Integration of Flexibilities to Energy Performance Contracting Business Models

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1 ABSTRACT

The revised Energy Performance of Buildings Directive (EPBD) aims for a fully decarbonized European building stock by 2050. (EC, 2024) Energy Performance Contracting (EnPC) offers a promising solution to enhance renovation rates, yet long payback periods remain a barrier. This paper presents a novel EnPC business model incorporating implicit and explicit flexibility services to reduce payback time and enhance profitability. The study utilizes literature reviews and stakeholder interviews from the EBENTO project to develop and validate this approach. Findings indicate that integrating flexibility services can generate additional revenue streams, optimize energy consumption, and shorten contract durations, making EnPCs more viable for residential applications.

Keywords: demand response, flexibilities, business model, energy performance contracting, planning

2 INTRODUCTION

The European building stock is currently responsible for 36% of all energy-related CO_2 emissions in the EU. The entire building stock will need to be highly energy efficient and carbon-neutral by 2050 to achieve the EU's climate objective. In 2020, the European Commission published the Renovation Wave strategy and action plan, an initiative aiming to double annual energy renovation rates in the next ten years and renovate 35 million buildings in Europe by 2030. Together with a very ambitious decarbonisation of heating this should enable to cut direct building sector greenhouse-gas emissions by 60% until 2030 (based on 2015 levels) as laid down in the Climate Target Plan 2030 (EC, 2020). The current Energy Performance of Buildings Directive (EPBD) is an essential element of the EU renovation strategy. It upgrades the existing regulatory framework to reflect higher ambitions and more pressing needs in climate and social action. These ambitious targets in the building sector require a high amount of capital and suitable financing mechanisms.

Energy Performance Contracting (EnPC) is one promising option to boost renovation rates and help to achieve the ambitious EU decarbonization targets in the building sector. EnPCs are contracts between building owners and Energy Service Companies (ESCOs) that target to facilitate energy efficiency improvements in buildings that are financed from guaranteed energy savings. This means that EnPCs are a financial and technical mechanism that enables organizations to implement energy efficiency measures and renewable energy projects without upfront capital investment. It is a contractual agreement between an energy service company (ESCO) and a client, typically a commercial or public sector entity, to improve energy efficiency and reduce energy costs. So far the EnPC market has stagnated in many Member States (Mayer, et al., 2023). The latest revision of the Energy Efficiency Directive (EED) however foresees to promote the energy services market and access to it. Member States shall promote and ensure the use of EnPCs for the renovation of large buildings. (EC, 2023)

However, a central barrier to the adoption of EnPCs are long payback periods and contract durations, which are not reasonable for many clients, especially in the residential sector (Mayer, et al., 2023). Newly constructed or renovated buildings typically have a potential for energy flexibilities, due to the installation of smart and flexible technologies (e.g. heat pumps, PV, batteries, EVs, ...). These energy flexibilities represent an additional revenue stream that could reduce payback time and increase the profitability of building renovations. The aim of this paper is to present a new EnPC business model that integrates savings and revenues from implicit and explicit flexibilities in the EnPC to reduce the payback period and improve the profitability of EnPCs. The new business model was developed as theoretical concept in the course of the Horizon Europe project, outlining the roles and responsibilities of different actors in the process.

3 METHODOLOGY AND POLICY BACKGROUND

3.1 Policy Background

The energy services sector in the EU, including ESCOs and EnPCs, follows a clear regulatory framework. This framework supports energy service contracts, financial tools, certified providers, and monitoring methods. The EED is the main driver, requiring Member States to strengthen the energy services market. Over the years, EU policies like the EED have increased interest in this sector. As a result, ESCO markets have grown steadily across Member States. Many countries have introduced laws to support these markets, including rules for ESCOs and EnPCs. However, implementation varies. Some rules are not yet fully adopted, and in some countries, the energy services market is still developing. The policy framework for flexibilities in buildings focuses on enhancing energy efficiency, demand response, and integration with renewable energy sources. EU regulations, such as the EPBD and the Electricity Market Design, encourage smart energy use by promoting digitalization, smart meters, and energy storage. These policies support the deployment of demand-side flexibility, allowing buildings to adjust energy consumption based on grid conditions. Financial incentives and regulatory measures, including dynamic pricing and flexibility markets, further encourage participation. However, implementation varies across Member States, requiring harmonized efforts to unlock the full potential of building flexibilities.

3.2 Methodological approach

This study used a multifaceted methodological approach to develop the new business model. A comprehensive literature review was conducted to identify existing EnPC business models and the general availability and potential of flexibility services in buildings. In addition to the desk research, in-depth interviews with a diverse range of stakeholders were conducted to verify the findings from the literature research and gain additional qualitative insights on the general market uptake of EnPCs in the European Union. Interview partners included (ESCOs), building owners, building managers, policy makers, and industry experts from several EU countries.

3.3 Market status of EnPCs in the European Union

Within the project EBENTO, a market analysis was done to assess the current state of development of EnPCs in the European Union. The analysis of the current market situation showed that an initial EnPC market development took place in all European countries but there is only a slight market growth. The main barriers that were identified in the analysis are a lack of awareness and understanding, lack of trust, high complexity, high payback periods and contract durations as well as high transaction costs and the split incentive dilemma. Legislative barriers often hinder progress, suggesting that a more standardised approach could facilitate market growth, streamline transactions, and reduce costs. Improving information dissemination and raising awareness are crucial steps forward. Lists of ESCOs prove highly valuable for customers seeking to understand the market. Facilitators specialising in EnPCs and energy agencies have pivotal roles to play, particularly within the public sector. The most relevant drivers of EnPCs in the residential sector are increasing energy costs, supportive schemes and the availability of competent facilitators or support services (e.g. one-stop-shops). Financial support and incentives, such as tax incentives, continue to be essential, particularly in countries with less mature markets. Member States are encouraged to utilise European Funds effectively, employing a smart mix of financial schemes that promote EnPCs and ESCOs. Furthermore, sharing best practices at the national and regional levels, along with lessons learned from EU-funded projects, can enhance collaboration among Member States. (Mayer, et al., 2023)

4 FLEXIBILITIES IN ENERGY PERFORMANCE CONTRACTING

4.1 Basic Elements of Energy Performance Contracting

EnPCs are agreements between building owners and contractors, usually ESCOs, to improve energy efficiency. These projects are funded through guaranteed future energy savings. ESCOs have the expertise to offer complete solutions that reduce energy costs. They can manage projects, arrange financing, install and maintain equipment, and work with other market players. EnPCs shift both the financial and technical risks of energy efficiency investments from the building owner to the ESCO. Since ESCOs have the necessary funds, skills, and experience, they can carry out the project and ensure the promised energy savings are achieved. (Csaszar, et al., 2015)

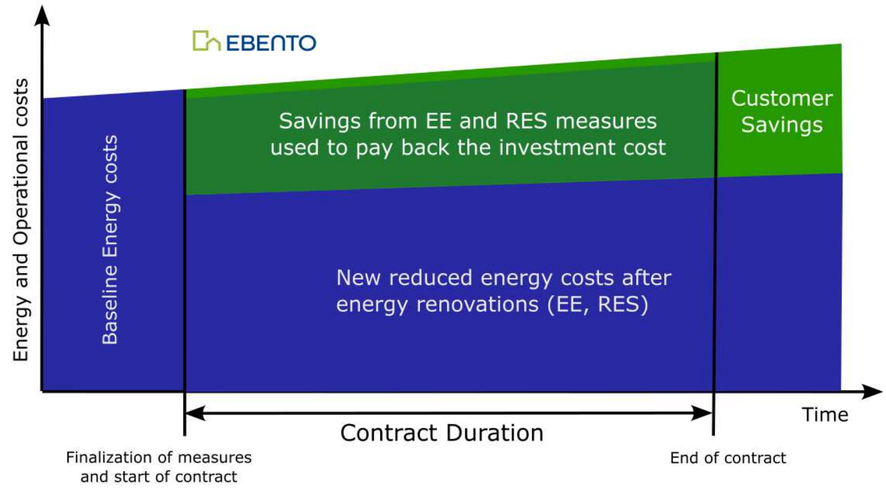

Figure 1: Energy savings and costs of a typical EnPC

The basic idea of the EnPC business model is that the ESCO will be renumerated based on the energy savings generated through the contract. Figure 1 illustrates this model, showing how energy efficiency measures reduce baseline energy consumption. Baseline energy costs represent the energy costs before the renovation measures are started. In this model, energy costs are expected to increase over time, which explains the steady rise in baseline costs and overall costs. After the energy efficiency measures are implemented, energy costs decrease, which is shown as "new reduced energy costs after energy renovations" in figure 1. The savings generated are used to repay the investment costs. Once the investment is paid back, the contract ends and the customer benefits from lower energy costs. Typically, not all savings are used to pay back the investment costs. A small portion of the savings favours the customer also during the contract duration, which represents the thin light green part above the savings within the contract duration.

4.2 Integrating Flexibilities in EnPCs

Flexibilities in buildings refer to the ability to adjust energy consumption based on demand, price signals, or grid conditions. By integrating smart technologies, energy storage, and demand response mechanisms, buildings can optimize energy use, reduce costs, and support grid stability. The incentive for shifting demand can be either price-based (implicit flexibilities) or market-based (explicit flexibilities). Implicit flexibilities shift demand to times with lower electricity prices, while explicit flexibilities adjusts demand based on signals from network operators to alleviate grid congestion. This adjustment is typically managed by an aggregator, who sets the baseline and modifies demand as needed.

4.2.1 Implicit flexibilities in EnPCs

Implicit flexibilities means that electricity demand is shifted based on price signals. There are two typical use cases for implicit flexibilities. The first implicit flexibilities use case is the demand optimization with fixed electricity tariffs. This means that flexible demand such as heat pumps or EV charging is shifted to increase self-consumption rate of on-site renewable energy sources (PV). In this use case, electricity prices for purchasing and selling electricity are assumed to be fixed (no hourly changes). As the electricity price for consumption is typically higher than the electricity price for electricity feed-in, electricity costs are reduced by increasing the self-consumption of the PV generation. Batteries could further increase the self-consumption rate and improve the business case.

The second use case of implicit flexibilities is the demand optimization with flexible electricity tariffs. In this use case also, flexible energy tariffs based on the day-ahead market have to be considered in the optimization. It is assumed that the electricity selling price is a fixed tariff and just the electricity purchasing price is flexible. Flexible energy prices provide another incentive for load shifting. Flexible tariffs could be either tariffs with hourly variable electricity prices linked to the spot market prices or tariffs with fixed period prices (peak-/offpeak-/shoulder-price). The combination of batteries with flexible electricity tariffs further increases the possibilities (charging in low-price hours) and potential cost savings.

Optimization according to flexible electricity prices is typically more relevant in the winter period, where not enough PV production for self-consumption optimization is available. For the realization of this use case, a multi-objective optimization with a building energy management system is needed to find the overall optimum consumption strategy. Batteries could further improve the potential energy cost savings in this use case as they increase the self-consumption rate and also further decrease costs as they could be charged from the grid in low price periods. Additionally, flexible grid tariffs (capacity-based tariffs) could further increase the complexity and the potential revenues.

Figure 2 shows the schematic of energy savings and costs of an EnPC with savings from implicit flexibilities. It can be seen that the savings from implicit flexibilities could further reduce the payback time of the investment costs and therby reduce the contract duration.

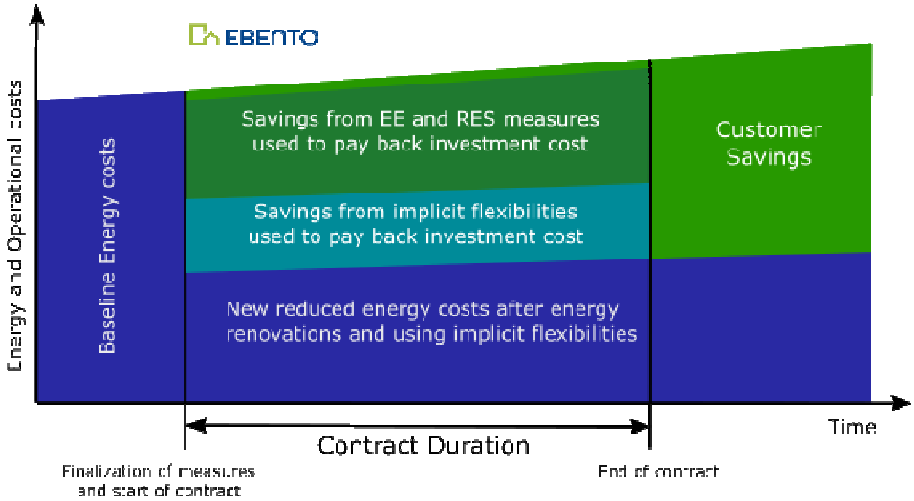

Fig. 2: Energy savings and costs of EnPC with implicit flexibilities

The main actors of typical EnPCs are the building owner and the ESCO. EnPCs with implicit flexibilities requires that the ESCOs have full control of flexible devices. Only if the ESCO can control the flexible devices, savings from implicit flexibilities could be considered in the contract. The electricity suppliers also play an important role as they have to offer dynamic tariffs, allowing the owner/occupant to adjust demand based on the investment by the ESCO, resulting in reduced energy costs. The latest recast of the EMD requires member states to force electricity suppliers to offer flexible electricity tariffs.

Facilitators represent another important actor in EnPCs. They could support to overcome the complexity barrier of EnPCs which is especially relevant if implicit flexibility savings are considered in the contract. Additionally, a smart meter for real-time measurement and billing is required. Monitoring tools and building energy management systems system for optimized control could further support the flexible control of loads and thereby increase the potential savings. For a proper consideration of flexibility savings in the EnPC, a detailed calculation and forecasting of the expected flexibility savings has to be done in the EnPC planning phase.

4.2.2 Explicit flexibilities in EnPCs

Explicit flexibilities means that flexible demand is shifted based on signals from network opoerators to alleviate grid congestion. This adjustment is typically managed by an aggregator, who sets the baseline and modifies demand as needed. ESCO can either act as the contractual party for an external aggregator, serve as the aggregator, or have no connection to the aggregator. In the latter, the owner contracts directly with the aggregator. The aggregator's role is to pool flexibility from various customers for flex requestors, typically distribution system operators (DSOs), Transmission System Operators (TSOs), or other balance responsible parties (Vanstraelen et al., 2021).

Figure 3 shows the schematic of energy savings and costs of an EnPC with additional revenues from explicit flexibilities. These external flexibilities do not reduce the energy costs but generate additional revenues that could be used to payback the investment costs and further reduce the contract duration. After the contract duration, the customer receives all revenues from explicit flexibility services (except the service fee if ESCO acts as an aggregator or operator).

EnPCs with explicit flexibilities involve multiple actors. Building owners act as contractual partner of the ESCO. Building owners, building managers or tenants provide flexibility by adjusting their energy consumption based on agreed-upon strategies. Aggregators combine the flexibility potential of many consumers and prosumers and and bundle it to a portfolio. The aggregator offers the bundled flexibility to different flexibility or energy markets. ESCOs could either have a contractual relationship with an aggregator or take over the capabilities and responsibilities of aggregators. If ESCOs act as technical aggregators, they bundle the flexibilities of their clients and control the flexible assets of multiple buildings. Therefore, the ESCOs need the control over flexible loads if the expected explicit flexibility revenues are integrated in the EnPC. Facilitators could support the whole process. Grid operators (DSOs/TSOs) are another important actor in this model as they provide the external signal to which aggregators and building owners respond during explicit flexibility actions. Policymakers create supportive regulations to ensure a fair and functional energy market. By working together, these actors enable EnPCs to maximize savings and efficiency while contributing to a more flexible and reliable energy system.

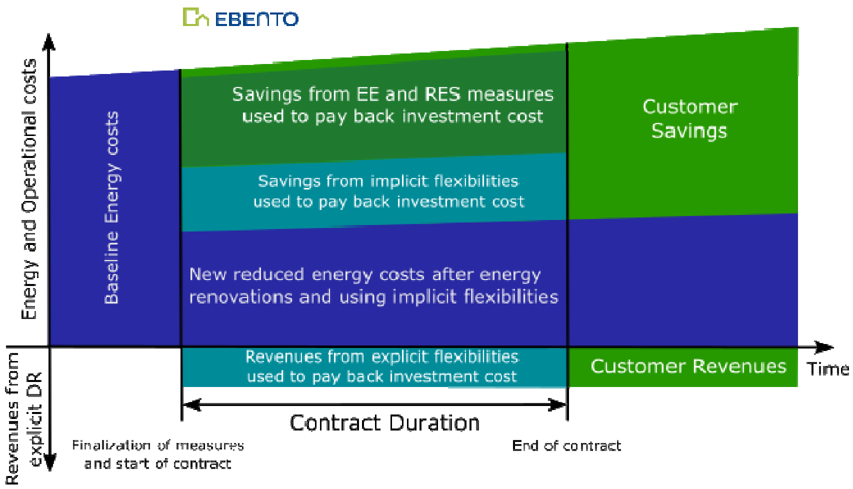

Fig. 3: Energy savings and costs of EnPC with external flexibilities

5 CONCLUSION

The results of the analysis show that the integration of flexibility services in EnPCs could shorten payback time and contract duration. Flexibility services in buildings can be categorized into implicit and explicit flexibilities. Implicit flexibilities generate electricity cost savings from a shift of demand to times with lower electricity prices, which could be either times with high PV production or times with low flexible electricity tariffs. Explicit flexibility services generate revenues from demand adjustments based on external signals from network operators to alleviate grid congestion. ESCOs can either act as the contractual party for an external aggregator or serve as an aggregator for the network operator. To integrate savings and revenues from flexibility services in the EnPC business model, the ESCO must have control over the building's energy management system and energy-flexible devices (e.g. heat pump or electric boiler). Figure 1 presents a schematic of energy savings and costs for an EnPC that includes flexibilities. It can be seen that the energy consumption is reduced through energy efficiency measures and savings from implicit flexibilities. Furthermore, revenues are generated from explicit flexibilities. The new EBENTO EnPC business model uses energy cost savings and flexibility revenues to pay back the investment costs and thereby reduce the contract duration of EnPCs.

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