Bundesministerium
für Wirtschaft
und Klimaschutz

Schlussbericht

FinSESCo - Fintech for Smart Energy System Contracting

Zuwendungsempfänger:	Stiftung Europa-Universität Viadrina
Vorhabenbezeichnung:	FinSESCo
Förderkennzeichen:	03EI6072A
Berichtszeitraum:	1.05.2022 bis 31.12.2024
Autoren:	Prof. Dr. Jens Lowitzsch, Renan Magalhães

Die Verantwortung für den Inhalt dieser Veröffentlichung liegt beim Autor.

Executive Summary

This report intends to present the final summary of the findings of the project, presenting the main contributions of our research to the consortium and to the project. During the setup phase, the project faced a number of constraints: two partners not being able to be funded and the third one with a strong delay to start. The analysis was adapted for our Indian Pilot, reflecting the expected challenges and the potential of the pilot site. Practical choices were necessary, such as the use of a standardized questionnaire for building owners, the focus on adapting strategies to the local context, and the documentation of socioeconomic background by extensive background analyses, enriching the evaluation with qualitative insights.

The evaluation of the FinSESCo platform was performed by including a variety of methodologies aimed at capturing its performance across different dimensions. These included qualitative interviews, surveys, and detailed case studies for each pilot, supported by quantitative analysis to identify drivers of acceptance. A comparative cross-pilot approach was used in order to develop EU-level insights, ensuring findings are relevant across different contexts. In this report we will present the main findings from the different evaluation processes. Overall, this review shows actionable recommendations to advance the platform's usability and scalability, and better alignment with local needs, while showcasing its potential to address barriers in energy efficiency investments across Europe.

1. User Experience and Design Evaluation – technical requirements

The primary goal of this analysis was to conduct an in-depth and comprehensive reassessment of the FinSESCo platform, focusing on the most anticipated functionalities but also assessing primary concerns on the user experience and design aspects. This reassessment was based on qualitative interviews (Brinkman & Kvale, 2014) with designers and potential users to gain valuable insights into the platform's most useful characteristics, the most appealing functionalities, what may be lacking, and how the initial design and usability are seen. The aim was to identify existing strengths, weaknesses, and areas for improvement, providing actionable recommendations to enhance the overall functionality and innovation potential of the platform for energy contracting, therefore while design elements were considered, they take a secondary role.

The analysis for this section is based on semi-structured user interviews conducted with designers and social media manager and users in October 2023, reflecting the viewpoint of potential users. The User Experience and Design Reassessment methodology draw on expert experiences and knowledge to conduct qualitative interviews with designers, people who use the FinSESCo platform in the pilots and other potential users. This approach aligns with the industry's best practices and allows for a nuanced understanding of the platform's usability and design aspects.

1.1. Results - Points to improve on the FinSESCo platform

General feedback

- **Language Consistency:** Respondents found the mix of English and German confusing. The platform should have a default language with an option to change it, ideally to English in this case.
- **Responsiveness:** Two respondents expected the platform to function well also on tablets and mobile devices. The lack of responsiveness, particularly regarding the monitoring or browsing functions, was a recurring issue across different tabs on the page.
- **Role Distinction:** The distinction between user roles was not clear. Respondents were unable to understand the difference between being an investor and uploading personal projects. This confusion also extended to navigating between tabs associated with different functionalities. It suggests that the roles should be more clearly differentiated at a higher level. One respondent cited Airbnb as an example, where property owners and holiday bookers have access to different areas of the site, making it easier to understand the functionality based on the user role.
- **Detailed Project Table:** While the detailed project table, including the small depiction of the project site, was positively received, the KPIs were not entirely clear. Respondents suggested providing more detailed information on the measures, possibly through an interactive section. One respondent suggested a more graphical representation of the numbers, such as combining the funding target and "bereits erreicht" in a pie chart.
- **"Mein Beitrag" Section:** Users understood that they needed to enter an investment amount but were unclear about the subsequent steps, such as clicking "Invest/Add." Questions arose about the payment process, including how money is transferred, what happens if the project fails, when and how interest is received, and whether there is a

contract after clicking the button. The payment process and contractual details need to be clarified.

- **Table Headlines:** Respondents were confused by the table headlines. They thought "investment" referred to the amount they personally invested. They were unsure about the meaning of "payments." One experienced respondent questioned how the yield could differ from the interest rate, expecting a constant 2.5% yield.
- **Graphical Representation:** Respondents wanted a more interactive and graphical representation of their portfolio. Suggestions included dynamic charts to clarify financial outlay and yield, and a summary of all data, such as total investment and total yield. Additionally, the project progress and associated time constraints were unclear. Respondents wanted to know when the project would be completed or if it was already built.

1.2. Summary findings

Despite their interest in the platform and its functionalities, the respondents expressed concerns about trusting the platform for larger investments due to the design and difficulty in fully understanding the platform's functions or the associated monetary flows. Clear assurances, such as endorsements from a bank or other reliable references, were considered necessary for building trust. Additionally, respondents suggested providing more information about the legal aspects of such investments.

Despite the critical feedback, all respondents recognized the platform's potential and utility. It is important to note that, at the time of submitting this report, the feedback has been duly presented to the team, considered, and addressed. The platform now features a much more refined and practical design compared to the initial mockup presented to the responden

2. Requirement analysis

We proceed to compare traditional energy efficiency (EE) investments with the ones made possible via the FinSESCo platform, examining the roles of demographics, motivational drivers, and what we call controllers. Traditional Energy Performance Contracting (EPC) usually faces barriers such as limited consumer awareness, legal complexities, and financial constraints that hinder broader adoption in private markets, despite its potential to decarbonize and reduce energy costs. By utilizing fintech platforms, such as FinSESCo, the process of EE investments can be democratized and reach a diverse group, different from the traditional one, offering solutions like crowdfunding, gamified investment processes, and smart contracts to address these limitations. This shift could significantly alter the profile of EE investors and improve engagement with underrepresented groups, such as tenants or lower-income households.

In our study, we presented how digital platforms can overcome traditional barriers to EE investments, providing insights into the interplay of socioeconomic demographics, motivational drivers, and controllers (such as experience in (co-)ownership of Renewable Energy installations) influencing EE investments. Prior research indicates that factors like income, homeownership, and environmental awareness shape willingness to invest, while past investment experiences can trigger future engagement. By examining these variables in both traditional and digital contexts, this part of our requirement analysis identifed strategies for broadening the acceptance of the FinSESCo platform in the sector of user investment. The findings compiled in this section identify not only the main investment segments of FinSESCo but also provide actionable insights into designing more accessible and impactful EE financing models.

We assume that the order of importance and the interaction of these drivers, controllers and socioeconomic factors and their influence on the willingness to invest may shift or be differently impacted by the digital factor. Aiming to fill this research gap, compare both models and guide the FinSESCo consortium to understand the profile of investors of EE measures via fintech while compared to the ones in traditional environment, a survey with German households were conducted in 2023. The resulting dataset allows us to correlate interest in the platform, knowledge of energy efficiency contracting models, and previous experience with crowdfunding investments in energy efficiency behavior. We translated our interests into four main research questions, trying to predict which groups would be interested in using the platform by interacting the different groups of variables (controllers and drivers), socioeconomic factors and the willingness to invest in EE and to invest in the FinSESCo platform.

2.1. Deliberations on the data collection

The data collection process is based on previous collections by Roth et al. (Roth et al., 2018, 2023) structuring the database with a focus on measuring the energy efficiency behavior and demand-side flexibility of renewable energy prosumers. The questionnaire was designed to enhance the existing database, this time targeting a broader range of prosumers and ensuring a better distribution of gender and income ranges, reaching a larger number of low-income prosumers and non-prosumers, as well as female prosumers.

It was conducted by the survey company Norstat between 28th of August, 2023 and 23th of November, 2023, utilizing its pool of respondents and filters established by its team to target prosumers within it. Thus, the questionnaire may not be representative of the demographics of German prosumers – how they are distributed across different societal strata, the main sectors they represent, or infer the percentage of prosumers in the country - data still unknown (Flaute et al., 2017). The questionnaire initially aimed to be representative of German society, aligning with the distributions in relation to the population of the states, age groups, and gender. Small adjustments were made during the data collection, with invitations sent to groups where a higher concentration of prosumers was observed without the use of filters. In the final phase of the collection, to achieve the expected numbers, internal questionnaire filters were used to exclude non-prosumers, and at the last moment, all those who were not female prosumers were excluded.

The data was collected in order to address the interests of the FinSESCo, aiming to outline a profile of the main stakeholders interested in the platform, identify investment and interest gaps, and match overlooked groups with the platform's usage. Possible relationships between potential platform usage and prosumership were translated into questions on the platform to utilize the data as broadly as possible. The data allows for the correlation of interest in the platform, knowledge of energy efficiency contracting models, and past experiences in crowdfunding investing in energy efficiency behavior, enabling a series of possible analyses for consumption habits to be tested.

2.2. Deliberation on the Sample

The total sample of the database consists of 2585 complete questionnaires. We have selected the main demographic and control variables for prosumership to briefly summarize the data characteristics. It is important to note that our database includes a high number of prosumers - a total of 925, with 464 of them being females. This is a robust database for understanding prosumer behavior, comparing it with non-prosumers, and conducting internal comparisons between genders and types of prosumership.

Our database initially aimed to be representative of the German demographic. Therefore, we sought to mirror the distribution by age groups according to the country data. However, as we tried to boost the number (co-)owners of the data, the invitations for the questionnaire focused on groups with a higher likelihood of encountering prosumers. Therefore, the data cannot be used to infer the number of prosumers in Germany.

To ensure the quality of the dataset, we conducted outliers test, t-test, and Wilcoxon test to examine differences in the samples of regular respondents and those who completed the survey after an interruption; syntax analysis searching for unusual values and characters. Additionally, we investigated the cooperation required to respond properly to matrix questions and the estimated time to complete the questionnaire. From the 2585 initial sample, we removed 31 questionnaires due to potential issues regarding their quality.

Income levels are defined based on thresholds derived from the median income. Specifically, incomes below 60% of the median are classified as low, those between 60% and 150% of the median as medium, and incomes above 150% of the median as high, using the main thresholds used for countries in the European Union (Hirsch et al., 2020).

2.3. Deliberation on the measurement

In our questionnaire, we have designed specific questions to understand the level of understanding of German households about energy efficiency contracting, their willingness to invest in models like FinSESCo and their willingness to invest in energy efficiency in general. To calculate their willingness to invest in EE measures, we have asked if they had already invested in energy efficiency measures to reduce electricity consumption or investment in measures to reduce requirements for heating. The respondents could also select which types of investments they have made. They were also asked if they are *planning* on performing these measures.

For each question, the respondent could opt for 0 – no, or 1 – yes, meaning that they that they had invested or are planning to invest for each specific measure. Afterwards, after being briefly introduced to the models and how the platform will work, we asked the questions on how familiar they were with "Energy Savings Performance Contracting" or "Energy Savings Contracting, if they would you use an Energy Savings Performance Contracting Service via FinSESCo, if they have ever used crowdfunding to fund their own project or if they have invested money through crowdfunding to finance a third-party project?

Afterward, respondents were asked to rate on a scale from -3 to +3, representing "Not familiar at all" to "Very familiar" for the first question, and "I wouldn't use it under any circumstances" to "I would definitely use it" for the second. We transformed the scale from -3 to 0 as 0, meaning individuals who were not familiar and/or "people who would not use the FinSESCo model", and from +1 to +3 as individuals who were familiar and would use the FinSESCo platform.

Respondents were are also asked what were their main drivers to invest or plan to invest in EE measures: Financial motivation; Environmental protection motivation; Previous knowledge motivation; Climate change motivation; Energy autonomy motivation; To sell excess energy motivation. For each answer, respondents could opt on a Likert scale from 1 - strongly disagree up to 5 – strongly disagree.

2.4. Deliberations on the model specification

Our analysis was based on backward stepwise regressions. Backward stepwise regression is a statistical method used for building regression models. In this approach, all independent variables are initially included in the model, and then, step by step, variables are removed based on their statistical significance until only the most significant variables remain (Thayer, 2002). The backward stepwise regression starts with a full model containing all independent variables and gradually removes variables that contribute the least to the model's predictive power (Hong & Mitchell, 2007; Ruengvirayudh & Brooks, 2016). This process continues until no further variables can be removed without significantly affecting the model's fit. Overall, backward stepwise regression is a valuable tool for identifying the most influential variables and building a predictive (Agostinelli, 2002) model that accurately captures the relationship between independent and dependent variables in our analysis. In our analysis, the significance level of α is < 0.05, as per (Agostinelli, 2002) and (Wang et al., 2007).

For this, we have created four different models. The models have as independent variables either an index to calculate the willingness to invest in EE measures using the FinSESCo platform (index_finsesco) or the willingness to invest in EE measures in general (index_ee).

The "index_finsesco" quantifies the willingness of respondents to use the FinSESCo platform, converting responses to the question "Are you familiar with 'Energy Savings Performance Contracting' or 'Energy Savings Contracting'?" (v_63_1) from a scale of -3 to +3, representing "Not familiar at all" to "Very familiar" for the first question, and "I wouldn't use it under any circumstances" to "I would definitely use it" for the second. a. The value of the variable v_63_1, here named y1, contains values on scale of 1 to 6; b. subsequently, we perform a log transformation. Log transformation is used to normalize skewed data, reduce the impact of extreme values, and make the data more normally distributed (Feng et al., 2014) as many behaviors and perceptions follow a skewed distribution, where a few individuals exhibit extreme behaviors or attitudes (Hammouri et al., 2020), Log transformation helps in stabilizing the variance and making the data (Feng et al., 2014); c. to this value, we add a constant of 1. Adding a constant (in this case, 1) before applying log transformation is a common practice to handle zero or negative values, since the log of zero is undefined; adding a constant ensures that all values are positive and hence, their logarithms can be computed; d. we normalize the value by dividing it by the mean of the values. e. finally, we take the square root of the total. Normalizing by the mean value of the transformed variables helps in standardizing the scores and making them comparable. This step ensures that the index is not biased by the scale of the original variables and is interpreted on a common scale.

After creating the independent variables, we divide the independent variables into three groups: drivers, controllers and demographics. Following is the list of the variables used in the four models calculated in this analysis.

Table 1 - Variables of the models

Variable	Description
	Indexes:
Y_1	index willingness to invest in energy efficiency
Y_2	index willingness to invest via FinSESCo
	Drivers:
X_1	v_40_1: Financial motivation
X_2	v_40_2: environmental protection motivation
X_3	v_40_3: previous knowledge motivation
X_4	v_40_4: climate change motivation
X_5	v_40_5: energy autonomy motivation
X_6	v_40_6: to sell excess energy motivation
	Controllers:
X_7	Home Ownership
X_8	Previous experience in crowdfunding
X_9	Previous knowledge in energy-efficiency contracting
X_{10}	Prosumer
	Demographics:
X_{11}	Income: Low
X_{12}	Income: Medium
X_{13}	Income: High
X_{14}	Age
X_{15}	Gender
X_{16}	Education

In our analysis, we employed bootstrapping to enhance the robustness and reliability of our regression models' coefficients (Sahinler & Topuz, 2007). Bootstrapping involves repeatedly resampling the original dataset with replacement and estimating the model on each resampled dataset. This process mitigates the influence of outliers, providing more accurate confidence intervals (Cribari-Neto & Zarkos, 1999; Streukens & Leroi-Werelds, 2016). Specifically, the data was resampled 10,000 times to ensure a comprehensive and reliable estimation of the model parameters, where each sample had the same size as the original dataset. We then calculated the Cook's Distance to identify influential points in the dataset (Filho et al., 2023) and remove the ones exceeding 4/n, where n is the number of observations. A new regression model was fitted to the dataset without the influential points, again, performing a backward stepwise regression.

To answer our research questions, we created four different regression models: i) considering as the independent variable the index to calculate the willingness to invest in EE and the interactions of the drivers and the demographic variables; ii) the index to calculate the willingness to invest in EE and the interactions of the controllers and the demographic variables; iii) considering as the independent variable the index to calculate the willingness to invest via FinSESCo and the interactions of the drivers and the demographic variables; and iv) the willingness to invest via FinSESCo and the interactions of the controllers and the demographic variables.

2.3. Results

For the model 1, with HIH having the largest propensity to invest, previous research indicating that the lack of financial means are an obstacle to EE-investments is corroborated. Within the groups that have a higher propensity to invest, i.e, HIH and MIH, a positive driver appears to be "counteracting climate change" for HIH and the drive to "sell excess energy" for MIH, while with regard to LIH we observe additionally the previous knowledge motivation as an incentive.

The results reflect, then, the previous research that show HIH and MIH, motivated by counteracting climate change, show a strong willingness to invest in EE. The emphasis on pro-environmental attitudes as drivers supports the point on social motivations for investment (Radtke et al., 2022). This is result is also supported by Bauwens (2016). The option to receive monetary returns from surplus energy motivates MIH to invest, highlighting how financial incentives can bolster demand flexibility among the higher-income households (Bauwens & Eyre, 2017; Radtke et al., 2022). In the context of Renewable Energy Communities, the literature shows that financial means among Consumer-Sellers (who are typically HIH) support demand flexibility for EE investments, specifically in household appliance use. This aligns with the point that financial resources enable HIH to engage in EE (Roth et al., 2023). However, only households with both consumption and selling options have a higher propensity to invest in energy-efficient technologies (Roth et al., 2023). The financial incentives associated with selling excess energy motivate households to invest in energy-efficient technologies, optimizing their utility and aligning with the economic drivers highlighted in our results. The counteracting climate change driver, in the literature, is also associated with community energy membership - rather than financial gains, while financial limitations are a key barrier, particularly for low-income households(Bauwens, 2016). This supports the point on financial constraints being an obstacle and aligns with the motives of HIH and MIH for ecological reasons (Radtke et al., 2022).

For our model II, controlling for home ownership, previous experience in crowdfunding or EE-contracting and prosumership we observe the same general picture, i.e., propensity to invest increasing with income. Interestingly, the strongest interacting element is homeownership followed by experience in crowdfunding. With both moderating elements stemming from experience we surmise that they reflect the financial barrier mentioned earlier: Richer HH are more likely to be homeowners, while poorer HH may have experience in crowdfunding precisely to overcome this obstacle. Unsurprisingly, home ownership as a co-factor is positively only relevant for HIH and MIH (who are the ones most likely to own), while have a negative interaction with LIH. Interestingly, the interaction between previous knowledge of EPC and low-income households convert the effect to be a positive co-factor.

Community experience, including previous involvement, increases trust and belief in citizen participation, while higher-income participants show lower behaviour change impacts, often due to a focus on financial returns. This aligns with previous experience as a positive influence and the higher propensity of wealthy households to participate as prosumers. (Hossain, 2018; Radtke et al., 2022; Bauwens et al., 2022). At the same time, RE ownership is linked with higher flexibility, reflecting how previous participation impacts engagement. The literature highlights especially for those in rural areas, who may have more frequent prosumership opportunities. (Roth et al., 2021). The results point to the fact that prosumership and crowdfunding experience increase investment propensity. By emphasizing the role of social mechanisms in linking ownership and behaviour, this passage aligns with the view that LIH and MIH can overcome financial barriers through community-based prosumership (Goulden et al., 2014; Rommel et al., 2018; Roth et al., 2018). Also, experience in energy-related activities significantly boosts flexibility and willingness to invest in EE. This aligns with experience being a key driver for higher-income groups in overcoming financial barriers to invest (Roth et al., 2018).

However, the literature shows that financial barriers for LIH limit their involvement in EE behaviours, emphasizing the need for policy interventions to ensure equitable participation (Hanke et al., 2021, 2023). Therefore, the results also reflect how prosumership and financial flexibility favour increased energy-efficient behaviours, emphasizing how experience as a prosumer interacts positively with investment propensity. (Roth et al., 2018, 2021).

Considering platform-moderated vis-a-vis conventional investments, in our model III the general observation is that the former lends itself to households with limited disposable income whereas the latter is more attractive to richer households. In this light unsurprisingly, we see that the possibility to receive monetary returns from the sale of excess production - as a generally strong motivator for HIH - converts into a negative driver as monetary returns under crowdfunding mechanisms are burdened or wiped out by transaction costs and costs of financing (which independently of the crowdfunding scheme is essentially an investment on borrowed money).

Conventional investment models with fixed returns are attractive to HIH, as they provide financial stability. In contrast, digital ones make it more appealing for LIH. Limited disposable income LIH hinders participating in renewable energy initiatives and access to economic benefits, such as avoided energy costs (Hanke et al., 2021; Roth et al., 2023). The results show that in the case of digital environment, financial drivers main drivers for LIH in the traditional forms of investment, such as monetary returns from energy sales, may not always encourage energy-conscious behaviors, as seen in (Radtke et al., 2022). There is also a shift as in the case for HIH the main relevant driver in this scenario was the expected energy autonomy.

Finally, in or model IV we see that prosumership have the highest positive interaction elements in particular for LIH. As expected, increasing age is a generally disincentivising factor since crowdfunding and the use of digital platforms appears to be strongly correlated with digital literacy. This effect, however, turns around when coupled with home ownership (although not statistically significant) with the explanation most likely being that with increasing age HH income decreases and in particular LIH and MIH homeowners seek to revert to alternative financing sources.

2.4. Conclusions and recommendations

This requirement analysis highlighted the potential of the FinSESCo platform in overcoming traditional barriers associated with Energy Efficiency investment. The platform’s investment flexibility, as well as the crowdfunding option with gamification and smart-contract-based characteristics, can make the access to EE investment more democratic and reach a larger base with greater diversity compared to past traditional EPCo models. The results indicate that digital platforms are uniquely placed to reach less-represented groups, such as tenants and lower-income households, while increasing overall willingness to invest in EE measures. This shift brings in a more inclusive model of energy efficiency and opens a new way for greater acceptance of sustainable energy solutions.

The interplay of socioeconomic factors with motivational drivers and control mechanisms, such as prior experience with renewable energy systems, shapes investment behavior. Our study identifies income level, homeownership status, and environmental awareness as the important predictors of an individual's willingness to invest in EE measures. These factors showed significant variations between traditional investment models and digital platforms. Especially in the case of low-income households, which had experienced crowdfunding before, it was found that they would be more inclined to invest in FinSESCo. As presented, low-income households are usually detached from EE investment. Therefore, the alternative mechanisms provided by the platform can help overcome the financial barrier. Digital platforms are seen as more accessible and flexible for such groups, and moreover, scalable, not bound by traditional structures of financing.

Targeting those particular groups on the FinSESCo platform means targeting lower-income households and tenants often locked out of traditional EPC models due to high up-front costs and requirements for home ownership. This, therefore, needs to apply targeted marketing stressing the possibility of accessibility by means of crowdfunding and customized financing models that ensure that the barriers related to financing are minimized. For middle-income households, long-term environmental benefits and potential cost savings with EE investments can be critical motivators. To that, higher-income households may be attracted by emphasizing the opportunities for energy self-sufficiency and reselling excess energy, which goes in line with their financial priorities.

Public awareness and educational campaigns will further help in refining the strategies for engagement. In the case of households unfamiliar with renewable energy or digital platforms, making clear, accessible information on the benefits and functionality of the

FinSESCo platform available will be a key activity in reducing entry barriers. Showing the value proposition of the platform transparently could also reduce anxieties—especially for older people or those with limited digital literacy.

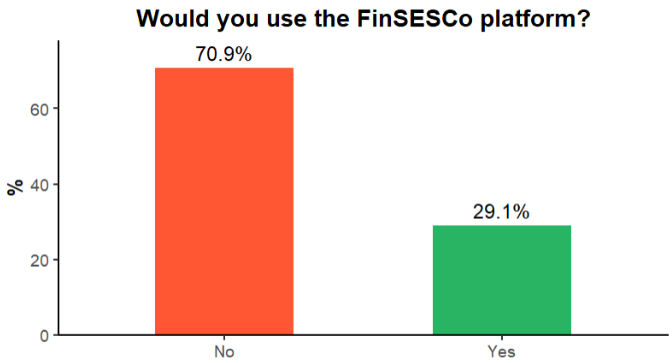
Also, community-based incentives or group financing models may help increase participation, particularly for poor households, where collective bargaining power or decreased risks because of group investments might be beneficial. Therefore, the consortium could also target prosumers and Renewable Energy Communities members and adapt the platform to include collective investments, as prosumers seem to be more willing to invest in EE via the platform. Taken in sum, these results encourage the conclusion that digital platforms like FinSESCo can bridge the gap between traditionally underserved demographic groups and the broader energy efficiency investment landscape. By overcoming financial barriers, embracing inclusivity, and tailoring strategies to the specific needs and motivators of each demographic, FinSESCo will go a long way toward accelerating the energy transition and ensuring broad engagement with sustainable energy solutions

3. Business model evaluation

We analyzed the potential of FinSESCO's business model using a questionnaire to find answers for the interests of FinSESCo and present the profile of the main stakeholders interested in the platform, show investment and interest gaps, and also link the overlooked groups to the usage of the platform. Using the previously described questionnaire, we first portrayed the main potential investor of the platform, comparing it to the differences from investing in the traditional model. In this stage of our analysis, we took the model itself and the impact it has on the profile of property or building owners seeking to have their projects financed. We do so by outlining the basic profile of the potential owner interested in the platform and through a market analysis for the pilot countries in FinSESCo, we then analyze how the profile characteristics are reflected in each market with its particularities and result in potentials or barriers for its implementation

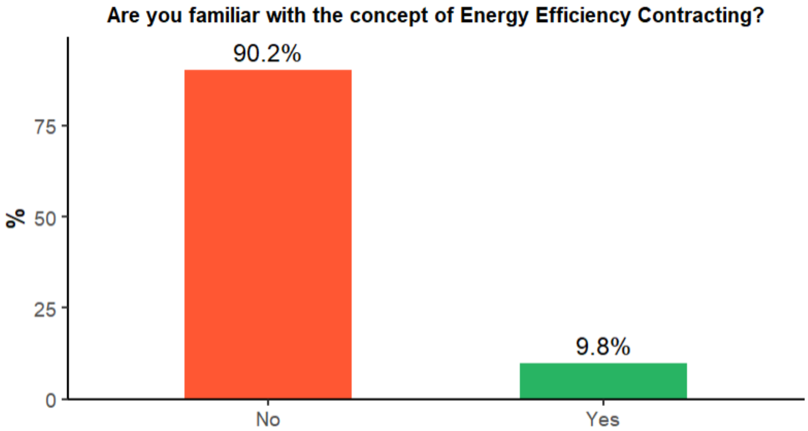
3.1. Overview

Image 1 – Share of respondents that would be willing to use the FinSESCo platform



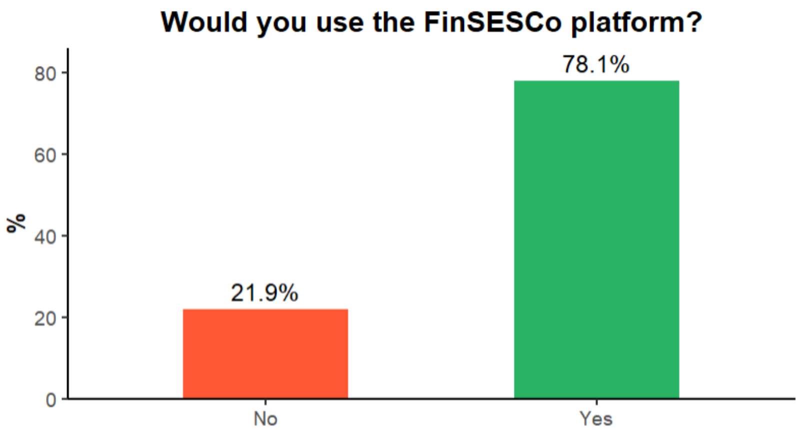
In our survey, we found that 29.1% of respondents, or 746 individuals, would be willing to use the FinSESCo platform. This proportion increases significantly when considering prior knowledge of Energy Performance Contracting methods.

Image 2 – Share of respondents that are familiar with the concept of EPCo



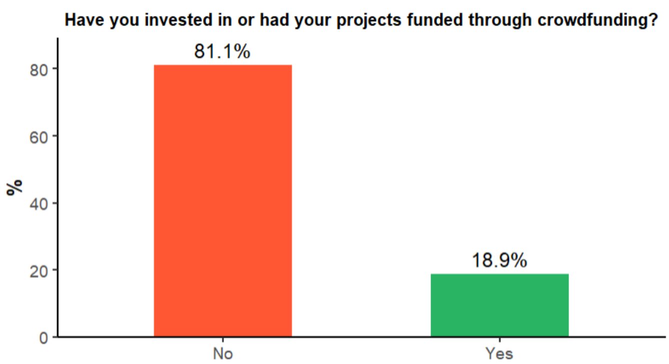
Although less than 10% of respondents are familiar with the concept, nearly 80% of those who are would be interested in using the platform. This highlights how interest is closely tied to knowledge and information.

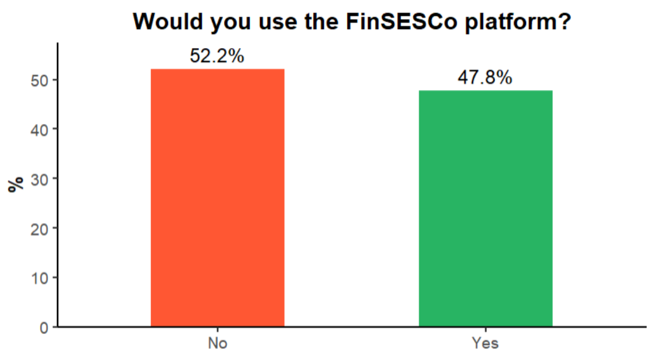
Image 3 – Share of respondents that would use the FinSESCo platform that are familiar with the concept of EPCo



Other factors also influence the willingness to use the platform, including past experiences with collective financing through crowdfunding.

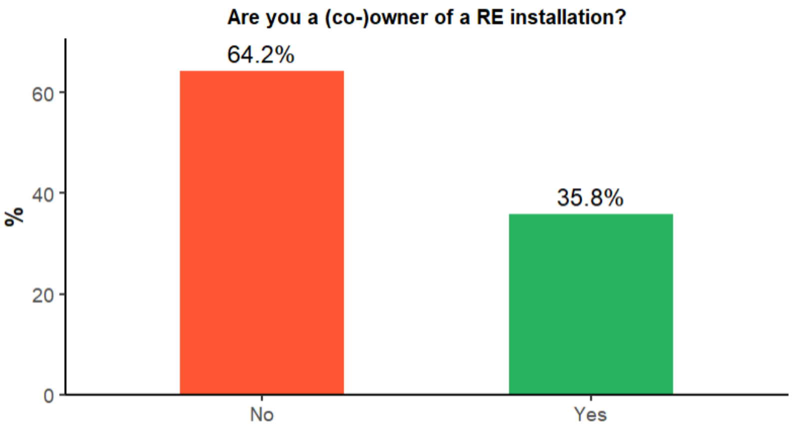
Image 4 and 5 – Share of respondents that had a past experience with crowdfunding and the share that would use the platform.

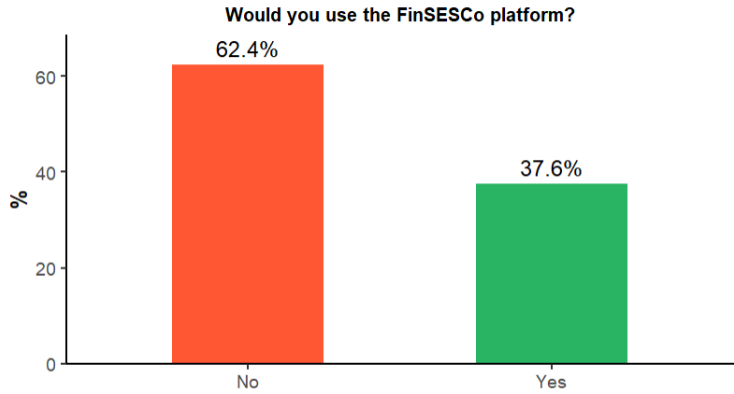




The share of potential users rises notably among those with previous experience in crowdfunding—almost 50% of them would use the platform. Similarly, past involvement in the (co-)ownership of Renewable Energy Installations (REI) appears to have an impact.

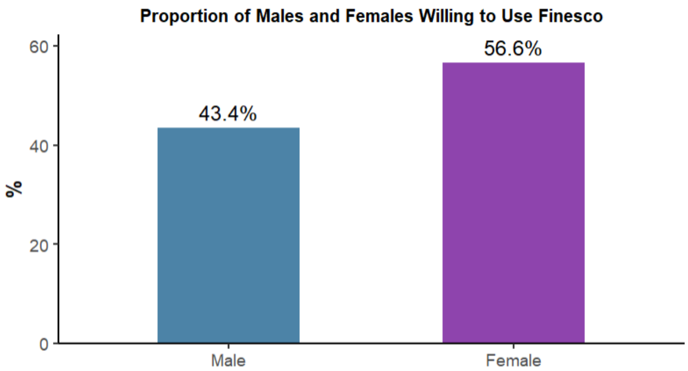
Image 6 and 7 – Share of respondents that had an experience with (co-)ownership of REI and the share that would use the platform.

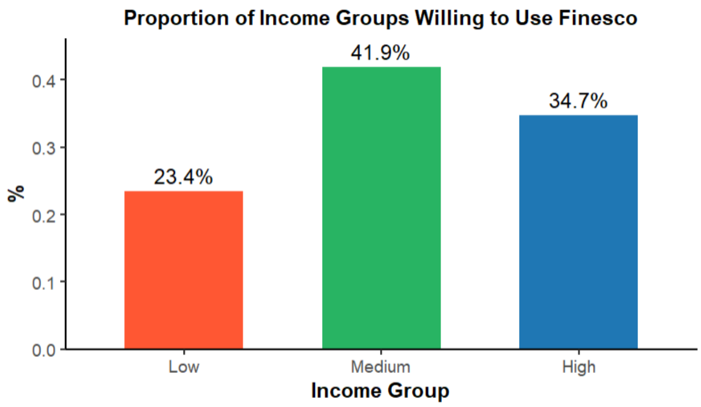




Almost 40% of respondents with such experience, often prosumers, would be willing to use the platform, representing 345 individuals from the entire sample. Potential users vary across demographics. Interestingly, 56% of them are female. We also observe a notable proportion from low-income households, though the majority belong to medium-income households.

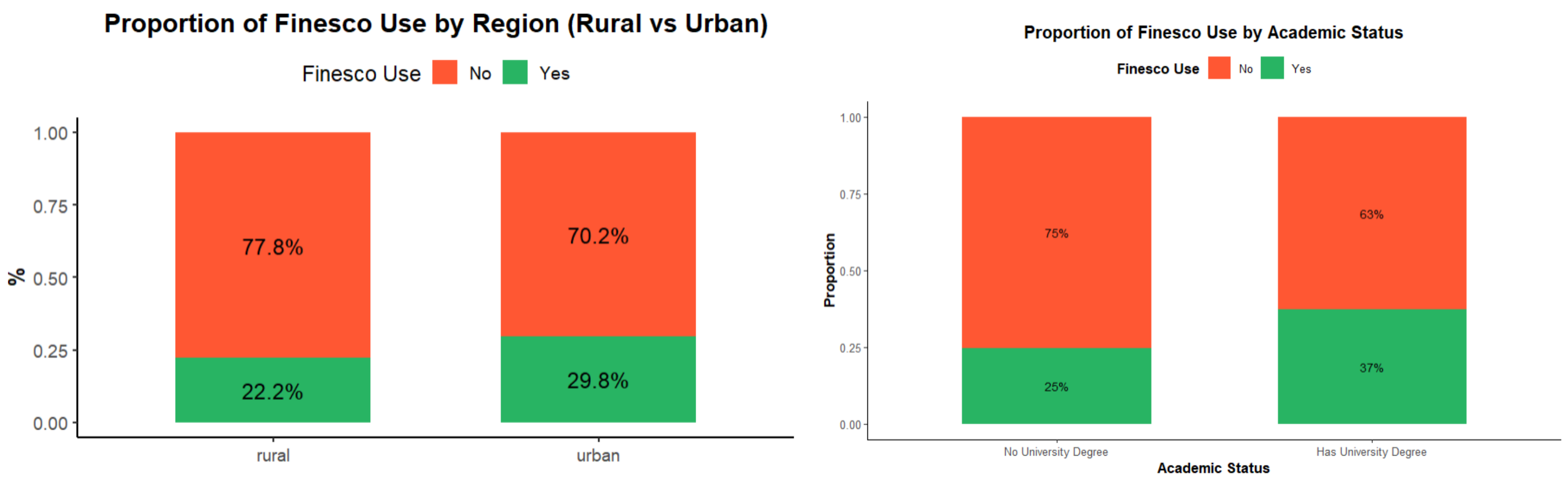
Image 6 and 7 – Share of potential users by gender and income group





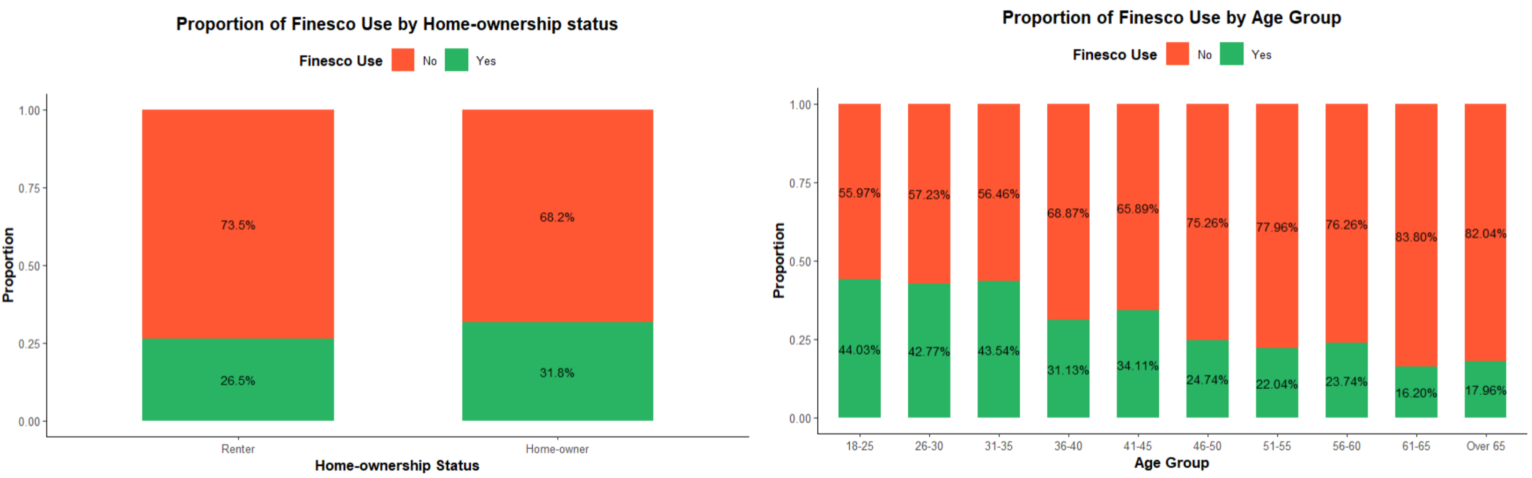
There is no significant difference in interest between respondents from rural and urban regions, but those with an academic background show slightly higher willingness.

Image 8 and 9 – Share of potential users by region and educational level



We also find differences based on homeownership status. As expected, homeowners are more likely to use the platform. Interestingly, contrary to the typical profile of energy efficiency investors, a younger demographic forms a substantial share of potential users.

Image 10 and 11 – Share of potential users by region and educational level



3.3. Recommendations

Our analysis provides some important insights into the potential adoption of the FinSESCo platform and suggests ways to increase engagement among key demographic groups.

Platform and Gender Interest:

Our findings suggest that there is a very strong interest from women, with over 56% of potential users self-identifying as female. This mirrors broader trends in crowdfunding investment, which has been found to be slightly more prevalent among women. Within our sample, 7% of the women have invested in their own projects through crowdfunding, and 5% of the men have done so. Likewise, 22% of the women reported having invested in third-party projects, while 20% of the men have done so. These insights point to a special opportunity to tailor FinSESCo's outreach and engagement strategies to attract female users, in particular, by highlighting the collaborative and accessible nature of the platform.

Age and Familiarity:

Interest in the platform is strongest among those aged 31–45, who also report higher familiarity with EPC models. While familiarity with EPC remains low at less than 10%, its impact on adoption is clear: nearly 80% of those familiar with EPC report interest in using the platform. Among older respondents aged 56–60, familiarity is low at 7%. However, 16% of them express interest upon learning about the platform. This may indicate that with targeted educational efforts, adoption could be expanded among older age groups.

Income and Education:

While the largest bulk of potential users comes from medium-income households at 42%, the platform has also generated considerable interest from low-income groups, which stand at 23%. In a surprising finding, 33% of potential users never held any higher education degree, and yet they comprise 56% of those willing to adopt the platform. This is indicative of the huge untapped potential of the lower-income group and implores the need to have accessible financing mechanisms tailored for them.

Housing Status and Urban-Rural Divide:

Against the energy efficiency investment trend of a renter and non-homeowner population showing almost the same interest as homeowners in using the platform, 47% of the interested respondents are renters. Apart from that, although there is no big gap between the two groups, urban respondents still have a slightly higher willingness to adopt the platform than rural residents. This might mean that solutions more specific to the problems of renters and urban dwellers, such as landlord-tenant collaboration models or shared investment schemes for multi-family buildings, would be something that FinSESCo could explore.

Prosumership and Renewable Energy:

Past experience in renewable energy prosumership positively influences platform adoption. About 40% of the respondents with co-ownership experience in renewable energy installations express interest in using the platform—a clear testimony to how FinSESCo could leverage already existing prosumer communities as early adopters and ambassadors.

General Adoption Trends:

After having been briefly introduced to the FinSESCo platform, roughly 30% of respondents—750 out of 2,565—would be willing to use it. These results show how crucial the awareness-building initiatives are in driving adoption.

4. Market Analysis

Building on the governance structures identified at the European level in Deliverable 2.1, this chapter focuses on the specific national conditions of the pilot locations—Romania, Germany, Austria, and India. By examining the national schemes and market potentials for energy performance contracting and crowdfunding platforms, particularly in the renewable energy (RE) sector, we aim to highlight the opportunities and challenges associated with implementing the FinSESCo platform. As detailed in Deliverable 2.1, relevant EU directives and regulations for energy-saving contracting (ESC) include the 2012/27/EU Energy Efficiency Directive (EED), the Directive on the Energy Performance of Buildings (EPBD), and the European Commission's Recommendation on Energy Poverty.

Crowdfunding platforms, on the other hand, require a license for their business activities under Regulation (EU) 2020/1503 on European crowdfunding service providers for business (ECSP Regulation). An ECSP license enables pan-European business activities, provided that a notification is sent to the national supervisory authority when expanding into other European markets. As an overarching organization, the European Crowdfunding Network (EUROCROWD) promotes crowdfunding as an alternative funding mechanism for small and medium-sized enterprises and innovative projects across Europe.

This chapter provides an overview of how these policies have been implemented by the Member States (MS) and insights on the Indian market conditions for ESCOs and Crowdfunding platforms.

4.1. Romania

4.1.1. National Regulations

Romania has transposed 16 national measures as regards the EED and 2 as regards its amendment. The Government Decision No. 1329/2023 regulates the operation of ESCOs and introduces standardized contracts. It mandates the registration of ESCOs in a national database and sets standards for their operation.

The Financial Supervisory Authority (ASF) is the regulatory body overseeing non-banking financial markets in Romania, including crowdfunding platforms. ASF's role involves supervising the compliance of crowdfunding platforms with both national laws and EU regulations.

4.1.2. Energy Performance Contracting

The ESCO market in Romania is less mature compared to the other European pilot countries. EU funds, the Modernisation Fund, and the National Recovery and Resilience Plan (NRRP) provide potential financial support for energy efficiency projects, as a key area for ESCOs. Thanks to the grants, energy efficiency improvements in public buildings have been incentivized. Nevertheless, as this EU support is often coming in the form of investment grants, interest in EPC is limited (JRC, 2021).

4.1.3. Crowdfunding market

With a volume of EUR 2 mil in 2023 the crowdfunding market in Romania remains relatively small. In 2024, the market experienced a transaction growth rate of 1.4%, with an average funding amount being EUR 7,200 (Statista, 2023).Keyplayers in the Crowdinvesting (equity-based crowdfunding) are *EquityNet, CrowdCube* and *Seedrs*. The CrowdSpace website lists 8 crowdfunding platforms active in Romania, with only the Dutch *WhyDonate* offering green energy as an investment category (CrowdSpace, 2023).

4.2. Germany

4.2.1. National Regulations

The EED is implemented in 38 legal measures including the Energy Efficiency law (*Energieeffizienz-Gesetz, EE*), which entered into force on November 18, 2023. It provides a cross-sectoral framework for energy saving measures and targets a 45% decrease of final energy consumption until 2045 compared to the year 2008.

Furthermore, the Energy Services Act (*Energiedienstleistungsgesetz, EDL-G*) promotes the use of EPC as a means for companies to meet their energy efficiency obligations.
The legal basis for crowdfunding is the German Asset Investment Act *(Vermögensanlagengesetz, VermAnlG*). It enables online platforms to broker financial investments for projects with a maximum volume of up to EUR 6 million (DKB, 2024).

Crowdfunding platforms in Germany must comply with the regulations set by the Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin, 2014). (Federal Financial Supervisory Authority). Pursuant to Section 32 (1) of the German Banking Act (KWG), anyone wishing to provide financial services in Germany on a commercial basis or to an extent that requires a commercially organized business operation requires written permission from BaFin. The BaFin furthermore checks whether a license under the ECSP Regulation is required.

4.2.2. Energy Performance Contracting

The market volume for the energy contracting (EC) segment is between EUR 9.6 and 10.3 billion, with EUR 0.6 billion (7% of the overall market volume) attributed specifically to energy saving contracting (ESC) (BfEE). With 64%, the largest share of the EC market is held by energy supply contracting (ELC). 37% of companies offered lease or management contracting, while 21% provided energy saving contracting. The distribution within the members of the industry association *Vedec e.V.* are even more prevalent with 74% in the ELS and only 7% in the ESC segment.

Contracting is primarily offered by energy supply companies (municipal utilities and other energy suppliers, 40 % of providers) and companies that describe themselves as contractors (35%).

Among specialized contractors ESC accounted for 21% of sales, while it represented around 2% of sales for energy supply companies and municipal utilities (Stadtwerke). Out of 142 surveyed ESCOs, 66% anticipate moderate to very strong growth in the energy contracting market (Dena, 2023).

The German Energy Agency *dena* maintains a database (Dena, 2023) of contracting examples, offering an overview of best practices from various application areas. At the date of writing the database encompasses 28 examples.

As stated in Deliverable 2.1 a lack of knowledge or information is one of the main hindrances for the development of EPC. To address this problem, the Federal Ministry for Economic Affairs and Energy has established the Energy Efficiency Platform to develop and discuss joint solutions together with the relevant stakeholders from business, civil society, science, the affected public departments and the federal states.

4.2.3. Crowdfunding market

Taken together Crowdfunding, Crowdinvesting und Peer-to-Peer-Lending reached a volume of USD 1.2 bil in 2019, with 51 % of the market volume attributable to P2P lending and 24.6 % to real estate crowdinvesting. There are about 200 donation and reward-based, 78 equity-based and 16 lending-based crowdfunding platforms operating in Germany (CrowdfundingHub, 2021). The transaction value in the donation and reward-based crowdfunding market is projected to reach EUR 53.57 mil in 2024 (CrowdfundingHub, 2021; Statista, 2023b). The average funding per campaign was roughly EUR 8,000 in 2023.

Kickstarter, *Indiegogo*, *Startnext*, *Wemakeit* and *Ulule* are the biggest crowdfunding platforms. Germany also has several green energy crowdfunding platforms that provide both debt and equity financing for environmental, social, and governance (ESG) projects. The largest equity crowdfunding platforms specifically offering renewable energy investments are *Invesdor*, *bettervest*, *Econeers*, *Moneywell* and *GLS crowd*. Major debt-based platforms include *ecoligo* and *ROCKET Green.* Collected volume of equity-based crowdfunding for RE projects doubled from 2018 to 2020, from EUR 11.1 mil to EUR 20.4 mil. Multiple platforms started offering crowdfunding of energy efficiency investments, where the Crowd receives a share of the savings achieved.

The German Crowdfunding Association (*Bundesverband Crowdfunding eV*) represents the political and public interests of Crowdfunding platforms in Germany.

4.3. Austria

4.3.1. National Regulations

In Austria the EED was translated into 51 legal measures, including the Federal Energy Efficiency Act (EEffG) in 2014, which was amended in 2023 according to the EU’s EED and the Renewable Energy Expansion Act, which sets concrete expansion targets and was enacted in July 2021.

The Alternative Financing Act (*Alternativfinanzierungsgesetz, AltFG*) stipulates investment limits and disclosure provisions for crowdfunding platforms.

4.3.2. Energy Performance Contracting

While energy-saving contracting projects are prevalent in Austria's public and private service sectors, they have not yet been widely adopted by SMEs. Under the program line *“Energiesysteme der Zukunft*” of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMVIT) a pilot for a ESC-platform for Small-

Medium Enterprises (SME) was developed. This database includes anonymized data on energy-saving measures identified in the manufacturing SME sector through public consulting initiatives.

DECA (*Dachverband Energie-Contracting Austria*) represents the interests of Austrian energy service providers, is the point of contact for energy efficiency issues, an active networking organization and an interface to other stakeholders.

4.3.3. Crowdfunding market

Crowdfunding has become a popular alternative financing method for startups, SMEs, and some larger projects, including renewable energies. The Crowdinvesting market reached EUR 26.5 mil in 2017 (CrowdCircus, 2024). The transaction value in the donation and reward-based crowdfunding market is projected to reach EUR 3 mil in 2024, with a projected growth of 1.44% p.a. (Statista, 2023c)

8.7% of the European crowdfunding platforms operate in Austria. Examples for crowdfunding platforms in the green energy segment are *Conda, WhyDonate*, *Invesdor*, *ROCKETS Green*, *EcoCrowd* and *Crowd4Climate*.

4.4. Overview

Table 2 - ESCO Library[1] + Energy Performance Contracting

Name	**Countries of Operation[2]**
Johnson Controls	AU, GE, RO
Siemens AG	AU, GE
EnergoBit ESCO S.A	RO
ENERGY SERV SRL	RO
DALKIA GmbH	GE
YIT Germany GmbH	GE
Veolia India	IND

[1] As provided by the JRC European Energy Efficiency Platform (E3P)

[2] Within the pilot countries

Table 3 - RE-Crowdfunding Platforms

Name	Countries of Operation[3]	Size of funds raised	RE-Crowdfunding Strategy
Bettervest	GE	EUR 23.8 mil	Crowd-funding energy efficiency projects in Germany and Africa
Conda	AU, GE	Debt: EUR 240 mil	Crowd-investing for Start-ups and SMEs
Crowd4Climate	AU	Debt	Crowdfunding of eco-friendly projects in Austria and developing countries that cut GHG
DKB Crowd	GE	Debt	Crowdinvesting in climate protection projects
EcoCrowd	AU, GE		Crowdfunding platform for sustainable projects and start-ups
Ecologio	GE	Debt: EUR 40 mil	Funding of solar projects in emerging markets
Econeers	GE	Debt+Equity: EUR 37.7 mil	Platform for crowdinvesting in sustainable companies and energy transition projects in Germany
EcoZins	GE	Debt	
FairZinsung	GE	Debt	Crowdfunding platform for ecologically and socially sustainable projects i.a. solar parks.
GLS Crowd	GE	n.a	Platform for ecological and social crowdinvesting
GreenVesting	GE	n.a	A financing service partner for energy projects and real estate. Experienced in photovoltaic system development, finance and operation since 2012.
Impact Funding	GE	n.a	
Invesdor	GE, AU	Debt: EUR 0.3 bil Equity: EUR 0.14 bil	Offering crowdfunding service for project initiators, energy communities and energy cooperatives seeking financing and/or implementing citizen participation in RECs
Klimja	GE, AU	Debt: EUR 10.5 mil	
LeihDeinerUmweltGeld	GE	Debt: EUR 19 mil	Crowdfunding platform, specialized in citizen-oriented project financing and consulting, marketing, processing and administration of swarm financing.
Mercurcap GmbH	GE	n.a	Crowdfunding of sustainability projects

4.5. Impact of Market Structure on Platform Adoption

Homeownership and Renewable Energy Co-Ownership:

Renewable energy and co-ownership, in contrast to homeownership, show big differences across the EU, massively affecting platform adoption. In countries with strongly developed collective renewable energy initiatives, such as Germany or Austria, familiarity with collaborative models increases the willingness of people to use platforms such as Finesco. Contrarily, high levels of homeownership—for example, about 95.6% in 2023 for Romania—

[3] Within the pilot countries

EUROPA Presents opportunities for tailored approaches that target individual energy efficiency investments; innovative solutions in tenant-heavy markets (e.g., Austria, Germany) will be needed in order to engage landlords and property managers in co-ownership or benefit-sharing schemes.

Size of EPC and Crowdfunding Markets:

The other related factor would be the maturity of the EPC markets and crowdfunding ecosystems. With Germany's well-established EPC market, valued at EUR 9.6–10.3 billion, and one of the strongest crowdfunding ecosystems, with a value of USD 1.2 billion in 2019, this adoption for Finesco should come easily. Austria's EPC market is much smaller and oriented toward public and private sectors, while the crowdfunding sector in Spain has begun developing, amounting to a value of USD 10.33 million by the year 2024. Romania's nascent EPC market and fledgling crowdfunding ecosystem have only EUR 2 million as of 2023.

Private vs. Public Ownership of Multi-Story Buildings:

The ownership structure of multi-story buildings differs across the countries, impacting the dynamics of renovation. In Germany and Austria, private owners own a high share of multi-story buildings, which implies fragmented interests that may impede decisions related to renovations. In Romania and Spain, a larger share of multi-story building stock is publicly owned, which should in theory ease the renovation procedures with the central decision-making process.

Juridical Challenges for a Multilingual Platform:

A multilingual platform in all those countries faces juridical challenges, especially since there is no single European capital market. Every country has its own rules for crowdfunding and energy efficiency investment; this requires the adaptation of their operation in line with national regulations. For example, crowdfunding platforms are regulated by the ASF in Romania and under BaFin within Germany, according to the German Asset Investment Act. So, hence, to translate the platform means more than language adaptation; it requires thorough customization in compliance with the legal framework of each country.

4.6. Summary

Renewable Energy Co-Ownership

- **Germany:** High adoption (43%). Positive influence—familiarity with prosumership makes platform adoption smoother. **Action:** Leverage familiarity by emphasizing platform benefits for collective projects.
- **Austria:** Moderate adoption (30%). Positive influence but requires targeted campaigns. **Action:** Highlight successful public-private co-ownership models on the platform.
- **Spain:** Low adoption (~15%). Limited influence due to low familiarity. **Action:** Offer educational resources to build trust and awareness of co-ownership.
- **Romania:** Very low adoption (<5%). Negative influence—concept largely unfamiliar. **Action:** Build awareness campaigns and pilot projects showcasing individual benefits.

EPC Market Size and Knowledge

- **Germany:** Large market (EUR 9.6–10.3 billion). Strong positive influence due to widespread knowledge of EPC benefits. **Action:** Position the platform as a tool to streamline EPC processes for stakeholders.
- **Austria:** Smaller market; moderate influence. **Action:** Focus on showcasing success stories and expanding awareness in untapped sectors.
- **Spain:** Medium-sized, growing market. Moderate positive influence. **Action:** Target urban regions with higher awareness and highlight financial savings.
- **Romania:** Nascent market. Minimal influence due to limited knowledge. **Action:** Develop partnerships to increase awareness and provide training programs.

Crowdfunding Market Size

- **Germany:** USD 1.2 billion. Strong positive influence—platform adoption aligns with existing ecosystem. **Action:** Highlight platform as an extension of current crowdfunding practices.
- **Austria:** Moderate size; growing interest. Moderate positive influence. **Action:** Focus on green energy projects to attract environmentally conscious investors.
- **Spain:** USD 10.33 million (2024 forecast). Limited influence due to smaller scale. **Action:** Encourage local governments to co-finance initial projects to build trust.
- **Romania:** EUR 2 million (2023). Minimal influence due to underdeveloped ecosystem. **Action:** Promote early-stage campaigns and government-backed initiatives.

Homeownership rates

- **Germany & Austria:** High rental rates—mixed influence; landlords may resist involvement. **Action:** Introduce landlord incentives for platform engagement, like shared cost-savings.
- **Spain:** Balanced ownership/rental mix. Positive influence if tailored to both groups. **Action:** Develop dual pathways for individual homeowners and tenant-landlord partnerships.
- **Romania:** Predominantly individual ownership (95.6%). Positive influence if targeted correctly.

Private Ownership of Multi-Story Buildings

- **Germany, Austria:** High prevalence of private ownership. Negative influence—diverse interests slow decision-making. **Action:** Promote digital tools on the platform to coordinate stakeholders and simplify decision processes.
- **Romania, Spain:** Higher public ownership. Positive influence—centralized processes support renovations. **Action:** Focus on integrating platform solutions into public-sector energy programs

5. Pilots and Impact Evaluation

5.1. Romania

5.1.1. Pilot Objectives

The Romanian pilot was designed to demonstrate the utility and functionality of a measurement and verification (M&V) tool for energy performance contracts. It focuses on the following aspects: (a) gathering and visualizing real-time data from smart meters, inverters, environmental telemetry stations or other IoT assets; (b) comparing different investment scenarios by the means of analysing the financial viability of existing projects (ongoing or finalized); and (c) assessing the financial viability of investments in green energy sources, including up-to-date financial KPIs based on real-time data.

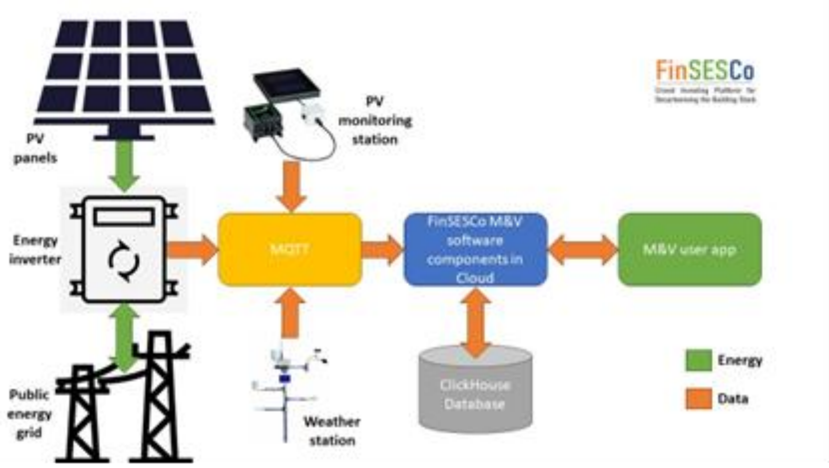
5.1.2. Methodology

The Romanian pilot utilized the same XML schema as the original XML used in the German and Austrian pilots, with SimpleXML Parser and XML Dom Parser being employed. The intention was to maintain consistency across all pilots in the project. As part of the FinSESCo project, the XML file was implemented based on building data to calculate renovation scenarios, verify energy savings, and present these savings on the investor dashboard. New tags, such as <photo> and <layers>, were added to the original scheme, with recommendations for their inclusion in other pilots as well. In evaluating the Romanian pilot, we aimed to investigate the effectiveness of the XML tool in this specific context.

5.1.3. Results

During the pilot, we tested the implementation of the M&V feature as follows: data from the inverter within the PV installation was successfully transmitted to the Cloud gateway using several methods—proprietary hardware for reading the inverter memory, API integration provided by the inverter's manufacturer, the inverter's cloud application, and direct configuration of the inverter. This data was then forwarded to the MQTT broker, where the application processed and stored it in the ClickHouse Database. The following scheme summarizes this process:

Image 12 – Romanian Pilot Scheme



5.1.4. Lessons Learned

Familiarity with energy efficiency contracting was fundamental to the success of the pilot implementation. The building owner had experience in both using this approach for renovations and installing renewable energy systems. Additionally, the owner was comfortable with and familiar with the concept of crowdfunding for renewables, which allowed for the successful incorporation of partial external financing through crowd investing. This experience, although it played a minor role, demonstrated the owner's readiness to have project data published on the crowd investing platform, contributing to the project's overall transparency and funding success. Thus, encouraging and rewarding owners to publish their data has a high potential in enabling the adoption of energy performance contracts by generating awareness of the benefits to other potential investors and beneficiaries.

5.1.5. Successes and Challenges

Successes: Energy Performance Contracting (EPC) is gradually gaining traction in Romania, indicating a positive trend toward broader adoption, even though it hasn't yet reached full maturity. The pilot evaluation indicates a generally favorable perception of the tool, with most participants expressing trust in it. This growing trust suggests that the tool is seen as a valuable resource in the region's efforts to improve energy efficiency. Additionally, the pilot owner's experience with grants, particularly through the "Green House" (Casa Verde) program, highlights a solid foundation in leveraging financial mechanisms to support energy efficiency projects. This experience indicates that the platform could be expanded to include options for managing loans, grants, and energy service agreements, further enhancing its appeal and effectiveness.

Challenges: Despite the positive outlook, there are notable challenges that must be addressed to ensure broader adoption and success. One key issue is the potential complexity of the M&V tool, which may not be easily understood by users without basic knowledge of economics or technology. This could necessitate the involvement of energy advisors, which runs counter to the goal of making the platform user-friendly and accessible. Additionally, ensuring that the platform is suitable for various financing options presents another challenge, as it requires careful consideration of how to integrate these options seamlessly while catering to the diverse needs and capabilities of potential users.

5.1.6. Impact

In terms of impact, the Romanian pilot implementation has a high potential to showcase the benefits of measurement and verification (M&V) instruments for renewable energy adoption within the Balkan region. Furthermore, based on previously tracked investments within the region, M&V has the potential to increase the trust of investors or financial institutions to support these projects. The building owner expressed that having real-time access to energy and financial data can promote a more responsible usage of energy and generate awareness regarding energy waste.

The impact of the project was enhanced through participation to fairs facilitating interaction with stakeholders and potential customers, and publication of 2 scientific articles depicting the results of the Romanian pilot. Another positive impact within the Romanian pilot was the exchange of know-how between partners with complementary technical competencies and roles within the FinSESCo project, from regions with different regulations and practices. The renovation rate of buildings in Romania is relatively low, despite the country's need for significant improvements in energy efficiency. Currently, about 1.3% of residential buildings undergo an average renovation each year, resulting in energy savings of 30–60%. However, the rate of in-depth renovations, which save over 60% of energy, is even lower at just 0.1%. For non-residential buildings, the renovation rate is slightly better at 1.9%, with 0.4% for deep renovations. Given that 77% of buildings in Romania were constructed before 1980, many of them lack modern energy efficiency standards, creating a significant need for upgrades. The Romanian government and various organizations have been working to increase the rate of renovations, aiming to improve energy performance and meet the EU’s climate goals. Experts suggest that to meet climate and energy targets, the renovation rate needs to triple in the coming years, especially in transitioning buildings to near-zero energy standards.

The number of energy consultants and experts involved in energy efficiency projects has been steadily increasing, particularly driven by national and EU-funded initiatives like the National Recovery and Resilience Plans (NRRP). These initiatives aim to boost energy efficiency by creating more opportunities for professionals in this field, but the exact current number of certified energy consultants isn't consistently published. Romania has a building stock in which around 77% were built before 1980, with approximately 8.5 million dwellings. With a renovation rate of 1.3% per year for residential buildings, this suggests that roughly 110,000 buildings undergo some form of energy renovation annually. In-depth renovations, which result in more significant energy savings of over 60%, occur at a much lower rate of 0.1% for residential buildings. This indicates that about 8,500 buildings might receive these more extensive upgrades each year. Non-residential buildings: The renovation rate for non-residential buildings is slightly higher, at around 1.9% annually, which would account for a few thousand additional renovations each year. In total, around 120,000 to 130,000 buildings could be undergoing some level of renovation annually, but this still leaves a large gap to meet Romania's climate and energy efficiency targets.

In Romania, the energy performance certification (EPC) system is an essential part of the country's effort to comply with European Union energy efficiency standards, particularly the Energy Performance of Buildings Directive (EPBD). The EPC provides a rating for buildings based on their energy consumption, and this rating is mandatory for all buildings sold, rented, or significantly renovated. Therefore, Romania is steadily advancing in its implementation of energy performance certification, but challenges remain, especially in retrofitting older buildings and ensuring compliance with nZEB standards. The new service can be described as a measurement & verification instrument for assessing the energy performance of buildings (residential & non-residential) in the context of energy performance contracting. As of 2024, the number of PV prosumers in Romania has reached around 130,000, with expectations that this number will grow to 200,000 by the end of the year. This growth is driven by government incentives, such as the Green House PV subsidies, and the increasing affordability of photovoltaic systems. The total installed capacity of these prosumers is projected to increase from 1.7 GW to 2 GW by the end of 2024.

Reduction in Electricity Bills: Prosumers generally experience significant savings on their electricity bills, often reducing their dependence on the grid by up to 80%. A typical prosumer with a 3-6 kW installation can save between 30-50% on their energy bills. For larger systems, especially those with capacities of 5-6 kW, the savings can be even more substantial.

Payback Period: The payback period for PV systems in Romania is usually between 5 to 7 years, depending on the size of the installation and initial investment. The Casa Verde (Green House) subsidy program has made the initial investment more affordable, further shortening the payback period.

Additional Income from Surplus Energy: Many prosumers also benefit by selling surplus energy back to the grid. This can generate additional income and further reduce the time required to recoup the initial investment. The value of the electricity fed into the grid depends on the negotiated price with energy suppliers.

IoT energy measurement systems allow prosumers to track energy consumption and production in real-time. This data provides insights into when the system is generating the most energy, enabling users to adjust their consumption patterns to maximize the use of solar power and minimize reliance on the grid. Studies suggest that this can improve energy efficiency by 10-20%.

5.1.7. Recommendations

Potential Data Monetization for Users: Users who consent to data monetization should have the opportunity to benefit from this process. Before using FinSESCo, users could be granted access to data from completed similar projects, allowing them to evaluate potential returns on investment. Additionally, this data could serve the broader scientific community, contributing to research and development efforts.

Tracking Features for Prosumers: Introducing tracking features for prosumers could offer additional advantages. The data collected from the national RO pilot could be utilized to promote energy efficiency practices among occupants. Furthermore, this data could be leveraged to train AI models, enhancing their accuracy and utility in energy management and other applications.

XML Schema: The current implementation relies on the German XML schema, but the next step involves refining the dXML to better suit the project's needs. This includes making decisions about adopting an XML schema for geometrical shading, which will be important for calculating improvements in reducing solar gains during the summer. The use of cooling degree days (CDD) will be essential in this process.

Enhancing Renovation Alternatives: New renovation alternatives need to be developed, particularly in the absence of a hydraulic heating system and in regions with low heating degree days (HDD). These alternatives should include low-cost measures that can be easily implemented. Additionally, tags for describing features such as cooling ceilings should be explored to ensure comprehensive modeling of energy efficiency measures.

Integrating Grant Functionality: To further enhance the platform's utility, it is recommended to integrate a functionality that allows users to access information on available grants and financing options for energy efficiency projects. This feature would be especially valuable for users with limited experience with complex financial mechanisms, supporting them in identifying and securing funding sources for their projects. Additionally, this functionality could streamline the application process by offering tools for grant eligibility assessment, application tracking, and grant management, ultimately making the platform a more comprehensive resource for energy efficiency initiatives.

5.2. Germany

5.2.1. Pilot Objectives

The aim of the pilot was to investigate the feasibility of producing a renovation project definition from existing data and applying energy control post-renovation. From the outset, we understood that energy-saving contracting and third-party financing were not well-received. However, responses to the entire questionnaire were obtained. The test for measuring and verifying savings is still pending, as the building has only recently been renovated.

5.2.2. Methodology

The methodology involved setting up a prototype that consumes XML data from energy performance certifications or CityGML, allowing for customization of the renovation plan. Data imports were conducted via 3D GIS LoD2 City of Berlin and SketchUp using the GEORES extension. For parsing, two PHP tools were used: SimpleXML Parser and XML Dom Parser. The choice of parser depended on the specific task. A special method was developed to maximize code reutilization for other countries. In fact, the same code could be used for all pilots, including in Spain.

The user interface was converted to be bilingual. Users could select basic parameters for economic calculations and choose measures for building elements. The simulation reused some code from previous projects, and the economic analysis was conducted twice, accounting for imputed interest rates and calculating the Net Present Value (NPV). Costs, extracted from literature (Schmitz, Krings, Dahlhaus, & Meisel, 2012/13), were embedded in the code and adjusted for the current year. Users can also adjust energy prices and interest rates. An online questionnaire was sent to the building owner, based on a video showcasing the approach, and responses were received in PDF format.

Image 13 – Developments of the Project

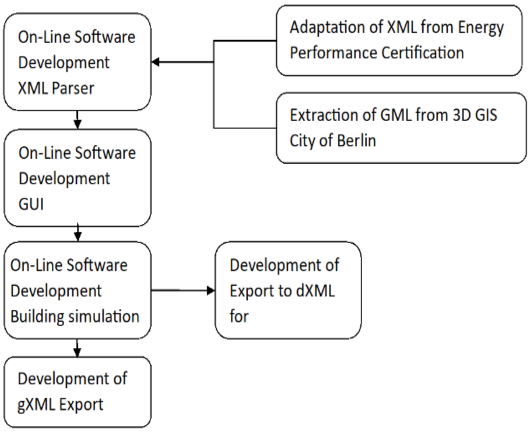


Image 14 - Screenshot of the Berlin Pilot data

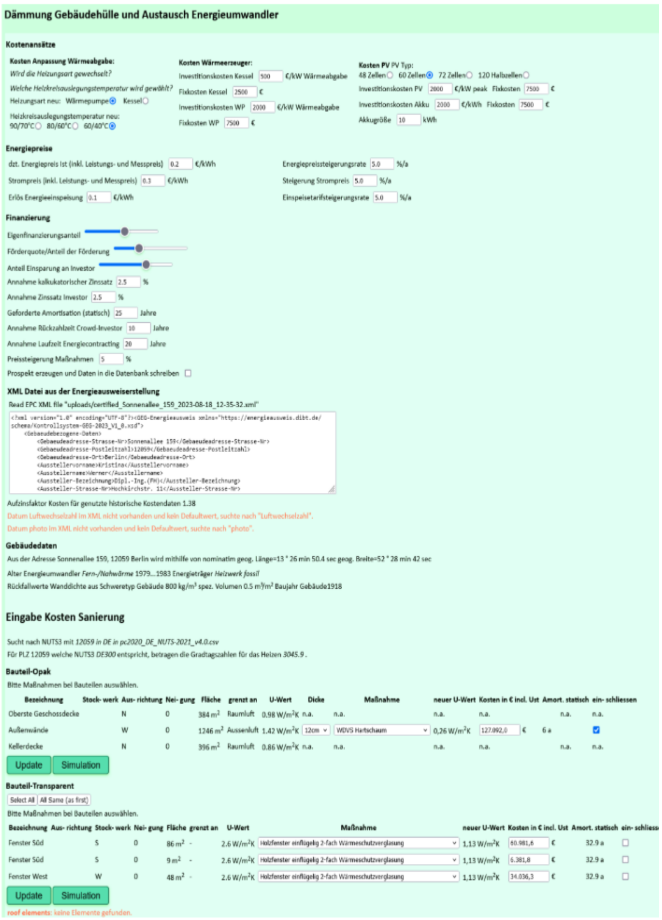


Image 15 - Manual additions to the CityGML

The aerial image of the building showed some occlusion by vegetation. Manually drawing windows is particularly challenging when the façade is structured in 3D.

5.2.3. Results

The 3D GIS did not improve throughout the project, so windows could not be extracted and had to be added manually (Figure 3). The XML from Energy Performance Contracting included totals for building elements, leading to significant differences in the amount of building data. Since the GML tool in SketchUp did not allow for different window qualities, the analysis remained general, which aligns with a typical renovation approach of replacing all windows.

5.2.4. Lessons Learned

Key takeaways and best practices from the pilot experience include:

What Worked Well: The XML parsing was effective, and the selection of building elements for renovation performed as expected.
What Did not Work: The investment tool was seen as standard software and was not developed to a high TRL (Technology Readiness Level), leading to deficiencies compared to commercial crowd-investing software.
Areas for Improvement: BIM should have been included to compare the use of data from energy performance certifications.
Recommendations: The process of energy-saving contracting is viable but not preferred by owners of multiple buildings who can finance renovations from their own funds.

5.2.5. Successes and Challenges

Notable successes include the effective XML parsing and the general functionality of the tool. However, challenges arose with the investment tool, which was not sufficiently developed for testing. Owners of multiple buildings, who can finance renovations independently, did not prioritize energy-saving contracting. The energy consultant was preferred over the tool, although using such a tool remains a viable option.

5.2.6. Impact

The pilot project impacted stakeholders, customers, and end-users by introducing a new tool and new financing methods, though the latter was not necessary. The building owner decided to start renovations immediately, though we cannot definitively claim the project influenced this decision. The persistent availability of building data online could accelerate renovations, though economic viability remains the main driver. Some impacts, such as advancements in 3D GIS LoD3 and XML accessibility, were not evident during the pilot period. Additionally, some startups were founded during the project that use AI to generate renovation plans.

In Germany, the asset-based Energy Performance Certificate (EPC) is mandatory only for non-insulated buildings built before 1977 with fewer than five apartments (DENA, 2023). This requirement results in a significantly smaller sample size compared to Austria. However, the methodology called Individual Renovation Plan (iSFP) provides a more detailed approach.

Table 4 - Comparison of Renovation Triggers

Type	**Cost**	**Content**
Asset-based EPC	€500–€700 (depending on building size) (ISTA, 2024)	General renovation tips without in-depth assessment
iSFP	€1600–€2100 (€650 funded)	Detailed summary of renovation measures with a timeline
Operational EPC	€130 + €50 for corrections	Very general renovation tips without assessment

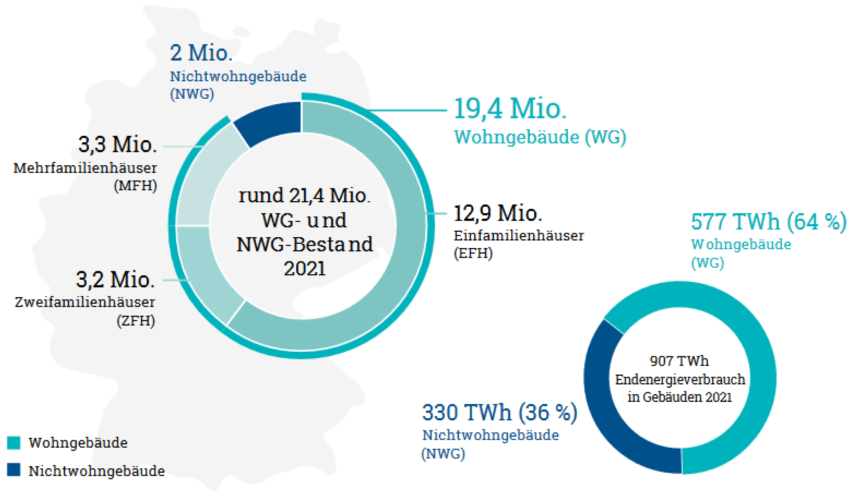
A proposed new service can be described as an asset-based energy performance certification with a simulated renovation plan, including photovoltaic (PV) systems and heat pumps.

Proposed Service: Upgrade Operational EPC

- Cost: €300
- Content: Cost-optimal renovation project.
- Target Market: Residential buildings within a 10-year period.
- Market Size: 10% of residential buildings.

If 10% of the potential 577 TWh energy demand in residential buildings is targeted, achieving a 60% reduction could result in savings of **35 TWh over a 10-year period**.

Image 16 - energy consumption of buildings



Source: DENA, 2023

Assuming that heating and domestic hot water (DHW) account for 85% of energy consumption (Umweltbundesamt, 2023), which equates to 123.4 million tons of CO_2 per year, the proposed savings would result in 6.36 million tons of CO_2 over 10 years, or 0.636 million tons of CO_2 per year.

5.2.7. Recommendations

Display Optimization: Avoid showing identical building elements in a list by displaying totals, although this could be problematic if renovation is limited to one façade. It's better to have individual building elements in the XML.

Shading Calculations: While calculations for one year are possible, detailed shading calculations are not feasible without excluding a detailed analysis of solar yield. Exporting to gbXML for import into building simulation software (e.g., EnergyPlus) allows for such simulations.

Energy Price Volatility: Due to volatile energy prices, it may be beneficial to calculate a range of prices, including different price increases and imputed interest rates.

Data Quality Check: It is recommended to check and improve the quality of input data before contracting an energy consultant. The self-operated tool is suitable for this purpose.

Energy Controlling Preparation: The tool can be used to prepare energy controlling and store a digital twin, which could be seen as overkill for renovations every 30 years, but it is valuable for buildings undergoing continuous improvements.

EPC Improvements: For in-depth analysis, Energy Performance Certificates (EPC) should include details about windows. The market tendency to offer lower-priced EPCs is detrimental. Operational EPCs based on consumption should be used in parallel. In the future, a mandatory individual renovation plan should be considered alongside the data generation of asset-based EPCs.

5.3. Austria

5.3.1. Pilot Objectives

The pilot was based on two attempts to accurately design the building in SketchUp and export it to CityGML, followed by converting the CityGML data into XML format. Additionally, the pilot sought to calculate different renovation variants and simulate the impact of integrating a heat pump into the building's energy system. These steps were intended to assess the feasibility and accuracy of using digital tools for comprehensive renovation planning.

5.3.2. Methodology

The methodology employed a range of resources to facilitate the renovation project. SketchUp, enhanced with the GEORES extension, was used for initial design and digitalization. The process involved utilizing FinSESco PHP services for data management, and producing gbXML for further analysis. CityGML data was validated and converted to gbXML, which was then imported into Energy Performance Certification (EPC) software. Additional features included one-click integration of energy converters, venting, and Domestic Hot Water (DHW) systems. The comprehensive data was subsequently processed through external energy consulting software, which automatically generated a detailed 140-page renovation report.

5.3.3. Results

In Styria, the use of software capable of generating XML files is mandatory, providing a solid foundation for renovation planning for all buildings on the market, whether for rent or sale. This standardized approach ensures that building data is readily available, which is crucial for the feasibility and attractiveness of crowdinvesting in renovation projects. However, while the owners expressed interest, many still prefer alternatives like subsidies and personal capital. The availability of building data, combined with rising renovation costs and stricter regulations on fossil-fuel boilers, underscores the potential for a significant market in energy-efficient renovations.

5.3.4. Lessons Learned

Automated processes for digitizing buildings have proven effective, but achieving optimal performance requires moving beyond piecemeal renovation approaches. Cost-effective renovations depend on eliminating patchwork measures and leveraging economies of scale. The project highlighted that energy performance certification benefits owners only when the data is of high quality and remains consistent. Extensive data acquisition is also critical for ensuring accurate and useful renovation outcomes. An opportunity to improve economic efficiency may arise by combining renovation efforts with necessary external work, such as repainting the building's exterior.

In Austria, building data is made available to public administration on a regional basis, but the availability and quality of this data can vary across regional governments. Annotated bodies or administrative entities play a key role in ensuring that data quality is improved, further enhancing the potential for successful and efficient renovation projects.

5.3.5. Successes and Challenges

Exporting data to energy contracting projects has been feasible, particularly for photovoltaic (PV) systems, as their neutral performance impact made integration smoother. However, several unexpected challenges arose. The CityGML format, although widely used, required misclassification of categories and proved inadequate for representing complex building structures. No further development or viable alternatives have emerged, and some CityGML viewers struggled to handle global coordinates, reducing the overall effectiveness of the digital tools.

There are potential bottom-up approaches that could target the measures included in the FinSESCo tool, as well as strategies to overcome barriers to installing more renewable energy systems. A key challenge is the current state of distribution grids, which are not designed to handle a significant increase in grid feed-in. In urban areas, the absence of intelligent transformers is somewhat offset by diverse energy demand, but in rural regions, the problem is more pronounced. Even in cities, a rapid expansion of rooftop PV installations on commercial buildings could strain the existing infrastructure.

5.3.6. Impact

The energy consulting market in Austria is estimated to be about one-tenth the size of Germany's. In Graz, 20 energy consultants from 11 entities are registered for building consultations (E-Control, 2024). Energy consultation costs in Vienna vary based on the package and scope, ranging from 66 euros for a 30-minute session to 264 euros for 120 minutes. For WienEnergie clients, these services are offered for free. The market's competitiveness makes it difficult to establish a unique selling proposition, particularly since energy agencies benefit from co-financing. The low fees provided by utilities further limit opportunities for independent energy consultants to maintain a viable business.

Since energy performance certification (EPC) data is available when a building is sold, the proposed project approach could significantly benefit subsequent property owners. However, the cost of 300–500€ highlights that a lack of free public energy consultation services may limit the project's broader impact, though the FinSESCo solution has strong scalability potential.

Privately owned single- and double-family buildings in Austria total approximately 400,000, with an energy demand for heating of 212,825 TJ (Statistik Austria, 2022). With 100 new renovation plans per year and 300 energy consultants, approximately 30,000 buildings could be improved. Assuming an average reduction of 30% in energy demand, this translates to annual savings of about 4,800 TJ. If the savings rate increases to 40% through enhanced project preparation and presentation, and 50% of projects involve DIY efforts, the reduction in end-use energy demand could reach 9,600 TJ per year.

Over 10 years, energy demand could be reduced by 77% with energy consultants alone, and by 54% using the FinSESCo approach. This assumes all buildings have digital twins, owners possess adequate skills to implement 50% more projects, and sufficient funding is available to support the increased number of projects. However, political changes, particularly post-election, could affect these expectations, especially as most countries do not mandate asset-based EPCs.

Finally, discussions around the renovation rate are critical. Some studies suggest that 25% of owners are active (immowelt, 2024). This does not significantly alter project impact since the calculations are based on a modest renovation rate. Even with a tenfold increase in the base renovation rate, a 50% increase over the 2% base rate raises the new rate only from 20% to 21%.

In Austria, asset-based EPCs are standard, allowing for direct impact when applying the FinSESCo approach. Assumptions include:

- Deep Energetic Renovation: 40%
- Partial Renovation: 20%
- Energy Systems (with/without deep renovation): 40% / 60%
- Thermal Solar and PV: 60% / 30%

Impact Estimate: 100,000 t CO2/year (0.1 million t CO2/year). For public buildings, a flat improvement rate assumes 50% energy systems, thermal solar, and PV adoption, yielding an effect of only 2,400 t CO2/year.

5.3.7. Recommendations

Stakeholders involved in operating the EPC portal for public administration are bound by the procurement conditions set by the administration. While there is some flexibility for offering private access to their own EPC data, as demonstrated by the rollout in Austria via ImmoZeus, broader uptake remains limited. Energy agencies were initially identified as potential operators of such platforms, but this has not materialized, necessitating the exploration of alternative approaches (although not a concern if data from energy performance certification is present).

Policymakers play a crucial role by setting the conditions for crowd investing and energy contracting. Currently, strict regulations are in place to prevent money laundering and restrict the duration of projects for alternative investments. While energy contracting regulations are less stringent, implementing mandatory but affordable insurance could help increase demand.

Furthermore, the persistence and accessibility of data from Energy Performance Certification (EPC) are governed by legal entities, and data management varies across Austria's regions. Salzburg, Styria, Burgenland, Carinthia, Lower Austria, and Tyrol share a common XML schema for EPC data collection and storage (energieausweise.net). In contrast, Vorarlberg operates a more advanced yet closed system (eawz.at). Developing solutions that harmonize these different regional approaches will be crucial for advancing energy performance and renovation projects.

6. Final Considerations

The evaluation of the FinSESCo platform underscores its potential to redefine energy efficiency investments by addressing barriers and leveraging opportunities across diverse contexts. Through comprehensive analyses, the project identified key insights into socioeconomic dynamics, the viability of the business model, and emerging opportunities in global markets, such as India.

The socioeconomic requirement analysis highlighted critical drivers influencing the adoption of energy efficiency measures and the FinSESCo platform. Key factors such as income, education, homeownership, and familiarity with renewable energy systems emerged as significant predictors of investment willingness. Low-income households showed potential for engagement through flexible financing options and targeted outreach, addressing a traditionally underserved demographic. The analysis also revealed the importance of environmental motivations and prior experience with crowdfunding as drivers of platform adoption. By tailoring strategies to these socioeconomic factors, FinSESCo can expand its reach and inclusivity, fostering participation from a wider array of stakeholders.

The business model evaluation affirmed the platform's capacity to overcome traditional barriers in the energy efficiency market. FinSESCo's innovative integration of crowdfunding, gamification, and smart contracts positions it as a transformative tool in democratizing investments. The analysis emphasized the platform's alignment with emerging trends in digital finance, offering users a streamlined, transparent approach to energy projects. Challenges such as trust in financial mechanisms and digital literacy among specific user groups were addressed through recommendations for targeted education and marketing strategies. Additionally, the adaptability of the business model to various regulatory frameworks ensures its scalability across different national markets.

The upcoming Indian pilot presents a unique opportunity to test the platform in a rapidly growing market for renewable energy. With India's high energy demand and ambitious sustainability goals, FinSESCo can play a pivotal role in bridging financing gaps for energy efficiency projects. Key expectations include addressing the complexities of the regulatory environment, adapting the platform to local socioeconomic conditions, and demonstrating its value in fostering private investment. The pilot will also explore the potential of FinSESCo to engage smaller investors and communities, leveraging collective financing to accelerate the adoption of renewable energy solutions.

By integrating insights from socioeconomic requirement analysis, business model evaluation, and pilot findings, FinSESCo has demonstrated its potential as a scalable, inclusive solution to energy efficiency financing. The platform not only addresses existing market barriers but also lays the groundwork for broader adoption through innovative, user-centered approaches. As the project moves forward, the lessons learned provide a roadmap for enhancing the platform's impact, ensuring its relevance and effectiveness in diverse socioeconomic and regulatory contexts.

References

Agostinelli, C. (2002). Robust stepwise regression. *Journal of Applied Statistics*, *29*(6), 825–840. https://doi.org/10.1080/02664760220136168

Bauwens, T. (2016). Explaining the diversity of motivations behind community renewable energy. *Energy Policy*, *93*, 278–290. https://doi.org/10.1016/j.enpol.2016.03.017

Bauwens, T., & Eyre, N. (2017). Exploring the links between community-based governance and sustainable energy use: Quantitative evidence from Flanders. *Ecological Economics*, *137*, 163–172. https://doi.org/10.1016/j.ecolecon.2017.03.006

Bauwens, T., Schraven, D., Drewing, E., Radtke, J., Holstenkamp, L., Gotchev, B., & Yildiz, Ö. (2022). Conceptualizing community in energy systems: A systematic review of 183 definitions. *Renewable and Sustainable Energy Reviews*, *156*, 111999. https://doi.org/10.1016/j.rser.2021.111999

Bureau of Energy Efficiency (BEE). (2023). List of 56 ESCOs with validity till 24th August 2025. Retrieved from https://beeindia.gov.in/sites/default/files/56%20ESCOs%20with%20validity%20till%2024th%20August%202025.pdf

Brinkmann, S., & Kvale, S. (2014). InterViews: Learning the craft of qualitative research interviewing (3rd ed.). SAGE Publications, Inc.

Cribari-Neto, F., & Zarkos, S. G. (1999). Bootstrap methods for heteroskedastic regression models: Evidence on estimation and testing. *Econometric Reviews*, *18*(2), 211–228. https://doi.org/10.1080/07474939908800440

CrowdCircus. (2024). Österreichische Crowdfunding Plattformen. Retrieved from https://crowdcircus.com/oesterreichische-crowdfunding-plattformen

Crowdfunding: Aufsichtsrechtliche Pflichten und Verantwortung des Anlegers. (2014). BaFin. Retrieved from https://www.bafin.de/SharedDocs/Veroeffentlichungen/DE/Fachartikel/2014/fa_bj_1406_crowdfunding.html

DECA - Dienstleister Energieeffizienz und Contracting Austria. (2024). Retrieved from https://www.deca.at/wir-ueber-uns

Digital Capital Raising: market data & analysis | Statista. (2003). Statista. Retrieved from https://www.statista.com/study/47352/fintech-report-alternative-financing/

Dolce Vita Advisors. (2024). Regulatory landscape of crowdfunding in India. Retrieved from https://dolcevitaadvisors.com/regulatory-landscape-of-crowdfunding-in-india/#_ftn2

DKB. (2024). Über uns: Die Plattform DKB-Crowd | DKB - Investieren Sie jetzt. DKB. Retrieved from https://www.dkb-crowdfunding.de/ueber-uns

Feng, C., Wang, H., Lu, N., Chen, T., He, H., Lu, Y., & Tu, X. M. (2014). *Log-transformation and its implications for data analysis*. *26*(2).

Filho, D. F., Silva, L., Pires, A., & Malaquias, C. (2023). *Living with outliers: How to detect extreme observations in data analysis*.

Flaute, M., Großmann, A., Lutz, C., & Nieters, A. (2017). *Macroeconomic Effects of Prosumer Households in Germany*. *7*(1).

Goulden, M., Bedwell, B., Rennick-Egglestone, S., Rodden, T., & Spence, A. (2014). Smart grids, smart users? The role of the user in demand side management. *Energy Research & Social Science*, *2*, 21–29. https://doi.org/10.1016/j.erss.2014.04.008

Hammouri, H. M., Sabo, R. T., Alsaadawi, R., & Kheirallah, K. A. (2020). Handling Skewed Data: A Comparison of Two Popular Methods. *Applied Sciences*, *10*(18), 6247. https://doi.org/10.3390/app10186247

Hanke, F., Grossmann, K., & Sandmann, L. (2023). Excluded despite their support—The perspectives of energy-poor households on their participation in the German energy transition narrative. *Energy Research & Social Science*, *104*, 103259. https://doi.org/10.1016/j.erss.2023.103259

Hanke, F., Guyet, R., & Feenstra, M. (2021). Do renewable energy communities deliver energy justice? Exploring insights from 71 European cases. *Energy Research & Social Science*, *80*, 102244. https://doi.org/10.1016/j.erss.2021.102244

Hirsch, D., Padley, M., Stone, J., & Valadez-Martinez, L. (2020). The Low Income Gap: A New Indicator Based on a Minimum Income Standard. *Social Indicators Research*, *149*(1), 67–85. https://doi.org/10.1007/s11205-019-02241-6

Hong, X., & Mitchell, R. J. (2007). Backward elimination model construction for regression and classification using leave-one-out criteria. *International Journal of Systems Science*, *38*(2), 101–113. https://doi.org/10.1080/00207720601051463

Hossain, M. (2018). Grassroots innovation: The state of the art and future perspectives. *Technology in Society*, *55*, 63–69. https://doi.org/10.1016/j.techsoc.2018.06.008

Kompetenzzentrum Contracting. (2024). Deutsche Energie-Agentur GmbH (Dena). Retrieved from https://www.dena.de/kompetenzzentrum-contracting/

LenderKit. (2021). Crowdfunding in India: Market overview. Retrieved from https://lenderkit.com/blog/crowdfunding-in-india-market-overview/

Radtke, J., Yildiz, Ö., & Roth, L. (2022). Does Energy Community Membership Change Sustainable Attitudes and Behavioral Patterns? Empirical Evidence from Community Wind Energy in Germany. *Energies*, *15*(3), 822. https://doi.org/10.3390/en15030822

Rommel, J., Radtke, J., Von Jorck, G., Mey, F., & Yildiz, Ö. (2018). Community renewable energy at a crossroads: A think piece on degrowth, technology, and the democratization of the German energy system. *Journal of Cleaner Production*, *197*, 1746–1753. https://doi.org/10.1016/j.jclepro.2016.11.114

Roth, L., Lowitzsch, J., & Yildiz, Ö. (2023). Which (co-)ownership types in renewables are associated with the willingness to adopt energy-efficient technologies and energy-conscious behaviour? Data from German households. *Energy Policy*, *180*, 113683. https://doi.org/10.1016/j.enpol.2023.113683

Roth, L., Lowitzsch, J., Yildiz, Ö., & Hashani, A. (2018). Does (Co-)ownership in renewables matter for an electricity consumer's demand flexibility? Empirical evidence from Germany. *Energy Research & Social Science*, *46*, 169–182. https://doi.org/10.1016/j.erss.2018.07.009

Roth, L., Yildiz, Ö., & Lowitzsch, J. (2021). An Empirical Approach to Differences in Flexible Electricity Consumption Behaviour of Urban and Rural Populations—Lessons Learned in Germany. *Sustainability*, *13*(16), 9028. https://doi.org/10.3390/su13169028

Ruengvirayudh, P., & Brooks, G. P. (2016). *Comparing Stepwise Regression Models to the Best-Subsets Models, or, the Art of Stepwise*. *42*.

Sahinler, S., & Topuz, D. (2007). BOOTSTRAP AND JACKKNIFE RESAMPLING ALGORITHMS FOR ESTIMATION OF REGRESSION PARAMETERS. *Case Studies*.

Statista. (2023b). Crowdfunding in Germany: Digital capital raising. Retrieved from https://www.statista.com/outlook/dmo/fintech/digital-capital-raising/crowdfunding/germany

Statista. (2023c). Crowdfunding in Austria: Digital capital raising. Retrieved from https://www.statista.com/outlook/dmo/fintech/digital-capital-raising/crowdfunding/austria

Statista. (2023d). Crowdfunding in India: Digital capital raising. Retrieved from https://www.statista.com/outlook/dmo/fintech/digital-capital-raising/crowdfunding/india

Statistik Austria. (2022). Energieeinsatz der Haushalte. Retrieved from https://www.statistik.at/statistiken/energie-und-umwelt/energie/energieeinsatz-der-haushalte

Streukens, S., & Leroi-Werelds, S. (2016). Bootstrapping and PLS-SEM: A step-by-step guide to get more out of your bootstrap results. *European Management Journal*, *34*(6), 618–632. https://doi.org/10.1016/j.emj.2016.06.003

Thayer, J. D. (2002). *Stepwise Regression as an Exploratory Data Analysis Procedure*.

Wang, Q., Koval, J. J., Mills, C. A., & Lee, K.-I. D. (2007). Determination of the Selection Statistics and Best Significance Level in Backward Stepwise Logistic Regression. *Communications in Statistics - Simulation and Computation*, *37*(1), 62–72. https://doi.org/10.1080/03610910701723625

World Bank. (2020). Transforming India's energy efficiency market: Unlocking the potential of private ESCOs. Retrieved from https://blogs.worldbank.org/en/ppps/transforming-indias-energy-efficiency-market-unlocking-potential-private-escos

Berichtsblatt

1. ISBN oder ISSN	2. Berichtsart (Schlussbericht oder Veröffentlichung)
	Schlussbericht

3. Titel
Schlussbericht - FinSESCo - Fintech for Smart Energy System Contracting

4. Autor(en) [Name(n), Vorname(n)]	5. Abschlussdatum des Vorhabens
Lowitzsch, Jens; Magalhães, Renan	31.12.2024
	6. Veröffentlichungsdatum
	7. Form der Publikation Document Control Sheet
8. Durchführende Institution(en) (Name, Adresse) Stiftung Europa-Universität Viadrina Große Scharrnstraße 59, 15230 Frankfurt (Oder)	**9. Ber.-Nr. Durchführende Institution**
	10. Förderkennzeichen 03EI6072A
	11. Seitenzahl 39
12. Fördernde Institution (Name, Adresse) BMWK Scharnhorststraße 34-37 10115 Berlin	**13. Literaturangaben** 43
	14. Tabellen 4
	15. Abbildungen 16

16. DOI (Digital Object Identifier)

17. Vorgelegt bei (Titel, Ort, Datum)

18. Kurzfassung
This report intends to present the final summary of the findings of the project, presenting the main contributions of our research to the consortium and to the project. During the setup phase, the project faced a number of constraints: two partners not being able to be funded and the third one with a strong delay to start. The analysis was adapted for our Indian Pilot, reflecting the expected challenges and the potential of the pilot site. Practical choices were necessary, such as the use of a standardized questionnaire for building owners, the focus on adapting strategies to the local context, and the documentation of socioeconomic background by extensive background analyses, enriching the evaluation with qualitative insights.
The evaluation of the FinSESCo platform was performed by including a variety of methodologies aimed at capturing its performance across different dimensions. These included qualitative interviews, surveys, and detailed case studies for each pilot, supported by quantitative analysis to identify drivers of acceptance. A comparative cross-pilot approach was used in order to develop EU-level insights, ensuring findings are relevant across different contexts. In this report we will present the main findings from the different evaluation processes. Overall, this review shows actionable recommendations to advance the platform's usability and scalability, and better alignment with local needs, while showcasing its potential to address barriers in energy efficiency investments across Europe.

19. Schlagwörter

20. Verlag	21. Preis

Entwurf

Document control sheet

1. ISBN or ISSN	2. type of document (e.g. report, publication) Veröffentlichung (Publikation)

3. title
Schlussbericht - FinSESCo - Fintech for Smart Energy System Contracting

4. author(s) (family name, first name(s)) Lowitzsch, Jens; Magalhães, Renan	**5. end of project** 31.12.2024
	6. publication date
	7. form of publication Document Control Sheet
8. performing organization(s) name, address Stiftung Europa-Universität Viadrina Große Scharrnstraße 59, 15230 Frankfurt (Oder)	**9. orginators report no.**
	10. reference no. 03EI6072A
	11. no. of pages 39
12. sponsering agency (name, address) BMWK Scharnhorststraße 34-37 10115 Berlin	**13. no. of references** 43
	14. no. of tables 4
	15. no. of figures 16

16. DOI (Digital Object Identifier)

17. presented at (title, place, date)

18. abstract
This report intends to present the final summary of the findings of the project, presenting the main contributions of our research to the consortium and to the project. During the setup phase, the project faced a number of constraints: two partners not being able to be funded and the third one with a strong delay to start. The analysis was adapted for our Indian Pilot, reflecting the expected challenges and the potential of the pilot site. Practical choices were necessary, such as the use of a standardized questionnaire for building owners, the focus on adapting strategies to the local context, and the documentation of socioeconomic background by extensive background analyses, enriching the evaluation with qualitative insights.
The evaluation of the FinSESCo platform was performed by including a variety of methodologies aimed at capturing its performance across different dimensions. These included qualitative interviews, surveys, and detailed case studies for each pilot, supported by quantitative analysis to identify drivers of acceptance. A comparative cross-pilot approach was used in order to develop EU-level insights, ensuring findings are relevant across different contexts. In this report we will present the main findings from the different evaluation processes. Overall, this review shows actionable recommendations to advance the platform's usability and scalability, and better alignment with local needs, while showcasing its potential to address barriers in energy efficiency investments across Europe.

19. keywords

20. publisher	**21. price**

Entwurf