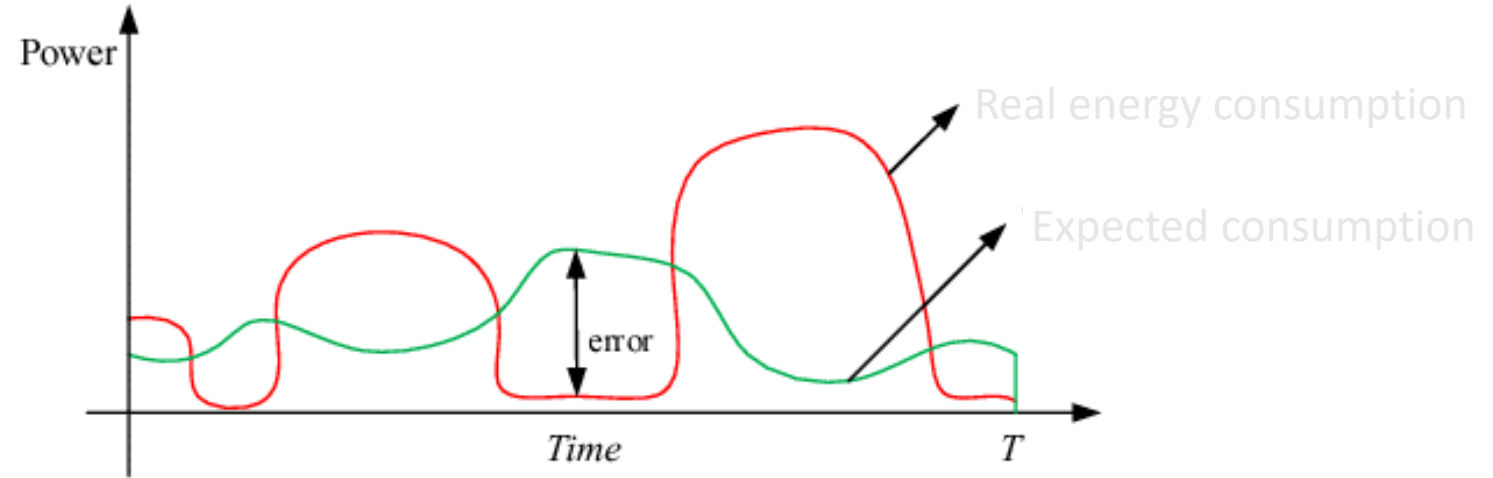
The HEART cloud platform allows the decision maker (designer, building owner, investor) to find the **optimal configuration** under the technical-economic point of view



The operational phase

The HEART cloud platform acts as an **adaptive-predictive energy management tool**.

It also allows those who manage the building (energy manager, owner etc.), but also the O&M service and the investor, to **monitor the technical and economic performance** and to detect any anomalies in real-time.



Immediate detection of faults or anomalies

The cloud based platform, can support and facilitate the decision making, reducing the choices' processing time by at least 30% and decrease the final outcome uncertainty to a margin of +/- 5%

Conclusion (1/2)

The advanced data analytics of the simulation is used to:

- enhance and **fact-check awareness of renovation cost-effectiveness**: high and reliable energy and economic performances are guaranteed in decision-making by the fact the Toolkit is based on robust/cost-effective technical solutions coupled with advanced energy model/optimization logic to ensure the selection of the best retrofit strategy. The system is designed for keeping track and considering in the best strategy selection the presence of incentive mechanisms (on-bill repayment or tax-finance) for energy efficiency interventions. Thanks to this approach, an IRR equal to or greater than 7% can be easily ensured on the investment.
- **Increase the level of confidence and reduce the investment risk**: the energy and economic performance in the operational phase is ensured by an accurate BEMS and by several reporting strategies to keep the various stakeholders aware about the behaviour of the building, preventing wrong habits and allowing timely and effective interventions and maintenance programs. The mismatch between the expected and the actual performances will be kept below 5%.
- **provide a cloud data management**: this represents a twofold advantage in ensuring the **self-learning and updating of the algorithm** (thus allowing for an even further increase in the performance of the system) and in reducing the risk of investors thanks to a fact-checked track record of installations.

Conclusion (2/2)

Energy retrofit of existing buildings, when properly managed, represents an interesting form of investment and is attractive for funding. However, unlike other forms of energy finance, results and payback times are foggy because of the **uncertainty margins related to building projects and management**. These barriers can be removed by introducing **appropriate tools** for planning, forecasting and control of energy performance that safeguard the investments. Thanks to the transition to the Energy Internet of Things enabled by HEART, *“marketers or brokers will have more information to plan more user-oriented marketing strategy”* and the same can be said for entrepreneurs, financiers and decision makers.

In HEART, suitable ICT tools developed within the cloud-based platform **enforce energy performance guarantees, provide proper information and assure greater certainty for investors**. This latter factor can offer a significant contribution to the development of new rules and strategies for real estate and energy finance, innovating traditional conservative

HEART’s control strategies, in fact, aim to draft the procedures for a regulation of local energy trading in a “free market” regime, whilst the tariffs definition is outside the scope of the project. In this way, HEART facilitates the decision making process at political level by:

- providing a common understanding of opportunities, needs and risks related to managing energy exchange;
- identifying the players and professionals needed to implement the concepts elaborated;
- providing a base for building a well-structured regulatory framework for the exchange of metered energy.

HEART not only promotes relevant opportunities of economic development; it also anticipates the legislation, and assumes a significant social dimension **transforming consumers into promoters** of wise energy users and rising awareness towards energy and environmental related matters.

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