This paper was first published at eceee Summer Study 2022
https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/

4-012-22 David Jenkins

Identifying the case for Next Generation Energy Performance Certificates

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Abstract

The 2003 Energy Performance in Buildings Directive (EPBD) resulted in EU member states formulating standardised responses to grading and assessing the energy performance of their building stock. The 2018 update of the EPBD raised the possibility of using Energy Performance Certificates (EPC) for new metrics and applications, placing the challenge of upgrading our built environment under greater scrutiny. This includes attempting to quantify the "smartness" of buildings, as gauged by a "Smart Readiness Indicator", but it also raises the question of where EPCs should go next – and, by extension, what can we reliably do with current EPC frameworks across Europe? Can new challenges, and targets, of a decarbonised building stock be met within the current scope of EPCs?

The €2M Horizon2020 crossCert project aims to test a sample of buildings across Europe using the responses of different countries to the EPBD. In doing so, the project will i) identify differences in approaches to EPC assessment, ii) report on the impact of these differences for the same building sample, iii) use this analysis to propose new, "next generation" EPC approaches and iv) test out these new approaches with target user groups to better understand their potential.

This study will document the current variations of EPC frameworks across Europe and compare those with proposed next-generation EPC approaches from a range of European projects, including the above. To understand the argument for a different approach, this research will reflect on the changes that have occurred since the EPBD was first introduced including: improved access to high-performance building simulation and empirical energy data, new (e.g. heating) technologies reaching mass market, and the requirement of these simple energy rating calculations to enforce mandatory action, rather than provide advisory guidance.

Introduction

The role of the Energy Performance in Buildings Directive (EPBD) (European Commision 2002) in improving the energy efficiency of the European building stock is well-documented. In particular, the Directive defined the use of Energy Performance Certificates (EPC) in a way that could be standardised and applied to different EU member states. The relative success of the EPBD has resulted in EPCs being the main vehicle from which to define building energy efficiency within energy policy. Whilst there are advantages to this ubiquity of use, it does raise a question of how we respond to new challenges and, should we need to change the basis of our energy assessment approach, are European countries agile and prepared enough to do this?

With respect to new challenges, there are also new advancements relating to building modelling and technologies that should be considered. The software and hardware used in building energy modelling has evolved since the first EPBD documentation, and this paper will discuss whether energy policy has kept pace with this. Furthermore, the metrics that we require from building modelling do not just align with simple benchmarks of annual energy/carbon; for smart buildings and smart energy networks, we need to know timing and more detailed characteristics of energy demand.

Beyond the technical improvements in modelling, application of EPCs has also changed. The use of EPC recommendations for mandatory, as opposed to compulsory, measures (e.g. to allow a property to be sold or leased) is a fundamental change in how EPCs impact end-users (UK Government 2020). The desire to have the EPC as a common anchor to all analyses of energy efficiency in buildings, across technical assessment, consumer interaction, and policy formation, does suggest such new uses should be under continuous review.

With respect to this changing landscape, it is difficult to plan the evolution of such an entrenched energy assessment framework (or, rather, a family of different frameworks) when it is so active in so many different countries. However, this level of use is also an advantage, providing an evidence base of numerous case-studies and working examples of different versions of EPCs in action. By sharing good-practice and understanding the relative merits of EPC approaches in those different countries, it should be possible to better prepare energy assessment methodology for the new challenges and applications identified.

Responding to this situation, a number of "Next Generation EPC" Horizon projects are now active that are attempting to propose new metrics, modelling approaches, and applications for EPCs. CrossCert, a €2M Horizon2020 project, aims to test a sample of buildings across different European countries with different EPC approaches that are currently active in those countries. Furthermore, new EPC output metrics being proposed (such as the Smart Readiness Indicator (SRI) (Ramezani, Silva, and Simões 2021)) will be tested – both on buildings themselves but more qualitatively with the users and assessors of EPCs. From this work, the project hopes to provide a clearer picture as to how EPCs can be used moving forward, what degree of harmonisation is possible (or desirable) across different countries governed by the EPBD, how such change can be co-produced with end-users of EPCs, and what other tools/approaches could be part of the wider ambition to characterise the energy demand of the European building stock.

This paper will summarise the initial setting up of the crossCert project, and propose a clearer basis from which new methods and metrics can be critiqued. The main focus will be on the residential sector, though there are areas of crossover with non-residential energy assessment (which is included in the scope of the crossCert project).

The role of Energy Performance Certificates

The similarity in aesthetic of EPCs across different countries can give a misleading impression with respect to harmonisation of energy assessment methodologies across Europe. Even within a single country, differences can exist between building sector (residential vs non-residential), calculation choice (where such choice exists), and geographical regions within that country (e.g. in the UK, Scotland has a slightly different EPC process to England and Wales despite the EPC document being visually similar). Understanding differences in EPC generation is fundamental when judging whether new metrics and applications are suitable for a given EPC framework [NB this paper shall refer to "EPC framework" as the overarching approach of a given country/region to assessing buildings, including the calculation methodology and assessment process itself]. A new metric that can be generated by a calculation methodology in one country may not transfer equally well to another country that takes a different approach. The discussion below attempts to categorise some of these key distinctions by using examples of existing frameworks in chosen European countries.

Differences in calculation methodology

The development of any calculation methodology will, clearly, be influenced by the building stock and heating/cooling practices of a particular country. For example, a warmer country may be expected to have greater attention to detail on residential cooling systems (and the inputs for modelling such technology) than that of a country with a negligible residential cooling load. Availability of data, at scale, will also differ between countries and this will impact the development of a calculation methodology; a framework requiring input not generally available/accessible in a given country will be impossible to implement.

Somewhat outside these physical limitations of building stock, climate, and input data, a country has a choice to make in relation to the use of building physics calculations. Within the EPBD, providing standardisation is assured, it is possible to construct a framework that relies on steady-state modelling, dynamic building simulation, or empirical energy data; or a combination of these routes. Informed by a previous review conducted by the authors (Semple and Jenkins 2020), Table 1 summarises some residential calculation approaches from a selection of six European countries. Whilst this table does not go into the detail of how these are chosen for an assessment (where an assessor may have to consider building type, new build vs existing, availability of input data etc when selecting the appropriate method for that building), it does demonstrate the variation that exists across, and within, countries. This must be accounted for when considering any form of harmonisation of existing or new EPC-based output metrics.

Table 1. Summary of EPC calculation approaches for residential buildings in chosen European countries

Country	Name of methodology/model	Type of calculation used
France	36month actual energy use[1]	Actual consumption
	3CL (simplified)	Reduced-input steady-state calculation
	3CL	Standard-input steady-state calculation
Germany	36month actual energy use	Actual consumption
	DIN 4108 (simplified)	Reduced-input steady-state calculation
	DIN 4108/18599	Standard-input steady-state calculation
Italy	DOCET	Reduced-input steady-state calculation
	UNI 1130	Standard-input steady-state calculation
Poland	36month actual energy use	Actual consumption
	PN-EN ISO 13790 (simplified)	Reduced-input steady-state calculation
	PN-EN ISO 13790	Standard-input steady-state calculation
Spain	CERMA	Reduced-input steady-state calculation
	HULC	Standard-input steady-state calculation
UK	RdSAP	Reduced-input steady-state calculation
	SAP	Standard-input steady-state calculation

In France, residential EPCs (under the Diagnostic de Performance Energétique (DPE)) have previously been generated from full or simplified versions of the "Calculs des Consommations Conventionnelles dans les Logements" (3CL) (Raynaud et al. 2019); notably, having a reduced-input/simplified method of a more comprehensive calculation is quite common across Europe (as shown in Table 1) for buildings where some input information is inaccessible (e.g. existing buildings). For buildings constructed before 1948 in France, and for instances where collective heating systems are used, it was previously possible to use 3years of utility bill data to generate an energy assessment. However, last year, France implemented an updated approach (that is not analysed in detail in this paper) where there is the effective removal of the option that uses consumption data.

Germany takes a similar approach in that two versions of the "Deutsches Institut fur Normung" (DIN 4108 and 18599) (Federal Ministry for Economic Affairs and Energy 2020) can be used across existing and new buildings respectively. Again, there is the option of using measured consumption data, but for those buildings constructed between 1974 and 2009.

Italy has notable regional differences when applying energy assessment frameworks, making country-wide generalisation more difficult. However, the method "Diagnosi e Certificazione Energetica degli Edifici Residenziali Esistenti" (DOCET) contains a simplified calculation for existing buildings with a slightly more involved process offered by Ente Nazionale Italiano di Unificazion (UNI) (Ente Nazionale Italiano di Unificazione (UNI) 2014).

The situation in Poland is slightly different in terms of the maturity of EPCs, but the general approach is similar to France and Germany in that an International Standard ISO 13790 (International Organisation for Standardisation (ISO) 2008) is used as the basis for both a simplified and extended energy assessment method, but there is also the option for using real consumption data for existing buildings where that data is available.

Spain makes use of the "Herramienta Unificada Lider Calenar" (HULC) method for new buildings, with a reduced-input approach available for existing buildings called "Certificacion Energetica Residencial Metodo Abrevido" (CERMA) (CTE 2021).

Finally, the UK has an established Standard Assessment Procedure (SAP) (BRE 2019) for generating EPCs of new residential buildings, with a Reduced Data version (RdSAP) (BRE 2012) used for existing buildings. Real energy consumption data is not currently used within the EPC framework. There are some distinctions between

[1] Until July 2021, after which this is removed as an option

how this is applied in Scotland compared to the rest of the UK (including choice of output metrics), though the calculation engine is essentially the same. The UK approach, at time of writing, is also being updated with the (delayed) introduction of SAP10, though the calculation method of the approach is very similar to that which already exists.

The above discussion is just a simple overview on the selection of calculation approaches in a small selection of countries. If the analysis was expanded to non-residential buildings, the additional use of dynamic simulation software (such as with some types of non-domestic buildings in the UK (Department for Communities and Local Government 2017)) would add further variation to the approaches taken. Beyond the choice of building physics engines, there are further choices made to support these approaches such as how thermal properties (e.g. U-values) of buildings are defined and the use of look-up tables and the categorisation of buildings for simplification of input selection. This demonstrates the difficulty in taking a universally consistent view to upgrading EPC processes across different countries at the same time.

Differences in current application

EPCs should allow an end-user to make informed decisions about energy efficiency in a timely way, ensuring that such a process can be replicated at scale. However, the outputs of an EPC must be qualified and placed in context of how that metric was generated – whether for simple metrics of carbon and energy that currently exist with EPCs, or for any proposed new metric. Without this context, the results of an EPC could be used to make a decision that is not supported by the process that created that metric. An example of this may be to use an entirely theoretical estimate of energy consumption (e.g. kWh/yr) as a proxy for a real energy bill, where that method does not account for any aspect of individual household behaviour (UK Government 2014); for this reason, the division of asset-based energy and operational/occupant energy is often highlighted within assessment framework legislation (with the former more commonly used for generating the EPC rating). In addition to any building science arguments against this, the way such information may be understood by an end-user (who may not be aware of the asset/operational distinction) must be accounted for. This is an argument for using processes of co-production and engagement with target end-users when designing new EPC metrics, as adopted by the crossCert project.

When reviewing how EPCs are used across Europe, and the policies and actions they influence, variation can be seen – but, linked to the above discussion on calculation methodology, it could be argued that such variation should indeed be seen due to differences in how those EPC metrics are generated. Fundamentally, a “kWh” metric from a UK EPC is not directly comparable to the same metric in a German EPC. This makes planning next-generation EPCs extremely challenging.

There are common uses of EPCs that are appropriate for generalising across different European countries due to the original objectives of the EPBD that helped stimulate those approaches. So, the use of EPCs to signpost market transformation across a building stock, the communication of basic energy efficiency guidance to a building owner, and the linking of EPC metrics to simple subsidies and financial support for improvements are universal applications. More specific applications, such as the UK Green Deal using an amended version of EPC calculation methodologies to calibrate loan products (and repayments), place greater scrutiny on existing EPC metrics (Jenkins, Simpson, and Peacock 2017). For example, might an EPC that is informed by real consumption data be more suitable for this example than an entirely theoretical one using a reduced-input calculation method (as was the case in the UK)?

Other examples of EPCs supporting funding instruments are common across Europe: the Energy Saving at Homes scheme in Greece, the French Energy Transition Tax Credit for renovations, the Austrian Multi-storey Renovation Programme and, in addition to the Green Deal example above, the UK has also used EPCs for deciding eligibility of financial support for onsite generation. This small selection of examples asks different questions of EPC outputs which are potentially more specific than just using an energy rating to legislate against a more general assessment of energy efficiency.

Fundamentally, we cannot take a black-box approach to calculation methods when choosing suitable applications of EPC metrics. How this influences future use of EPCs, and generation of new metrics and indicators, is discussed later in the paper.

Other forms of energy modelling

Before identifying new uses of existing EPCs, it is important to reflect on other options for characterising energy demand (and related metrics). This allows for a discussion where, should current EPCs be deemed unsuitable for generating specific forms of output (or for specific applications), alternatives could be proffered and critiqued.

This can include an understanding of the Performance Gap between modelled and real estimates of energy use, but it is also a comparison of the methods used to generate those outputs, and what data and building science might be used in that process.

Dynamic simulation modelling for compliance

Dynamic simulation usually refers to the more transient, high-resolution energy modelling used with detailed building design tools (with commercial and open-source options reviewed elsewhere (Sola et al. 2020)). Such software tends to be more resource-intensive (and requires higher model literacy) than the steady-state software (used to output monthly and annual metrics) that is so common with EPC generation. However, as noted earlier, dynamic simulation does have a role to play with some forms of EPCs in some countries, particularly when modelling the more complex thermal systems being used with non-residential buildings; residential building energy assessments are far more likely to access steady-state software across Europe.

One notable advancement in dynamic simulation is in the area of urban energy modelling. This is often motivated by the desire to model many buildings (e.g. communities and towns) simultaneously, whilst still producing output metrics that can access high resolution modelling. Developments in such modelling also have the added benefit of improving the efficiency of this higher-resource modelling where, without such efficiencies, modelling multiple buildings would not be feasible. Many examples of this now exist (Baetens and Saelens 2016; De Jaeger et al. 2018; McCallum, Jenkins, and Vatougiou 2020; Remmen et al. 2018), suggesting a movement away from traditional thoughts of dynamic modelling being too labour-intensive for multi-building energy assessments of dwellings. Noticeable in the aforementioned studies is the reliance on different data sources to populate these more detailed models. With (typically) hourly simulations, the need to have some template or empirical description of activity and system control is apparent – as opposed to, for example, total hours/day heating used in a steady-state model. This can be achieved through access to smart meter data, or standard templates informed by a large sample of such data. There is also the need to have access to building construction and fabric information. One technique responding to this has been described elsewhere by the authors (McCallum, Jenkins, and Vatougiou 2020) through the use of GIS data and, where available, existing EPC lodgement databases (where the input information for those EPCs can be used to generate new thermal models of multiple buildings).

Use of empirical data

As noted in Table 1, real consumption data is already part of the picture in some EPC assessment methods, albeit with caveated conditions. It may be questioned whether the improved access to real energy data (e.g. smart and other advanced metering) has actually driven any change in the assessment of buildings, or if we are relying on mostly theoretically assessment approaches because they were developed at a time when we did not have such access to energy data. A converse argument, noted above, relates to the desire to have a replicable assessment that is solely focussed on the building asset and, essentially, blind to the type of occupant. This can be particularly valuable within an energy compliance structure that is attempting to improve physical building forms (and related services) regardless of the activities of the occupants.

However, in addition to the examples noted above, real consumption data is playing a greater role in energy assessment. One of the more well-documented schemes, NABERS (NABERS 2021), is also being trialled for UK offices (Building Research Establishment 2020) and there is an evidence base of measured consumption being used for standardised assessments.

Outside of existing rating schemes, there is much research on how consumption data could be implemented into future frameworks. This ranges from relatively low temporal resolution data (aiming to achieve similar, annual metrics to those already generated in EPCs), to higher resolution offerings that could provide a new generation of metrics that require transient data to be relevant to demand flexibility, design of low-carbon energy networks, and understanding timing of peak demand (Crawley et al. 2020). The low-resolution approach is more immediately relevant to current EPC approaches, whereas the latter may be more significant for longer-term discussions around what we actually want future energy assessment to be.

New uses of EPCs

As carbon targets, technologies, and applications move on, we are likely to ask new things of EPCs – either using existing outputs in different ways or designing new metrics that can be delivered by current EPC models (or amended versions of those models). Clarifying this evolution of use, from a user perspective, is of great importance prior to designing new metrics. As noted below, more metrics does not necessarily mean a more effective EPC, so such indicators and information should be chosen carefully.

Identifying new applications

There is an argument that EPCs, designed for use as an approximate energy rating for a building asset, should not be used beyond the original boundaries of the EPBD. However, any tool that purposes to predict an energy consumption metric in a highly visible way might be at risk from “mission creep”. It is not a given that an end-user of even a simple EPC kWh/yr metric, including those forming policy, will understand the context and calculation of that value and the limitations that should be applied when using that figure.

Nevertheless, the platform created by EPCs provide a vehicle from which additional assessments can be considered – and the idea that new sectors may benefit from this. The Smart Readiness Index (SRI, noted below), would be of potential benefit to those working at energy network level, such as aggregators and District Network/System Operators, when attempting to understand the ability of individual homes (and, subsequently, aggregated numbers of homes) to provide demand flexibility to the network. Traditional EPC metrics would be of less value to such actors, with annual, modelled metrics of energy consumption having limited application to network modelling and the understanding of peak demand.

More recent revisions of the EPBD (European Parliament 2018), as well as preparing EPCs for new metrics, have attempted to focus outputs on end-users, through the use of Renovation Passports. More generally, this recognises that EPCs are used by a range of end-users and formatting outputs to meet those different users is a challenge. One innovation that may support this endeavour is the growing use of online EPC documentation. Whereas hard-copies of EPCs have to, in some sense, be all things to all users, online (or online access to) EPCs (as currently used in the UK) could be tailored and filtered to the individual accessing the information at a given time. This would address the concern of information overload with EPCs, where the addition of more metrics, indicators, and supporting information, could dilute the key outputs being sought by a specific user.

Smart Readiness Index (SRI)

As noted above, the desire to better characterise the relationship between energy supply and demand within a low/zero carbon energy network involves sectors beyond just the built environment. The SRI is a consequence of the revised EPBD (European Parliament 2018) recognising the need to capture the use of smart technology in buildings, and their value when accounting for demand flexibility opportunities in the design of future energy systems. The SRI relates to a voluntary scheme that attempts to consider how smart technology might be used to i) maintain energy performance by adaptative control of energy use, ii) maintain a healthy indoor environment through smart controls, and iii) respond to signals from the grid for purposes of energy flexibility (European Commission 2020). The SRI would be embedded and linked to the standard EPC document, and use information recorded during an EPC assessment.

Using, mostly, steady-state calculation methods and relatively simple, building-focussed assessment frameworks to inform a sector outside the built environment is arguably a different application of EPCs than was originally intended – though the prototype SRI is currently undergoing field trials and testing to see how this might work in practice (and some research suggests linking this with dynamic EPCs (Seduikyte et al. 2021)). It is, however, a useful case-study for analysing how legislation might need to respond to new EPC metrics, and vice versa (and whether such metrics should be used in the same way as traditional EPC energy ratings). Furthermore, it is a useful way of testing and discussing the technical, building science limitations of EPC calculation methodologies. Demand flexibility, inherently, requires some transient understanding of energy demand, which residential (and most non-residential) EPCs do not provide. The SRI aims to use indicators (e.g. existence of smart control and other smart technologies) to infer a level of “smartness”, that may have a positive impact on objectives relating to demand flexibility, or identifying buildings that have demand flexibility potential. Further work will investigate whether the use of a standardised energy compliance vehicle to provide proxy metrics of transient demand will be appropriate – and, noting the cross-testing mentioned below, whether this performs equally well across different European building stocks and assessment frameworks.

Other metrics and KPIs

There have been attempts in some countries to use EPC-type outputs to provide metrics linked with comfort and environment (beyond energy). The UK’s SAP model (noted above) does have an overheating appendix within the SAP documentation. This estimates an internal operating temperature that is sensitive to the inputs used in the SAP calculation and, in turn, is linked to an overheating risk. However, this is not a part of the main regulatory process that EPCs are used for in the UK.

Work elsewhere, from the X-tendo project, has attempted to find out the desire for new metrics from end-users (Zuhaib et al. 2022), noting a particular interest in outputs for indoor air quality, the efficiency of ventilation systems, and the impact of outdoor air pollution on indoor air quality. The same study explores, from an end-user perspective, how real energy consumption data could be used with EPCs, with some respondents expressing interest in real energy use metrics from past occupants of their building.

Having documented a desire from end-users for new metrics, there is still the technical challenge of evaluating whether such metrics are possible from existing methodologies – a key element of a number of Horizon-funded projects working in this area (including crossCert). A process is required that evaluates the methodology for suitability and, if a new metric has a strong justification but is not consistent with a given calculation methodology, propose new forms of assessment that could generate that metric.

Assessing the assessment

EPCs are not just about the underlying calculation methodology used by assessors; they should be understood as part of the wider energy compliance framework that is driven by the EPBD. Whilst there is a direct link between choice of, for example, building physics and suitability of application, the choices made for the overall energy compliance framework within different countries are not limited to numerical calculation assumptions. Before setting a path for future use of EPCs, including new metrics, a structure needs to be in place that can i) critique any new assessment method or new version of an existing method against forward-looking criteria and ii) demonstrate the implications of taking different approaches on the assessment of real buildings.

Criteria of suitability

The authors have already documented a series of criteria from which to judge the suitability of an assessment framework (Jenkins et al. 2021). These are sensitive to the purpose of the assessment, near-future usage of energy assessments in buildings, and the underlying calculation methodology. In summary, the criteria include: i) alignment with reality, ii) ability to quantify demand flexibility, iii) accommodation of new technology, iv) suitability for punitive action, v) ability to extrapolate/standardise, vi) quality of input information.

Criteria (i), (ii), and (vi) are directly related to the numerical calculation methodology whereas (iii), (iv), and (v) require a wider understanding of how the framework is implemented and the legislation being linked to that. However, even these latter criteria require an understanding of the numerical calculations underpinning the whole framework. For example, referencing criterion (iv), this depends on the nature of the policy being implemented in a given country (e.g. threshold of EPC to allow a building owner to sell or lease a property) but it also only has meaning if placed in context of how an EPC rating has been calculated. Is it "fair", for example, to restrict an individual's choices for what they can do with a property based on an approximate steady-state model that does not directly consider that individual, and where (referencing criterion (i)) there is a known issue with the Performance Gap of that underlying model when compared to real energy data? Alternatively, if that same criterion was applied to an EPC that was generated through real consumption data, whilst it may seem more legitimate to penalise an owner (who may have empirically proven high energy consumption), how does the energy framework distinguish between wasteful practices of the occupant and physical issues with the building?

This is a good example of how an appraisal of a method is reliant on what we then do with that method – the above situation is only really a problem when the EPC rating is being used for mandatory requirements of a building, rather than advisory action. Hence, any chosen judgement criteria should be broad enough to capture numerical and legislative consequences of the design of any EPC framework.

Proposed cross-testing of sample buildings

The crossCert project has defined a methodology to test a sample of buildings, for both existing and near-future energy assessment frameworks. The sample of 100-150 buildings, from a selection provided by project partners from across Europe, will undergo a staged assessment for existing (used in different countries), prototype, and future EPCs assessments. In particular, during these stages, the generation of different metrics (such as the SRI) will be evaluated and the ability of different European methods from across Europe to generate different metrics investigated.

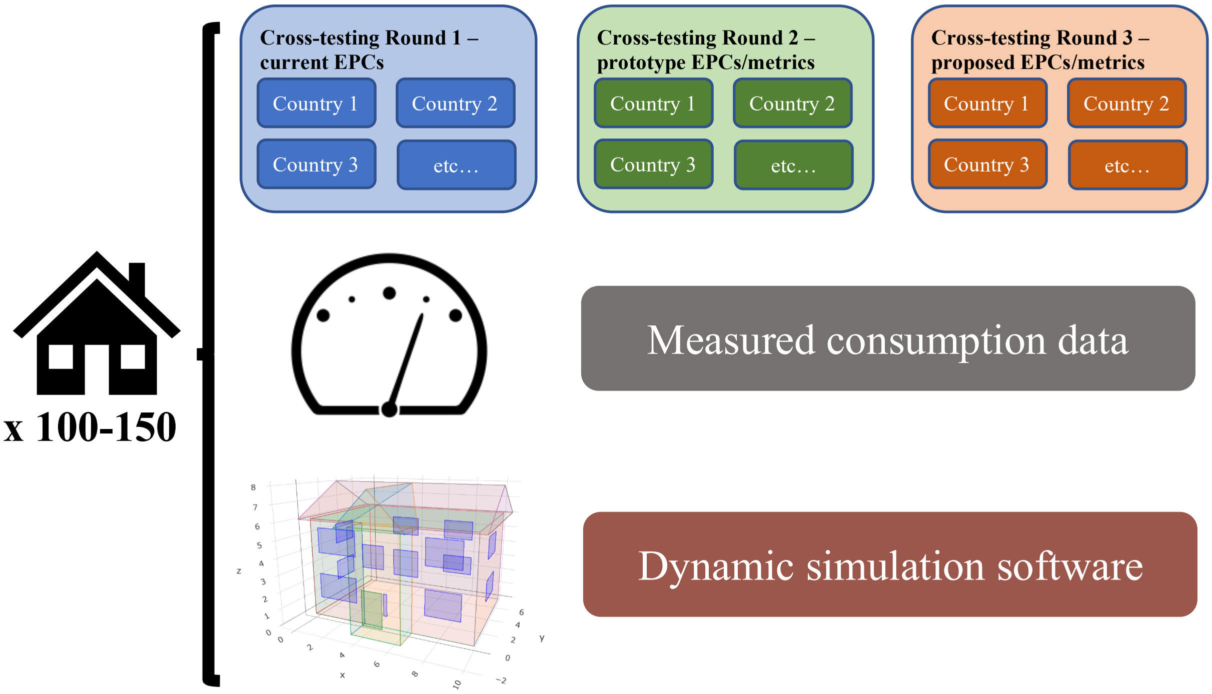

Figure 1. Cross-testing process applied to building sample in crossCert

Figure 1 illustrates the process, demonstrating the quantity of output that will be generated for comparative analysis. The three cross-testing rounds will be applied to all available buildings, where those methods allow this (see below for limitations), to i) investigate how current EPC methodologies from across Europe perform on the same buildings, ii) understand how currently proposed metrics (such as the SRI) perform, and iii) demonstrate less-tested approaches that emanate from crossCert and other next-generation EPC projects. Alongside this, real energy consumption data will be collected (where available) and dynamically modelled versions of a sub-sample of buildings will be generated to provide reference points to the steady-state modelled EPC outputs from the different assessment frameworks. This additional information will help understand the ability of different methods to produce different types of output. Other work in crossCert, not described here, will also communicate these results to target user groups to understand the value of different metrics in practice, and in policy.

Limitations and barriers to cross-testing

There are a number of issues and considerations with cross-testing that have been identified by crossCert and, as well as making a comparison of energy assessments more difficult, these can impede attempts at harmonisation of new frameworks and EPC metrics across different countries. Some of these are listed below, and indicate how different methods leading from the same set of requirements (i.e. the EPBD) can deviate significantly.

The effect of building stock on assessment choices

Country-specific responses to the EPBD will, naturally, be devolved and constructed in a way that reflects the buildings, heating/cooling technologies, and other energy uses of that country. As indicated in Table 1, similarities do exist when defining overall philosophy of approach, but when the calculation methodologies are analysed in detail, differences are clear. The authors have previously noted, for example, how thermal transmittances (U-values) of materials are categorised in different ways, particularly with reduced-input methods that rely on look-up tables for assessing existing buildings (Semple and Jenkins 2020). Therefore, even if the building physics calculation engine of two methods are similar, their use of input values could be quite different. Therefore, cross-testing of different EPC frameworks should include use of inputs (relating to the local building stock from the country of origin) as well as the calculations emanating from those frameworks.

Accessing official tools for standard EPC creation

The standard, formatted EPC for a given country usually requires the use of approved EPC software (with a selection noted in Table 1). In many countries, this involves the use of (by design) a "closed-box" model that ensures a degree of standardisation and consistency across the generated EPCs. In addition to the calculation metrics, the EPC energy efficiency recommendations can be generated – this can be a semi-automatic process, though usually involving some judgement by the assessor in choosing from default, approved recommendations from the energy compliance database of options. However, if attempting to apply the EPC assessment of, say, Country 1 to the buildings of Country 2, it may be inappropriate to rely on the energy efficiency recommendation database of Country 1 for the buildings of Country 2 (related to the above point). Furthermore, weather data of Country 2 must be added to the EPC model of Country 1, and many commercial EPC packages will not allow for this. Therefore, this type of cross-testing requires some element of open-source modelling when applying local methods to non-local buildings. It also means that a Country 1 EPC of a Country 2 building should be heavily caveated. In addition to this process, to recognise the incomplete nature of the above comparison, CrossCert will be supporting this analysis by also looking, where available, at larger lodgement databases; effectively comparing the assessed building stock of one country with that of another as part of a wider trend analysis.

Differences in input data collection

When applying different methods for different building stocks, it should also be noted that input requirements of different EPC frameworks are not the same. To continue the example above, this may result in not having all the data from a building of Country 2 to run the model from Country 1. For crossCert, this will partly be addressed by project partners having direct access to some of the sample buildings being tested – and so additional data (beyond that generally stored in the EPC lodgement database of that country) can be obtained if required. This does, however, reiterate the fact that EPC assessments from different countries are not directly interchangeable.

Lack of harmonisation within a single country

Linked to the above point, a lack of current harmonisation in EPC approaches does place a significant challenge on any attempt to make universal upgrades and innovations to existing EPC frameworks. It is likely, through the work of crossCert, that recommendations for next-generation EPCs do have a country-specific variation – or, at least, EPC frameworks across Europe should be categorised by (for example) calculation type and recommendations tailored to those different types of EPC approach. It is also necessary to clarify why this harmonisation is being attempted. This may be seen as a way of assimilating best-practice across multiple examples of EPC implementation but, as already noted in this paper, despite a common starting point of the EPBD, country-specific EPCs have evolved over time and the industries, applications, user groups and impact on local policy may also have taken a more country-specific shape. Any recommendation for next-generation EPC evolution must be sensitive to these factors.

Conclusions

Within the context of next-generation EPCs, this paper has proposed a framework of energy assessment cross-testing to enable best-practice sharing of existing EPC approaches, as well as testing out new metrics and methods from prototype assessment approaches. Additionally, a structure has been suggested for judging the suitability of energy assessment methods, whether comparing methods from different countries or critiquing new approaches that are being proposed for next-generation EPCs.

Evolving EPCs in a harmonised way across Europe will be difficult, yet this is what is being attempted with the introduction of new metrics (such as the SRI). There needs to be a system to judge the suitability of specific EPC frameworks for innovations. It is important to include end-users in this discussion; although the EPBD may have had an element of top-down implementation, due to the success of EPCs there are now many different end-users who rely on EPCs to aid decisions and record the transformation of buildings. Any significant change to EPCs must therefore identify the value of those changes from the perspective of different actors, as well as reflecting on any impact such changes may have on current applications of EPCs.

With considerable reliance on steady-state, theoretical methods of assessment, the boundaries of such approaches must be highlighted and limitations accepted. Promising innovations relating to efficient energy demand calculations, both within and without standard energy assessment frameworks, need to be considered as part of the formulation of future EPCs. This evolution must be made in context of what we need energy assessment to do now, not what was required during the original introduction of the EPBD.

Projects are now taking a more empirical approach to this; directly, in terms of the use of real energy consumption data for understanding energy performance, but also in the testing and demonstrating of new propositions for EPCs. Demonstration and thorough quality-checking is key here, and the work of crossCert and a number of other European projects should be welcome in this regard.

The crossCert project is in its early stages, but the above framework and initial background work will be put into practice with real buildings, and informed by active energy assessors and end-users, with results disseminated later in the project.

Acknowledgements

The crossCert project is funded by the Horizon2020 programme, grant ID 101033778

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