Non-domestic building stock energy and carbon modelling for policy advice
A user requirements survey

Julian Bischof[1,2] and Aidan Duffy[2]

[1] Institute for Housing and Environment (Institut Wohnen und Umwelt (IWU)) – Research Institute of the State of Hesse and the City of Darmstadt, Darmstadt, Germany
[2] Dublin Energy Lab and School of Civil and Structural Engineering, Technological University Dublin, Dublin, Ireland

Abstract

In recent years, many building stock models have been developed to advise and guide policymakers. In most models, however, user needs were not formally established. Therefore, the aim of this paper is to formally undertake a user needs' assessment for building stock energy and carbon models. To achieve this aim, a bilingual exploratory online user requirements' survey was developed. The survey was designed to gather information in the following areas: the general interests of the potential model users; their experiences with related studies and models; the desired properties of non-domestic building stock energy models; and any technical limitations, such as computational resources. A total of 19 responses were obtained. Users favour tools which are: usable, transparent; flexible; compatible with other tools; and provide clear, understandable results.

In recent years, many building stock models have been developed to advise and guide policymakers on the pathway to climate neutrality. However, in most models, user needs were not formally established, but have been assumed by the model developers.

Objectives

- Address the gap in the available literature addressing non-domestic building stock model user needs
- Formally undertake a user needs' assessment for building stock energy and carbon models

Methodology

Exploratory research approach due to unknown population of potential users

ENOB:dataNWG

60 potential users were contacted by email. They were known to the ENOB:dataNWG project team either through former projects or by targeting specific contacts based on their occupation.

Bilingual online survey comprising 21 questions

German   English   Google Forms

The survey was designed to gather information in the following areas:
- the general interests of the potential model users;
- their experiences with related studies and models, particularly regarding non-domestic building stocks;
- the desired properties of non-domestic building stock energy models;
- and any technical limitations, such as computational resources or software platform compatibility.

Scope, content and comprehensibility of the questionnaire was reviewed by three experts in related fields of research.

Due to its size, the survey is not further repeated in this paper, but can be accessed online via the QR codes above. The presented findings in the 'Results' section refer back to the survey questions via the question reference numbers in brackets.

Results

User Groups A total of 19 responses were obtained, giving a response rate of 32%. Based on these responses 11 user groups were identified from question 1: "Which possible user group of a potential Non-Domestic Building Stock Energy and Carbon-Emission Model do you belong to?". These were further clustered, based on most likely use of the model and similarities between the respondents' economic activities, into four primary user groups: 'Research'; 'Consultancy, Planning, Certification'; 'Government Department / Ministry / Advisory Body, Politics, Civil Service'; and 'Associations, Church, Industry'. (see Figure "Assigned User Groups (Q1)").

Assigned User Groups (Q1)

- Research
- Consultancies, Planning, Certification
- Government Department / Ministry / Advisory Body, Politics, Civil Service
- Associations, Church, Industry
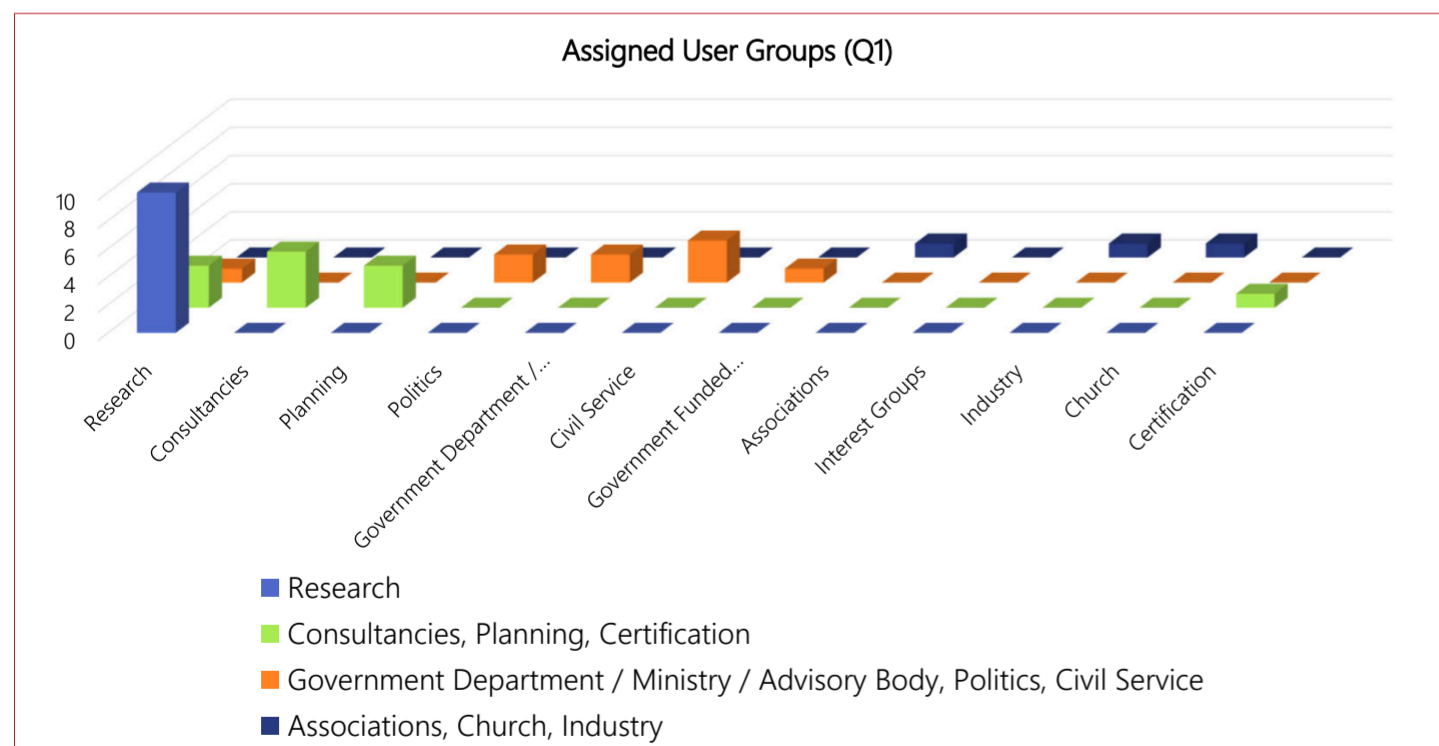
Members of the primary user group 'Research' are involved in the generation and publication of knowledge, while those in 'Consultancies, Planning, Certification' tend to be professionals providing consulting and compliance services. Three quarters of this group belonged to consultancies and planning. It should be noted that this group has influence on the policy development process, as it has been observed that they regularly provide advisory services to the group of 'Government Department / Ministry / Advisory Body, Politics, Civil Service'. The 'Government Department / Ministry / Advisory Body, Politics, Civil Service group members were all in the public sector involved in implementing policies and advising policy makers. The fourth primary user group includes all other occupation; this group's members share interests in the stock asset ownership (church, industry and associations) and in the supply of energy, materials and services to building stocks (industry). Because respondents could choose more than one economic activity, a small number could be allocated to multiple end-user groups. Where this occurred, they were allocated to the group containing the majority of their stated economic activities.

General user interest and experience Almost 80% of the sample had experience in the use of modelling software simulation tools for non-domestic building stocks or were using the results of such tools (Q5). This shows that the survey-participants-targeting correctly identified potential users.

To provide more insight into the probable use of a new non-domestic building stock model, participants were asked which questions they would use it to answer (see "Probable use of a new non-domestic building stock model (Q11)"). Some participants indicated how they would go about this: six proposed using life cycle assessment and three suggested conducting scenario analysis.

Probable use of a new non-domestic building stock model (Q11)
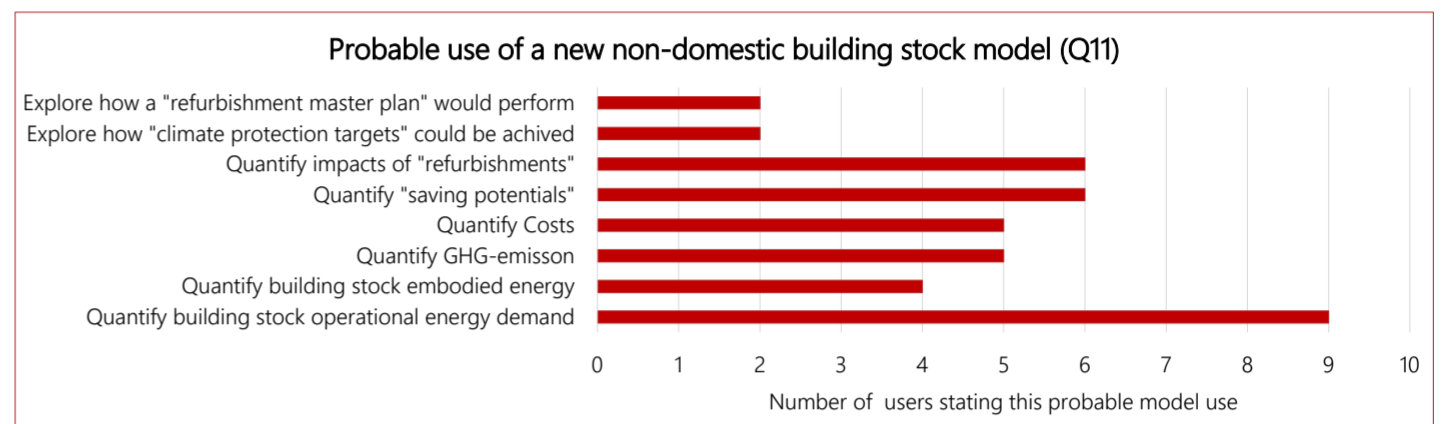
Desired model properties The respondents identified several helpful model requirements (Q9): usability (n=6); flexibility (n=5); a high-quality user interface (especially for easy visualisation of results) (n=5); compatibility (technical) with other software-programs (n=4); and transparency (n=4).

Beside these helpful model requirements, users were asked to identify important shortcomings of existing models and studies (Q10). While the responses to this question were varied, two shortcomings were notable because they were reported by members of different user groups; these were the 'high complexity of models' and 'poor data availability'. Proposed solutions to these shortcomings (Q10), included to 'simplify' the models and include 'uncertainty quantification'. In summary, no major common shortcoming was identified. However, the users indicated a preference for simple and understandable model methodologies rather than complex ones (Q9).

The need for a model which considers the whole life-cycle is supported by all respondents (Q13) and the majority (n=13) rate the life-cycle phases A1-C4 according to the EN 15978:2011 as most relevant (Q14). The majority (n=16) of respondents also recognised the need for uncertainty quantification of model results (Q12).

Life-cycle perspective and uncertainty quantification (Q12/Q13)

Legend see Figure "Assigned User Groups (Q1)"

Technical model framework Regarding the technical model requirements, the maximum acceptable model computational time (Q18) was identified as less than one hour, independently of the stock's population (n=10). Unsurprisingly, the preferred software solution (Q19) was one based on familiar software, with a slight tendency toward standalone (n=6) rather than browser-based platforms (n=4).

Requirements Elicitation The findings of this exploratory survey are summarised below as a general requirements elicitation list which can be used in the development of holistic energy and carbon non-domestic building stock models suitable for informing policymaking.

- Model outputs of energy, GHG-emission and cost (Q3 and Q15);
- Possibility to simulate the current and future building stock (Q4);
- Usability, flexibility, high-quality user interface (especially for easy visualisation of results), compatibility with other software programs and transparency (Q9);
- Appropriate, clear methodology that considers the whole system and can forecast the future development of the non-domestic building stock (Q9);
- Simple, understandable model methodology (Q10);
- Uncertainty quantification (Q10 and Q12);
- Life-cycle perspective (Q13);
- Consideration of the whole life-cycle (A1 - C4) (Q14);
- Provide outputs normalised by building area (Q16);
- The model's computational time has to be below 1 hour (Q18);
- The model should be based software infrastructure that allows easy access to inputs and outputs also to non-expert users -that are non-programmers- and at the same time allow expert users with programming experiences to further develop the model to their needs (Q19).

Conclusion

This paper undertakes a formal user needs' assessment for building stock energy and carbon models using an exploratory research approach. The survey analysis of a sample of potential users provides an understanding of their requirements, thus allowing the design of modelling tools which help meet their expectations.

Four primary user groups were identified: 'Research'; 'Consultancy, Planning, Certification'; 'Government Department / Ministry / Advisory Body, Politics, Civil Service'; 'Associations, Church, Industry'. Almost 80% of respondents had experience in the use of modelling software simulation tools for non-domestic building stocks, or were using the results of such tools, thus indicating that a relevant sample of potential end-users was obtained. Almost all respondents believed it important to have such simulation-tools for the analysis of the non-domestic building stock.

In summary, the results indicate that users favour tools which are: familiar and intuitive to use (are usable); are well documented (usable and transparent); offer several features (flexible); and are open source (flexible and transparent); are interoperable with other tools (compatible); and provide clear, understandable results. The model should provide representative results and be based on a clear methodology that considers the whole system and can forecast its future development. The preference for the implementation of the resulting computer application was for one which allows easy access to inputs and outputs, and can be used by expert and non-experts (i.e. non-programmers) alike.

Acknowledgements