MOEEBIUS

Modelling Optimization of Energy Efficiency in Buildings for Urban Sustainability

D2.2 - New Business Models and Associated Energy Management Strategies

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Glossary

Acronym	Full name
ACER	Agency for the Cooperation of Energy Regulators
BEMS	Building Energy Management Systems
BOOT	Build-Own-Operate-Transfer
BRP	Balance Responsible Party
B2B	Business to Business
CEB	Council of Europe Development Bank
CEM	Contract Energy Management
CHP	Combined Heat and Power
DB	Database
DER	Distributed Energy Resource
DR	Demand Response
DSM	Demand Side Management
DSO	Distribution System Operator
DSS	Decision Support System
DTC	Distribution Transformer Controllers
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECO	Energy Companies Obligation (*UK*)
ECO.AP	Programme for Energy Efficiency in the Public Buildings (*PT*)
EE	Energy Efficiency
EE Law	Law on Efficient Use of Energy (*RS*)
EED	Energy Efficiency Directive
EEF	Energy Efficiency Fund (*PT*)
EESA	Energy Efficiency Services Agreement
EIB	European Investment Bank
ENTSO-E	European Network of Transmission System Operators for Electricity
EPC	Energy Performance Contract/ Energy Performance Certification (*section 0*)
EPBD	Energy Performance of Buildings Directive
ESC	Energy Supply Contract
ESCO	Energy Service Company
ERSE	Energy Services Regulatory Authority
EU	European Union
EV	Electric vehicle
FCDM	Frequency Control by Demand Management
FFR	Firm Frequency Response
FM	Facility Manager or Facility Management
GGF	Green for Growth Fund
GIZ	German Agency for International Cooperation
HVAC	Heating, ventilation and Air Conditioning
IAQ	Indoor Air Quality
ICP	Investor Confidence Project
ICT	Information and Communication Technology
IEC	Integrated Energy Contracting
JRC	Joint Research Centre
KfW	German Development Bank
KPI	Key Performance Indicator

Acronym	Full name
LL	Living Lab
LPG	Liquefied Petroleum Gas
LV	Low voltage
M	Million
MOEEBIUS	Modelling Optimization of Energy Efficiency in Buildings for Urban Sustainability
MV	Medium Voltage
M&V	Measurement and Verification
NAG	Neighbourhood Area Grid
NEBEF	Notification d'Échange de Blocs d'Effacement *(FR)*
NEEAP	National Energy Efficiency Action Plan (*PT*)
NIST	National Institute of Standards and Technology
NZEB	Near Zero Energy Buildings
OEM	Original Equipment Manufacturer
O&M	Operation and Maintenance
PACE	Property Accessed Clean Energy
PPEC	Promoting Efficiency in Electricity Consumption (*PT*)
PPP	Public-Private Partnership
PT	Portugal
PV	Photovoltaics
RE	Renewable Energies
ROI	Return on Investment
RS	Serbia
R&D	Research and Development
SCE	Energy Certification System (*PT*)
SEAF	Sustainable Energy Asset Framework
SEDC	Smart Energy Demand Coalition
SME	Small and Medium Enterprises
SoTA	State of The Art
STOR	Short Term Operating Reserve
ToU	Time-of-Use
TSO	Transmission System Operator
UI	User Interface
UK	United Kingdom
UNDP	United Nations Development Programme
USA	United States of America
VPP	Virtual Power Plant

1 Executive summary

This task focuses on developing innovative business models for energy services companies (ESCOs) and demand response (DR) aggregators which are aligned with the stakeholders' requirements. This was accomplished through a benchmarking including a review of the existing business models and current market status in Europe and identification of their barriers and success factors. Additionally, opinions of specialists were gathered through questionnaires and interviews and brainstorming sessions with stakeholders and experts through a Living Lab. Topics like energy certification, occupants' awareness and energy management are addressed in an innovative way to introduce new ESCO business approaches that are not local, but transferable to diverse business environments, providing solutions with high replication potential. DR business models introduce predictive analytics, peak demand management and a framework for participation on external market.

This document is a pillar to open new monetization approaches to the dynamic energy trading markets. The role of this deliverable is to present the innovative business models of the MOEEBIUS project. The analysis starts by taking into account the different business stakeholders and scenarios addressed in the project as presented in D2.1 "End-user & Business Requirements". In addition, the evaluation of different business models and energy strategies identified will be provided by the MOEEBIUS Living Lab members, which are actively participating on project activities (D7.2 "MOEEBIUS Living Lab Activities Planning").

This document starts with a brief introduction of the methodology followed and a description of the business perspective of the stakeholders involved in the ESCO and DR business models. Then the current state of the art of the existing business models and ESCO and DR market statuses are assessed, identifying main barriers and success factors and allowing the development of innovative business models that are then allocated to the MOEEBIUS pilot-sites.

The main outcome of this document is a proposal of four innovative ESCO business models and three innovative DR business models. The ESCO business models developed introduce energy management based on enhanced energy performance contracts (EPCs), a condition/efficiency EPC model for ESCOs, a tool for raising occupants' awareness for energy savings and the valorisation of buildings through energy certification. Incorporation of comfort and health parameters as part of an EPC, real time automation, predictive maintenance, gamification and behavioural triggering are some examples of innovative aspects that were introduced in the ESCO business models. Regarding DR, the business models developed include predictive analytics, peak demand management and a flexible DSM framework for participation on external market.

2 Objectives of the report

The objective of the deliverable is to develop innovative business models for ESCOs and Aggregators taking into account the existing market status. In addition, energy management services, to be further associated with the different business models identified, are also presented. D2.2 analyses and defines new ESCO and DR business models to be addressed and validated in the project for the end-users involved in MOEEBIUS.

2.1 Scope of the document

This deliverable aims, by extending currently existing energy performance contracts (EPC) formats, to introduce novel ESCO business models and corresponding alternative management strategies that will consider significant energy performance improvements without sacrificing occupants' comfort and health in the indoor environment. Alternative strategies will be shaped either for maximizing energy savings (under automated control scenarios) by regulating occupants' comfort at the boundary limits of identified comfort zones, or for establishing optimal balance between energy performance, comfort and health, according to the requirements of buildings occupants and managers.

Moreover, this task defines in details the business role of aggregator and associated business models to provide hybrid mixes of DR services for peak-load management, ancillary services provision, energy efficiency (EE) or combinations of them.

Respective DR strategies will be formulated that, on the basis of accurate, realistic and robust prosumer profiles and distributed energy resources flexibility models, trace back demand flexibility to "context aware" user/occupant behavioural models, offer fine grained control (equivalent or even higher than existing Direct Control Programmes) fully respecting prosumer preferences and needs, as well as, EE targets or conflicting requirements. Such strategies will promote the efficient integration of flexible demand with distributed generation and district-wide systems (district heating) within the smart grid as the means to tackle balancing inconsistencies resulting from the continuous and massive integration of distributed intermittent and non-controllable renewable sources.

MOEEBIUS will not only focus on the business environment at the project's pilot sites, but through the Living Lab and the involvement of relevant stakeholders from other EU countries will introduce new business approaches that are not local, but transferable to other business environments.

2.2 Relevance to other deliverables

The role of this deliverable is to present the innovative business models of the MOEEBIUS project. The analysis starts by taking into account the different business stakeholders and scenarios addressed in the project as presented in D2.1 "End-user & Business Requirements". In addition, the evaluation of different

business models and energy strategies identified will be provided by the MOEEBIUS Living Lab members, which are actively participating on project activities (D7.2 "MOEEBIUS Living Lab Activities Planning").

On the other hand, the definition of innovative business models along with MOEEBIUS Energy Performance Assessment Methodology (D2.3 "MOEEBIUS Energy Performance Assessment Methodology") will enable the Pilot Roll-Out and Validation activities (WP7 "Pilot Setup and Validation") towards the evaluation of MOEEBIUS framework in pilot premises. More specifically, the different business models identified in the document will be considered during ex-ante pilot analysis (D7.2 "Ex-Ante Analysis and Baseline Definition") and will be further tested on the different pilot roll outs of the MOEEBIUS project (D7.3- "MOEEBIUS Validation Framework – Validation Scenarios and Deployment Plan").

It is obvious, that the definition of "New Business Models for End-Users and Energy Management Strategies" is a cornerstone activity towards the establishment of a business focusing MOEEBIUS framework.

2.3 Deliverable Structure

The document is structured as follows:

- **Chapter 3** presents a brief introduction of the methodology followed;
- **Chapter 4** describes the business perspective of the stakeholders involved in the ESCO and DR business models;
- **Chapters 5 and 6** present the current state of the art of the existing business models and market status, being **Chapter 5** relative to ESCO and **Chapter 6** relative to DR;
- **Chapter 7** describes the innovative business models developed;
- The innovative business models and services are then allocated to be validated in the MOEEBIUS pilot sites in **Chapter 8**;
- Finally, **Chapter 9** presents the main conclusions of the present work.

3 Introduction

EE has an enormous potential, the investment in EE can provide many different benefits to many different stakeholders. Either by directly reducing energy demand and respective costs (which allows investment in other goods/services) or helping the achievement of other objectives (e.g. making healthier indoor environments or boosting industrial productivity).

The improvement of EE is strategic to enhance the energy system and environmental sustainability, economic and social development and prosperity (IEA, 2014).

Therefore, EE plays a key role in reaching EU energy policy objectives, regarding for example: competiveness (reduction of energy costs for households/businesses); security of supply (reliability of supply, reduction of energy imports); and sustainability (limiting environmental impacts and creating jobs from energy sustainability) (IEA, 2014). Figure 1 summarizes in a non-exhaustive way the multiple benefits that can be obtained from EE improvements.

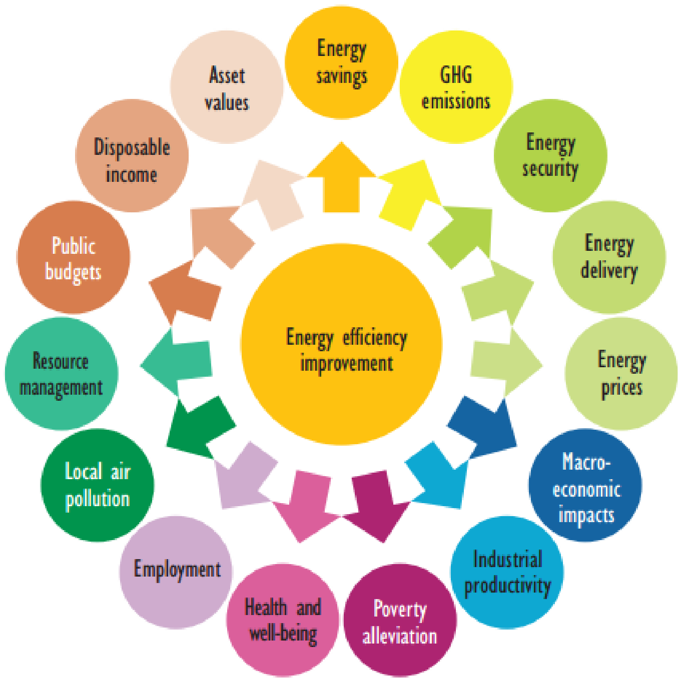


Figure 1: Multiple benefits of EE improvements (IEA, 2014).

Energy services and the use of ESCOs can play a critical role in promoting EE at the market level. During the last years, the awareness and understanding of EE services have increased and mistrust have decreased. These were based on the growing importance of energy consumption cost efficiency due to rising energy prices and growing environmental awareness.

Financial institutions also acquired more experience. Operational since the early 1990s, ESCOs can handle projects, manage or mobilize financial resources, undertake installation and maintenance work as well as assume the performance risk of their projects.

However, the added value can be a lot more than lowering the user's energy bill. Amongst others, energy exchange forecasts can be provided to the market with better knowledge of the user's behaviour than it is currently the case.

As it is important to not only have the technical relations clear between the different market roles, we also provide reward mechanisms for the distribution system operator (DSO), energy retailer, aggregator and the End User (EC, 2015; e-balance, 2015).

On the other hand, DR is able to increase the system's adequacy and to substantially reduce the need for investment in peaking generation by shifting consumption away from times of extremely high demand. It can act as a cost effective balancing resource for variable renewable generation adding stability to the system.

Apart from the indirect benefits that DR delivers to society by lowering the costs and optimising the efficiency of the electric systems and markets, it also provides direct benefits to consumers by paying them directly for the value of their demand-side flexibility.

Moreover, DR is regarded as key tool to achieve the EU targets for renewable energies and energy savings which denotes the need to develop new business models for DR and clarify the roles of all the stakeholders involved.

3.1 Methodology

The methodology for developing this work included a review of the existing business models and current market status in Europe, identification of their barriers and success factors; and also questionnaires and interviews with stakeholders and brainstorming sessions with experts through a Living Lab (LL). Then, by taking into account feedback from external parties, we defined the final list of business models and the associated strategies considered for implementation. Finally, the applicability of business models to the pilot sites of the MOEEBIUS project was considered, setting that way the framework for the final deployment of MOEEBIUS tools in premises.

Figure 2 presents a schematic representation of the methodological framework used for developing this work.

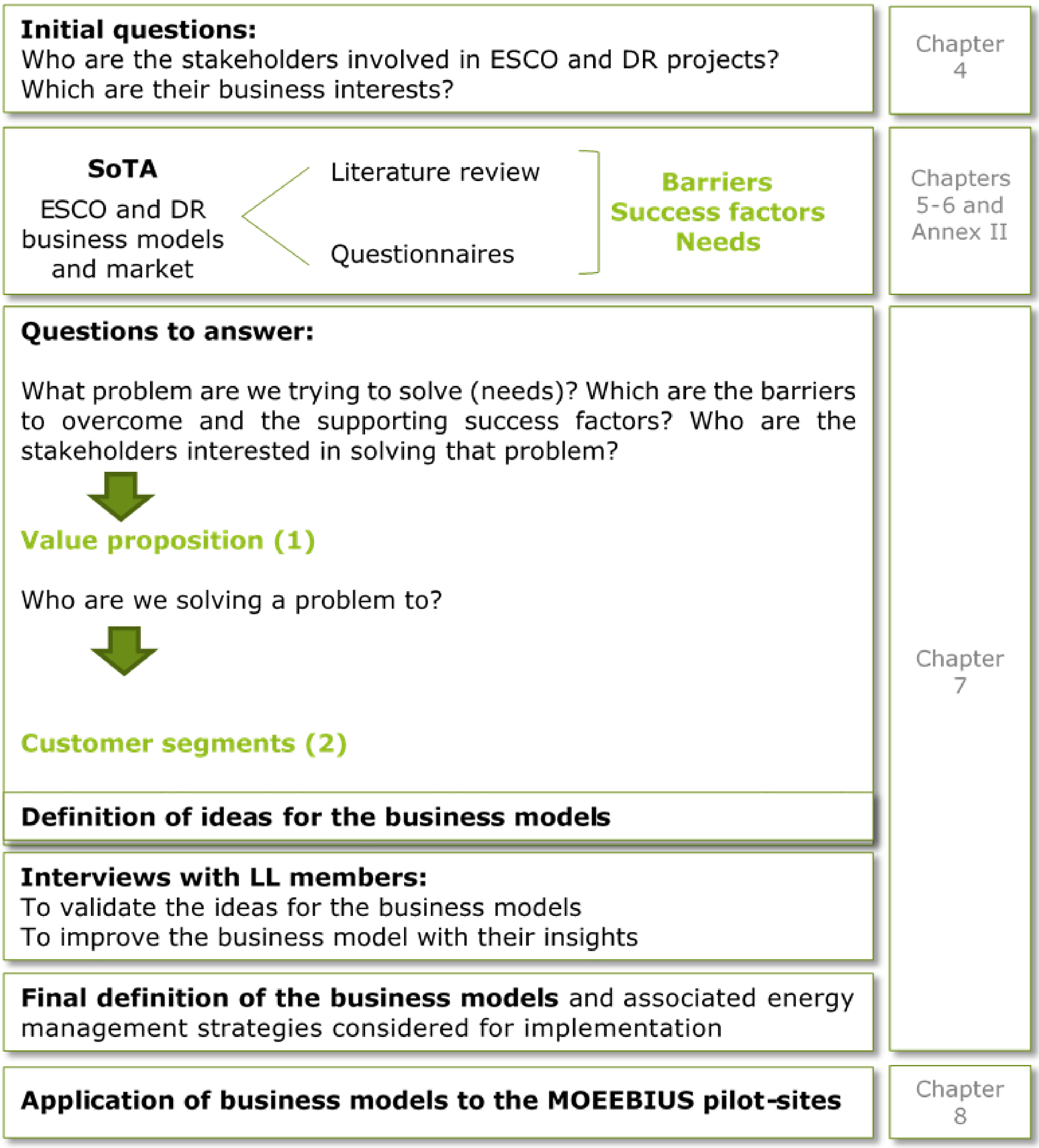


Figure 2: Methodological framework.

3.1.1 Definition of business models

"When a business goes to the market it implicitly or explicitly operates a business model which describes how it intends to create, capture and deliver value." (Tolkamp, 2015) In order to characterize and compare the business models, the business model Canvas was used. This tool was developed by Osterwalder and Pigneur (2010) and is a strategic management and a short startup template for developing new or documenting existing business models. It is also a strategic management and entrepreneurial tool. It is a simple way to analyze and compare the many different business models, through its organized and clear structure.

The business model Canvas is divided in nine parts (Figure 3): 1) Value proposition, 2) Customer Segments, 3) Channels, 4) Customer Relationships, 5) Key Activities, 6) Key Resources, 7) Key Partners, 8) Revenue Streams and 9) Cost Structure.

7

Key partners
The network of suppliers and partners that make the business model work

Who are our key partners?

5

Key activities
The main activities a company must do to make the business model work

What key activities does our value proposition require?

6

Key resources
The main assets required to make the business model work

What key resources does our value proposition require?

1

Value proposition
The bundle of products and services that create value for a specific customer segment

Which of our customer's problems are we helping to solve?

Which costumer needs are we satisfying?

What is the specific product or service?

4

Customer relationships
Relationships that the company establishes w/ its customer segments

How will we get, keep and grow customers?

3

Channels
How the company communicates w/ and reaches its customer segments

Through what channels customers want to be reached?

2

Customer segments
The different groups of people or organizations the company aims to reach and serve w/ the business model

Who are we solving a problem or fulfilling a need?

Who are the customers? The value preposition matches their needs?

Single-sided or multisided market?

9

Cost structure
All cost incurred to operate the business model

What are the most important costs?

8

Revenue streams
The money the company generates from each customer segment served w/ the business model

What value are our customers willing to pay? Revenue model? Pricing tactics?

Figure 3: Business model canvas.
adapted from Osterwalder and Pigneur (2010)

3.1.2 Characterization of the ESCO and DR markets - Questionnaires

In order to characterize the ESCO and DR markets a literature review of the existing business models and current market status in Europe were carried out (with a main focus on the pilot countries – Portugal, Serbia and UK), allowing the identification of barriers and success factors. Additionally, specialized questionnaires were prepared to further characterize the ESCO and DR market in the pilot countries. Responses to the questionnaires were collected from a mix of LL members and MOEEBIUS partners that operate in the pilot countries.

Regarding the ESCO market, questionnaires gathered a total of 16 answers (12 from Portuguese entities and 4 from Serbian entities). Regarding the DR market, questionnaires gathered 7 responses (from 6 UK entities and 1 entity from Ireland). Further details on the questionnaires used are presented in *Annex I - Questionnaires* and the results obtained are presented in *Annex II – Analysis of the questionnaires*.

3.1.3 Validation and co-creation of business models - Interviews

Based on the evaluation of the ESCO and DR market and identification of main barriers and success factors (both through literature review and questionnaires), MOEEBIUS Consortium has developed ideas for innovative ESCO and DR business models, aiming to overcome the barriers that currently prevent their application in buildings. Then, there were conducted several interviews with LL members, both ESCOs and aggregators, in order to validate and improve the innovative business models through their insights, to ensure they meet the real needs of the ESCO and DR projects stakeholders.

A total of 31 LL members were interviewed in order to validate and co-create the innovative business models for ESCOs and DR. Regarding ESCO innovative business models, 26 entities were consulted (15 ESCOs, 2 energy/ESCO associations and 9 relevant non-ESCOs). The non-ESCO entities interviewed were 6 specialists in this topic from scientific and academic organizations and 3 consultants that develop their work in this topic. Of the entities interviewed, 20 operate in Portugal, 2 in Serbia, 2 in Spain and 2 in UK. Regarding the DR innovative business models, a total of 5 DSM aggregators, operating in UK and Ireland.

The results of these interviews were incorporated in the innovative business model definition presented in Chapter 7 where additional feedback from the LL members regarding innovative aspects, strengths and weaknesses of each business model is also highlighted.

This interviews allowed the final definition of the innovative business models and associated energy management strategies that were then allocated to the MOEEBIUS pilot-sites where they will be validated.

4 MOEEBIUS stakeholders – Business perspective

This section provides a summary of the stakeholders involved in MOEEBIUS along with their business perspective. The goal is to associate the business roles, as initially identified in D2.1 "End-user & Business Requirements", with the different business models examined in the project.

From the business point of view, MOEEBIUS main stakeholders are ESCOs, aggregators, facility managers, building occupants, maintenance companies and retrofitting advisor companies.

Additionally, building owners, technology suppliers and public bodies, as external parties that are indirectly interested in MOEEEBIUS business framework, are characterised too.

4.1 Main stakeholders

Facility manager (FM)
Definition
The FM can be a facility owner, third-party operator or a person responsible for the operation of all systems within a facility (e.g., heating, lighting, etc.). In case of a third-party company, it could provide additional services to the owner of the facility (e.g., maintenance, cleaning services, etc.) addressing also the role of ESCO Company as examined in the project. Within MOEEBIUS, the role of the FM is to operate the building in an energy efficient way. We are distinguishing its role from ESCO who offers additional services related to building performance.
Interests
• Monitoring energy use, recommending energy savings, deciding for investments in equipment, identifying/reporting problems, providing maintenance and communicating with the building occupants for energy related topics; • Reduce energy bills and to reduce energy consumed - without reducing the benefits for the occupants; • Operate the building in an energy efficient way, fully preserving building occupants' preferences and needs; • Examine the participation on business strategies that are beneficiary for building owners.

Table 1: Facility manager - Business perspective.

Maintenance company
Definition
The Maintenance Company observes the correct implementation of the corresponding regulations. This actor is mainly a third-party operator or a person responsible for the maintenance of all the systems within a facility (e.g., heating, lighting, etc.). Maintenance and repair involves fixing any sort of mechanical, plumbing or electrical device should it become out of order or broken. It also includes performing routine actions, which keep the device in working order or prevent trouble from arising (preventive maintenance).
Interests
• Periodically check the status of the building equipment and define the maintenance activities needed in order to avoid equipment failures. • Proceed with the corrective actions required to ensure a high level building performance

Table 2: Maintenance Company - Business perspective.

Retrofitting advisor company
Definition
The Retrofitting Advisory Company provides an analysis of building performance, and further defines the optimal retrofitting strategies that will affect energy-building performance. This actor is mainly a third-party operator or a person responsible for the maintenance & retrofitting of all the systems within a facility. Retrofitting is the process of modifying something after it has been manufactured. For buildings, this means making changes to the systems inside the building or even the structure itself at some point after its initial construction and occupation. Within MOEEBIUS project, we are examining the role of Retrofitting Advisory Companies as part of the integrated building management framework.
Interests
• Examine different alternatives for the building and further recommend a list of retrofitting activities to improve energy efficiency.

Table 3: Retrofitting Advisory Company - Business perspective.

Energy Service Company (ESCO)
Definition
An ESCO is a commercial business providing a range of energy solutions including designs and implementation of energy savings projects, retrofitting and energy conservation. ESCOs develop, implement and provide or arrange financing for upfront EE investments for its clients. Within MOEEBIUS project, we address the role of ESCOs as the companies able to provide integrated building management services to building owners.
Interests
• Provide a broad range of energy services to final energy users, addressing both individual buildings and groups of building premises, including: EE advice, energy audits, feasibility studies, design and implementation of retrofitting projects, energy conservation, equipment procurement, M&V, O&M and project financing; • The ESCO can act as a facility manager, maintenance company, retrofitting advisor company enabling that way the provision of an integrated building management framework.

Table 4: ESCO - Business perspective.

Following the definition of business roles at building level, we further proceed with the analysis at district level.

Aggregator
Definition
The DSM Aggregator "aggregates" multiple end users at his portfolio to form a single market participant. The aggregator enables end users to offer flexibility for specific purposes and thus facilitates residential and small commercial building participation in energy markets. More specifically, the Aggregator's role is to gather ("aggregate"), analyse and efficiently organize customers' loads portfolio, towards identifying appropriate clusters of prosumers and respective DER flexibilities that will facilitate optimal placement in energy markets through the associated energy management strategies. By creating agreements with industrial, commercial, institutional and residential electricity consumers, the business actor aggregates their capability to reduce energy and/or shift loads on short notice. Therefore, the Aggregator is acting as the mediator of consumers towards participation in DR Programmes.
Interests
• Flexible demand side optimisation; • Define clusters of prosumers with similar or complementary characteristics towards an optimal portfolio management framework; • Aggregate customer's flexibility and provide this to energy retailers, DSOs or other energy market entities

Table 5: Aggregator - Business perspective.

We have to point out that one of the main innovation of MOEEBIUS project is the incorporation of ESCOS capabilities to DSM Aggregators. More specifically, the DSM Aggregator is not exclusively defined as an actor that provides energy services to market actors; rather it provides direct energy management services to consumers (or clusters of consumers).

An additional innovation of the MOEEBIUS project is the incorporation of building occupants as main business actors of the platform. The users are active elements of the building that are continuously interacting with the different entities that consist of the MOEEBIUS platform. Therefore, even with no direct business role, the building occupants are considered as main actors of the project.

Building occupants
Definition
The building occupants are the final consumers of energy and are directly responsible for the behaviour change, related with the awareness and understanding of EE. This actor is the agent that requires electricity for end-uses (and might also produce it, being in that case a "prosumer"). An end user of the energy system is defined as any legal entity that exchanges energy via the power grid, but does not have production of electricity as primary activity. Most of them currently only consume energy from the grid. Within MOEEBIUS project we address this role as one of the major roles as the goal of the project is to establish an energy efficient environment fully preserving end users' needs and preferences.
Interests
Towards this direction, tools and applications will be available for the end occupants of buildings to further address the need for the establishment of a sustainable environment. The consumers can have many kinds of reasons to participate in an Services that are useful for end users from a business perspective include: • Access historical energy consumption and production data; • Access predicted production/consumption data; • Access predicted energy exchange with the grid data; • Become a provider of flexibility in the energy exchange with the grid (on request the user can change his energy consumption). User strategies determine the amount and shape of flexibility provided.

Table 6: Building occupants - Business perspective.

4.2 Additional stakeholders

Along with the definition of main stakeholders involved in project activities, there are additional stakeholders indirectly addressed by the MOEEBIUS project activities. The analysis here goes to third parties that may be interested for MOEEBIUS business models.

Building owner:

The main interest of the building owner is in lowering costs and upgrading of the building (by maximising its occupants' comfort) in order to be able to spent less in maintenance activities and receive higher revenue from tenants. The building owner can play the role of the customer in an ESCO or DR project and can also act as a channel for reaching the building occupants (end-users) and access their needs, exchange information and raise awareness.

Technology suppliers (services/systems/equipment):

Electronics and household appliances can incorporate into their products features that enable the unlocking of flexibility in the consumption, production or exchange of energy. Technology suppliers provide intelligent energy devices and electronic solutions incorporating information and communication technology (ICT). In an

ESCO project this stakeholder usually acts as a key-partner of the ESCO or Aggregator, for example being able to develop and deliver the ICT solutions needed to access the building performance and implementing solutions that provide information and support decision making both for the ESCO, the Aggregator and the customer.

Public bodies:

Public bodies are "contracting authorities" (Directive 2012/27/EU) which are *"State, regional or local authorities, bodies governed by public law, associations formed by one or several of such authorities or one or several of such bodies governed by public law"* (Directive 2004/18/EC). Public bodies have a key role in stimulating, promoting and supporting EE initiatives. In addition, they can participate in EE projects as investors, customers or beneficiaries (DAREED, 2014).

Public bodies can have different roles in an ESCO or DR project, for example they can be the customer, or act as a key-partner for the ESCO or Aggregator or as a channel to reach customers. As customers, Public bodies can be the beneficiaries of the ESCO or DR project (if the project refers to buildings that belong or are operated by the Public body) or the beneficiary of the ESCO or DR project can be the community (in that case the Public body is a customer that acts like a representative of the community). Their goals are related with lowering energy consumption and lowering the costs and improve environmental performance at district and building levels (DAREED, 2014).

We have identified two core business entities in the project: **ESCOs** (acting as FMs, Maintenance and Retrofitting Companies) and **DSM Aggregators**. The definition of main system stakeholders will further facilitate the review of existing market models towards the definition of innovative business models in the MOEEBIUS project. In the next section, we are starting with the presentation of current market status (for each of the stakeholders) which will further enable the identification and further analysis of new business models.

5 ESCO business models and market

The definition of the existing business models for ESCOs and their current market status is one of the main objectives of this derivable. Focusing on their success factors and deployment barriers, a review of the existing business models and current market status in Europe (especially for MOEEBIUS pilot countries) is provided.

An ESCO, as a commercial business providing a range of energy solutions to its customers, is able to design and implement energy savings projects. For that reason, the ESCO needs to follow a business plan defining specific agreements with customers, including the respective roles and responsibilities.

The ESCO market is extremely important because it turns possible the development of win-win relationships between the customer (who, by entering in an ESCO contract, saves energy and consequently money) and the ESCO (who invests or arranges investment and obtains return on the investment throughout the ESCO contract).

5.1 ESCO existing business models

The energy services market is envisaged as a key factor for implementing EE measures and achieving energy savings in buildings. ESCO models were developed in the USA and afterwards brought to Europe and have been used since the 1970s. The present section describes the ESCO models that are currently used.

5.1.1 Energy performance contracts (EPC)

An energy performance contract (EPC) is a partnership between a customer and an ESCO that allows the customer to improve the demand-side EE of their facilities (EU-ESCO, 2010), and consequently save energy and money.

EPC is a performance based business model. This means that the ESCO will be remunerated based on the energy savings generated through the contract. The cost savings obtained with the EE measures will help finance the project. The ESCO will guarantee a minimum savings level that they are then responsible in reaching.

The most common forms of EPC are shared-savings and guaranteed-savings, but it is also possible to perform variable contracts.

EPC is well suited for large scale projects, especially in the public sector. As EPC is a complex contract form, it is not suited for smaller projects because of the high transaction costs. The long payback times that are generally associated with EPC can make it less attractive for the private sector. Setting up an energy baseline

can be hard and the measurement and verification process needed to follow up on the project results can be costly. (Warget, 2011)

5.1.1.1 Shared-savings EPC

With shared savings EPC the ESCO finances the project for implementation of EE measures at the customer facilities. Then, savings obtained with the project are shared between the client and the ESCO during a period previously determined and with share rates previously agreed (EC-JRC, 2016; DAREED, 2014). Table 7 summarizes the shared-savings EPC business model.

<table>
<tr><td rowspan="2">7 - Key partners
Financial Institutions; Construction and technical partners</td><td>5 - Key activities
Project preparation, development and operation</td><td rowspan="2">1 - Value proposition
Energy savings without prior investment or commitment; Savings from the first moment</td><td>4 - Customer relationships
Contractual (medium-term, 10-15 years)</td><td rowspan="2">2 - Customer segments
Large buildings: Public bodies; Corporate clients (building owners, commercial and industrial)</td></tr>
<tr><td>6 - Key resources
Technical and financial know-how</td><td>3 - Channels
Public projects; Special events</td></tr>
<tr><td colspan="2">9 - Cost structure
Construction cost; Interest rates</td><td colspan="3">8 - Revenue streams
Energy savings from the project</td></tr>
</table>

Table 7: Shared-savings EPC business model.

The ESCO obtains financing as usual for implementing the project. EE measures are generally directed at demand side measures but supply side measures (such as setting up efficient heat boilers) can also be incorporated.

The duration of the contract depends on the level of retrofitting necessary and the respective investment. For large refurbishment measures, including insulation measures on the thermal building envelope it is expected a long-term contract (8-15 years). For EPC involving low levels of investment (e.g. 'EPC light'), short-term contracts (2-3 years) are also possible (GIZ, 2012).

5.1.1.2 Guaranteed-savings EPC

In a guaranteed-savings EPC the ESCO assumes the risk of the project's performance. Because the ESCO has the risk, financing is obtained by the customer (either through own funds or loans) and the ESCO will in return guarantee a minimum energy savings level (percentage). If savings exceed the guaranteed level, they can be absorbed by the ESCO or split between the ESCO and customer (EC-JRC, 2016; DAREED, 2014). Table 8 summarizes the guaranteed-savings EPC business model.

<table>
<tr><td rowspan="2">7 - Key partners
Construction and technical partners</td><td>5 - Key activities
Project preparation, development and management</td><td rowspan="2">1 - Value proposition
Guarantees energy savings; Stable cash-flows</td><td>4 - Customer relationships
Contractual</td><td rowspan="2">2 - Customer segments
Corporate clients willing to invest in EE</td></tr>
<tr><td>6 - Key resources
Technical know-how</td><td>3 - Channels
Corporate projects;
Special events</td></tr>
<tr><td colspan="3">9 - Cost structure
Construction cost</td><td colspan="2">8 - Revenue streams
Energy savings from the project</td></tr>
</table>

Table 8: Guaranteed-savings EPC business model.

5.1.1.3 *Variable contract term EPC*

With a variable contract term EPC the ESCO designs, finances and implements the project. If the savings obtained are less than expected the contract term can be extended to allow the ESCO recover its full investment. In the First Out variation of this business model, the ESCO takes all the savings until it has received its full payment (SEAI, 2012). Table 9 summarizes the variable contract term EPC business model.

<table>
<tr><td rowspan="2">7 - Key partners
Financial Institutions; Construction and technical partners</td><td>5 - Key activities
Project preparation, development and management</td><td rowspan="2">1 - Value proposition
Energy savings without prior investment or commitment; Savings from the first moment</td><td>4 - Customer relationships
Contractual (term depends on ESCO recovering its full investment)</td><td rowspan="2">2 - Customer segments
Corporate clients</td></tr>
<tr><td>6 - Key resources
Technical and financial know-how</td><td>3 - Channels
Corporate projects;
Special events</td></tr>
<tr><td colspan="3">9 - Cost structure
Construction cost; Interest rates</td><td colspan="2">8 - Revenue streams
Energy savings from the project</td></tr>
</table>

Table 9: Variable contract term EPC business model.

5.1.2 Energy supply contract (ESC)

An energy supply contract (ESC), is a contract in which the ESCO assumes responsibility to provide the customer with a set of energy services (e.g. HVAC, lighting, etc.), at a certain level of service. The ESCO takes over operation and maintenance of the equipment and sells the output (useful energy) to the costumer. Costs for all equipment upgrades, renewal and repairs are borne by the ESCO, but ownership typically remains with the costumer (SEAI, 2012).

Typical examples are photovoltaics (PV), combined heat and power (CHP) or biomass heat supply installations. For example, in the case of heating, this

includes planning and installation of equipment, energy distribution, operation and maintenance of the production facilities, procurement of fuel, etc.

The ESC focus is on the efficiency of energy supply aiming to lower the cost of operation and maximize ESCO earnings, and at the same time provide security of supply. This way, supply-side EE is improved because the "useful energy" is guaranteed to the customer. The biggest weakness of ESC is that all the EE measures stay on the supply side and there are no incentives to lower the demand side consumption.

ESC is generally oriented towards decentralized (local) power supply rather than larger centralized solutions. However, the ESC model can be used to build up district heating systems as well (Warget, 2011).

Energy savings are typically around 10-20%. Usually, energy services achieve economic and environmental benefits because renewable energy solutions are considered in the contracting approach.

The main difference between EPC and ESC is that EPC goes beyond ESC. Whereas ESC is based on a business model that guarantees energy supply; EPC is a business model focused on energy savings. The goal is to avoid wasting energy and to invest the savings in EE (EU-ESCO, 2010). Table 10 summarizes the energy supply contract business model.

7 - Key partners Financial Institutions; Construction and technical partners	**5 - Key activities** Project development, management and operation	**1 - Value proposition** Guarantees energy supply ("input"); "Useful energy" service; Improvement of EE of supply;	**4 - Customer relationships** Contractual: typically 10-15 years	**2 - Customer segments** Buildings with energy saving potential: Public bodies; Corporate clients (building owners, commercial and industrial)
	6 - Key resources Technical and financial know-how and marketing		**3 - Channels** Funded projects; Special events	
9 - Cost structure Maintenance/management cost; Construction cost (supply side)		**8 - Revenue streams** Fee for the function provided (flat/escalating rate)		

Table 10: Energy supply contract business model.

5.1.3 Chauffage

A *chauffage*, also referred to as comfort contracting, is a contract form that is developed to provide a "function" (for example: keeping a room at 21 ºC) and incorporates EE on both the supply side and the demand side (Warget, 2011). However, demand-side EE measures are often "light" when compared with and EPC (*chauffage* does not include comprehensive retrofitting measures or equipment substitution) and are essentially focused on management and optimization of the building's operational conditions. A common example is the

ESCO implementing energy management system at the customer facility and monitoring/managing its operating conditions (functions that were contracted).

This arrangement is an extreme form of energy management outsourcing. Firstly, the current cost baseline will be accessed, analysing how much is the customer paying to provide the function. The ESCO will then deduct an amount from what the customer is paying prior to the contract and offer the customer a flat or escalating rate lower than his current costs.

As in an ESC, the ESCO will be responsible for everything needed to provide the function. This can include setting up heat boilers/coolers, procurement of fuel, operation, service and maintenance of production facilities as well as customer side technical installations. To lower the cost of operation and maximize their earnings the ESCO will optimize and implement supply-side EE measures.

Compared to EPC, *chauffage* contracts are generally less complex with lower transaction costs and without the same need for costly measurement and verification. On the other hand, EPC contracts may have more comprehensive demand-side EE measures reaching a wider range of areas and may be better suited for larger building. Table 11 summarizes the *chauffage* business model.

<table>
<tr><td rowspan="2">7 - Key partners
Financial Institutions;
Construction and technical partners</td><td>5 - Key activities
Project development, management and operation</td><td rowspan="2">1 - Value proposition
Guarantees a function ("output");
Improvement of EE of supply;
Management & optimization of energy consumption</td><td>4 - Customer relationships
Contractual (variable lengths)</td><td rowspan="2">2 - Customer segments
Buildings with energy saving potential:
public bodies;
corporate clients (building owners, commercial and industrial)</td></tr>
<tr><td>6 - Key resources
Technical and financial know-how and marketing</td><td>3 - Channels
Funded projects;
Special events</td></tr>
<tr><td colspan="2">9 - Cost structure
Maintenance/management cost;
Implementation/construction cost (small)</td><td colspan="3">8 - Revenue streams
Fee for the function provided (flat/escalating rate)</td></tr>
</table>

Table 11: *Chauffage* business model.

5.1.4 Integrated energy contract (IEC)

An Integrated Energy Contract (IEC) is a combination of an ESC, for example involving a CHP to supply heat and power, and an EPC, for example involving lighting upgrades (SEAI, 2012). Table 12 summarizes the integrated energy contract business model.

7 - Key partners	5 - Key activities	1 - Value proposition	4 - Customer relationships	2 - Customer segments
Financial Institutions; Construction and technical partners	Project preparation, development and operation **6 - Key resources** Technical and financial know-how	Energy savings without prior investment or commitment; Savings from the first moment; Guarantees energy supply ("input"); "Useful energy" service; Improvement of EE of both supply and demand	Contractual (medium to long term) **3 - Channels** Public projects; Special events	Buildings with energy saving potential that need large retrofits: Public bodies; Corporate clients (building owners, commercial and industrial)
9 - Cost structure Construction cost; Interest rates			**8 - Revenue streams** Energy savings from the project	

Table 12: Integrated energy contract business model.

This model extends the ESC model by including demand-side EE measures. Two objectives are combined: reduction of energy demand through the implementation of demand-side EE measures in the building (e.g. HVAC, lighting), and efficient supply of the useful energy demand, preferably from renewable energy sources (DAREED, 2014).

As compared to ESC, the range of services and thus the saving potential are extended. Results to be achieved by the EE service now include also modernization of the installations, lower consumption and maintenance costs and improvement of the energy indicators (DAREED, 2014).

The IEC model prioritizes making demand-side EE measures before moving on to supply side measures and tries to solve some of the problems with EPC and ESC; EPC being overly complex and expensive for many projects and ESC being completely supply side oriented (Warget, 2011).

5.1.5 Build-Own-Operate-Transfer (BOOT)

In the Build-Own-Operate-Transfer (BOOT) business model the ESCO elaborates the project, builds/deploys, operates with the owner and in the end of the contract transfers the installation/system to the customer. As ESC, this type of contract is typical in projects aimed at producing systems, such as CHP or PV.

Customers enter into long term supply contracts with the BOOT operator and are charged accordingly for the service delivered; the service charge includes capital and operating cost recovery and project profit (EC-JRC, 2016). This way, the ESCO investment and operational costs are covered by subscription fees. Due to

the long-term nature of the arrangement, the fees are usually raised during the contract period. The BOOT model is similar to a loan made by the ESCO to the costumer, which also includes energy management during the contract period. Table 13 summarizes the BOOT business model.

<table>
<tr><td rowspan="2">7 - Key partners
Financial Institutions; Construction and technical partners</td><td>5 - Key activities
Project preparation, development and operation</td><td rowspan="2">1 - Value proposition
Energy savings without prior investment or commitment; Guarantees energy supply (“input”); "Useful energy" service;</td><td>4 - Customer relationships
Contractual (long-term, 20-25 years)</td><td rowspan="2">2 - Customer segments
Corporate clients; Public bodies</td></tr>
<tr><td>6 - Key resources
Technical and financial know-how</td><td>3 - Channels
Public projects; Special events</td></tr>
<tr><td colspan="2">9 - Cost structure
Construction cost; Interest rates</td><td colspan="3">8 - Revenue streams
Fee for the function provided (flat/escalating rate)</td></tr>
</table>

Table 13: Built-Own-Operate-Transfer business model.

5.1.7 Summary of ESCO existing business models

This section presents a summary comparison between the seven ESCO business models previously described, highlighting the main strengths and weaknesses of each one of them (Table 14).

Business model	Strengths	Weaknesses
EPC with shared savings	Shared savings model (win-win situation for both the ESCO and the customer).	The ESCO finances the total investment of the project and it is totally responsible for repaying the loan.
EPC with guaranteed savings	It is functional/ performance risk; Extra-savings can be taken by ESCO as a bonus.	The customer finances the total investment of the project. The ESCO assumes the risk of the project's performance and if the agreed target cost savings are not achieved, then the ESCO compensates the customer.
Variable contract term EPC	If the savings obtained are less than expected the contract term can be extended to allow the ESCO recover its full investment	The ESCO finances the total investment of the project and it is totally responsible for repaying the loan.
Energy supply contract (ESC)	ESCO receives a fee for the service; the reduction of the energy production cost will mean greater profit margin. The key benefit for the customer is the cost efficiency of the solution, the standard quality of the service and the "no need to worry about" the installation and maintenance of the energy production facilities.	The ESCO manages the cost and risk of delivering the contracted service.
Chauffage	Compared to EPC, *chauffage* contracts are generally less complex with lower transaction costs and without the same need for costly measurement and verification.	The ESCO finances the total investment of the project (however, lower than in an EPC) and it is responsible for maintenance costs.
Integrated energy contract	Extends the ESC model by including demand-side EE measures. Combines two objectives: reduction of energy demand through the implementation of demand-side EE measures in the building and efficient supply of the useful energy demand, preferably from renewable energy sources.	The ESCO finances the total investment of the project and it is totally responsible for repaying the loan.
Built-Own-Operate-Transfer (BOOT)	Customers are charged accordingly for the service delivered by the ESCO. For the ESCO the service charge includes capital and operating cost recovery and project profit.	The ESCO finances the total investment of the project and it is totally responsible for repaying the loan. The ESCO is also responsible for the energy management and for operational costs.

Table 14: Main strengths and weaknesses of current business models for ESCOs.

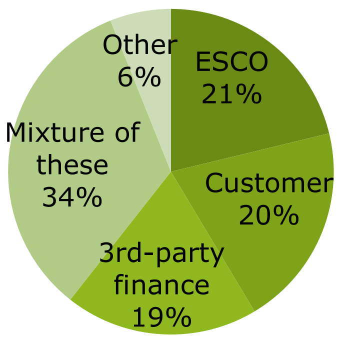
5.2 ESCO market situation

This section reviews the current ESCO market status in the European Union putting special attention in the countries that are going to be involved in the Living Labs and where there are pilot sites, namely Portugal, UK and Serbia.

5.2.1 European Union

ESCO Market in the EU
Regulatory factors/Legislation
The European Commission has long been supporting the ESCO industry through legislation and programmes. These efforts have been increased in recent years, in particular through directives, standards (as EN 15900:2010), campaigns, funding schemes, market researches, databases (as Transparense[1]) and several projects. The main legislation related with the ESCO industry and reduction of energy consumption in buildings are the Energy Efficiency Directive (EED) 2012/27/EU and the Energy Performance of Buildings Directive 2010/31/EU (EPBD). In summary the EPBD defines the following (EC, 2016): • *"energy performance certificates are to be included in all advertisements for the sale or rental of buildings;* • *EU countries must establish inspection schemes for heating and air conditioning systems or put in place measures with equivalent effect;* • *all new buildings must be nearly zero energy buildings by 31 December 2020 (public buildings by 31 December 2018);* • *EU countries must set minimum energy performance requirements for new buildings, for the major renovation of buildings and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls, etc.);* • *EU countries have to draw up lists of national financial measures to improve the energy efficiency of buildings".* The EED establishes a set of binding measures to help the EU reach its 20% EE target by 2020 and requires that all EU countries use energy more efficiently at all stages of the energy chain. Regarding buildings, the following aspects stand out (EC, 2016): • *"EU countries make energy efficient renovations to at least 3% of buildings owned and occupied by central government;* • *EU governments should only purchase buildings which are highly energy efficient;* • *EU countries must draw-up long-term national building renovation strategies which can be included in their National Energy Efficiency Action Plans".*

[1] http://www.transparense.eu/eu/epc-databases/data-collection

Financing sources
There are several funding schemes for ESCO projects offered by the European Commission. The multi-annual Financial Framework is an important source for funding EPC policies and measures. Aligned with EU 2020 strategy "Smart, Sustainable and Inclusive Growth", the present framework (2014-2020) has been designed to serve as the support of a shift to a competitive low carbon economy (EC-JRC, 2014). Horizon 2020 funds support the research, demonstration and market up-take of energy efficient technologies. Funds are available to support energy efficient buildings, industry, heating and cooling, SMEs and energy-related products and services, as well as for improving the attractiveness of EE investments. Under the Intelligent Energy Europe, the European Commission has set up a series of facilities funding Project Development Assistance (PDA) to support public authorities (regions, cities, municipalities or groupings of those) and public bodies in developing bankable sustainable energy projects. These PDA facilities aim to bridge the gap between sustainable energy plans and real investment through supporting all activities necessary to prepare and mobilise investment into sustainable energy projects. These activities can include feasibility studies, stakeholder and community mobilisation, financial engineering, business plans, technical specifications and procurement procedures. The European Energy Efficiency Fund (EEEF), an innovative public-private partnership (PPP), is a toll for financing EE, small-scale renewable energy, and clean urban transport projects (at market rates) targeting municipal, local and regional authorities and public and private entities acting on behalf of those authorities. Other tools available are JESSICA funds and PPPs for the delivery of EE projects, the European Investment Bank, Private Financing for EE instrument (PF4EE) and European Structural & Investment Funds (ESIF). Transparense (2015) reveals that the financing sources used in the EU are mainly a mix of investments made by the ESCO, the customer and 3rd-party entities or, on a smaller scale, an investment done by one of these three entities alone (Figure 4).    **Figure 4: Financing sources for ESCO projects in the EU.**

adapted from Transparense (2015)

A successful EE finance structure incentivizes each of the main stakeholders involved, and balances the relative risks of implementing EE projects (WSGR, 2012). The main issues that need to be addresses are presented in Figure 5.

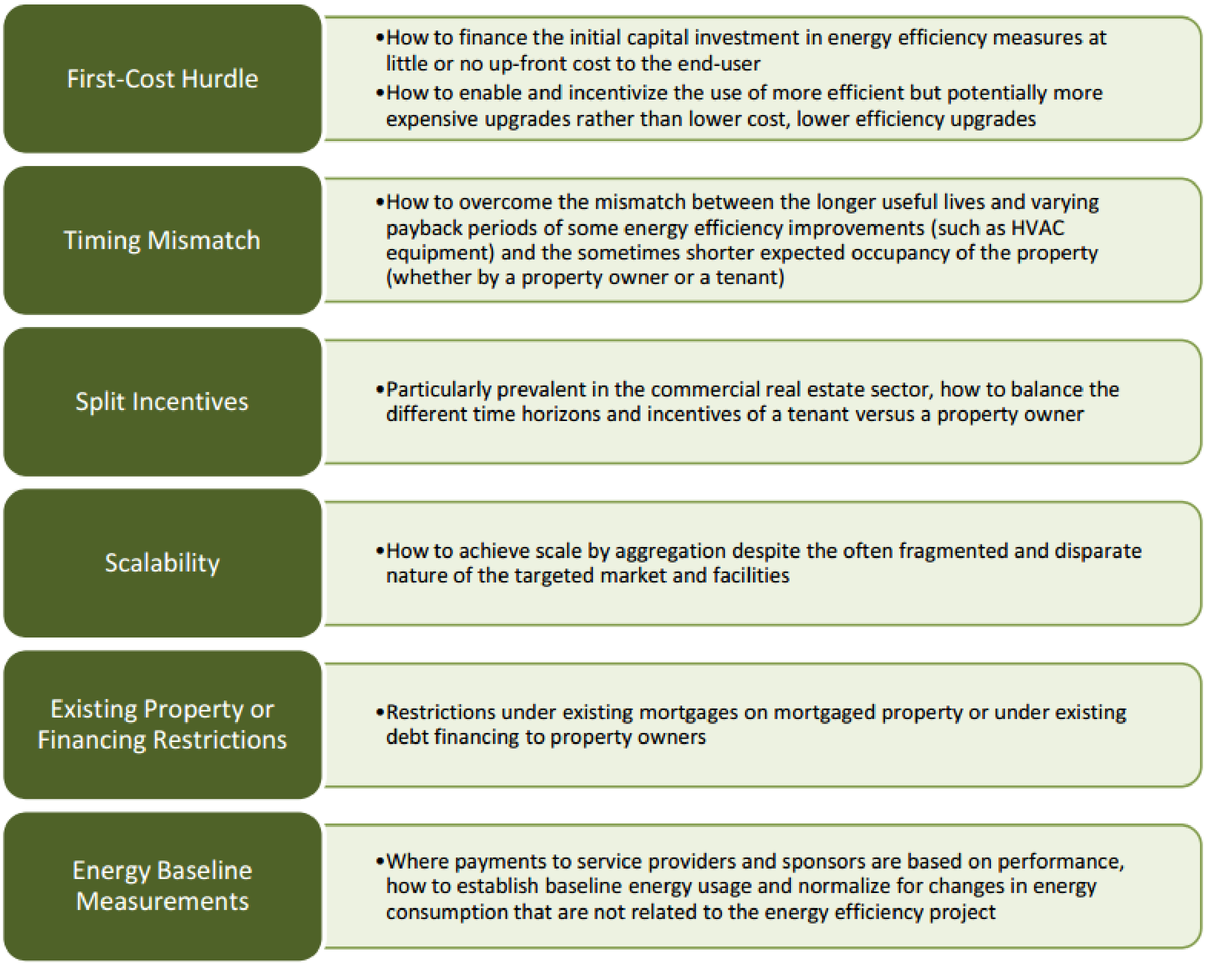


Figure 5: Main issues of a successful EE finance structure (WSGR, 2012).

Property Assessed Clean Energy (PACE) programmes are a financing model that enables local governments to raise money to fund clean energy projects in households or commercial buildings, who choose to participate in the program. The customers pay for the projects during a pre-agreed period through a special tax or assessment on the property tax bill of property owners. Financing is secured with a lien on the property, and then if the property is sold before the end of the repayment period, the new owner inherits both the repayment obligation and financed improvements. This model has been largely used in the US but has not yet been experienced in Europe (Almeida, 2015).

Barriers

The main barriers encountered in the EU are the lack of information on the complexity of the ESCO concept, leading to lack of trust in the ESCO industry, the subsidy/policy uncertainty and also the lack of support from government and regulation. Other barriers identified are the customer demand, the raising affordable finance, the complex accounting and book-keeping rules, the financial crisis and finally the split incentives between landlords and tenants (Transparense, 2015). Figure 6 shows the barriers encountered in the EU and their relative importance.

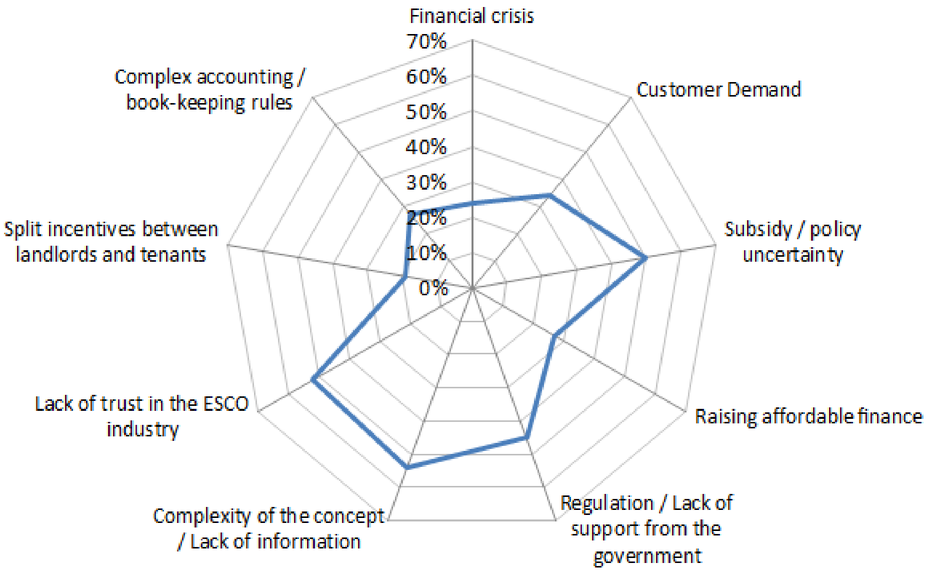


Figure 6: Barriers to ESCO projects in the EU.
adapted from Transparense (2015)

Drivers
Pressure to cost reduction is highlighted as the main driver of ESCO projects in the EU. Other factors are the increase of energy prices, the customer demand, governmental policies, availability of financing and public subsidies and the financial crisis (Transparense, 2015). Figure 7 summarizes the drivers of ESCO projects in the EU and their relative importance.

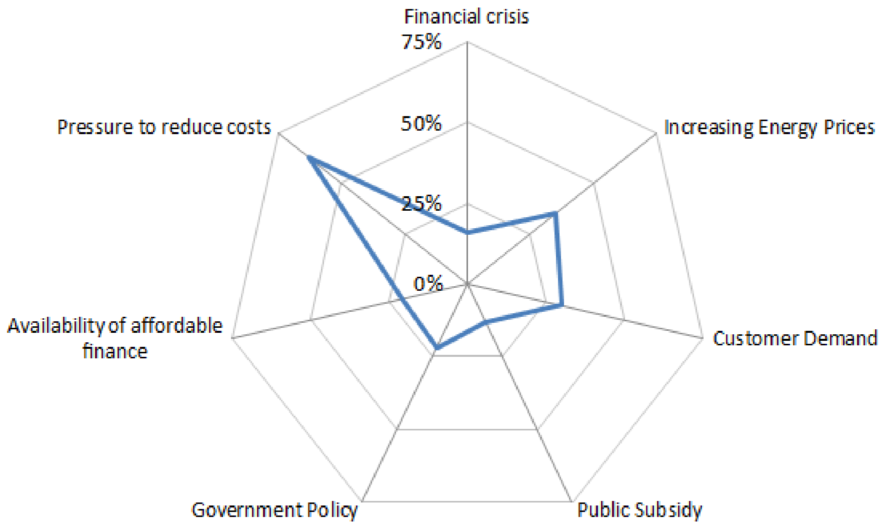


Figure 7: Drivers of ESCO projects in the EU.
adapted from Transparense (2015)

The Investor Confidence Project[2] (ICP) Europe is a good example of an action to fight the current barriers of the ESCO market, being an innovative and actionable intervention to access financing for the building renovation market by standardizing how EE projects are developed and measure. ICP was developed in the USA by the Environmental Defense Fund and produced, among other open-source tools and energy performance protocols for the development of EE projects in buildings.

Another good example of bridging the gap between ESCOs and investors in Europe is the Sustainable Energy Asset Framework (SEAF)[3], aiming to make DR, EE and distributed renewable generation accessible to small and medium-sized enterprises through the development of a software platform that will be designed to function in ten European member states. By the end of the project (2018) it is expected a substantial investment in projects, unlocked through the platform.

Table 15: ESCO market in the EU.

[2] http://europe.eeperformance.org/
[3] https://www.seaf-h2020.eu/

5.2.2 Portugal

ESCO Market in Portugal
Market size/Market potential
The Portuguese ESCO market can be considered an intermediate market (Transparense-PT, 2013). The market was relatively small and operated with 10-12 companies until 2009 (EC-JRC, 2014) including private ESCOs with financial capacity, private small ESCOs, public and public-private joint ventures, and large energy companies, namely Galp Energia, EDP, Endesa and Union Fenosa (Transparense-PT, 2013). After 2009, the ESCO market had a steady, though slow increase during the preceding years, in spite of the struggle of the real estate and the industrial sectors, aggravated by the financial crisis. EC-JRC (2014) estimated that in 2014 the private sector had around 50 M€ in actual contracts - mainly in industry. Regarding the public sector, they identified a great potential – at least €100M if the current program ECO.AP can succeed and really lift off. The study revealed a market potential around 100-200 M€ reflecting the EE projects that have a payback time of maximum 10 years. Currently, there are around 50 ESCOs registered in the official Directorate General of Energy and Geology database (DGEG, 2016).
Types of projects
The key ESCO clients are from the industrial segment and this sector is still the most interesting for ESCOs, as it offers the higher energy savings potentials resulting in better rates of return. Also the public sector has become more interesting for ESCOs because of ECO.AP programme (IEA, 2016a), however EC-JRC (2014) states that *"some experts indicated that prescribed, strict conditions in the contracts may reduce ESCOs potential profits and thus interest in these projects".* Other important client for ESCOs is the services buildings sector. The main technologies offered by ESCOs have been the installation and operation of renewable energy supply solutions, which is now moving towards more integrated projects (including both supply and demand sided technologies; and raising awareness for behavioural changes) (EC-JRC, 2014).
Regulatory factors/Legislation
Portugal advanced significantly regarding the establishment of programmes and legislation to improve EE in buildings between 2011 and 2015. In 2011 the ECO.AP (Programme for EE in Public Buildings) was launched aiming to reduce energy consumption in the Public Sector by 30% (ECO.AP, 2011). A large number of ESCO companies or ESCO-type companies offering ESCO services registered in order to be able to participate in ECO.AP. However, the programme could not be started yet, because the market does not have these financing capacities. It was proposed that paying guarantees should be issued by the Portuguese State in order to secure the investments, but decision has not been taken. In 2013, the Decree-Law 118/2013 was launched, with the aim to ensure and promote the improvement of buildings' energy performance through the Building Energy Certification System (SCE), which integrates the Regulation of Energy

Performance of Residential Buildings and the Regulation of Energy Performance of Commercial and Services Buildings. This Decree-Law replaced the previous 2006 Decree-Law package (78, 79 and 80/2006). SCE promotes the ESCO and Facility Management market because it requires that buildings have: limited heating and cooling needs; thermal quality of the envelope; limited solar factors for the glazed areas (minimising the overheating of spaces); limited primary energy need; maintenance plan; etc. Which are services that an ESCO or a Facility Managers can offer to customers (SCE, 2013). Additionally, Decree-Law 118/2013 gives the first step towards Near Zero Energy Buildings (NZEB), implying that new public buildings should be NZEB from 2018 onwards and all the new buildings from 2020 onwards. In 2015, Decree-Law 68-A/2015 was launched, transposing Directive 2012/27/EU to the Portuguese jurisdiction. This legal document specifies the set of obligations and mechanisms that the government and companies (which are not small and medium enterprises (SMEs)) will have to put in place for the achievement of the stated objectives of efficiency and energy savings. According to this law, companies that are not SMEs have to perform "independent and profitable" audits to their facilities and, in some cases, their assets such as car fleets. Audits will be profitable when EE measures identified have a higher benefit to cost (i) of its implementation and (ii) the completion of the audit itself. After the completion of a first audit, companies must conduct new audits at least every four years and in some cases every eight years. Before this Decree-law, the Portuguese legal framework already had legislation which involved carrying out energy audits, but only for very specific situations. The Lisbon municipality is implementing the first EPC in the public sector under this mechanism. This EPC will replace 20.000 incandescent lamps from the traffic lighting system by LEDs, resulting in energy savings of approximately 94% (IEA, 2016a).
Market factors (economical context)
The Portuguese economy faced considerable difficulties over the last years, but it is slowly starting to recover. Although, the key ESCO clients are from the industrial segment and this sector is still the most interesting for ESCOs, the Portuguese building pool is mainly constituted by old buildings, particularly in the residential sector, that usually need large interventions to improve their envelope's thermal performance. Regarding the public sector, it is necessary to develop the financial mechanisms that will allow to truly launch ECO.AP.
Awareness
The ESCO Portuguese market needs to be better explained and disseminated, as shown in Figure 9 the lack of understanding of the ESCO concept's complexity (by customers and also by financing entities) is considered the main barrier for the development of the Portuguese ESCO market. Hence, it is necessary that *"Facilitators (Ministries, Universities, the National Energy Agency, ADENE, ESCO associations) and interested companies regularly promote the ESCO solution amongst potential clients and decision makers via conferences, trainings and written material"* (EC-JRC, 2014). However, the trust in the market has been slowly increasing, for example through the recognition of ESCOs by the Directorate General of Energy and Geology,

contributing to the creation of financial mechanisms offered by private banks, specific for ESCO and renewable energies (RE) projects.

Financing sources

There are funding mechanisms available in Portugal. The EE Fund (EEF) is a financial instrument for funding programmes and measures identified in the the National EE Action Plan (NEEAP), encouraging EE for citizens and businesses by supporting EE projects and promoting behavioural change. The EEF also supports projects with EE potential not covered by the NEEAP. Other funding mechanisms are the Innovation Support Fund that offers financial incentives to pilot projects related to EPC in private buildings and the Consumption Efficiency Promotion Plan which is a mechanism to promote EE measures (IEA, 2016a).

Portuguese ESCOs are traditionally small, having difficulty in financing projects with their own equity. On the other side, the client (particularly the public sector and the most part of commercial and industry) also do not have the financial means to support the project.
Therefore, as concluded by Transparense (2015), in Portugal financing has to be secured by financing entities (banks) or funding mechanisms (3rd-party entities) or by a mix of investments made by the ESCO, the customer and financing 3rd-party entities (Figure 8). The customer alone solely finances 7% of the ESCO projects.

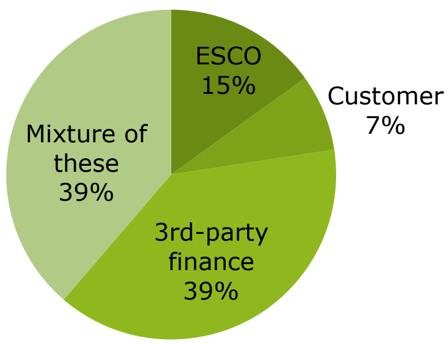


Figure 8: Financing sources for ESCO projects in Portugal.
adapted from Transparense (2015)

Barriers

Transparense (2015) found that the main barrier encountered in Portugal is the lack of information on the complexity of the ESCO concept, which leads to lack of trust in the ESCO industry by the clients and also by financing entities. Additionally, the economic crisis that the country is passing aggravates affordable financing of the ESCO projects and there is lack of support from the government/regulation guiding to uncertainty in subsidies and policies. Figure 9 shows the barriers encountered in Portugal and their relative importance.

IEA (2016a) states that the ESCO market has *"evolved as a result of public programmes and legislative changes but the lack of appropriate financial resources and access to capital is probably the most significant barrier to its expansion"*, which may also be justified by the lack of information and understanding on the ESCO concept.

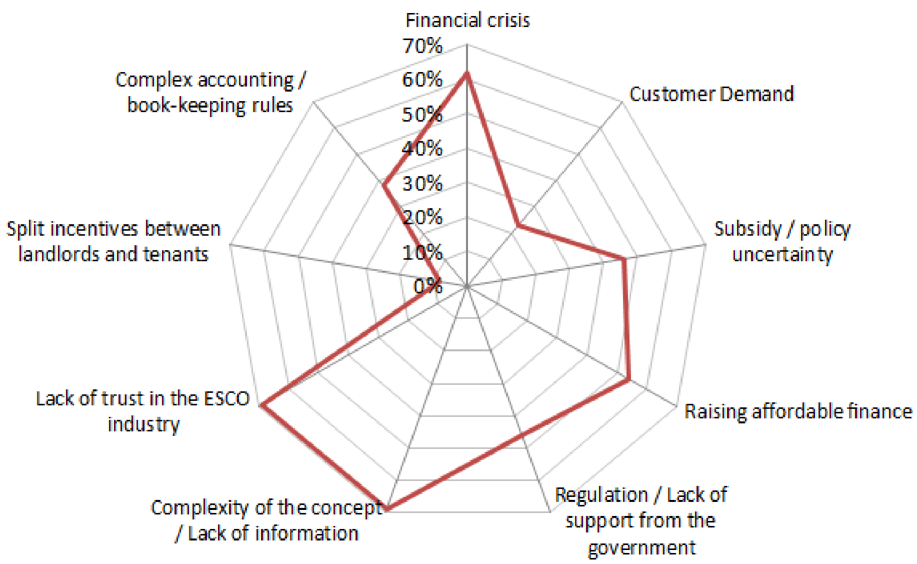


Figure 9: Barriers to ESCO projects in Portugal.
adapted from Transparense (2015)

<table>
<tr><th>Drivers</th></tr>
<tr><td>The driver of ESCO projects that markedly stands out in Portugal is the increase of energy prices. Other drivers are the pressure to reduce costs and the economic crises (Transparense, 2015). Figure 10 presents the drivers of ESCO projects in Portugal and their relative importance.

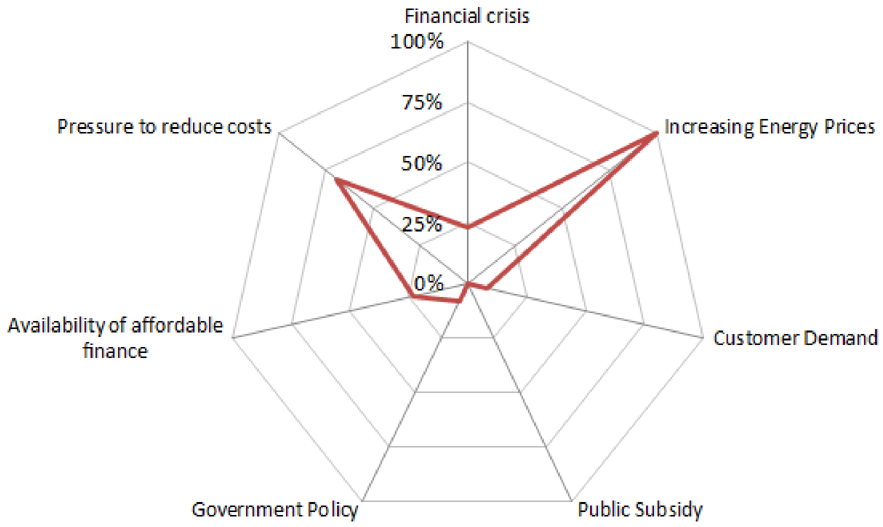


Figure 10: Drivers of ESCO projects in Portugal.
adapted from Transparense (2015)

EC-JRC (2014) indicated the following key drivers for the ESCO market development in Portugal: National legislation and accreditation system; ECO.AP programme; Interest by new players; Ensure financing mechanisms; Increase trust in the ESCO market and EU legislation resulting in national support for EE.</td></tr>
<tr><th>Needs/Recommendations</th></tr>
<tr><td>IEA (2016a) points out the following recommendations regarding EE in buildings for the Portuguese government:
"Implement in full, without delay, the Energy Efficiency Directive and develop an action plan for the period 2017 to 2020 to ensure the achievement of an overall national 25% energy efficiency target and a 30% target for public administration."
"Prepare a coherent monitoring and verification plan of the resources used and energy savings with clear responsibilities and task-sharing for data collection as well as co-ordination to finalise NEEAP reporting."
"Establish, at reasonable cost, a financing framework for energy efficiency investments in SMEs and boost diverse markets for energy efficiency services.
"Develop additional requirements towards near-zero-energy buildings."
"Channel EU structural funds or other suitable financing sources to fund initiatives supporting energy-use improvements and innovation for buildings."</td></tr>
</table>

Table 16: ESCO market in Portugal.

5.2.3 United Kingdom

ESCO Market in United Kingdom
Market size/Market potential
The UK has a well-developed ESCO market, that can be considered and advanced market (Transparense, 2013), as EPC business model has been used for decades, even though it was previously designated by Contract Energy Management (CEM). There are around 30-50 ESCOs operating in the UK, reflecting a considerable increase from 2009. This growth was motivated by an increasing demand for energy awareness and thus energy services and also by the pressure to reduce costs (EC-JRC, 2014). The ESCO market potential is estimated in €1 billion for the non-domestic sector (Transparense-UK, 2014). Large international manufacturers of building automation & control systems are the major players in this market, as well as energy service and supply companies and facility management companies. Also, there is a growing number of construction companies, small consultancies and dedicated ESCO firms. Even municipalities have entered the energy services market in recent years (EC-JRC, 2014).
Types of projects
CEM/EPC dominate the energy service contracting market and BOOT contracts also work well in the UK (EC-JRC, 2014). As shown in Figure 11 the building types at which EPCs were being carried out in UK are mainly from the public sector and there are also projects in hospitals, sports, university, schools and offices (Transparense-UK, 2013). The interventions mainly focus on HVAC, public lighting, energy conversion and supply technologies, and also indoor lighting that has attracted much attention with the spread of LED technologies (EC-JRC, 2014).

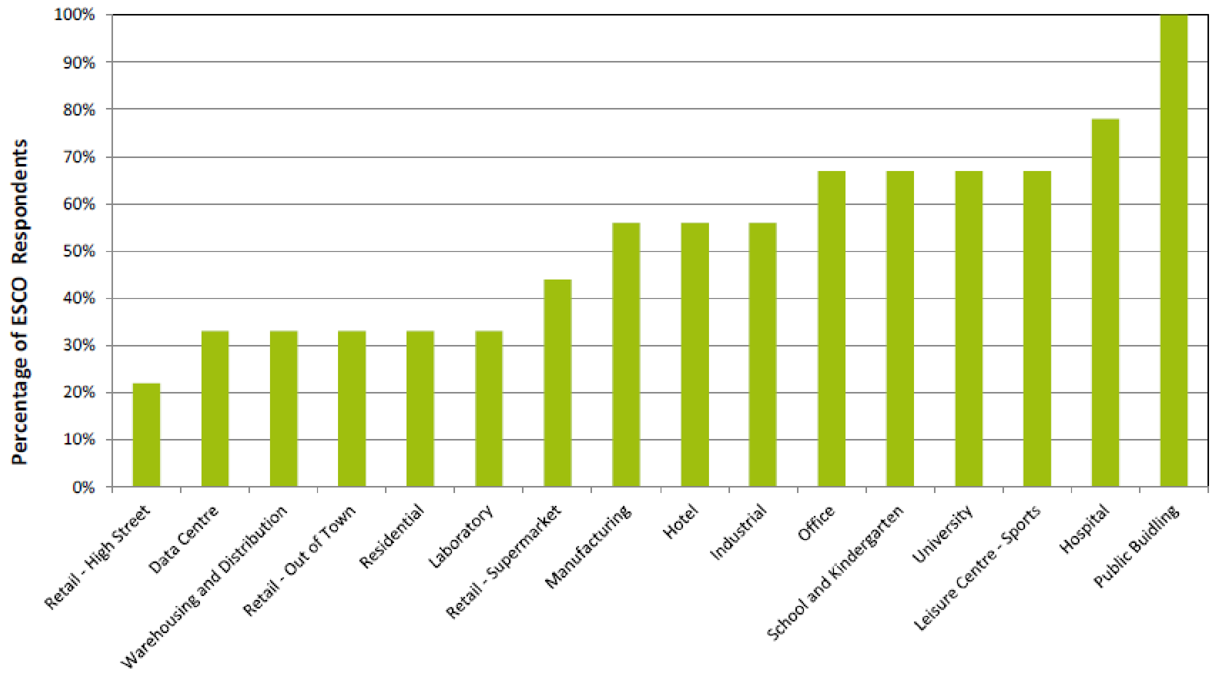


Figure 11: Distribution of EPCs by building type (Transparense-UK, 2013).

Regulatory factors/Legislation
In the UK there is no specific regulation on ESCOs and EPC, which allows market influenced, tailored and fluid contracts. Programmes like RE:FIT[4] contribute to significantly improve the prospects of EPC trough *"introducing and testing standardized energy savings contracts for bundled municipal and private buildings"*. By contrast, the UK has strong policy systems for climate and energy conservation and stringent targets. So, new ESCOs particularly in utilities consider beneficial to enter in the energy savings and renewable energy fields (EC-JRC, 2014). An example is the Energy Companies Obligation (ECO), introduced in January 2013, with the aim to reduce energy consumption in UK and support people living in fuel poverty. ECO will run until 2017, supporting EE projects in low-income households and in properties that are harder to treat. This obligation requires that larger energy suppliers deliver EE measures to domestic energy users (IEA, 2016b).
Market factors (economical context)
Industrial and municipal projects are largely motivated to reduce costs. Other customers use the ESCO model to participate in energy generation (EC-JRC, 2014).
Awareness
There is lack of information on ESCO projects and difficulty in understanding the concept, as shown in Figure 13. The lack of information and trust is most critical in the case of financial institutions. In order to fight this weakness, a number of associations are active in developing trainings, guidelines and helpdesks. Also, there are several public demonstration projects combined with extensive experience sharing and information dissemination (EC-JRC, 2014).
Financing sources
In the UK, EE investments are originated form: banks (mostly Royal Bank of Scotland and Co-Op), private investors and specialist funds (Transparense-UK, 2013). The UK government created a public bank to finance projects of EE and RE and mobilise other private sector capital into the UK's green economy. The Green Investment Bank[5] has backed 74 green infrastructure projects committing £3 billion to the UK's green economy. It has been suggested by experts that this source could be an important kick for the ESCOs (EC-JRC, 2014). The Green Deal provides a framework that supports people own equity EE improvements in buildings by allowing them to pay the investment through their energy bills rather than upfront. Before signing a Green Deal Plan, an assessor will recommend improvements that are appropriate for a property and indicate their feasibility (IEA, 2016b). An innovative brokerage system has been put in place to extend the availability of ECO funding beyond the energy companies themselves (IEA, 2016b).

[4] https://www.london.gov.uk/what-we-do/environment/energy/energy-buildings/refit
[5] http://www.greeninvestmentbank.com/

Transparense (2015) has concluded that the financing sources used in UK are a 1/3 done by a 3rd-party entity, a 1/3 by a mix of investments made by the ESCO, the customer and 3rd-party entities and the other 1/3 is equality distributed between the ESCO and the customer (Figure 12).

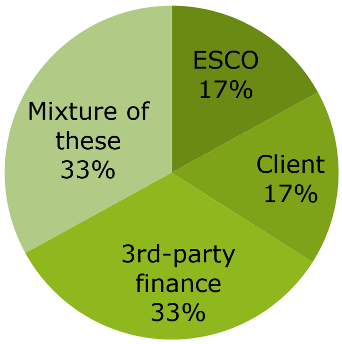


Figure 12: Financing sources for ESCO projects in UK.
adapted from Transparense (2015)

Barriers

Despite the ESCO market is mature, it is not widespread in the UK and the main barrier encountered is the **lack of information on the complexity of the ESCO concept**, followed by the complexity in accounting and book-keeping rules. There are also barriers caused by lack of trust in the ESCO industry, split incentives between landlords and tenants and uncertainty in subsidies/policies (Transparense, 2015). Figure 13 shows the barriers encountered in UK and their relative importance.

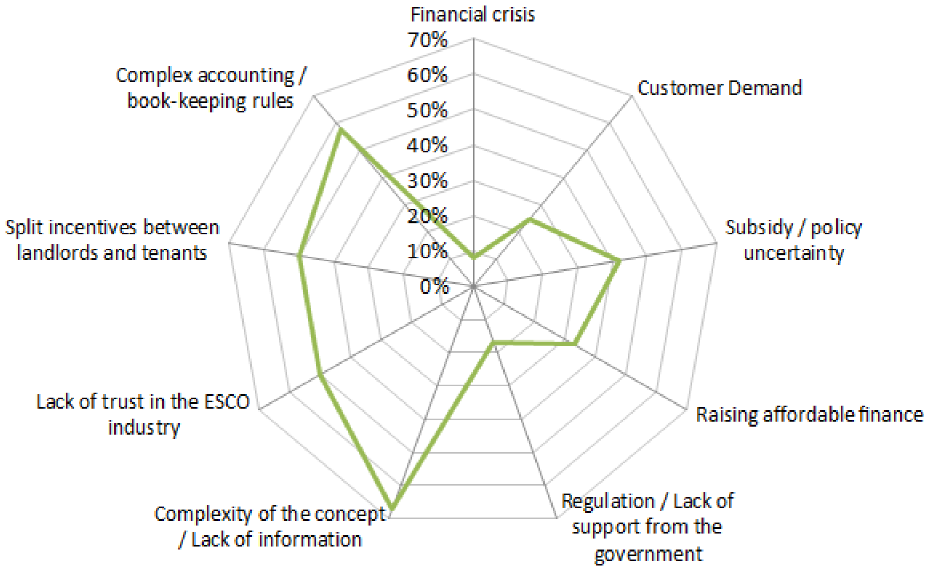


Figure 13: Barriers to ESCO projects in UK.
adapted from Transparense (2015)

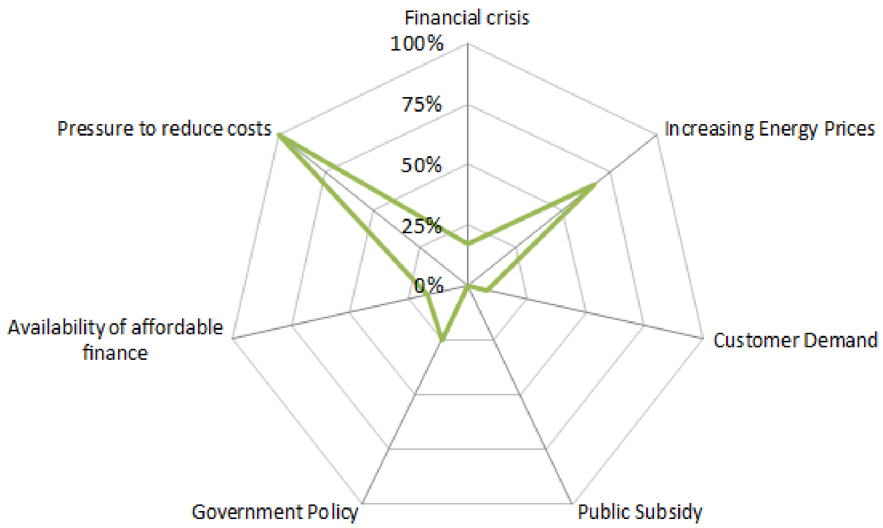
Drivers
The driver that markedly stands out in UK is the **pressure to reduce costs**. Other drivers are the increase of energy prices and the governmental policies (Transparense, 2015). Figure 14 presents the drivers of ESCO projects in United Kingdom and their relative importance.  **Figure 14: Drivers of ESCO projects in UK.** ***adapted from Transparense (2015)***

Table 17: ESCO market in UK.

5.2.4 Serbia

ESCO Market in Serbia
Market size/Market potential
The ESCO market in Serbia is in its very earlier stage, currently Serbia is one of the countries in Central and Eastern Europe with lowest rates of EE (CMS, 2015). It is estimated there is a substantial potential for EE improvements and development of RE in Serbia, both in terms of volume and value, mainly due to neglected maintenance of industrial equipment and buildings (especially public ones) and a large stock of equipment beyond its economic and physical life (EBRD-2, 2014). The average energy saving potential is in the range from 25% in public buildings up to 50% in public lighting (EC-JRC, 2014). EC-JRC (2014) indicates there are only a few (2 or 3) firms that can provide ESCO services operating in Serbia and their main focus is in industry. Services provided include: design, engineering and consulting in project preparation, development and implementation of EE projects, installation and maintenance of EE, financial services and project funding.
Types of projects
A few EE projects have been carried out in industry based on ESCO models, primarily regarding the reconstruction of heat supply systems in production facilities, through replacement of boilers and installation of CHP. The business models used were mainly BOOT, and in a few cases EPC with shared savings (EC-JRC, 2014). Two models of ESCO agreements, one for public buildings and another one for public lighting are set in the *Rulebook on Model Energy Service Contracts for the Implementation of Energy Efficiency when Users are from Public Sector* (ESCO By-Law), allowing PPP to be established between ESCOs and the relevant public partner (e.g. State, municipality, public company). These two model agreements three contractual periods: preparatory period, implementation period and guarantee period (CMS, 2015).
Regulatory factors/Legislation
In recent years Serbia achieved considerable legislative reforms in several important economic sectors. Some of these reforms aim to accelerate the harmonization of the Serbian legal system with EU regulations preparing the full EU membership of the country (EBRD, 2014a). As a Contracting Party to the Energy Community Treaty, Serbia has started to implement the relevant EU directives in the fields of EE and RE. At the legal/regulatory level, the Law on Efficient Use of Energy (EE Law), which was adopted in March 2013, transposed core provisions of Directive 2010/31/EU into Serbian legislation. The EE Law establishes the basis for EE policy and has requirements on energy management system, labelling of energy-related products, energy performance in buildings, EE requirements in energy production, transmission and distribution, financial mechanisms for EE (as the EE Fund) and promotion of the ESCO market (EBRD, 2014a), (ECS, 2015).

The EE Law is the first coherent and wide-ranging legislation regulating EE in Serbia. Despite the EE Law was adopted in 2013, it has practically become applicable only in May 2015. The EE Law explicitly defines the ESCO and sets out the rules for EPC generally in line with the EU, aiming at providing the overall legal framework for EE arrangements (CMS, 2015).
In order to enable implementation of the possibilities introduced by the EE Law a rulebook, the *Rulebook on Model Energy Service Contracts for the Implementation of Energy Efficiency when Users are from Public Sector* (ESCO By-Law), was also adopted in May 2015 (CMS, 2015).
However, the implementation of certain provisions, as on inspection of heating and air conditioning systems, will be achieved only after the adoption of secondary legislation on the basis of the EE Law (ECS, 2015).

Market factors (economical context)

Regarding the economical context, Serbia experienced considerable difficulties over the last years, but it is slowly starting to recover (EBRD, 2014a).

In recent years, the efforts of the Serbian government to increase EE in public buildings has increased significantly, as shown by the recent legislation. It is well known that schools and hospitals in certain regions of the country need to be renovated, as they present poor energy performance status and overall conditions. The tools to resolve this problem are ESCOs and PPPs which can provide both technical and financial solutions (EC-JRC, 2014).

On the other hand, Serbia still enjoys lower tariffs for electricity for households than the EU countries, but the government is planning to introduce market priced energy tariffs for households, industry and services; and also to liberalize the market. This will cause increased prices for electricity, which can be strong driver for the developing the ESCO market, even in the residential sector (EC-JRC, 2014).

Awareness

The Serbian ESCO market, as market in its very earlier steps, suffers from low awareness and low trust as shown in Figure 16. There is a necessity to better explain the ESCO concept and disseminate it.

Financing sources

In accordance with the EE Law a revolving Fund for EE is planned to be established by the Serbian government, aiming to become a good source for supporting ESCO projects in the future. The Fund shall be based on an annual programme and investment projects shall be awarded through open public calls including criteria as an energy audit or feasibility study for EE (EC-JRC, 2014).

Specific products for the ESCO market have not yet been developed by commercial banks in Serbia, despite they are aware of its potential, they do not have enough information on implementing, operating and funding this type of projects. Commercial banks mediate credit lines from International Financial Institutions (e.g. European Bank for Reconstruction and Development (EBRD), European Investment Bank (EIB), the World Bank and Germany’s Public Investment Bank (KfW)) for EE projects that can be used for financing ESCO projects.

Other examples of financing facilities that support EE and RE projects in Serbia are the Green for Growth Fund (GGF), the Council of Europe Development Bank (CEB) and the United Nations Development Programme (UNDP). Figure 15 summarizes the regional initiatives and programmes offering financial and/or technical assistance to improve EE in the Western Balkans, having a total amount of financing available to over 700 M€ (ECS, 2015).

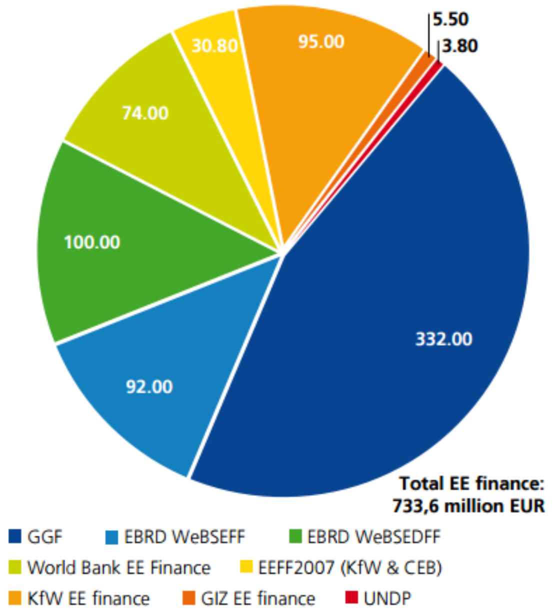


Figure 15: EE financing in the Western Balkans Q1 2015 – M€ (ECS, 2015).

The EBRD launched in 2013 a set of assignments to support the creation of a sustainable market for EE in the Western Balkans and support countries in achieving their objectives as specified in their National EE Action Plans. Under de Regional EE Programme for the Western Balkans, the following financial mechanisms are available: a credit line facility (WeBSEFF II[6]) for EE and RE accessible by both public and private sector borrowers, including ESCOs, and a direct financing facility (WeBSEDFF[7]) to provide financing to ESCO projects developed by SMEs regarding EE and RE improvements in the industry sector. These financing schemes are available through local banks in Serbia. An important feature is that in addition it is provided free support by financial and engineering experts to help the banks assess the potential cost benefits of projects. (EBRD, 2014b).

Barriers

EC-JRC (2014) points out the following barriers to ESCO projects in Serbia:

- Scarce capacity of the public sector to identify/prepare ESCO projects;
- Dubiety on the facilities' ownership;
- Lack of pilot projects carried out by ESCOs in the public sector;
- Lack of market based financial solutions (direct or through commercial banks). Commercial banks are conscious of the ESCO concept, but do not have specific financial offers;

[6] Western Balkans Sustainable Energy Financing Facility - http://www.webseff.com/
[7] Western Balkans Sustainable Energy Direct Financial Facility - http://www.websedff.com/

- Price of electricity, gas and heat are lower than market prices;
- Lack of trust and resistance towards ESCOs and other PPP concepts because of fear of corruption;
- Lack of experienced ESCO companies and project developers;
- EE is perceived solely as a technical issue and there is unawareness of its financial benefits;
- Lack of reliable energy consumption data to use for establishing baseline consumption. For example: the measurement for heat energy has been performed for several facilities together and not on regular basis in public buildings and there are no individual meters in apartment blocks;
- Lack of system to monitoring and verifying energy savings.

Figure 16 summarizes the relative importance of these barriers in Serbia.

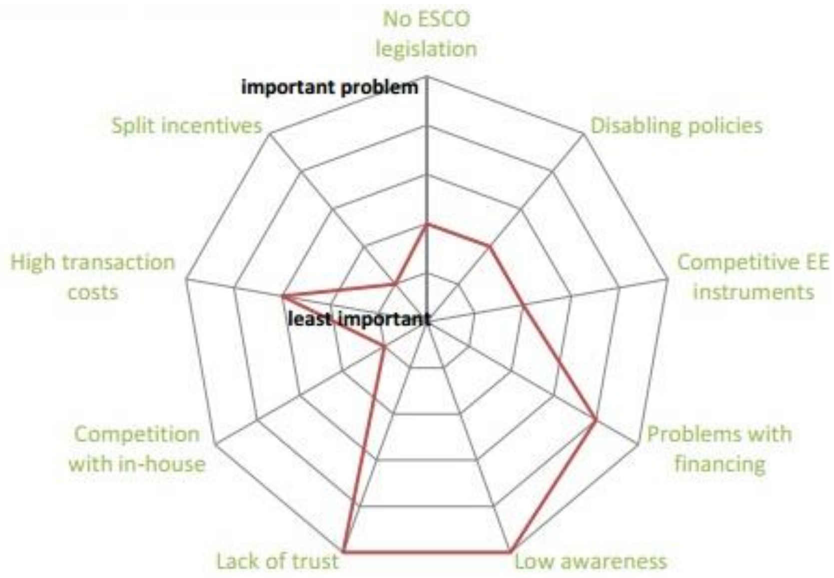


Figure 16: Barriers to ESCO projects in Serbia (EC-JRC, 2014).

Drivers

ESCO market in Serbia can be motivated by the following drivers (EBRD, 2014a):

- Increase of energy prices;
- Out-dated and inefficient industrial equipment, as well as lack of metering and control devices.

The increase in energy prices creates an additional cost burden on businesses and buildings owners which are already challenged in the current economic climate and improving EE is an effective response to this challenge (EBRD, 2014a).

Needs/Recommendations

The challenges regarding the overall operability of the EE Law include (CMS, 2015):

- Need to introduce particular sector-specific incentives for EE in the relevant legislation (notably, the real estate legislation and the tax-related one)
- Gradual raising of financiers' perceptions of the actual feasibility of the ESCO projects.

Regarding the second challenge, a current problem is that the financing entities in Serbia often assess the credit worthiness of the client instead of the project itself. However, similarly to other countries where the ESCO concept was introduced for the first time, it is expected that, gradually, with the first projects becoming successfully implemented, financiers may become more and more receptive for engaging in the financing of ESCO projects. (CMS, 2015).

Table 18: ESCO market in Serbia.

While the presentation of ESCO markets in pilot countries, provides insights about the identification of new business models, a summary of success factors and needs in existing situation follows as an outcome of SoTA work:

5.2.5 Success factors

EC-JRC (2014) found that the success factors of ESCO projects can be summarized in the following categories:

- **Legal and political drivers**: long-term, manifested and credible commitment by the public authorities; supportive policies; dedicated ESCO legislation and measures; complementing measures on energy services; removal of regulatory barriers and ESCO services standardization.
- **Procedural factors/tools**: tools, models and handbooks for the various stages of an ESCO project implementation; standard documents; flexibility in the content and preparatory procedure of a contract and statistics system, data collection, centralized data collection and management systems (which decrease transaction costs).
- **Financing**: EU and national grants, financial incentives, preferential loans and third party financing (openness of the banking sector for financing ESCO projects).
- **Information and awareness**: motivation for refurbishing sites by municipalities (which motivates EE investments); environmental and climate awareness; awareness raising activities
- **Structural and market related changes:** energy price; recovery of the construction industry; ESCO associations and facilitators; progressive projects *("(…) a client starts with a smaller project, and when trust has established, the client purchases the next service level or involves further buildings in the project. One successful project stimulates the contract for another.")* and the development of ICT and smart technologies.

5.2.6 Gaps and needs in existing situation

The main limiting factors for ESCO market establishment were found to be the following by EC-JRC (2014) and Transparense (2015):

- **Lack of awareness and information** on the complexity of the ESCO concept, leading to distrust by end-users and also by financial institutions.

- **Legal and political barriers**: erratic legislation, lack of official/generally accepted ESCO definition, certification and standards; ambiguous legislation and lengthy procurement.
- **Institutionalization and project tools**: lack of facilitators and lack of proper M&V practices.
- **Financing barriers**: accounting of EPC projects as loans by public authorities; problems with bank financing (low awareness and motivation to finance ESCO projects); aversion to loans by potential ESCO clients and high transaction costs.
- **Market and partnerships problems**: lack of trust by the clients; lack of well-established partnerships and failed projects.

This chapter provided a summary of the State of the Art of the ESCO business models and of the ESCO market, with a specific focus in the countries where the MOEEBIUS pilot sites are located (Portugal, UK and Serbia). The SoTA analysis allowed the identification of the success factors and gaps and needs, which will provide the basis for the identification of the specific issues that the ESCO innovative business models should address, i.e., barriers they should overcome, problems they need to solve and also success factors that are able support them.

6 Demand response business models and market

One of the main objectives of the project is to provide innovative market models for Demand Side Aggregators, in addition to ESCOs. Towards this direction, a review of the existing business models and current market status in Europe is provided. Demand Side Management (DSM) programs in MOEEBIUS pilot countries will have special attention.

Demand Response (DR) is a tariff or programme established to incentivise changes in electric consumption patterns by end-use consumers in response to changes in the price of electricity over time, or to incentivise payments designed to induce lower electricity use at times of high market prices or when grid reliability is jeopardised. DR is able to increase the system's adequacy and to substantially reduce the need for investment in peaking generation by shifting consumption away from times of extremely high demand. It can act as a cost effective balancing resource for variable renewable generation. Adding stability to the system, it lowers the need for coal and gas fired spinning reserves – must run power plants, burning fuel continuously, in order to be ready to supply power at short notice. It can decrease the need for local network investments, as it can shift consumption away from peak hours in regions with tight network capacity.

Apart from the indirect benefits that DR delivers to society by lowering the costs and optimising the efficiency of the electric systems and markets, it also provides direct benefits to consumers by paying them directly for the value of their demand-side flexibility. In the USA this amounted to over €2.2 billion in 2014. Finally, it encourages market competition, by allowing the participation of third party service providers (aggregators) and rewarding service-oriented suppliers.

Within the 2030 EU policy framework, DR is regarded as key tool to achieve the targets of at least 27% for renewable energy and energy savings by 2030. It is now clear to policymakers that Europe will not be able to achieve these goals in a secure and cost-efficient manner unless our energy system becomes more flexible. DR and consumer empowerment are understood as integral parts of the Energy Union's action plan, as they increase security of supply, by reducing dependence on foreign imports and supporting renewable integration. In the wider EU policy context, DR is not only promoted because it addresses the energy trilemma (Figure 17), but also because it helps to reach a competitive, secure and sustainable economy. The current status on EU market with the definition of existing business models is presented in the next section.

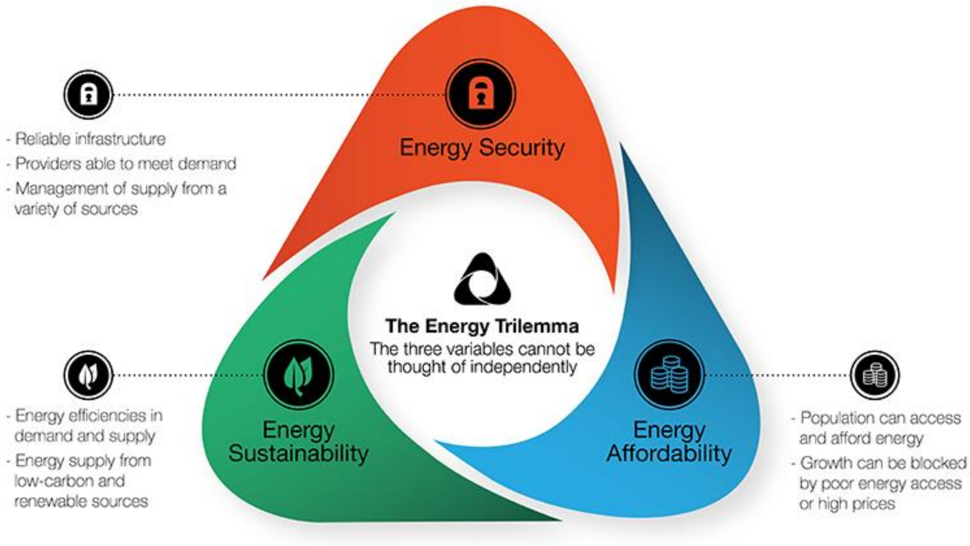


Figure 17: Energy trilemma (ARUP, 2015).

6.1 Business Framework for Aggregators

Demand Response programmes can be categorised into two groups: In **Explicit DR** schemes (sometimes called "incentive-based") the control of aggregated changes in load are traded in electricity markets, providing comparable services to supply-side resources, and receiving the same prices for those services. Usually this takes place within the balancing, capacity or wholesale energy markets. Consumers receive direct payments to change their consumption upon request (i.e., consuming more or less), which is typically triggered by activation of balancing services, differences in electricity prices or a constraint on the network. Consumers can earn from their flexibility in electricity consumption individually or by contracting with an aggregator. The latter can either be a third-party aggregator or the customer's supplier.

Implicit DR (sometimes called "price based") refers to consumers choosing to be exposed to time-varying electricity prices or time-varying network tariffs (or both) that partly reflect the value or cost of electricity and/or transportation in different time periods and react to those price differences depending on their own possibilities and constraints (no commitment).

It is important to note that neither form of DR is a replacement for the other. Many customers participate in Explicit DR through an aggregator, and at the same time, they also participate in an Implicit DR programme, through more or less dynamic tariffs. The requirements and benefits of each are different and build on each other. The two are activated at different times and serve different purposes within the markets. They are also valued differently. While consumers will typically receive a lower bill by participating in a dynamic pricing programme, they will receive a direct payment for participating in an Explicit DR programme.

Perhaps most importantly, Explicit DR provides a valuable and reliable operational tool for system operators to adjust load to resolve operational issues. Implicit DR, on the other hand, allows consumers to benefit from price fluctuations in the wholesale energy markets to the extent they are willing and able.

Within MOEEBIUS project, we are going to examine both options with special focus on explicit DR programmes towards the establishment of an innovative framework for EU Demand Side Management Aggregators. Prior to the definition of the existing business framework for EU aggregators, we present the European Regulatory Framework for DR.

The main regulation frameworks that impact in DR business models are:

Regulation Framework	Description
The Electricity Directive – 2009/72/EC	The Electricity Directive of the Third Energy Package defines the concept of "EE/demand side management", acknowledging the positive impact on environment, on security of supply, on reducing primary energy consumption and peak loads.
The Energy Efficiency Directive (EED) – 2012/27/EU	The EED (2012/27/EU) constitutes a major step towards the development of DR in Europe. According to its Art. 15.2, Member States were required to undertake an assessment of the EE potentials of their gas and electricity infrastructure.
Network Codes for energy transmission	The codes are a set of rules drafted by European Network of Transmission System Operators for Electricity (ENTSO-E), with guidance from the Agency for the Cooperation of Energy Regulators (ACER), to facilitate the harmonisation, integration and efficiency of the European electricity market

Table 19 - Main regulation frameworks that impact in DR business models.

6.1.1 Demand Response business model for aggregators

The role of the Aggregator, as proposed by Smart Energy Demand Coalition (SEDC), is depicted in the next schema providing services for different energy market situations.

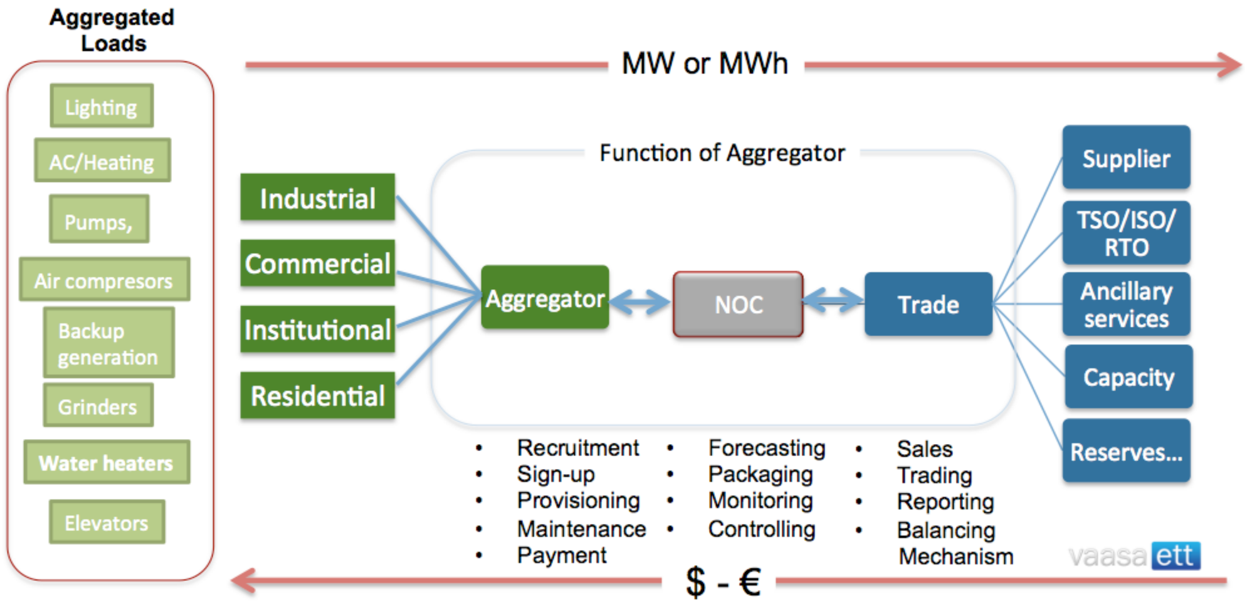


Figure 18: Business role of aggregator.

The next schema provides an overview of the potential services that an Aggregator may offer to traditional business actors, defining that way the potential business models for the role of Aggregator.

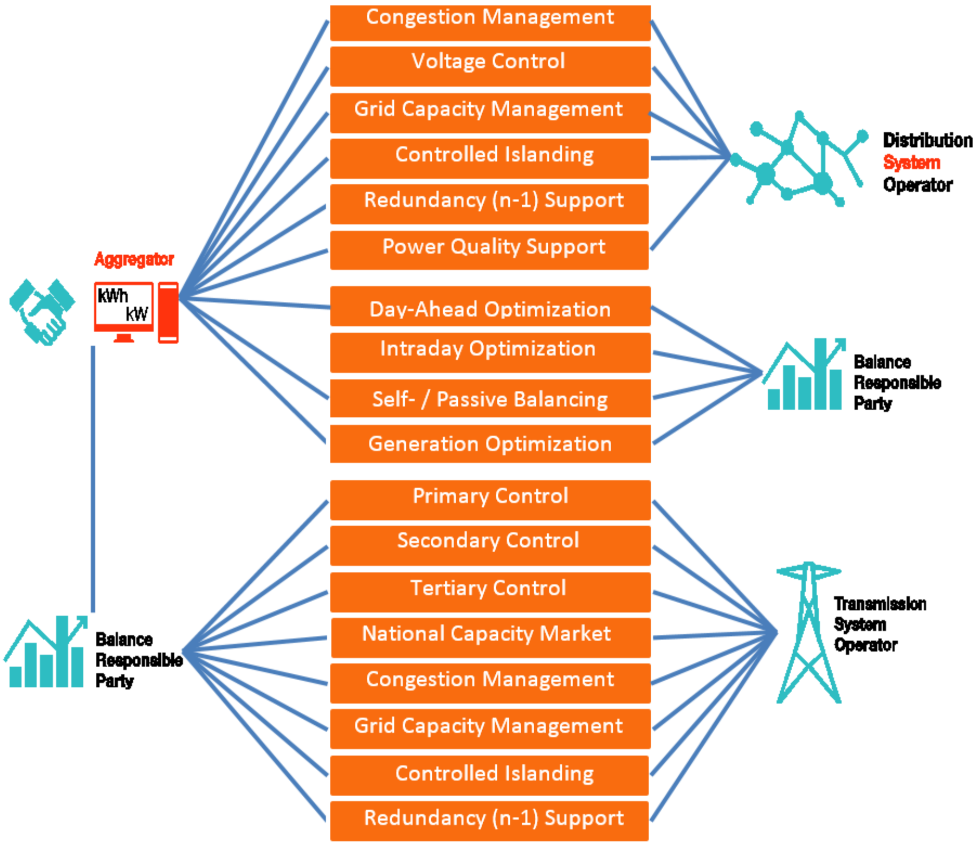


Figure 19: Current business framework of aggregator.

It is obvious that different business services can be provided to cover the timeline framework of energy markets operation:

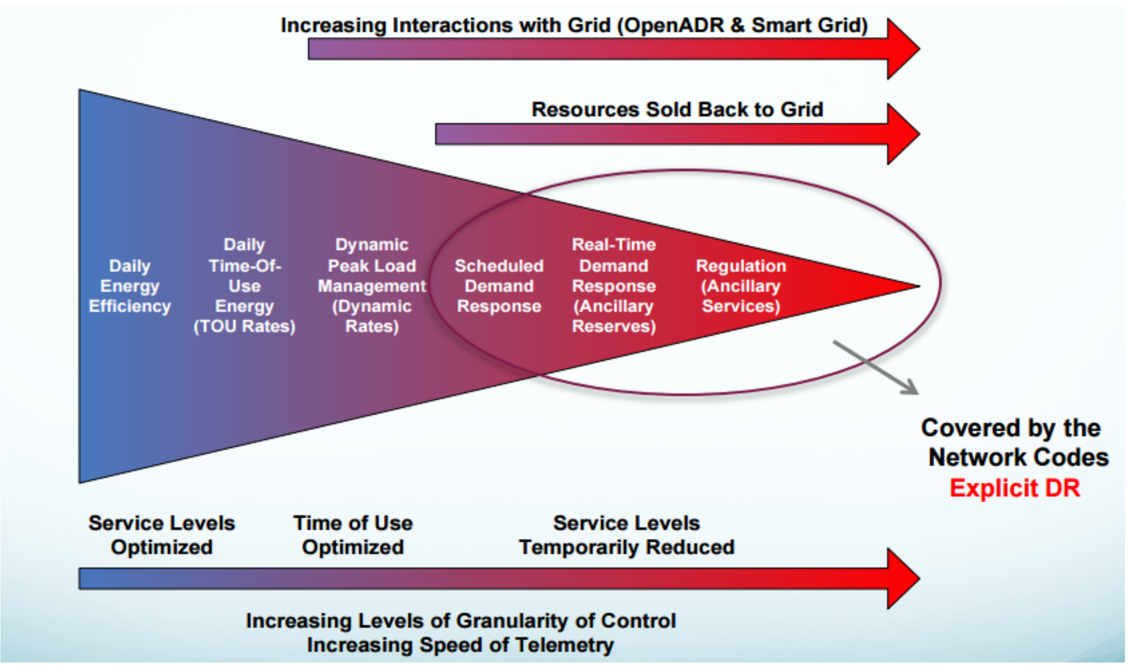


Figure 20: Timeline for aggregator operation.

Following the taxonomy of Aggregator services to current business domains, we proceed with a high-level hierarchy of the business programmes available in energy markets:

Time based supply tariffs: This is the most common (implicit DR) approach for exploiting demand side flexibility. Over all intensities of usage approximately 80% of Member States currently use such tariffs; when weighted by electricity consumption this ratio is over 90%. Regarding the variety of supply tariff types, on- and off-peak tariffs are most common, with approximately 60-70% of countries using these tariffs. The next most popular category was 'other', which included responses similar to real-time pricing (such as hourly and spot prices) and on/ off peak (day/ night and weekend/ weekday rates). When weighted by electricity consumption the prevalence of all tariffs is higher; on/off peak tariffs still dominate at approximately 80-90% usage.

Time based network tariffs: As opposed to supply tariffs, the usage of time-based network tariffs is less geographically widespread. Interestingly, over all intensities of usage (universal, common, occasional) we see such network tariffs to be available more often for residential consumers, though with a bias towards larger consumers in universal usage; this is true in both the weighted and unweighted cases. This indicates that, despite being more widely available, network tariffs are adopted less often by residential consumers.

Demand participation in wholesale markets: Explicit demand side flexibility is less about retail tariffs than about direct integration with wholesale markets. Suppliers who buy electricity in the wholesale market can use demand side flexibility to adjust their electricity need to match their contracted wholesale position.

Demand participation in balancing markets: A similar trend emerges regarding demand participation in balancing. Around 60% of Member states are allowing or planning to allow participation in balancing for demand side resources.

Capacity remuneration mechanisms: In this case, the participants receive remuneration based on their availability (and not active participation). A monthly incentive (per kW) is offered to reduce energy by a previously agreed amount once an electric-resource facility reaches a pre-determined level.

By combining the energy market services (presented in Figure 18) with the different contractual agreements presented above, we identify the details of the business models for Aggregators. The next table summarizes the DR business model for aggregators, particularly in the UK.

<table>
<tr>
<td rowspan="2">7 - Key partners
Electrical utility, large energy consumers, electrical installers</td>
<td>5 - Key activities
Win contract from utility for electrical demand, acquire clients on board, manage demand availability, respond to demand side event, Reporting and Payments</td>
<td rowspan="2" colspan="2">1 - Value proposition
To lead the way in managing energy through innovative smart grid technology, and in so doing, provide our loyal customers and partners with the most cost effective platform through which to sustainably optimise their electricity consumption whilst maximising their energy savings potential</td>
<td>4 - Customer relationships
Multi-year contracts with customers, offer ancillary services</td>
<td rowspan="2">2 - Customer segments
Multi-sided market: Electrical utility on one side and large energy consumers on the other.

Large energy users are segmented as: Industries, Public Buildings</td>
</tr>
<tr>
<td>6 - Key resources
Demand control technology, Approval of Utility, Awareness amongst energy consumers</td>
<td>3 - Channels
Lobbying in government for positive legislation, digital marketing, seminars, roadshows, in house sales force, sales channel partners</td>
</tr>
<tr>
<td colspan="3">9 - Cost structure
Hardware manufacturing, installations, maintaining software infrastructure</td>
<td colspan="3">8 - Revenue streams
Revenue is collected from electrical utilities by winning a tender. Payments</td>
</tr>
</table>

Table 20: DR business model for aggregators.

The taxonomy of the services is provided in order to show the potential for DR Aggregator operation. Nevertheless, the current regulatory and market framework poses significant boundaries to the mass penetration of DR Programmes. In the next section, we present the status in EU DR Market focusing mainly on the pilot countries of MOEEBIUS project.

6.2 Demand response market situation

6.2.1 European Union

The map presented in Figure 21 provides an overview of the current framework for Explicit DR in the 16 countries examined. The research shows that six European countries already provide a framework allowing for the development of DR services: Ireland, Great Britain, Belgium, France, Switzerland and Finland.

Although there are remaining regulatory issues Explicit DR is a commercially viable product offering. Among this group, France and Switzerland stand out due to fact that they have restructured the roles and responsibilities of market

participants specifically in order to enable independent aggregation. Ireland has made significant progress in enabling demand-side resource participation in their market. Great Britain remains green due to its competitive energy market, open balancing markets and the fact that independent aggregation is enabled (though not fully described). However, Great Britain’s leadership is now in question. The newly introduced Capacity Market does not place demand-side resources on an equal footing with generation, and now provides almost a £1 billion annual subsidy predominantly to existing generation facilities.

Finland and Belgium are green despite their lack of clarity surrounding the role of the independent aggregator. Both markets have created appropriate programme requirements and payment structures for demand-side resources; this is allowing market development while the surrounding regulatory issues are reviewed.

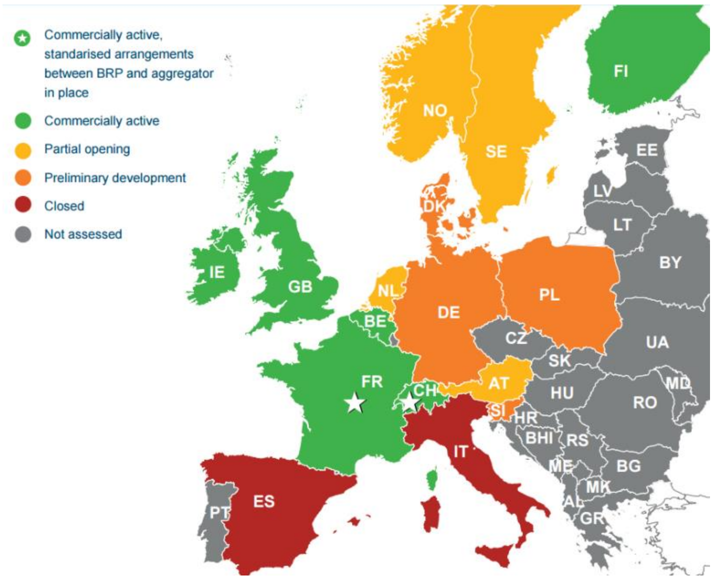


Figure 21: Map of explicit DR development in Europe today (SEDC, 2015).

The analysis reviewed markets according to four criteria. These are: 1) Enabling consumer participation and aggregation 2) Appropriate programme requirements 3) Fair and standardised measurement and verification requirements, and 4) Equitable payment and risk structures.

Though the measurable improvement on DR penetration, the overall result of the review reveals multiple remaining barriers to the establishments of consumer centred DR framework. There are three overarching trends highlighted:

The regulatory framework in Europe for DR is highly fragmented

The EU DR market is still in its early development phase and fragmentation is a result. Each Member State has a different regulatory framework and progress is not similar when it comes to opening up electricity markets to customer participation. This is a problematic development in the context of the aimed harmonised Internal Energy Market.

There is a positive dynamic towards opening balancing markets to demand-side resources

In many European countries, regulators and TSOs have been improving the programme requirements of their different balancing products to enable demand side resources participation (e.g. in Austria, Belgium, Finland and France). Positive dialogues have also been established between TSOs and service providers to improve the definition of baseline methodologies.

In the majority of countries consumer access to DR service providers is problematic

Consumers have the choice to select any third party provider of, for example, energy management services they like. However, in most European markets, consumers cannot choose a separate services provider for providing DR. They are restricted to their supplier, or at least need their supplier's permission before working with a third party aggregator. Often the supplier is in direct competition with the aggregator, or may have other reasons to hamper the uptake of DR, and thus has an incentive to block the aggregator from doing business with the consumer. In the majority of the countries examined, the roles and responsibilities are unclear, and do not allow for direct access of consumers to service providers, therefore they do not offer them a clear path to market.

The more in-depth the analysis, the more this issue is understood as a critical barrier throughout Europe to the development of consumer oriented services and DR. There is therefore an urgent need to clarify the role of new market participants, such as third party aggregators, and their interaction with existing market participants, such as Balance Responsible Parties (BRPs)/suppliers when helping consumers sell their flexibility into the market.

Following the review of European Status about DR, a detailed analysis of market situation per pilot site is provided with special focus on UK pilot site (mature DR market framework) which stands as the lighthouse pilot in MOEEBIUS project for the evaluation of DR Strategies.

6.2.2 Portugal

Demand-response market in Portugal
Market size/Market potential

The penetration of Active DR Schemas in Portugal are rather low, focusing only on the implementation of variable tariff schemas. This fact is even highlighted in EU reports, where current technological limitations set boundaries on a market penetration of Demand Side management programmes. While a detailed analysis of Portugal market has been provided, the focus is on the consumption side analysis and the current efforts on implementing active demand programmes.

There are almost 6,2 million consumers in mainland Portugal, most of them using low voltage, 23.500 medium voltage (MV) and 350 high and extra high voltage. They used more than 49 billion kWh in 2013. After the opening of the electricity market in Portugal, consumers who wish to do so are free to choose their electricity supplier.

Considering the different uses of energy in households (Figure 22), energy used in the kitchen has the highest weight, accounting for over one third (39%), followed by water heating with 23%.

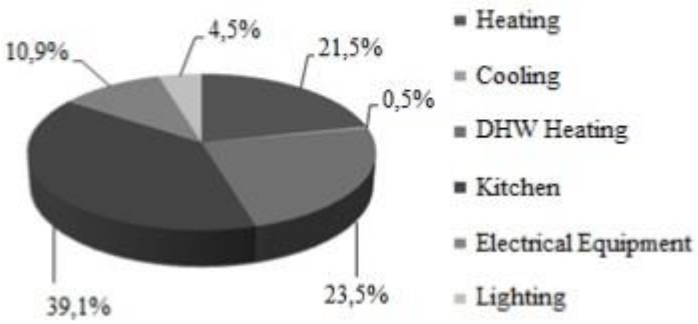


Figure 22: Uses of energy in households in Portugal.

However, depending on the type of use, the dominant source of energy is different: in the kitchen dominates the use of electricity, while in water heating is predominant the use of bottled LPG (Liquefied Petroleum Gas).

Considering the final use of electricity, it becomes clear that consumptions in the kitchen and in electrical appliances were the highest, being respectively responsible for 41% and 33% of the overall electricity consumption in the reference period.

Types of projects/Pilot projects

That related to implementation of active demand programmes, variable retailer price schemas define the current framework in Portugal. Based on Energy Services Regulatory Authority (ERSE), the most effective way to promote EE is through the definition of tariffs that allow the recovery of costs associated with each and every activity of the electricity sector and by tariff structures and prices that reflect

marginal or incremental costs.

This methodology is incorporated in the Portuguese electricity tariff code. Different price schemas are provided by the retailers based on the regulatory framework:

- Dual Tariff Schemas; where a differentiation among low prices and high prices is defined. Distinction among Dual Tariff Schemas is delivered also during the whole annual period, addressing the seasonal factor of demand
- Tri Tariff Schemas: where the differentiation on prices consist of: high, moderate, low. In this case, a high flexibility on price schemas enables the adoption of the optimal polity that fits to customer needs. In addition to the promotion of variable tariff schemas, ERSE has developed a mechanism for promoting efficiency in electricity consumption (PPEC).

PPEC consists of a tender mechanism, by which eligible promoters (suppliers, network operators, consumers' rights associations, EE agencies, etc.) submit initiatives to improve electricity efficiency in the industrial, services and household/residential sectors. The annual budget is 10 million euro and, as foreseen in the tariff code, that amount is supported through the Global Use of System Tariff, paid by all consumers. PPEC comprises two types of measures:

- Tangible – Installation of equipment with a level of efficiency superior to standard equipment on the market, therefore producing measurable consumption reductions. In Table 21 some examples of tangible measures are shown, as well as their technical characteristics.
- Intangible – Disseminating information on energy efficient practices in order to promote a change in behaviours. An example of this kind of measures is energetic audits, information campaigns, seminars and conferences.

Measure	Assumptions
Residential lighting (Fluorescent Compact Lighting 18 W)	- Aimed for the household segment - Useful lifetime: 6 years - Annual consumption reduction: 62 kWh (relative to 75W incandescent light bulb)
Electronic ballasts	- Aimed for the services segment - Useful lifetime: 16 years - Annual consumption reduction: 63 kWh (relative to a ferromagnetic ballast and considering T8 bulbs of 36W)
Electronic speed variator (<=70KW)	- Aimed for the industrial segment - Useful lifetime: 15 years - Annual reduction in consumption: 25%

Table 21: Examples of tangible measures.

It is obvious that the aforementioned analysis highlights demand side policies that reflect mainly the establishment of an energy efficient environment without focusing on the penetration of commercial DR models. Therefore, the rest of this section highlights only some innovation projects on DR with small scale demonstrations.

In collaboration with the Portuguese government, and with the participation of public buildings and households in Lisbon, the "Automated Demand Response Project" will demonstrate an automated DR system which can adjust electricity demand and supply without reducing customer comfort. The system will also be able to provide automatic operation management of air-conditioning equipment in

response to the needs of individual customers.

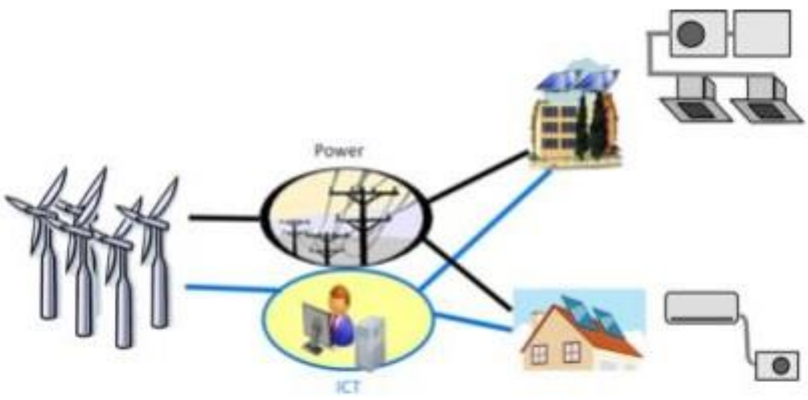


Figure 23: Automated Demand Response Project.

Manual DR operation with the cooperation of utility customers involves an uncertainty of power adjustment. The project will increase certainty through automatic DR operation and also address the growing need for electricity demand and supply stability with the large-scale deployment of RE. The project also aims to establish a system to achieve economic efficiency by shifting electricity demand from periods of higher power costs to periods of lower power costs.

Inovgrid is EDP's umbrella project for smart grids. It presents an answer to several challenges, including: the need for increased EE; the pressure to reduce costs and increase operational efficiency; the integration of a large share of dispersed generation; the integration of electric vehicles and the desire to empower customers and support the development of new energy services.
The project InovGrid started in the Portuguese municipality of Évora, where the infrastructure spanned the entire municipality, reaching around 30 thousand electricity customers with an annual consumption of approximately 270 GWh. Currently, the project is expanding to other Portuguese cities, including Guimarães, Lamego, Batalha/Marinha Grande, Alcochete, Algarve and São João Madeira; reaching more than 150 thousand consumers.

From a technical perspective, the architecture of the system includes the following components:

- EDP Boxes, installed in all low voltage (LV) customers, offering advanced smart meter functionalities, such as real time readings on demand, load diagrams, voltage monitoring and remote services (connect/disconnect, contracted power and tariff setup, tampering alarms, etc.);
- Distribution Transformer Controllers (DTC) installed in every secondary substation, acting as data concentrators and local metering, monitoring and automation devices (power quality monitoring, MV switching, local sensors, etc.);
- A communication network based on programmable logic controllers and GPRS technologies, linking EDP Boxes and DTCs to head end systems;
- Electric vehicle (EV) charge stations;
- Efficient public lighting systems, based on LED luminaries with advanced control.

The mix of components and technical architecture used in Évora goes well beyond smart metering, serving other applications such as LV substation monitoring and automation.

Active DR is stimulated by providing user-friendly interfaces for consumers with information on energy consumption, generated energy and management tools to react to external signals (e.g. price). Additionally, the project investigates the use of a real-time gateway for stakeholders to control the local consumption of electricity using demand-side management of large energy consuming devices such as heat pumps, EVs, etc.

Integration with Smart Homes is achieved by providing energy management functions of home automation devices and smart appliances that stimulate EE. Smart Metering Infrastructure includes the EDP Box to substitute the conventional meters at the consumer/producer premises and the DTC at the MV/LV substations. This equipment enables grid monitoring through data gathering at the consumer and substations level, data analysis functions and interface with commercial and technical central systems, enhancing grid automation and new market solutions.

Integration of DER is achieved using advanced control and automation functionalities distributed over different levels of a hierarchical control structure that matches the physical structure of the electrical distribution grid. This hierarchical control architecture enables the coordinated and synergistic management of (Distributed Energy Resources) DER, including distributed generation (DG), responsive loads and distributed small-scale storage.

From a societal point of view, the business case for InovGrid is based on a set of benefits of the project accruing to several stakeholders, including: the DSO itself, regulators, electricity users, energy services companies, electricity retailers, distributed generation promoters and vendors, electric vehicle owners and vendors and, considering the economic and ecological impact, society in general. The deployment in Évora provided ample evidence about many of these benefits, as shown in the following diagram.

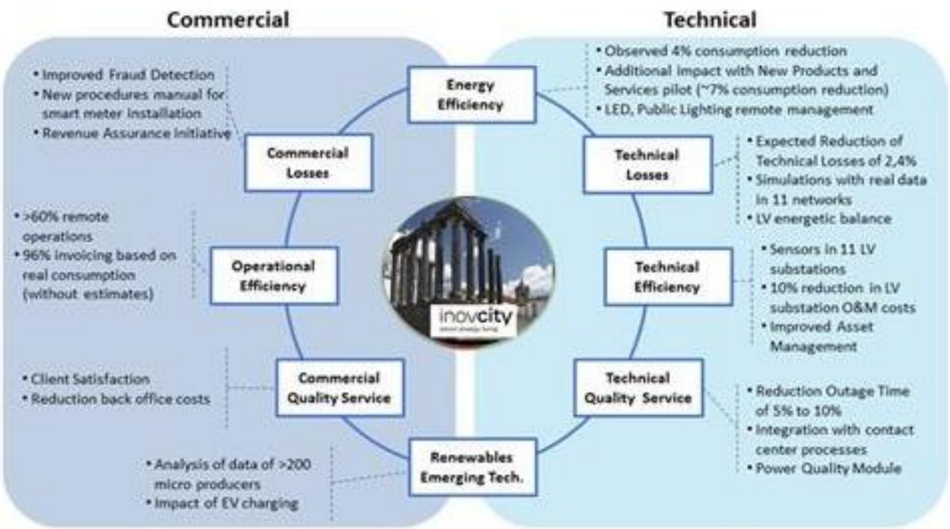


Figure 24: InovGrid business a technical framework.

These evidences have supported EDP's assessment of the societal implications and cost-benefit analysis of a full smart grids rollout and the conclusion that smart grids have the potential to create substantial value for the society as a whole. The InovGrid project is being developed in close cooperation with several organizations including Research Institutes and Universities across Europe, Industrial Partners, Local and National Authorities, Energy Sector Associations and Regulators, the involved Communities and other relevant stakeholders. Therefore, this project is considered as the lighthouse project on the field of smart grids in Portugal.
Regulatory factors/legislation
Portugal has a national energy strategy that aims to increase the share of renewable energy in its final energy consumption to 31%. It is now one of Europe's leading countries where large-scale deployment of RE has been achieved. RE, including wind and hydro power generation, accounted for about 70% of the country's electricity demand in the first quarter of 2014. Further deployment of wind and PV power generation is now being planned, and the need for more efficient use of renewable energy is expected to increase. Therefore, there is a high need for penetration of Demand Side management schemas that will enable the penetration of large scale renewable energy sources generation.
Market factors (economical context)
As a consequence of the previous monopolistic supply structure and price regulation, the retail market remains concentrated. The market share of the three biggest companies in the liberalized market was 85% in 2013. In 2013 Portugal had its highest switching rate so far of household consumers: 26,8% compared to 13.2% in 2012. Customers' prices have increased considerably in previous years. From 2008 to 2012, final electricity prices have increased annually on average by 7.8% for domestic customers and 6.2% for industrial customers. The price increase for both domestic and industrial customers was due to an average annual increase in taxes and levies of 16% and 19%, respectively. This is influenced by a set of subsidies to ordinary producers, namely the compensation for stranded costs due to the liberalization process and the payments of feed-in tariffs for renewable and CHP.

Table 22: Demand response market in Portugal.

6.2.3 United Kingdom

Demand-response market in United Kingdom
Market size/Market potential

Unlike most other environments and industries, the electricity grid cannot tolerate any imbalance between supply and demand. Any momentary deviation from this equilibrium will result in costly blackouts.

To avoid such catastrophic scenarios, UK's National Grid has a wide range of balancing mechanisms that could be used to maintain such equilibrium. The general idea is simple – when the overall demand is approaching the available electricity supply, the clients are asked to either increase generation (if they a primary electricity producer), or reduce their consumption, or switch to locally generated electricity (such as back-up generators). The opposite scenario could happen when supply exceeds demand, in which case the reverse actions are taken (Ward et al, 2012).

Below is a table for estimated overall potential for DR to reduce peak demands die to non-domestic buildings prepared by Ofgem:

	Estimated load flexibility during peak hour by scenario (winter week day, Great Britain) (GW)		
	Conservative	Moderate	Stretch
All non-domestic sub-sectors – including lighting	1.2	2.5	4.4
All non-domestic sub-sectors – excluding lighting	0.6	1.2	1.8

Table 23: Estimated overall potential for DR to reduce peak demands (Ofgem, 2012).

There are two key markets for providing DR in the UK (Curtis, 2015):

1. Short Term Operating Reserve (STOR) – *"reserve power in the form of either generation or demand reduction to be able to deal with actual demand being greater than forecast demand and/or plant unavailability"*
2. Frequency Response – Firm Frequency Response (FFR) *"provides firm provision of Dynamic (continually matching) or Non-Dynamic Response (set points) to changes in Frequency"*; and – Frequency Control by Demand Management (FCDM) *"provides frequency response through interruption of demand customers. The electricity demand is automatically interrupted when the system frequency transgresses the low frequency relay setting on site".*

Table 24 presents the estimated overall potential for DR to reduce peak demands which includes market size and returns summary.

Programme	Overall Capacity Per Year (MW)	DR Capacity Per Year (MW)	Procurement Method	Returns Per Year, Per MW
FFR - Primary	200-700	Unknown	Tender	£15,000 to £20,000
FFR - Secondary	700-1400	Unknown	Tender	£30,000 to £40,000
FCDM	150-200	150-200	Bilateral	£30,000 to £40,000
STOR	2500-3500	200-700	Tender	£20,000 to £30,000

Table 24: Estimated overall potential for DR to reduce peak demands – Market size and returns (Curtis, 2015).

These markets have the following features: FFR and FCDM run continuously and returns are based on an hourly availability payment; STOR has two daily operational windows (approximately, 07:00-14:00 and 16:00-22:00) and the basis for the returns are an availability payment and a utilisation payment; STOR DR capacity is provided by 150-250MW of load reduction and 300-500MW from load replacement (e.g. using backup generators, CHP, etc.) (Curtis, 2015).

Types of projects

DR is one balancing mechanism used by the National Grid to maintain equilibrium and is enabled through a number of different programmes the fall into two categories. The first category covers DR services aim at providing a fast response rate (within seconds) based on a grid frequency trigger e.g. if the frequency in the UK goes below 49.7 Hz then the balancing mechanisms like turning off assets or turning on batteries are achieved. The second category covers the more traditional DR services that provide a slower response rate (up to 20 minutes to start demand reduction) to grid conditions and are activated based on a human decision process at the National Grid.

Figure 25 provides an example of how an event would proceed for the second category of DR. In short, KiWi Power will aggregate together a number of sites that provide demand reduction and sell this contract to the National Grid. When required, the National Grid will request that this contract is dispatched at which point the sites will be activated via a remote start signal (or manually by phone call) and must achieve the contracted certain drop level (reduction of electricity consumption). Once the network stress that caused the contact to be dispatch has been resolved then the National Grid will request that the assets are returned to their normal operation and a stop signal will be sent to each asset.

There are some important conceptual considerations on how DR can achieve a demand reduction, with the three main methods being:

(1) Through real turn-down where sites turn various energy consuming assets off (down).
(2) Through "generation behind the meter", where site's load is displaced via locally generated electricity (i.e. using back-up generators will reduce the energy draw of the site from the electricity grid).
(3) Where a site's back-up generator is big enough to (1) offset 100% of the site load and (2) export the extra energy back to the grid. This in effect will simultaneously reduce the demand and increase the supply of electricity.

All three methods lead to the same effect – reducing the demand of the site for electricity from the Grid.

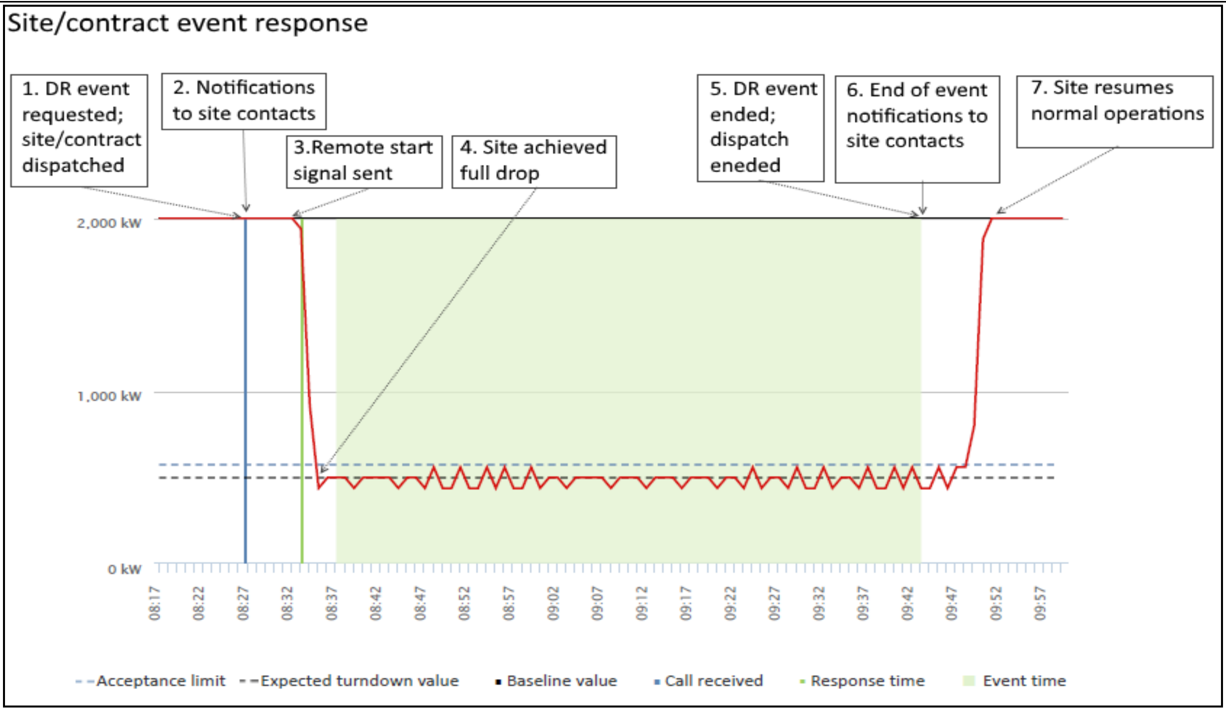


Figure 25: Example of a DR event.

Programmes

There are a number of different balancing programmes in the UK that can be used for DR and cover both fast and intermediate response rates as previously described. Details of each of these programmes is provided in Table 25.

DR Programmes Summary				
Programme	Short Term Operating Reserve (STOR)	Frequency Control by Demand Management (FCDM)	Firm Frequency Response (FFR)	Triad
Type	Reserve Power	Frequency response	Frequency response	Charges avoidance scheme
Method of dispatch	Dispatch instruction via the STOR SRD terminal	Automatic activation when frequency drops below 49.7Hz	Automatic activation when frequency drops below 49.7Hz	Dispatch based on the likelihood of peak demand
Response time	10 or 20 minutes	2 seconds	30 seconds	N/A
Duration of event	Up to 2 hours	15 minutes	30 minutes	Usually 1-2 hours
Availability	All year with Predefined daily windows	24/7	24/7	Winter time workdays (4-6PM)
Capacity commitment	Depending on contract	Varies	Varies	N/A
Availability declarations	Weekly	Weekly	Weekly	Same day

Table 25: DR programmes summary.

Regulatory factors/Legislation
National Grid places great emphasis on the creation of flexibility within companies' electricity demand as a fundamental part of the UK's future low carbon grid. Prevailing views expect the underlying requirement for new balancing services provision to grow over the next decade: anticipated that an increasing part of British electricity supplies will also come from renewables in the new future, resulting in a requirement for evermore sources of balancing services.
Market factors (economical context)
Energy market observers expect the underlying requirement for balancing services provision - both in the UK and overseas - to grow over the next decade: deregulation; ageing generation & infrastructure; renewables, electric vehicles and storage; environmental considerations; cost transparency & consumer bills; distributed generation and microgrids. DR is driven by both the retirement and closure of existing older large generators, together with less running of large fossil fuelled stations as governments look to cut greenhouse gas emissions, whilst ensuring that electricity consumption and production are in balance at all times. Spikes in demand for power and unexpected dips in supply have plagued electricity generators and their customers for decades, but in some ways the problem has worsened, exacerbated by the rise in the use of renewable power, especially in Europe. Countries such as Britain face such a severe power generation crunch: Ofgem has warned that the 'margin' in the network (spare capacity over peak demand) could fall to as low as 2% during the 2015-16 winter. This difficulty represents a significant opportunity for DR companies such as KiWi Power which use smart grid technology to divert electricity from commercial & industry consumers to users who need it more. Growing consensus that demand-side flexibility is a critical resource for achieving a low carbon, efficient electricity system at a reasonable cost: hence why governments are taking a series of steps to curb demand and 'push' driving growth in DR, both in the UK and overseas.
Awareness
The awareness for DR is gradually increasing in the UK. The awareness is limited to commercial and industrial customers only. Residential customers are predominantly unaware of DR and its benefits.

Financing sources

As mentioned earlier, the utilities such as National Grid pay DR aggregators. A portion of the payments are then transferred to end customers based on availability and event payments.
Three times a year, an aggregator tenders to win contracts for the rest of the current and next year. Within 10 days at the end of each month, the aggregator will review the client's earnings and produce an earnings statement detailing all revenue streams for the previous month.
Payments are made on quarterly basis (unless otherwise agreed) and the client is expected to send aggregators a quarterly invoice for the appropriate amounts. Payments are divided into Site Availability payment depending on MW capacity made available for the contract duration and a Site Utilisation payment depending on number of hours that a DR is conducted.

Barriers

Ofgem's consultation provided an opportunity to understand consumers' experiences of DR and to gather qualitative data on the perceived barriers to further uptake. Each interviewee was asked to list the barriers that prevent further engagement with DR and the responses are summarised below.

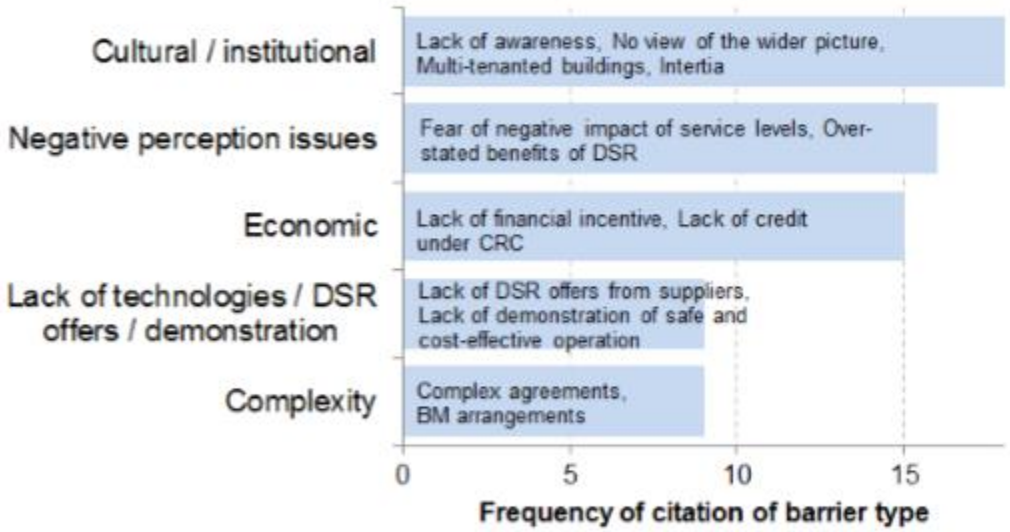


Figure 26: Barriers to DR (Ofgem, 2012).

Although the barriers listed were wide-ranging in Ofgem's study, some common topics emerged (Ofgem, 2012):

- Because energy is not a focus of most of the organisations in this sector, DR is not generally a priority. Some organisations are investing in EE measures (particularly in low energy lighting), but for the majority DR is not currently a priority.
- There was widespread concern that implementing DR measures could have negative impacts on the levels of service or comfort for building occupants (and feedback suggested that generally no impact on service levels would be accepted).
- Other barrier often cited was the relatively low and/or uncertain financial incentives for DR projects.

Drivers

	Enabler	Barriers addressed
Confidence-building & education	Guarantees of no negative impact on services as a result of implementing DSR.	• Perceived negative impact of DSR. • Concern that DSR measures could lead to reduced levels of service or comfort. • Low awareness of DSR. • Lack of prioritisation of DSR activities.
	A mechanism by which another party would be responsible for consequential damages arising from any negative impacts resulting from DSR.	
	Certification of DSR equipment to demonstrate that it meets set criteria.	
	Trials in different building types to demonstrate: 1) No negative impacts on levels of service. 2) Economic benefit (ideally < 2 year payback).	
	Trials and publication of successful case studies to demonstrate safety and cost-effectiveness of DSR solutions (including automated devices).	
	Education (of energy managers in particular) to provide greater knowledge of flexible loads and awareness of DSR.	
	Information targeted at decision-makers at relatively high levels[75] within organisations, promoting the benefits of engaging with DSR for the organisation and the wider benefits (economic, environmental, security of supply etc.).	
	Collaboration (e.g. between major retailers) whereby companies agree to work together to reduce demands. The CSR / reputational benefits could be appealing.	
	Improved energy metering has been a significant factor in enabling many organisations to improve energy efficiency. Better metering will also help to enable demand side response by improving awareness of the loads that could be available for DSR and the extent of flexibility they offer.	
Economic incentives	Consider how environmental benefits of DSR delivered at the wider system level could be credited to participating organisations, e.g. under the CRC.	• Lack of an economic case for implementing DSR measures.
	Mechanism(s) to ensure a share of the revenues from DSR goes towards creating a budget for energy efficiency could provide incentive for facilities managers to engage.	
Reduced complexity	Tailor DSR offers to the target audience – i.e. far more streamlined and simple.	• Overly complex DSR agreements.
	Engaging with DSR would be simpler if tariffs were the same in all buildings, such that DSR contracts could be tendered for across a suite of buildings or the portfolio as a whole.	
	Improve market access by relaxing the constraints on becoming a party to the grid code (enabling demand side participants to operate in the 1 hour-ahead balancing market).	

Table 26: Drivers of DR (Ofgem, 2012).

Success factors
Other source of suggested DR enabling mechanisms is provided by an ongoing study into the potential for DR in Great Britain – Great Britain Electricity Demand Project[8]. This study has investigated DR potential in the industrial sector and identified the following enabling mechanisms: • Increased financial incentive / adequate compensation – It is required adequate compensation for potential lost revenue for the industrial consumers who provide DR by interrupting production. • Technical upgrades – Rapid response and automation can be facilitated by the installation of new technology and industrial organisations may invest if there are sufficient returns. • Greater flexibility in DR schemes' requirements – Reduced periods between committing to provide DR and delivering demand reductions and opportunity to decide to be in and out of DR at short notice. • Greater compatibility and coordination between DR schemes – Ensure that flexibility offered via STOR that is not used may still deliver a useful service via alternative mechanisms. • Increased price information and visibility – The lack of transparency of potential DR revenues leads to difficulties for organisations evaluating the economic feasibility of participating in DR and is a barrier to further DR uptake. Even though the mechanisms by which DR may be offered differ by sector (e.g. large industries might be able to change their working patterns in response to price signals while commercial organisations are unlikely to do that), there are parallels between drivers identified for DR in the industrial sector and in the commercial/public sectors (Ofgem, 2012).
Needs
Ofgem (2012) states that it is necessary to guarantee a set of drivers in order to facilitate the DR penetration, once financial incentives alone are not sufficient to stimulate the DR market. Energy users denote concern of DR potentially leading to negative impacts on level of service, highlighting the need for further trials and appropriate guarantees with DR offers. Organisations may be more receptive to DR offers it there is confidence that business operations will not be disrupted, an adequate financial incentive and the DR scheme is suitably tailored and not too complex. Since currently there is much interest in the field of EE, Ofgem (2012) suggests that DR solutions should be promoted alongside EE measures. The relationship between aggregators and suppliers/BRP is not yet regulated in UK. However, as the aggregator is not required to contract directly with the supplier/BRP, this lack of clarity has not yet had a negative impact on the market. In future, it will be important to clarify this relationship for the fairness of all involved (SEDC, 2015).

Table 27: DR market in United Kingdom.

[8] http://www.sustainabilityfirst.org.uk/index.php/energy-demand-side/gb-electricity-demand

6.2.4 Serbia

Demand-response market in Serbia
Market size/Market potential
Currently, there is a low penetration of commercial DR programmes in Serbia and thus the literature review highlights the potential of the customers to participate on theoretical DR programmes. Based on National Renewable Energy Action Plan of the Republic of Serbia: "Market and grid design that enable the integration of variable resources could cover measures such as trading closer to real time (changing from day-ahead to intra-day forecasting and rescheduling of generators), aggregation of market areas, ensuring sufficient cross border interconnection capacity and trade, improved cooperation of adjacent system operators, the use of improved communication and control tools, demand-side management and active demand side participation in markets (through two-way communication systems — smart metering), increased distributed production and domestic storage (e.g. electric cars) with active management of distribution networks (smart grids). Towards this direction, and planning on a harmonization with ENTSOE market rules, the examination of demand-side management potential is an ongoing process. Especially with the mass penetration of wind power in existing electricity grid, there is a requirement for implementation of flexible demand programmes, in order to minimize wind curtailment in the case of large-scale integration.
Types of projects (possible)
Possible participation of loads in the wholesale market: As it was described previously, the Serbian wholesale market is currently dominated by PE EPS wholesaler of tariff consumers, where the domestic generation companies - its daughter companies - can only sell to PE EPS wholesaler of tariff customers, for regulated prices, and PE EPS procures the shortage or sells the surplus that emerged when serving domestic consumption of tariff consumers, to importing and exporting traders usually through monthly contracts. From the above it is apparent, that in the current Serbian wholesale market theoretically load participation could have two forms. One possibility could be that a large industrial consumer becomes a trader and conducts its own procurement from import and exports or sells its excess, and flexibility to general traders of the competitive market segment. However, in the current setting this is not a relevant option, since the regulated price is considerably lower than what a consumer could realize from imports. A more possible form of load participation on the wholesale level could be that large industrial consumers remain within the regulated 'supply chain' and participate in a program which enables PE EPS wholesaler of tariff consumers to directly or indirectly use their flexibility. Regarding the current incentives of industrial consumers to consume in less costly time periods, the active energy part of the regulated tariff - which at present applies to all users – varies with the time of use. Tariff rate for active energy is higher (HT) in the hours between 7:00 and 23:00, and a lower tariff (LT) applies in the rest of the hours. For industrial users the ratio of the two tariffs applied in the

two time periods is HT:LT = 3:1. Regarding the metering equipment, industrial consumers connected to the transmission system are equipped with smart meters, those industrial consumers who are connected to the distribution network have metering systems of various quality. However, such a time of use tariff could be implemented with simple two rate meters as well, which is prevalent in Serbia.

- Evaluation of load participation possibilities in the Serbian wholesale market:

The current ToU rates in place directly give incentives to large industrial consumers to shift consumption to the off-peak period. However, this HT, LT tariff does not exploit most of the potentials of large industrial consumers, as it is too rigid, only applies two time periods and is set for a long time in advance. As these consumers are equipped with advanced meters, their DR potentials could be further exploited by more complex price-based DR programs.

The Regulator with the assistance of PE EPS wholesaler of tariff consumers could enhance the current ToU rate systems for these consumers by for example adding an additional block during the day in the most intense hours, this way the peak period between 7:00 to 23:00 could be divided into a higher peak and a lower peak period that better reflects wholesale costs. Furthermore, adding critical peak pricing to the ToU rate system in the few really expensive periods could also enhance the strength of the connection between retail and wholesale markets. Real-time pricing programs would be an unimplementable alternative for the current Serbian market, since they not only require transparent hourly wholesale prices, and a high level of customer awareness, but also a change in the current regulated tariff system which is based on yearly set tariffs.

A more direct form of utilizing demand responsiveness of large consumers on the wholesale level would be the organization of an incentive-based program. The incentive-based program could have the advantage compared to the price-based programs, which the demand reduction valuable to the wholesale market could be directly insured by penalties, and therefore the curtailed amount would be more predictable. A possible way of introducing such program is that the Regulator files discounted rates which could be applied for the participating large industrial consumers supplied from the regulated segment. In return for the discounted rates large industrial consumers would reduce their load according to predetermined rules (regarding the needed load reduction, maximum number of events per year, penalty for non-compliance, etc.) when PE EPS wholesaler of tariff consumers notifies them.

However currently only the distribution/supplier companies are in direct (legal) connection with consumers, therefore the implementation of such a program would either require a change in the legal framework that allows a direct connection between the large industrial consumers and the wholesaler of tariff consumers, or a strong cooperation between PE EPS wholesaler of tariff consumers and the DSO/Supplier companies, where the DSO/Supplier companies would be intermediaries between the wholesaler and the consumers, and in a special way they could be considered as aggregators.

The MOEEBIUS project focuses on large tertiary and small scale residential consumers. Therefore, the analysis covers these aspects of the project, focusing

on the description of retail customers market.

Possible participation of loads in the retail market:

As it was already described in the country overview, the Serbian retail market although is opened for all non-household consumers, and household consumers with an annual consumption above 200.000 kWh, the full market is currently operating under regulated tariffs, as no consumers have exercised their eligibility to procure from the competitive market segment. As a result, currently all small-scale consumers are supplied by the five distribution companies, which are all daughter companies of the PE EPS holding. This situation is likely to remain in the near future until the option of consumers to stay in the regulated market segment is maintained and regulated tariffs are lower than the cost of import possibilities.

Regarding the regulated retail prices of small scale consumers, there are two types of tariffs, a single-tariff, that does not depend on the time of consumption and a two-rate tariff with higher tariff (HT) rate applying between 7:00 and 23:00 and a lower tariff rate which applies in the rest of the time. The two-rate tariff evidently could only be charged to consumers equipped with at least mechanical two-rate meters. For these consumers the relative ratio of prices under lower (LT) and higher tariff (HT) rates of active energy is LT:HT = 1 : 3.

In case of consumers connected to the low voltage level network there are two categories defined:

1. "Low voltage consumption" category: For the consumers of this group monthly maximum active power, reactive and active energy are metered. All these customers are equipped with two rate meters, and the relative ratio of prices under lower (LT) and higher tariff (HT) rates of active energy is also LT:HT = 1 : 3.
2. "Consumer spending" category: For these consumers only active energy is metered and two rate and single rate meters are also common. For these consumers the relative ratio of prices under lower tariff rates (LT) higher tariff rates (HT) and the single daily tariff rate (ST) is LT:HT:ST = 1 : 4 : 3.5. Consumers equipped with two-rate meters can also choose to pay under the single-tariff regime, i.e. the ToU price system is optional. The number of residential consumers in the different tariff categories is shown in the table below.

Current other DR programs:

Besides the above described two-rate tariff system there are two recently introduced direct load control programs for households operated by the distribution network companies. Both programs are direct load control programs where the supply of boilers and storage heaters and single-point water heaters are controlled by the remote control system. Consumers can choose between the two programs. The programs differ in the following characteristics:

- Supply may be interrupted two times, each for three hours at most daily and between two interruptions supply lasting at least four hours shall be provided. Consumers are given an 85% discount on the HT and LT regular

tariff for active energy in return. • Electricity is supplied for ten hours a day, of which 8 hours have to be supplied continuously. If daily temperature measured at 7:00 AM is -10°C or lower in the relevant area, an additional two hours of supply has to be provided between 12:00 and 22:00. Consumers in return receive discount on the LT part of the two-part tariff. The volume of controlled capacity is currently very small, but more extensive introduction is planned. Costs of the equipment needed for the controlled load programs are recovered through the distribution part of the tariff. Metering service is provided as a regulated monopoly service by the distribution companies and there is no separate charge within the distribution part of the tariff for metering. All meters are read once a month. There is a concept that almost three million meters will be replaced during the next ten years in the distribution network. Several projects were realized during 2007 by the distribution companies regarding installing 150.000 meters and 12.000 metering sites were equipped with load remote reading and management systems. Regarding the current deployment of smart meters, the current deployment of smart meters is around 3-5%. However, this share could increase to approximately 30% in the next five years, the pace of growth will depend on the distribution companies' tender procedures for metering purchase. Regarding the financing of the smart meters that were installed in the previous years the mother company EPS got credit and it was decided that part of these funds should be directed to the distribution companies to finance new smart meters. These expenses will be later recovered through the regulated tariff. Regarding the procurement of these meters, Technical Board of Distribution companies proposed what kind of functionalities should be introduced with new meters and EPS Managing Board approved this proposal. Producer of new meters was selected according to public tender procedure, published by EPS.
Market factors (economical context)
The Serbian electricity industry is under the process of restructuring. The former vertically integrated utility is now performing as a (100% state owned) holding company, PE EPS, where generation, distribution and supply are all carried out in different daughter companies. There are five generation companies, a wholesaler PE EPS, and five distribution companies, which in case of regulated tariff consumers – currently all consumers - are also the retailers. Transmission system operation is carried out by PE EMS, which is fully unbundled from PE EPS, however also owned by the State. At present there are no plans for privatization but the investment plans of EPS are foreseen on a PPP basis. Market rules and distribution code are currently in a drafting phase.

Table 28: Demand response market in Serbia

Following the review of commercially available DR programmes around Europe, we need to identify the parameters that lead to the successful implementation of DSM programmes. The definition of these success factors will further trigger the development and demonstration of DR strategies in MOEEBIUS project.

6.2.5 Success factors and requirements in existing DR framework

The SEDC has developed 10 guidelines for enabling DR participation in the markets, including the wholesale, balancing, reserves and other system services markets. These have been categorized in four stages: 1) Involve the consumer 2) Create products 3) Develop measurement and verification requirements 4) Ensure fair payment. These are described below and together they form a four step process to fully open electricity markets to consumer participation.

Step One– Involve the Consumer

- Rule 1: Aggregation should be legal, encouraged and enabled in any electricity market where generation participates
- Rule 2: The aggregated pool of load must be treated as a single unit and the aggregator be allowed to stand in the place of the consumer
- Rule 3: National regulators and TSOs should oversee the creation of streamlined, simple contractual relationships between incumbent players and the aggregator
- Rule 4: Regulators and TSOs should create clear participation and payment requirements between regional players, which protect the legitimate interests of all participants – including those of new entrants

Step Two – Create products

- Rule 5: Create unbundled products that allow a range of resources to participate, including demand side resources
- Rule 6: Provide a complete product description that includes the technical specifications of both demand and supply

Step Three – Develop measurement and verification requirements

- Rule 7: Establish appropriate and fair measurement and communication protocols

Step Four – Ensure fair payment and solve the missing money problem

- Rule 8: Ensure Demand Response services are compensated at the full market value of the service provided
- Rule 9: Create market structures which reward and maximize flexibility and capacity in a manner that provides investment stability
- Rule 10: Penalties should be fair and tailored to the business model of the providers

These ten rules form the basis of consumer centric market design to enable Demand Response. They ensure that retailers and aggregators have access to markets and can empower a range of consumers to earn from their consumption flexibility & they create a level playing field where supply and demand can compete. Enabling Demand Response in Europe requires four steps – 1) allowing

for service providers to work/exist in the markets, 2) ensuring those markets include products appropriate for both supply and demand side resources, 3) establishing the appropriate measurement and communication protocols to safeguard reliability and 4) ensuring fair reliable payment for services provided. The missing gaps and recommendations for an open DR market framework are presented in the next section.

Towards this direction, ENTSOE (2015) indicates the following key requirements for the development of an emerging DR market:

- **Price signals need to reveal the value of flexibility for the electricity system**. One of the main challenges for the European electricity system is the lack of effectiveness of price signals to stimulate appropriate investment and performances. Accurate short-term market price formation is needed to reveal the value of flexibility in general and of DR specifically. Proper energy price formation in the day-ahead, intraday and balancing energy markets requires not only that DR activations are based on price signals, but also that the price signal reflects DR activations.
- **Efficient use of DR is based on an economic choice between the value of consumption and the market value of electricity**. This choice arises when the consumer is exposed to variable prices or if the consumer can sell its flexibility on the market, possibly with the help of an aggregator. Efficient price exposure requires accurate allocation of energy based on actual metering, with a precision in metering adapted to each product.
- **Price information, consumption awareness and possibility to act** require strong consumer involvement, which can be facilitated with automation or by delegating the DR process from the consumer to a company. Efficient DR requires all involved parties to take appropriate actions, which are allowed by access to relevant price information and possibility to act. However, in some markets, these can incur significant transaction costs for the consumer, especially for small consumers and complex products. Consumption awareness is necessary to identify DR potential, which can be difficult not only for households but also for industrial consumers since it requires dedicated expertise. This expertise is a core business activity for companies developing DR resources such as aggregators and retail companies.
- **Regulatory barriers, when present, need to be removed to unlock full DR potential, including barriers related to the relationship between independent aggregators and suppliers.** Any evolution must preserve the efficiency and well-functioning of markets and their design components, such as the pivotal role of balance responsible parties, their information needs and balancing incentives. From a TSO perspective, the choice of the market model results from a trade-off between the imperatives not to increase residual system imbalance and to facilitate the development of additional resources.

- **DR should develop itself based on viable business cases.** Subsidies should remain limited and clearly identified. The willingness of demand side actors to participate in the market essentially depends on the economic incentives they receive, i.e., the existence of a business case and the correct allocation of the benefits it brings.
- **Communication and control technologies need to enable DR for small consumers and provide guarantees on their reliability.** Emerging technologies and automation are important tools for DSR participation in the markets. TSOs and DSOs need to support and implement solutions that include communication and control technologies enabling DSR for small consumers, such as multiple use of advanced metering technology/smart meters and steering components for boiler reserve control.

Additionally, ENTSOE (2014) states there are five critical aspects that need to be addressed to explore the full potential of DR:

- **Roles and responsibilities of the relevant parties need to be clear** in order to facilitate and enable the delivery of DR and customer engagement, which requires an important collaboration between TSOs and DSOs.
- **Define efficient data handling procedures** through a framework to optimise the use of DR across multiple parties ("DR sharing"), ensuring that TSOs, DSOs, suppliers and other market participants are able to gather the data required to fulfil licence, regulatory and commercial obligations.
- **Ensure security of supply with DR**, defining and ensuring performance criteria for DR.
- *"**Market integration of DR** as another market participant on equitable and transparent terms with generation and storage"* which means opening markets to DR on a non-discriminatory basis and creating "DR friendly" products to allow markets to deliver appropriate price signals and incentives to develop DR in the system.
- **Common European framework for DR** with regional/national settings.

In this deliverable, the analysis is mainly focusing on the definition of innovative business models that unleash the capacity of customers towards their participation on DR programmes. However, we also define regulatory and financial aspects that should be also considered for the mass penetration of demand side management programmes.

This chapter provided a summary of the State of the Art of the DR business models and of the DR market, with a specific focus in the countries where the MOEEBIUS pilot sites are located (Portugal, UK and Serbia). The SoTA analysis allowed the identification of the success factors and gaps and needs, which will provide the basis for the identification of the specific issues that the DR innovative business models should address, i.e., barriers they should overcome, problems they need to solve and also success factors that are able support them.

7 MOEEBIUS innovative business models

One of the main objectives of this report is to introduce novel ESCO business models and corresponding management strategies, by extending current EPC formats. These novel business models will consider significant energy performance improvements without sacrificing occupants' comfort and health in indoor environment.

The work is focusing on developing innovative business models, which are aligned with stakeholders' requirements following the review of existing business models and current market status in Europe, identification of their barriers and success factors; and also through questionnaires and interviews with stakeholders and brainstorming sessions with experts of MOEEBIUS Living Lab. The Living Lab (from which were involved 31 ESCOs/Aggregators and experts in the topic for business models definition) is an environment for experience sharing towards user-driven open innovation, oriented to:

- Widely disseminate the project outcomes to stakeholders for generating a broad awareness and engagement in the project activities;
- Create opportunities for further exploitation and replication of results;
- Obtain feedback from the stakeholders and optimize all developments, directly addressing their critical needs

The business analysis did not only focus on the limited environment at pilot sites (where these will be tested), introducing new business approaches that are transferable to other business environments, providing solutions with high replication potential.

7.1 ESCO innovative business models

In this section, the innovative business models for ESCOs are described. We have identified four innovative approaches: (i) energy management based on enhanced EPCs; (ii) condition/efficiency EPC model for ESCOs (iii) raising occupants' awareness as a tool for energy savings; and (iv) valorisation of buildings through energy certification. A detailed analysis of each of these business models follows.

7.1.1 Energy management services based on enhanced Energy Performance Contracts (EPCs)

This business model is the provision of an energy management framework as an extension of shared-savings EPC. The main innovation of the proposed framework is that apart from energy savings KPIs, additional **health and comfort parameters** are considered in the EPC. The energy management operation is performed by fully preserving end users' preferences and needs.

As a starting point, the ESCO is responsible for the initial investment, performs a study of the building to identify its savings potential and develop an energy management system, which enables the establishment of an optimal energy management framework. The ESCO further monitors energy consumption, provides consulting services and occasionally may perform improvements in equipment maintenance or optimisation (applying low cost or no cost measures). The return of the investment cost is obtained by a pre-agreed percentage of the energy savings achieved during the project period. On the other hand, the ESCO offers to customers, energy savings and energy management without prior investment while economical savings are shared with the customer.

By extending current EPC formats, MOEEBIUS introduces new business aspects that will consider significant energy performance improvements **without sacrificing occupants' comfort and health** in the indoor environment. MOEEBIUS proposes a comprehensive approach that can holistically infer **user preferences** on a number of ambience conditions enabling that way the extraction of user comfort and health parameters. The MOEEBIUS models will enable fine-grained personalized adaptation of the ambient environment to user preferences, supporting that way the establishment of not only an energy efficient but also ambient and sustainable environments in buildings. Different strategies will be shaped for establishing optimal equilibria between energy performance, comfort and health according to the requirements of buildings occupants and managers. Table 29 summarizes the energy management based on enhanced EPCs business model.

<table>
<tr>
<td colspan="2" rowspan="2">7 - Key partners
Technical partners (Suppliers of monitoring systems; control systems; meters, ICT);

ESCOs offering energy management services.</td>
<td colspan="2">5 - Key activities
Establishing data connection and collection;
Integrated energy and contextual management framework.</td>
<td colspan="2" rowspan="2">1 - Value proposition
Energy savings without investment offered by an ESCO;
Energy savings fully preserving contextual and operational building parameters.</td>
<td colspan="2">4 - Customer relationships
Contractual (short to medium-term) incentivised by the desire to obtain energy savings fully preserving building occupants preferences.</td>
<td colspan="2" rowspan="2">2 - Customer segments
Building owners that do not have an internal team for energy management (have no one monitoring energy bills);

Buildings that have potential for energy savings;
Commercial and public buildings that are willing to increase holistic building performance.</td>
</tr>
<tr>
<td colspan="2">6 - Key resources
Data acquisition from heterogeneous sensor and metering devices;
Software that enables the integrated management of building premises.</td>
<td colspan="2">3 - Channels
Personal sales;
Exhibitions;
Utilities; Public projects;
Special events.</td>
</tr>
<tr>
<td colspan="5">9 - Cost structure
Technology and labour cost;
Small investment in equipment;
maintenance or optimisation (measures with fast paybacks, e.g. < 1 year – low cost or no cost).</td>
<td colspan="5">8 - Revenue streams
Energy savings from the project (for example: 50% for the ESCO and 50% for the costumer) as in typical ESCO models.
The main differentiation is the incorporation of contextual and operational building parameters on optimization process.</td>
</tr>
</table>

Table 29: Energy management based on enhanced EPCs business model.

Regarding feedback from the LL members that collaborated in the co-creation of the innovative business models, Table 30 highlights the main innovative characteristics, strengths and weaknesses of "energy management based on enhanced EPCs" business model.

Innovative characteristics
• The general idea of this model is innovative (77%) and interesting (100%). • In order to ensure that the ESCO does not lose money and that the customer is satisfied, engineering costs should be reduced. This could be obtained by using very fast methodologies and maximising procedures automation. For example: using remote energy audits (instead sending a team of engineers to analyse an installation). • This model already exists, but only for the Industry. • It is very important to ensure the occupants' comfort and to ensure that the type of optimisation chosen takes into account occupants' preferences. A lot of potential for EE is lost because of lack of transparency and lack of information sharing between the system managers and building occupants.

- Introduction of health and comfort parameters into the model.
- Instead of applying this model to only one building, the model could aggregate several buildings in the same system (providing scalability and impact).
- Energy management needs to become more dynamic and to place the customer in the centre of the business because he is the "driving force" to achieve higher savings and at the same time he wants to maintain his comfort levels and "business as usual" status.
- It should include a pedagogical component to teach the customer the most efficient way to operate his systems, so he can understand how to achieve higher savings (e.g., a Building User Manual).
- The customer engagement will be higher if more information is shared. It is necessary to share information besides sharing the risk. The customer should have access to all that is being implemented in real time (trust, transparency and teaching).
- ESCOs should always perform an initial study of the savings potential and share it with the customer so he can understand what will be his benefits (accurately predicting savings - credibility of the technicians and in the entire process need to be ensured). If there is no potential, then the ESCO project should not advance. This way customers would gain more trust in the ESCO market. The most important for any ESCO project is to ensure that the customer understands the value of his benefits before entering in an ESCO project and during the contract period.

Strengths

- It is increasingly more common and natural asking the costumer for responsibility and performance guarantees.
- The model is important because it encourages the end user to save and there is risk sharing between the ESCO and the customer.

Customer needs addressed/Value proposition (1)

- Customer obtains savings without investment from his side.
- It is a win-win situation for the customer and the ESCO.
- Need to maintain "business as usual" status, i.e. any energy saving initiative should not interfere in any way with end users comfort or should not alter the way business performs.

Customer segments (2)

- The application of this model depends on the type of building.
- Buildings with larger potential will be large commercial buildings with intensive energy consumption (e.g. hospitals, supermarkets large hotels and sports complexes with swimming pools).
- It should have wide applicability in the public sector, where there is not so much concern about consumption and where is a greater potential for savings.
- It would have more success in the domestic sector because each person invests directly in their energy expenses so there is more motivation. However, mainly in countries that have higher needs for heating/cooling and for customers that require higher levels of comfort.
- Any market segment where the end-users are heavily involved into day-to-day operations: Hospitality (Hotels, Leisure Centres), Office buildings, Healthcare, Education, Retail (Shopping centres).
- Facilities requiring specific operational conditions (for temperature, humidity,

ventilation, etc.).

Channels (3)

- A pilot-project should be disseminated to increase the confidence in ESCO projects and raise interest in implementing this type of projects. Other dissemination activities could be knowledge dissemination, showcase best practices, commercial campaigns and cooperation with government.
- Facilitators would be a very good channel to disseminate this model because they would allow to obtain trust and confidence from the potential customers.
- The most appropriate channels to use depend on the customer we are addressing. Direct contact is the best approach because the value proposition is quite intangible.
- There are very well-positioned players, such as energy traders (utilities) – they would be a natural channel, and also telecom operators.
- Direct sales or partnership with BMS provider/energy consultants.
- Media and direct dissemination.
- For large buildings (residential and commercial): a presentation at the facility.
- For medium buildings: utilities and banks can serve as a vehicle to reach the customers.
- For the public sector: through energy agencies and calls for tender for management of public installations.
- For domestic sector: door-to-door selling, housing associations and parish councils.
- For the commercial sector: through business associations and direct contact to potentially interested large energy consumers.
- Using seminars does not make sense because people who go to seminars are more technical and the applicability of this model will be in buildings where there is not this more technical staff.

Key activities (5)

- Technical support.
- Provide internal financing or arrange external financing.
- Detailed understanding of specific business requirements for each individual client. These requirements normally are part of the tendering process.
- Listen to the customer to understand his needs.
- Energy audit, define retrofitting options, assessment and selection of the best option, retrofitting execution and exploitation of the facility.

Key resources (6)

- Increased engineering capabilities to fully assess BMS configuration and profiling.
- Higher CAPEX in cases where full BMS are not deployed and details control of the environment is not possible prior to the execution of an ESCO contract.
- Personnel for auditory, for retrofitting execution and for the exploitation.
- Retrofitting design.
- Retrofitting equipment requirements.
- Financial: investment for audit and retrofitting.

Key partners (7)

- Technology and equipment manufacturers;
- For SMEs (small cafes, restaurants, services): even manufacturers of smaller

devices (such as freezers) and/or a large retailer;
- Technology companies to analyse data and create viewing platform.
- Financing institutions;
- Universities and R&D institutions to stimulate constant innovation.
- Facility management companies.
- BMS providers.
- Energy consultants.
- The customer – view the customer as a potential partner for ideas.

Revenue streams (8)
- By sharing the savings.
- It is important to define a time-horizon for the application of this model. After a pre-defined period, the savings should go entirely for the customer.
- As for some customers this is a must have feature, the revenue model should ensure savings are still attractive enough for the client even when implemented with such constrains. Savings sharing model should offer 2 tiers of services: higher saving without this feature and lower savings with this feature activated.
- The model more interesting and comfortable for the customer is to pay a fixed fee. For example, the ESCO could estimate the savings in the beginning of the project and remove X% from the energy bill. This X% would be shared between the customer and the ESCO (with eventual annual adjustments).
- The customer can pay a fixed quote, or pay for the use of energy at a lower ratio than before due to the energy savings obtained.

Weaknesses

- This model is not innovative because there are already some market practices in that direction (23%). This business model can only be innovative through the models used to calculate savings.
- This business model implies risk for the ESCO (50%).
- Main question is how much will the service cost in order to ensure a balance between making the customer satisfied and ensure the ESCO does not lose money, since the savings may be small.
- Other issue is that in offices buildings different companies the customer will be the facility manager. The question is: What are the areas where the manager may act? It may be very conditioned and the potential of savings very low.
- The main difficulty is the fact that the technicians that operate the model do not understand or "feel" the benefits, so they are not motivated to save energy. It is necessary to create this culture through education (starting in schools).

Customer relationships (4)
- The customer relationship implies results (65%). It is necessary to provide more and more savings, if the customer stops saving then he will not be satisfied.
- Provide assistance to the customer with high quality customer care.
- It is necessary to raise awareness of both technicians and decision-makers through education and then verify if they are applying the knowledge correctly. EE needs to be seen as a benefit and not as a cost (which is how it is seen currently).
- Depends on the cost of implementing such a feature and if there's already an

existing BMS in place. • Keep the existing customers through their satisfaction with the service, this is key. In order to really engage the customer is essential to offer updates and innovations. Their interest and motivation will be stimulated by novelties introduced in the system that simplify their day-to-day operations. • The ESCO should ensure that the customer still motivated for achieving savings. **Cost structure (9)** • Engineering time needed to implement such optimal comfort strategies to specific BMS systems (if these are not already in place). • CAPEX for BMS installation if such systems are not already in place. • Main cost would be the investments in auditory and retrofitting analysis and execution. After the retrofitting, the exploitation costs.

Table 30: Feedback from LL members on "energy management based on enhanced EPCs" business model.

The main aspects referred by the LL members about "energy management based on enhanced EPCs" business model are summarized in Figure 27.

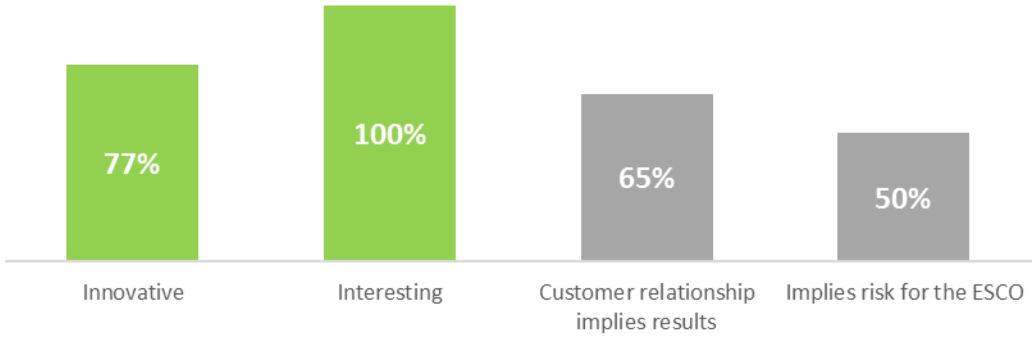


Figure 27: Main aspects referred by the LL members about "energy management based on enhanced EPCs" business model.

7.1.2 Condition/efficiency EPC model for ESCOs

Studies show that virtually every building suffers from **incompletely installed controls systems**, excessive chilling and heating capacity, and an inability to obtain the data needed to let ESCOs understand how a building is really performing. The National Institute of Standards and Technology (NIST) found that an average building lasts **only two-thirds** of its forecast life before it needs to be replaced or substantially retrofitted. Often the explanation for this cluster of problems is **incomplete or improper building maintenance** of the building's during life cycle. In addition, there is a lack of proper data connection and collection, as despite the sensors installed, their readings are not properly collected.

The proposed business model is the provision of a holistic management framework where the focus is not only on the real time building operation to ensure energy savings but also takes into account maintenance and retrofitting aspects under a common EPC. Once data collection is established, the service oriented architecture allows ESCOs to perform different energy management strategies (real time, maintenance and retrofitting) through a single point of management, executed automatically in a distributed and scalable environment. This innovative EE Services Agreement (EESA) involves ESCOs in holistic energy optimization framework **(retrofitting, maintenance & real time control)** along building's whole lifecycle. By, enabling accurate baselining, improved commissioning and deviations management (in real-time or through retrofitting), optimized payback periods (by maximizing operational/ energy cost savings) and attractive Return on Investment (ROI) rates are achieved to ensure the viability of ESCO as a new business role in energy markets.

Towards the establishment of this new business model, a main ESCO prerequisite is the extraction of accurate building models that will enable a better understanding of building dynamics and will support on the selection of optimal real time and meso level control strategies. Along with dynamically updated DER models, the MOEEBIUS platform will incorporate occupants' profiling mechanisms that will provide insights about buildings occupants' performance. By incorporating this knowledge to the framework, we ensure **accurate simulations of building performance** and thus we guarantee ESCO management process results.

The service will be offered by ESCOs to the building managers. Customers will be charged a constant service fee based on the size of installation, which means the number of collected data points and energy management strategies implemented. This puts in balance the expected work by ESCOs and the value proposition and price paid by a customer. Table 31 summarizes the condition/efficiency EPC model for ESCOs.

7 - Key partners Technical partners (Suppliers of monitoring systems; control systems; meters, ICT) ESCOs offering energy management services.	**5 - Key activities** Establishing data connection and collection; Creating different energy services, further combined to set flexible EPC contracts.	**1 - Value proposition** Real time building optimization as a traditional ESCO service. Optimized equipment maintenance; Early anomaly or fault detection; Reduction of workload for manual fault detection Retrofitting advisory planning Evaluation of achieved or projected savings.	**4 - Customer relationships** Offered as a service (subscription fees); Early adopters can be approached first, buy-in is an option.	**2 - Customer segments** Facility managers or owners of large commercial buildings; Facility managers of retail chains; The main focus is on buildings that require different types of energy management services.
	6 - Key resources Field/ configuration engineers; Building technicians; Software (cloud) engineers.		**3 - Channels** Direct offering to customers; Integration with existing platforms and services; Offered through OEM channel as a service for OEMs.	
9 - Cost structure Configuration/installation cost (one time) Operational cost – subscription and usage of a cloud platform & platform maintenance.			**8 - Revenue streams** Revenue per service offered by the ESCO to building manager. There is a flexibility on the services offered by ESCO.	

Table 31: Condition/efficiency EPC model for ESCOs.

The main innovative aspect of this business model is the incorporation of different energy management operations (**real time automation, predictive maintenance and identification of retrofitting opportunities)** under a single EPC. Therefore, the role of ESCO is expanded, addressing the holistic building simulation and operation process.

Regarding the feedback from the LL members that collaborated in the co-creation of the innovative business models, Table 32 highlights the main innovative characteristics, strengths and weaknesses of "condition/efficiency EPC model for ESCOs" business model.

Innovative characteristics
• The general idea of this model is innovative (73%) and interesting (100%). • This business model is extremely important, but will only work as an add-on to a maintenance contract. It is not possible to value it alone because the costs cannot be offset. • It makes sense that a preventive maintenance contract includes a term on energy performance, that is, to include energy in a larger service for

preventive maintenance of the facility, relative to more technical systems (but not lighting, for example). This model includes a sharing of gains for the two sides, it is simple and investments are small (which means a lower risk for the ESCO).

- It can be innovative if it is connected with EE. It can cause externalities to EE, transforming EE not only in savings but also in a reduction of the O&M costs.
- It is important to analyse not only the consumption, but also the process, the types of equipment used and their utilisation. So this model would be more interesting if it also included evaluation of equipment consumption (EE of utilisation).
- This business model is a decision support tool that should be included in all ESCO projects and should be mandatory to ensure the profitability of such projects. This tool should be used by the ESCO as an add-on to any EE project.
- The offer of a re-commissioning service/maintenance service for an existing BMS.
- The platform should include an estimation of the costs avoided/gains, allowing the customer to understand his direct benefits.
- This tool will allow to centralise and simplify the maintenance assessment process, instead of having periodic revisions.

Strengths

- Typically, these contracts are smaller (4-5 years) and even if the customer does not receive savings, he knows that the system is in a good maintenance condition and he does not have to worry. On the other hand, meanwhile he received a local insulation and replacement of one or two valves without investing or having to worry about it.
- The model can be very interesting for maintenance optimization.
- Maintenance should be included in the ESCO contract.

Customer needs addressed/Value proposition (1)

- Many facilities have this problem and this prediction is very important.
- It complements, but does not resolve the needs for savings.
- In order to address the needs for savings, this model should also include equipment retrofit and implementation of EE measures.
- Some BMS companies try to overcharge for the maintenance of their BMS systems and clients are often locked in proprietary systems with no free access to data.
- This business model is necessary. In Spain, there is a big opportunity to improve maintenance because it is not correctly performed (high potential for savings) and its costs are not understood.
- A breakdown causes unexpected situations and probably production losses, therefore companies want to avoid these situations.
- It is useful both for customers with existing preventive maintenance and without. For customers who do not have a preventive maintenance (only react to failures of equipment) it will prevent the arising of problems. These customers may not notice the benefits, but they will not have unsatisfactory situations due to failure of equipment and the consequent derived problems.

Customer segments (2)

- Any type of consumer.

- Mainly facility managers of large commercial buildings.
- Hotel chains, retail chains, shopping centres, offices and nursing homes for senior people.
- Commercial buildings with large energy consumption and applied to large systems (e.g. heating and cooling systems).
- HVAC systems.
- Systems for which a shut-down is very costly.
- Any type of building with existing BMS or existing automation in place.
- Commercial buildings with old systems.
- Companies with central plants or owners of buildings with multiple tenants and with central production of energy.
- Also individual domestic users with any generation system as boiler or heat pumps could be interested.

Channels (3)
- This solution is easier to sell (maintenance costs are well allocated an are easier to identify that EE potential), so it can have a direct approach to the customer.
- Direct approach to the customer.
- Maintenance companies.
- Facility managers.
- Business associations.
- Insurance companies.
- Energy consultants.
- Internet, through a demonstration explaining the system, allowing the customer to try it and understanding the benefits of using it.
- Companies: personal and direct contact.
- Individual users: mail, e-mail, phone, web and advertising campaigns.
- Calls for tender for management of public installations.

Key activities (5)
- Assessment of the existing systems.
- Implementation of a data gateway to allow data extraction from the current system and possibly system re-configuration.
- Design of the required monitoring system, its installation and of the required software. After that, the continuous analysis of the obtained results and, if in ESCO's charge, decision making and maintenance execution.

Key resources (6)
- Technical: BMS engineers, data interconnectors and interfaces.
- Financial.
- Hardware: sensors, electronic devices…
- Personnel to analyse the results and assess the maintenance needs.

Key partners (7)
- Maintenance companies. For companies with maintenance department it would necessary to have a good relation with them and trust from their side in order to share information, suggestions and analyse the results.
- Facility managers and housing associations.
- Engineering companies, equipment suppliers and brand representatives.
- Independent BMS installers who have knowledge of most of the existing BMS

on the market and can provide support for all. However, a good financial incentive scheme for them has to be establish as they will cannibalise their own market.

Revenue streams (8)

- By sharing the savings.
- This business model could be included in the services offered by a maintenance company, an equipment manufacturer or an insurance company. The payment could be a small fee added to the services already provided by these companies.
- This service is hard to price as it depends on the type of existing BMS and how easy/difficult is to maintain it and to interface with it for data extraction and re-calibration and re-commissioning. In UK such service could be developed for customers with existing TREND BMS – notoriously expensive to maintain and hard to interface with.
- There are two aspects: one would be a cheaper maintenance cost for the BMS compared to the status quo; second is linked to increased savings from higher EE after system re-commissioning. Saving sharing model should still apply.
- The benefit is not measurable, but if the customer does not understand the benefit he will not be willing to pay.
- The payment could be between 1-10€ per consumption point, depending on the complexity of the installation and the detail of the data presented.
- This service could be included in the energy bill as an add-on very low fee.
- The customer should pay for the initial investment. Then, in the monitoring phase the savings should be divided between the ESCO and the customer.
- The customer should pay an annual fee for the service.
- Exploitation and maintenance of the generation plant in our charge (ESCO) and energy sales to customer with price comprising all the terms.
- Fixed quote for the control service from ESCO side and maintenance decisions and costs by the consumer.

Weaknesses

- There are similar models in the market, it does not seem innovative (27%).
- This business model needs to be associated with the general maintenance of a facility because it is not viable alone, it is complementary (73%).
- Maintenance and EE should be separated. This business model does not improve EE (46%) it optimises maintenance by extending equipment maintenance periods. Typically, these models are used in large industrial plants and equipment whose shutdown periods have high costs (e.g. a cogeneration plant) because in these cases there are earnings.
- All the transaction costs associated with performance are negative. The maintenance is part of the installation structure and so it should be an installation cost. Particularly for public contracts. Since it is something that exists weather there is an ESCO project or not, I believe that maintenance should be apart from it.
- The main issue of this business model is the definition of highly accurate algorithms, which imply gathering a large amount of historic information.
- The maintenance market is not well understood.
- This business model is interesting from a theoretical point of view, but in reality it would be very difficult to implement.

Customers relationships (4) • Customer need to understand that he is still saving. • The big issue is the valorisation of maintenance. Maintenance costs and savings need to be valorised clearly in the platform, so the customers know exactly how much he is saving. • Keep the existing customers through their satisfaction with the service, this is key. It should have a very appellative and user friendly graphic interface for the end user, so he is motivated to understand how the systems are functioning. **Cost structure (9)** • Main costs would be in engineering time for the development of robust stochastics models and deployment of detailed model and sensors. • Hardware and licensing cost to access BMS data. • CAPEX for developing data collection and processing infrastructure. • It should be a macro level toot because the customization will be very expensive. • Costs would be in acquisition and installation of the required hardware, working hours of personnel for supervision of the results, and according to the contract form, maintenance costs.

Table 32: Feedback from LL members on "condition/efficiency EPC model for ESCOs" business model.

The main aspects referred by the LL members about "condition/efficiency EPC model for ESCOs" business model are summarized in Figure 28.

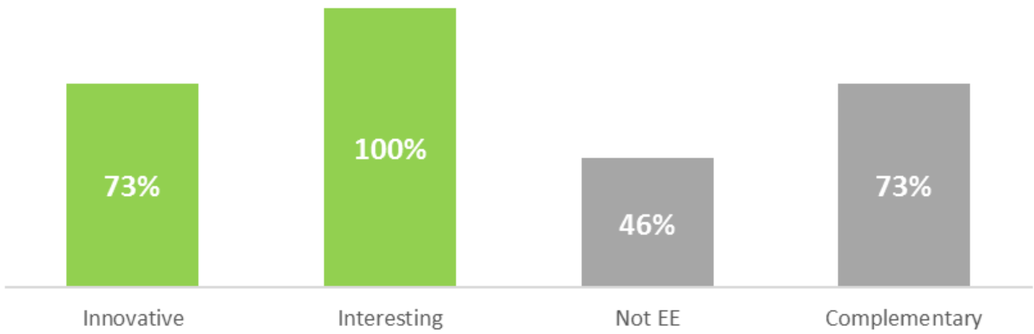


Figure 28: Main aspects referred by the LL members about "condition/efficiency EPC model for ESCOs" business model.

7.1.3 Raising occupants' awareness as a tool for energy savings

Raising occupants' awareness about the rational use of energy is envisaged as the key component for successfully improve energy efficiency. In most cases, residents and building users are not aware of the potential and possibilities for energy savings and this is a main goal for ESCOs towards EPCs fulfilment. There is a growing trend of utilities looking to expand their energy efficiency programs through non-hardware-based methods in order to more cost effectively engage a larger percentage of their customer bases. With increased access to metering infrastructure (AMI) smart meter data and software-based tools, many companies are designing ways to use **behavioural and analytical concepts** in the energy industry that have been successfully implemented in other industry sectors. If the cost savings are shared between ESCOs and consumers, it will be of the interest for all parties to ensure the rational behaviour of tenants and users of buildings.

Therefore, one of the main innovations promoted by MOEEBIUS is to incorporate as part of the energy management framework, a **gamification framework** that will raise occupants' awareness about EE and will ensure high level of fulfilment on EPCs. There are different methods to achieve energy savings by increasing end users' awareness, for example:

- Training and following instruction on how to achieve improvements;
- Learning from the direct assessment of the impact of behavior change on the savings achieved through **behavioural triggering** based on detailed evaluation of the consumption data;
- Learning through comparison with other end users (e.g., neighbours);
- Learning about the most effective ways to use existing measuring and control equipment.

Within MOEEBIUS framework, a combination of the aforementioned techniques will be considered, ensuring the successful establishment of a raising awareness framework. By incorporating this innovative framework to other energy management techniques, the proposed business model aims to **promote the enhancement of customer awareness and confidence on EPC effectiveness and on the ability of ESCOs to guarantee results**, thus fighting two of the main barriers that have hindered the growth of the ESCO market.

This business models aims to offer personalized information to customers through an internet portal and/or a smartphone application, enabling that way the implementation of successful behavioural triggering strategies. Table 33 summarizes the raising occupants' awareness as a tool for energy savings business model.

7 - Key partners	5 - Key activities	1 - Value proposition	4 - Customer relationships	2 - Customer segments
Energy suppliers and ESCOs; IT companies; Technical partners; Faculties; Non-governmental organisations dealing with training and education (energy).	Education; Providing information on consumption and billing; Establishing channels for exchange of information; Motivation of tenants. **6 - Key resources** Educators from partner companies; Equipment needed for communication channels.	Energy savings with small or no investment; Increasing knowledge about energy efficiency; Supplying information about energy bills and billing; Advising and consultation.	Contractual (short to medium-term) incentivised by the desire to obtain energy savings; Support by key partners; Recommendations. **3 - Channels** Internet portal with private log in for all stakeholders within contract; Applications for mobile devices; Automatic trigger messages.	Building owners that do not have an internal team for energy management (have no one monitoring energy bills); Buildings that have potential for energy savings; Domestic, commercial and public buildings.
9 - Cost structure Technology and labour cost; Small investment in equipment maintenance or optimisation (measures with fast paybacks, e.g. < 1 year – low cost or no cost).		**8 - Revenue streams** Combined/in synergy with basic/additional ESCO business models; Energy savings from the implantation of the associated strategies (for example: 50% for the ESCO and 50% for the costumer).		

Table 33: Raising occupants' awareness as a tool for energy savings business model.

Regarding the feedback from the LL members that collaborated in the co-creation of the innovative business models, Table 34 highlights the main innovative characteristics, strengths and weaknesses of "raising occupants' awareness as a tool for energy savings" business model.

Innovative characteristics
• The general ideal of this model is innovative (81%) and interesting (100%). • In terms of end users there are already similar models, but I consider this an interesting model. • The most important would be to raise awareness, particularly for environmental issues associated with energy consumption. • This model can only work if it assumes that people will have a passive attitude and not an active attitude. The information has to reach out people, they are not willing to sign in at website in order to view the information. For a mainstream public this information has to be very simple and concise so that the person does not waste time. • In order to achieve energy savings, it is necessary to have consumptions well allocated and use the right incentives to motivate behavioural changes. For example: Opower found that in order to encourage/motivate customers to behave more efficiently they could give them all kinds of information/incentives and customers did not change their behaviour, but they

discovered that the comparison with neighbours ("Did you know your neighbour consumes less than you?") had results.
- Gamification to trigger behavioural change with end users target groups.
- It is very important to provide KPIs (references and measurable indicators to understand what is the state of the art of the market) to consumers. This references should allow consumers to compare their consumption with the one of similar consumers and motivate them to save energy. The platform should provide comparisons with average levels and with ideal values (efficient).
- Installation of smart meters is an urgent measure in the market. They should be obligatory for new construction. These systems cost between 250-500€ (which is a small increase in the value of a new construction) and the increase of awareness allow savings around 5-10%.
- This system would provide benefits for utilities and allow them to implement DR schemes.
- Feedback to customer should be personalized taking into account the type of consumer and the type of equipment (e.g., initially there could be an analysis of the equipment installed and its utilization).
- Makes available at any moment the knowledge about the energy consumption in an easy way (as from the smartphone or tablets). Instantaneous access to consumption data can encourage EE measures and changing behaviour.

Strengths

Customer needs addressed/Value proposition (1)
- In terms of end users there are already similar models, but I consider this an interesting model. It can be very interesting and innovative if it is used for B2B and if it is more focused in behaviour than in the systems.
- It increases end user awareness of energy saving activities and delivers information and savings.
- Addresses needs for savings if it is mixed with DR and other solutions (as batteries), so we obtain scalability.
- Addresses needs for savings if customers use the platform and the tools that allow them to save. This business model is dependent on the customers.
- Currently, customers only have access to their global monthly consumption. Instantaneous access to consumption data will enable to understand which are the moments of greater demand and which are the causes, allowing better knowledge of their consumption performance.

Customer segments (2)
- Domestic sector: both small domestic owners and large property owners.
- It can be very interesting and innovative if it is used for B2B and if it is more focused in behaviour than in the systems.
- Commercial and public buildings (e.g. using a logic of gamification and competition between departments with championships and prizes).
- It would be more directed to higher-income families and new constructions. For refurbishments or public housing, it would be difficult to pay for such a service.
- Office buildings, residential buildings and SMEs.
- The customer segment should not be the residential sector because there is no interest for such systems. Instead of the residential sector, this model should be offered to maintenance technicians and professionals who also need awareness and are more motivated to use these kind of systems. There is a

very high potential in large commercial buildings, particularly in hotels (e.g., in Algarve and Costa del Sol). The impact and savings potential would be much superior in this segments than in the residential sector.

Channels (3)

- There are very well-positioned players, such as energy traders (utilities) – they would be a natural channel, and also telecom operators.
- This service should be offered by a utility as an add-on service.
- This service should be associated with other products as an add-on (e.g. EDP has a commercial campaign that offers a monitoring system in the purchase of photoelectric centrals).
- It is important to combine this solution with other services that customers value such as security (alarms, camera) and comfort. This solution should be sold with a concept like "your home in your hand" as Google's Nest thermostat.
- Associations for consumer's protection and housing companies.
- Facility management companies.
- Companies: personal and direct contact.
- Individual users: mail, e-mail, phone, web and advertising campaigns.
- Calls for tender for management of public installations.

Key activities (5)

- Marketing.
- Acquisition and installation of the equipment necessary to obtain saving (e.g. consumption allocators, batteries).
- Establishing data connection and collection.
- Education and motivation of building occupants.
- A well-developed end user's engagement programme has to be deployed.
- Maintenance of the web-server.

Key resources (6)

- Depending of the levels of complexity, it can involve consultation rounds with behavioural scientist to analyse end user's behaviours and establish biggest potential changes
- Development of energy saving measures.
- Deployment of specific technology to allow end user competition.
- Peer comparison, introduction of social norms, etc.
- Hardware for monitoring.
- Web service for gathering information and providing it to the user interface.

Key partners (7)

- Technological company to develop the platform;
- Companies specialized in social engagement.
- Utilities.
- Any entity who is directly involved with the end-users, i.e. Utility companies for Residential Market, Facility management companies for Office buildings, etc.
- The customer (view the customer as a potential partner for ideas). Because he will interact with the system this could be a way to access his real needs and ideas for improvements.

Weaknesses

- This business model is not innovative (19%); utilities have already similar services.
- This service needs to be an add-on to other services/products (62%).
- These devices bring intelligence. In the future we will witness the rise of photovoltaic systems (solar self-consumption and price competition), electric vehicles and reduced price of batteries. Consumers are going to be prosumers. In each house there will be a system that will read the customer usage profile and every evening make the decision whether it is necessary to purchase energy or not. But, or these systems are autonomous and make decisions for us, or no one will change behaviour.
- I am sceptical about smart meters because I think it is just a transition phase. I have had two experiences with similar systems and I think that customers will see it 1 or 2 times and then they lose interest.
- The cost of these systems does not justify the investment in Portugal, but in countries that have large heating requirements (such as Serbia) it might make sense because there is a greater potential for savings in heating.
- The performance of this model depends on the customer (58%) and it requires some risk for the ESCO (46%), which implies that it can only advance where behavioural change justifies the investment cost and the ESCO needs to ensure that the customer is motivated to save energy.
- This model has some constraints because it is not able to reach the elderly or people not familiarly with technologies.
- People are not interested in such systems. Some demonstration projects regarding similar systems have been developed and did not have successful results.

Customer relationships (4)

- It is very important to guarantee that the technical aspects work properly and that the information that reaches the customer has quality. And also the quality of the portal and application (user friendliness and facility to view/search information).
- Savings depend on customer's behaviour, the ESCO cannot guarantee results.
- This can only be used as an additional feature on an existing service as in some cases (i.e. office buildings) it will be hard to quantify contribution towards the overall savings. Furthermore, once initial activities and communication to end users has been performed and the novelty factor disappeared, it requires constant effort to keep end users engaged.
- It should have a very simple, appellative and user friendly graphic interface, so he is motivated to learn more about his consumption and EE. The customer needs to feel it as a pleasant experience and not an obligation. Gamification and social networks could be used.
- Customers might be interested in such a service because of the novelty it introduces. But, once the novelty has passed it will be very difficult to maintain their interest.

Revenue streams (8)

- The customer is not willing to pay much for this service, only a small amount

of money. In order to apply this business model to the residential sector (mass-oriented) partnerships would be needed. We cannot escape to the investment cost in smart meters, but we can ensure that the platform maintenance costs are the lowest possible. Could be used e.g. a hybrid model charging an overhead fee to cover the development costs (minimize investment costs) and lower monthly fees (that could be based on the savings obtained) to cover the platform's maintenance costs.
- Monthly fee depending on the utilisation of the portal.
- The customers may not be willing to pay, but if this business model is associated with DR the revenue stream could come from there. In this way, the customer would not need to pay directly for the service.
- Subscription of the service during a defined time period (for example, 6 months) and then the customer would be free to renew the subscription whenever he wants.
- The costumer could pay a small monthly fee with the obligation of remain in the contract for 5 years.
- This service could be an outcome of an energy audit and in that case the customer would pay for the audit.
- This service is a tool that helps selling ESCO projects, it should be an add-on offered to customers to allow them to verify the savings achieved by an ESCO project.
- The customer should support the initial investment, but with a guarantee that he will be able to save X% (if he changes his behaviour). If not, he would be compensated by the ESCO.
- It is hard to establish if the customer would be willing to pay for this service. This can be offered as an add-on to existing contract for an increase % of the savings being retained by the ESCO.
- This service should be offered as an add-on fee in the energy bill. With enough scalability the cost could decrease to cents per consumption point (assuming that the smart metering equipment was already installed in the facility).
- For customers without purchasing power there should be State incentives for the smart meters' installation.
- There are 2 options: a) the customer pays for the smart metering equipment and then a small monthly fee or b) the customer outsources energy management to an ESCO and he pays a monthly fee to the ESCO.
- Offered by the ESCO like a product as a service.

Cost structure (9)
- Specialist time if behavioural scientists are employed.
- CAPEX for technology i.e. smart meters and data collection infrastructure for the residential market plus IHD (In Home Displays) or access to online services.
- Development of the platform and application for smartphones.
- Acquisition and installation of the required equipment. Maintenance of the web-server.

Table 34: Feedback from LL members on "raising occupants' awareness as a tool for energy savings" business model.

The main aspects referred by the LL members about "raising occupants' awareness as a tool for energy savings" business model are summarized in Figure 29.

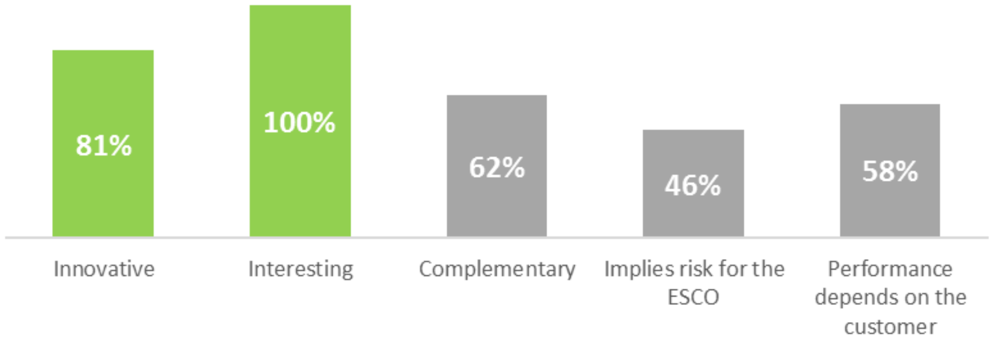


Figure 29: Main aspects referred by the LL members about "raising occupants' awareness as a tool for energy savings" business model.

7.1.4 Valorisation of buildings through energy certification

The aforementioned analysis presented business models that are directly associated to the Product-Service Systems of Energy Service Companies (ESCOs). However, main goal of the project is the identification of innovative business models based on new revenue models. We are identifying alternative revenue streams that promote the business role of ESCO, as a provider of energy services:

- By developing properties certified with a **green building label**: 'Green' building certification systems assess a building's performance according to environmental and wider sustainability criteria. In this model, a property or building manager designs and operates buildings certified according to a voluntary 'green' certification scheme, expecting to realize a sales price premium compared to conventional buildings.
- By profiting from **rent increases** after the **implementation of EE measures**. The establishment of an energy efficient and automated environment provides benefit to any building ensuring also the long-term prompt operation of any property.

The valorisation of residential and commercial buildings through energy certification is a business model that introduces an innovative approach to ESCO services. It allows for **"selling" EE through building's energy certification",** aiming to valorise the building by raising its energy certification label and at the same time improving its energy performance through the implementation of EE measures and energy retrofitting actions. The role of ESCO is to ensure that the appropriate energy saving measurements are taking place, supporting that way an increase on energy performance certification.

Towards this direction, different MOEEBIUS activities are directly associated with the proposed business model. On the one hand, there is a trend by moving from traditional energy performance certifications (EPC) to operational EPCs, with energy performance calculated based on actual building conditions. Towards this direction, activities related to **real time building management** associated with **predictive maintenance** strategies will be considered as a main factor for energy certification. In addition, health and comfort related indicators (as examined in the MOEEBIUS framework) could be considered as factors of building certification. This mixture of energy and well-being parameter leads us to the definition of enhanced EPC certifications that may further provide added value to the building owners and their properties. In addition, a main prerequisite for energy performance certification is an accurate baseline definition. Therefore, we need to establish a standardized, model-based Measurement and Verification Protocol that sets the basis for improved energy performance baselining and holistic evaluation of building performance throughout its whole lifecycle.

On the other hand, a module for retrofitting decision-making will be considered as a supportive tool for this business model. The retrofitting advisory engine may

facilitate the decision maker to explore a portfolio of potential building retrofitting projects (taking into account several parameters: initial investment, ROI, Life Cycle Costs and performance benefits will characterize each retrofitting activity) and will further enable the definition of a set of optimal solutions for retrofitting. Therefore, the retrofitting decision-making engine will enable the selection of retrofitting plans that will ensure a better energy certification label.

With better energy certification, the tenants of residential buildings might be willing to pay more for rents to a building owner because they will ensure higher levels of comfort and energy efficiency. On the other hand, companies that are engaged on guaranteeing good building performance will also promote the idea of better energy performance certification labelling. Table 35 summarizes the "valorisation of buildings through energy certification" business model.

<table>
<tr>
<td rowspan="2">7 - Key partners
ESCOs;
Independent consultants;
Engineers and architects allowed for building energy certification.</td>
<td>5 - Key activities
Labelling of projects in terms of energy performance based on the result of the energy certificate;
Proposition of retrofitting advisory plans.</td>
<td rowspan="2">1 – Value proposition
Valorisation of the building by raising energy certification label;
Improvement of the building's energy performance;

Energy savings through the selection of optimal retrofitting plans

Improvement of the comfort level and heath of the occupants.</td>
<td>4 - Customer relationships
Short-term: Tenants and building owners;
Mid-term: Building owners;
Long-term: Real State actors and public authorities.</td>
<td rowspan="2">2 – Customer segments
Building owners;
Real State actors;
Public authorities.</td>
</tr>
<tr>
<td>6 - Key resources
Standardized Measurement and Verification Framework;
Retrofitting Advisory Engine that enables optimal selection of retrofitting plans.</td>
<td>3 – Channels
Real State Fairs;
Presentations to public/private building owners;
Mandates that define the specifications for EPCs;
Add on to ESCO typical services.</td>
</tr>
<tr>
<td colspan="3">9 - Cost structure
Technology and labour cost;
Investment in EE measures;
Investment in equipment retrofitting and/or optimisation.</td>
<td colspan="2">8 - Revenue streams
Contracts for energy certification in residential and service buildings
Contracts for energy savings due to retrofitting activities.</td>
</tr>
</table>

Table 35: Valorisation of buildings through energy certification.

Regarding feedback from the LL members that contributed on the co-creation of MOEEBIUS innovative business models, Table 36 highlights the main innovative characteristics, strengths and weaknesses of the "valorisation of buildings through energy certification" business model.

Innovative characteristics

- The general idea of this model is innovative (65%) and interesting (88%).
- It has value and it is considered that companies would be interested, but it is very important to obtain tax reductions according to the label achieved. Other incentives could be subsidizing technology.
- Energy certification should become a stamp that accounts, in addition to the energy performance component, also environmental and water consumption components. If we focus solely on energy certification we are belittling other things that are very important.
- Energy certification can only work if there are associated tax benefits (58%) or other incentives. For example, a company could have tax deduction in order to be motivated to get higher levels of energy certification. Otherwise there is no motivation to do so.
- It is necessary to ensure that the certification is properly performed (contrary to what happens currently in the domestic sector in Portugal and Spain), ideally certification schemes like LEED should be used. Certification needs to have credibility and rationality.
- This business model should also include a platform (as business models 1 and 3) to show the customer what exactly is being done and what is the impact of the measures applied. The customer needs to know what will be his economic benefit.
- The fact of valorisation through energy certification is not innovative, but it is the identification of efficiency weakness in order to determine the most suitable retrofitting actions.

Strengths

- The building owners and facility managers of large international companies start to see that the value of their building is highly increased with certification.
- Energy certification is increasingly more important.

Customer needs addressed/Value proposition (1)

- If it has associated tax benefits and incentives to use more efficient construction materials.
- Savings, because it would need to include significant EE measures.
- Savings, because it will allow to reduce significantly customers' energy bill.
- However, savings are not the motivation for this business model, the main concern is the value and not the energy.
- Buildings require an energy certification for its rental/sale. Currently there are many companies which offers this certification for the current state of the building, but not much offer deeply analysed improvement measures or retrofitting actions in order to get a better certificate.

Customers segments (2)

- All buildings (residential and business).
- Mainly the domestic sector because the commercial sector is not concerned with this issues.
- Building owners.
- SMEs.
- Office buildings, retail and hospitality.
- Large commercial buildings (higher savings potential).

- High income residential buildings (higher investment capacity).
- Large international companies, shopping centres and offices (motivation: corporate responsibility and sustainability).
- Building owners who have the obligation to perform energy certification.

Channels (3)

- Dissemination could be made by the municipalities or by the Tax Authority (e.g. by mail or email asking "Would you like to pay less Municipal Property Tax?"). After this first approach, it would be accompanied by ESCOs.
- Direct approach to the costumer, housing associations and commercial associations.
- Energy agencies.
- Energy consultants.
- Before implementing this model, it is necessary to educate and inform people of the advantages of such model to create trust and understanding. Marketing would be very important.
- It would be very interesting to study the real estate market and understand if there is the correlation between the energy label of a building and sales (selling speed, additional value…).

Customer relationships (4)

- This service should be offered as an add-on to the obligatory certification scheme.

Key activities (5)

- Technical and financial.
- An energy audit has to be performed; depending on the existence of a BMS data can be collected automatically but a human analysis needs to be performed as well.
- Analysis of actual state, design potential efficiency improvement measures, select the most suitable and execute the retrofitting.

Key resources (6)

- Consulting time.
- Access to BMS data.
- Personnel for the energy audit, analysis of the retrofitting options and retrofitting execution.
- Equipment and elements for the retrofitting.
- Acquisition of the required elements for the retrofitting

Key partners (7)

- Certification companies/qualified experts.
- Municipalities and energy agencies.
- Financing entities and State (funds).
- Energy consultants.
- Energy auditors.
- Companies for the retrofitting execution, if needed.

Weaknesses

- This business model is not innovative (35%) It is pretty much what has been practiced in the market.
- This business model is not interesting (12%). Energy certification has no value to anyone. The energy label does not identify whether a building is sustainable or not or if its occupants have high levels of comfort.
- From the investor's point of view, there is no guarantee on the valorisation of his investment. This business model would be based only on the investor's good-will.
- Customers are not interested in this model (62%), even if the buildings were Net Zero Energy Buildings. E.g. in a house people will invest in good insulation. But their motivation is not the energy label because that does not say anything to people.
- If this business model was associated with the usual EU certification scheme, then it would not be interesting for no one. But if this model uses alternative certification schemes (as LEED and BREEAM), then it could be interesting.
- This business model would be very difficult to implement.
- The main barrier of this model is that the customer will need to understand very clearly what are his benefits, i.e., that he will have profitability in the future.
- There are two important limitations for this model: the discredit of energy certification and the high costs of the EE measures than would be necessary to implement in order to achieve a higher energy label.
- Other issue is the fact that with this model is more difficult for the customer to access the project results (instead of simplifying the process of explaining to the customer exactly what are the savings and providing more transparency, this model does the opposite). To obtain customer’s trust it is necessary to ensure total transparency.
- A higher energy certification label without a rational utilization of the systems does not have results. It is important to ensure an efficient utilization in order to obtain savings.

Revenue streams (8)

- This business model is hard to sell and the EE measures are expensive.
- Should be charged overhead because certification does not take into account customers’ behaviour. For example: an overhead value dependent on the difference between certification levels and building area.
- The valorisation of assets is complicated. The customer should only pay for the EE service.
- The ESCO should pay itself with the savings until achieving revenue for the work developed.
- The ESCO should provide a free budget to the customer including investment cost and estimated savings. This cost could be charged overhead or divided between a time period.
- This model should be an add-on to the mandatory certification scheme. Before the emission of the certificate the ESCO would perform the study of measures needed to apply to increase the building classification (preliminary audit) and the customer could opt to do so or not.

Cost structure (9) • Specialist consulting time from certified energy auditors. • Data collection form BMS systems to document the assessment. • Main costs are investment costs in retrofitting (if needed) and the personnel costs for the energy audit.

Table 36: Feedback from LL members on "valorisation of buildings through energy certification" business model.

The main aspects referred by the LL members about "valorisation of buildings through energy certification" business model are summarized in Figure 30.

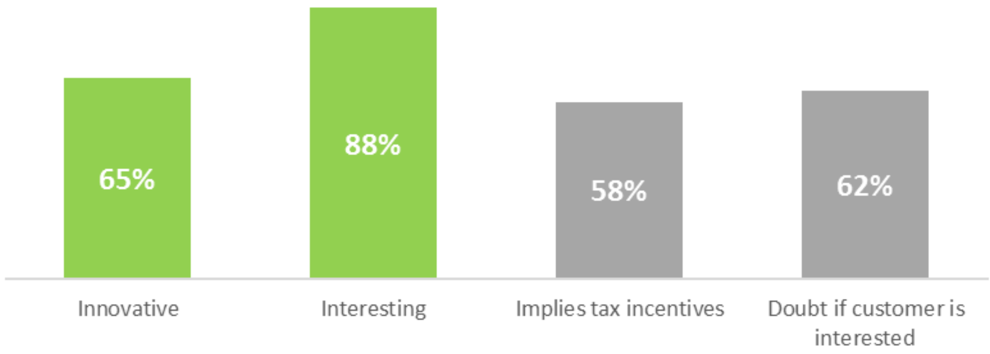


Figure 30: Main aspects referred by the LL members about "valorisation of buildings through energy certification" business model.

We have to point out that "valorization of residential and tertiary buildings through energy certification" is a business model that stands on top of current EPCs framework by covering the gap between real life and existing energy simulations through a methodology that is applicable in all member states.

The Energy Performance of Buildings Directive (EPBD) (2002/31/EC1; 2010/91/EU2), introduced EPCs as an important instrument to enhance the energy performance of buildings. All EU member states adopted this directive by:

- Introducing an independent EPC control system (art. 18);
- Assuring competence of the certifiers in the accreditation procedure (art. 17);
- Introduction of penalties for non-compliance, including for poor quality of the EPCs (art. 27);
- Increasing the availability of EPCs in sale and rent transactions and the visibility of the energy label in commercial advertisement (art. 13);

After several years of the directive in place, to date, independent control systems for EPCs have been formally established. In a number of countries, e.g. Greece, Hungary, Latvia, Czech Republic, Croatia, Germany, Poland, Romania and Slovenia, this only happened in 2013-2014. Thus, it is still in the early implementation stage. For example, in Poland, Latvia and the Czech Republic the rules for EPCs quality control are being defined recently.

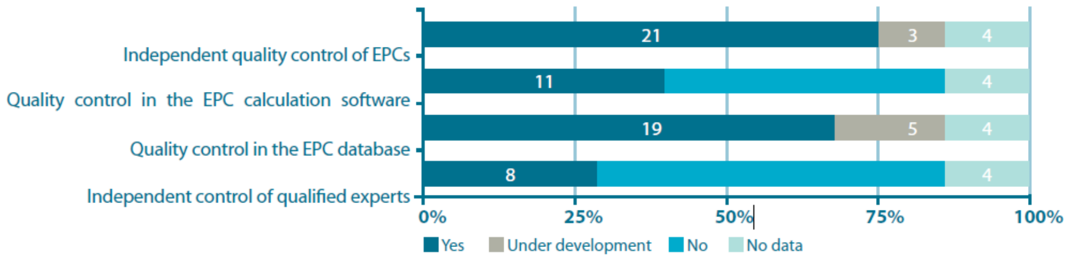


Figure 31: Independent quality control of EPCs across EU-28 (BPIE, 2014).

Although Annex II of the EPBD gives guidance on the measures to verify the energy performance certification, the **approaches vary between Member States.**

There is not a common methodology defined for the energy certification of buildings around Europe, and the energy simulation software used do not cover the gap between real existing buildings and simulation models. A common methodology for EPCs in Europe could provide building owners, tenants, real state actors, and public authorities accurate information about the energy performance of the European building stock, allowing for an extra valorization category in buildings.

We have identified **four business models for ESCOs** within MOEEBIUS framework. The definition of these models takes into account the main business objectives of MOEEBIUS framework towards the:

- Provision of enhanced **building and district level models** addressing the complexity and impact on energy performance of different building and district-wide systems
- Extension of current Energy Performance Simulation framework by incorporating to the physical sub-system (buildings, their equipment and their usage, along with districts and their systems), the **human subsystem** (occupants and their behaviours) and the general **surrounding environment** (weather, its fluctuations and impact on the other systems)
- **Real-time building performance optimization** (during the **operation** and **maintenance** phase) associated with optimized **retrofitting decision** making on the basis of improved and accurate LCA/ LCC-based (Life-Cycle Assessment/ Life-Cycle Cost) performance predictions
- Establishment of a **standardized, model-based Measurement and Verification Protocol** that sets the basis for improved energy performance base lining and holistic evaluation of building performance throughout its whole lifecycle

By incorporating these main objectives to the proposed MOEEBIUS business models for ESCOs we ensure high level of innovation and further high potential for replication by the end of the project. The same approach is also followed for the extraction of Aggregator business models as presented in the following section.

7.2 MOEEBIUS energy management strategies for ESCOs

Following the identification of ESCO business models, we proceed with the definition of the high-level **energy management strategies** associated with each business model examined in the project. The different management strategies examined within the context of MOEEBIUS framework will consider significant **energy performance improvements without sacrificing occupants' comfort and health** in the indoor environment. Alternative strategies will be shaped either for **maximizing energy savings** (under automated control scenarios) by regulating occupants' comfort at the boundary limits of identified comfort zones, or for establishing **optimal equilibria** between energy performance, comfort and health, according to the requirements of buildings occupants and managers.

It is clear that a main innovation of the proposed framework is the incorporation of **comfort and health related parameters in building management strategies.** Therefore, as part of the building operation process, the selection of optimal control strategies will take into account **comfort KPIs** and **health related boundaries**. MOEEBIUS will address occupant profiling and occupant's behaviour as a fundamental factor for the optimisation of energy performance at building level, through the implementation of a framework that will both address occupants' preferences and be adaptive to the operational patterns of the monitoring area. In that context, energy performance optimization shall take into account occupants' comfort and occupant-specific preferences. In addition, Indoor Air Quality (IAQ) aspects should be addressed to satisfy the requirements for the establishment of a "healthy" building environment under automated control actions (e.g. demand-controlled ventilation).

Furthermore, one of the main objectives of the project is the delivery of a **holistic management framework** that takes into account not only real time automation, but also predictive maintenance and retrofitting activities as part of the operation process. Towards this direction, the End-User Application will accommodate the Integrated MOEEBIUS Decision Support System (DSS) that incorporates Predictive/ Sanitary Maintenance, Retrofitting Strategies Evaluation and real time building management.

As a new approach on the implementation of energy management strategies, we considered also a supportive **behavioural triggering framework**. One of the main objectives of the project is to incorporate occupants' Profiling Mechanism as part of the proposed framework, in order to highlight the role of occupants as a critical element of the building. The building occupants -through interaction with mobile UIs - will continuously provide personalized information to identify

individual needs and preferences. On the other hand, and towards the active engagement of building occupants, the users get informed about building conditions and further triggered to adopt energy efficient behaviours. Therefore, the holistic energy management framework will take into account personalized preferences and needs and will further provide the appropriate control settings/messages towards the establishment of both energy efficient and ambient environments.

Through business models analysis, and in order to ensure high level of quality on the services offered by ESCOs, we highlight the need to limit the gap between simulated and real time building management process. Post-Occupancy Evaluation studies in built and occupied buildings have demonstrated **huge gaps between predicted and actual energy consumption**. In more detail, the performance gap generates a consequent gap between payback estimates and techno-commercial ROI calculations in ESCO projects. Customer expectations are based on previous energy audits, which typically use simplistic and inaccurate calculations to show acceptable paybacks of 2-5 years. This situation imposes significant risks for the implementation of "paid from savings" contracts by ESCOs.

In turn, ESCOs are forced to add installation and commissioning services, project management, man effort, M&V costs to hedge the risks induced by prediction uncertainty and inaccuracy. The duration until break-even typically doubles compared to the simple payback calculation that many customers start out with. Even in more promising areas for EPC contracting, like critical facilities where energy costs are significantly higher and facilities owners are willing to remunerate ESCOs accordingly (e.g., manufacturing, data centres, laboratories or clean rooms, industrial facilities involving specialized processes, etc.), a very high service standard is typically expected and may include stringent liability clauses in case things do not go as planned. This introduces extra risks for ESCOs and significantly reduces their profit margins, in the absence of specialized methods and tools that can provide the accuracy and/or the management of deviations required for the satisfaction of the "paid from savings' contract clauses.

Consequently, the successful penetration and effective application of ESCO business models relies on **minimizing the gap between actual and predicted building energy performance**. Through the incorporation in the MOEEBIUS platform of a real time building dynamic assessment engine, we ensure a real time monitoring of building conditions and adaptation to dynamically updated building simulations, taking into account continuously updated building models. The role of this Building DAE engine is to trigger accurate (based on the initial plan) energy management strategies that will facilitate the establishment of novel, more robust and attractive business models, characterized by attractive payback periods and increased utility for all stakeholders involved.

Through the identification of the main **energy management strategies** to be incorporated in the MOEEBIUS platform, a holistic energy performance optimization framework is considered to tackle the causal factors that have hindered the ESCO market growth and prohibited the unleashing of the tremendous EE potential of the building sector. An imperative step, towards this direction, is to understand **building occupant behaviour** and integrate it in dynamic building simulations addressing the optimization needs of different stages of the building lifecycle. Capturing the real-life complexities of building in highly accurate, robust and dynamic user models will ensure that occupants are taken into account, not only in **real time energy management** strategies (enabling accurate predictions), but also, in **O&M optimization activities** (real-time) which continuously adapt the performance of the building to constraints (occupancy, weather, occupants' preferences, etc.), thereby making sure that energy efficiency does not compromise other performance criteria (**occupant's comfort, health** and **well-being**) or the building operations. Properly addressing current building needs through the selected management strategies, will promote the enhancement of customer confidence in EPC effectiveness and ESCOs ability to guarantee results and mutually agree with customers on savings targets, thus reducing business risks that have hindered the growth of the ESCO market, especially at EU level.

7.3 Demand Response innovative business models

Following the presentation of traditional business models related to the role of the Aggregator, we proceed with the definition of innovative DR business models that will be examined in MOEEBIUS project.

The main objective of the MOEEBIUS is to enable effective **peak-load management** and the transformation of demand-driven Virtual Power Plants (VPPs) to active energy market commodities, competitive against traditional resources (power generation) used for the provision of balancing and ancillary services to the distribution grid. In addition, MOEEBIUS should allow Demand Side Aggregators to test and validate **hybrid business models** that combine Demand Response Services provision to the distribution grid with Energy Efficiency Services provision to building or district managers, thus enabling improved hedging and profit maximization through control strategies applied over non-critical but of significant size building loads (HVAC and Lighting).

The extraction of new business models is following consultation with Living Lab members that provided their feedback about the definition of new DSM and DR business models. By the end of this process, we propose the following innovative business models for DR: (i) Predictive analytics for clusters of buildings, (ii) Peak demand management and (iii) Flexible DSM framework for participation on external markets.

7.3.1 Predictive analytics for buildings

Predictive analytics is an extension of traditional ESCO service offered by Aggregators. The cloud based predictive analytics solution will enable dynamic real-time energy management across the globe and witness all around improved efficiency for the customers.

The predictive analytics solution is part of the Building Energy Management Systems (BEMS) market. The BEMS' 2013 market size in Europe was $938.5M with double-digit growth forecasted from 2013-2018. The predictive analytics solution fits the EE requirements of a DR aggregator and targets customers by dramatically controlling energy costs, making accurate decisions on energy and getting the greatest possible performance out of customers' assets.

A software that measures the building current conditions and compares them to a pre-set list verifying if adjusting will be needed (identification of deviations between performance predictions and real-time measurements as a main innovation introduced in MOEEBIUS project). In this case, **outliers' detection** in portfolio performance lead to the implementation of DSM strategies from Aggregator side, enabling that way the smooth operation of portfolio.

The unique selling point of this solution is its user-friendly software platform that runs complex algorithms at the backend and presents actionable results to

customers such as alerts for abnormal energy usage, benchmarking against external conditions and forecasting tools to calculate energy costs going forward. Within MOEEBIUS project, we incorporate user behavioural patterns as part of the demand flexibility framework, enabling that way the extraction of accurate DR policies towards eliminating deviations between performance predictions and real-time measurements.

A DR aggregator will need in-house capabilities of designing hardware and software for demand management. Additionally, a tie up with leading utilities will strengthen brand recognition and aids geographical expansion of this service. Table 37 summarizes the predictive analytics for buildings business model.

<table>
<tr>
<td rowspan="2">7 - Key partners
Subcontractors;
Electrical installers;
Electrical utilities</td>
<td>5 - Key activities
Obtain high quality historical meter and sub-meter data;
Build accurate predictive model using data;
Constant feedback from customers</td>
<td rowspan="2">1 - Value proposition
To offer large energy users clear results and actions that can maximise their energy savings potential;
Minimize deviations between performance predictions and real-time measurements</td>
<td>4 - Customer relationships
Constantly improving client interface (app and website);
24/7 technical support to analyse data</td>
<td rowspan="2">2 - Customer segments
Large energy users are segmented as:
Industries;
Public buildings and Commercial buildings.

We will focus on hotels and shopping malls as they are most keen on increasing energy efficiency</td>
</tr>
<tr>
<td>6 - Key resources
Access to real time energy data;
Continuous 2 way communication between hardware and cloud server;
Meter collection devices</td>
<td>3 - Channels
Utilising existing customer base from DR business;
Partnering with utilities in international markets</td>
</tr>
<tr>
<td colspan="3">9 - Cost structure
Development; 24/7 technical support; Cloud maintenance; Software; Exploit the hardware already installed in premises</td>
<td colspan="2">8 - Revenue streams
Software as a service model where customers pay a subscription charge for using the software.</td>
</tr>
</table>

Table 37: Predictive analytics for buildings business model.

Regarding feedback from the LL members that collaborated in the co-creation of the innovative business models, Table 38 presents the main aspects highlighted for "predictive analytics for buildings" business model.

Innovative characteristics
• Big data. • Smarter buildings from older building stock. • Accurately capturing behaviour of buildings and knowing how to optimise versus demand response service response availability/capability and pricing. • Knowing what can be offered in trading and what you will need. • This is a natural progression of a traditional DR model. • Why only pay end users like commercial and industrial customers for turning down their loads? Rather DR aggregator can offer predictive analytics at a cost which will offset DR payments.
Strengths
Addresses customer needs/Value proposition (1) • Enable facility manager to perform better by: a) identify issues remotely and b) save energy. • Energy efficiency and consumption profiles. • Facilities management companies – be able to look at their buildings, especially if mandated to reduce energy usage. Identify opportunities to trade energy with others. The market is becoming volatile. • Data aggregation. • Data visualisation. • Leveraging excess capacity of assets. • System charges optimization. • Customers want to know what they can do to reduce energy bills, increase EE and meet carbon emission targets. This predictive analytics model can meet all three of the needs. **Customer segments (2)** • Big energy consumers with dedicated facilities managers. • Complex buildings (industrial scale facilities). • Possibly small scale buildings when energy savings are combined with energy management services. • Facilities management users rather than owners (e.g. Bilfinger). • Building and facilities managers. Aggregators and suppliers getting into this segment (e.g. energy department of an energy retailer). • Large energy users (commercial and industrial) customers. Customers that can get paid for DR control. **Channels (3)** • Energy providers (utilities). • Facility management companies. • Face-to-face contact (because trust is an issue), traditional marketing tools (e.g. glossy brochures). • Through energy managers, building managers, facilities managers. • Through partners (BEMS vendors and operators, FM companies, technology vendors). • Direct sales network; through System Integrators & Value added Resellers; partnership with Utilities (Energy suppliers).

Key activities (5)
- Perform data analytics and develop subsequent algorithms.
- Development of user interface.
- Data acquisition.
- Accurate predictive models.
- Transparent activities.
- Financial incentives in contracts.
- Accurate models. Being able to interface with on-site assets. Non intrusively add in sensors at minimal cost to maximise ROI & minimise time to recover investment.
- BEMS data harvesting for baseload determination.
- Telemetry.
- Provide analytics that can lead to easy to implement energy savings.

Key resources (6)
- Web developers.
- Data analysts.
- Building energy (services) engineers.
- Both financial and technical resources, e.g. computing ability at a level sufficient to deliver the innovation.
- Need to be able to talk to facility managers.
- Software platforms and dashboard development and maintenance (Outsourcing to TPIs/energy brokers).
- Ensure to provide an extremely good user experience in the software.

Key partners (7)
- Companies with access to building data: a) facility management companies and b) BEMS operators and vendors.
- Probably utilities if their data are of high granularity (depends on the developed algorithms).
- Financial and technical.
- Facilities management companies. Sub-contractors & ESCOs have their own teams but most often will use sub-contractor or partnership with facility manager. Small facilities might use aggregator + sub-contract combination.
- Energy brokers.
- System integrators.
- Energy consultants.

Revenue streams (8)
- Initially an income model based on savings (pay as you save).
- In case of big roll out (many clients) move to subscription based model (software as a service).
- The biggest value to the customer is transparency. Risk mitigation (almost risk free is also important).
- Share the benefits. Create model to share installation costs and then the savings. Some companies might also pay a monthly fee for reporting data also (data is valuable for other aspects beyond demand response).
- Software could be sold as a software as a service (e.g., Software as a Service with subscription per package).
- The value that the customer is willing to pay depends on number of meters/controllers installed on site (directly proportional).

Weaknesses
Customer relationship (4) • Achieving anticipated energy cost reductions. • Provide conveniences and make life easier for facilities managers. • Attendance at targeted events (e.g. trade fairs). • Need to be more 'push' than pull of data and providing observations, opportunities and ideas rather than just data. • Needs to be kept high level and simple so that suggested actions can be passed on and executed. • Minimise upfront cost. • Continuously provide software updates. • Prove real savings through analytics. **Cost structure (9)** • Main cost is in the development of the algorithms and getting access to data for that. • Main cost is in component costs for smarter buildings (e.g. meters and data analytics). The initial set-up costs are the most important, not the operational costs. • Cloud maintenance. • Software licencing. • Need a very good technology team with UX, software and data experts. • Need a very low cost hardware that will lead to low upfront costs.

Table 38: Feedback from LL members on "predictive analytics for buildings" business model.

7.3.2 Optimal peak demand management

Peak demand management is a solution for energy consumers to control their peak demand and reduce annual energy bills by 30-50%. It is observed that for many large energy users in the USA, a single peak demand at any point in time can affect electricity bills for the next 12 months. **Hence, large savings are possible for controlling the peaks**. More specifically, the service automatically (in advance) notices a **potential peak load (KW_{max})** and directs the energy management system for cutting functionality without intruding end-user comforts.

The main innovation of MOEEBIUS project is the incorporation of building occupants' behavioural patterns on demand flexibility profiles, enabling that way the implementation of accurate DR strategies towards minimizing potential peak loads. Apart from providing tools to Aggregators that enable accurate demand forecasting and VPP management, we can scale the peak demand management to clusters of prosumers, enabling that way the coordinated management of portfolio.

In accordance to this business model is **ToU optimization** strategies, where an optimization process is considered taking into account differences on electricity prices (in most of the cases high electricity prices are associated with peak demand). This enables customers to lower energy costs by shifting energy consumption during low price hours and avoiding that way the consumption during high price hours. In this case, price based DR strategies are considered as the way for implementing **ToU optimization**. The engine will constantly collect and analyse energy price data (*alternative tariff selection*), in order to identify how user behaviour is transformed on the basis of variable Electrical Peak Demand, Electrical Energy (Usage), Reactive Demand Tariffs, or through the offering of Incentives and Rebates. This will allow for the creation of high-level **flexibility profiles** illustrating the response **capacity of demand in price-based control strategies** for peak-load management optimization. Table 39 summarizes the details about peak demand management business model.

<table>
<tr>
<td rowspan="2">7 - Key partners
Building data analytics firm; Global electric utilities; Partner with energy storage and PV providers</td>
<td>5 - Key activities
Obtain high resolution, high quality historical meter + sub-meter data; Obtain ToU prices per region and customer type; Obtain tenant comfort requirements; Get asset performance data and forecast its usage</td>
<td rowspan="2">1 - Value proposition
A solution for energy consumers to control their peak demand and reduce annual energy bills by 30-50%</td>
<td>4 - Customer relationships
Offer customers a basket of solutions for energy management: Peak demand; Analytics; DR services to minimize consumption during peak hours</td>
<td rowspan="2">2 - Customer segments
Energy consumers that pay exorbitantly high penalties on peak demand

Customers in energy markets that offer the option for dynamic pricing schemas, such as demand charges and ToU tariffs</td>
</tr>
<tr>
<td>6 - Key resources
Instant asset control technology; Accurate forecasting; Monitoring and automatic control tool</td>
<td>3 - Channels
Utilising utility partner's contacts, additional services to portfolio customers</td>
</tr>
<tr>
<td colspan="2">9 - Cost structure
Hardware manufacturing; Software development costs; Installations; Cloud infrastructure; Operations support labour, 24/7 technical support</td>
<td colspan="3">8 - Revenue streams
Software as a service model with pricing depending on number of assets controlled; Revenue streams by avoiding extra costs due to the optimal portfolio management during peak demand or peak pricing hours</td>
</tr>
</table>

Table 39: Optimal peak demand management business model

Regarding feedback from the LL members that collaborated in the co-creation of the innovative business models, Table 40 presents the main aspects highlighted for "optimal peak demand management" business model.

Innovative characteristics
• Forecasting. • Need to control such that it does not exceed energy limits, otherwise customer could be stuck with higher penalties – need adequate notice to control this (take corrective action in time). • Predictive modelling would greatly help – do scenario investigations in advance to avoid such incursions as well as determine what corrective actions can be taken rather than taking non-optimal reactionary steps at short notice (e.g. cooling a building overnight versus suddenly having to turn on a generator to avoid a peak). • Customers being easily able to see when their sites have peak power (historic and forecast)

- Ability to automatically reduce peaks which will lead to lower energy bills.

Strengths

Customer needs addressed/Value proposition (1)
- Reduce electricity transmission and distribution cost.
- Reduce the electricity cost for the customer (end user).
- Financial savings.
- Need to reduce demand and avoid maximum demand/transmission cost penalties & general cost, i.e., purchase the same energy at lower cost.
- System charges optimisation: a) HVAC assets scheduling and b) on site generators scheduling.
- Customer wants to reduce their energy bills to increase bottom line.

Customer segments (2)
- Grid operators (both DSO and TSO).
- End users (mainly large energy consumers).
- Possibly small customers if appropriate tariffs are to be introduced.
- Facilities managers.
- Energy analysts and economists.
- Prosumers.
- Medium/large commercial buildings, industrial buildings with multiple assets, esp. non-synchronous heavy loads.
- Large energy users that have high power peaks. Also preferably customers that pay demand charges.

Channels (3)
- Energy providers (utilities).
- BEMS operators.
- Limited per customer, usually top-down growth driven.
- Energy managers, whoever is responsible for billing energy costs. Site service through FM company.
- Existing customer's portfolio.
- Direct sales.

Key activities (5)
- Develop interface with customers.
- Appropriate signal generation.
- Predictive algorithms.
- Big data work and development of accurate forecasting models.
- Accurate modelling.
- Cost effective main meter metering.
- Ability to monitor and control assets.
- Data analytics.
- BEMS data harvesting.
- Telemetry.
- Demand forecasting.
- Ability to instantly communicate with asset under control to turn on/off when peak approaches.
- Accurate forecasting of site/asset loads to predict when peak occurs.

Key resources (6)
- ICT infrastructure (e.g. control rooms).
- Customer relationships.
- IT personnel.
- Data analysts.
- Real-time dispatch capability.
- Software platforms and dashboard development and maintenance (outsourcing to TPIs/energy brokers).
- HVAC engineers.
- A good technical team that can build such an efficient algorithm.
- Cloud based data analytics system to predict and control peaks.

Key partners (7)
- TSO/DSOs.
- Energy suppliers (utilities).
- ICT vendors.
- Energy analysts.
- Aggregators.
- ESCOs.
- Software companies.
- FM companies.
- BEMS operators and vendors.
- Technology (HVAC and generators) vendors.
- Energy storage companies.
- Distribution energy companies (e.g., solar).

Revenue streams (8)
- Share of the electricity cost savings.
- Share of reduced bills of customers.
- Grid services (depends on the regulatory framework).
- Risk sharing incentive and peak shaving.
- Use savings to fuel such investments. Similarly use penalty avoidance to justify such a service, esp. if the facility has growth plans.
- Model could be a shared savings model where energy bill reduction due to this model could be shared between customer and DR aggregator.

Weaknesses

Customer relationship (4)
- By delivering the anticipated cost reductions.
- Target the facilities management companies rather than the building owners.
- To get customers – reduce costs for same energy usage.
- To keep customers – show evidence of savings made.
- To grow customers – bring in innovation (e.g. modelling) to identify further savings potential. Having to adapt the load to a market with dynamic energy pricing as the grid de-centralises will help.
- Comparing energy bills after implementing this peak demand management model *vs.* baseline bills (i.e., without model being implemented).

Cost structure (9)
- Customer acquisition.
- ICT infrastructure.

• Remote-control capability and interoperability. • Installation & possibly (initially) model development – but this could be spread over multiple projects. • Cloud maintenance. • Software licencing. • Technology team for product & software development. • Controlling hardware development cost. Sales & marketing cost in establishing this business model.

Table 40: Feedback from LL members on "optimal peak demand management" business model.

7.3.3 Flexible DSM framework for participation on external market

The previous analysis highlights hybrid business models that combine DR capacities with EE Services to building or district managers. Further to this, the typical role of Demand Side Aggregator should be also addressed. The Demand Side Aggregator performs **co-ordinated optimisation** at district level and can actively take part in energy trading with **external parties** on behalf of the district members, who are not allowed for direct participation in energy trading. The Demand Side Aggregator operator decides on the activation of the resources offered by each customer of the portfolio. This is the definition of Virtual Power Plant (VPP) setup by utilizing the aggregated flexibility of Distributed Energy Resources (DERs) under diverse DSM strategies launched by the aggregator. There are different external factors that may lead to the activation of DR strategies (Congestion Management, Grid Capacity Management etc.…).

As mentioned at the introductory section, no integration with external parties is considered for the MOEEBIUS project and thus the main innovation is the incorporation of a **Dynamic Pricing Simulation Engine**, which facilitates the simulation of external parties' role. The engine will constantly collect and analyse energy market data, following market dynamic fluctuations and will feed this data to the MOEEBIUS platform, triggering that way the associated DSM strategies. While both automated DR and price based DR strategies may be considered for the implementation of this business model, the focus is on the evaluation of price-based control strategies for district management process. The development of this Dynamic Pricing Simulation engine, stands beyond the traditional business schemas and guidelines, enabling that way the dynamic optimization process on different "what if" scenarios and supporting the optimal and flexible placement of DR Aggregators in different energy markets.

A further innovation of this business model is that participation of consumers in DR schemas is considered by **fully preserving end users comfort preferences** and **operational needs**. The goal is to identify how user behaviour is transformed on the basis of different price schemas, or through the offering of Incentives and Rebates. This will allow for the creation of accurate demand flexibility profiles illustrating that way the response capacity of demand. The next table summarizes the principles for optimal participation of DR Aggregator on external markets.

<table>
<tr>
<td rowspan="2">7 - Key partners
Building data analytics firm; Global electric utilities;</td>
<td>5 - Key activities
Obtain high resolution, high quality historical meter + sub-meter data; Obtain market data from external sources that enable the simulation of different market models that fit to the actual market conditions;</td>
<td rowspan="2">1 - Value proposition
A solution for Aggregators to select from different business strategies and demonstrate DSM strategies to the optimal portfolio clusters</td>
<td>4 - Customer relationships
DR services to minimize end users disturbance by selecting the optimal DSM strategies; Selection of optimal market conditions for implementation of DSM strategies</td>
<td rowspan="2">2 - Customer segments
Energy consumers that are not willing to participate on traditional models (end users disturbance)

Energy markets that offer the option of different DR products and thus the optimal placement on energy markets is critical for Aggregators</td>
</tr>
<tr>
<td>6 - Key resources
Instant asset control technology; Accurate forecasting; Monitoring and automatic control tool</td>
<td>3 - Channels
Utilising utility partner's contacts</td>
</tr>
<tr>
<td colspan="3">9 - Cost structure
Hardware manufacturing; Software development costs; Installations; Cloud infrastructure; Operations support labour, 24/7 technical support</td>
<td colspan="2">8 - Revenue streams
Software as a service model for DR Aggregators. To provide a tool that enables the optimal placement in energy markets and ensures the reliable participation of customers on optimally selected DR services</td>
</tr>
</table>

Table 41: Flexible DSM framework for participation on external market business model.

Regarding feedback from the LL members that collaborated in the co-creation of the innovative business models, Table 42 presents the main aspects highlighted for "flexible DSM framework for participation on external market" business model.

Innovative characteristics

- Upscaling.
- Economies of scale.
- Reliability.
- Ability to monitor and gain control of a wide variety of assets and aggregate. Use this to enter trading market that would not be available directly to the energy user.
- Ability to apply fast control and dynamic control would be most valuable.

Strengths

Addresses customer needs/Value proposition (1)

- Financial, e.g. creation of new income stream.
- Offer energy users potential savings they would otherwise could not enjoy by indirectly getting them into the energy trading market (via a 3rd party who

aggregates & does the trading on their behalf). This is done without a need for expertise and without compromise to comfort or convenience.

Customer segments (2)
- Broad customer base from electric vehicles to household applications.
- Small companies, retailers, small industrial players who at present cannot trade energy directly due to cost, logistics, poor ROI if done on individual basis.

Channels (3)
- Classical and traditional media (e.g. TV).
- Aggregators will offer directly or through a FM company or building manager. Could also be offered through a retailer.

Customer relationship (4)
- Attendance at targeted events.
- Exposure in traditional media.
- Get customers – offer energy market entry opportunity 'for free'.
- Keep customers – deliver without affecting energy supply.
- Grow customers - Get customer progressively into the smart grid (so that in future any microgeneration and/or storage can be optimally utilised.

Key activities (5)
- Work regarding flexibility.
- Need to have control.
- Need to be able to interface with existing assets (inter-operability).
- Modelling and forecasting are key enablers.

Key resources (6)
- Communications.
- Cheap data.
- Cyber and physical security.

Key partners (7)
- Security companies.
- OEM's (e.g. HVAC and auto companies).
- Aggregators, retailers, building or facilities managers depending on set up.

Revenue streams (8)
- Customers will not pay anything without a new value stream outside of the core platform. A solution could be adoption of a "freemium" style costing model.
- Revenue share (this would not be part of a customer's core business so you need to have means to 100% fund this).

Weaknesses

Cost structure (9)
- The most important cost is in infrastructure.
- Need an agreement to enable 100% funding of the installation.
- Need to demonstrate on-going savings (ROI <1 year) to get the customer into the scheme and then remain. It needs to be seen as 'no risk' to the customer.

Table 42: Feedback from LL members on "flexible DSM framework for participation on external market" business model.

Following the detailed presentation of the MOEEBIUS DR business models, we point out that the main innovation is not on the types of business services offered by DSM Aggregators but on the way we are going to implement the different business services by:

- Providing a mixture of **auto DR** and **price based DR** strategies, enabling that way the active participation of different types of end customers
- Identifying how **user behaviour** is transformed on the basis of different building context and energy market conditions. This will allow for the extraction of accurate demand flexibility profiles, illustrating that way the response capacity of demand by fully preserving building occupants comfort preferences and operational needs.
- Integrating of a **Dynamic Pricing Simulation Engine**, which facilitates the evaluation and further optimal selection of market opportunities through a simulation process. This innovative functionality enables the definition of VPP setups (utilizing the aggregated flexibility of DERs under diverse DSM strategies launched by the aggregator) and further the evaluation of alternative DSM management strategies for selection of the optimal one to be applied in the portfolio.

Through the identification of business models, we cover the high level MOEEBIUS objective to allow effective **peak-load management** and the transformation of demand-driven VPPs to an active energy market player, competing against traditional resources (power generation) used for balancing and ancillary services to the distribution grid. **Hybrid business models** that combine DR and EE Services for building or district managers are considered for testing and validation during the project period.

The next step of the work is the definition of demand response strategies to be considered in MOEEBIUS project, complementing the identification of Aggregator business models. Such strategies promote the efficient integration of flexible demand on a way that ensures the provision of services to traditional market stakeholders and further supports the implementation of energy efficiency strategies at district level.

7.4 MOEEBIUS Demand Response Strategies

Following the definition of DSM Aggregator business models, we proceed with the identification of the associated DR Strategies that will enable the successful implementation of these business models. As a high level objective, DR strategies are formulated by tracing back demand flexibility to "context aware" user behavioural models, offering that way fine grained control (equivalent or even higher than existing Direct Control Programmes) fully respecting prosumer preferences and needs. This is a main principle considered for the definition of MOEEBIUS DR strategies.

There are different types of DR strategies considered for the MOEEBIUS project:

Implicit DR (also sometimes called "price-based") refers to consumers choosing to be exposed to time-varying electricity prices that reflect the value and cost of electricity in different time periods. Armed with this information, consumers can decide to shift their electricity consumption away from times of high prices and thereby reduce their energy bill.

Time-varying prices are offered normally by electricity suppliers and can range from simple day and night prices to highly dynamic prices based on hourly wholesale prices. DR Aggregators, on a way of managing consumers demand and enabling that way the active participation of prosumers on business activities, can define more sophisticated tariff schemas including **time-of-use pricing**, **critical peak pricing**, and **real-time pricing**. As mentioned above, the main innovation of MOEEBIUS project is the dynamic analysis of different price models and schemas, to identify how user behaviour is transformed on the basis of variable Electrical Peak Demand, Electrical Energy (Usage) and Demand Tariffs. This will allow for the creation of **high-level demand flexibility profiles** illustrating the response capacity of demand in **price-based control strategies** for peak-load management optimization.

In **explicit DR schemas,** (sometimes called "incentive-based" or "volume-based") there is no need for continuous enrolment of customers on DR strategies. Consumers receive a specific reward (when part of a contractual agreement) to change their consumption upon request from Aggregator. This consumption change can be delivered manually (e.g. Interruptible/curtailable (I/C) service by triggering rewards and incentives for DR participation), but the main objective of the MOEEBIUS project is to provide an automated DR framework, enabling that way the seamless (and non-intrusive) implementation of DR strategies.

Therefore, we are considering direct load control as the approach to be examined in the project. In direct load control, the program operator remotely shuts down or cycles customer's electrical equipment, enabling that way the implementation of a fully automated DR framework. Once again, we highlight the role of MOEEBIUS profiling mechanism that enables the delivery of Context-Aware Flexibility Profiles,

reflecting real-time demand flexibility as a function of multiple parameters, such as time, device operational characteristics, environmental context/conditions, occupant comfort preferences and health/ hygienic constraints. This is a main innovation of MOEEBIUS framework towards the establishment of a human-centric automation framework, fully preserving building occupants' preferences and needs.

As mentioned above, neither form of DR is a replacement for the other. Many costumers participate in Explicit DR through an aggregator, and, at the same time, participate in Implicit DR programme, through more or less dynamic tariffs. The requirements and benefits of each are different and build on each other. The two serve different purposes within the markets. They are also valued differently. While consumers typically receive a lower bill by participating in a dynamic pricing programme, they receive a direct payment for participating in an Explicit DR programme. Towards this direction, **mixed demand response strategies** should be examined, where portfolio customers participating on both types of DR services (explicit & implicit). In that case, we can easily address one of the main objectives of the project towards the establishment of a **hybrid business model** that combines both demand response and EE Services offered by DR Aggregators.

The next step is the taxonomy of high-level demand response strategies to the different DR business models identified above. The following table provides this information:

	MOEEBIUS Demand Response Strategy		
MOEEBIUS DR Business Model	Implicit demand response	Explicit demand response	Mixed demand response
Predictive analytics for buildings		X	
Peak demand management	X	X	X
Flexible DSM framework for participation on external market	X	X	X

Table 43: High level taxonomy of DR Business models and Strategies.

By identifying the detailed business models and the associated business strategies, we need to consider also the business schemas for implementation of DR strategies. Parameters related to contractual agreements and remuneration of consumers for DR participation are out of the scope of this section, as we need to first identify the pilot areas that will examine the different business strategies. An initial analysis is performed in the next section, where we highlight the role of MOEEBIUS pilots on the evaluation of the different DR business models.

8 Business models and services in MOEEBIUS pilot sites

Future work will consist in the validation of the innovative business models in three large-scale demonstration pilot sites, located in Portugal, UK and Serbia, incorporating diverse building typologies, heterogeneous energy systems and spanning diverse climatic conditions.

The Portuguese pilot site includes: a) school complex with swimming pool and multi-sport hall, b) a kindergarten and c) a city hall. A hotel with a photovoltaic system will be the pilot site in UK. In Serbia the case study will be composed by blocks of domestic apartment buildings with district heating.

Table 44 summarizes which business model will be tested in each of the pilot sites and is followed by a description of the reasons that led to this allocation.

<table>
<tr><th colspan="2"></th><th colspan="3">MOEEBIUS Pilot Sites</th></tr>
<tr><th colspan="2">MOEEBIUS Business Models</th><th>Portugal</th><th>UK</th><th>Serbia</th></tr>
<tr><td rowspan="4">ESCO</td><td>Energy management services based on enhanced EPCs</td><td>(1)</td><td></td><td></td></tr>
<tr><td>Condition/efficiency EPC model for ESCOs</td><td>(2)</td><td></td><td></td></tr>
<tr><td>Raising occupants’ awareness as a tool for energy savings</td><td></td><td></td><td>(3)</td></tr>
<tr><td>Valorisation of buildings through energy certification</td><td colspan="3">This business model will not be tested.</td></tr>
<tr><td rowspan="3">DR</td><td>Predictive analytics for buildings</td><td></td><td>(4)</td><td></td></tr>
<tr><td>Optimal peak demand management</td><td></td><td>(5)</td><td></td></tr>
<tr><td>Flexible DSM framework for participation on external market</td><td></td><td>(6)</td><td></td></tr>
</table>

Table 44: Business models that will be tested in the pilot sites.

1) “Energy management based on enhanced EPCs” business model is going to be tested in two Portuguese pilot sites: b) kindergarten and c) city hall. Both these buildings need an energy management system in order to optimise consumption. In pilot b), due to almost constant utilization of hot water, special attention should be given to access its energy consumption in order to analyse retrofitting the type of equipment and production system. In pilot c), due to the high costs about HVAC units operation, the special interest of the Portuguese pilot site c) is on the optimal management of this type of device.

2) The other Portuguese pilot site, the pilot a) school complex with swimming pool and multi-sport hall, will test “condition/efficiency EPC model for

ESCOs" business model. In this pilot site, due to the high costs about swimming pool operation, the special interest of this pilot site is on the optimal management of the equipment dedicated to the swimming pool operation, namely the water heating system, water distribution system and dehumidification equipment.

3) Raising awareness about the rational use of energy is most usually the key component of most ESCO business models, but it is not in usual practice to use it as a stand-alone model. Buildings in Serbian pilot site are less than 5 years old and, consequently, are not suitable for business models based on refurbishment of building envelope or installations. Measurement of consumed energy on the flat level is already applied for the all buildings. For the same reasons they are suitable to test effects and business model of applying only various measures for awareness raising. Thus it will be feasible to measure and quantify savings generated solely by raising of knowledge level of inhabitants by the means described in the business model.

4) DR goes hand in hand with analytics as they both address the pilot customer's same needs, i.e., reducing energy costs. By conducting predictive analytics on the building assets, we get better visibility of the customer's energy consumption patterns and we can recommend actions (such as shifting energy consumption during peak times) which will reduce energy bills.

5) "Optimal peak demand management" will be tested in the UK pilot site because we want to arrive at innovative ways to reduce peak demands for customers. By doing so, we can help balance the grid and also lower pilot customer's energy bills. Energy is cheaper at off-peak times and thus, a peak demand management model can provide savings to pilot customers.

6) "Flexible DSM framework for participation on external markets" will be test in the UK pilot site with the incorporation of a Dynamic Pricing Simulation Engine, which facilitates the simulation of external parties' role. The engine will constantly collect and analyse energy market data, following market dynamic fluctuations and will feed this data to the MOEEBIUS platform, triggering that way the associated DSM strategies. While both automated DR and price based DR strategies may be considered for the implementation of this business model, the focus is on the evaluation of price-based control strategies for district management process.

Valorisation of buildings through energy certification will not be tested because the pilot sites allow the adequate validation and test of three business models and this

business model was not chosen because it was the one that LL members considered would be more difficult to gather interest from customers.

9 Conclusions

As one of the first steps towards achieving the goals of MOEEBIUS project, deliverable D2.2 provides the definition of innovative business models for ESCO and DR projects. D2.2 is an outcome of Task 2.2 that analyses and defines new business models for ESCOs and aggregators to be addressed and validated in the project for the end-users involved in MOEEBIUS.

Currently, several barriers prevent the generalization of ESCO business models. The main barrier appears to be the lack of awareness and information on the complexity of the ESCO concept, leading to distrust by end-users and also by financial institutions. The present work developed four innovative ESCO business models aligned with stakeholders' requirements, aiming to overcome the barriers that prevent the implementation of ESCO projects.

In the other hand, the main success factors are pointed to be legal and political drivers denoted by long-term, manifested and credible commitment by the public authorities; supportive policies and dedicated ESCO legislation and measures; removal of regulatory barriers and services standardization; procedural factors and tools, such as tools for the various stages of an ESCO project; standardization; financing and information and awareness; and also structural and market related changes, reflected by energy price; ESCO associations and facilitators; and the development of smart technologies

The main outcome of this document is a proposal of four innovative ESCO business models and three innovative DR business models.

The ESCO business models developed introduce energy management based on enhanced energy performance contracts (EPCs), a condition/efficiency EPC model for ESCOs, a tool for raising occupants' awareness for energy savings and the valorisation of buildings through energy certification. The main innovations introduced by each of the ESCO business models developed are:

- Incorporation of comfort and health parameters as part of an EPC. The role of ESCO is to ensure not only EE but high levels of comfort.
- Incorporation of real time automation, predictive maintenance and identification of retrofitting opportunities as part of an EPC aimed to optimise equipment maintenance.
- Gamification and behavioural triggering framework to raise occupants' awareness for energy consumption and to ensure accurate energy savings.
- "Sell" of EE through energy certification with the motivation of valorising a building.

Regarding DR, there were developed three innovative business models including predictive analytics, peak demand management and a flexible DSM framework for participation on external market.

Future work will consist in the validation of the innovative business models in three large-scale demonstration pilot sites, located in Portugal, UK and Serbia,

incorporating diverse building typologies, heterogeneous energy systems and spanning diverse climatic conditions. Pilot sites include: school complex with swimming pool and multi-sport hall; city hall; hotel with a photovoltaic system; and blocks of domestic apartment buildings with district heating. It is foreseen that the future work will allow to understand the acceptance and behaviour change of occupants and create conditions to infer recommendations for policies and incentives to trigger the adoption of ESCO projects. Further research could be conducted on strategies to combine the integration of the ESCO business models developed with DR schemas for electricity, district heating and renewable energy systems.

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11 Annex I - Questionnaires

11.1 ESCO market characterization questionnaire

MOEEBIUS - ESCO Market Characterization Questionnaire

The following questionnaire is aimed at gathering information to support MOEEBIUS (Modelling Optimization of Energy Efficiency in Buildings for Urban Sustainability) in the definition of New Business Models and Associated Energy Management Strategies, focusing on the extraction of requirements for the ESCO market and innovative ESCO business models.

Introduction

1 - What is your affiliation type?

- ☐ ESCO (a company whose core activity is providing ESCO services)
- ☐ Utility with ESCO offers
- ☐ Facility or property management company
- ☐ Other company, which offers ESCO solutions among others
- ☐ Outra: ______

2 - Country of reference

Please select the country in which your company/division is located

______

ESCO Market Characterization

Please provide information about the ESCO market of the country where your company/division is located.

3 - How many ESCOs operate in the country of reference?

Please give the latest information. Note: We understand an ESCO as a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria.

URL: https://docs.google.com/forms/d/1DzvpHC0kDmxd4oCpN6FF5Zpz7MOIxc7aeLbi7FJZUFE

11.2 Demand response market characterization questionnaire

MOEEBIUS - Demand Response (DR) Market Characterization Questionnaire

The following questionnaire is aimed at gathering information to support MOEEBIUS (Modelling Optimization of Energy Efficiency in Buildings for Urban Sustainability) in the definition of New Business Models and Associated Energy Management Strategies, focusing on the extraction of requirements for the Demand-Response market and innovative DR business models.

Introduction

1 - What is your affiliation type?

- ☐ Aggregator
- ☐ Distribution system operator (DSO)
- ☐ Utility with DR initiatives
- ☐ Other company that offers DR initiatives
- ☐ Outra: ______

2 - Country of reference

Please select the country in which your company/division is located

______

DR Market Characterization

Please provide information about the DR market of the country where your company/division is located.

3 - How many DR operators are present in the country of reference?

Please give the latest information. Note: We consider DR operators as aggregators or Distribution System Operators (DSOs) with DR initiatives.

- ○ I don't know
- ○ Please insert total number:

Aggregators:

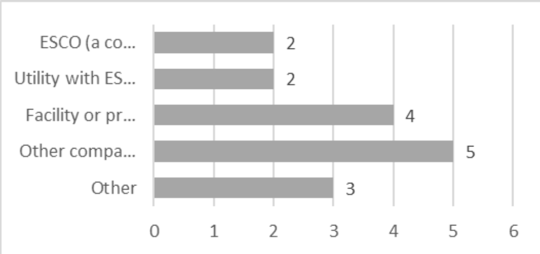
______

URL: https://docs.google.com/forms/d/162GKXTWhHWw6hJl--2eREVj5RuOpuKaWM6RqJqh-Tv8

12 Annex II – Analysis of the questionnaires

12.1 ESCO market

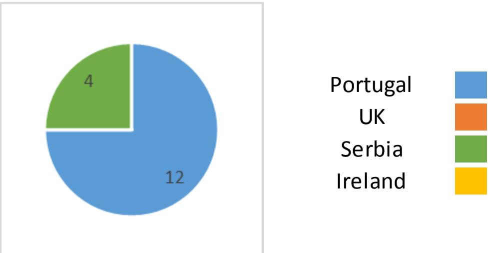
1. Affiliation type and country of reference:



Legend:
ESCO (a company whose core activity is providing ESCO services)
Utility with ESCO offers
Facility or property management company
Other company, which offers ESCO solutions among others
Other

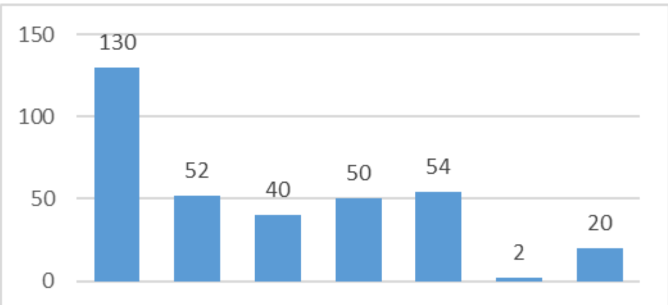
The questionnaire had a total of 16 responses. The majority of the respondents are ESCOs or other companies which have ESCO offers (56%).

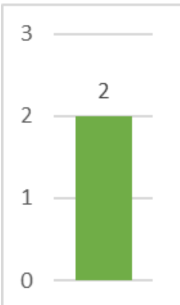
2. Country of reference:



Regarding the country of reference, there are 12 (75%) respondents from Portugal and 4 (25%) from Serbia.

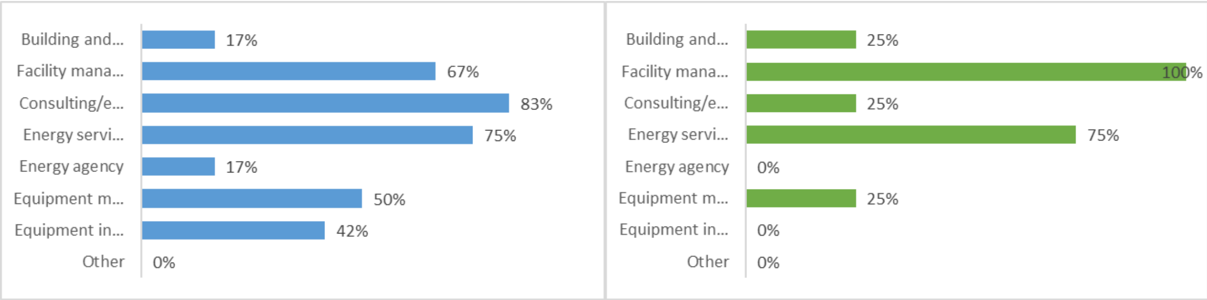
3. Number of ESCOs:



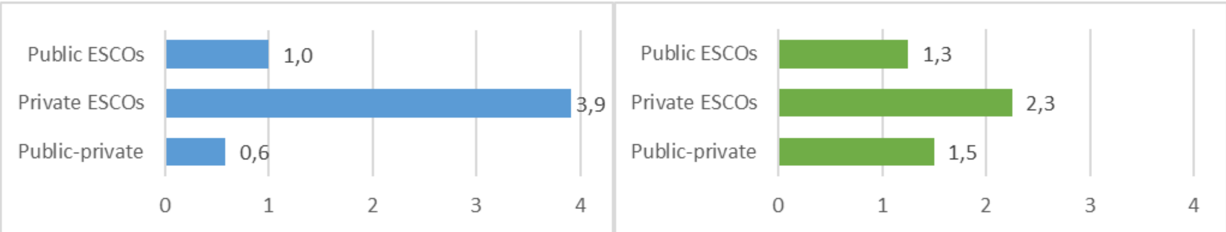


Respondents referred there are 2 to 5 top ESCOs in Portugal, although more than 50 are registered for public contracts in DGEG. In Serbia the ESCO market is beginning and respondents indicated there are 2 ESCOs.

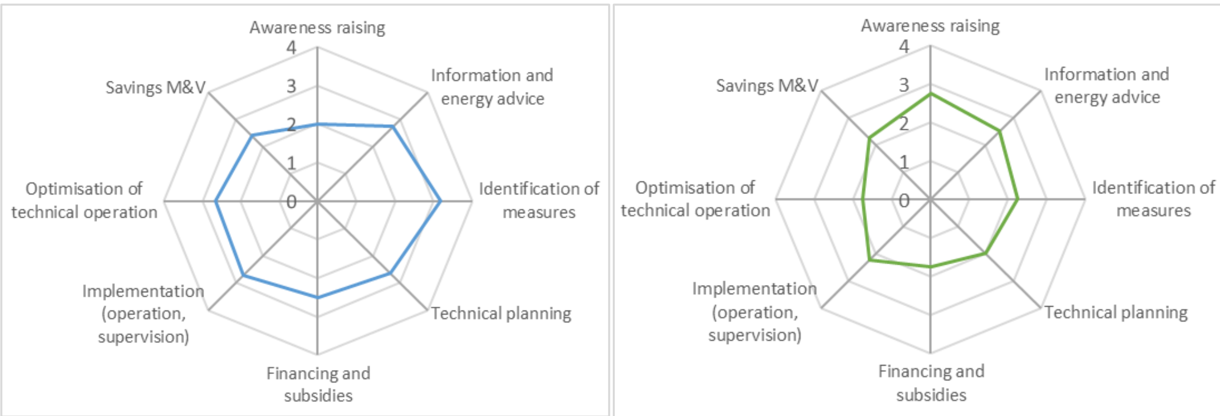
4-5. Types of ESCOs:



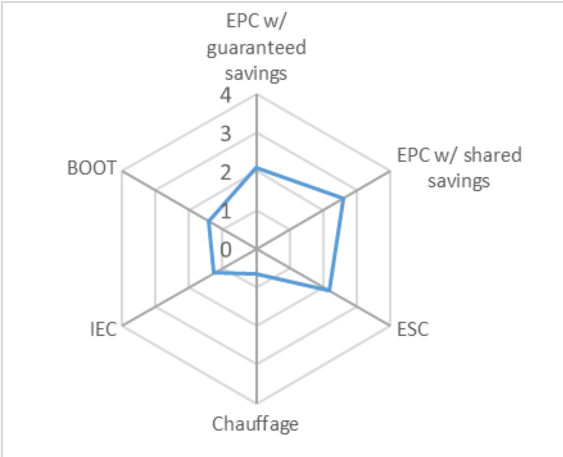
Legend:
Building and control manufacturers
Facility management and operation companies
Consulting/engineering firms
Energy service & supply companies
Energy agency
Equipment manufacturer or supplier
Equipment installer
Other

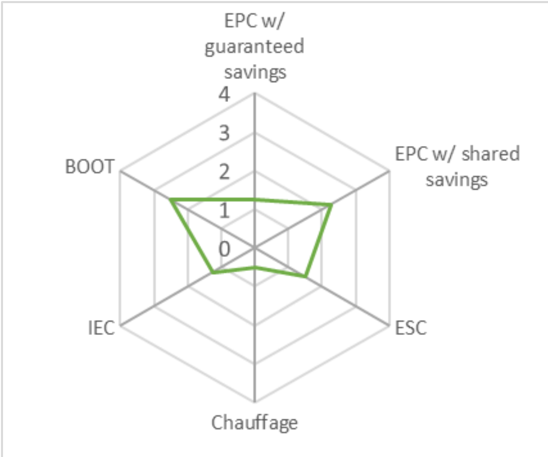


6. ESCOs' positioning in the EE value chain:



7. Most common type of contracts used:





Legend:

EPC w/ Guaranteed Savings (ESCOs guarantee the energy savings, clients take the financial risk)

EPC w/ Shared Savings (ESCO and client share the savings, ESCOs take financial risk)

Energy supply contract

Chauffage

Integrated energy contract

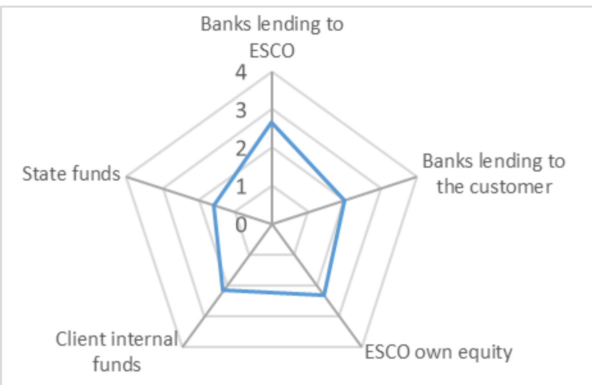
Build-own-operate-transfer (BOOT)

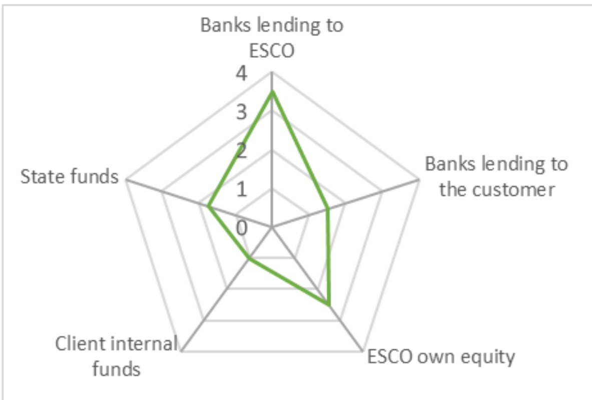
8. Current size of the ESCO market:

Portugal

- 5 M€/year
- 7 M€/year
- 30 M€
- 50 M€

9. Sources of financing of ESCO projects:





10. Potential size of the ESCO market:

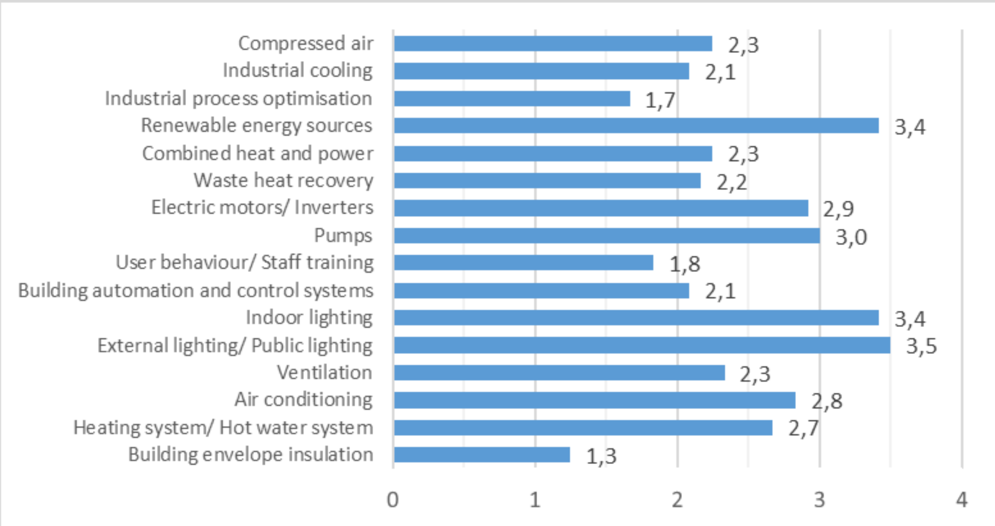
Portugal

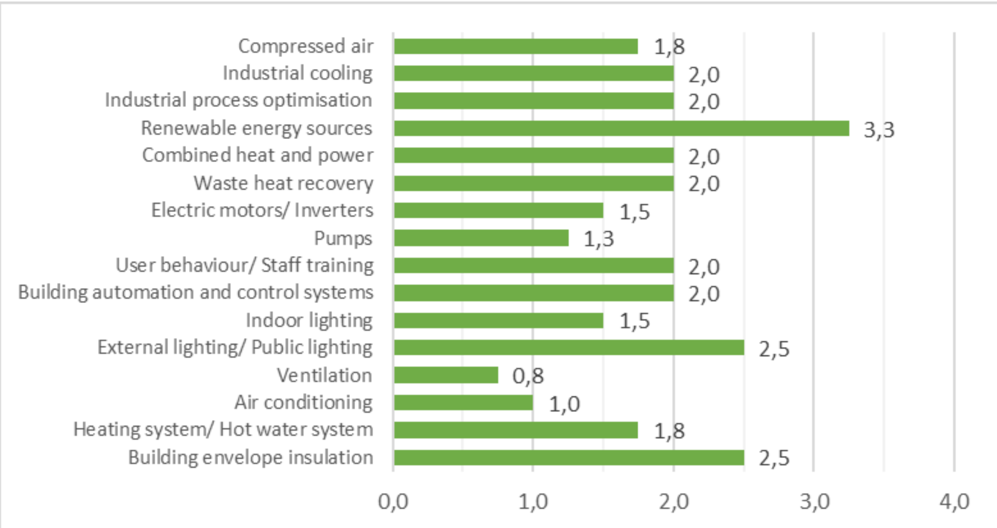
- 20 M€;
- 100 M€;
- 250 M€.

Serbia

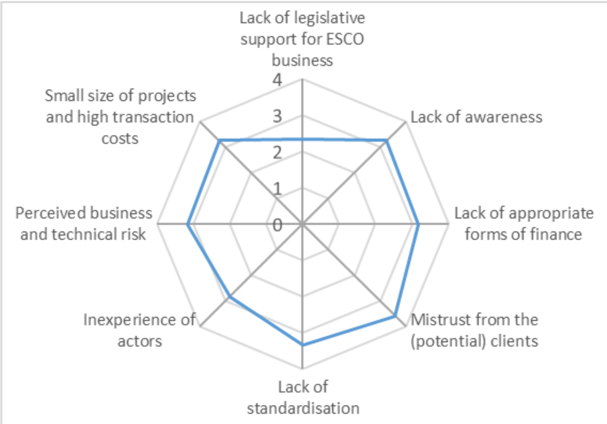
- 500 k€;
- 500 M€;
- 1.000 M€.

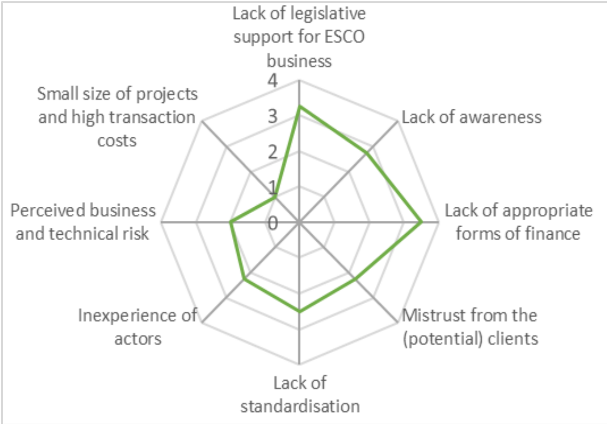
11. Technologies/fields of applications covered by ESCOs:



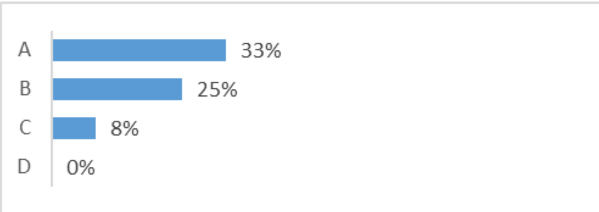


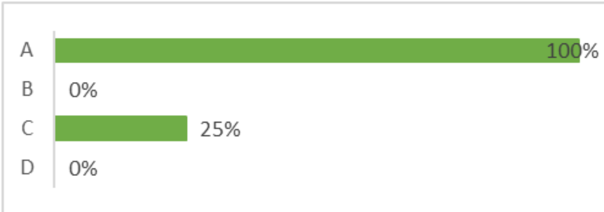
12-16. Barriers to ESCO projects:





If you have indicated the legislative framework as an important barrier, please select all applicable examples or specify others (13):





Legend:

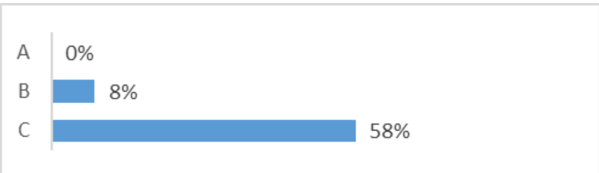
A - Complexity and inflexibility of the public procurement rules

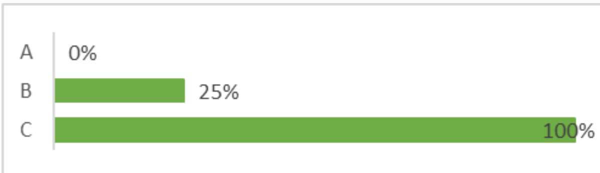
B - Contractual arrangements specific to ESCO projects are ''incompatible'' with national contractual regulations and definitions

C - The ESCO model is not recognised by the authorities as an individual business model providing a serv model providing a service, but as a contract for delivering goods

D - International accounting rules

If you have indicated the lack of appropriate forms of finance as an important barrier, please select all applicable examples or specify others (14):





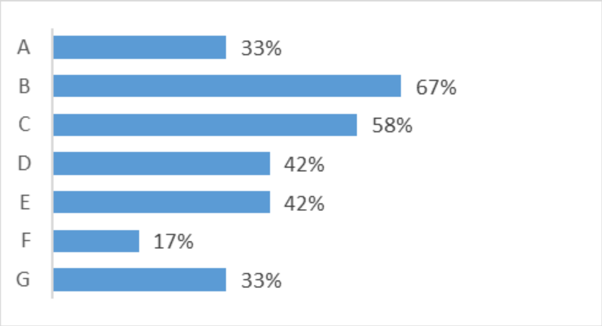
Legend:

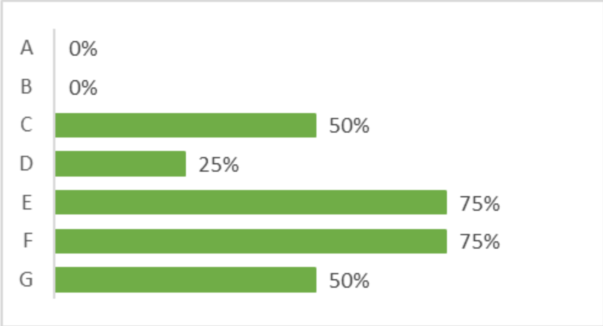
A - ESCO projects are not profitable without state grants (please explain below which sector and why)

B - Freeze in refurbishment investments are ''incompatible'' with national contractual regulations and definitions

C - Commercial banks do not have appropriate portfolios

If you have indicated the perceived business and technical risks as an important barrier, please select all applicable examples or specify others (15):





Legend:

A - The risk that energy efficiency interventions might compromise the production or operation processes related to the core business

B - The aversion to outsource energy management

C - The lack of flexibility and long commitment required with ESCO contracts

D - The small size of projects and low priority of energy efficiency investments on the corporate agendas

E - Unstable potential clients

F - Low and fluctuating energy prices

G - The lack of reliable energy consumption data makes it difficult to establish baselines and hence provide reliable data on actual savings

Ways to minimise the barriers **(respondents' comments) (16):**

Portugal

- Minimize risk for ESCO; public finance will lead to smaller interest rates and length of contract include O&M costs and responsibilities in public contracts allow contract to extend in time to allow recovery from a "bad year";
- The hiring of energy performance contracts by the public sector will increase customer confidence in these solutions;
- Complexity and inflexibility of the public procurement rules is one of the barriers;
- With a public or private fund available for all existing ESCOs and insurance companies providing performance insurance, and also some marketing proposals for client's awareness of the ESCO project benefits;
- Standardizing how energy efficiency projects are developed, documented and measured, e.g., Investor Confidence Project (ICP) Europe: http://europe.eeperformance.org/;
- Standardize ESCO projects (to increase trust and facilitate financing);
- Information and awareness (to increase trust);
- New business models;

- There must be interest from customers in apply their effort in ESCO projects. The success of ESCO project it's dependent of the financial growth of each market sector, and respective business strength from companies. ESCO services it's not a priority in investments allocation in companies that have improve their productivity process, their marketing and communication plan or enhance human resources;
- More information about the advantages of ESCO implementation and more flexible financial support and a legislative framework that invite the small consumers to implement in their buildings efficiency measures;
- More awareness to the benefits in Energy Efficiency, not only shrinking as an investment cost, but as a profit benefit, comfort occupancy and increasing productivity.

Serbia

- Through awareness and financing;
- Through increased focus from all stakeholders.

17. Drivers of ESCO projects (respondents' comments):

Portugal

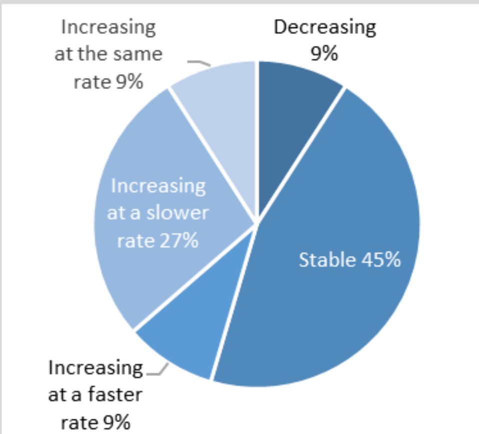
- Outsource of CAPEX and OPEX risk, lack of resources (technical, human, time, etc. – not money) to invest in new projects lack of capital to invest in own projects;
- Lack of customer technical knowledge; lack of customer capacity to investment, or investment directed to the core activities; lack of knowledge of how to measure savings. Who decides to purchase the equipment is not who is responsible for its O&M, so that decisions are not taken considering equipment's efficiency;
- 1. Energy costs/ 2. Economic value from ESCO projects/ 3. Competitiveness with savings/ 4. Legislation (tax if you don´t reduce energy consumption)/ 5. Environment concerns;
- Pressure to reduce consumption and costs;
- 1- Energy costs/ 2- Legislative framework/ 3- Climate change;
- Investment availability;
- Financial viability;
- Technical reliability;
- Market needs;
- Awareness;
- Mandatory legislation.

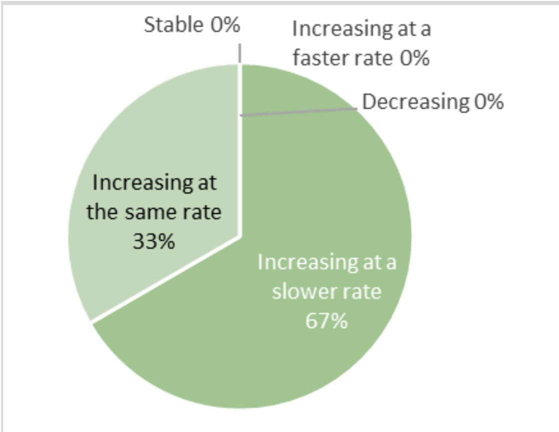
Serbia

- Average energy consumption is very high;

- Energy prices constantly rising;
- Decreasing subsidies for energy carriers and energy from Government;
- Consumer increasing interest for energy savings;
- Gradual increase of knowledge on ESCO topic with all stakeholders;
- Current state of the country is very good for the ESCO. Building stock is very old (most of the buildings were built in 1970-1980). Energy consumption is very high.

18. Evolution of the ESCO market in 2015/2016:





Portugal:

Decreasing (respondents' comments):

- The public contract framework collapsed due to: 1) Too demanding for ESCOs; 2) Incompatibilities with public contractual framework

Stable (respondents' comments):

- The energy performance contracts tend to be contract lasting several years. The ESCO cannot take the risk of the customer's business, so the contracts with investment made by the ESCO should be protected by bank guarantees. Taking into account the state of Portuguese banks it is very difficult to obtain bank guarantees, and these become very expensive.
- In Portugal the last year is one of decreasing of investments, so this applies also to ESCOs.
- Instability of the Portuguese economy and allocation of investments for other areas with more needs and better return of benefits.

Increasing at a slower rate (respondents' comments):

- Due to economic crises, and inexperience of the players.

Serbia:

Increasing at a slower rate (respondents' comments):

- Market is still in early phase of development;

19. Innovations needed:

Portugal

- Free access to funds, insurance performance guarantees;
- Change the Framework and contact models. Use innovative schemes (pay-as-you-save, PACE, etc.);
- 1 – Standardisation/ 2 – State Funds;
- None. Market decides when the ESCO services will have a important role in business activities of companies.
- A credit model that allow reach money with a better interest rate, probably including the banks in business model and share some of the profit.
- Electronic energy meters of the overall consumption, for each sector and type of energy consumed, in order to create benchmark and KPI's indicators for the market, to easily compare consumptions.

Serbia

- Refurbishment of building envelope
- Raising of awareness

20. Observations:

Portugal

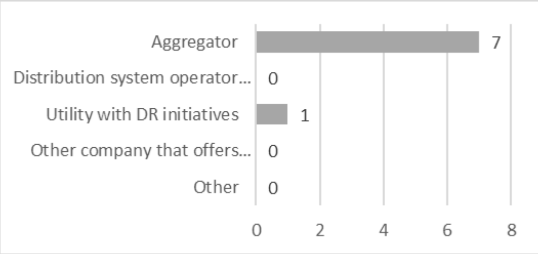
- It is clear that ESCOs should not support 100% of capital since it increases the project costs There is a clear link between EE and O&M; Any public framework should include O&M along with Energy Management.
- There is a lot to do to improve and establish ESCO as reality and a sustainable business model.

Serbia

- Serbia has a very small number of ESCOs.

12.2 Demand response market

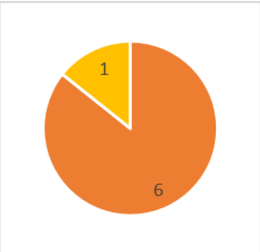
1. Affiliation type and country of reference:



Legend:
Aggregator
Distribution system operator (DSO)
Utility with DR initiatives
Other company that offers DR initiatives
Other

The majority of the respondents are aggregators (5) and 1 is both aggregator and utility with DR initiatives.

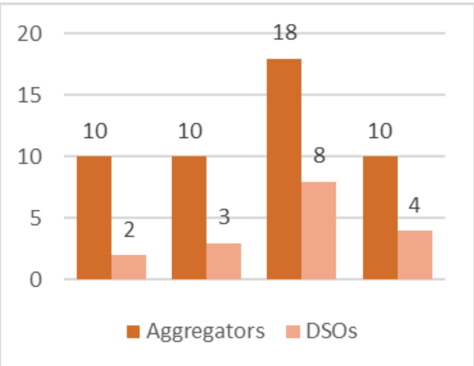
2. Country of reference:

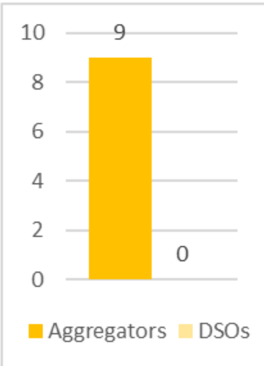


Portugal
UK
Serbia
Ireland

All respondents are from UK and Ireland (6 from UK and 1 from Ireland) because neither Portugal nor Serbia have DR operators.

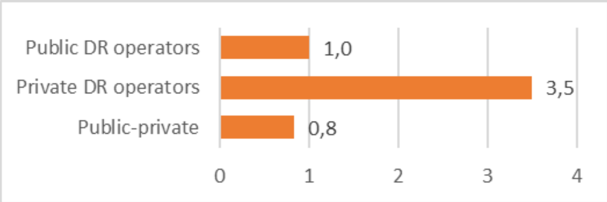
3. Number of DR operators (aggregators and DSOs with DR initiatives):

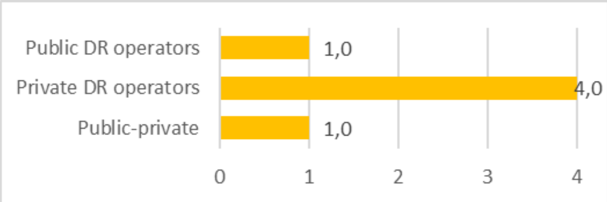




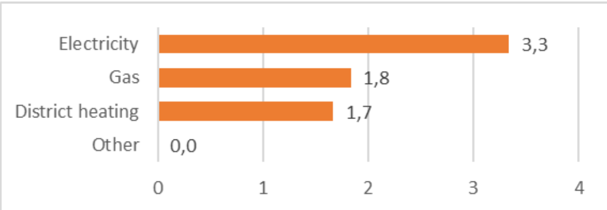
In UK the responses on number of aggregators varies between 2-8 and the responses on number of DSOs with DR initiatives varies between 10-18. In Ireland there are 9 aggregators and none DSO with DR initiatives.

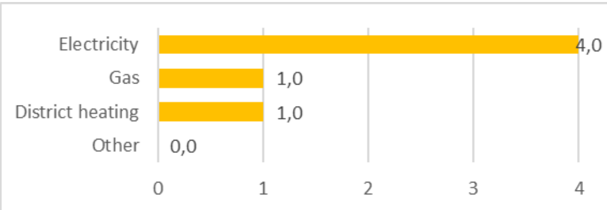
4. Types of DR operators:



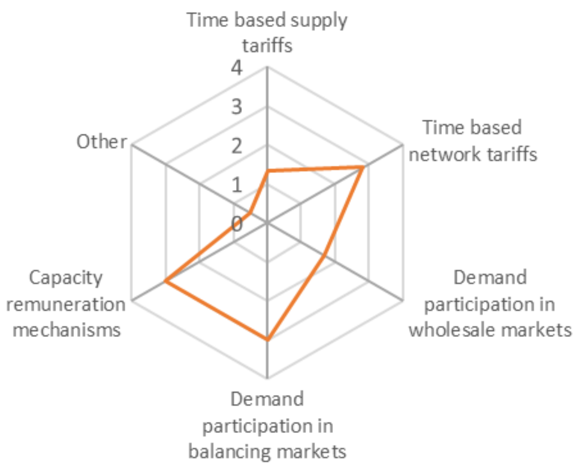


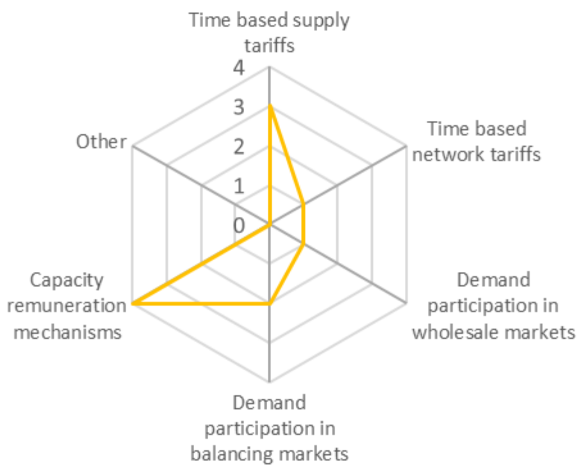
5. DR operators' positioning in the energy value chain:





6. Most common type of business programs used:





7. Current size of the DR market:

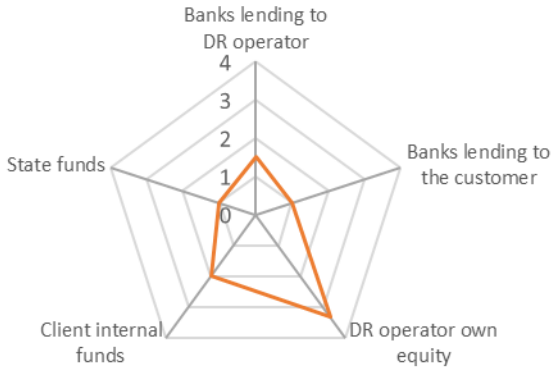
UK:

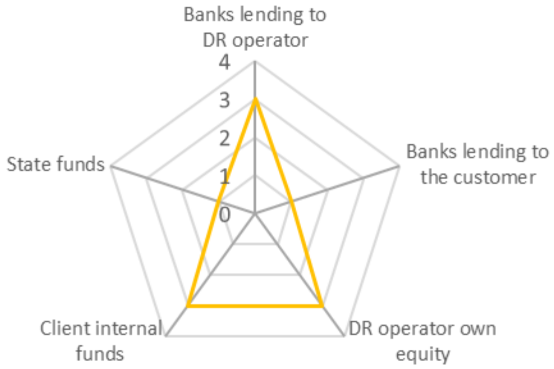
- 50 M€

Ireland:

- 10 M€

8. Sources of financing of DR projects:





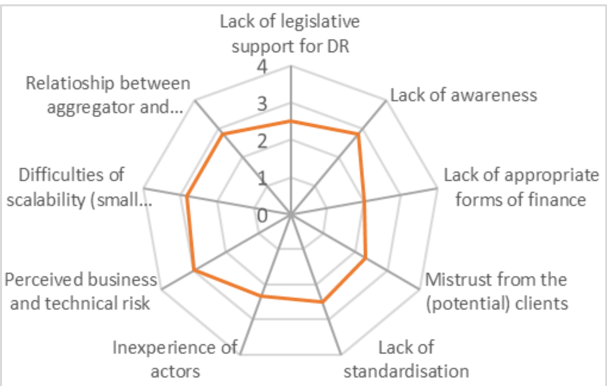
Other: Private Equity and High-net-worth individuals (HNWI's); Paid by grid operator.

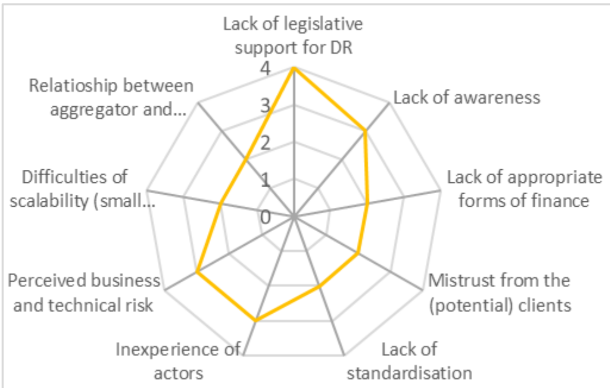
9. Potential size of the DR market:

UK:

- 790M (if 5% of peak demand is managed through DR)

10. Barriers to DR projects:





Other: DSO constraint of DR operators.

Ways to minimise the barriers **(respondents' comments) (11):**

UK:

- By engaging with customers and ensuring that they understand the value proposition and for them to have confidence in what you will be providing. National Grid's Power Responsive website has gone some way in educating large C&I customers. Strong regulatory support and financial incentives with longevity will also be critical to grow DSR @ scale. Ability to enter and engage one's VPP into the wholesale trading markets will also be v important. There are some regulatory support emerging from EU to facilitate sale of one's VPP into wholesale markets without unnecessary interjection from large suppliers.
- Standardisation, increased financial incentives for demand to be "flexibilized".
- PR releases about importance of DR.
- Incentives from government to support DR.
- Impartial education for clients
- Legislative framework for suppliers - separate for Aggregators and DNO/TSO
- Cut subsidies for legacy coal and gas power plants and increase the allocation for balancing services through DR services. Faster smart meters rollout and data collection infrastructure in place plus improved settlement mechanism to allow smaller sites and capacities to participate in DR programmes all the way down to residential customers. Improve legislation on storage (batteries) which are currently seen as generation assets and limit the potential of participation in DR services.

Ireland:

- More support from regulators and government for the promotion of Demand side participation is the critical point. Also the benefits of Demand Side participation should be rewarded to help promote further take up in schemes.

12. Drivers of DR projects:

UK:

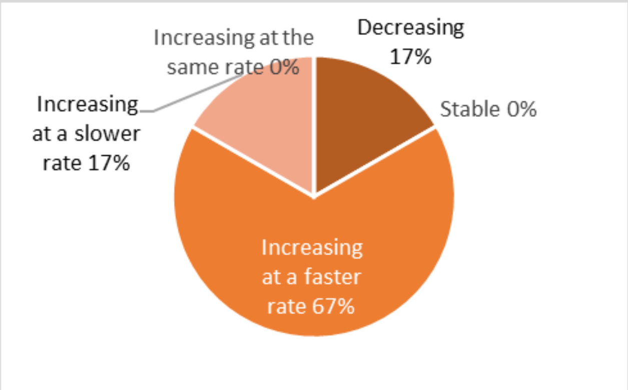
- Longevity of contractual positions;
- Ongoing education of large C&I customers;
- Monetising DSR into multiple markets; including capacity auctions and wholesale trading markets;

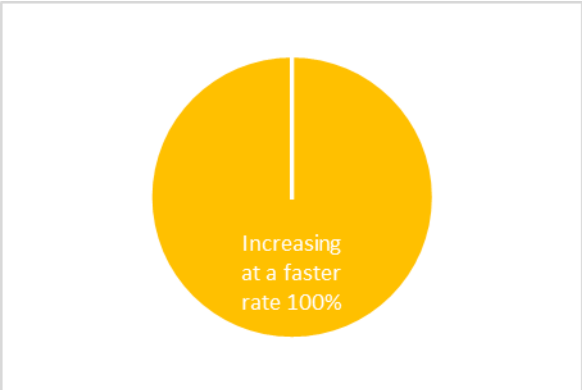
- Forging key relationships and partnerships within the DSR value chain;
- DECC to promote DSR and to provide clear and positive regulatory signals;
- Financial Incentive;
- Market Demand (UK Capacity Market);
- Technical Developments;
- Preparation for the energy world of tomorrow (decentral, more volatile);
- Participation in the "Energiewende";
- Savings and Revenue
- 1. 2020 CO2 cuts targets - this should encourage closing down coal power plants at a faster rate in the next 4 years;
- 2. Government support for DR services - this should improve legislation and allow more flexible services in the DR market;
- 3. Smart meter rollout - availability of half hourly and minute by minute data will allow participation in DR programmes for smaller sites which currently don't justify the business case for DR equipment (long payback times);
- 4. Improved BMS systems - smarter building and asset controls will allow a larger asset base to participate in DR services;
- 5. Growing new build projects and retrofit projects (same as no. 4).

Ireland:

- 1. Revenue generation for industrial and commercial sites.
- 2. Increased renewable generation on system requires more flexible capacity to turn up and down.
- 3. Reduced grid inertia into future requires more flexible and faster responding capacity.
- 4. Regulatory changes to enable scheme availability
- 5. Technology availability

13. Evolution of the ESCO market in 2015/2016:





UK:

Decreasing (respondents' comments):

- Stable demand for balancing power but increased number of suppliers lead to decreasing prices;

Increasing (respondents' comments):

- Change in the way National Grid is provisioning DR services; introduction of the Transitional Arrangement (TA).

Ireland:

Increasing (respondents' comments):

- There are more operators in the market now then there was in 2010-2014. The Northern Ireland market has recently opened up to participation. Industry are more aware of the benefits of DR participation and more comfortable with participation.

14. Innovations needed:

UK:

- Providing Negawatts (VPP of avoided flexible load) rather than Megawatts (diesel and gas gensets) for balancing purposes and DSR initiatives. Negawatts are V low marginal costs and it will be totally carbon neutral too;
- Optimization of flexibility in multiple markets;
- Enabling of low cost flexibility;
- Having the right quality of flexibility at the right time;
- Develop time of use tariffs along with peak demand charges that will further incentivise consumers to shift demand to off peak hours.
- The key aspect is the ability of market players to provide a range of services using the same equipment / infrastructure, such as: DR, energy efficiency, energy performance certificates, assets predictive maintenance, predictive billing etc.

Ireland:

- For customers it is all about ROI. An investment is required to enable DR participation in a customer site. The higher the ROI, the less the perceived risk to the site. A combination of benefits to the customer helps to maximize ROI, DR, Ancillary services, price and energy efficiency services.

15. Observations:

- Central markets are currently oversupplied and expected regulatory developments will put even more pressure on prices;
- Ancillary services will soon be available to the Demand side in 2016, either in the interim arrangement market or through initial technology trials with a view to enabling full participation from the end of 2017. This will help increase the amount of revenue available to customers and assist aggregators in offering different services.