Key considerations in the design of a One-Stop-Shop retrofit model

Orlaith McGinley[1,2,3], Paul Moran[1,2], Jamie Goggins[1,2,3]
[1]Civil Engineering, School of Engineering, College of Science & Engineering, National University of Ireland, Galway, University Road, Galway, Ireland
[2]SFI MaREI Centre, Ryan Institute, National University of Ireland, Galway, University Road, Galway, Ireland
[3]Energy Resilience and the Built Environment (ERBE) Centre for Doctoral Training, National University of Ireland, Galway

email: o.mcginley2@nuigalway.ie, paul.t.moran@nuigalway.ie, jamie.goggins@nuigalway.ie

ABSTRACT: The Irish Government's Climate Action Plan emphasizes the need for increased retrofit activity within the built environment. As such, the plan has set targets for the completion of 500,000 energy efficient retrofits by 2030 at a rate of 50,000 per annum. Ireland's current retrofit uptake rate is considered relatively low, at approximately 23,000 primarily shallow retrofits per annum. Thus, a significant step change is required to drive retrofit investment at a national scale, however, there are various barriers existing to such. Considering these targets, the establishment of a One-Stop-Shop (OSS) retrofit model has been identified in the Climate Action Plan as a key action. Such OSS models are emerging across Europe, with some OSS style models already introduced in Ireland. However, significant upscaling is required to deliver on the targets set. This paper provides a definition of a OSS model, highlights its benefits and how it responds to some of the barriers limiting retrofit uptake in Ireland. Secondly, this paper reviews existing literature and business models of existing European OSS models, with focus on the customer segment in these models. A brief discussion on the potential reach of such customer segments in the Irish context are presented, based on available statistics. The main finding of the paper is that there is limited published research on the characteristics and motivations of households engaging with existing OSS models and retrofitting in general in Ireland. A deeper understanding of such will be crucial to the success of the establishment of a OSS model in Ireland as a policy measure toward the achievement of the Climate Action Plan targets set.

KEY WORDS: One-Stop-Shop; Retrofitting; Energy Efficiency

1 INTRODUCTION

Improving the energy efficiency of Ireland's existing building stock is a key policy focus for Ireland's achievement of the energy and emissions targets set [1], [2], [3], [4], [5], [6]. Improving the residential sector is a particular focus, as it contributes approximately 23% of the total national energy consumption in Ireland [7]. Recognising the urgent need to improve energy efficiency in existing dwellings, Ireland's Climate Action Plan proposes to substantially increase the level of existing dwelling retrofits in Ireland to 500,000 existing dwellings by 2030 at an average rate of 50,000 dwellings per annum [4]. The buildings must also be retrofitted to have a maximum energy demand of 125 kWh/m^2/year which is equivalent to a Building Energy Rating (BER) of B2 [8]. A BER is an energy performance certificate for residential buildings in Ireland.

However, the current annual rate of retrofit uptake using grant aid is circa 23,000 retrofits per annum. Of the retrofits completed in 2019, only 2,600, that is 11%, achieved a B2-BER or better. This is far from the 50,000 B2-BER retrofits per annum set in the Climate Action Plan. Thus, for Ireland to achieve these ambitious targets set, a significant step change is required not only in increasing retrofit uptake, but in increasing retrofit depth. However, various motives and barriers to retrofitting exist from the perspective of both supply and demand side stakeholders in the retrofit market in Ireland.

In the Irish context, economic or financial limitations form key barriers to retrofit uptake from a demand side stakeholder (homeowner) perspective. These include the high upfront costs and long paybacks associated with retrofitting, grant availability, and the complexity of funding structures [9], [10], [11]. In addition, awareness, knowledge and information barriers as to the benefits of retrofitting, and the measures and schemes available, are prevalent among Irish homeowners [9], [10], [11], [12]. Moreover, the associated technical difficulties of retrofitting, including the stress and disruption imposed, deter homeowners from retrofit investment [9]. Furthermore, market barriers such as the split incentive existing between landlords and tenants have limited the reach of the Irish retrofit market [13].

From the supply side stakeholder perspective, limitations exist in the traditional models through which retrofits are provided [14]. In Ireland, these limitations are categorised by highly fragmented supply chains and skills gaps in the area amongst construction professionals [10], [15].

Institutional or regulatory deficiencies also form retrofit barriers [16]. In the Irish context, this includes the competing priorities which exist among the government. Moreover, the government has, thus far, failed to comply with their climate change commitments, failing to meet their 2020 energy and emissions targets set, and being largely off track to meeting the 2030 targets set, unless accelerated action is taken [10], [17], [18].

One-Stop-Shop (OSS) models are a possible solution for overcoming some of the discussed barriers. It, therefore, is not surprising that the OSS model has been supported by the European Commission, through the smart financing for smart buildings initiative [19], and through the amended Energy Performance of Buildings Directive (EPBD) (Directive 2018/844/EU) [20]. OSS models are emerging across Europe,

while Ireland's Climate Action Plan proposed the establishment of a OSS model for energy efficiency upgrades as a specific action toward the achievement of their retrofit targets set [4].

By definition, OSS models offer full service retrofitting, which consists of several phases, broadly including the initial building evaluation and thorough analysis, the proposal of retrofit solutions, fully co-ordinated and managed retrofit execution, followed by quality assurance procedures and continued commissioning of the building [21]. Moreover, through providing a single point of contact, the OSS model guides homeowners through the entire retrofit process [22].

This paper aims to demonstrate the benefits of OSS models and how OSS models can address some of the persistent barriers which exist in Ireland. Secondly, the paper reviews existing literature related to OSS models, and the features of existing European OSS models, to gain an insight into the characteristics of homeowners most interested in, or engaging, with OSS models. These insights were considered in terms of the nature of occupancy of Irish dwellings, to highlight the potential reach of such a customer segment in an Irish OSS model toward the achievement of the Climate Action Plan targets. Figure 1 and Figure 2 show the traditional and OSS retrofit models, respectively.

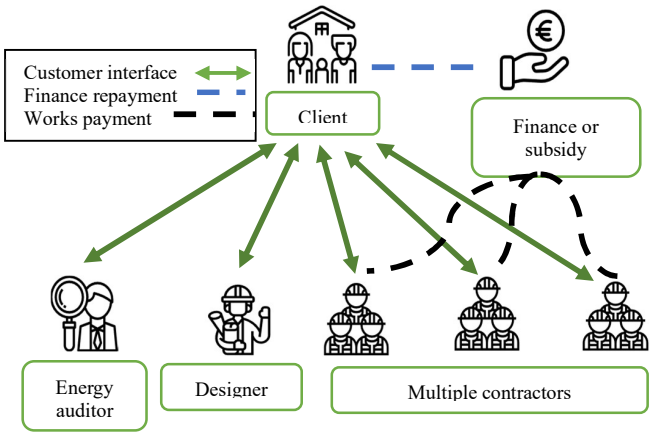

Figure 1. Traditional retrofit model

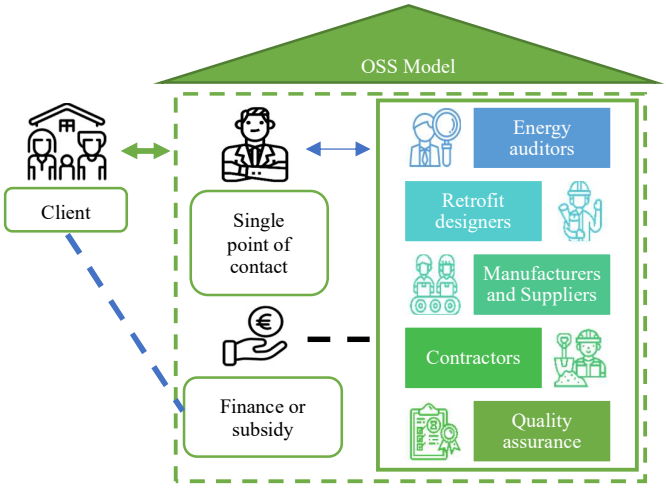

Figure 2. One Stop Shop retrofit model

2 THE BENEFITS OF THE OSS MODEL

Traditional retrofit models are characterised by a fragmented retrofit value chain in which separate actors complete separate fractions of the retrofit works [23]. Moreover, traditional retrofit models present homeowners with an extremely complex decision making process, in which they must make non-expert decisions, often in the absence of proper information, on the optimal retrofit for their home [16].

Moving towards OSS models means moving toward a customer centred service model, with a single customer interface and point of contact who takes responsibility, and project manages [23]. This bridges the gap between the fragmented supply chain and demand sides, and reduces the need for homeowners to manage various building professionals otherwise involved in the retrofit process [16]. As such, OSS models are considered beneficial for supporting the retrofit decision process. They also, through providing homeowners with tailored advice on both the retrofit packages available and their benefits, from one reliable source, remove the awareness and informational barriers which exist [16], [22]. Through supporting the decision making process, OSS models enable the implementation of more extensive retrofits in a step-wise motion than would otherwise be implemented in absence of such information and support [16], [22], [24]. Moreover, OSS models can reduce the disruption, hassle or stress otherwise associated with complex extensive retrofit, by enabling quicker completion [16].

OSS models have various benefits in the context of easing the economic or financial limitations prevalent in the retrofit market. OSS models often increase access to capital, grants or loans [16], [21]. Additionally, the presence of a single point of contact reduces the likelihood of unreliable repayment plans [16]. OSS models also reduce the high transaction costs associated with retrofit projects, by allowing individual projects to be pooled from both the homeowners and supplier point of view [16]. As well as this, through supporting the retrofit decision-making process, OSS models help identify the most financially viable retrofit packages [16].

Additional benefits of OSS models from a homeowner perspective include that they facilitate the inclusion of a homeowners functional wishes into the design of retrofit solutions, in recognition of the fact that homeowners are motivated differently and prioritise different retrofit benefits [22], [25]. Individual household characteristics and socio-economic considerations are also taken into consideration [22]. As a result tailored solutions are offered, ensuring optimal retrofit packages are selected [16], [22], [24]. Moreover, OSS models integrate energy efficiency into renovation processes, meaning homeowners will more willingly accept energy efficient solutions [16], [22], [24]. In addition, through supporting and involving the homeowner throughout, homeowners become more satisfied with the overall retrofit process; while the quality assurance systems offered by OSS models increases the credibility to the offerings, reduces risk aversion associated with new technology adoption, and improves homeowner trust [16], [22].

OSS models also have benefits from a supply side stakeholder perspective. Suppliers can benefit from the pooling capacity of an integrated supply side, which provides single service suppliers the opportunity to extend their offerings, and

enter wider market sections or value chains as a new entrant, providing a more resilient business structure [16]. OSS models also enable economies of scale and can serve as a lobbying group or representative for suppliers [16]. Additionally, as discussed, significant upskilling of the construction sector is required to facilitate retrofit uptake. Integrating the supply side through the OSS model serves to provide a forum for co-ordinated collaboration of various partners, allowing for knowledge, skills and innovation transfer among key market players, bringing a balance of skills into the retrofit process that might otherwise be missing [16].

While the OSS model has advantages, some disadvantages exist, including the fact that OSS models generally reduce a homeowner's ability to choose preferred suppliers at various steps of the retrofit process, while the retrofit options might be limited to those that are offered by the OSS [26]. Furthermore, conflicts of interest may arise between the different disciplines involved in the OSS, while having a single point of contact might introduce project biases [26]. Finally, issues arising between the homeowner and the OSS will impact the entire project, as opposed to one element as with the traditional model [26]. Moreover, while Grøn-Bjørneboe et al. [22] did find that various benefits of the OSS model existed, the concept in itself is not a sufficient motivator for houseowners to undertake extensive renovation. Nor was it conclusive to say that the OSS model would make renovation more accessible to those without a vested interest in retrofitting in the first place [22]. Therefore, the OSS model may ensure better retrofits for those already interested parties, but it may not prove to be enough of a motivator for those in doubt about retrofitting. Thus, questions remain as to whether a OSS model is enough to solve the slow progress of renovating the existing building stock in Ireland.

3 CUSTOMER SEGMENTS IN ONE-STOP-SHOP MODELS

OSS models are emerging in Europe, and as such, it is important to determine whether a OSS market even exists, who the target customers are, and who can most benefit from the OSS model. Moreover, OSS models are an innovative retrofitting concept, therefore, requiring the interest of early adopters, and open-minded people more likely to engage in a new and innovative service [21]. Furthermore, it is important to determine not only who is willing to engage, but their capacity to engage [21]. There is increasing research interest in this area. Some studies have investigated householder interest in OSS models, including the motivating factors behind their interest [24]. Other studies have investigated the perceived benefits to householders, through assessing the outcome of actual implemented OSS models [22]. Other studies have provided insight into the considerations of OSS models from comparing existing OSS models, or through the learnings of OSS research projects [16], [21], [27], [28]. However, no such studies exist in the Irish context, thus far.

Pardalis et al. [24] found that of the 971 Swedish homeowners surveyed, approximately 20% of homeowners had a positive view towards OSS models, indicating an appreciable interest for OSS models among Swedish homeowners and the existence of a market for OSS models among Swedish homeowners. Of the homeowners surveyed, 76% intended to renovate their home in the future, with 71% preferring to renovate individual components of their dwellings, while only 5% wished to renovate their whole house in steps [24]. Guaranteed quality, clear costs, estimations of future energy savings and careful inspections were considered critical to the success of a OSS, from the perspective of those most interested homeowners. Conversely, from the perspective of uninterested parties, the higher costs associated with OSS models, and the want for freedom of choice in choosing the actors performing the renovation, were the main reasons for disinterest in the OSS model [24].

Mahapatra et al. [21] found that the length of time a person owned a house can influence their engagement with the OSS model, given that homeowners who have owned a house for several years may have greater capacity to avail of mortgage financing for the works. Other considerations include the age group, education level and income level of the proposed customers [21], [22], [24]. Pardalis et al. [24] highlighted that householders aged 30 to 50 years, with a university level education, a medium to high income and with an energy concern or an interest for environmental issues showed significant interest in the concept of a OSS model for renovation [24]. Grøn Bjørneboe et al. [22], citing the findings of a survey of Danish houseowners [29], found that approximately 20% of younger house owners aged 25 to 39 years, would feel motivated by OSS to undertake renovation.

The dwelling type played a role in buildings retrofitted as part of OSS models. Interestingly, in the existing OSS models presented in [16] and [28], a total of 18 out of 28 case studies cited owner occupiers of single family houses as their customer segment. One in particular, namely Oktave in France, specifically limited their customer segment to single family homes in which the homeowners either (i) had nearly, or fully, paid their mortgage, (ii) were high income families or (iii) were first time buyers [16], [28]. Some OSS models identified multi-family buildings and apartment blocks, while less models targeted social housing [16], [28]. Additionally, some OSS models had more than one customer segment.

The success of the OSS model in Ireland relies on engaging customers who are willing to undertake retrofits at the depth required to meet the Climate Action Plan targets. However, there is a lack of research assessing the interest among Irish householders toward engaging with OSS models, and moreover, the characteristics of those engaging with OSS models.

3.1 Household profiles in Ireland

Figure 3 shows the nature of occupancy for Irish housing units according to the 2016 census. Approximately 44% of dwellings (circa 611,877 dwellings) are owner-occupied without a loan or mortgage, while 39% of dwellings (circa 535,675) are owner occupied with a loan or mortgage [30].

In terms of the age profile of householders in Ireland, home ownership becomes the majority tenure in Ireland at aged 35 and older [30]. Looking more closely at these owner-occupiers in Ireland, approximately 71,833 owner-occupiers in Ireland without a mortgage are aged 30-50 years, while 348,440 owner occupiers with a mortgage are aged 30-50 years. However, the number of persons without a mortgage in Ireland increase with age, particularly after the age of 40, with approximately 586,456 households without a mortgage being aged 40 and

above. The highest percentage of householders without a mortgage is among those aged 65 and over (Figure 4).

While there are no studies which investigate the income of homeowners engaging with OSS models in an Irish setting; a study conducted by Collins and Curtis [32] found that the likelihood of applying for more comprehensive retrofits increased with individual income. Such insight might be applicable to the OSS model in the Irish context and suggest that higher income households would be more willing to engage with an OSS model for deep retrofit. Figure 5 shows the average median income of various tenure types across all counties in Ireland. While there are no statistics detailing the number of owner occupiers in Ireland which are of a particular incomes, Figure 5 suggests that the average median income of owner occupiers without a mortgage is approximately €37,000, while owner occupiers with a mortgage are considered the highest earners [33]. While the census collected data on both the nature of occupancy of Irish households, and the education level of Irish householders, there are currently no data sets linking these data.

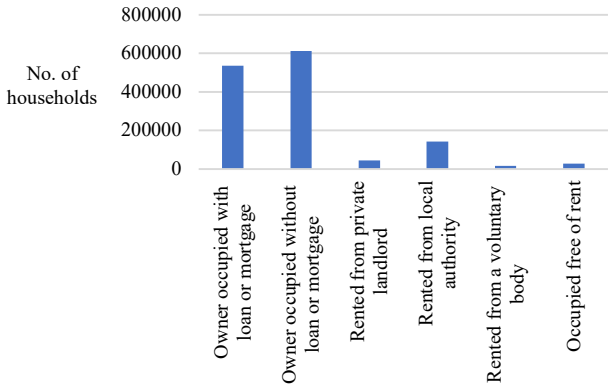

Figure 3. Nature of occupancy in Irish dwellings (Source: Adapted from [30]).

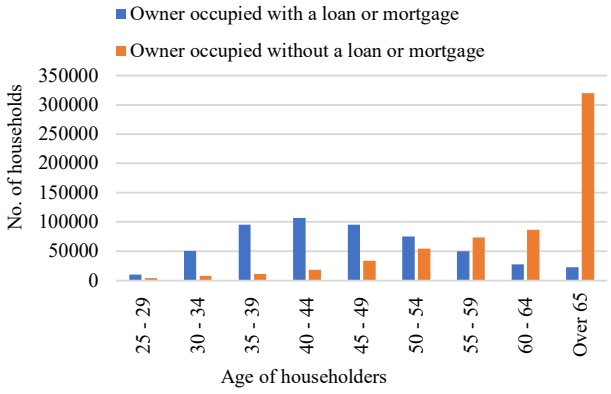

Figure 4. Age profiles of owner-occupiers in existing Irish dwellings (Source: Adapted from [31])

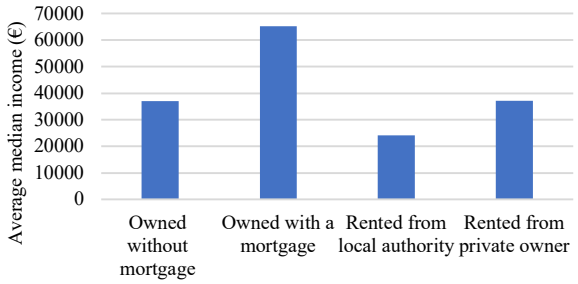

Figure 5. Average median income of different tenures, for all counties in Ireland (Source: Adapted from [33])

If an Irish OSS model is to be designed based on the findings of previous studies and existing models, (i.e. based on (i) single family homes in which the homeowners had fully paid their mortgage, or based on (ii) householders between the age of 30 to 50 years), it can be deduced from the statistics discussed that there is significant potential for a OSS model to contribute to the achievement of the Climate Action Plan targets of 500,000 retrofits to a B2-BER or better by 2030, given the number of such households in the Irish context. However, it is limiting to presume that opportunity exists only among such householders in Ireland. For example, there is increased growth in the rental sector, with the home ownership rate in Ireland falling consistently [30]. There is also a willingness to pay among rental tenants for improved energy efficiency [34]. Therefore, an effective Irish OSS model should be designed so as to be attractive and inclusive to other customer segments, beyond those already targeted in existing OSS models, in order to maximise the reach and impact of the OSS model toward the achievement of the Climate Action Plan targets.

No studies currently exist which assess the interest of Irish householders towards engaging with OSS models, or which assess the characteristics of those households engaging with OSS services. Moreover, the success of the OSS model in Ireland relies heavily on engaging customers who are willing to undertake retrofits at the depth required to meet the Climate Action Targets of 500,000 B2-BER or better retrofits by 2030. However, limited studies exist which examine the factors influencing customers engagement with comprehensive, deep retrofitting in Ireland.

Recognising these literature gaps, future research in line with the TURNKEY RETROFIT project [35], will evaluate the existing OSS models operating in Ireland, through collating key insights from both supply and demand side stakeholder perspectives. From the demand side perspective, the characteristics of the householders engaging with the service will be collected, including demographic and socio-economic information, the depth of retrofit implemented, and their motivations or demotivation of engaging with such a model. In addition, the householders' experience of engaging with the service will be evaluated to determine the quality of the services, how customer relationships were maintained, and the householder's satisfaction with the performance of the retrofits implemented. Providing such insight will serve to better inform the definition of the customer segment in the Irish context. Moreover, these insights will provide a critical evidence base into how OSS concepts in Ireland can be best designed and

implemented to guide extensive energy renovation on a national scale.

4 CONCLUSION

In Ireland, a step change is required to drive retrofit investment at a national scale to achieve the ambitious retrofit targets set by Ireland's Climate Action Plan. However, if Ireland is to achieve these targets, significant barriers, from both the supply and demand-side perspective, must be overcome. As such, the establishment of a One-Stop-Shop (OSS) retrofit model has been identified as a key action in the Climate Action Plan to aid in the achievement of these targets, recognising the various benefits of such a model, in terms of how they respond to some of the most persistent barriers in the Irish retrofit market. OSS models are emerging across Europe, with several OSS style retrofit models existing in Ireland. However, significant upscaling of the market is required to go from 2,600 grant-aided retrofits to B2-BER or better completed in 2019 to an average of 50,000 B2-BER retrofits per annum over the next 10 years, as set in the Climate Action Plan. Thus, it is crucial to carefully consider the factors influencing the design of the most effective OSS model in the Irish context.

This paper, firstly, provided an insight into the benefits of OSS models, including how they respond to some of the most persistent barriers to retrofit uptake in the Irish context. Secondly, by reviewing the existing literature and existing European OSS models, some key insights into the characteristics of homeowners most interested in, or engaging, with OSS models were discussed. Such customer segments were considered in terms of the nature of occupancy of Irish dwellings, to highlight the potential reach of an Irish OSS model toward the achievement of the Climate Action Plan targets.

The research revealed that an appreciable interest in the OSS concept exists among homeowners in some European countries, as a result of the recognition of the benefits that the OSS model presents in excess of those offered in a traditional retrofit model. There is some consistency across the literature and within the existing European OSS models, that single-family homes are most frequently targeted in the customer segment. The review of existing literature and existing studies highlighted that homeowners without a mortgage, of a certain age, of higher income, and even, a higher education level, may be more willing to engage with OSS models. However, it is held that the Irish OSS model should be designed to be attractive and inclusive to other customer segments, to better contribute to the achievement of the Climate Action Plan targets set.

The key finding, however, is that there is significant room for further research into the definition of the characteristics and motivations of householders engaging with existing Irish OSS models, as these will largely influence how householders will respond to OSS model offerings. This deeper understanding into the customer segment will inform both the design of policy related to the establishment of OSS models in Ireland, and the design of the business model itself. Moreover, a deeper understanding into the householder motivation towards engaging with such OSS models can inform the design of information that will be central to incentivising engagement on a national scale, given that the success of the OSS model will depend on how they are communicated to those on whose decision to act they depend. Thus, future research is to be conducted to address the research gaps in the Irish context in this space.

ACKNOWLEDGMENTS

The authors would like to acknowledge the financial support of European Union's Horizon 2020 research and innovation programme under grant agreement No. 839134, as well as from Science Foundation Ireland (SFI) for the ERBE Centre for Doctoral Training under grand agreement No 18/EPSRC-CDT/3586 and the MaREI Centre under grant agreement No. 12/RC/2302_P2.

REFERENCES

[1] Department of Communications, Climate Action and Environment , "Ireland's Transition to a Low Carbon Energy Future 2015 - 2030," 16 December 2015. [Online]. Available: https://www.dccae.gov.ie/en-ie/energy/publications/Pages/White-Paper-on-Energy-Policy.aspx. [Accessed 12 September 2019].

[2] Department of Communications, Climate Action and Environment , "National Energy Efficiency Action Plan," 2017. [Online]. Available: https://www.dccae.gov.ie/documents/NEEAP%204.pdf. [Accessed 12 September 2019].

[3] Department of Communications, Climate Action and Environment , "National Mitigation Plan," 19 July 2017. [Online]. Available: https://www.dccae.gov.ie/en-ie/climate-action/publications/Pages/National-Mitigation-Plan.aspx. [Accessed 12 September 2019].

[4] Department of Communications, Climate Action and Environment, "Climate Action Plan," 17 June 2019. [Online]. Available: https://www.dccae.gov.ie/en-ie/climate-action/topics/climate-action-plan/Pages/climate-action.aspx. [Accessed 12 September 2019].

[5] Department of Communications, Climate Action and Environment, *Ireland Long Term Renovation Strategy 2017 - 2020,* Department of Communications, Climate Action and Environment , 2017.

[6] Department of Public Expenditure and Reform, "Project Ireland 2040 National Development Plan 2018-2027," Department of Public Expenditure and Reform, Dublin, 2018.

[7] Sustainable Energy Authority of Ireland , "Energy in Ireland 2019 Report," SEAI , Dublin , 2019.

[8] Sustainable Energy Authority of Ireland , "Domestic Energy Assessment Procedure," Sustainable Energy Authority of Ireland , Dublin , 2019.

[9] M. Collins and J. Curtis, "An examination of the abandonment of applications for energy efficiency retrofit grants in Ireland," *Energy Policy,* vol. 100, pp. 260-270, 2017.

[10] R. Desmaris, O. Jauregui, O. McGinley and J. Volt, "D 2.1 Market and PESTLE Analysis," TURNKEY RETROFIT Consortium, 2019.

[11] M. Collins and J. Curtis, "Identification of the information gap in residential energy efficiency: How information asymmetry can be mitigated to induce energy efficiency renovations," Economic and Social Research Institute (ESRI), Dublin, 2017.

[12] Sustainable Energy Authority of Ireland and Economic Social Research Institute , "Policy insights for encouraging energy efficiency in the home: A compilation of findings from a research fellowship co-funded by the SEAI and ESRI," SEAI , Dublin, 2018.

[13] Irish Green Building Council , "INTRODUCING MINIMUM ENERGY EFFICIENCY PERFORMANCE STANDARDS IN THE RENTAL SECTOR," IGBC, Dublin , 2019.

[14] D. Brown, "Business models for residential retrofit in the UK: a critical assessment of five key archetypes," *Energy Efficiency,* vol. 11, pp. 1497-1517, 2018.

[15] S. Zuhaib, R. Manton, M. Hajdukiewicz, M. M. Keane and J. Goggins, "Attitudes and approaches of Irish retrofit industry professionals

towards achieving nearly zero-energy buildings," *International Journal of Building Pathology and Adaptation ,* vol. 35, no. 1, pp. 16-40, 2017.

[16] B. Boza-Kiss and P. Bertoldi, "One-Stop-Shops for energy renovations of buildings," European Commission, Ispra , 2018.

[17] Climate Action Network Europe, "EU Countries off target in fighting climate change," 18 June 2018. [Online]. Available: http://www.caneurope.org/publications/press-releases/1619-eu-countries-off-target-in-fighting-climate-change. [Accessed 9 September 2019].

[18] Sustainable Energy Authority of Ireland , "National Energy Projections," Sustainable Energy Authority of Ireland, Dublin, 2019.

[19] European Union: European Commission , "Accelerating clean energy in buildings. Annex to the Clean Energy for All Europeans. 30.11.2016. COM(2016) 860 final," Brussels .

[20] "Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency," Official Journal of the European Union/L156/75, 2018.

[21] K. Mahapatra, L. Gustavsson, T. Haavik, S. Aabrekk, S. Svendsen, L. Vanhoutteghem, S. Paiho and M. Ala-Juusela, "Business models for full servie energy renovation of single family houses in Nordic countries," *Applied Energy ,* vol. 112, pp. 1558-1565, 2013.

[22] M. Grøn Bjørneboe, S. Svendsen and A. Heller, "Using a One-Stop-Shop Concept to Guide Decisions When Single-Family Houses are Renovated," *Journal of Architectural Engineering ,* vol. 23, no. 2, 2017.

[23] E. Mlecnik, I. Kondratenko, J. Cre, J. Vrijders, P. Degraeve, J. Aleksander van der Have, T. Haavik, S. Aabrekk, M. Gron, S. Hansen, S. Svendsen, O. Stenlund and S. Paiho, "Collaboration Opportunities in Advanced Housing Renovation," *Energy Procedia ,* vol. 30, pp. 1380-1389, 2012.

[24] G. Pardalis, K. Mahapatra, G. Bravo and B. Mainali, "Swedish House Owners' Intentions Towards Renovations: Is There a Market for One-Stop-Shop?," *Buildings ,* vol. 9, no. 7, p. 164, 2019.

[25] Sustainable Energy Authority of Ireland , "Behavioural insights on energy efficiency in the residential sector," Sustainable Energy Authority of Ireland , Dublin, 2017.

[26] K. Balson, M. Moreira and L. Simkovicova, "Description of one-stop-shop models for step by step refurbishments," EuroPHit, 2016.

[27] R. Moschetti and H. Brattebo, "Sustainable business models for deep energy retrofitting of buildings: state-of-the-art and methodological approach," in *SBE16 Tallinn and Helskini Conference: Build Green and Renovate Deep* , Tallinn and Helsinki , 2016.

[28] J. Volt, S. Zuhaib and S. Steuwer, "Benchmarking of promising experiences of integrated renovation services in Europe," TURNKEY RETROFIT project , 2019.

[29] Bolius , "Boligejeranalyse 2016," 2016. [Online].

[30] Central Statistics Office , "Census of Population 2016 - Profile 1 Housing in Ireland - Tenure and Rent," 2016. [Online]. Available: https://www.cso.ie/en/releasesandpublications/ep/p-cp1hii/cp1hii/tr/. [Accessed 19 May 2020].

[31] Central Statistics Office , "E1016: Private Households in Permanent Housing Units 2011 to 2016 by Nature of Occupancy, Aggregate Town or Rural Area, Age group of Reference Person, County, City and Census Year," 2018. [Online]. Available: https://statbank.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=E1016&PLanguage=0. [Accessed 19 May 2020].

[32] M. Collins and J. Curtis, "An examination of energy efficiency retrofit depth in Ireland," *Energy and Buildings ,* vol. 127, pp. 170-182, 2016.

[33] Central Statistics Office , "IIA15: Household Gross Income by County, Tenure, Year and Statistic," [Online]. Available: https://statbank.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=IIA15&PLanguage=0. [Accessed 26 May 2020].

[34] M. Collins and J. Curtis, "Rental tenant's willingness-to-pay for improved energy efficiency and payback periods for landlords," *Energy Efficiency,* vol. 11, no. 8, pp. 2033-2056, 2018.

[35] TURNKEY RETROFIT , "TURNKEY RETROFIT," [Online]. Available: https://www.turnkey-retrofit.eu/. [Accessed 29 May 2020].