TÉCNICO LISBOA

Feasibility analysis of new business models for residential PV installations in Catalonia, Spain

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Abstract

This work provides a strategic assessment of the possibilities that the PV engineering and installation company, SUD Energies Renovables, needs to consider in order to properly face the residential PV market in Catalonia (Spain). By analysing the main elements that can influence its success in such market -technology, regulation, competitors, current positioning, etc.- it is going to be developed a new business model for the company.

The company around which is going to be built the dissertation is one of the most recognized in Spain, known, among other things, for developing the biggest self-consumption installation of Catalonia in 2017. In fact, this is its core business: industrial applications. In addition, in last years, the company is also approaching the residential market, believing that it would explode in few times. However, the company lacks a clear strategic development of how should approach the domestic market, since it involves many other actors that are not present in the commercial one.

In this regard, this project contributes in giving the suitable tools to the company in order to generate increasing profits without modifying, in a greater way, its current processes and characteristics.

Keywords— solar photovoltaics, residential market, business model, strategy, SUD.

Resumo

Este trabalho fornece uma avaliação estratégica das possibilidades que a empresa de engenharia e instalação de painéis solares, a SUD Energies Renovables, precisa considerar para enfrentar adequadamente o mercado fotovoltaico residencial na Catalunha (Espanha). Ao analisar os principais elementos que podem influenciar o seu sucesso em tal mercado - tecnologia, regulação, concorrentes, posicionamento atual, etc. - será desenvolvido um novo modelo de negócio para a empresa.

A empresa em torno da qual vai ser construída a dissertação é uma das mais reconhecidas na Espanha, conhecida, entre outras coisas, por desenvolver a maior instalação de auto-consumo da Catalunha em 2017. Na verdade, este é o seu core business: aplicações industriais. Além disso, nos últimos anos, a empresa também está se aproximando do mercado residencial, acreditando que iria explodir em poucos momentos. No entanto, a empresa carece de um claro desenvolvimento estratégico de como deve se aproximar do mercado residencial, uma vez que envolve muitos outros atores que não estão presentes no mercado comercial.

Neste sentido, este projeto contribui para dar as ferramentas adequadas à empresa, de modo a gerar lucros crescentes, sem modificar, de maneira maior, os seus processos e características atuais.

Palavras-chave – solar fotovoltaica, mercado residencial, modelo de negócio, estratégia, SUD.

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KPI	Key Performance Indicator
LCOE	Levelised Cost of Energy
LCOS	Levelised Cost of Storage
PPA	Power Purchase Agreement
PV	Photovoltaics
SUD	SUD Energies Renovables, S.L.
SWOT	Strengths, Weaknesses, Opportunities, Threats
USP	Unique Selling Proposition
VUCA	Volatility, Uncertainty, Complexity, Ambiguity

1 INTRODUCTION

Renewable energies are a product of the energy that the Sun delivers to the Earth at every moment. They are clean, safe, inexhaustible and, most of them, extremely competitive in the market.

The Sun generates energy through a process of nuclear fusion: hydrogen atoms fuse together producing a helium atom and releasing large amounts of energy. This energy, in a very small part, reaches the Earth in the form of electromagnetic radiation, which is retained by the atmosphere. This fact let the Earth maintain a roughly constant temperature, allowing life to exist.

However, this temperature has not followed its usual records over the past several decades. In fact, the last four years (2014-2017) are set to be the four warmest global years on record [1], which exemplifies the massive potential of human beings to produce environmental transformations.

The human impact on the planet is basically due to the enormous use of hydrocarbons, which have made possible the prevailing demographic and economic growth. Therefore, the current period of human evolution coincides with the period of environmental instability, which is quite different to what has happened for most of human history, when humans had to adapt to climatic changes to survive.

In parallel to the temperature rise, nearly 1.1 billion people around the world don't have access to electricity [2], with the economic and social consequences that it entails. There is a strong link between the access to electricity and human development: the access to better energy services bring resources to health, education and communication; opportunities to jobs; social, economic and politic participation; etc.

Hence, there exist nowadays several challenges related to energy that should be addressed without increasing the mark on the planet. The only way to mitigate climate change (and its devastating effects) as well as to facilitate the access to electricity for the worldwide poor regions, is to increase the deployment of renewable technologies. This seems the only path to achieve, as a society, a sustainable development.

The current work is focused on the renewable source that has undergone the fastest increase during the recent years: solar photovoltaics, which is driving the transition from the old and centralized energy model to a new and decentralized paradigm. Solar photovoltaics is one of the conversion ways of solar energy, and it is based on the transformation of the Sun radiation into electricity. The other technology -solar thermal- is used to obtain heat.

The first chapter of the dissertation is intended to provide the framework of the work, detailing the main driving forces of the project: the problem that is intended to solve and the reasons behind the development of the dissertation. In the same way, it is going to be defined the main goals that the work pursues and the different steps that are going to be followed to fulfil those objectives.

1.1 Motivation

The research field of the dissertation is contextualized in an inflexion point of the European electricity model, in which the power system is undergoing an evolution from the conventional grid to a modern system. This gradual change is mainly characterized by the possibility of producing electrical energy locally using non-conventional power sources, such as solar or wind.

This is the distributed generation, which has enabled the creation of a new energy actor: the prosumer. This word, derived from the union of the concepts producer and consumer, refers to the people that consume and produce energy. Thus, the paradigm is changing from the passive consumers (they are only connected to the grid consuming electricity) to the active consumers (or prosumers), which participate in both actions and contribute reducing the overall demand on the grid [3].

As of today, solar PV is the best technology to guide the grid modernization, since is the cheapest, the easiest to install and the most mature. For those reasons, it is clear to think about this technology as the electricity source of the future. The Sun will always produce energy for everybody and it will never send the invoice to the consumer.

And this is precisely the main reason behind the current work: Solar photovoltaics, as a technology, will be part of our lives and the lives of our children in the coming years, and it is necessary to analyse which are the best ways to exploit it.

As an energy engineer, I have always been linked to this power source -its characteristics, evolution and trends, regulatory framework, etc.- but the fact that nowadays it has reached grid parity in many countries around the world [4] and it is ready to be extensively deployed, has made me increase the interest in this area.

This ‘about-to-explode’ technology becomes more evident in countries where the potential is extraordinary, but the current development is not the appropriate one, such as Spain. Its levels of irradiance are one of the best in Europe [5], but its solar photovoltaic installed capacity lags way behind countries such as the UK or German [6].

And it will be interesting to analyse the topic from inside one of the most well-known companies of the sector in Spain: SUD Renovables. Thus, the problem that is intended to solve with this dissertation is

how the company should approach and come into the residential Solar PV market in the coming years in Catalonia.

The company is an engineering and installation SMEs that has looked to the residential PV market with a certain distance until nowadays. As this is a new market for everybody, it is difficult to predict who will be mainly in charge of it: the big utilities, the medium size retailers, the small installers, etc.

The uncertainty that surrounds this situation has made the company keep focusing on the industrial market while waiting until the residential market is sufficiently mature. And now that is ready to be exploited, it is important to study the current positioning and future possibilities of the company in this market, which also increases the motivation to carry out the dissertation.

Therefore, this research topic acquires the characteristic of stimulating by two main factors: (i) the great future of solar photovoltaics as a power source in the Spanish energy mix and (ii) the possibility to develop this project in one of the leading Spanish companies of the sector.

1.2 Research objectives

The aim of the current work is to provide the tools to SUD Renovables for a suitable exploitation of the Residential PV market in its area of work: Catalonia, Spain.

However, a successful entry into this market cannot be no matter what but taking into account several considerations. Firstly, the business model that can be developed to fulfil the goal should provide a clear value (functional and/or emotional) to the customers. Secondly, the company should obtain direct profits with the implementation of such a business model. And finally, the exploitation of the residential Solar PV market cannot entail a dramatic increase in the company resources and operations; i.e., the company should be able to sustain it with a non-significant modification of the current logistics and characteristics.

Hence, in other words, the research topic intends to analyse how the company can create value for society and for itself with a sustainable growth, in the residential solar PV sector in Catalonia.

Apart from this general objective, the dissertation also pursues other specific goals, that would be addressed along the chapters:

- Study the evolution of the residential PV market at four different levels: world, Europe, Spain and Catalonia. It would be interesting to know how we have reached the current situation as well as to present the most possible future trends of this small-scale PV market, which is based on two main components: PV modules and batteries. It is important to separate the study between these elements because their stages of development are quite different.
- Depict the regulatory framework that surrounds the current residential PV market in Spain. The last decade has been very controversial in terms of the law in this country, mainly due to the volatility of the decisions. For this reason, is not only important to clarify the current regulation but also to try to know which will be the path to follow in the nearer future.

- State the main challenges of the solar PV technology. A suitable exploitation of the residential PV would not only depend on the analysis of the market but also on the peculiarities of the technology. Which are the characteristics of the solar PV -and other renewable sources- that are making the energy (and power) transition so difficult?
- Determine the main characteristics of SUD Renovables as a PV engineering and installation company. This means to present a brief history and to define its main operating markets, technologies, logistics and resources.
- Undertake a suitable business model considering the main concepts of the business (window of opportunity, reference market, positioning and segmentation, etc.) and using the most important tools (Business Model Canvas, Vale Proposition Canvas, SWOT, etc.).
- Set the implementation strategy of the developed business model. Here, the changes in the current logistics and operations should be stated, as well as propose the appropriate communication plan for the suitable deployment of the business model.
- Assess and describe the risks of the future scenario, which means state its degree of probability, its level of impact and the possible mitigation activities.
- Present other potential alternatives to the presented business model in order to generate more profits in the sector.

The respective objectives of the dissertation are going to be completed in part thanks to having an internal vision of the company (market, technology, logistics, operations, etc.). This would be the best methodology to undertake the work since every section is going to be developed with a first-hand knowledge. In the end, the future of how SUD should look upon the residential solar PV market should be much clearer. And it would be possible to conclude if it is feasible for the company to complement the current activities in the industrial market with the continuous development of small-scale installations.

2 CASE STUDY: RESIDENTIAL SOLAR PV MARKET FOR SUD RENOVABLES

The second chapter of the dissertation defines the boundaries of the work, basically from two points of view: the company and the market.

From the company perspective, it is interesting to determine its current positioning, as well as its main operating markets and technologies. On the other hand, the analysis of the market -Residential Solar PV in Catalonia- provides a general framework of the prevailing panorama of the PV sector together with the description of the regulatory situation in Spain and the challenges that this technology faces nowadays.

2.1 Company profile

The first issue of the case study to address is the contextualization of the company. To undertake such description in a proper way, the main concepts that surround the company as of 2018 should be detailed: how they arrived in its current situation, which is its principal source of profits and which are its main perspectives for the coming future.

Especially this last concept would be explained in deep. Firstly, by introducing a project that may be key for the future of the company and that would be developed during this year 2018: the *Impuls Solar Vallès* case. Secondly, using two business and management tools that might help in the contextualization of the company perspectives.

2.1.1 Definition and description of activities

SUD Energies Renovables is the engineering company of the group SUD, which is composed of different companies with a wide experience in the industrial, energetic and environmental sector. It

provides an integral service in the field of engineering, construction and exploitation of renewable energies.

It was founded in 2006 and, since then, it has developed more than 150 installations of renewable energy, with an equivalent total installed capacity of more than 15 MW (mainly solar PV).

SUD group is composed by SUD Renovables, S.L. -the engineering company-, InstalSUD -the installation, control and maintenance company- and OnaSUD Energia -the promoter of solar PV parks-.

Own engineering:

It is the head office of the SUD group, located in the city of Vic (province of Barcelona). With a multidisciplinary team, it undertakes viability studies, engineering projects, work directions, measurements, legalizations, permits management and, especially, turnkey projects in the field of solar PV.

Own installer:

It is the company of the group that is in charge of the installation and industrial coordination to carry out the different works (together with the operational management of the engineering), as well as the control and maintenance of the installations.

At their facilities in Artés (Barcelona), they assemble structures and matchings, thus achieving more autonomy in the specific design of each project and guaranteeing the quality throughout the construction and execution process. The fact that SUD has an own installer easier the whole chain of developing a solar PV project, and represents an important differentiating value with the competitors.

Despite the company activities vary from a wide range of projects -solar, wind, biomass, energy efficiency, sustainable lighting…-, the current focus is on the solar PV market and, in particular, on the industrial PV self-consumption market.

As of today, it is among the most important solar PV engineering companies in Catalonia and it is the representative in this region of UNEF (the main association of solar PV in Spain).

2.1.2 Specialization in self-consumption

2.1.2.1 What is the self-consumption?

The self-consumption is the energy production with the installation of solar PV panels or mini wind turbines, which the client uses to meet their energy demands instantly. The renewable energy produced

is transmitted through the interior network of the building to supply energy to the immediate needs of the users.

Since the installation is kept connected to the public distribution network, there will be no power or energy supply problems, as there will always be energy available. All energy produced by panels or wind turbines is energy that the user doesn't have to buy; therefore, the customer will be generating increasing annual savings due to the progressive rise in the electricity bill.

2.1.2.2 Advantages of the self-consumption

The continuous increase in the electricity price decreases dramatically the competitiveness of the SMEs in the territory. It is important, then, to highlight the advantages of investing in a self-consumption installation:

- Protection against fluctuations in the electricity market: the investment in a self-consumption installation implies the immediate purchase of electricity from the next 25 years, at a cheaper price than that of the grid and which will remain fixed over time.
- Reduction of power (kW): these systems allow reducing the contracted power in the most expensive periods of the different electric tariffs, generating additional savings in the power fixed term in the invoice.
- Savings in electricity consumption (kWh): the energy generated by the self-consumption plant is consumed by the owner's internal installation, so it is not necessary to buy it on the grid.
- Increase in competitiveness: the economic gains generated by the installation can be used in other areas of the business to increase productivity, renovate machinery, hire personnel, etc.
- The maintenance is the only cost associated once the system is completely installed, and it is quite easy to carry out.

These are the direct advantages that have an effect on a business that decides to install a solar PV system for self-consumption, but these installations have also indirect advantages that are important to mention:

- Improvement of the corporate image: environmental protection is a task that is daily added to individuals, public and private entities. The use of renewable energies by the proprietary company is a powerful selling argument to highlight.
- Contribution to reducing the energy demand. The energy that the user will use thanks to the PV system will not be produced somewhere else, which, in the case of Spain, has an approximate 60% probability to be generated by a thermal power plant [7]. Therefore, it contributes decreasing the emissions to the atmosphere and in the mitigation of climate change.
- Little environmental impact. Unlike wind power, the small-scale solar PV produces an almost null environmental -and visual- impact, since normally the modules do not modify the aesthetics of the building.

- It contributes to the change of the energy model, which is evolving from a centralized generation to a decentralized (and more sustainable) one. It also empowers the citizen in the use of its own energy.
- It helps in reducing the dependency of the supplying companies and of the countries that are energetically rich (in uranium, gas, coal, etc).

2.1.2.3 SUD: pioneer in self-consumption

Since grid-connected self-consumption began viable in Spain (early 2013), SUD has positioned itself as a pioneer in the realization and legalization of the first solar PV and wind installations for self-consumption with grid connection.

Since then, SUD has accumulated a large number of installations, with more than 10 years of experience in PV installations (more than 150 installations, which add nearly 15 MW of electrical power), being one of the most active and most experienced companies in the sector in Spain.

In fact, SUD developed a solar PV installation for self-consumption that, at its time, represented the biggest in Catalonia: 650 kWp in Balenyà, Barcelona (*Figure 1*).

Figure 1. *650 kWp installation in the new warehouse of BonPreu, in Balenyà (Barcelona). Source: SUD Renovables Twitter account*

This installation, which was opened up in the spring of 2017, would be overcome by another one of SUD: more than 2 MWp in Gurb (Barcelona), which will be completely operative from the beginnings of 2019 on.

2.1.3 The *Impuls Solar Vallès* project: the starting point?

As of 2018, SUD has almost dedicated its whole activity to the industrial solar PV market, having only installed a dozen residential systems.

However, in April 2018, the green energy cooperative *SOM Energia* (with more than 50.000 members), opened an engineering contest to develop 100 PV self-consumption projects, in a domestic level. The

project, called *Impuls Solar Vallès,* was thought for members of the cooperative that had a well-oriented roof at home and a medium-high electricity consumption (more than 2.500 kWh/year).

Impuls Solar Vallès follows the example of other experiences -such as *Oleada Solar* or the *Solar Collective*- that show that the most effective way to enhance residential solar installations is to add many customers at once, in order to lower prices and facilitate the logistics and the installation job.

SOM Energia awarded the project to SUD at the end of April 2018, which represented an important challenge for the company. At the end, 118 families were registered in that project [8]. In addition, the guidelines to undertake such PV installations were to perform it at a relatively low price, with a high quality and, if possible, before the end of the year. This joint purchase was thought to be implemented to the Catalan regions of *Vallès Oriental* and *Vallès Occidental*. The 4 options for the customers ranged from 1,65 kWp to 4,95 kWp, and all of them with the same ratio cost/power installed (1,65 €/Wp):

Table 1. *The different options of installations for the Impuls Solar Vallès project*

Type of installation	Number of panels	Peak Power (kWp)	Nominal Power (kWn)	Price (€) [excl. VAT]	€/Wp
BASIC	6	1,65	1,5	2.722,5	1,65
MEDIUM	10	2,75	2,5	4.537,5	1,65
EXTENDED	14	3,85	3,6	6.352,5	1,65
MAXIMUM	18	4,95	5	8.167,5	1,65

The initial offer was a solar PV installation for self-consumption (PV modules, inverters, structure and wiring) without accumulation (batteries) or any element that prevents the injection into the network if there are times of production surplus. However, after talking with all the families, it has been seen that the possibility to include batteries in some of the installations is quite high.

Without any doubt, the development of these approximate 100 installations during the year 2018 would represent an inflexion point for SUD in the residential solar PV market. The company would not stop doing industrial installations to only focus on *Impuls Solar Vallès*; therefore, it is a clear test for it to check if both type of projects -industrial and domestic- can be managed simultaneously and without important problems. In fact, from May 2018 to December 2018, SUD would develop more than 30 industrial projects together with the 100 residential installations for the members of *SOM Energia*.

2.1.4 Three Horizons of Growth and Company Lifecycle

In a continuously changing environment -and especially the emerging markets of renewable energies- the only sustainable competitive advantage is systematic innovation. Hence, innovation is a mechanism of strategic differentiation.

In this sense, two different representations might help to put in a frame the value and strategy of the company: (i) the three Horizons of Innovation, which exemplifies the importance of devoting resources to the future markets and (ii) the Company Lifecycle, in order to define the current stage of the company (growth, maturity, decline…).

In 2000, McKinsey's published a revolutionary book [9], where it was defined three horizons of growth with the objective of maintaining a continuous strategy of growth and innovation. It represented such description as *Figure 2* shows:

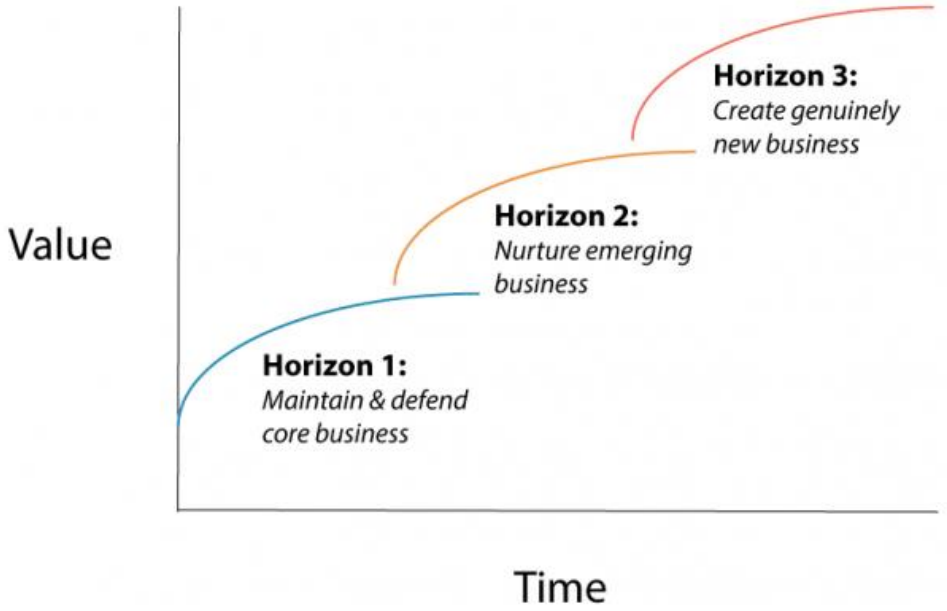


Figure 2. *Three Horizons of Growth defined by McKinsey's [10]*

Applying this concept to the SUD strategic framework, the different businesses can be separated between the industrial market, the domestic market and the new shared self-consumption market:

- **Horizon 1** (Current and mature business): **Industrial projects**

Despite being the core business since the beginning of the company lifetime, the market for industrial installations has still a long way to go. The objective of this business is to maintain the high level of quality and keep increasing its profitability.

- **Horizon 2** (Emerging business): **Residential installations**

Some resources of the company must be allocated to the Horizon 2 since it is a growing market with great expectations for the future. The residential solar PV market represents the second horizon for SUD: nowadays few resources of the company are working on it, but in the coming years the portion should gradually increase until possibly becoming the Horizon 1.

- **Horizon 3** (New business): **Shared self-consumption for residential installations**

It is a new market that nowadays doesn't exist (or practically). The regulation is very unclear about the exchange of energy between different people, but studies show a great potential of this market once the legislation makes it feasible.

In fact, according to Eurostat, Spain is the European country where more people live in a flat (*Figure 3*) [11]. Thus, without enough space in the roof for all the people in the block, new ideas of peer-to-peer energy trading should appear to optimize the PV installations.

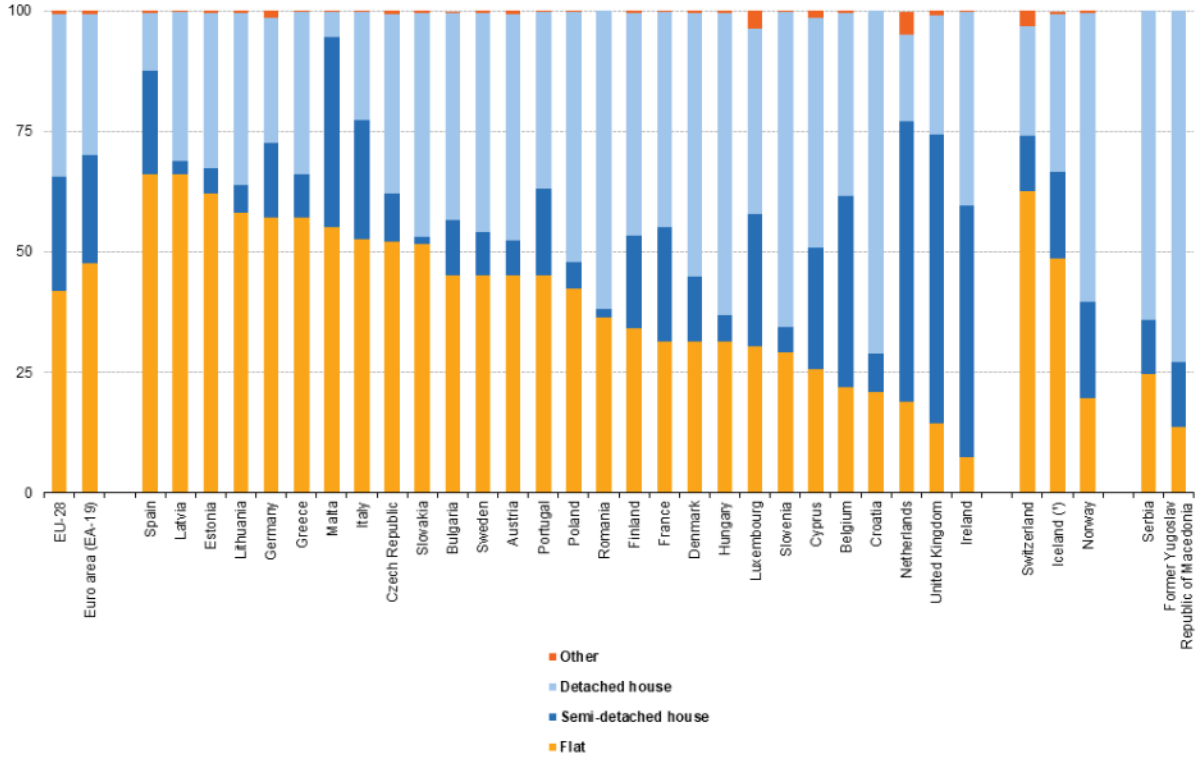


Figure 3. *Distribution of population by dwelling type and country, 2016 [11]*

As *Figure 3* shows, two-thirds of Spanish people (66,1%) live in a flat [11]. Therefore, after covering the commercial sector and the residential (single-family houses), new solutions should be studied for involving the rest of the population into the self-consumption field.

The most probable option is that that the first two horizons would coexist each other in the future because it is hard to think the disappearance of the industrial market despite the 'exploitation' of the domestic sector. The existence (or not) of the horizon 3 would basically depend on the future political decisions and the improvement in the technology of peer-to-peer.

Figure 4 shows the strategy of SUD in the 3 Horizons of Innovation framework:

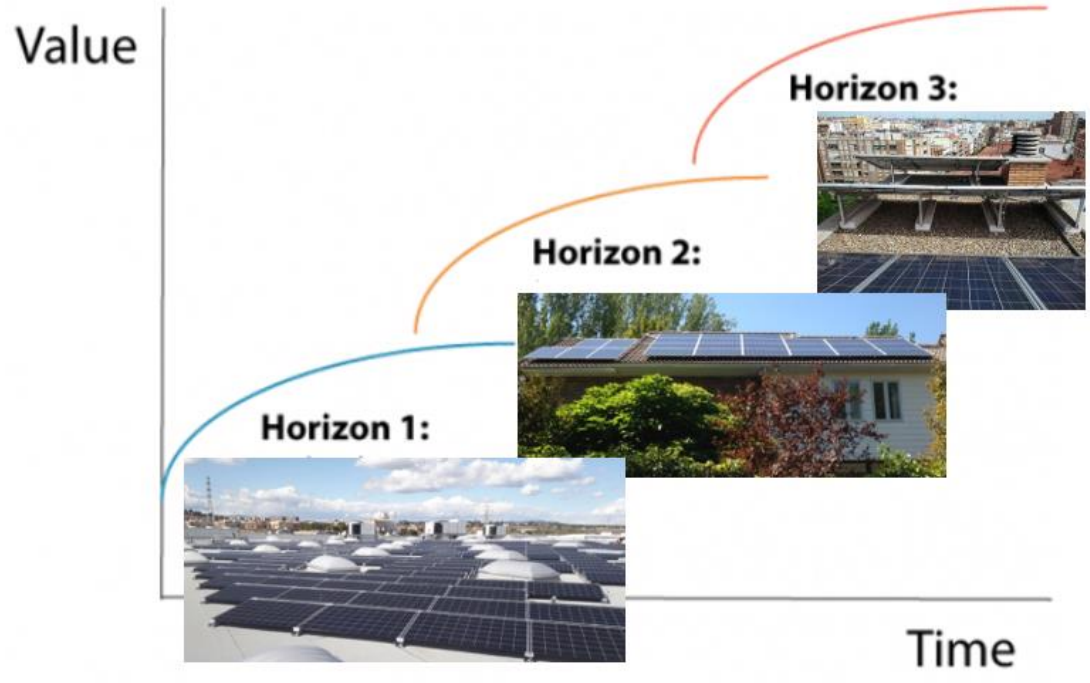


Figure 4. *Three Horizons of Growth applied to SUD strategic framework*

On the other hand, it is also interesting to analyse the progression of the company over time, using the Company Life Cycle representation, which plots the volume of sales during its lifetime.

It all begins after the phase of development, when the product or service is still not introduced into the market. Then, there is the launch process that makes way for the growth stage, when the business obtains profits. After that, there is a moment when sales and cash continue to increase but a lower rate, and the profits start to decrease compared to the previous year: it is the shake-out stage, which precedes the maturity. There, also the volume of sales is decreasing year after year. In the final stage, the decline process, the company observes that its sales, cash and profits decrease at significant rates.

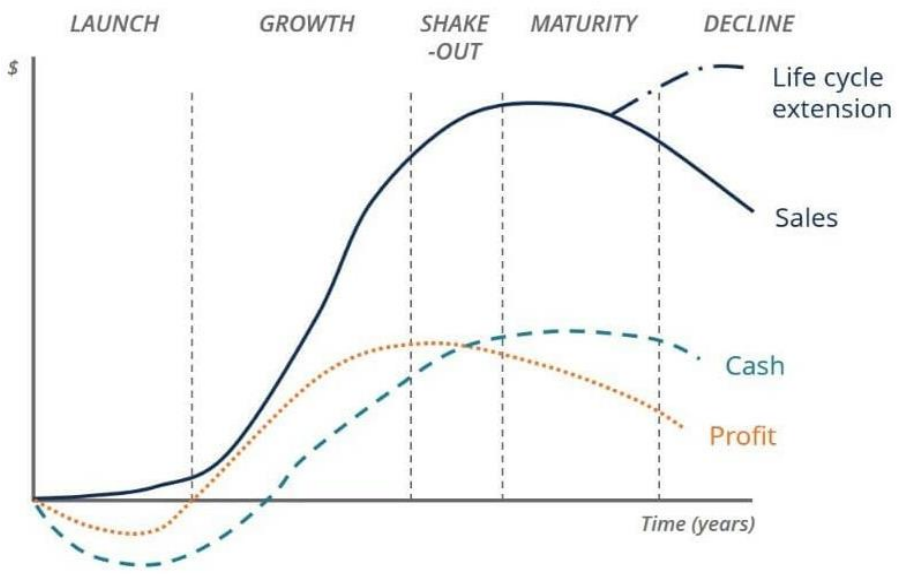


Figure 5. *Company Lifecycle by phases of development [12]*

SUD, as any other business, is also constructing its own S-curve (*Figure 5*). In order to determine its exact position, it is possible to represent its power installed capacity (which will have a similar profile as the sales volume) over its lifetime (2006-2018). During its first year, SUD didn't undertake any project, and its first installation started up in February 2007.

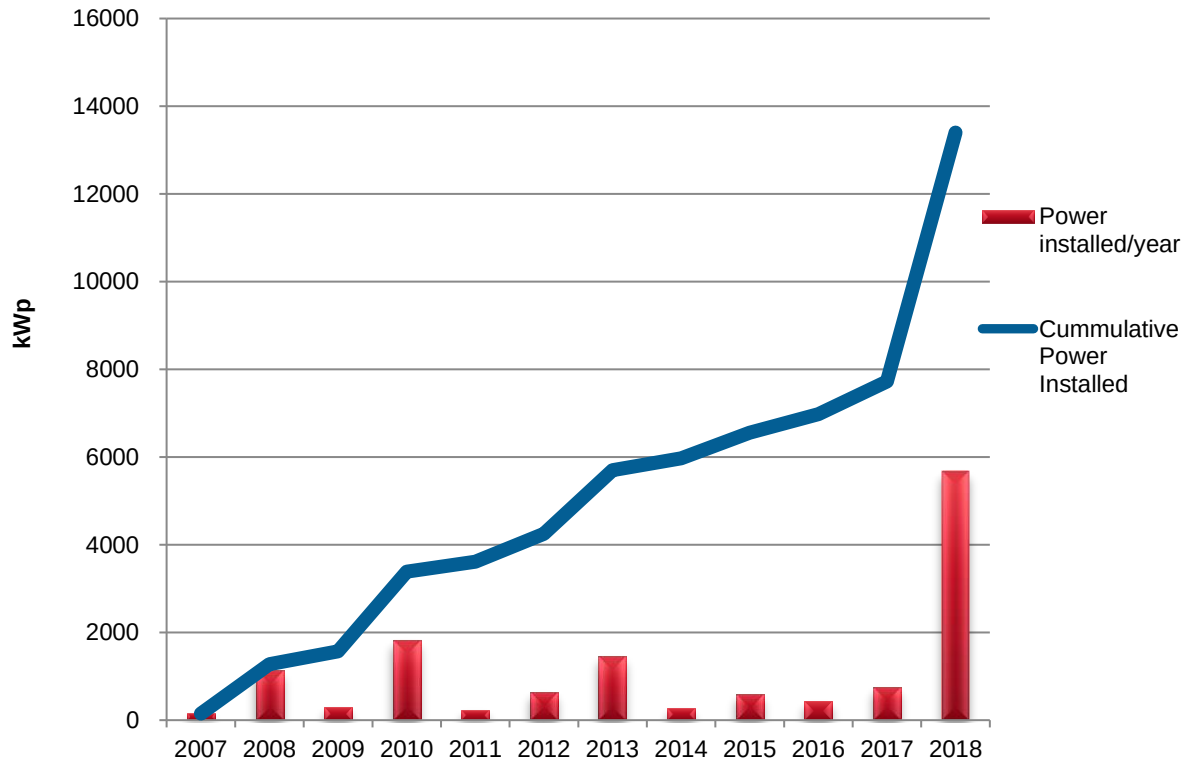


Figure 6. *PV power installed capacity evolution (2007-2018) by SUD*

As it shown in Figure 6, The company's lifetime (2006-2018) has passed through many different moments. The changes in regulation have marked its possibilities in the market and so its sales over time. But the efforts to be profitable have been worth it because in the year 2018 is living its best times and with great expectations for the future.

The SUD lifecycle can be divided into three different eras:

- 2006-2010: The beginnings and the development of the first big installations connected to the grid. Due to the favourable regulation, that greatly bonified the energy that came from solar PV modules, SUD was able to carry out 26 projects (more than 3,3 MWp) until 2010, when the Spanish regulation changed and the whole renewable energy sector entered into crisis.

- 2011-2014: A difficult period with few installations projected. The PV sector was living a complex situation and SUD was only able to develop 22 installations. 2,5 solar MWp were installed, but 1,3 MWp were divided in only two installations. To complement its activity, the company also undertook different biomass projects, with a total power installed of around 2 MWp and started activities in Peru, where the company worked in the electrification of poor regions by developing small-scale PV installations [13].

- 2015-2018: The exploitation of the self-consumption. Despite the legislation was still not playing in favour, the fast maturity of the PV technology allowed the company a continuous flow of new installations to project. The huge reduction of price (more than 80% decrease in comparison with 2010) and the increase in the module's efficiency reawaken the interest in this green energy source. From 2015 to 2017, SUD carried out 41 installations; but only for 2018, it has been already signed a total installation of 52 projects (excluding the 100 residential projects of *Impuls Solar Vallès*), which lead to an installed capacity of nearly 6MW.

With these characteristics, SUD can be positioned nowadays into the early stages of 'Growth' phase in the S-curve, basing its business on the industrial solar PV installations. The objective that every company is trying to achieve is a path of sustained growth, i.e., to try to be in the 'Growth' and 'Maturity' phases of this characteristic S-curve. The differentiation element that would easier this way -instead of the obsolescence path- is innovation. In order to obtain a sustained growth, SUD would need to construct in the future a new S-curve -residential market- to position it over the current one -industrial market-.

2.2 Residential PV market and technologies

Once having detailed in deep the characteristics of the company, the other important element to study is the market: residential solar PV in Catalonia (Spain). Firstly, it is going to be contextualized the PV technology inside the whole energy sector, highlighting the main characteristics that make this energy source the one with greatest perspectives.

After that, it is going to be entered in detail into the PV sector, illustrating the evolution, current panorama and future trends of the market in four different levels: the world, Europe, Spain and Catalonia. Thus, the intention would be to address the main technologies of small-scale PV for self-consumption: PV modules and batteries. The characteristics and evolution of both elements may differ, which can be important to consider in the next phase of the work: the development of a suitable business model.

However, prior to that main section, the different challenges that come along this market should be considered, either the ones that are external (especially the regulation issues) or internal (inherent to the characteristics of the technology).

2.2.1 PV sector inside the current energy paradigm

Nowadays, still more than 80% of the world energy consumption comes from fossil fuels: oil, coal and gas. Despite the global energy commitments during the last 50 years, it is a percentage that has barely been reduced along the time. In fact, according to the World Bank, in 1965 the percentage of fossil fuel energy consumption was 94,5%, which has gradually decreased until now basically due to the increase in nuclear energy production [14].

As *Figure 7* shows, hydropower has had the same weight during the past 50 years: around 7% of the worldwide energy has come, every year, by this renewable source. During the 80' and 90' nuclear power started to appear and gaining importance every year until stabilizing its energy production in a similar figure than hydropower (6-7%) [15].

During the current century, the rest of the renewables entered into the game, being the wind power technology at the front. However, their importance in the worldwide energy mix is still insignificant, which leads to a prevailing massive use of fossil fuels to cover our energy demand. In fact, during the last 30 years, the percentage of fossil fuels energy consumption has not been almost modified, oscillating between 82 and 84%.

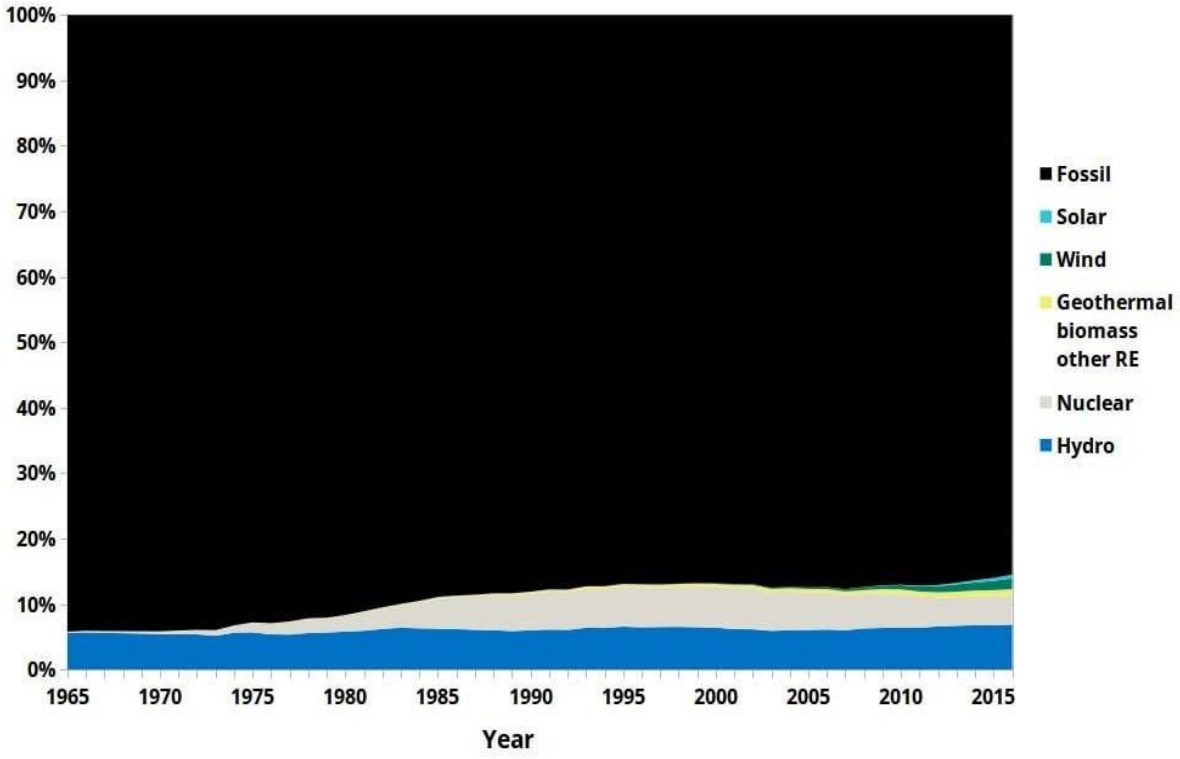


Figure 7. *Global energy consumption 1965-2016 [15]*

Hence, it has been seen that a great push of modern renewables in the global energy sector has a minimum effect on the figures. But the characteristics of these technologies are thought to have an impact in the sector of electricity generation and not the global energy production.

According to EnerData, in 2016, only 13,7% of the energy that was consumed around the world was electricity: it was consumed 1822,1 Mtoe (21191 TWh) of electricity, while the global energy consumption was 13276,3 Mtoe. The rest of the energy went basically to the transportation and heating [16].

Therefore, when talking about electricity generation, the importance of fossil fuel in the mix throughout the decades has been reduced in a more significant way (but still not too much). *Figure 8* shows how in 1973, oil, coal and gas accounted for 75,2% of the world electricity production, while in 2015 this figure was 66,3%. Especially important is the decrease in oil production for electricity generation: it has lost more than 20% of the pie during these years, which has shifted basically to an increase in the natural gas and nuclear production; and the appearance of the modern renewables (7,1%) [17].

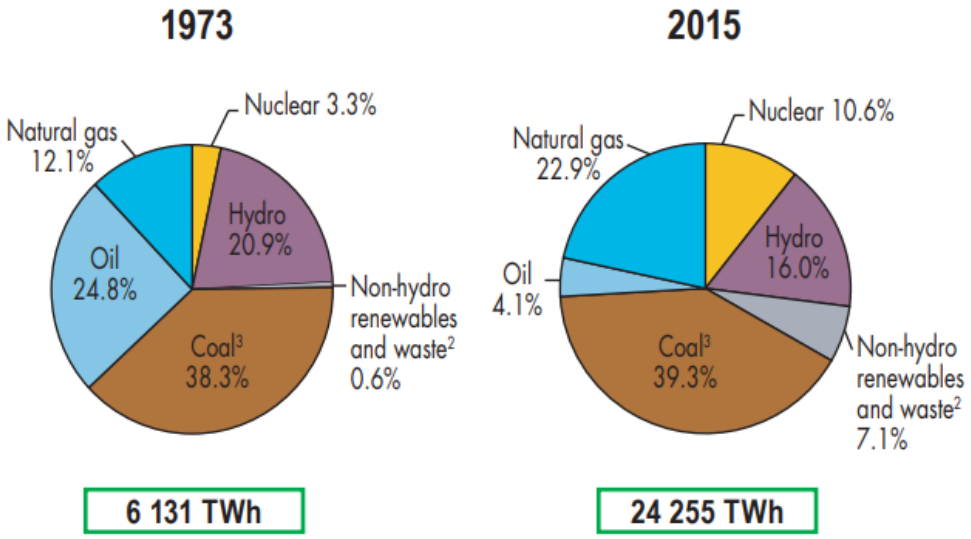


Figure 8. *1973 and 2015 sources shares of electricity generation [17]*

As it has been seen, the predominance -also in the electricity sector- fall back onto fossil fuels, especially coal. Therefore, the main goal in the next decades is to accelerate this shift towards clean technologies.

To undertake such a challenge, many countries are taking the appropriate steps. In 2016, two-thirds of the net new power capacity was renewable, led by an important increase in PV. That year, new solar PV installed capacity grew by nearly 50%, being China the country with a higher increase (it added 34,5 GW, which represented half of the new PV capacity worldwide) [18].

2016 was the first year ever that net growth of solar PV surpassed any other source. The top-4 of net additions was as follows: 74 GW of solar PV, 57 GW of coal, 52 of wind and 29 GW of gas. Moreover, part of the installed capacity of coal (26 GW) and gas (12 GW) was retired that year [18].

Therefore, this new period of renewables growth is led by Solar PV, which at the same time is driven by the incredible registers of China.

In 2017, the situation didn't change so much: China even increased its net growth in PV with respect to the previous year, and the rest of the countries lagged way behind its figures. In the case of Spain, it only increased its new PV capacity by 0,135 GW [6]. In spite of that, it remains inside the top-10 countries with a bigger solar PV park [19].

However, the PV contribution to cover the electricity demand is still a few important (*Figure 9*). In 2017, the average worldwide was close to 3%, being Honduras the region with the best numbers (13,26%). Europe reached a figure close to 4%, with Germany, Greece and Italy at the front (between 7 and 8%). Despite its good conditions, Spain it's located behind countries like Belgium, Switzerland or Denmark, with a reduced 3,1% [19].

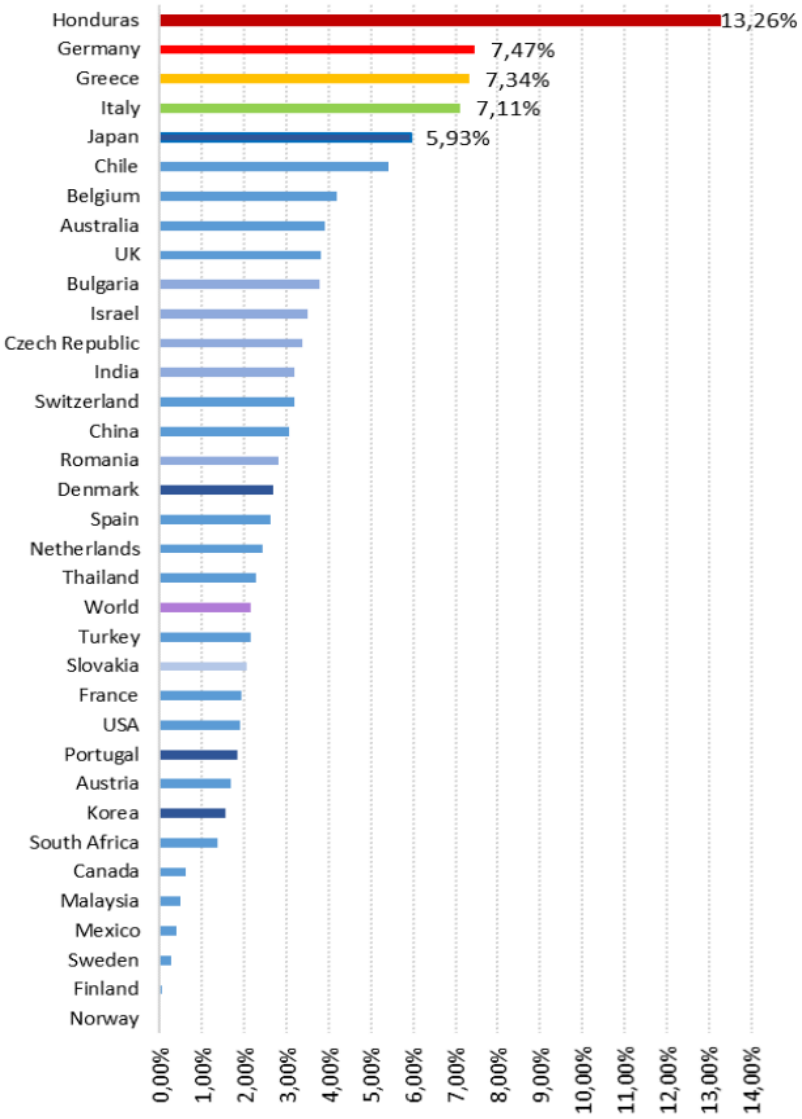


Figure 9. *Theoretical percentage of electricity consumption supplied by Solar PV in 2017, by country. [19]*

Concerning to Europe, this region has experienced an important increase in PV addition capacity in 2017, after many years of a downward trend: 9,2 GW of new PV capacity was installed, which represents a 30% of increase compared to the 7 GW installed in 2016. In global numbers, Germany (42 GW) remains the leading country, followed by Italy (19,7 GW), UK (12,7 GW), France (8 GW) and Spain (5,6 GW) [6].

These figures are presented in *Figure 10*.

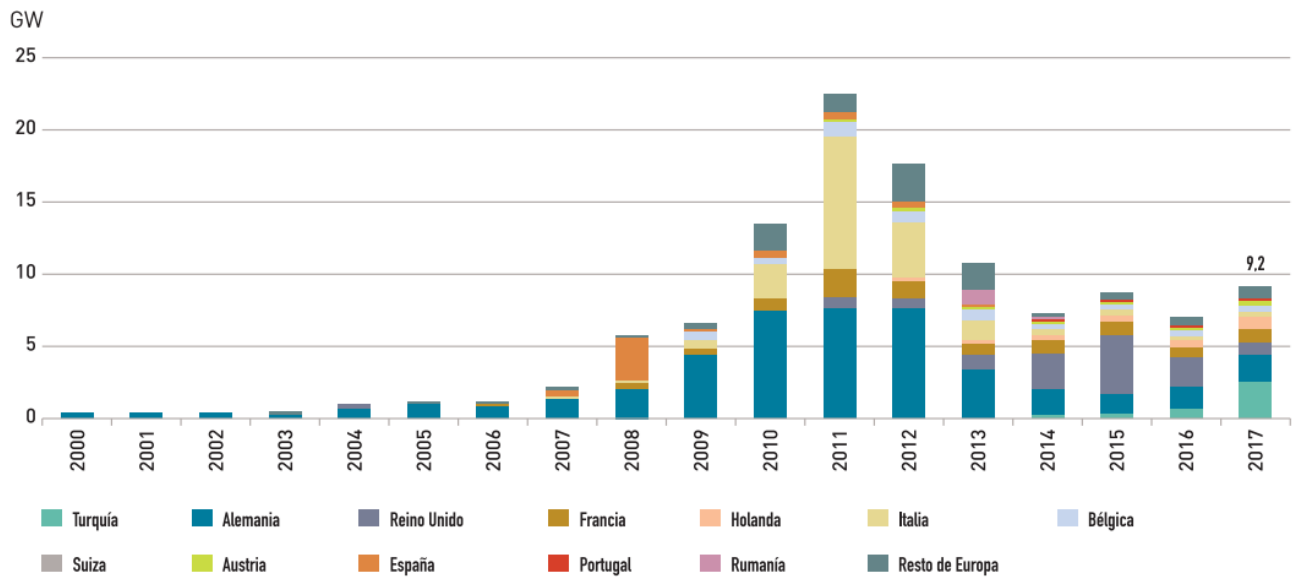


Figure 10. *Yearly Solar PV Installed Capacity in Europe by country [6]*

In the end, PV technology, together with wind power, are the key to increase the percentage of renewables in any region, because it is difficult to think in important additions of technologies such as hydro, biomass or geothermal. Thus, the objective of most countries is to have an electrical grid 100% (or close) supplied by renewable technologies. And, in fact, this is already a reality. There are seven countries that already have almost 100% renewable energy: Iceland (100%), Paraguay (100%), Costa Rica (99%), Norway (98,5%), Austria (80%), Brazil (75%) and Denmark (69,4%) [20].

But truth is that most of them rely on a huge generation of hydro (and, in the case of Iceland, geothermal), which significantly increase its percentage. The rest of the countries, which do not have the characteristics to have important hydro o geothermal capacity, should keep increasing its portion of wind and solar to reach a decarbonized electrical grid.

In the case of Spain –and in Catalonia as well- this fact is especially significant. Despite its good resources, last year only 33,7% of the electricity came from a renewable technology (see *Figure 11*), which represented a significant decrease with respect to 2016, where this figure was 40,3%. This drop was mainly caused by the low hydro generation in 2017. On the other hand, and for the sixth consecutive year, nuclear power was the leader of the electricity production in 2017 (22,4% of demand coverage) [7].

	2016	2017
NUCLEAR	22,6	22,4
CARBÓN	14,2	17,1
CICLO COMBINADO	10,3	13,6
COGENERACIÓN	10,3	11,3
TURBINACIÓN BOMBEO	1,3	0,9
RESIDUOS NO RENOVABLES	1,0	1,0
EÓLICA	19,0	19,1
HIDRÁULICA	14,5	7,4
SOLAR FOTOVOLTAICA	3,1	3,2
SOLAR TÉRMICA	2,0	2,2
OTRAS RENOVABLES	1,4	1,5
RESIDUOS RENOVABLES	0,3	0,3

	2016	2017
RENOVABLES	40,3	33,7
NO RENOVABLES	59,7	66,3

Figure 11. *Electricity demand coverage in Spain during 2016 and 2017. [7]*

In Catalonia, as it can be seen in *Figure 12*, things aren't much better: there's a bigger percentage of sustainable energy (renewables and nuclear) than in Spain, but a lower percentage of only renewables. In 2016, half of the electricity was produced by nuclear power (49,4%), while renewables (basically hydro, wind and solar) only accounted for 16,67% of the demand coverage. Thus, the energy dependency of Catalonia (coal, gas and uranium) is even bigger –in percentage values- than the one in Spain [21].

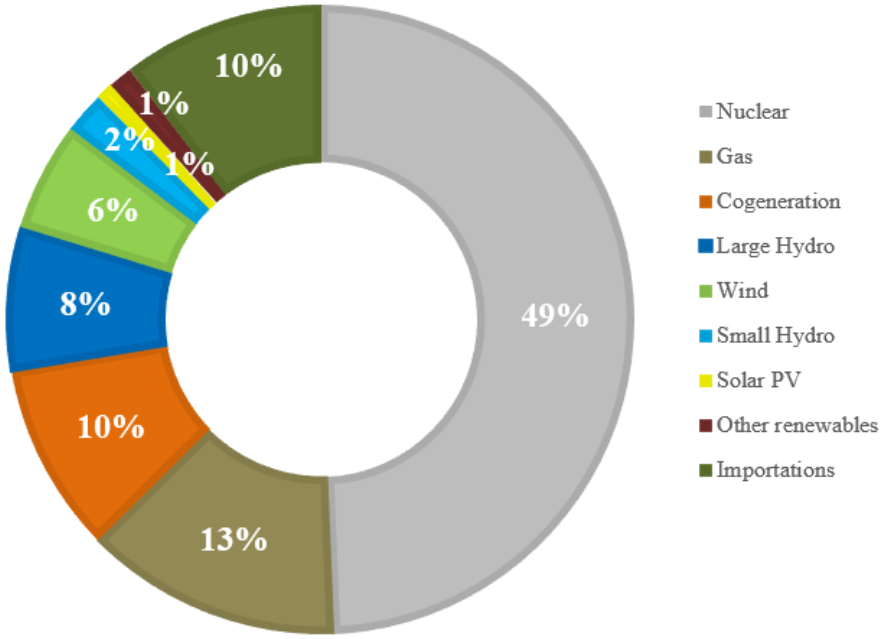


Figure 12. *Electricity demand coverage in Catalonia during 2016.* [21]

As it is shown in *Figure 12*, solar PV represented around 1% of the electricity production in Catalonia. This figure is lower than the Spanish average and way below other European regions. APPA, UNEF, PIMEC and EolicCat developed a positioning study of the PV situation in Catalonia in comparison with two European regions with similar demographic characteristics, in terms of surface and population density. These two regions are Baden-Württemberg (a south-west federal state of Germany) and Belgium [22].

The results, presented in *Table 2*, do not leave room for any doubt: Baden-Württember has 74% of the insulation of Catalonia and it has 18 times more of PV power installed. Belgium, with around 63% of the Catalan insulation, had 13 times more PV capacity by the end of 2017.

Table 2. *Comparative study of the PV power installed in Catalonia vs two similar regions [22]*

Region	Surface (km^2)	Inhabitant/ km^2	Annual Specific production (kWh/kWp)	PV Power installed (MWp)	kWp/km^2
Catalonia	31.895	235	1.350	269	8,4
Baden-Württemberg	35.751	300	1.000	5.393	151
Belgium	30.528	385	850	3.420	112

In parallel to the important energy dependency, Spain (and Catalonia as well) had also experienced a significant increase in the electricity price during last years. According to Eurostat, Spain is the fifth European country with a higher electricity price, which clearly affects the life of the families and the competitiveness of the SMEs (*Figure 13*).

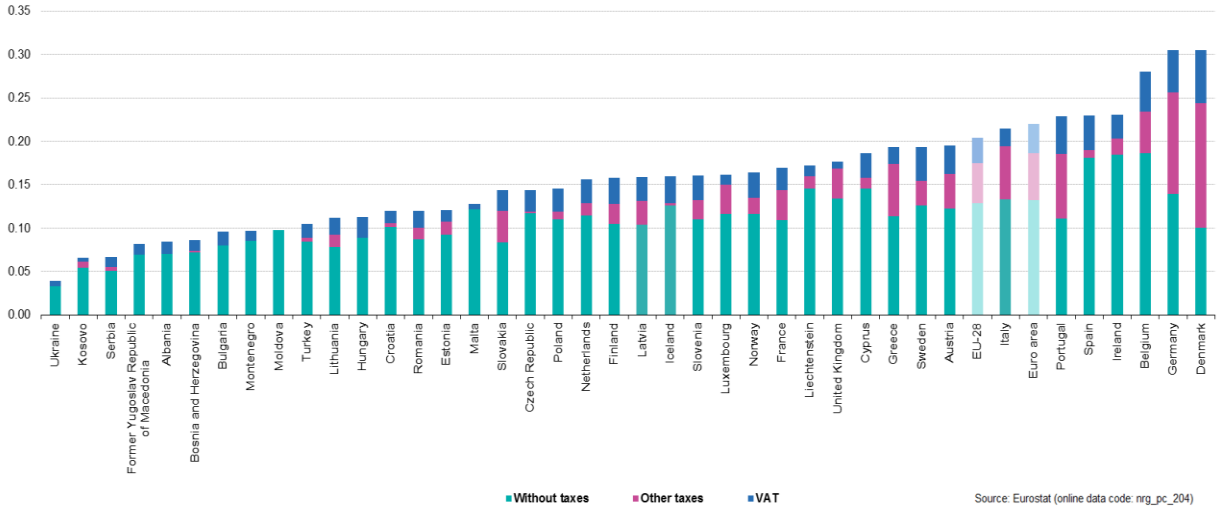


Figure 13. *Electricity prices for household consumers in 2017 [23]*

2.2.2 Trends and perspectives of PV modules and batteries

The fast improvement in solar PV technology last years is going to have a continuation in the coming years. Many and many countries are seeing that a higher deployment of renewable sources not only improves the air pollution but also it helps to reduce the energy dependency.

According to IRENA, the prices of PV modules in Europe has dropped by 83% from 2010 to 2017, basically due to the great reductions in selling price by the Chinese manufacturers, who is leading the worldwide tendencies in solar energy. In fact, in 2016 the average selling price of PV modules in China were a bit lower than 0,45 USD/W [24].

And these prices were even lower in 2017. According to the Bloomberg Energy Finance (BNEF), in the last quarter of 2017, the monocrystalline module price in China averaged 0,37 USD/W, and it predicts a continuous decrease to 0,24USD/W by the end of 2018. And the worldwide PV market would be significantly affected for these important reductions, that were only seen during 2011 [25].

Furthermore, it also found out that during the first semester of 2018, the LCOE of PV registered an 18% reduction in comparison with the same period of the previous year, reaching 70$/MWh [26].

Therefore, it is expected a new dip in costs after some years of a bit of standstill. And in this case is not associated with economies of scale -increasing production capacity- but to the increase in the production efficiency associated with newer cell designs [24].

One of the processing methods that has improved costs is the diamond wire technology, which allows reducing considerably the material losses when slicing. Another trend that has been successfully introduced into the market –and it is expected to keep gaining market share- is the Passivated Emitter and Rear Cell (PERC) technology. It as a solar cell architecture that allows multi-crystalline cells to capture more light, which leads to an improve of efficiency [24].

According to a recent study published by Lazard [27], where it analyses the Levelised Cost of Energy of different technologies, the main renewable sources continue to decrease its costs in comparison with the conventional technologies. However, the study also states that this decrease is becoming every year a little bit lower.

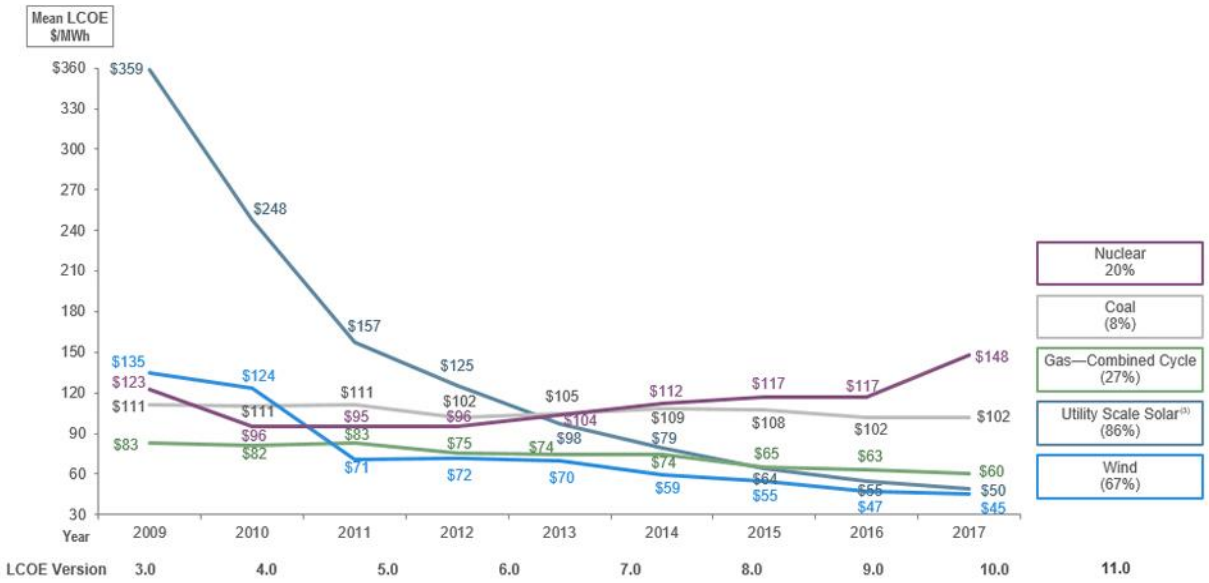


Figure 14. *Historical mean LCOE values of the main energy sources [28]*

Most of utility-scale PV LCOE reductions took place in the first four years under study. If the last four years are considered, the LCOE of utility-scale PV fell by 36% (*Figure 14*). And when comparing the data of 2017 with the one in 2016, the reductions of the LCOE were 9% [27].

But in the case of the installations that concern to SUD activity, commercial and industrial-scale PV energy, their costs only fell by 8% in the last four years and by less than 1% in the last year [24].

Given that large-scale solar and wind energy already have LCOE lower than conventional generation, this stagnation might not seem like a big problem. The problem is that neither PV solar nor wind can be generated at will and by adding storage to these technologies often eliminates the cost advantage.

As an example, Lazard calculated that large-scale crystalline silicon PV now has an LCOE range of 46 to 53$/MWh of generation, less than the lowest level cost for coal (60$/MWh) and gas (68$/MWh). However, as an example, by adding a battery and bi-directional inverters to the PV system to deliver 10 hours of storage with a capacity factor of 52%, it raises the cost to 82$/MWh [27].

The next challenge for renewable energies, therefore, will be to beat traditional generation competitiveness even with storage, especially in the case of small-scale installations. In fact, cconcerning the residential market, there is a wide range of cost reductions depending on the country. From Q2 of 2013 to Q1 of 2017, the total installed costs of residential PV installations have decreased by between 18-66%. The figures for Spain are a bit above the average: 48% reduction (from 2.900 to 1.500 USD/kW) [24].

Hence, as the reduction of wind and solar energy costs are slowing down, the key will be how much additional storage costs can fall. Here it appears the concept of LCOS (Levelized Cost of Storage).

While the LCOEs are essentially a calculation of the electricity generation costs under certain conditions, the LCOS must take into account the value of the energy stored when it is discharged back into the electrical system [29]. This value can vary widely depending on how many functions the energy is carrying out and the value of each one.

The study of the Lazard LCOS project that lithium-ion had the best prospects of reducing capital costs, as *Figure 15* shows. It expects lithium-ion batteries will drop 36% in the next five years, compared to 28% for zinc bromide flow batteries and 19% for vanadium batteries [29].

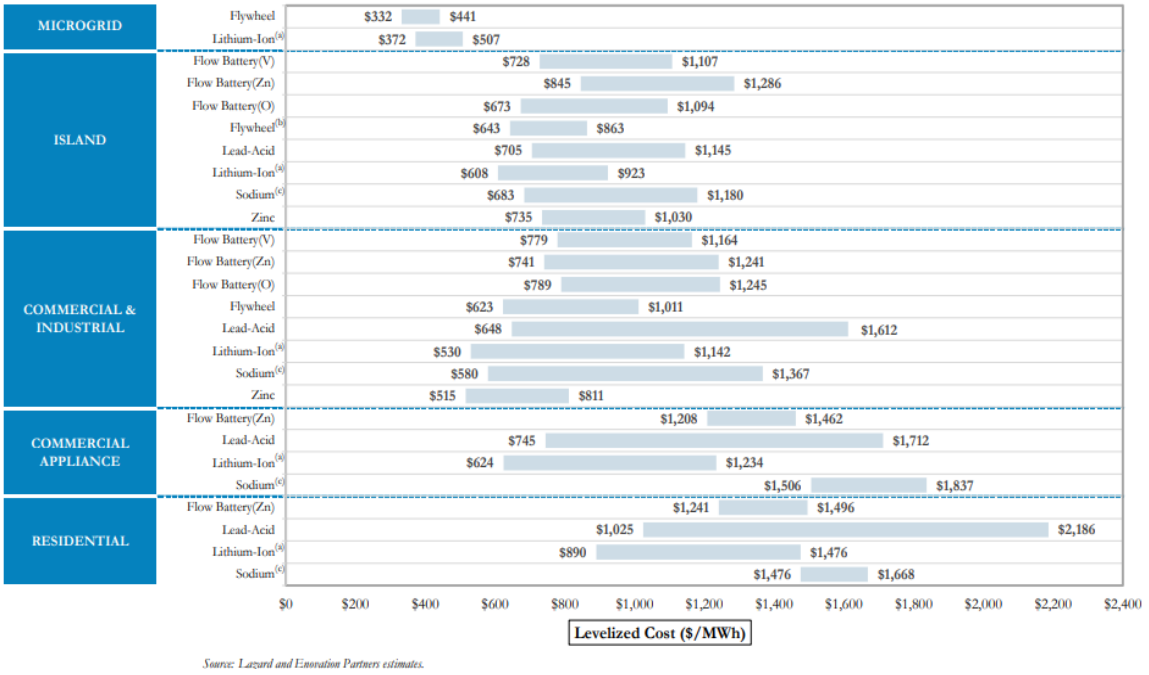


Figure 15. *Unsubsidized Levelized Cost of Storage by different storage technologies [29]*

The lithium-ion market has been especially studied, since it is maybe the one with great projections. BNEF's shows a fall of this technology by nearly 80% during the last seven years: from 1,000 $/kWh in 2010 to $209 $/kWh in 2017, as *Figure 16* exemplifies [30].

Figure 16. *Lithium-ion battery prices evolution (2010-2017) [30]*

It also establishes the year 2025 as the one that the price of this kind of batteries would be lower than 100$/kWh. In the absence of knowing whether this fact can be a reality, cheapening in this way the battery markets would not only easier the residential PV market but also the faster incorporation of the electric vehicles.

What it is clear is that PV technology, as one of the green sources with a better future, would not be able to cover the base load of any developed society if it operates alone. Hence, the development of storage technology will definitely mark the competitiveness of solar energy in the market.

And this link is especially strong when talking about residential PV technology. Until now, it has been much more feasible to install it in commercial applications -which have the same load profile as the Sun- without the need of including batteries in the system. However, in domestic cases, the energy demand has two peaks: at midday and especially at night, where there is no radiation. If a storage system cannot complement the PV modules, the payback time of the system extends considerably.

2.2.3 Regulatory framework

In Spain, the situation of renewables in the last decade has been marked by important technological advances combined with poor regulations for their deployment. And it is clearly differentiated in two periods:

- The first lustrum (2007-2011): Spain was among the countries with more PV capacity installed worldwide, despite the technology was still very expensive. Nearly 5 GW of solar PV was installed [6].
- The second lustrum (2012-2016): The Government decided to considerably slow down the PV installations at the same time that the technology was becoming better and cheaper. Only 0,5 GW of solar PV was installed [6].

It can be said that everything that concerns the legislation for renewables in Spain began on May 25, 2007. That day, it was published the RD 661/2007, which regulated the production of electricity using renewable technologies [31]. It established the right for new PV installations to receive a premium of 440 €/MWh, which was 10 times higher than the normal market price [32]. This fact entailed two aspects: (i) thousands of (small and large) investors decided to participate in this game and (ii) Spain installed nearly 4.000 MW of solar PV until 2010, despite the Government predictions were less than the 10% of this figure (363 MW) [33].

Obviously, this tremendous and sudden increase of PV installations put Spain at the lead worldwide, having nearly the 10% of the world PV installed capacity.

The Government fixed the date of September 29, 2008, the deadline to benefit from the premium [31], which resulted in a chaotic situation: the producers paid what was necessary (sometimes more than 7 or 8 €/Wp) and signed what the bank offered to finance the installation [34].

SUD, as an engineering and installation company, had to hurry up in that period to carry out as more installations as possible before the deadline, since the profitability of the system depended on that. That moment, the only important aspect was to register the installation before the deadline, since the Government promised them a fixed return for a period of 25 years.

As it can be observed in *Figure 17*, SUD installed 1.558 kWp from January, 2007 to November, 2010. 47% of that power (741 kWp) was installed in only two months: August and September of 2008 -just before the premium was over-. During the rest of the 47 months of that period, SUD installed only 818 kWp.

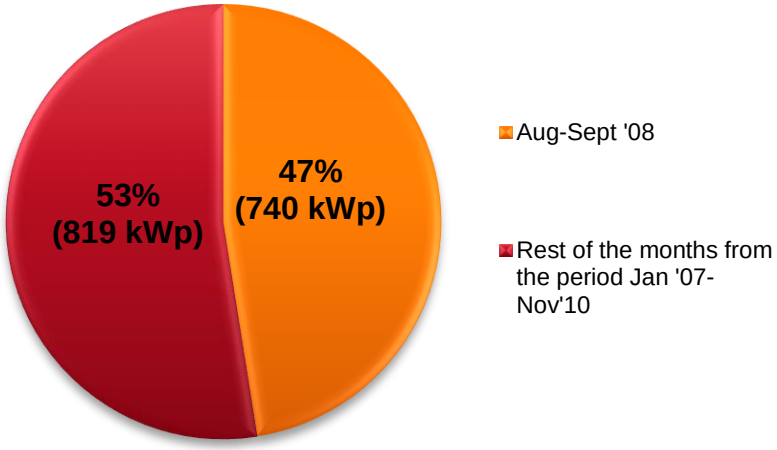


Figure 17. *PV power installed by SUD (Jan'07-Nov'10)*

However, this great (but short) period of solar PV coincided with a deep economic crisis in the country and a large tariff deficit of the electricity sector, which scared the two politic parties that governed during the following years:

- Firstly, Zapatero's government -which was key for the push of renewable technologies- decided to limit the benefits for the PV technology for three years (2010, 2011 and 2012). At the same time, he established a toll of 0,5 €/MWh for all production plants [35].

- Secondly, Rajoy's Government -which entered in December 2011-, fixed as a priority to reduce the tariff deficit. He directly suspended the benefits for all renewable facilities and the economic reward of these technologies was subject to the government's will: it was defined a complex formula of many variables to set the value of the economic compensation [36, 37].

After the approval of this set of laws, the situation was critical for most of the PV companies and especially for the investors. In fact, there are in Spain 62.000 families completely ruined due to the sudden change in the PV regulatory framework [38].

During the next years (2011-2016), the cost of PV technology greatly decreased, but Spain was losing positions in the ranking of capacity installed year after year. This fact entailed an important cut of the sector jobs as well: from 42.000 in 2008 to the less than 10.000 in 2012 [33].

However, if the technology was becoming cheaper, why it didn't start to appear more PV installations without the need of having bonus/premium? Basically, because in October 2015, the Government introduced another law that frightened most of the potential customers: RD 900/2015, also known as the 'Sun tax' law.

That regulation established that the users of self-consumption installations must pay more tolls for the maintenance of the grid than the rest of the consumers, despite being the ones who least use it. It

stipulated (i) a charge for power installed and (ii) a charge for self-consumed energy. However, these extra-charges were only applied to installations with a power bigger than 10kW, which represented just the 4% of the Spanish households [39].

Therefore, this law has worked more in the sense of scaring the people that the amount of the tax itself: from that moment on, most of the potential customers started to think that having solar panels in their roof was unfeasible or illegal. In addition, the tax entailed an important increase in the administrative obstacles to carry out a PV installation, which moved more away, if possible, people from this business.

2016 and 2017 have been two years of intense work by the companies of the sector, in the sense of denying the public 'bad' opinion towards this type of installations. In the end, the objective was to make clear that producing solar energy at home was not only completely legal but also viable, and would help the users to obtain economic and environmental gains.

The uncertainty in the sector was every time lower, and people started to lose the fear of this technology. Furthermore, on June 2018, there was another change in the Spanish Government: Rajoy's Government (PP) –known for being averse to the renewables deployment- gave way to Sanchez's Government (PSOE), which has promised to eliminate the 'Sun tax' and to introduce different policies in favour of changing the current energy model to a cleaner one. One of the ideas of its group in charge of leading the energy transition is the gradual elimination of the coal power plants before 2025 and the close of nuclear plants before 2030 [40, 41].

Thus, the coming years are seen from a very positive perspective. It can be the first time that the solar PV technology is highly competitive, and it is combined with a suitable regulatory framework.

2.2.4 Technology challenges

Solar PV technology has one of the best considerations among the set of energy sources: nowadays it is seen as a technology that has nearly zero visual impact and which has become economically acceptable. In spite of that, it has several challenges that it would be necessary to face in order to undertake the mentioned transition to a decarbonized and decentralized energy model.

Three of the main solar PV challenges are going to be assessed during this point of the dissertation:

1. The low power density of renewable sources in comparison with the conventional technologies. This fact makes important to start talking about the concept of power transition (and not only energy transition).

2. The intermittency problem, which still difficulties nowadays the incorporation of renewable sources –on a large scale- into the energy mix.

3. The complexity in the end-of-life management of the PV modules, which the world would need to face in the next decades and can lead to a solar waste crisis.

Those challenges are explained more in detail straightaway:

- Power density problem

Nowadays our immense use of energy –especially from thermal sources- completely fits our standard of livings. In Spain, the households, cities, industries…, are demanding an amount of energy that can be easily supplied by the current power installed capacity. However, most of this energy supply is not as clean is it could be, since almost half of it comes from coal and gas power stations.

To overcome this issue, a change in the energy model is necessary, and the weight of renewable sources in the energy mix should increase. Therefore, it has appeared the concept of 'energy transition'. That refers to the strict swap of technologies: for example, from coal and gas to solar and wind.

However, the characteristics of those energy sources significantly decrease the possibility to carry out such a transition. And not only for the intermittency problem but also for its power density issue: in order to provide the same amount of energy as a thermal power plant, wind and solar require much more space. The next representation clearly exemplifies this problem:

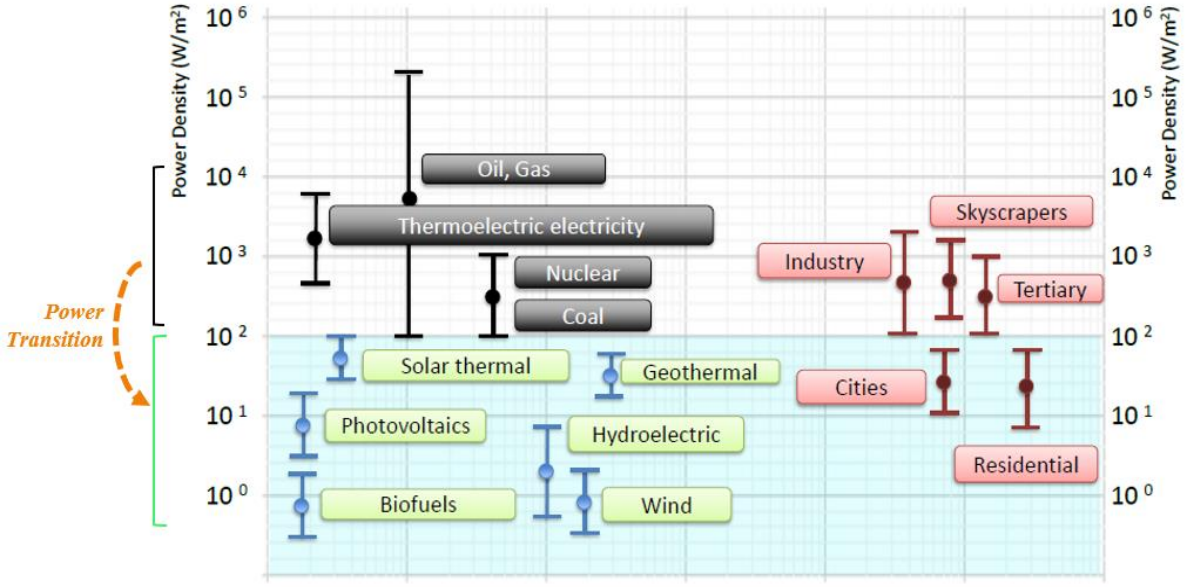


Figure 18. *Power density of the main energy sources and societal sectors [42]*

As it can be seen in *Figure 18*, while conventional sources have a power density always higher than 100 W/m^2 (and usually much higher), renewable technologies lag way behind, with values a little bit lower than the demanded by people in their daily usage of energy.

Therefore, a key goal for green technologies to take a bigger part of the energy mix would be to increase its efficiency of production: producing more energy with (at least) the same space. And this is precisely what solar PV is doing in the last years: the rise in the technology maturity not only comes from its price reduction but also for its gradually improvement in efficiency.

Applying this concept to SUD, only from 2016 to 2018 the evolution in the modules power density is notorious. In 2016, the modules usually used were the REC250PE, with a peak power of 250 Wp and an area of 1,65 m^2 (151,5 W/m^2) [43]. However, in 2018, SUD is already carrying out installations using high-efficient modules like the SUNPOWERX22-360-COM, with 360 Wp of power and 1,63m^2 of area, which leads to a power density 46% higher: 220,9 W/m^2 [44]. Obviously, these significant values of power density are reduced when considering the installation as a whole and not only the sun capture area.

- Intermittency issues

The main problem with modern renewable technologies is their intermittency. It is obvious that if there is no sun, electricity cannot be generated -the same if there is no wind-. This means that renewables are only an alternative to fossil fuels or nuclear if there is a large-scale and efficient storage system. But that does not exist today, except reservoirs, and in the case of Spain there is a fairly large risk of desertification.

One storage system that is currently used is that of solar thermal, with molten salts. However, it has the problem that when storing energy in the form of heat, its duration is very limited in time. Hydrogen is also discussed as a storage system. At the moment, it is something that cannot be done on a large scale and its production is not cheap, and it is under research to make it cheaper.

Finally, as it has been seen in a previous section, batteries are being developed at high speed, but up to date, there is nothing installed on a large scale, except a Tesla battery mounted in Australia, with a 129 MWh capacity [45]. However, to be able to guarantee the electricity supply of a day in Spain -last year, 734,6 GWh [7]-, it would take about 5.700 units of that battery. And considering that each one would cost around 25.000€ [30] and a replacement time of approximately 7-8 years, it seems an unfeasible option for the moment.

Therefore, nowadays renewables cannot work as a direct alternative to nuclear, since all of them need storage as a backup. In addition, given that renewable generation capacity is limited to the existence of a resource, the power needed to install to replace the energy generated by a nuclear power can be 5-6 times the power of the nuclear. The nuclear ones work about 8,000 hours a year at full power, and solar only 2000 (considering one-axis tracking). Hence, to generate the same as a nuclear with photovoltaic, we would need 4 times (8000/2000) the amount of nuclear power. Adding the losses that would appear with the accumulation system, it gives an even higher value: around 5 MW of solar power for each MW of nuclear.

So this leads to the conclusion that the only alternative to nuclear at the moment is any fossil fuel thermal: coal, fuel, gas. Closing the nuclear ones would inevitably lead us to burn coal. In fact, this is what happens precisely in Germany, which decided to close nuclear power and 35% of its power generation is done with coal [46]. On the opposite side, there is the case of UK, which is shutting down coal and holding nuclear and has lowered its coal generation rate from 40% in 2014 to 6,7% in 2017 [47,48].

However, this is what happens nowadays; and it has been seen that the PV world is moving so fast in the last years, so the most probable is that this clean source will keep gaining importance in the electricity mix the next years to become one day a direct alternative to thermal technologies.

- End-of-life management

The last challenge that is going to be highlighted is the volume of decommissioned PV panels during the next decades. As it is a quite recent technology, the issue of how the world would face with its waste it is still a mystery. According to a study developed together by IRENA and IEA, there would be around 78 million tonnes of PV panel waste worldwide by 2050, being China, the Unites States and Japan its main originators [49].

The main problem with this huge amount of waste is that its materials are not easy to manage. In fact, solar modules usually contain toxic chemicals (such as cadmium, lead and chromium) that make the entire solar panel to be considered as hazardous: these materials cannot be extracted without breaking apart the whole module. *Figure 19* exemplifies the diversity of materials throughput of Solar PV in

comparison with other sustainable sources. Thus, like any other waste that should be treated carefully, activities such as dumping or landfilling should be completely avoided.

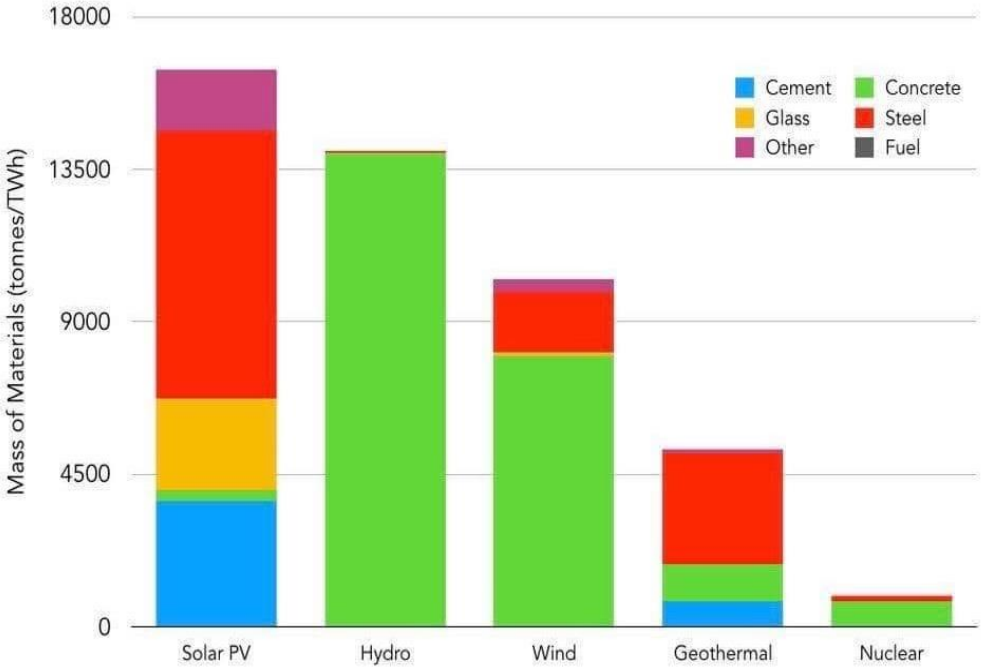


Figure 19. *Materials Throughput for each sustainable energy source* [50]

However, the study of IRENA and IEA also estimates that if solar PV panels are recycled at the end of their lifetime and they are completely introduced back into the economy, the value of the recovered material could exceed USD 15 billion by 2050 [49]. And there exist nowadays some organizations, like PVCYCLE [51], which are taking care of that issue.

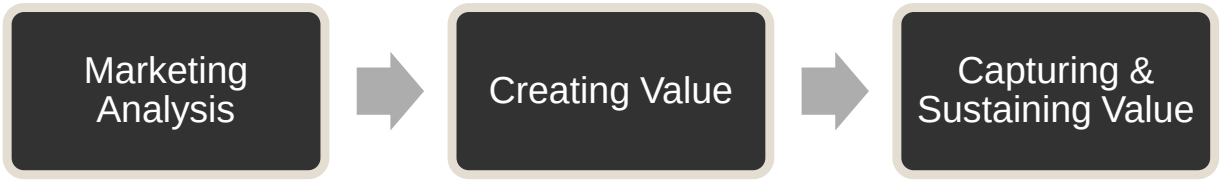
3 BUSINESS MODEL: RESEARCH & DEVELOPMENT

Once the work has been properly contextualized within its two main pillars –the company situation and the technology 'state-of-the-art'-, the core objective of the dissertation can be developed. Hence, in this chapter, an adequate business model for SUD in the residential PV market is going to be proposed, considering the main points of the previous chapter.

Firstly, it is going to be analysed the market with an internal point of view, with the objective of positioning the company in relation to the main competitors. To complete such a goal, it would be necessary to study in deep the characteristics of the customers and identifying the SUD opportunities within its reference market. In addition, it is going to be developed a strategic analysis (SWOT matrix), in order to exemplify in a clearer way the main opportunities and threats of SUD inside this new market for it.

After having segmented the market and positioned the company, the business model is going to be completed with (i) the business model canvas, highlighting the customer's segments and the value proposition; and (ii) the unique selling proposition, which analyses in deep the similarities and differences between SUD and its main competitors.

Therefore, the methodology that is going to be followed is the typical of a marketing process:



3.1 Marketing analysis

In chapter 2, the market has been studied in deep with an external focus, representing the evolution, perspectives and challenges of it, considering a four-level point of view: world, Europe, Spain and Catalonia.

The objective of this point would be to approach the analysis in a more detailed way: studying the market opportunities and the company strengths in the residential PV market in Catalonia, as well as identifying its threats and weaknesses. However, prior to developing a concrete analysis of the type of customer that SUD would target, it is important to clearly define the reference market in which the company is located.

3.1.1 The reference market

The reference market is a concept that helps to orient a company inside a business, and should be the first marketing strategic decision. Thus, it is much more than an identification of the sector where the company is competing: it identifies potential customers, it defines the basic need to cover, it evaluates the competitors, etc.

The reference market -or relevant market- relies on a three-dimensional design developed by Derek Abell [52]:

- WHO: the customers to deliver the solution.
- WHAT: which is the need that we are satisfying?
- HOW: the solution (product or service) itself

In the case of SUD, there's a significant difference between the current reference market (industrial) and the reference market that is considered in this work (domestic): the customer changes, and so does the need that is intended to cover and the solution that is offered. Therefore, it is studied the reference market applied to the residential PV market in Catalonia, which presents the picture shown in *Figure 20*:

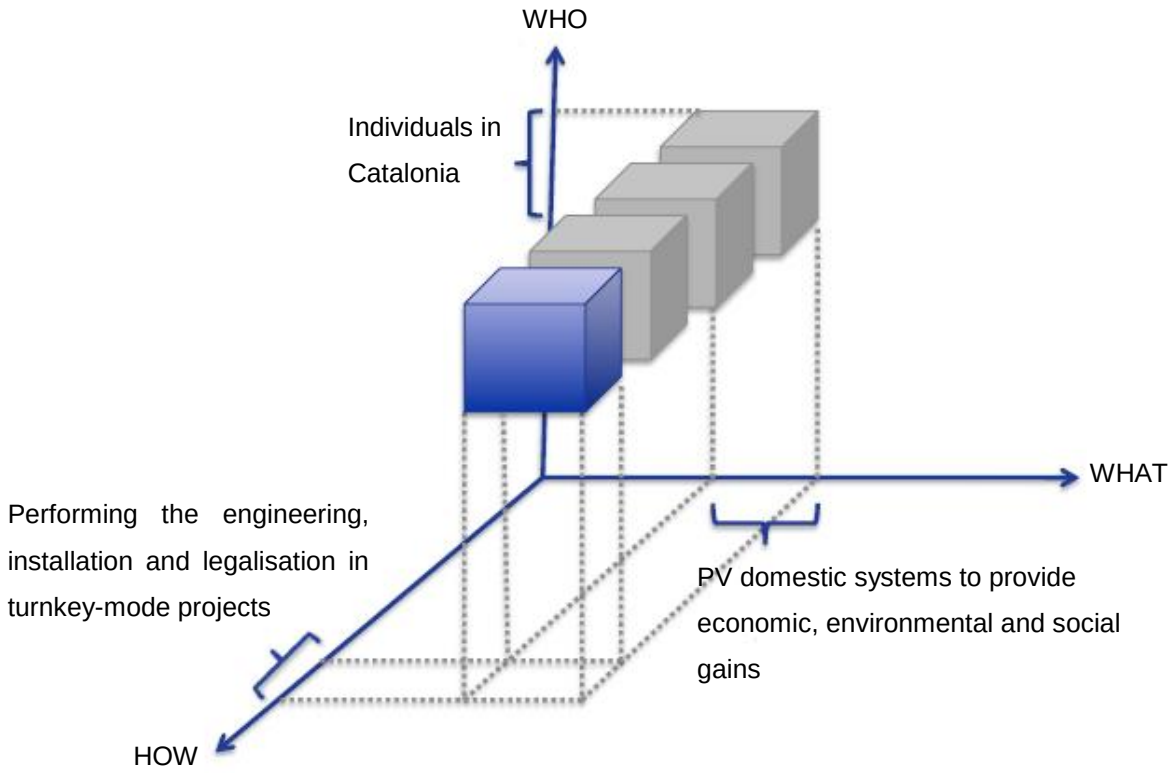


Figure 20. *Three-dimensional model developed by Abell applied to SUD in the case-study market*

The solution will target individuals and not businesses, since this is already the current main target market. Obviously, not all the individuals in Catalonia are subject of becoming customers, and it would be described in the next points which are the most suitable market segments to target.

The demand of those customers can vary depending on the specific case but, in general, they have the need to obtain long-term economic benefits, while contributing to enhance a distributed and decarbonized energy model. In addition, they may wish to be in the vanguard of the new products and services.

In order to satisfy the mentioned needs, the company will provide both functional and emotional values. Regarding the functionality of the solution itself, this will be based on the elaboration of the engineering project, the installation works and the paperwork to process and legalise the PV system. Hence, this is the main value that the company should provide to the customer: a complete development of a PV domestic installation in turnkey-mode projects. As it has been seen in section 2.1.4., the company will face this market in the growth stage; and, during this phase, the functional value is where it works better: the customer will make the switch from other categories only if he sees a clear practical usefulness in the company's solution.

However, as it has been mentioned, the value given to the customer is not only a physical installation but also it entails a benefit in social issues. The fact that the customer can produce his own energy not

only helps to evolve the current energy model and democratize the energy, but also it increases the empowerment of the citizen in a fundamental common good.

The reference market analysis is only the first step in the marketing decision process to get success in a new business. After that, in order to provide a strategic point of view to the company, different business analysis models can be developed, highlighting SWOT analysis, PESTLE analysis, and Porter's Five Forces framework.

Since most of the aspects that consider PESTLE strategy have already been presented in chapter 2, and Porter's Five Forces provides a more external perspective (focusing on the external impact), it has been considered the SWOT analysis as the most suitable one to study the company's potential in this new market.

3.1.2 SWOT matrix

After setting the company's play area inside this new market, it is going to be used one of the most popular modules in strategic company analysis: SWOT matrix. This tool gives a general overview of the internal (strengths and weaknesses) and external (opportunities and threats) environment of the company inside its market.

The company should pay attention to the strategic analysis since it is important to move faster within its environment. The sector in which it is involved could be considered a VUCA environment, which stands for Volatility, Uncertainty, Complexity and Ambiguity. The renewable energy -and especially the PV world- is a brand-new sector that intends to break with the conventional systems of energy production, so that the level of difficulty of defining suitable business models increases in comparison to other categories.

Only by defining the proper strategy to compete in this sector, SUD would be able to position itself as a reference company in the residential solar PV market, as it already does with the commercial market. Hence, the SWOT matrix of the company in this market would be as *Figure 21* shows:

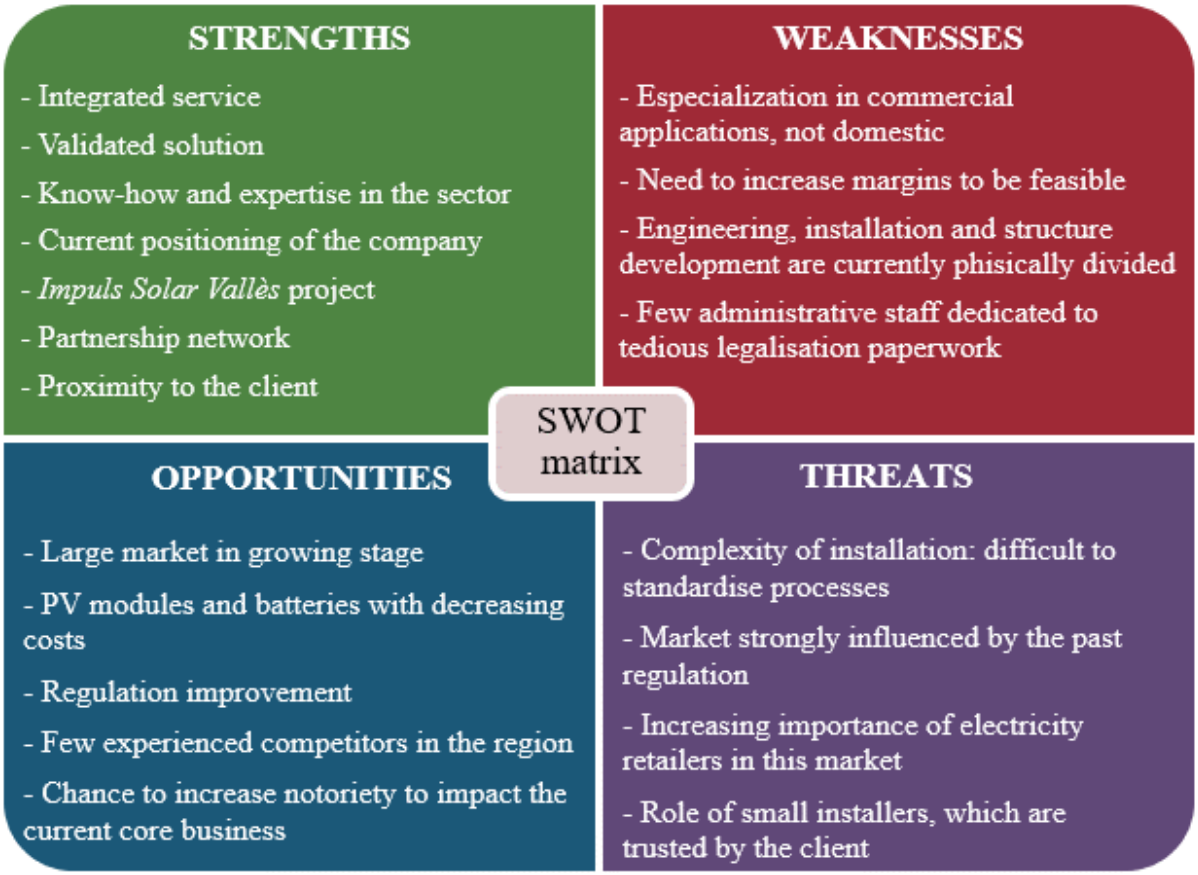


Figure 21. *SWOT matrix applied to SUD in the case-study market*

On the negative side (right column), SUD faces two important challenges. Firstly, the difficulty to standardize processes: each installation may be developed with a different structure that requires on-site visits to define the best solution. This fact, as well as the slow bureaucracy to legalise such small installations, makes it difficult to gain important profits. Secondly, the mistrust of most of the potential customers towards this sector, basically caused by the harmful regulation of the past years.

Other troublesome, such as the entrance of new actors from different sizes (retailers, small installers…) or the few experiences of the company in this market, may affect the business model but with a smaller proportion. Regarding the company current logistics and operations, they can be also improved: the location -in three different places- of the most important activities can affect the processes efficiency.

Concerning the positive aspects (left column), SUD has a consolidated trajectory as engineering and installation company in the solar PV field. Moreover, it offers the complete development of the installation: from the initial processing of the licenses with the city council, passing from the elaboration of the executive projects and the final installation, legalisation and maintenance of the system. The fact that the whole value chain passes inside the SUD group without externalisation, substantially increases its power against the competitors.

One of the other key points of the value that SUD may offer is the *Impuls Solar Vallès* project, which will be developed during the end of 2018 and the beginnings of 2019. Apart from gaining expertise from

such 100 residential installations, the company would obtain a good publicity in this market, and the next customers that decide to put a PV installation on their roof would have SUD as one of the reference companies in Catalonia to develop it.

Furthermore, this market presents important opportunities, which would likely exist only for a limited period. Therefore, SUD faces a window of opportunity in the next years to successfully approach the residential PV market. The window of opportunity is a defined period when an action can be undertaken with the most probability of success due to the suitable conjunction of factors.

In the case of SUD, different elements are going in favour of this process during the current and next months. And such factors either were detrimental in previous times or would not be suitable on a future occasion. Therefore, it is defined straightaway the characteristics of these three pillars, that would mark the duration of the window of opportunity:

- **Regulation**: the volatile regulation in Spain has strongly influenced this market since 2007. Now, the entrance of the PSOE's Government can change things up again. By the moment, it has already been created a Ministry of Ecological Transition and the promises of favouring again this damaged sector has appeared right afterwards. It will be necessary to see in what degree those promises will go to the facts, but what is clear is that it seems increasingly closer the moment when the rulers will take matters into their own hands to fight against climate change [53].

- **Technology**: the European Commission has decided to eliminate in September 2018 the import controls regarding the Chinese PV modules in Europe, which reached, in some cases, percentages around 64% if they sold their products at a lower price than the one fixed by the European Union [54]. This scrap would directly affect the market, since the European producers will have to adapt their prices to be competitive with the Chinese products, which at the end would result in a significant reduction of the global PV modules costs.

  In parallel, the prices of storage technology will decrease, with every time more important companies deciding to enter into this market. In fact, according to BNEF, it is estimated that global battery capacity will double in 2021 to more than 278 GWh/year, while the world demand for lithium is expected to quadruple by 2025 [55]. Thus, the next years are crucial to manage the combination of batteries together with the solar modules, since it seems that nowadays it is still too early due to the important differences between both technologies.

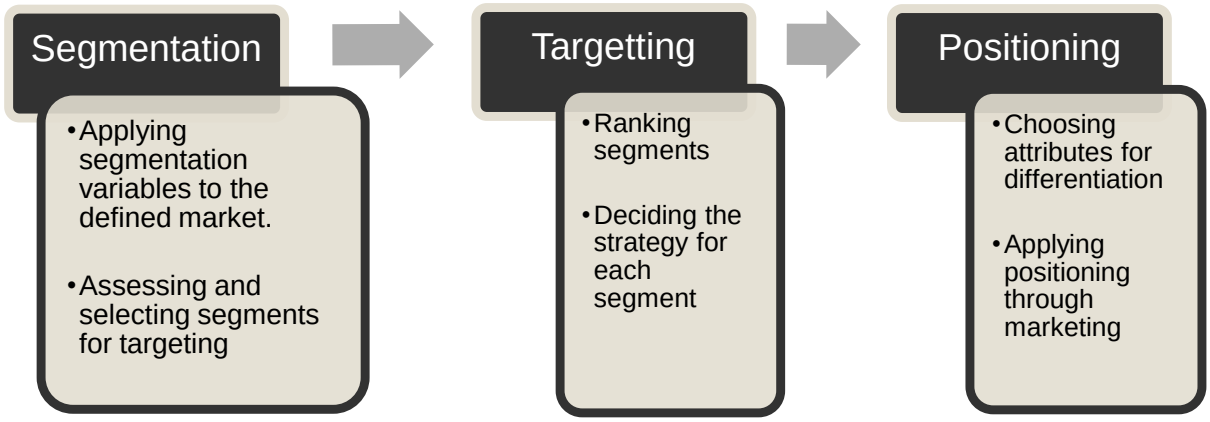
- **Competitors**: SUD has been practically the only PV engineering in Catalonia for the last decade. It has operated in the commercial sector, developing the biggest installations of the region. Therefore, if the company would have decided to play also in the residential market, it would have been almost alone. However, the high payback time of such installations during the last years, made it impossible to approach this market. Nowadays, when the prices of the technology make the small-scale installation feasible, new SMEs started to appear and big companies begin to allocate important resources into this market.

In spite of that, SUD is still one of the model companies and advantages most of its competitors in a key factor: the expertise. In the Unique Selling Proposition analysis, it is going to be detailed more in deep the competitor's advantage of SUD versus its rivals.

After the marketing analysis, it has been seen that the company is nowadays in a strategic competitive position to succeed in the residential PV market in Catalonia, and the outcome of such a challenge would depend more on the decisions of the company itself. Hence, how to be economically profitable inside this environment, which is going to be studied in the next points.

3.2 Creating value

In order to clearly identify business opportunities and so create value for the company, it is going to be used the classical marketing concepts: segmentation, targeting and positioning.



3.2.1 Segmentation and targeting

The process of segmentation is probably the most difficult marketing decision, since it must be decoded what's happening in the market to decide who to target and how. In other words, the segmentation study is undertaken in order to define groups of customers according to their interests or needs in relation to our service.

There exist different levels of market segmentation, each one referred to the degree of the market that has been segmented [56]:

- Mass Marketing: the same solution to all the customers (no segmentation).
- Segment Marketing: different solutions to one or more segments (a little bit of segmentation).
- Niche Marketing: several solutions to subgroups within segments (more segmentation).
- Micromarketing: solutions to satisfy the needs of specific individuals and locations (complete segmentation).

In the case of SUD, it would provide different options to several segments. Therefore, it would work on the second level: segment marketing. These options would depend on the characteristics of the customer, so that it is necessary to define several parameters to properly classify the potential customers. After that, it would be possible to determine the services to provide to each segment: a simple solar PV installation, an installation with accumulation, a participation in utility-scale projects, etc.

The parameters that are used to carry out such segmentation can be classified into four big groups: demographic, geographic, psychographic and behavioural [57]:

- **Demographic**: measures the basic measurable characteristics of individual consumers and groups, such as age, gender, income, family status, job or nationality. Those parameters allow creating segments between customers. For instance, concerning the age category, it can be

divided among children, teens, young adults, adults and older adults. The age range that is more feasible for our and the rest of the possible target segments are presented in *Table 3*.

- **Geographic**: parameters like the location (country, city, neighbourhood…) or the climatic conditions are subject to create different segments, and so that should be also analysed to target the proper market.

- **Psychographic**: this type of segmentation is thought to provide more information about what's happening in the consumer mind. It mainly considers interests and opinions, activities, lifestyle and personality.

- **Behavioural**: it puts the focus on the current customer behaviour toward a given product. Thus, variables such as brand attitude or benefit sought are considered in this type of segmentation.

All those parameters have been processed based on the experience inside the company and the knowledge of the market, and it has been possible to extract the different segments. All this information is summarized in *Table 3*.

Table 3. *Segmentation analysis based on the evaluation parameters*

EVALUATION PARAMETERS		SEGMENTS
DEMOGRAPHIC	Gender and Age	Couple from 30 to 40 years
		Male adults from 50 to 65 years.
		Male ancients aged more than 65 years old
	Nationality, Income and social class	Catalan nationality. Medium-high social class and significant acquisition power
	Studies and job	Higher education in technical fields such as architecture or engineering.
		Recently retired
	Type of home	Single-family house
		Apartment block
GEOGRAPHIC	Location	Towns of less than 10.000 inhabitants in Catalonia (Spain) Quiet neighbourhoods, normally in a residential area.
		Big cities in Catalonia
	Climatic Conditions	Mediterranean climate. Temperature ranges from around 0ºC in winter to nearly 40ºC in summer.
PSYCHOGRAPHIC	Interests	They enjoy travelling and practising sport (like hiking or paddle). Also, they have interest for new technological gadgets
	Opinions	Considered progressive. Want to fight for leave a better world to their children and grandchildren
	Lifestyle	Healthy life. Constants visits of friends and family at home
	Personality	Affable and hard-working people
BEHAVIOURAL	Brand attitude	Positive feelings toward the service
	Benefit sought	Economical savings seekers
		Care of environment as a priority

In our case -the analysis of the residential PV sector in Catalonia- it is a market in a clear stage of growth. For that reason, it would be better to not segment it, since the company would reduce its growth potential [58]. Thus, it is important to make a record of the capacity of SUD to offer different possibilities to different segments (as it has been said before, applying a segment marketing degree).

However, in a decision-taking process, as it is the one, targeting is the essential step to reduce uncertainty and increase accuracy for the most suitable decision. Hence, the set of segments presented in *Table 3* have been also analysed in order to target the proper market, which would be the one to begin the activity.

Therefore, the business model that is going to be presented and analysed its implementation is the one referred to the first target market, which has the following basic characteristics:

Catalan adults from 50 to 65 years. High acquisition power and high education studies, with positions of responsibility in their jobs. They live in a single-family house in a quiet residential area, with hobbies related to healthy habits and the latest technological advances. They do not intend to use our service for the economic savings, but to contribute to leave a better world for their children and to reduce its dependency from big utilities.

The decision to target such a market at the beginning is based on the experience of past customers inside the company, and it has the economic reason as the main argumentation behind. It would be difficult to be profitable in such a margin-reduced market if SUD doesn't choose a type of customer that is not much worried about the price, but about the functionality of our solution.

In order to reach such target market, positioning is the tool that will mark the odds of the company to succeed in the market, since it will help to define how the company wants to be perceived by the customer.

3.2.2 Positioning

The last step to create value is the positioning, which refers to the definition of the company's identity in its market. It is important to consider that such identity is established for the brand, and not for the product or service that is offered. Thus, SUD must be seen in the eyes of the customer considering also its trusted experience in the commercial sector, its leadership capacity within the sector in Catalonia, its productive activity in Peru, etc.

One of the best tools to position the company value proposal is the positioning map (*Figure 22*), which is constructed taking into account the customer basic needs in relation with the service and considering the main competitors in the market.

In this sense, the two variables that are plot are Experience and Trustworthiness (x-coordinates) and Price (y-coordinates), since they are the ones believed to be more critical to the quality of the current business model.

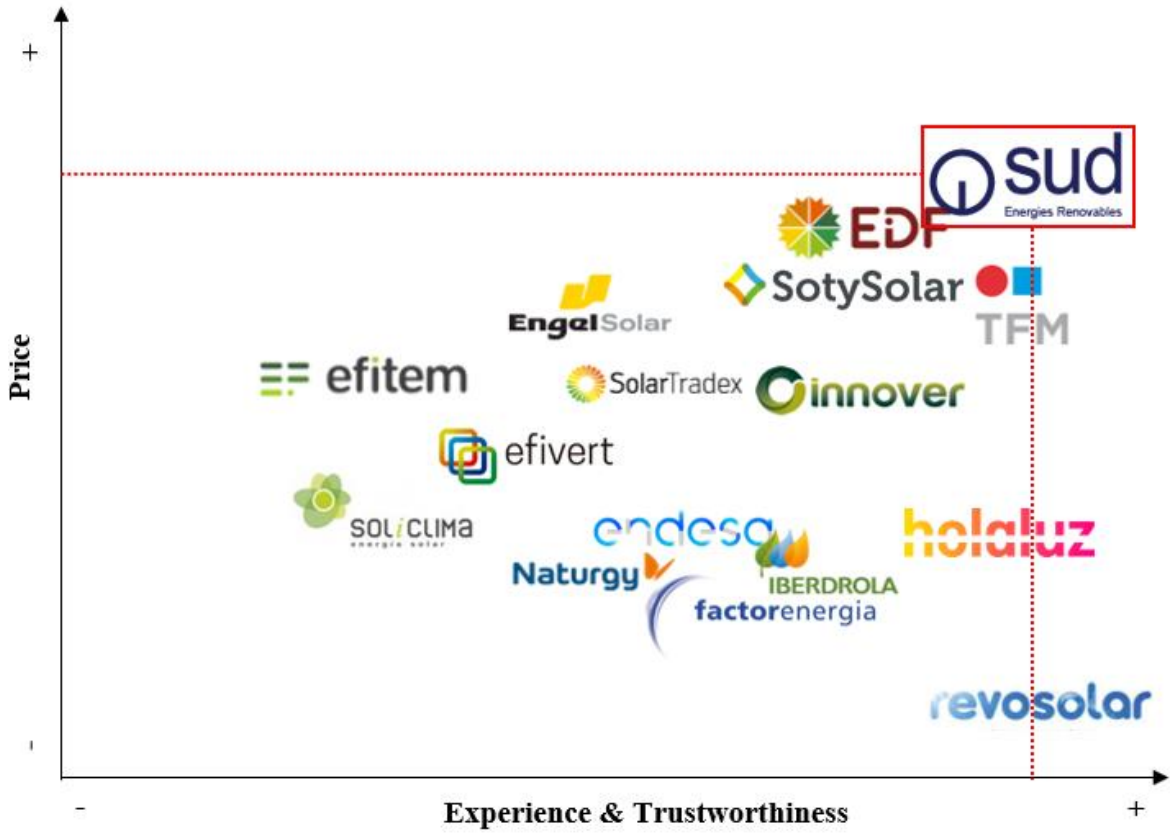


Figure 22. *Positioning map applied to SUD in the case-study market*

The analysis of the positioning map leads to several different conclusions, that can be summarized as follows:

- SUD should be positioned in the upper-right side of the graph in order to succeed in the residential PV market. Many other companies (either because their core business is a different one or because they are beginners in the market) are currently fixing the price way cheaper, which leads to very short margins. If SUD wants to approach such market should be seen as a premium brand, with a wide experience and knowledge inside the PV sector in Catalonia.

  For that reason, the target customer is the one that does not care much about the money but to the effectiveness of the solution. Being on the upper side of the graph means fixing the installation price above 2 €/Wp (depending on the technology, size of installation…), considering today's prices and without accumulation. With accumulation, an average installation (4 kW) should have a price higher than 4€/Wp.

  In order to succeed in its first projects in the domestic market, SUD has positioned itself in the down-right part of the graph. In fact, the 100 installations of the *Impuls Solar Vallès* project are expected to be developed with very little margins (1,65€/Wp all of them), with the main intention to gain publicity rather than important profits. Therefore, as nothings prevent repositioning, SUD should undertake the most suitable repositioning path: the bottom-up approach. It the end, the most important point is to minimise the gap between the desired positioning and the perceived positioning.

- The direct competence of SUD are the companies with a relatively similar profile, such as EDFSolar, SotySolar, Innover and TFM. Despite some differences that exist among those companies, they all have an important experience in the sector and they are mainly working in the commercial sector, but they are starting to develop their first domestic installations. To differentiate the company from these others, SUD needs to look for added values, which are going to be studied in the coming point.

- Retailers companies -HolaLuz, Iberdrola, Naturgy and Endesa- are starting to create divisions of solar PV domestic self-consumption. They are fixing prices around 1,5€/Wp and can be defined as companies with few experience in the field but important trustworthiness.

  SUD should not try to compete with these companies, since they are offering special electricity tariffs to the customers that, in addition, install a PV system with them. Hence, they can lower the price of the PV installation since they gain profits by another side (obtaining a new customer to sell him the electricity).

  As it has been said, these variables of the positioning map are applied to the general brand (and not the product or service itself) and those companies can take benefit from being widely known in the market to generate confidence into the client. This is specially applied for the case of Holaluz, which is seen in the recent times very positively in the eyes of the Catalan costumer, putting it apart from the other retailers that are part of the Spanish oligopoly (Endesa, Naturgy and Iberdrola).

- The rest of the companies -in general- do not represent a direct competitor for SUD, since its size is quite reduced and their experience in the sector is much smaller. It is important to mention the case of Revosolar, since it exemplifies the situation of the residential PV market in Catalonia: despite they are offering very reduced prices (around 1-1,2 €/Wp), they are developing dozens of installations due to the collective business model (similar to the *Impuls Solar Vallès* project). This fact -to carry out a lot of installations at the same time- generates trust to the customer: if they see that their friends and neighbours that are doing the same, they are not so afraid of entering in such an unknown market.

3.3 Capturing and sustaining value

After defining the strategic analysis of the company in order to create value in the market, the next job is to capture such value and then sustain it along the time. This shift (from creating to capture) is what will bring perspectives for the company, since it is the change from obtaining revenues (creation) to get profits (capture) [59]. To perform such a shift, different tools are used in the marketing world. Firstly, the Business Model Canvas and the Value Proposition Canvas help to design the service in the most suitable way to satisfy the customer needs. Then, the Unique Selling Proposition analysis defines the differentiating features of our service in comparison with the main competitors.

3.3.1 Business model canvas and value proposition canvas

A business model is the plan to generate revenues and profits, so that should be treated in a deeper way in order to (i) structure the business and (ii) be able to create new strategic alternatives.

One of the best tools to describe and analyse a company's business model is the Business Model Canvas. It was proposed by Alexander Osterwalder in 2010 and it divides the business model into nine building blocks that cover four main areas: customers, offering, infrastructure and finances [59]. It shows the rationale of how a company aims to make money and it gives both a general overview of a company's business model and a specific vision of its elements.

It's presented straightaway the Business Model Canvas for the case study of this dissertation (*Figure 23*). After that, the 9 blocks that constitute the Canvas are deeply described to explain the reasoning behind each aspect.

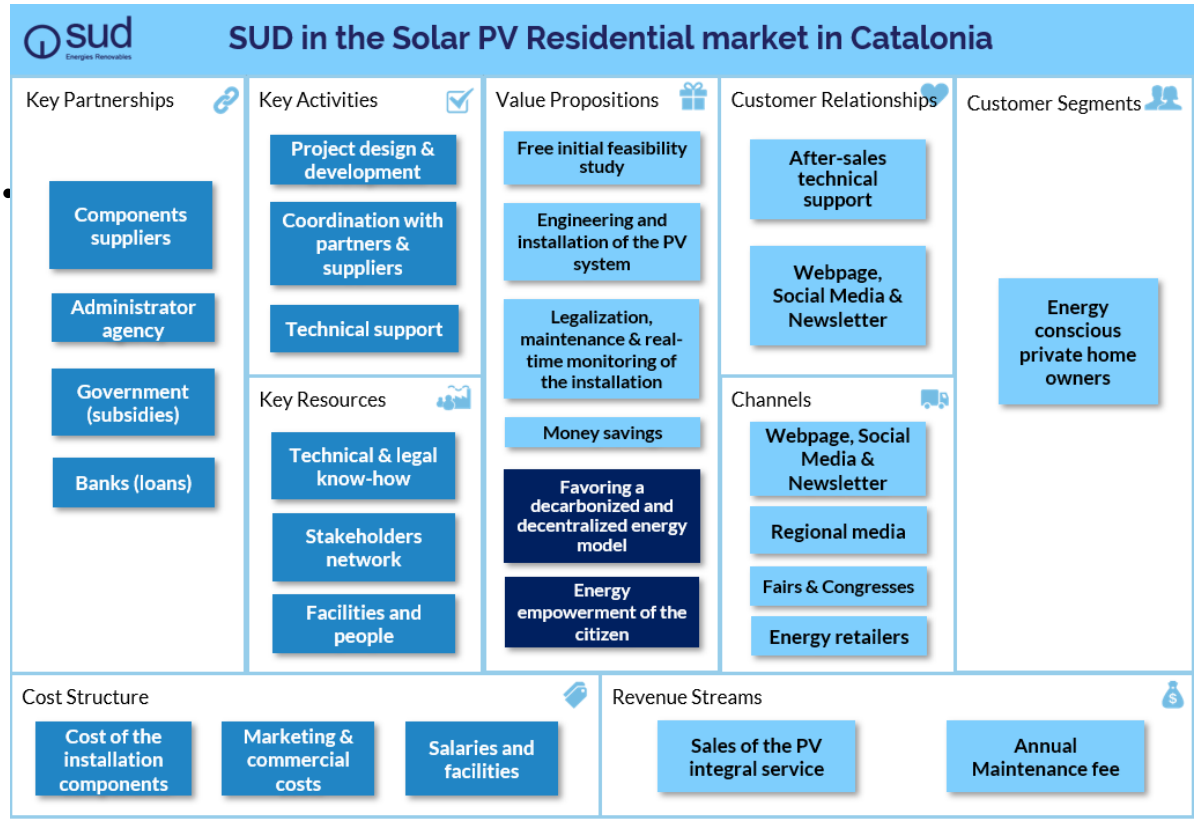


Figure 23. *Business Model Canvas applied to SUD in the case-study market*

The set of customers to whom SUD is delivering the service is the private homeowners and, more specifically, the ones with the characteristics described in the targeting section (environmentally conscious which live in a single-family house, with a medium-high acquisition power, etc).

- **Value proposition**

It is the reason why a customer would choose our offer instead of one of the competitors. Firstly, SUD offers a free technical and economic feasibility study, in order to give the general numbers to customers in terms of price and characteristics of their future PV installation. If the customers decide to go ahead with the project, the company offers a complete development of the solution: from the initial design and development phase, to the final legalisation step, passing through the project coordination and the installation of the system. After that, SUD also provides maintenance (if desired) and allows a real-time monitorization of the installation. All of that will enable the customer to obtain economic savings of his electricity bill.

On the other hand, the customer will obtain indirect benefits with our solution. He contributes to reducing the CO_2 emissions, while also favouring a decentralized energy model, reducing the distance between the production and consumption points (becoming a prosumer). Furthermore, he has been energy empowered, as he has acquired an important role in management one of his basic needs, favouring the democratization of the energy.

- **Channels**

The customer segment can be reached in many ways. The webpage, social media and newsletter should be one of the most important, and so that should be potentiated. In addition, the important role of SUD in the PV sector in Catalonia allows the company to be present in some of the regional newspaper (or even the regional TV).

Moreover, the different energy fairs that are being undertaken during the year can be a source of customers, as well as the agreement with some Catalan energy retailers. In this sense, SUD would be benefited from the fact that those energy retailers -such as *Estabanell Energia* or *SOM Energia*- don't have the technical knowledge to develop a domestic PV installation to many of their customers that would like to have one.

- **Customer relationships**

The main relationship that SUD established with the customer segment is the technical support. Once the installation has been developed, SUD is in charge of coordinating the problems that may appear (a damaged PV module, a molten fuse in the inverter, a malfunction in the battery, etc). It needs to put in contact with the product manufacturer to manage the issue in the shortest possible time. In addition, SUD should maintain an online contact with their customers through social media, newsletter and website.

- **Revenue streams and cost structure**

The revenue streams represent the cash the company obtains from the customers. In our case, it is mainly the payment to the customer when accepting the project. After paying it, he has the option to

also contract maintenance for several years, from which the company also receive money. On the other hand, concerning to the elements that drive the company's costs, they can be divided into three: (i) the payments to suppliers, (ii) the representative costs and (iii) the cost of the employees and facilities.

- **Key Activities**

In order to successfully run the business, there are some crucial actions that the company needs to perform well. These are mainly related to the project development and coordination: designing the system in a proper way and coordinating the *tempo* with the suppliers of the components, the installers and the reception of the work permits. Moreover, the constant technical support (both during the project and after it) is key, since the customer needs to feel secure that what he has paid for will work in the perfect conditions during its whole lifetime.

- **Key Resources**

The essential asset of the business model is the human one. The knowledge of the employees, especially regarding the technical aspects, regulatory issues and installing skills, is the fundamental resource of the business model. After that, is also very important the network of stakeholders -especially partners and suppliers- to always be competitive in the market. Furthermore, the facilities of the company represent a key resource, since the business model requires a degree of flexibility, and so that a warehouse to stock the components is needed (apart from the offices where engineers and administrators work).

- **Key Partnerships**

This block describes the network of partners and suppliers that allow the suitable development of such business model. In the case of SUD, the companies that supply the elements of the installation (PV modules, inverters, batteries…), as well as the dealers that deliver the material, are the most important partners. In addition, the agency that undertakes administrative work, the regional and national governments (to provide aids or subsidies) and the banks (to give loans if required) are part of the partnership structure.

Entering deeply into the two most important aspects of this Business Model Canvas (the Customer Segments and the Value Proposition), the Value Proposition Canvas can be also constructed [60].

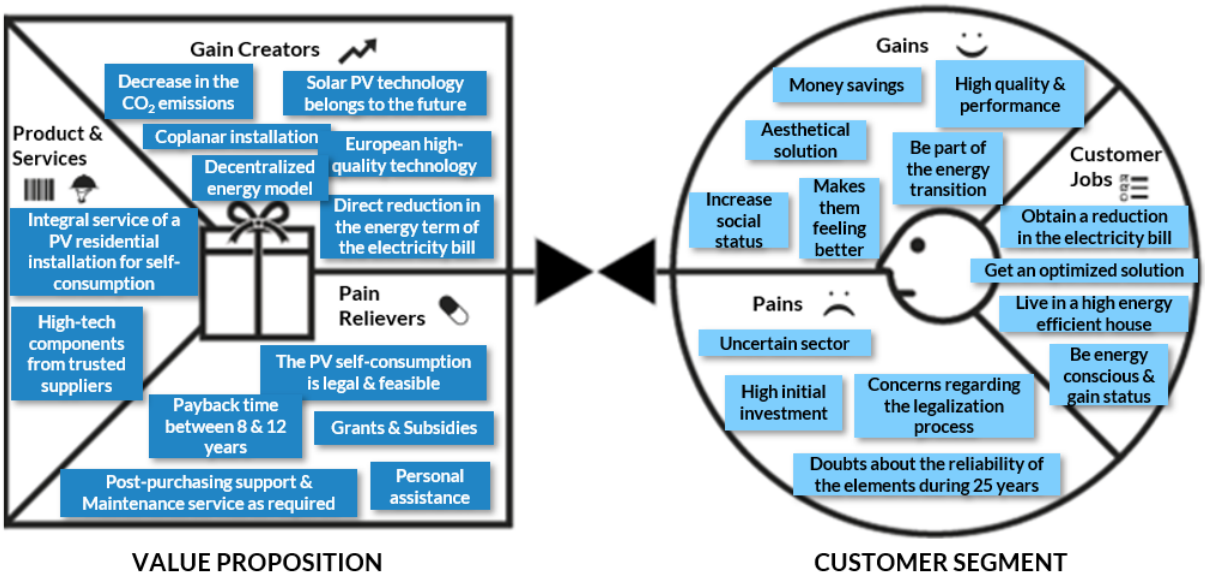


Figure 24. *Value Proposition Canvas applied to SUD in the case-study market*

Customer Segment:

- **Customer Jobs**

The different tasks (or needs) the customer needs to be completed can be divided into three. Firstly, the functional aspect of the solution: to be the most suitable one in terms of energy production but also in compromise with the aesthetical integration of the modules in the roof. Secondly, the customer would like to obtain long-term economic savings with such an installation. And finally, the social point of the service: he desires to live (and say it to its closers) that he lives in a modern, high-efficient house, which allows him to gain social status.

- **Pains**

The customer experience risks, fears and different undesired situations when acquiring a product or service. In our case, they are mainly caused by the novelty factor of the PV sector: uncertain and volatile regulation, concerns regarding the reliability of the modules and batteries during their entire lifetime, doubts about the legalisation phase of the project, etc. In addition, the monetary issue is another source of potential negative emotions, since still the initial investment is quite high (between 15.000 and 20.000€ if the battery is included).

- **Gains**

The benefits that SUD customer expects are quite different, but all of them classified in two main pillars: functional and emotional values. With our service, the customer will be benefited by an aesthetical solution with the best quality and performance that produces green energy, allowing to get monthly economic savings. In addition, he is taken direct action to mitigate climate change and favours the transition to a new energy model in the country. All of these aspects will help him to feel much better and be proud of his installation.

Value Proposition:

- **Products and Services**

On the left side of the Value Proposition Canvas, there are listed the set of products and services that help the customer to get their jobs done. In our case, it is mainly the integral service of a PV domestic installation: engineering, legalisation, installation and maintenance. Furthermore, the different high-tech elements from reliable partners and suppliers that constitute the solution are helping to satisfy the customer needs.

- **Pain Relievers**

Our solution alleviates the customer pains in different ways. The uncertainty that surrounds this sector should be dismissed with the divulgation of the real rules: the PV self-consumption is completely legal, and it is getting more common every year. Moreover, the concerns about the important initial investment are mitigated with the grants and subsidies that are given by many city councils and with the payback time calculation. As this kind of installation is not affected by the 'sun tax', the payback time is lower than 15 years, depending on the electrical consumption and the quality of the elements purchased. Concerning the doubts of the component's reliability, the customer will be benefited from a trusty personal, on-site assistance and a continuous maintenance of the installation for 25 years, if he desires so.

- **Gain Creators**

The service that is delivered to the customer create gains with the following aspects. The usage of the newest technology ensures a high performance. Most of the installations are going to be coplanar (same orientation and inclination as the roof), which allows to have an aesthetical solution. Moreover, the system involves a direct savings in the energy term of the electricity bill, a decrease in the CO_2 emissions, and a reduction between the production and consumption points (favouring the transition to a decentralized energy model). All these aspects, together with the fact that it is a brand-new sector with great expectations for the future makes the customer feeling much better with his investment.

Figure 25 shows one of the examples that represent the kind of installation, around which the current work is built. In addition, the customer coincides with the target market that is proposed in the presented business model. The installation is composed of 18 modules REC of 275Wp each (4,95kWp of total power installed), inverter Fronius (5kWn) and battery Sonnen (10kWh). Such installation allows a nearly complete self-consumption: as it can be observed in the down-right blue graph, it was 96,2% of grid independence during a specific week.

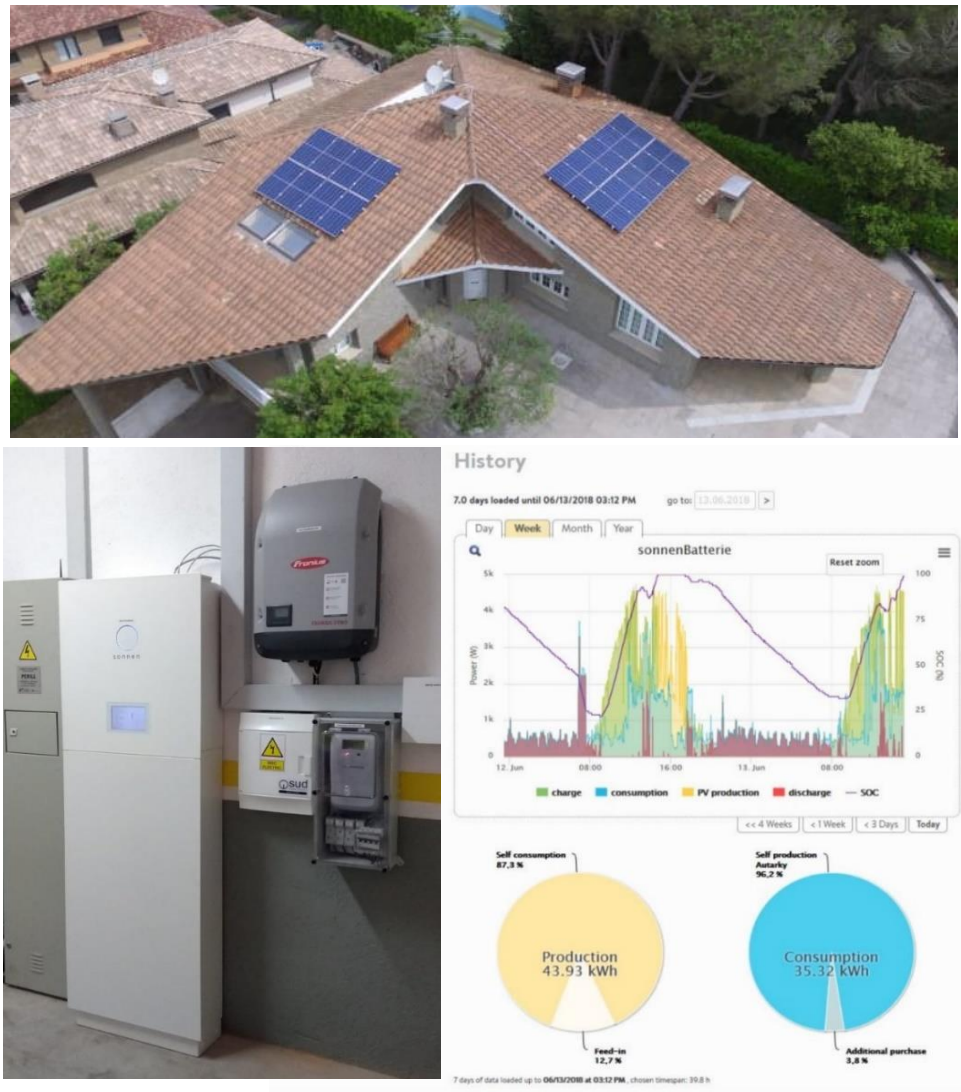


Figure 25. *Example of one of the residential PV installations developed by SUD. Source: SUD Renovables Twitter account*

3.3.2 Unique selling proposition

There exist two main aspects that can be used to succeed in any market:

- Price: being cheaper than the rest of the offer in the market by reducing costs.
- Differentiation: searching for added values that can be offered to the customers so that the company becomes the preferred option.

As it has been seen along the dissertation, SUD should focus in the second point to make the most of this market, and for that reason it is important to develop a unique selling proposition strategy (USP). The USP is a differentiation strategy that provides the tools to compete in the market in a unique way. To achieve that, the solution that is offered needs to provide an exclusive value that effectively covers the demand of the customer.

To have a unique selling proposition, the company needs two main elements. Firstly, a clear definition of the value that is proposed, to whom, how, etc. This factor has been widely analysed in the previous point. Secondly, it is needed a differentiation analysis against the competition, in the sense of studying in which points our offer provides a better value than the rest and in which others the company should improve.

Hence, in the next lines, it is going to be analysed the solution that SUD should offer to the market in comparison with its main competitors, which have been grouped in two main blocks.

The first one corresponds to the specialized engineering companies (with a high or low level of experience): their core business is the PV self-consumption sector. The most important company in this group is EDFSolar. The other block is the group of retailers that are starting in this business, from which it is highlighted Holaluz as the one with the best options.

Table 4. *Analysis of the most important activities of a domestic PV installation. Strategic comparison of SUD, EDFSolar and Holaluz*

	EDF	holaluz	SUD Energies Renovables
Free preliminary study	✓	✓	✓
Design, development & bureaucracy	✓	✓	✓
Own installation company in the region	✗	✗	✓
Maintenance & after-sales support	✓	✓	✓
Energy management	✗	✓	✗

As it can be observed in *Table 4*, the main competitive advantage of SUD is having an own installer in the region (Catalonia). EDFSolar has a good network of installers but their business is also distributed to the rest of Spain. Both SUD and EDFSsolar lack the main differentiation value of Holaluz: the energy management. Due to its characteristic of energy retailer, it can offer different possibilities to the customer in order to join this business (adapted tariffs, management of energy surpluses…).

However, as it can be seen in *Figure 26*, where it is represented a basic comparison of the three companies, Holaluz lacks the experience in developing such projects. On the other hand, they have an excellent reputation specially in representing the customer in legal issues and helping him to be benefited from the city council aids.

Regarding EDFSolar, its knowledge and experience are almost excellent, and the only concern is its capacity for trust in Catalonia. They are based in Galicia and, despite having an office in Barcelona, the Catalan residential customer can consider this issue when deciding on a project developer. It is not the same as it happens with the industrial sector: a company would only look after their benefits and it will dedicate few worries to the degree of contact of the PV engineering company, and that's why the installations that EDFSolar has developed in Catalonia are all commercial-sized.

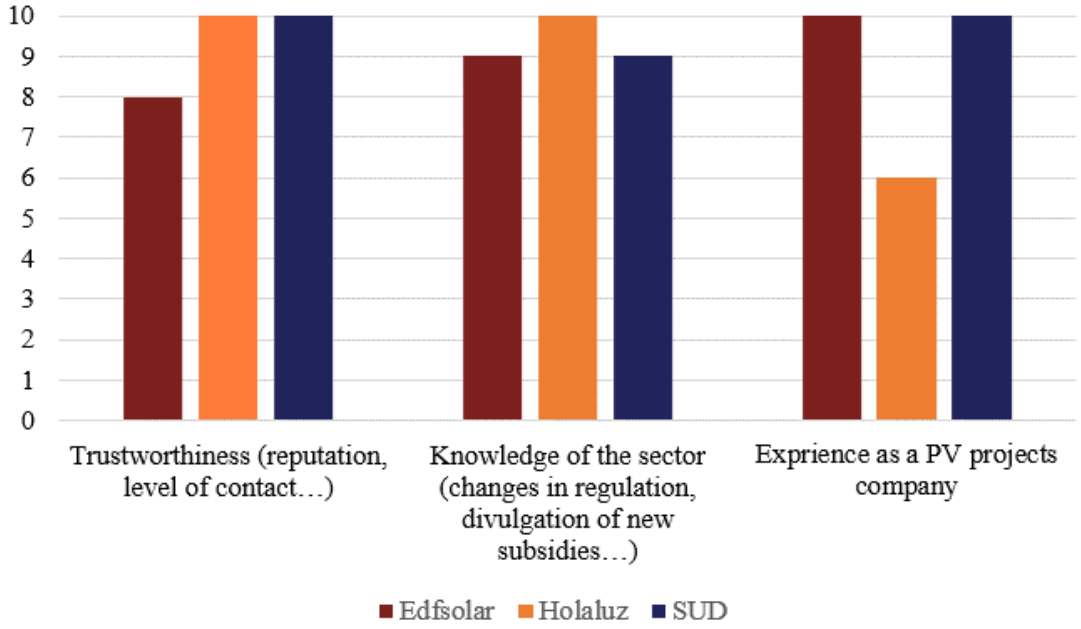


Figure 26. *Comparison of three indicators between SUD, EDFSolar and Holaluz*

To conclude this third chapter of the work, some of the main findings can be pointed out.

- There exists an appealing window of opportunity nowadays to undertake such business model.
- SUD should target a customer which doesn't have the economic savings as a priority and rely more on the high experience and trustworthiness of the company.
- In that sense, the company should increase its margins in order to be viable in that market and to differentiate itself from the retailer companies, which are starting to enter into this business. They are fixing low prices since they have the capacity to offer special electricity tariffs to their

customer, to which SUD cannot compete since it's not a retailer. Instead, SUD may partner with such companies (especially Holaluz) for developing complex or big projects that they are not able to carry out.

- Regarding the USP strategy, the two main values that SUD should potentiate are (i) the own installation company and (ii) its high reputation in the Catalan market. As it was mentioned in Chapter 2, SUD is the representative of UNEF in Catalonia and it has a reference role within the sector.

Moreover, such business model introduces new elements to work out well for the approach to this market. The two most important of them - the unification of the activities in a single location and the introduction of a new department - are going to be detailed in the next chapter, within the implementation strategy of the business model.

4 BUSINESS MODEL: IMPLEMENTATION

The implementation strategy of the presented business model will be focused on three main pillars: the operational plan, the communication strategy and the risk management.

4.1 Organizational chart and operations plan

In order to maximise the generated value, it is important to have efficient input-transformation-output processes. That is what operations management is about. And, in the case of SUD, there still a way to improve such aspect. A solar PV project is made up of five main phases: (i) on-site visit, design of the system and development of the executive project, (ii) administrative procedures to obtain the permits and legalise the installation, (iii) order and reception of the components from the suppliers, (iv) installation and (v) maintenance.

As it has been mentioned in the SWOT analysis section, one of the weaknesses of the current company business model is that the key activities are physically split. At SUD headquarters it is completely carried out the steps 1 and 2; as well as the step 3 and 5 together with Instalsud (installation company), who also performs the stage 4. Concerning the step 3, SUD is considering several suppliers for the PV modules, inverters and batteries. However, regarding the PV structures supplier, all the projects have a common denominator: CSolar.

Therefore, as this is a key supplier, should be considered in the company organigram, since also its main business is related to SUD. *Figure 27* shows (above) the current company organization chart, in which is included CSolar due to its vital relevance, and (below) the organigram that is recommended in order to increase the efficiency of the process:

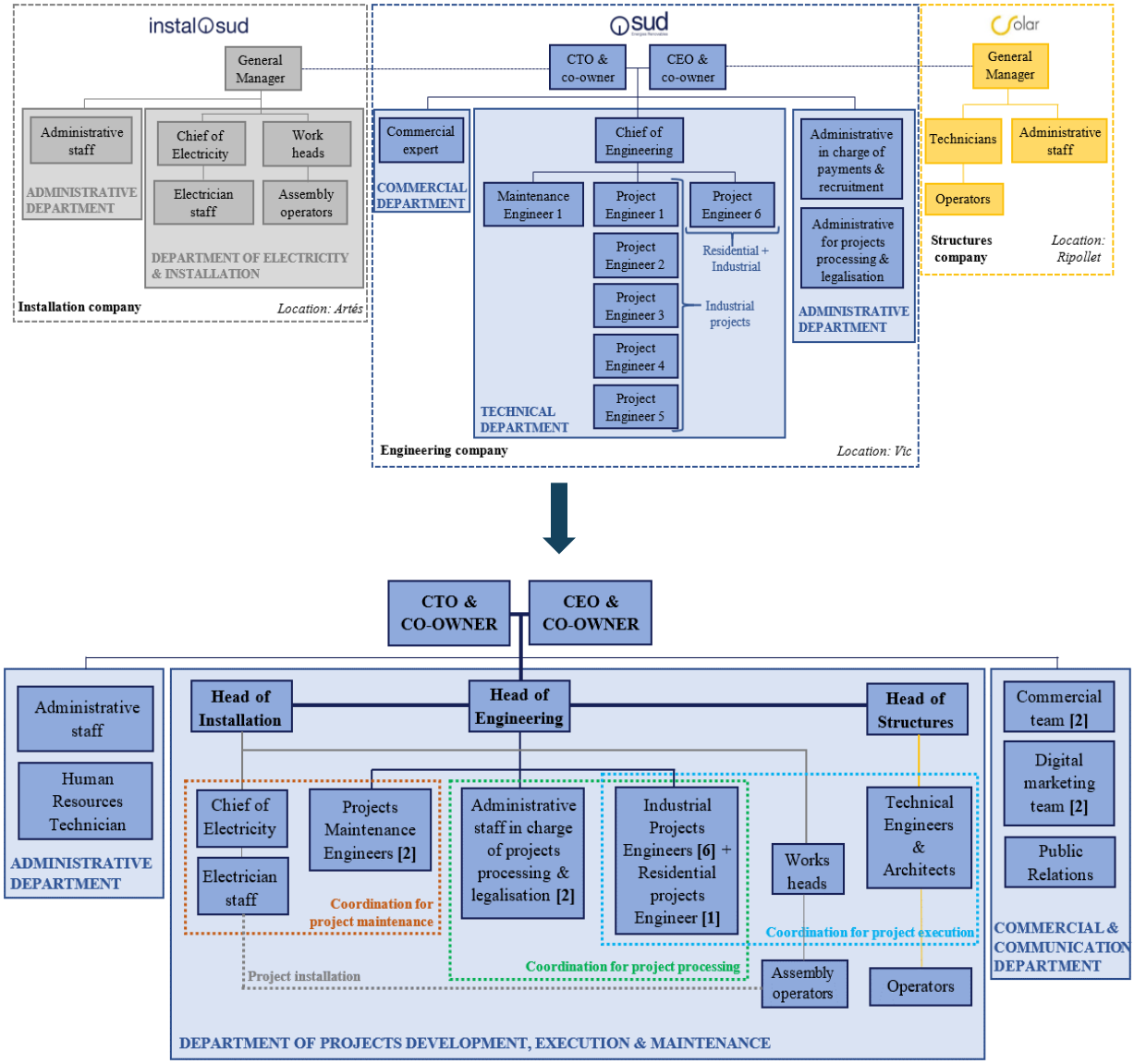


Figure 27. *Suggested variations in the SUD organigram due to the new business model*

The modifications introduced are based on the following strategy: the unification of the activities in a single place. The fact that all the activities are concentrated in the same industrial unit enables a much better cooperation among them. This improvement is especially significant in the final steps of a project development, execution and maintenance, since it is fundamental to maintain a good communication to keep solving the problems that appear as well as to have a suitable planning for the upcoming works. This fact is not only important for the current core business -industrial market- but also for the new residential market, where almost every roof has different characteristics and the cooperation between the structure's supplier, the engineer that has developed the project and the work head becomes critical.

The other suggestions for improvement of the organizational chart (which are also shown in the previous figure) are presented straightaway:

- Strengthen the bonds among the three activities -engineering, installation and structures supplier- with a weekly meeting between the heads of those sections and (when possible) the CTO. Until now, for example, the head of engineering has assumed responsibilities of project design and development. With this proposition, the head of engineering has only to carry out coordination and management jobs: to have a general vision of the projects that are being developed, when are thought to be finished, when is needed to receive the components, when it is the moment to inform the head of installation, etc. And with such a perspective, the coordination with the other two activities will improve significantly, reducing the margin of errors in the work.

- The entrance in the residential market requires hiring three people in the department of projects development and maintenance. A maintenance engineer and an administrative technician, since a residential project require more or less the same amount of work than a big-commercial plant for maintenance (hours of displacement, coordination the equipment repair, etc) and for processing (unfortunately, the bureaucracy is not equivalent with the power installed). In addition, a project engineer is recommended to support and carry out both industrial and domestic projects depending on the peaks of work. In this way, there is one engineer that is exclusively dedicated on residential installations and does not combine both markets (as it didn't happen until now).

- The commercial department is extended and changes its name to commercial & marketing department, since new people are hired in the stage of obtaining new projects and making awareness of us. Until now, only one person was exclusively dedicated to getting an accepted offer (without considering the two co-owners, also working on this). With this new structure, two people should work on that. In addition, as the world has evolved, an important digital strategy has become crucial to interact with the potential customers. And in this sense, three other job positions are created: (i) a SEO, SEM & Website Analytics expertise, (ii) a social media strategist and (iii) a Public Relations. In the next point, it is going to be deeply analysed the proper digital marketing strategy that SUD should carry out.

- The administrative staff -except the one in charge of projects processing- is joined in a unique administrative department, that would incorporate another figure: the human resource specialist, in charge of the hiring process for the entire company.

Obviously, if the organization changes, its operational strategy so does. This chapter does not intend to give any sales forecast or monetary milestones, but to analyse the existing processes and suggest points for improvement. And one of the key aspects is the operational plan, which is going to be analysed from two points of view: (i) how to measure the progress and (ii) how should be the internal communication between the different parts when a project is developed.

To successfully track a project progress, it is important to define the Key Performance Indicators (KPIs) that would make it more efficient. In a residential solar PV project, there are several steps that don't depend on SUD, but on other institutions. For example, the quickness that the city council takes to give

the construction permit or the problems that the energy retailer may put for the connection point. However, on the other stages that the company is involved, it can be suggested the most important KPIs to ensure the maximum process efficiency:

1. **On-site technical visit**. The first step is crucial since it will directly affect the next weeks of working on the project. In the visit, the engineer must ensure the technical feasibility of the project. That is, to prove that the modules will have enough space in the roof, to measure the elements that may overshadow the modules (chimneys, other buildings…), to determine the type of structure that is going to be mounted, and to define the zones of the house to carry out the electrical installation: (where is going to be installed the inverter, the fuses box, etc). It is basic to ensure these aspects since the drawings and the executive project would depend on that, as well as the third KPI.

2. **Communication with the client: get a mediator role**. When managing several projects in parallel, each one is at a different stage of development. It is important to be on the middle of all the actors (client, the power distribution company, the suppliers, the installers, etc) and manage the situation so that nobody gets nervous or angry. Sometimes, a project may surpass another one that has come before only because a client has an urgency. Hence, when for example the project is stuck in getting the construction permit or the connection point, the engineer has to properly manage the situation: as the problem is not on SUD's roof, the client should know it so that he doesn't make the company hurry.

3. **Easier the things for installer & head of engineering.** The final indicator to optimize the whole process is involved with the last stages of project development and execution. The experience has proved that most of the mistakes occur when the installer is on-site mounting the system. There, the structure may not be compatible with the type of roof, there might be not enough space for the electrical elements or not Wi-Fi connection to monitor the plant, etc. Thus, the engineer must prevent these problems to avoid buying new materials to finish the installation or to spend more hours than the required there (or even to come another day). For that it is fundamental the first KPI and, if something it is still not clear, the second KPI, in order to reduce at the minimum, the number of visits to the site. Ideally, SUD should only go twice to the house -the first technical visit and the day of installation-.

Apart from defining the most important KPIs, some other techniques may be applied to measure the progress of a project. The most important internal communication path may be the one that relates the project engineer with the head of engineering, who is in charge of the order of the material and undertaking the meetings with the structure's supplier and the head of installers team.

And for easier his job, SUD may use a digital tool of collective access -such as spreadsheets in a Google Drive- to keep tracking the process of a project (see *Figure 28*). In that way, the head of engineering observe, anytime he wants, the specific stage of development that every project is located.

	Customer	Engineer	Visit	Drawings	Executive Project	Construction permit	Connection point	Order of the material	Receipt of the material	Estimation week of installation	Installation	Final legalisation
PV Project 1	Customer 1	Engineer 1								1st week of June		
PV Project 2	Customer 2	Engineer 2								3rd week of July		
PV Project 3	Customer 3	Engineer 3								1st week of August		
PV Project 4	Customer 4	Engineer 4										
PV Project 5	Customer 5	Engineer 5										

Figure 28. *Example of a possible process tracking in a spreadsheet*

Marking in green the steps successfully completed and, in orange, the ones in progress, the head of engineering can decide in a better way when he has to order the material and to define an approximate time of installation. In this way, the specific engineer is also alert of his project evolution, while he is starting to develop another one.

The information presented in the table must be available for everyone in the company, including the administrative staff (in charge of receiving the permits for the construction and for the connection to the grid) and the CTO, who should have a general vision of the all the projects that are being undertaken. When a project ends its legalisation, it should be removed from the spreadsheet and when a new order is confirmed, a new row should be created.

In the end, now that the company is growing and the number of new projects is evolving exponentially, the key is to reduce the physical communications between the engineers and the head of engineering and also the CTO, except when important technical doubts appear.

Considering the new organizational chart and the other aspects that have been presented, the internal communication loop and activities evolution of a solar PV project in SUD should look like *Figure 29*:

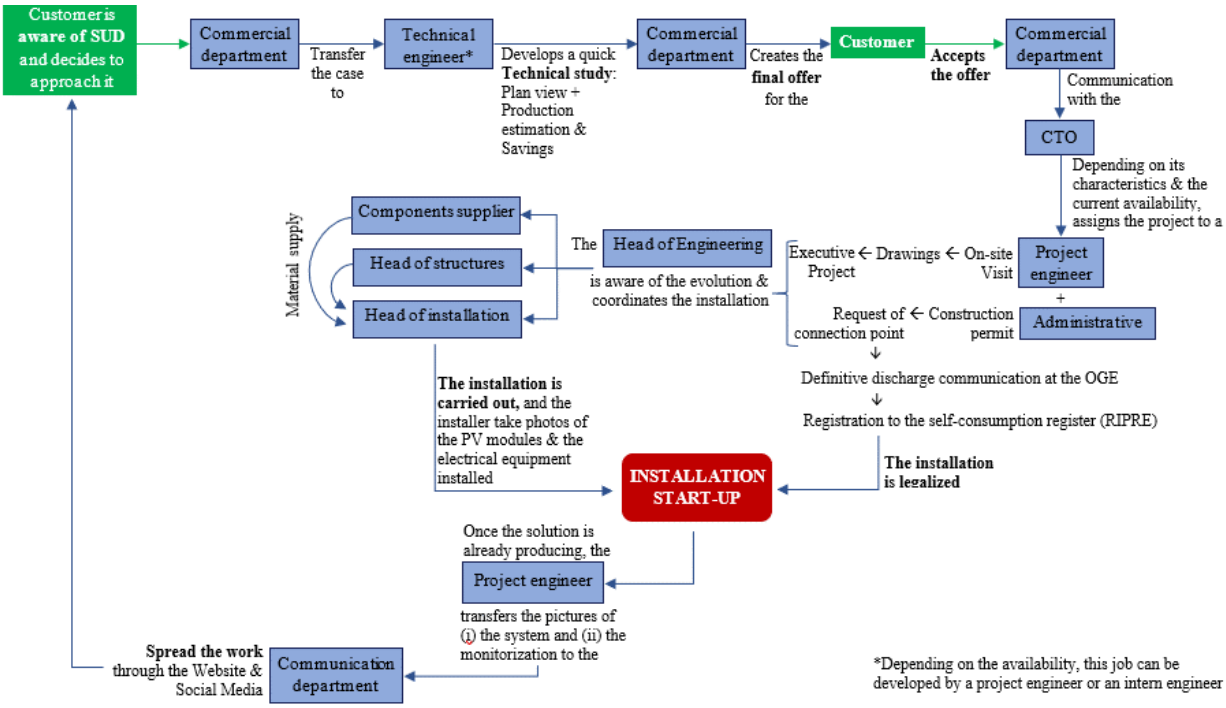
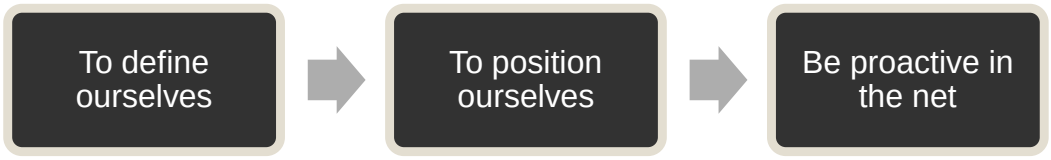


Figure 29. *Steps of a PV project execution with the new suggestions introduced*

Nowadays, the Internet allows every one of us to create an own personal brand with the specific characteristics that are desired to be potentiated. Thus, it helps to give visibility to our talent, which, in the case of SUD, it includes the activities, meetings, opinions, etc.

Create a personal brand consists of “identifying and communicating the characteristics that make us stand out, be relevant, different and visible in a homogeneous, competitive and changing environment" [61]. In order to undertake that, the company needs first to have a clear definition and position of its message.



Despite SUD is among the top companies in the region, many other companies appear before it in the website when searching for the keywords that are part of this business. As an example, when searching “empresa energía solar catalunya”, “empresa autoconsumo fotovoltaico” and so on, SUD doesn’t even appear in the first pages of Google, while its competitors (EDFSolar, SoliClima, Factor Energía, Engel Solar, Innover, TFM, Revosolar...) are on the first or second page. Hence, considering that SUD is among the top-3 companies in this market, the company needs to improve its web positioning.

Therefore, the current website needs to be optimized in order that Google considers us at a higher level. Not having any person inside a company that is specialized in such job clearly makes to lose reputation, since nowadays when a customer hears about our company, the first thing that he does is searching it at the Internet.

Furthermore, the divulgation of the job on the different channels -social media and website- is also needed to be potentiated. Especially in this case of the residential market. Until now, usually, when an industrial installation was completed, two or three pictures of it were posted on the main social media channels. However, the engagement was not so remarkable since most of the people see this kind of installation far from their interest.

Therefore, the job divulgation on social media becomes an important part of a residential PV project development, since it helps to spread awareness of what the company is doing. The public would look upon this kind of installations with a different perspective since they are closer to think that such an installation (and such energy and economic savings) could be done on their own house.

In addition, in such an unknown market for the general public, the social media would serve to divulge the truths and myths of the PV self-consumption, which would help to spread awareness of the technical and economic viability of these installations. In this way, by publishing on Twitter, Facebook and LinkedIn short videos and writing articles in the blog explaining the advantages and demystifying some topics would benefit the business. The channels to focus on are suggested considering the characteristics of the target market. In this way, channels such as Instagram or Pinterest -more addressed to the younger public- are discarded.

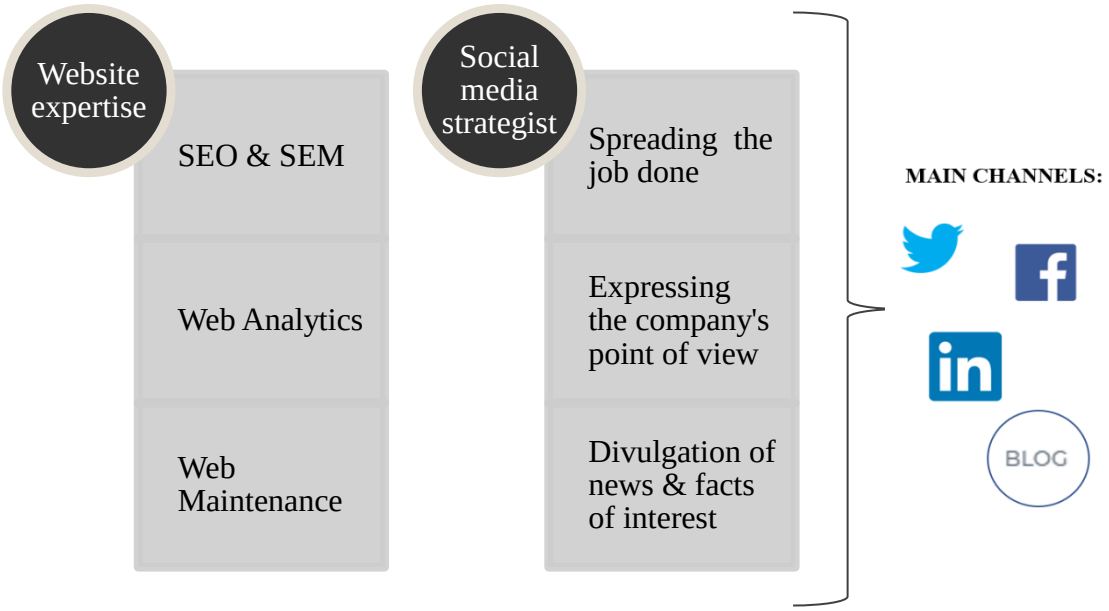


Figure 30. *Summary of the jobs to be done and channels to focus to create an online personal brand for SUD*

- **PR activities**

The other strategy to complement the current company operations is the creation of a new actor: the Public Relations. As of today, it is the CTO who is mainly in charge of managing the press releases when necessary and also publishing some articles about the situation of the PV self-consumption.

Therefore, the CTO has been dedicating part of their time into the communication strategy (website, social media, press releases, etc). Considering the exponential increase in the number of installations, the notoriety of the company..., it's becoming essential to have an expert team developing such jobs.

In the specific case of the PR, this figure should help in increasing the company's prestige and achieving new objectives. In order to do that, the PR should be in charge of the following functions:

- Developing press releases regarding the company's important activities.
- Managing the company's events, conferences and congresses.
- Assisting to other events related to the company's field of interest.
- Establishing and maintaining contacts with journalists, creating a channel between the company and the media (regional and national).
- Creating new relationships with public figures, mainly politicians.

Obviously, these jobs can also be undertaken with the collaboration of the two company co-owners, but the main intention is to free them from all kind of work that should be considered "extra" to what their main functions should be. In the case of the CEO, that is to define the strategic decisions, setting new collaboration agreements, modelling the company values, have the last decision of how the money is spent, etc. What concerns to the CTO, he should be more focused on everything that concerns to the technical team (development of new projects, analyse the current processes and try to optimize them, bringing the best technical options for the company to the CEO, etc).

4.3 Risk management

As this business model involves many different aspects -market, technology, regulations, etc.- it is important to assess the risks and prepare a mitigation plan. The results of the risk management plan are summarized in *Table 5*:

Table 5. *Risk management table. VL: Very low, L: Low, M: Medium, H: High, VH: Very high*

Risks and consequences	Probability	Impact	Mitigation response
Chinese batteries prices follow what has happened with PV modules, and make it possible to develop a PV self-consumption installation with accumulation at low prices.	M	H	Define a proper strategy analysing the market and choosing the batteries (either Chinese or not) with the best performance, ensuring a high-quality service.
The retailer companies keep gaining experience of PV self-consumption installations by lowering prices.	H	L	Marketing campaigns, activities, events…, that help to expand the notoriety of the company in such market, which allow SUD to be positioned in a much higher rank, offering a premium solution and without playing with little margins.
The small, local installers are increasing its market share since they are trusted by the clients	L	L	
Regulation uncertainty. For example, a new law that worsens the situation of the PV self-consumption sector in Spain. The business is less appealing for the customers, so sales are reduced	L	VH	Diversification. In case the bad regulations strike again, the company can look up other markets, such as the South-American (as it did years ago), or the European (partnering with top companies that can trust SUD).
SUD does not adapt to the new changes in location, logistics and operations	VL	VH	Carry out constant meetings and team building activities to gather together the employees from many different backgrounds and responsibilities.

In any case, one of the alternatives to the presented mitigation response is to keep focusing on the current core business: the industrial market. In such activity, SUD has a wide knowledge and experience and would be more resistant to potential risks. Furthermore, there are other investment opportunities that the company may consider, apart from the industrial and residential market. They can be a good

opportunity to diversify resources and profits, and so that they would help the company to keep growing. Such other business opportunities are presented in the next chapter of the work.

5 OTHER BUSINESS OPPORTUNITIES

As of 2018, SUD has been working on four main activities since it was created back in 2006. More than 90% of the benefits have been obtained by developing solar PV industrial installations, both for selling energy to the grid and for self-consumption. The rest of the work is split in residential PV installations, other projects based on renewable sources (biomass, solar thermal and wind), and around 6.000 small installations in Peru, that helped to electrify some of the poorest regions of the country.

All of this has made that nowadays SUD is able to work in most of the projects that involve the solar PV technology, especially in its area of predominance: Catalonia. In this point are going to be described two of the possible windows of opportunities that the company may consider in the coming years: the utility-scale and the shared-self consumption markets. Both are expected to keep gaining importance if the objectives of renewable production fixed by the European Union (and for Spain and Catalonia as well) has to be accomplished.

5.1 Utility-scale market

SUD has looked with a certain distance the utility-scale PV projects that have been developed in Spain during the last decade. Especially because they were constructed in the Spanish regions with a higher irradiation than the one in Catalonia (Andalucía, Extremadura, Castilla La Mancha, Murcia…).

In fact, in Spain, we can find nowadays nearly 30 solar PV parks of more than 10 MW, no one of these in Catalonia. Furthermore, the auction in 2017 awarded 3.909 MW to solar PV projects (and 1.128 to wind power), that are going to be developed in the coming years [6], and that would nearly double the current utility-scale PV capacity in the country.

However, mainly important companies are going to be in charge of the development of such projects, that are expected to be from big sizes and in the southern regions of Spain. The one that would stand out above the rest is the solar PV park that is going to be developed in Mula (Murcia), with a capacity of 494 MW, representing the biggest installation in Europe [62].

This fact leaves some opportunities in this sector for SUD since its main area of work (Catalonia) is still away from such PV projects. Despite the irradiation levels are not among the best in the country, Catalonia count with a regional Government that is pushing for this technology and with some regions (around Lleida) that present closer irradiation levels to the southern regions in Spain.

Hence, SUD may look for strategic partnerships and for different possibilities of funding to go ahead with such projects.

5.1.1 Strategic partnership

If SUD decides to carry out ground-mounted PV projects, it would probably rely on the consolidated partners. For example, with REC module manufacturers, that offers a PV panel with 345 Wp and 17,2% efficiency. This would be the easiest solution to carry out such installation since it is reliable and relatively cheap.

However, this would also mean to keep relying on what is working right now, mono or multi-crystalline silicon technology (in this case, multi), without having a future perspective. In this sense, in the next lines are going to describe a new PV technology, that is though for the future and is available nowadays: Heterojunction (HJT) cell technology. And the company that is pushing more for this technology worldwide is a Swiss company called Meyer Burger, to which SUD may create strategic bonds.

Meyer Burger is the company that manufactures the machines to produce high-efficient PV modules, combining two powerful technologies: Heterojunction (HJT) and Smart Wire Connection (SWCT).

Heterojunction solar cells combine the advantages of crystalline silicon with the great absorption and passivation properties of amorphous silicon. However, HJT can only use nowadays monocrystalline n-type silicon. On the other hand, using SWCT to connect the cells (instead of the conventional busbar technology) greatly reduces the conduction losses and the production costs [63].

“Compared to standard c-Si technology, heterojunction cells generate 35% more kWh/m^2 and therefore reach the lowest levelized cost of electricity (LCOE)” [64]. In fact, recent experiments carried out by the company show an average efficiency of 23,7% (reaching a maximum of 24,02%). The monofacial module has a capacity of 335 W, while the bifacial reaches figure up to 400 W [65]. Furthermore, the modules lifetime is about 40 years and the yearly degradation is just 0,1%, in comparison with 0,35% of standard technologies [66].

This fact allows to clearly reduce the CAPEX, which allows a greater IRR and accumulated NPV for the investor. Considering a cost of 0,39 €/Wp [67], it has been undertaken a financial profitability study using Meyer Burger’s bifacial heterojunction PV module. The results for an installation of 10MW -in comparison with the REC345- are extensively presented in *Appendix 1*.

These numbers are done considering today's prices and without taking into account the most probable descend in prices that will occur at the end of 2018 and the beginnings of 2019. Hence, the results would probably be even better if such an installation is finally carried out.

As it is a very recent technology, the main problem for Meyer Burger is that need some installations that work properly with HJT, to generate trust for future clients. Therefore, SUD should be one of the European pioneer companies that dare to go ahead with this technology, as it has done Enel Green Power [68] or EcoSolifer [69] before. These two companies are PV producers (not like SUD); thus, the partnership between Meyer Burger (PV machinery manufacturer) and SUD (engineering and installation company), would require an intermediate actor that manufacture and deliver the mentioned high-efficient bifacial modules.

5.1.2 Financing methods

To carry out such big PV projects, SUD would require external investment, since it is not able to afford investments of million euros. In fact, depending on the characteristics of the PV module used, the global installation cost would be around 0,7-0,8€/Wp. Hence, the project cost may range from 2,1-2,4M€ (3MW) to 14-16M€ (20 MW). Most likely is that the company will decide to go for smaller projects (from 3 to 10 MW), rather than more than 10 MW; but it would mostly depend on the capacity of the investor.

To get this money, SUD has two possible alternatives: (i) the appearance of a powerful investor that is able to afford this kind of investments, or (ii) a collective citizen participation:

- Attract important investors:

Due to the great reductions in project costs and the high levels of irradiation of Spain, many foreign investors are attracted to this sector. They got significant IRR and low payback periods. Furthermore, the Government has now decided to eliminate the electric generation tax of 7% [70], which meant that if a producer sold its energy at 50€/MWh to the market, he received 46,5€/MWh. Hereinafter, he would receive the entire 50€/MWh, which still increases the profitability of such projects.

As it has been said, in *Appendix 1* it is shown the financial profitability of a utility-scale project example, which results in IRRs higher than 11% and payback returns lower than 10 years.

- Collective participation

The Catalan Government approved last year the SOLARCAT strategy, in order to favour the development of PPAs (Power Purchase Agreements) in the renewable sector [71]. The Government pretends to buy the entire renewable energy that is generated in a Catalan PV park, from a private promotion of collective participation.

This is also a great opportunity for SUD to develop such utility-scale projects and to increase its social power among the Catalan citizens, since everyone would be able to contribute with smaller or bigger proportions to get the project off the ground. Despite everyone that contributes would get profitability, most of them would mainly decide to help for environmental and social purposes.

5.2 Shared self-consumption

In section 2.1.4. it has been presented this topic as the Horizon 3 for SUD: it can be said that the market doesn't exist nowadays (or practically) but it shows great expectations for the future. This market found an opportunity when the Spanish Constitutional Court declared legal the possibility to share the energy between different points of electricity supply [72].

This fact occurred in June 2017 and until now, only one PV installation has been developed and legalised in Spain with these characteristics. It consisted of a 2,52 kWp system done by SUD (engineering and installation) together with Holaluz (legalisation). Therefore, SUD has been a pioneer in such a new market, so that other institutions are trusting the company to act as a consultant to develop shared self-consumption installations.

This is the case of the Barcelona City Council, which is constructing many social housings, each one with a PV installation on the roof. The intention is to provide electricity to all the families that live in these blocks (between 45 and 50 families) and to the common services (parking, lift, etc). Hence, SUD is nowadays among the top Spanish companies in such a promising market, so that it may consider the possibility to do business within it, apart from the normal process of project engineering and installation.

The business opportunity that is presented consist of an improvement of the shared-self consumption installation that is being thought for the moment. Nowadays, this kind of installations works as follows:

If 50 families are sharing the PV installation that is on the roof of their community block, each one can get access, each hour, to the 2% of the energy that is produced. For example, if during an hour, 25 kWh are generated, each house can get 0,5 kWh. However, if there is a family that is not at home and doesn't consume anything at that hour, these 0,5kWh are directly injected to the grid and the distribution company can sell it to another one. Hence, this surplus of energy cannot go to any neighbour that need it, which would be the more logical thing. Therefore, what is done is to only share the installation between families but not sharing the energy.

Figure 31 illustrates such description: each load has his own energy meter from the distribution company, and each family is seen as a separate installation from the other. The red elements represent a device that read the consumption of each house (and common loads) and integrates the data into a general server, to then perform the statistical analysis of PV consumption vs grid consumption. These devices are not mandatory but very useful.

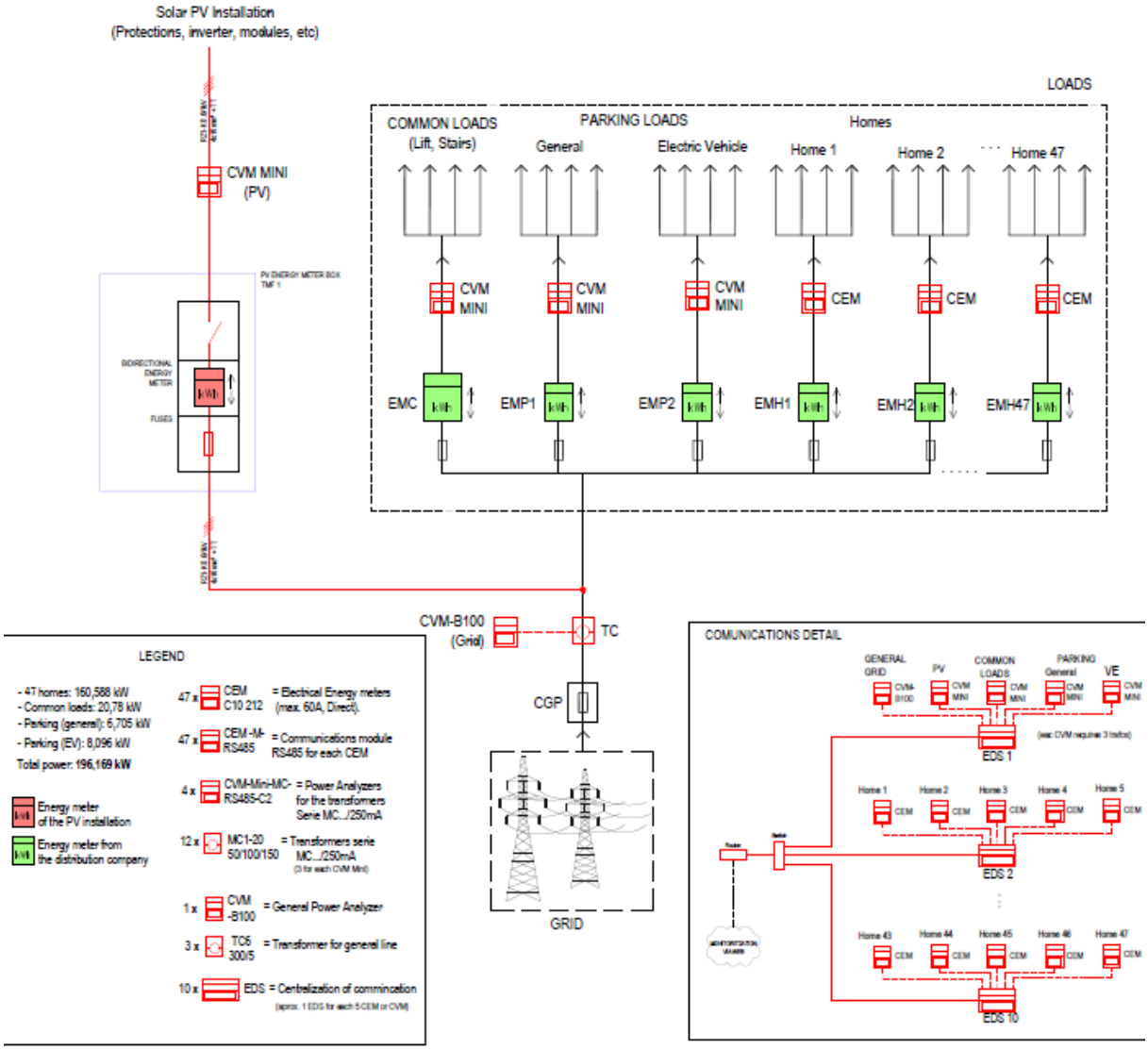


Figure 31. *Example of a self-consumption installation that is being developed nowadays*

However, instead of looking at each installation separately, what it could be done is to use only one general energy meter, that cover all the loads of the community block. In this case of example, having a contracted power of 200 kW would be enough, so that it is (practically) avoided the surpluses of energy.

In this case, if the installation produces 25 kWh during a specific hour, none of the energy would go away from the system, being shared with the loads that require it. The key issue here is to have an integrated smart software that is storing all the data of consumption of each load. In this sense, despite only some families can benefit from the PV energy produced (the ones that are at home during the day), this system would be computing all the time how many kWh would go to each home, and it would apply the proportional discounts in the electricity grid to everyone. Thus, in this way, the people that are outside during the day is not adversely affected by this system, since they would have paid for it so that they should be also benefit in an equal manner as the rest of the neighbours. In *Figure 32*, it is shown this

example improved, where the individual smart meters are eliminated and substituted by an IT smart system (represented in pink).

With the implementation of such system, SUD can generate profits from developing and selling the IT software, thanks to its knowledge and experience.

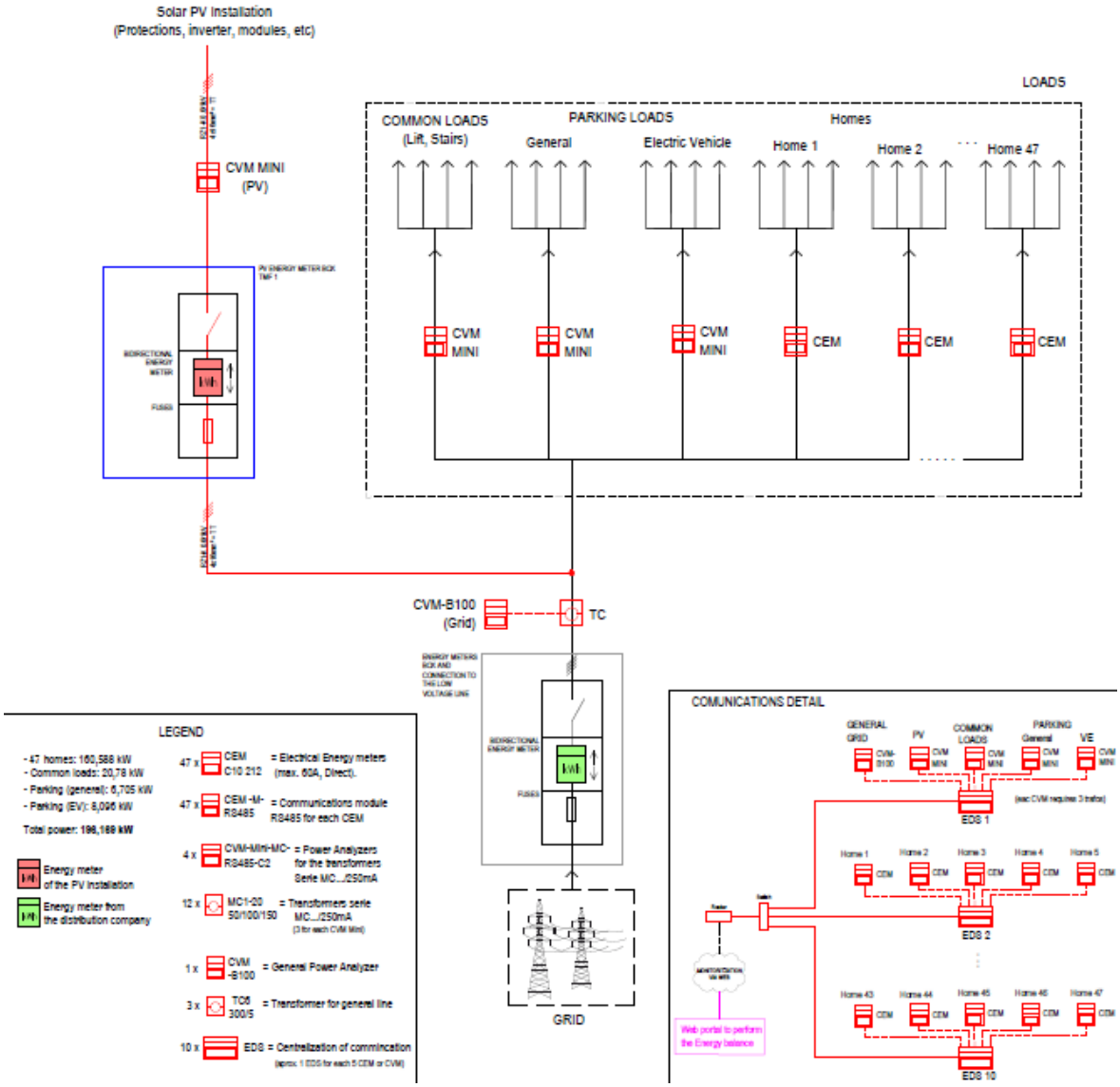


Figure 32. *Example of an improved self-consumption installation*

6 CONCLUSIONS

This work intended to describe how the company SUD Energies Renovables should incorporate the residential PV market to its core business in order to follow its growth path. Therefore, the purpose was defining the strategy that would allow the company to create, capture and sustain value for itself and for the customers within this market.

To complete such research topic, it has been firstly contextualized the case study -company, market and technology- to then analyse and describe the suitable business model.

From the company perspective, it has been analysed its evolution since it was founded in 2006, passing through many different periods due to the volatility of the Spanish regulation. However, thanks to a great capacity of resistance and a diversification strategy, SUD has evolved in such a way that nowadays is one of the most experienced companies in Spain of its sector: industrial solar PV installations for self-consumption.

This represents its core business, Horizon 1; but the company must also enhance and support strategies to face its Horizon 2 (residential market) and Horizon 3 (shared-self consumption market), in order to sustain the current growth period until reaching the maturity stage.

A second relevant factor to put in a frame the study case was the analysis of the PV situation if a four-level perspective: world, Europe, Spain and Catalonia. It has been observed how Spain (and Catalonia as well), lags the European average in percentage of electricity production from solar PV, despite being one of the countries with higher levels of solar irradiation. This is mainly explained by the uncertainty the Spanish regulation, which has put investors away from such market during several years.

However, the prospects have improved and by next year it is expected that the harmful laws are going to be abolished, so that it would be aligned, for the first time ever, the regulation issue together with the technology maturity. In fact, for the last semester of 2018, and beginnings of 2019, it is predicted a new important drop in the PV modules prices due to the elimination -by the European Commission- of the import controls from Chinese products, which would force the European manufacturers to also adjust their prices. This down-trend evolution of the module prices will be followed, in the next years, by the

battery prices. Lithium-ion is the technology expected to lead this market, with a potential price lower than 100$/kWh before 2025.

But the technology costs do not represent the most important element of the presented business model for the residential market. It has been seen that a proper positioning together with the suitable differentiation strategy is more important to increase profits in such activity.

Due to the characteristics of the competitor's environment, SUD should position itself to the high-quality and high-price side of the market. Many retailer companies are entering into that business by lowering the price, since they have an added value: they can offer adapted electricity prices, management of surpluses…, to the new customers that contract the electricity with them together with a self-consumption installation.

Thus, SUD would not be able to compete in such a segment and should be focused on offering a high-quality installation thanks to its top experience and trustworthiness. To do that, the target customer is a Catalan male adult, from 50 to 65 years old, which do not care so much about the payback period of the installation but to the other intrinsic features of these systems (aesthetic solution, CO_2 emissions avoided, disconnection from the big retailer companies, etc).

Hence, SUD should prioritize profits rather than notoriety, as it hasn't done with the *Impuls Solar Vallès* project, in which the company is developing 100 domestic PV installations with very low margins. On the positive side, this project has worked to place the company in a reference position for the Catalan customer and to keep gaining experience in this market.

And this is precisely what the company should spread for generating trust in the future customers. Its main added values are: (i) the high level of knowledge (technology, regulation, bonifications, etc) of the market; (ii) the great experience in this sector (around 15MW installed) and (iii) the own installation company that SUD has in the region.

To this end, different variations of the current logistics and operations are proposed in order to improve the processes efficiency. In broad strokes, the company may consider joining -in a single industrial unit- the key activities of a PV project development that are currently split in different locations: engineering, structures manufacturing and installation. This modifies a little bit the current organizational chart and the current operations as well. Moreover, it has been detailed another point of improvement: the creation of the communication department, integrated by a digital marketing team -in order to improve the current web positioning- and a PR specialist.

Both measures -especially the first one- are not only though to increase the chances in the residential market but also to enhance the current work on the industrial market.

Finally, apart from the residential market business model, it has been proposed other ways to obtain profits in this PV sector in Catalonia. Firstly, the growing utility-scale market with a promising technology, Bifacial Heterojunction PV modules, which presents significant values of energy yield along its lifetime in comparison with the conventional panels, allowing important levels of IRR for the investor. In that sense, it has been seen that a collective participation of citizens can be a good way of funding such big projects.

Furthermore, SUD should keep enhancing its work in the shared-self consumption market, which has great expectations for the future. In fact, Spain is the European country where a higher percentage of people lives in a flat (66%).

To end with, the company is nowadays in a suitable position to face the residential PV market with good prospects. However, the company should not only rely on its abilities to undertake as much domestic PV projects as they can, because it may affect the current core business. Now that the environment is changing so fast, with different actors entering into the game and applying different strategies, SUD should carefully decide in which zone wants to play in order to optimize its processes and so maximise its profits

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8 APPENDICES

8.1 Appendix 1: Financial profitability for two study cases: REC vs Meyer Burger

FINANCIAL PROFITABILITY - REC CASE				**CAPEX***					**OPEX****				
				It includes the Civil works and the Grid Interconnection (assumed equal to 450.000€ for this case) and the investment of the installation itself, described as follows:					It includes precautionary maintenance, corrective maintenance, modules cleaning, grass control, security, insurance and guarantees, electricity supply and ADSL, the costs of market representation and the toll for grid access. It doesn't include the yearly rent to the owner of the land			*** It is considered a single-axis tracking installation. In Catalonia, this type of installation can reach a specific production of **2000 kWh/kWp.**	
Solar PV module	REC 345 Wp												
Park capacity	**7 MWp**												
Initial Investment*	5.574.210 €					*€/Wp*	*Cost (€)*						
Yearly Rent Price	1.500 €/ha				PV modules	0,32	2.240.000 €						
Number of hectares	15 ha				Inverters	0,06	420.000 €						
Energy price of the pool market	0,049 €/kWh	(average of last 50 months)			Structures	0,16	1.120.000 €						
Yearly Inflation (%)	2,00				Instalation	0,18	1.260.000 €						
Yearly Energy Price increase (%)	2,50				Engineering	0,008	56.000 €		According to NREL, it is estimated at:				
Yearly degradation of Production (%)	0,35				Safety and Security	0,0015	10.500 €		**13 €/kW**				
					Insurance	0,00103	7.210 €						
IRR	**11,21%**				Comunications	0,0015	10.500 €						
Payback (years)	**8,0**					**0,73203**	**5.124.210 €**						
Accumulated NPV	**13.163.895 €**												

Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Energy selling price (€/kWh)		0,0490	0,0502	0,0515	0,0528	0,0541	0,0554	0,0568	0,0582	0,0597	0,0612	0,0627	0,0643
Energy Produced (kWh)***		14.000.000	13.951.000	13.902.172	13.853.514	13.805.027	13.756.709	13.708.561	13.660.581	13.612.769	13.565.124	13.517.646	13.470.334
Total money IN (€)		686.000	700.689	715.692	731.017	746.670	762.658	778.989	795.669	812.706	830.108	847.883	866.038
Rent (€)		22500	22950	23409	23877	24355	24842	25339	25845	26362	26890	27427	27976
OPEX** (€)		91000	92820	94676	96570	98501	100471	102481	104530	106621	108753	110928	113147
Total Money OUT (€)		113.500	115.770	118.085	120.447	122.856	125.313	127.819	130.376	132.983	135.643	138.356	141.123
Cash Flow (€)	-5.574.210	572.500	584.919	597.607	610.570	623.814	637.345	651.169	665.293	679.723	694.465	709.527	724.915
Accumulated Cash Flow (€)	**-5.574.210**	**-5.001.710**	**-4.416.791**	**-3.819.184**	**-3.208.614**	**-2.584.800**	**-1.947.455**	**-1.296.285**	**-630.993**	**48.730**	**743.195**	**1.452.722**	**2.177.637**

Year	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Energy selling price (€/kWh)	0,0659	0,0675	0,0692	0,0710	0,0727	0,0746	0,0764	0,0783	0,0803	0,0823	0,0844	0,0865	0,0886
Energy Produced (kWh)***	13.423.188	13.376.207	13.329.390	13.282.737	13.236.248	13.189.921	13.143.756	13.097.753	13.051.911	13.006.229	12.960.707	12.915.345	12.870.141
Total money IN (€)	884.582	903.523	922.870	942.631	962.815	983.431	1.004.489	1.025.998	1.047.967	1.070.406	1.093.326	1.116.737	1.140.649
Rent (€)	28535	29106	29688	30282	30888	31505	32136	32778	33434	34102	34785	35480	36190
OPEX** (€)	115410	117718	120073	122474	124923	127422	129970	132570	135221	137926	140684	143498	146368
Total Money OUT (€)	143.945	146.824	149.761	152.756	155.811	158.927	162.106	165.348	168.655	172.028	175.469	178.978	182.558
Cash Flow (€)	740.637	756.699	773.109	789.875	807.004	824.504	842.383	860.649	879.312	898.378	917.858	937.759	958.092
Accumulated Cash Flow (€)	**2.918.274**	**3.674.973**	**4.448.082**	**5.237.956**	**6.044.960**	**6.869.464**	**7.711.847**	**8.572.496**	**9.451.808**	**10.350.186**	**11.268.044**	**12.205.803**	**13.163.895**

FINANCIAL PROFITABILITY - MEYER BURGER CASE														
Solar PV module	Meyer Burger 335 Wp (400 Wp bifacial)													
Park capacity	**10 MWp**													
Initial Investment*	8.470.300 €													
Yearly Rent Price	1.500 €/ha													
Number of hectares	15 ha													
Energy price of the pool market	0,049 €/kWh (average of last 50 months)													
Yearly Inflation (%)	2,00													
Yearly Energy Price increase (%)	2,50													
Yearly degradation of Production (%	0,1													
IRR	**11,95%**													
Payback (years)	**9,0**													
Accumulated NPV	**46.891.276 €**													

CAPEX*

It includes the Civil works and the Grid Interconnection (assumed equal to 450.000€ for this case) and the investment of the installation itself, described as follows:

	€/Wp	*Cost (€)*
PV modules	0,39	3.900.000 €
Inverters	0,06	600.000 €
Structures	0,16	1.600.000 €
Instalation	0,18	1.800.000 €
Engineering	0,008	80.000 €
Safety and Security	0,0015	15.000 €
Insurance	0,00103	10.300 €
Comunications	0,0015	15.000 €
	0,80203	**8.020.300 €**

OPEX**

It includes precautionary maintenance, corrective maintenance, modules cleaning, grass control, security, insurance and guarantees, electricity supply and ADSL, the costs of market representation and the toll for grid access. It doesn't include the yearly rent to the owner of the land

According to NREL, it is estimated at:

13 €/kW

*** It is considered a single-axis tracking installation. In Catalonia, this type of installation can reach a specific production of **2000 kWh/kWp.**

Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Energy selling price (€/kWh)		0,0490	0,0502	0,0515	0,0528	0,0541	0,0554	0,0568	0,0582	0,0597	0,0612	0,0627	0,0643	0,0659
Energy Produced (kWh)***		20.000.000	19.980.000	19.960.020	19.940.060	19.920.120	19.900.200	19.880.300	19.860.419	19.840.559	19.820.718	19.800.898	19.781.097	19.761.316
Total money IN (€)		980.000	1.003.496	1.027.554	1.052.190	1.077.416	1.103.247	1.129.698	1.156.782	1.184.516	1.212.915	1.241.994	1.271.771	1.302.262
Rent (€)		22500	22950	23409	23877	24355	24842	25339	25845	26362	26890	27427	27976	28535
OPEX** (€)		130000	132600	135252	137957	140716	143531	146401	149329	152316	155362	158469	161639	164871
Total Money OUT (€)		152.500	155.550	158.661	161.834	165.071	168.372	171.740	175.175	178.678	182.252	185.897	189.615	193.407
Cash Flow (€)	-8.470.300	827.500	847.946	868.893	890.356	912.345	934.875	957.958	981.608	1.005.838	1.030.663	1.056.098	1.082.157	1.108.855
Accumulated Cash Flow (€)	**-8.470.300**	**-7.642.800**	**-6.794.855**	**-5.925.961**	**-5.035.605**	**-4.123.260**	**-3.188.385**	**-2.230.428**	**-1.248.820**	**-242.982**	**787.681**	**1.843.779**	**2.925.935**	**4.034.790**

Year	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
Energy selling price (€/kWh)	0,0675	0,0692	0,0710	0,0727	0,0746	0,0764	0,0783	0,0803	0,0823	0,0844	0,0865	0,0886	0,0908	0,0931
Energy Produced (kWh)***	19.741.554	19.721.813	19.702.091	19.682.389	19.662.706	19.643.044	19.623.401	19.603.777	19.584.174	19.564.589	19.545.025	19.525.480	19.505.954	19.486.448
Total money IN (€)	1.333.484	1.365.454	1.398.191	1.431.712	1.466.038	1.501.186	1.537.177	1.574.031	1.611.768	1.650.410	1.689.979	1.730.496	1.771.984	1.814.468
Rent (€)	29106	29688	30282	30888	31505	32136	32778	33434	34102	34785	35480	36190	36914	37652
OPEX** (€)	168169	171532	174963	178462	182031	185672	189385	193173	197037	200977	204997	209097	213279	217544
Total Money OUT (€)	197.275	201.221	205.245	209.350	213.537	217.808	222.164	226.607	231.139	235.762	240.477	245.287	250.192	255.196
Cash Flow (€)	1.136.209	1.164.233	1.192.946	1.222.362	1.252.501	1.283.378	1.315.013	1.347.424	1.380.629	1.414.648	1.449.501	1.485.209	1.521.792	1.559.272
Accumulated Cash Flow (€)	**5.170.999**	**6.335.232**	**7.528.178**	**8.750.540**	**10.003.041**	**11.286.419**	**12.601.432**	**13.948.856**	**15.329.484**	**16.744.133**	**18.193.634**	**19.678.843**	**21.200.635**	**22.759.907**

Year	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Energy selling price (€/kWh)	0,0954	0,0978	0,1003	0,1028	0,1054	0,1080	0,1107	0,1135	0,1163	0,1192	0,1222	0,1252	0,1284
Energy Produced (kWh)***	19.466.962	19.447.495	19.428.047	19.408.619	19.389.211	19.369.822	19.350.452	19.331.101	19.311.770	19.292.458	19.273.166	19.253.893	19.234.639
Total money IN (€)	1.857.970	1.902.515	1.948.127	1.994.834	2.042.660	2.091.633	2.141.779	2.193.129	2.245.709	2.299.550	2.354.681	2.411.135	2.468.942
Rent (€)	38405	39173	39957	40756	41571	42402	43250	44115	44998	45897	46815	47752	48707
OPEX** (€)	221895	226333	230860	235477	240187	244990	249890	254888	259986	265185	270489	275899	281417
Total Money OUT (€)	260.300	265.506	270.816	276.233	281.757	287.392	293.140	299.003	304.983	311.083	317.304	323.651	330.124
Cash Flow (€)	1.597.669	1.637.008	1.677.311	1.718.601	1.760.902	1.804.240	1.848.639	1.894.126	1.940.726	1.988.467	2.037.377	2.087.484	2.138.818
Accumulated Cash Flow (€)	**24.357.576**	**25.994.585**	**27.671.896**	**29.390.497**	**31.151.399**	**32.955.639**	**34.804.278**	**36.698.404**	**38.639.130**	**40.627.596**	**42.664.973**	**44.752.458**	**46.891.276**