"This is part of the project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 745594"

Project Title:

New Buildings Energy Renovation Business Models incorporating dual energy services

NOVICE

Grant Agreement No: 745594

Collaborative Project

Final Publishable Report

Deliverable No.	D1.4
Work package	WP 1
Task	Task 1.2 Project Reporting and Communication
Lead beneficiary	IERC
Authors	J Southernwood
Delivery date	31/05/2020
Status	Report
File Name:	D1.4 Final Publishable Report v1.0

Dissemination level		
PU	Public, fully open, e.g. web	X
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC.	

	Deliverable administration				
No & name	**Task 1.2 Project Reporting and Communication**				
Status	FINAL	**Due**	M36	**Date**	31/05/2020
Author(s)	J Southernwood				
Description of the related task and the deliverable in the DoA	This task aims at establishing and maintaining fluent communication within the NOVICE consortium and with the EC. All deliverables and milestones shall be reviewed so as to ensure high quality that meet the project objectives and align with both technical and non-technical commitments as well as the EC requirements in due time and manner. WP Leaders will be in charge of reviewing technical deliverables of their WP and the Coordinator will be responsible of final review, validation and submission to the EC. The Project Coordinator will act as an intermediary between the Consortium and the EC. The Coordinator will facilitate a fluent communication with the EC with the objective of informing the assigned Project Officer (PO) and Project Technical Advisor (PTA) about the main achievements, problems or deviations in the development of the project and asking for approval of the solutions proposed by the Steering Committee of the General Assembly if necessary, in order to assure the compliance of project objectives. The communication flow within the Consortium will be bottom-up and top-down, through typical communication methods: online meetings for group discussion, emails for more comprehensive assessment and phone for quick actions and decision making. All consortium members will attend a face-to-face meeting at 6 monthly intervals. Prior to each meeting, an agenda will be formulated and emailed by the Project Coordinator, with the assistance of the hosting partner. All partners will keep updated records of their financial statements and provide documentation on expenses on a 6 month basis, for internal budget monitoring. The Coordinator will produce progress reports on a yearly basis, comprising an explanation of the work carried out, the review of the objectives for the period and exploitation and dissemination of results, by collecting inputs from all participant partners. Contractual reports envisaged are two Periodic Progress Reports at Months 10 and 27 including a “technical periodic report” and a “financial periodic report”, and a Final Report at Month 36 to summarise the project’s activities over its full duration, covering the main aspects of the work, objectives, results, conclusions and future plans, especially regarding post project activities. It is also anticipated that there will be a project review meeting involving the PO and external reviewers in M19 to assess the project progress. This meeting will be coordinated by IERC.				
Comments					

V	Date	Authors	Description
0.1	11/05/2020	J Southernwood	First draft for review by partners
0.2	23/05/2020	Ignacio Torrens, Eddie Streng, Daniel Ring, Andreea Le Cam	Review of the first draft
0.3	226/05/2020	Andreea Le Cam	Additional text all sections
0.4	26/05/2020	Jo Southernwood	Final draft
0.5	29/05/2020	Dan Clarke	Final review
1.0	29/05/2020	Jo Southernwood	Final version for submission

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

ADE	Association of Decentralised Energy
BEMS	Building Energy Management System
BMS	Building Management System
BRP	Balancing Responsible Party
CHP	Combined heat and power
DFFR	Dynamic Fast Frequency Response
DR	Demand response
DSO	Distribution System Operator
DSR	Demand Side Response
EE	Energy Efficiency
EED	Energy Efficiency Directive
EPC	Energy Performance Contracting
ESCO	Energy Services Company
EV	Electric Vehicles
FFR	Fast Frequency Response
HP	Heat Pump
HVAC	Heating, ventilation and air conditioning
ICT	Information and communications technology
LED	Light Emitting Diode
MoU	Memorandum of Understanding
NLGES	Noel Lawler Green Energy Solutions
NOVICE	New buildings energy renovation business model incorporating dual services
PV	Photovoltaic panels
RES	Renewable Energy Sources
RM	Ramping Margin
ROI	Return on investment
RRD	Replacement Reserve (De-Synchronized)
STOR	Short Term Operating Reserve

SWOT	Strengths, Weaknesses, Opportunities and Threats
TOR	Tertiary Operating Reserve
TSO	Transmission System Operator
UPS	Uninterruptible Power Supply
WP	Work Package

1 NOVICE IN BRIEF

NOVICE (**N**ew buildings energy ren**ov**ation business models incorporating dual energy serv**ice**s) is a three-year project, co-funded by the European commission, which aims to develop and demonstrate a new business model that combines both energy efficiency and demand response services. Our mission is to develop an innovative business model for the renovation of buildings by combining energy efficiency with demand response services in a single offering. Energy service companies cooperate with demand response aggregators enabling faster repayment of investments by combining their respective revenue streams. NOVICE brings together a highly experienced consortium that consists of stakeholders from the entire value chain: research institutions, engineering and technology companies, financing institutions, Energy Services Companies (ESCOs), aggregators and facility management companies.

Building renovation rates in Europe need to double in the coming years in order to achieve the energy targets set out in the energy efficiency directive. At the same time the energy sector must transition to a flexible network of prosumers able to change their demand profiles in response to the intermittent nature of renewable energy generation. Many assets that are commonly installed or upgraded during energy efficiency retrofit projects (such as HVAC systems, CHP and RES installations, BEMS and heat pumps) can also be used to provide flexibility services to the electricity grid. Taking advantage of revenues from both energy efficiency and demand response flexibility in one integrated service increases the value that these assets can deliver to the building owner and improve the return on investment (ROI) of energy efficiency renovation projects. An Enhanced Energy Performance Contract (EPC) will guarantee building owners a minimum level of energy savings and occupancy comfort whilst ensuring that a maximum value can be extracted from the flexibility potential of on-site energy assets. The result is a new business model that allows ESCO to work together with demand response aggregators to provide a holistic package of energy services, enhancing the business case for renovation projects and driving up renovation rates across Europe.

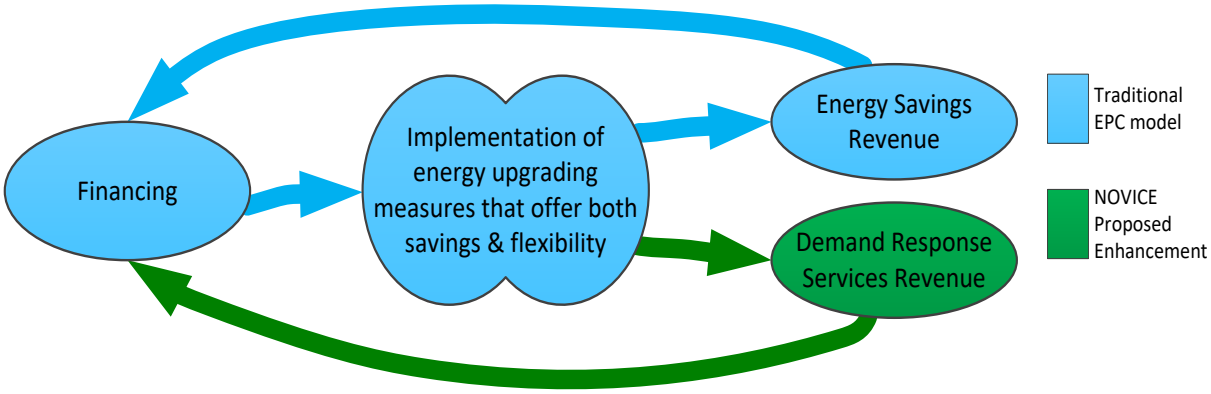

Figure 1-1: The new EPC model proposed by NOVICE

1.1 NOVICE PROJECT OBJECTIVES

NOVICE's ambition was to provide the mechanism for a significant share of the DR market to be used in the renovation of European tertiary buildings through ESCOs. The main specific objectives of NOVICE were:

1) To **engage and train new actors** and stakeholders (aggregators, ESCOs, technology providers, FMs, engineering consultants) in an augmented building renovation process that will increase the market value of building renovation and increase the available capital funding reserves for investments in building renovation.
2) To **address the barriers** (regulatory, market, technological, financial) for dual energy services in building renovation so as to set-up a sustainable framework for a new enhanced EPC model that will enable investments in building retrofits when national DR markets reach maturity.
3) To prescribe **the building energy renovation technologies** (mainly HVAC, energy storage, on site RES, BEMS and ICT solutions) **that increase both flexibility (defined as DR potential) of buildings and energy efficiency**.
4) To develop an innovative business model and a **new EPC template for ESCOs providing dual energy services along** with the facilitation of the new modus operandi of ESCOs including the drafting, negotiation and processing of the new EPC template based on the dual energy services business model.
5) To **demonstrate the effectiveness and advantages of the NOVICE innovative business model for dual energy services** in building retrofitting projects.

1.2 OBJECTIVES OF THIS REPORT

The objectives of this final project report are to:

- Describe in brief the work that has been undertaken over the project's three-year duration;
- Show how the project has achieved each of the objectives described in section 1.1;
- Signpost the reader to other project deliverables that give more detail on the project's results;
- Outline ideas for next steps and additional actions that could help to further the roll out of the proposed business model in the coming years.

2 SETTING THE SCENE

2.1 EUROPE'S BUILDING RENOVATION CHALLENGE

The European Union's recently amended Energy Efficiency Directive (EED) sets a target for Member States to improve energy efficiency across the Union by 32.5% by 2030. As approximately 40% of all energy consumption can be attributed to buildings, and over 75% of the EU's building stock is inefficient, it is imperative that Member States take action to increase building renovation rates from the current level of 1% per annum. In addition, the energy sector is undergoing transformational change and moving away from the traditional unidirectional flow of energy from generator to consumer to become a network of flexible prosumers that are able to generate, consume and store energy to accommodate the higher proportion of intermittent renewable energy generators on the grid as needed.

2.2 ENERGY PERFORMANCE CONTRACTING – A SOLUTION?

Building owners (also referred to as 'clients') throughout this document wishing to improve the energy efficiency of their building must tackle the daunting task of deciding which energy efficiency measures are most suitable for implementation. Faced with this challenge, many building owners choose to enter into an Energy Performance Contract (EPC) with an Energy Services Company (ESCO) to take advantage of the many benefits offered by such a contract.

In an EPC, the ESCO proposes a turnkey solution comprising of a holistic package of energy efficiency measures that are best suited to the building and the needs of the building occupants. If the building owner lacks the capital to invest in the proposed solution, the ESCO can arrange finance so that there is no upfront cost to the building owner. As shown in Figure 2-1:, the ESCO handles all aspects of the installation including the engineering design, liaising with suppliers, managing the installations and verifying the savings that have been achieved. The ESCO guarantees the level of energy savings that their client can expect (typically 20% to 50% of the baseline), and provides a system to measure and verify the savings. The ESCO recovers the investment through the savings achieved on annual energy bills, reduced maintenance costs or other available subsidies or tax incentives which the client agrees to pay to the ESCO, either in full or in part, for the agreed duration of the EPC.

The benefits of an EPC to the building owner are clear. There is no requirement for upfront capital and it is possible for the investment to stay off the client's balance sheet using third party financing. The risk associated with specifying, installing, operating and paying for energy efficiency equipment is transferred to the ESCO through the performance guarantee. If the agreed savings are not achieved (and providing

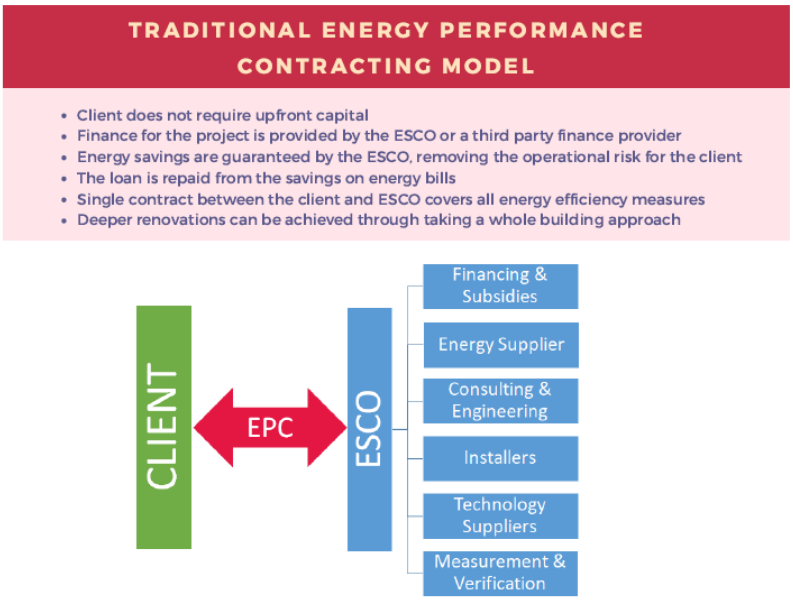

Figure 2-1: Interaction between key stakeholders in the traditional EPC model

that there have been no material changes to the building or its use on the client side), it is the ESCO, not the building owner, that suffers from reduced return on investment (ROI). The ESCO handles the entire installation process, liaising between the various contractors and technology providers and specifying a holistic package of energy efficiency measures for the whole building.

2.3 BARRIERS TO EPC

Despite the benefits, uptake of EPCs across Europe is lower than expected. One of the reasons for this is that a typical EPC has a duration of 5 to 15 years, a contract length that is unattractive to private sector clients where organisations often expect a payback period of less than 3 years. In many countries this has limited the growth of EPCs to public sector clients who are more accepting of long contract lengths due to the relative security and longevity of their operation. A further barrier relates to the lack of available finance to ESCOs for facilitating EPCs. Finance providers such as banks run credit checks whenever a new loan application is made. If the ESCO already has loans taken out to finance other existing projects the finance provider may consider that a further increase to the ESCO's debt levels is too risky. In practice this limits most ESCOs to taking on no more than 3 new EPCs per year and can limit the value of the energy efficiency investments they are able to make. NOVICE has developed a new innovative business model to help remove some of these barriers.

2.4 NOVICE EXPLAINED

The NOVICE model seeks to enhance the traditional EPC in order to make it more attractive to building owners and investors and to increase the uptake of EPC across Europe. The enhancement is to consider how the site can participate in demand response programmes to generate a dual revenue stream – one from traditional energy efficiency savings and a second through payments from network operators for grid balancing services - to further increase the project returns.

From the client's perspective there is little difference between the traditional EPC and the NOVICE model. The building owner still only manages a single contract with the ESCO, and it is still in an EPC format (Figure 2-2:). NOVICE proposed how the EPC needs to be enhanced to include clauses covering the distribution of demand response revenues to be shared between all parties whilst simultaneously maintain the traditional performance guarantees on thermal comfort and building operation parameters.

However, from the ESCO's perspective they now have an additional relationship to manage with a demand response aggregator. The aggregator deals with all aspects of managing a building's flexibility potential, from identifying the onsite energy assets that could be used to balance the grid without impacting on site operation or thermal comfort of occupants, to managing the relationship with the network operator and the revenues generated from participating in active demand response programmes. NOVICE proposed that the relationship between ESCO and aggregator is managed through a Memorandum of Understanding (MoU).

The additional financial benefits of the NOVICE model compared to a traditional EPC are presented in Figure 2-3:. In a traditional EPC, part (or all) of the guaranteed savings are used to repay the initial capital investment, for a duration that is agreed by the client and the ESCO. In the NOVICE model, the additional revenue obtained from participating in the demand response schemes contributes to the repayment of the initial financing, thus reducing the payback period and therefore the EPC duration. The questions that the NOVICE project has tried to answer over its three-year duration are: what is the value of energy asset flexibility in typical commercial buildings; and, by how much can EPC contract duration be reduced through including revenues from demand response.

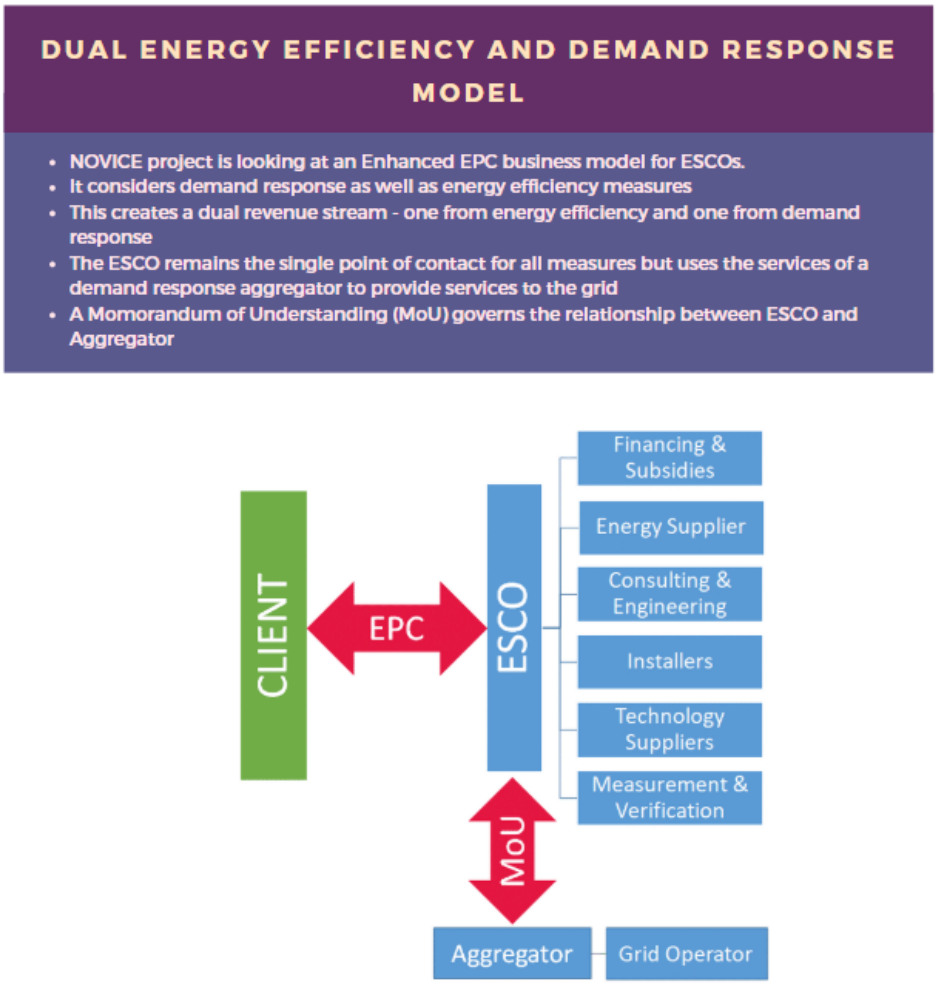

Figure 2-2: Interaction between key stakeholders in the NOVICE model

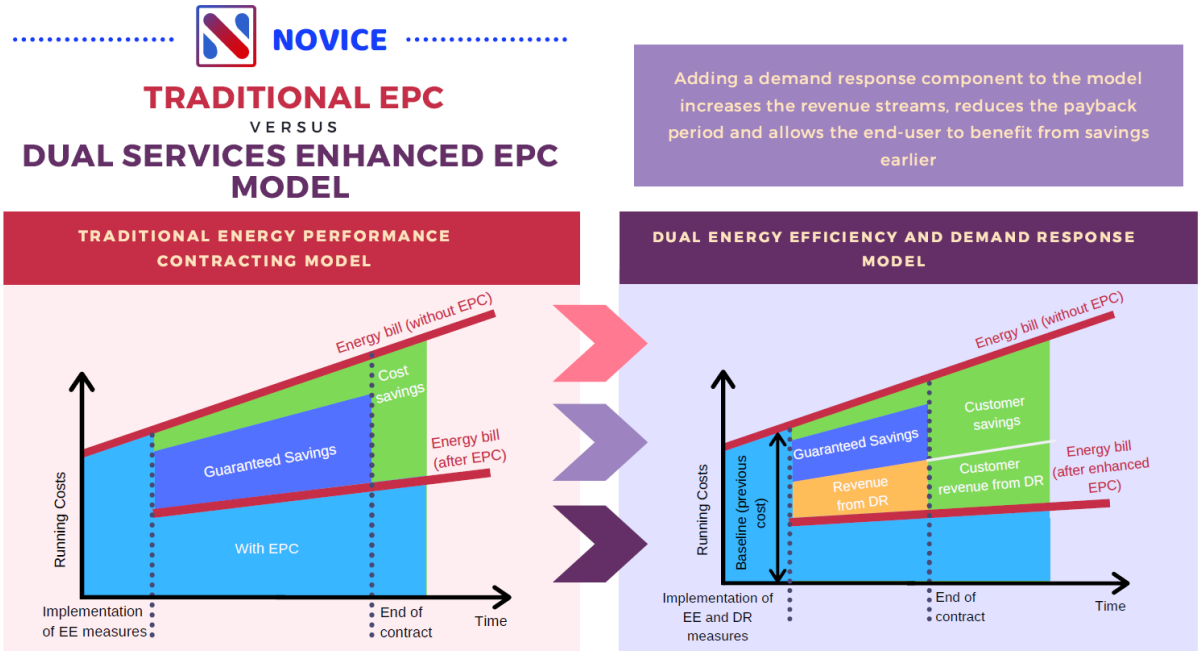

Figure 2-3: Financing for the traditional EPC and for the NOVICE model

3 APPROACH AND METHODOLOGY

3.1 BRIEF SUMMARY OF WORK

The NOVICE project consisted of 8 Work Packages (WPs), described below and represented visually in Figure 3-1.

- **Work Package 1** related to the overall management activities of the project including risk management, communication between the partners and the European Commission, project reporting data management and intellectual property management.

- **Work Package 2** investigated and identified the particular building renovation technologies that can offer both energy savings and demand response potential. The technologies identified covered all aspects of building energy systems including building energy supply systems, building envelope technologies and ICT technologies referring to both BEMS and communication systems. Commonly used thermal comfort standards for building occupants were reviewed which allowed an analysis of the different control techniques that can be used to enable DR services without affecting the wellbeing of occupants. The appropriate renovation technologies were costed and compared from an energy and economic perspective with common building upgrade interventions undertaken commonly in most building renovations today.

- **Work Package 3** reviewed the regulatory framework and the market maturity status for the operation of ESCOs and aggregators in Europe. After mapping the market, policy gaps and barriers in nine European Countries, a SWOT analysis was carried out to identify the most suitable markets for operating the dual energy services business model. The role of EPC facilitators as an intermediary market player that can assist to build collaborations between ESCOs, aggregators, facility management companies and building owners was investigated as a means of promoting the NOVICE model. Also in this WP, a series of guidelines and recommendations for policy makers was developed to identify best practices that could help immature DR and EPC markets to reach maturity more quickly.

- **Work Package 4** covered the development of the advanced EPC template to facilitate the provision of dual energy services through building renovation. This work package reviewed standard EPC templates and aggregator contracting agreements searching for similarities and differences, and proposed the ways in which a standard EPC template may need to be modified in order to account for the inclusion of DR. This WP also proposed a template for a Memorandum of Understanding (MoU) to govern the relationship between ESCO and aggregator, defining the role of each party and their respective responsibilities towards the client and each other.

- **Work Package 5** identified the particular building typologies that are more suitable for the NOVICE model and carried out theoretical modelling to assess the potential for energy savings and revenues from participation in demand response programmes. For each building archetype, different scenarios were modelled to reflect the key market features and electricity system operational framework of different European countries as identified in WP3, and a feasibility study was carried out to determine the theoretical impact of the dual energy services scheme on payback periods for building renovation investments.

- **Work Package 6** concerned the demonstration of the NOVICE business model on specific building renovation projects. Two case studies were selected to demonstrate different elements of the NOVICE model (see section 3.2 for further details): (1) a leisure centre in Dublin (Ireland) was used to assess the impact of a demand response event on the thermal comfort of building occupants, and understand the value of the MoU between ESCO and aggregator; (2) a supermarket in Kilkenny (Ireland) was used to demonstrate the validity of the NOVICE business model in terms of the impact of including demand response revenues on the overall payback period of the package of energy efficiency measures.

- **Work Package 7** used the inputs from WPs 3, 4, 5 and 6, to outline the key elements of the new NOVICE business model to be adopted and rolled out by ESCOs. The aim was to accelerate the market uptake of building energy upgrades by introducing to the ESCO market the dual energy services scheme that reduces the payback period of energy efficiency investments. The description of the business model covers all aspects of the ESCO operation including possible changes to organisational processes and determination of the value proposition.

- Finally, **Work Package 8** covered the dissemination, communication and exploitation activities of the project.

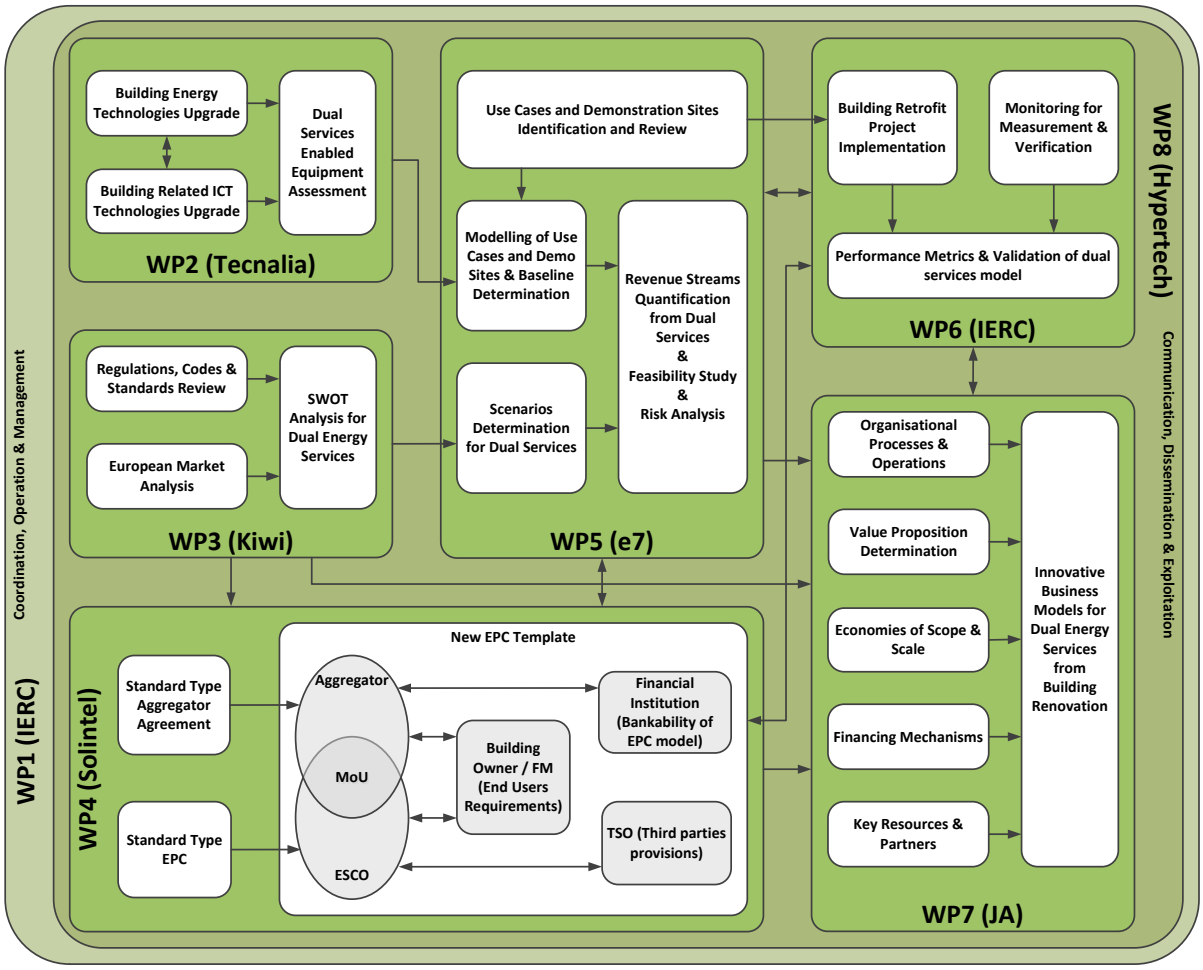

Figure 3-1: Conceptual Work Plan of NOVICE

3.2 CHALLENGES IN FINDING DEMONSTRATION SITES

The NOVICE team encountered the following barriers when searching for sites at which the NOVICE model could be demonstrated:

- Most of the clients working with the project partners preferred not to enter into an EPC, preferring to self-finance projects and avoid the EPC procurement process which can be complex and expensive.
- The available building energy renovation projects were in an advanced stage of development, either fully designed or already being installed, with no possibility to change the scope to include demand response.
- Smaller ESCOs that are establishing themselves in the market do not have the capacity to adapt their business model to include DR and aggregation at this stage.
- For potential demonstration sites located in countries where the EPC/ESCO market is relatively immature, the addition of demand response to the contract increases complexity to the point where clients no longer wish to engage in an EPC. This is the case in Austria.
- Even in countries with mature EPC/ESCO markets, an immature demand response market makes it impossible to fully implement the NOVICE dual service model in tertiary buildings because the financial and/or administrative burdens of aggregation weakens the business case for participation (e.g. Germany).
- In some countries, where demand response market is mature and aggregation is allowed, the aggregators only want to work with large amount of flexibility, therefore reducing the spectrum of available sites to very large industrial sites (e.g. Ireland).
- Many clients felt that the outcome of installing the recommended energy efficiency measures was not worth the level of disruption to their business.

Given the above mentioned difficulties, the NOVICE project team decided to demonstrate different elements of the business model at two separate demonstration sites. The new plan was to look for specific data from clients of project partners that have already implemented energy efficiency projects. While not ideal, this approach would allow the use of real energy and cost data from a site that had already undertaken an energy efficiency project to determine the 'business as usual' case. A theoretical evaluation of the site's potential for flexibility would be overlaid to determine the 'dual services' case for comparison, showing whether the dual services approach would have strengthened the business case for the building renovation project. After careful consideration, the most suitable demonstration sites were as follows:

- **Site 1: Leisure Centre in Dublin, Ireland.** Noel Lawler Green Energy Solutions (NLGES), the NOVICE project ESCO partner, already had an EPC with Dublin City Council covering three leisure centres in the city. Although not an ideal demonstration site since the buildings were already under EPC and already had energy efficiency measures installed, the Council were willing to allow demand response to be added to the scope of works covered by the contract, provided this did not introduce additional risk to the Council or impact negatively on building operation.
- **Site 2: Supermarket in Kilkenny, Ireland.** NLGES were successful in obtaining agreement from a supermarket chain in Ireland to carry out an analysis of its suitability for the NOVICE approach. The supermarket had already carried out a number of energy efficiency refurbishment projects with NLGES and therefore robust energy and cost data was available to assess the business as usual case. An aggregator provided an assessment of the opportunities for demand response revenues.

4 KEY FINDINGS

4.1 MOST SUITABLE BUILDING ENERGY ASSETS

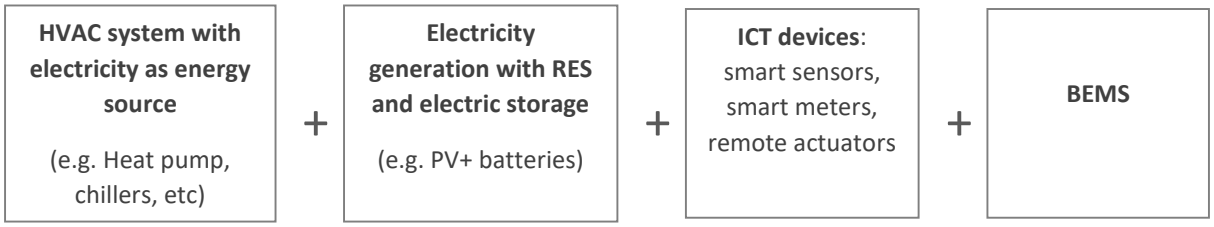

Figure 4-1: Most suitable combination of technologies for NOVICE

The output from WP2 was a series of 'Technology Kits' which are designed to assist building owners who are considering a building refurbishment to choose the most appropriate energy efficiency and demand response technologies and control strategies. The kits outline the most commonly found Heating Ventilation and Air Conditioning (HVAC) and other systems and suggest the most cost effective ways of implementing the dual energy services business model. This makes it very easy for a building owner/manager to see at a glance which technologies they should consider in their refurbishment scheme based on the existing conditions in the building. The toolkit accessibility was further improved through the launch of a simple online tool that allows the building owner to select the HVAC and other equipment currently installed in the building, and then view the technology kit that best suits their circumstance. The tool can be accessed on the NOVICE project website http://novice-project.eu/hvacRetrofitTool/.

From the analysis undertaken, it is clear that HVAC technologies based on electricity as the energy source are most suitable for DR, because these technologies allow the implementation of strategies based on electrical load shedding (explicit demand response) as well as those based on the use of electricity according to the energy tariff (implicit demand response). The most suitable HVAC technologies for combining energy efficiency with demand response are heat pumps and chillers as these are often the items with the largest and most easily controllable capacities. These must be combined with insulated distribution networks (ducts and pipes) and variable flow fans and pumps to ensure maximum levels of energy efficiency are achieved.

In terms of demand response potential, in order to allow effective implementation of demand response strategies, HVAC technologies should be combined with renewable electricity generation sources and electrical energy storage systems, in particular, onsite PV panels with batteries. This allows the site to participate in a much wider range of demand response programmes, including those designed to restore and balance grid frequency. These typically have a very short duration (a few seconds to several minutes) but require assets to respond to signals from the grid within very short time period (within seconds or fractions of a second).

Finally, ICT devices (such as smart sensors, smart meters and remote actuators) and BEMS are required to implement both implicit and explicit DR strategies. BEMS allow the management of whole systems, enabling optimized DR strategies to be easily deployed on receipt of a dispatch signal from the grid operator. BEMS also allow the energy efficiency of the whole system to be maximised at all times. ICT devices allow the physical execution of DR strategies and ensure that the building remains within the agreed comfort parameters at all times.

4.2 MOST SUITABLE BUILDING TYPOLOGIES

The NOVICE project team analysed the different non-domestic building typologies found around Europe (offices, educational buildings, health care facilities, hotels and restaurants, sports facilities, wholesale and retail trade service buildings) in terms of:

- Energy consumption per square meter
- Floor area coverage
- Energy consumption per building
- Building size distribution
- Energy efficiency potential
- Demand response potential
- The status of operational constraints (e.g. regulations on air change rates in the health sector)
- Building age distribution

For each building typology, the parameters above were scored (low, medium or high) to establish the most suitable building types in which to deploy the proposed NOVICE business model. As a result of this analysis, the NOVICE team selected the following building typologies as most suited to the NOVICE business model:

- **Offices** account for around 30% of commercial building floor area, the highest of any of the building classes examined. Energy consumption in offices constitutes about 20% of the overall non-residential demand and in general, offices have high potential for both energy efficiency improvements and participation in demand response programmes with few regulatory or operational constraints preventing participation in a NOVICE-style approach to energy management. In many countries, EPC has been embraced by public sector organisations as a way of improving energy efficiency in the long term without the need for an initial capital outlay. The NOVICE business model could provide a means of driving uptake of EPCs in the private sector by reducing contract duration if it can be shown that a dual energy services approach can be beneficial for office buildings.

- **Hotels and restaurants** occupy around 15% of the European non-residential building stock by floor area and can have significant energy demand, particularly in Southern latitudes that have large cooling requirements in the summer. The need to keep guests comfortable at all times can lead to high energy consumption in this sector and therefore, a high potential for energy efficiency improvements and participation in demand response programmes is expected. Many larger hotels include additional facilities such as swimming pools, spas, restaurants and conferencing facilities, which can significantly drive up energy consumption while at the same time provide a large opportunity for energy saving and demand response actions. Operational constraints and the need for quick return on investment sometimes prevents hotel owners from undertaking refurbishment works because of the level of disruption and potential loss of income during the refurbishment. However, larger hotel chains are often competing for the same business and run at very tight margins, so reducing the operating cost could support an increase in profits more easily than increasing the occupancy rates.

- **Health Care Facilities** such as hospitals tend to be located in large buildings and often have high energy consumption per square meter, as they are occupied at all times. They must maintain comfortable indoor conditions for building occupants and are filled with a large quantity of energy intensive equipment. Hospitals are present in every European city and have

high potential for energy efficiency due to the large amount of energy consuming equipment on site and the need to continuously regulate the temperature, humidity and air quality for the comfort of building users. Critically there is significant potential for demand response participation as many hospitals have on-site generators or combined heat and power plants (not considered in this report) that can be used to export electricity to the grid when required. The main obstacle in health care facilities is overcoming operational and implementation constraints, as conserving energy is often not a priority in health care environments, particularly hospitals. However, pressure to reduce costs has boosted uptake of EPCs in this category of buildings, making hospitals particularly suitable for dual energy services approach.

4.3 Most Suitable Markets

The review of EPC and demand response market conditions in Europe have highlighted that there is currently no single European country that presents the optimum conditions for implementing the NOVICE model. In many ways this is not a surprise as if there was a suitable market, then it is likely that the market actors in that country would already have implemented a profitable dual services business model. However, it is possible to pick out the policies, regulations and market forces that are most conducive to the implementation of a combined energy efficiency and demand response service model. The list of conditions that would be ideal for implementing a NOVICE approach include the following:

- A strong and well-established ESCO market that is trusted by their clients.
- Government support for implementing EPCs such as:
    - informational schemes that promote the benefits of EPC to potential clients.
    - finance for EPC feasibility studies.
    - government supported frameworks for EPC contracts.
- Several DSR markets that are open for participation by aggregated demand response loads or generators.
- Aggregation of demand response units is legally allowed, clearly defined and well regulated.
- Aggregators do not need permission from the Balancing Responsible Party (BRP), Transmission System Operator (TSO) or Distribution System Operator (DSO) in order to offer their services to customers.
- Both energy generation and demand response can be aggregated and offered to the market.
- The prequalification process is not overly bureaucratic and relates to pooled loads rather than individual units or sites.
- The national government is committed to increasing the energy efficiency of its building stock, reducing the proportion of electricity from nuclear power, and increasing the share of renewables on the grid.
- A white and/or green certificate scheme with an energy obligation that encourages participation of the private sector in energy efficiency projects.
- Incentives for implementing energy efficiency actions exist in all business sectors.

Of all the countries assessed, the ones that are most suited to the NOVICE approach are the UK and France, closely followed by Ireland. The UK and France both have well developed ESCO markets, several DSR markets that are open to participation and a TSO that is open to adjusting the regulations to encourage more participation in flexibility markets. Both markets still have barriers to overcome, however, there are no regulations that would prevent the delivery of a joint services business model

if clients could be persuaded to accept it. In Ireland, whilst the ESCO market is still small, this is largely due to the lack of awareness of the benefits of EPC among clients rather than any regulatory barriers. The Irish TSO has opened several DSR markets and is hampered mainly by large minimum load requirements and the need to bid into the market annually. Despite this, it would be possible to operate a joint services EPC in Ireland if clients could be persuaded to participate.

The countries least suited to implementing the NOVICE model are currently Italy, where aggregation of loads to participate in the DSR markets was only made legally allowable at the end of 2019, and Denmark, where the large proportion of hydro-electric power stations on the grid and excess capacity on the network means there is a weak business case for demand response services. A summary of market readiness in Europe is given in Figure 4-2.

In order to assess how interested the ESCOs and Aggregators would be to adopt the NOVICE model, a survey was designed and distributed to several businesses in Europe. The results from these surveys shows the disparity in market size and maturity of the EPC and demand response markets: there were 24 responses from ESCOs and just 7 from aggregators.

4.3.1 ESCO Survey – key findings

The ESCO survey results are summarised in Figure 4-3. The ESCO survey revealed that most of the energy efficiency interventions that were undertaken through EPCs involved assets that could be also used for participating in demand response schemes. Almost half of the respondents see the project financing as the biggest barrier to processing contracts. This confirms that there is a real market need to improve the business case for the EPCs. A large majority (80%) of ESCOs use third party financing for their projects. The survey showed that 51.6% of ESCOs recover their investment through energy savings, 19.4% from the electricity sale, 16.1% from the sale of heat and 12.9% responded they access other revenues, possibly referring to maintenance savings, subsidies or tax incentives. The results inspired NOVICE to further investigate how investors perceive demand response in terms of project bankability and to find out if the demand response component of any revenues generated could be guaranteed. This is discussed further in section 4.8.

The second half of the survey related to the flexibility potential of the NOVICE model and showed that only 15% of ESCOs are already offering some form of flexibility service. Furthermore, the readiness of ESCOs to adopt the NOVICE model is supported by the answers of 40% of respondents who would be willing to participate in demand response schemes with their assets, while 30% stated that they would like to do so but lack the knowledge to take action.

4.3.2 Aggregator survey – key findings

The aggregator survey results are summaried in Figure 4-4. The aggregator survey showed that in term of the types of energy assets that usualy participate in demand response, backup generators and CHPs are the most commonly used systems, followed closely by energy storage systems and HVAC systems. The most commonly participated in demand response programe today is the fast frequency response scheme, followed by the capacity market mechanism. In contrast to the ESCOs, only 37.5% use third party financing and only 25% see project finance as a barrier to processing contracts, which reflects the lower upfront costs associated with demand response compared to energy efficiency. An interesting find was that 50% of aggregators are already offering energy efficiency along with their flexibility services, while 25% would like to add energy efficiency to their services, but they feel they

do not have in-house knowledge and 25% find it too complicated. The expectations for the payback periods are also much lower than those of the ESCOs. Most of the aggregators (87.5%) would be willing to consider projects with payback period less than 3 years and a 12.5% of respondents do not engage in projects that have a payback period larger than one year.

4.3.3 Building owner and facility manager survey – key findings

The end-user survey results are summaried in Figure 4-5. The building owners and facility managers that participated in the survey are operating in several countries around Europe (Italy, Greece, Germany, UK, Spain, Ireland). Of those who are currently implementing energy projects, 40% are using the EPC model, 40% use energy supply contracting and 20% are involved in financing and leasing projects. This shows that the EPC model is fairly well known used already, but it is clear that there is still potential for the EPC market to grow.

43% of respondents identified that their sites have additional energy savings potential, while 57% answered that they could be potential for energy saving. This shows that there is significant optimization potential. The lack of finance and poor return on investment were identified as the main barriers to implementing energy savings projects. The second most commonly identified barrier is lack of interest from the management team, indicating that energy efficiency is a low priority for many building owners.

64% of the building owners already have energy monitoring systems in place, which provide real time data. Almost 43% of respondents see the confidentiality and security of data management as an issue, with 29% identifying that it is dependent on the client and a further 29% do not consider it an issue.

As for the flexibility potential, 57% of the total respondents believe they have energy assets whose operating times and running hours cannot be managed flexibly. 28% of end-users are already participating in flexible electricity procurement. When asked about the barriers that prevent them from participating in flexibility schemes, the most commonly identified barrier was lack of interest from the management team (40%). An important barrier that was also invoked was the current regulations (30%). This shows that the flexibility market still needs to develop in some countries to allow for easier access to these demand response programs.

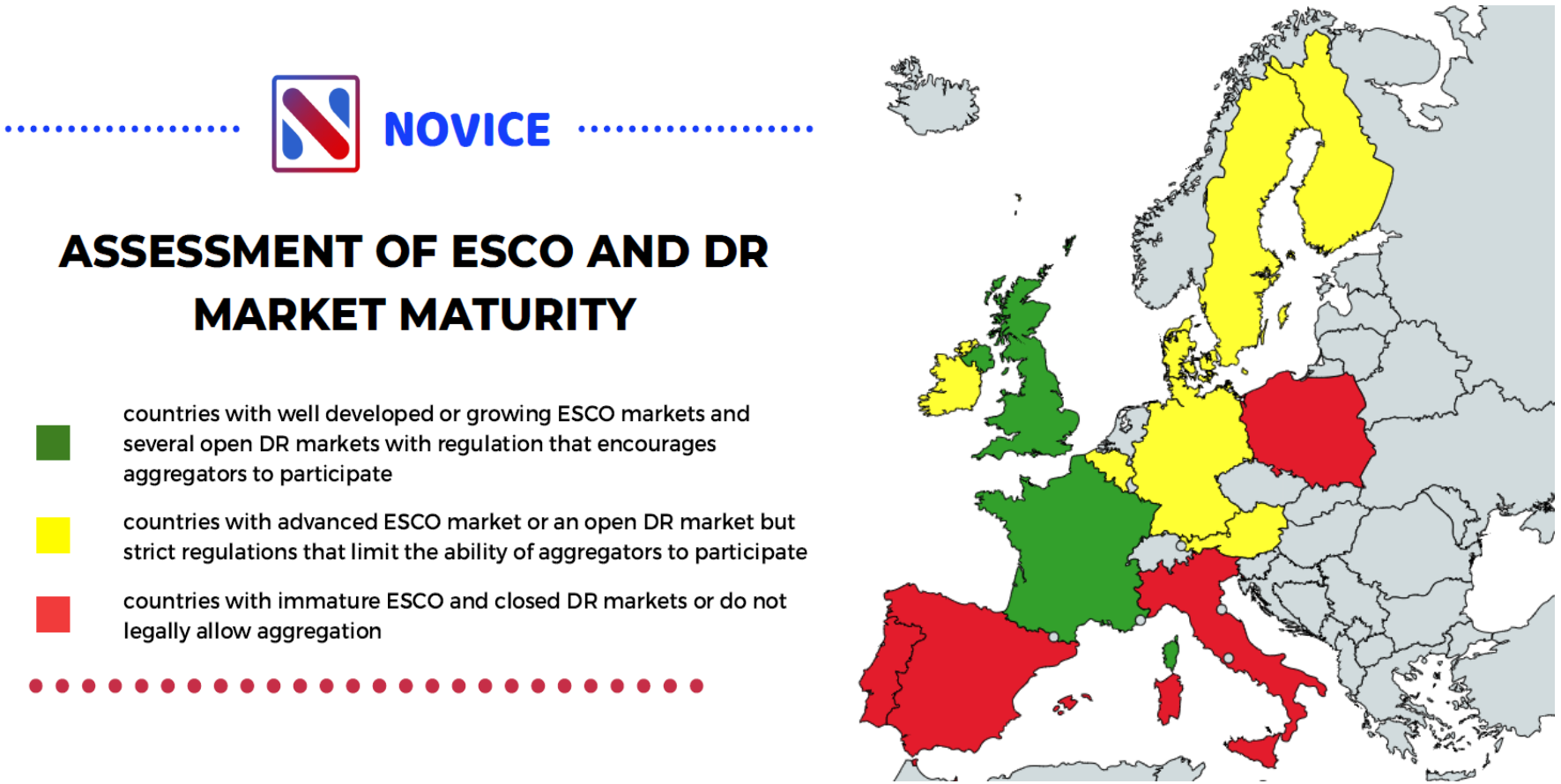

Figure 4-2: Assessment of market readiness of European countries for NOVICE

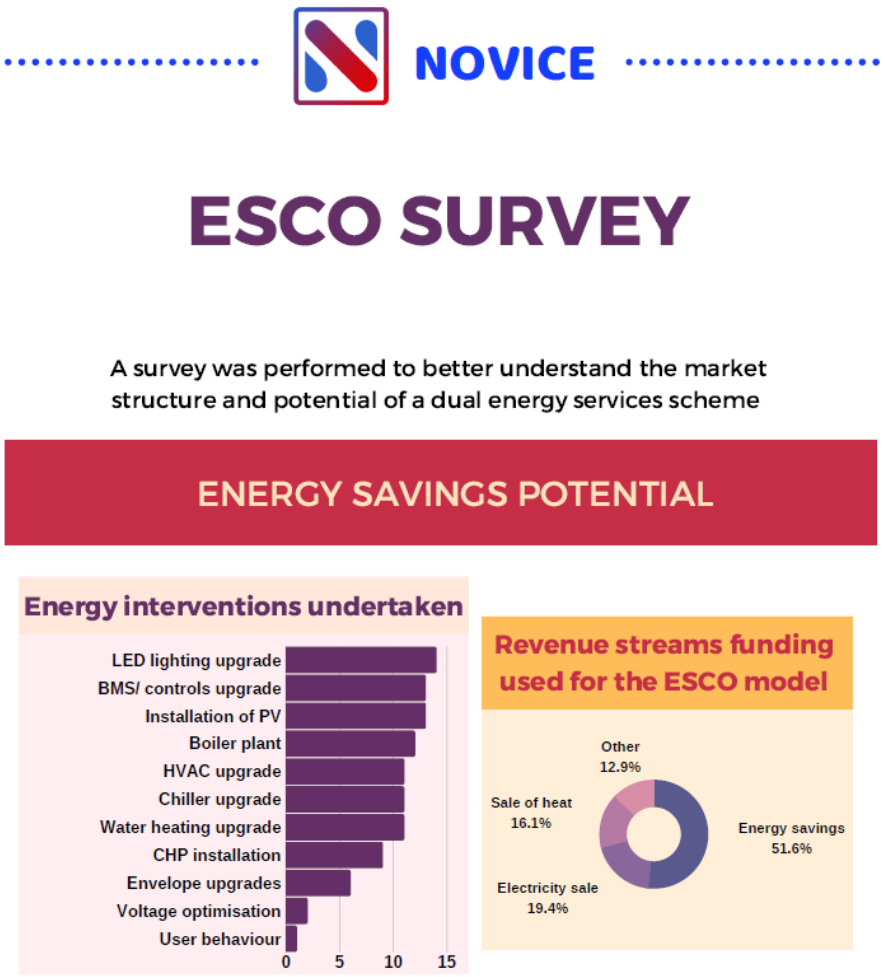

Figure 4-3: Summary of key results from the ESCO survey

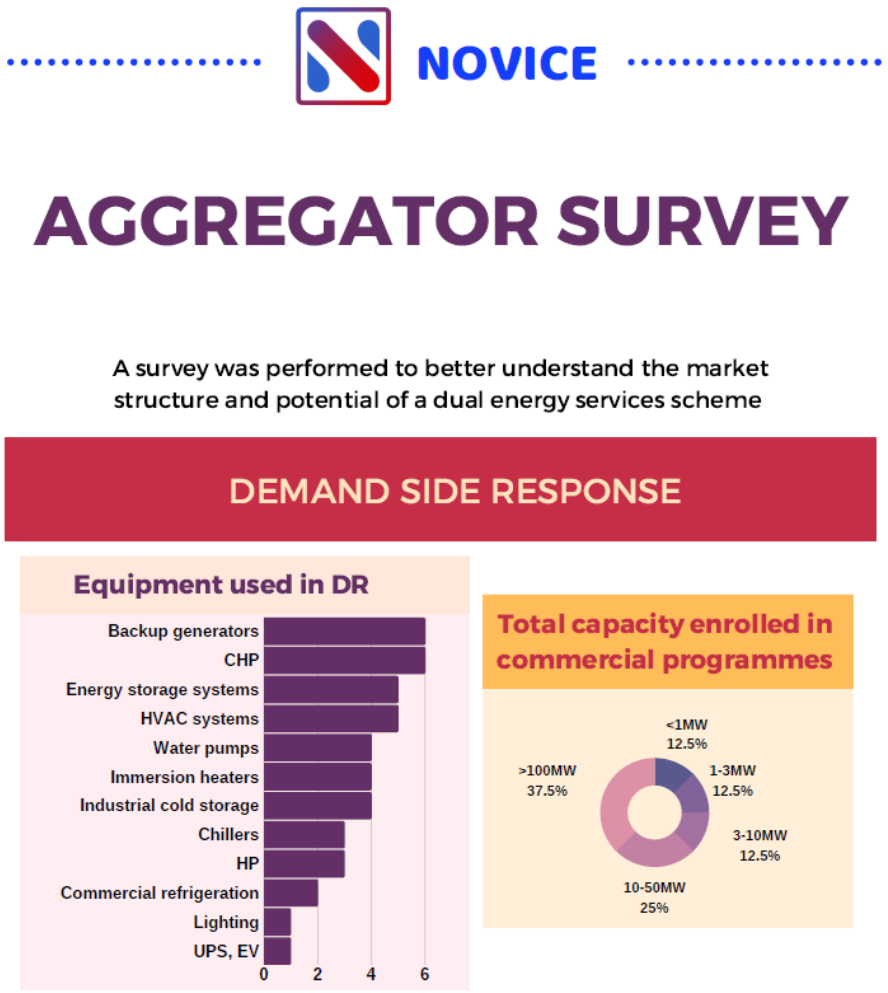

Figure 4-4: Summary of key results from the aggregator survey

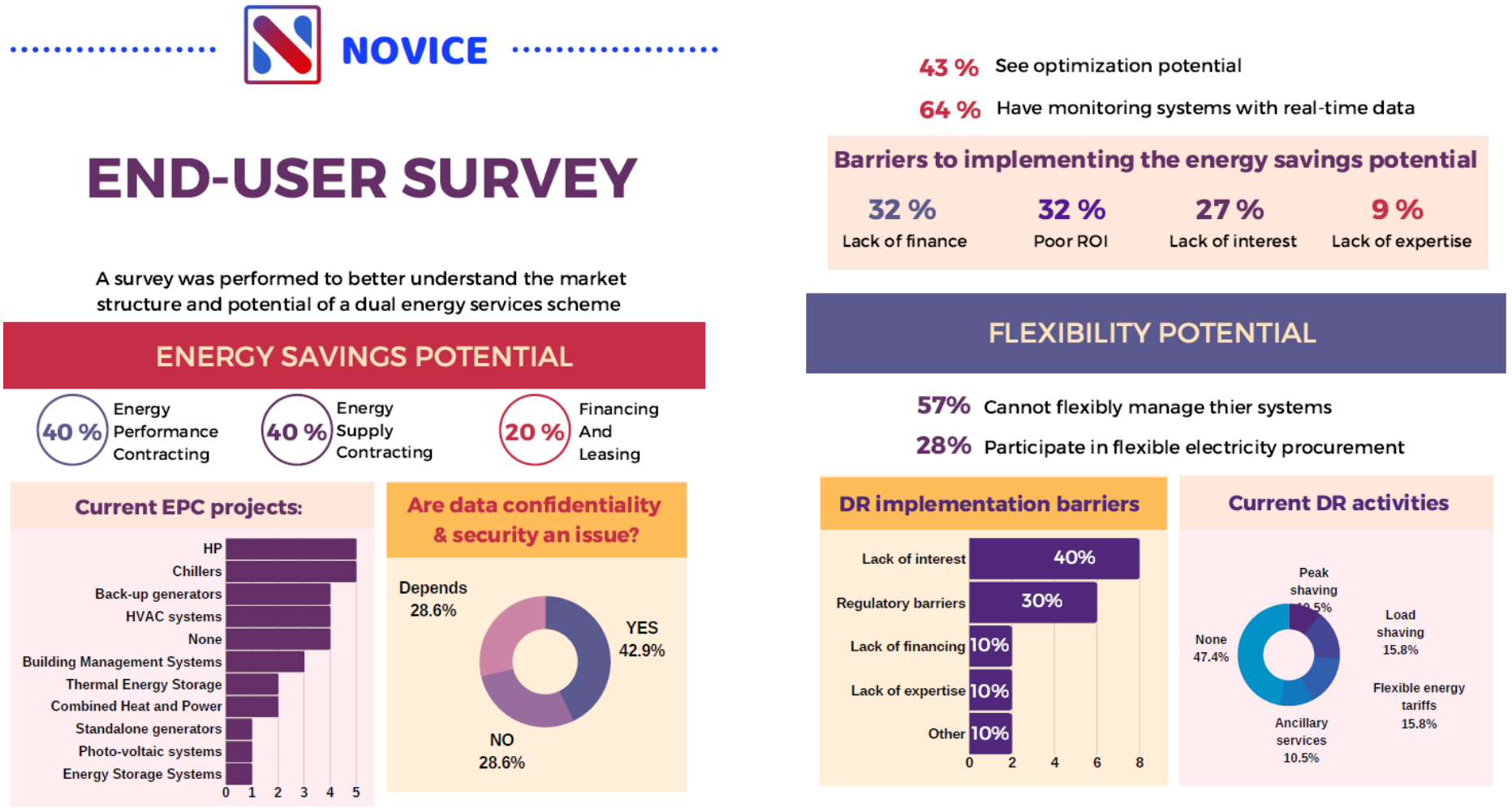

Figure 4-5: Summary of key results from the end-user survey

4.4 IMPACT OF DR ON PAYBACK TIME OF REFURBISHMENT PROJECTS

The data for Demonstration Site 2 (Supermarket in Kilkenny, Ireland) was provided by Noel Lawler Green Energy Solutions (NLGES) and the analysis combines an assessment of the energy efficiency opportunities with a quote for the demand response potential of the site from a local aggregator. The question that this analysis tried to answer was whether participating in demand response schemes would reduce the overall payback period of the proposed energy efficient building refurbishment project, thus improving the business case for the EPC.

The analysis identified the following energy efficiency upgrades that resulted in a reduction of total site energy consumption of 36% compared to the current baseline energy consumption:

- Upgrade existing lighting systems to LEDs.
- Improvements to the control and operation of the store's HVAC system.
- Upgrade the refrigeration system (which provides cooling for fridge and freezer cabinets) including using new refrigerant to comply with F-gas regulations.
- Install heat recovery to use waste heat from the refrigeration system to preheat domestic hot water.
- Install solar PV panels to the roof of the supermarket.

Table 4-1 presents the energy savings, the capital cost, the annual savings and the payback period for each energy efficiency measure. Following the implementation of the energy efficiency measures, it is expected that the total annual site electrical and thermal energy savings would amount to 963,381 kWh. While the refrigeration measure has a high initial cost, it achieves a considerable reduction in energy consumption of 75% compared to the previous system.

Table 4-1: Details of Energy Efficiency Measures

Energy Efficiency Measure	Energy Savings (kWh)	Capital cost (€)	Annual Savings (€)	Payback Period (years)
Lighting	220,140	203,000	53,421*	3.8
Refrigeration	332,655	1,000,000	36,592	27.3
HVAC	27,609	12,000	3,037	4.0
PV	279,879	251,099	29,250	8.6
Heat recovery	103,098	30,000	4,849	6.0
Total	**963,381**	**1,496,099**	**127,149**	**11.8**

The energy efficiency measures reduce site electricity consumption by 39%, which can be further reduced through the installation of solar PV panels. In total, this amounts to a reduction in site electricity consumption of 57%. The overall payback period associated with installing this package of measures at the supermarket is 11.8 years. This represents the business as usual case for a traditional EPC.

The NOVICE dual services model adds a demand response component to the traditional EPC. Half hourly electricity data was provided to a local aggregator who used it, along with data about the site's energy assets, to determine the demand response programmes in which the site could participate, and provide an estimate of the likely achievable annual revenues. The aggregator identified that the HVAC and refrigeration equipment found at the supermarket site can be used in programmes that require fast response time with short duration, while the on-site backup generator can be used to provide flexibility for longer duration events. It is estimated that by participating in the combination

of demand response programmes recommended by the aggregator, the supermarket could realise a further €13,000 per year in additional revenues. These additional revenues would come at no extra capital cost to the client, since this aggregator does not charge for the installation of the required dispatch technology, preferring instead to recover their costs from the first year revenues. The ability for site assets to participate in multiple demand response programmes simultaneously is somewhat unusual and appears to be a specific feature of the Irish DR market, making it particularly attractive in comparison to other countries.

Figure 4-6: presents the result of this analysis. It is found that the overall project payback period reduces from 11.8 years to 10.7 years, simply from selling the site's flexibility to the electricity grid. This equates to a 9.3% improvement in the payback period through combining energy efficiency with demand response compared to energy efficiency alone. This decrease in project length comes at no additional cost to the building owner, as it uses the assets already installed in the building and the aggregators usually provide the demand response equipment at no charge.

Further analysis showed that if the supermarket owner also installs a 150 kW battery storage system on site at an additional capital cost of €83,500, then the payback period of the project can be further reduced to 9.9 years. This equates to an overall reduction in payback time of up to 16%, from 11.8 years to 9.9 years.

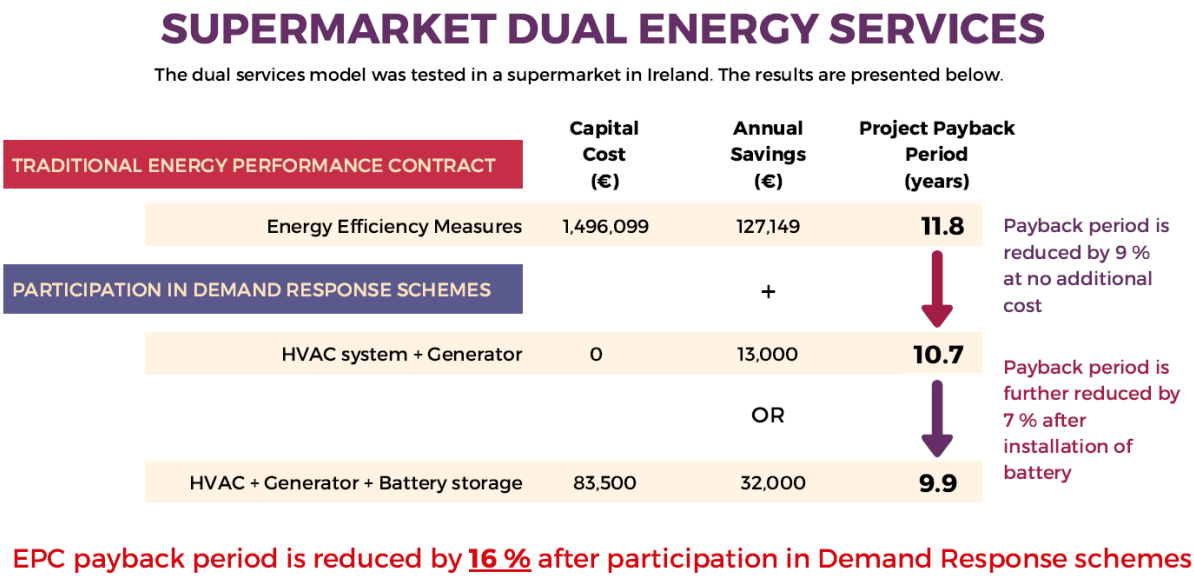

Figure 4-6: Impact of demand response services on the payback period of a traditional EPC

The reduction in payback period is an important result for the NOVICE project. It shows that the proposed business model improves the business case for EPCs, potentially making it easier for ESCOs to sell this type of project to their clients, by minimizing one of the main barriers to EPC uptake – contract duration. This of course, is based on the Irish demand response market prices and regulations, and therefore will differ in other European countries where the markets have reached a different level of maturity.

4.5 Impact on Thermal Comfort

Demand response is seen as a practice that could potentially reduce the thermal comfort of building occupants, due to HVAC assets being used to provide flexibility to the grid instead of conditioning the building. Complaints from building occupants are one of the most difficult challenges that the facilities manager will experience on a day-to-day basis, and there is evidence to suggest that comfortable indoor conditions contribute positively to staff health and productivity, so it is important to ensure that participating in a demand response event does not negatively impact on thermal comfort. Energy efficient buildings are better able to maintain comfortable indoor conditions when participating in demand response events compared to older, less efficient ones.

The NOVICE project team performed a simulated demand response event by turning off HVAC equipment for two hours at Demonstration Site 1, a leisure centre with a pool in Dublin, Ireland (Figure 4-7:). The scope of the simulation was to find out:

- How much load shedding potential there is in a typical leisure centre?
- What would be the impact of a two-hour demand response event on indoor conditions, and;
- Would any of the building users notice?

Figure 4-7: Leisure Centre in Dublin

The task began with identifying which equipment could be safely turned off with little impact on the indoor conditions such as air temperature and humidity, while ensuring that CO_2 levels remain within acceptable ranges. The team of energy experts working on the project identified all the non-essential HVAC equipment in the leisure centre which included air handling units, pumps and fans.

In order to assess the impact that a demand response event would have on the thermal comfort, a survey was designed to be undertaken before, during and after the simulation. The objective of the survey was to determine whether or not the people using the building during the demand response event noticed any change in conditions during their visit. To avoid any bias, the participants were not told of the demand response event or that the building operation had changed, but instead they were told that the aim of the survey was to identify their level of satisfaction with the indoor environment.

The survey asked the participants to identify the areas of the leisure centre in which they had spent most of their time, what their activity level had been during their visit and what was their overall satisfaction with temperature, humidity and air quality inside the building. The critical question that was asked at the very end was “Thinking about the time you have spent in the leisure centre today did you notice a change in conditions during your time here?”

On the day of the test, a group of people was surveyed before any equipment was turned off – this group formed the control group as all of their answers related to the leisure centre under normal operating conditions. Then at 5pm on a Monday afternoon, the busiest time of the week for most leisure centres, all non-essential equipment was turned off for two hours. Another group of users was

surveyed during and immediately after the simulated demand response event - this group formed the test group. The actual temperature, humidity and CO_2 levels were measured throughout the experiment to ensure that they did not drift outside acceptable ranges.

After 2 hours with non-essential equipment turned off, the conditions in the leisure centre had slightly changed but remained within acceptable ranges in all cases:

- The temperature did not change by more than 1.3°C in all areas, with reception getting slightly warmer while the pool and gym areas got slightly cooler.
- Humidity levels increased everywhere, and as expected, the largest increase was in the pool hall where humidity rose from 70% to 99%.
- CO_2 levels remained fairly constant in the reception and pool hall, but increased to the edge of the acceptable range in the gym.

Figure 4-8: summarises the results of the perception of the occupants about the indoor conditions.

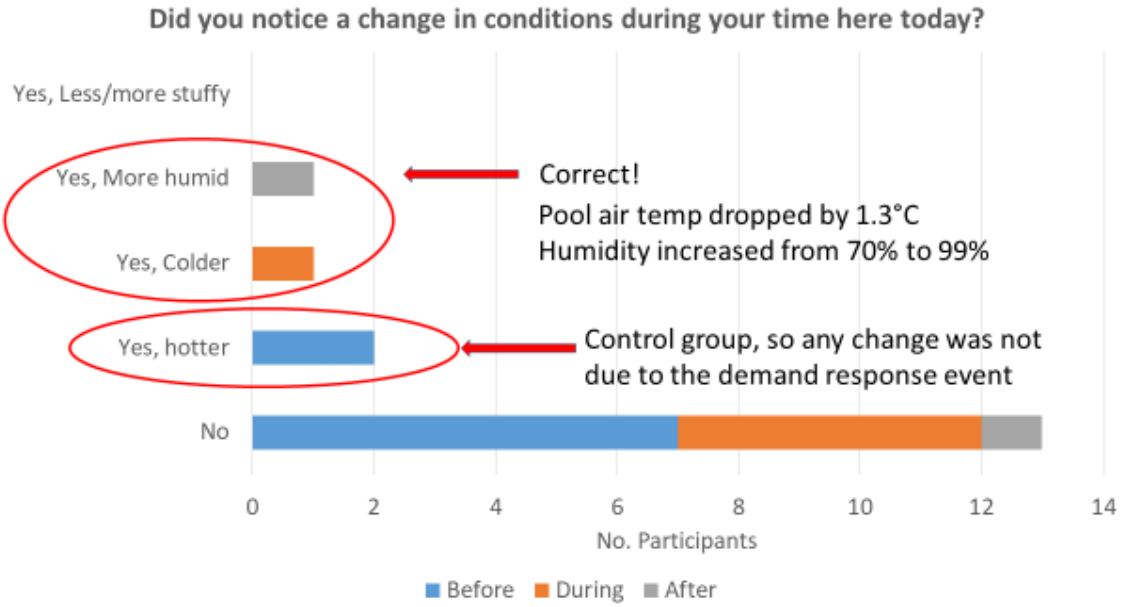

Figure 4-8: Survey results in the Leisure Centre

The majority of people did not notice any change in indoor conditions. Of those that said they did notice a difference, two of them were in the control group, meaning that any observed change happened before the experiment and therefore was not influenced in any way by the demand response event. So 22% of people in the control group claimed to notice a change in conditions when conditions were not changing. Only two people (25% of the test group) said they noticed a change in conditions that was matched by the data collected by the monitoring equipment. Effectively this means that there is almost no difference in perception of thermal comfort between the control group and the test group.

This very small study shows that it is possible to participate in a load shedding demand response event without increasing the number of complaints received from occupants about their thermal comfort, even in relatively sensitive environments like leisure centres. The ability of a building to participate does depend on the particular conditions inside each building but if building conditions change slowly

enough, building users will not notice the changes. In addition, most real demand response events do not last as long as two hours, which indicates that use of the NOVICE model would not negatively impact thermal comfort of building users.

4.6 UNSUITABLE SITES FOR THE NOVICE MODEL

The second objective of the simulated demand response event at Demonstration Site 1 (Leisure Centre in Dublin, Ireland) was to determine how much flexibility was available from this site. Figure 4-9: shows the power consumption before, during and after the simulated demand response event. The simulation was performed by first turning off the site's Combined Heat and Power plant (CHP), (which normally provides the majority of the site's heat and electricity demands), in order to force the site to draw all of its power requirements from the mains. This established the base site load at 85 kW. Next, the HVAC system was turned off (with the exception of critical operating systems) for two hours, between 17:00 and 19:00. The power consumption during this period remained fairly constant at around 40 kW. When the event finished and the CHP was turned back on, the building load returned quickly to its previous state.

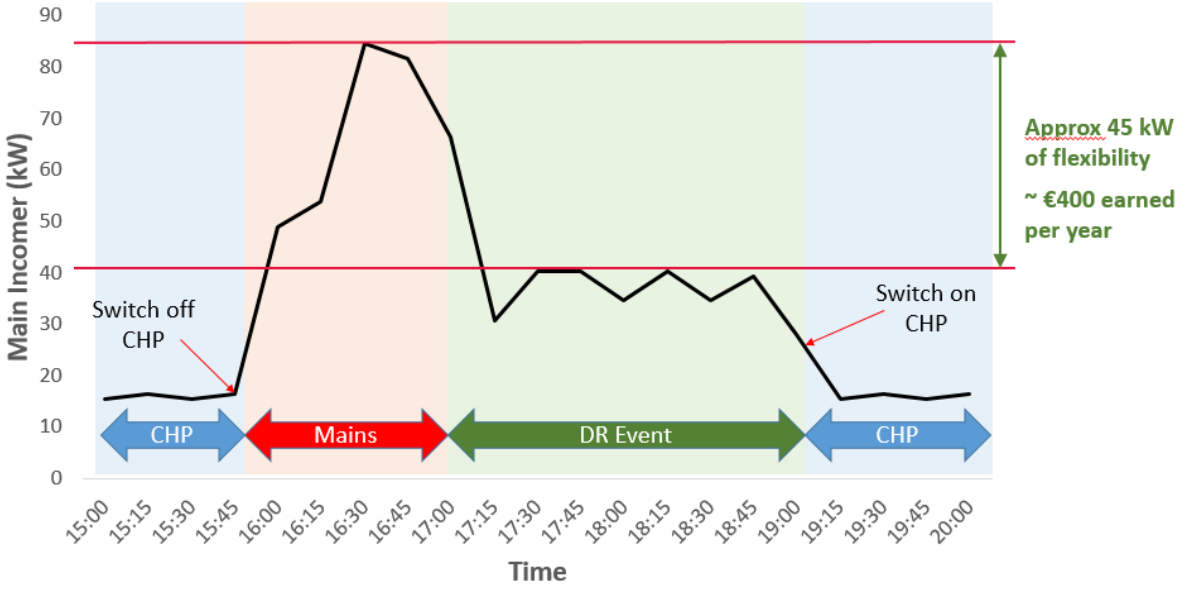

Figure 4-9: Demand response event impact on the power consumption at the Leisure Centre

The results of this simulated demand response event show that there is a maximum flexibility potential at this site of 45 kW, worth approximately €400 per annum at current market rates. This is insignificant compared to the annual savings achieved through the implementation of energy efficiency measures at this site and would have had almost no impact on payback period and contract duration.

The reason that this leisure centre performed so poorly compared to the supermarket in terms of achievable demand response revenues (€400 per annum for the leisure centre compared to €13,000 per annum for the supermarket) is that the HVAC equipment was the only energy asset available to participate in DR programmes and therefore revenues were limited to those achievable from load shedding. This may have been different had demand response formed part of the original EPC as a detailed analysis of the potential revenues from participating in Fast Frequency Response programmes may have justified the additional investment in the battery storage technology required to facilitate this.

The load shedding opportunities were also significantly restricted by the leisure centre's requirement to avoid disruption to normal operation, as several items of equipment had to be left running and were not included in the demand response simulation. Export of excess CHP capacity to the grid was also not considered in these simulated events as the CHP does not have the ability to export to the grid. Currently in Ireland it is not financially or operationally viable for CHPs of the size found at the leisure centre to export and be paid for electricity generated.

This case study shows that the suitability of a particular site for use of the NOVICE business model is heavily dependent on the site control strategy, the size and type of energy assets on site that are available for participating in demand response, and the client's level of acceptance of disruption to normal operation.

4.7 KEY CONTRACTUAL CONSIDERATIONS

4.7.1 ESCOs and Aggregators: Common or Conflicting Interests?

When examined independently, both ESCO and aggregator approach their respective clients with separate services that share a common goal: bringing value to clients through maximising revenues from onsite energy assets. In that respect, finding clients with a sizeable energy footprints and a desire to invest in assets for energy generation or energy storage are a common requirement for both parties. This commonality does however create something of a conflict of interest: the reduction of site electrical load through energy efficiency measures delivered by the ESCO may negatively impact on the available flexible loads and therefore the aggregators revenue stream from demand response services.

However, in practical terms NOVICE has not found this potential conflict to be a significant issue or one that discourages interaction between ESCOs and aggregators. Instead both parties seem to recognise the benefits of working together in terms of reduced cost of sale through cross referrals and warm leads, access to new markets and clients, and the added value that can be offered to clients through the ability to offer the services of the other party. In terms of seeking new opportunities and presenting combined energy efficiency and demand response proposals, it is likely that a collaborative approach would be beneficial and in this context, a contractual agreement around this strategy is relevant.

4.7.2 The ESCO-Aggregator relationship

The NOVICE partners, particularly Kiwi Power (aggregator) and NGLES (ESCO), sought to establish a working arrangement between aggregators and ESCOs for the purposes of combining the revenue streams of energy efficiency and demand response in a single and unified approach to an asset owner. The arrangement was formalised in a Memorandum of Understanding (MoU) which describes the bilateral agreement between an aggregator and ESCO, their common line of action, their roles and responsibilities in implementing energy management and demand response, the aim for adopting clean energy efficient technologies and achieving continual energy efficiency improvements.

The aggregator's role is to extract the maximum value from the energy assets that are covered by the EPC through offering the asset's flexibility potential to the electricity system operators while avoiding negative impacts on the comfort of the building occupants and asset operation. The ESCO seeks to minimise the energy consumption of buildings, to ensure that it meets the building owner's thermal comfort requirements as efficiently as possible. The aggregator therefore acts as an intermediary

between the ESCO and the TSO to implement efficient demand response mechanisms and handle all the legal and regulatory aspects of doing so.

From the point of view of the client, one of the incentives to work with an ESCO is that projects are offered on a turnkey basis which removes much of the complexity and technical hurdles to implementing several energy efficiency projects in parallel. Demand response is extremely complex with several programmes available dependent on the asset type, its available flexible load, the time in which it can respond to a dispatch signal and the redundant time required between dispatch signals for the asset to "recharge". Each of these programmes is only accessible via a contract with the relevant TSO, which requires extensive pre-qualifications and testing to ensure dispatch signals can be implemented successfully and to desired outcomes. Medium-sized assets must be aggregated together to meet minimum thresholds and to ensure any interruptions in availability can be mitigated by the pool of aggregated assets. Therefore, at the outset of the NOVICE project, an MoU between aggregators and ESCOs appeared to be the ideal tool to maintain a seamless, single point of contact service to clients while adding the complex and dynamic aspects of demand response to the revenue generating options available. NLGES have signed two separate MoUs with two different aggregators. In each case the MoU was modified slightly to accommodate the requirements and preferences of each aggregator.

In order to provide estimates and agree an EPC with the client, the ESCO must be able to understand and predict revenue streams over the proposed EPC duration (typically at least 8-15 years) with a high degree of confidence in its accuracy. Energy prices and therefore the savings offered by implementing energy efficiency measures are well understood and predictions can be based on current prices, industry estimates of future prices, and inflation, alongside standard accounting metrics for investments such as net present value. However, demand response contracts usually have much shorter durations of between 1-3 years due to the significant level of uncertainty on the future value of DR programmes. This inherent difference in contract length causes a problem for the ESCO who must accurately predict revenue streams over the 15 year EPC duration without being certain of the size of the DR revenue stream in 3 years' time.

This uncertainty may ultimately affect the agreement between both parties as their original agreement may require a break clause and could mean that the ESCO/aggregator arrangement may not span the entire duration of the EPC. As the market develops, so too will the working relationship between ESCO and aggregator, so the agreements they enter may need to be more flexible than the initially proposed MOU allows.

4.7.3 An example of DR revenue uncertainty

As an example, in the UK there have been significant reductions in revenues on some Demand Response programmes in the relatively short period of time since they were first established. For example, the Short Term Operating Reserve (STOR) provides an availability payment to assets for the times when it makes itself available for dispatch (an additional payment is made for utilisation if an asset is actually dispatched). The value of this availability payment has reduced by 64% over the period of the NOVICE project (June 2017 to May 2020, see Table 4-2). The value of Dynamic Fast Frequency Response (DFFR) in the UK has also decreased over the same time period. Some demand response programmes use a market model with dynamic pricing, further increasing the complexity of accurate forecasts.

Table 4-2: Selected variations in demand response programmes between 2017 and 2020 (Source: National Grid)

Programme	**£ / MWh Jan 2017**	**£ / MWh Jan 2020**	**% change**
Dynamic Fast Frequency Response (DFFR)	£21.46	£13.09	-39%
Programme	**£ / MWh April 2017**	**£ / MWh April 2020**	**% change**
Short Term Operating Reserve (STOR): Availability payment	£5.12	£1.85	-64%

There are several structural reasons why the Demand Response market has seen reductions in revenues in recent times. A key aspect is that large gas and coal fired power stations are still able to bid into the market (e.g. Capacity Market and STOR). With their large capacity they can undercut more financially intensive storage. In addition, National Grid (the UK TSO) has deployed new hedging strategies, moving from focussing on security of supply 12 months ahead, to procuring the 2 GW of STOR capacity just 4-5 months ahead and causing downward pressure on prices as providers compete more intensively. There have also been many more players entering the market as more assets realise the potential of their flexible load and this increased supply is also causing prices to fall. DFFR, which has a response time of within 2 seconds, has seen a high penetration of storage assets that were not in the market a few years ago. This has also caused the market for Static FFR (full response within 30 seconds) to be very limited as frequency responses can be managed by the faster reacting DFFR market.

Conversely upward pressure on prices are also expected in the near to medium term. In the UK the Government announced its intention to move to a net zero carbon economy by 2050 (Department for Business Energy & Industrial Startegy, 2019) and the carbon intensity of the energy sector will be critical in achieving that target. Increasing the carbon price could limit the downward pressure on the market price of high capacity carbon intensive generation types (such as the large coal and gas plants described earlier). The Association of Decentralised Energy (ADE) recognise the importance of flexibility and working with government they aim to ensure flexible resources receive “appropriate price signals” that enable further innovation to incorporate assets such as electric vehicles (Energy UK, Association for Decentralized Energy, & BEAMA, 2020). This is a clear recognition that simply adding flexible assets into a market will not solve the problem, and that appropriate market structures and prices are needed to maintain revenues for the enabling organisation, (such as demand response aggregators), to continue to operate.

The analysis presented in this section takes the UK market as a case study because it is one of the most mature markets in Europe, but it is likely that most European countries will experience similar pricing complexities as they mature. Therefore, the NOVICE MoU template forms a good basis for negotiations between the ESCO and the aggregator for providing demand response services to a new or existing ESCO client. However, given the complexity of the contract and dynamic nature of demand response prices it may not be possible to have a generic agreement for all client types in all instances. In addition, the MoU cannot provide enough certainty to support the EPC over its full contract length so other forms of formalising the relationship between ESCO and aggregator may need to be considered in future.

4.7.4 Alternative ESCO-Aggregator Contracting Options

The UK market has matured in a way that allows for better integration of activity between ESCOs and aggregators. The growth of the flexibility market and the awareness of flexibility within the industry

allows for a level of trust and mutual understanding to be built up between both parties. In this case, a rigid MoU contract may not be required.

In recent discussions with ESCOs it was expressed that access to clients could be conducted in a quid-pro-quo basis with no legal requirements placed on either party. In another discussion an ESCO described how they may be willing to become a more strategic partner and take on some of the operational responsibilities for flexibility provision. This demonstrates that there is a spectrum of mutually beneficial options for collaboration that industry players can adapt to fit with their strategic capabilities and resources. Partnerships can leverage the expertise and assets of both organisations. Therefore, several possible collaborations may be worth exploring further, post project, as described below and in Figure 4-10.

- **Option 1: The ESCO offers flexibility services to their client.** In this option the ESCO would become a capacity aggregator taking on the obligation to provide flexibility when required. The ESCO would need to sign a contract with the aggregator and source the flexibility from its portfolio of clients under separate contracts. The ESCO would develop a sufficient level of understanding about flexibility services to be able to describe the opportunities to their client base, and also understand the assets and the operational parameters of the client in order to determine the availability of the asset to participate in flexibility markets. The ESCO would be able to source additional clients within its portfolio and adjust the contract with the aggregator to increase its capacity of flexible services offered. The expertise for optimisation between different markets in order to maximise revenues, and the technology required for metering and dispatch would remain the responsibility of the aggregator. This would also mean that the ESCO would not need to take on additional risk and complexity of contracting directly with the networks. In this instance the ESCO would be a service provider (continuing to offer turnkey services) in addition to the EPC, but separate from it. The aggregator will allocate payment from the network to the ESCO for distribution amongst its clients. The aggregator and the ESCO may retain a proportion of these funds for services rendered.

- **Option 2: The ESCO introduces the aggregator to the client.** In this case the ESCO leverages the trust and relationships established with their client and assists in on-boarding them to the aggregator. The established relationship will enable more efficient communication (and if necessary training) about flexibility services and that the impacts on any business operations will be very limited. Much of the data required by the aggregator will also be required and collected by the ESCO, in which case there is little marginal cost in passing on this data. The level of engagement and support provided by the ESCO will determine the fee that will be payable directly from the aggregator. The aggregator will distribute flexible services payments directly to the clients retaining a proportion for services rendered.

Pan European flexibility policy (TERRE) will mean that there is a need for additional flexible assets in the near future, and thus provides plenty of opportunities for the ESCO and aggregator collaboration to take place. In terms of refining the alternative model to the MoU, some further testing will be required for this to be fully understood.

Another way to expand the uptake of dual service business models would be for flexible services to be included in the audit and investment process for publicly funded energy efficiency programmes (such as the RE:FIT programme in the UK). Without this being included in the template for these programmes there is no driver for an ESCO to be able to include it, and no transitivity between audit

providers. If flexible services could be included as a line in the audit process, then all ESCOs would have the opportunity to include this in their financial models.

In addition, adaptation of existing policies such as the Article 8 of the European Energy Directive, that support energy efficiency could also include flexibility services. This would mandate that businesses were made aware of the flexibility potential of their assets, even if they are not mandated to implement anything. The audit process could include revenues, energy savings and CO_2 savings as benefits of DSR.

Industry associations also have a role to play in advocating dual service models and the win-win-win it offers clients ESCO and aggregators. The validation that the reputation of industry associations would bring in backing the dual service business model would encourage clients that are taking their first tentative steps towards energy efficiency.

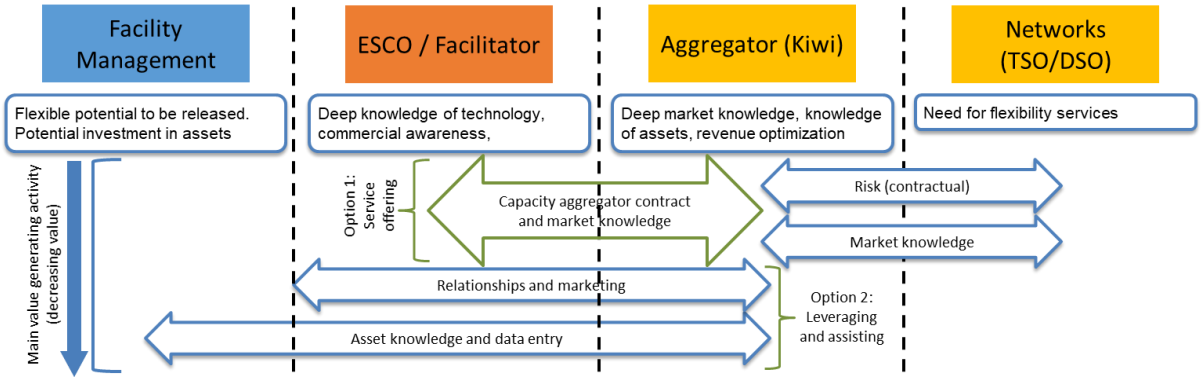

Figure 4-10: Alternative ESCO/Aggregator Contracting Options

4.8 Impact on Finance for EPCs

The definition of bankability is that the project is robust enough from a revenue and risk perspective to attract finance under the terms of an EPC contract. The results of NOVICE's research on finance concludes that the majority of financial institutions which provide finance for projects operated under EPCs will not yet rely on the future savings as receivables. Rather, they rely on the value of the physical assets and the credit rating of the parties to secure the investment. On the rare occasion where a project is secured in the 'true' EPC fashion (i.e. secured against the value of future energy savings) this is usually through an equity investment within an SPV structure.

Thus far, each financial fund is held to its own internal criteria for approving or rejecting financing requests. While there are general commonalities between fund criteria, each one is nonetheless bound to its own specificities and there is often little crossover. The resounding conclusion from all funds is that the bankability of a NOVICE EPC is largely reviewed on a project-by-project basis. However, if: (a) the savings are substantial; (b) the demand response aspect can be justified by the greater overall value it brings to the entire project and; (c) the financial model fits the fund's general expectations, then the project would be considered as bankable.

Further analysis on finances for the combined energy efficiency and demand response projects proposed for Demonstration Site 2, the Supermarket in Kilkenny, Ireland, was showed three important findings. Firstly, the NOVICE dual revenue stream business model clearly has added value for an investor since it evidently improves the main financial metrics that influence investment decisions. Secondly, the difference between a project that includes or excludes demand response revenues is

small, and therefore not a major influencing factor in financing decisions. Thirdly, replicability makes the project more attractive to investors.

For the supermarket, the single largest driving factor influencing the investment decision remains the energy efficiency measures behind the project, rather than the supporting demand response value. However, in the case of a supermarket that operates multiple similar sites that could deploy similar energy efficiency and demand response solutions at each one, there is an excellent opportunity to create a larger project bundle which makes the investment more attractive to finance providers.

5 THE FUTURE OF BUILDING RENOVATION IN EUROPE

5.1 THE FUTURE OF EPC

The NOVICE project has shown that when scoping energy efficient building refurbishments, including demand response as an opportunity can generate an additional revenue stream that could reduce overall project payback period by up to 16%. Whilst the value of the demand response revenue stream is always likely to be small in comparison to the revenues from energy savings and reduced maintenance costs, a 16% reduction in payback period (and therefore improved return on investment) is likely to turn projects that were on the borderline of being investible into projects that are economically viable. It is therefore worth considering the potential for DR in every whole building energy refurbishment, but in particular in cases where the economic viability is marginal. This could help to drive up building renovation rates in Europe whilst at the same time accelerating the smart energy transition.

NOVICE proposed this approach as a means of making EPC more attractive to all stakeholders. Indeed, the project has shown that an ESCO presenting their client with a dual services EPC is, in theory, likely to have a competitive advantage over an ESCO presenting a traditional EPC that considers energy efficiency alone, due to the shorter contract duration and better return on investment. However, in practice, the case for a dual services EPC is not so clear cut due to external market based factors.

The NOVICE model of deploying a dual services EPC can only work successfully in countries that have both a mature EPC and a mature demand response market. The reality is that the level of market maturity varies widely across Europe, and it is rare to find a country where both markets are mature enough to successfully use the NOVICE approach. For example, Ireland has one of the most open and mature DR markets in Europe but EPC is not a commonly accepted contracting model for energy efficiency projects. In contrast, Italy has a thriving market for EPCs and ESCOs but has one of the least mature demand response markets in Europe, with aggregation of demand response loads only being made legal at the end of 2019. Most countries in Europe have similar levels of disparity between their EPC and demand response markets, making it almost impossible to fully deploy the NOVICE model at the current time.

Although the perfect market conditions for NOVICE are rare, the situation is rapidly evolving, driven by ambitious European targets on energy efficiency and renewable energy generation. In practice, the approach of combining EE and DR to improve the business case for investment in building renovations can be used with or without EPC. ESCOs (or companies that could become ESCOs) operating in countries with open DR markets should consider including demand response as part of their opportunities assessment when carrying out energy audits. This requires them to build relationships with local aggregators and develop a strategy for discussing this complex concept with their clients. ESCOs operating in countries with immature DR markets should closely monitor the market developments and be ready to modify their business model in response to any changes in accessibility.

5.2 CHECKLIST FOR USE OF THE NOVICE MODEL

In order for the NOVICE dual services approach of combining energy efficiency with demand response via an EPC to be deployed in practice, the following conditions must be met:

- **The right equipment:** The building must include energy assets that can be used in a flexible way such as industrial equipment, HVAC equipment, refrigeration equipment, energy generation, battery storage, renewable energy generation with battery storage and a BMS. A

BMS is critical for allowing dispatch of the flexibility assets. The more types of equipment on site, the more DR markets the site can participate in therefore the greater the value of flexibility.

- **The right building type:** Buildings more than 20 years old, that have not yet undergone a refurbishment often have lots of opportunity for energy saving. Buildings with a large annual energy consumption, where energy is a significant cost to the building owner are more likely to take up EPC. Buildings with a wider range of acceptable operating parameters have a bigger opportunity for flexibility revenues. Large hotels, large offices, hospitals, large retail premises and sports facilities appear to be the most suited to NOVICE.

- **The right market:** As discussed above, NOVICE can only successfully operate in a country with both a mature EPC market and a mature DR market. Building owners and ESCOs must accept the EPC model as an acceptable and trusted method of achieving improved energy performance. Aggregation must be allowed. Energy assets must be allowed to participate in a range of DR programmes, rather than having commit to only one.

- **The right contractual models:** Standard EPC contractual templates are needed to minimise the legal and administrative burden and cost of procuring dual services EPCs, particularly because these are likely to be more complex than standard EPCs. ESCOs must be willing and able to sell, finance, and operate an EPC. ESCOs and aggregators must be willing to work together and must find suitable contractual approaches to managing the relationship between them including: client management; roles and responsibilities; distribution of revenue streams. The NOVICE MoU can be used as a starting point for these discussions but other tools to formalise the relationship between ESCO and aggregator can also be used if they are more appropriate.

- **The right finance:** In order to drive up building renovation rates in Europe, the barrier of access to finance for energy efficiency projects must be overcome. Due to the uncertainty over revenues from demand response, most third party investors would not consider a dual services EPC to be any more bankable than a standard EPC. Standardisation of contracts and processes, and bundling of similar projects will increase the attractiveness to investors.

As markets around Europe mature, those stakeholders that are ready to embrace the new approach that the NOVICE model offers will have a competitive edge over their peers, making them leaders in their field.

6 REFERENCES

Department for Business Energy & Industrial Startegy. (2019). *UK becomes first major economy to pass net zero emissions law*. Retrieved from https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law.

Energy UK, Association for Decentralized Energy, & BEAMA. (2020). *Delivering on the Potential of Flexibility - A smart flexible energy system in the transition to a net-zero economy*. Retrieved from https://www.beama.org.uk/resourceLibrary/delivering-on-the-potential-of-flexibility-a-smart-flexible-energy-system-in-the-transition-to-a-net-zero-economy.html