PVFINANCING

D2.6 Business Model Report

Germany

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Introduction

There are two main suitable business models for Germany: one is *self-consumption* and the second is *supply* or *Power Purchasing Agreement Model (PPA).* The main criteria to decide the type of model is the number of consumers. Self-consumption is recommended for "one" purchaser, meaning one family or one company. PPA is used for more than one buyer.

Self-consumption is only allowed when the plant operator and the consumer are the same entity. The operator doesn´t have to be the owner of the facility, but has to bear the economic risks of the plant operation. In this business model the electricity purchaser has the option to buy the PV system or the rent it "Pacht"[1]. In the case of "Pacht" there should be a single consumer as the lessee of the PV system. One of the requirements to rent the facility is to transfer the risks for operation to the lessee in order to qualify for self-consumption to avoid the complete payment of the EEG surcharge. In the market there are providers offering contracts for this. In the *self-consumption* model, the user has the obligation to have an electricity contract with a utility to secure the electricity supply.

All PV installations are charged with an "EEG surcharge" for self-produced and consumed electricity. This takes place in three steps: in 2015 the charge will be of 30% of the EEG surcharge, in 2016 will be of 35% and from 2017 the amount will reach 40%. Systems up to 10 kWp and with an annual generation of less than 10MWh are exempt from this charge.

PPA model is applied when self-consumption is not possible, meaning when the plant operator and the consumer are not the same person (requirement of being consider self-consumer). In this model, the purchaser has two contract options: the first option offers 100% of electricity supply, which includes the PV electricity produced from the system and electricity from the grid when needed. This tariff is cheaper than the grid tariff. The second contract option offers the supply of electricity produced from the PV system. In this case the tenant must have a contract with a utility for the supply from the public grid. The electricity bill will be a mix of both. PPA's are charged with the whole EEG surcharge.

[1] In Germany the model of renting the system is called "Pacht", which differs from the "Leasing" in the contract conditions regarding the transfer of risks for the operation.

The excess of electricity produced can be feed into the public grid receiving the corresponding Feed-In-Tariff (EEG). In the case of self-consumption, if not all the electricity can be consumed, this hast to be feed into the grid. The FiT is currently too low, but is still important as a back-up in case the off-taker defaults. In the following chapters the different business models in the different application segments will be presented.

The optimization of the consume profile, which currently differs between the sectors and its electricity consume (e.g. households is between 20% and 40% and large buildings is around 70% and 90%) is one of the keys to make the business models profitable. This factor influences particularly the household sector. This could be achieved through technical improvements and the appropriate sizing of the PV system.

1. Residential Single Houses

Segment environment

Currently is the “Residential Single House” segment one of the biggest where PV is being installed in Germany. About 80% of the PV systems are ≤10 kWp and 12% between 10 kWp and 40 kWp. The market is principally driven by this segment based on self-consumption, due to the reduced amount of “EEG surcharge” that the user has to pay or the exemption of this surcharge if the system is up to 10 kWp.

Segment Drivers

If the households have enough economic solvency they would tend to finance the PV systems through equity. If not, they are likely to rent (“Pacht”) the system.

Profitability is the main driver to develop power systems for households in Germany. The current tariff of electricity from the grid in this segment is 29 ct/kWh, while the electricity cost of electricity produced with a PV system is around 12-18 ct/kWh. Soft factors as energy independency and CO2 emission reduction are also important drivers for the single houses to invest in PV systems.

If the consumer doesn’t have or doesn´t want to invest the money in the PV system and wants to benefit from savings without investment, they would tend to use the “Pacht” financial scheme.

Business Models

The two models of the single-family houses are based on self-consumption due to the reduced EEG surcharge to be paid. Other options are not profitable. The consumption profile of household in Germany is around 20% - 40% depending on the size of the system. The remainder electricity is feed into the grid and will get the FiT (which could make it less attractive). Hence the increment of the consumption profile is the key for a higher profitability.

The two business models are based on an average example of a household of 4 people which invest in a 5 kWp PV system. The size of the system was based on the regular consume of approx. 4.000 -4.500 kWh/a.

If the household has sufficient amount of equity, it will regularly invest with a higher percentage of equity.

Business Model 1: Self-consumption financed through 100% equity

As mentioned in the introduction, a requirement for self-consumption is that the plant operator and the consumer are the same person. In this case the household has a plenty amount of equity and decide to invest 100% of the total cost of a PV system.

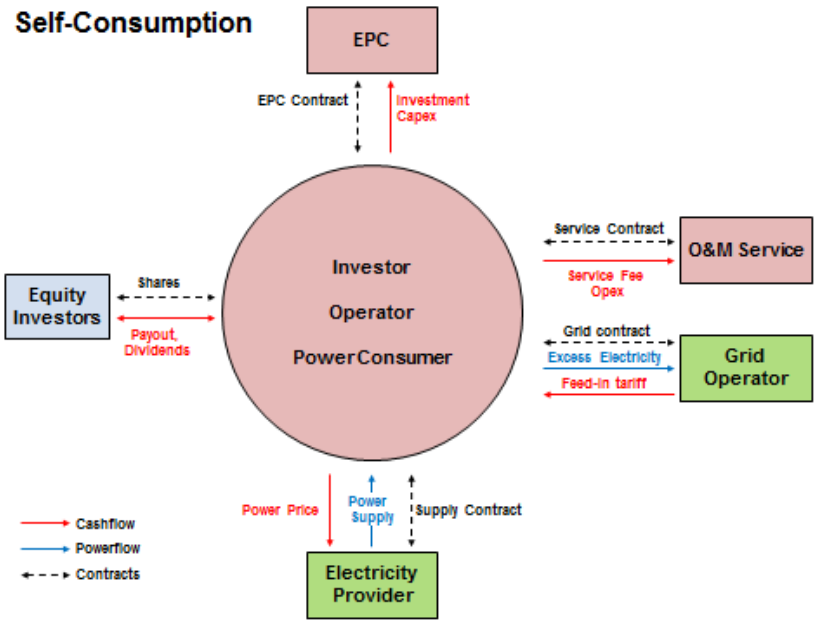


Figure 1: Self-consumption financed through 100% equity

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project		
PV System Size	kWp	5
Specific System Cost	EUR/kWp	1.520
Total System Cost	EUR	6.840
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	6.840
Fixed Operation Costs	EUR p.a.	183
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	950
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	808
Degradation	% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	6.840
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	-
Interest Rate		%	3,8%
Discount Rate		%	2,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	70%	EUR/kWh	0,1224
Self-consumption	30%	EUR/kWh	0,2900
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	999
Project IRR	%	3,40%
Equity IRR	%	3,40%
Payback Period	Years	17,15
LCOE* (w/o subsidy)	EUR/kWh	0,19
LCOE (w subsidy)	EUR/kWh	0,19
Min DSCR**	x	-
Min LLCR***	x	-

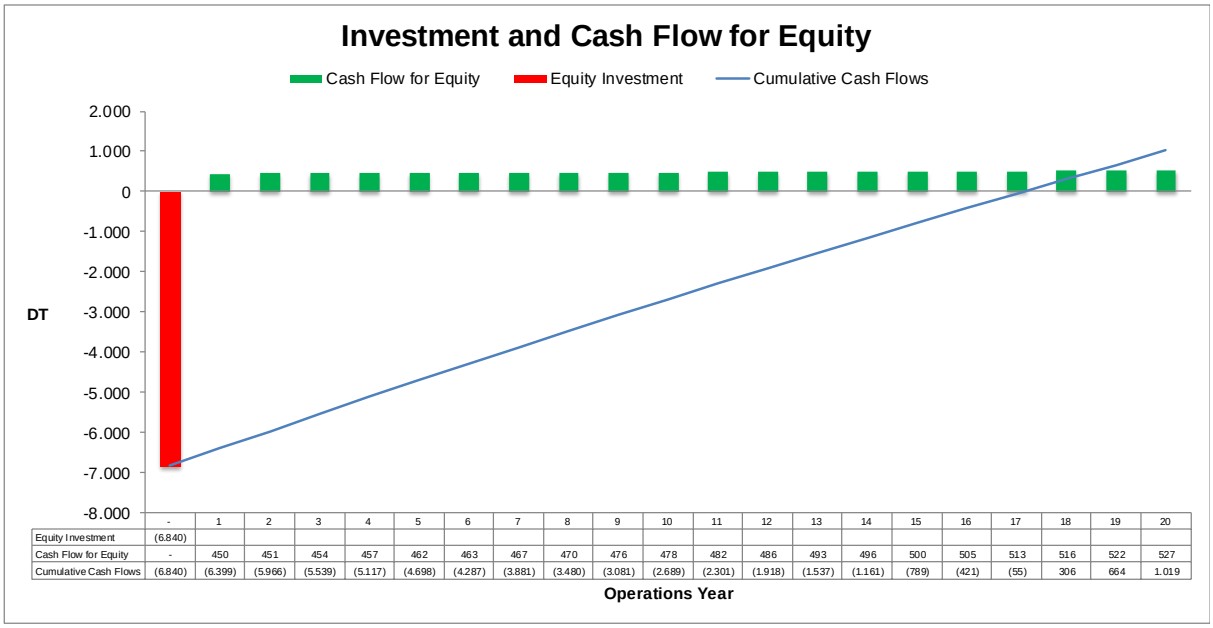
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 2: Project Overview - Business Model 1

The results above indicate that installing a PV system based on equity is profitable:

- The Levelized Cost of Electricity (LCOE) corresponding to 19 ct/kWh is lower than the current electricity price of the grid which corresponds to 29 ct/kWh.
- The Equity IRR is more than 3 %.
- The EEG surcharge isn't applied since the PV system is ≤10 kWp

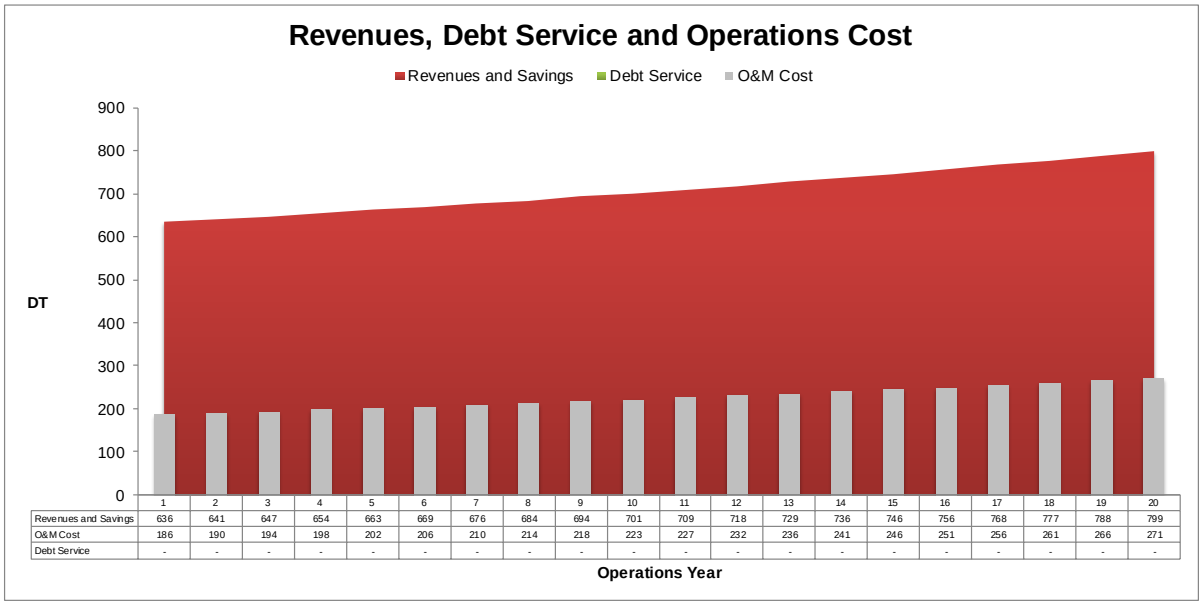
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(6.840)																				
Cash Flow for Equity	-	450	451	454	457	462	463	467	470	476	478	482	486	493	496	500	505	513	516	522	527
Cumulative Cash Flows	(6.840)	(6.399)	(5.966)	(5.539)	(5.117)	(4.698)	(4.287)	(3.881)	(3.480)	(3.081)	(2.689)	(2.301)	(1.918)	(1.537)	(1.161)	(789)	(421)	(55)	306	664	1.019

Figure 3 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	636	641	647	654	663	669	676	684	694	701	709	718	729	736	746	756	768	777	788	799
O&M Cost	186	190	194	198	202	206	210	214	218	223	227	232	236	241	246	251	256	261	266	271
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 4 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in year 17. After that the household obtains a profit from the self-consumed electricity (savings).
- The only costs to pay during the period are regarding O&M which leaves high profit margin.

Business Model 2: Self-consumption financed through 30% equity and 70%loan

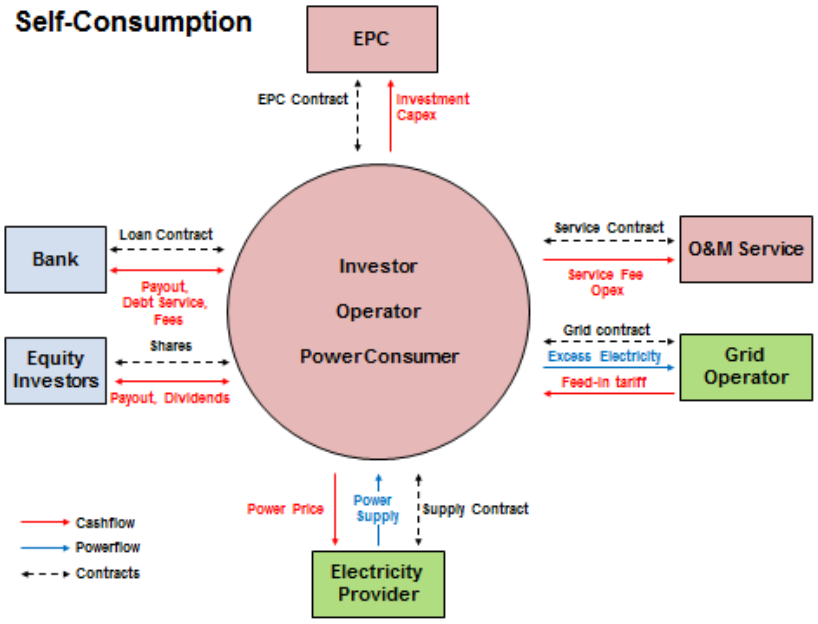


Figure 5 Self-consumption financed through 30% equity and 70% loan

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project			
PV System Size		kWp	5
Specific System Cost		EUR/kWp	1.520
Total System Cost		EUR	6.840
Investment Subsidy		EUR	-
Total System Cost incl. Subsidy		EUR	6.840
Fixed Operation Costs		EUR p.a.	183
Variable Operation Costs		EUR/kWh	-

PV Generation			
Specific Yield		kWh/qm/a	950
Performance Factor		%	85%
Specific System Performance		kWh/kWp/a	808
Degradation		% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	2.117
Debt (Gearing)	70%	EUR	4.788
Loan Tenor		Years	15
Interest Rate		%	3,8%
Discount Rate		%	2,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	70%	EUR/kWh	0,1224
Self-consumption	30%	EUR/kWh	0,2900
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	296
Project IRR	%	3,30%
Equity IRR	%	2,85%
Payback Period	Years	19,14
LCOE* (w/o subsidy)	EUR/kWh	0,20
LCOE (w subsidy)	EUR/kWh	0,20
Min DSCR**	x	1,06 x
Min LLCR***	x	1,11 x

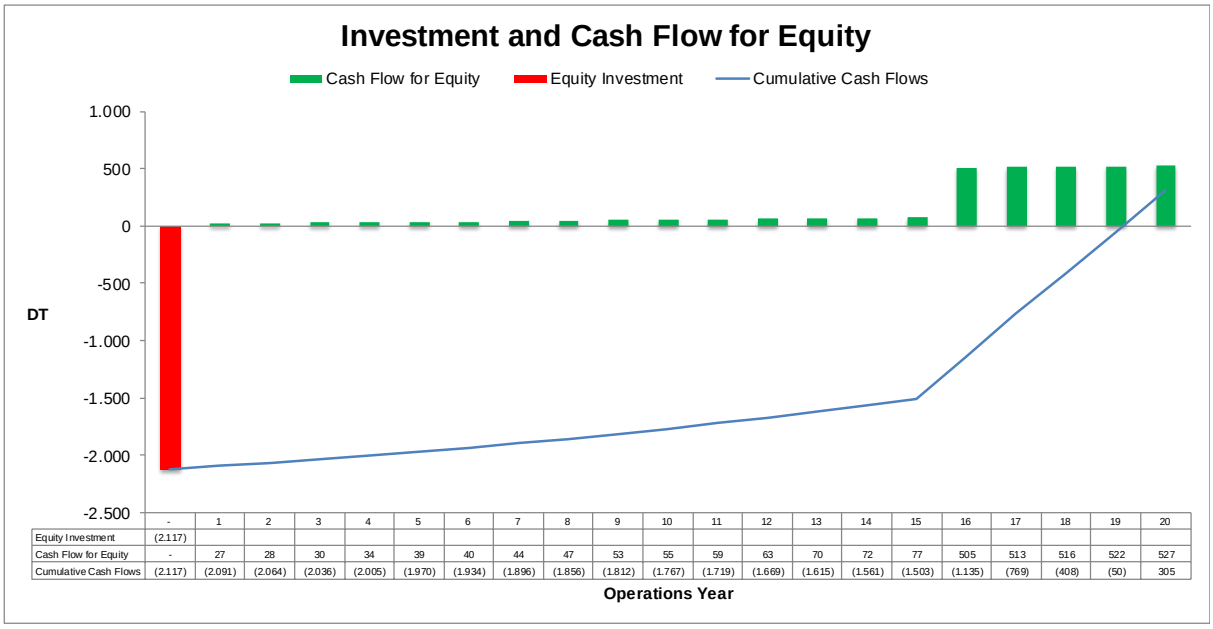
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 6: Project Overview - Business Model 2

The results above indicate that installing a PV system with a higher amount of debt than equity is profitable:

- The Levelized Cost of Electricity (LCOE) corresponding to 20 ct/kWh is lower than the current electricity price of the grid which corresponds to 29 ct/kWh.
- The EEG surcharge isn't applied since the PV system is ≤10 kWp.
- The IRR is around 3% and the DSCR and LLCR are over 1.

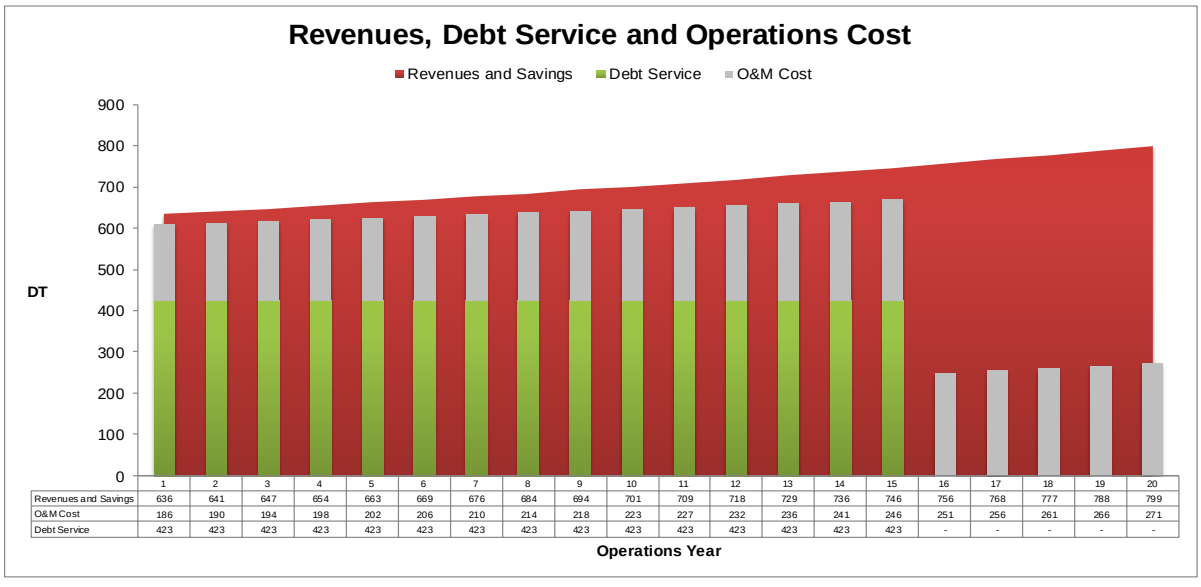
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(2.117)																				
Cash Flow for Equity	-	27	28	30	34	39	40	44	47	53	55	59	63	70	72	77	505	513	516	522	527
Cumulative Cash Flows	(2.117)	(2.091)	(2.064)	(2.036)	(2.005)	(1.970)	(1.934)	(1.896)	(1.856)	(1.812)	(1.767)	(1.719)	(1.669)	(1.615)	(1.561)	(1.503)	(1.135)	(769)	(408)	(50)	305

Figure 7 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	636	641	647	654	663	669	676	684	694	701	709	718	729	736	746	756	768	777	788	799
O&M Cost	186	190	194	198	202	206	210	214	218	223	227	232	236	241	246	251	256	261	266	271
Debt Service	423	423	423	423	423	423	423	423	423	423	423	423	423	423	423	-	-	-	-	-

Figure 8 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in year 19. After that the household obtains all the profit from the self-consumed electricity (savings).
- Even though a loan has to be paid, there are still revenues from the savings for the owner of the system.

Comparing the two models it is showed that with a bank loan the consumer does not have a big initial down payment and makes fixed gradual payments throughout the first 15 years to cover the overall investment. There are additional costs involved due to the interest payments, which increases the payback period for financing to 19 years.

2. Residential Multi-Family Houses

Segment environment

In multi-family houses people usually rent their apartments, thus the common approach is to supply PV electricity via a PPA. To get people to sign a PV PPA, for the lower income households, the price advantage is the key. The self-consumption profile of multi-family houses in is around 80% - 90% depending on the size of the system, the excess of electricity is feed into the grid.

A one year contract is common for grid electricity supply and since the PV electricity is delivered together with grid electricity this market standard has to be offered as well if not less (e.g. monthly cancellation). In general, an absolute hassle-free signup is necessary for a tenant.

Segment Drivers

Since bigger systems can be applied and tenants have very high electricity prices, the PPA model is feasible in the multi-family segment. For higher income households other soft factors are more important (energy independence, CO2 savings).

One reason for households to not sign a PPA is a lack of trust in the company or a lack of interest in electricity savings because the total savings a relatively low. As mentioned before, this changes with the income class of the household.

Business Models

The following two business models described in the multi-family segment are based on the Power Purchasing Agreement. The reason is because there is more than one buyer involved (see introduction).

Business Model 1: PPA financed through a cooperative (100% equity)

The first model is a PPA financed through an energy cooperative (equity investors). The energy investors could be the tenants or other investors. In this model the tenants get the 100% supply (see introduction) and pay the consumed electricity to the cooperative, this includes the electricity produced by the PV system and from the grid when needed. The cooperative should have a separate agreement with a utility for the electricity supply from the grid.

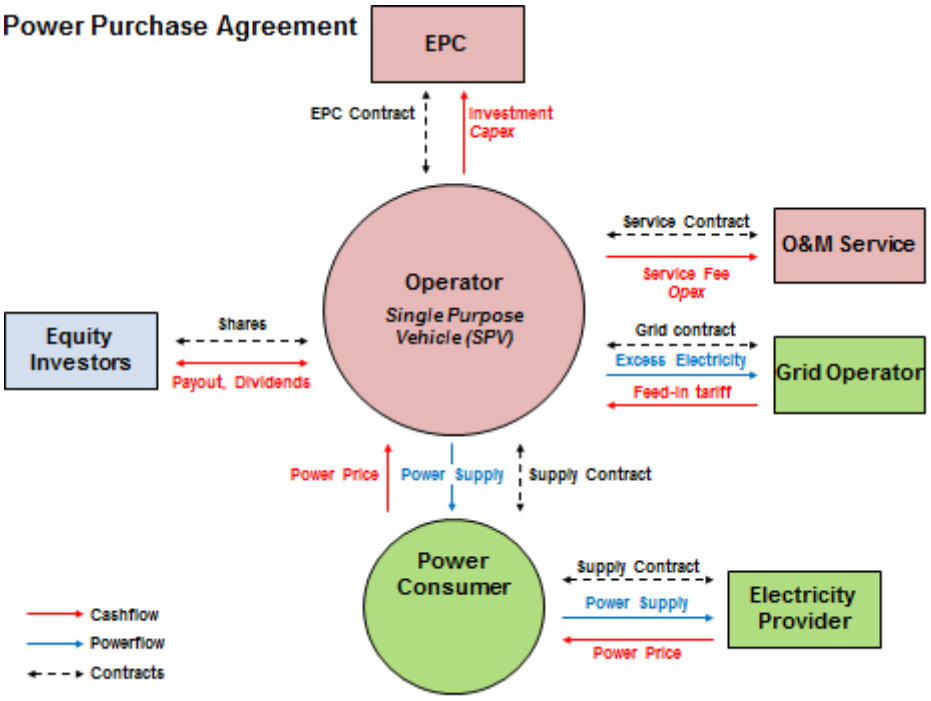


Figure 9: Self-consumption financed through 100 % equity (investors)

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project		
PV System Size	kWp	50
Specific System Cost	EUR/kWp	1.275
Total System Cost	EUR	63.750
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	63.750
Fixed Operation Costs	EUR p.a.	1.056
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	950
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	808
Degradation	% p.a.	0,30%

Investment			
Project Duration		Years	20
Equity		EUR	63.750
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	-
Interest Rate		%	3,8%
Discount Rate		%	2,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	15%	EUR/kWh	0,1206
Self-consumption	-	EUR/kWh	-
Fees		EUR/kWh	-
Net-metering	-	EUR/kWh	-
Fees		EUR/kWh	-
Excess Electricty		EUR/kWh	-
PPA Tariff	85%	EUR/kWh	0,2300
Fees		EUR/kWh	0,0630
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	61.715
Project IRR	%	9,22%
Equity IRR	%	9,22%
Payback Period	Years	10,78
LCOE* (w/o subsidy)	EUR/kWh	0,13
LCOE (w subsidy)	EUR/kWh	0,13
Min DSCR**	x	-
Min LLCR***	x	-

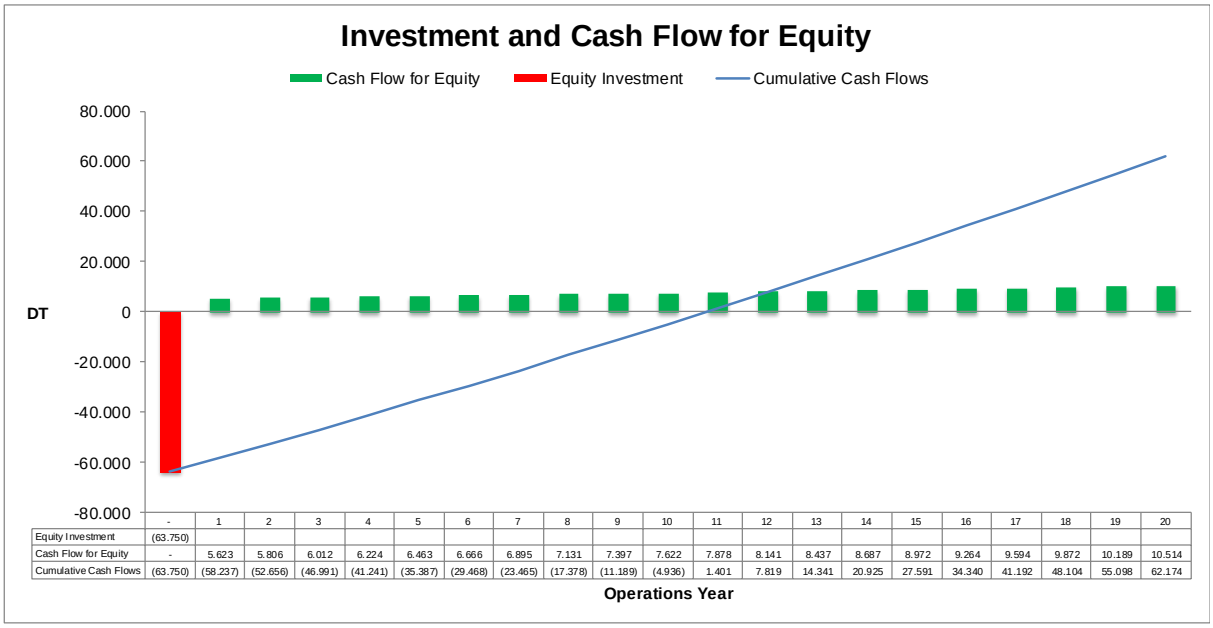
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 10: Project Overview - Business Model 1

The results above indicate that installing a PV system financed through equity (energy cooperatives) is profitable:

- The PPA Tariff corresponding to 23 ct/kWh (EEG-surcharge included) is lower than the current electricity price of the grid which corresponds to 29 ct/kWh.
- The IRR is 9%, though an EEG-surcharge of 0,063 Euros / kwh that has to be paid.

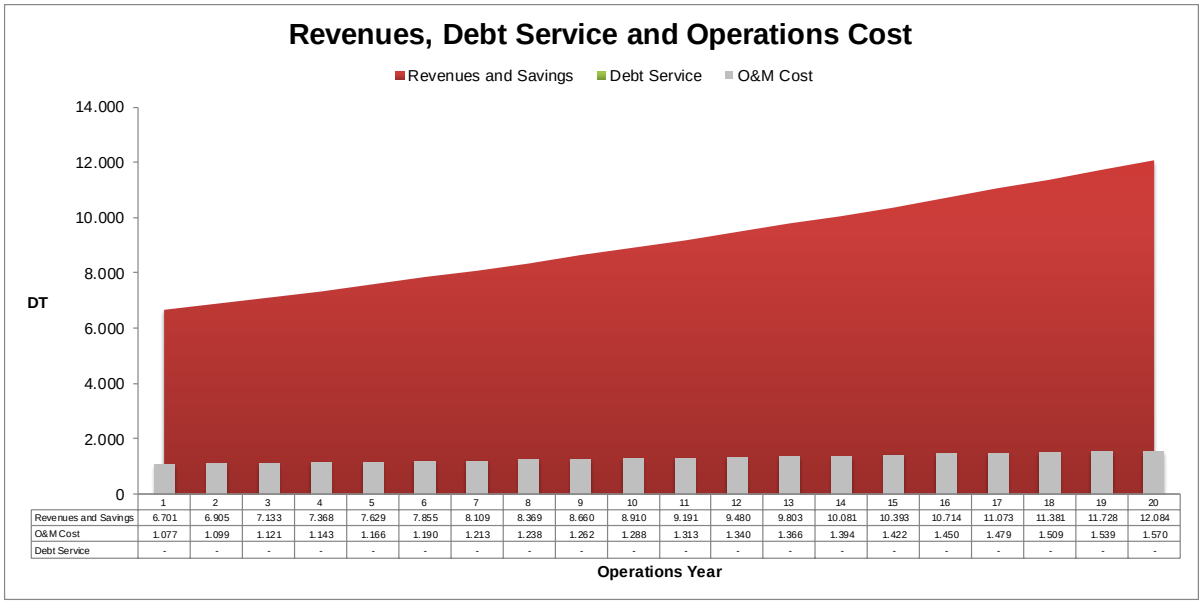
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(63.750)																				
Cash Flow for Equity	-	5.623	5.806	6.012	6.224	6.463	6.666	6.895	7.131	7.397	7.622	7.878	8.141	8.437	8.687	8.972	9.264	9.594	9.872	10.189	10.514
Cumulative Cash Flows	(63.750)	(58.237)	(52.656)	(46.991)	(41.241)	(35.387)	(29.468)	(23.465)	(17.378)	(11.189)	(4.936)	1.401	7.819	14.341	20.925	27.591	34.340	41.192	48.104	55.098	62.174

Figure 11 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	6.701	6.905	7.133	7.368	7.629	7.855	8.109	8.369	8.660	8.910	9.191	9.480	9.803	10.081	10.393	10.714	11.073	11.381	11.728	12.084
O&M Cost	1.077	1.099	1.121	1.143	1.166	1.190	1.213	1.238	1.262	1.288	1.313	1.340	1.366	1.394	1.422	1.450	1.479	1.509	1.539	1.570
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 12 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in the eleventh year. After that the investor obtains a profit from the self-consumed electricity (savings).
- Since the PV system is paid with equity (investors), all the revenues from the savings are for them. After the initial investment in year zero, the investor obtains all revenues and the only costs to cover are O&M costs.

Business Model 2: PPA -Utility- financed through 70% loan and 30% equity

The second model is a PPA financed through a loan and equity. The 15 year loan is given to a company which acts as an investor. With the current bank conditions in Germany, the debtor should be individuals with creditworthiness.

A potential investor and operator could be a utility, who at the same time would be the supplier. For the utility it would be easier to get a bank loan. The utility could use other providers to operate and sell the services.

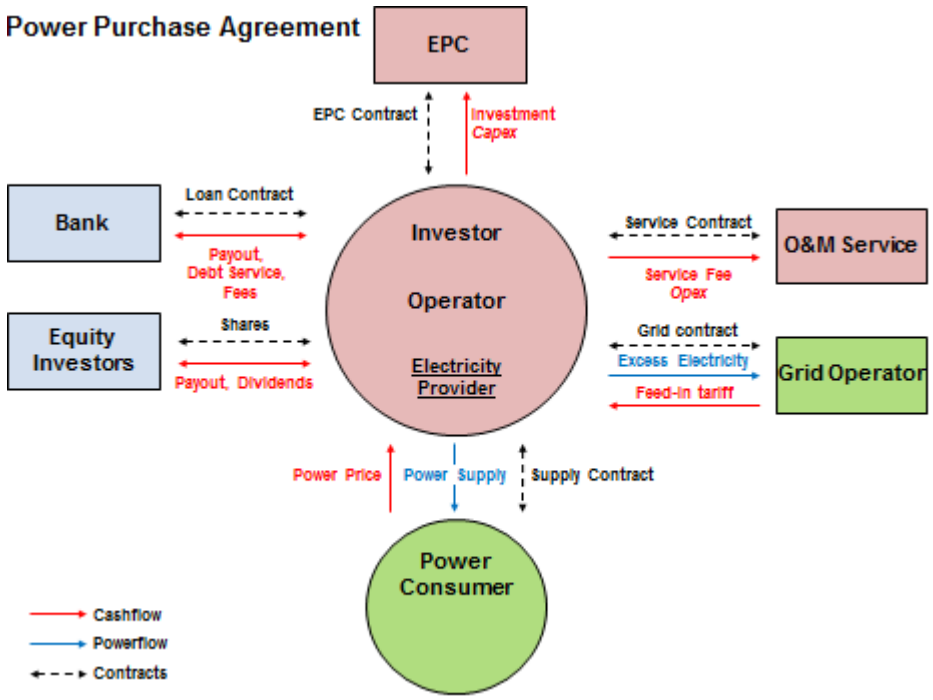


Figure 13: Self-consumption financed through 70% loan and 30% equity

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project		
PV System Size	kWp	50
Specific System Cost	EUR/kWp	1.275
Total System Cost	EUR	63.750
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	63.750
Fixed Operation Costs	EUR p.a.	1.056
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	950
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	808
Degradation	% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	19.729
Debt (Gearing)	70%	EUR	44.625
Loan Tenor		Years	15
Interest Rate		%	3,8%
Discount Rate		%	2,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	15%	EUR/kWh	0,1206
Self-consumption	-	EUR/kWh	-
Fees		EUR/kWh	-
Net-metering	-	EUR/kWh	-
Fees		EUR/kWh	-
Excess Electricty		EUR/kWh	-
PPA Tariff	85%	EUR/kWh	0,2300
Fees		EUR/kWh	0,0630
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	52.019
Project IRR	%	8,85%
Equity IRR	%	14,23%
Payback Period	Years	9,00
LCOE* (w/o subsidy)	EUR/kWh	0,15
LCOE (w subsidy)	EUR/kWh	0,15
Min DSCR**	x	1,42 x
Min LLCR***	x	1,75 x

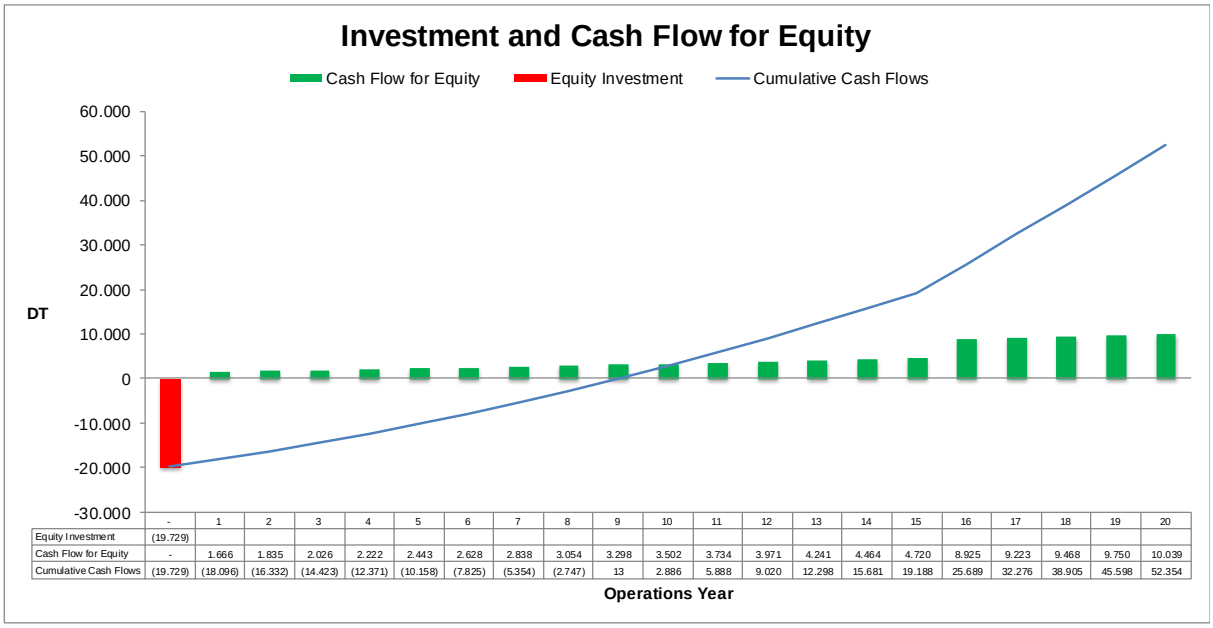
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 14: Project Overview - Business Model 2

The results above indicate that installing a PV system being financed by a loan is profitable.

- The PPA Tariff corresponding to 23 ct/kWh (EEG-surcharge included) is lower than the current electricity price of the grid which corresponds to 29 ct/kWh.
- The project IRR is 9% and the equity IRR is 14% due to the EEG-surcharge.
- The DSCR and LLCR is over 1.
- The Net-Present Value is positive.

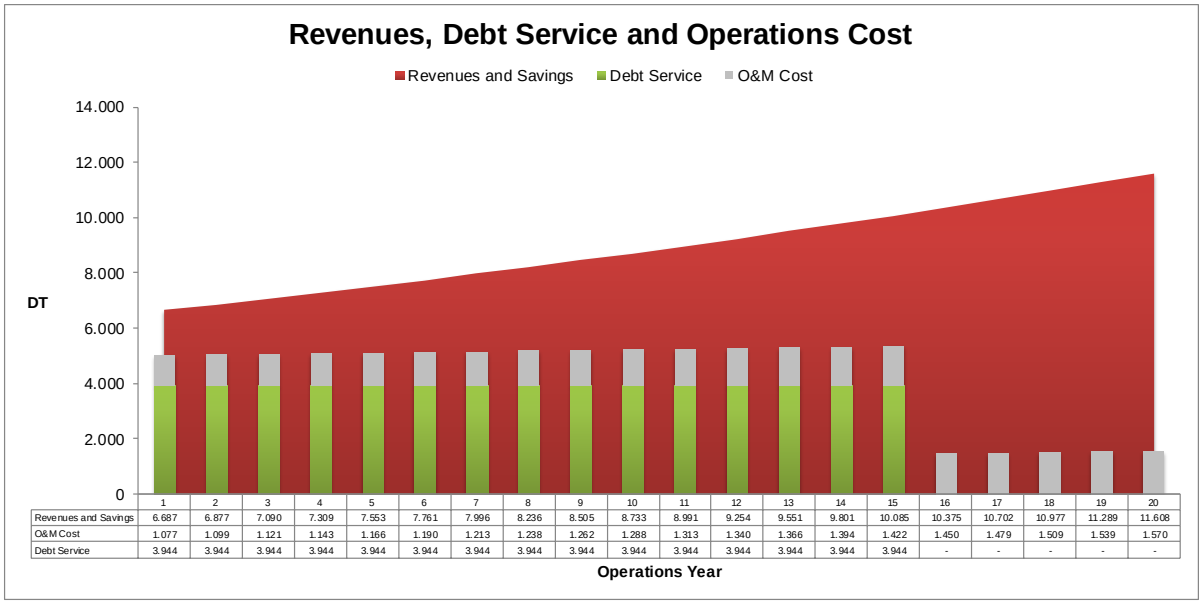
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(19.729)																				
Cash Flow for Equity	-	1.666	1.835	2.026	2.222	2.443	2.628	2.838	3.054	3.298	3.502	3.734	3.971	4.241	4.464	4.720	8.925	9.223	9.468	9.750	10.039
Cumulative Cash Flows	(19.729)	(18.096)	(16.332)	(14.423)	(12.371)	(10.158)	(7.825)	(5.354)	(2.747)	13	2.886	5.888	9.020	12.298	15.681	19.188	25.689	32.276	38.905	45.598	52.354

Figure 15 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	6.687	6.877	7.090	7.309	7.553	7.761	7.996	8.236	8.505	8.733	8.991	9.254	9.551	9.801	10.085	10.375	10.702	10.977	11.289	11.608
O&M Cost	1.077	1.099	1.121	1.143	1.166	1.190	1.213	1.238	1.262	1.288	1.313	1.340	1.366	1.394	1.422	1.450	1.479	1.509	1.539	1.570
Debt Service	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	-	-	-	-	-

Figure 16 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in the ninth year. After that, the owner(s) of the PV system obtains the complete profit from the self-consumed electricity (savings).
- The 70% loan is paid by all the revenues from the savings in the first 15 years. After this, the investor obtains all revenues and the only costs to cover are O&M costs.

3. Commercial Shopping Malls

Segment environment

Due to the usual structure of one owner and a group of tenants, a PPA would also be the only viable approach. Still not many PV projects have been implemented in this segment due to the lack of information regarding the profitability.

Two business models are suggested with different financial options such as cooperative and loan. The consumption profile of shopping malls is around 90% depending on the size of the PV system, the excess of electricity is feed into the grid.

Segment Drivers

Profitability is also the main driver to use PV systems for commercial shopping malls. The green image resulting from the PV system is a plus for tenants with a lot of customer traffic. This is a new driver which has been becoming stronger in the last years. In the future, certain regulations may force owners of existing buildings to increase energy savings which would be another driver for PV investments.

Business Models

The following two business models described in the commercial shopping center segment are based on the Power Purchasing Agreement. The reason is because there is more than one buyer involved (see also introduction). Since there are not many projects implemented in this segment, the following models are suggestions.

Business Model 1: PPA financed through a cooperative

The first model is a PPA financed through an energy cooperative (equity investors). The energy investors could be the tenants or other investors. In this model the tenants get the 100% supply (see introduction) and pay the electricity that they use to the cooperative, this includes the electricity produced by the PV system and from the grid when needed. The cooperative should have a separate agreement with a utility for the electricity supply from the grid. The excess of electricity is feed into the grid and receives the FiT.

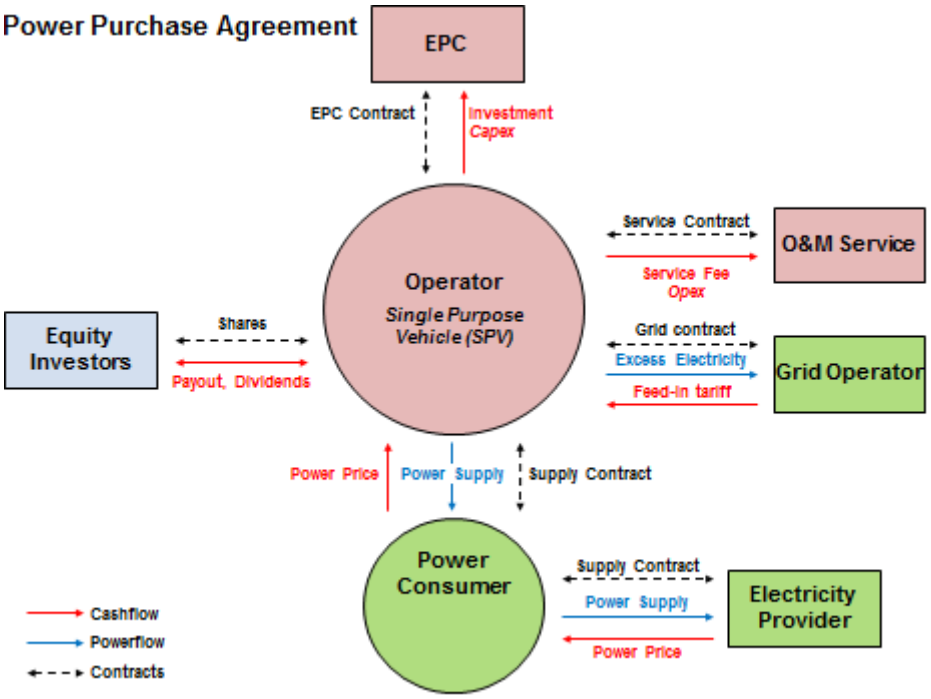


Figure 17: Self-consumption financed through 100 % equity (investors)

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project		
PV System Size	kWp	120
Specific System Cost	EUR/kWp	1.230
Total System Cost	EUR	147.600
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	147.600
Fixed Operation Costs	EUR p.a.	2.314
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	950
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	808
Degradation	% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	147.600
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	-
Interest Rate		%	1,3%
Discount Rate		%	2,0%

PV Business Model				
Category		Share	Unit	Price
Feed-in Tariff		5%	EUR/kWh	0,1146
Self-consumption		-	EUR/kWh	-
	Fees		EUR/kWh	-
Net-metering		-	EUR/kWh	-
	Fees		EUR/kWh	-
	Excess Electricty		EUR/kWh	-
PPA Tariff		95%	EUR/kWh	0,2200
	Fees		EUR/kWh	0,0630
	Overysupply Price		EUR/kWh	-
	Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	149.696
Project IRR	%	9,49%
Equity IRR	%	9,49%
Payback Period	Years	10,56
LCOE* (w/o subsidy)	EUR/kWh	0,13
LCOE (w subsidy)	EUR/kWh	0,13
Min DSCR**	x	-
Min LLCR***	x	-

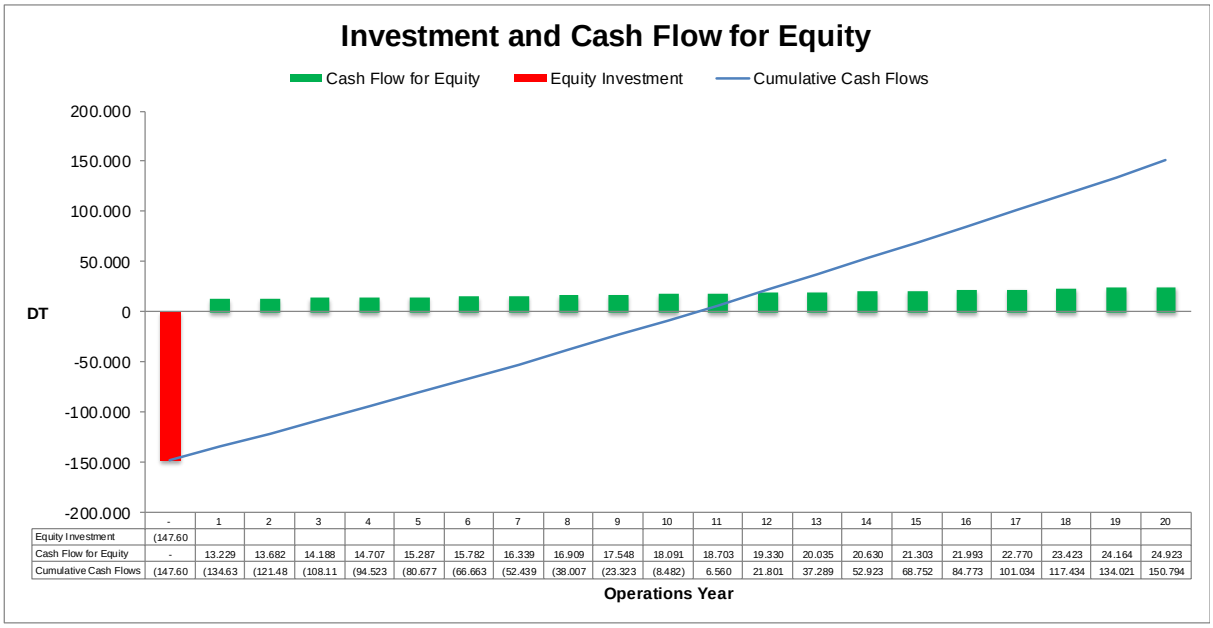
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 18: Project Overview - Business Model 1

The results above indicate that installing a PV system financed through equity (through an energy cooperative) is profitable:

- The PPA Tariff corresponding to 22 ct/kWh (EEG-surcharge included) is lower than the current electricity price of the grid which corresponds to the 25-29 ct/kWh (price for small electricity consumers).
- The IRR is 9%.
- The Net-Present Value is positive.

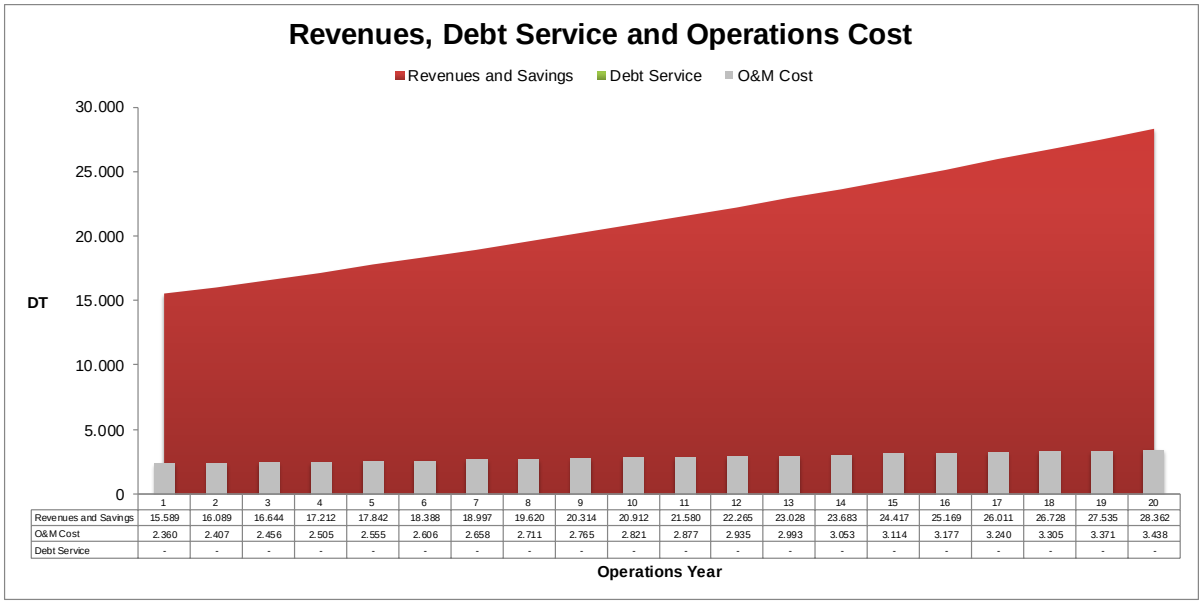
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(147.60																				
Cash Flow for Equity	-	13.229	13.682	14.188	14.707	15.287	15.782	16.339	16.909	17.548	18.091	18.703	19.330	20.035	20.630	21.303	21.993	22.770	23.423	24.164	24.923
Cumulative Cash Flows	(147.60	(134.63	(121.48	(108.11	(94.523	(80.677	(66.663	(52.439	(38.007	(23.323	(8.482)	6.560	21.801	37.289	52.923	68.752	84.773	101.034	117.434	134.021	150.794

Figure 19 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	15.589	16.089	16.644	17.212	17.842	18.388	18.997	19.620	20.314	20.912	21.580	22.265	23.028	23.683	24.417	25.169	26.011	26.728	27.535	28.362
O&M Cost	2.360	2.407	2.456	2.505	2.555	2.606	2.658	2.711	2.765	2.821	2.877	2.935	2.993	3.053	3.114	3.177	3.240	3.305	3.371	3.438
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 20 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in the eleventh year. After that the investor obtains a profit from the savings.
- Since the PV system is paid with equity (investors), all the revenues from the savings are for them. After the initial investment in year zero, the investor obtains all revenues and the only costs to cover are O&M costs.

Business Model 2: PPA financed through a 70% loan and 30% equity

The second model is a PPA financed through a loan and equity. A company which manages and owns the PV system will get the loan. With the current bank conditions in Germany, the debtor should be individuals with creditworthiness.

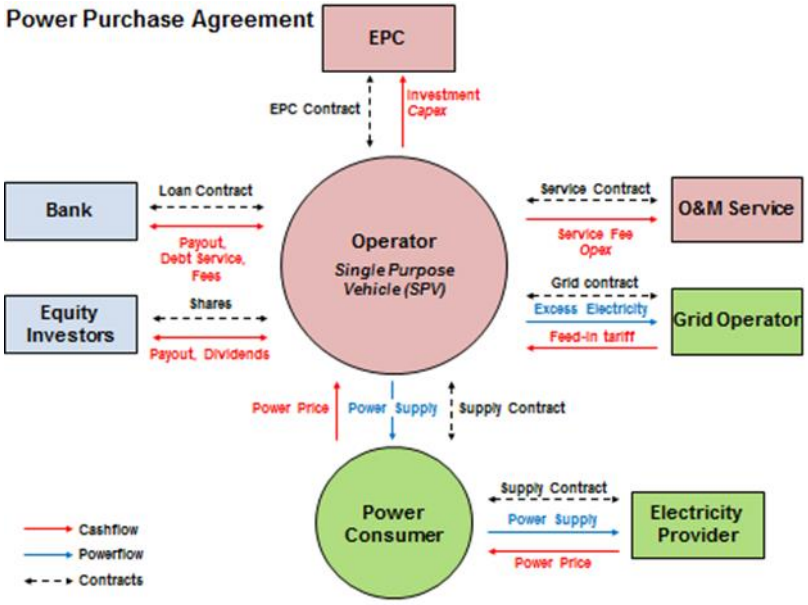


Figure 21: Self-consumption financed through 70% loan and 30% equity

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project		
PV System Size	kWp	120
Specific System Cost	EUR/kWp	1.230
Total System Cost	EUR	147.600
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	147.600
Fixed Operation Costs	EUR p.a.	2.314
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	950
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	808
Degradation	% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	45.678
Debt (Gearing)	70%	EUR	103.320
Loan Tenor		Years	15
Interest Rate		%	3,8%
Discount Rate		%	2,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	5%	EUR/kWh	0,1146
Self-consumption	-	EUR/kWh	-
Fees		EUR/kWh	-
Net-metering	-	EUR/kWh	-
Fees		EUR/kWh	-
Excess Electricty		EUR/kWh	-
PPA Tariff	95%	EUR/kWh	0,2200
Fees		EUR/kWh	0,0630
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	134.541
Project IRR	%	9,38%
Equity IRR	%	15,26%
Payback Period	Years	8,42
LCOE* (w/o subsidy)	EUR/kWh	0,14
LCOE (w subsidy)	EUR/kWh	0,14
Min DSCR**	x	1,45 x
Min LLCR***	x	1,82 x

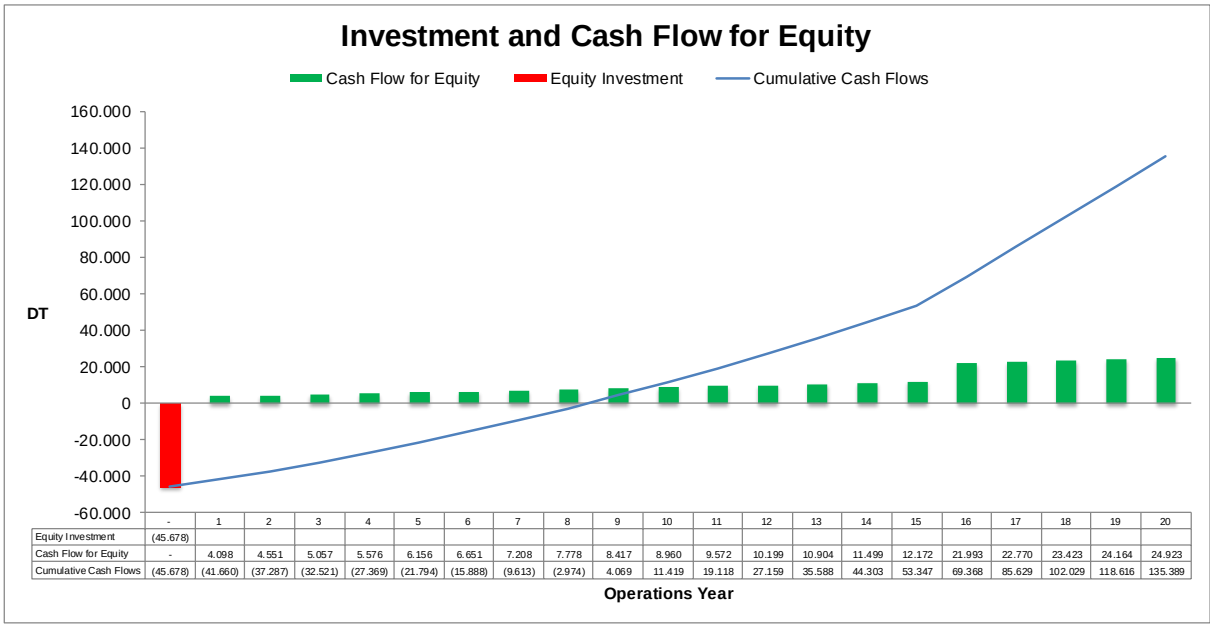
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 22: Project Overview - Business Model 2

The results above indicate that installing a PV system being financed with a loan and equity is profitable.

- The PPA Tariff corresponding to 22 ct/kWh (EEG-surcharge included) is lower than the current electricity price of the grid which corresponds to the 25-29 ct/kWh (price for small electricity consumers).
- The payback period is in the eighth year.
- DSCR is 1,45 and the LLCR is 1,82.
- The Net-Present Value is positive.

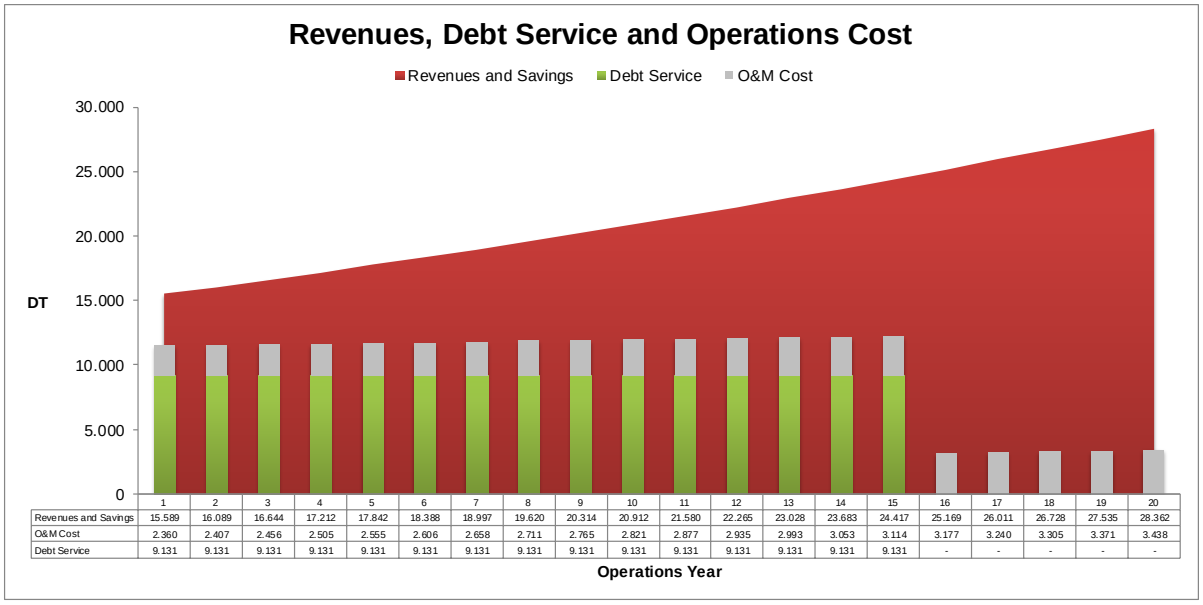
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(45.678)																				
Cash Flow for Equity	-	4.098	4.551	5.057	5.576	6.156	6.651	7.208	7.778	8.417	8.960	9.572	10.199	10.904	11.499	12.172	21.993	22.770	23.423	24.164	24.923
Cumulative Cash Flows	(45.678)	(41.660)	(37.287)	(32.521)	(27.369)	(21.794)	(15.888)	(9.613)	(2.974)	4.069	11.419	19.118	27.159	35.588	44.303	53.347	69.368	85.629	102.029	118.616	135.389

Figure 23 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	15.589	16.089	16.644	17.212	17.842	18.388	18.997	19.620	20.314	20.912	21.580	22.265	23.028	23.683	24.417	25.169	26.011	26.728	27.535	28.362
O&M Cost	2.360	2.407	2.456	2.505	2.555	2.606	2.658	2.711	2.765	2.821	2.877	2.935	2.993	3.053	3.114	3.177	3.240	3.305	3.371	3.438
Debt Service	9.131	9.131	9.131	9.131	9.131	9.131	9.131	9.131	9.131	9.131	9.131	9.131	9.131	9.131	9.131	-	-	-	-	-

Figure 24 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in the eighth year. After that the owner of the PV system obtains a profit from the self-consumed electricity (savings).
- The PV system is partially paid with a loan and all the revenues from the savings are to pay the system the first 15 years. After this, the investor obtains all revenues and the only costs to cover are O&M costs.

4. Commercial Large Office Buildings

Segment environment

Usually building owners will not invest themselves because their real estate investments yield high returns and the investment including the implementation of a PPA with the tenants requires a completely different skill set. Therefore, they will rather lease the roof to an external plant operator or energy service company. They are used to lease building equipment and contract energy services, thus this approach would be more natural to them.

Since large office buildings could be occupied by one company, the self-consumption might be an option to avoid the payment of the whole EEG surcharge. This is presented in one of the models. The system could also be rented (“Pacht”) for self-consumption (see introduction). The consumption profit in this sector is around 75%.

Segment Drivers

For existing buildings the reduction of electricity costs for the tenants is the key driver for an investment because it allows increasing the rent by decreasing the service charges. Here also the “green image” resulting from the PV system is a plus for tenants with a lot of customer traffic. For new buildings all these reasons apply, but in addition energy certificates are already a strong incentive to invest in PV because they come with tax and financing incentives for low energy buildings. The PV system reduces the external energy demand which results in tax incentives and lower financing costs.

Business Model 1: Self-consumption financed through 20% equity and 80%loan

The first model is self-consumption, where the user of the PV system is only one and where operator and user of the PV system are the same entity. In this model the investor will take a loan of 80% from a local bank and give 20% of equity for the PV system.

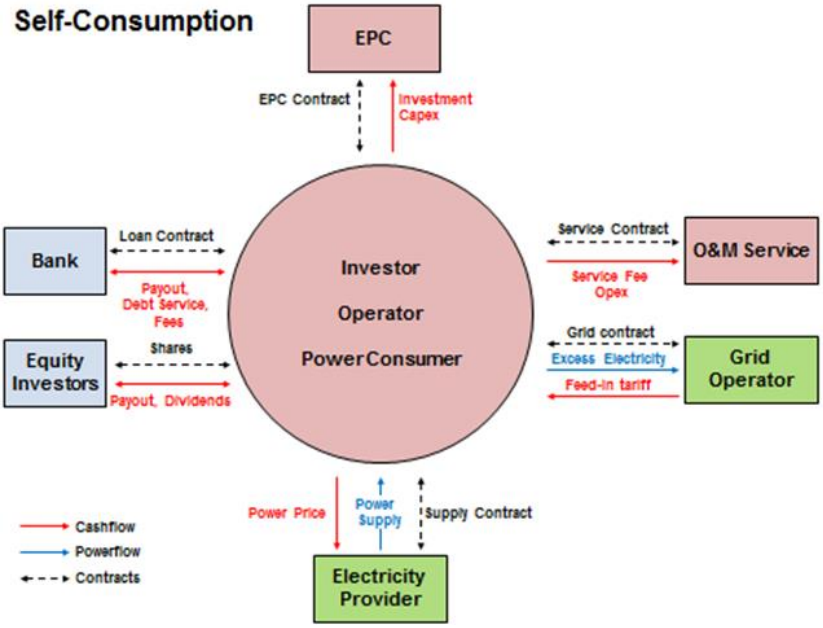


Figure 1 Self-consumption financed through 20% equity and 80% loan

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project			
PV System Size		kWp	100
Specific System Cost		EUR/kWp	1.230
Total System Cost		EUR	123.000
Investment Subsidy		EUR	-
Total System Cost incl. Subsidy		EUR	123.000
Fixed Operation Costs		EUR p.a.	1.945
Variable Operation Costs		EUR/kWh	-

PV Generation			
Specific Yield		kWh/qm/a	950
Performance Factor		%	85%
Specific System Performance		kWh/kWp/a	808
Degradation		% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	25.969
Debt (Gearing)	80%	EUR	98.400
Loan Tenor		Years	15
Interest Rate		%	3,8%
Discount Rate		%	2,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	25%	EUR/kWh	0,1154
Self-consumption	75%	EUR/kWh	0,2000
Fees		EUR/kWh	0,0250
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	90.614
Project IRR	%	8,59%
Equity IRR	%	16,36%
Payback Period	Years	8,06
LCOE* (w/o subsidy)	EUR/kWh	0,14
LCOE (w subsidy)	EUR/kWh	0,14
Min DSCR**	x	1,30 x
Min LLCR***	x	1,51 x

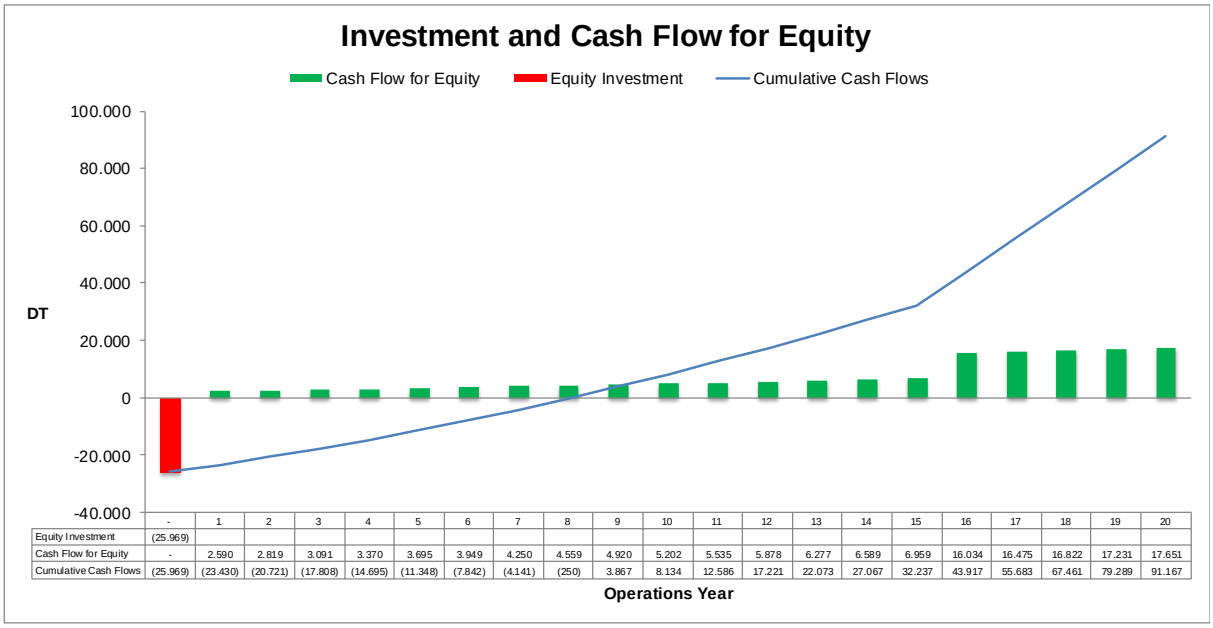
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 25: Project Overview - Business Model 1

The results above indicate that installing a PV system with a higher amount of debt than equity is profitable:

- The Levelized Cost of Electricity (LCOE) corresponding to 14 ct/kWh is lower than the current electricity price of the grid which corresponds to 20-25 ct/kWh (depending on the consumption).
- The EEG surcharge is only of 40% due to the self-consumption, in 2015 0,025 Eurocents / kwh.
- The project IRR is 9% and the equity IRR 16%.
- The DSCR and LLCR are over 1.

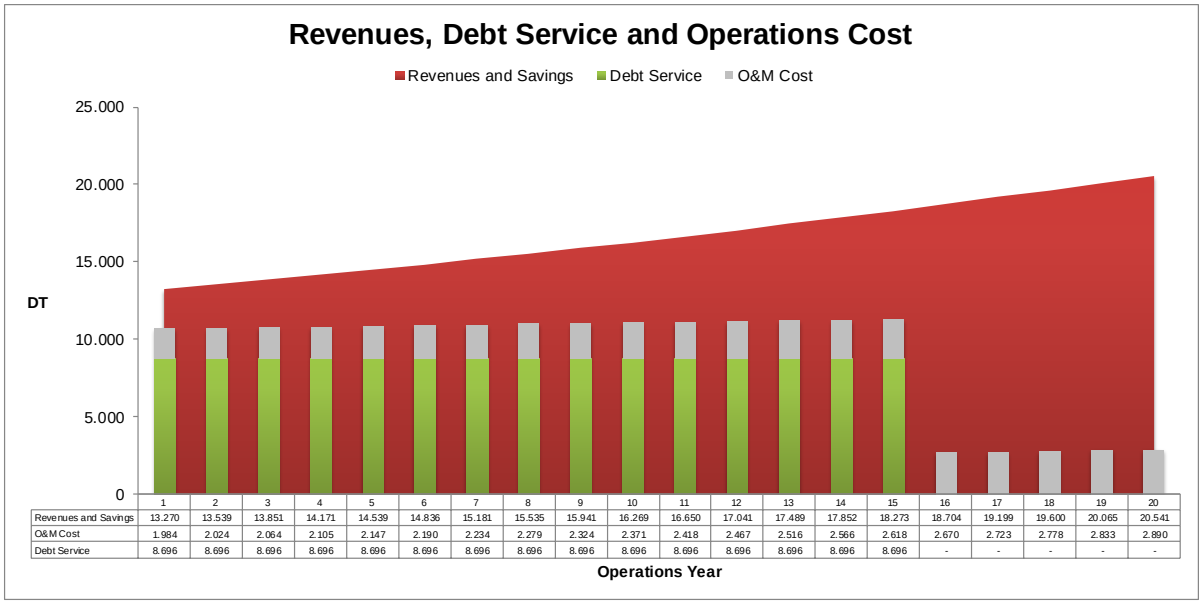
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(25.969)																				
Cash Flow for Equity	-	2.590	2.819	3.091	3.370	3.695	3.949	4.250	4.559	4.920	5.202	5.535	5.878	6.277	6.589	6.959	16.034	16.475	16.822	17.231	17.651
Cumulative Cash Flows	(25.969)	(23.430)	(20.721)	(17.808)	(14.695)	(11.348)	(7.842)	(4.141)	(250)	3.867	8.134	12.586	17.221	22.073	27.067	32.237	43.917	55.683	67.461	79.289	91.167

Figure 26 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	13.270	13.539	13.851	14.171	14.539	14.836	15.181	15.535	15.941	16.269	16.650	17.041	17.489	17.852	18.273	18.704	19.199	19.600	20.065	20.541
O&M Cost	1.984	2.024	2.064	2.105	2.147	2.190	2.234	2.279	2.324	2.371	2.418	2.467	2.516	2.566	2.618	2.670	2.723	2.778	2.833	2.890
Debt Service	8.696	8.696	8.696	8.696	8.696	8.696	8.696	8.696	8.696	8.696	8.696	8.696	8.696	8.696	8.696	-	-	-	-	-

Figure 27 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is 8 years. After that the investor obtains a profit from the self-consumed electricity (savings).
- Even though a loan has to be paid, there are still revenues from the savings for the owner of the system.

Business Model 2: PPA financed through investors

In the second model there are several users in the building. Hence applies the PPA model financed through investors (suggestion). In this model the tenants get the 100% supply (see introduction) and pay the electricity that they use to the company who represent the investors, this includes the electricity produced by the PV system and from the grid when needed. The company who represent the investors should have a separate agreement with a utility for the electricity supply from the grid.

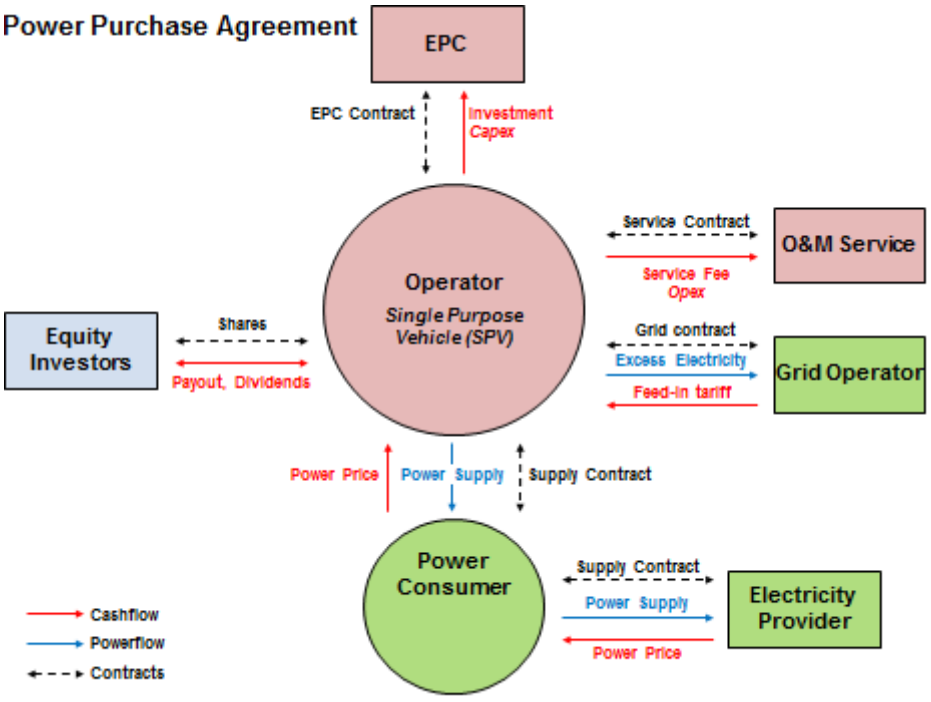


Figure 28: Self-consumption financed through 100 % equity (investors)

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project		
PV System Size	kWp	100
Specific System Cost	EUR/kWp	1.230
Total System Cost	EUR	123.000
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	123.000
Fixed Operation Costs	EUR p.a.	1.945
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	950
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	808
Degradation	% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	123.000
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	-
Interest Rate		%	-
Discount Rate		%	2,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	25%	EUR/kWh	0,1154
Self-consumption	-	EUR/kWh	-
Fees		EUR/kWh	-
Net-metering	-	EUR/kWh	-
Fees		EUR/kWh	-
Excess Electricty		EUR/kWh	-
PPA Tariff	75%	EUR/kWh	0,2000
Fees		EUR/kWh	0,0630
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	69.364
Project IRR	%	6,59%
Equity IRR	%	6,59%
Payback Period	Years	13,16
LCOE* (w/o subsidy)	EUR/kWh	0,13
LCOE (w subsidy)	EUR/kWh	0,13
Min DSCR**	x	-
Min LLCR***	x	-

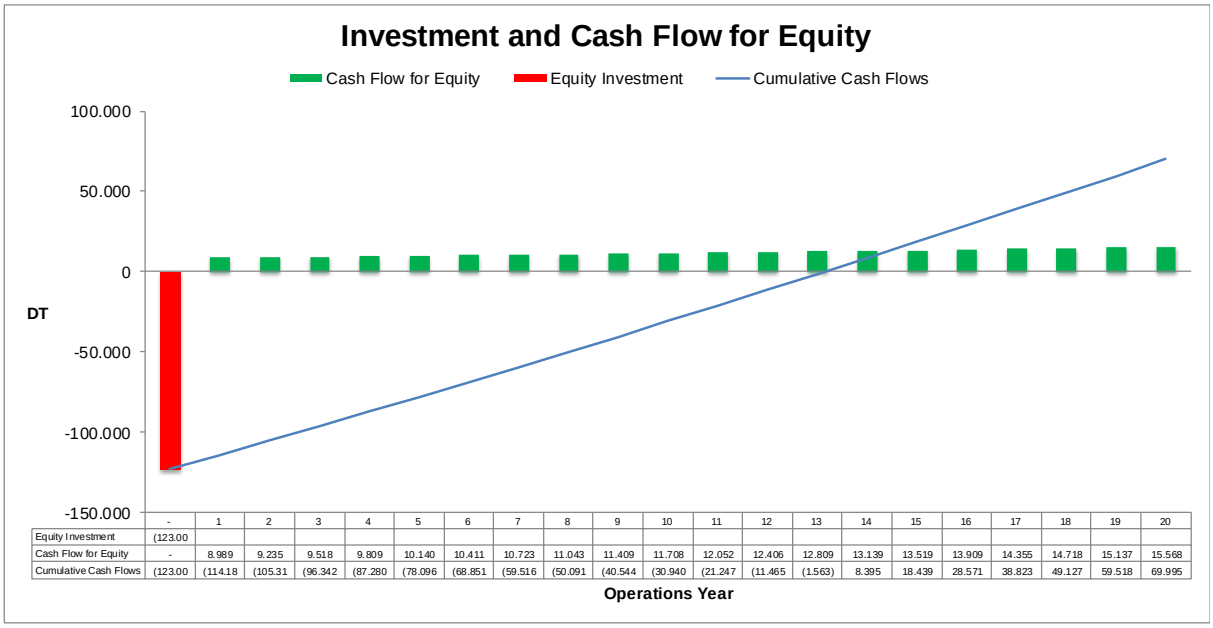
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 29: Project Overview - Business Model 2

The results above indicate that installing a PV system financed through equity (investors) is profitable:

- The PPA Tariff of 20 ct/kWh (EEG-surcharge included) would be lower or equal to the current electricity price of the grid which corresponds to 20-25 ct/kWh (depending on the consumption).
- The IRR is 7%.
- The Net-Present Value is positive and the payback period is in 13 years.

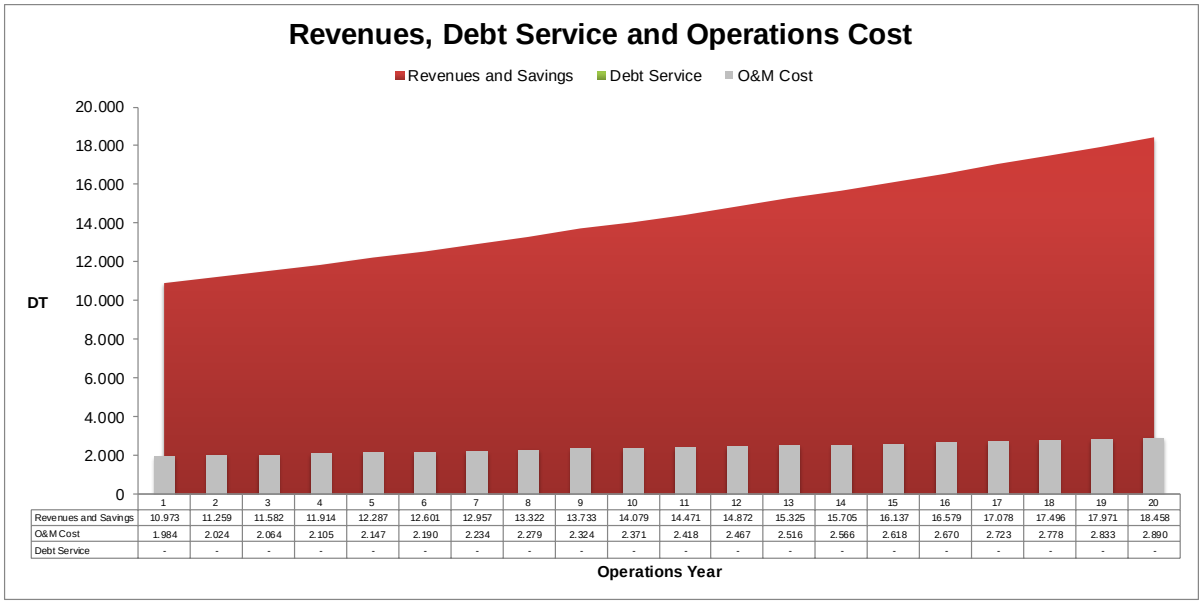
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(123.00																				
Cash Flow for Equity	-	8.989	9.235	9.518	9.809	10.140	10.411	10.723	11.043	11.409	11.708	12.052	12.406	12.809	13.139	13.519	13.909	14.355	14.718	15.137	15.568
Cumulative Cash Flows	(123.00	(114.18	(105.31	(96.342	(87.280	(78.096	(68.851	(59.516	(50.091	(40.544	(30.940	(21.247	(11.465	(1.563)	8.395	18.439	28.571	38.823	49.127	59.518	69.995

Figure 30 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	10.973	11.259	11.582	11.914	12.287	12.601	12.957	13.322	13.733	14.079	14.471	14.872	15.325	15.705	16.137	16.579	17.078	17.496	17.971	18.458
O&M Cost	1.984	2.024	2.064	2.105	2.147	2.190	2.234	2.279	2.324	2.371	2.418	2.467	2.516	2.566	2.618	2.670	2.723	2.778	2.833	2.890
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 31 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in the year thirteen. After that the investor obtains the entire profit.
- Since the PV system is paid with equity (investors), all the revenues from the savings are for them. After the initial investment in year zero, the investor obtains all revenues and the only costs to cover are O&M costs.

5. Public Educational Buildings

Segment environment

For educational buildings the first key question is who is paying the electricity bill. In the case of Germany, the municipality is usually the building owner and is paying the electricity bill. They are often willing to lease the roof to PV plant operators. However they need a trustworthy entity and ideally the local utility would lease the roof to operate the PV system.

Since schools don´t work on weekends they might have excess of electricity. Regularly this is around 25% (consumption profile is 75%) and would be feed into the grid to get the FiT.

Segment Drivers

A sufficient incentive for the municipality would be 5-10% savings on the electricity bill. The second frequent argument is no price advantage but a 20 years fixed price.

Business Model 1: Self-consumption financed through a cooperative

This concerns a self-consumption model, since the user of the educational building and the electricity consumer could be one entity. The funding would be through a cooperative (equity investors).This model is a suggestion. Here the tenant gets 100% of electricity supply and even though he is not the owner of the system, he bears the risks (see introduction). The tenant pays for the electricity to the cooperative; this includes the electricity produced by the PV system and from the grid when needed. The cooperative should have a separate agreement with a utility for the electricity supply from the grid.

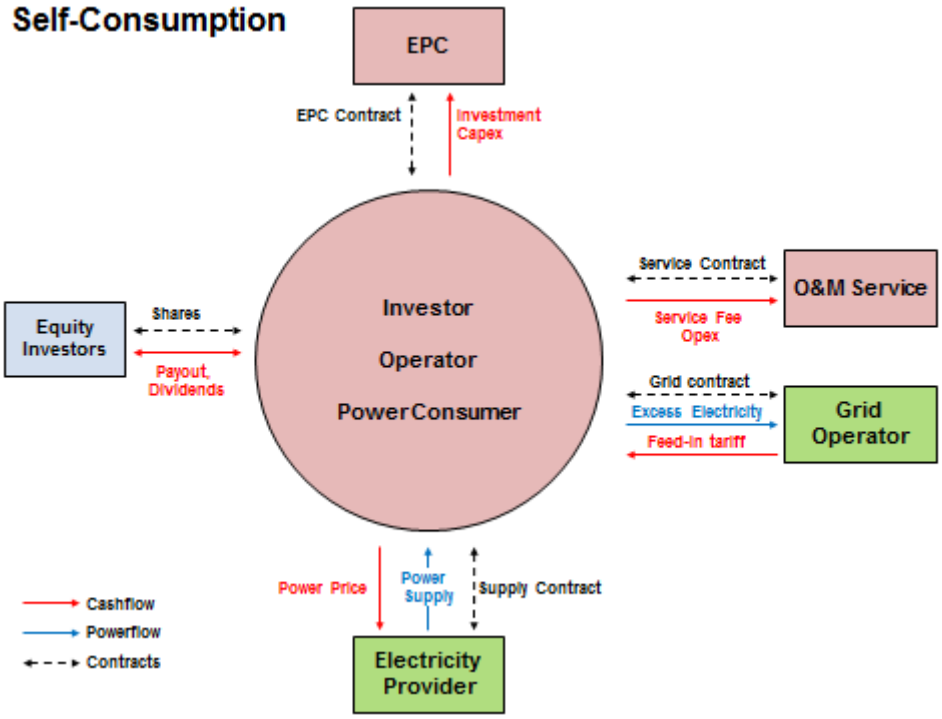


Figure 32: Self-consumption financed through 100 % equity (investors)

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project		
PV System Size	kWp	50
Specific System Cost	EUR/kWp	1.275
Total System Cost	EUR	63.750
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	63.750
Fixed Operation Costs	EUR p.a.	1.056
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	950
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	808
Degradation	% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	63.750
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	-
Interest Rate		%	-
Discount Rate		%	2,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	25%	EUR/kWh	0,1206
Self-consumption	75%	EUR/kWh	0,2000
Fees		EUR/kWh	0,0250
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	49.426
Project IRR	%	8,19%
Equity IRR	%	8,19%
Payback Period	Years	11,41
LCOE* (w/o subsidy)	EUR/kWh	0,13
LCOE (w subsidy)	EUR/kWh	0,13
Min DSCR**	x	-
Min LLCR***	x	-

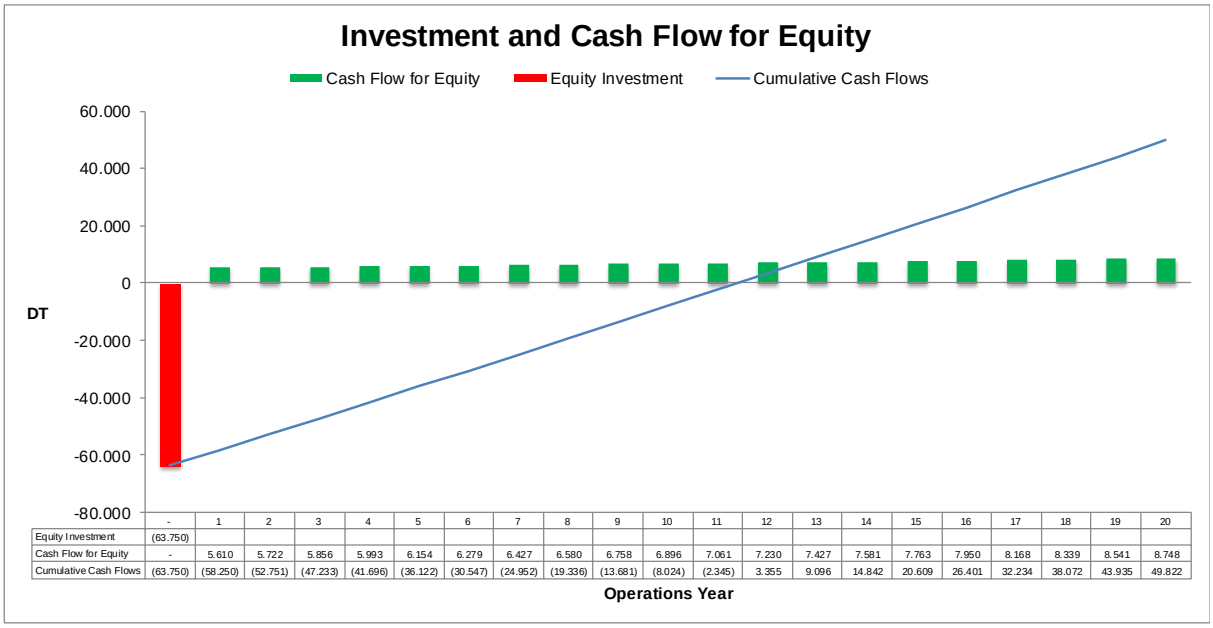
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 33: Project Overview - Business Model 1

The results above indicate that installing a PV system financed through equity (investors) is profitable:

- The Levelized Cost of Electricity (LCOE) corresponding to 13 ct/kWh is lower than the current electricity price of the grid which corresponds to 20 ct/kWh.
- The IRR is 9% and the Net-Present Value is positive.
- Since the model is self-consumption only 40% of the EEG surcharge must be paid.

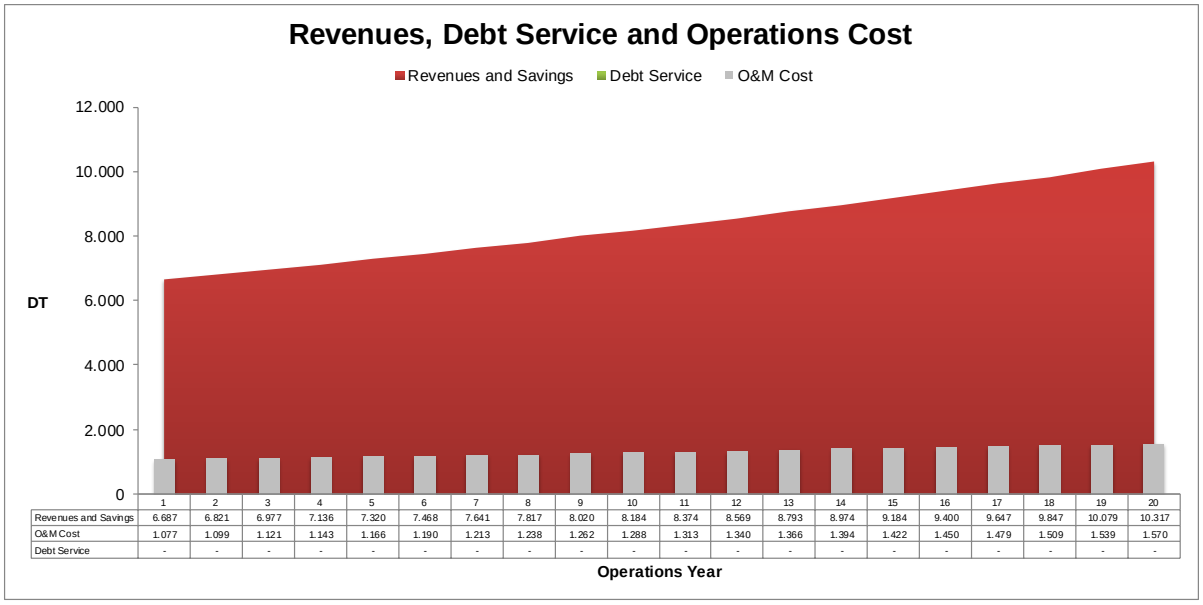
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(63.750)																				
Cash Flow for Equity	-	5.610	5.722	5.856	5.993	6.154	6.279	6.427	6.580	6.758	6.896	7.061	7.230	7.427	7.581	7.763	7.950	8.168	8.339	8.541	8.748
Cumulative Cash Flows	(63.750)	(58.250)	(52.751)	(47.233)	(41.696)	(36.122)	(30.547)	(24.952)	(19.336)	(13.681)	(8.024)	(2.345)	3.355	9.096	14.842	20.609	26.401	32.234	38.072	43.935	49.822

Figure 34 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	6.687	6.821	6.977	7.136	7.320	7.468	7.641	7.817	8.020	8.184	8.374	8.569	8.793	8.974	9.184	9.400	9.647	9.847	10.079	10.317
O&M Cost	1.077	1.099	1.121	1.143	1.166	1.190	1.213	1.238	1.262	1.288	1.313	1.340	1.366	1.394	1.422	1.450	1.479	1.509	1.539	1.570
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 35 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in 11 years. After that the investor obtains a profit from the self-consumed electricity (savings).
- Since the PV system is paid with equity, all the revenues from the savings are for the investors. After the initial investment in year zero, the owner of the system obtains all revenues and the only costs to cover are O&M costs.

Business Model 2: Self-consumption financed through a loan

In this second model the PV system will be rented to the educational unit (“Pacht” model). The investor (represented by a company) will finance the system through a loan. Here the tenant gets the 100% supply (see introduction) and pays the electricity that he used to the investor. The “company” should have a separate agreement with a utility for the electricity supply from the grid. In this model the tenant bears also the risks (see introduction).

The electricity not consumed on the weekends will be also feed into the grid.

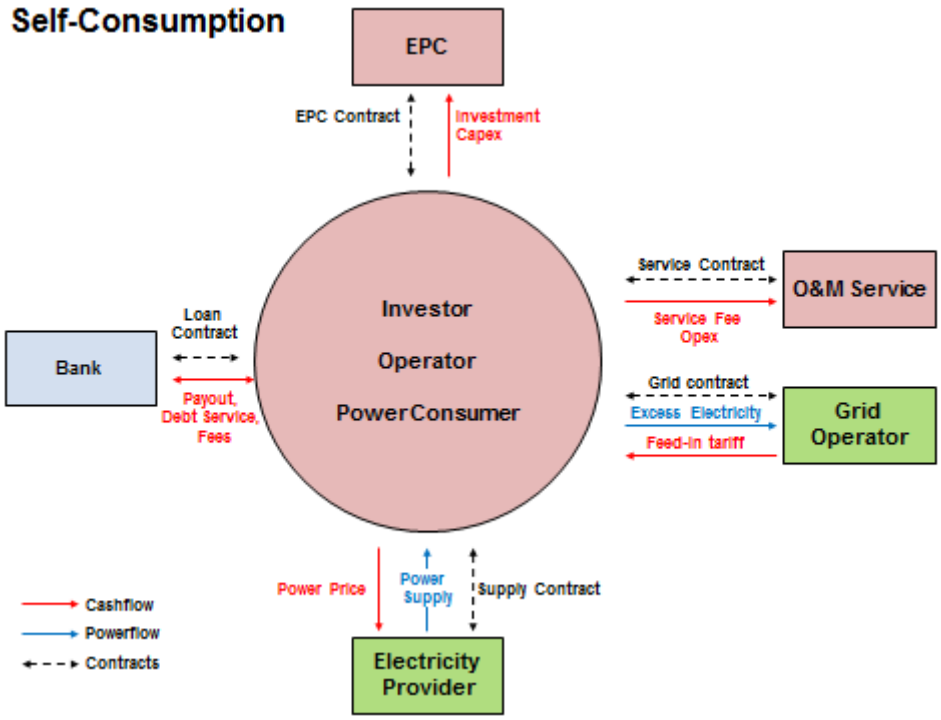


Figure 36: Self-consumption financed through 100 % loan

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project		
PV System Size	kWp	50
Specific System Cost	EUR/kWp	1.275
Total System Cost	EUR	63.750
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	63.750
Fixed Operation Costs	EUR p.a.	1.056
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	950
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	808
Degradation	% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	19.729
Debt (Gearing)	70%	EUR	44.625
Loan Tenor		Years	15
Interest Rate		%	3,8%
Discount Rate		%	2,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	25%	EUR/kWh	0,1206
Self-consumption	75%	EUR/kWh	0,2000
Fees		EUR/kWh	0,0250
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	42.881
Project IRR	%	8,07%
Equity IRR	%	12,82%
Payback Period	Years	9,76
LCOE* (w/o subsidy)	EUR/kWh	0,15
LCOE (w subsidy)	EUR/kWh	0,15
Min DSCR**	x	1,42 x
Min LLCR***	x	1,65 x

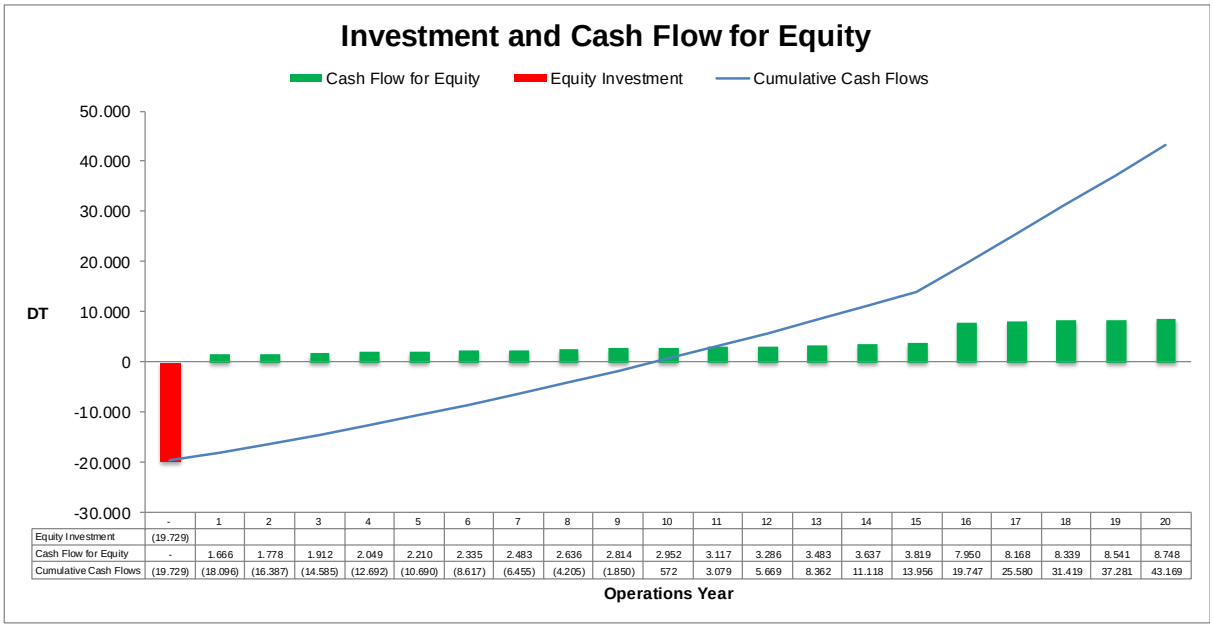
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 37: Project Overview - Business Model 2

The results above indicate that installing a PV system financed through a loan is profitable:

- The Levelized Cost of Electricity (LCOE) corresponding to 15 ct/kWh is lower than the current electricity price of the grid which corresponds to 20 ct/kWh.
- The project IRR is 8% and the equity IRR is 13%.
- The DSCR and LLCR are over 1.
- Since the model is self-consumption the EEG surcharge to pay is only of 40%.

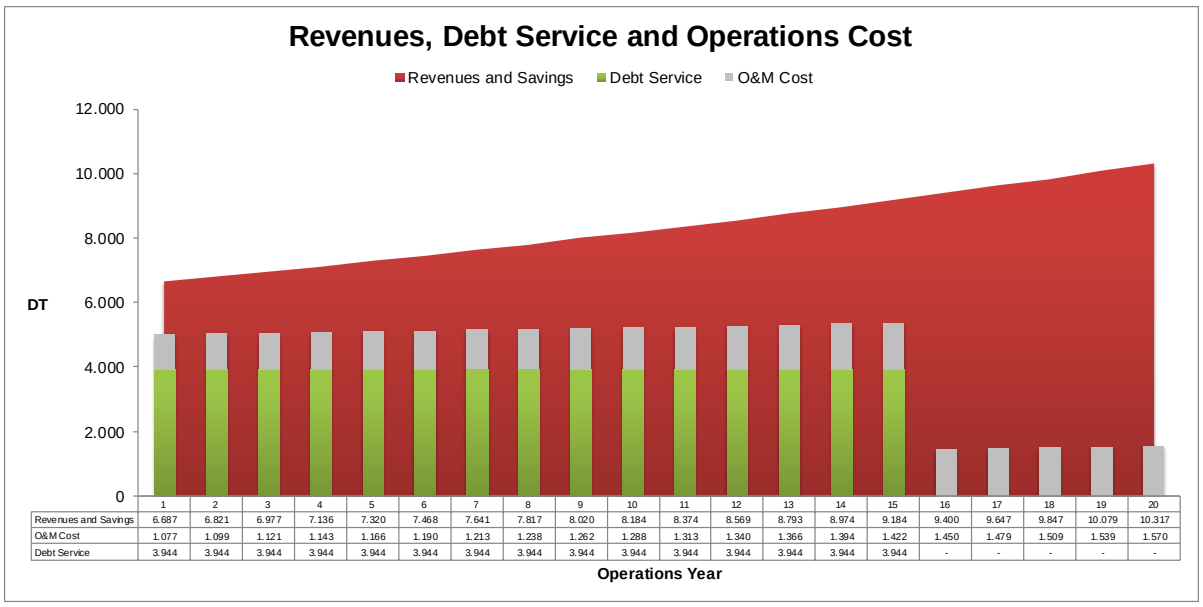
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(19.729)																				
Cash Flow for Equity	-	1.666	1.778	1.912	2.049	2.210	2.335	2.483	2.636	2.814	2.952	3.117	3.286	3.483	3.637	3.819	7.950	8.168	8.339	8.541	8.748
Cumulative Cash Flows	(19.729)	(18.096)	(16.387)	(14.585)	(12.692)	(10.690)	(8.617)	(6.455)	(4.205)	(1.850)	572	3.079	5.669	8.362	11.118	13.956	19.747	25.580	31.419	37.281	43.169

Figure 38 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	6.687	6.821	6.977	7.136	7.320	7.468	7.641	7.817	8.020	8.184	8.374	8.569	8.793	8.974	9.184	9.400	9.647	9.847	10.079	10.317
O&M Cost	1.077	1.099	1.121	1.143	1.166	1.190	1.213	1.238	1.262	1.288	1.313	1.340	1.366	1.394	1.422	1.450	1.479	1.509	1.539	1.570
Debt Service	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	3.944	-	-	-	-	-

Figure 39 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in the tenth year. After that the investor obtains a profit from the self-consumed electricity (savings).
- The revenues and savings are the first 15 years to pay the loan. After this the revenues are for the investors and the only costs to cover are O&M.

6. Industrial Parks

Segment environment

The most straightforward option for industrial parks with a group of off-takers connected to local grid of the park area is a PPA. However, electricity prices for large commercial and industrial consumers are relatively low and with the EEG surcharge that has to be paid projects in this segment are far away from being profitable. Therefore this segment lacks any activity and implemented projects.

The only option for industrial parks would be self-consumption to avoid the EEG surcharge. However, since more than one user is in the park, this is not possible.

In the present report other options where analyzed and explored. These are presented in the following 2 business models (suggestions).

Segment Drivers

Profitability is also the main driver in this segment. The “green image” of the companies investing in PV systems could be also an important driver to attract customers.

Business Model 1: PPA financed through equity

In the first model an investor (or several) buys the PV system through equity and supply the industry park (see introduction). The companies in the industry park could invest through a cooperative (suggestion).

Here the purchasers get the 100% supply (see introduction) and pay the electricity that they use to the company who represent the investors, this includes the electricity produced by the PV system and from the grid when needed. The company who represent the investors should have a separate agreement with a utility for the electricity supply from the grid.

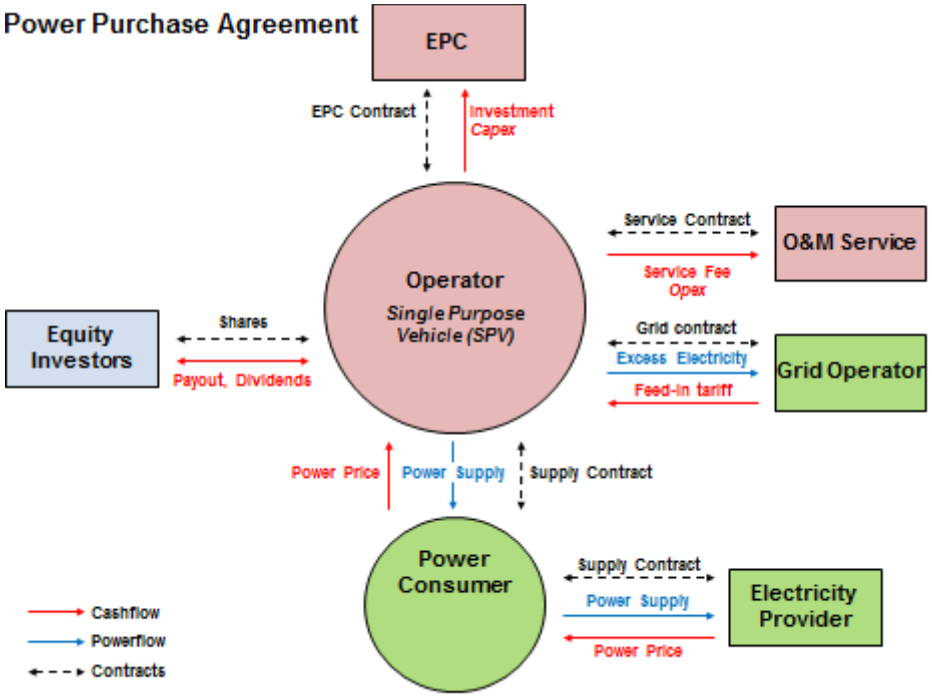


Figure 40: Self-consumption financed through 100 % equity (investors)

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project		
PV System Size	kWp	1.000
Specific System Cost	EUR/kWp	990
Total System Cost	EUR	990.000
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	990.000
Fixed Operation Costs	EUR p.a.	15.000
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	950
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	808
Degradation	% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	990.000
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	-
Interest Rate		%	-
Discount Rate		%	3,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	5%	EUR/kWh	0,1108
Self-consumption	-	EUR/kWh	-
Fees		EUR/kWh	-
Net-metering	-	EUR/kWh	-
Fees		EUR/kWh	-
Excess Electricty		EUR/kWh	-
PPA Tariff	95%	EUR/kWh	0,1500
Fees		EUR/kWh	0,0630
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	188.688
Project IRR	%	4,70%
Equity IRR	%	4,70%
Payback Period	Years	16,99
LCOE* (w/o subsidy)	EUR/kWh	0,11
LCOE (w subsidy)	EUR/kWh	0,11
Min DSCR**	x	-
Min LLCR***	x	-

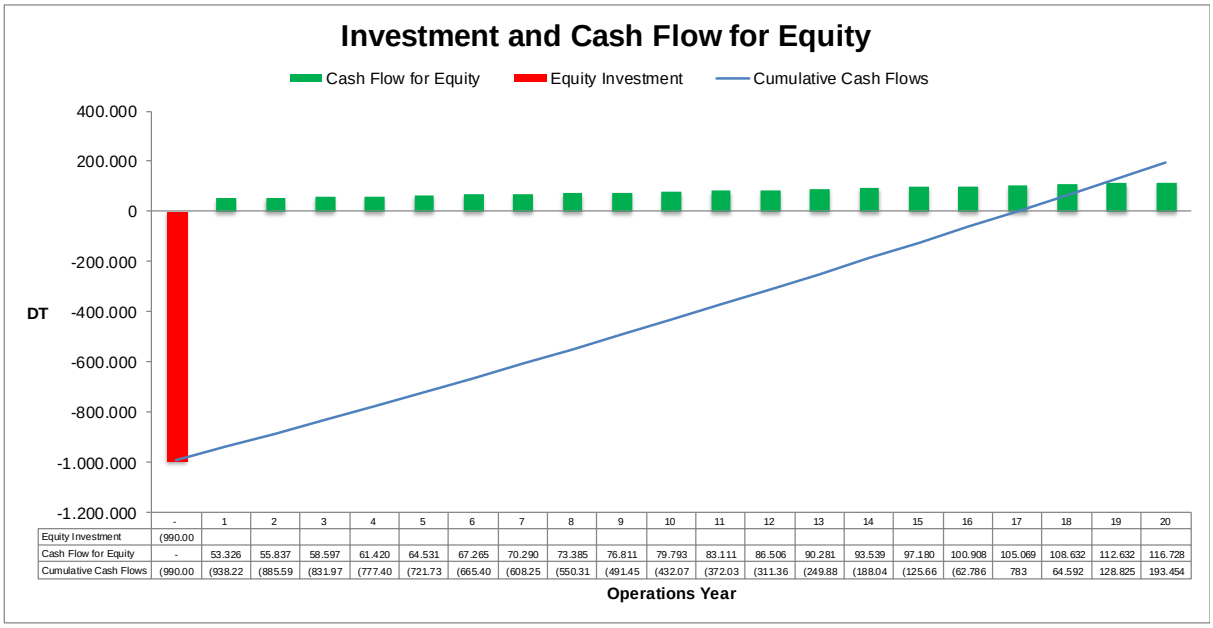
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 41: Project Overview - Business Model 1

The results above indicate that installing a PV system financed through equity (investors) is profitable:

- The PPA Tariff of 15 ct/kWh (EEG-surcharge included) would be equal to the current electricity price of the grid which corresponds to 15 ct/kWh (price depends on the consumption).
- The IRR is 5% due to the EEG-surcharge.
- The Net-Present Value is positive and the payback period is in 17 years.

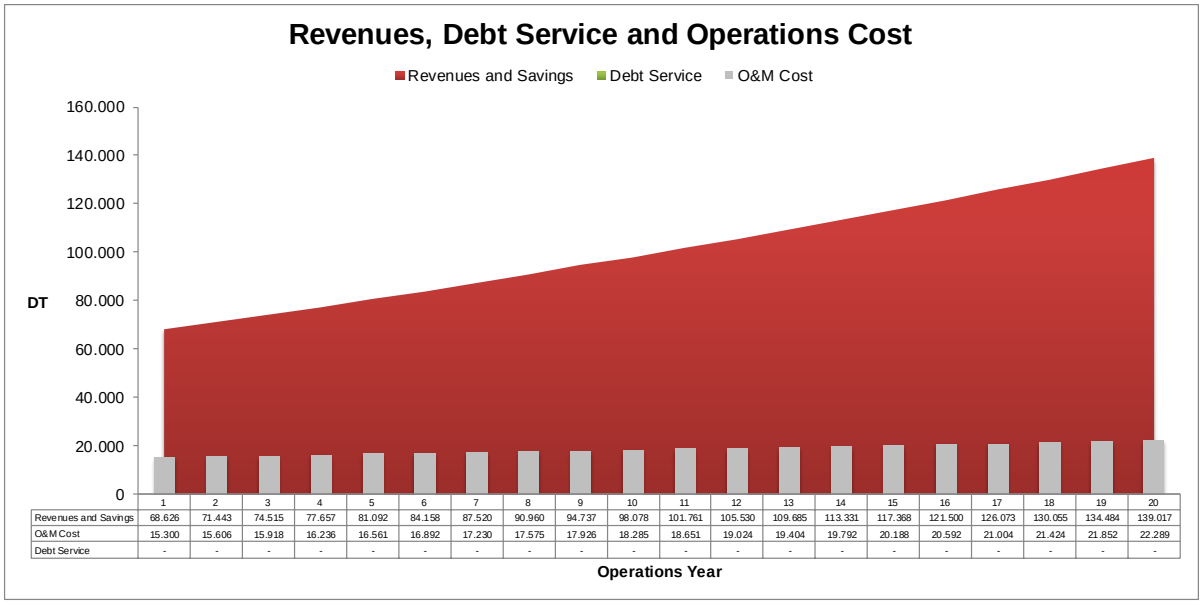
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(990.00																				
Cash Flow for Equity	-	53.326	55.837	58.597	61.420	64.531	67.265	70.290	73.385	76.811	79.793	83.111	86.506	90.281	93.539	97.180	100.908	105.069	108.632	112.632	116.728
Cumulative Cash Flows	(990.00	(938.22	(885.59	(831.97	(777.40	(721.73	(665.40	(608.25	(550.31	(491.45	(432.07	(372.03	(311.36	(249.88	(188.04	(125.66	(62.786	783	64.592	128.825	193.454

Figure 42 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	68.626	71.443	74.515	77.657	81.092	84.158	87.520	90.960	94.737	98.078	101.761	105.530	109.685	113.331	117.368	121.500	126.073	130.055	134.484	139.017
O&M Cost	15.300	15.606	15.918	16.236	16.561	16.892	17.230	17.575	17.926	18.285	18.651	19.024	19.404	19.792	20.188	20.592	21.004	21.424	21.852	22.289
Debt Service	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 43 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in year seventeen. After that the investor obtains a profit from the self-consumed electricity (savings).
- Since the PV system is paid with equity (investors), all the revenues from the savings are for them. After the initial investment in year zero, the investor obtains all revenues and the only costs to cover are O&M costs.

Business Model 2: PPA financed through 70% loan and 30% equity

In the second model an investor (or several) buys the PV system through a loan 70% and 30% equity and supply the industry park (see introduction). As in the business model 1 of this segment, the companies of the industry park could invest through a cooperative (suggestion).

The purchasers get the 100% supply (see introduction) and pay the electricity that they use to the company who represent the investor(s), this includes the electricity produced by the PV system and from the grid when needed. The company who represents the investors should have a separate agreement with a utility for the electricity supply from the grid.

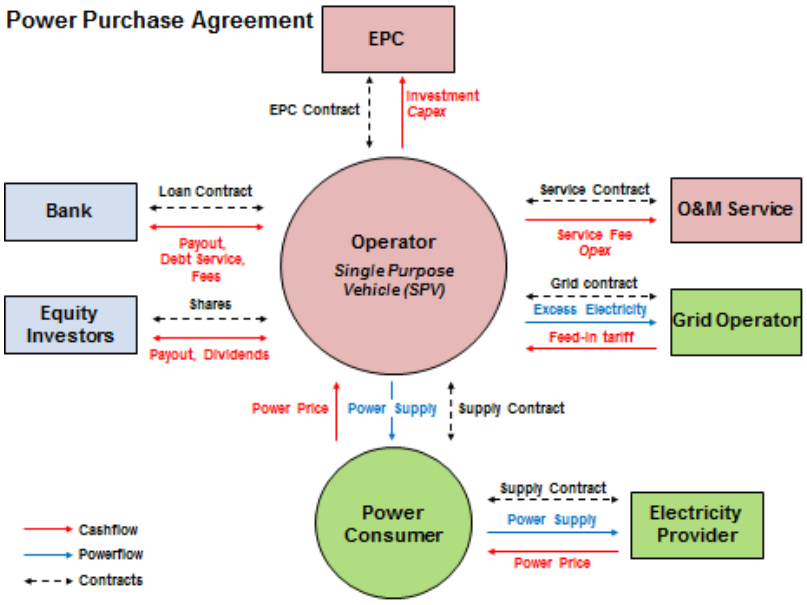


Figure 44: Self-consumption financed through 70% loan and 30 % equity

Profitability Analysis

The main project characteristics and results are illustrated in the tables below:

Project Overview

PV Project		
PV System Size	kWp	1.000
Specific System Cost	EUR/kWp	990
Total System Cost	EUR	990.000
Investment Subsidy	EUR	-
Total System Cost incl. Subsidy	EUR	990.000
Fixed Operation Costs	EUR p.a.	15.000
Variable Operation Costs	EUR/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	950
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	808
Degradation	% p.a.	0,50%

Investment			
Project Duration		Years	20
Equity		EUR	306.656
Debt (Gearing)	70%	EUR	693.000
Loan Tenor		Years	20
Interest Rate		%	4,3%
Discount Rate		%	3,0%

PV Business Model			
Category	Share	Unit	Price
Feed-in Tariff	5%	EUR/kWh	0,1108
Self-consumption	-	EUR/kWh	-
Fees		EUR/kWh	-
Net-metering	-	EUR/kWh	-
Fees		EUR/kWh	-
Excess Electricty		EUR/kWh	-
PPA Tariff	95%	EUR/kWh	0,1500
Fees		EUR/kWh	0,0630
Overysupply Price		EUR/kWh	-
Undersupply Penalty		EUR/kWh	-

Results		
Net-Present Value	EUR	98.949
Project IRR	%	4,60%
Equity IRR	%	5,18%
Payback Period	Years	17,07
LCOE* (w/o subsidy)	EUR/kWh	0,12
LCOE (w subsidy)	EUR/kWh	0,12
Min DSCR**	x	1,02 x
Min LLCR***	x	1,50 x

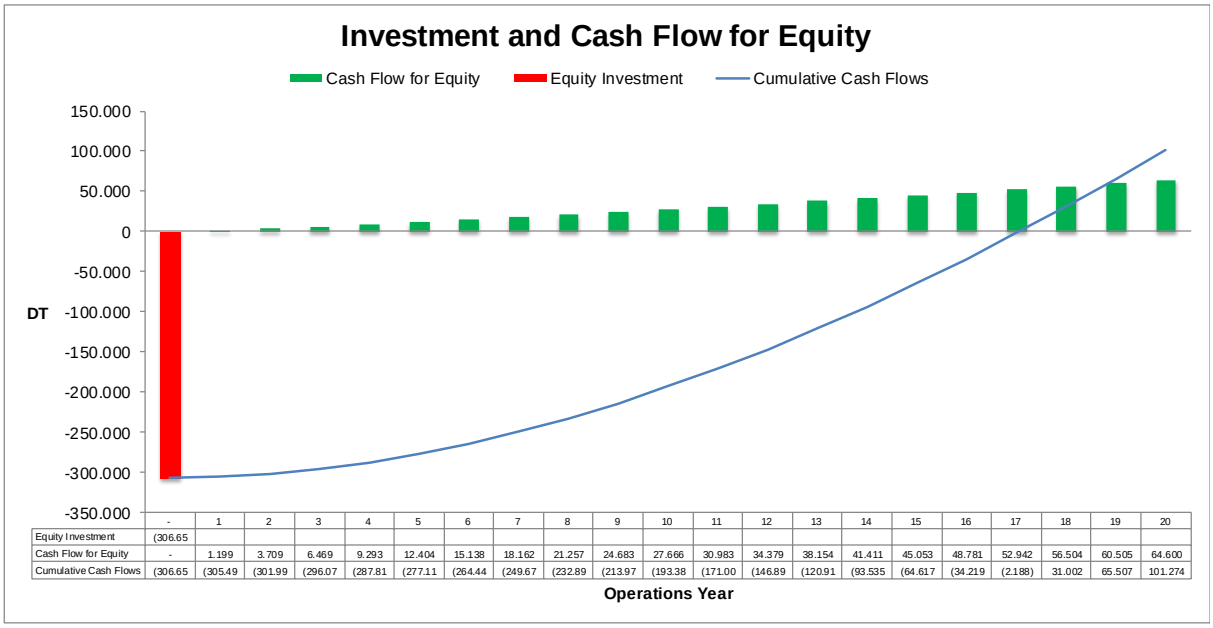
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Figure 45: Project Overview - Business Model 2

The results above indicate that installing a PV system financed partly through a loan is profitable:

- The PPA Tariff of 15 ct/kWh(EEG-surcharge included) would be equal to the current electricity price of the grid which corresponds to 15 ct/kWh (price depends on the consumption).
- The project IRR is 4,60% and the equity IRR is 5%.
- The Net-Present Value is positive and the payback period is in 17 years.

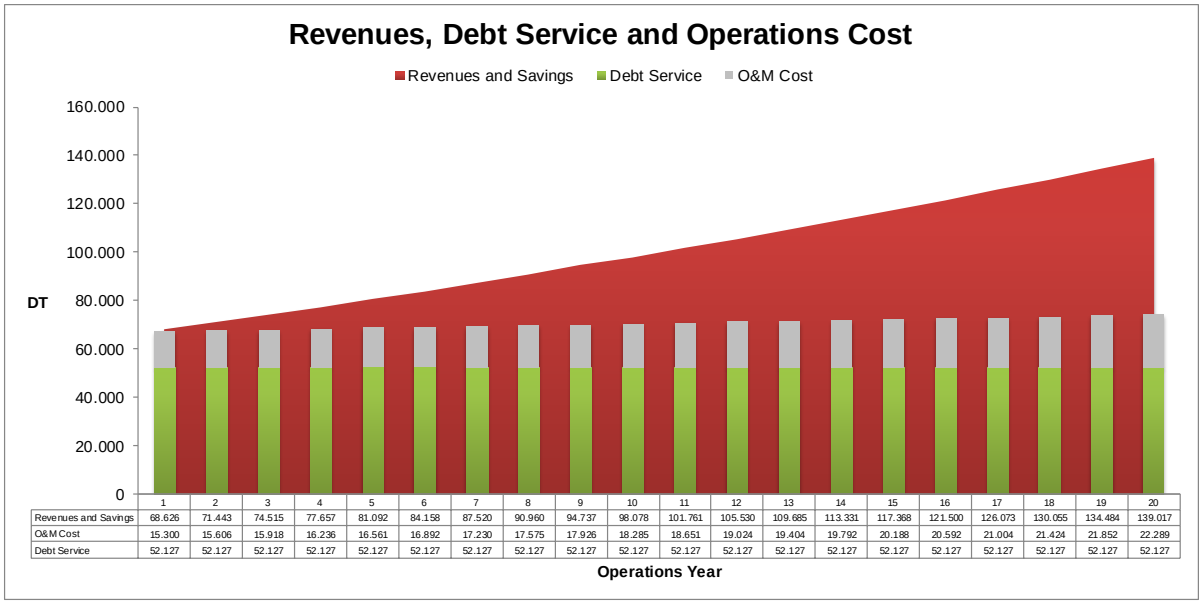
Project Cash Flows



	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equity Investment	(306.65																				
Cash Flow for Equity	-	1.199	3.709	6.469	9.293	12.404	15.138	18.162	21.257	24.683	27.666	30.983	34.379	38.154	41.411	45.053	48.781	52.942	56.504	60.505	64.600
Cumulative Cash Flows	(306.65	(305.49	(301.99	(296.07	(287.81	(277.11	(264.44	(249.67	(232.89	(213.97	(193.38	(171.00	(146.89	(120.91	(93.535	(64.617	(34.219	(2.188)	31.002	65.507	101.274

Figure 46 Project Cash Flow: Investment and Cash Flow for Equity

Project Cash Flows



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	68.626	71.443	74.515	77.657	81.092	84.158	87.520	90.960	94.737	98.078	101.761	105.530	109.685	113.331	117.368	121.500	126.073	130.055	134.484	139.017
O&M Cost	15.300	15.606	15.918	16.236	16.561	16.892	17.230	17.575	17.926	18.285	18.651	19.024	19.404	19.792	20.188	20.592	21.004	21.424	21.852	22.289
Debt Service	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127	52.127

Figure 47 Project Cash Flow: Revenues, Debt Service and Operation Cost

- The payback period is in the year seventeen. After that the investor obtains a profit from the self-consumed electricity (savings).
- Since the PV system is paid with a loan, all the revenues from the savings are to pay this the first 15 years. After this the investor obtains all revenues and the only costs to cover are O&M costs.

Conclusion

In Germany there are only two possible business models: the first one is self-consumption which is applied when there is one electricity consumer in entity with the operator; the second one is PPA, used where there is more than one user involved.

Currently is the installation of small/medium PV systems for self-consumption one of the largest and most stable in Germany in spite of the introduction of the EEG surcharge in 2014 for self-consumption. The main reason is the reduction, and under some conditions, the exemption of the payment of the EEG surcharge: systems ≤10 kWp and with an annual generation of 10 MWh are exempt from this charge; all other pay currently 35% (2016) and will reach 40% of the surcharge in 2017. This mainly concerns sectors installing small/medium systems including the residential (single house and multifamily) as well as public educational buildings.

This report has shown that large systems are also profitable when used for self-consumption. This takes place when there is only one purchaser and the operator and the user are the same entity. However, this is still not being currently used in Germany due to the long payback periods.

The PPA model in Germany is the main sector affected by the EEG surcharge due to the payment of the whole charge. Nevertheless, this report demonstrated that with the implementation of appropriate financial schemes this could be improved.

Actions to improve and increase the installation of PV systems in these sectors are the optimization of the self-consumption profile, as well as the dissemination and implementation of financial schemes[2] such as loan and cooperatives to facilitate financing and investment.

[2] The different financial schemes will be described in the framework of this project in the deliverable 3.2 “Fact-sheets for selected financing schemes”. See: http://www.pv-financing.eu/project-results/