Energy Efficiency and the City:
An Integrated Urban Tool Dedicated to Local Stakeholders and Citizens

Anne-Françoise MARIQUE[1], Simon CUVELLIER[2], Sigrid REITER[1]

[1] Local Environment: Management & Analysis (LEMA), University of Liège, Chemin des Chevreuils 1, B52/3, 4000 Liège, Belgium
[2] Architecture et Climat, Université catholique de Louvain, SST/LOCI, Vinci, Place du Levant 1, bte L5.05.02, 1348 Louvain-la-Neuve, Belgium

SUMMARY

There is an urgent need to reduce energy use in our cities. In Europe, energy consumption in the building sector represents more than 40% of the final energy use. This sector, as well as the transportation and industrial sectors, is considered as a major contributor to climate change caused by the release of carbon dioxide and others greenhouses gases. Promoting energy efficiency in buildings is often presented as a viable approach to the mitigation of climate change.

Energy efficiency in the building sector has thus been the focus of extensive world-wide research over the past decades. Numerous research have describe the use of mathematical models and simulation tools as the most credible approach to model the behaviour and to predict the energy consumption of a system. Most of them focus on the heating requirements of residential or tertiary buildings at the individual building scale. More recently, the role that the urban form plays in influencing the energy consumption of individuals buildings has also been studied extensively. Amongst their numerous advantages, the approaches based on mathematical models and simulation tools can account for a large number of parameters that are known to act upon the energy consumption of a system and to perform parametric variations to test the impact of energy efficiency strategies.

However, three main challenges are often neglected or considered individually:

- (1) The major challenge of the retrofitting of the existing building stock. In fact, the low rate of construction of new efficient buildings in most European countries (1-2% a year) impose to consider the existing building stock as the main target to improve energy efficiency in the building sector.
- (2) The importance of the location of a building and the characteristics of the neighbourhood in which it is located (density, diversity of function, access to amenities, etc.) on the generation of mobility patterns and quality of life. In fact, it seems counterproductive to produce or retrofit efficient buildings without any concern to the location of the building and its impact of the mobility of the inhabitants.
- (3) The impact of the lifestyles and behaviours of citizens on the energy consumption. On the one hand, the rate of private ownership in the residential building sector is high in most

European regions and private owners are key actors in the retrofitting of the building stock. On the other hand, small adaptations to individual behaviours (e.g., thermostat, heated area, etc.) can help to drastically reduce energy consumption.

Last but not least, although citizens, local authorities and policy makers are the first actors that can concretely act to alter the energy consumption in buildings and in cities, scientific results and findings related to building energy efficiency remain mainly concentrated in the academic and scientific fields. Raising public awareness of the impact of the citizens to energy efficiency and providing them with user-friendly assessment tool to help them to make the most efficient choices are crucial and could quickly lead to significant reductions in the total energy consumption of a territory.

In this context, this contribution presents a novel integrated urban tool, dedicated to local authorities and citizens. This tool aims at addressing the previously highlighted main challenges, in an integrated approach. The methodology developed to allow a precise energy assessment (heating, cooling, ventilation, lighting, appliances and cooking) of the Walloon (Belgium) residential building stock, at the individual, neighbourhood, city and region scales, on the basis of a "bottom-up" approach, is firstly presented. This methodology uses a typological classification of buildings and thermal simulations. Many parameters are defined and taken into account to exhaustively capture the specificities of numerous types of buildings (e.g., type of buildings, number of floors, common ownership, orientation, thermal performances of the walls, floors, roofs, windows, ventilation type, etc.). Occupation modes are also modelled to capture the impact of occupants' behaviour on energy consumption. Moreover, to take into account the impact of urban form on energy consumption and solar gains, "solar" factors are defined and applied, according to the type of neighbourhoods in which the building is located. Individual results obtained through this methodology have been compared and calibrated with data from regional year books to ensure their accuracy.

These results related to building energy consumption are then crossed, in an integrated approach, with several indicators of urban sustainability, in order to take into account in the balance, amongst others, the impact of the location of buildings and neighbourhoods on transportation energy consumption or the impact of the urban form on the production of solar renewable energy. In this contribution, transportation energy consumption and mobility patterns, potential production of renewable energy, diversity of functions at the neighbourhood scale, access to amenities (green public spaces, schools, shops, etc.) as well as available services by public transportation and active commuting are presented, mapped, crossed with building energy efficiency and discussed. Numerous parametric variations are then performed to highlight priority types of buildings and neighbourhoods, as well as main actions to promote, at different scales, to reduce the total energy consumption of a household, a neighbourhood or a city. These results inform the development of specific policies adapted to the specificities of main types of buildings and to the specificities of the environment in which they are located. These results also show the importance of the retrofitting of the private building stock and the relevance of taking into account, in an integrated approach, building energy consumption are urban characteristics.

Our scientific results are finally mobilized to produce an online integrated urban tool dedicated to citizens and local stakeholders. This tool makes accessible to a large non-specialised audience the

results of a three-year scientific research study that combined numerous tools (a geographic information system, a typological classification of buildings and neighbourhoods, a dynamic thermal simulation software, life-cycle assessments, statistical analyses of national censuses, etc.) in Wallonia (Belgium). Numerous data and results related to energy consumptions (e.g., the results of over 250,000 thermal simulations of buildings) are made available online, in a very simple and intuitive form. More concretely, these actors can find, in this tool, practical and personalized hints and strategies, adapted to their own situation, in order to help them to make the best choices to improve the energy efficiency of their dwellings, mobility and ways of lives. A quantification of the potential gains related to the proposed strategies is also provided in the tool. The first feed-back from users are presented to conclude this contribution.