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Regional Networks for the development of a Sustainable Market for Bioenergy in Europe

Case study: Combined solution for reduction of CO_2 emissions in Viļķene elementary school, Latvia

Supported by INTELLIGENT ENERGY EUROPE

Acknowledgements

This report has been produced as part of the project BioRegions. The logos of the partners cooperating in this project are shown below and more information about them and the project is available on www.bioregions.eu

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Title of the project

Combined solution for reduction of CO_2 emissions in Viļķene elementary school

Objectives of the project

The project aims to realize the transition from technologies, using fossil energy resources (diesel), to technologies, using renewable energy sources (wood pellets) and to improve energy efficiency in buildings of Baumaņu Kārļa Viļķene elementary school. Implementation of this project will allow to reduce the carbon dioxide emissions and to save on fuel costs.

Project Timeline

Preparation of the project including application submission was done in October and November 2012. Implementation of the project was planned in 2013, but since the application has been rejected in the first round of the call for proposals, it will be re-submitted in March 2013 and in case of success will be implemented in the end of 2013 or 2014.

The project can be implemented in 11 months, including 5 months for the construction works.

No	Activity	Months										
		1	2	3	4	5	6	7	8	9	10	11
1.	Preparation of the construction plan and technical documentation											
2.	Renovation and reconstruction works											
3.	Building supervision											
4.	Information to public about project implementation process and achieved results											

Description of local conditions

Project Operator:

Limbazi municipality is a founder of Viļķene elementary school and has made a decision to do the implementation of CO_2 emissions reduction project in Viļķene elementary school. The decision was made after carrying out energy audits in two Viļķene elementary school buildings. Energy audits were performed by Ekodoma, ltd. This school is one of the few buildings in the region owned by municipality where heat is supplied using fossil fuel – diesel oil. Heating costs are growing and that is a burden to the limited budget of municipality.

Site selection:

Viļķene is located in the central part of the region at 15 km distance from the centre of the region – Limbaži town. There are 1 430 inhabitants living in the village.

Implementation of this project will give significant contribution for reaching the fundamental targets set in the Biomass Action Plan for Limbaži region developed with the support of BioRegions project:

- Keep the use of biomass in the final energy consumption at least 80% and increase gradually, ensuring optimum use of local biomass potential;
- Improve efficiency of biomass use for at least 20% till 2022;
- Decrease energy consumption in buildings for at least 30% till 2022.

Viļķene elementary school is one of the few municipality owned organizations where for heating the fossil fuels are used.

Technology analysis

There are three buildings (see Figure 1) in the territory of Viļķene elementary school:

- School building with classrooms
- Dormitory building
- Sports hall (built in 2008)

School building

Dormitory building

Sports hall

Fig.1.Existing buildings in the territory of Viļķene elementary school

School building was built in 1962. In the school building recently old windows have been replaced and roof has been refurbished and thermally insulated. Historical part of the dormitory building was built in 1871 and the new part to the building was built in 1971. Both

buildings do not meet energy efficiency requirements of the national building code for thermal characteristics of building envelope.

Heating for both buildings and the new sports hall is supplied from a local boilerhouse. Hot water is prepared in electrical boilers. Two diesel oil boilers (see Figure 2) are relatively new and were installed in 2008. However, with the rapid increase in oil prices, the existing solution has got very expensive in operation. Due to high fuel purchase price, the current heat tariff is 63 LVL/MWh (~90 EUR/MWh).


Fig.2. Existing diesel oil boilers and the boiler house

The capacity of each diesel boiler is 285 kW (570 kW in total), however mostly only one boiler is used to cover the heat demand. In the sports hall additional heat source (with a capacity 133 kW) – hot air blowers running on diesel oil are installed (see in Figure 3). Hot water to sports hall is provided from the boiler house.

Fig.3. Autonomous heating system in the sports hall

Existing heating system before the reconstruction is visualized in Figure 4 and after project implementation – in Figure 5.

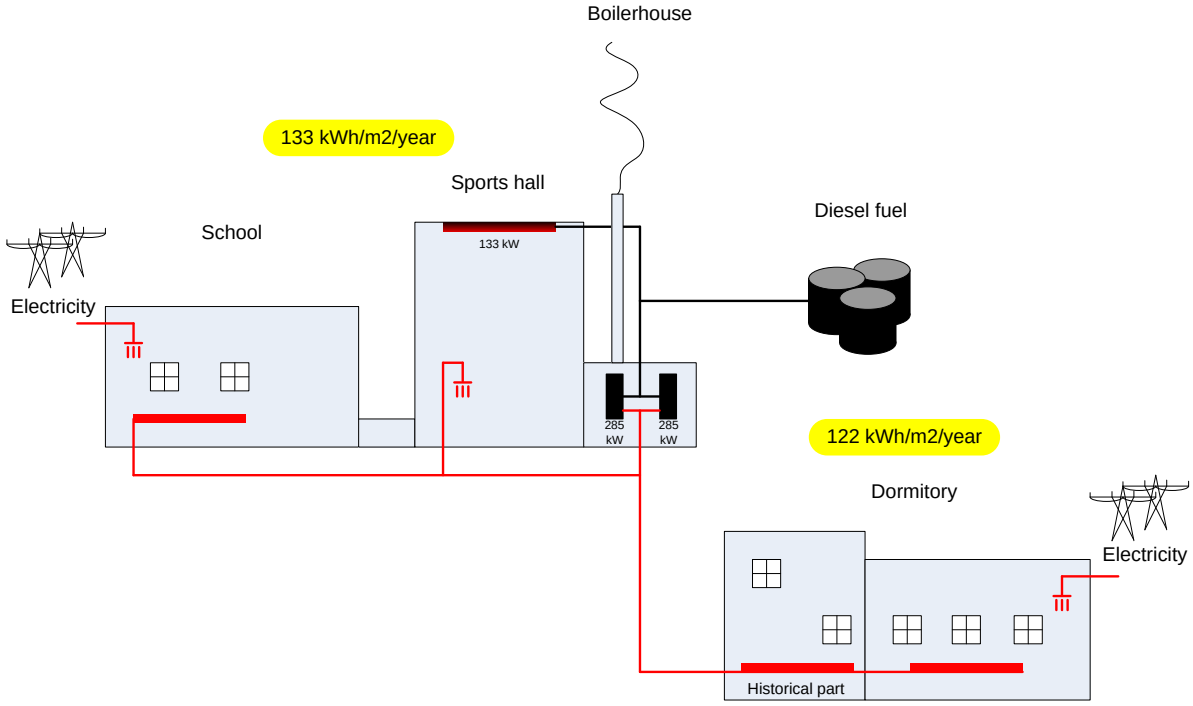


Fig.4. Schematic view on existing heating system

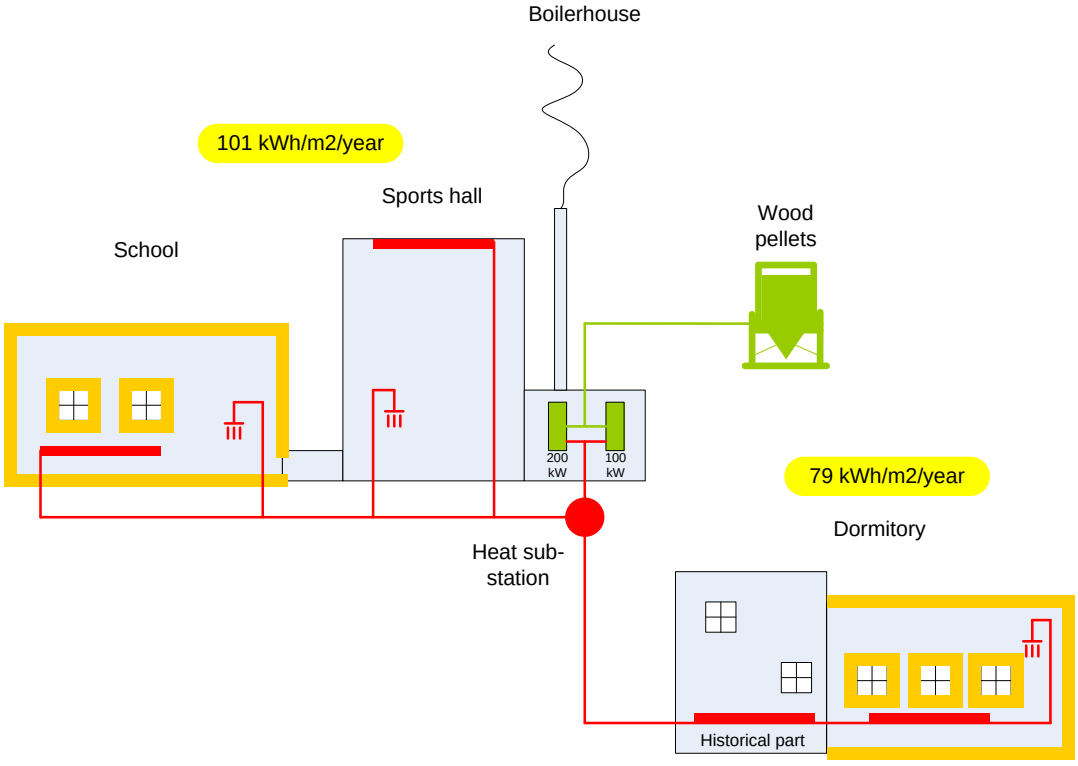


Fig.5. Schematic view on heating system after the project implementation

According to the results of energy audits, the technical condition of the school and dormitory building is satisfactory; however the thermal resistance levels do not comply with the requirements of the building code. Current heat consumption in the buildings is high; nevertheless, during the heating season the indoor temperature levels are lower than required by the building code.

The proposed energy efficiency measures include:

- Insulation of both building envelope
- Replacement of windows
- Roof insulation
- Replacement of doors
- Replacement of the diesel oil boilers with wood pellet boilers
- Installation of a new heat sub-station
- Replacement and insulation of heat pipes

After the implementation of the above mentioned measures it is planned that heat and hot water consumption in the building will decrease to 101kWh/m^2 in school and 79kWh/m^2 in dormitory building. This will give around 130 tons of CO_2 emission savings per year.

Fuel Supply:

1. Diesel oil costs 0.579 LVL/l (0.824 EUR/l). Average annual fuel costs were around 23 000 LVL (32 950 EUR).

2. Biomass
   There are number of wood pellet suppliers operating in the region. The average price of wood pellets in the market is around 100 LVL/t (including transportation costs).

Implementation of the project

Following the objectives of the Limbazi region bioenergy action plan, the municipality decided to improve energy efficiency and stop the use of fossil fuel in Viļķene elementary school. Municipality asked Ekodoma for advice and it was decided that first detailed energy audit for both buildings – school and dormitory building will be carried out. Based on the results of energy audit, appropriate size of wood pellet boiler was chosen to replace existing diesel boilers that due to the high fuel price got too expensive in operation.

System design:

Calculations made during the energy audit has proved that heat output necessary for space heating and hot water preparation after complex renovation would decrease from originally 133 kWh/m^2/year to 101 kWh/m^2/year and 122 kWh/m^2/year to 79 kWh/m^2/year in school and dormitory buildings respectively.

Capacity of new wood pellet boilers was selected based on the calculated energy demand after thermal insulation of the buildings. Measures proposed in the energy audit and afterwards included in the project technical documentation are following:

1) For the school building:
   - Insulation of the building envelope with 100 mm, window sills with 30mm and building plinth with 50mm foam polystyrene, rock wool or equivalent heat

insulation material. Removal of old glass blocks and decreasing the size of windows.
- New roof cover material (except for the new sports hall), insulation of the roof or installation of an additional heat insulation layer to reach the necessary requirements.
- Change of the obsolete windows and doors.
- Insulation of the floor above basement with 100 mm insulation material.
- Change of the floor in the former sports hall and insulation with a 50 mm insulation material.
- Replacement of diesel oil boilers with wood pellet boilers in the boiler house.
- Installation of a new heat sub-station to be able to regulate independently heat supply to the school and the dormitory building.
- Installation of a new heating system that will allow having evenly distributed temperature levels among rooms in the buildings and avoiding overheating of separate rooms while for others heat is lacking.
- Replacement of existing radiators and installation of thermostatic valves in order to be able to regulate temperature in separate rooms depending on their use.
- Installation of new heating system in the sports hall.

2) For the dormitory building:
   - Insulation of the building envelope with 100 mm, window sills with 30mm and building plinth with 50mm foam polystyrene, rock wool or equivalent heat insulation material. Installation of the hydro insulation and precipitation water collection and drainage system.
   - Insulation of attic with 300mm loose wool.
   - Change of the obsolete windows.
   - Change of old wooden doors and installation of new closing mechanisms.
   - Change of the floor in the former sports hall and insulation with a 100 mm insulation material.
   - Change of existing heating system to allow having evenly distributed heat energy supply in the rooms.
   - Installation of thermostatic valves on the radiators to be able to regulate temperature in separate rooms depending on their use.
   - Installation of new space heating and hot water distribution line from heat-substation installed in the school building to dormitory building in order to be able to replace electrical hot water boilers for hot water preparation with hot water from the wood pellet boilerhouse. Heat distribution line will be pre-insulated with two pipes in one shell.

Technology providers:

A pellet boiler supplier and a construction company for renovation of school and dormitory buildings will be selected in a public commission.

Financing of the project:

Investment costs of the project were initially estimated are 359 462 EUR (252 630 LVL). Buildings belong to municipality and the project investment costs will be covered by municipality budget. Part of the project financing is obtained in a terms of a bank loan. Two options to cover investment costs based on a full reimbursement by municipality budget combined with a bank loan and a financial support (grant) were considered. Financial evaluation of those options (with/without subsidy) is given in Appendix 1 of this document.

Option without subsidy is capital intensive for municipal budget. Therefore it was decided to evaluate available grants options considering financial capacity of Limbazi municipality.

One of the most attractive State support instruments for energy efficiency and renewable energy projects in Latvia is the Climate Change Financial Instrument (CCFI) or internationally known as Green Investment Scheme. CCFI is a programme of State Budget and resources are obtained from realizing state owned assigned amount units within the framework of international emissions trading which is one of the Joint Implementation projects under the Kyoto Protocol.

CCFI was first introduced in 2009 and is managed by the Ministry of the Environmental Protection and Regional Development. The main purpose of this instrument is to reduce green house gas (GHG) emissions, thus contributing to global climate change prevention. Also adaptation to effects caused by global climate change is of the scopes of CCFI. For municipality investments several calls for applications has been announced:

- Increasing energy efficiency of municipal buildings. Round 1 (2010)
- Technology transfer from fossil to renewable energy sources (2010)
- Complex solutions for GHG emission reduction in state and municipality owned professional school buildings (2010)
- Complex solutions for GHG emission reduction in municipality owned public buildings. Round 2 (2010)
- Low energy consumption buildings. Round 2 (2011)
- Use or renewable energy resources for GHG emission reduction. Round 1 (2011)
- Use or renewable energy resources for GHG emission reduction. Round 2 (2012)
- Use or renewable energy resources for GHG emission reduction. Round 3 (2012)
- GHG emission reduction in public street lighting systems (2012)
- Complex solutions for GHG emission reduction. Round 1 (2012)
- Complex solutions for GHG emission reduction. Round 2 (2012)
- Complex solutions for GHG emission reduction. Round 3 (expected 2013)

Finally application was prepared and submitted to the CCFI financing call “Complex solutions for GHG emission reduction. Round 2” that was due to 02 November 2012. First results were announced in December 2012 and Limbazi municipality were required for clarifications. In March 2013 the application were directed for the further evaluation, however, municipality have decided to re-submit the application for the Round 3 to be announced in summer 2013.

In this program the maximum investment for one project should not exceed 600 000 LVL (about 854 000 EUR) and for educational organisations (schools) up to 85% of total eligible investment costs are covered.

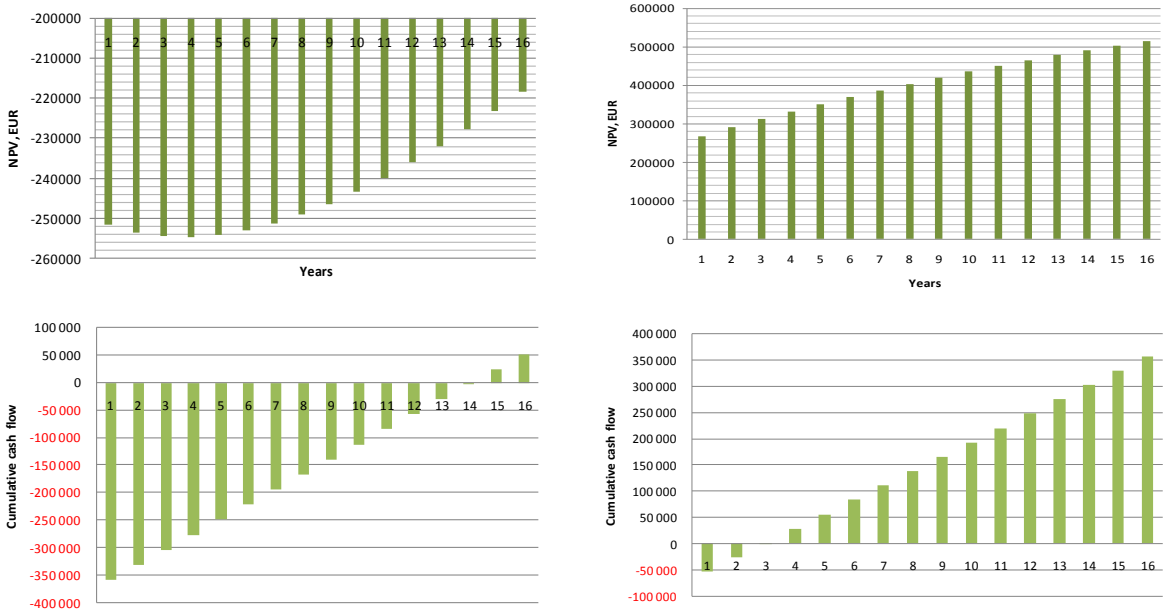
Financial evaluation of the project

The following table presents the costs, benefits and main assumptions used as input to the financial model built within the BioRegions project in order to evaluate the financial viability of this case study. Firstly, the capital and annual operation and maintenance costs after the project implementation are presented, whereas the incomes consist by avoided costs for energy as a comparison between before and after the implementation of the project. If a discount rate of 5% is assumed, the project‘s Net Present Value (NPV) can only get positive if more than 25% of total costs is provided as a subsidy.

				Without subsidy		With subsidy		
	Currency			LVL	EUR	LVL	EUR	0.7028 LVL/EUR
Capital costs	Investment costs			252 630	359 462	252 630	359 462	currency
	Assumed subsidy	Amount		0	0	214 735	305 543	currency
		Ratio		0		85		%
	Loan	Amount		176 841	251 624	26 526	37 744	currency
		Interest		5		5		%
		Payback time		15		15		years
	Own funds			75 789	107 838	11 369	16 175	currency
O&M costs	Fuel purchase costs			7 209	10 258	7 209	10 258	currency
	Maintenance costs			703	1 000	703	1 000	currency
Income	Annual heat sale			0	0	0	0	currency
	Annual electricity sale			0	0	0	0	currency
	Other (annual) income			0	0	0	0	currency
	Annual savings on energy costs			27 200	38 702	27 200	38 702	currency
Evaluation criteria	Net present value		NPV	-146 172	-207 985	344 652	490 399	currency
	Internal rate of return		IRR	-		-		%
	Simple Payback Period		SPB	13		2		years
	Year of implementation			2014				-
	Lifetime (evaluation)			15				years
	Discount			5				%
	Potential energy savings			181				MWh/y
	Potential CO_2 savings*			130				t/y
*Calculated according to the energy audit results as savings from replacing diesel oil and savings from replacing electricity for hot water preparation								

Return of investments

The cumulative discounted cash flow is shown in the Figure 6. Without subsidy the expected payback time is 13 years, with subsidy the simple payback period is only 2 years. This is a clear indication that subsidy in CCFI program is very generous.



Without subsidy With subsidy

Fig.6. NPV and cumulative cash flow

Sensitivity analysis

Sensitivity analysis were performed on four parameters:

- Project investment costs,
- Energy consumption after project implementation,
- Fuel price,
- Support intensity.

The result of the sensitivity analysis is given in Figure 7.

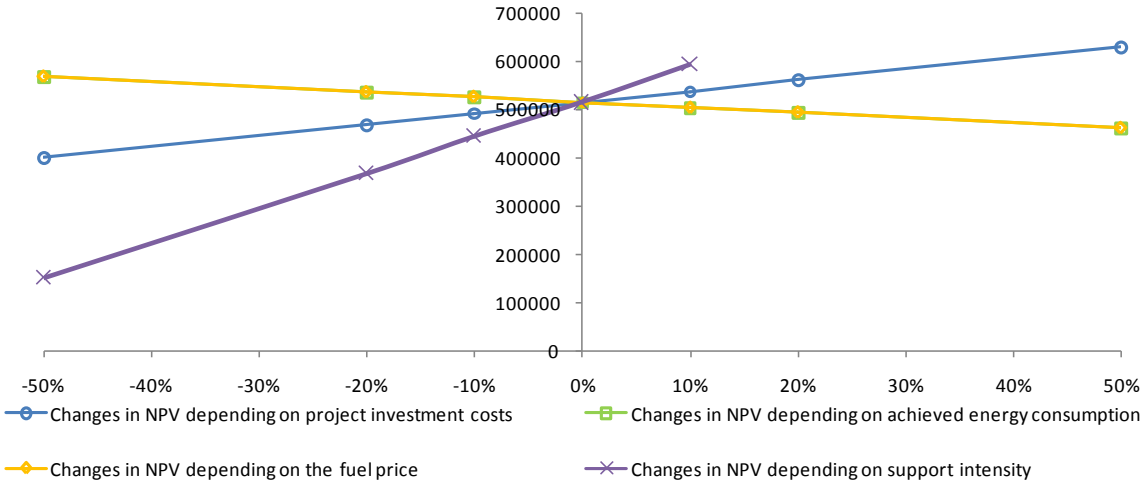


Fig.7. Sensitivity analysis of four parameters

The most important parameter affecting NPV value of the project is support intensity. In the base scenario, the support intensity is assumed 85%. Without support NPV value is negative.

If for some reason the total investment costs are rising, the NPV for 15 years period will get negative only when increase in investment costs will be more than 50% compared to initially planned amount.

Conclusions

Implementation of the Vilkene elementary school reconstruction project is in compliance with approved Biomass action plan designed within the BioRegions project. Complex refurbishment of the buildings with switch from fossil fuel use to using renewable energy sources will result in energy efficiency increase and simultaneously in decrease of local dependence on imported fossil fuels. Utilisation of wood pellets increases energy self sufficiency and stabilises the heat prices on acceptable level.

The decision to use complex solution for the renovation was done because simple replacement of the diesel oil boilers by new biomass boilers would save fuel costs, but still lot of energy would be wasted caused by poor thermal characteristics of the old buildings. Moreover the old heating system did not provide the necessary comfort level in terms of room temperatures.

As shown in the financial evaluation above, despite the important social and economic benefits such a project brings to the local communities, it lacks the required financial viability and, therefore, public financial support is strongly needed for its realisation. Currently provided investment grant at 85% amount of total investment is very generous. Also with a lower support it would have been possible to pay back investments in reasonable period of time.

Appendix 1: Financial evaluation results

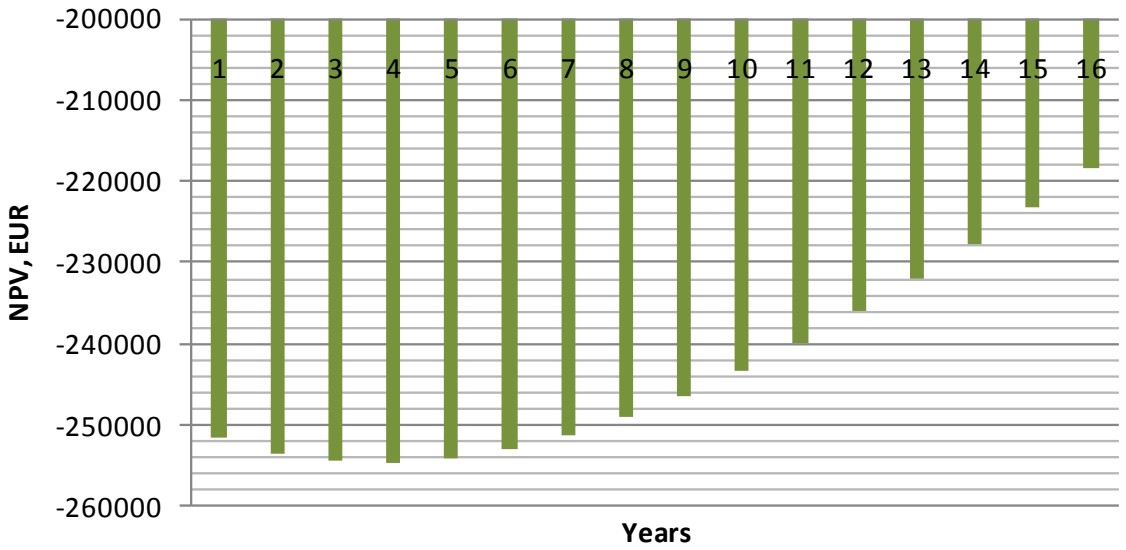
Without subsidies

Years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Revenues	0	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702
Costs	0	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258
Free cash flow	-251624	-1912	-1073	-234	605	1443	2282	3121	3960	4798	5637	6476	7314	8153	8992	9831
DF	1	0.95	0.91	0.86	0.82	0.78	0.75	0.71	0.68	0.64	0.61	0.58	0.56	0.53	0.51	0.48
PV		-1821	-973	-202	497	1131	1703	2218	2680	3093	3461	3786	4073	4324	4542	4729
NPV	-251624	-253444	-254417	-254620	-254122	-252992	-251289	-249071	-246391	-243298	-239837	-236051	-231978	-227654	-223113	-218384

NPV	-207 985
IRR	-11%

Investment costs	359462	EUR
Self-financing	107 839	EUR
Bank loan	251 624	EUR
Savings	38 702	EUR/year
Costs	11 258	EUR/year

Interest rate	5%
Discount rate	5%



With subsidies (85%)

Years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Revenues	0	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702	38 702
Costs	0	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258	11 258
Free cash flow	267799	23041	23167	23293	23418	23544	23670	23796	23922	24047	24173	24299	24425	24551	24677	24802
DF	1	0.95	0.91	0.86	0.82	0.78	0.75	0.71	0.68	0.64	0.61	0.58	0.56	0.53	0.51	0.48
PV		21944	21013	20121	19266	18447	17663	16911	16191	15501	14840	14207	13601	13020	12463	11930
NPV	267799	289743	310756	330877	350143	368591	386254	403165	419356	434857	449698	463905	477505	490525	502988	514919
NPV	490 399															
IRR	-															

Investment costs	359462	EUR
Self-financing	16 176	EUR
Bank loan	37 744	EUR
Savings	38 702	EUR/year
Costs	11 258	EUR/year

Interest rate	5%
Discount rate	5%