Webtool to help owners and design professionals to characterize the qualities and needs of historical residential buildings with heritage value

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The sustainable energy retrofit of historical or listed buildings is becoming a challenge for Belgium, as for many other countries worldwide. A crucial issue is the renovation of pre-1914 dwellings that have a certain historical and cultural value and that constitute, according to the Walloon Heritage Institute, more than 25% of the residential stock in Wallonia (the French-speaking region of Belgium).

The 'Energy renovation of pre-war Walloon buildings with heritage value' research project (P-Renewal, 2017-2021), funded by the Walloon region of Belgium and coordinated by *Architecture et Climat* in partnership with the *Belgian Building Research Institute*, was framed within this context. The originality of this project consisted in its bottom-up and multicriteria approach: strategies are proposed on the basis of the analysis of several case studies according to different evaluation criteria. One of the objectives of P-Renewal was to develop a methodological webtool for the renovation of historical buildings and to validate intervention strategies aiming at improving the internal comfort and the global environmental performance, while preserving the heritage value. This cognitive and reflexive support to the renovation process follows the guidelines and development proposed by the European standard 'Conservation of cultural heritage - Guidelines for improving the energy performance of historic buildings' (EN16883, 2017), while supporting the process with scientific advances and important technical complements.

The methodological webtool encompasses the strategies and results obtained during the project in order to develop a robust database allowing a global reflection on the sustainable and energy retrofit of historical buildings with heritage value. It was developed in consultation with field actors in the renovation sector; it is aimed at technical users, but also to non-experts.

The webtool leads the users to tackle a series of questions that can help to define coherent solutions adapted to the specificities of their building and its envelope. The interface of the webtool was developed to offer, in the same visualisation screen: on the one side, a series of information or recommendations and, on the other, questions about the potential choices available supported by graphical tools (e.g., decisions trees, double entry tables, etc.).

The user can iteratively follow the different steps to determine one or more retrofit measures to implement, or can focus on specific aspects such as: the specificities and potentials of the building type; the characteristics of the building envelope (e.g., the priority of an intervention according to the heritage value, state of obsolescence (Figure 1), energy objectives, etc.); or, directly establish the renovation intervention according to a decision tree (Figure 2).

PITCHED ROOF			Condition / Age			
			1	**2**	**3**	**4**
			Framework in bad condition and/or absence of underroof	Framework in good condition but absence of underroof and/or roof covering in bad condition	Roof with underroof showing normal state of repair without significant deterioration	In new condition or substantially renovated since less than 5 years
Energy Performance	**1**	Non-existing insulating layer $U \geq 1,5$ W/m²K	priority	priority	necessary	
	2	Poor Insulating layer ≤ 5cm $1,5 \geq U \geq 1$ W/m²K	priority	priority	necessary	
	3	Medium Insultaing layer 5 to 10 cm $1 \geq U \geq 0,4$ W/m²K	priority	priority	possible	non-priority
	4	Important Insulating layer > 12 cm $U \leq 0,4$ W/m²K			non-priority	non-priority

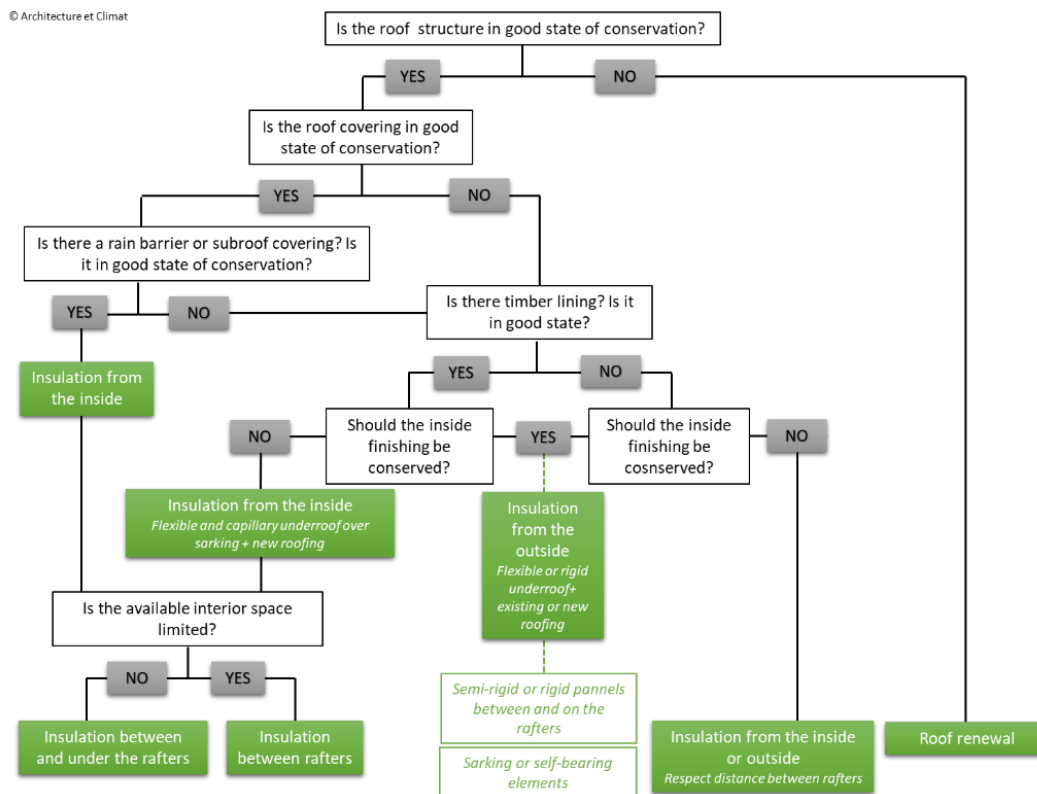Figure 1: Matrix 'State of conservation / U-value' for pitched roof

Figure 2: Decision tree for the renovation of the pitched roof

After inputting the general data about the building, the user of the webtool can identify the type of building according to its dimensional, architectural, spatial and construction specificities. Then, the user can choose the element(s) of the building envelope that might require renovation: roof (pitched/flat); facade walls; floor slabs; cellar floor; and/or, window frames. For each of these elements, the webtool proposes a series of criteria to determine the heritage value, the state of conservation, and the energy performance.

Renovation works may to be carried out without a real programming, as a rapid response to an emergency, and without asking the correct questions or managing the possible interactions between energy efficient measures and other intervention strategies. Therefore, in order to help owners and designers to develop a real retrofit program, each of the proposed energy interventions was subject to a brief analysis of possible interactions. These measures could be addressed at the same time for a question of habitability, conservation, maintenance or complementarity in the improvement of indoor comfort and energy performance.

All these methodological steps were consolidated into a freely-accessible webtool, via www.p-renewal.be (currently only available in French), which was designed to assist the decision-making process for the renovation of pre-war residential buildings with heritage value in Wallonia, and be potentially transferred to other contexts and building types. The outcomes of the different methodological steps previously described can all be downloaded via the webtool. In addition, recommendation sheets are also available to approach energy renovation, and its evaluation, in a comprehensive, balanced and sustainable way.

The project demonstrated that heritage value and energy performance should not be considered as antagonistic objectives, but rather that these should be seen as complementary goals, while also addressing issues of spatial use, internal comfort and environmental performance in a perspective of circular economy. Indeed, it is possible to improve energy performance and occupants' comfort while preserving heritage values. Our historic buildings have assets and specificities that, once recognised, should orient the priorities of each renovation project.