Needs, solutions and business model for the supervision, efficiency and energy management of final users in the context of Industry 4.0 and the Internet of Things (IoT)

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Thesis to obtain the Master of Science Degree in

Energy Engineering and Management

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November 2018

Abstract

Companies are nowadays shifting towards more customer-centered products and services. All those involved in the energy-related sectors are in need of continuously improving productivity and energy efficiency in order to comply with growing stricter regulation towards a decarbonized energy transition, where renewable energy sources (RES) and energy storage systems will play a key role in the energy supply side. However, the potential for energy savings on the demand side has also gained ground in the last years and will be key with the massive electrification and digitalization of all sectors.

Despite the existing potential in demand-side improvements, Energy services companies (ESCos) have not totally succeeded in penetrating the European markets as key enablers for energy efficiency measures. Particularly in Spain, where energy prices are remarkably above European average, energy services providers still face several barriers related to the 2008 economic crisis: lack of knowledge and trust in ESCo industry, lack of standardized practices and official certification bodies, inefficient support processes and schemes by the public sector and difficulties to access to financing sources.

This thesis performs a deep analysis of the energy services Spanish market, key competitors and key enabling technologies in order to provide an innovative business model from the perspective of one established market leader as technology provider in the electrical sector. The proposed business model is aimed to overcome all these barriers, while delivering maximum value to the identified customer segments' needs through a platform as a service model designed for the centralized energy management of several distributed installations. ABB will be in the epicenter of this business model in order to join the competencies needed from several key partners and facilitate access to financing sources by establishing an innovative revenue model based on the delivered performance.

Keywords

Energy efficiency; energy management system; demand-side management; demand response; business model canvas; value proposition canvas.

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Acronyms

Acronyms	Meaning
A	Ampere
A3e	Association of Energy Efficiency Companies
AC	Air Conditioning
AMI	Association of Comprehensive Maintenance and Energy Service Companies
ANESE	National Association of Energy Service Companies
B2B	Business to business
BM	Business Model
BMC	Business Model Canvas
BMS	Building Management System
BOOT	Build-Own-Operate-Transfer
CAGR	Compound Annual Growth Rate
DCS	Distributed Control System
DER	Distributed Energy Resources
DMS	Distributed Management Software
DR	Demand Response
DSM	Demand-Side Management
DSO	Distribution System Operator
EBPD	Energy Performance of Buildings Directive
EE	Energy Efficiency
EED	Energy Efficiency Directive
EEF	European Energy Efficiency Fund
E-Mobility	Electric Mobility
EMS	Energy Management System
EP	Electrification Products
EPC	Energy Performance Contract
ESC	Energy Supply Contract
ESCo	Energy Services Company
ESIF	European Structural & Investment Funds
EU	European Union
EV	Electric Vehicle
GHG	Green-House Gas
GPRS	General Packet Radio System
HMI	Human-Machine Interface
IA	Industrial Automation
ICT	Information and Communication Technologies
IEC	Integral Energy Contract
IoT	Internet of Things
IT	Information Technologies
kWh	Kilo-Watts hour
M&V	Measurement and Verification
MCU	Micro-Controller Unit
MES	Manufacturing Executions System
MOM	Manufacturing Operations Management
MPU	Micro-Processing Unit
MWh	Mega-Watts hour
NZEB	Nearly-Zero Emissions Building
OMS	Operation Management Software
OS	Operating System

OT	Operations Technologies
PF4EE	Private Financing for Energy Efficiency
PG	Power Grids
PLC	Programmable Logic Controller
PLM	Product Lifecycle Management
PPP	Public-Private Partnership
R&D	Research and Development
RD	Royal Decree
RES	Renewable Energy Sources
RM	Robotics and Motion
SaaS	Software as a Service
SCADA	Supervisory control and data acquisition
SI	System Integrator
SME	Small and Medium Enterprises
SWOT	Strengths, Weaknesses, Opportunities and Threats
TIA	Totally Integrated Automation
TSO	Transmission System Operator
UK	United Kingdom
UPS	Uninterruptable Power Supply
USA	United States of America
VPP	Virtual Power Plant

I. Introduction

In this section, we will contextualize the scope of this thesis, cover some key definitions critical to keep track on the following sections, state the research question that has motivated the work and outlay the main points covered by this document.

1.1. General Picture: Digitalization & Energy

During the past years, worldwide Green House Gases' (GHG) emissions have stabilized at around 32 billion tons of carbon-dioxide equivalent (GtCO2-eq) since 2014. Decreasing energy intensity is the main factor behind the flattening of global energy-related GHG emissions since 2014, which is in fact driven by energy efficiency improvements, together with the shift to renewables and other low-emission fuels [1]. Energy efficiency policies around the world have focused mainly in the building envelope, leaving still a lot of room for improvement in cooling, heating, lighting and electrical appliances in general.

Digitalization, which is defined as the spreading application of information and communication technologies (ICT) across the economy, is expected to enhance the participation of energy efficiency and other demand side management applications in electricity markets and energy management systems (EMS). Data are growing at such a high rate that internet traffic has tripled in the past five years [2]. Digitalization has the potential to transform totally the current paradigm, breaking down boundaries between energy sectors, increasing suppliers and consumers' flexibility and permitting the better integration of renewable energy sources (RES).

1.2. Key Definitions

IoT

The term "Internet of Things" represents the place where objects are connected to networks to provide a range of services or applications. The IoT covers both machine-to-machine (M2M) connections, where devices interact and share data without the direct involvement of people, and things connected to networks to enable people to remotely control processes or manage their devices.

Industry 4.0

The concept of Industry 4.0 -or "forth industrial revolution"- encompasses all connectivity that can be reached with focus on the manufacturing industry (see Figure 1). Moreover, it also covers real changes to the physical world such as 3D-printing technologies, new augmented reality hardware, robotics, and advanced materials [3].

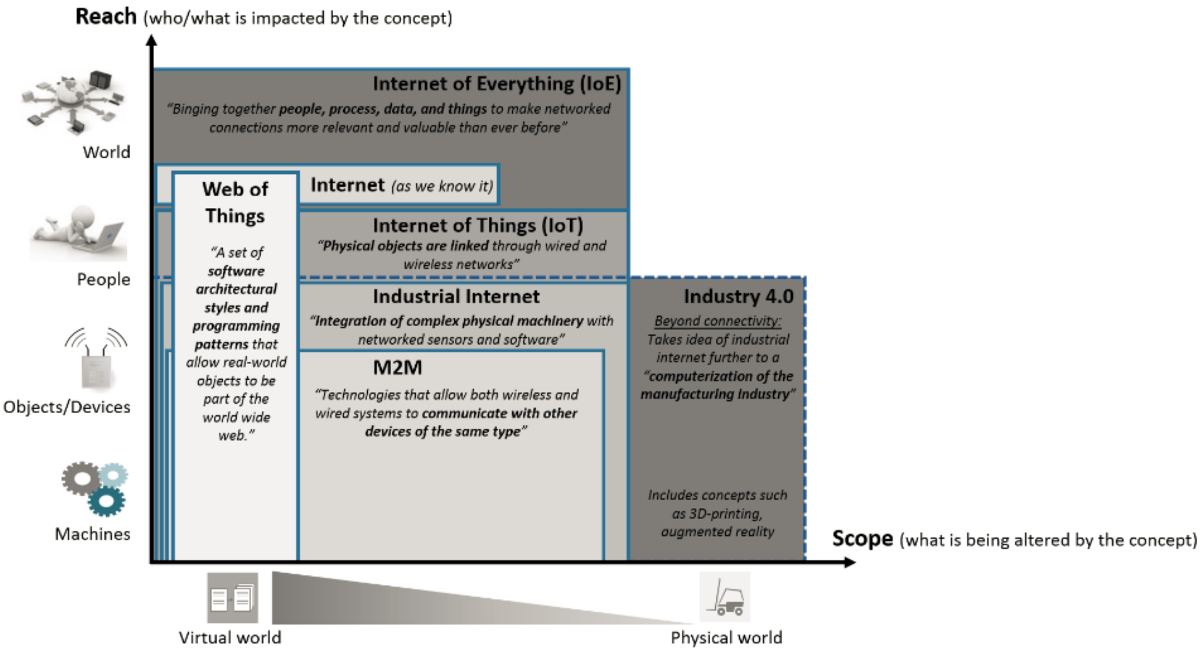


Figure 1. Concept disambiguation [3]

DSM

Demand Side Management refers to any initiative or technology that encourage consumers to optimize their energy use. It is a general term that covers both Energy Efficiency (EE) and Demand Response (DR) [4].

DR

Demand response -or Demand Side Response- refers to changes in end-consumer behaviors to adjust their electricity consumption patterns during periods of peak demand, when power supply is scarce or electricity networks are congested, in response to time-based market prices or financial incentives. For connected devices, demand response functionality might enable a power utility or aggregator to remotely turn off loads (or turn on distributed generating units) in end-customer sites to avoid grid issues. DR is classified into 2 categories:

- **Implicit DR:** Also called "Price-Based DR", where consumers are exposed to time-varying electricity prices and can adjust their consumption patterns based on these prices.
- **Explicit DR:** Also called "Incentive-Based DR", where consumers trade their flexibility upfront on different electricity markets. This task is usually facilitated and managed by a DR aggregator that can be an independent party or a supplier.

EE

Energy Efficiency refers to achieving the same delivered service or product with less energy usage. Energy Services Companies (ESCos) have traditionally focused in EE, since the liberalization of electricity markets and DR practices are relatively new concepts. Having this in mind, we will define the 2 key energy efficiency services offered by ESCos (see Figure 2 for illustrative example):

- **Energy Performance Contracts (EPC):** *"Contractual arrangement between the beneficiary and the provider of an energy efficiency improvement measure, verified and monitored during the whole term* *of the contract, where investments (work, supply or service) in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement or other agreed energy performance criterion, such as financial savings."* [5]

- **Energy Supply Contracts (ESC):** Contractual arrangement for the efficient supply of energy, which is normally contracted and measured in energy units delivered -MWh, kWh, etc.-.

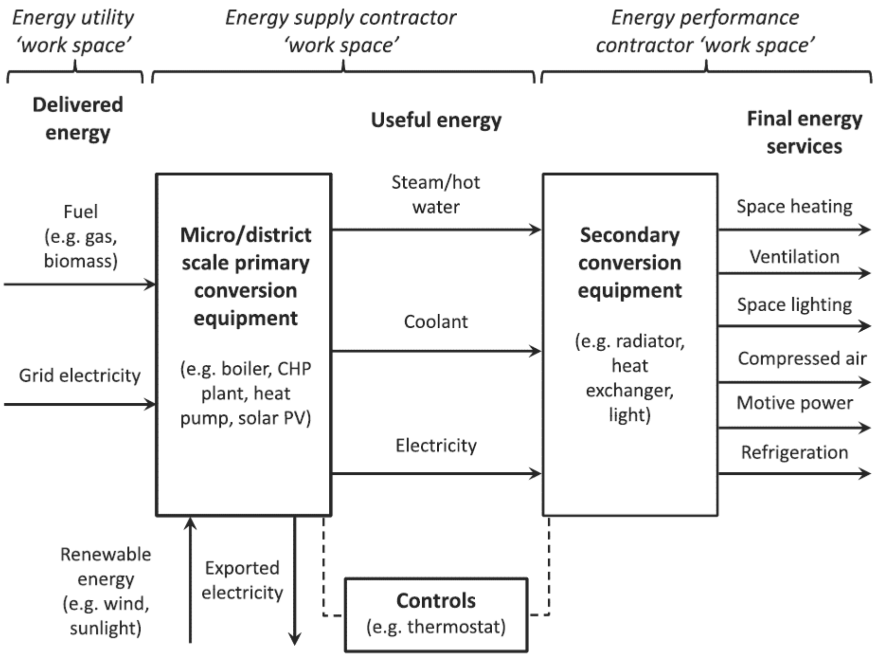


Figure 2. Typical "work space" of energy utilities & ESCos [6]

ESCO

An Energy Services Company is a firm providing a range of energy-related solutions including design and implementation of energy savings projects, retrofitting and energy issues (conservation, supply, risk-management and so on). They also develop, implement and facilitate financing for upfront EE investments for its clients [7].

DER

The term Distributed Energy Resources (DER) refers to any kind of small-scale energy resources where generation or storage occur at or near the point of consumption (solar photovoltaics, wind power, batteries, etc.). DER are usually connected to the distribution level electricity grid. The term also refers to bigger-scale decentralized generation systems.

Aggregator

Also known as demand response providers, aggregators gather different consumers' loads, as well as energy supply from distributed producers such as renewable power plants or generation units in industry, in order to provide balancing services to the grid by adjusting power demand and/or shifting loads at short notice. The aggregated loads are managed as a single flexible consumption unit and traded to the markets or to the grid operator. Therefore, aggregators act as a link in between large numbers of individual “prosumers” (consumers and producers) and power markets/grid operators.

BM

In this thesis, we will understand the Business Model (BM) as the rationale of how an organization creates, delivers and captures value [8].

1.3. Importance of digitalization for renewable energies and energy storage integration in electricity markets

As commented before, one of the greatest potentials of digitalization is the disruption of all energy sectors -especially the electricity sector-, increasing flexibility and integration of all systems and players involved, which could affect the following key areas:

- **Demand Response:** Huge investments in generation capacity and new electricity infrastructure could be avoided through both explicit and /or implicit demand response, where digitalization will enable customers responding to varying energy prices in order to obtain financial benefits.
- **Integration of Renewable Energy Sources:** Energy storage and demand response development will allow to better match consumption, where countries such as China -for example-, curtail around 17% of wind energy generation due to insufficient grid flexibility [9].
- **Electric Mobility:** Similarly, digitalization could help shifting the charging to periods where there is renewable supply excess and lack of demand.
- **Distributed Energy Resources:** Especially in the residential sector, digitalization could facilitate how prosumers manage, store, sell their energy surplus and validate transactions; with technologies such as blockchain or peer-to-peer electricity trades gaining momentum around the “energy communities” concept.

1.4. Context: Ability ABB Digital Solutions

ABB, as a multinational company, is divided into 4 main vertical divisions: Electrification Products (EP) -i.e. distribution level-, Power Grids (PG) -i.e. transmission level-, Industrial Automation (IA) and Robotics & Motion (RM). From EP in Spain, we intend to develop a cross-divisional tool that may be used in the future to merge all areas involved in energy and non-energy management into one unique solution, covering topics such as process automation, drives, lighting, AC, energy trading, renewables and so on.

The digitalization of the industry (Industry 4.0) and the IoT are revolutionizing the market, business models and the relationship with customers. At ABB, which has been traditionally a technology provider, we are developing a digital energy monitoring solution based on Cloud with the integration of the products that we manufacture for the distribution of energy in all types of facilities. This solution -i.e. “Ability”- is a combination of protection switchgear and energy measurement gear, a specific communication architecture and a data management web platform. Although the solution has the potential to cover the requirements of the Spanish market today, we need to understand the transformation, new needs and contribution of the different "players" of the market.

1.5. Research Question

After having introduced thoroughly the context of this thesis, we will introduce the main research questions that will narrow and drive the work:

- Which is the current market situation in Spain regarding energy services?
- Which is the most promising business model related to energy services from Ability ABB point of view as one of the main electrical equipment providers in the Spanish market?

1.6. Structure of the thesis

As already seen, **part one** defines the framework and scope of this work, introducing several important definitions and the direct relationship of energy services with renewables and energy storage.

Part two constitutes the general literature review, focusing on works related with business model generation and innovation in the field of energy services.

Part three provides a deep analysis of the Spanish energy services market, by covering the general, legal and regulatory framework, market size, main segments, barriers, drivers, and financing practices.

Part four will review all technologies involved in the proposed energy management solution and highlight the key differentiating technologies.

Part five describes the main players involved in energy services markets with examples, as we as provides a deep analysis of three selected key competitors.

Part six reviews the most widespread business models used in the Spanish energy services market and proposes a final business model from the perspective of the analyzed solution, to finally provide a qualitative evaluation using a variation of SWOT tool.

Part seven summarizes the outcomes obtained from the work, extracts conclusions and proposes future steps for further research and analysis.

II. Literature Review

Many scientific texts related to these areas of study can be found in the main academic research databases and search engines. In order to narrow the scope, a list of texts have been selected regarding 3 main areas of review due to the following reasons:

- **General electricity market structure:** The electricity market can be strictly correlated to energy services and several topics discussed in this thesis.
- **Demand Side Management:** As previously explained, DSM covers both Demand Response and Energy Efficiency related topics.
- **Business Modelling:** Being the main point of study of this thesis, several key texts have been selected regarding business modelling and/or any of the 2 previous mentioned points.

The topics of "industry 4.0" and "Internet of Things (IoT)", although taken into account in the review process and included in some of the selected texts, have been considered to be far too broad to constitute any relevant segment for the literature review classification.

General Electricity Market Structure

Three main texts have been found to be relevant for the study. [10] include an explanatory overview of the wholesale electricity market (focusing on the Nordic one), as well as a deep dive into the general economics of DSM, highlighting DSM requirements in different market places and the potential role of the demand response aggregator figure. It is complemented with a simulation study in order to discern the relationship between the increased share of RES and DSM on price volatility of the Nordic electricity market. [11] perform an empirical analysis by gathering all data from the Spanish electricity market in the period 2011-2014 in order to evaluate the nexus between power system balancing costs evolution and in increasing presence of intermittent renewable energy sources. [12] take a different approach and focus on a deep analysis of electricity infrastructure, while covering all issues to be addressed in order to enable the energy transition away from supply of unmanaged demand. Several barriers and challenges for the energy infrastructure and its relationship with the final user through service-oriented operation are tackled.

Demand Side Management

[13] perform an extensive classification of all DR related programs, splitting them into two main categories: Incentive Based Programs and Price Based Programs - also called Explicit DR and Implicit DR by other authors, respectively -. Benefits and costs related to these programs are analyzed, from the point of view of both participants and programs' owners. [14] analyze how one of the largest Finnish electricity retailers struggled in developing business solutions in the field of energy efficiency services, evidencing fundamental challenges for traditional firms in a growing liberalized market. Al last, [15] study from an exhaustive sample of Spanish manufacturing firms which profiles and behaviors are related with investments in energy efficiency solutions and services.

Business Modelling

Several authors have written about business modelling within the scope of electricity markets and DSM in general. However, there is no common classification when it comes to different business models. For example, [16] construct four general value propositions based on missed opportunities by a purely national supply market in the UK. From there, they build on eight different business models that may capture the value offered by these propositions and perform a qualitative comparison with the current archetype. [4], for example, focuses the classification on the different actors of the electricity market ecosystem. Besides, all studied business models are grouped into two categories -DR and EE- and further classified depending on the load interruption frequency and duration tolerances. [17], on the other hand, perform an exhaustive analysis of 144 business models sampled from companies in Europe and USA, classifying the category of "Demand Response and Energy Management Systems" into different business models based on customer segments, offered services and revenue streams.

Other authors like [18] and [19] focus on the utility firms segment in different ways. The former analyzes the existing challenges and opportunities for German utility firms in the RES field by interviewing a sample of them, as well as classifies the different business models into utility-side BM and customer-side BM; whereas the latter provides a deep understanding of the possible impacts that smart grids and the energy transition may trigger from the point of view of the traditional utility company, categorizing them into 3 different categories related with business model innovation.

[6] study the different business models possible in between the public sector in UK and ESCOs by interviewing representatives of both parts. The text describes potential benefits and limitations of each proposed scenario, highlighting the interactions in between all actors.

Similarly to [4], [20] group different business models of their analysis into EE, DR and RES. However, in this paper, business models are previously grouped based on the ownership of the assets, the place where they are installed and the source of the financial resources, ending up in three main categories: Customer-owned product-centered BM, third party service-centered BM and Energy community BM.

Lastly, [21] conduct a series of interviews to representative companies of the electricity sector and DR activities in general. The final business model identification takes into account the origin of the response -supply or demand- and the number of processes or installations involved -distributed or centralized-, leading to 4 BMs: Power plant optimization, Virtual Power Plant (VPP), Large-scale DR and Small-scale DR.

III. Spanish Energy Services Market Analysis

In this section, we will perform a general market assessment in order to extract conclusions and apply them later on the business model generation.

3.1. General Framework

The Spanish DSM market is focused mainly in EE services. Regarding DR, Spain was one the first country to introduce a default price for households based on the market spot price -a good start for the implementation of implicit demand response-. However, although it is possible for end customers to access the free market or simply access to tariffs with price-discriminative periods, implicit demand response is not offered as an energy service but as a “choice” for the customer. ESCos offering EE services normally include optimization services as such, but as a part of much broader scope of services. Explicit demand response is even less widespread: There is only one scheme allowing explicit DR, the Interruptible Load Programme, and it is limited to several large industrial consumers managed by the system operator [22]. DR aggregation is not legal yet in Spain and, although it is believed that these flexible demand services will start to open, it is not a sufficiently developed topic to be included in the current scope of the thesis. Explicit DR and the figure of the DR aggregator will be potentially crucial in a medium-term future and they should be taken into account in future studies.

In consequence, the only focus of the market is in EE services, which are divided into 2 offerings: **EPCs** and **ESCs** (see definitions in 1.2). The EPC market is specially divided, with about 7% of large companies having around 50% of market share and the remaining 93% covered by more than 1000 ESCos registered as Small and Medium Enterprises (SMEs) [23]. EPC market segments are both public and private, with public segment growing at a constant and accused rate (see Figure 3). ESC market is not remarkably divided, with the main segments being municipalities, offices and retail.

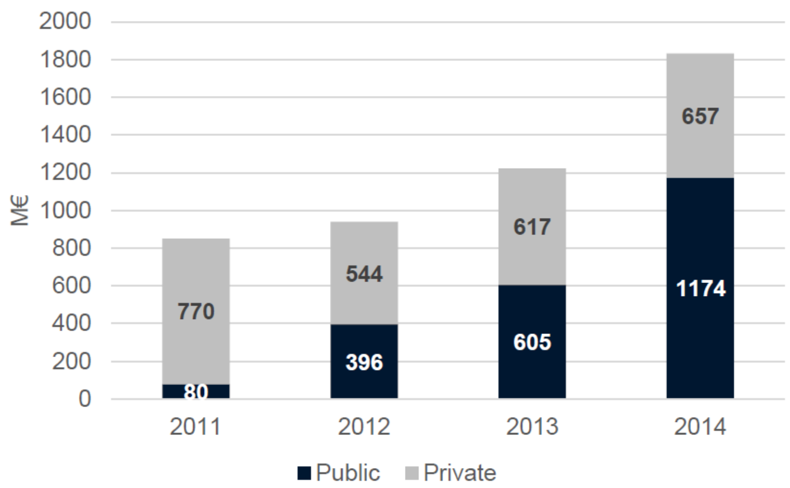


Figure 3. EE-EPC Market volume [23]

EE market in Spain has not reached the expected penetration by any means -meaning that there is still a huge room for improvement and end customers are still reluctant to buy EE services-. Further on in this section, we will try to review the main reasons for this outcome.

3.2. Legal and Regulatory Framework

In this subsection, we will review the main points affecting Energy Efficiency services regarding EU regulation in general and Spain in particular. Most of the developed normatives in the past decade in EU are focused on EE in buildings. There are 2 key normatives in this framework: **Energy Performance of Buildings Directive (EPBD)** and **Energy Efficiency Directive (EED).**

Later on, we will also highlight the main transpositions of these European directives in Spain.

EPBD

EPBD 10/31/EU is the main piece of legislation for energy efficiency and energy savings in buildings. Therefore, it helps boosting EE services industry through several public measures. Some of the most important measures covered by EPBD will be highlighted now [24]:

- *"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".*

EED

The EED 2012/27/UE establishes a common framework of binding and concrete measures to help the EU reach its 20% EE target by 2020. The following points are the most significant regarding buildings [5]:

- *"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"*

The transposition in Spain of this EED brings us to the Royal Decree RD56/2016, which is the most important Spanish law regarding energy audits, accreditation of EE service providers and energy auditors and the promotion of energy efficient supply.

RD 56/2016

The key point covered by RD 56/2016 [25], which is the transposition of EED, is the one related to energy audits, which are developed in chapter 2. It states that big companies, defined as those with more than 250 employees and/or more than 50M€ of annual sales volume -or the general annual balance exceeds 43 M€-, are obliged to perform an energy audit every 4 years. This energy audit will be performed on-site every 4 years or will be validated through a certified Energy Management System (EMS) according to European and international standards.

This fact is obviously vital for EE service providers since it establishes the starting point where many companies will start to keep in mind EE and energy management systems as a necessary procedure, opening an opportunity for energy services to show the real added value they provide and starting to really penetrate the market.

Support Schemes

The article 18 of the EED enforces several obligations on member states in order to support the energy services market. In Spain, the obligations transposed till the date are the following [23]:

- Annual contribution to the National Energy Efficiency Fund.
- Plan to Promote Mobility with Alternative Energy Vehicles (Plan Movea).
- Efficient Vehicle Incentive Programs (Plan Pive).
- The Investment Fund for Diversification and Energy Saving (FIDAE).
- Aid Program to Improve the Energy Efficiency of Existing Buildings (PAREER-CRECE).
- Program to Promote Industrial Competitiveness.
- Climate Projects Program of the Carbon Fund for a Sustainable Economy (fes-co2).
- Aid program for the renovation of municipal street lighting.
- Aid program for energy efficiency measures in SMEs and large industrial enterprises.
- Aid program for modal shift and more efficient use of transport modes.
- Aid program to improve energy efficiency in railway systems
- Aid program to improve energy efficiency in desalination plants.
- Communication Campaign.

Currently, although there are several programs subsidized by the Spanish Government, public subsidies are not commonly perceived as a driver in the ESCO industry and many times these kind of projects suffer from lack of interest from the public sector, relying most of the times on external or even internal financing -the same ESCO is financing the projects- [23] [26].

3.3. Market Overview

Here we will highlight the main aspects that define the Spanish energy services market. The main existing business models, however, will be reviewed in "Business Model Generation" section.

3.3.1. Market Size

Before digging into energy services market in Spain, it is important to highlight that other markets that are directly correlated are also showing signs of continuous growth. For example, global IoT market is expected to reach around 1.7 trillion $ by 2019 -triple the size of 486 billion $ from 2013- [27].

The European energy services EU market (see Figure 4 for size evaluation) was estimated at 2.4 billion € ESCO revenue in 2015, with a forecasted growth to 2.8 billion € in 2024 -at 1.7% CAGR- [28].

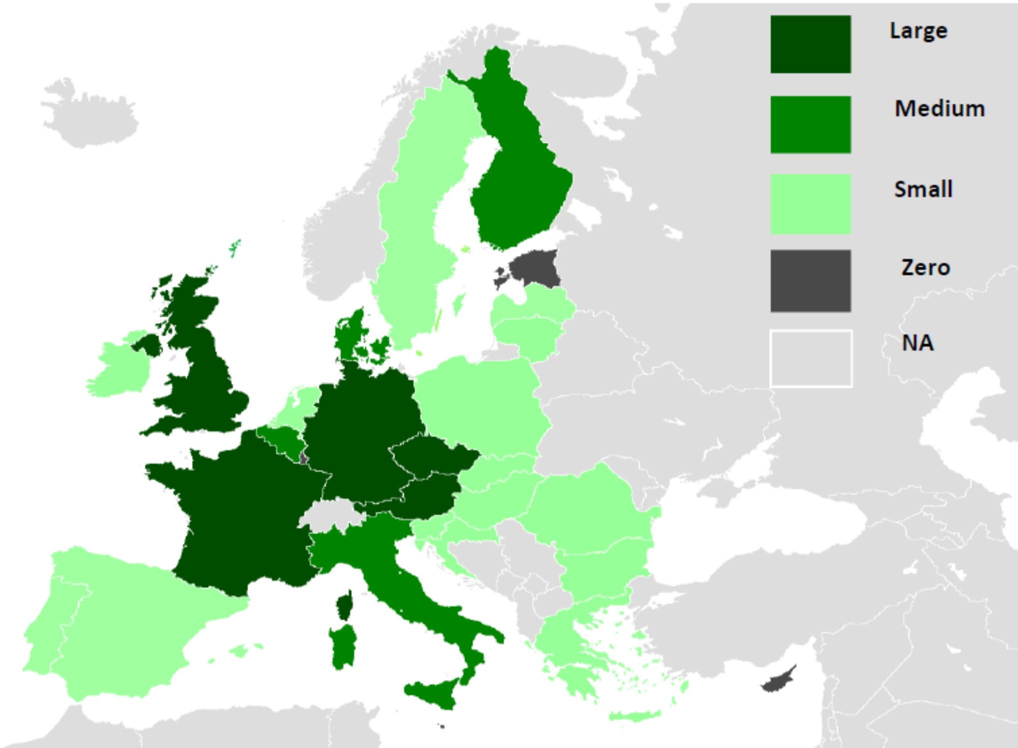


Figure 4. Qualitative size evaluation for ESCo European markets [29]

Regarding energy services market status in **Spain** -according to JRC EU Market Report [30]-, although there are more than 1000 companies registered as energy service providers, only a small fraction of them actually work as ESCos. According to [26], current ESCo Spanish market size ranges between 400 and 500 M€ annually. This estimation includes energy supply costs, investments, maintenance costs and projects development. However; if we also take into account monitoring, installation, measurement & verification activities and so on; market size is actually difficult to estimate -according to [30], the sector may be worth 1 billion € per year-.

In general, all authors agree that the Spanish sector will experience a small and constant growth. The following presented data intends to add some relevant quantitative indicators developed by [30]:

- Number of ESCos (2015): +1000 companies registered as "Energy Services Companies"
- Number of EPC providers (2016): 20-30 companies offering performance-based EE projects
- Number of EPC projects (2016): 200-3000 performance-based EE developed projects

3.3.2. Market Sectors

In this section, we will review the main sectors that could mean an important customer segment for the development of energy services. In Figure 5 we can appreciate the distribution by percentage of final energy consumption by sector.

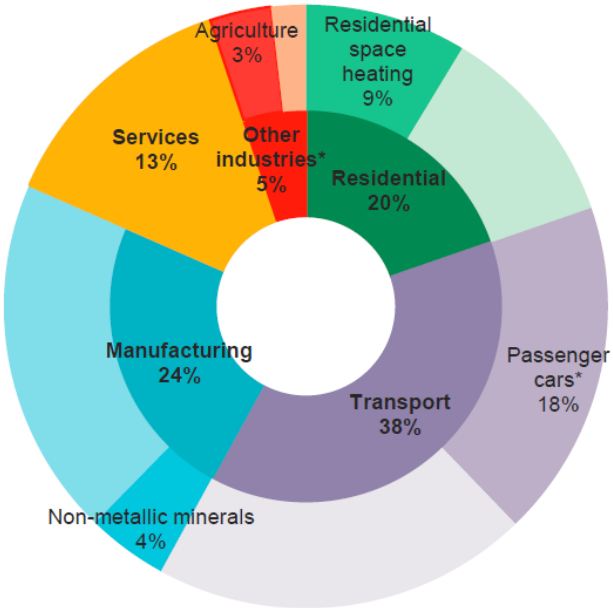


Figure 5. Final energy consumption by end-use sectors in Spain [31]

Even though transport represents a huge percentage of final energy use in Spain, it is mostly covered by fossil-fuels (see Figure 6). Energy services are not normally related to fossil-fuel consumption on road transport. Although E-mobility will represent a huge opportunity for EE, DR and energy services in general, we will leave transport out of the scope of this thesis since its development is still in preliminary phases.

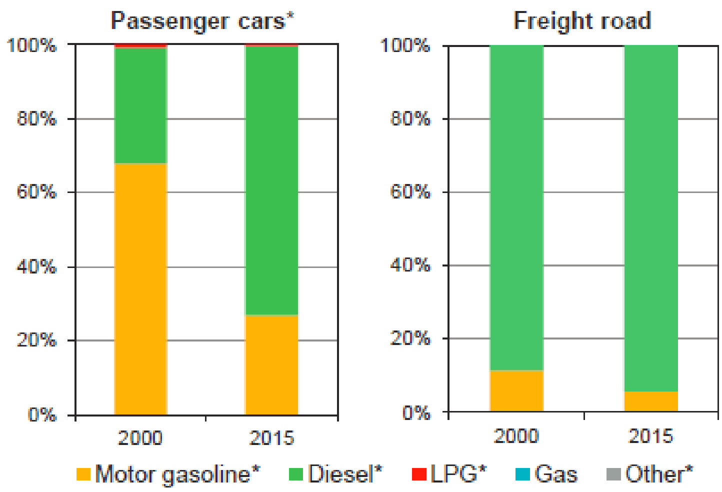


Figure 6. Energy consumption in road transport by source in Spain [31]

At last, it is important to highlight the results presented in the Spanish report on EE services market conducted by QualitEE consortium and Creara energy experts under the scope of EU's Horizon 2020 programme [23]. In

Figure 7, we can see the results obtained from surveys directed to 18 important representatives of Spanish energy services industry compared to EU data extracted from literature review. It is evident that Spain differs in some sectors compared to the European average. This fact is related to several barriers that we will review later.

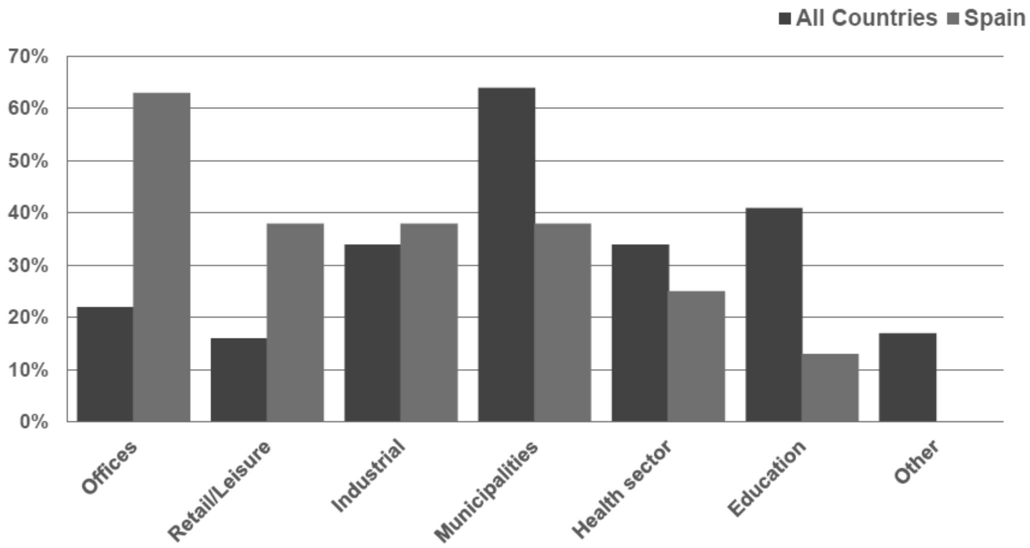


Figure 7. Energy services customers' nature according to survey (all-Europe vs Spain comparison) [23]

Based on this, we will review the sectors we believe are more important for the energy services market: Industry, Tertiary sector and Public sector.

Industry

Industry is a very interesting sector due to its energy intensive processes, its advanced knowledge and relationship with energy efficiency and its already established relationship with technology providers as ABB. Industrial manufacturers always seek for processes optimization and will be interested in projects related with energy efficiency. In Figure 8, we can appreciate the most energy-intensive subsectors, as well as the growing share of electricity in manufacturing industry´s energy mix.

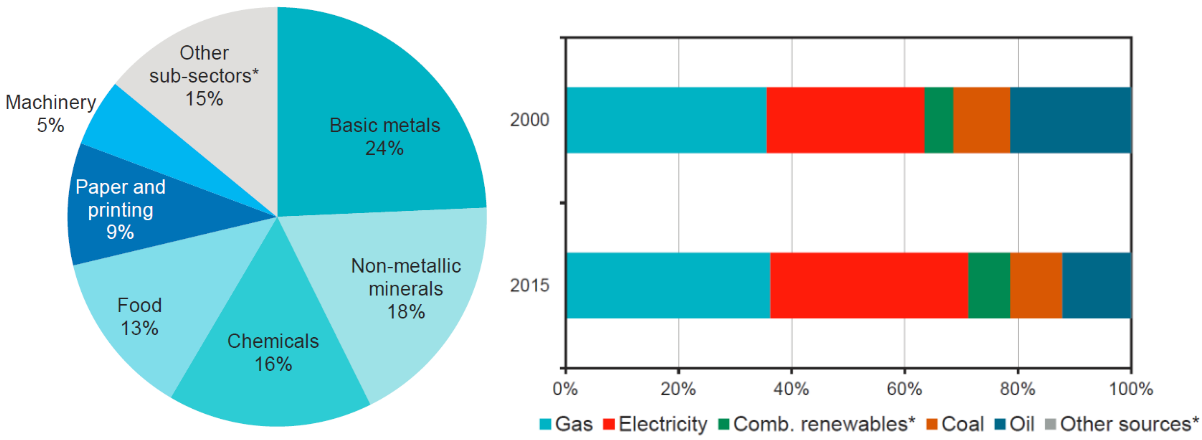
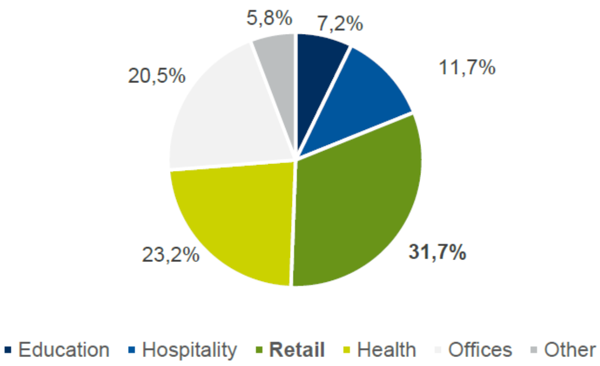


Figure 8. (Left) Manufacturing energy use by sub-sector in Spain. (Right) Manufacturing energy consumption by source in Spain [31]

Tertiary Sector

Tertiary sector differs from industry in several points. Although it is not such an energy intensive sector, it has some potential advantages and different sub-segments (see Figure 9) willing to invest in EE and management. Energy in tertiary sector is more dispersed in several installations. However, this fact could represent an opportunity since customers may want to obtain a solution in order to centralize the monitoring and management of much dispersed locations. Moreover, tertiary sector gives usually more importance to its "green image" and uses it as a marketing tool, so an EE service could add value in this way. At last, the share of electricity in the representative tertiary sector energy mix is higher than the one in industry (see Figure 9).



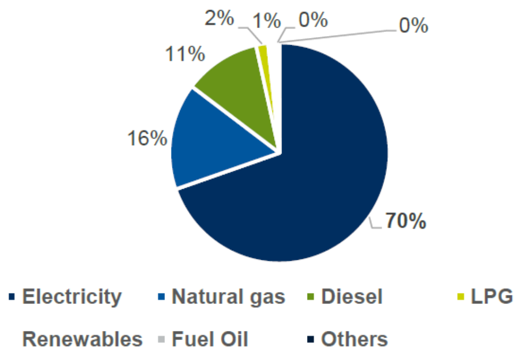


Figure 9. (Left) Energy consumption by sub-sector, tertiary sector in Spain. (Right) Final energy consumption by source, tertiary sector in Spain [32]

Public Sector

The public sector is a very important sector to take into account. As we have previously seen in Figure 3, EE market volume in public projects is growing at a constant and accused rate. Also, as seen in point 3.2, several European policies -and their transposition in the Spanish framework- are aiming to boost energy services market and will start -and sometimes be more restrictive- in public buildings in order provide visibility and serve as an example. For example, the EPBD describes Nearly Zero Emissions Buildings (NZEB) as those with a high energy efficiency level with minimum levels of required energy covered mainly by renewables [33] and established that all new public buildings must be NZEB by the beginning of 2019 -whereas for non-public buildings, the stated year is 2021-.

In conclusion, public sector will be, without doubt, an important sector buying energy services and participating actively in the market through different subsidies and support schemes.

3.3.3. Barriers

Overall, the main barriers in the Spanish market are related to the lack of trust and information in the energy services industry. Spain differs from Europe in several key points. For example, 50% of respondents from the surveys performed in [23] recognized the lack of standardized Measurement and Verification (M&V) practices as a barrier in the Spanish market. On the other hand, even though decreasing energy prices are considered as a barrier for several stakeholders in Europe, increasing energy prices are considered as a driver in Spain (see 3.3.4).

Now we will review and classify the main barriers found in the Spanish market:

- **Regulatory & Administrative:** In general, local Spanish governments in Spain are very inefficient in decision-making processes. Moreover, public procurements are time-consuming and lengthy; public administrative accounting is not used to deal with energy savings.
- **Informational/Structural:** Several interrelated barriers fall into this category, such as the lack of standardized M&V practices, lack of official certification bodies, lack of information by the public, lack of trust in energy services industry and low demand.
- **Financial:** Due to the public administration inefficiencies, ESCos in Spain had always obtained financing from banks or other entities. However, after the economic crisis, this path has become difficult for many SMEs. Some of these companies have been forced to use own financing in order to reach customers and consequently have lost customer acquisition capabilities.

Again, Qualitee report [23] extracts data from Transparensee European project [34] and compares EU identified barriers with the results obtained from representatives of the Spanish energy services industry (see Figure 10).

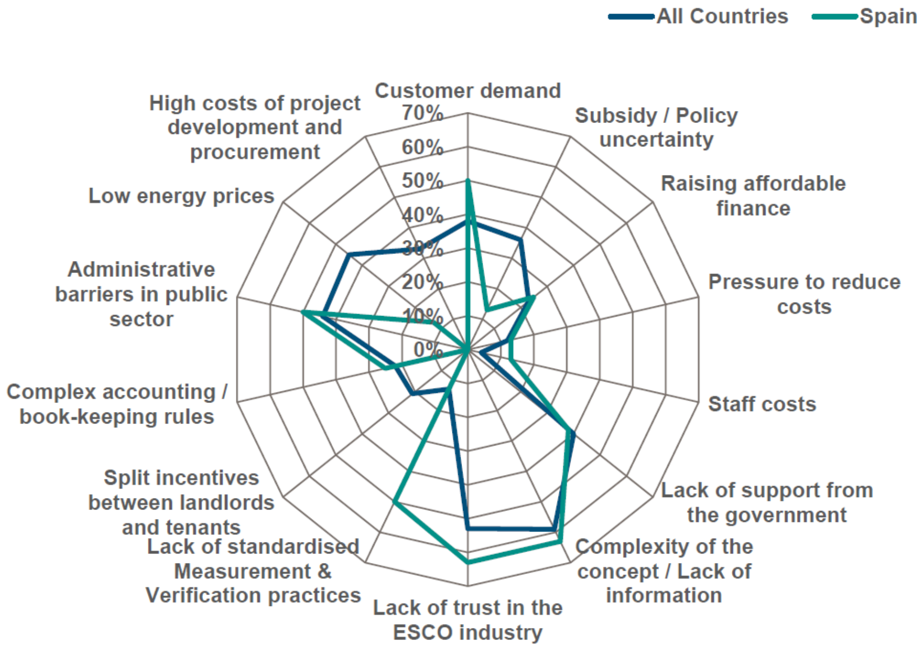


Figure 10. Main barriers to energy services business - EU vs Spain [23]

3.3.4. Drivers

The pressure to reduce energy costs is seen as a main driver for the energy services industry in both EU -where it is the most important driver [35]- and Spain. However, increasing energy prices in Spain stand out as the main driver by far (see Figure 11). It is important to highlight how "limited budgets in public sector" is not considered as a main driver in Spain. In line with the previously seen administrative barriers, it is evident that these are more related to the decision-making process than to budget capabilities.

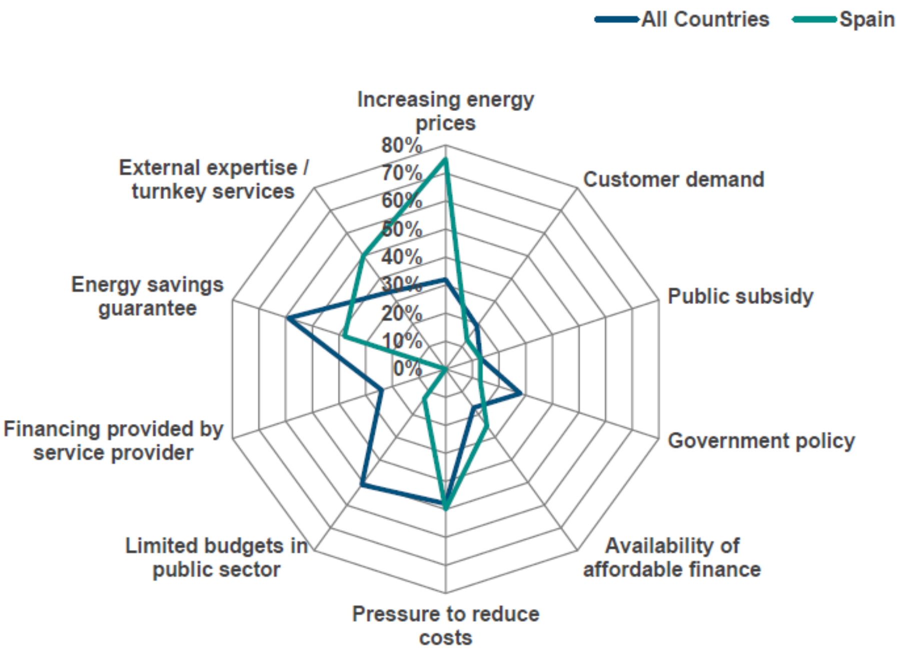


Figure 11. Main drivers for EPC projects in EU vs Spain [23]

3.3.5. Financing

As mentioned before, most Spanish companies do not rely on public subsidies for obtaining finance. There are several funds at European level under the scope of EU's Horizon 2020 initiative. The most important would be the European Energy Efficiency Fund (EEF), which is a public-private partnership (PPP) giving support to municipal, local and regional authorities. Other important funds are JESSICA funds and other European PPPs: the European Investment Bank, Private Financing for EE instrument (PF4EE) and European Structural & Investment Funds (ESIF) [35]. In Figure 12, we can appreciate the main financing sources for EE projects at European level.

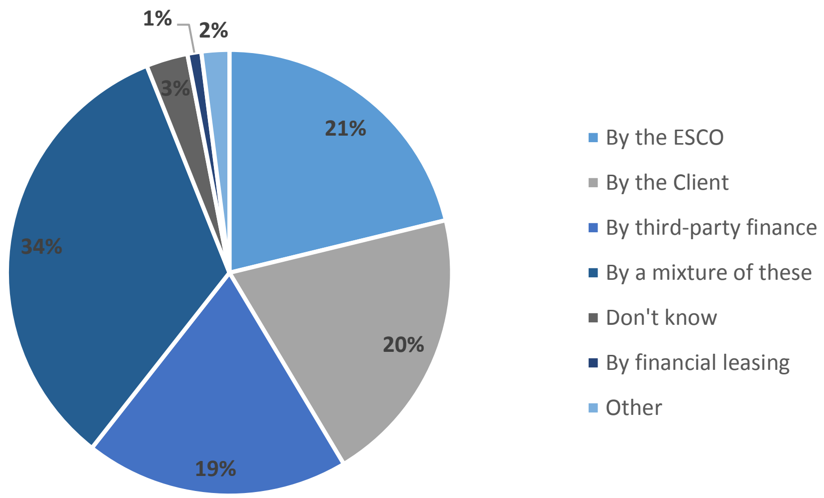


Figure 12. Financing sources for ESCO projects in the EU. (Source: Own elaboration from Transparensee database [36])

Data gathered from Spanish respondents in Transparensee database are not determinant -according to [36], all respondents finance their projects by a mixture of the previously mentioned sources-. However, according to [23], the most used financing sources in Spain are borrowing debt -about 90% of respondents- and EPC providers' internal funds -around 60% of respondents- (see Figure 13).

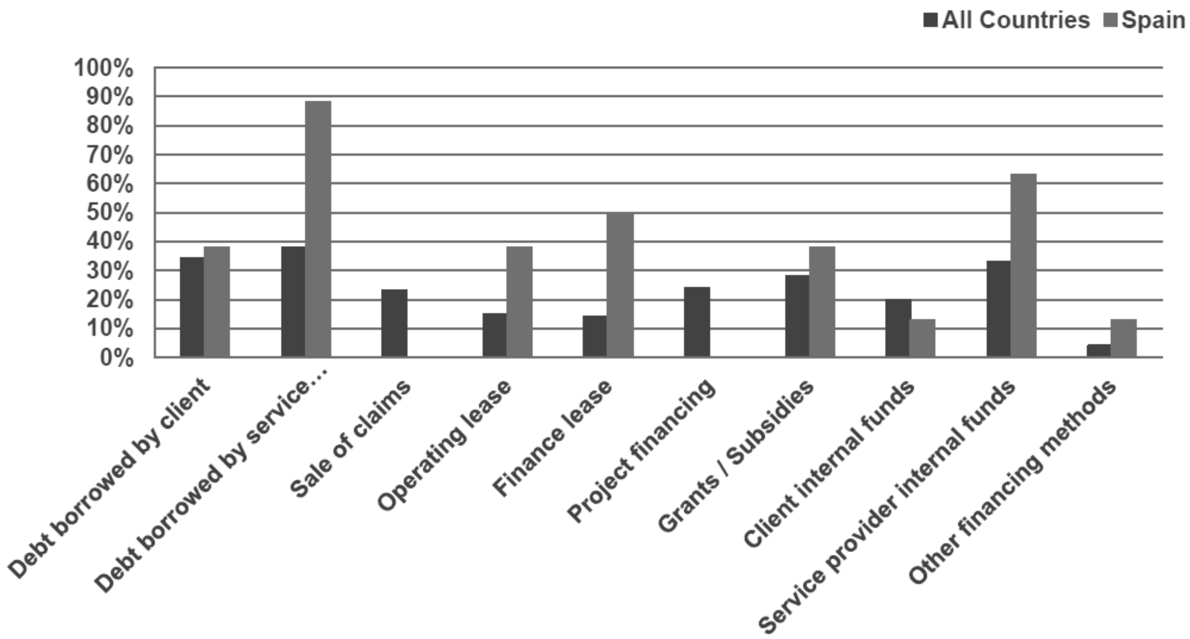


Figure 13. Financing sources in Spanish energy services market [23]

IV. Technology Analysis

An energy management solution is, in most cases, a bundle of different products and services, such as devices, software, platforms, applications, etc. In this section, we will depict the main blocks or layers that define our solution, as well as highlight which elements could provide us a competitive advantage over other market players.

The typical building blocks involved in an IoT platform development are: the hardware or devices, the communication networks, the software backend -which is the data access layer-, the built applications on the software and the security that covers all blocks. The platform itself would be a part of the software backend, as seen in Figure 14.

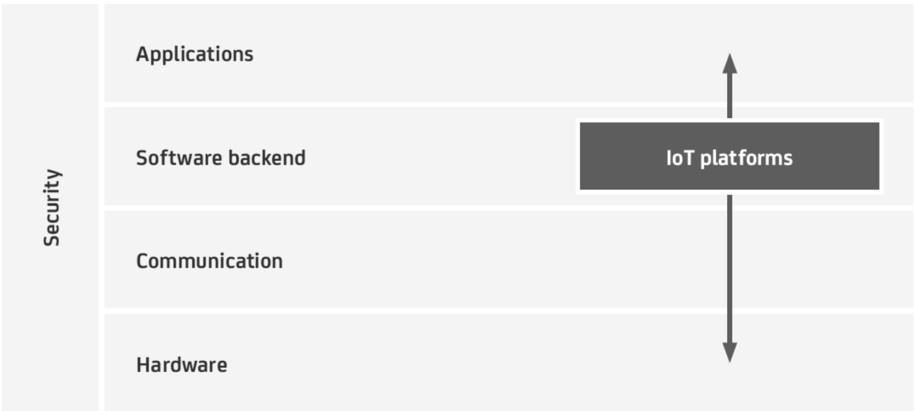


Figure 14. Main layers involved in IoT-platform solutions [37]

Regarding our case, we will further on classify the different layers of the proposed solution in a slightly different way.

4.1. Hardware (Metering)

The hardware layer is represented by all metering devices, which can be equipped with built-in microprocessors, sensors, actuators and communication hardware. All data is produced in this layer in order to be processed in the next one. The devices can be classified in two main categories:

- **Simple Devices**: Formed by the hardware, a microcontroller unit (MCU) and a firmware -permanent software programmed into a read-only memory-. They generate, transmit data and perform simple actions, normally with limited capabilities.
- **Smart devices**: Formed by the hardware, a micro processing unit (MPU) and an operating system (OS). They can enable local computing, analytics and time-sensitive decisions at a certain level -meaning reduced band-with costs due to local data processing-. They have improved capabilities concerning security, connectivity, operability and reliability. Most of the times they may also be equipped with a built-in user interface.

At ABB, we have a broad portfolio already developed with connectivity capabilities and digitalization purposes: circuit breakers -from low calibres up to 6300 A-, electricity meters, contactors, modular protection and control for home automation with KNX protocols, contactors, soft-starters for drives and more switchgear [38].

It is important to highlight 2 flagship products that will provide us a competitive advantage over other firms:

- **Ekip-up**: It is a digital unit that can be attached to old or obsolete main circuit breakers. This way, it upgrades the main breaker of the installations by providing monitoring, protection, control and connectivity capabilities for the cloud platform [39]. It is a brand-agnostic product, meaning that it can be attached to and upgrade equally other non-ABB products.
- **CMS-700**: Following the same line of the previous product, it is a centralized monitoring unit that can provide measurements at sub-metering level up to 96 lines of the facility (96 single-phase or 32 three-phase lines or a mix of the two up to the limit of 96 sensors). It is also enabled for cloud connectivity, brand-agnostic and easily adaptable to any distribution panel [40].

4.2. Edge Device

The edge device -also called edge gateway or just gateway- is a type of smart device which extends data processing capabilities normally located at cloud level to local installations -on-site-. The term “edge” refers to the boundary depicted by the hardware layer in Figure 14. Compared to data processing in the cloud, an edge device allows us to reduce delays in data transfer (latencies) and secure operations at local level in case there is a cloud network failure or connectivity loss [41].

This option may be interesting for time-sensitive applications, critical data processing and increased security -sensitive data can stay at edge layer without the need of going back and forth to the cloud-, and has several advantages: faster data analysis with reduced lag times, lower costs associated to data management and storage and reduced bottlenecks in network traffic.

In other words, the edge gateway concentrates all data measured from different communicable meters distributed in the installation, which may communicate through different protocols, in a single device. Afterwards, it processes, analyses and sends relevant data to the cloud in order to be further processed of used in different applications.

At ABB, we are working with an edge device for our solution development. This gateway is able to read and process data from the main industrial and commercial communication protocols used nowadays, such as Modbus TCP -usually called Ethernet-, Modbus RTU, KNX, DMX512 and more. The gateway itself can connect to the cloud via GPRS or just by connection to a standard modem. In case the user does not want to use the cloud platform, it can also be connected directly to the customer’s internal SCADA, building management system (BMS) or distributed control system (DCS). In line with the products regarding this solution, the edge device used in ABB intended to be brand-agnostic. However, depending on the metering devices, it may be necessary to develop non-ABB products firmware into the system in order to be readable.

4.3. Communication Network

The communication network involves everything related to the transportation of data, either physical or wireless. It is the link in between the hardware and the network, via proprietary or open-source communication protocols.

As previously mentioned, at ABB we try to make our solution easily accessible for all potential customers. Therefore, we are used to work with the most widespread communication protocols in different industrial, tertiary and public sectors.

4.4. Software Backend/Cloud Platform

On the other side of the communication -this is, after having produced the data in the hardware, collected it and processed it in the gateway and transmitted via communication networks-, is where we find the software backend. The software backend manages the connected devices, networks and provides the necessary data integration and interface to other systems in order to obtain valuable insights through algorithms, apps, etc.

In this layer we can mainly find the database/storage, the device management, event-processing and basic and advanced analytics, as well as the backend hardware and the middleware -software that acts as a bridge between an operating system or database and applications-.

At ABB, we work with a cloud platform as backend for our solution, for reasons of security, accessibility and scalability. The software development, as well as the software integration related with the gateway, is outsourced to a subcontracted company in order to be provide more dynamism and a fast response to customer needs in the development phase of the platform.

4.5. Security

Security is a cross-layer that covers all before mentioned layers (including application layer seen in Figure 14). Now we will review the main aspects covered by security in each layer:

- Hardware + Edge layers: Physical protection of the devices, as well as firmware authentication for the correct communication between devices and gateways.
- Communication layer: End-to-end encryption of data in order to ensure data privacy.
- Software backend layer: Privacy management, stored data.
- Applications layer: Application identity and access management (also applicable to other layers).

V. Competitor Analysis

In this section, we will describe the main players within DSM framework. Further on, we will perform a deeper analysis with three selected key competitors, which could potentially imply greater dangers in terms of competition.

5.1. Main Players

Due to the vast and diverse products and services offered in DSM framework, there are several market players which can be involved in one way or another. These players could not necessarily be specialized in just one service or product category; and therefore, in reality, some of them are normally a bundle of the players described below. For example, some ESCOs are also software developers or some Information and Communications Technologies (ICT) integrators offer also consulting services.

ESCos

As previously explained, an Energy Services Company is a firm providing a range of energy-related solutions including design and implementation of energy savings projects, retrofitting and energy issues (conservation, supply, risk-management and so on). They also develop, implement and facilitate financing for upfront EE investments for its clients.

There are +1350 ESCos registered officially in Spain [42]. Some examples with important presence in the Spanish market are Creara, iON Smart Energy, Escan or FN Energia (see Annex I – Researched companies and players).

Technology Suppliers

A technology supplier is any firm providing intelligent energy devices or electronic solutions which incorporate information and communication technologies (ICT). Speaking in general terms, it is the firm that develops and manufactures the hardware that enables energy monitoring and management. Therefore, a technology supplier is normally in a close relationship with ESCos.

Some examples are Circutor, Schneider Electric, Carlo Gavazzi, Satel, OpenDomo, Socomec, Cysnergy or Janitza.

Software Developers

A software developer is in charge of the development and integration of the platform or application related with the energy service. An important characteristic of a software development is being brand-agnostic, meaning that it is highly compatible with any hardware brand. The majority of the times, software developers also participate in the development of the gateway (as seen in 4.2), which is the hardware device that gathers, processes and sends the data to the software backend -a cloud platform in our case-.

Some examples of important software developers in the Spanish market are Energy Minus, Dexma, Smarkia, Seinon, CO2ST, Kinetic (CISCO), Energisme and Wattics.

Associations

An association joins several energy services companies and other stakeholders and provides additional services such as consulting, training or marketing. Essentially it is a way of providing trust and market presence for those companies offering energy-related services and solutions. In some occasions, public bodies are also members of these associations, providing a link in between public authorities and different stakeholders (ESCos, technology suppliers and so on).

The most important are AMI -Association of Comprehensive Maintenance and Energy Service Companies-, ANESE -National Association of Energy Service Companies- and A3e -Association of Energy Efficiency Companies- [43].

Public Bodies

Public bodies are key when it comes to promoting, stimulating and supporting EE or DR initiatives. They can act as customers, partners or representatives of the community. A public body committed to DSM strategies will enhance and boost the general implementation and success of all the stakeholders involved in the value chain. Normally, the aims of a public body are lowering energy consumption and costs, while improving general performance in buildings and districts.

Aggregator

As previously explained, the DSM aggregator acts as an energy manager in between the utilities and the consumers/prosumers. Aggregators gather diverse end users at their portfolios to form a single market participant. This way, they enable end users flexibility, which is offered to utilities or other market actors in order to obtain benefits through the participation in explicit DR programs.

Even though explicit DR programs are not widespread in Spain (see Figure 15), DSM aggregators are a key figure to take into account in the near future, since they will enable RES integration to the grid and new business models for utilities and end customers' interaction -as seen previously in II in several authors' analyses-.

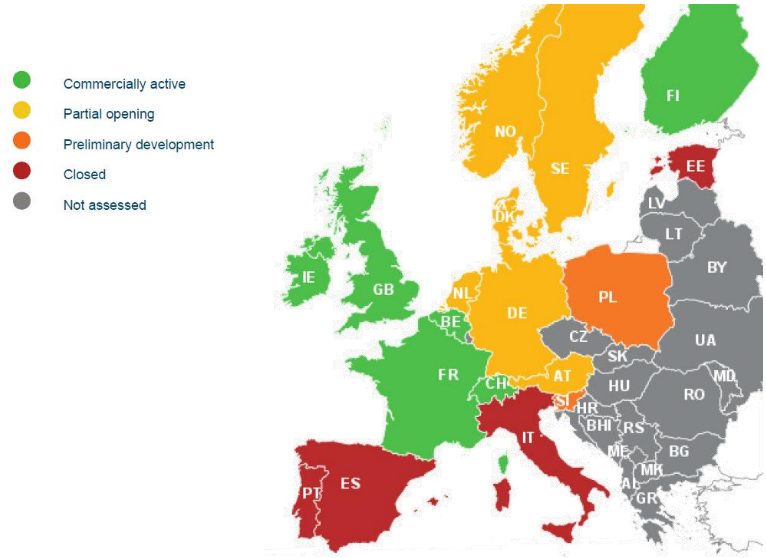


Figure 15. Explicit demand response development in Europe [22]

Utilities

Utilities have a key role in DSM markets, especially in liberalized energy markets, since they are the energy producers and they charge for the costs associated with energy consumption. As mentioned above, new relationships and stakeholders are appearing between end consumers and utilities. Therefore, they are also a key player in the energy value chain to keep in mind.

In Spain, the main dominants of the market are Endesa, Iberdrola, Unión Fenosa and E.ON.

Consulting Firms, Systems Integrators and Engineering Firms

Even though consulting firms, systems integrators and engineering firms perform different jobs, they all have in common that they prescribe or recommend the final solution adopted by the end customer. This will include, in many cases, the hardware, the software and the energy services. Therefore, these players are also crucial in DSM markets and should be taken into account.

5.2. Key Competitors Analysis

Keeping in mind that ABB has traditionally been a technology supplier, we will now deeply analyze three selected players that represent a main threat, due to their recent activities related with **digitalization and energy management solutions and services**. We will try to keep the same analysis structure for all three, although some points may vary based on the information obtained or the difference on the companies' activities carried out.

5.2.1. Emerson

Emerson is a global technology and engineering company, with a strong presence in process industries, utilities, transport and infrastructure (see segments in Table 1). All relevant information has been extracted from [44], [45] and [46].

Key Segments with Digital Focus

Segment	Revenue (B$) [44]	Growth (%) [44]	Main sub-segments brief description (% of revenues)	Main customers/industries	Overlap with ABB
Automation solutions	9,5	5	4 main sub-segments: -Measurement & analytical instrumentation (33%) -Valves, actuators & regulators (28%) -Process control systems & solutions (21%) -Industrial solutions (18%)	Oil & gas, chemicals and power generation	Strong
Commercial & residential solutions	5,8	7	2 main sub-segments: -Climate technologies (72%) -Tools & home products (28%)	Commercial buildings & construction, facility management & maintenance, food retail & hospitality	Weak

Table 1. Emerson key segments overview (own elaboration)

Main Offerings

In this point, we will analyze the main portfolio offerings in "automation solutions" business due to the strong overlap with ABB. Emerson is mainly focused in industry **automation** and it has a vast portfolio of digital offerings -called as a whole by the name of "Plantweb"-, as seen in Figure 16, where the different colored numbers depict the 4 different layers of offerings, being: 1.Devices; 2.Control; 3.Data Management; 4.Services. Further on, we will highlight the most important offerings in each layer that could mean a competitive threat.

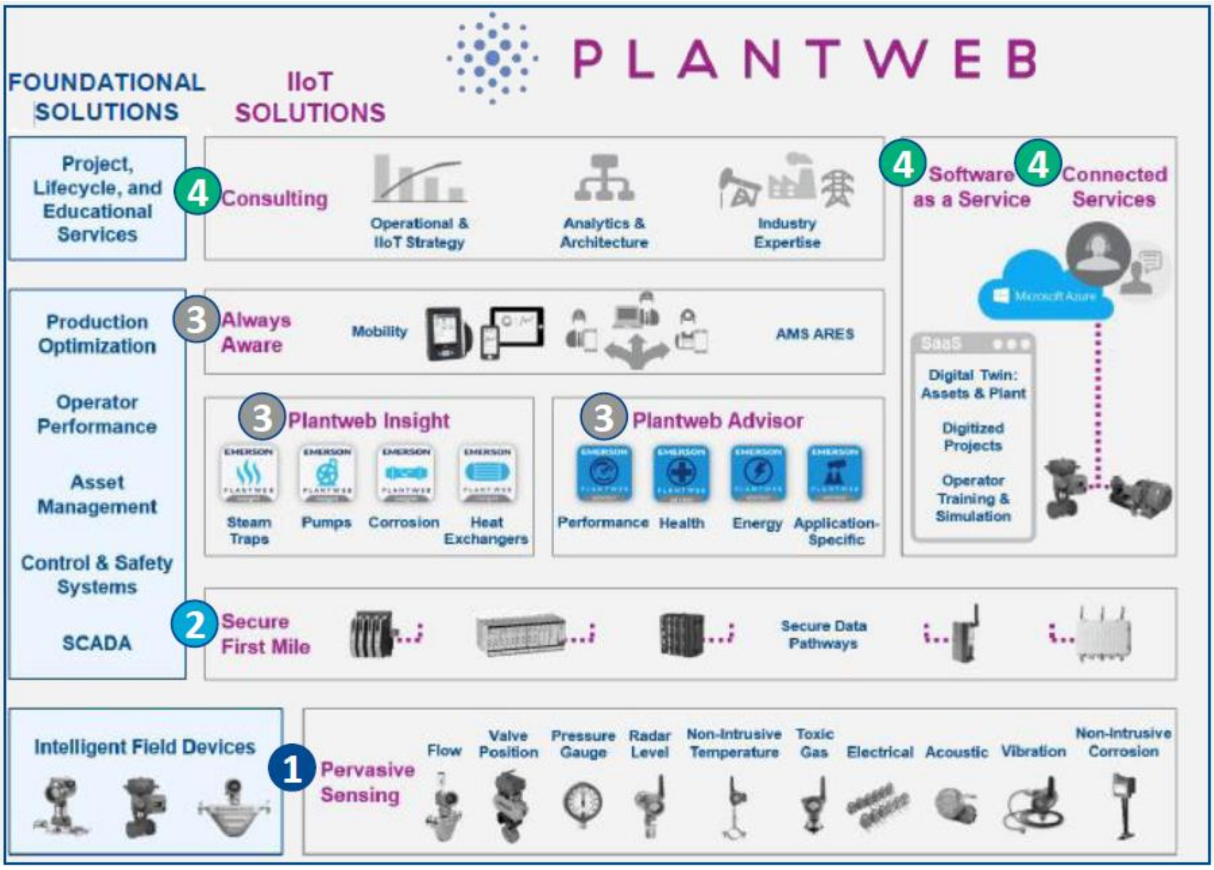


Figure 16. Emerson's "Plantweb" digital ecosystem portfolio [45]

1. **Devices:** Emerson has one of the largest portfolios of wireless, non-intrusive sensors, which can also measure several non-energy variables.
2. **Control:** Emerson can provide several communication architectures depending on the customer needs. They claim to operate with edge connectivity, telecom/router and cloud connectivity. However, these architectures are working inside "plantweb" ecosystem, and therefore the may imply potential proprietary issues.
3. **Data Management:** It is the layer with the major part of digital offerings by Emerson -control layer is the second biggest-. 3 main offerings:
    a. **Plantweb Insights:** Plug-&-Play analytics applications with pre-configured algorithms that translate data into valuable insights for very specific devices, such as: Steam traps, pumps, wireless pressure gauges, heat exchangers, etc.

b. **Plantweb Advisor:** Similar to the previous one, but with customizable algorithms and directed to several specific asset monitoring functions: Performance advisor (+17 different assets), health advisor (+7 assets) and energy advisor (energy and emissions management).

c. **Always Aware:** Basically solutions that provide mobility functionalities and relevant-time alerts. The two main offerings are DeltaV Mobile -monitoring app in smartphones- and AMS Ares -centralizes data and alerts from other Emerson apps-.

4. **Services:** 3 main offerings:

   a. **Connected Services:** A team of Emerson experts provides the service of securely enabling the connection of different Emerson products and applications.

   b. **Software as a Service (SaaS):** Cloud-hosted applications and services that provide customers with de capability of simulating their operating assets of the plant for improving efficiencies or training.

   c. **Consulting:** Consulting services that also help promoting other digital products and services.

Recent R&D Efforts, Investments and Acquisitions

Regarding **R&D**, Emerson spent about 2% of total 2017 revenues, without any specific strategy identified regarding digital & energy services solutions [46].

Emerson's **investment** activity has been very limited since 2016. Unlike the other two competitors analyzed -Siemens and Schneider-, Emerson does not have a venture capital arm.

On the other hand, Emerson plans to spend around 550M$ per year on **acquisitions** and share repurchases. They could not acquire Rockwell Automation for $29B in 2017 [46].

General Overview - Evaluation

In this final part, we will try to summarize the strengths and weaknesses extracted from the competitor's analysis, as it can be seen in Table 2.

Strengths	Weaknesses
- Very complete portfolio and industry expertise - Ability to deliver "full-package" services & products without the need of 3rd parties - 40 billion $ installed base [46] - n. 1 ranked company for control systems in several industries -chemicals, power, oil & gas...-, software solutions -advanced process control, asset management, simulation software- and industrial wireless infrastructure [47]	- Lack of strong capital arm may limit purchasing ability for investments and acquisitions - Plantweb digital ecosystem is not open for 3rd party developers, which could result in fewer and slower applications' development and due to reduced key partnerships' participation - Intense focus in industry reduces reach to other market segments and other potential revenues

Table 2. General competitor evaluation - Emerson (own elaboration)

5.2.2. Schneider

Schneider has always been a traditional competitor for ABB, especially in industrial sector and low voltage switchgear. They claim to be ahead in the learning curve of industrial IoT and digital offerings in terms of investment and maturity of offerings. Global specialists in energy management, automation and software, their focus segments can be appreciated in Table 3. All relevant information has been extracted from [48], [49], [50] and Schneider's website for portfolio analysis (see Annex I – Researched companies and players).

Key Segments with Digital Focus

Segment	**Revenue (B$)** [48]	**Growth (%)** [48]	**Main sub-segments brief description (% of revenues)**	**Main customers/industries**	**Overlap with ABB**
Building	11	4	·Power monitoring & control ·Network connectivity ·Home & buildings automation ·Renewable energy conversion & connection ·EV charging ·Building management systems	Hotels, hospitals, residential & commercial buildings (real state, integrators, panel builders, building management companies)	Strong
Industry	6	6	Distributed control systems, motion controllers, variable speed drives, Human-Machine Interfaces (HMI), Programmable Logic Controllers (PLC), industrial software for: manufacturing operations management, modeling/simulation, and asset management.	Oil & gas; mining, minerals & metals; food & beverage; manufacturing industries	Strong
Infrastructure	5	-2	Automation and remote control systems, different software solutions: Distribution Management Software (DMS), Operation Management Software (OMS), Supervisory Control And Data Acquisition (SCADA) and pipeline management software	Water pipelines & treatment, oil & gas pipelines, municipalities	Strong
IT	4	2	Specialized in critical solutions for applications where power continuity and quality is essential: Single-phase and 3-phase Uninterruptable Power Supplies (UPS) and all related equipment, services and software management	Data centers	Strong

Table 3. Schneider key segments overview (own elaboration)

Main Offerings

Here we will review Schneider's IoT and Digital ecosystem -called **EcoStruxure-**, which is claimed to be open and enable design and operation of connected systems with best security. As seen in Figure 17, Schneider's digital ecosystem is divided into three main layers covering all mentioned segments: 1. Connected products; 2. Edge control; 3. Apps, analytics & services. The solutions offered are very vertical, covering mainly 6 domains of expertise: Buildings, Power, IT, Machines, Plants and Grids.

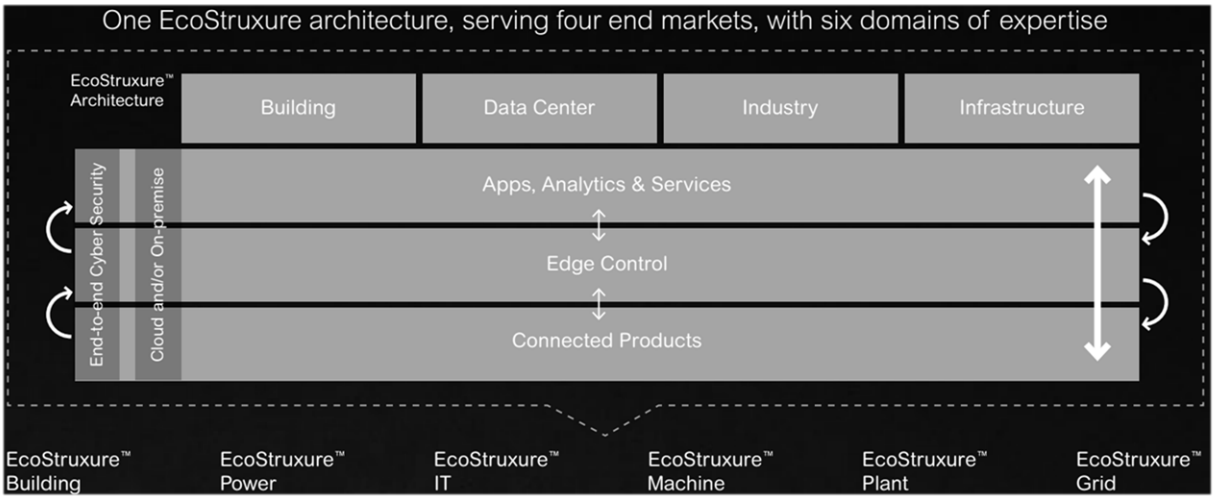


Figure 17. Schneider's EcoStruxure architecture

Now, we will provide an overview of the main offerings found in each of the segments mentioned in Table 3:

1. **Building**
    a. **Building Insights:** Cloud based energy management software
    b. **EcoStruxure Building Advisor:** Remote and on-site building operations optimization
2. **Industry**
    a. **Wonderware:** Manufacturing Executions System (MES)/Manufacturing Operations Management (MOM) software
    b. **SimSci:** Modeling/Simulation software. Digital twins of assets and processes
    c. **Avantis:** Remote asset management & predictive maintenance software
3. **Infrastructure**
    a. **EcoStruxure ADMS:** Unified DMS, SCADA, OMS, and EMS solution
    b. **OASyS DNA:** SCADA software for oil and gas and utilities
    c. **Enterprise Pipeline Management Solutions:** Integrated, open, end-to-end solution for pipeline management and operation
4. **IT**
    a. **StruxureWare Data Center Expert:** Vendor-neutral, scalable monitoring software which collects, organizes, and distributes critical alerts, surveillance video and key information
    b. **EcoStruxure Power Monitoring Expert:** Software package for power management and metering diagnosis (algorithms + experts advice)
    c. **EcoStruxure Power SCADA Operation:** Data-acquisition monitoring and control software

Partners Ecosystem

It is important to highlight Schneider's open partner ecosystem programmes, since they imply a strong advantage against competitors in terms of joint research and development of solutions.

- **EcoXpert partner program:** With around 3000 members worldwide specialized in building optimization, power management and energy efficiency. It has 3 levels of partnership: Partner, Certified –several certifications available, such as Building Management, Connected Power, Critical Power, Datacom, Light & Room Control- and Master -4 masteries: Hotels, Healthcare, BMS Services, Data Centres- [51].
- **System Integrator Alliance Program:** With around 1300 members, it is especially dedicated to system integrators. Also, it is split into Partners (1200), Certified (80) and Masters (4) [52].
- **Collaborative Automation Partner Program (CAPP):** With around 50 members worldwide, it is formed by hardware and software technology partners that provide complementary solutions that complete Schneider Electric solutions for connected products, edge control, and software [53].
- **Global Digital Alliances:** Microsoft, Accenture, Intel and Cisco complement Schneider's technology and knowledge in order to create solutions for specific market challenges towards digital transformation [54].

Recent R&D Efforts, Investments and Acquisitions

Regarding **R&D**, Schneider spent 1,2 billion $ in 2017, about 4,8% of total revenues, with specific strategy identified in IoT, digitalization and IT/OT convergence [49].

Schneider's **investment** activity has been driven by Aspen, which is the capital arm, focusing in energy, new materials and environment start-ups [55].

Concerning last Schneider's **acquisitions**, 4 out of 5 have been software companies, with the other one being a renewable energy services company. They also have a history of several important SCADA acquisitions (Citect in 2006 and Invensys in 2014) [56].

General Overview – Evaluation

In here we will summarize the main conclusions extracted from the analysis into strengths and weaknesses (see Table 4).

Strengths	Weaknesses
- Installed base plus openness for 3rd party devices [49]: +1,5M connected assets, +20% FY16-F17 growth 480K installed sites w/ 20K SI's and developers - Strong capital arm (Aspen) - Wonderware is hardware and protocol agnostic - Really strong and extensive partners ecosystem - Strong presence in renewables and EV charging - Software important acquisitions - Close relationship with big players (Accenture, Microsoft, Intel, Cisto, Enel)	- The provided solutions are very verticalized --> need for horizontal communication and marketing between verticals - The vast range of specific offerings may overwhelm customers' profiles seeking for more horizontal and general solutions

Table 4. General competitor evaluation - Schneider (own elaboration)

5.2.3. Siemens

Siemens is a global technology company with core activities in electrification, automation, digitalization and a strong presence in wind and solar generation. A deeper review of focus segments is depicted in Table 5. All relevant information has been extracted from [57], [58], [59], [60] and Siemens website.

Key Segments with Digital Focus

Segment	**Revenue (B$)** [57]	**Growth (%)** [57]	**Main sub-segments brief description (% of revenues)**	**Main customers/industries**	**Overlap with ABB**
Digital Factory	11	12	·Complete product portfolio for manufacturing industries ·Product lifecycle and data-driven services for value chain optimization	Manufacturing Industries	Strong
Building Technology	7	6	Automation technologies and digital services for safe operation & management of buildings	Owners, commercial buildings tenants, building construction contractors	Strong
Mobility	8	4	·Passenger and freight transportation products and automation ·Road traffic technology ·Digital solutions and services	Public transport and logistics	Strong
Process Industries & Drives	9	-2	Complete product portfolio, software and services for moving, measuring, controlling and optimizing all kinds of mass flows.	Manufacturing, oil & gas, mining and metals	Strong
Power & Gas	15	-6	Products and services for energy generation from fossil fuels and for production and transportation of oil & gas	Generators and oil & gas companies	Strong
Energy Management	12	3	Solutions for transmitting, distributing and managing electrical power and for providing intelligent power infrastructure.	Power providers, TSOs, DSOs, infrastructure developers	Strong
Siemens Gamesa Renewable Energy	8	33	Manufacturing, development, management, operation and maintenance of wind farms	Utilities	No
Healthineers	14	2	Healthcare technology, imaging and diagnostics tools	Health	No
Siemens Financial Services	N/A	N/A	B2B financial solutions	Software Projects	No

Table 5. Siemens key segments overview (own elaboration)

Main Offerings

Siemens offers a complete digital portfolio that covers products lifecycle: starting from digital twins for virtual testing to data analytics for generating value from data in the field. The offerings related to digitalization and IoT are grouped by Siemens in 3 main blocks (see Figure 18).

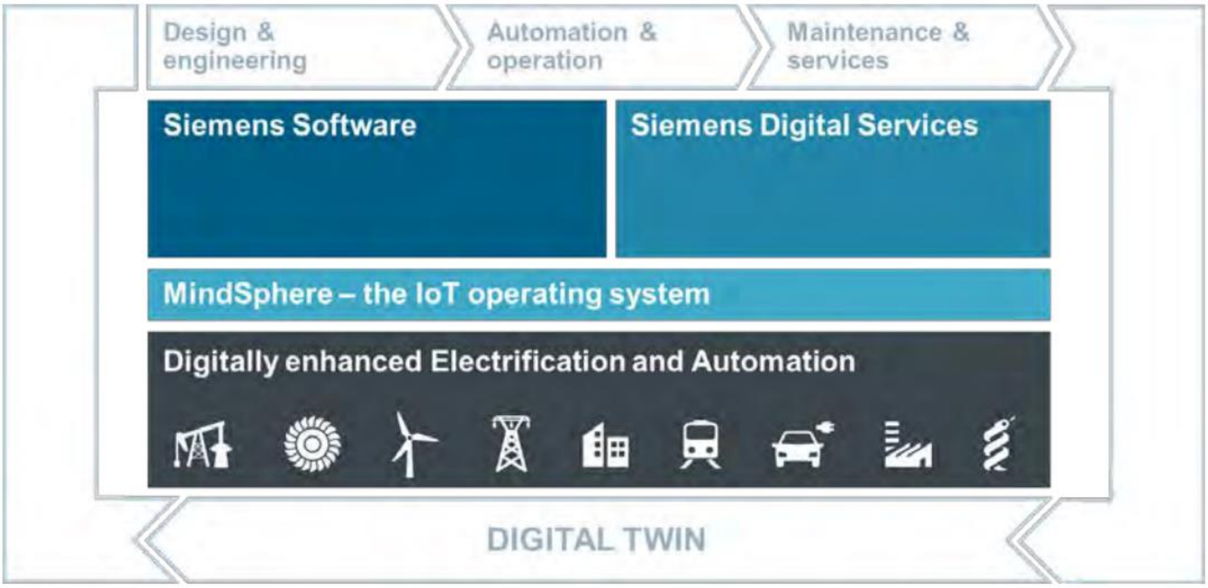


Figure 18.Siemens' "MindSphere" digital ecosystem [61]

1. **Siemens Software:** Several on-site or cloud-hosted -in MindSphere- software solution directed mainly to manufacturing industries to digitalize and integrate their entire industrial value chain through Product Lifecycle Management (PLM) solutions, Manufacturing Operations Management (MOM) solutions, and Totally Integrated Automation (TIA) equipment. Relevant number of offerings also found in utilities sector.
2. **Siemens Digital Services:** Software+services offerings, many of which are hosted on MindSphere. Aim for leveraging data, increase availability of assets, optimize maintenance and performance in general. The utilities sector is the one with most digital services offerings.
3. **MindSphere IoT Operating System:** Cloud-based, open, IoT operating system aimed for connecting products, plants, systems, and machines. Mainly focused on industrial sector.

Partners Ecosystem

In the same way as Schneider, Siemens has a strong partner ecosystem. However, Siemens approaches partners in a different innovative way with a business model perspective. There are two main innovative business models that have proven successful for joint research and development with partners and customers:

- **Co-innovation with Customers:** There are 20 vertical application centers in 17 countries worldwide in order to co-innovate with customers in different applications -MindSphere Applications Centres-. Siemens provides know-how and infrastructure as a service and customers pay for these services [62].
- **Marketplace for 3rd Party Applications:** App store and IaaS for 3rd party developers to market and sell products and services directly from the Siemens website [63].

Recent R&D Efforts, Investments and Acquisitions

Regarding **R&D**, Siemens spent 5,2 billion $, about 6,2% of total 2017 revenues, with projected increase in digital spending of 10% in 2018 [58].

As Schneider, Siemens also has a capital arm -called Nexus47-. **Investment** activity has been directed to young companies with promising digital technologies [64]. Nexus47 plans to deploy 1000 M€ in investments over the next 5 years [60]. Also important to mention a recent 43M$ investment in ChargePoint, a strong player in EV charging infrastructure.

Last Siemens' **acquisitions** have focused on virtual design and software companies [64]. It is important to highlight the acquisition of Spanish wind giant Gamesa in 2017, becoming a global leader in wind generation.

General Overview – Evaluation

In this subsection, we will summarize the main conclusions extracted from the analysis into strengths and weaknesses (see Table 6).

Strengths	Weaknesses
- Installed base plus openness for 3rd party devices - 1M+ connected assets, +20% 2016-2017 growth from SW and digital services [58] - Deep know-how in a broad range of markets and industries - Powerful partners and solutions joint collaboration ecosystem - Vast digital portfolio: MindSphere, Software, Services, Security - Perceived as a reliable, trustworthy and high quality brand - Extensive experience in industrial automation - Powerful capital arm - Focus in software	- Competition for highly qualified personnel with "digital talents" remains intense - Lack of openness for hardware and devices of other brands than Siemens - MindSphere considered not mature and with limitations (e.g. too specific to Siemens)

Table 6. General competitor evaluation - Siemens (own elaboration)

VI. Business Model Generation

In this section, we will firstly review the main business models used by companies offering energy services in Spain. Afterwards, we will use several business modelling tools in order to evaluate which business model will provide more potential value to our solution.

6.1. Main Business Models

There are two main business models used in Spain regarding energy use: Energy Supply Contracting (ESC) and Energy Performance Contracting (EPC). As seen in Figure 2, energy supply contractors' workspace focuses on the useful energy delivered to the customer, such as electricity, hot water and coolant. Energy performance contractors' workspace, however, goes to the end of the energy delivery value chain and focuses on the final energy services delivered, such as ventilation, space heating, lighting, refrigeration and so on.

In this subsection, we will review these two mentioned business models, as well as other possible configurations.

6.1.1. Energy Performance Contracting

As seen in 1.2, an energy services company using and EPC arrangement delivers a project to the customer so he or she can improve the energy efficiency on the demand-side of the facilities. The savings obtained will proportionally serve as remuneration for the energy services company and to help finance the projects. Therefore, this is a performance-based business model. After having completed the contract period, the customer will continue obtaining savings from the measures implemented.

EPC is the most widespread business model used by ESCos [23]. However, it is better suited for larger projects, since there are high transaction costs associated to the complexity of the contracts and the measurement and verification of savings. There two main EPC types that generally stand out: Shared savings EPCs and guaranteed savings EPCs (see Figure 19). Now we will describe and review the main EPC types.

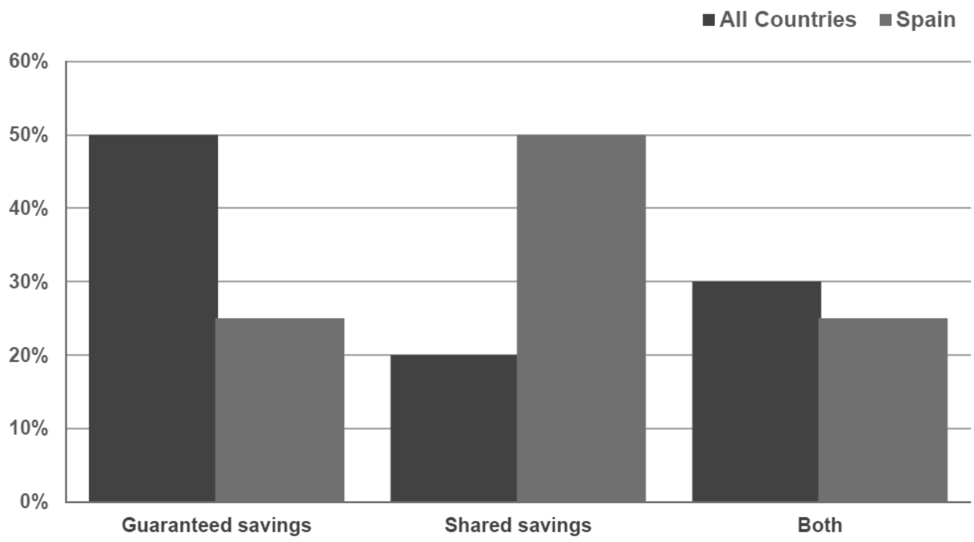


Figure 19. EPC types used in EU vs Spain according to survey [23]

Shared Savings EPC

In a shared savings energy performance contract, the ESCo obtains financing for the EE implementation project, which is normally focused on demand-side measures -although it can also include supply side EE measures-. The savings obtained from the implementation are then shared in between the ESCo and the customer, according to the period and sharing rates contractually agreed [65].

As an advantage, this model attracts customers since they can implement EE measures without any prior investment, share risks and repay the debt based on the performance of the project. On the other hand, ESCos using this model may be limited to a number of customers since they have to consume their own resources in order to obtain finance.

Guaranteed Savings EPC

In this model, the ESCo assumes the risk of project's performance by guaranteeing a previously defined minimum amount of energy savings. If this minimum is not reached, the ESCo will be penalized and pay the difference. If savings are above the determined level, the ESCo may receive the extra benefits or they may be shared in between ESCo and customer, depending on the contract [66].

As main advantages, the ESCo does not need to dedicate so many resources -since the customer looks for finance- and may obtain extra benefits if the savings exceed the agreed minimum. As main disadvantage, the ESCo assumes all performance risks and may be penalized if the savings do not reach the established minimum.

Variable Contract Term EPC

The ESCo finances the project as in a shared savings model. However, if the savings obtained do not reach the expected value, contract length can be extended until the customer has repaid the ESCo. In some cases, ESCos use a variation of this model called "First out", where all savings obtained from the project go straight to the ESCo until the payment is totally completed -the savings are not shared-.

6.1.2. Energy Supply Contracting

In an energy supply contract, the ESCo assumes responsibility of providing secure supply of useful energy, which the customer pays for. In general, the ESCo is in charge of operation and maintenance and the ownership of the equipment -such as photovoltaics, combined heat and power or biomass equipment- remains with the client. Therefore, the ESCo is focused on improving EE of the supply side in order to maximize its revenues.

As main advantages, the customer does not need to worry about the supply of energy for a monthly fee and the ESCO can maximize benefits by the reduction of energy costs. The main disadvantage is that the ESCo is contractually obliged to provide secured energy supply, which implies risk.

6.1.3. Chauffage

Also called comfort contract, a *Chauffage* is a contract aiming to provide a certain operational condition demanded by the customer -for example, maintaining a certain room at 21ºC or a refrigeration chamber at a certain temperature and ventilation conditions-. It is a form of outsourcing energy management and the measures implemented by the ESCo can be on both the supply side and the demand side, although demand-side measures are less complex than the ones implemented in EPCs and do not include retrofitting or equipment substitution. The customer normally pays a monthly or yearly fee.

As a main advantage, the complexity of a *Chauffage* contract is less accused than that of EPCs. Similarly than in shared savings EPCs, the disadvantage is that ESCo companies normally finance the projects and assume the operation and maintenance costs –although they are relatively lower-.

6.1.4. Integral Energy Contracting

An integral energy contract (IEC) is basically a combination of an ESC and an EPC. Therefore, the ESCo will implement EE measures in both supply and demand side. Measures from demand side are normally prioritized due to higher economic costs associated with supply side improvements. IECs are therefore more complex and suited for larger projects. The ESCo normally obtains financing and the revenues come from the project's savings.

As a clear advantage, an IEC has more potential for EE implementations since it covers a broader scope. However, the high transaction costs associated with the complexity of the contract, measurement and verification of savings may translate into a barrier for smaller projects.

6.1.5. Build-Own-Operate-Transfer (BOOT)

A BOOT contract is typically used in supply-side measures. The ESCo designs, builds and operates the energy supply installation until the end of the contract, where it is transferred to the customer. BOOT contracts are mainly long term and customers pay a monthly fee that will cover initial investment, operation costs and profits.

As a main advantage, this arrangement offers great value to customers since ESCos deal with all the investment and the entire projects. However, this could also mean a disadvantage from ESCos' perspective.

6.2. Customer Needs - Value Proposition

Besides from the performed market research, we will use the Value Proposition Canvas tool [67] in order to have a better perspective from the customer segments mentioned in 3.3.2 and better design a solution that adjusts to their main needs. The conclusions obtained from this process will be integrated into 2 building blocks of the Business Model Canvas developed in 6.3: **Customer Segments** block and **Value Proposition** block.

The value proposition canvas is split into two parts, as it can be seen in Figure 20:

The right side of the canvas represents the **Customer Profile**, which describes the customer segment we are trying to address in a more detailed and structured way breaking it down into 3 blocks. The first block, **Customer Jobs**, explains what the customers try to get done at work. The second, **Customer Pains**, expresses bad outcomes, risks and obstacles that the customer may encounter by doing these jobs. The third, **Customer Gains**, describes the outcomes that the customer wants to achieve and the benefits that he or she seeks.

The left side of the canvas represents the **Value Map**, which describes the set of features of a value proposition that targets a specific customer segment. It is also divided into 3 blocks. The first one, **Products & Services**, is basically a list of all products and services embedded in the value proposition. The second, **Pain Relievers**, is aimed to describe how these products and services will alleviate the customer pains described at the right side of the canvas. Similarly, **Gain Creators**, describes how the products and services will create customer gains.

Finally, it is important to check the **fit** in between both sides of the canvas, this is, if all important customer jobs, pains and gains are addressed in the value map. This way, it will be more probable that the designed solution provides value to the customer segment -increasing then the chances of success in the market-.

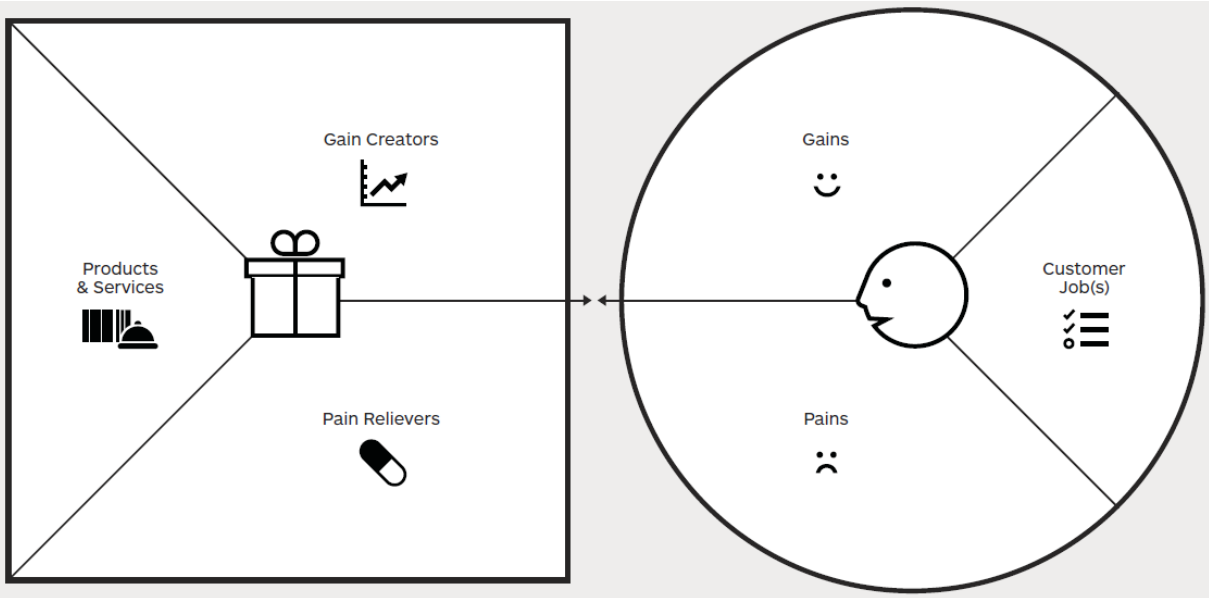


Figure 20. Value Proposition Canvas Template [67]

In our case, for the value proposition design, we have used the value proposition canvas tool with the 3 proposed customer segments: Industry, tertiary sector and public sector. Annex II – Value Proposition Canvas Design Process – Industry, Annex II – Value Proposition Canvas Design Process – Tertiary Sector and Annex II – Value Proposition Canvas Design Process – Public Sector include a snapshot of the design process conducted in each customer segment.

At ABB, we are looking for a general solution that can be used by any customer regardless of the sector and that aims to be established as a cross-divisional tool in all ABB verticals. Therefore, we have merged all 3 developed value proposition canvas into a general one that addresses the main customer jobs, pains and gains in all 3 segments. In the next page, the final proposed value proposition canvas can be observed (Figure 21).

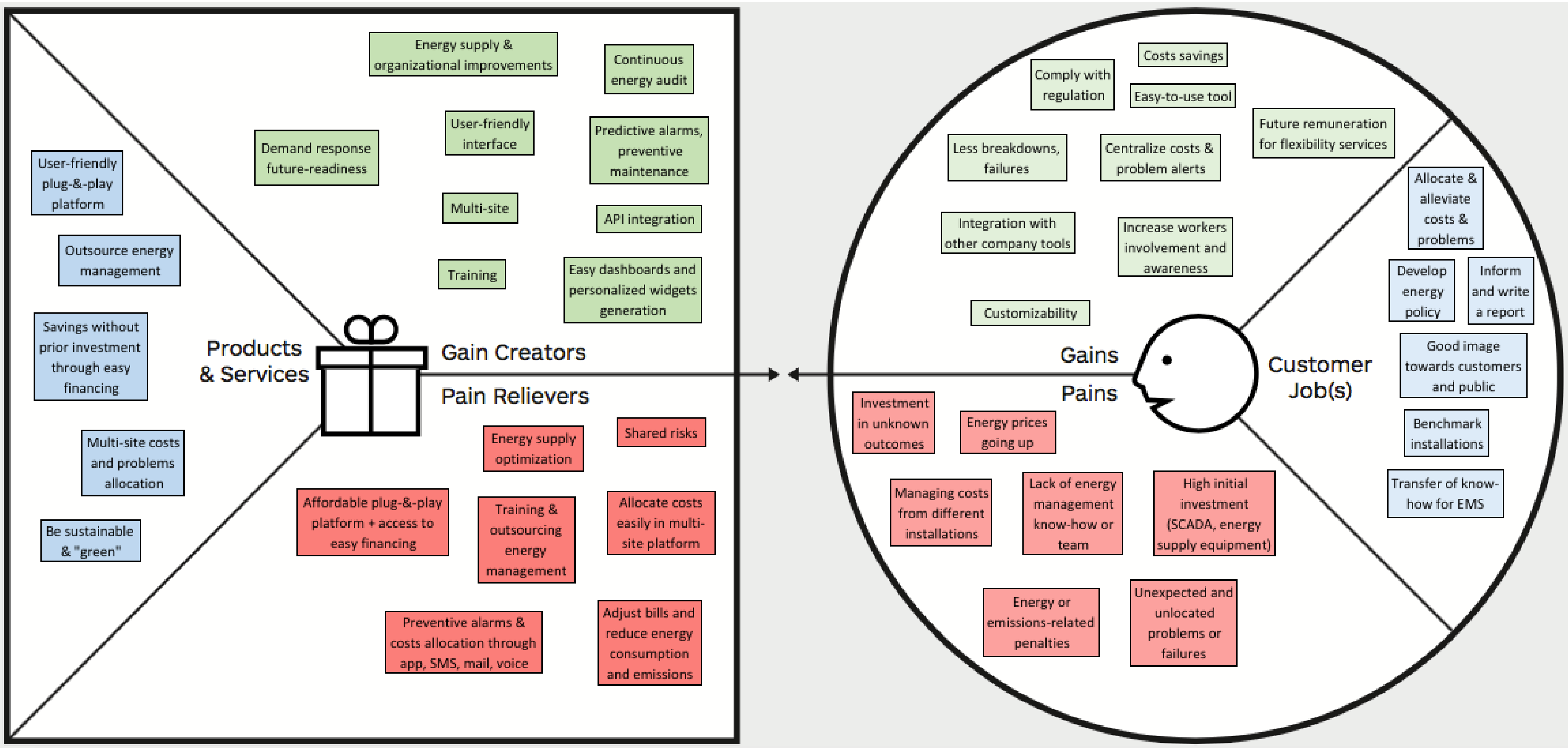


Figure 21. Value Proposition Canvas proposal (own elaboration)

6.3. Business Model Proposal

After having designed the value proposition targeting our customer segments, we will zoom out from the value proposition canvas in order to fit these two blocks into the 9 building blocks of the Business Model Canvas (BMC) tool (see Figure 22). The business model canvas is a tool designed to picture a general overview of how a business works. It is summarized in 9 building blocks: the 4 on the right side represent the customer side, whereas the 4 on the left represent the company side. Finally, the value proposition is placed on the center in order to connect company and customer.

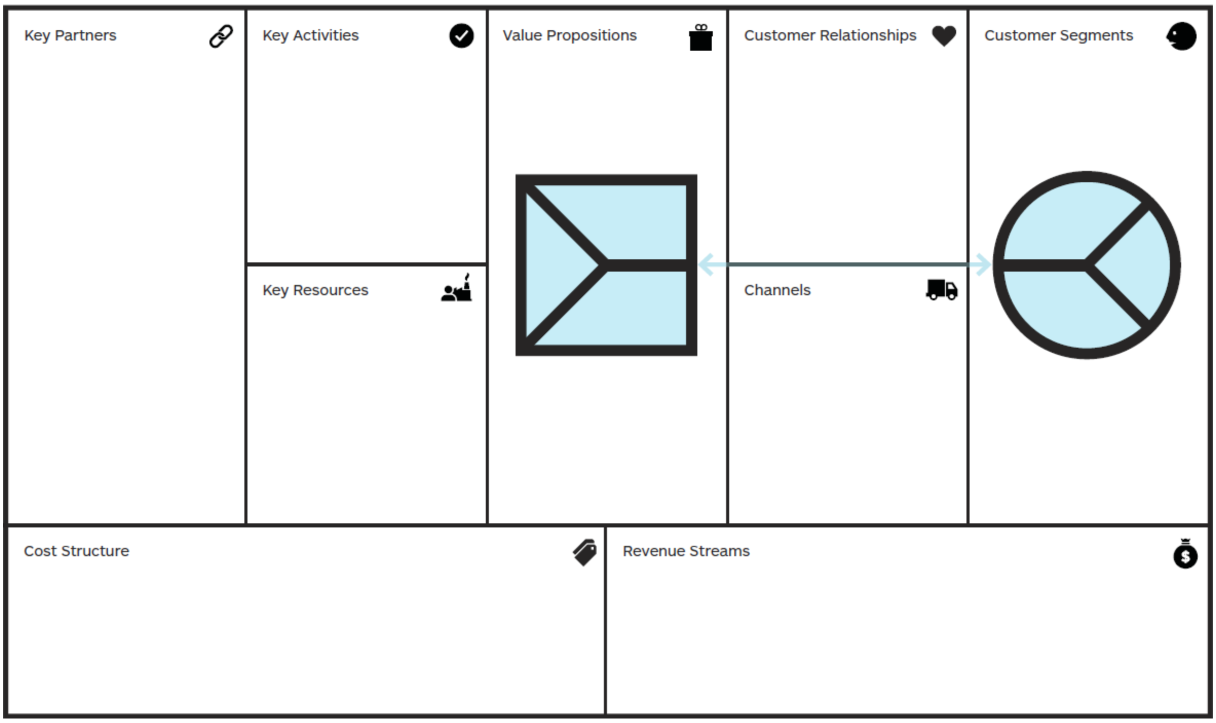


Figure 22. Value proposition canvas fit into business model canvas [67]

It is important to highlight that a business model canvas is a tool where several assumptions regarding the optimal functioning of a business are proposed. These assumptions need a validation process on the market which will refine the specific building blocks and the business model in general. The validation process will lead to the confirmation or rejection of the initial hypotheses and, in the latter case, to the pivoting of the initial model and proposition of different assumptions.

Now, we will propose what we believe is the business model that provides more value to our targeted customer segments, while reducing our cost structure in order to obtain maximum benefits. The following Figure 23 depicts our final proposal for ABB Ability solution. Further on, we will describe each of the assumptions proposed in all building blocks.

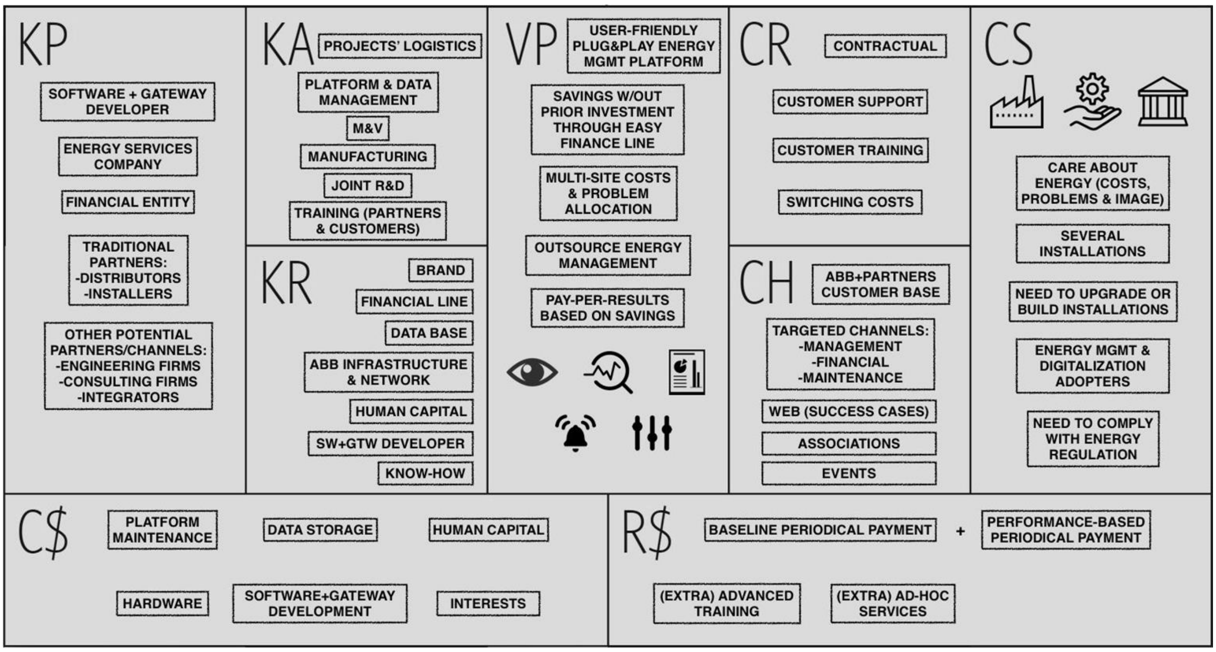


Figure 23. Business Model Canvas proposal (own elaboration)

Now we will review all building blocks following the order proposed by [8].

Customer Segments

As commented in 6.2, the targeted customer segments will be industry, tertiary sector and public sector in Spain -represented by the upper icons-. Several common characteristics have been placed in the BMC in order to better describe the customer:

- The customer **cares about energy** -either energy **costs**, **problems** and failures associated with energy supply or the **company image** related to sustainable energy consumption and emissions-.
- The customer owns **several dispersed installations** -either dispersed through a building or several geographical area- and is seeking for a solution able to cover all of them.
- The customer **needs to upgrade, retrofit or build a new electrical installation**. This kind of customer is the one targeted traditionally by ABB. The wide portfolio of ABB products can fulfil these requirements and include connectivity with a free trial period of the platform, meaning that the solution can be up-sold in the traditional prescription of ABB products.
- The customer is actively **interested in energy management & digitalization solutions.**
- The customer **needs to comply with regulation**, as seen in EED or RD 56/2016.

Value Proposition

Also following 6.2, we have summarized the value proposition into 5 assumptions:

- The main description of the solution is a **user-friendly, easy-installation (plug-&-play) energy management cloud platform.**

- The first offered added value are **savings without initial investment through an "easy financing" line** that will be managed by ABB. This way, we will address the financial barrier that customers face and provide trust through ABB brand for the financial entity.
- The configuration of the platform (cloud) allows customers to centralize data, **allocating costs and problems from several disperse installations**.
- The platforms offers easy-to-understand insights regarding energy and the service is complemented by an energy service company certified by ABB, providing the ability to **outsource energy management**.
- A part of the financing provided to the customer will be re-payed based on the obtained savings from the projects. This way, the customer will be encouraged to perform better and ABB will share part of the risks, improving trust and engagement of both parties. This revenue model will be better explained in Revenue streams.

The last 5 icons included in the value proposition are aimed to depict the main functionalities that the solution will provide: Monitoring (eye icon); analysis & optimization (lens icon); reporting (report icon); alarms, preventive & predictive maintenance (bell icon); remote control & automation (control icon).

Channels

Channels describe how we reach the targeted customer segments. We have included the following:

- The first channel will be the already established **sales force** through the **customer base** of both **ABB and partners** included in this solution. As commented in Customer Segments, it is important to up-sell traditional products offerings with this solution, since all ABB products are in transition to become digital and enable connectivity. Traditional partners, such as distributors and installers, will also be an important channel. However, in order to avoid repetition of concepts, we have included them in Key Partnerships.
- Another channel will be **ABB web page.** Customer trust will be engaged through a series of demonstration success cases available for download.
- **Associations**, as commented in 5.1, will be a key channel for marketing activities and customer reach, especially in the public sector.
- **Events & fairs** will also be a main channel in order to gain presence in the market and showcase the solution and success cases.
- At last, we have included 3 figures that may influence the buyers when it comes to purchasing our solution: **Plant/building manager, financial manager and maintenance manager/responsible**. All 3 of them have requirements that our solution is able to fulfil, and therefore they must be taken into account as potential channels.

Customer Relationships

Customer relationships describe how we establish and maintain our relationship with the different customer segments (customer acquisition & retention):

- The first and most obvious will be the **contractual agreement** ABB-Customer. The payment model, period and the legal responsibilities will be defined.
- ABB will offer **customer support** through ESCo partners and especial technical customer support through ABB Service team.
- ABB will also offer basic **training** to the final customer, as well as deep training to partners in order enable them to prescribe the solution properly to final customers.
- Finally, the customer will be bound to **switching costs** in case he/she wants to abandon. Although the data is owned by the customer and could be extracted from the platform, all services extracted from it (business intelligence, automatic reports, alarms, etc.) will be lost with the platform. The customer may also face compatibility problems if the switch is towards a proprietary solution non-compatible with the existing meters.

Revenue streams

Revenue streams describe how a company captures value with a price that customers are willing to pay. At ABB, we will implement a payment scheme that is a variation of the shared revenues model reviewed in 6.1.1. Since ABB will provide the financing and assume the risks related to it, there is no need to guarantee a minimum amount of savings (guaranteed savings model). The risks will be shared through this alternative variation, which we have called "Increasing shared savings by milestones". This revenue model is formed by 2 parts, a fixed one and a variable one:

- **Baseline periodical payment**: This payment will be performed periodically (i.e. yearly) by the customer in order to cover base expenses, which include installation and commissioning of all the hardware and software involved in the project, including the cloud platform. The amount of the payment will be proportional to the size of the project and will be split in equal into the periods through all the duration of the contract in order to reduce the impact on customers' resources.
- **Performance-based periodical payment**: This payment will cover all variable costs (human capital for customer support and energy services, platform maintenance, data storage, etc.) and will be based on the customer's achieved savings, which will be verified through specific measurement and verification procedures (M&V) conducted by the ESCo partner in the platform. ABB-customer will agree a set of consecutive milestones that will define certain sub-periods. Each sub-period will define how much percentage of the savings will be addressed to the repayment of the project (+interests) towards ABB. The milestones will represent how much of the project has been repaid (i.e. 40% of the total cost of the project for the first milestone). When the customer achieves a milestone, he/she will enter the next sub-period and obtain a higher share of the savings. This way, ABB encourages the customer to perform better and achieve a faster return of the investment (ROI), while the customer still saves money. The duration of the contract will be agreed in between ABB and customer -and will be variable since it is performance-dependent-, as well as the specific milestones and percentage of shared savings directed to each party in each sub-period. Figure 24 shows a graphical example of this performance-based payment.

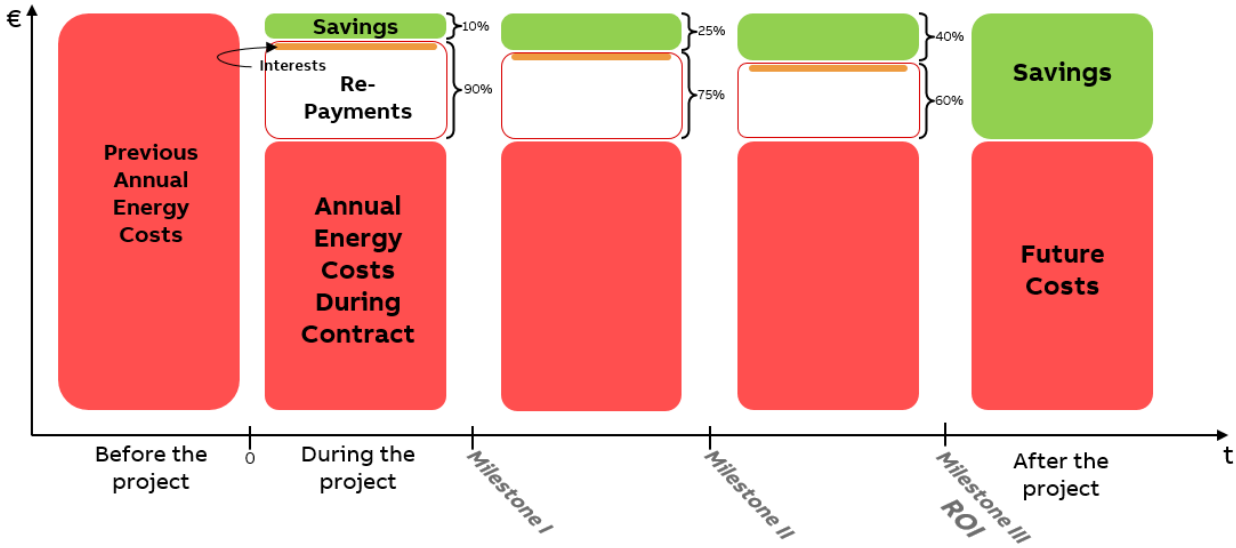


Figure 24. Increasing shared savings revenue model - Example (own elaboration)

Besides from this main revenue model, we have included 2 extra revenue streams based on the experience from some customers' requests:

- Some customer segments may already have an energy management team or department and need extra **advanced training** in order to fully manage the tool themselves.
- Also, some customer segments may need to integrate their company software tools within the platform or other **extra ad-hoc services**. This developments will be charged separately or included in the project cost.

Key Resources

These are the most important assets that our company needs to deliver the solution. We have summarized them into the following:

- ABB **brand** will be key when it comes to gain customers' trust, as well as confidence to the financial entity.
- The **financial** line will play a key role in customer acquisition, since it converts the high initial investment into split periodical payments.
- The **database** is a crucial resource due to several reasons. It is the source of information where we build our services from, it is owned by the customer and private.
- **ABB infrastructure and networks** will be very important in order to reach as many customers as possible and deliver the solutions on time (installation & commissioning).
- The **gateway and software developer** (partner) has been included as a key resource since we need to work together as our customers' needs evolve and the market demands different developments and solutions.
- Al last, the **human capital** and the **know-how** will also be essential for projects implementation and know-how transfer to partners (training).

Key Activities

Key activities describe the most important activities that need to be performed well by the company:

- **Logistics** and **manufacturing** will obviously be crucial for customer satisfaction, so the solution is delivered on time.
- Correct **platform and data backend management** needs to be done on a continuous basis in order to ensure functioning of the tool and data safety.
- **Measurement and verification** will be the basis of the proposed revenue model, since it will validate the repayments deduced by the savings achieved by the project.
- **Joint research and development** (ABB-Software developer-ESCos) will ensure that our solution adapts quick enough to our customer segments and market requirements.
- At last, **training** for customers and partners will be essential for the acceptance of the platform tool and delivery of total value.

Key Partnerships

Key partnerships show the key suppliers and partners that add external resources and activities to the business model. We have selected the following ones:

- The **software and gateway developer**, as mentioned in Key Resources.
- The **energy services company,** which will assume certain activities depending on the scale of the project, such as installation, commissioning and basic customer training. Its core activity will be energy services extracted from the interpretation of the data.
- The **financial entity** that will provide the initial capital for the projects.
- **Traditional partners**, such as **distributors** and **installers**, will be also a key channel to expand customer reach.
- We have also identified other potential partners/channels that could prescribe our solution to final customers, since they are often involved in the decision-taking process of this kind of projects. These are mainly, **consulting firms**, **engineering firms** and systems **integrators**.

Cost Structure

The cost structure describers all the costs involved in operating the business model. We have initial fixed costs needed to develop the platform and variable costs proportional to the number and size of projects implemented:

- **Software and gateway development** are initial costs needed to get the platform ready to market. The main costs are intellectual property rights, integration of the software to ABB servers/network and human labour for these developments.
- **Hardware** costs will be specific to each projects and proportional to their size.
- **Human capital** costs will also be proportional to the projects developed. However, the purpose for the near future is to extract basic needs from our customers' feedback in order to develop an "essential" pack of the solution directed to customers with more basic needs, where all insights will be automated through several business intelligence algorithms without the need of human labour interpreting data -

basic functionalities such as power optimization, tariff optimization, reactive energy compensation simulation and so on-.

- **Platform maintenance** and **data storage** will also depend on each project, although costs could be reduced in a future due to scalability.
- Finally, **interests** demanded by the financial entity have been also taken into account.

6.4. Business Model Evaluation – SWOT Analysis

In this section, we will use the SWOT analysis tool in order to obtain an initial evaluation of the proposed business model. The acronym SWOT stands for [68]:

- **S**trengths: Internal features or characteristics of the business that provide a competitive advantage over other competitors.
- **W**eaknesses: Internal features or characteristics that place the business model at a disadvantage compared to other competitors.
- **O**pportunities: Elements or characteristics in the environment -external to the business model- that could provide a competitive advantage if exploited.
- **T**hreats: Elements or characteristics in the environment that could cause trouble for the business.

In order to obtain extra insights from an inside perspective, we have conducted a questionnaire directed to workers with different profiles involved in the project. This qualitative questionnaire has been proposed as an application of the business model canvas blocks into the SWOT analysis. This way, several trigger questions or statements have been presented to the respondents and grouped by the BMC block that they specifically address. The questionnaire has been divided into 3 parts:

1. Strengths & Weaknesses: These two blocks from SWOT analysis have been joined because the presented trigger questions cover both of them. 5 possible answers ranging from "-2" to "+2" -total negative answer to totally positive answer, respectively- have been provided in order to clearly delimit the feedback and obtain determinant insights. The trigger questions have been presented in a way that a score closer to "2" means a potential strength identified and vice versa.
2. Opportunities: This block has been separated from threats due to different trigger statements proposed from "threats" block. Also, 5 possible answers ranging from "-2" to "+2" -"totally agree" to totally disagree", respectively- have been provided. The trigger statements have been presented in a way that a score closer to "2" means a potential opportunity and a score closer to "-2" means a potential threat.
3. Threats: Similarly to "opportunities", 5 possible answers ranging from "-2" to "+2" -"totally agree" to totally disagree", respectively- have been provided. The trigger statements have been presented in a way that a score closer to "2" means a potential threat and a score closer to "-2" means a potential opportunity.

Scores obtained from parts 2 and 3 of the questionnaire have also been cross-compared, showing consistent results. The following Table 7 shows a summary of all insights obtained from the development of this master thesis embedded in the SWOT analysis tool. The statements included in the **SWOT** analysis are related to the previous business model proposal (section 6.3) and are mainly based on the results obtained from the questionnaire and the performed market analysis (section III), technology analysis (section IV) and competition analysis (section V).

Strengths	Weaknesses
- Our resources needs are predictable and revenues streams are recurrent - We are capable of providing an end-to-end solution aligned with our customers' needs - Strong partnership and joint collaboration with trusted ESCos provides us with useful know-how - The software developer detached from ABB gives us dynamism and capacity to adapt to new market requirements - Extensive ABB channels' reach - Known and trusted brand: Wide experience in automation and other industries - The technology used for data processing before the cloud (edge gateway) is hardly replicable and reduces the costs for data traffic & management - Success cases with public authorities and important industries increase customer's trust - Strong customer acquisition strategy through easy financing - Our technology is non-proprietary	- Revenue streams are not diversified - Issues with deployment of projects --> Logistics - Our key activities are not hardly replicable - Our channels are not completely integrated - Platform under development - Need to integrate non-electricity measurements (water flow, humidity, temperature, etc.) - It is a solution based on results --> Risk of losing customer interest if savings are not clearly valorized - Need for continuous development of platform features in order to keep customer engaged
Opportunities	**Threats**
- Solution can upsell traditional products into services with recurring revenues - Other ABB divisions with their respective products and services could be integrated and generate strong synergies - There are cross-selling opportunities with partners, that complement our value proposition - Future market developments such a Demand Response may provide future revenue streams - Wide range of customer segments applicable --> Horizontal solution compared with competitor's more vertical offerings focused mainly on industry - Higher potential for cost savings in Spain (higher energy prices than European average) - Potential gamification as added value for commercial, offices and public buildings	- Substitutes: Competitors' focus may offer more value in certain segments (such as Emerson excellence in non-energy metering for industries or Siemens excellence in digital simulation of industrial processes -Digital Twins-) - We depend excessively on one key partner, which also collaborates with competitors - Competitors extensive partners' ecosystems could put in danger our market reach and share - Competition in the market is growing - Facility manager and other targeted users may be restricted to a number of areas and the potential savings very low --> difficulties to sell the value proposition - Potential for heating savings in Spain are low - Changes on regulation depending on province may limit our partners influence area

Table 7. ABB solution SWOT analysis (own elaboration)

VII. Conclusions – Next Steps

During the development of this thesis, we have performed a deep analysis of Spanish energy services market current situation in order to study which business model configuration could have more potential for the successful implementation of an energy management and monitoring cloud-based platform solution.

Spain remains behind leading European countries when it comes to energy efficiency, renewables and energy storage implementation and integration into the grid. In particular, even though energy prices in Spain are way above the European average, the energy services market remains unexploited due to several key barriers: lack of knowledge and trust in ESCo industry, difficult access to financing sources and time-consuming and complex processes and contracts.

With the help of several business modelling tools, such as the value proposition canvas or the business model canvas, we have analyzed market needs from the perspective of each of the targeted customer segment -industry, tertiary sector and public sector- and designed a value proposition aligned with those needs and embedded in a business model that has the potential of overcoming all mentioned barriers.

ABB will be the center piece of the model and will demonstrate the viability of the solution with real success cases and a powerful platform for the clear valorization of the outcomes, providing trust in between customers and energy services providers and a clear display of information that helps different stakeholders perform their jobs in an easier way -or even be used for marketing purposes-. In other words, ABB brand will be used as the quality assurance of the projects.

At the same time, the provided financing line by ABB and the proposed revenues model -where a part of the re-payment is based on the customer's performance- will ensure that the customer does not face any economic barrier related to the higher initial investment usually associated to the projects. The financing process is intended to be standardized in order to reduce implementation times.

At last, with ABB as a nexus and catalyzer in between the other involved parties, the capacity of offering an end-to-end solution -initial audit, financing, installation and commissioning of hardware and software, training and customer support- provides us with the opportunity of reducing the complexity of the processes involved in an energy efficiency project, where normally a customer has to be in contact with several stakeholders instead of just one intermediary.

The proposed business model, together with the used technology, is expected to deliver maximum value to the customers and provide ABB with a competitive advantage over other market players. However, although we have performed an initial evaluation with feedback from people involved in the project -and an established know-how in energy services market-, it is key to validate all the assumptions proposed in the business model canvas in order to totally fit our value proposition with the customer segments. We are working on several demonstration cases in each of the 3 mentioned segments in order to validate the business model -or pivot to a new iteration in case it is not validated-. Due to timing reasons -duration of the internship- it has not been possible to achieve the validation phase, which is one of the main proposed next steps of this thesis.

This study could be continued or extended in many ways. We think the most important **next steps -**apart from the validation of the business model- could be:

- Study of the integration of hardware from other ABB division into the platform, such as drives, industrial automation key performance indicators (KPIs) and products from medium and high voltage.
- Study of future revenue streams for customer retention. For example, implement RES or energy storage systems as an upgrade -since the previous stage of these implementations is an energy audit, which is continuously done in the platform-. Also, the platform could serve as an enabler for future participation of the customers in the electricity market through explicit demand response programs, acquiring and validating data about the energy traded.

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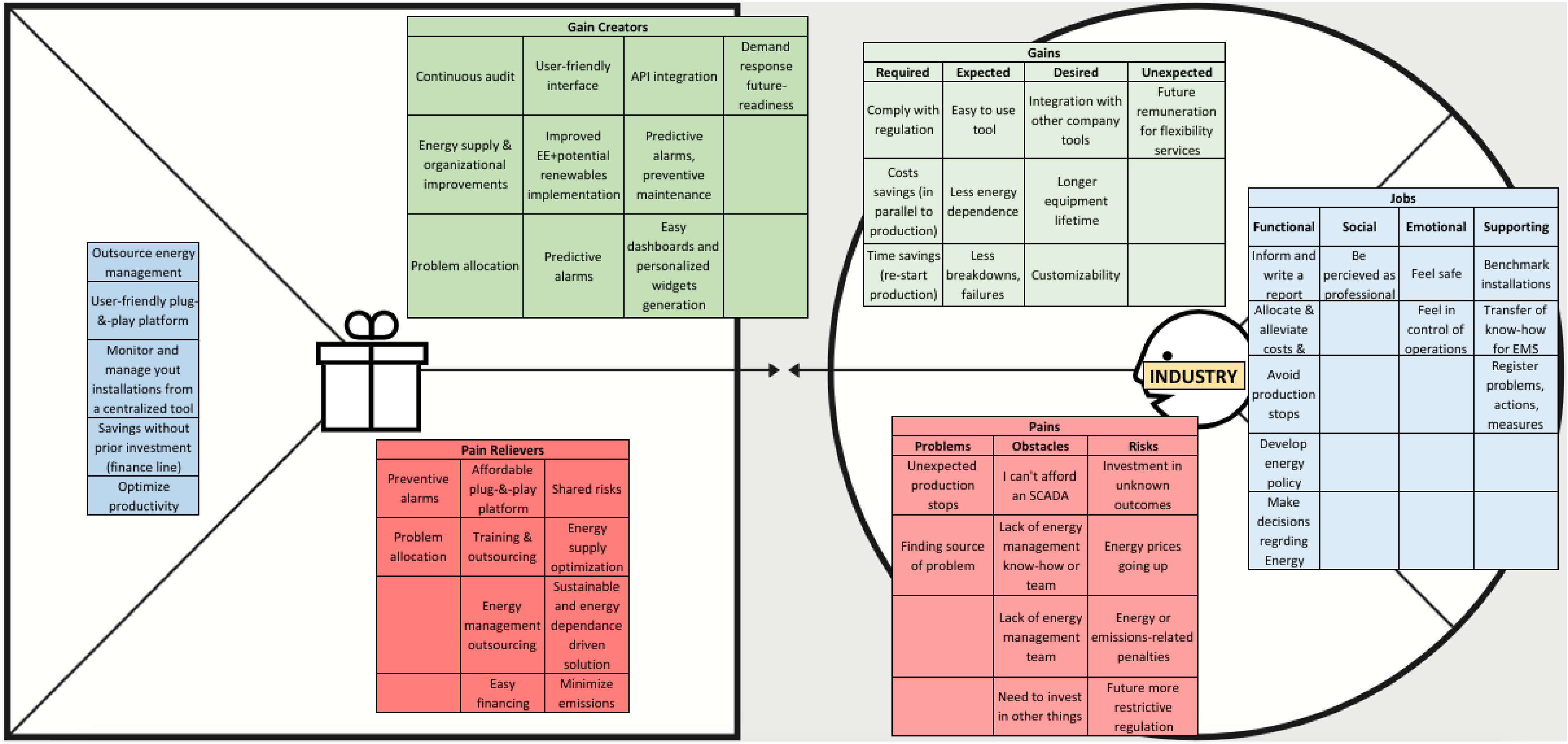
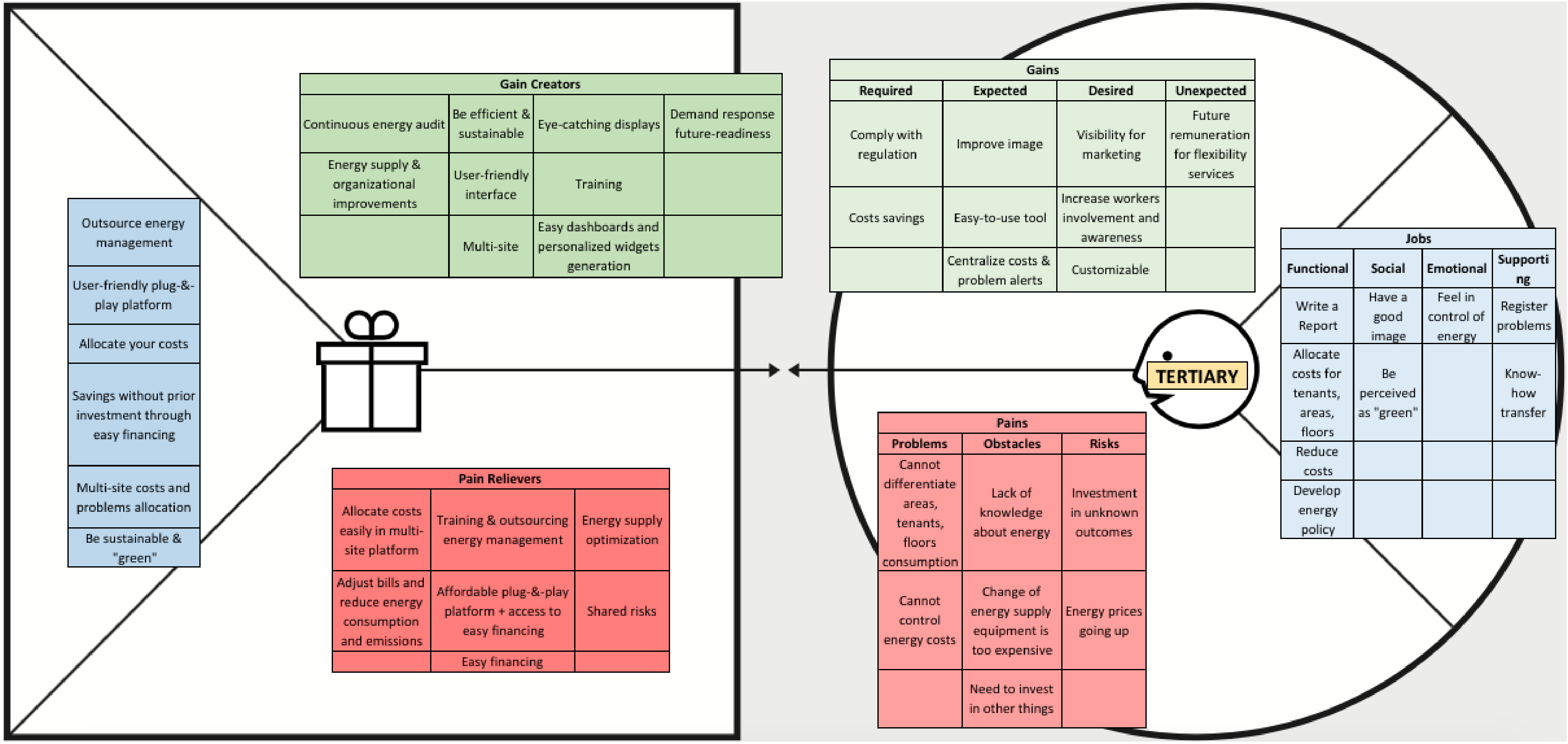
Annex I – Researched companies and players

Company	Web Page
A3E	https://www.asociacion3e.org/
ABB	https://new.abb.com/
AMI	http://www.amiasociacion.es/
ANESE	http://www.anese.es/
Carlo Gavazzi	https://www.gavazzionline.com/CGNA/Home
Circutor	http://circutor.es/en/
Cisco (Kinetic)	https://www.cisco.com/c/en/us/solutions/internet-of-things/iot-kinetic.html
CO2ST	http://www.co2st.es/
Creara	http://www.creara.ws/
Cysnergy	http://cysnergy.com/
Dexma	https://www.dexma.com/
E.ON	https://www.eon.com/en.html
Emerson	https://www.emerson.com/en-gb/automation-solutions
Endesa	https://www.endesa.com/en.html
Energisme	https://energisme.com/fr/?lang=en
Energy Minus	https://www.energy-minus.es/
Escan	http://english.escansa.es/
FN Energia	http://fnenergia.com.es/
Iberdrola	https://www.iberdrola.es/en/business
iON Smart Energy	https://www.ionse.es/en/
Janitza	https://www.janitza.com/
OpenDomo	https://www.linkedin.com/company/opendomo-services-s.l./
Satel	https://www.satel-iberia.com/en/
Schneider Electric	https://www.schneider-electric.co.uk/en/
Seinon	https://www.seinon.com/
Siemens	https://www.siemens.com/global/en/home.html
Smarkia	https://www.smarkia.com/en
Socomec	https://www.socomec.co.uk/Home_en.html
Union Fenosa	https://www.unionfenosagas.com/en
Wattics	https://www.wattics.com/

Annex II – Value Proposition Canvas Design Process – Industry



Annex II – Value Proposition Canvas Design Process – Tertiary Sector



Annex II – Value Proposition Canvas Design Process – Public Sector