D2.6 Business Model Report

Spain

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Introduction

Regulatory support

Nowadays in Spain, it is not common to invest in PV technology, mainly due to the situation of great uncertainty that the regulatory changes have created. The moratorium on the FiT mechanism for new renewable energy installations, presented in January 2012, strongly weakened the PV sector, which was already in a delicate situation after the entry into force of different retroactive measures since 2010, such as:

- The Royal Decree 1565/2010, which modified the government support for electricity produced from existing PV plants. Existing Feed-in Tariffs (FiTs) were cut down by:
  - 5% for small-size roof installations (< 20 kW)
  - 25% for medium-size roof installation (> 20 kW)
  - 45% for ground installations
- The Royal Decree-Law 14/2010, which requires electricity generators to pay a fee of 0,50 EUR/MWh for the electricity fed into the grid, in order to reduce the electricity sector's tariff deficit.

Additionally, a net-metering regulation was expected to be published in the months following the FiT moratorium. The regulation process started in November 2011, however the final regulation was not published until the beginning of October 2015 and only regulates self-consumption. No net-metering mechanism was introduced.

This new law regulates the administrative, technical and economic arrangements for the production and supply of electricity for self-consumption. It should be noted that the Royal Decree affects all supply points connected to the electricity distribution network. Isolated facilities are therefore exempt, i.e., installations which do not have any grid connection point.

The new law establishes two types of self-consumption with different conditions:

- <u>Self-consumption 1 (just for self-consumption)</u>
  - There is only one consumer party for the installation.
  - The owner of the generation facilities must be the same as the owner of the supply point.
  - It is not necessary to register the generation facility as an electricity production facility, however, it is necessary to enlist it in the self-consumption register (*Registro Administrativo de autoconsumo*, Law 24/2013, December 26, of the Electricity Sector).
  - Contracted power can be up to a maximum of 100 kW and the generation facility's capacity cannot exceed the supply point's contracted power.
  - The consumer does not receive payment for the excess electricity injected to the grid.
  - It is mandatory to install measuring equipment to register net generation.
- <u>Self-consumption 2 (self-consuming and selling)</u>

- There might be a consumer and a producer for the same installation.
- The owner of the generation facility may differ from the owner of the supply point.
- It is necessary to register the generation facility as an electricity production facility in the electricity production facilities register (*Registro Administrativo de instalaciones de producción de energía eléctrica,* Royal Decree 413/2014, June 6).
- The generation facility's capacity shall not exceed the supply point's contracted power, but there is no limit as in self-consumption 1.
- The consumer may receive compensation for the excess electricity injected to the grid.
- It is mandatory to install bidirectional measuring equipment to register net generation and measurement equipment at the associated consumption point.

Consumers who decide to self-consume under the new Royal Decree of 2015 will have to continue paying the electricity access tariffs of consumption like any other consumer. At the same time they will have to bear the charges associated with the costs of the electrical system. For now, these charges are divided into two types (the law indicates that this might change in the future):

- Fixed charges, based on capacity
- Variable charges, based on self-consumed kWh

There are some exceptions that should be mentioned regarding the payment of both variable and fixed charges for self-consumption:

<u>Variable charges</u>

- Consumers whose contracted power is less than or equal to 10 kW are exempt from paying the variable charges for self-consumption.
- Cogeneration production facilities are exempt from any charges until December 31, 2019.
- Mallorca and Menorca have reductions in the variable charges for self-consumption and the Canary Islands, Ceuta and Melilla and Ibiza-Formentera's electrical systems have total exemptions of these payments.

<u>Fixed charges</u>

- PV systems up to 100 kW with no meter measuring the total customer's consumption (not legally required) and no battery systems are exempt of paying fixed charges.

This new regulation has been published recently so we were unable to draw conclusions from its impact even though in general terms it does not seem to be incentivising the PV market in the country. For the analysis at hand the characteristics of this new regulation have been taken into account.

It should be noted that, even though self-consumption is legally permitted, to have a second supply contract is not. This hampers the possibility of signing a PPA, having a PV system for a multi-family house, etc.

Also, exclusively buying PV electricity from a third party with a PPA contract has not been taken into consideration in Spain. Firstly because nowadays people are not willing to sign a long term contract for PV electricity and secondly, the new regulation establishes a fee for generating PV electricity, which makes offering a contract of this kind not profitable, especially in the case of small installations. Electricity suppliers would need to raise PPA tariffs to cover the fee for generating PV electricity and therefore would stop being competitive.

PV project development

In order to calculate the profitability of a PV project, the owner must take into account several variables. To reflect the Spanish context for PV project development country specific variables are discussed below.

Irradiation levels

The average irradiation levels for Spain range between 1.250 kWh/sqm/year in the north, close to the border with France, and 2.400 kWh/sqm/year for the Canary Islands. Therefore Spain is one of the European countries with the highest irradiation levels, although levels depend strongly on the region under study. For the study at hand Madrid has been chosen as the place where the consumer will install the PV system. Madrid's average irradiation level is 2.070 kWh/sqm/year.

The solar irradiation plays a role in the annual production of a PV system and therefore on the site selection for the PV plant. As stated before, it is an important variable when studying the profitability of the PV project as it influences on the generation calculation, but it does not affect the investment costs.

PV system characteristics

<u>PV System Size</u>

The first step in designing a PV system is sizing, as the electricity generation depends on it. For example in the case of self-consumption: On the one hand, if the PV system is undersized it will not generate enough power and the consumer will have to pay for both, the PV system and the electricity from the grid. On the other hand, if the system produces excess power, the consumer will either lose the power or has to sell it bearing additional costs of selling it on the spot market.

For these reasons the first step that investors should take is to identify how much electricity they need/want their system to generate, in order to appropriately size the PV system.

<u>Performance Ratio (PR)</u>

The Performance Ratio represents the relation between the actual energy performance compared to the theoretical possible energy performance. This ratio intends to capture generation losses caused by temperature, shade, inefficiencies or failures of components such as the inverter, among others.

An average system performance ratio of 85% can be assumed, based on the following sources:

- The Fraunhofer Institute for Solar Energy Systems (ISE) investigated the PR of more than 100 PV system installations and annual PR was between ~70% and ~90%.
- Moreover, other sources indicate that typical rate for PR amounts to >80% nowadays.

PV System Economic Lifetime

The economic lifespan of the PV system is estimated on the basis of the following sources:

- Most of the reports consulted consistently use 25 to 35 years for projections.
- PV Cycle, European association for the recycling of PV modules, estimates the lifetime of a PV module at 35 years.

Consequently, and with the aim of avoiding overestimating, a PV system lifetime of 20 years has been chosen as the average lifespan of a PV system.

PV installation costs (CAPEX and OPEX)

When investing in a PV installation, the owner must take into account all costs associated with the PV system. Some of these costs vary between countries. The country specific PV system costs, which vary according to the size of the system, cover CAPEX and OPEX costs and can be divided into:

- Investment costs (CAPEX): The investment includes among others the following costs:
  - Modules
  - Inverter
  - Mounting system
  - Installation
- Operations & Maintenance costs (OPEX): PV systems can be considered relatively maintenance free compared to other RES systems such as wind generators. Maintenance costs vary according to the size and type of the project.
- Roof and land lease costs: These costs vary significantly depending on the location and dimension of the land/roof. No data was identified during desktop research for these costs in Spain. For the case studies we are considering that the needed surface is property of the investor/ consumer.

Current financing environment

Several economic factors must be taken into account when deciding which financing scheme best fits a PV investment, not only the previously mentioned installation costs, but also country specific economic values. Among the country specific values we can find the ones that are representative for the country's economy, such as inflation, interest rates, etc. and those related to the regulatory support given in that country. Listed below are economic values that are taken into account in Spain:

- The inflation rate, which measures how fast prices for goods and services rise over time. This rate can be used as a measure of the escalation rate of O&M, lease costs and insurance costs over the PV system’s lifetime. In Spain the average yearly inflation rate from 2007 until 2015 was 1,6%.

- The interbank rate, which is the rate of interest charged on short-term loans between banks. The interbank rate in Spain had an average of 4,16% from 1991 until 2015.
- The benchmark interest rate, is set by the European Central Bank and serves as a minimum reference rate of return for investors when investing in a project. The yearly benchmark interest rate in the Euro Area was 2,35% from 1998 until 2015 on average.

The following table provides data for the above mentioned values in Spain.

Inflation rate	Current rate (March 2015)	-0,70%
	Long term target	2,00%
Interbank interest	Current rate (November 2015)	- 0,10%
	Projected (2020)	0,64%
Benchmark interest rate (Euro Area)	Current rate (November 2015)	0,05%
	Projected (2020)	0,36%

Table 1: Financing parameters for Spain[1]

Support schemes

In many countries support measures have led to extensive investment in PV installations. Spain used to have extensive support measures for PV installations, but over time they have gradually been withdrawn. Currently there are no incentives for this technology. In addition the latest regulation (October 2015) for the self-consumption market includes, among other changes, a fee charged for every kWh of PV self-consumption, which demotivates the installation of these PV systems.

Financing schemes

Since the elimination of the FiT and the publication of the draft for a new regulation which further discourages installing PV, there is uncertainty about the legal situation of PV systems. Although PV self-consumption is legally permitted, investing in installations of this technology has become less usual. So even though different financing mechanisms exist for the Spanish PV market, not all of them (or hardly any) are currently being used.

In order to present different cases for the application segments, a bank loan has been chosen for the second case study even though the BM in all cases is the same.

[1] Sources: Trading Economics; Organization for Economic Co-operation and Development (OECD stats)

Current Electricity Market Framework

In Spain, the approval of the Law 54/1997 for the Electricity Sector marked the beginning of the sector's liberalization process by opening up grid activities to third parties, establishing an organized energy trading market and decreasing public involvement in the system's management.

Currently, Law 24/2013 for the Electricity Sector regulates its structure and functioning. This law maintains the distinction between regulated and non-regulated activities, while trying to drive effective competition in the sector. These activities are: generation, transmission, distribution, energy recharging services, commercialization, national and international exchanges, and economic and technical management of the electrical system.

Tariff Structure

In Spain, the electricity tariff consists of different components, which vary depending on the type of consumer. The components are:

- Capacity based component (power term)
- Volume based component (energy term)
- Penalty for excess reactive power
- Other concepts of the electricity bill

Tariff costs

In Spain, the segmentation of consumers for the tariff groups is based on the consumer´s contracted power (power term) instead of the typical consumer categories (residential, commercial, industrial, etc.). The different tariff groups for low voltage clients are shown in the following tables, as well as average consumption, type of supply and number of tariff periods for each tariff group.

Low voltage tariff groups				
Power term	Tariff	nº of tariff periods	Type of supply	Average annual consumption (kWh/consumer)
<= 10 kW	2.0 A	1	Households, small offices	2.403
	2.0 DHA	2	Households with electric batteries, street lighting	6.454
	2.0 DHS	3	EV charging points	-
> 10 y <= 15 kW	2.1 A	1	Small offices	8.980
	2.1 DHA	2	Street lighting	-
	2.1 DHS	3	EV charging points	-
> 15 kW	3.0 A	3	Medium businesses, shops, offices, small industries	45.436

Table 2: Low voltage tariff groups

1. Single-family

Segment environment

For the residential segment only the case of single-family houses has been included in this study, as multi-family houses are not legally permitted to install PV systems for individual self-consumption, and there is no other business model, like PPA, available in the country.

The following table provides average data for the chosen example for a residential single-family house PV project development.

System size (kWp)	4
Turnkey system prices (EUR/kWp)	2.396
O&M costs (EUR/kWp/a)	18,05
Construction timing	1 month
Operation timing	20 years

Table 3: PV installation and operation costs for Spanish residential single-family house (including taxes)[2]

In order to present different cases for the residential segment, a bank loan has been chosen for the second case study even though the BM (self-consumption) is the same. The loan presents the following characteristics:

- Maximum Debt Limit: 40.000 EUR
- Debt Gearing: 90%
- Margin: 6,95 %
- Upfront Fee: 0%
- Commitment Fee: 0%
- Tenor: 5 years
- Grace Period: 0 years

It should be highlighted that the possibility of a residential single-family house owner asking for debt financing through a loan, is not very common in Spain. However in order to show a different option for consumers, a general bank loan (not specific for PV systems) was chosen for residential consumers.

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[2] Source: CREARA, *Grid Parity Monitor;* CREARA, *PV Plant Case Study*

A 90% debt gearing was chosen in order to show an extreme case, to represent how much the BM changes with a loan compared to full equity. As 90% debt gearing is not likely to happen, a proper valuation of the specific loan characteristics should be performed to properly understand the business case of a specific consumer.

Segment Drivers

As stated before not many residential consumers install PV systems due to the uncertainty created by the different changes in the law. The few investors/ parties that invest in this technology normally do so to gain independence from electric companies as well as hedging against rising electricity prices, although some consumers also invest in PV technology because of their environmental consciousness.

Business Models

Below you find the case study for the business model in the residential (single-family) application segment in Spain.

At this point, the only possible business model is self-consumption. In order to present two cases we are distinguishing between self-consumption with and without financing mechanism.

It should be highlighted that the business model most to be found in the market is the first one. The second case is based on the possibility that the residential single-family house owner asked for debt financing through a loan, which is not very common in Spain. As neither PPA contracts nor leasing mechanisms are options for consumers, the consumer interested in PV systems covers the total initial investment himself.

Business Model 1: Self-consumption

Self-consumption for residential consumers corresponds to self-consumption 1. In this case there are some characteristics that should be mentioned:

- As the contracted power of these consumers is less than 10 kW, they are exempt from paying the variable charges for self-consumption.
- As the most common case will be not to have a meter for total consumption nor a battery system, these consumers will be exempt of paying the fixed costs for self-consumption set by law.
- This type of consumer does not receive payment for the excess electricity injected to the grid as self-consumption 1 was chosen.

The expected situation for this type of BM will be the one illustrated in the figure below.

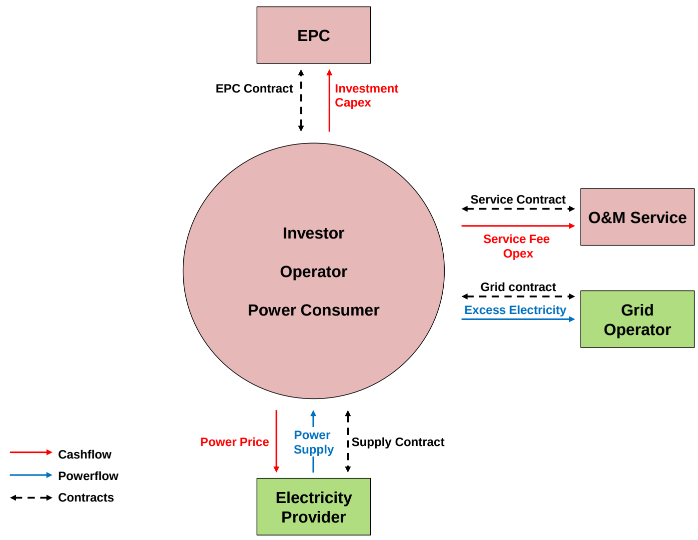


Figure 1: Residential self-consumption

Profitability Analysis

As stated before for the first case for a residential single-family house we chose a 4 kWp PV system with no financing mechanism, as the most common situation in Spain is that the consumer covers the total investment of the PV installation.

The main project characteristics and results are illustrated in the table below.

PV Project			
PV System Size		kWp	4
Specific System Cost		EUR/kWp	2.396
Total System Cost		EUR	9.583
Investment Subsidy		EUR	-
Total System Cost incl. Subsidy		EUR	9.583
Fixed Operation Costs		EUR p.a.	81
Variable Operation Costs		EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	2070
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.760
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	20
Equity		EUR	9.583
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	-
Interest Rate		%	1,5%
Discount Rate		%	0,6%

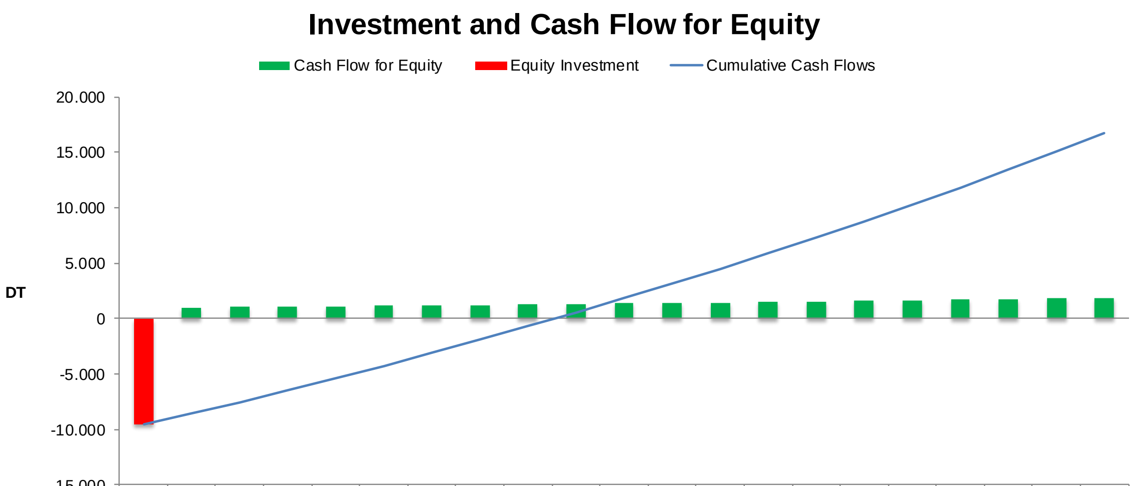
PV Business Model				
Category		Share	Unit	Price
Feed-in Tariff		-	EUR/kWh	-
Self-consumption		100%	EUR/kWh	0,1504
	Fees		EUR/kWh	-
Net-metering		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Excess Electricty		EUR/kWh	-
PPA Tariff		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Overysupply Price		EUR/kWh	-
	Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	16.749
Project IRR	%	11,68%
Equity IRR	%	11,68%
Payback Period	Years	8,57
LCOE* (w/o subsidy)	EUR/kWh	0,09
LCOE (w subsidy)	EUR/kWh	0,09
Min DSCR**	x	-
Min LLCR***	x	-

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 2: Business Model 1 Project Overview

From the results it should be noted that installing a PV system is profitable for residential consumers in Spain as the LCOE is lower that the electricity price they have to pay to the utility. However, due to the continuous changes in regulation which create uncertainty consumers are not willing to invest in this technology. Even though a new regulation has just been published, consumers mistrust the situation given the changes that have occurred in the last years and because this new regulation is planned to be changed within a maximum period of two years.



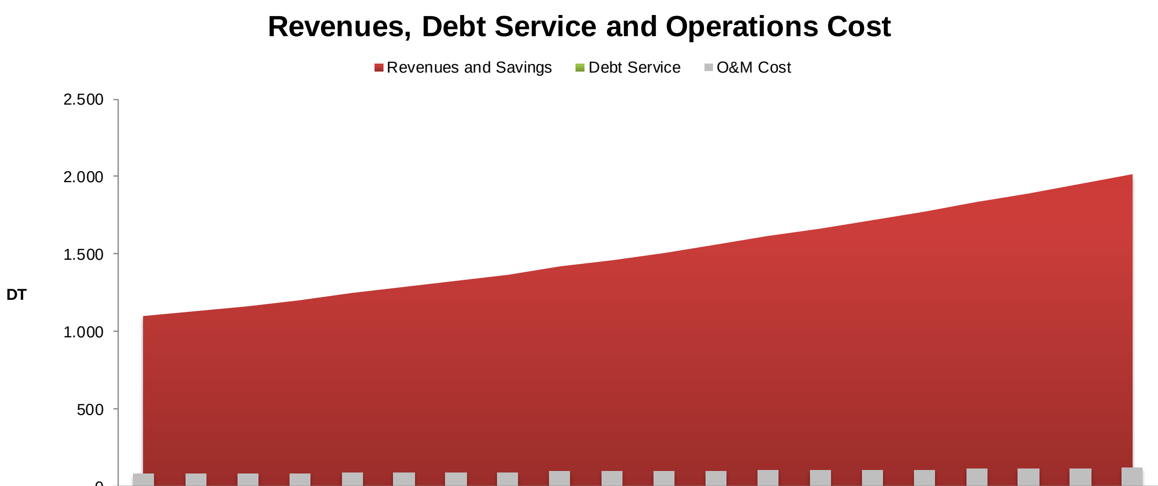
	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(9.583)																				
Cash Flow for Equity	-	1.014	1.046	1.081	1.118	1.159	1.195	1.235	1.276	1.323	1.364	1.410	1.457	1.510	1.556	1.609	1.663	1.724	1.776	1.836	1.897
Cumulative Cash Flows	(9.583)	(8.575)	(7.542)	(6.480)	(5.389)	(4.264)	(3.113)	(1.929)	(713)	539	1.822	3.141	4.495	5.891	7.320	8.788	10.297	11.851	13.443	15.079	16.758

Operations Year

Figure 3: Investment and cash flows for Equity for Business Model 1

From the figure above it can be seen that the payback period is close to 7 years (7,21 years), i.e. the single-family house owner recovers the initial investment after 7 years. After that he obtains a profit from the self-consumed electricity (savings).

As the consumer has not requested any financing mechanism all the "revenues" from the savings are for the consumer. After the initial investment in year cero, the consumer obtains all revenues and the only costs he has to cover are O&M costs.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	1.096	1.129	1.166	1.204	1.247	1.284	1.326	1.370	1.418	1.461	1.509	1.558	1.613	1.662	1.716	1.772	1.835	1.890	1.952	2.016
O&M Cost	82	83	85	86	88	90	92	93	95	97	99	101	103	105	107	109	112	114	116	118
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Operations Year

Figure 4: Revenues, debt service and operations costs for Business Model 1

Figure 4 shows how revenues and savings increase gradually throught the lifetime of the system, this is mainly due to the fact that electricity prices rise.

Business Model 2: Self-consumption with bank loan

The second case for Spanish single-family houses is self-consumption 1, as the one before, but in this case the consumer has requested financing through a loan from a bank. The main characteristics of this case are the ones stated in Business model 1 and the characteristics of the loan previously mentioned.

The expected situation for this type of BM will be the one illustrated in the figure below.

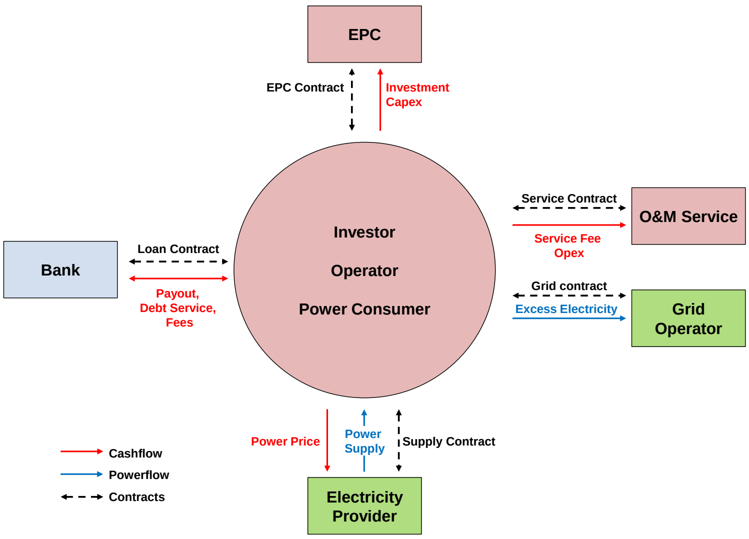


Figure 5: Residential self-consumption with loan

Profitability Analysis

As for the first case, we chose a 4 kWp PV system but added a bank loan as financing mechanism. This case is chosen in order to present different cases for residential single-family houses, even though it is not very likely to happen.

The main project characteristics and results are illustrated in the figures below.

PV Project		
PV System Size	kWp	4
Specific System Cost	EUR/kWp	2.396
Total System Cost	EUR	9.583
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	9.583
Fixed Operation Costs	EUR p.a.	81
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	2070
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.760
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	20
Equity		EUR	958
Debt (Gearing)	90%	EUR	8.625
Loan Tenor		Years	5
Interest Rate		%	7,2%
Discount Rate		%	0,6%

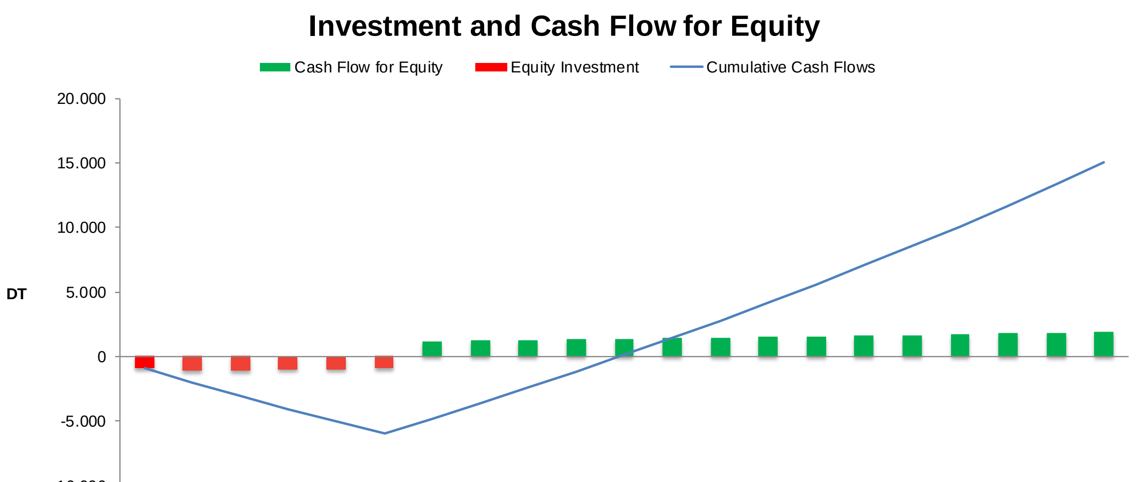
PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	-	EUR/kWh	-
Self-consumption	100%	EUR/kWh	0,1504
Fees		EUR/kWh	-
Net-metering	-	EUR/kWh	-
Fees		EUR/kWh	-
Excess Electricty		EUR/kWh	-
PPA Tariff	-	EUR/kWh	-
Fees		EUR/kWh	-
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	15.005
Project IRR	%	11,68%
Equity IRR	%	13,91%
Payback Period	Years	9,94
LCOE* (w/o subsidy)	EUR/kWh	0,14
LCOE (w subsidy)	EUR/kWh	0,14
Min DSCR**	x	0,48 x
Min LLCR***	x	0,51 x

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 6: Business Model 2 Project Overview

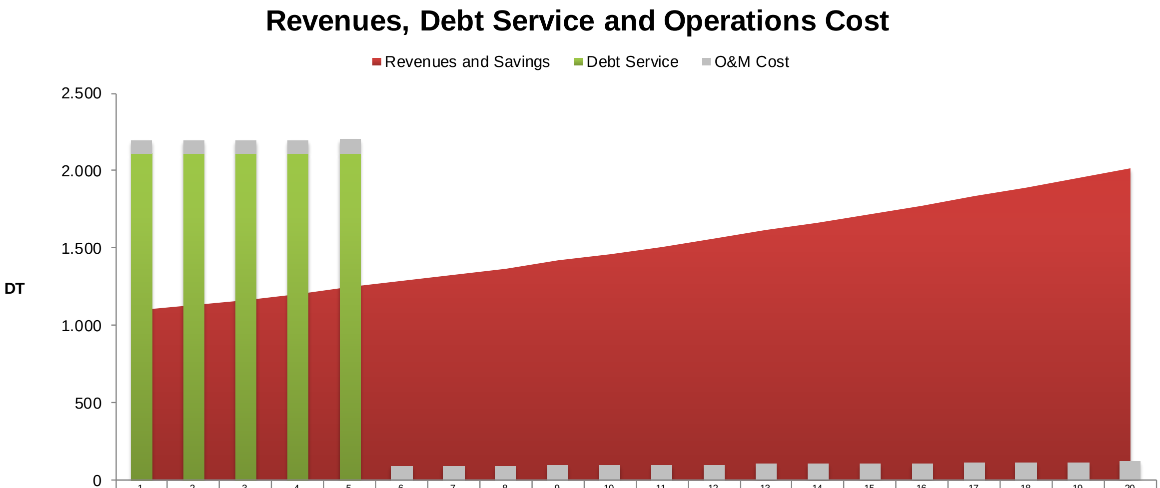
The indicators presented in the table show that the LCOE in this second case is still lower than the electricity tariff for the residential consumers.



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(958)																				
Cash Flow for Equity	-	(1.098)	(1.066)	(1.031)	(994)	(953)	1.195	1.235	1.276	1.323	1.364	1.410	1.457	1.510	1.556	1.609	1.663	1.724	1.776	1.836	1.897
Cumulative Cash Flows	(958)	(2.049)	(3.102)	(4.114)	(5.084)	(6.009)	(4.857)	(3.674)	(2.458)	(1.205)	78	1.396	2.751	4.146	5.575	7.044	8.552	10.107	11.699	13.334	15.014

Operations Year

Figure 7: Investment and cash flows for Equity for Business Model 2



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	1.096	1.129	1.166	1.204	1.247	1.284	1.326	1.370	1.418	1.461	1.509	1.558	1.613	1.662	1.716	1.772	1.835	1.890	1.952	2.016
O&M Cost	82	83	85	86	88	90	92	93	95	97	99	101	103	105	107	109	112	114	116	118
Debt Service	2.112	2.112	2.112	2.112	2.112	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Operations Year

Figure 8: Revenues, debt service and operations costs for Business Model 1

Comparing the first case with the second one for Spanish single-family houses it can be stated that with the bank loan the consumer does not have any initial down payment and makes fixed gradual payments throughout the first 5 years to cover the overall investment. Because of the interest payments there are additional costs involved, which increases the payback period for financing slightly to 9,94 years.

During the first years the consumer will use the saving from the electricity bills for paying back the loan to the bank (principal plus interest rate). After the first 5 years, the consumers receive all revenues (savings) and the only costs that he has to cover are O&M costs.

2. Commercial Large Office Buildings

Segment environment

The following table provides average data for Spain for the chosen example for a commercial office building.

System size (kWp)	30
Turnkey system prices (EUR/kWp)	1.870
O&M costs (EUR/kWp/a)	18,7
Construction timing	1 month
Operation timing	20 years

Table 4: PV installation and operation costs for Spanish commercial office building (including taxes)[3]

Current financing environment

In order to present different cases for the commercial segment, a bank loan has been chosen for the second case study even though the BM (self-consumption) is the same. The loan presents the following characteristics:

- Maximum Debt Limit: 60.000 EUR
- Debt Gearing: 90%
- Margin: 4,95 %
- Upfront Fee: 0%
- Commitment Fee: 0%
- Tenor: 5 years
- Grace Period: 0 years

It should be highlighted that the possibility of an office building owner asking for debt financing through a loan, is not very common in Spain. However in order to show a different option for consumers, a general bank loan (not specific for PV systems) was chosen for commercial consumers.

A 90% debt gearing was chosen in order to show an extreme case, to represent how much the BM changes with a loan compared to full equity. As 90% debt gearing is not likely to happen, a proper

[3] Source: CREARA, *Grid Parity Monitor;* CREARA, *PV Plant Case Study*

valuation of the specific loan characteristics should be performed to properly understand the business case of a specific consumer.

Segment Drivers

For office buildings the main benefit that a PV system offers to the building owner is increasing the buildings attractiveness/value for tenants. The owner is able to increase renting prices in exchange for lower electricity costs for tenants. Further, having a PV system provides a green image for the users as well.

Formerly, these factors were taken into account when renting a building, but, given the current economic situation, few people are willing to spend more on renting a building which is more sustainable or renewable.

The building owner is the one who makes the investment. Several years ago when PV systems received support mechanisms, they used to demand certain levels of performance parameters for the investment, for example a payback period of between 8 and 10 years. Currently if a building owner decides to invest in PV, profitability is not the main decision criteria.

Business Models

Below you find the case study for the business model in the commercial (office building) application segment in Spain.

At this point, the only possible business model is self-consumption. In order to present two cases we are distinguishing between self-consumption with and without financing mechanism.

It should be highlighted that the business model most likely to be found in the Spanish market is the first one. The second case is based on the possibility that the office building owner asked for debt financing through a loan, which is not very common in Spain. As neither PPA contracts nor leasing mechanisms are options for consumers, the consumer interested in PV systems covers the total initial investment himself.

Business Model 1: Self-consumption

Self-consumption for commercial consumers corresponds to self-consumption 1. In this case there are some characteristics that should be mentioned:

- As the contracted power of these consumers is above 10 kW, the consumers will have to pay the variable charges for self-consumption, 1,787 cEUR/ kWh.
- As the most common case will be not to have a meter for total consumption nor a battery system, these consumers will be exempt of paying the fixed costs for self-consumption set by law.
- This type of consumer does not receive payment for the excess electricity injected to the grid as self-consumption 1 was chosen.

The expected situation for this type of BM will be the one illustrated in the figure below.

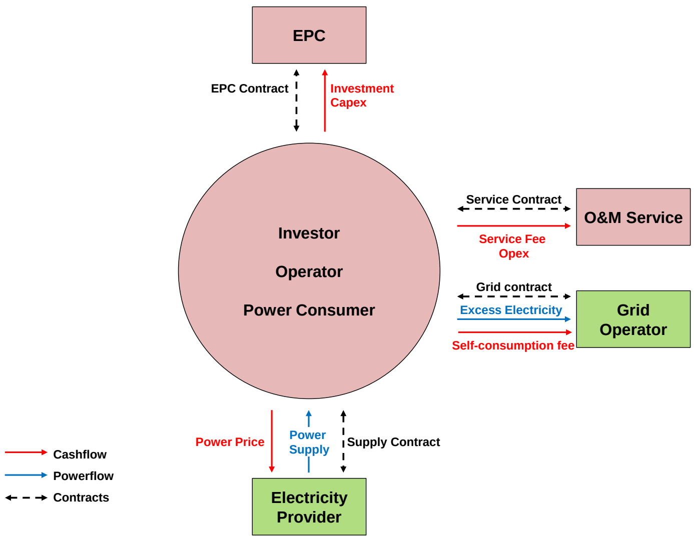


Figure 9: Commercial self-consumption

Profitability Analysis

As stated before for the first case for a commercial office building investor/ consumer we chose a 30 kWp PV system with no financing mechanism, as the most common situation in Spain is that the consumer covers the total investment of the PV installation.

The main project characteristics and results are illustrated in the table below.

PV Project		
PV System Size	kWp	30
Specific System Cost	EUR/kWp	1.870
Total System Cost	EUR	56.100
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	56.100
Fixed Operation Costs	EUR p.a.	561
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	2070
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.760
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	20
Equity		EUR	56.100
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	7
Interest Rate		%	1,5%
Discount Rate		%	0,6%

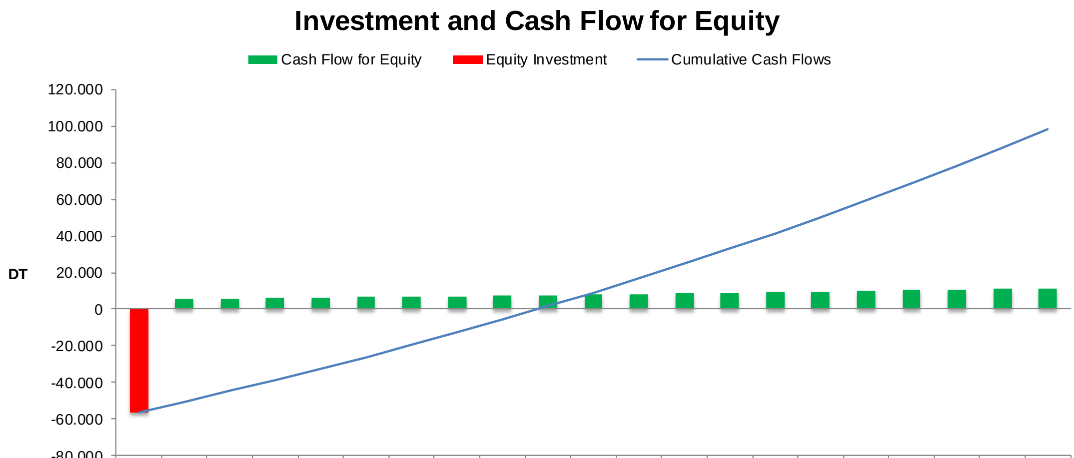
PV Business Model				
Category		Share	Unit	Price
Feed-in Tariff		-	EUR/kWh	-
Self-consumption		100%	EUR/kWh	0,1306
	Fees		EUR/kWh	0,0179
Net-metering		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Excess Electricty		EUR/kWh	-
PPA Tariff		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Overysupply Price		EUR/kWh	-
	Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	98.186
Project IRR	%	11,48%
Equity IRR	%	11,48%
Payback Period	Years	8,79
LCOE* (w/o subsidy)	EUR/kWh	0,07
LCOE (w subsidy)	EUR/kWh	0,07
Min DSCR**	x	-
Min LLCR***	x	-

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 10: Business Model 1 Project Overview

From the results it should be noted that installing a PV system is profitable for commercial (office building) consumers in Spain as the LCOE is lower that the electricity price they have to pay to the utility. However, due to the continuous changes in regulation which create uncertainty consumers are not willing to invest in this technology. Even though a new regulation has just been published, consumers mistrust the situation given the changes that have occurred in the last years and because this new regulation is planned to be changed within a maximum period of two years.

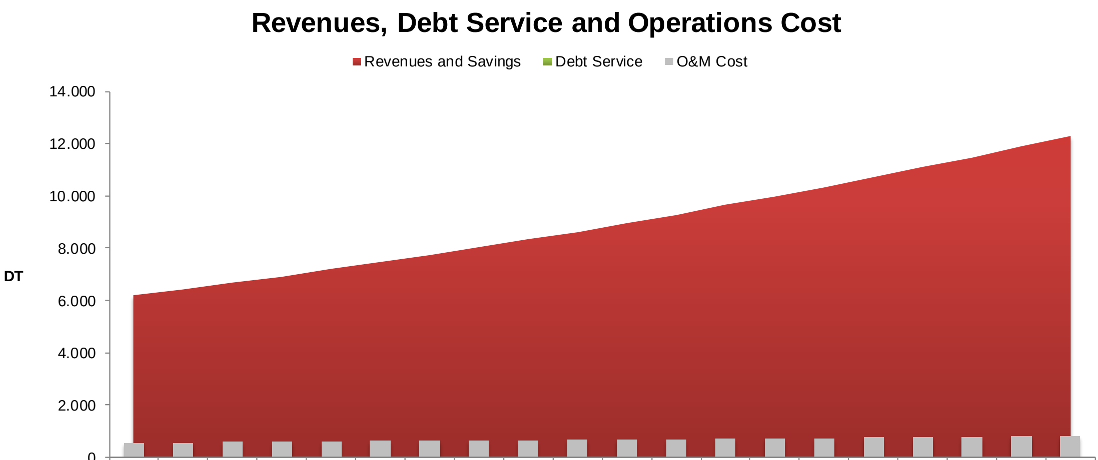


	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(56.100)																				
Cash Flow for Equity	-	5.634	5.851	6.087	6.330	6.601	6.841	7.108	7.385	7.693	7.964	8.268	8.582	8.933	9.241	9.587	9.943	10.342	10.692	11.085	11.491
Cumulative Cash Flows	(56.100)	(50.500)	(44.719)	(38.742)	(32.564)	(26.160)	(19.565)	(12.753)	(5.719)	1.564	9.059	16.792	24.770	33.024	41.511	50.262	59.283	68.610	78.193	88.069	98.244

Figure 11: Investment and cash flows for Equity for Business Model 1

From the figure above it can be seen that the payback period is close to 8 years (7,92 years), i.e. the office building owner recovers the initial investment after 8 years. After that he obtains a profit from the self-consumed electricity (savings).

As the consumer has not requested any financing mechanism all the “revenues” from the savings are for the consumer. After the initial investment in year cero, the consumer obtains all revenues and the only costs he has to cover are O&M costs.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	6.200	6.423	6.670	6.925	7.207	7.459	7.739	8.028	8.349	8.634	8.951	9.279	9.643	9.965	10.325	10.697	11.111	11.476	11.885	12.307
O&M Cost	565	571	583	594	606	618	631	643	656	669	683	696	710	724	739	754	769	784	800	816
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 12: Revenues, debt service and operations costs for Business Model 1

Figure 4 shows how revenues and savings increase gradually throught the lifetime of the system, this is mainly due to the fact that electricity prices rise.

Business Model 2: Self-consumption with bank loan

The second case for Spanish commercial office buildings is self-consumption 1, as the one before, but in this case the building owner has requested financing through a loan from a bank. The main characteristics of this case are the ones stated in Business model 1 and the characteristics of the loan previously mentioned.

The expected situation for this type of BM will be the one illustrated in the figure below.

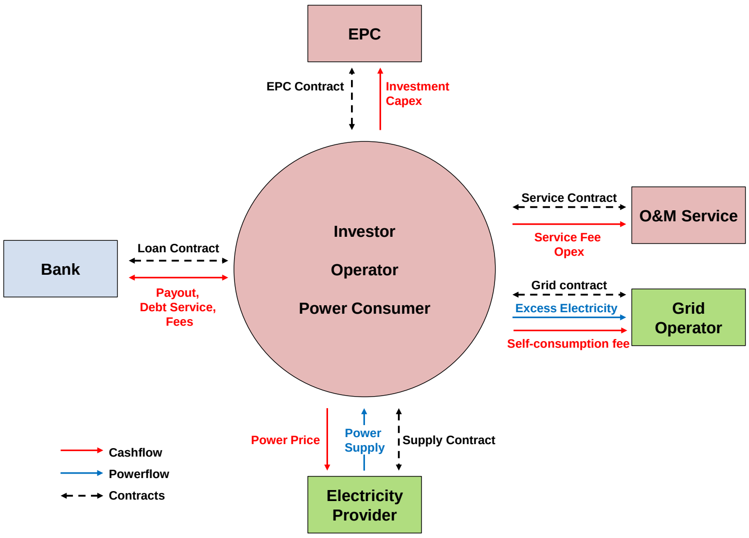


Figure 13: Commercial self-consumption with loan

Profitability Analysis

As for the first case, we chose a 30 kWp PV system but added a bank loan as financing mechanism. This case is chosen in order to present different cases for office buildings, even though it is not very likely to happen.

The main project characteristics and results are illustrated in the figures below.

PV Project			
PV System Size		kWp	30
Specific System Cost		EUR/kWp	1.870
Total System Cost		EUR	56.100
Investment Subsidy		EUR	-
Total System Cost incl. Subsidy		EUR	56.100
Fixed Operation Costs		EUR p.a.	561
Variable Operation Costs		EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	2070
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.760
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	20
Equity		EUR	5.610
Debt (Gearing)	90%	EUR	50.490
Loan Tenor		Years	10
Interest Rate		%	5,2%
Discount Rate		%	0,6%

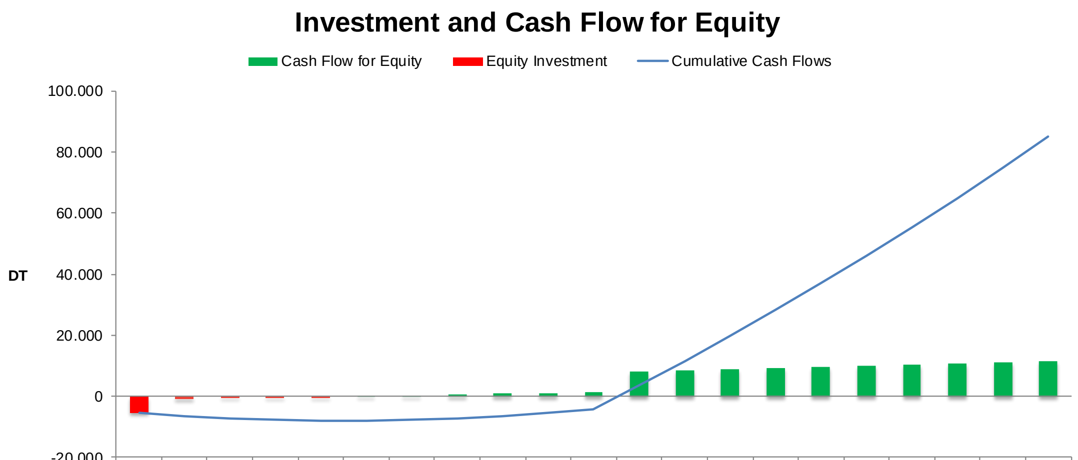
PV Business Model				
Category		Share	Unit	Price
Feed-in Tariff		-	EUR/kWh	-
Self-consumption		100%	EUR/kWh	0,1306
	Fees		EUR/kWh	0,0179
Net-metering		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Excess Electricty		EUR/kWh	-
PPA Tariff		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Overysupply Price		EUR/kWh	-
	Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	84.978
Project IRR	%	11,48%
Equity IRR	%	19,78%
Payback Period	Years	10,54
LCOE* (w/o subsidy)	EUR/kWh	0,10
LCOE (w subsidy)	EUR/kWh	0,10
Min DSCR**	x	0,86 x
Min LLCR***	x	1,01 x

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 14: Business Model 2 Project Overview

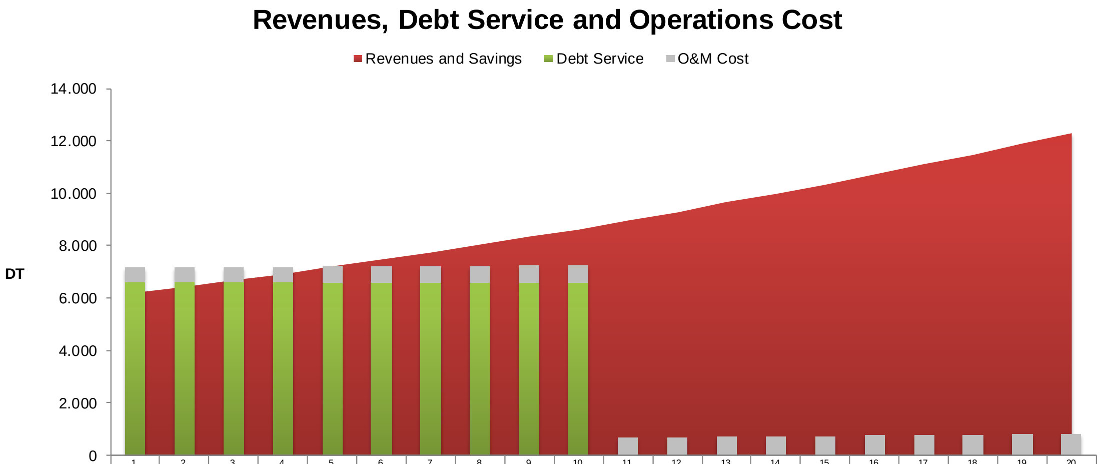
The indicators presented in the table show that the LCOE in this second case is still lower than the electricity tariff for the commercial (office buildings) consumers.



	-	1	2	3	4	5	6	7	8	9	10
Equity Investment	(5.610)										
Cash Flow for Equity	-	(952)	(735)	(499)	(256)	15	254	522	798	1.106	1.378
Cumulative Cash Flows	(5.610)	(6.556)	(7.282)	(7.773)	(8.022)	(8.008)	(7.763)	(7.263)	(6.502)	(5.455)	(4.158)

	11	12	13	14	15	16	17	18	19	20
Equity Investment										
Cash Flow for Equity	8.268	8.582	8.933	9.241	9.587	9.943	10.342	10.692	11.085	11.491
Cumulative Cash Flows	3.575	11.553	19.807	28.294	37.045	46.066	55.393	64.976	74.852	85.027

Figure 15: Investment and cash flows for Equity for Business Model 2



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	6.200	6.423	6.670	6.925	7.207	7.459	7.739	8.028	8.349	8.634	8.951	9.279	9.643	9.965	10.325	10.697	11.111	11.476	11.885	12.307
O&M Cost	565	571	583	594	606	618	631	643	656	669	683	696	710	724	739	754	769	784	800	816
Debt Service	6.586	6.586	6.586	6.586	6.586	6.586	6.586	6.586	6.586	6.586	-	-	-	-	-	-	-	-	-	-

Operations Year

Figure 16: Revenues, debt service and operations costs for Business Model 1

Comparing the first case with the second one for Spanish office buildings it can be stated that with the bank loan the consumer does not have any initial down payment and makes fixed gradual payments throughout the first 10 years to cover the overall investment. Because of the interest payments there are additional costs involved, which increases the payback period for financing slightly to 10,54 years.

During the first years the consumer will use the saving from the electricity bills for paying back the loan to the bank (principal plus interest rate). After the first 10 years, the consumers receives all revenues (savings) and the only costs that he has to cover are O&M costs.

3. Shopping centres

Segment environment

The shopping centre segment has to be analyzed as an isolated case in Spain. The technical building code multi-store buildings and entertainment centers with more than 5.000 m^2 of built-up area to have a minimum contribution of PV electric power to consumption. The minimum nominal capacity of the system to be installed is calculated by a formula that takes into account:

- Climate zone
- Built-up area of the building
- Building use

All shopping centers built since 2009 (first year in which the regulation was effective) have a PV system. If there were no regulation requiring the installation of a PV plant, owners would be willing to rent their roof to a plant operator to install a PV system, especially given the large surfaces that shopping centers dispose of on their roofs, but they would not install the PV system themselves due to the unfavourable situation that the regulatory changes have created.

The following table provides average data for Spain for the chosen example for a commercial shopping centre.

System size (kWp)	100
Turnkey system prices (EUR/kWp)	1.595
O&M costs (EUR/kWp/a)	17,55
Construction timing	1 month
Operation timing	20 years

Table 5: PV installation and operation costs for Spanish commercial shopping centres (including taxes)[4]

Current financing environment

In order to present different cases for the commercial segment, a bank loan has been chosen for the second case study even though the BM (self-consumption) is the same. The loan presents the following characteristics:

[4] Source: CREARA, *Grid Parity Monitor;* CREARA, *PV Plant Case Study*

- Debt Gearing: 70%
- Margin: 4,95 %
- Upfront Fee: 0%
- Commitment Fee: 0%
- Tenor: 5 years
- Grace Period: 0 years

It should be highlighted that the possibility of a commercial shopping centre owner asking for debt financing through a loan, is not very common in Spain. However in order to show a different option for consumers, a general bank loan (not specific for PV systems) was chosen for commercial consumers.

Current Electricity Market Framework

In commercial shopping centres the energy generated by the PV system is currently used to overcome common uses, reducing energy costs for tenants and increasing the value of the building for the owner. Although, in some cases were the PV generated electricity is higher than the electricity consumed in common uses, the shopping centre owner divides the electricity generated profits between the different tenants, reducing their electricity bill.

In this case a 3.1A tariff rate has been chosen, which has an average cost of 10,5395 cEUR/ kWh.

Segment Drivers

Because installing the PV system is mandatory, the owner generally does not pay attention to any performance parameters for the investment. The system is built to fulfill the minimum requirements of the regulation and the main objective is therefore to minimize costs. Investors carry out a study of the economic impact. For this segment, the study serves as an indicator for the owner to decide on the capacity to be installed. In all cases we analyzed except one, the system’s capacity was limited to the required one.

Business Models

Below you find the case study for the business model in the commercial (shopping centre) application segment in Spain.

At this point, the only possible business model is self-consumption. In order to present two cases we are distinguishing between self-consumption with and without financing mechanism.

It should be highlighted that the business model most to be found in the market is the first one. The second case is based on the possibility that the shopping centre owner asked for debt financing through a loan, which is not very common in Spain. As neither PPA contracts nor leasing mechanisms are options for consumers, the consumer interested in PV systems covers the total initial investment himself.

Business Model 1: Self-consumption

Self-consumption for commercial consumers corresponds to self-consumption 1. In this case there are some characteristics that should be mentioned:

- As the contracted power of these consumers is above 10 kW, they will have to pay the variable charges for self-consumption, 1,5692 cEUR/ kWh.
- As the most common case will be not to have a meter for total consumption nor a battery system, these consumers will be exempt of paying the fixed costs for self-consumption set by law.
- This type of consumer does not receive payment for the excess electricity injected to the grid as self-consumption 1 was chosen.

The expected situation for this type of BM will be the one illustrated in the figure below.

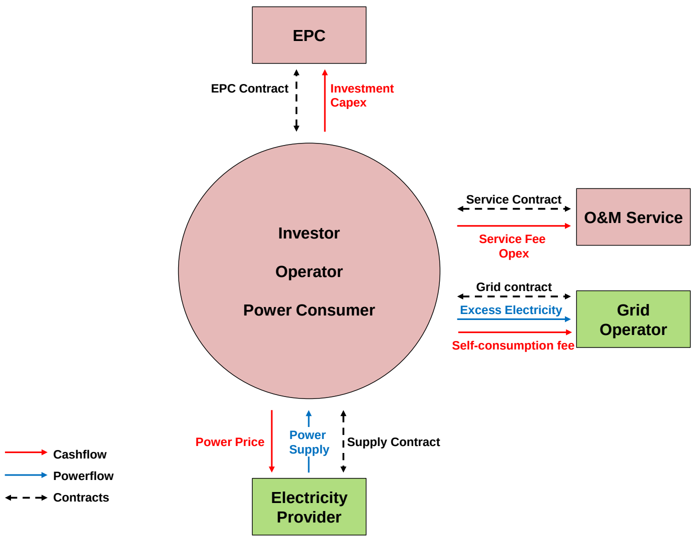


Figure 17: Commercial self-consumption

Profitability Analysis

As stated before for the first case for a commercial shopping centre owner we chose a 100 kWp PV system with no financing mechanism, as the most common situation in Spain is that the consumer covers the total investment of the PV installation.

The main project characteristics and results are illustrated in the table below.

PV Project			
PV System Size		kWp	100
Specific System Cost		EUR/kWp	1.595
Total System Cost		EUR	159.500
Investment Subsidy		EUR	-
Total System Cost incl. Subsidy		EUR	159.500
Fixed Operation Costs		EUR p.a.	1.755
Variable Operation Costs		EUR/kWh	-
PV Generation			
Specific Yield		kWh/qm/a	2070
Performance Factor		%	85%
Specific System Performance		kWh/kWp/a	1.760
Degradation		% p.a.	0,70%
Investment			
Project Duration		Years	20
Equity		EUR	159.500
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	7
Interest Rate		%	1,5%
Discount Rate		%	0,6%

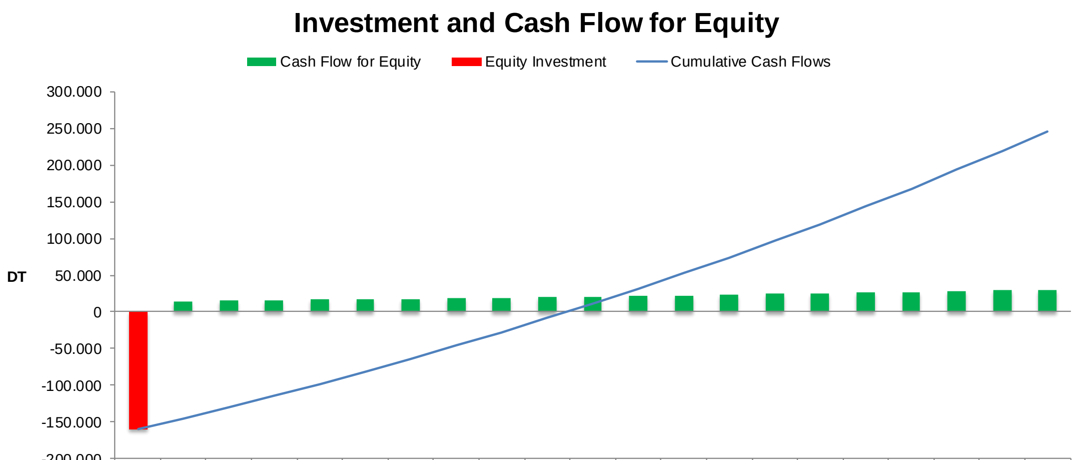
PV Business Model				
Category		**Share**	**Unit**	**Price**
Feed-in Tariff		-	EUR/kWh	-
Self-consumption		100%	EUR/kWh	0,1054
	Fees		EUR/kWh	0,0157
Net-metering		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Excess Electricty		EUR/kWh	-
PPA Tariff		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Overysupply Price		EUR/kWh	-
	Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	246.157
Project IRR	%	10,42%
Equity IRR	%	10,42%
Payback Period	Years	9,43
LCOE* (w/o subsidy)	EUR/kWh	0,06
LCOE (w subsidy)	EUR/kWh	0,06
Min DSCR**	x	-
Min LLCR***	x	-

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio

Figure 18: Business Model 1 Project Overview

From the results it should be noted that installing a PV system is profitable for shopping centre consumers in Spain as the LCOE is lower that the electricity price they have to pay to the utility. However, due to the continuous changes in regulation which create uncertainty consumers are not willing to invest in this technology. Even though a new regulation has just been published, consumers mistrust the situation given the changes that have occurred in the last years and because this new regulation is planned to be changed within a maximum period of two years.

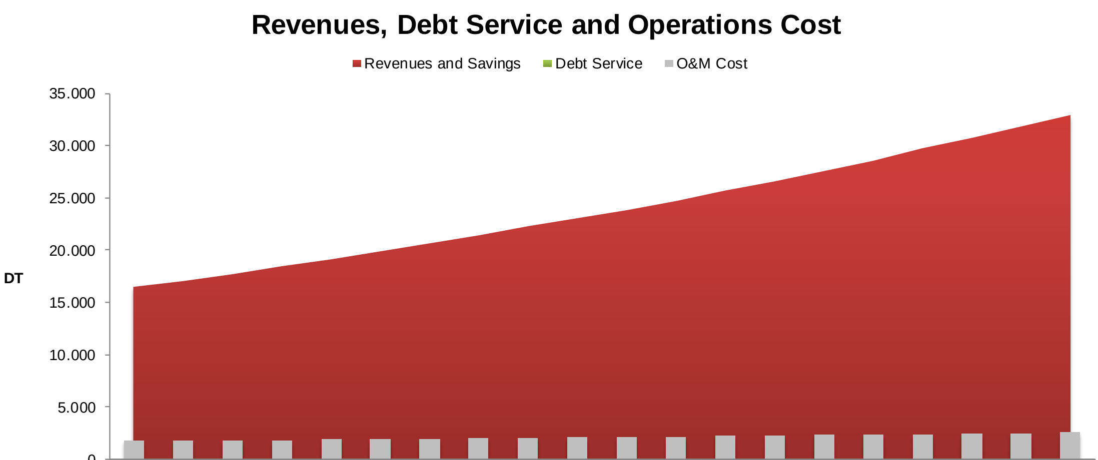


	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(159.50																				
Cash Flow for Equity	-	14.690	15.274	15.904	16.555	17.280	17.921	18.637	19.377	20.201	20.928	21.742	22.582	23.519	24.345	25.269	26.224	27.292	28.229	29.280	30.366
Cumulative Cash Flows	(159.50	(144.89	(129.81	(114.19	(98.035	(81.273	(63.994	(46.133	(27.677	(8.552)	11.141	31.475	52.468	74.199	96.557	119.623	143.416	168.027	193.329	219.414	246.302

Figure 19: Investment and cash flows for Equity for Business Model 1

From the figure above it can be seen that the payback period is close to 9 years (8,42 years), i.e. the shopping centre owner recovers the initial investment after 9 years. After that he obtains a profit from the self-consumed electricity (savings).

As the consumer has not requested any financing mechanism all the "revenues" from the savings are for the consumer. After the initial investment in year cero, the consumer obtains all revenues and the only costs he has to cover are O&M costs.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	16.459	17.060	17.726	18.414	19.175	19.855	20.609	21.388	22.252	23.021	23.876	24.759	25.740	26.610	27.580	28.581	29.696	30.681	31.781	32.917
O&M Cost	1.769	1.786	1.822	1.858	1.896	1.933	1.972	2.012	2.052	2.093	2.135	2.177	2.221	2.265	2.311	2.357	2.404	2.452	2.501	2.551
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 20: Revenues, debt service and operations costs for Business Model 1

Figure 4 shows how revenues and savings increase gradually throught the lifetime of the system, this is mainly due to the fact that electricity prices rise.

Business Model 2: Self-consumption with bank loan

The second case for Spanish shopping centres is self-consumption 1, as the one before, but in this case the shopping centre owner has requested financing through a loan from a bank. The main characteristics of this case are the ones stated in Business model 1 and the characteristics of the loan previously mentioned.

The expected situation for this type of BM will be the one illustrated in the figure below.

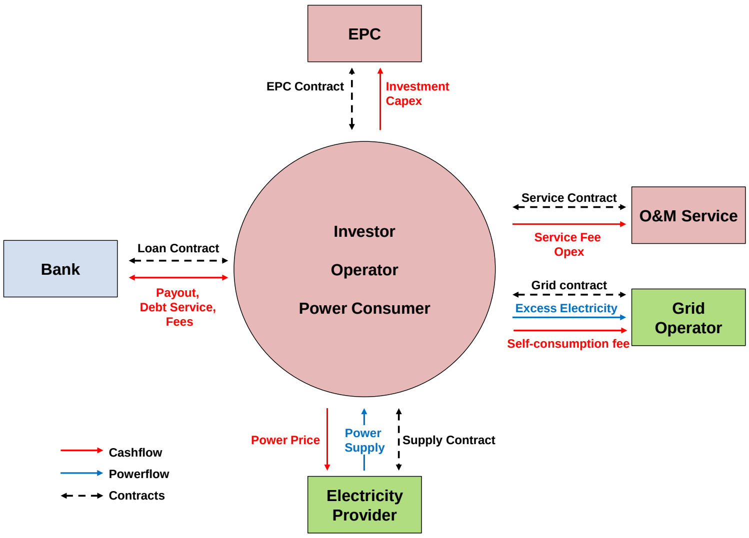


Figure 21: Commercial self-consumption with loan

Profitability Analysis

As for the first case, we chose a 100 kWp PV system but added a bank loan as financing mechanism. This case is chosen in order to present different cases for shopping centres, even though it is not very likely to happen.

The main project characteristics and results are illustrated in the figures below.

PV Project		
PV System Size	kWp	100
Specific System Cost	EUR/kWp	1.595
Total System Cost	EUR	159.500
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	159.500
Fixed Operation Costs	EUR p.a.	1.755
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	2070
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.760
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	20
Equity		EUR	47.850
Debt (Gearing)	70%	EUR	111.650
Loan Tenor		Years	10
Interest Rate		%	5,2%
Discount Rate		%	0,6%

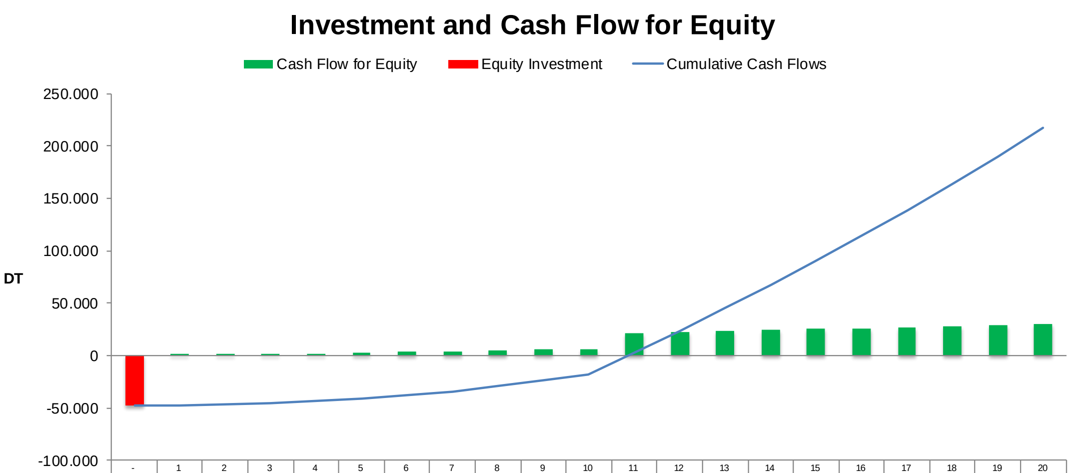
PV Business Model			
Category	**Share**	**Unit**	**Price**
Feed-in Tariff	-	EUR/kWh	-
Self-consumption	100%	EUR/kWh	0,1054
Fees		EUR/kWh	0,0157
Net-metering	-	EUR/kWh	-
Fees		EUR/kWh	-
Excess Electricty		EUR/kWh	-
PPA Tariff	-	EUR/kWh	-
Fees		EUR/kWh	-
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	216.949
Project IRR	%	10,42%
Equity IRR	%	13,91%
Payback Period	Years	10,89
LCOE* (w/o subsidy)	EUR/kWh	0,08
LCOE (w subsidy)	EUR/kWh	0,08
Min DSCR**	x	1,01 x
Min LLCR***	x	1,19 x

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 22: Business Model 2 Project Overview

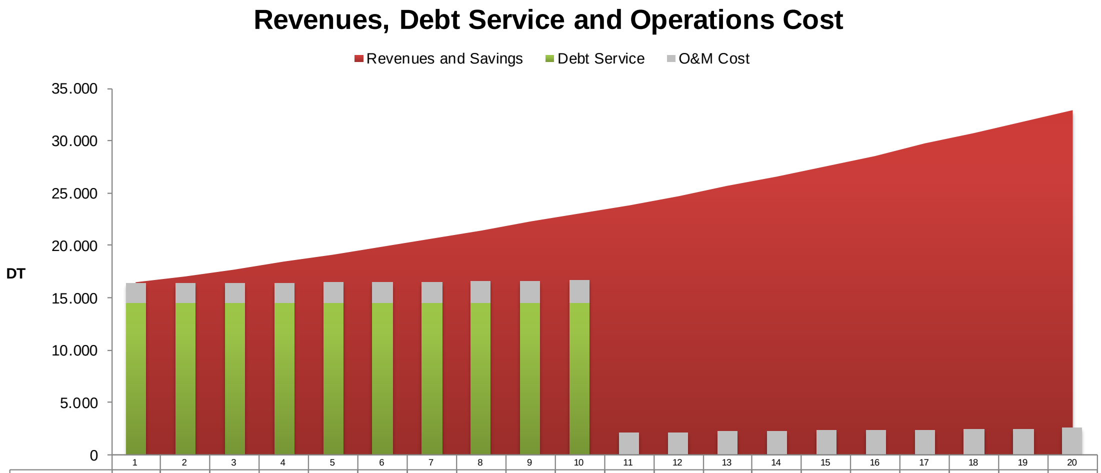
The indicators presented in the table show that the LCOE in this second case is still lower than the electricity tariff for the shopping centre consumers.



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(47.850																				
Cash Flow for Equity	-	126	709	1.340	1.991	2.715	3.356	4.073	4.812	5.636	6.363	21.742	22.582	23.519	24.345	25.269	26.224	27.292	28.229	29.280	30.366
Cumulative Cash Flows	(47.850	(47.725	(47.025	(45.709	(43.766	(41.132	(37.896	(33.994	(29.410	(24.074	(18.087	2.248	23.240	44.972	67.330	90.396	114.189	138.800	164.101	190.186	217.075

Operations Year

Figure 23: Investment and cash flows for Equity for Business Model 2



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	16.459	17.060	17.726	18.414	19.175	19.855	20.609	21.388	22.252	23.021	23.876	24.759	25.740	26.610	27.580	28.581	29.696	30.681	31.781	32.917
O&M Cost	1.769	1.786	1.822	1.858	1.896	1.933	1.972	2.012	2.052	2.093	2.135	2.177	2.221	2.265	2.311	2.357	2.404	2.452	2.501	2.551
Debt Service	14.565	14.565	14.565	14.565	14.565	14.565	14.565	14.565	14.565	14.565	-	-	-	-	-	-	-	-	-	-

Operations Year

Figure 24: Revenues, debt service and operations costs for Business Model 1

Comparing the first case with the second one for Spanish shopping centres it can be stated that with the bank loan the consumer does not have any initial down payment and makes fixed gradual payments throughout the first 10 years to cover the overall investment. Because of the interest payments there are additional costs involved, which increases the payback period for financing slightly to 10,9 years.

During the first years the consumer will use the saving from the electricity bills for paying back the loan to the bank (principal plus interest rate). After the first 10 years, the consumers receives all revenues (savings) and the only costs that he has to cover are O&M costs.

4. Public education buildings

Segment environment

In Spain public education buildings can be divided in two types, schools and universities, which each have different ways of managing their funds. For schools the decision makers have reduced funds which forces them to prioritize, and due to the great uncertainty and unfavourable situation that the regulatory changes have created for PV public schools decision makers are not willing to install PV systems.

In the case of universities, many public university buildings in Spain are protected as monuments, mainly because of their special architectural or historical merit. This poses an additional barrier besides regulatory uncertainty, when considering the installation of a PV system. Generally speaking it could be stated that installing these systems is not feasible in the Spanish public universities.

The following table provides average data for Spain for the chosen example for a public education building.

System size (kWp)	30
Turnkey system prices (EUR/kWp)	1.870
O&M costs (EUR/kWp/a)	18,7
Construction timing	1 month
Operation timing	20 years

Table 6: PV installation and operation costs for Spanish public education buildings (including taxes)[5]

Current financing environment

In order to present different cases for the public education segment, a bank loan has been chosen for the second case study even though the BM (self-consumption) is the same. It should be noted that public education buildings present the same characteristics as offices in Spain. The loan presents the following characteristics:

- Maximum Debt Limit: 60.000 EUR
- Debt Gearing: 90%
- Margin: 4,95 %

[5] Source: CREARA, *Grid Parity Monitor;* CREARA, *PV Plant Case Study*

- Upfront Fee: 0%
- Commitment Fee: 0%
- Tenor: 5 years
- Grace Period: 0 years

It should be highlighted that the possibility of a public education building owner asking for debt financing through a loan, is not very common in Spain. However in order to show a different option for consumers, a general bank loan (not specific for PV systems) was chosen for public education consumers.

A 90% debt gearing was chosen in order to show an extreme case, to represent how much the BM changes with a loan compared to full equity. As 90% debt gearing is not likely to happen, a proper valuation of the specific loan characteristics should be performed to properly understand the business case of a specific consumer.

Segment Drivers

For public education buildings the main benefits that a PV system could offer are increasing their greener image, although due to barriers previously mentioned no installations are being carried out.

Business Models

Below you find the case study for the business model in the public education building application segment in Spain.

At this point, the only possible business model is self-consumption. In order to present two cases we are distinguishing between self-consumption with and without financing mechanism.

It should be highlighted that the business model most likely to be found in the Spanish market is the first one. The second case is based on the possibility that the public education building owner asked for debt financing through a loan, which is not very common in Spain. As neither PPA contracts nor leasing mechanisms are options for consumers, the consumer interested in PV systems covers the total initial investment himself.

Business Model 1: Self-consumption

Self-consumption for public education buildings corresponds to self-consumption 1. In this case there are some characteristics that should be mentioned:

- As the contracted power of these consumers is above 10 kW, the consumers will have to pay the variable charges for self-consumption, 1,7870 cEUR/ kWh.
- As the most common case will be not to have a meter for total consumption nor a battery system, these consumers will be exempt of paying the fixed costs for self-consumption set by law.
- This type of consumer does not receive payment for the excess electricity injected to the grid as self-consumption 1 was chosen.

The expected situation for this type of BM will be the one illustrated in the figure below.

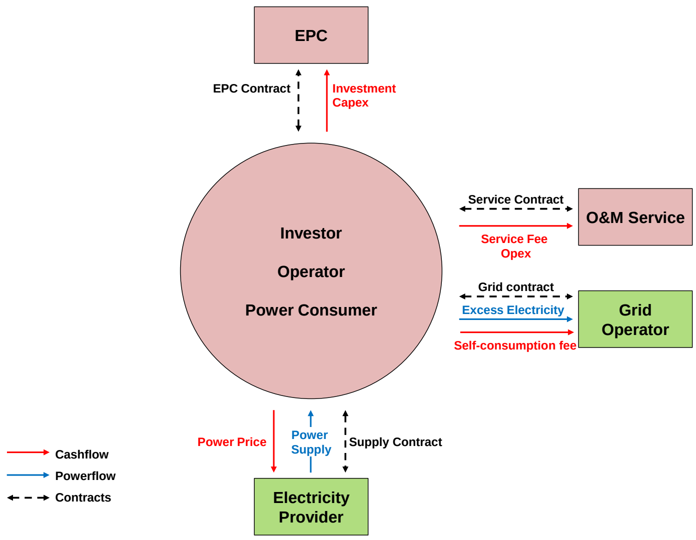


Figure 25: Public education self-consumption

Profitability Analysis

As stated before for the first case for a public education building investor/ owner we chose a 30 kWp PV system with no financing mechanism, as the most common situation in Spain is that the consumer covers the total investment of the PV installation.

The main project characteristics and results are illustrated in the table below.

PV Project			
PV System Size		kWp	30
Specific System Cost		EUR/kWp	1.870
Total System Cost		EUR	56.100
Investment Subsidy		EUR	-
Total System Cost incl. Subsidy		EUR	56.100
Fixed Operation Costs		EUR p.a.	561
Variable Operation Costs		EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	2070
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.760
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	20
Equity		EUR	56.100
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	7
Interest Rate		%	1,5%
Discount Rate		%	0,6%

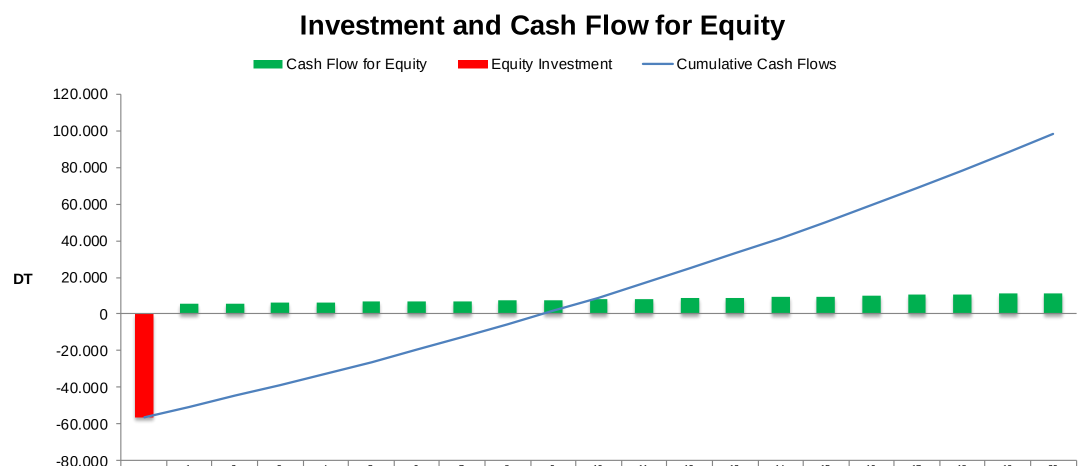
PV Business Model				
Category		Share	Unit	Price
Feed-in Tariff		-	EUR/kWh	-
Self-consumption		100%	EUR/kWh	0,1306
	Fees		EUR/kWh	0,0179
Net-metering		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Excess Electricty		EUR/kWh	-
PPA Tariff		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Overysupply Price		EUR/kWh	-
	Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	98.186
Project IRR	%	11,48%
Equity IRR	%	11,48%
Payback Period	Years	8,79
LCOE* (w/o subsidy)	EUR/kWh	0,07
LCOE (w subsidy)	EUR/kWh	0,07
Min DSCR**	x	-
Min LLCR***	x	-

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 26: Business Model 1 Project Overview

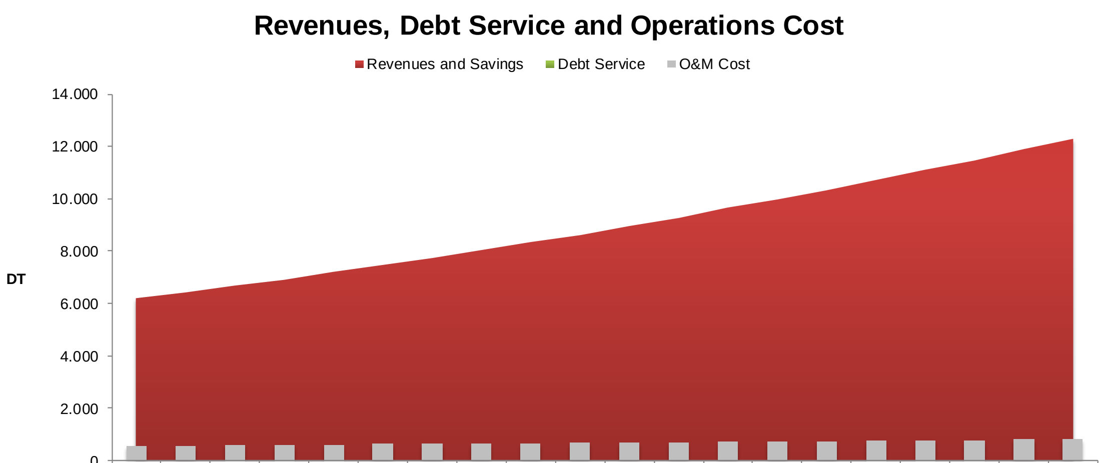
From the results it should be noted that installing a PV system is profitable for public education building consumers in Spain as the LCOE is lower that the electricity price they have to pay to the utility. However, due to the continuous changes in regulation which create uncertainty consumers are not willing to invest in this technology. Even though a new regulation has just been published, consumers mistrust the situation given the changes that have occurred in the last years and because this new regulation is planned to be changed within a maximum period of two years.



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(56.100)																				
Cash Flow for Equity	-	5.634	5.851	6.087	6.330	6.601	6.841	7.108	7.385	7.693	7.964	8.268	8.582	8.933	9.241	9.587	9.943	10.342	10.692	11.085	11.491
Cumulative Cash Flows	(56.100)	(50.500)	(44.719)	(38.742)	(32.564)	(26.160)	(19.565)	(12.753)	(5.719)	1.564	9.059	16.792	24.770	33.024	41.511	50.262	59.283	68.610	78.193	88.069	98.244

Figure 27: Investment and cash flows for Equity for Business Model 1

As the consumer has not requested any financing mechanism all the "revenues" from the savings are for the consumer. After the initial investment in year cero, the consumer obtains all revenues and the only costs he has to cover are O&M costs.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	6.200	6.423	6.670	6.925	7.207	7.459	7.739	8.028	8.349	8.634	8.951	9.279	9.643	9.965	10.325	10.697	11.111	11.476	11.885	12.307
O&M Cost	565	571	583	594	606	618	631	643	656	669	683	696	710	724	739	754	769	784	800	816
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 28: Revenues, debt service and operations costs for Business Model 1

Figure 4 shows how revenues and savings increase gradually throught the lifetime of the system, this is mainly due to the fact that electricity prices rise.

Business Model 2: Self-consumption with bank loan

The second case for Spanish public education buildings is self-consumption 1, as the one before, but in this case the building owner has requested financing through a loan from a bank. The main characteristics of this case are the ones stated in Business model 1 and the characteristics of the loan previously mentioned.

The expected situation for this type of BM will be the one illustrated in the figure below.

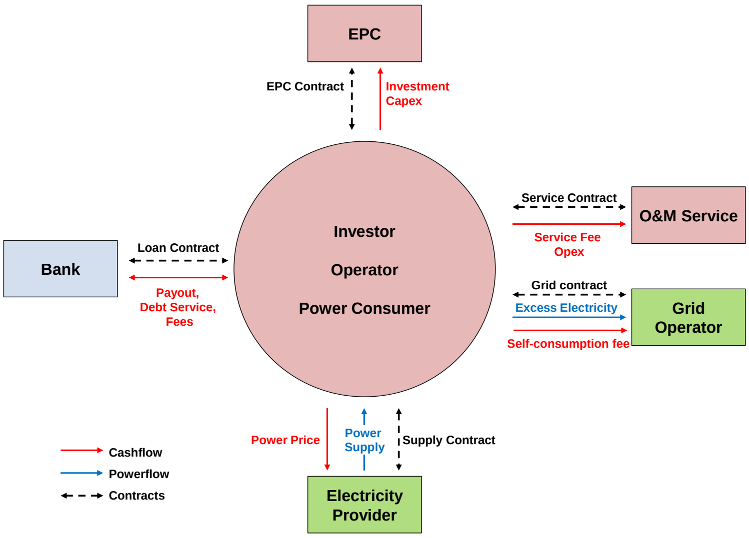


Figure 29: Public education self-consumption with loan

Profitability Analysis

As for the first case, we chose a 30 kWp PV system but added a bank loan as financing mechanism. This case is chosen in order to present different cases for public education buildings, even though it is not very likely to happen.

The main project characteristics and results are illustrated in the figures below.

PV Project			
PV System Size		kWp	30
Specific System Cost		EUR/kWp	1.870
Total System Cost		EUR	56.100
Investment Subsidy		EUR	-
Total System Cost incl. Subsidy		EUR	56.100
Fixed Operation Costs		EUR p.a.	561
Variable Operation Costs		EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	2070
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.760
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	20
Equity		EUR	5.610
Debt (Gearing)	90%	EUR	50.490
Loan Tenor		Years	10
Interest Rate		%	5,2%
Discount Rate		%	0,6%

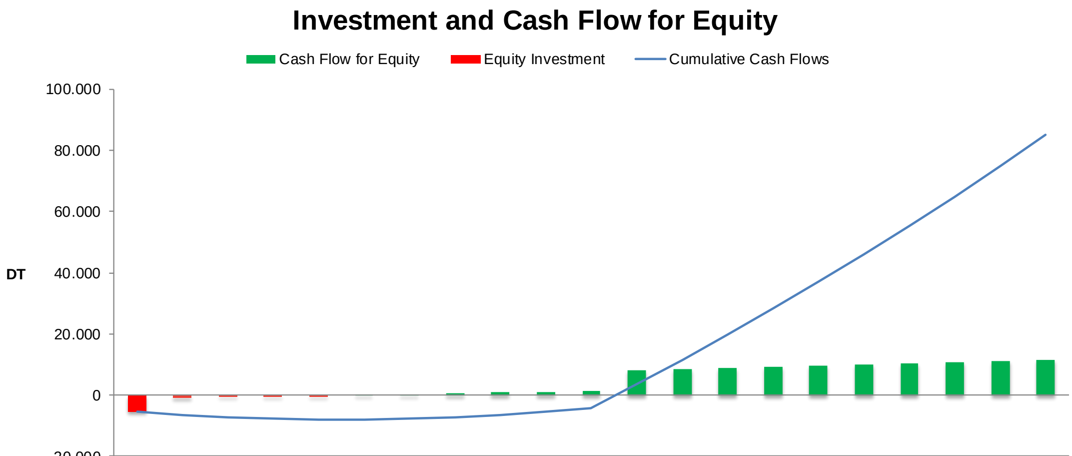
PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	-	EUR/kWh	-
Self-consumption	100%	EUR/kWh	0,1306
Fees		EUR/kWh	0,0179
Net-metering	-	EUR/kWh	-
Fees		EUR/kWh	-
Excess Electricty		EUR/kWh	-
PPA Tariff	-	EUR/kWh	-
Fees		EUR/kWh	-
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	84.978
Project IRR	%	11,48%
Equity IRR	%	19,78%
Payback Period	Years	10,54
LCOE* (w/o subsidy)	EUR/kWh	0,10
LCOE (w subsidy)	EUR/kWh	0,10
Min DSCR**	x	0,86 x
Min LLCR***	x	1,01 x

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

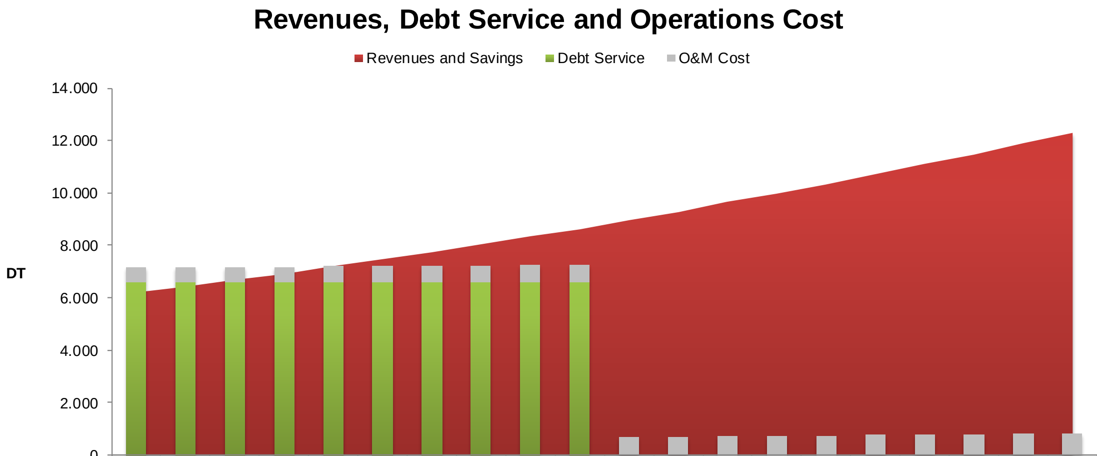
Figure 30: Business Model 2 Project Overview

The indicators presented in the table show that the LCOE in this second case is still lower than the electricity tariff for the public education building consumers.



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(5.610)																				
Cash Flow for Equity	-	(952)	(735)	(499)	(256)	15	254	522	798	1.106	1.378	8.268	8.582	8.933	9.241	9.587	9.943	10.342	10.692	11.085	11.491
Cumulative Cash Flows	(5.610)	(6.556)	(7.282)	(7.773)	(8.022)	(8.008)	(7.763)	(7.263)	(6.502)	(5.455)	(4.158)	3.575	11.553	19.807	28.294	37.045	46.066	55.393	64.976	74.852	85.027

Figure 31: Investment and cash flows for Equity for Business Model 2



	1,0	2,0	3,0	4,0	5,0	6,0	7,0	8,0	9,0	10,0	11,0	12,0	13,0	14,0	15,0	16,0	17,0	18,0	19,0	20,0
Revenues and Savings	6199,969	6422,553	6669,652	6924,578	7207,281	7458,950	7738,936	8027,833	8348,743	8633,537	8950,961	9278,526	9642,913	9965,426	10325,46	10697,03	11110,89	11476,35	11884,88	12306,55
O&M Cost	565,488	571,143	582,566	594,217	606,101	618,223	630,588	643,20	656,064	669,185	682,569	696,220	710,144	724,347	738,834	753,611	768,683	784,057	799,738	815,733
Debt Service	6586,401	6586,401	6586,401	6586,401	6586,401	6586,401	6586,401	6586,401	6586,401	6586,401	-	-	-	-	-	-	-	-	-	-

Figure 32: Revenues, debt service and operations costs for Business Model 1

Comparing the first case with the second one for Spanish public education buildings it can be stated that with the bank loan the consumer does not have any initial down payment and makes fixed gradual payments throughout the first 10 years to cover the overall investment. Because of the interest payments there are additional costs involved, which increases the payback period for financing slightly to 10,54 years.

During the first years the consumer will use the saving from the electricity bills for paying back the loan to the bank (principal plus interest rate). After the first 10 years, the consumers receives all revenues (savings) and the only costs that he has to cover are O&M costs.

5. Industrial park buildings

Segment environment

Nowadays in Spain, it is not common for industrial consumers to invest in PV technology, although, it should be mentioned that there are a few cases where industrial building owners invest in PV in order to gain a certain degree of independence from electric companies.

Industrial companies do not invest in PV mainly due to the situation of great uncertainty that the regulatory changes have created.

The following table provides average data for Spain for the chosen example for an industrial park building.

System size (kWp)	500
Turnkey system prices (EUR/kWp)	1.700
O&M costs (EUR/kWp/a)	25,5
Construction timing	2 months
Operation timing	20 years

Table 7: PV installation and operation costs for Spanish industrial parks buildings (including taxes)[6]

Current financing environment

In order to present different cases for the industrial park buildings segment, a bank loan has been chosen for the second case study even though the BM (self-consumption) is the same. The loan presents the following characteristics:

- Debt Gearing: 60%
- Margin: 4,95 %
- Upfront Fee: 0%
- Commitment Fee: 0%
- Tenor: 5 years
- Grace Period: 0 years

[6] Source: CREARA, *Grid Parity Monitor;* CREARA, *PV Plant Case Study*

It should be highlighted that the possibility of an industrial park building owner asking for debt financing through a loan, is not very common in Spain. However in order to show a different option for consumers, a general bank loan (not specific for PV systems) was chosen for industrial consumers.

Segment Drivers

The main driver for industrial companies is profitability, i.e. they install PV systems to save on electricity costs. There is no difference between energy-intensive companies and the ones with less energy intensive processes, all of them install the system for this reason.

In industrial companies the owner of the building (and the company) is also the one who invests to install a PV system. As in the other application segments, industrial companies do not focus on individual performance parameters for PV installations when analyzing the investment, as the investment is usually done as part of a general energy optimization.

Business Models

Below you find the case study for the business model in the industrial park building application segment in Spain.

At this point, the only possible business model is self-consumption. In order to present two cases we are distinguishing between self-consumption with and without financing mechanism.

It should be highlighted that the business model most to be found in the market is the first one. The second case is based on the possibility that the industrial park building owner asked for debt financing through a loan, which is not very common in Spain. As neither PPA contracts nor leasing mechanisms are options for consumers, the consumer interested in PV systems covers the total initial investment himself.

Business Model 1: Self-consumption

Self-consumption for industrial consumers corresponds to self-consumption 2. In this case there are some characteristics that should be mentioned:

- As the contracted power of these consumers is above 10 kW, they will have to pay the variable charges for self-consumption of 1,2362 cEUR/ kWh.
- The industrial consumers will have to pay the annual fixed cost for self-consumption, accounting for 11,9914 EUR/ kW.
- The consumer receives directly from the grid operator a payment for the excess electricity injected to the grid, the remuneration is based on the daily market. For this exercise we have considered an average of 50 EUR/ MWh.
- The consumer has to pay a fee of 0,50 EUR/MWh for the electricity fed into the grid, as stated by the Royal Decree-Law 14/2010, for electricity generators.

The expected situation for this type of BM will be the one illustrated in the figure below.

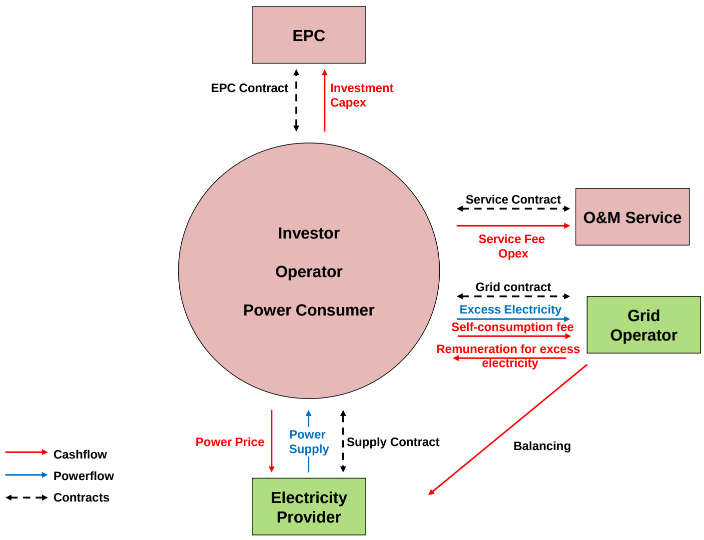


Figure 33: Industrial self-consumption

Profitability Analysis

As stated before for the first case for an industrial park building park owner we chose a 500 kWp PV system with no financing mechanism, as the most common situation in Spain is that the consumer covers the total investment of the PV installation.

The main project characteristics and results are illustrated in the table below. It should be noted that self-consumption data appears in the net-metering part. Therefore the remuneration for the excess electricity injected into the grid is represented by the excess electricity while the charges are included as fees.

PV Project			
PV System Size		kWp	500
Specific System Cost		EUR/kWp	1.700
Additional CapEx (e.g. Batterie)		EUR	-
Investment Subsidy		EUR	-
Total System Cost		EUR	850.000
Fixed Operation Costs		EUR p.a.	18.746
Variable Operation Costs		EUR/kWh	0,0005

PV Generation		
Specific Yield	kWh/qm/a	2070
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.760
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	20
Equity		EUR	850.000
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	7
Interest Rate		%	1,5%
Discount Rate		%	0,6%

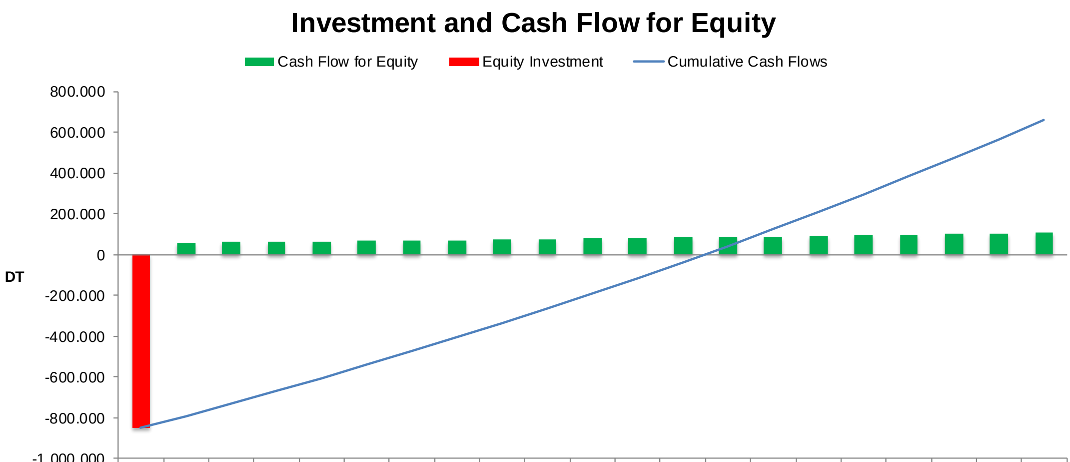
PV Business Model			
Category	**Share**	**Unit**	**Price**
Feed-in Tariff	-	EUR/kWh	-
Self-consumption	-	EUR/kWh	-
Fees		EUR/kWh	-
Net-metering	100%	EUR/kWh	0,0957
Fees		EUR/kWh	0,0124
Excess Electricty		EUR/kWh	0,0500
PPA Tariff	-	EUR/kWh	-
Fees		EUR/kWh	-
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	661.209
Project IRR	%	6,26%
Equity IRR	%	6,26%
Payback Period	Years	12,47
LCOE* (w/o subsidy)	EUR/kWh	0,08
LCOE (w subsidy)	EUR/kWh	0,08
Min DSCR**	x	-
Min LLCR***	x	-

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 34: Business Model 1 Project Overview

From the results it should be noted that installing a PV system is profitable for industrial consumers in Spain as the LCOE is lower that the electricity price they have to pay to the utility. However, due to the continuous changes in regulation which create uncertainty consumers are not willing to invest in this technology. Even though a new regulation has just been published, consumers mistrust the situation given the changes that have occurred in the last years and because this new regulation is planned to be changed within a maximum period of two years.

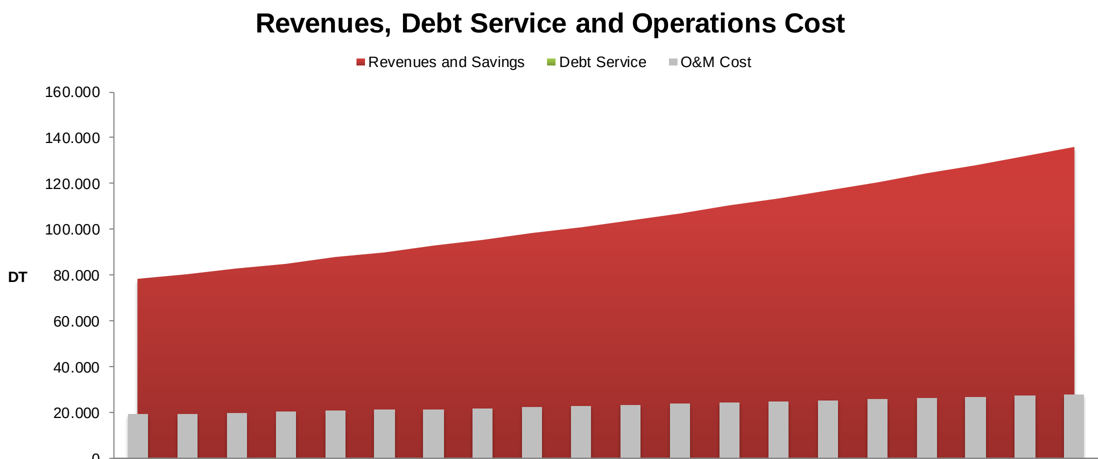


	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(850.00																				
Cash Flow for Equity	-	59.156	60.967	62.869	64.840	67.122	69.001	71.196	73.470	76.094	78.268	80.797	83.417	86.432	88.942	91.854	94.869	98.330	101.225	104.573	108.039
Cumulative Cash Flows	(850.00	(791.20	(730.97	(669.24	(605.95	(540.84	(474.31	(406.08	(336.10	(264.06	(190.41	(114.84	(37.302	42.560	124.243	208.088	294.161	382.833	473.562	566.724	662.390

Figure 35: Investment and cash flows for Equity for Business Model 1

From the figure above it can be seen that the payback period is close to 12 years (11,68 years), i.e. the industrial park building owner recovers the initial investment after 12 years. After that he obtains a profit from the self-consumed electricity (savings) and the one sold to the market.

As the consumer has not requested any financing mechanism all the "revenues" from the savings as well as the income from electricity sale are for the consumer. After the initial investment in year cero, the consumer obtains all revenues and the only costs he has to cover are O&M costs.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	78.494	80.493	82.783	85.149	87.835	90.124	92.738	95.439	98.501	101.118	104.100	107.183	110.671	113.661	117.063	120.579	124.552	127.966	131.845	135.853
O&M Cost	19.337	19.526	19.914	20.309	20.713	21.123	21.542	21.969	22.407	22.850	23.303	23.766	24.239	24.719	25.210	25.710	26.222	26.741	27.272	27.813
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 36: Revenues, debt service and operations costs for Business Model 1

Figure 4 shows how revenues and savings increase gradually throught the lifetime of the system, this is mainly due to the fact that electricity prices rise.

Business Model 2: Self-consumption with bank loan

The second case for Spanish industrial park buildings is self-consumption 2, as the one before, but in this case the industrial park building owner has requested financing through a loan from a bank. The main characteristics of this case are the ones stated in Business model 1 and the characteristics of the loan previously mentioned.

The expected situation for this type of BM will be the one illustrated in the figure below.

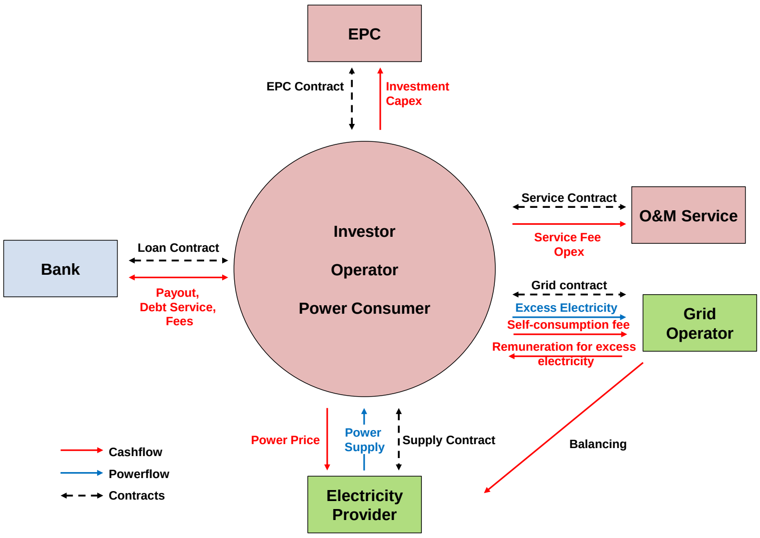


Figure 37: Industrial self-consumption with loan

Profitability Analysis

As for the first case, we chose a 500 kWp PV system but added a bank loan as financing mechanism. This case is chosen in order to present different cases for industrial park buildings, even though it is not very likely to happen.

The main project characteristics and results are illustrated in the figures below. As in Business model 1, it should be noted that self-consumption data appears in the net-metering part.

PV Project		
PV System Size	kWp	500
Specific System Cost	EUR/kWp	1.700
Additional CapEx (e.g. Batterie)	EUR	-
Investment Subsidy	EUR	-
Total System Cost	EUR	850.000
Fixed Operation Costs	EUR p.a.	18.746
Variable Operation Costs	EUR/kWh	0,0005

PV Generation		
Specific Yield	kWh/qm/a	2070
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.760
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	20
Equity		EUR	342.101
Debt (Gearing)	60%	EUR	510.000
Loan Tenor		Years	10
Interest Rate		%	5,2%
Discount Rate		%	0,6%

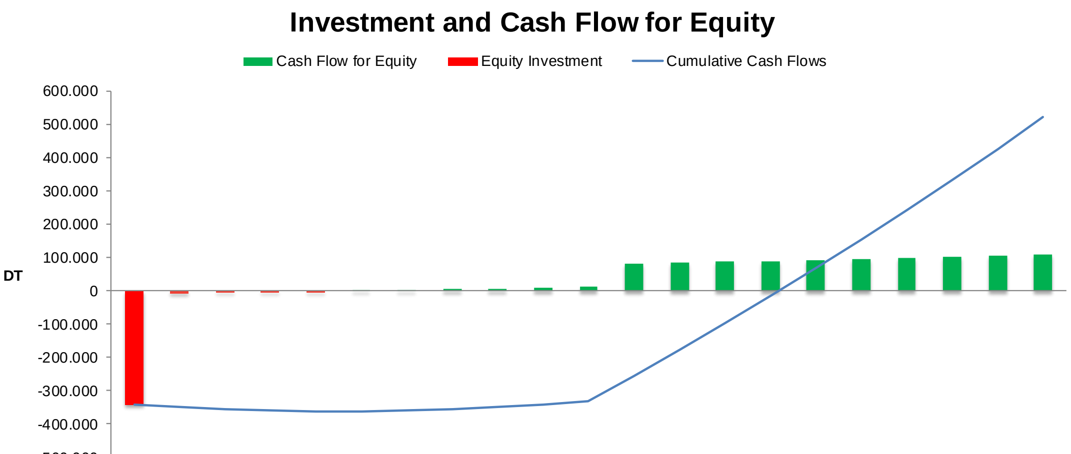
PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	-	EUR/kWh	-
Self-consumption	-	EUR/kWh	-
Fees		EUR/kWh	-
Net-metering	100%	EUR/kWh	0,0957
Fees		EUR/kWh	0,0124
Excess Electricty		EUR/kWh	0,0500
PPA Tariff	-	EUR/kWh	-
Fees		EUR/kWh	-
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	521.391
Project IRR	%	6,23%
Equity IRR	%	6,71%
Payback Period	Years	14,19
LCOE* (w/o subsidy)	EUR/kWh	0,10
LCOE (w subsidy)	EUR/kWh	0,10
Min DSCR**	x	0,89 x
Min LLCR***	x	1,01 x

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 38: Business Model 2 Project Overview

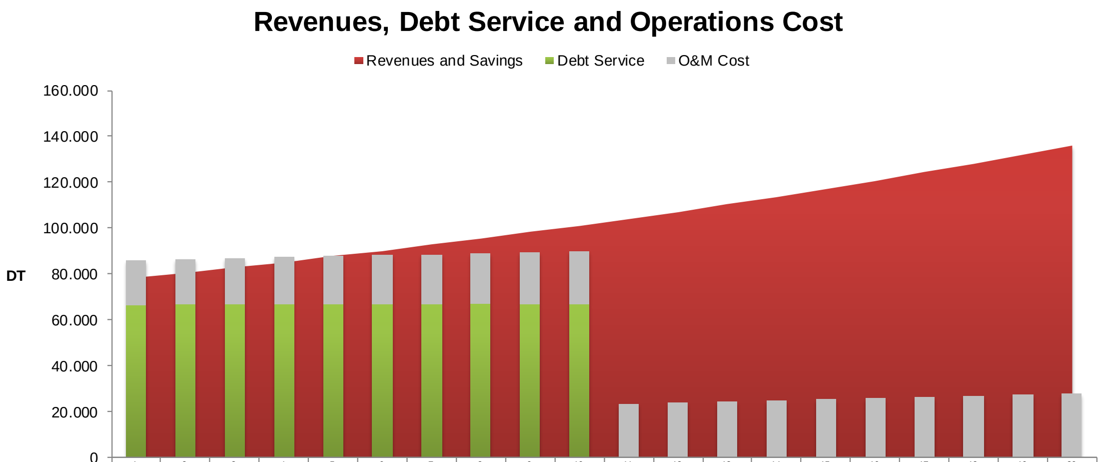
The indicators presented in the table show that the LCOE in this second case is still lower than the electricity tariff for the industrial consumers.



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(342.10																				
Cash Flow for Equity	-	(7.373)	(5.858)	(4.225)	(2.254)	28	1.907	4.102	6.376	9.000	11.174	80.797	83.417	86.432	88.942	91.854	94.869	98.330	101.225	104.573	108.039
Cumulative Cash Flows	(342.10	(349.42	(355.21	(359.36	(361.56	(361.53	(359.69	(355.76	(349.69	(341.17	(330.65	(255.08	(177.54	(97.681	(15.998	67.847	153.920	242.592	333.321	426.483	522.149

Operations Year

Figure 39: Investment and cash flows for Equity for Business Model 2



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	78.494	80.493	82.783	85.149	87.835	90.124	92.738	95.439	98.501	101.118	104.100	107.183	110.671	113.661	117.063	120.579	124.552	127.966	131.845	135.853
O&M Cost	19.337	19.526	19.914	20.309	20.713	21.123	21.542	21.969	22.407	22.850	23.303	23.766	24.239	24.719	25.210	25.710	26.222	26.741	27.272	27.813
Debt Service	66.529	66.825	67.094	67.094	67.094	67.094	67.094	67.094	67.094	67.094	-	-	-	-	-	-	-	-	-	-

Operations Year

Figure 40: Revenues, debt service and operations costs for Business Model 1

Comparing the first case with the second one for Spanish industrial park buildings it can be stated that with the bank loan the consumer does not have any initial down payment and makes fixed gradual payments throughout the first 10 years to cover the overall investment. Because of the interest payments there are additional costs involved, which increases the payback period for financing slightly to 14,19 years.

During the first years the consumer will use the saving from the electricity bills and any additional income from the electricity sale for paying back the loan to the bank (principal plus interest rate). After the first 10 years, the consumers receives all revenues (savings plus income from energy sale) and the only costs that he has to cover are O&M costs.