Energy Efficiency Directive 3.0: can "metered savings" approaches support EU's Renovation Wave objectives?

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Abstract

In its 2030 Climate Target Plan, the European Commission stressed that additional cuts in energy consumption are needed to reach more ambitious climate goals. The Commission's analysis includes significant greenhouse gas emission cuts in the building sector. This priority is also reflected in the Commission's "Renovation Wave" initiative.

These expectations should be put in perspective with the recent slowdown of energy efficiency improvements in the EU and the worrying lack of progress in reducing energy consumption from space heating (Thomas & Rosenow, 2020). For these reasons, building policy will be one of the main focuses of the revision of the EU's climate and energy legislation, starting in 2021.

This paper highlights what adopting these increased climate goals means for building policy. It zooms in on one policy tool, the energy savings obligation, part of Article 7 of the Energy Efficiency Directive. It identifies synergies and trade-offs between this provision and renovation objectives. It reviews the existing literature on Article 7, with a focus on issues related to measurement, verification and evaluation of energy savings.

The paper explores the prospects that the use of "metered savings" methodologies offer to improve the reliability of energy savings estimates. In the EU, these approaches have been mainly used to support energy savings in the industrial sector. In the U.S., regulators and utilities are piloting the use of these methodologies, combined with pay-for-performance financing schemes in the building sector (SENSEI, 2020). The paper discusses the opportunities and limits of using these methodologies to achieve both EED and Renovation Wave objectives, in order to draw lessons for the revision of climate and energy legislation in 2021.

Introduction

The European Union (EU) has begun a revamp of its climate and energy legislation following its commitment to become climate neutral by 2050 (EU, 2020). Renovating the EU's ageing buildings is a flagship project for this ecological transition. Building renovation can bring tangible benefits to citizens. It is also a major challenge. Currently, the building sector is responsible for 40 % of final energy consumption and 36 % of greenhouse gas emissions (GHG) in the EU (European Commission (EC), 2020b). The EU has already endorsed the objective of achieving a "highly energy efficient and decarbonised building stock" by 2050 (EU, 2018a). It has sharpened its buildings policies over the last decades. But current legislation is insufficient to reach more ambitious 2030 and 2050 climate goals.

Several current initiatives are exploring the potential of making better use of metered energy consumption data to boost the effectiveness and efficiency of building programmes. In the U.S., regulators and utilities are piloting the use of these methodologies in the building sector, combined with pay-for-performance (P4P) financing schemes (SENSEI, 2020). In the

EU, the SENSEI project[1] is looking at ways to combine P4P arrangements with the energy performance contracting model. Its aim is to reward energy efficiency as an energy resource and a new grid service and to turn the retrofit project's value into an investable asset for private financing. These developments build on recent advancements in methods to estimate energy savings, a field known as advanced measurement and verification (advanced M&V). The European Commission has recognised the potential of P4P schemes to accelerate building renovation in its "Renovation Wave" communication (2020e).

This paper discusses the prospects that advanced M&V offers to achieve renovation and energy objectives. The first section highlights what adopting increased climate goals means for building policy. The second section zooms in on one policy tool, the energy savings obligation, part of Article 7 of the Energy Efficiency Directive (EED) and identifies synergies and trade-offs between this provision and renovation objectives. The third section discusses the opportunities and limits related to the use of "metered savings" methodologies in the context of Article 7 and building programmes.

New climate goals require renewed ambition for building policy

This section highlights what adopting increased climate goals means for building policy. It is based on findings from the Commission's most recent analysis. First, it reviews the impact of adopting a new 2030 climate target on the building sector. Secondly, it looks at the role that different technical solutions will play in decarbonising buildings faster. Finally, it takes stock of existing EU policies and targets in this field.

TOWARD A DECADE OF CLIMATE ACTION IN THE BUILDING SECTOR

The Commission (2020b) assessed that a "balanced, realistic and prudent pathway" to climate neutrality requires GHG emissions reduction of 55 % by 2030.[2] This target endorsed by EU legislators (Council of the EU, 2021) represents sizable additional emission cuts.

To prepare for the revision of climate and energy legislation, the Commission (2020c, 2020d) assessed how the different sectors of the economy would contribute to the additional GHG cuts. In the building sector, the EU would reduce emissions by 60 % by 2030 compared to 2015 (EC, 2020b). This is three times more than what the previous Commission's analysis had modelled (Climact & Ecologic Institute, 2020). The Commission expects building decarbonisation to accelerate significantly.

SOLUTIONS TO ACCELERATE THE DECARBONISATION OF THE BUILDING SECTOR

The energy performance of the EU building stock is poor, and 85–95 % of the buildings that exist today will still be standing in 2050 (EC, 2020e). This makes renovation of existing buildings a priority. Unfortunately renovation rates and depth are currently low (EC, 2019c). The Commission (2020e) has acknowledged this challenge with the publication of the "Renovation Wave for Europe" strategy.

In the impact assessment on the 2030 target, the Commission foresees an increase in renovation rates and depth, reducing the energy demand from buildings, and an increase in fuel switching interventions (EC, 2020d). Compared to previous Commission's modelling, analysts noticed a "strategic shift" in favour of an almost full phase-out of liquid and solid fossil fuels (Climact & Ecologic Institute, 2020). While the relative role of technologies and the pace of changes can be discussed (see for example Buildings Performance Institute Europe (BPIE), 2020), reaching 2030 and 2050 climate goals requires a balance between reducing energy demand and decarbonising energy sources in the building sector.

The Commission (2020a) also expects buildings to increasingly contribute to "energy system integration," which it defines as "the coordinated planning and operation of the energy system 'as a whole,' across multiple energy carriers, infrastructures, and consumption sectors." The Commission highlights the specific role of heat electrification in this regard. Indeed, electrified heat loads can provide significant energy system value when they can operate in a flexible manner (Lowes, Rosenow, Qadrdan & Wu, 2020).

The Commission notes that "consumer choice" can be a strong driver to reduce energy use in buildings (EC, 2020d). Recent analysis (Brugger, Eichhammer & Dönitz, 2019) suggests that new societal trends, including evolving consumer preferences could either decrease energy demand or counterbalance efficiency gains in a way that leads further away from realising the EU's goals.

EU POLICIES AND BUILDING DECARBONISATION

Overall, the current EU framework appears inadequate to drive sufficient action, as shown by the reality of renovation rates and depth in the EU (EC, 2019c) and by several policy gap analyses (EC, 2020c, 2020d; CE Delft, 2020; BPIE, 2021). The EU framework does not set specific sectorial targets on buildings, except for a renovation target on the central government building stock (Economidou, Todeschi, Bertoldi, D'Agostino, Zangheri & Castellazzi, 2020). But several policies and targets that influence the pace of decarbonization in the building sector are under review.

Climate legislation

The EU climate legislation puts a cap on GHG emissions, which has an impact on the building sector:

- The EU Emission Trading System currently encompasses 30 % of total buildings emissions. It covers emissions from large fossil fuelled district heating, electric heating, as well as the electricity used by heat pumps (EC, 2020c). It sets a cap on these emissions and creates a carbon price in these sectors.
- Member States' "effort sharing" targets cap the remaining buildings' emission. This means that Member States have the responsibility for addressing emissions from domestic fossil-fuelled heating systems. They are free to use pricing, financial and regulatory policies as they see fit.

1. The SENSEI project is funded from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 847066. More information available at https://senseih2020.eu.

2. This target is expressed including GHG emissions and removals, compared to 1990 levels.

The upcoming revision of climate legislation will therefore set targets and responsibilities for achieving higher GHG cuts in the building sector.

Energy legislation

Energy market legislation, energy efficiency and renewable energy policies also drive building decarbonisation. The governance regulation (2018b) requires Member States to set their contributions to the achievement of the EU-level 2030 renewable energy and energy efficiency targets. These contributions are not binding and Member States' pledges in the area of energy efficiency are so far not adequate to meet the existing EU-level target (EC, 2020b). This framework is under review, with potential increases in ambition for these targets (EC, 2020b).

Recent energy consumption trends are concerning. Indeed, energy efficiency improvements have slowed down in recent years and there is a worrying lack of progress in reducing energy consumption from space heating (Thomas & Rosenow, 2020). The Commission (2020f) noted that the energy efficiency policies in place are insufficient, even if weather conditions and the substantial drop in energy demand due to COVID-19 may lead to the achievement of the 2020 efficiency targets. When it comes to reaching new climate goals, even a "rigorous enforcement" of the existing efficiency legislation would not be sufficient (EC, 2020b).

Other provisions in the energy legislation have an impact on buildings GHG emissions. For example, the Renewable Energy Directive (EU, 2018c) includes targets to increase the share of renewable energy used in heating and cooling. These targets are indicative at the moment and close to business-as-usual (EC, 2020d). Another example is Article 7 of the EED (EU, 2018d), which requires Member States to achieve energy savings by putting in place policy measures. The Commission (2020d) envisages a revision of Article 7 of the EED. This paper further discusses the role of this provision to drive building renovations.

Building legislation

The Energy Performance of Buildings Directive (EPBD) (EU, 2018a) contains a number of provisions to promote the improvement of the energy performance of buildings within the EU. Building codes stemming from the EPBD have contributed to regulating energy consumption from new buildings and buildings undergoing a major renovation. But they leave a large share of buildings out of the scope of minimum requirements (Sunderland & Santini, 2020). The Commission (2020d) is therefore considering introducing minimum energy performance requirements on existing buildings. Building owners would need to achieve a certain performance by a deadline and/or at trigger points (such as sales, new rental contract, etc.). Such measures could play a significant role in the building policy mix. The Renovation Wave strategy (2020e) also lists a number of initiatives to reinforce the building renovation supply chain, including by addressing the role played by the financial sector.

SUMMARY OF FINDINGS

- New climate targets require an unprecedented intensification of buildings' decarbonisation.
- The renovation of existing buildings is a particular challenge.
- Energy efficiency, fuel switching, flexibility and consumer choices are key building blocks of buildings' decarbonisation.
- Several targets and policies are in place, but the EU policy framework does not drive sufficient action.
- The Commission envisages ramping up a number of targets and obligations, including the energy savings obligation in Article 7 of the Energy Efficiency Directive.

Article 7 of the EED and national building decarbonisation policies

The previous section looked at how legislators could reinforce the policy mix in the building sector to reach climate goals. This section reviews the existing literature on Article 7 of the EED to identify synergies and trade-offs with renovation objectives. It briefly introduces the role of Article 7 in the EU policy mix before analysing its interaction with building policies.

ARTICLE 7 IN THE EU POLICY MIX

Under Article 7 of the EED, Member States must trigger a certain amount of energy savings among energy end users from national policy measures. For the 2021–2030 period, this amount corresponds to new annual energy savings of 0.8 % calculated on the basis of annual final energy consumption. Energy savings can be achieved across all sectors and are not limited to buildings. Article 7 helps achieve the energy efficiency targets and drives energy efficiency markets, giving it a specific role in the EU policy mix.

A tool to reach the EU energy efficiency target

By focusing on energy savings from national policies, Article 7 participates in reaching the EU energy efficiency target, which the EED sets as an absolute level of energy consumption in primary and energy terms. The link between Article 7 and the EU target is complex, because policy is not the only factor influencing energy consumption. The Commission has nevertheless expected Article 7 to deliver more than half of the energy savings required to reach the current 2030 energy efficiency headline target (EC, 2016). The role of Article 7 is particularly important given that national energy efficiency targets are not binding on Member States.

Article 7 also encourages the development of a comprehensive policy mix. Indeed, Member States are free to implement policy measures that are best adapted to their local circumstances, as long as they complement and go beyond EU measures (Santini & Thomas, 2020).

A driver for energy efficiency markets

During its most recent evaluation of Article 7, the Commission (2016) highlighted the role of Article 7 in creating a market for energy efficiency products and services. Article 7 "addresses a wide range of market and regulatory failures and can, in particular, be instrumental for making energy efficiency services and investments a business case." It "allows ensuring the stability to investors that in turn helps unlock the needed financing for implementing the energy efficiency measures."

Article 7 in particular led to the multiplication of energy efficiency obligation schemes (EEOSs), which involve energy companies in the realisation of energy savings. Before the EED came into force in 2012, only five Member States had mandatory EEOSs on energy utilities in place (International Energy Agency, 2017). In 2020, 15 Member States and the UK have EEOS delivering energy savings, with more in development (ENSMOV, 2020).

ARTICLE 7 AND NATIONAL BUILDING POLICIES: SYNERGIES AND TRADE OFFS

Member States have achieved an important share of energy savings in the buildings sector. In the first commitment period, which ran from 2014 to 2020, they expect to have delivered at least 42 % of the savings through policy measures focusing only on buildings (Forster, Kaar, Rosenow, Leguijt & Pató, 2016). Many further energy savings in the buildings sector are expected from "cross cutting" policy measures, such as EEOSs.

Buildings sector policy measures include EEOSs, subsidy schemes, the promotion of energy performance contracting and the early ban of certain equipment (Santini & Thomas, 2020). Fuel switch interventions are eligible under Article 7 as long as they deliver end-use energy savings. The ambient heat used by heat pumps is excluded from the measurement of final energy consumption, increasing the eligible energy savings from switching to these technologies.[3]

The 2018 revision of the EED further encouraged energy saving policies in existing buildings. Member States can claim all the savings from a policy measure promoting renovation (e.g., a subsidy that can be directly linked to an investor's decision to renovate a building) even if the national building code stemming from the EPBD mandates a minimum outcome for this renovation (EC, 2019b). In other sectors, eligible energy savings must be additional to EU law.

It is nevertheless difficult to distinguish the driving role of Article 7 on national buildings policy from that of climate effort sharing targets. Article 7 obligations and effort sharing targets are closely interlinked and might play a different role in countries depending on how ambitious the national climate target is set (Graichen, Scheuer & Thomas, 2021). The specificity of Article 7 lies in the requirement for Member States to demonstrate the impact of their policies.

Unfortunately, a large number of Member States are not on track to achieve their 2014–2020 Article 7 obligations (European Commission, 2020f). In addition, there are "credibility issues in relation to the eligibility, additionality, materiality and double counting" for some policy measures notified by Member States, posing "a risk to the delivery of the expected energy savings" (Forster et al., 2016). Stakeholders and analysts have been relaying these concerns (Fawcett & Rosenow 2016; Rosenow & Scheuer, 2019; Coalition for Energy Savings, 2020). The accounting methods used for measuring energy savings can strongly influence the degree of target achievement (Schlomann, Rohde & Plötz, 2014). Although the Commission and Member States acknowledge the need for "a proper measurement and verification of reported energy savings" (EC, 2019a), evaluation practices are neither standardised nor harmonised at EU level (Broc, Thenius, Di Santo, Schlomann, van der Meulen, van den Oosterkamp, Marić & Matosović, 2018). As a result, the Commission has a delicate enforcement task when it comes to assessing the credibility of Member States' estimates. It has listed the improvement of monitoring and verification rules as an option to reinforce Article 7 (EC, 2020g).

Another concern is that it is unclear whether the national building policies under Article 7 are fully aligned with the climate neutrality objective. For example, many Member States provide support for installing new, more efficient fossil fuel equipment (Tognetti, 2020). Some of these schemes participate in fulfilling the Article 7 obligations. Indeed, Article 7 does not differentiate between technologies based on the fuel they use (Santini & Thomas, 2020). The installation of more efficient fossil-fuel boilers has brought significant energy savings over the past decade (Thomas & Rosenow, 2020) but it is unclear if these measures are aligned with the new climate neutrality goal.

Overall, Article 7 has the potential to drive the ambition of national building policies. It is unique in that it requires assessing the impact of policies on delivering energy savings. Nevertheless, a number of implementation challenges and the reality of renovation in Europe suggests that progress can be made to improve synergies between Article 7 and building national policies.

SUMMARY OF FINDINGS

- Article 7 of the EED requires Member States to put in place energy savings policies which complement and go beyond EU measures.
- It has a specific role in the EU policy mix, both as a tool to reach the EU energy efficiency target and a driver for energy efficiency market.
- Article 7 is not limited to buildings, but Member States achieve an important share of energy savings under Article 7 in this sector.
- Overall, Article 7 has the potential to drive the ambition of national building policies and is unique in that it requires an assessment of the impact of national policies on delivering energy savings.
- Nevertheless, a number of implementation challenges and the reality of renovation in Europe suggests that progress can be made to improve synergies between Article 7 and building national policies.
- Decision makers and stakeholders have identified the reliability of energy savings estimates as a key area for improvement to increase the impact of Article 7.

An increased role for 'metered savings' in the building sector?

The previous section showed that the potential of Article 7 of the EED to drive building renovation could be stepped up, particularly by improving the reliability of energy savings estimates. Several initiatives are exploring the potential for making better use of metered energy consumption data to boost the effectiveness and efficiency of building programmes. This section

3. For more information, see EC, 2019b.

examines the opportunities and limits of this proposal. First, it takes stock of the use of metered savings methods under Article 7. Secondly, it discusses the potential of "advanced M&V" to improve energy savings estimates in the building sector. Finally, it discusses some other potential benefits associated with these methods.

USE OF METERED SAVINGS UNDER ARTICLE 7

The EED requires Member States to report on the impact of their energy savings policies under Article 7. It allows four methods to calculate energy savings (other than for taxation measures). Only one of these methods requires using *ex post* metered energy consumption data:

- With "deemed savings" methods, programme managers assign an energy savings value to a specific intervention by using results of previous independently monitored energy improvements in similar installations. A number of Member States have developed "catalogues" of standard measures, often in the context of their EEOS (Labanca & Bertoldi, 2016). Practitioners also call this approach *ex ante* measurement of savings, because programme participants do not have to track the evolution of their energy consumption after the intervention.
- With "scaled savings" methods programme managers determine energy savings by using engineering estimates. It is restricted to cases where establishing robust measured data for a specific installation is difficult or disproportionately expensive.
- The "surveyed savings" method can only be used to estimate energy savings resulting from changes in consumer behaviour, as a result of an information campaign for example. The EED does not allow using this method to track energy savings resulting from installing equipment.
- With "metered savings" methods, programme managers determine energy savings from an intervention by recording the actual reduction in energy use. Practitioners also call this approach *ex post* measurement of savings, because participants track their energy consumption over time. To determine the savings, programme managers shall take into account other factors which may affect energy consumption, such as "additionality, occupancy, production levels and the weather" (EU, 2018d).

Member States report using metered savings in the industrial sector, for example in the Italian White Certificate programme (Di Santo, De Chicchis & Biele, 2018). Two main factors could explain why metered savings methods are not used in building programmes, where deemed savings are more popular:

- The costs of deploying metered savings methods might exceed the expected benefits of doing so in the building sector. Establishing energy savings from a programme requires balancing the desire for precision against the cost of evaluation (Neme & Cowart, 2013). In the past, setting an individualised baseline for the large number of, often smaller scale, interventions in the building sector may have proven more difficult than in the industrial sector, where there is a smaller number of projects to monitor.
- Establishing a set of standard values might facilitate the straightforward administration of programmes such as EEOSs.

On the other hand, the use of deemed savings means that obligated parties do not bear the risk of underperformance. Instead, this risk is borne by the taxpayers or ratepayers who finance the programmes (SENSEI, 2020). In the building sector, this risk is important, as there is often a considerable gap between the measured and the predicted performance of the building. This "performance gap" can for example be linked to installation issues or how the user is interacting with the equipment (McElroy & Rosenow, 2018).

There is little scrutiny over the deemed savings values used by Member States. Analyses of engineering estimates and deemed savings adopted by different countries in the context of the EED however shows that savings estimates for a similar individual action may vary greatly among countries (Labanca & Bertoldi, 2016).

CAN ADVANCED M&V IMPROVE BUILDINGS SAVINGS ESTIMATES?

Advocates of metered savings methods argue that with these methods the benefits of energy efficiency actions should increase, while the costs of metering are declining. Indeed, the entity claiming the savings must monitor energy consumption before and after the intervention. This should act as an incentive for high quality installation and for providing advice to consumers on how to use their equipment.

Meanwhile, software and hardware developments have enriched metered savings methods (Northeast Energy Efficiency Partnerships, 2015). Literature captures these developments under the term "advanced measurement & verification (M&V)", sometimes also called "M&V 2.0" or "automated M&V". Advanced M&V builds on the increasing availability of granular energy consumption data, often stemming from smart meters, and on the ability to process large volumes of data thanks to advanced analytics and automated processing (Franconi, Gee, Goldberg, Granderson, Guiterman, Li & Smith, 2017). This allows for a continuous treatment of data and can potentially reduce costs related to engineering expertise (Granderson, Price, Jump, Addy & Sohn, 2015).

It is possible to apply advanced M&V methods to individual projects, typically at commercial and industrial sites, or to an aggregated number of sites like residential buildings. This has raised the attention of the Efficiency Valuation Organization (EVO) which notes (2020) that aggregated approaches have the potential to lower costs and improve programme-level savings estimates over the deemed savings values typically used in residential programmes. Energy consumption over portfolios of large numbers of buildings tend to be much more stable and manageable (Recurve, n.d.).

In the U.S., programme managers are already using automation extensively for behaviour programmes in the residential sector (Rogers, Carley, Deo & Grossberg, 2015). Legislators and regulators have encouraged the use of meter data in demand-side management programmes (EVO, 2020). While this use is not systematic (Gold, Waters & York, 2020), a number of utilities and programme managers are piloting pay-for-performance schemes based on metered savings methodologies, including in the residential sector (SENSEI, 2020; Best, Fisher & Wyman, 2019).

By 2024, it is expected that almost 77 % of European consumers will have a smart meter for electricity, and about 44 % will have one for gas (Alaton & Tounquet, 2020). This opens possibilities to use advanced M&V methods in building programmes to improve energy savings estimates. Recently, several European initiatives have been exploring this option (SENSEI, 2020; Green Finance Institute, 2021). Advanced M&V practitioners however meet a number of challenges:

- Different modelling algorithms and software tools are available. The comparison between the different tools and the estimate of uncertainty is subject to a rich literature. Practitioners are working to address methodological issues and better understand error levels and uncertainty (EVO, 2020; Touzani, Granderson, Jump & Rebello, 2019; SENSEI, 2021). EVO has set up a testing portal designed by Berkeley Lab to compare the predictive accuracy of any tool or model. Programme managers involved in establishing Article 7 savings should discuss a number of elements including the confidence level expected from aggregated savings estimates in the building sector.
- Practitioners are discussing the issue of non-routine events (NREs). These events modify energy use but are not linked to the energy savings measure and are not part of the energy model. They include for example changes in the number of occupants, changes in occupancy schedules, removal of equipment, installation of solar panels (EVO, 2020). EVO (2020) defines NREs as "the most significant complication" that advanced M&V approaches face. Indeed, there is no "automated silver bullet" to conduct adjustments to the level of savings estimate due to NREs (EVO, 2020). This often requires an engineer's insight (Granderson et al., 2015).
- Establishing programme-level savings is also a challenge. Automated analysis might require additional adjustments to establish the final energy savings (Franconi et al., 2017), possibly requiring questionnaires or interviews (Rogers et al., 2015). For use under Article 7, these adjustments should establish how to discount for the impact of natural market developments (including the free rider effect) and other EU legislation (like ecodesign).

Provided that these challenges are tackled, advanced M&V could help public authorities in Europe increase certainty over the impact of energy efficiency policy measures on energy savings. This is important in the context of Article 7, but also in order to reach the more ambitious 2030 climate targets. Providing Member States with reassurances that their policies are actually delivering savings would help them design the optimal policy mix to decarbonise the building sector effectively.

CAN ADVANCED M&V BRING OTHER BENEFITS TO BUILDING PROGRAMMES?

While increasing the reliability of savings estimates would be an important benefit, proponents of advanced M&V methods argue that they bring other benefits for public authorities and service providers.

Potential benefits for public authorities

Pay-for-performance schemes and aggregators

Advanced M&V enables public authorities to make "timely" performance-based payments to contractors, including aggregators (Franconi et al., 2017). SENSEI (2020) describes pay-for-performance (P4P) schemes as "energy efficiency programmes [that] aim to deliver greater and more persistent energy savings by compensating energy efficiency resources based on a comparison of metered energy consumption and modelled counterfactual energy consumption, i.e., consumption in the absence of the energy efficiency action." *Ex post* estimates of energy savings are used as the indicator for the energy efficiency project's performance. The energy consumption of the building is tracked over time, and payments are either made at the end of the measurement period, or on an ongoing basis "as the savings occur" (Szinai, Borgeson & Levin, 2017).

In the case studies reviewed by the SENSEI project (2020), aggregators often act as intermediaries between end users and the organisation delivering P4P payments. They engage end users to save energy by offering services, and they can decide if and how they share performance rewards with them (SENSEI, 2020).

In the EU, many energy efficiency programmes deliver subsidies for the installation of equipment. This provides an incentive for the private sector to install as many equipment pieces as possible, without necessarily ensuring high quality installation and maintenance (SENSEI, 2020). P4P schemes redirect the incentives to obtaining as many energy savings as possible, which should in principle result in a higher quality of installation and persistent energy savings (SENSEI, 2020).

Establishing the right performance structure is not an easy task though. In many of the pilot schemes reviewed in the context of the SENSEI project, public authorities or utilities have combined the performance payment with a non-performance grant to lower the risks for aggregators engaging in the P4P programme (SENSEI, 2020).

Resource planning

Energy efficiency is often not adequately compensated for the benefits it brings to the energy system, which is at odds with the "energy efficiency first" principle (EU, 2018b; ENEFIRST, 2020). Better understanding the performance profile of energy efficiency projects can put them on an equal footing with energy supply projects (SENSEI, 2020), including in resource planning.

In addition, the availability of granular meter data can allow for more targeted action, including time- and location-specific interventions. A flexible operation of the energy system will increasingly require such interventions.

Potential benefits for service providers

Energy performance contracting

Advanced M&V techniques can enable the development of energy performance contracting (EPC) in the building sector. Energy services companies have traditionally avoided customers without stable energy-use baselines because of the resources needed to perform onsite energy analysis (Rogers et al., 2015). In the residential sector, high transaction costs and market fragmentation constrain the development of EPC (Labanca, Suerkemper, Bertoldi, Irrek & Duplessis, 2015). Advanced M&V may enable energy services companies to extend the scope of their activities, as smart meters roll out (Labanca et al., 2015). In addition, access to granular data provides better insights on what is happening in the building. This can help increase customer engagement (Franconi et al., 2017). This improved knowledge can also be of value for the investor community who is seeking to reduce risks in energy efficiency investments (Franconi et al., 2017). Spurring EPC development however requires other elements, such as having an appropriate data sharing framework, the customers' willingness to pay for energy efficiency measures and an adequate incentive structure provided by public authorities.

Capturing operational and behavioural savings
Advanced M&V can capture the impact of a mix of investment upgrades and behavioural measures, thus better taking into account operational savings, i.e., how end users are running the equipment. Operational savings can be no- or low-cost measures that come in addition to retrofit measures (Grueneich & Jacot, 2014). Capturing these savings can open markets for service providers.

SUMMARY OF FINDINGS

- In the EU, metered savings are seldomly used in the building sector.
- Deemed savings methodologies can facilitate programme administration but puts the performance risk on the public authority mandating the energy savings.
- With metered savings, the entity claiming the savings has an incentive to ensure persistent savings, including by providing high quality installation and maintenance services.
- Several initiatives are exploring the potentials of using 'metered savings' methodologies to boost the effectiveness and efficiency of building programmes.
- Software (e.g., data analytics) and hardware (e.g., smart meters) developments captured under the terminology "advanced M&V" opens potentials to improve building programme-level savings estimates. The costs of using meter data have declined.
- M&V practitioners are working on refining these methodologies. A discussion will be needed in the context of Article 7, to establish for example the confidence level expected from such savings estimates.
- Advanced M&V could help public authorities in Europe increase certainty over the impact of energy efficiency policy measures on real energy savings. This is important in the context of Article 7, but also in order to reach the more ambitious 2030 climate targets.
- The use of metered savings methods opens other perspectives. It could enable public authorities to design pay-for performance schemes and rely on aggregators to deliver energy savings, and to better recognise the role of energy efficiency in resource planning. It can participate in the development of energy performance contracting and help engage customers on operational and behavioural energy savings.

Conclusion

As EU legislators are looking at policy options to accelerate renovation, this paper highlights the scope to improve synergies between Article 7 of the EED and building renovation policies. While advanced M&V methodologies can participate in improving building programmes' energy savings estimates, EU practitioners should solve a number of methodological questions related to the models. To advance this discussion, the Horizon 2020 SENSEI project has developed a next generation energy efficiency meter named "eensight" based on machine learning and is seeking feedback from practitioners (SENSEI, 2021). Programme managers involved in establishing Article 7 savings should discuss a number of elements including the confidence level expected from aggregated savings estimates in the building sector.

Advocates of advanced M&V methods highlight the role they can play in aligning the incentives through pay-for-performance schemes and the development of energy performance contracting in the building sector. While this discussion is promising, the question remains open on how to better compensate energy efficiency financially for the benefits it brings to the energy system. The SENSEI project is exploring business models and should provide some insights on viable transaction flows. The revision of climate and energy legislation in 2021 should also open doors to better reward energy efficiency and distributed resources.

This paper has a number of limitations and calls for additional research.

First, it does not discuss deemed savings methodologies in detail, although they present a number of advantages. Because they put the performance risk on the public authority mandating the energy savings, they require significant efforts to evaluate programmes and adjust the deemed values over time. Currently, few data related to Article 7 programmes are publicly available, constraining public scrutiny of the energy savings estimates reported by Member States. More resources need to be devoted to evaluation to understand how to increase certainty over Member States' deemed values. This is essential for the Commission to understand the impact of the Article 7 energy savings obligations and for Member States aiming to meet their obligations and deliver on challenging 2030 climate goals. The costs of achieving this increased certainty need to be balanced against the costs of using the metered savings approach and assessed alongside the differences in the energy savings delivered through the two measurement methods. Further research to explore the costs and benefits of the two approaches is needed.

Secondly, other proposals could reinforce the synergies between Article 7 and climate goals in the building sector. The question of whether public authorities should continue subsidising the installation of equipment running on fossil-fuel should be explored more systematically by EU legislators. In addition, accelerating building renovation requires other policies such as minimum energy performance standards. Legislators could look at reinforcing the synergies between these standards and Article 7, with a particular focus on equity issues.

Finally, this paper remains broadly theoretical. The experience with using advanced M&V for building programmes is still recent, and there is to our knowledge no pilot in the EU, except in Germany where metered savings methods are explored, but with no exclusive focus on buildings (Weiß, Werle, Pehnt, Blohm, Chmella, Becker, Geissler, Grein & Milojkovic, 2017; Werle, Weiß, Ernst & Hermann, 2019). As regulators and utilities are testing pay-for-performance schemes in the residential sector in California and in New York (SENSEI, 2020), more evaluation data should become available, feeding into the European discussion. Developments in the United Kingdom (Green Finance Institute, 2021) should also inspire EU practitioners.

In the meantime, stakeholders, decision makers and M&V practitioners should continue the dialogue and pilot pay-for-performance schemes making use of advanced M&V methods. EU institutions should also be interested in these developments, especially as the European Court of Auditors (2020) has flagged that the cost effectiveness of buildings projects could be improved.

Piloting these schemes now is particularly important as this field of research is evolving quickly. As EVO (2020) notes, "the brisk addition of demand-response […] efforts and new distributed generation […] resources (e.g., electric vehicles) will complicate known [advanced M&V] methods. Meter-based energy use is core to all of these efforts and will require the coordination of multiple baselines. Inevitably the need for 'integrated M&V' to delineate savings from [energy efficiency], [demand response], and [distributed generation] will require M&V approaches to evolve."

References

Alaton, C., & Tounquet, F. (2020). *Benchmarking smart metering deployment in the EU-28.* Final Report. Tractebel Impact, European Commission. ISBN 978-92-76-17295-6. doi:10.2833/492070. MJ-02-20-176-EN-N. © European Union, 2020.

Best, C., Fisher, M., & Wyman, M. (2019). *Policy Pathways to Meter-Based Pay-for-Performance.* Paper originally presented at the International Energy Program Evaluation Conference 2019.

Broc, J. S., Thenius, G., Di Santo, D., Schlomann, B., van der Meulen, J., van den Oosterkamp, P., Marić, L., & Matosović, M. (2018). *What can we learn from sharing experience about evaluation practices?.* Conference paper, International Energy Policy & Programme Evaluation Conference 2018.

Brugger, H., Eichhammer, W., & Dönitz, E. (2019). *Energy efficiency vision 2050: how do societal changes shape energy efficiency and energy demand?.* Fraunhofer Institute for Systems and Innovation Research ISI. eceee 2019 Summer Study Proceedings.

Buildings Performance Institute Europe (The) (BPIE). (2020). *On the way to a climate-neutral Europe – Contributions from the building sector to a strengthened 2030 climate target.*

Buildings Performance Institute Europe (The) (BPIE). (2021). *The road to climate-neutrality: Are national long-term renovation strategies fit for 2050?.*

CE Delft. (2020). *Zero carbon buildings 2050 – Background report.*

Climact, & Ecologic Institute. (2020). *Analysing the impact assessment on raising the EU 2030 climate target – How does the European Commission's approach compare with other existing studies?*

Coalition for Energy Savings (The). (2020). *Energy Efficiency Directive Article 7, National progress and outlook on the energy savings obligation.*

Council of the European Union. (2021, April 21st). *European climate law: Council and Parliament reach provisional agreement* [Press release].

Di Santo, D., De Chicchis, L., & Biele, E. (2018). *White certificates in Italy: lessons learnt over 12 years of evaluation.* International Energy Policy & Programme Evaluation Conference 2018.

Economidou, M., Todeschi, V., Bertoldi, P., D'Agostino, D., Zangheri, P., & Castellazzi, L. (2020). Review of 50 years of EU Energy Efficiency Policies for Buildings. *Energy and Buildings*, 225, 110322. https://doi.org/10.1016/j.enbuild.2020.110322

Efficiency Valuation Organization (EVO). (2020). *IPMVP's Snapshot on Advanced Measurement & Verification.*

ENEFIRST. (2020). *Defining and contextualizing the E1st principle.* Deliverable D2.1 of the ENEFIRST project, funded by the H2020 programme, grant agreement number: 839509. https://enefirst.eu/wp-content/uploads/D2-1-defining-and-contextualizing-the-E1st-principle-FINAL-CLEAN.pdf

ENSMOV. (2020). *Snapshot of Energy Efficiency Obligation Schemes in Europe (as of end 2019).* Deliverable of the ENSMOV project, funded by the H2020 programme, grant agreement number: 840034. https://ensmov.eu/wp-content/uploads/2020/06/ENSMOV_Snapshot_EEOS_provisional.pdf

European Commission. (2016, November). *Impact assessment accompanying the document – Proposal for a directive of the European Parliament and of the Council amending directive 2012/27/EU on energy efficiency.* SWD/2016/405 final.

European Commission. (2019a, January). *Report of the work of the task force on mobilising efforts to reach the EU energy efficiency targets for 2020.*

European Commission. (2019b, September). *Commission Recommendation on transposing the energy savings obligations under the EED.* (EU) 2019/1658.

European Commission. (2019c). *Comprehensive study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU.* Final Report prepared by Ipsos Belgium and Navigant for the European Commission, Directorate-General for Energy.

European Commission. (2020a, July). *Powering a climate-neutral economy: An EU Strategy for Energy System Integration.* COM(2020) 299 final.

European Commission. (2020b, September). *Stepping up Europe's 2030 climate ambition – Investing in a climate-neutral future for the benefit of our people.* COM(2020) 562 final.

European Commission. (2020c, September). *Commission staff working document. Impact assessment accompanying COM(2020) 562 final.* SWD(2020) 176 final. Part 1.

European Commission. (2020d, September). *Commission staff working document. Impact assessment accompanying COM(2020) 562 final.* SWD(2020) 176 final. Part 2.

European Commission. (2020e, October). *A Renovation Wave for Europe – greening our buildings, creating jobs, improving lives.* COM(2020) 662 final.

European Commission. (2020f, October). *2020 assessment of the progress made by Member States towards the implementation of the Energy Efficiency Directive 2012/27/EU and towards the deployment of nearly zero-energy buildings and cost-optimal minimum energy performance requirements in the EU in accordance with the Energy Performance of Buildings Directive 2010/31/EU.* COM(2020) 954 final.

European Commission. (2020g, October). *EU energy efficiency directive (EED) – evaluation and review*. Consultation on the Review and the Revision of Directive 2012/27/EU on Energy Efficiency.

European Court of Auditors (The) (ECA). (2020). *Special report: Energy efficiency in buildings: greater focus on cost-effectiveness still needed.* ISBN 978-92-847-4399-5. ISSN 1977-5679. doi:10.2865/996083. QJ-AB-20-004-EN-N.

European Union. (2018a). *Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency.* Official Journal of the European Union, L 156/75, 19 June 2018.

European Union. (2018b). *Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action.* Official Journal of the European Union, L 328/1, 21 December 2018.

European Union. (2018c). *Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.* Official Journal of the European Union, L 328/82, 21 December 2018.

European Union. (2018d). *Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending directive 2012/27/EU on energy efficiency.* Official Journal of the European Union, L 328/210, 21 December 2018.

European Union. (2020). *Long-term low greenhouse gas emission development strategy of the European Union and its Member States.* https://unfccc.int/process/the-paris-agreement/long-term-strategies

Fawcett, T., & Rosenow, J. (2016). The Member States' plans and achievements towards the implementation of Article 7 of the Energy Efficiency Directive, in: Zgierewicz, A. (Ed.), *Implementation of the Energy Efficiency Directive: Energy Efficiency Obligation Schemes.* European Parliament.

Forster, D., Kaar, A. L., Rosenow, J., Leguijt, C., & Pató, Z. (2016). *Study evaluating progress in the implementation of Article 7 of the Energy Efficiency Directive.* Final Report for DG Energy.

Franconi, E., Gee, M., Goldberg, M., Granderson, J., Guiterman, T., Li, M., & Smith B. A. (2017). *The Status and Promise of Advanced M&V: An Overview of "M&V 2.0" Methods, Tools, and Applications.* Rocky Mountain Institute and Lawrence Berkeley National Laboratory.

Gold, R., Waters, C., & York D. (2020). *Leveraging Advanced Metering Infrastructure To Save Energy.* American Council for an Energy-Efficient Economy.

Graichen, J., Scheuer, S., & Thomas, S. (2021). *Strengthening synergies between climate effort sharing & energy savings obligations, an input to the "Fit for 55" package.* Stefan Scheuer SPRL. *https://www.stefanscheuer.eu/wp-content/uploads/2021/01/20210201-Synergies-between-ESR-EED.pdf*

Granderson, J., Price, P. N., Jump, D., Addy, N., & Sohn, M. D. (2015, April). Automated measurement and verification: Performance of public domain whole-building electric baseline models. *Applied Energy*, 144, 106–113. https://doi.org/10.1016/j.apenergy.2015.01.026

Green Finance Institute. (2021). *Towards a protocol for metered energy savings in UK buildings.*

Grueneich, D., & Jacot, D. (2014). Scale, Speed, and Persistence in an Analytics Age of Efficiency: How Deep Data Meets Big Savings to Deliver Comprehensive Efficiency. *The Electricity Journal*, 27 (3), 77–86. ISSN 1040-6190. https://doi.org/10.1016/j.tej.2014.03.001

International Energy Agency. (2017). *Market-based Instruments for Energy Efficiency.* OECD/IEA, Paris.

Labanca, N., & Bertoldi, P. (2016). *Energy Savings Calculation Methods under Article 7 of the Energy Efficiency Directive.* EUR 27663 EN. https://doi.org/10.2790/855880

Labanca, N., Suerkemper, F., Bertoldi, P., Irrek, W., & Duplessis, B. (2015, December). Energy efficiency services for residential buildings: Market situation and existing potentials in the European Union. *Journal of Cleaner Production*, 109, 284–295. https://doi.org/10.1016/j.jclepro.2015.02.077

Lowes, R., Rosenow, J., Qadrdan, M., Wu, J. (2020). Hot stuff: Research and policy principles for heat decarbonisation through smart electrification. *Energy Research & Social Science*, 70, 101735. ISSN 2214-6296. https://doi.org/10.1016/j.erss.2020.101735

McElroy, D., & Rosenow, J. (2018). Policy implications for the performance gap of low-carbon building technologies. *Building Research & Information* 47 (5), 611–623. https://doi.org/10.1080/09613218.2018.1469285

Neme, C., & Cowart, R. (2013). *Energy efficiency feed-in-tariffs: key policy and design considerations.* Energy Futures Group and Regulatory Assistance Project. eceee 2013 Summer Study Proceedings.

Northeast Energy Efficiency Partnerships. (2015). *The changing M&V paradigm. Review of key trends and new industry developments, and their implications on current and future EM&V practices.* Report prepared by DNV GL.

Recurve. (n.d.). *Portfolio Aggregation & Uncertainty.* https://www.recurve.com/how-it-works/portfolio-aggregation-uncertainty

Rogers, E. A., Carley, E., Deo, S., & Grossberg, F. (2015, December). *How Information and Communications Technologies Will Change the Evaluation, Measurement, and Verification of Energy Efficiency Programs.* American Council for an Energy-Efficient Economy.

Rosenow, J., & Scheuer, S. (2019). *Closing the loopholes: Assessment of the potential impact of tax measures on energy savings claimed under Article 7 of the EED.* Regulatory Assistance Project et Stefan Scheuer consulting. https://www.raponline.org/knowledge-center/closing-loopholes-assessment-impact-tax-measures-claimed-energy-savings-eed

Santini, M., & Thomas, S. (2020). *Article 7 of the Energy Efficiency Directive 3.0. How to maximise the energy efficiency* *opportunity for climate neutrality.* Regulatory Assistance Project. https://www.raponline.org/knowledge-center/article-7-energy-efficiency-directive-3-0-how-maximise-energy-efficiency-opportunity-climate-neutrality

Schlomann, B., Rohde, C. & Plötz, P. (2014). Dimensions of energy efficiency in a political context. *Energy Efficiency*, 8, 1-19. https://doi.org/10.1007/s12053-014-9280-8

SENSEI. (2020). *Experience and lessons learned from pay-for-performance (P4P) pilots for energy efficiency.* Deliverable 4.4 of the SENSEI project, funded by the H2020 programme, grant agreement number: 847066. https://zenodo.org/record/3887823#.YFsUF-Yo-8V

SENSEI. (2021). *Methods for the dynamic measurement and verification of energy savings.* Deliverable 7.1 of the SENSEI project, funded by the H2020 programme, grant agreement number: 847066. https://zenodo.org/record/4695123#.YHiUD-gzY2w

Sunderland, L., & Santini, M. (2020). *Filling the policy gap: Minimum energy performance standards for European buildings.* Regulatory Assistance Project. https://www.raponline.org/knowledge-center/filling-the-policy-gap-minimum-energy-performance-standards-for-european-buildings

Szinai, J., Borgeson, M., & Levin, E. (2017, January). *Putting your money where your meter is: A study of pay-for-performance energy efficiency programs in the United States.* Prepared for the Natural Resources Defense Council and Vermont Energy Investment Corporation.

Thomas, S., & Rosenow, J. (2020, February). Drivers of increasing energy consumption in Europe and policy implications. *Energy Policy*, 137, 111108. https://doi.org/10.1016/j.enpol.2019.111108

Tognetti, F. (2020). *Analysis of existing incentives in Europe for heating powered by fossil fuels and renewable sources.* On behalf of Coolproducts and the European Environmental Bureau (EEB).

Touzani, S., Granderson, J., Jump, D., & Rebello, D. (2019, June). Evaluation of methods to assess the uncertainty in estimated energy savings. *Energy and Buildings*, 193, 216–225. https://doi.org/10.1016/j.enbuild.2019.03.041

Weiß, U., Werle, M., Pehnt, M., Blohm, M., Chmella, T., Becker, M., Geissler, J., Grein, A., & Milojkovic, F. (2017). *Funding measured energy savings: first findings on performance-based "Energy Savings Meter" funding scheme.* eceee 2017 Summer Study Proceedings.

Werle, M., Weiß, U., Ernst, C., & Hermann, L. (2019). *Metering energy savings: insights from the "Energy Savings Meter" funding scheme.* eceee 2019 Summer Study Proceedings.

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