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Review

Lessons From EU-Projects for Energy Renovation

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Abstract

There is an urgent need for energy renovation of the existing building stock, in order to reach the climate goals, set in Paris in 2016. To reach climate targets, it is important to considerably lower energy demand as well as switch to fossil-free heating systems. Unfortunately, renovation rates across the EU remain at a low level of 1% per year. Deep renovation, which lowers energy use with 60% or more, accounts only for 0,2% of renovations. The heating transition thus progresses much more slowly than the electricity transition. We draw on the framework of technological innovation systems, which allows comparison of different transitions. In the literature, it is argued that the configurational nature of the renovation system is one of the main reasons for the slow heating transition. The renovation system is context-bound and consists of many actors both on the demand-side and the supply-side, which leads to a fragmented market. For increasing the speed of the heating transition, it is deemed important to counter this fragmentation. We carried out a review of reports and publications of EU-funded projects on energy renovation. In many projects fragmentation in the building sector was identified as one of the main obstacles. We analyzed the deliverables of these energy renovation projects to find tried and tested solutions. One of these is the so-called one-stop-shop, which promises to improve the organization of the supply side, while also providing an appropriate and affordable solution to the customer. In the discussion we argue that the energy renovation system could be improved by increasing collaboration on the supply side and at the same time simplifying the renovation process for customers. A promising tool to make this happen is the one-stop-shop.

Keywords

energy renovation; EU-projects; heating transition; technological innovation systems

Issue

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1. Introduction

The transition towards a more sustainable energy system will have huge ramifications for our built environment. To reach the climate goals, set in Paris in 2016, the built environment needs to considerably lower its energy demand. This is called the heating transition, which comprises two main aspects: first, reducing energy demand by building insulation and secondly, switching to fossil-free heating systems. Therefore, there is an urgent need for energy renovation of the existing building stock. Unfortunately, energy renovation rates across the EU remain at a low level of around 1% per year (BPIE, 2014; Esser et al., 2019; Sandberg et al., 2016). Moreover, the depth of the energy renovation achieved is rather shallow in most cases. Deep renovation, referring to renovation which lowers energy use with 60% or more, accounts for only 0,2% of total refurbishments (Schimschar et al., 2011). This means that both the pace and the quality or depth of energy renovation needs to increase to achieve climate goals by 2050.

There is a marked difference between the progress of the transition to renewable electricity compared to the heating transition. How could this divergence between the electricity transition and the heating transition be explained and what can we learn from the comparison between the two transitions? Some authors hypothesize that the nature of the heating transition, with a plethora of local stakeholders and the need for made-to-measure solutions for individual households and neighborhoods, causes a slower development path, compared to more centralized technologies such as large wind turbines (Wesche et al., 2019). In this respect, we examined the case of the "Energiewende" in Germany.

Germany is one of the leading countries in the energy transition (Beveridge & Kern, 2013; Hake et al., 2015), however for the building sector the Energiewende did not lead to similar progress. As Bauermann (2016, p. 237) succinctly stated, "the Energiewende which implies a revolution for the energy sector only provides little stimulus to a slowly developing residential heating market." Germany has performed a pioneering role in the promotion of renewable energy sources (RES); integration and stimulation of renewable energy have been an important part of German energy policy for over 30 years. The potential for the production of renewable energy (biomass, solar, and geothermal) is large (Bechberger & Reiche, 2004). Although Germany is heavily dependent on coal (51%) and nuclear (31%), in 2002 RES already had a share of 9% in electricity production (Bechberger & Reiche, 2004). At that time, Germany was world leader in wind energy and second in solar PV. The origin of this success lies in a combination of policy measures in place since 1990, when the Act on Supplying Electricity from Renewables or StrEG (Stromeinspeisungsgesetz) came into force (Bechberger & Reiche, 2004). This led to a breakthrough of wind energy. For solar PV the StrEG was not sufficient, here another policy measure was crucial, the Renewable Energy Sources Act or EEG (Erneuerbare Energien Gesetz) in 2000, which introduced guaranteed feed-in tariffs for 20 years (2004). The production of electricity with RES in Germany increased from 9,4% in 2011 to 40,8% in 2019 (Eurostat, 2019; Renn & Marshall, 2020). However, in these historic overviews (Bechberger & Reiche, 2004; Hake et al., 2015) it is observed that the Energiewende apparently had little effect on the heating transition. Therefore, in the next paragraphs we will dive somewhat deeper into the policies and progress of energy renovation in Germany.

Goals regarding energy use in the built environment in Germany are relatively ambitious, with 14% renewable by 2020 and climate neutrality by 2050 (Bauermann, 2016, p. 235). Germany has a renovation rate of 1%, which is comparable to other EU-countries. However, only 10% of these renovations fall in the category of "deep renovation" (Baginski & Weber, 2017; Haase & Torio, 2021; Maia et al., 2021). What policies are in place to reduce energy demand, and will the goals be met, considering the low rate of progress? The reduction of energy demand in the built environment, more specifically in dwellings, is targeted with two main approaches. The first is directed at the building itself, through insulation of walls, roof, floor and windows. The second approach is the improvement or replacement of heating systems. Apart from these building related approaches, there are policies that aim to change energy behavior. In Germany the first approach is targeted with the Energy Saving Act (1976), in which the "Wärmeschutz" supports insulation. For the second approach, heating systems, the Ordinance for Heating Systems (Heizungsanlagen-Verordnung, HeizAnlV) was put in place two years later, in 1978 (Jacob & Kannen, 2015). In 2002 these two instruments have been replaced by the Energy Savings Act (Energieeinsparverordnung, EnEV, 2002), which was updated in 2009 and 2014 (Jacob & Kannen, 2015). In 2007 the Building Retrofit Programme (CO_2-Gebäudesanierungsprogramm) was installed, which provided subsidies for homeowners to take energy saving measures when they retrofit their buildings. This program was evaluated by Clausnitzer et al. (2008), showing that 88,590 dwellings made use of this program. To stimulate the use of renewable energy for heating the Erneuerbare-Energien-Warmegesetz (EEWarmeG) was approved in 2008. Its goal was to increase RES for heating from 11% in 2011 to 14% in 2020 (Eder et al., 2021). However, most regulations are not obligatory for existing buildings.

Regarding the progress of transition in Germany's built environment we mention three scenario studies specifically investigating the heating transition in Germany. First, we refer to Bauermann (2016), who analyzes five policy scenarios, focusing on the heating market; he shows that the goals for renewable heating and for the reduction of energy demand in the existing stock will not be met with existing policies. Without regulatory and financial incentives homeowners will continue to cling to the cheaper fossil systems. Bauermann concludes that both obligations and subsidies are necessary instruments to reach the goals. Secondly, focusing on Niedersachsen, Haase and Torio (2021) examine three scenarios for the heating transition, their conclusion is that the penetration of renewable heating systems will not substantially increase, in spite of the available subsidies. They argue that this is because fossil systems, such as the combination of gas and heat pump, are also subsidized, so these remain economically more attractive. Furthermore, especially for buildings with a low energy demand, fossil systems remain the most economic option. To remedy this situation, it is important to restrict subsidies to fully renewable systems, for example combinations of heat pump and solar PV. Thirdly, the transition to near zero energy buildings (NZEBs) in Germany is investigated by Schimschar et al. (2011). Similar to the other two studies, Schimschar et al. conclude that the goals are only achievable with an intensive policy package and a high turnover of energy refurbishment, new buildings on NZEB-level, and demolition.

These modelling studies shed light on the long-term effects of policy measures. They predict the expected decisions of homeowners against the background of energy policies, prices and technologies. Homeowners are important actors in the energy renovation system. We will now look more closely at the perspective of the homeowner. Homeowners see their property as a home, a private place where they want to feel safe and comfortable (Gram-Hanssen et al., 2007). According to Baginski and Weber (2017), the decision of a homeowner to renovate should not be framed as an investment, but as a decision of a consumer. Furthermore, financial arguments are only one of the factors for owners to embark on an "renovation journey." For example, Pomianowski et al. (2019) draw on empirical research in the REFURB project and argue that economic aspects are not sufficient as a motivation of homeowners. They argue that aspects such as healthy indoor climate, architectural aesthetics, and real estate value are equally important for choosing elements to be included in renovation packages. Wilson et al. (2018) point to the complex decision-making process of homeowners and the different influences on this process, such as stage of life, meanings of home, and household dynamics. Decisions are also influenced by aesthetic considerations (Sunikka-Blank & Galvin, 2016). Esser et al. (2019, p. 50) show that personal benefits, health, environmental and financial aspects (lower costs) are all strong motivations. They find that the driver to improve the residence is the strongest.

To contribute to an explanation of the slow progress of the heating transition we draw on the framework of technological innovation systems (TISs). In this approach a technological sector or domain is viewed as a system, in which interaction between actors and the existing institutions strongly influence the speed and direction of innovation. This approach emphasizes that problems can inhibit the functioning of the system. So, the identified barriers and drivers that are often described in renovation literature (D'Oca et al., 2018) do not occur in isolation, they are part of an innovation system. The innovation systems approach has been applied to the sector of energy renovation before. In 2001, Rohracher (2001) argued to analyze sustainable building as an innovation system. For the ecological refurbishment of buildings, he concluded that there is a "deadlock of supply and demand" (Rohracher, 2001, p. 145), and further argues that a feasible approach to tackle this deadlock is by organizing a local market transformation. An application of the systems approach on the Dutch situation is provided by Faber and Hoppe (2013) and Kieft et al. (2017, 2020). Multiple systemic problems are identified that act as a blocking mechanism in the transition of NZEB-houses. Kieft et al. (2017) also reveal how systemic problems, such as the project-based approach and financial aspects, interact. For energy renovation, Kieft et al. (2020) argue that we have to differentiate between two types of logic: the steps-logic and the leaps-logic. In both types of logic, the analysis of problems and solutions differ quite widely. Kieft et al. (2020) argue that these approaches to energy renovation could be seen as representing two different innovation systems or TISs.

With the existing literature on different innovation systems, it becomes possible to compare such systems and try to explain the variations in speed and success. The slow pace of the transition to renewable energy has been explained in the context of the TIS by Negro et al. (2012). The progress of renewable energy has picked up in recent years, and thus it can now serve as a benchmark for the progress of energy efficiency in the building stock, also called the heating transition. Comparing the transition to renewable sources of electricity with the heating transition, Wesche et al. (2019) argue that the main cause of the slow heating transition is the configurational nature of its TIS. A configurational innovation system is characterized by a multitude of actors, both on the demand and the supply side, as opposed to the more compact and linear system that can be found in a generic TIS. Furthermore, Wesche et al. (2019) argue that configurational TISs are strongly embedded in the local context, which further slows down the pace of transition. Actors on the supply side tend to be locally organized, while sector organizations on a national level are not much interested in energy renovation but have other priorities. Knowledge in firms at the local level is not specialized but rather divided over many types of building projects. On the demand side, the large influence of customers is detrimental to the speed of the transition, because of the need for tailor-made solutions instead of standardization. Wesche et al. (2019) illustrate this argument by highlighting the multiplicity of components, produced by different manufacturers, offered by local installers to households. Adding to this, we should note that for a deep renovation several energy measures are necessary, all requiring specialized installers and building engineers. Moreover, households often need loans or other financial products to finance a refurbishment. To assess, calculate and combine the available measures for an energy renovation requires considerable technical knowledge of buildings, materials and installations. Therefore, access to such knowledge is crucial both for installers and homeowners.

Energy renovation is complex, innovative, and expensive, which is demonstrated by studies of the innovation system of energy renovation (Wesche et al., 2019), by long-term scenario studies (Bauermann, 2016; Haase & Torio, 2021), and by studies directly informed by homeowners' motivations (Galvin, 2012; Mlecnik et al., 2019; Wilson et al., 2015). What solutions have been developed to increase the pace of energy renovation? Several proposals to improve the local renovation system have been put forward by EU-funded projects, which we will examine in the next section.

In the remainder of the article, we will first describe our research approach (Section 2). Next, we look into the solutions for fragmentation that are proposed in EU-renovation projects (Section 3). The last part is focused on discussion and lessons learned (Section 4).

2. Research Approach: Inventory and Review of EU-Projects

In the EU-Seventh framework Programme as well as in the EU-Horizon 2020 Programme a considerable effort has been made to develop and demonstrate new solutions to energy renovation issues. We carried out an inventory of recent EU-funded renovation projects of the past 10 years. We identified 87 potentially relevant projects in several EU-databases (CORDIS, 2018). We also used snowballing to identify related projects. From this initial list we selected the projects focused on building owners and users, thus excluding projects that were primarily technical. This narrowed down the original list of projects to 38 relevant projects, which we subsequently investigated by visiting the project websites and retrieving deliverables, such as reports and information materials. The project deliverables in the sample were analyzed with Atlas.ti to find recurring themes that pertained to homeowners and energy renovation. One of the important themes emerging from this inventory is that in many projects it is considered important to counter fragmentation on the supply side as well as on the demand side. Therefore, we selected the projects that are especially relevant to this theme for further analysis and studied the reported findings. For this article, we focus on this project sample, such as REFURB, MORE-CONNECT, TripleA-reno, and Energiesprong/Transitionzero. In that sense, this article is a review of "lessons learned" in these EU-projects (Table 1).

Table 1. Overview of EU-projects that referred to one-stop-shops.

EU-project	Theme	Start	End
Abracadabra	New renovation strategy which aims at reducing the initial investment for deep renovation	2016	2019
COHERENO	Strengthen the collaboration of enterprises by eliminating barriers for collaboration, providing guidance on how to collaborate and developing services for customer segments	2013	2016
ERACOBUILD	Develop deeper, more durable cooperation and coordination between national funding bodies across Europe, to increase the quality and impact of research in the construction sector	2010	2012
iBroad	Support for "energy auditors" with ICT-based tools, including building logbook and renovation roadmap	2017	2020
Heron	Forward-looking socio-economic research on energy efficiency in EU countries; overcoming market barriers and promoting deep renovation of buildings	2015	2017
Innovate	Development and roll-out of innovative energy efficiency services	2017	2020
MORE-CONNECT	Developing prefabricated, multifunctional renovation elements and installation/building services; furthermore, the development of a one-stop-shop platform for both the customer and the production side	2014	2018
NewTrend	New participatory integrated design methodology (toolkit) to improve the energy efficiency of the existing European building stock and to improve the current renovation rate; targeted at the neighborhood level	2015	2018
ProGetOne	Combines the goal of safety upgrades to face future earthquakes in seismic zones and energy renovation	2017	2021
P2Endure	Plug-and-play product and process innovation for energy-efficient building; developed an "e-marketplace" with "plug-and-play" solutions for renovation	2016	2020
REFURB	To decrease the fragmentation of the renovation process and to bridge the gap between the supply side and demand side with dedicated renovation packages for different market segments within the residential sector	2015	2018
Stunning	Stakeholder community and knowledge sharing around renovation hub; business models for renovation, typology of one-stop-shops	2017	2019
TripleA-reno	Develop new customer-centered business models and decision support tools, designed as a gamified platform for users	2018	2021
TURNKEY RETROFIT	Develop an integrated home renovation service, designed as a homeowner-oriented renovation journey, aiming to transform the complex and fragmented renovation process into a simple, straightforward and attractive process for the homeowner	2019	2021

3. Lessons From EU-Projects: Solutions for Fragmentation

In our project sample, the urge to counter fragmentation was expressed in many projects. Several approaches are developed and tested. A common proposition is the formation of a "one-stop-shop for renovation." In the development of such a one-stop-shop, cooperation on the local level and knowledge exchange between stakeholders on the supply side is stimulated. On the other hand, a one-stop-shop also aims to support homeowners with decision making in the renovation process.

The one-stop-shop for renovation is a concept that was first investigated in the EU by ERACOBUILD, an EU-funded project that ran from 2010 to 2012 (ERACOBUILD, 2012). In this project it was argued that:

> Existing barriers include the fragmentation of the renovation process, which is split among many SMEs, each doing a fraction of the renovation work. Moreover, homeowners do not have a structured way to obtain all the necessary information for decisions on renovation solutions, contacts with building companies, quality assurance, and financing opportunities. (Haavik et al., 2012, p. 5)

ERACOBUILD aimed to learn from demonstration projects in Norway, Belgium, and the Netherlands, and to pave the way for new one-stop-shops (Mlecnik et al., 2012). Importantly, ERACOBUILD also published guidelines to help SMEs to develop a business model for a one-stop-shop for renovation (Haavik et al., 2012).

A second EU-funded project that addressed the fragmentation of the renovation process is REFURB, which aimed to help the homeowner with navigating the energy renovation journey (European Commission, 2015; Pomianowski et al., 2019). In this project both the supply as well as the demand side of the renovation market was investigated, including a SWOT-analysis of seven one-stop-shops in EU-countries (D3.3/D3.4). An important barrier for homeowners is the difficulty to obtain the necessary information for decisions on renovation solutions. Interestingly, they found that the non-technological solutions, such as new ways of financing, new approaches to organize the supply side, quality assurance and one-stop-shop solutions, proved to be more important than the technological solutions to seduce homeowners to renovate to NZEB-level (Cuypers & Rathje, 2016, p. 29). The project aimed to bring together the supply side (building construction sector) and demand side (homeowners) by developing a "compelling offer": a renovation package based on a match between available technologies and homeowners' concerns. For example, in the Better Home program in Denmark, homeowners first got a free energy review to assess what needed to be done and then were brought into contact with qualified craftsmen who could carry out the renovation. Better Home also worked together with local banks to secure competitive loans to help homeowners to finance renovation projects. REFURB's partner Leiedal (Belgium) developed an online tool, My Energy Compass, which can inspire development of tools in other regions in Europe. This tool gives information and nudges the homeowner to proceed in the renovation journey (Antonov & Pomianowski, 2017).

Thirdly, TURNKEY RETROFIT is an EU-funded project that emphasizes that the energy renovation market in the EU is potentially very large, keeping in mind the high ambitions on EU-level for renovating existing building stock (European Commission, 2019). The project identifies the fragmentation of this energy renovation market as one of the main problems, pointing to both the supplier and customer's side. Integrated renovation services are seen as one of the solutions for fragmentation. On the basis of an evaluation of nine integrated services the key elements for the TURNKEY RETROFIT integrated service/one-stop-shop are outlined. A homeowner-oriented renovation journey was developed, which offered tailormade solutions and guides the homeowner through the whole renovation process. This also included a technical offer, help with finding financial support, but went even further and provided on-site coordination of works and quality assurance. Furthermore, TURNKEY RETROFIT also developed a digital platform for homeowners (D'Oca et al., 2019; Desmaris et al., 2019; Volt et al., 2019).

Fourth, we find the Energiesprong campaign in the Netherlands (Energiesprong, 2021), which aimed to use the social housing sector as a catalyst for kickstart net-zero energy refurbishment markets. The related, EU-funded project Transition Zero aimed to build on the success of Energiesprong and advance its implementation to the UK and France. Supported by Energiesprong, more than 12,000 dwellings were built or renovated to ZEB-standards. However, for renovation, the aim to stimulate zero energy renovations in the private market largely failed, presumably because of rising prices, as is shown by the low numbers of zero energy renovations in owner-occupied dwellings (Bekkema & Opstelten, 2019). Furthermore, the expected financial benefits of scale and experience did not materialize for the same reasons, which caused social housing corporations to retract from zero energy renovations (Van Goor & Brink, 2020).

Fifth, the EU-funded project MORE-CONNECT (MORE-CONNECT, 2018) sought solutions in the combination of prefabricated, multifunctional renovation elements and the provision of renovation services. To that end, MORE-CONNECT developed a "one-stop-shop," where the end-user will deal with only one party, which is responsible for the total renovation. Hindrance will be reduced to the minimum by limiting renovation time to five days, while occupants can stay at home during the renovation process.

Lastly, we briefly refer to TripleA-reno (TripleA-reno, 2018), which refers to Affordable, Acceptable, and Attractive renovation, with users in the centre. In this project, a gamified platform was developed to provide users of deep renovation projects with attractive, understandable, and personalized information (D'Oca et al., 2019). Another relevant EU-funded project in this respect is COHERENO, which ran from 2013 to 2016 (see, e.g., Mlecnik et al., 2012, 2019; Straub, 2016).

Summarizing, the concept of the one-stop-shop is promoted as an appropriate solution for defragmentation in the renovation market. Such "shops" provide easy access to information and building analysis to customers, they connect stakeholders from different backgrounds, from building physics to financial assistance. The proposed shops do not necessarily contain all these functions, for example MORE-CONNECT is focused on prefabricated building elements and building modeling, while REFURB proposes a combination of renovation measures with financial solutions. Other approaches contain elements of gaming, such as TripleA-reno. Lessons learned from existing one-stop-shops are described in several projects (Haavik et al., 2012; Mlecnik et al., 2012, 2019).

4. Discussion

The diagnosis of the slowness of the heating transition by Wesche et al. (2019) suggests that stronger organization and cooperation of the supply sector is needed to make progress. Moreover, the demand side also needs to be involved, the cooperation of the primary decision maker, the homeowner, is necessary. The "one-stop-shop" for renovation is one of the solutions that is proposed to bring together stakeholders from the building sector with homeowners. In the literature, it is recognized that one-stop-shops can reduce transaction costs of energy renovations (Ebrahimigharehbaghi et al., 2019). In our inventory, we identified several EU-projects that have investigated and demonstrated such a "one-stop-shop," in which stakeholders worked together to formulate a "convincing offer" for homeowners.

However, the homeowner often needs to search for information about specific components or technical approaches, because not all installers have up-to-date technical knowledge to advise on new or innovative solutions. Moreover, there are also financial, regulatory, or other elements relevant to the TIS. For example, homeowners often need a loan to cover the considerable costs of the renovation. In many EU-countries it proves difficult to get such a loan, because banks have uncertainties about the energy performance or the value of the renovated property (Lugies, 2021).

The heating transition is highly context-based, as it depends on local suppliers and individual customers. According to Wesche et al. (2019), this situation contributes to the slow pace of the heating transition. Other factors are a lack of knowledge, lack of available finance for homeowners, and a low level of regulation. Together, the fragmentation of the market, lack of sufficient information, and absence of guarantees are important factors that keep customers from investing in deep energy renovation.

The heating transition is dependent on two main parts: reducing demand and renewable supply. Reducing energy demand through energy renovation of existing buildings progresses very slowly, as previously stated in the Introduction (BPIE, 2014). The same goes for the transition towards renewable heating systems (Bauermann, 2016). Compared to the financial incentives for renewable electricity, policies to stimulate fossil-free heating systems stay behind (Haase & Torio, 2021). On the basis of these studies, it is expected that without proper financial and regulatory incentives for renewable heating systems the dominance of fossil-based systems is likely to continue in the coming decades (Bauermann, 2016; Haase & Torio, 2021). Policies for sustainable heating could be improved by learning from the simple, long-term financial remuneration that was provided for individual PV-systems in Germany.

Furthermore, the analysis of the renovation system (Wesche et al., 2019) suggests that measures to improve cooperation and communication between stakeholders in the renovation system on local as well as national levels could increase the energy renovation rate. Several EU-projects have demonstrated that one-stop-shops are a viable solution to remedy the fragmentation of the supply-side and provide clear and accessible information to customers.

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Conflict of Interests

The author declares no conflict of interests.

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