D6.1
Reports on Pilot Projects
Collection of 24 condensed reports

D6.1: 'A minimum of 3 pilot projects per Member of Consortium will be set up and executed. Results are documented as reports, i.e. a total of at least 18 condensed reports will be issued.'

Work package leader: Dr. Ingo A. Schneider, HSLU

Work package co-leader: Dr. Felipe Toro, IREES

The national implementation partners are responsible for the respective reports.

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Project partners

Fraunhofer ISI

BPIE

FIRE
FEDERAZIONE ITALIANA PER L'USO RAZIONALE DELL'ENERGIA

Environmental *Change* Institute

eci

UNIVERSITY OF OXFORD

BORGOC

NATIONAL TECHNICAL UNIVERSITY OF ATHENS

ECEEE
european council for an energy efficient economy

Unil
UNIL | Université de Lausanne

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IREES
research for future.

ISR - University of Coimbra

www.mbenefits.eu

Multiple benefits of energy efficiency

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 785131. This document only reflects the authors' views and EASME is not responsible for any use that may be made of the information is contains.

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1 Introduction

The M-Benefits project: ***Valuing & Communicating the Multiple Benefits of Energy Efficiency*** aims at creating a framework for the inclusion of the multiple benefits of energy efficiency in investment assessment and decision-making of companies and relevant stakeholders.

This overall goal is achieved with the combination of research activities and development of a robust methodology to assess and quantify non-energy benefits and their effect on the financial investment evaluation.

A central element of the project is the ***Implementation and validation of M-BENEFITS methodology into pilot projects.*** The collection of evidence-based information on the impacts of energy and non-energy benefits (multiple benefits) was conducted in earlier work packages and it was an important input for the development of the toolbox as well as for the energy managers in industrial and service sectors, when evaluating energy efficiency measures.

Furthermore, a M-Benefits toolbox in Excel was developed within work package 4 to assist energy managers at companies with the identification, categorization and financial evaluation of multiple benefits, considering possible effects from non-energy benefits from a strategic point of view. Energy managers were also trained in the countries where pilot projects were conducted. The results of these pilot projects (work package 6) are presented in this report. This work package has been coordinated by the HSLU in Switzerland.

The main objectives of work package 6 are:

- Implementation of the MBenefits approach to assess multiple benefits of energy efficiency in the investment decisions of companies.
- Creation of exemplary real-life case studies in the framework of pilot project cooperation in Austria, Germany, Greece, Italy, Poland, Portugal and Switzerland where implementation partners were located.
- building-up evidence base and know-how on non-energy related benefits and on the process of data search and implementation within companies
- Evaluation and validation of the M-Benefits Methodology at the participating companies together with at least the energy manager and other management level involved. The robustness, adaptability, acceptance, and usability of the method are assessed.
- Implementation of possible improvements of the methodology during the pilot phase.
- Encouraging the further use of the MBenefits tools in these companies for future energy efficiency investments.

The pilot projects in the different countries were conducted at different speeds and with different challenges, influenced mostly by the pandemic situation. Nevertheless, the participation from several companies in almost all countries was observed and at least 24 exemplary projects were successfully conducted and are documented in this report.

The case studies and summaries of the pilot projects reflect the work each partner had with the company's energy managers and other professionals involved in identifying energy efficiency measures from the energy audits reports or from the pipeline of projects energy managers provided. Energy efficiency measures are described concisely at each company level and its reporting structure goes along the MBenefits Methodology and Pilots Projects Guideline.

The Methodology is a comprehensive five step structure of different analysis which build up on each other:

- Company analysis
- Energy & operations analysis
- Strategic analysis
- Financial analysis
- Presenting the results before the advisory board

Figure 1. An overview of the M-Benefits Methodology and the steps in the pilot projects

Based on the energy audit available at company level, the analysis of the energy efficiency measures including non-energy benefits started with the company analysis. The energy efficiency measures to be analysed were identified by the energy managers during their audits. The purpose of the multiple benefits of energy efficiency measures is to expand the standard view energy professionals on energy efficiency measures and get a more comprehensive view on the activities of the company that provide value and involve the relationship with customers and providers.

The following step is the Energy & Operation analysis. In this step the energy efficiency measure is evaluated from the energy side and connected with the energy services offered and important production processes connected to the measure are identified. During the energy and operation analysis some initial non-energy related benefits were identified. The next step is to identify and confirm the corresponding non-energy benefits of the measure through the strategic analysis based on the company analysis and an expanded view of the energy efficiency measure.

Conducted through the quantified non-energy benefits of the strategic analysis the financial analysis adds costs and figures to the business case and delivers financial indicators as performance for the investment. The last step is the presentation of the business case in front of the advisory board and at best receive a positive investment decision.

2 Reports of Pilot Projects

2.1 Reports Austria

Author, Organization (Reinhard Ungerböck, GEA)

2.1.1 Austrian Pilot 1: Energy Efficiency in mining industry

Company name: Sandvik Mining and Construction GmbH

Project Idea and Rationale

The initial idea for this project was the complicate logistic situation of the lacquer station in the company: besides to poor insulation and an old ventilation system the maneuvering with steel parts, that have to be lacquered, is lengthy, takes time and resources and blocks other processes. Therefore, the idea was to think this station new from scratch in order to smoothen the workflow and save energy at the same time.

The genesis of the project was very dynamic and a bunch of other shortcomings in logistics came up until the project became 10 times bigger (investment volume) than the initial project idea.In this paper two variants of the project are elaborated: the initial idea with solely improving the lacquer hall (EEM1) and the version with the completely new logistic system (EEM2)

EEM1 New construction of the lacquering and cleaning hall

Multiple benefits of energy efficiency — Project idea and rationale basic variant

Current situation and weaknesses:

The thermal situation as well as the logistic situation in and around the lacquering hall are inadequate: the heating demand is high and the process flow is complicate, when steel parts have to be treated.

Energy-efficiency measure(s) proposed and advantages:

Reconstruction/new construction of the laquering station and associated improvement of logistics. In the course of the conversion of the laquering hall (new doors, opening to the logistics wing), the box will also be thermally insulated. This will reduce transmission losses and increase comfort - besides to the improvements for the logistics

Figure 2. Project Idea and Rationale- Sandvik Mining and Construction GmbH

EEM2 New building for finishing, logistics, freight forwarding, steel delivery and adaptations incl. insulation to existing lacquer and cleaning hall.

Multiple benefits of energy efficiency — Project idea and rationale extended variant

Current situation and weaknesses:

In addition to the logistic weaknesses nearby the lacquering hall also the logistics for storing of steel parts (source material as well as intermediate and final products) are inadequate. Moreover for delivering source materials long distances through the whole plant have to be taken. This reduces potential production areas in favor of traffic areas.

Energy-efficiency measure(s) proposed and advantages:

In addition to the basic variant an whole new building for logistic purposes is foreseen. The idea for this project came from starting with design of the basic variant and took of from one improvement idea to the next and so on. Meanwhile two further extensions are planned, not only for logistics, but also for situating the whole administration and design center nearer to the production halls.

There are no further energy benefits for the first extended variant, that is calculated for this use case

Figure 3. Project Idea and Rationale. Sandvik Mining and Construction GmbH

Results of the Company Analysis

Sandvik Mining and Construction G.m.b.H. in Zeltweg develops and produces tunnelling and mining machines for the mining of mineral and ore resources and for the excavation of tunnels. It is part of the Sandvik Mining and Rock Technology business unit within the global Sandvik group of companies.

The Zeltweg site, with a history of more than 165 years, is the competence centre for engineering and production of machines for cutting rock as well as for mobile conveyor belt systems.

The products of the Zeltweg plant are used both for the production of underground cavities in the construction industry, e.g. tunnels and caverns, and in underground mining for driving roadways and extracting raw materials.

Typical products from the very extensive portfolio include bolter miners, roadheaders, continuous miners, borer miners, etc.

As the headquarter of the company sits in Sweden, sustainability is an important topic throughout all activities, although the branch itself and many of Sandvik's clients are from the fossile economy (e.g. coal mines)

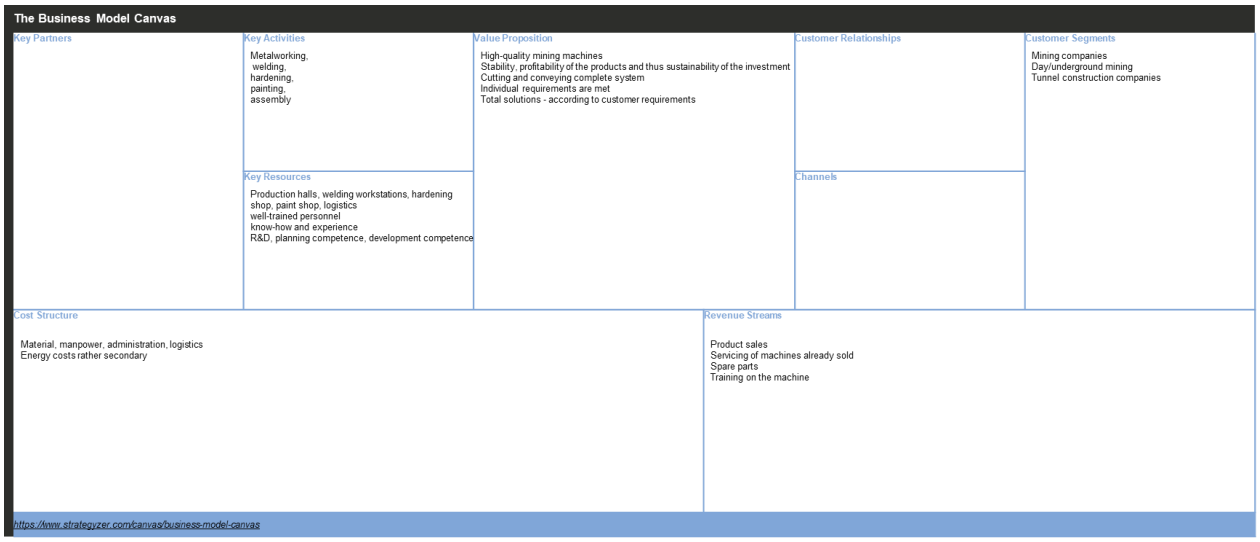


Figure 4. Results of the Company Analysis. The Business Model Canvas. Sandvik Mining and Construction GmbH

Results of the Energy Analysis

For the M-Benefits only the plant in Austria has been investigated. The main energy sources are electricity (for all processes, including the hardening of steel parts in a high-temperature oven – a very energy-intensive process) and heat from the biomass district heat plant. A small share of natural gas is used for heating purposes, incidentally exactly the lacquer hall is heated through naturals gas.

Current energy consumption:

- Energy carriers impacted by the project: electricity, natural gas
- Consumption
  - Electricity: 5,623,000 kWh/y
  - Natural gas: 164,000 kWh/y
  - District heat (biomass): 8,360,000 kWh/y

Future energy consumption (basic and extended variant)

- Estimated physical savings: 44,000 kWh/year (natural gas)
- Estimated financial savings: 1,500 €/year

Figure 5. Results of the Energy Analysis. Sandvik Mining and Construction GmbH

Results of the Operations Analysis

For the lacquer station, the process is quite standardized: steel parts are moved into the cleaning station, positioned and cleaned (wet). After drying, the parts are moved into the next room, the lacquer room. The parts are positioned and then painted. After the paint drying, the parts are moved out of the hall.

The complicate thing about the status quo is, that the drying box is a passage room to the painting room. In case anything big must be moved out of the painting room, the cleaning room has to be emptied beforehand. (see drawing with yellow arrows). The improvement of logistics will provide a straight workflow.

The energy services for all those process steps are compressed air (for cleaning), ventilation (during the painting and drying) and heating (mainly during drying)

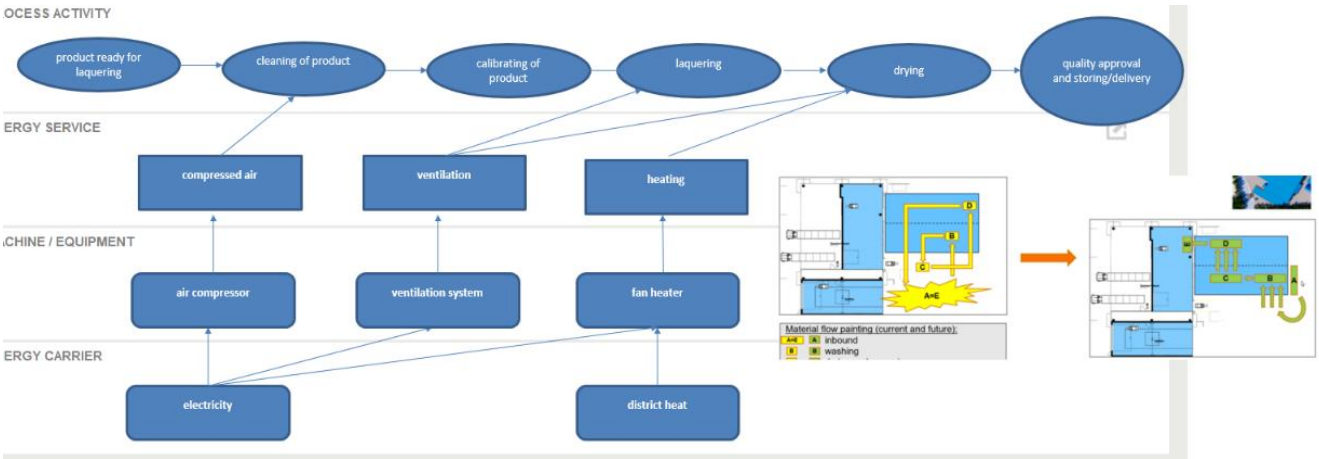


Figure 6. Results of the Operations Analysis-Operational diagram. Sandvik Mining and Construction GmbH

Results of the Strategic Analysis

For the basic variant mainly logistic effects nearby the hall arise. This leads particularly to a better production cycle (faster, more reliable) and brings advantages on costs and maybe also sales, in addition, also the risk of delivery delays is related to this effect.

The additional space can also be used for new value creation.

In terms of risks besides to the delivery delay risk also a reduced risk on working accidents and thereby absenteeism can be expected.

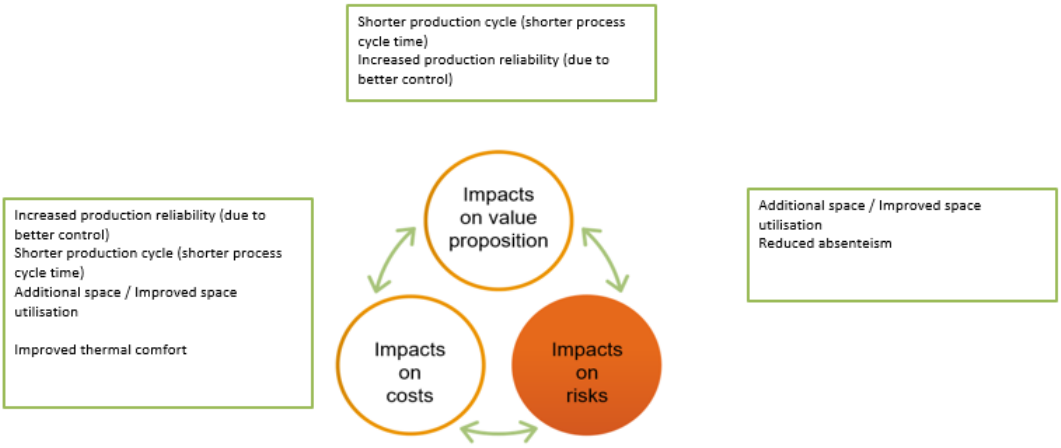


Figure 7. Results of the Strategic Analysis. Sandvik Mining and Construction GmbH

For the extended variant, some more effects on logistic topics arise in addition to the basic variant. This implies that orders can be processed faster (time-to-customer), the quality of products is higher due to fewer absences, respectively worker replacements and – most important – one additional working space can be generated. This means more turnover and consequently more profit.

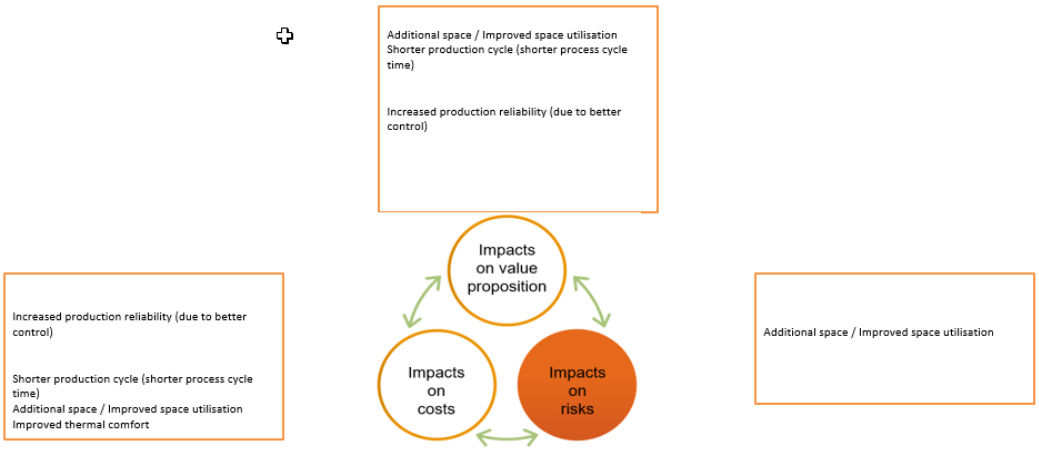


Figure 8. Results of the Strategic Analysis. Sandvik Mining and Construction GmbH

Results of the Financial Analysis

EEM1 basic variant:

Financial analysis

Energy benefits only

- CAPEX: 100'000 €
- NPV: -67.787 €
- IRR: -19,66 %
- Discounted payback: 43 years

All benefits

- CAPEX: 100'000 €
- NPV: 55.675 €
- IRR: 20,26 %
- Discounted payback: 4 years

Discount rate: 7.5 %

Investment duration: 10 years (i.e. the number of years taken into account to compute NPV and IRR)

Figure 9. Results of the Financial Analysis. Sandvik Mining and Construction GmbH

EEM extended variant:

Energy benefits only

- CAPEX: 610'000 €
- NPV: -580,000 €
- IRR: - %
- Discounted payback: over 50 years

All benefits

- CAPEX: 610'000 €
- NPV: -87,000 €
- IRR: 4,29 %
- Discounted payback: 8 years

Discount rate: 7.5 %

Investment duration: 10 years (i.e. the number of years taken into account to compute NPV and IRR)

Figure 10. Results of the Financial Analysis. Sandvik Mining and Construction GmbH

Key Arguments for the Project Implementation

EEM basic variant:

Just from the point of view of the energy savings this project should rather not be approved. But as there are several non-energy-benefits as a “side effect” – improved process flow, better logistics, reduced health risk (accidents AND thermal comfort) – the project becomes attractive and profitable for the company. Further the effects on sales (quicker production circle) can only be described qualitatively yet.

EEM extended variant:

The optimization and refurbishment project of the lacquering hall was the starting point for a much larger program: a comprehensive re-launch of the logistics at the plant.

Although also the NPV of all quantitative effects is negative, the effects are mostly qualitative, thereby from strategic nature:

The new logistic scheme reduces distances, saves space, increases safety and opens the path for follow up projects, i.e. new administration and design centres next to the production halls (see sketch below)

Figure 11. Key Arguments for the Project Implementation. New logistic scheme. Sandvik Mining and Construction GmbH

2.1.2 Pilot 2: Energy Efficiency in the Glass industry in Austria

Company name: Stölzle Oberglas

STOELZLE GLASS GROUP

Multiple benefits of energy efficiency

1. Waste heat utilisation of the electrode cooling of the melting bath via district heat extraction
2. Control and Measurement Technology - EMS Energy Monitoring System Introduction

STOELZLE GLASS GROUP

Implementing partner: Reinhard Ungerböck, GEA
Responsible person: Thomas Mayrold, Stölzle

2019-xx-xx Title, author, organisation ... 2

Project Idea and Rationale

The Glass industry is a very energy intensive branch in Austria and Europe. Thereby a focus on optimization of energy costs is already in the DNA of companies in this branch. Still there are many untapped efficiency potentials, especially in areas that are not related to the main energy use: the melting bath. In this respect 2 measures have been analysed that are not directly

<u>EEM1 Waste heat utilization of the electrode cooling of the melting bath via district heat extraction</u>

Multiple benefits of energy efficiency — Project idea and rationale 1

Current situation and weaknesses:

The electric electrode heating of the glass melting bath is cooled with process water in a continuous flow system. The fresh water is heated from approx. 15° C to 40° C and fed directly back into a creek via the oil separator. However, this cooling water leads to partial overloading of the oil separator.

Energy-efficiency measure(s) proposed and advantages:

If the cooling water is circulated and cooled by an adsorption refrigeration unit, this results in lower water consumption and an additional feed quantity for district heating. Furthermore, the separation efficiency of the oil separator is improved. However, with a possible expansion of the melting bath, the amount of cooling water will then exceed the capacity of the oil separator.

Figure 12. Project Idea and Rationale. Stölzle Oberglas

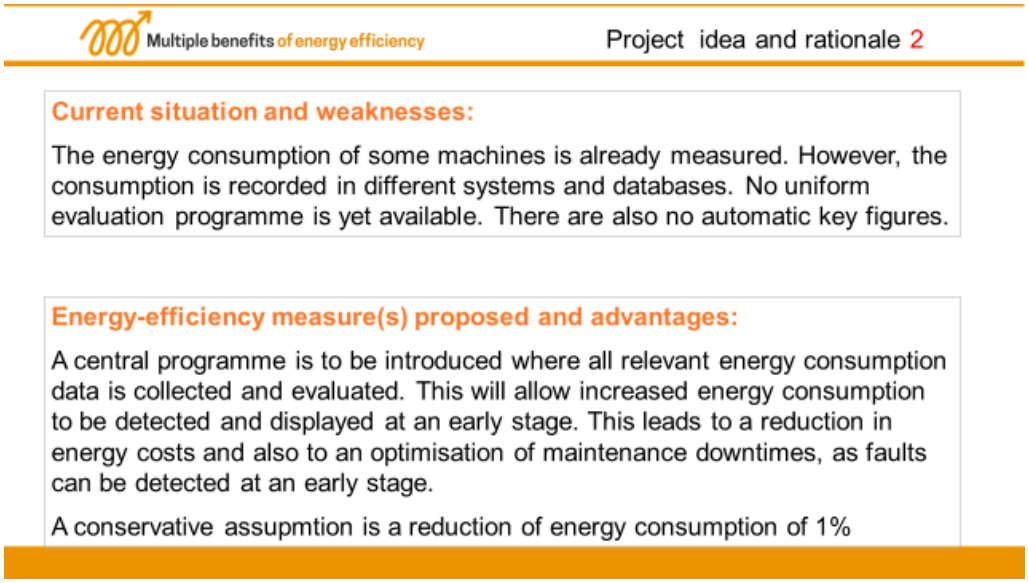


Figure 13. Project Idea and Rationale. Stölzle Oberglas

Results of the Company Analysis

Stölzle Oberglas is a multinational company with plants in Austria, Poland, Czech Republic, France and Great Britain. The Austrian headquarters of the Stoelzle Glass Group started its manufacture of hollow and packaging glass in 1871, formerly being a production site of flat glass. Over the past 20 years, Stoelzle has turned into one of the leading producers of high-end glass packaging worldwide.

Investments in all aspects of production, quality control and logistics together with its motto “STO success is based on successful employees” have turned Stoelzle into Europe’s leanest and most efficient producer of pharmaceutical glass packaging.

The production amounts to almost 1.5 billion pieces of container glass in white flint, amber and green glass each year, what reflects an impressive output of 250 tons of glass every day.

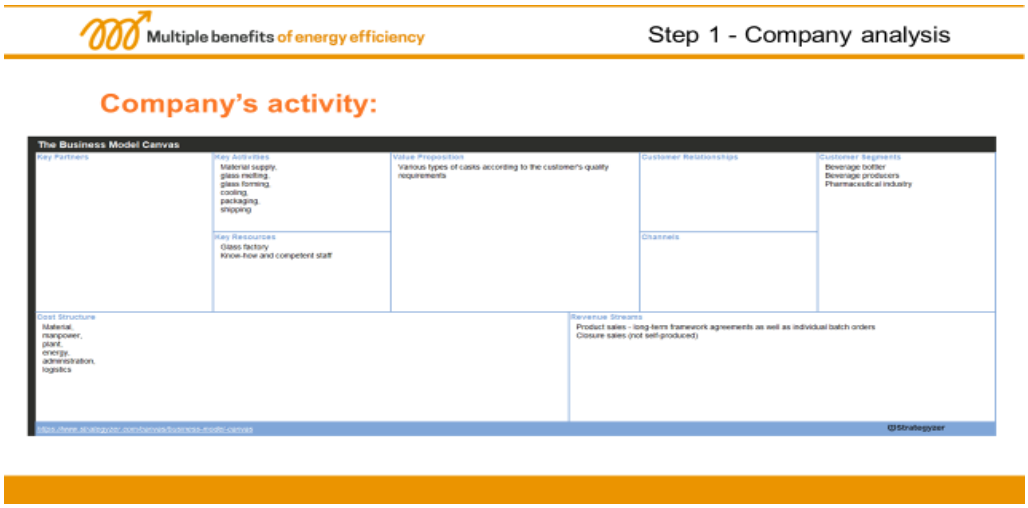


Figure 14. Results of the Company Analysis. Stölzle Oberglas

Results of the Energy Analysis

For the M-Benefits only the plant in Austria has been investigated. The main energy source is natural gas, which is used to heat up the glas melting bath. The know-how of this process is a key-resource of the company and energy costs take a regular position in all optimization processes at the plant.

Besides to this there is not sufficient awareness for supporting processes or follow up processes, because their influence on the overall energy costs is limited. In this respect it is still surprising that there is no automated energy monitoring system in place yet.

Current energy consumption:

- Energy carriers impacted by the project: electricity, natural gas and district heat feed in
- Consumption
  - Electricity: 85,876,000 kWh/y
  - Natural gas: 210,727,000 kWh/y
- Production (sales)
  - District heat feed in: 18,418,000 kWh/y

Future energy consumption (after EEM 1 implementation)

- Estimated physical savings: 1,336,000 kWh/year (natural gas)
- Estimated increased energy sales: 5,000,000 kWh/year (district heat feed in)
- Estimated financial savings: 170,000 €/year

Future energy consumption (after EEM 2 implementation)

- Estimated physical savings: 588,760,000 kWh/year (electricity)
- Estimated physical savings: 2,107,270 kWh/year (natural gas)
- Estimated financial savings: 125,000 €/year

Figure 15. Results of the Energy Analysis. Stölzle Oberglas

Results of the Operations Analysis

For EEM1 the operational analysis shows that most of the energy use is for heating up the glass melting bath with natural gas. Electricity takes a minor role and is mainly used for auxiliary processes and a temperature fine-tuning through electrodes. These electrodes have to be cooled in specific areas, which also consumes significant energy.

Excess heat is already used as waste heat for the district heat grid of the city of Köflach, mainly the waste heat is taken directly from the melting bath. But it is also possible to generate waste heat from other processes:

If the cooling water of the electrodes is circulated (in a closed circle) and cooled by an adsorption refrigeration unit, this results in lower water consumption and an additional feed quantity for district heating. Furthermore, the separation efficiency of the oil separator is improved. However, with a possible expansion of the melting bath, the amount of cooling water will then exceed the capacity of the oil separator.

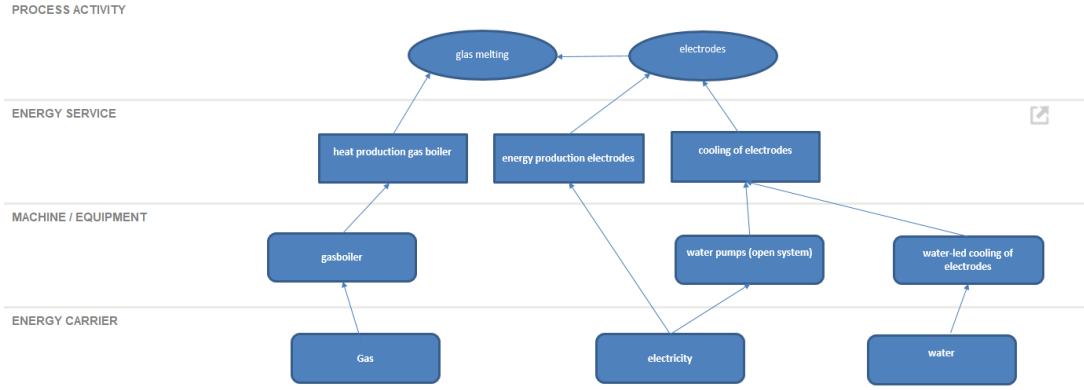


Figure 16. Results of the Operations Analysis- Operational diagram. Stölzle Oberglas

Results of the Strategic Analysis

For EEM1 the strategic analysis shows mainly reduction of risks besides to the major cost factor of sales of waste heat and the minor cost factor of reduced water consumption.

The relation to the municipality must not be underestimated: there is a close connection between plant and city through the role of the plant as employer, environmental impacts, taxes and many more. Thereby a larger input into the district heat grid and reduced environmental risks and impacts are advantageous.

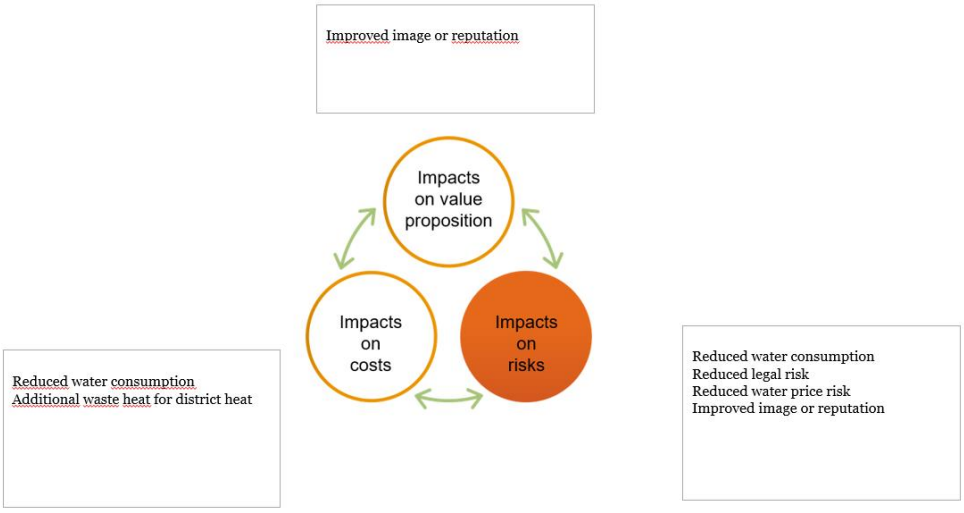


Figure 17. Results of the Strategic Analysis. Stölzle Oberglas

For EEM2 there is a high impact especially on non-energy benefits to be expected. Not only the production costs per unit will decrease, in addition better product quality should lead to a higher sales volume and/or to higher sales prices

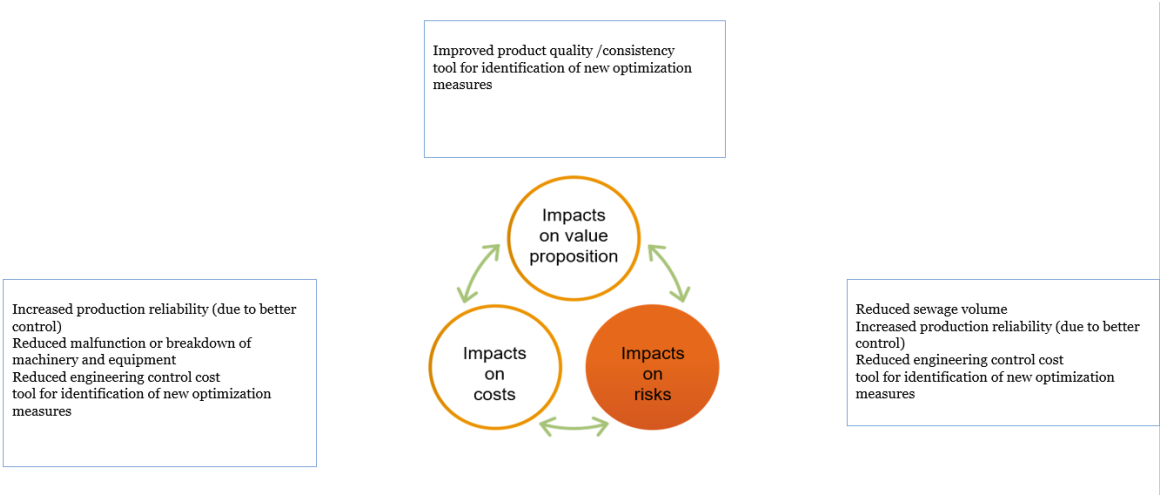


Figure 18. Results of the Strategic Analysis. Stölzle Oberglas

Results of the Financial Analysis

EEM1:

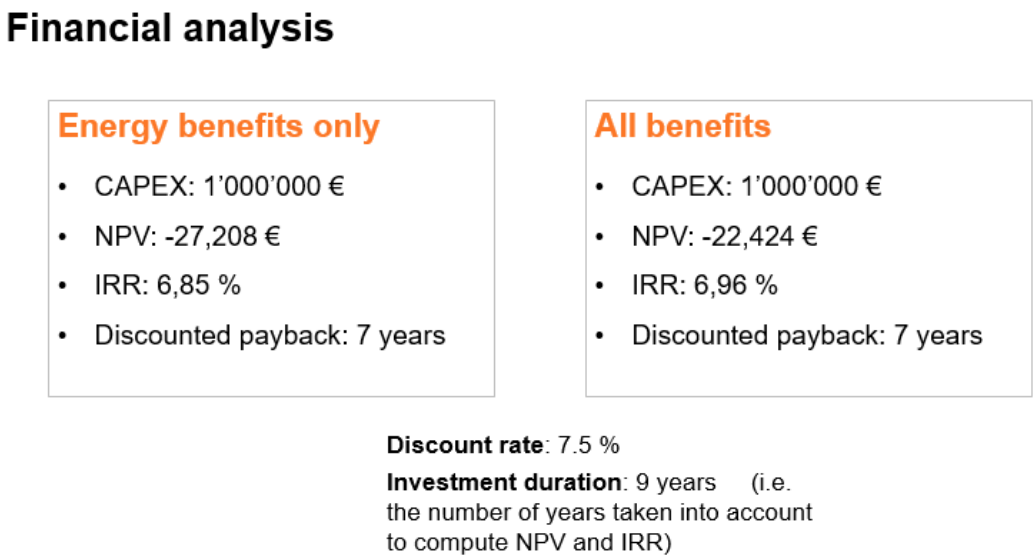


Figure 19. Results of the Financial Analysis. Stölzle Oberglas

EEM2:

Energy benefits only

- CAPEX: 270,000 €
- NPV: 420,000 €
- IRR: 49,96 %
- Discounted payback: 3 years

All benefits

- CAPEX: 270,000 €
- NPV: 850,000 €
- IRR: 99,79 %
- Discounted payback: 2 years

Discount rate: 7.5 %
Investment duration: 9 years (i.e. the number of years taken into account to compute NPV and IRR)

Results of the Financial Analysis. Stölzle Oberglas

Key Arguments for the Project Implementation

EEM1:

In addition to the pure economic calculation a number of non-quantifiable (non-energy) benefits come along:

Stölzle is a major employer for the city of Koeflach and thereby in the center of attention when it comes down also to environmental issues and interaction with the city. With the increased feed in into the district heat grid, an improved risk situation regarding the water consumption a long-lasting good relationship can be ensured.

Moreover, a proper corporate environmental responsibility (CER) becomes more and more important for the sales in the branch of glas industry

EEM2:

Apart from the pure economic performance – which already meets all requirements for a positive investment decision – additional benefits can be expected with a high probability:

First priority: We expect to increase our product quality, which should lead to a higher sales volume and/or to higher sales prices

Second priority: the EMS will very likely open the path for optimization measures with impact not solely on energy consumption, but also benchmarks in production and in sales and for the reduction of various risks, due to improved analysis possibilities.

2.1.3 Pilot 3- Refurbishment of Changing rooms and showers in steel industry in Upper Styria

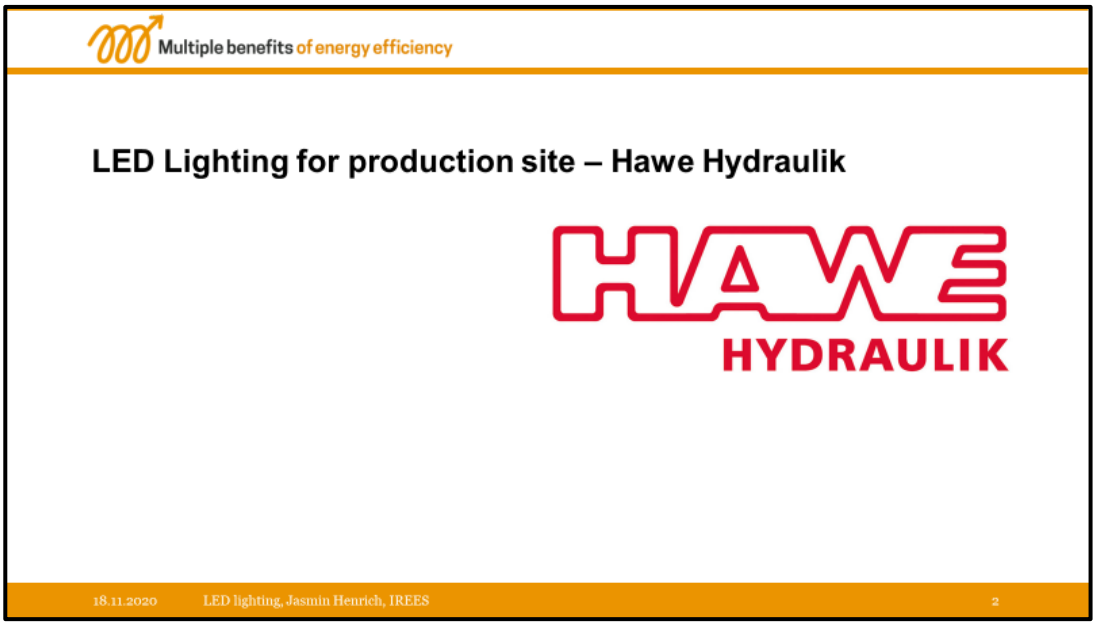
Reason why the reports could not be delivered in time: as this project has already been implemented prior to the M-Benefits-project, the analysis had to be performed ex post. Feedback on the assumptions has been promised by the client but postponed several times.

Further the Covid19-situation made conversation even more complicate, so the contact to the client almost ceased completely. Finally, the decision hat to be taken to take all assumptions as given but mark them all respectively. This will be done until the above-mentioned date.

2.2 Reports Germany

Authors, Organization: (Jasmin Henrich, Felipe Toro, IREES GmbH)

2.2.1 Pilot 1: Energy Efficiency Measure: LED Lighting at production site Freising HAWE Hydraulik



Project Idea and Rationale

The energy efficiency measure at the Company HAWE is located at the production site in Freising. The current lighting of the production halls are to be substituted by led lighting. The current lighting is obtained by fluorescent tubes. The total area of the company in Freising amounts up to 13.000 m2.

The current light obtained from the fluorescent tubes is not a constant light color as different light colors are observed in the different lamps due to pollution and the age of the tubes. Another effect observed is the flickering of the tubes because of the humid atmosphere. Related to that is the high risk of corrosion of the fixing holding the tubes.

The energy efficiency measure identified in this site through energy audits is to install LED lights and substitute the fluorescent tubes. The expected benefits are consistent lighting, no flickering effect, better energy efficiency, better and clear visibility and reduced maintenance costs in particular reduction of special waste as a complete substitution of the fluorescent tubes and lamps. The offer for these new LED lamps were given to the company directly by a professional light company in Germany.

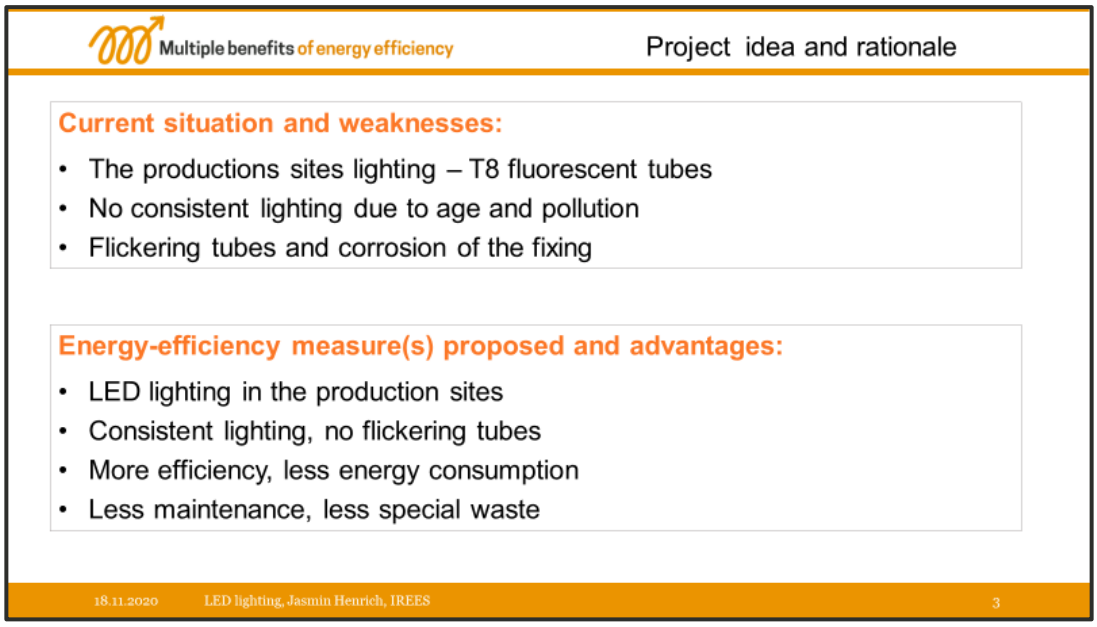


Figure 20. Project Idea and Rationale. Pilot 1 HAWE Hydraulik

Results of the Company Analysis

HAWE is a global producer of hydraulic components and systems for mechanical and plant engineering in 6 areas covering infrastructure, efficient production, energy, nutrition and nature, resources and health. Over 2,500 employees work professionally and flexibly on innovative solutions for customers.

One of their slogans is “solutions for a world under pressure”. Their core business principle is customer orientation as they are advertising the perfect solution for the customers problem using the slogan “solutions for problem solvers” based on building longstanding business relationships on trust. Hawes’ other business principles are innovation, products, technology, quality, industrial safety and environmental protection, internationality, staff and leadership, suppliers and revenue optimization and cost structure.

HAWE Hydraulic supplies compact, energy-saving and durable hydraulic components and systems. These are characterised, for example, by: consistent steel structure (no pressurised cast or aluminium parts), design of the components for high pressures, compact design, zero leakage or verified low leakage, approvals for special operating conditions (e.g. ATEX).

Economic, ecological and social sustainability is part of HAWE's corporate responsibility. The corporate principles, the matrix certification (ISO 14001, ISO 45001 & ISO 50001) as well as the certification according to ISO 9001 symbolize the way of thinking of the group of companies. HAWE's quality management system sets standards that are valid for the entire HAWE Group worldwide. In addition, HAWE began in 2008 to develop and implement an environmental and energy management system as well as an occupational health and safety system. Sustainable earnings, a healthy equity base and long-term thinking in corporate management secure jobs and relationships with business partners in the long term.

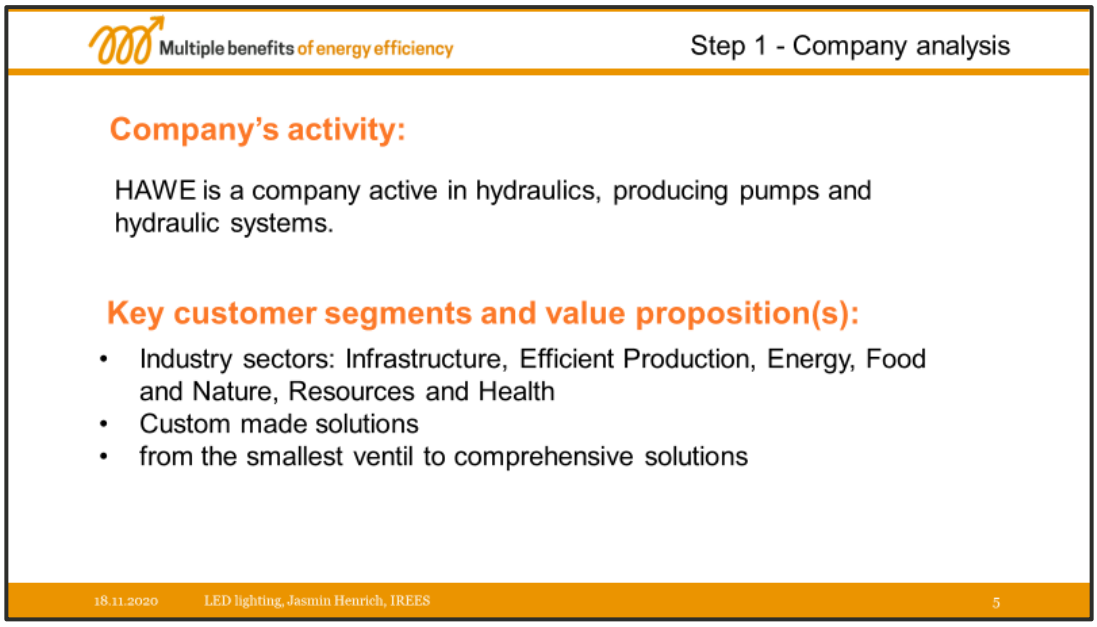


Figure 21. Results of the Company Analysis. Pilot 1 HAWE Hydraulik

Results of the Energy Analysis

The company is ISO 50001 certified and therefore has an energy management system in place where energy consumption is controlled, and energy efficiency measures are yearly planned, evaluated for investment and implemented or rejected. The company has a yearly allocated budget for energy efficiency measures. The company production requires electricity, natural gas and possibly co-generation at sited to produce their wide arrange of products and delivered services.

With respect to the energy efficiency measure in place the company provided us the total electricity consumption on site which amounts up to 4.6213 MWh/year. Through the LED EE measure the production site estimates electricity savings that amount up to 482 MWh/year, or a 10.4 % of total electricity consumed in 2019.

The estimated financial savings are calculated with 81.915 EUR/year energy benefits only.

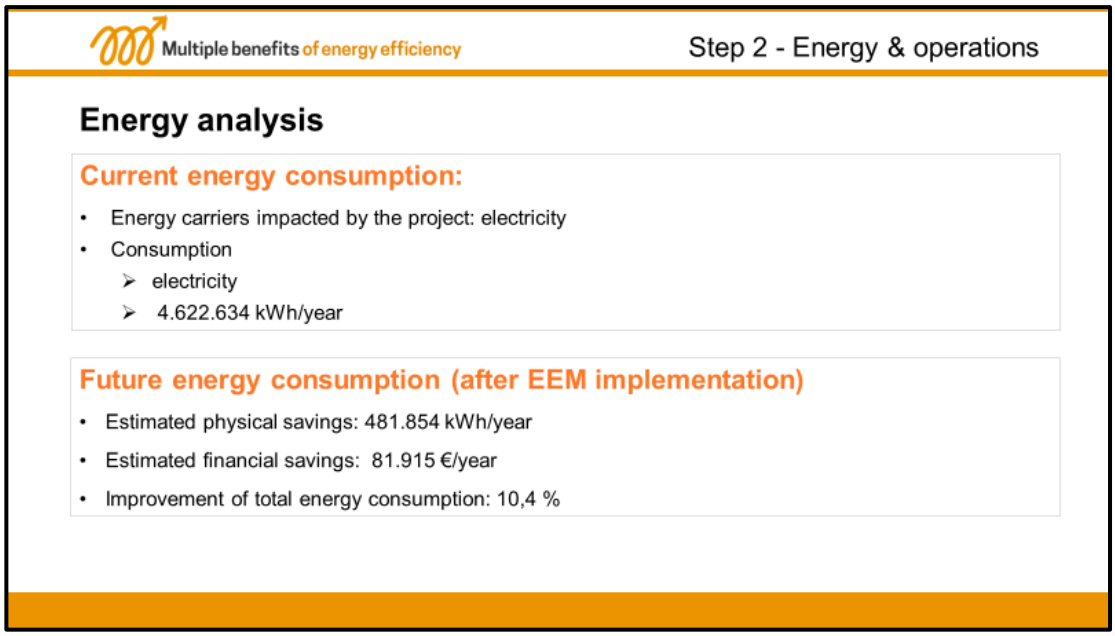


Figure 22. Results of the Energy Analysis. Pilot 1 HAWE Hydraulik

Results of the Operations Analysis

The operational analysis is very helpful at getting an overview on the production processes in the plant and the added value of the energy efficiency measure in the production processes. The IREES team conducted a series of workshops with the Energy Manager from HAWE. In this particular step, we identified the different production processes at the different halls and connected them with the energy services delivered (lighting, clear vision) as well as the LED technology. This enables the energy manager to have a wider perspective and impact of a proposed energy efficiency measure in core areas of the company's activities for their clients.

The current lighting already provides 500 lux at each hall which will be improved by the LED lamps. In this process we focued on the identifying the different working process and activities in each production hall and the number of employees working under normal conditions there. Five production halls number H1 till H5 below will receive new LED lamps. The following activities were found:

H1: This hall has production activities with 50-60 employees. The main activities correspond to turning and grinding. Important parameters are the measurement of quality of the products that can be affected by temperature changes. The production activities in H1 are identified as important.

H2: This hall covers the activities of assembly and special machine construction with 50-60 employees. The products obtained here are pump bodies and oil test benches which includes screwing together many parts. Here at the individual workplaces (not for the whole hall) there new lighting was installed. However, a better individual lighting does not impact the production processes itself.

H3: includes an automatic high-bay warehouse with around 10 employees which activities are mainly storage and retrieval and therefore a middle effect for improved LED hall lighting.

H4: corresponds to the warehouse, packing and shipping with 20-30 employees with high racks but not automated. The loads are done with forklift, pallet trucks and lift trucks.

H5: corresponds to the thermal deburring for different products. Main activities include drilling, milling and washing with 25-30 employees and is also considered important.

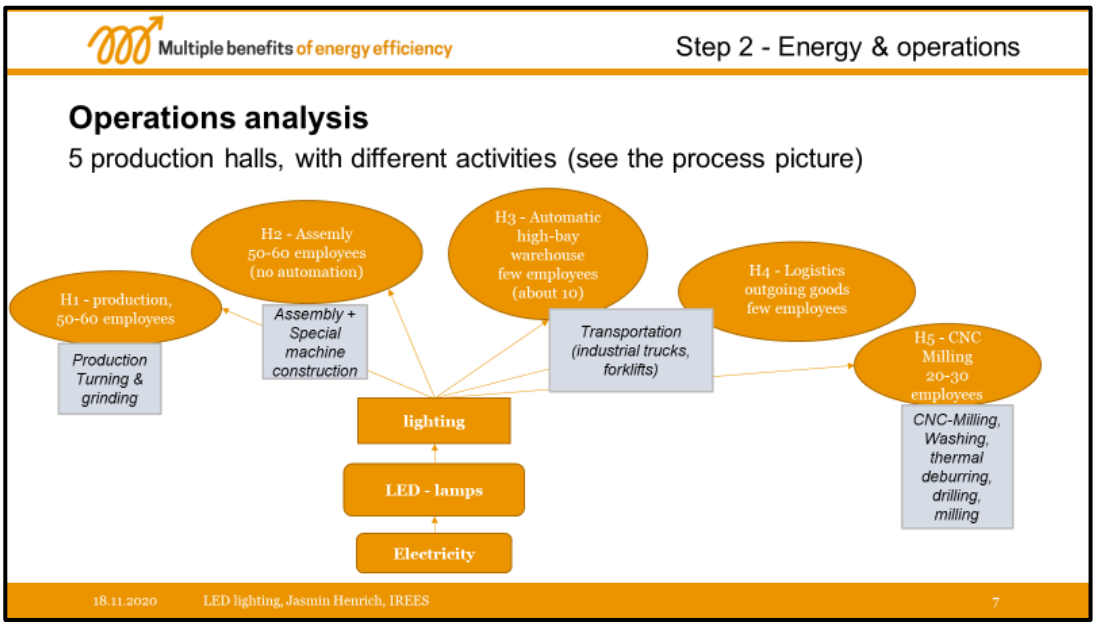


Figure 23. Results of the Operations Analysis-Operational diagram. Pilot 1 HAWE Hydraulik

Results of the Strategic Analysis

The strategic analysis was conducted with HAWE in a 2-hour workshop together with the energy manager. The discussion over the Multiple Benefits list as suggested in the tool and the operational analysis in the step before resulted in the following impacts:

Value proposition impacts:

- Contribution to company's vision or strategy, due to the business principles of industrial safety and environmental protection and their certificates energy management ISO 50.001 and environmental management ISO 14.001
- Improved image or reputation, see above and for the communication of the public image

Cost reduction:

- Reduced hazardous waste, LED are no hazardous waste and fluorescent tubes are
- Reduced maintenance + reduced costs for technical control, the LED system has a maintenance period from seven years in comparison to the current tubes with a maintenance period of 2 years
- Reduced CO2 costs because of the higher efficiency and smaller energy consumption
- Improved visual comfort, due to more consistent lighting and higher value of lux

Risk impacts:

- Improved safety (especially transportation), due to the higher value of lux, the attention and visual comfort of employees rises and the transportation of goods through forklifts and industrial trucks increases
- Reduced CO2 and energy price risks, due to the smaller energy consumption

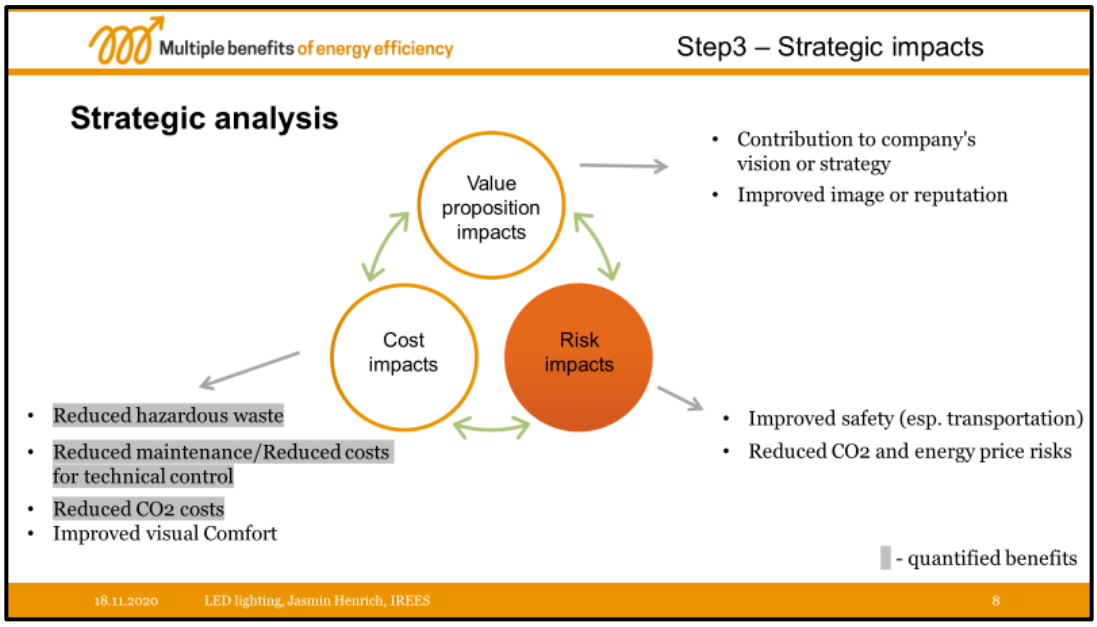


Figure 24. Results of the Strategic Analysis. Pilot 1 HAWE Hydraulik

Results of the Financial Analysis

The quantification of the multiple benefits of this measure was quite challenging as the information obtained on productivity was not conclusive for instance on another company site that installed a similar LED system. Furthermore, due to the Corona situation the energy manager worked from home office and it was difficult to get in touch with the production. In addition, the colleague of the energy manager was sick the whole time of the project and the trainee got back to school in the quantification phase. Nonetheless, three out of four identified non-energy benefits were quantified.

The investment for the LED system is 331.000 EUR, as offered to them by a special lighting company. This value corresponds to a detailed planning and therefore the investment value is rather reliable. HAWE financial depatment indicated to the EM that the discount rate is to be set at 3 % and the investment duration is 5 years. The energy benefits, meaning saving of electricity only, results in a net present value of 34.000 EUR, the internal rate of return is 6,49 % and the simple payback time results in 5 years.

The calculation with the multiple benefits changed to the following. The net present value changed to 78.000 EUR, the internal rate of return to 10,86 % and the simple payback time changed to 4 years. The energy benefits save every year 307.000 EUR and the multiple beneftis save in addition every year 21.000 EUR.

The non-energy benefits quantified for this measure are the reduced hazardous waste, the reduced maintenance and technical control costs and the CO2 reduction costs. The costs for visual comfort increase, reduced accidents or increased productivity is only mentioned qualitatively but there was not enough data for supporting a calculation in this respect.

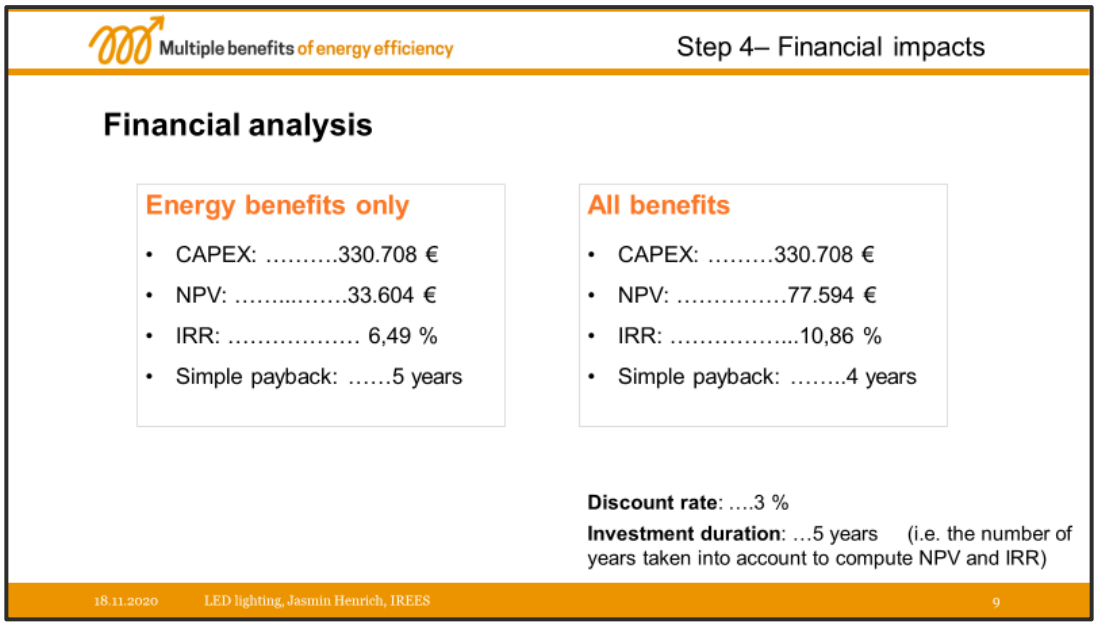


Figure 25. Results of the Financial Analysis. Pilot 1 HAWE Hydraulik

Key Arguments for the Project Implementation

As was already discussed in the strategic analysis the key arguments to implement the measure would be:

The improved visual comfort of the employees, which results in a higher satisfaction of the employees and contributes to the health and a better quality of the products.

The contribution to vision and strategy as HAWE's strategy to keep long lasting relationships with their clients, and therefore the business principles industrial safety and environmental protection and in their quality statement of a sustainable production and management are very important for that purpose This EEM supports these activities.

The reduced risks of accidents due to the better lighting. As the employees get slower tiered and the old flickering tubes are replaced with new consistent LED lighting the probability of accidents especially with forklifts and other industrial trucks is reduced.

Figure 26. Key Arguments for the Project Implementation. Pilot 1 HAWE Hydraulik

Key Issues and Highlights

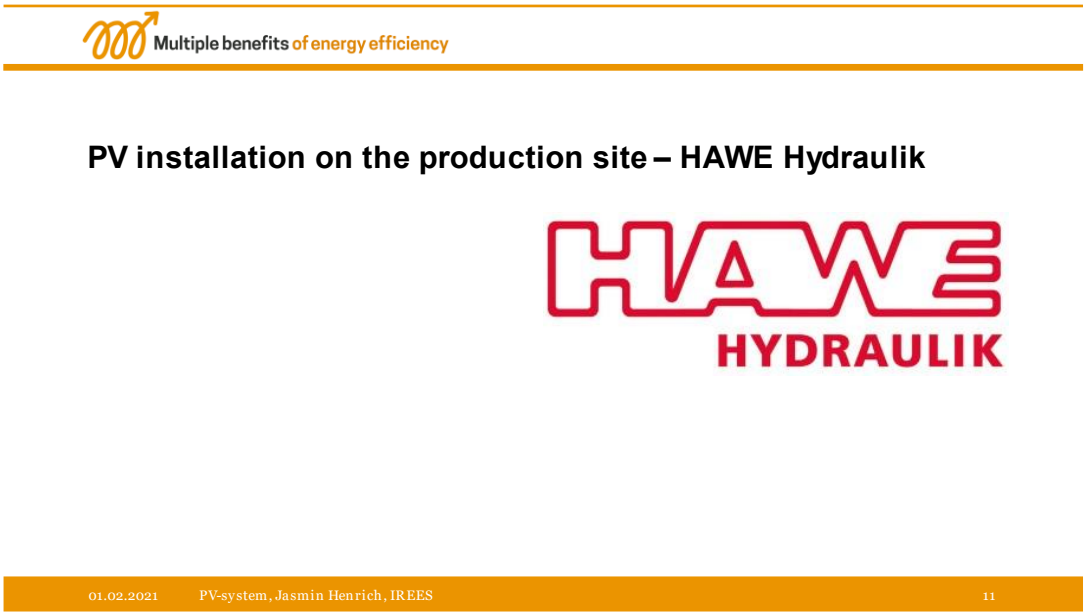
The benefit from changing the LED lamps in the production halls was twofold. On the one hand, clearer rooms motivated people to work more productively and diminish risk of accidents. However, there were no complaints from the employees with respect to accidents but only for improving the quality of vision and motivation to work in the new environment. The quantification of this impacts resulted to be very challenging as the company did not find suitable data to quantify the positive impacts.

One approach suggested was that based on literature or other experiences in other studies could be also used in this case for the company. However, the energy manager was very hesitant to use assumed values for his company, as this will arise several questions from his directors and he is not able to explain all the facts and numbers. Therefore, this approach was not followed more with this company. These insecure assumptions were not keen to be used in presentations with other staff members.

The highlights with the energy manager from HAWE was the continuous meetings which we had over half a year where both sides learned a lot how to apply the methodology. It was great to see that he had the full trust of his CEO and that his management is very committed to their environmental goals. HAWE showed what is possible when the management is committed to produce environmentally friendly and not only focusing on profit. Which means that the business case was not prior for the decision-making process of the measure but rather the multiple benefits.

2.2.2 Pilot 2: Energy Management: PV system on the production site Kaufbeuren

HAWE Hydraulik SE



Project Idea and Rationale

The project idea is about the installation of a 2.2 MWp photovoltaic system on the roof of production hall 5 at the production site in Kaufbeuren.

The production site already produces electricity through a small PV system on two parts on the roofs of other production halls. The planned PV installation is supposed to be installed on 40 parts on the roof which amounts to approx. 50 m2. Currently, the electricity consumed by the production plant is supplied via the normal electricity grid. The installation of a PV system would provide electricity which would be self-consumed by the plant.

The advantages would be cheaper electricity, a certain degree of autonomy and reduced CO2 emissions. Additionally, the PV system brings an insulation effect through the shading on the roof. That means less heat and cold intake in summer and winter in the production hall.

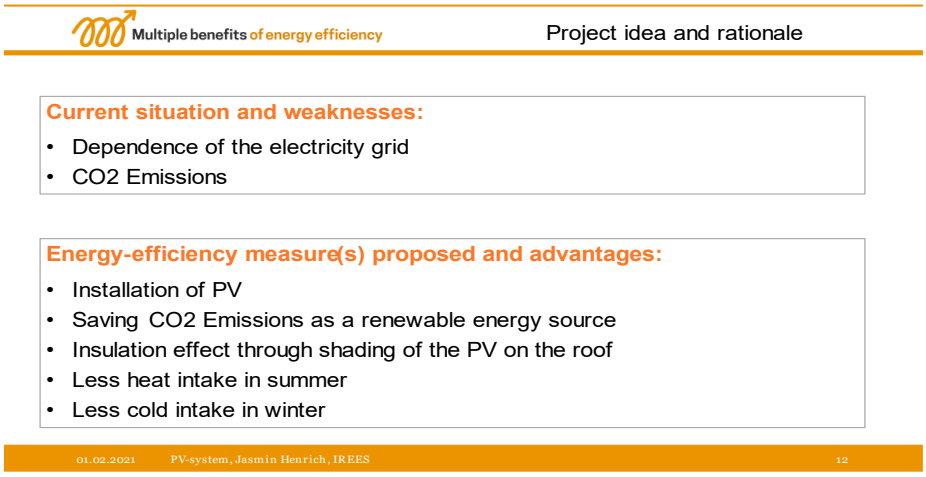


Figure 27. Project Idea and Rationale. Pilot 2, HAWE Hydraulik

Results of the Company Analysis

HAWE is a global producer of hydraulic components and systems for mechanical and plant engineering in 6 areas covering Infrastructure, efficient production, energy, nutrition and nature, resources and health. Over 2,500 employees work professionally and flexibly on innovative solutions for customers.

One of their slogans is “solutions for a world under pressure”. Their core business principle is customer orientation as they are advertising the perfect solution for the customers problem using the slogan “solutions for problem solvers” based on building longstanding business relationships on trust. HAWEs’ other business principles are innovation, products, technology, quality, industrial safety and environmental protection, internationality, staff and leadership, suppliers and revenue optimization and cost structure.

HAWE Hydraulik supplies compact, energy-saving and durable hydraulic components and systems. These are characterised, for example, by: Consistent steel structure (no pressurised cast or aluminium parts), Design of the components for high pressures, Compact design (minimisation of space requirements), Zero leakage or verified low leakage, Approvals for special operating conditions (e.g. ATEX). In addition, HAWE provides a broad service for the HAWE products and systems all over the world including installation, start-up and maintenance services at client’s sites as well as repair and modifications as well as complaint handling and analysis. Furthermore, HAWE provides spare parts and special services and trainings worldwide.

Economic, ecological and social sustainability is part of HAWE's corporate responsibility. The corporate principles, the matrix certification (ISO 14001, ISO 45001 & ISO 50001) as well as the certification according to ISO 9001 symbolize the way of thinking of the group of companies. HAWE's quality management system sets standards that are valid for the entire HAWE Group worldwide. In addition, HAWE began in 2008 to develop and implement an environmental and energy management system as well as an occupational health and safety system. Sustainable earnings, a healthy equity base and long-term thinking in corporate management secure jobs and relationships with business partners in the long term.

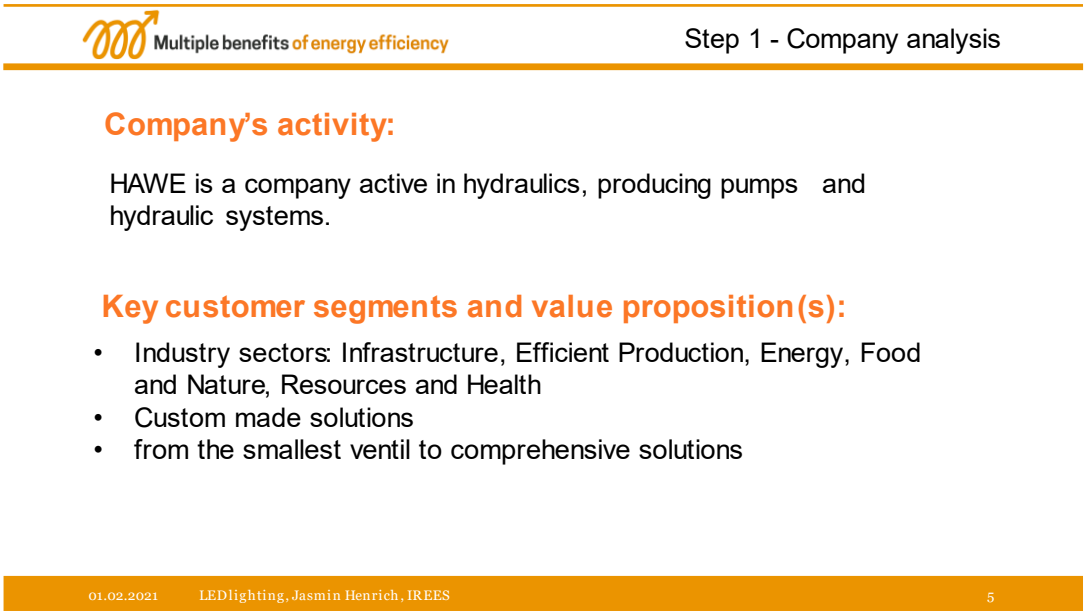


Figure 28. Results of the Company Analysis. Pilot 2, HAWE Hydraulik

Results of the Energy Analysis

The company is ISO 50.001 certified and therefore has an energy management system in place where energy consumption is controlled, and energy efficiency measures are yearly planned. The management evaluates the business case of the proposed measures and decide over implementation or rejection. The energy management receive a yearly allocated budget for energy efficiency measures.

The company production requires electricity, natural gas and possibly co-generation at sited to produce their wide arrange of products and delivered services. The total electricity consumption on production site Kaufbeuren is 12.800 MWh/year. The PV system proposed would produce electricity on site at about 3.000 MWh/year which will be used for own consumption. That would substitute the electricity from the public grid and reduces the dependency of the local energy supplier.

The estimated financial savings are calculated with 480.000 €/year energy benefits only. As the measure is no efficiency measure but a substitution of grid electricity there is no improvement of the total energy consumption but a decarbonization measure through renewable energy.

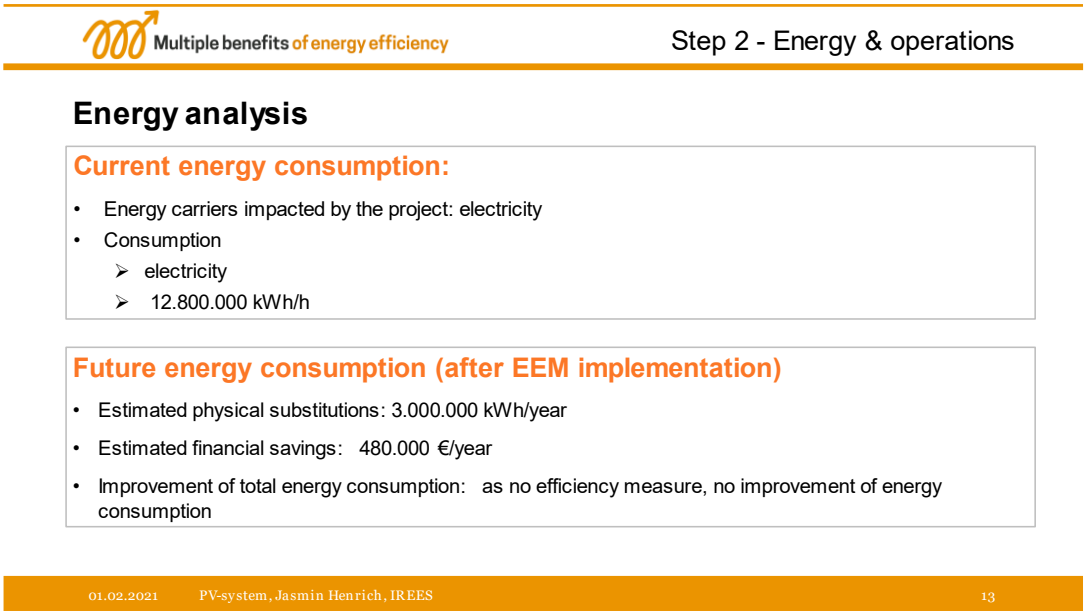


Figure 29. Results of the Energy Analysis. Pilot 2, HAWE Hydraulik

Results of the Operations Analysis

The operational analysis is a very good strategy to visualize the impacts of energy efficiency measures. The IREES team conducted a series of workshops with the Energy Manager from HAWE. In this particular step, we identified the different production processes at the different halls and connected them with the energy services delivered (electricity and other possible services) as well as the PV system. This enables the energy manager to have a wider perspective and impact of a proposed energy efficiency measure in core areas of the company's activities for their clients. As the installation of a PV system is not an energy efficiency measure but an alternative energy generation source the operational analysis is very limited. The most impacted area is the relationship with the electricity grid and its dependency.

The production hall on which the PV system will be installed contains a high bay warehouse and the shipping area with about 15 employees working in it. Due to the insulation effect, we tried to conduct the impacts on the employees and the process but as there are no value adding processes to the products we stopped following this approach. It was not possible to determine a plausible amount of natural gas savings for heating purposes due to the shading effect of the PV in winter (or cooling in summer), despite of locating data in the company.

The energy side of the insulation effect would result in a lower cooling demand in summer and a fewer heating demand in winter.

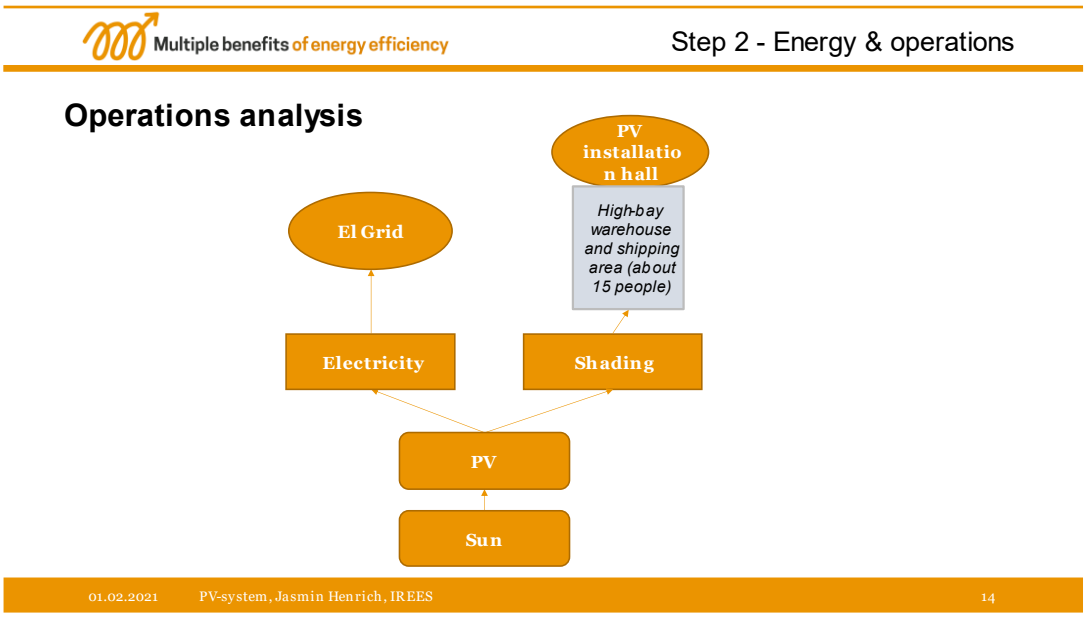


Figure 30. Results of the Operations Analysis- Operational diagram. Pilot 2, HAWE Hydraulik 2

Results of the Strategic Analysis

The strategic analysis was conducted with HAWE in a 2-hour workshop together with the energy manager. The discussion over the multiple benefits list as suggested in the tool and the operational analysis in the step before resulted in the following impacts:

Value proposition impacts:

Contribution to company's vision or strategy, due to the business principles of environmental protection and their certificates energy management ISO 50.001 and environmental management ISO 14.001

Improved image or reputation see above and for the communication of the public image.

Cost reduction:

Reduced CO2 costs, due to PV is a renewable energy source.

Electricity net injection, the generated electricity is not fully consumed by the plant a small amount is injected into the public electricity grid.

Reduced heating and cooling demand in summer and winter, as already mentioned could not be quantified because of capacity bottlenecks in the energy team.

Risk impacts:

Reduced CO2 and energy price risks, due to the smaller energy demand of the plant because of the amount covered by the PV system.

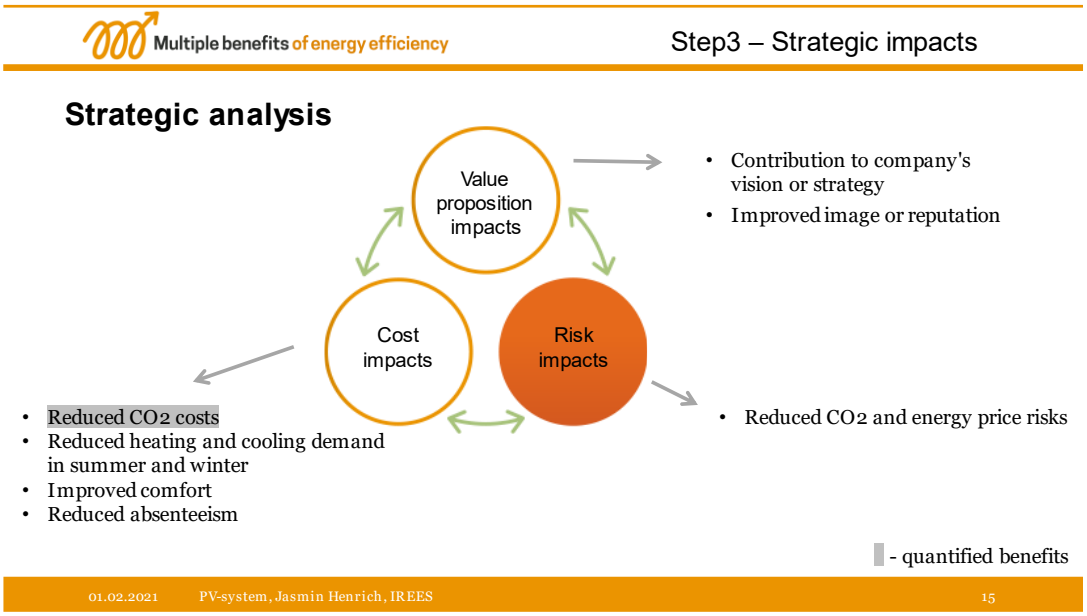


Figure 31. Results of the Strategic Analysis. Pilot 2, HAWE Hydraulik

Results of the Financial Analysis

The quantification of the multiple benefits of this measure was quite challenging as the information obtained on productivity was not conclusive for instance on another company site that installed a similar PV system. Furthermore, due to the Corona situation the energy manager worked in home office and it was difficult to get in touch with the production site. In addition, the colleague of the energy manager was sick the whole time of the project and the trainee got back to school in the quantification phase.

The investment for the PV system amounts to 1.525.000 €, as offered to them by an energy utility in Germany, the discount rate is set at 3 % by the financial department and the investment duration is 20 years. The energy benefits only, means saving of electricity, results in a net present value of 4.545.010 €, the internal rate of return is 26,51 % and the simple payback time results in 4 years.

The calculation with the multiple benefits changed to the following. The net present value changed to 4.775.000 €, the internal rate of return to 27,55 % but the simple payback time still remains at 4 years. The energy benefits save every year 480.000 € and the multiple beneftis save in addition every year 18.150€.

The multiple benefits in this pilot did not change a lot in the calculation of the business care as we only quantified the CO2 reduction of the PV system.

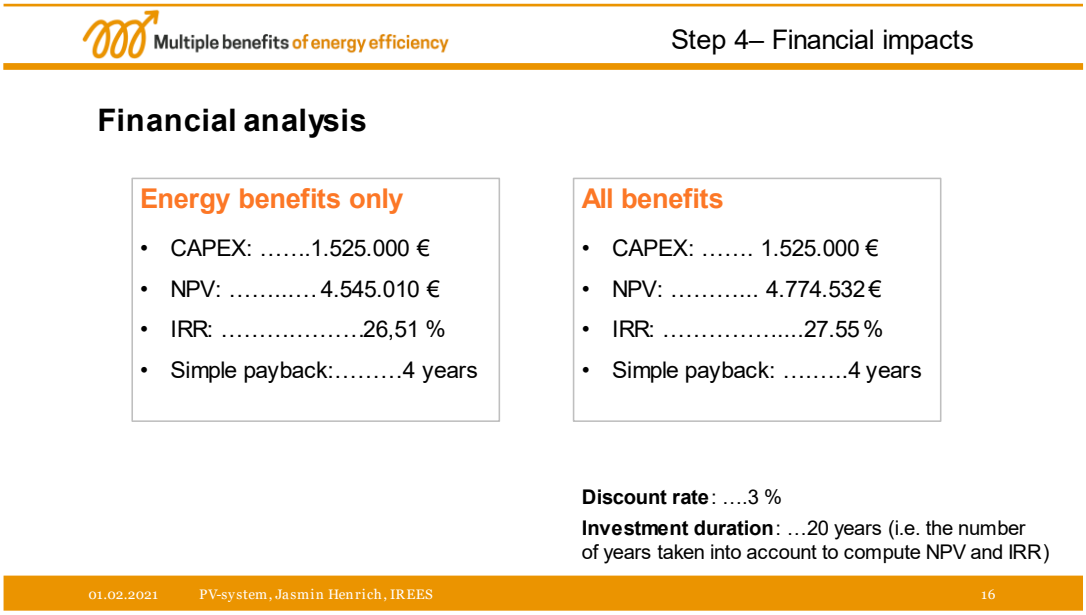


Figure 32. Results of the Financial Analysis. Pilot 2, HAWE Hydraulik

Key Arguments for the Project Implementation

As was already discussed in the strategic analysis the key arguments to implement the measure would be:

The reduced heating and cooling demand in the hall with the PV installation. That is an additional benefit which can be qualified when the measure is implemented and use it as referenz and best practice for further installations of PV systems on production halls. The second reason results out of the first one.

The insulation effect impacts the climatic conditions the workers are surrounded by and carries a more convenient working environment.

The third reason is also a result of the two first reasons why to implement the project. The hypothesis is a reduced absenteeism through the better and more convenient working condition in summer and winter.

Furthermore, the people work with a higher motivation, which can result better moods of the employees and in general in a better spirit in the team.

The measure also improves the image of the company and contributes to the vision and strategy of HAWE. This proves to be a great benefit as the energy manager indicated that figures of this business case are not the foundation of the decision-making for implementation of the measure.

Finally, the measure carries a risk reduction of the CO2 and energy price risks which prove to be very convenient because of the unclear course of the CO2 price trend.

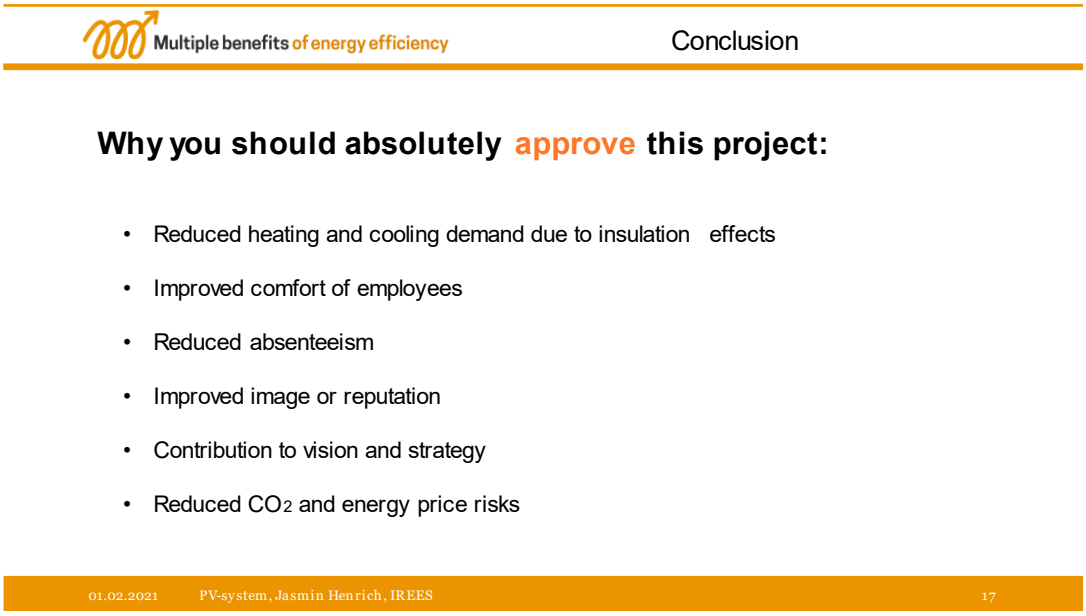


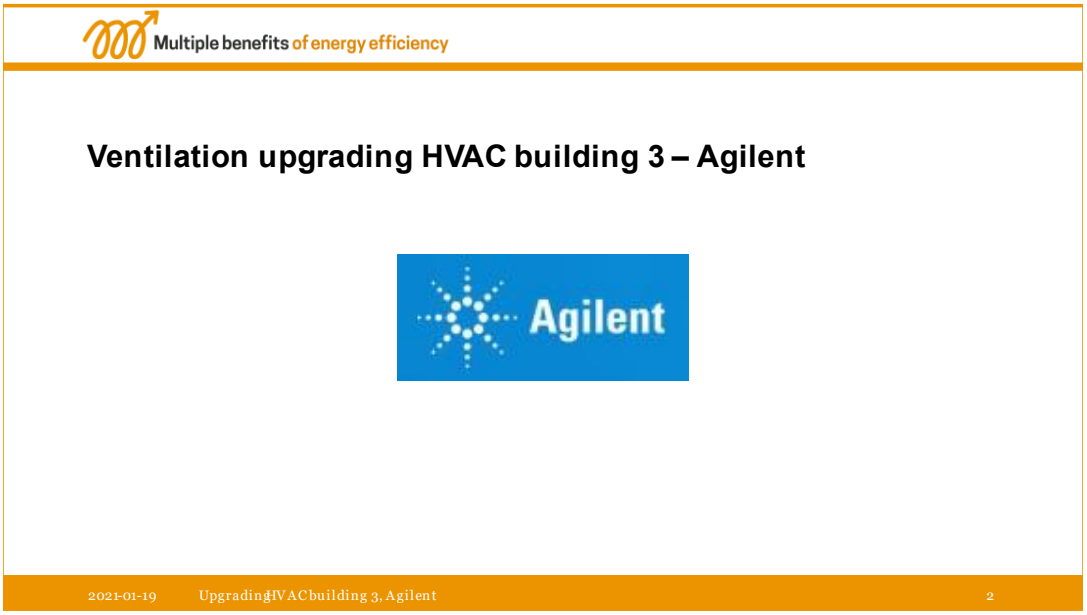
Figure 33. Key Arguments for the Project Implementation. Pilot 2, HAWE Hydraulik

Key Issues and Highlights

The main problem was the working condition the energy manager was in. Due to the Corona situation, he was working from home and was not able to get in contact with the production and the workers of the impacted processes.

2.2.3 Pilot 3: Ventilation (HVAC) upgrading for building 3

AGILENT



Project Idea and Rationale

The production site of Agilent in Waldbronn consists six buildings. Building 3 was built in 1984 and it requires an urgent upgrade especially with respect to the HVAC (heating, ventilation and air conditioning) unit to ensure a safe and comfortable use of the building for at least another 5 to 7 years or even more.

Due to the current Covid 19 pandemic the measure increased it importance because of the requirements of appropriate ventilation for the building and its employees with updated filter systems. The project concept includes the substitution of the current air handling unit (AHU) with a capacity of 620 MWh with a more energy efficient AHU equipment with a capacity of 90 MWh. The current AHU is replaced with a new one that contains more efficient air blowers. In addition, the air volume carried by the AHU will be reduced, from 41.000 m^3/h to 15.000 m^3/h, and the air conditioning function of the AHU will be transmitted to a variable refrigeration volume (VRV) unit, reducing energy consumption by 530 MWh gas and 7 MWh electricity. The VRV will be installed in decentral units and can be controlled individually in the different rooms or sectors. Furthermore, the traditional gas heating and cooling supply will be connected to the district heating and cooling like the other buildings, having a positive effect for the CO_2 emissions.

The old HAVC has reached the end of its lifetime after 38 years. The new concept considers the air re-circulation in order to use the excess heat for further uses such as preheating the ambient air for further ventilation. The current equipment increases the risks for outages and failures having an effect in production and comfort conditions which increases the importance of the measure. Furthermore, it contains asbestos fire valves which are carcinogenic.

The following graph summarizes the discussions with the energy managers with the company.

Multiple benefits of energy efficiency — Project idea and rationale

Current situation and weaknesses:

- Building 3 HVAC needs urgent upgrade because of safety purposes
- Risks of disruptions are increasing
- Pandemic requires good ventilation
- HVAC health issues: asbestos fire valves

Energy-efficiency measure(s) proposed and advantages:

- New efficient ventilation
- Installation of decentral VRV units
- Installation of a heat recovery
- Installation of central district heating and cooling

2021-01-19 Upgrading building 3, Agilent 3

Figure 34. Project Idea and Rationale. AGILENT

Results of the Company Analysis

Agilent Technologies Germany GmbH in Waldbronn is part of the Agilent Technologies, Inc. company which operates worldwide. It is an American technology company with their headquarters in the Unites States. Agilent is a global leader in life sciences, diagnostics, and applied markets. The location in Waldbronn is the biggest in Germany and has several administrative and operating enterprises. The operating enterprises are AT Manufacturing GmbH &Co.KG., AT R&D and Marketing GmbH & Co. KG., AT Sales & Services GmbH & Co.KG.

At the location in Waldbronn there are approximately 1000 employees working in the different enterprises. The location contains multi functions buildings, one sales and training building, one management building and one customer and technology building and two other buildings. Their products are produced under strict purity requirements from air, temperature and humidity. They test and validate every product and applications which requires a lot of test equipment on site.

The energy management from Agilent is partially subcontracted to CBRE in Germany which is the biggest global facility management and real estate consulting company. They are an external consultant with respect to facility management and identify and evaluate energy projects and energy efficiency measures. Since 2020, Agilent and CBRE agreed on a 5-year energy saving target and Agilent allow CBRE to present projects for investment decision with a horizon over 7 years payback time. This situation allows a broader portfolio of projects to be considered by the investment decision board.

In general Agilent Technologies, Inc. has set 4 goals to contribute to a sustainable future for the Agilent Group:

- Goal 1: 1 % energy reduction each year
- Goal 2: 95% solid waste diversion from landfill by end of 2020
- Goal 3: 2% water reduction per year
- Goal 4: 1% CO2e reduction per year

To reach these goals Agilent negotiated with CBRE to allow a higher pay back time from 3-5 to 7 years for energy projects, in order for CBRE reach the yearly and 5-year energy efficiency saving goals.

The following graph summarizes the discussion with the company during 2020 and in the excel tool for this project you may find the business canvas model and decision-making questionnaires for energy efficiency investments.

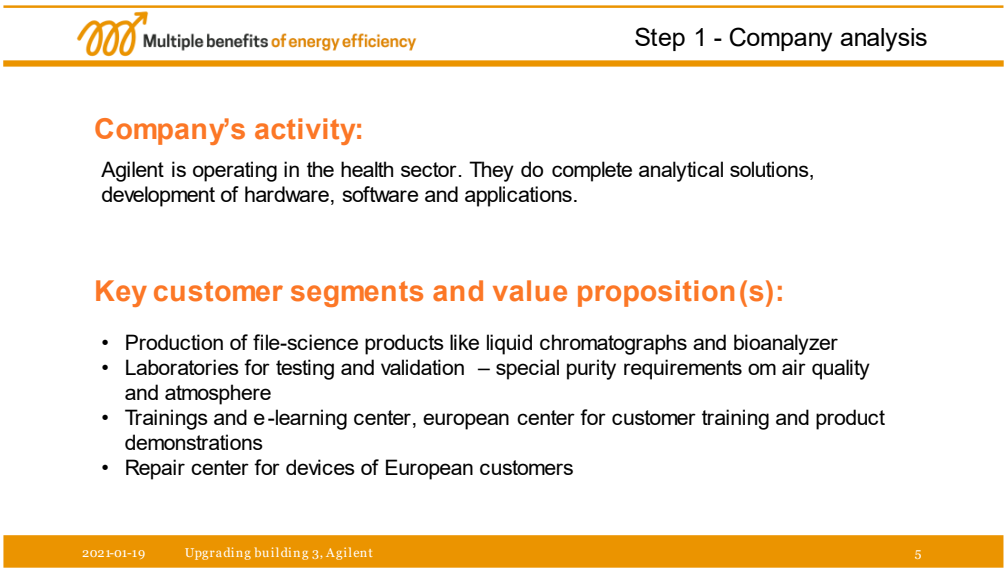


Figure 35. Results of the Company Analysis. AGILENT

Results of the Energy Analysis

The energy efficiency measure has significant impact mainly on gas and electricity future energy demand. The total electricity consumption of the site is up to 8.230 MWh/year. Through the implementation of the HVAC measure approximately 250 MWh/year of electricity can be reduced increasing the energy efficiency performance of the building.

Furthermore, it is important to note that the Building 3 at the company is currently supplied with heat obtained by natural gas burning at a low-temperature boiler. The total gas consumption of the site amounts to 550 MWh/year. Implementing the HVAC measure will result in reducing the demand of natural gas by 530 MWh/year which is almost the equivalent of the total gas consumption of the site.

The new AHU will be operated with the supply of warm or cool water from the district heating and cooling station. The AHU has an energy demand of about 90 MWh/year for hot water (heat) and approximately 1 MWh/year for cooling.

In total the physical savings correspond to the savings of the energy benefits, the reduction of energy and the additional consumption of the district heating and cooling add up to 700 MWh/year and the improved efficiency in financial terms have been estimated by the energy manager and his facility management team at around 64.000 €/year. The improvement of the total energy demand of 2019 regarding natural gas and electricity with the district heat substitution amounts to 8 %.

In addition to building 1 at the company, building 3 is the only building remaining for the production of heat with natural gas consumption. Through the new connection with the district heating the remaining 30 MWh gas consumption will substituted. After implementing this measure, the production site in Waldbronn will produce heat almost without gas.

The following graph summarizes the discussion with the company during 2020.

Multiple benefits of energy efficiency

Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Energy carriers impacted by the project: electricity , gas
- Consumption
  - Electricity: 8.230.000 kWh/year
  - Gas: 550.000 kWh/year

Future energy consumption (after EEM implementation)

- Estimated physical savings: 700.000 kWh/year
- Estimated financial savings: 65.000 €/year
- Improvement of total energy consumption: 8 % (gas and electricity)

2021-01-19 Upgrading building 3, Agilent 6

Figure 36. Results of the Energy Analysis. AGILENT

Results of the Operations Analysis

The operational analysis helped to visualize the measures and proved to be a powerful tool in helping to understand the design of the measure across the different buildings. It either helps to analyze the impacts of the measures on energy savings terms and also with respect to the possible connections. Production processes has measures for the company's products. The IREES team conducted a series of workshops with the Energy Manager from Agilent and the facility management from CBRE.

Building 3 is a multifunctional building which hosts the different departments of Agilent. Different activities of the company have space allocated in this building including:

- Functions of the department for Order Fulfillment (OF),
- Functions of the department for research and development (R&D)
- Functions of the department on Sales & Services esp. for trainings and repair.

The sections of OF in building 3 conduct 3-D printing part of the tool shop and an area for CIP activities.

The R&D sector includes the design and development of new High Pressure Liquid Chromatography (HPLC), the unit with customer's projects as well as the video room for marketing and training purposes. The sales department includes the European Field Service Centre (EFSC) for repairs and calibration of customer products.

The new ventilation and the decentral VRV units have a direct impact on every room and can be adjusted individually as required. It has also an impact on the air quality and comfort of the employees in all these areas, having a positive impact on customer related areas of the company. The following graph summarizes the discussion with the company during 2020 indicating the connection from energy carriers, towards the energy services generation equipment and the activities conducted in building 3.

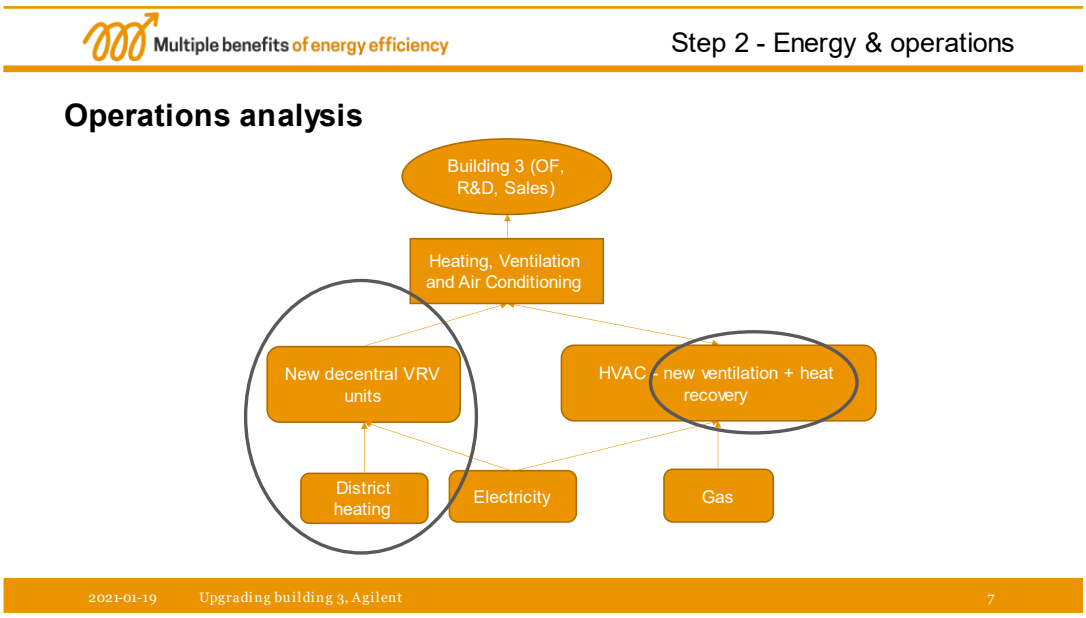


Figure 37. Results of the Operations Analysis-Operational diagram. AGILENT

Results of the Strategic Analysis

The strategic analysis of this measures has the objective to identify the energy and non-energy benefits (multiple benefits) of the proposed measure in relationship to the activities of the company in building 3. The identification of non-energy benefits led to considering which data and ways to quantify and monetize their impact for the subsequent financial analysis. Below you can find the list of multiple benefits (energy and non-energy) that were identified and discussed with the Energy manager and the facility management team at the company.

The quantified non-energy benefits correspond to use of additional space, postponed investment for a new building allowing to use building 3 for some additional time and reduced maintenance costs. The benefit of CO2 emissions is indirectly being absorbed by the electricity tariff, but it was quantified.

Postponing a new building can save an investment of around 30 million € this year, which means appr. 1 million € depreciation. Using the building without any repair and maintenance or reinvest for upgrade in a new modern HVAC system, will result in a high-risk operation which can directly impact the business for the employees using the space. De-motivation and frustration of users or a completely unusable area will result in business disruptions and daily unplanned expenditures.

The strategic analysis was conducted by Agilent and discussed with IREES. The quantification of the multiple benefits was mainly done by Agilent with support from IREES. The multiple benefits identified are listed below:

Value proposition impacts:

- Provide a comfortable environment and air quality for training, sales, marketing, and R&D activities
- Safe ventilation and health standards according to indoor air quality standards of ASHRAE
- Additional space for OF, R&D, Marketing and sales means improved customer relationship and more space to increase revenues.

Cost reduction:

- Additional space / Improved space utilization since the building would have been demolished because of safety purposes.
- Air quality improvement of ambient air, due to the decentral VRV units every room or section
- Postponed Investment to 5-7 years, due to further use of building 3 and postponed demolishment and construction of a new building
- Reduced CO2 emissions, due to the energy savings of gas
- Improved staff satisfaction and loyalty, due to the possibility of individual adjustment of the air conditioning in the workplaces
- Reduced maintenance cost, due to the new system a replacement of old HVAC with higher maintenance

Risk reduction:

- Reduced risk occupational disease/ Covid 19, due to the better ventilation and corona learnings applied in the measure.
- Reduced risk of disruption of HVAC because the old system reached its end of life.

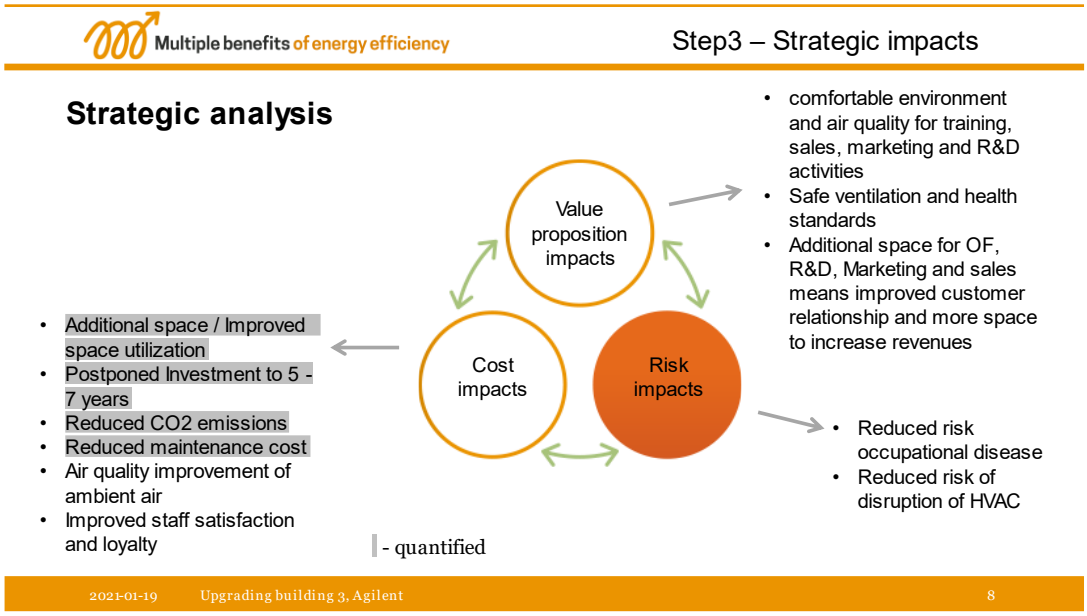


Figure 38. Results of the Strategic Analysis. AGILENT

Results of the Financial Analysis

The quantification of the multiple benefits of this measure has been prepared from Agilent in detail including data search inside of the organization.

With respect to the quantification of the non-multiple benefit "postponed investment", three options for quantifying these cases were considered. This option has an important impact of the economic calculation for the HVAC measure. One of the reasons is that a 30 million € investment can be postponed in time for at least 5 to 7 years.

The investment for the measure amounts 575.000 €. The discount rate given by Agilent financial department is set at 2 % and the investment duration is 15 years. The energy benefits, meaning only the saving from electricity and gas is considered, which results in a net present value of 540.000 €. The internal rate of return is 18 % and the simple payback time results in 6 years.

The calculation with multiple benefits but without the postponed investment changed the calculation to the following. The net present value changed to 1.200.000 €, the internal rate of return to 37 % and the simple payback time changed to 3 years. The energy benefits save every year 64.000 € and the multiple benefits save in addition every year around 60.000 €.

The calculation with multiple benefits and with the postponed investment changed the calculation to the following. The net present value changed to 6.800.000 €, the internal rate of return to 1720 % and the simple payback time changed to 1 year. The multiple benefits save in every year around 60.000 € without the postponed investment.

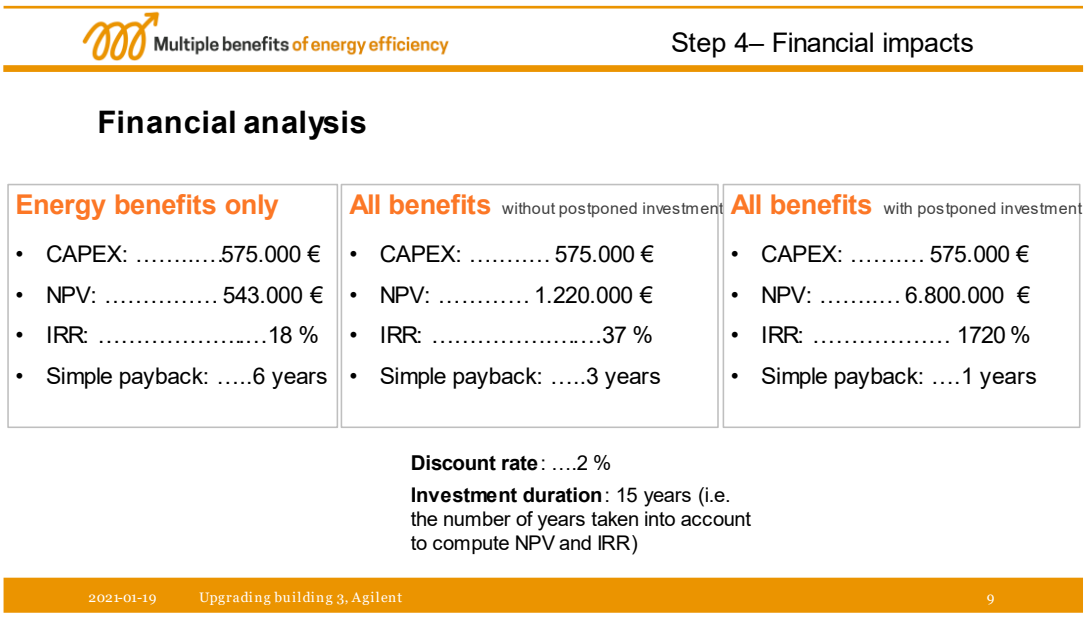


Figure 39. Results of the Financial Analysis. AGILENT

Key Arguments for the Project Implementation

Key arguments for the implementation of the project are discussed in the following. In the current situation with the pandemic of Covid-19 is the strongest argument the better ventilation which reduces the risks of infections, gives a better sense of safety to the employees and helps to adjust the air-conditioning to individual needs. Another argument related to the first are further upgrades on health standards. The old AHU contained asbestos fire valves which are being substituted by new ones.

The strongest operational argument is the further usage of needed space of the departments OF, R&C and Sales. If the AHU would not be renewed Agilent would need to build another building. Connected to this argument is the postponed investment of a new building to 5 - 7 years, which also carries the greatest financial benefit.

Furthermore, the AHU reached its end of operational life and was not working properly. The ventilation happened to break down unregularly which needed at least technical control and repairs.

In general, the measure speaks for itself. On the surface it seems like a rather unimportant measure but looking at the multiple benefits it clearly shows that this measure is very important and has different impacts on health and safety and the construction site. Having a look at the business case it shows clearly that the multiple benefits are impacting the project also from the financial site significantly.

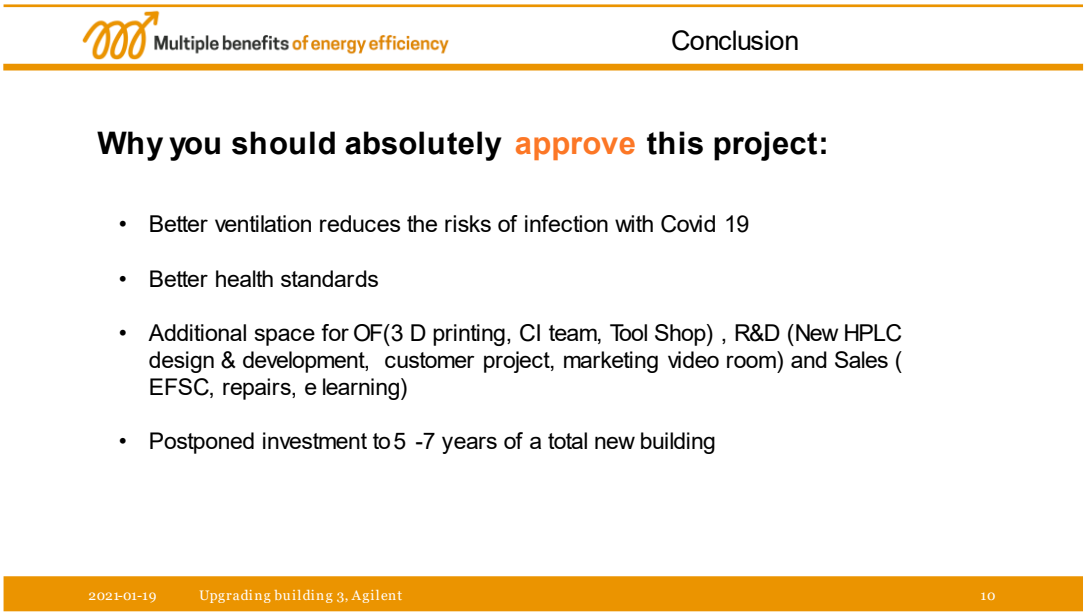


Figure 40. Key Arguments for the Project Implementation. AGILENT

Key Issues and Highlights

Check in our questionnaire and include it here:

- The energy manager was part of the training and this led to the definition of the several projects that were evaluated with the multiple benefits method and approach in 2020 (See slide below).
- The energy manager was very proactive with the IREES team and took care to transfer the methodology further to his facility manager consultants. We realized at least 5 different meeting workshops that helped the company identify energy measures and additional non-energy benefits following this approach.
- For the quantification of non-energy benefits the energy manager at the company was very proactive and took the initiative to talk to several colleagues from different departments inside of the company.
- The search for data inside of the company proved to be very difficult as not always data was easily found, or the data was not enough to make solid assumptions on values.
- During last year also the changes in conditions for the facility management team energy saving goals, allowing them projects with less than 7 years payback times, increased the number of projects to be considered for investment. However, this also created a reduced motivation to quantify additional non-energy related benefits.
- The energy manager and its facility management team were very active in defining energy efficiency and renewable energy measures for the company including the project bundle with at least 6 EEM as presented below. The bundle contributes to reduce 20% CO_2 emissions as well as energy costs, but the Multiple benefits Methodology also help them to identify several non-energy benefits and quantify some of them as presented in this report for building 3,
- The bundle includes projects in different areas such as LED lighting projects for buildings 1 and 4, planning a combined site power mitigation plant

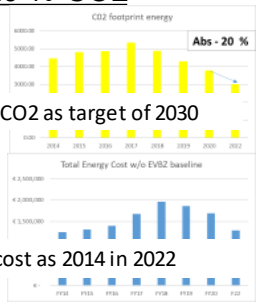
including a combined PV installation on the roof of B4 and B5 and battery storage and generators.

- Furthermore, 3 projects include ventilation, heating and cooling related measures (AHU/HVAC) for 3 buildings (in this report Building 3 project analysed in detail) improving efficiency and making use of waste heat streams. The last project includes a further optimization of the building management systems eligible to obtain certain support from the Government.
- The following list of multiple benefits was identified by the company and partially the ones presented in this report are the result for building 3.

WAD: Energy Projects with ROI <7years to achieve Climate Goal – 20 % CO2

Project Description (details see further slides)

- *LED project in B1 OF area and B4 office building (Invest $384k Saving $57k ROI 6.5 CO2 113 to)*
  - *Lighting tubes in B1 must be replaced and LED project in B2 done in 2020 did show a sufficient and value solution for B1 Replacement of lighting elements in B4 can be done during normal working hours because a lot of employees are working from home*
- *PV installation on roof of B4 and B5 (Invest $667k Saving $94.4k ROI 6.8 CO2 150 to)*
  - *790 modules with 312 kWp could be installed on roof space and reduces electricity from grid (300.000 kWh/yr; ~5 % of total power usage , 100 % selfusage), usage for ecar charging stations and reduced power peak*
- *AHU supply system in B1 and B2 (Invest $566k Saving $121k ROI 4.7 CO2 233 to)*
  - *Decentral cooling units and intelligent BMS can manage energy efficient usage of fresh air , electricity, heating and cooling*
- *AHU & chiller unit in B3 from 1984 are end of life (Invest $327k Saving $49k ROI 6.7 CO2 152 to*
  - *AHU 41.000 m³/h and chillers are on high risk regarding outages, AHU runs normally with return air*
  - *AHU could be replaced with 15.000 m³/h unit before we further use the B3 space for OF (3D printing), R&D and Sales functions. With replacingAHU we can delay a new building and safely operate the building another 5 to 7 years*
- *AHU units each running with ~20k m³/h in B5 (Invest $196k Saving $52k ROI 3.75 CO2 169*
  - *4 AHUs run 24*7 because of lab rooms with 14.500 m³/h exhaust air w/o reheating*
  - *Combining 2 units and activating re -heating for process exhaust air optimizes energy usage (heating, cooling, electrical power) and minimizes risks of outages. Learning after 3 years of operation !*
- *Further optimization of current BMS system (Invest $223k Saving $40k ROI 5.5 CO2 16 to)*
  - *Enables to better manage and operate the HVAC&E infrastructure*
  - *Upgrade and expansion gives us more data of consumption, alarm and operation points. Amount of consumption of legal CU of OF can be used to get a refund from German government for grant for production activities in Germany (40k/yr for natural gas and electricity, Ecotax)*
- *Site Power Outage Mitigation Plant (battery storage, generator,….)*
  - *($110k for further investigation of invest of $2to 3M to mitigate outages, site risk $2M revenue per day)*



Excluding business driven energy cost drivers !	
Capital Investment	**$2.7M***
Annual Cash Savings	$0.46M
Advantage	Up to €200k grant from German government (* not included)
ROI (ave)	5,7 years
OP Savings	$22K
Environmental impact	911 to CO_2

Figure 41. Key Issues and Highlights. AGILENT

Impact from strategic multiple benefits from these projects on

Reduce costs/Increase competitiveness	Increase value proposition	Reduce crucial Risks
Reduce hazardous waste costs	Contribute climate neutrality goals	Improve employee safety
Decrease O&M & technical control costs	Improve image & marketing of our products	Reduce legal risks (health/compliance)
Reduce CO2 costs from Gas burning	Improve operations of OF 3D Printing and R&D Sales	Keep relationship with German Government/Karlsruhe city
Increase employee visual comfort	Use of German Funding 200k€	Reduce business disrputions
Increase employee wellbeing	Leading role in using renewables	Reduction of hardware damages
Increase in productivity/less absteeism	Train Energy Manager on Multiple Benefits	
Reduce demand for heating and cooling in summer and winter	No disruption of trainings/R&D?	
Use B3 for 5-7 years delays investment		
Reduce emergency responses for outages		

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Figure 42. Key Issues and Highlights. AGILENT

2.2.4 Pilot 4: Heat recovery through waste heat usage

Company

Moll Marzipan GmbH

Berlin Germany

Project Idea and Rationale

The project idea and rationale were conducted by Moll though a bachelor-thesis student. It is about two devices which produce excess heat that is not used in other processes so far. These devices correspond to a cooling unit of a roasting process of nuts and a screw compressor which produces compressed air. The cooling unit displays a very high cooling load which can be relieved through a link out of the heat by a heat recovery. The cooling demand will be reduced, and the cooling unit can operate at a more stable level. Through the reduced cooling demand, the electricity consumption of the cooling unit is reduced as the unit operates with electricity.

The recovery of waste heat is realized through a hot water storage tank which is fed and connected by the waste heat of the cooling unit and the screw compressor. The hot water storage will supply the two heat sinks: domestic hot water production of the production site and a water storage for the preheating of a brewing unit. The tank of the brewing unit is designed to maintain the drinking water hygiene which is guaranteed by heating the water up to 60 °C once a day. The maintenance of the drinking water hygiene is currently achieved though district heating. Through the measure the district heat will be substituted with the waste heat.

The excess heat usage measure reduces electricity demand at the cooling unit, reduces district heating demand at the preheating of the brewing unit and the domestic hot water preparation.

The following graph summarizes the discussions with the energy managers with the company.

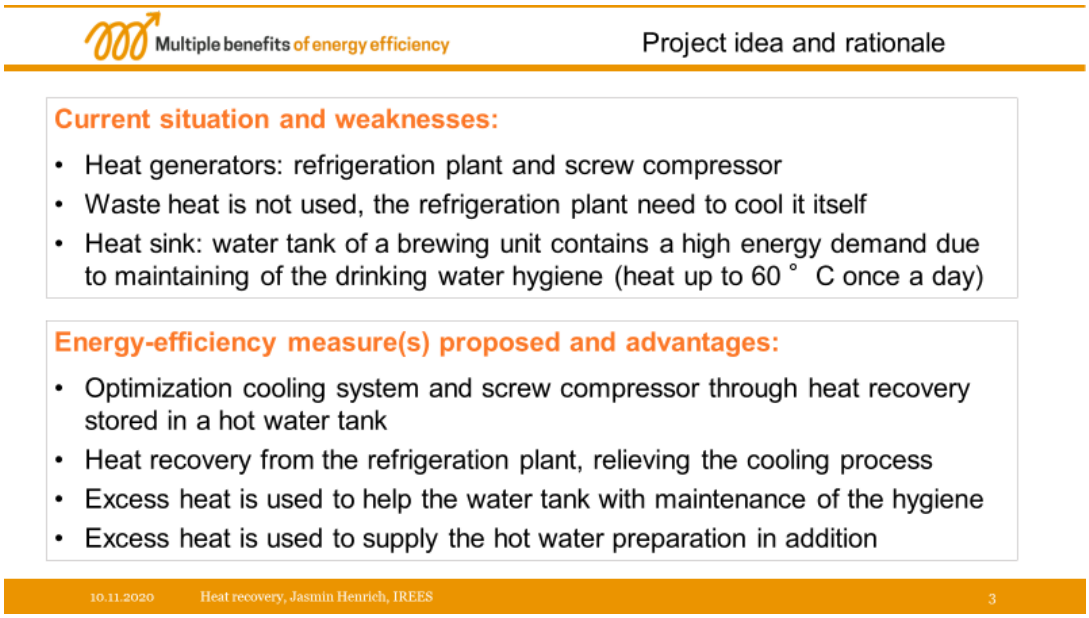


Figure 43. Project Idea and Rationale. Moll Marzipan GmbH

Results of the Company Analysis

Moll Marzipan GmbH trades and refines almonds, nuts and raw materials such as marzipan and persipan for the food industry. They are a medium-sized company with 94 employees of which 60 employees are working in shifts. The company is committed to a strict quality orientation and the slogan "Quality from Berlin", and this is clearly lived out.

The energy management is fully supported by the management. It is integrated into the daily production routine in the company and is constantly improved.

Based on the company's own demand for quality, implementation of customer requirements and optimization of production processes, comprehensive investments are continuously being made to modernize the technical equipment and infrastructure.

Moll Marzipan GmbH is very committed to their energy management and is an important partner at the Energy Efficiency Table Berlin and other networks.

The processes and procedures for energy management introduced in 2015 will be consistently continued and expanded.

Organizational changes and the further development of the integrated management system are reflected in the current management documentation. The prerequisites for maintaining and further developing the energy management system are still in place.

Multiple benefits of energy efficiency — Step 1 - Company analysis

Company's activity:

Moll Marzipan GmbH trades and refines almonds, nuts and raw materials such as marzipan and persipan for the wholesale trade.

Key customer segments and value proposition(s):

The company has dedicated itself to strict quality orientation and the slogan "Quality from Berlin", this is clearly noticeably lived.

Production of marzipan, persipan (blanching, grinding, roasting) and products from (oil) seed kernels (blanching, crushing, possibly roasting / candied) for industry and large-scale trade

Figure 44. Results of the Company Analysis. Moll Marzipan GmbH

Results of the Energy Analysis

The energy analysis was conducted by the company before hand through the bachelor student. We received the complete presentation and benefited very highly and saved a lot of time on the pilot.

The energy carriers important for the pilot are electricity and district heating. Their consumption is in total are 3.522 MWh/year electricity and 3.970 MWh/year district heating. The estimated physical savings of the energy efficiency measure, referring to the energy benefits only, amount up to 30 MWh/year for electricity and up to 437 MWh/year for district heating. That is an improvement of the total energy consumption of 6 % (only electricity and district heating considered).

The plant consumes CO2 free electricity from waterpower certified by the local energy company. The local district heating reports the following CO2 emissions value of 0,280 t CO2/MWh.

Altogether the financial savings of the energy benefits only are calculated with 21.939 EUR/year.

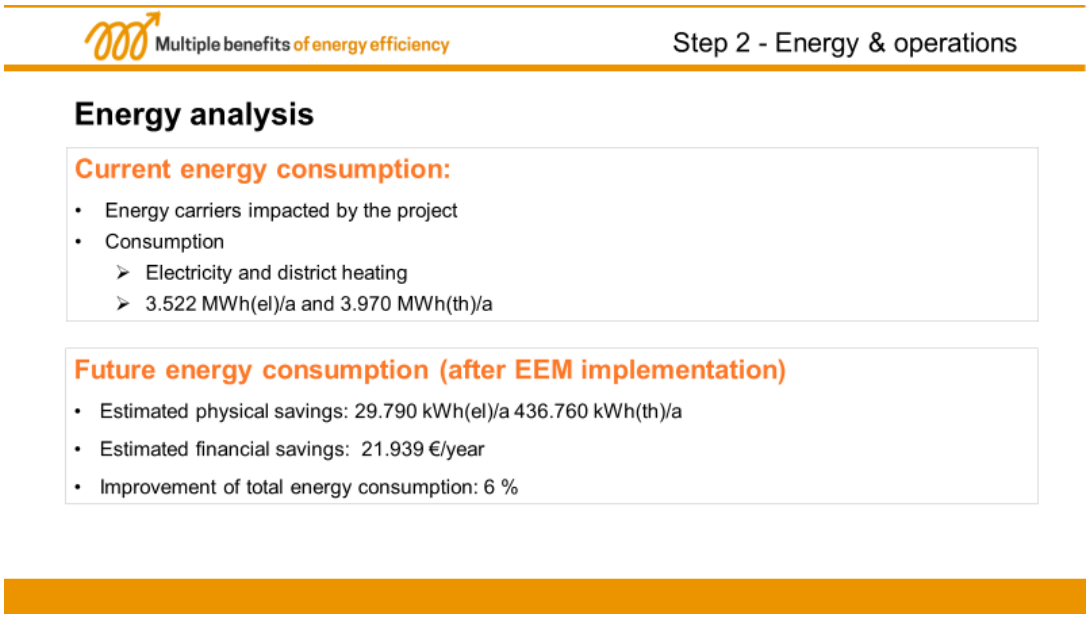


Figure 45. Results of the Energy Analysis. Moll Marzipan GmbH

Results of the Operations Analysis

The operational analysis helped to visualize the whole process and the heat flow and contribution to the other entities.

The heat recovery is located at the operational analysis at the level of machines. The excess heat from the refrigeration process and the screw compressor is linked out in the hot water storage tank which is fed in the domestic host water production and helps the brewer to maintain the drinking water hygiene. This is observed at the level of energy services together with cooling and compressed air.

Due to the smaller cooling load of the cooling unit, the plant cools with a higher consistency and the risk of a stops and breakdowns are reduced. The cooling unit cools a roasting process which is an important process in the plant. The excess heat usage of the screw compressor which produces the compressed air for packaging and sorting of goods does not impact the processes at all.

The most important production processes that are influenced using the waste heat correspond to the de-bittering process to produce persipan. The cleaning activities of the machines and equipment are not impacted as the waste heat is fed in the hot water production. Other processes on the cooling side are not impacted by the measure as well as the compressed air supplying the packaging and classification processes.

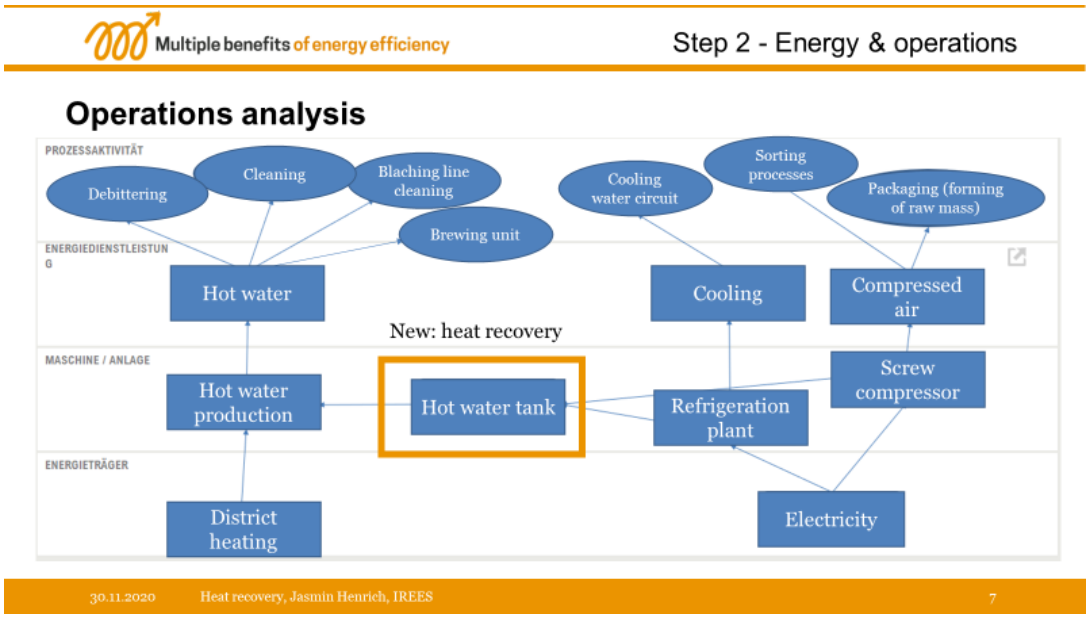


Figure 46. Results of the Operations Analysis-Operational diagram. Moll Marzipan GmbH

Results of the Strategic Analysis

The strategic analysis was realized with a 2-hour workshop with the company. The discussion and interaction with the energy management team and management are summarized in the following:

Value proposition impacts:

- Contribution to the vision or strategy of the company, due the continuous improvement and high value of the internal energy management and makes them a good role model at their activities at the Energy Efficiency Table Berlin and other networks.
- Improved image or reputation, due to the high value of quality (slogan "Quality from Berlin") the maintenance of the drinking water hygiene and customer-oriented values and see the explanation above.

Cost reduction:

- Reduction of water consumption, due to the smaller temperature rise less steam is needed to heat the water on the operating temperature.
- Reduced CO2 emissions, due to the reduction of district heating, which is taken from the normal district heating net, electricity is generated by hydropower and doesn't emit CO2 emissions.
- Reduced cooling demand, due to the link out of the heat which the cooling unit was supposed to cool, the plant works more in a stable manner and another additional cooling unit is not needed anymore.
- Reduced wear of machines and equipment, due to the relief of the cooling demand which reduces the load it must carry.
- Waste heat utilization, due to the heat recovery and hot water storage tank
- Shorter production cycle, due to the shorter preheating processes and lower temperature rises – but was not quantified due to a poor database and few time commitments of the company.

Risk impacts:

- Reduced CO2 and energy price risks

- Reduced risk of breakdown because of the reduced wear of machines and equipment
- Reduced water price risks, explanation of the risk impacts see above.

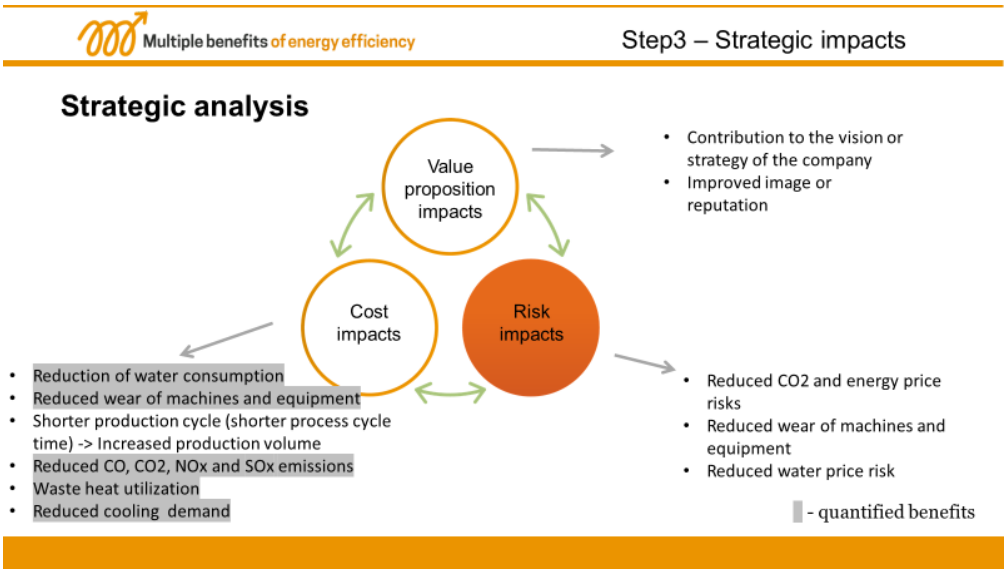


Figure 47. Results of the Strategic Analysis. Moll Marzipan GmbH

Results of the Financial Analysis

The company Moll had a very good database and already a very detailed idea of the project so the financial analyse was carried out convieniently. The investment calculation was conducted with an engineering company.

The investment amounts to 87.000 EUR, the discount rate is set by the financial department of the company at 4 % and the investment duration is considered with 6 years. The energy benefits only, means saving of electricity and district heating, results in a net present value of 44.000 EUR, the internal rate of return is 29 % and the simple payback time results in 3 years.

The calculation with the multiple benefits changed to the following. The net present value changed to 89.000 EUR, the internal rate of return to 62 % and the simple payback time changed to 2 years.

The energy benefits save every year 21.939 EUR and the multiple beneftis save in addition every year 6.673 EUR. Plus the saving of an additional cooling unit of 30.000 EUR which is one time taken into account.

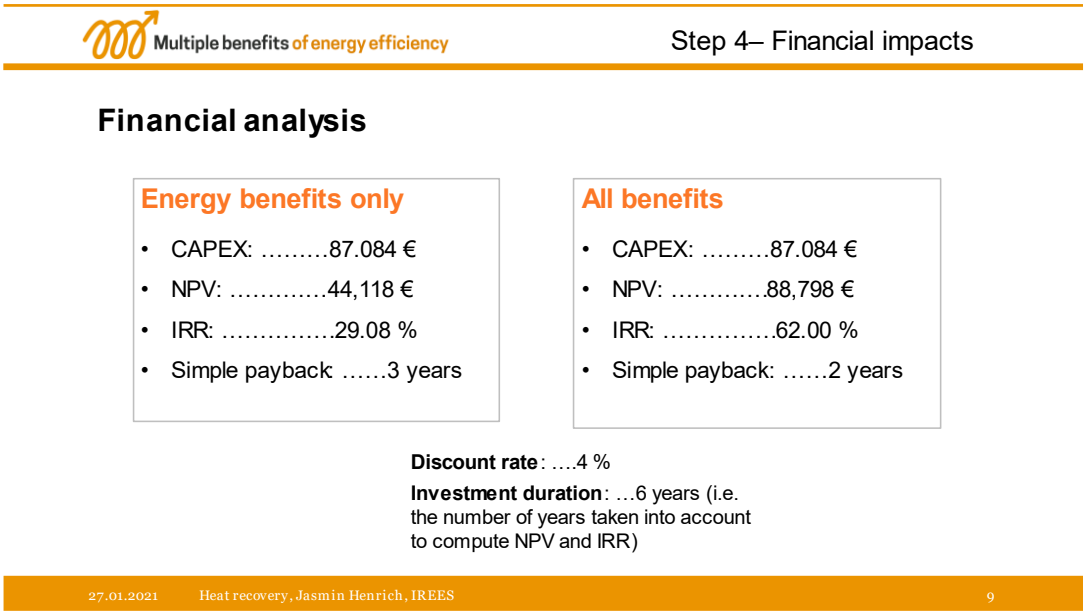


Figure 48. Results of the Financial Analysis. Moll Marzipan GmbH

Key Arguments for the Project Implementation

As was already discussed in the strategic analysis the key arguments to implement the measure would be:

First the increased production volume due to the shorter preheating processes and lower temperature rises at the heat levels. Furthermore, the cooling unit works more consistent which cools an important process in the company, which also results in a more stable and reliable production process.

Second there are the reduced water consumption that goes along with the reduced energy demand because of the waste heat usage. In addition, the measure reduces the wear of machines and equipment, which results in a longer life of the equipment. The reduction of the energy demand also results in the reduction of the CO2 emissions and reduces the financial pressure of the CO2 price.

The measure contributes to the vision or strategy of the company, due the continuous improvement and high value of the internal energy management and it also results in achievements which make them a good role model at their activities at the Energy Efficiency Table Berlin and other networks.

Furthermore, the improved image or reputation, due to the high value of quality (slogan “Quality from Berlin”) the maintenance of the drinking water hygiene is a very profound reasoning. Another argument for improving the image or reputation is environmentally friendly production through energy efficiency measures as Moll is also very customer-oriented and their marketing benefits from implementing this project.

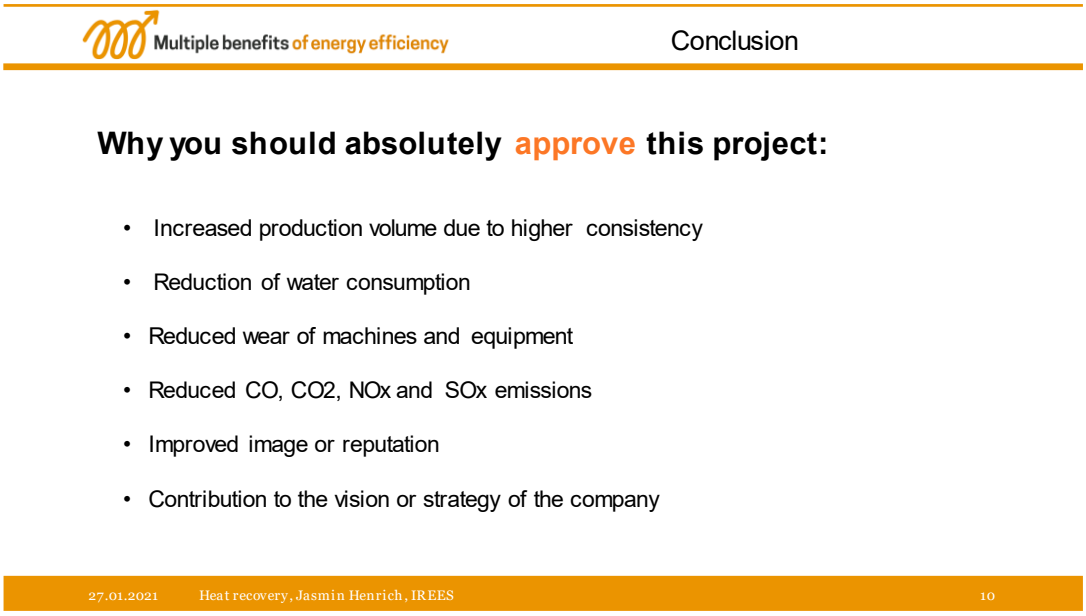


Figure 49. Key Arguments for the Project Implementation. Moll Marzipan GmbH

Key Issues and Highlights

The Company only had a small capacity for the project. They already quantified some multiple benefits but because of time issues they did not go deeper in the quantification process. In addition, the measure already had a payback period reduction from 3 to 2 years which has been enough for them. They did not see more advantages to do more quantification.

A highlight was that the company provided a solid database and that they joined the analysis energy and processes with people from different departments. The energy manager, the bachelor thesis student who prepared the database and an employee from the production who knew the process very well.

2.3 Reports Greece

Author, Organization (S.Karellas, C.Hatzilau, P.Pallis, NTUA)

2.3.1 Pilot 1: Replacement of LPG with liquefied natural gas (LNG) & Exploitation of exhaust heat rejected in the polymerization furnace, for the preheating of the coating bath water & Partial lighting system replacement with led technology.

(Aluminum industry – confidential)

Multiple benefits of energy efficiency

Application of three (3) EEM at an aluminum industry

[Speaker Name: Prof. S.Karellas, NTUA]

2020-November Implementation Partner, NTUA 2

Project Idea and Rationale

The company, which is treated anonymously, belongs to the aluminum sector, is based in Greece and has a significant international presence. It specializes in the study and design of aluminum profiles since 1971, while it is actively involved in the production and electrostatic painting of architectural profiles, offering complete solutions, in various colors and with remarkable durability.

The company's premises include a modern industrial unit for the production of aluminum profiles and an electrostatic paint coating unit of the latest technology, as well as other auxiliary spaces. Its total installed electric power is approximately 700 kW whereas the total installed thermal power is approximately 1450 kWth. Its annual energy consumption lies in the magnitude of 1 GWh electricity and 2 GWh thermal energy (i.e. app. 3 GWh total). Thermal energy is produced by the combustion of LPG in the boilers of the ovens and is used in the preheating of the raw material, the matrices but also a bath, the drying after the dyeing process and during the aging process. Electricity covers heating and cooling loads as well as the energy needs for production and lighting equipment.

The current pilot focuses on the reduction of energy consumption and the benefits thereby derived, upon the potential application of three Energy Efficiency Measures (EEM): (1) Replacement of LPG with liquefied natural gas (LNG), (2) Exploitation of

exhaust heat rejected in the polymerization furnace, for preheating the coating bath water, (3) Partial lighting system replacement with led technology.

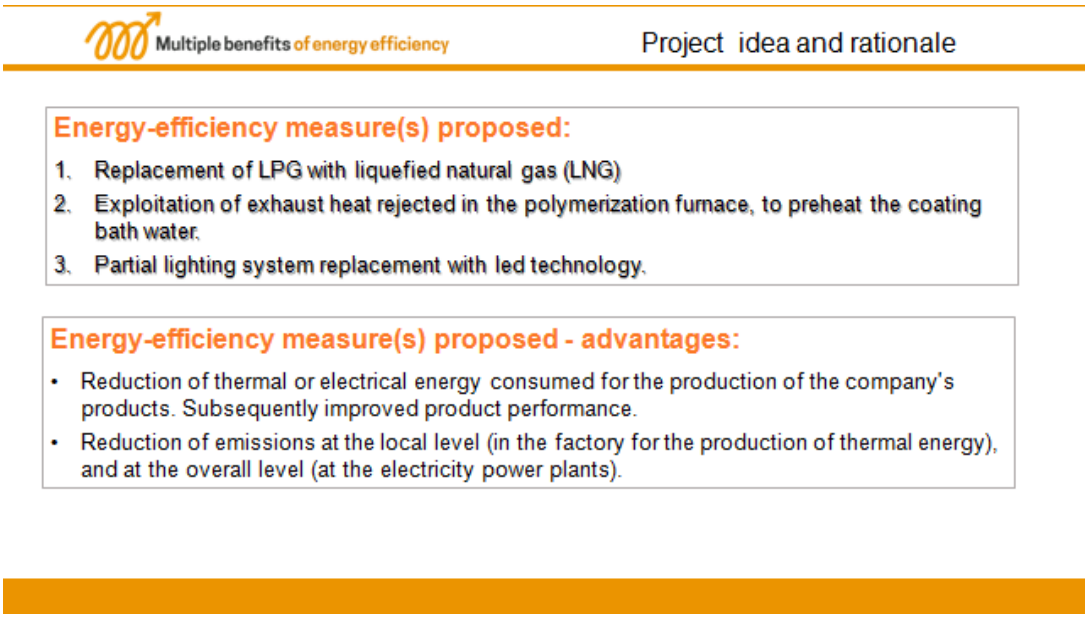


Figure 50. Project Idea and Rationale. Aluminum iCompany in Greece, confidential

Results of the Company Analysis

Key activities include the Production of aluminum profiles, Electrostatic painting of aluminum and Machine Profile processing. Key partners include Raw material suppliers (aluminum columns), matrix suppliers for aluminum profiles and powder suppliers for electrostatic painting. During the examination of potential EEM, two additional measures were identified i.e. the installation of photovoltaic panels on the roof of the building and the replacement of the coating chamber chiller with a new one with improved efficiency but were not short listed.

Value propositions cover the provision of customized aluminum profiles without complexity, the Design and production of aluminum profiles, the Ability to deliver ready for assembly profiles, Immediacy in communication, Quick delivery and the Possibility for provision of narrow quantities. Customer segments include Industries, Craft industries, Extrusion manufacturers and Traders. On the other hand, customer relationships are based on Building of long-term mutually beneficial relationships, dedicated personal assistance and Word of mouth. The company's key resources involve the complete industrial equipment for extrusion, dyeing and processing and Executives with knowledge, motivation and interest as well as Economic adequacy. The Cost Structure is comprised by Raw Material Price (up to 70% of cost) and the Production costs while scale economies apply.

Multiple benefits of energy efficiency — Step 1 - Company analysis

Company's activity:

Designing and producing specialized extruded aluminium profiles. Electrostatic painting of aluminum Machine Profile processing.

Studying and designing tailor-made innovative solutions.

Key customer segments and value proposition(s):

Segments: Industries, Craft industries, Extrusion manufacturers, Traders

Value propositions:

Provision of complex aluminum profiles without complexity

Ability to deliver ready-to-assemble profiles

Immediacy in communication

Flexibility in Delivery: Rapid Delivery & Possibility of delivering small quantities

Figure 51. Results of the Company Analysis. Aluminum iCompany in Greece, confidential

Results of the Energy Analysis

Three EEM are having a potential to be implemented on site. Regarding EEM1, the investment would involve the installation of an LNG Storage and Gasification Station as there is no NG network infrastructure in the area of the company so as to replace Liquified Petroleum Gas (LPG) currently used. The LNG Station would consist of an LNG tank and a pair of gasifiers for the gasification of the liquefied natural gas. The station would be supplied by trucks from the terminal of the location "Revythousa".

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Overall Consumption on site:
  - LPG consumption: ~ 2.000,00 MWh /year, Electricity : ~ 900 MWh consumed /year
- Energy carrier impacted by the project: Fuel
- Proposed EEM_1: Liquefied Petroleum Gas (LPG) replacement with Liquefied Natural Gas (LNG).

Future energy consumption (after EEM_1 implementation)

- Estimated physical savings: ~ 61,57 MWh/year
- Estimated financial savings: ~ 14.354,5 €/year
- Improvement of total energy consumption (Fuel): 3,00%
- Impact on indicators of energy performance: Annual Energy Consumption (Fuel)

Figure 52. Results of the Energy Analysis. Aluminum Company in Greece, confidential

EEM2 concerns of waste heat recovery from the polymerization furnace. Exhaust gases of the furnace exit into the atmosphere at a temperature of 265 °C and have the highest flow of 967.1 kg/h. There is a possibility of utilizing their heat, in order

to reduce the consumption of LPG for heating the bath tank. So, it is recommended to install an exhaust-water exchanger. The average thermal power delivered by the exchanger is 51.63 kW and is fully absorbed in the paint bath. The alternator operates the operating hours of the boiler which are estimated at 6.5 hours per day for 22 days per month and 11 months per year. This time period is covered by the polymerization furnace which operates 10 hours daily.

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Overall Consumption on site:
  - LPG consumption: ~ 2000 MWh /year, Electricity : ~ 900 MWh consumed /year
- Energy carrier impacted by the project:
  Waste Heat from the exhaust gas stream of the polymerization furnace for the preheating of the bath water. A boiler produces hot water for the coating bath at 75°C. Water returns from the bath at 57°C.
- Proposed EEM_2: Installation of a heat recovery system (gas/water exchanger).

Future energy consumption (after EEM_2 implementation)

- Estimated physical savings: ~ 88,08 MWh/year
- Estimated financial savings: ~ 4.379,20 €/year
- Improvement of total energy consumption: 4,29%
- Impact on indicators of energy performance: Annual Energy Consumption (Fuel & Energy)

Figure 53. Results of the Energy Analysis. Aluminum Company in Greece, confidential

Finally EEM3, concerns the replacement of traditional lightning with LEDs leading to an annual electricity reduction of 23,9 MWh. A market research and relevant requirements were submitted by the implementation partner to the company.

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Overall Consumption on site:
  - LPG consumption: ~ 2000 MWh /year, Electricity : ~ 900 MWh consumed /year
- Energy carrier impacted by the project: Electricity . Existing T8 lamps to be replaced by LED lamps.
- Proposed EEM_3: Partial lighting replacement

Future energy consumption (after EEM_3 implementation)

- Estimated physical savings: ~ 23,91 MWh/year
- Estimated financial savings: ~ 2.242,50 €/year
- Improvement of total energy consumption (electricity): 2,61%
- Impact on indicators of energy performance: Annual Energy Consumption (Electricity)

Figure 54. Results of the Energy Analysis. Aluminum Company in Greece, confidential

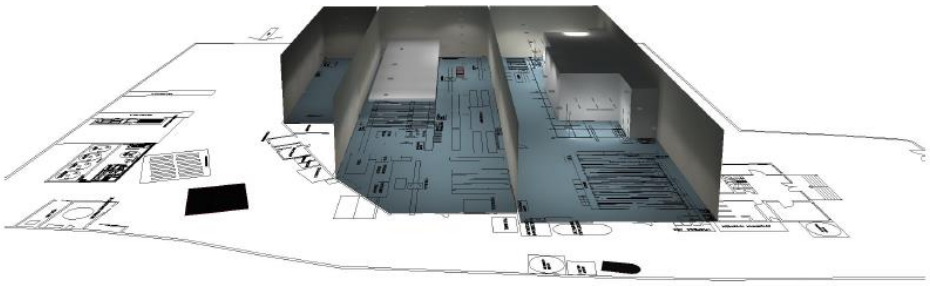


Figure 55. Figure 1: 3D description of lightning on the 1st floor of the company's main building. Aluminum Company in Greece, confidential

Results of the Operations Analysis

The company's operational flow diagram has been provided along with the information that decisions are made at the upper management level (PRESIDENT /CEO). No further extensive information has been provided by the company on this aspect.

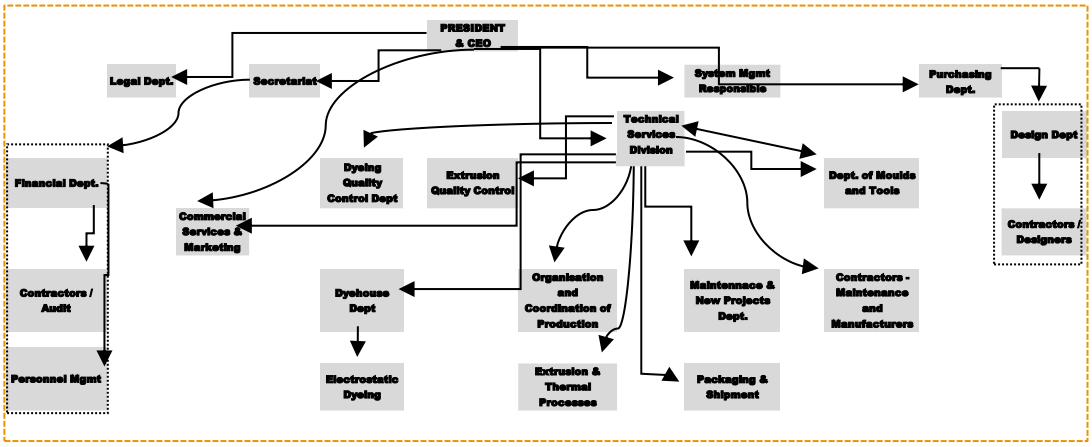


Figure 56. Figure 2:Operational flow diagram. Aluminum Company in Greece, confidential

The flow diagram of the production process is shown below while the indicators linked to each potential EEM are outlined in the following Table.

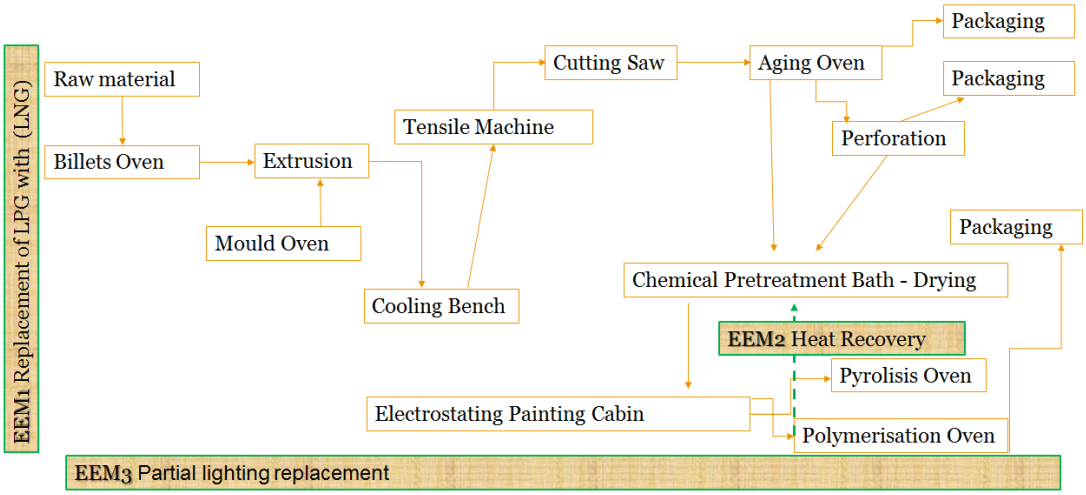


Figure 57. Figure 3: The EEM within the Production Process. Aluminum Company in Greece, confidential

Energy Efficiency Measure	Process Name/Description	Operational Excellence Indicators	
EEM1	Horizontal Measure / The entire Process	COSTS	NUMBER OF ACCIDENTS PER YEAR
EEM2	Polymerization	COSTS	PREPARATION TIME PER DAY
EEM 3	Horizontal Measure / The entire Process	COSTS	PREPARATION TIME PER DAY / PRODUCTION TIME PER DAY

Table 1: Operational Excellence Indicators

Results of the Strategic Analysis

The company's operational analysis in comparison with the examination of the decision making process of the company has led to the conclusion that there are options for the evolution of the decision making process into a future one incorporating the consideration of multiple benefits of Energy Efficiency Measures. Quantification of those benefits has been evaluated as subjective, so evaluation of additional; benefits has been mainly kept qualitative. The technological advancements present on the site in combination with the capabilities of the upper management as well as the readiness of all human resources show a much promising environment for the uptake of the multiple benefits' concept in the future..

The three potential measures to be applied are having an impact on the three pillars of the Value-Cost-Risk graph which is shown below. Cost impacts concern the avoided energy costs in all three EEM , the reduced no of accidents and increased safety in the case of EEM1, since LNG has a lower risk for accidents and with the avoided costs for regulatory compliance (e.g emissions reduction). In accordance, there is a reduced exposure to legal risks regarding emissions (EEM 1, EEM3), and for contribution to climate change in general in the future as all three EEEM are characterised by an advanced environmentally performance compared to the original processes.

Finally the EEMs proposed have a positive impact on the company's value proposition, namely as shown in the graph below.

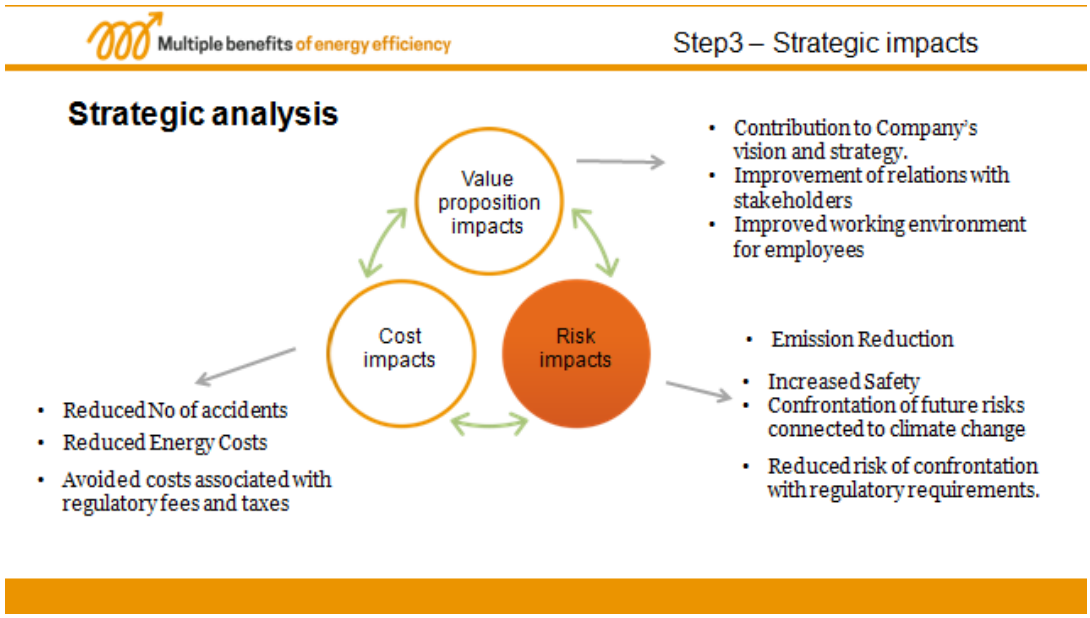


Figure 58. Results of the Strategic Analysis. Aluminum Company in Greece, confidential

Results of the Financial Analysis

All three examined EEMs have apart from the avoided – due to pure energy conservation – energy costs, additional "multiple benefits". Quantification of those could be undertaken solely in the case of reduced GHG emissions and in particular in the case of avoided CO2 emissions with the perspective of a future involvement in a voluntary or obligatory emissions certificate system. Therefore the revised financial indicators shown below should be considered as a minimum possible. Additionally monetized multiple benefits of the examined EEMs, described in previous sections would only improve the outcome of the financial analysis which is already quite encouraging.

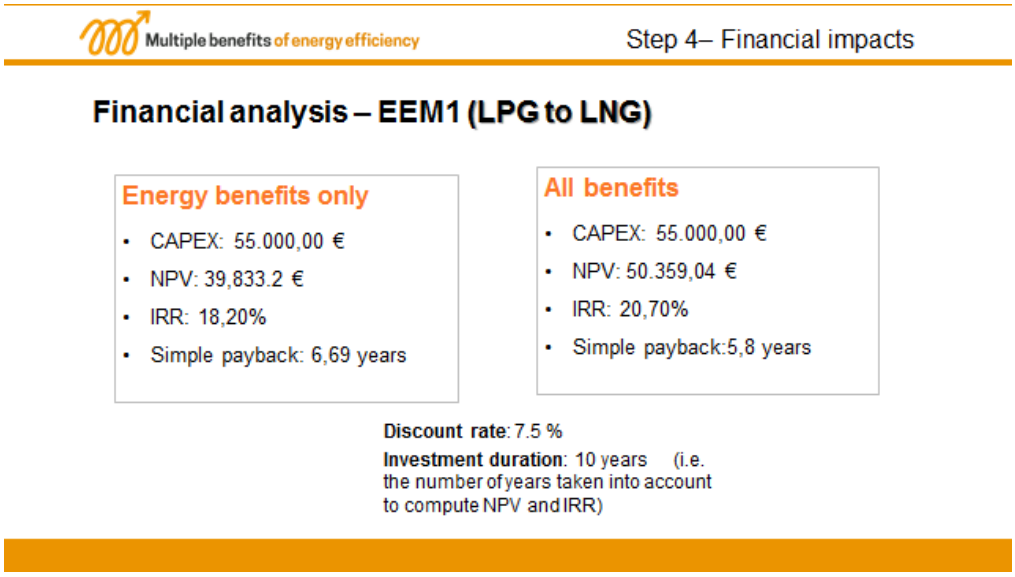


Figure 59. Results of the Financial Analysis. Aluminum Company in Greece, confidential

The first proposed EEM is the most costly one in terms of capital investment. It is also the most radical one in terms of alteration to the existing fuel supply system. Its application would have a simple payback time of 6,69 years while the incorporation of benefits concerning waste heat utilization and emission reduction leads to a simple payback period of 5,8 years.

The second of proposed measures (EEM2) concerns a total investment summing up to 12.900 Euro comprised by the equipment cost the cost of the heat exchanger and the controller of the system and its programming.

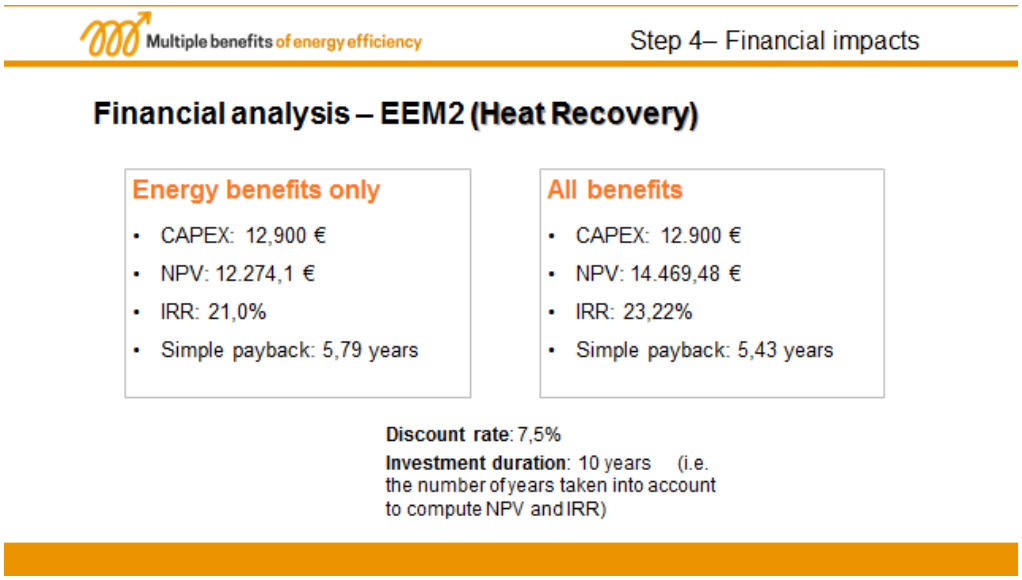


Figure 60. Results of the Financial Analysis. Aluminum Company in Greece, confidential

EEM3 concerning the replacement of 214 fluorescent bulbs with LED 22 W lamps is the most simple and less costly measure and can be applied horizontally to all the premises of the company.

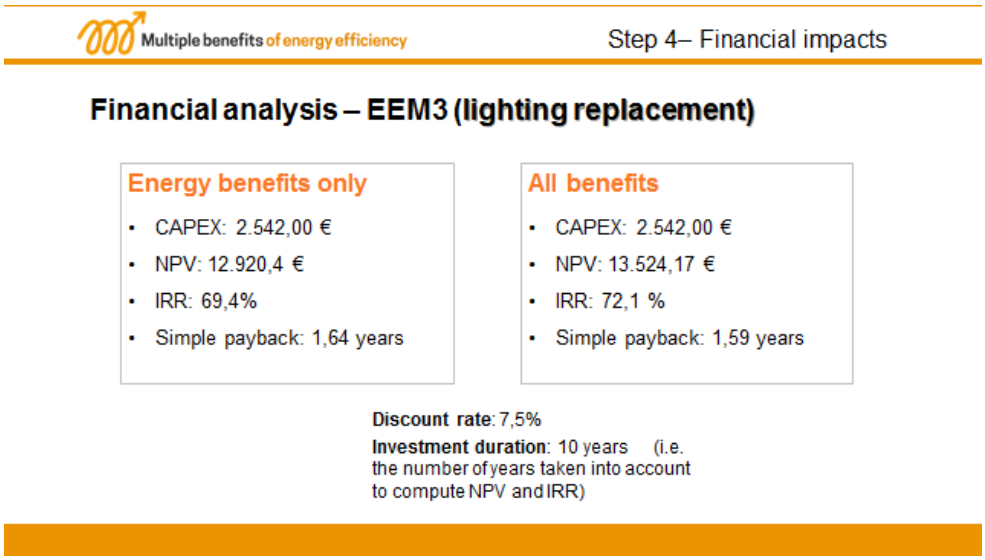


Figure 61. Results of the Financial Analysis. Aluminum Company in Greece, confidential

Key Arguments for the Project Implementation

The consideration of MB of EEM, dealt mostly with the environmental benefits i.e. emissions reductions and accident and legal risk avoidance. Value proposition mostly strengthens the relationships with stakeholders and the strategic image of the company. Quantification has been possible in the case of emissions avoidance whereas other benefits have been assessed qualitatively. The horizontal to the production process EEM1 and EEM3, add safety to the value proposition and have an impact overall to the entire operational and procedural flow diagram of the company. These two, are quite different since EEM1 concerns a larger investment whereas EEM3 is the least costly of all three EEM. EEM2 is a typical WHR measure which is evaluated as having a significant impact in terms of energy efficiency improvement while simultaneously offers additional value to the whole production process without such a high initial investment in monetary terms. The analysis of EEM3 through a study of the implementation partner is a good starting point for applying the MB concept in real life because it envisages a rather narrow initial capital. The company will consider implementing it as it acknowledges it has a positive impact on productivity and employees' well being though without a determined quantified impact as this is rather subjective and has to be viewed during the implementation of the measure and the general economy conditions applicable at the particular time period of implementation.

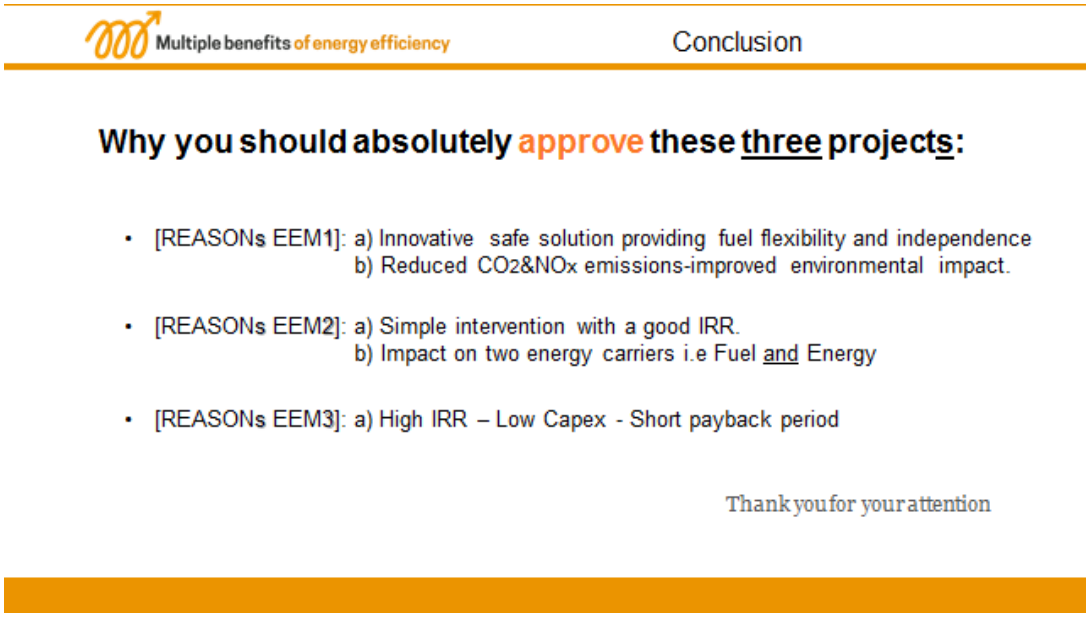


Figure 62. Key Arguments for the Project Implementation. Aluminum Company in Greece, confidential

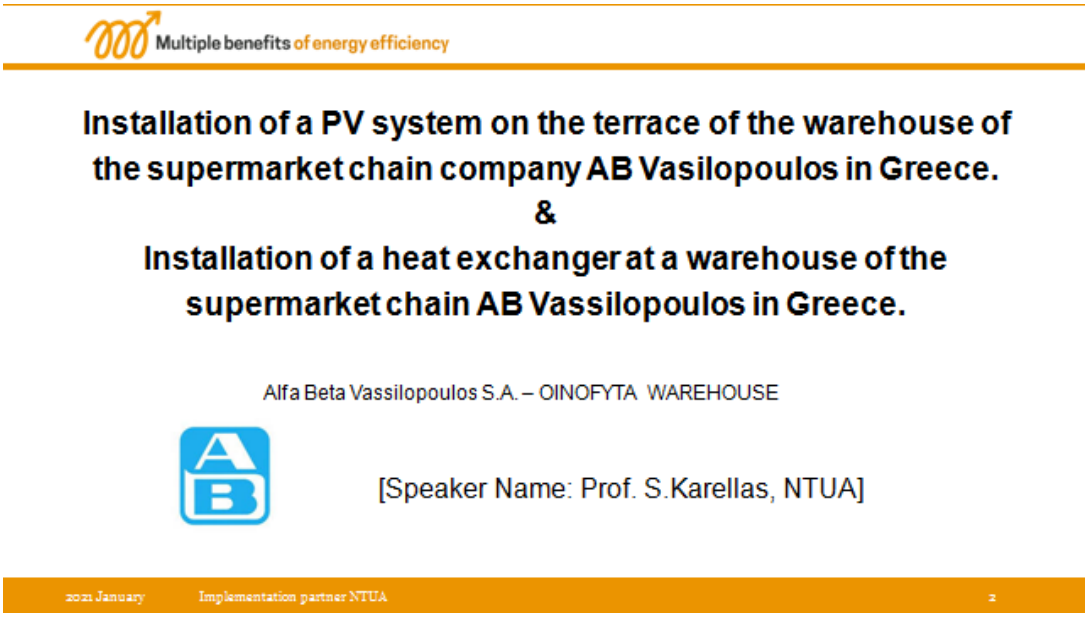
Key Issues and Highlights

The key personnel have been actively participating in all communication with the implementation partner. In fact, there have been five potential EEM identified initially, which the company has narrowed to three as having a larger potential of implementation. The application of the MB methodology proved valuable to the company's decision makers since it provided them with a whole new perspective of appreciating the profits of EEM investments. The identification of a low capital investment EEM such as EEM3 is considered an advantage compared to other MB pilot projects because it makes the implementation of a project where MB will be considered more tangible. Once implemented it can be a good starting point for the company to also consider investments which are more capital-consuming. The company, which participated from the very beginning of the project, acknowledged

that it has been useful to them to have the opportunity to view at energy investments with a different perspective. In fact, not only one but initially five and subsequently three short listed EEM were identified for examination. The idea of assisting companies such as the current company with implementing a low capital EEM by providing them with dedicated engineering studies as in this case submitted by the implementation partner to the Aluminium company is a good starting point for applying the MB concept in real life conditions. The company is also keen on examining the application of EEM1 and EEM2 in the future.

2.3.2 Pilot 2: Installation of PV system on the terrace of the warehouse of the supermarket chain company AB Vassilopoulos & Installation of a heat exchanger at a warehouse of the supermarket chain AB Vassilopoulos

AB Vassilopoulos Warehouse at Oinofyta



Project Idea and Rationale

The supermarket chain AB Vassilopoulos is a daughter company of the company Delhaize and has a long presence in Greece. It is comprised by 312 stores, 5 Central Warehouses and the Headquarters. The company which has already implemented significant EEM in the recent years and has achieved a reduction of its GHG emissions by almost 47% since 2008, seeks for additional improvements in EEM investments. The current pilot is implemented in one out of the five warehouses of the company, the warehouse at OINOFYTA in the area of VIOTIA. The plot is about 115000m² and the gross floor area is 30400m². The facility has 8 different storage rooms.

Taking into consideration that the company had already applied EEM such as low consumption light bulbs and smart lighting systems and that it already holds certifications such as owning the first BREEAM certified green building in Greece in 2010 and having the "GreenStore" certification in combination that the existing warehouse may fall outside from the scope of an obligatory Energy Audit, the task of implementing EEM can be characterized as challenging at least. Nevertheless, two potential EEM have been identified that can result into noteworthy advantages as shown on the Figure below. The development of a PV system concerns the part of the

terrace not covered with insulation. This part of the roof has a cross sectional area of 3025m². The second EEM concerns the installation of a heat exchanger consuming the hot ammonia gas before it reaches the condensers in order to heat water for mainly the consumption of the crafts washer and some other minor consumptions. Both measures are expected to strengthen the company's ambition for 2025: To inspire customers to make healthier choices, increase product transparency and eliminate waste.

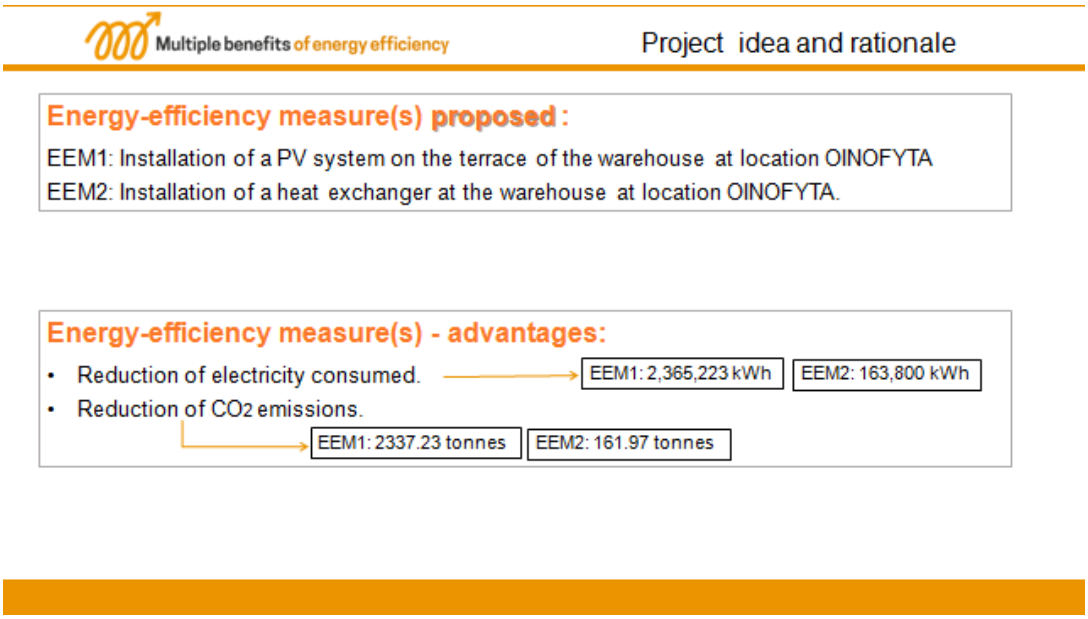


Figure 63. Project Idea and Rationale. AB Vassilopoulos Warehouse at Oinofyta

Results of the Company Analysis

The company's position in the supply chain plays a key role in mobilizing the company for improved energy efficiency. A company whose products are close to the consumer e.g. a food company has arguably higher motivations. The company acknowledges that there is a trend towards the increase of "green consumerism". There is a growing demand for products with minimal environmental impact. These differences in consumer preferences force companies to modify their products, production methods and communication strategies to adapt to current demand.

The Supermarket owns 312 stores as well as additional affiliate stores. AB was the first supermarket in Greece to introduce a customer loyalty scheme and had the first BREEAM-certified 'GreenStore' in Europe. It is a pioneer in sustainable services and significantly contributes to the life-quality of the local communities in which it operates and to Environmental protection. The company targets at increasing its economic, social and environmental value for the communities throughout the supply chain. It aims at being a healthy and safe place to work at and provide sustainably-sourced products. It also gives importance to the flexibility of customers to shop wherever and whenever they wish. The ambition for 2025 is to inspire customers to make healthier choices, increase product transparency and eliminate waste.

Multiple benefits of energy efficiency — Step 1 - Company analysis

Company's activity:

Retail company with 5 major warehouses. The current project concerns the warehouse at location OINOFYTA which is:

- Receiving fresh and frozen foods from producers
- Storing goods before their distribution.
- Acting as a regional distribution center.

Key customer segments and value proposition(s):

- Super market and affiliate stores are key segments.
- Value propositions:
  - The ability for customers to shop wherever and whenever they want.
  - Make healthier choices easier. Healthy and safe products. Sustainably sourced products.
  - Improved environmental performance (reduced food and plastic waste, reduced emissions).
  - Improvement of social footprint.
  - Healthy and safe place to work at.

Revenues streaming is made through on spot services, product's delivery and on-line services.

Figure 64. Results of the Company Analysis. AB Vassilopoulos Warehouse at Oinofyta

Results of the Energy Analysis

The energy consumed on the premises of the warehouse is solely electricity and the specific amount per area is approximately 242 kWh per m2. The electricity consumption of the warehouse is lower than that of respective alternate refrigeration facilities, a sign that energy management is completed with an advanced approach already. Annual energy consumption on the site is in the range of 7,500,000kWh. In order to evaluate the financial viability of the first investment, the annual cost of electricity with and without the existence of the PV has been calculated. Since the offsetting price ought to be calculated, i.e. when this price stops to be negative for a specific PV system, the initial analysis had to be upgraded to that for a larger PV area with a final power capacity of approx. 1330 kW and an area of approx. 21200m2.

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Energy carriers impacted by the project: Electricity.
- Consumption
  - 7,361,556.00 KWh consumed /year

Future energy consumption (EEM1 implementation - Installation of a PV system)

- Estimated physical savings: 2,362,223.00 kWh/year
- Net metering price: 0.058 €/kWh
- Estimated financial savings: 137,183.00 €/year

Figure 65. Results of the Energy Analysis. AB Vassilopoulos Warehouse at Oinofyta

The second measure concerns the exploitation of the heat of the superheated ammonia, exiting the compressors of the 2nd stage of the refrigeration circuit, and discarded unused through the air-cooled condensers in the atmosphere. Physical savings are done at the washer, the heat pump and the restaurant's kitchen.

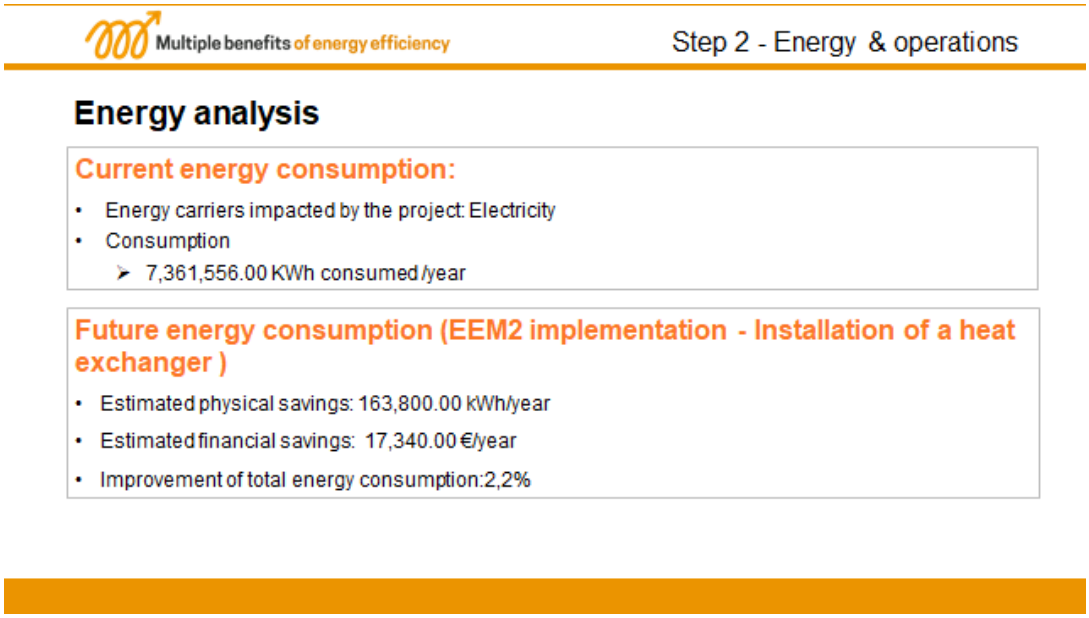


Figure 66. Results of the Energy Analysis. AB Vassilopoulos Warehouse at Oinofyta

Results of the Operations Analysis

The areas of the company affected by the two EEM are the roof of the warehouse's main building (PV system) and the refrigeration facility (Waste Heat Utilization).

In more detail, most of the roof of the AB Distribution Center in Oinofyta is covered by porous soft insulating material on which the installation of photovoltaics was deemed unsuitable due to its possible flammability. However, there is a part of the roof, just above the empty storage room and the crate washing machine, which is not covered by this material and in which the installation of PV has been examined. This part of the roof is square with a side length of 55m and therefore an area of 3025m2.

The refrigeration facility of the warehouse includes a two-stage compression system R717 (ammonia) which operates at temperatures of -10 ° C and -35 ° C. The upper stage of the ammonia system feeds -through a heat exchanger- a second circuit with 35% propylene glycol-water cooling medium. The ammonia circuit supplies following spaces: The first stage supplies the freezer compartment while the second stage feeds i) the maintenance chamber, the handling / loading corridor and the three fruit and vegetable compartments. The second circuit with the cooling medium supplies the meat storage vestibule the meat preservation chamber, the cheese chamber and the fisheries chamber.

The company's operational flow diagram is as follows.

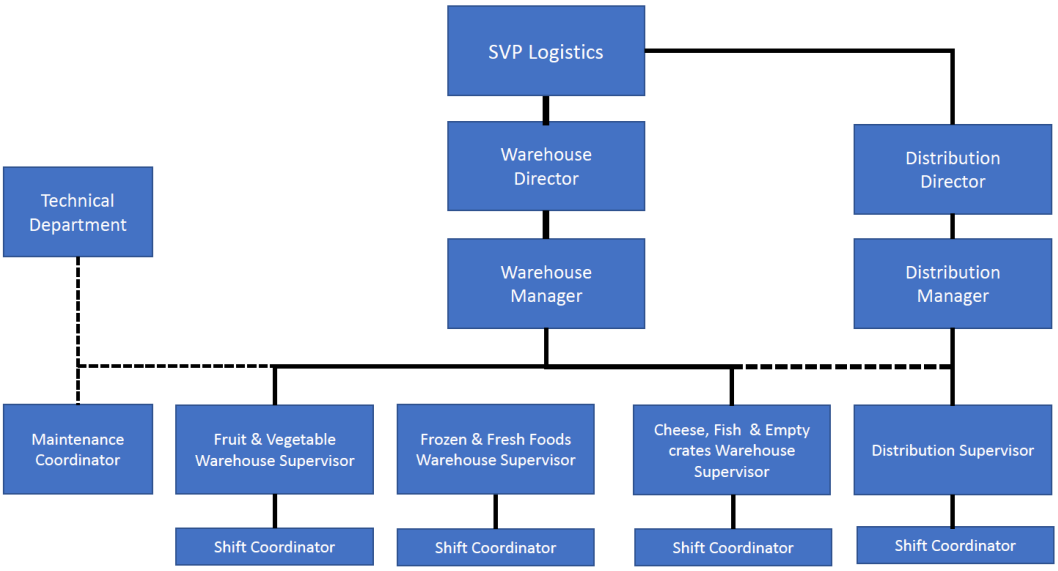


Figure 67. Results of the Operations Analysis-Operational diagram. AB Vassilopoulos Warehouse at Oinofyta

Results of the Strategic Analysis

Supermarkets are one of the most energy-intensive sectors among commercial buildings, therefore opportunities for energy conservation are quite valuable in many aspects.

At the specific location of AB Vassilopoulos, the potential implementation of the two aforementioned EEM are expected to have a strategic impact as depicted on the graph below. Cost impacts concern apart from the reduced energy costs also the potential for avoided costs linked to regulatory requirements, i.e. legal obligations towards emissions reduction and environmental protection, waste management and similar issues. In addition, both EEM lead towards an increased economic, social and environmental value for the communities where the stores of AB Vassilopoulos, operate. Moreover, the two EEM add value to the possibilities of providing the customers with sustainably sourced products. Relevant risks are also diminished, namely that of emissions increase or of confrontation with regulatory requirements (unforeseen fines or legal procedures).

Finally, the EEMs proposed, decrease the risk of not achieving the 2025 company's ambition for sustainability.

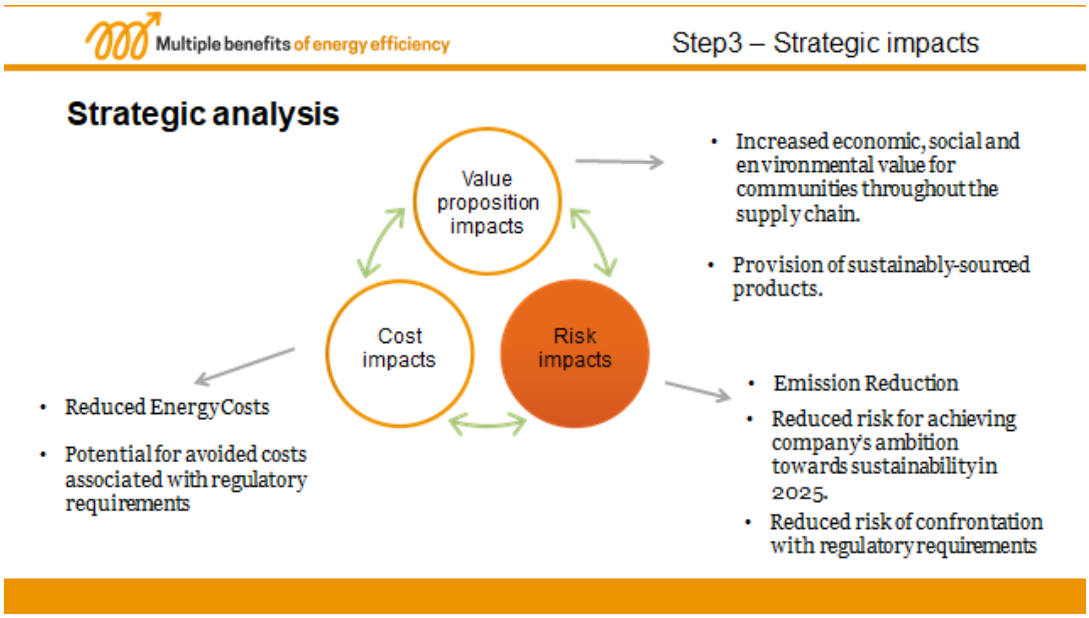


Figure 68. Results of the Strategic Analysis. AB Vassilopoulos Warehouse at Oinofyta

Results of the Financial Analysis

Quantification of additional benefits has been undertaken for the case of emissions reduction since the measurable quantified emissions reduction is a strategic target and of an outmost importance for the company. The target of the whole group (Delhaize) is a 50% carbon emissions reduction by 2030 from the operations and a reduction of 15% emissions from the value chain. During the financial analysis, the price of CO2 has been set with the assumption of a future involvement in a voluntary or obligatory emissions certificate system. Therefore, the price of CO2 has been set to €25/ton. The revised therefore financial indicators, shown also below, can be considered as a minimum possible. Further monetization of benefits would lead to even better outcomes. The application of both EEM lead to a payback time of less than 4 years which is quite promising.

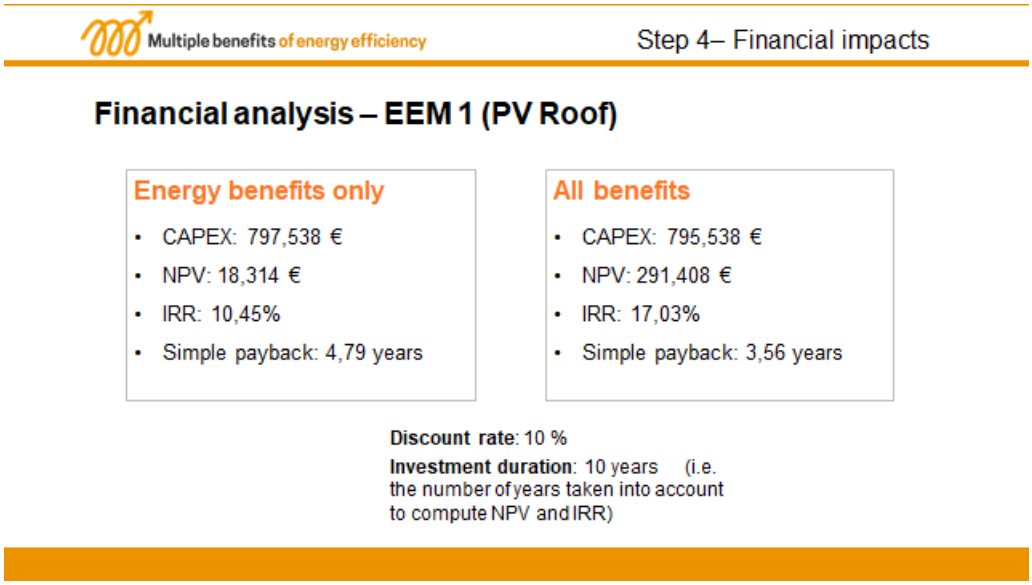


Figure 69. Results of the Financial Analysis. AB Vassilopoulos Warehouse at Oinofyta

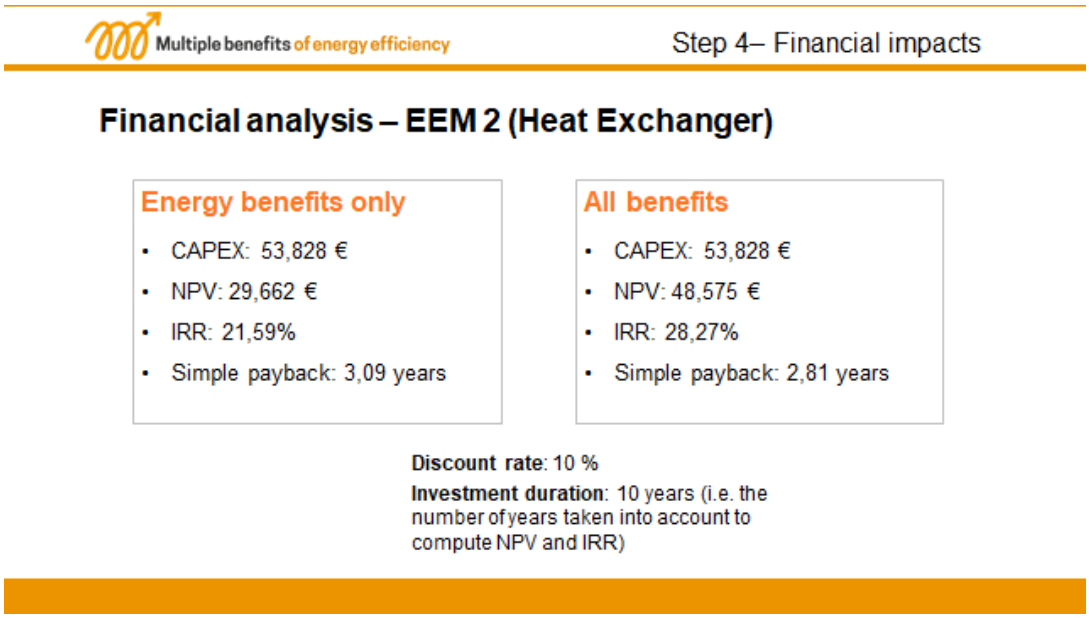


Figure 70. Results of the Financial Analysis. AB Vassilopoulos Warehouse at Oinofyta

Key Arguments for the Project Implementation

The installation of a PV system is a large investment having benefits for the whole warehouse, not only a part of its production process, deriving from the use of non-conventional energy i.e. RES and more specifically solar energy. It allows the consumer (in this case the Warehouse) to cover a significant part of his own consumption, while at the same time enables the network usage for indirect storage of RES. So, the advantage of net-metering is that the energy produced does not have to be synchronized with the energy consumed. The counterbalance of the produced energy is carried out obligatorily as a priority with the consumption that is electrically connected to the same supply with the production station. If afterwards an excess quantity injected into the energy network occurs, it is offset by the consumption of the next clearing account. So, the company benefits from increased flexibility regarding access to energy and promotes sustainable consumerism at the same time.

The second EEM is a typical heat recovery measure with a lower capital expenditure aiming at meeting the hot water requirements of the Distribution and Maintenance Centre and in specific of the crate washing machine, the cheese storage area and the restaurant.

Both EEM strengthen the 2025 strategic target to inspire customers to increase product transparency and access to sustainably sourced products. In addition, the analysis of both EEM monetize a strategic target i.e. that for GHG emissions reduction.

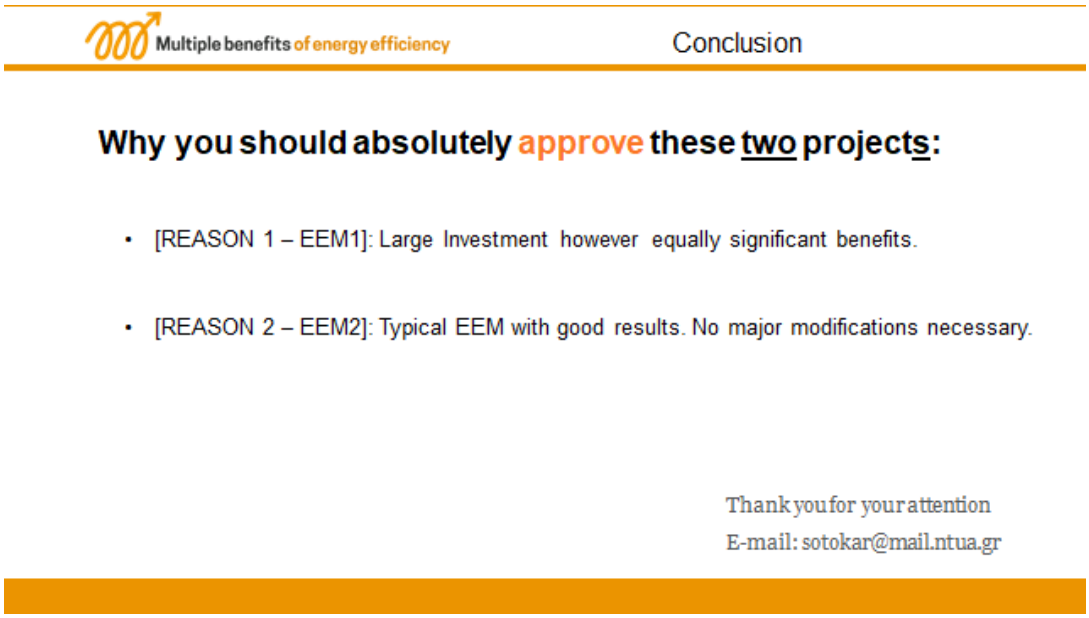


Figure 71. Key Arguments for the Project Implementation. AB Vassilopoulos Warehouse at Oinofyta

Key Issues and Highlights

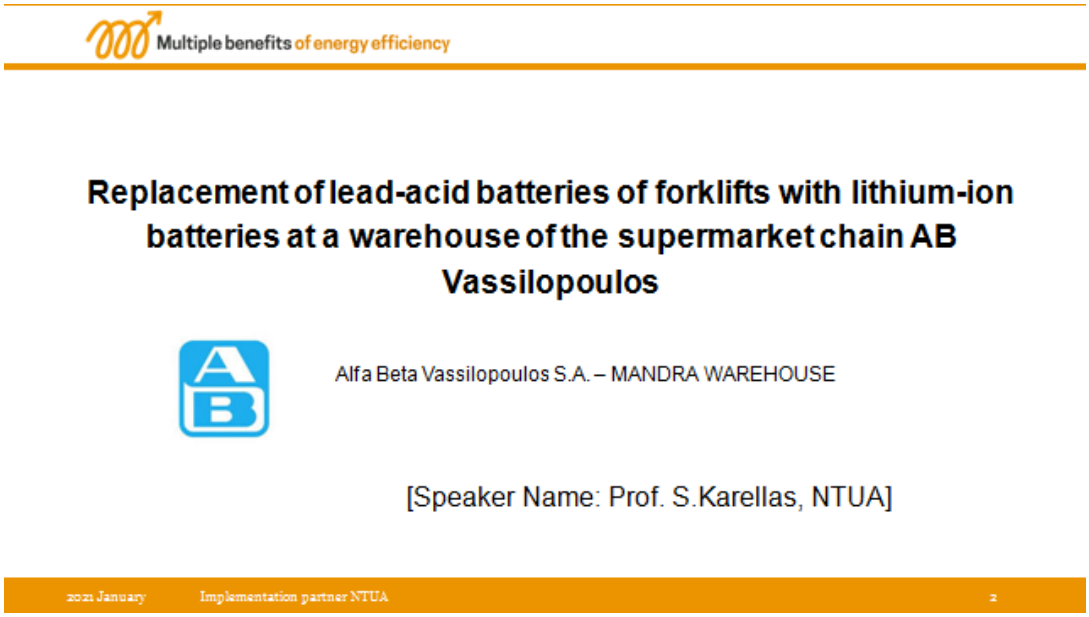
The company has welcomed the project and the concept of multiple benefits. The data provided was not so extensive and due to the fact that the company belongs to a wider group (Delhaize) it was not possible to fully exploit the potential of the MB methodology due to authorization issues. However, with the resources available on behalf of the Greek daughter company, a collaboration was established and there is also further interest for implementation of the methodology in additional premises of the company. The interest lies especially within the possibilities for utilising data for the quantification of those benefits. In any case the methodology was proved useful because some parameters were taken into consideration in a more weighted manner than previously even if only in a qualitative way.

The company's strategy which supports sustainable consumerism provided a fruitful ground for the application of the methodology because it stands exactly within the general strategic concept regarding the provision of sustainably-sourced products.

A general key point derived, is that the methodology can play a role in the achievement of targets of a mother company, even if these targets are not direct targets of the local company. For example, the additional benefits from the implementation of measures for GHG emission reduction, contribute towards Delhaizes' targets for-50% carbon emissions reduction by 2030 from the operations, & reduction of 15% emissions from the value chain.

2.3.3 Pilot 3: Replacement of lead-acid batteries of forklifts with lithium-ion batteries at a warehouse of the supermarket chain AB Vassilopoulos in Mandra, Attica

AB Vassilopoulos Warehouse at Mandra



Project Idea and Rationale

The supermarket chain AB Vassilopoulos is a daughter company of the company Delhaize with a long presence in Greece. It is comprised by 312 stores, 5 Central Warehouses and the Headquarters. The company has implemented EEM in the recent years and has achieved a reduction of GHG emissions by almost 47% since 2008. The current pilot is implemented in one out of five warehouses of the company, the warehouse at MANDRA in Attica which is comprised by two facilities. The current pilot concerns the implementation of an EEM on the first out of these two facilities (KAM1) the plot area of which is about 46123 m² and the gross floor area is 33127 m². In particular, EEM concerns the replacement of Lead-Acid Batteries with new Lithium-Ion Batteries for forklifts. This also involves the replacement of existing chargers with modern chargers designed to provide fast battery charging. Maximum utilization of these new batteries requires occasional charging during shifts. A significant advantage of this EEM is that forklifts operators, although not on a break time, are usually immobilized with their vehicles, waiting for the next task to be assigned to them. These time- intervals are eliminated with the usage of the new batteries because they are used to recover part of the lithium ion battery power. These charges not only do not create a problem with the life of the battery, but on the contrary help to increase their lifespan. In the case of lead acid batteries, these times cannot be used in an effective way, as occasional charges can cause serious problems in their life cycle. The examination of an additional EEM i.e.

the replacement of the NG heating boiler with a condensing boiler at the warehouse could not be conducted after all though initially planned.

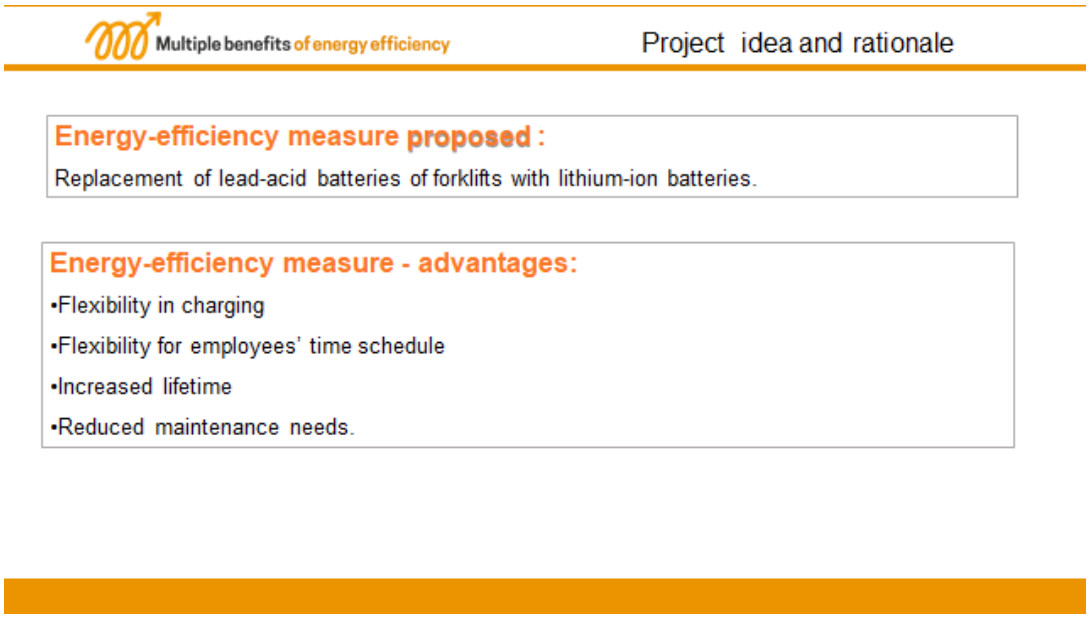


Figure 72. Project Idea and Rationale. AB Vassilopoulos Warehouse at Mandra

Results of the Company Analysis

The company's position in the supply chain plays a key role in mobilizing the company for improved energy efficiency. A company whose products are close to the consumer e.g. a food company has arguably higher motivations. The company acknowledges that there is a trend towards the increase of "green consumerism". There is a growing demand for products with minimal environmental impact. These differences in consumer preferences force companies to modify their products, production methods and communication strategies to adapt to current demand.

The Supermarket owns 312 stores as well as additional affiliate stores. AB was the first supermarket in Greece to introduce a customer loyalty scheme and had the first BREEAM-certified 'GreenStore' in Europe. It is a pioneer in sustainable services and significantly contributes to the life-quality of the local communities in which it operates and to Environmental protection. The company targets at increasing its economic, social and environmental value for the communities throughout the supply chain. It aims at being a healthy and safe place to work at and provide sustainably-sourced products. It also gives importance to the flexibility of customers to shop wherever and whenever they wish. The ambition for 2025 is to inspire customers to make healthier choices, increase product transparency and eliminate waste.

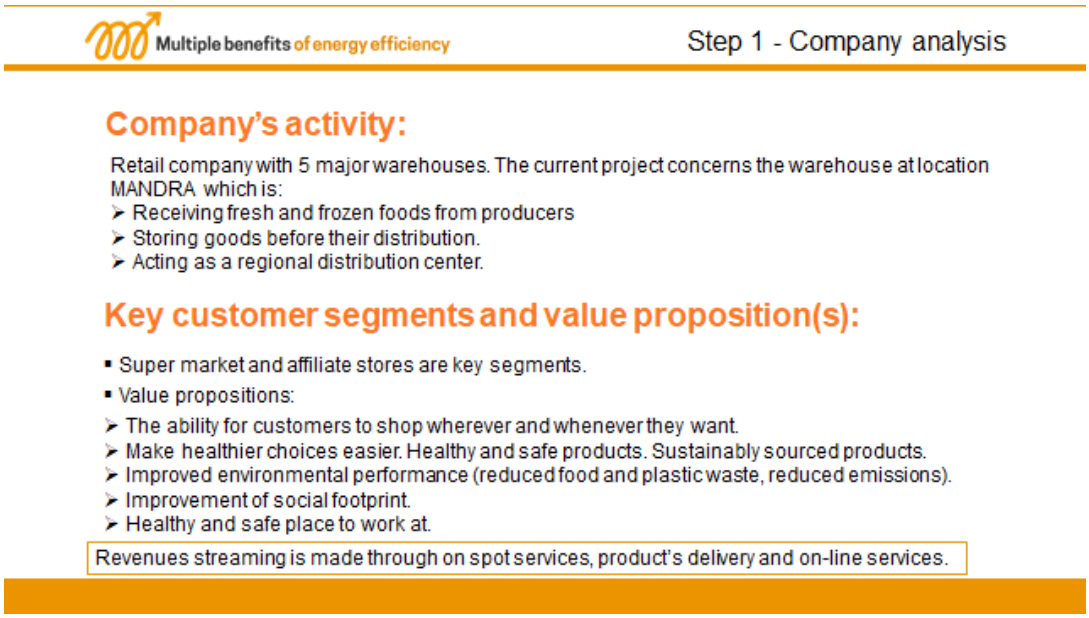


Figure 73. Results of the Company Analysis. AB Vassilopoulos Warehouse at Mandra

Results of the Energy Analysis

Initially two EEM were considered as having α potential to be implemented. Finally, due to lack of data at the time of reporting, only the EEM concerning the batteries substitution has been examined. The measure is considered at the buildings of the first facility (KAM1).

The choice of batteries for each vehicle has been made in order for the vehicle to meet the needs of an eight-hour shift. At the end of the shift, the battery is discharged, so the empty battery is placed in the appropriate position and connected to the charger, while the vehicle is equipped with a new charged battery, ready to cope with the eight-hour shift. Therefore, for the buildings in KAM1, which operate on a 24-hour basis (three eight-hour shifts), each charger performs three charges. Taking into consideration that lead batteries have a lower SOC (State of Charge) equal to 20% whereas the ion-lithium have a lower SOC of 5%, the subsequent analysis leads to the results shown below. What has also been taken into account, is the avoidance of batteries renewal, since the ion-lithium batteries have a longer lifespan. According to studies and data from manufacturers, it has a 3 fold higher lifetime than lead acid batteries.

Multiple benefits of energy efficiency

Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Energy carriers impacted by the project: Batteries for charging forklifts
- Consumption
  - 900569 kWh consumed per year for charging

Future energy consumption (after EEM implementation - Replacement of the batteries)

- Estimated physical savings: ~ 94797 kWh/year
- Estimated financial savings: ~ 10428 €/year
- Improvement of total energy consumption: 10,53% for charging
- Improvement of total energy consumption: 2,56%

Figure 74. Results of the Energy Analysis. AB Vassilopoulos Warehouse at Mandra

Results of the Operations Analysis

The EEM is applied on the internal transportation procedure. In specific, forklifts are used for (i) loading and unloading procedures of trucks on ramps, (ii) transporting products from unloading areas to appropriate shelves for storage and then to collect the products from the shelves for loading on the company's trucks, iii) placing products transferred from order collection machines to high shelves, as well as the reverse process.

The company's operational diagram is shown below.

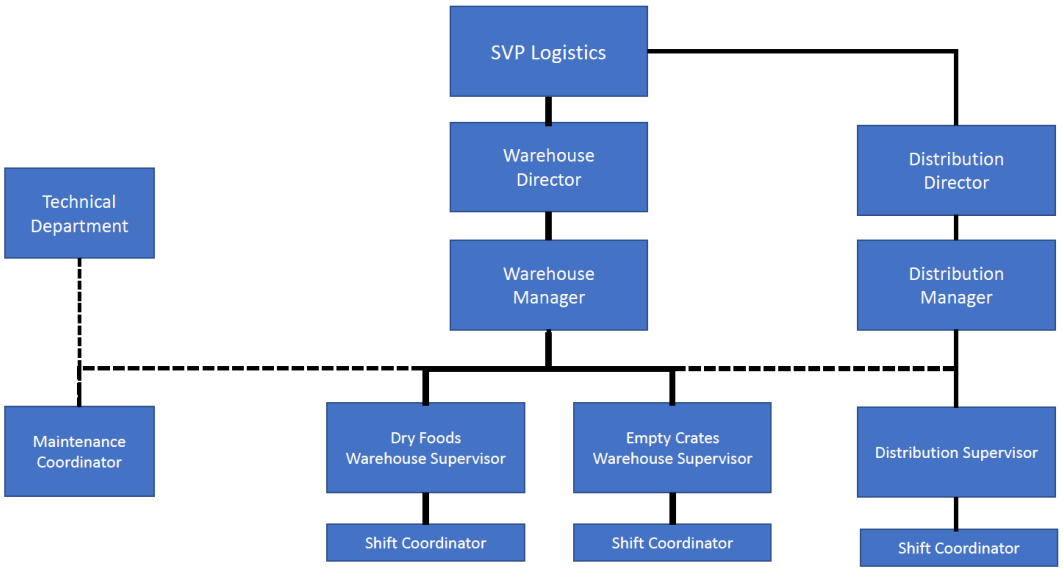


Figure 75. Results of the Operations Analysis-Operational diagram. AB Vassilopoulos Warehouse at Mandra

Results of the Strategic Analysis

The potential implementation of the aforementioned EEM is expected to have a strategic impact as depicted on the graph below. Cost impacts concern apart from the reduced energy costs also reduced maintenance and workforce costs. Consequently, there is reduced risk connected with the compulsory intervals for maintenance. That means that the time during which operation might need to stop due to maintenance and batteries changing, has decreased to some days every ten years because the new batteries have a higher lifetime.

The EEM may drive towards an increased economic, social and environmental value for the communities where the stores of AB Vassilopoulos, operate. In addition, the EEM adds value to the overall strategic target of the company, concerning the provision of customers with sustainably sourced products. What is more, the specific EEM increases employee's satisfaction in the sense that working conditions can improve. On the other hand, the fact that maybe less allocated workforce (no of employees) will be required for the specific process of handling the forklifts, might have a negative effect on the employee's well-being. Finally, the EEM proposed, decreases the risk of not achieving the 2025 company's ambition for sustainability.

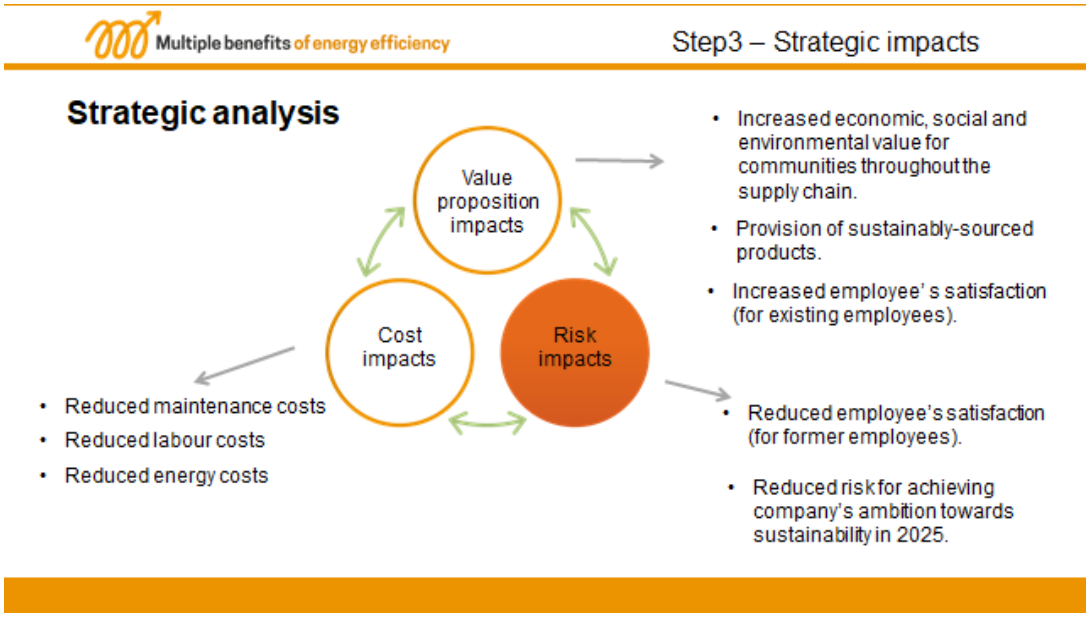


Figure 76. Results of the Strategic Analysis. AB Vassilopoulos Warehouse at Mandra

Results of the Financial Analysis

The capital expenditure includes apart from the new type of batteries, also the necessary chargers. The costs calculated and compared in the basic scenario and the MB scenario, concern the costs for purchasing the batteries in each case and the maintenance and workforce costs as well as emissions costs.

The investment of the EEM without the consideration of Multiple Benefits would lead to a simple payback time of 9,90 years while the incorporation of benefits concerning avoided maintenance and workforce costs and emission reduction leads to a simple payback period of only 5,78 years. The avoidance of costs for purchasing the batteries, were calculated within the basis and non-MB scenario because such costs are normally incorporated during the examination of energy investments.

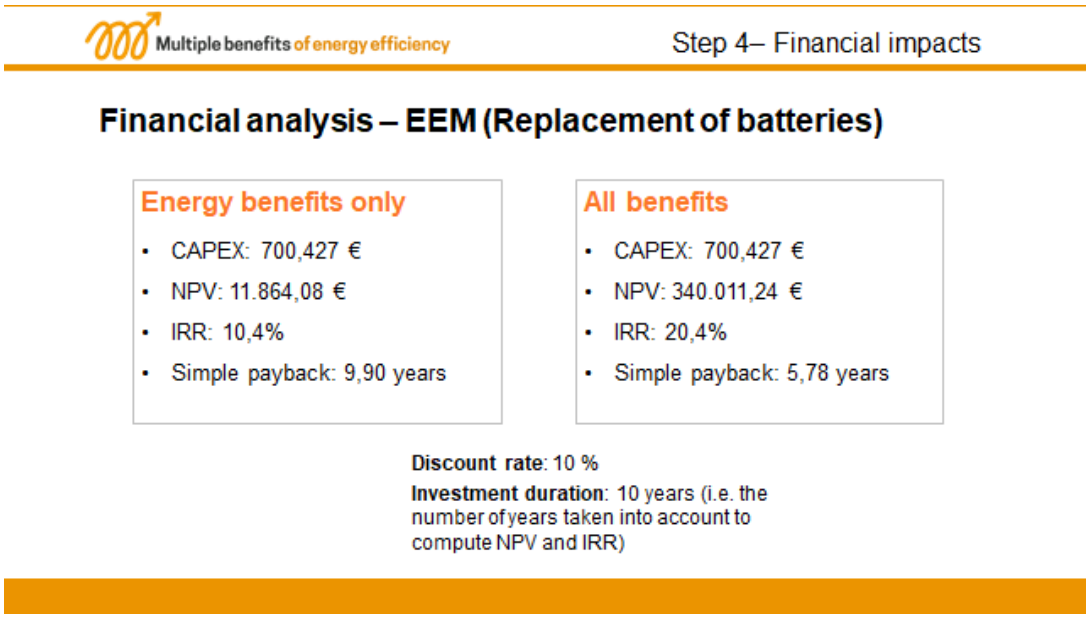


Figure 77. Results of the Financial Analysis. AB Vassilopoulos Warehouse at Mandra

Key Arguments for the Project Implementation

The selection of lithium-ion batteries has been made on the basis of several advantages in comparison to the lead batteries. First, this new technology leads to readjustment of the charging space and the breaks of the machine operators. It has a high density, so it can condense large amounts of energy into smaller batteries compared to other technologies encountered. It allows occasional charges during shifts, which leads to the avoidance of changing batteries in each shift. Each vehicle now has its own lithium-ion battery. The charging process does not include charging stages. For example, a 300 Ah battery is fully charged in 1 hour with a 300 A charger, in 2 hours with a 150 A charger and so on. No maintenance and supervision costs are required.

What is more, the technology leads to improved productivity, saves time and supports the sustainability target of the company for 2025 for reduced emissions and provision of sustainably sourced products.

Figure 78. Key Arguments for the Project Implementation. AB Vassilopoulos Warehouse at Mandra

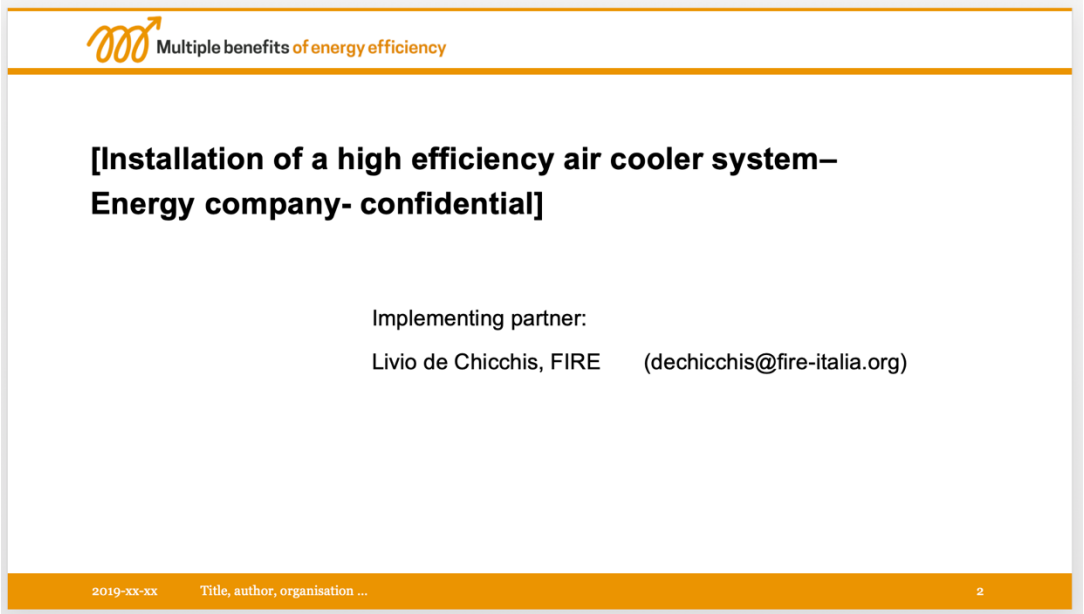
Key Issues and Highlights

The MB methodology proved useful for the evaluation of maintenance costs saved, of CO2 emission costs saved and for administration (workforce) costs saved. The methodology was applied assuming that potential personnel reduction which means less costs for the company, will not cause the dissatisfaction of the rest of the employees. The replacement of lead batteries with lithium-ion batteries is a much promising practice which is expected to be widely developed in the future, so it is also assumed to raise training needs and new workforce requirements. The additional benefit from the implementation of measures for GHG emission reduction, contribute towards Delhaize's' targets for-50% carbon emissions reduction by 2030 from the operations, & reduction of 15% emissions from the value chain as well as towards the strategic target for increased use of technology for the enhancement of productivity. The avoidance of costs for purchasing the batteries, since the ion-lithium batteries have a 3-fold higher lifespan, were calculated within the basis scenario (without MBs) because such costs are typically incorporated during the examination of energy investments.

2.4 Reports Italy

Author, Organization: Livio de Chicchis, FIRE

2.4.1 Pilot 1: Installation of a high efficiency air cooler system Energy company - confidential



Project Idea and Rationale

The plant was selected for the development of the pilot for two main reasons. Firstly, in the site an energy audit was realized in 2019 highlighting, among various opportunities, that of making the air-cooling system more efficient.

The site engineering department already evaluated several options to increase the effectiveness of the air cooler system on the amine circuit. The replacement of existing fans with more efficient ones did not appear to have economics attractive enough for approval, so that it was decided to extend the analysis considering also the related non-energy effects to have a holistic view of the project itself and to strengthen the economics.

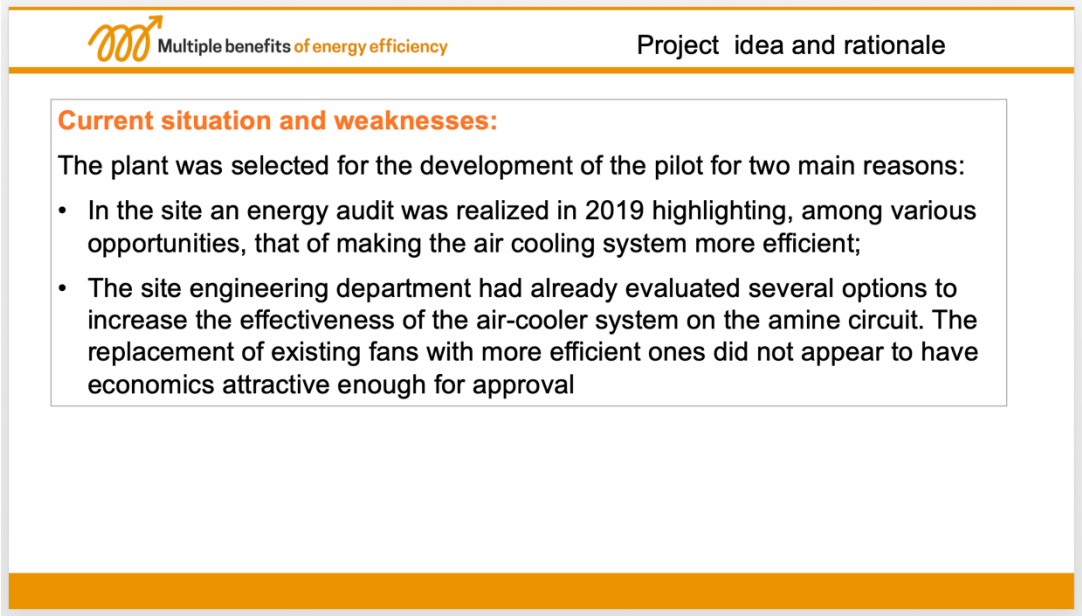


Figure 79. Project Idea and Rationale. Pilot 1, Energy company, confidential

Results of the Company Analysis

Company's activity deals with production of semi-finished products using hydrocarbon fractions from petroleum distillation as raw material. In particular, company is active in the exploration, development and extraction of oil, and in the procurement, supply, trading and transportation of natural gas, LNG, electricity, fuels and chemicals. Crude oils to produce fuels, lubricants and chemical products sold wholesale or through distribution networks.

Pilot project is focused on the processes of the production site. Final products are oil, gas and sulphur: oil produced is sent to depot, while the treated gas is injected into a distribution network. Sulfur is sold in a liquid state through tankers. No refining activities are carried out in this production site.

Optimization of production management is one of the priorities of company's business. Key customer segments are the subcontractors for sulplhur produced by the operations and the final users of the distribution network.

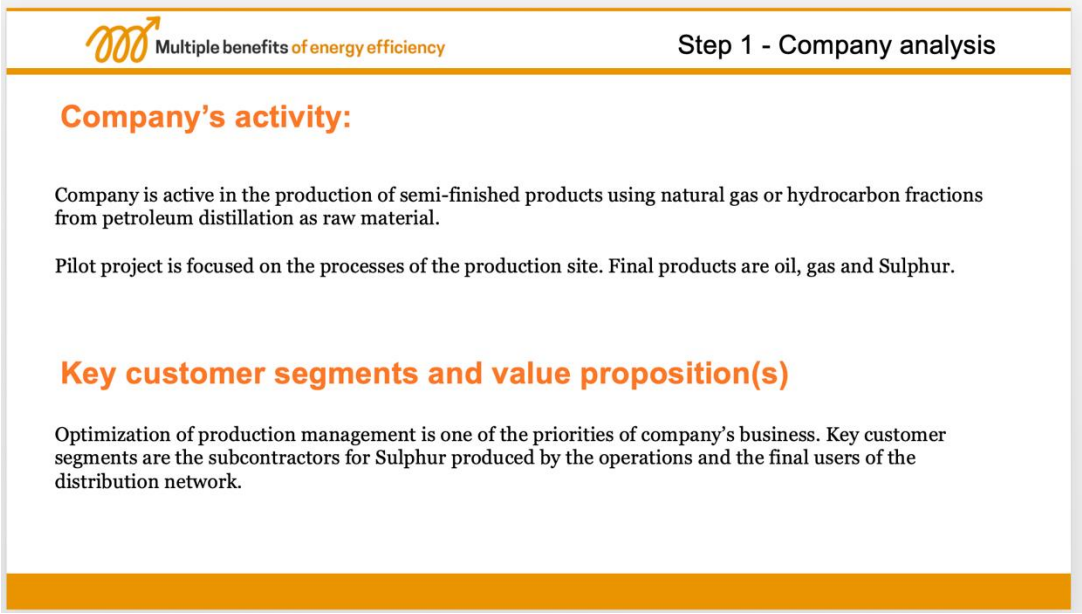


Figure 80. Results of the Company Analysis. Pilot 1, Energy company, confidential

Results of the Energy Analysis

Energy carriers used on site are the following:

- electricity, both self-produced and purchased from the national distribution network. The majority of electricity is self-produced by thermoelectric power plant consisting of a cogeneration unit and three auxiliary integration boilers.
- gas associated with the extraction of crude oil from wells (High Pressure Fuel Gas and Low Fuel Gas Pressure) supplied from the well fields, treated and consumed on site.

Measure analyzed in the pilot consists in the replacement of the fans and motors of the air cooler system of the amine circuit with high efficiency elements. The air flow control system is also updated by installing inverter-controlled motors.

The high efficiency air cooler is produced by a company specialized in heat exchange systems. The system uses high-efficiency fans with turbines designed to optimize the air flow and therefore reduce the absorption of electricity with the same flow rate.

Energy saving	**57 toe/year**
Emission saving	~95 tonCO2/year
CAPEX	~ 0.5 M€
Investment duration	20 years

Figure 81. Results of the Energy Analysis. Pilot 1, Energy company, confidential

Intervention produces an electricity saving. It must be considered that electricity is self-produced by the company from the extracted natural gas, so in the financial analysis natural gas saving will be enhanced.

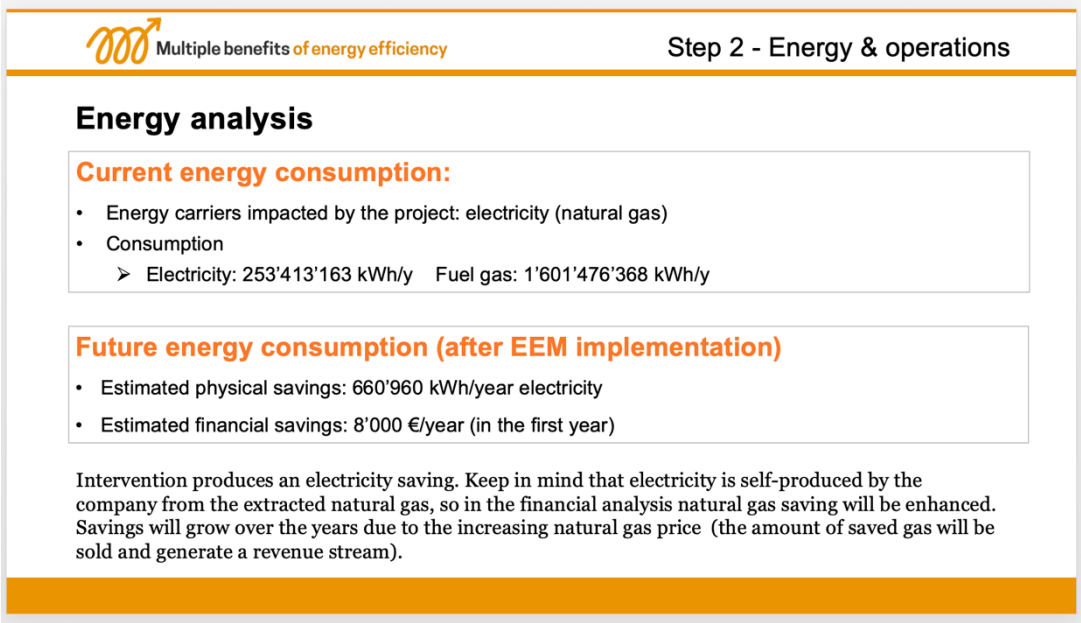


Figure 82. Results of the Energy Analysis. Pilot 1, Energy company, confidential

Results of the Operations Analysis

The plant receives the hydrocarbons extracted from the wells in the surrounding area and treats them in four oil lines and five gas lines. Crude oil fed to the plant undergoes all the treatments necessary for commercialization which essentially consist of the separation (oil, gas, water) and the consequent processing of the three phases present in the extracted fluid.

Area of intervention of the project is the gas line, in particular gas softening. The medium and low-pressure gas is sent to a desulphurization system in which hydrogen sulphide and carbon dioxide are extracted by absorption with amine. The hydrogen sulphide is sent to the sulfur recovery system, which generates liquid sulfur. The sweet gas is also subjected to a dehydration treatment. The outgoing gas, deprived of the quantity necessary for the internal use of the plant, is compressed, cooled by means of a chiller and finally introduced and sold to the gas network.

The new air cooler will be installed in the amine circuit, within the gas softening process activity.

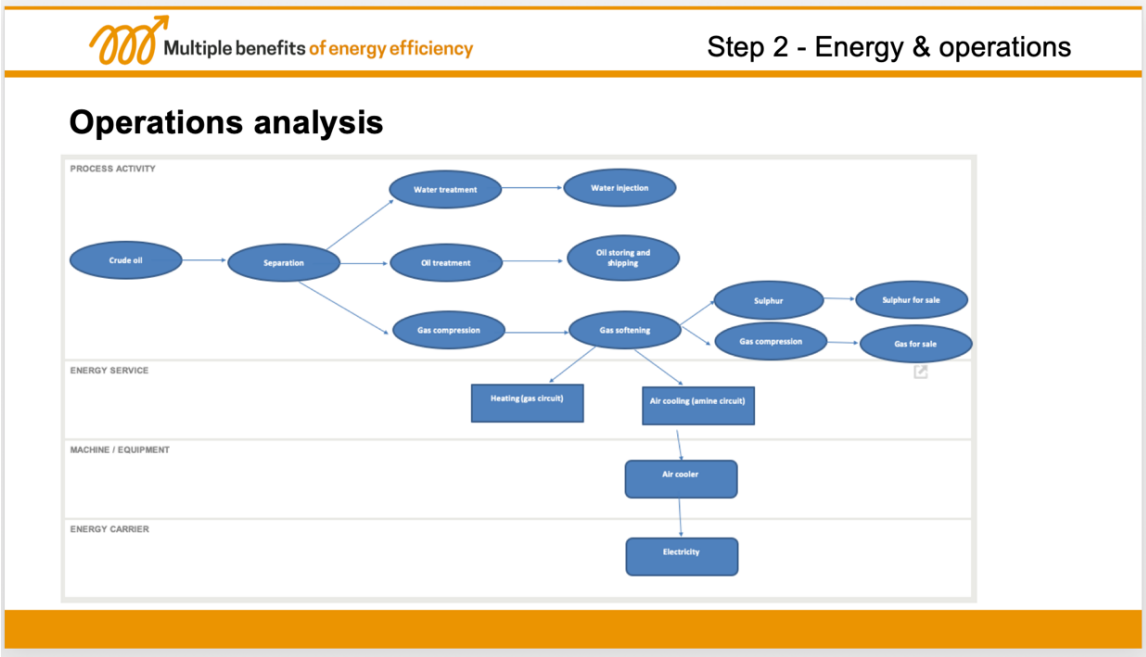


Figure 83. Results of the Operations Analysis- Operational diagram. Pilot 1, Energy company, confidential

Results of the Strategic Analysis

The main result of the pilot project is the improved flexibility of production. The new air cooler gives the opportunity to have two alternative scenarios:

- with the same air flow sent to the cooler, it allows to have less power absorption (energy saving)
- when the environmental temperature gets high enough, more air is sent for the same absorbed power. In this case there is no energy saving but the possibility to maintain product specification and production levels. Quantification of this production delta was not possible, but the benefit in terms of flexibility is clear: the possibility of keeping the amines specification gives the opportunity to choose to deliver more air flow for the same absorbed energy (compared to baseline case) and avoid a loss of production.

These two benefits (energy and non) are not simultaneously achievable but potentially, during the year and depending on the needs, the best hypothesis can be chosen.

Evaluation of the NEBs has also allowed to link energy efficiency intervention to company's value proposition in terms of reduction of GHG emissions and ensure integrity of the asset. In terms of GHG reduction, within the Emission Trading System free allowances will decrease over time starting from 2021. From then on, the reduction factor could therefore be relevant from an economic point of view. The energy price risk reduction can be marginal since the intervention area is limited, but if extended to all the air coolers it has considerable weight.

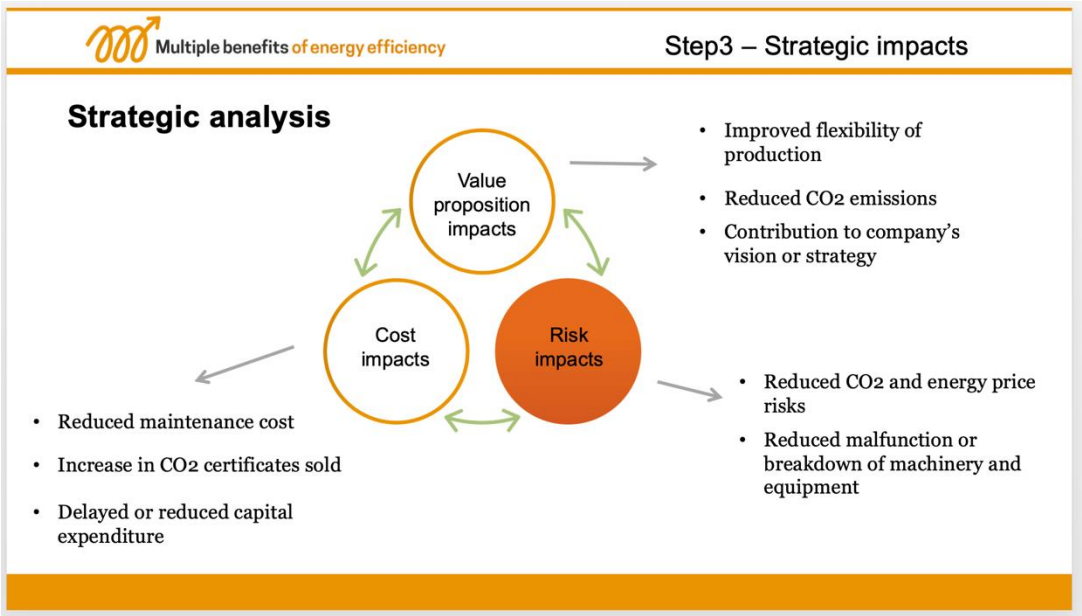


Figure 84. Results of the Strategic Analysis- Pilot 1, Energy company, confidential

Results of the Financial Analysis

Intervention does not present particularly attractive economics. It is strongly penalized by the high investment cost of the technology. Otherwise, economics improve significantly by including NEBs in the analysis. IRR and NPV (considering the possibility to obtain an incentive) become positive.

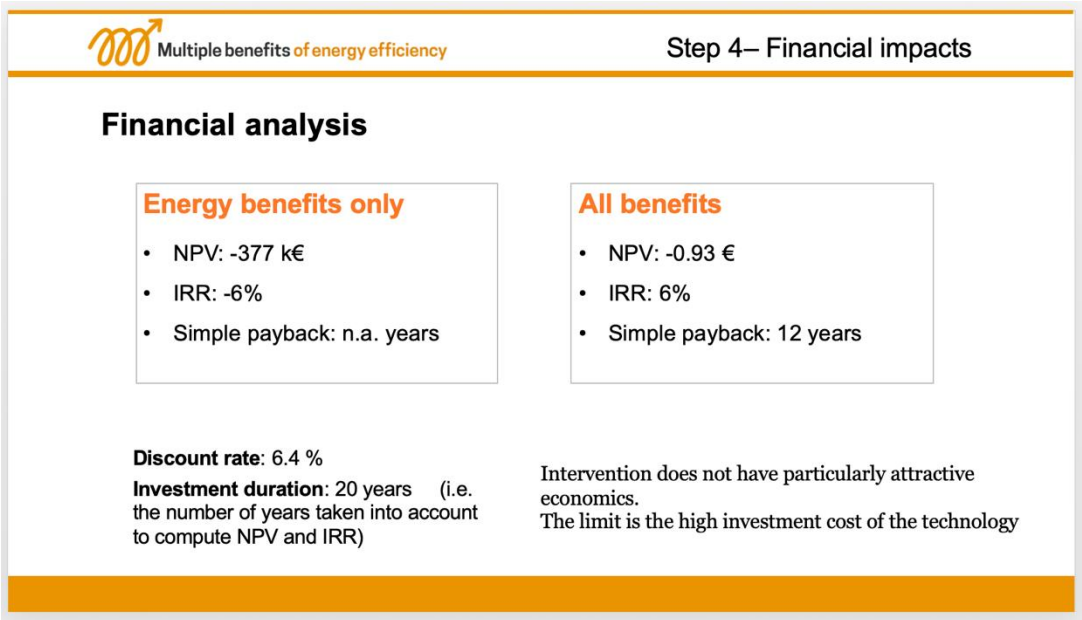


Figure 85. Results of the Financial Analysis. Pilot 1, Energy company, confidential

The figure above shows the NPV trend along the 20-years duration of investment:

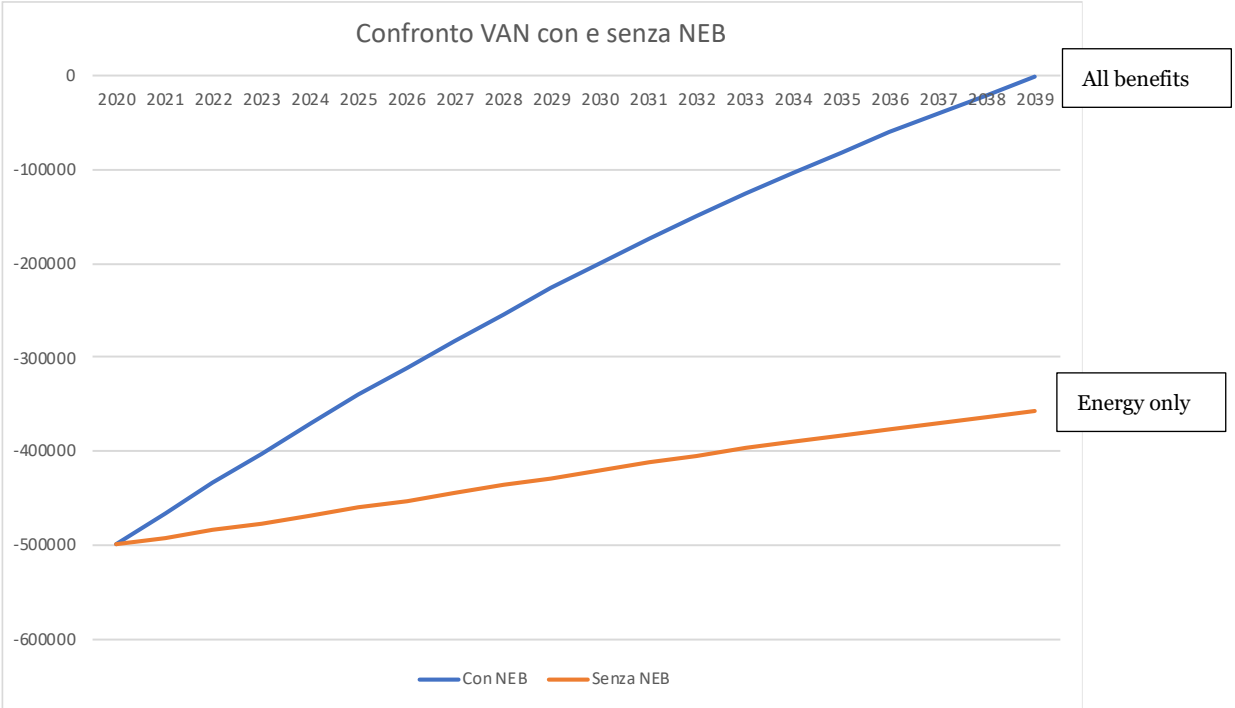


Figure 86. NPV trend along the 20-years duration of investment. Pilot 1, Energy company, confidential

Key Arguments for the Project Implementation

Besides the operational and financial results, indicated in the slide above, one of the outputs of the methodology was the identification of indicators to quantify the non-energy benefits of the interventions. A database of them has been created, to be used for future similar projects.

Other factors for which methodology played a role:

- enhancement of operational aspects compared to the usual tools used for the economic analysis of projects
- it allows to support energy efficiency projects which often, using the traditional methodology, do not produce adequate economic indicators for their approval;
- direct involvement of top management, that allows to build a value proposition;
- focus on energy efficiency and its link with company's decarbonization plan

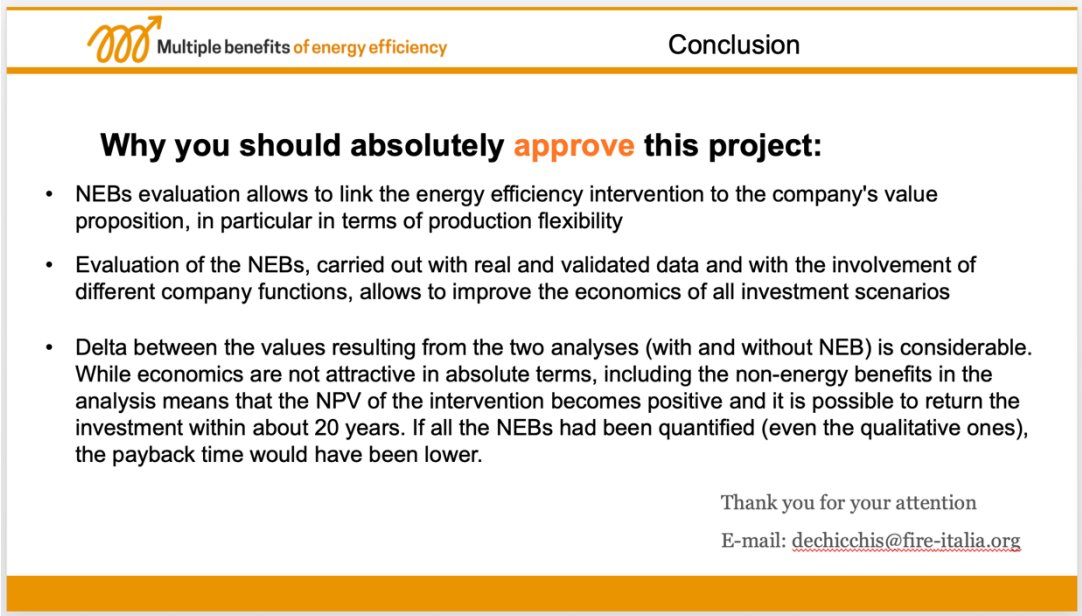


Figure 87. Key Arguments for the Project Implementation. Pilot 1, Energy company, confidential

Key Issues and Highlights

The main issues faced during the pilot project were the following:

- difficulty in quantifying and giving an economic value to some benefits (some identified NEBs remained qualitative), in particular those related to HSE aspects and on the corporate strategy;
- challenging collaboration between the various functions involved in the project.

2.4.2 Pilot 2: Energy Efficiency with M-Benefits methodology in O&G plants

Eni SpA, Fano Gas Treatment plant

Project Idea and Rationale

An Energy Assessment was realized in 2019, highlighting the opportunity for electrification of the site. Electrification of the compression system shifts the main energy consumption of the plant from natural gas carrier to electrical energy carrier.

This allows a greater injection of natural gas into the network and avoids CO2 emissions due to the combustion of fossil fuels at the site. On the other hand, there is a greater consumption of electrical energy due to the absorption of the electric motor that drives the compression system.

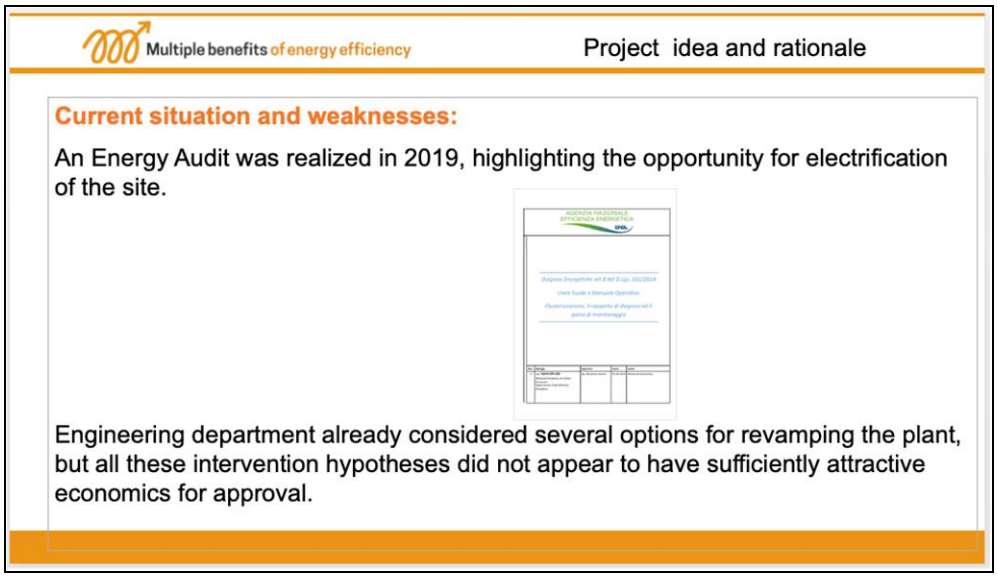


Figure 88. Project Idea and Rationale. Eni SpA, Fano Gas Treatment plant

Results of the Company Analysis

Eni is a global energy company that is changing direction to become a leader in the production and sale of decarbonized products. The new Eni will be increasingly sustainable, with demanding targets for 2035 and 2050.

The object of the project are the processes / services of the production site located in Fano plant. The plant came into operation in 1985, for the treatment of natural gas from the offshore production of various platforms in the central-northern Adriatic Sea.

Being an energy company, the reduction of GHG emissions and the safeguard of the environment are part of company's value proposition, as well as the safeguard of health and safety. From a production side, ensuring the operational continuity is expressly one of the priorities of the Eni business pointed out by the Management.

From an economic point of view, company uses part of the extracted gas to power their plants, so a saving in the self-consumed gas could lead to a revenue stream by selling it to distribution network.

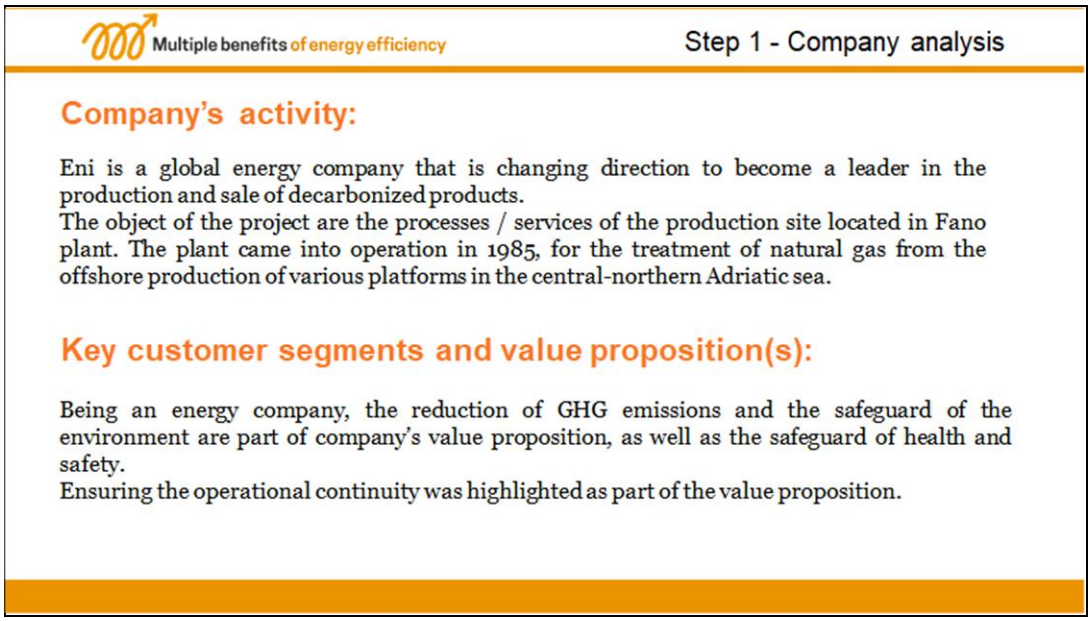


Figure 89. Results of the Company Analysis. Eni SpA, Fano Gas Treatment plant

Results of the Energy Analysis

In the current layout, plant's energy needs are almost totally covered by natural gas self-produced (extracted and treated) by the company. No electricity has to be purchased from the grid.

Area of intervention of the project is the compression unit of the gas (see operational analysis for more details). Five alternative scenarios of interventions have been identified.

A. *Replacement of gas turbines of the compressor unit with electric motors.* This means a complete electrification of the compressor's feed, with no more self-consumed gas but the necessity to purchase electricity from the grid

B. *Replacement of gas turbines of the compressor unit with electric motors and re-bundle of centrifugal compressors to reduce recirculation.* This is the

same intervention of scenario A with an additional efficiency of the compressors themselves.

C. *Replacement of gas turbines of the compressor unit with electric motors and centrifugal compressors with alternative compressors*. This is a total electrification, as above, combined with the replacement of the compressors.

D. *Installation of endothermic motors coupled to new alternative compressors*. Energy source is still natural gas, there is a retrofit of motors and compressors.

E. *Installation of internal combustion motors coupled to a new alternative compressor to replace a single line*. It is the same intervention of scenario D, implemented only in a single line with deferred investment.

One of the goals of the pilot project is to identify the most suitable scenario of intervention and see how the economics are going to change considering NEBs (Non-Energy Benefit) and NEL (Non energy Losses) in the analysis such as Maintenance reduction costs, more reliability and less downtimes, GHG emission reduction, confort improvement, accident risk reduction, noise reduction, etc,
Energy and non-energy savings changes between the five scenarios. In the slide, future consumption for Scenario A is reported.

Energy and non-energy savings are variable over the 20-years investment duration, so that it is worth identifying a value of saving (physical and financial) different from year to year. Furthermore, savings will occur starting from 4th year. In the slide, values for that period are reported.

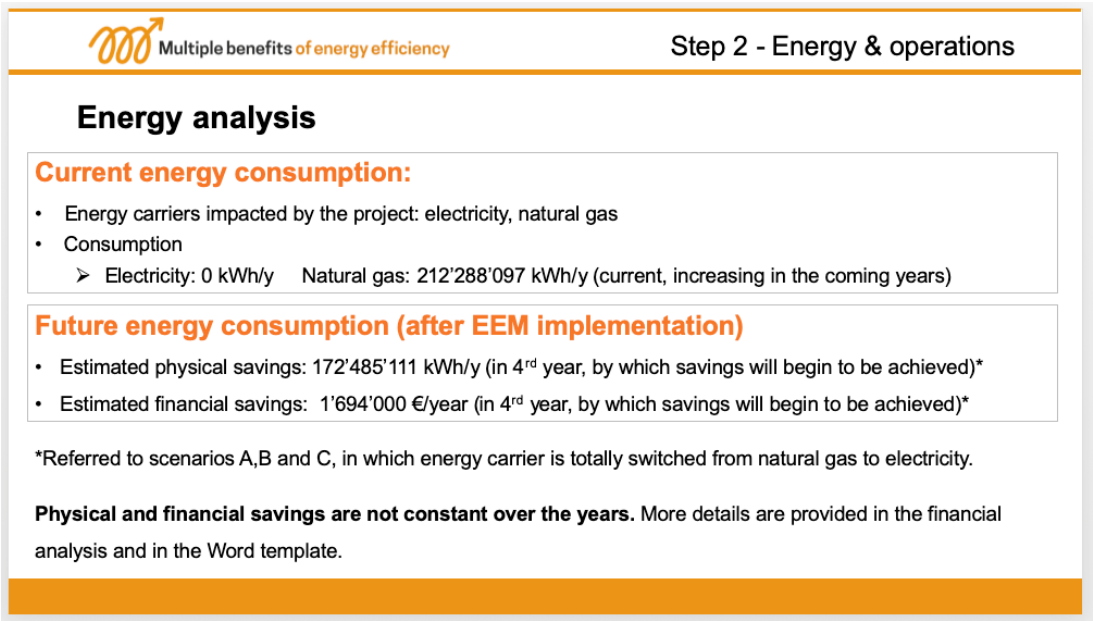


Figure 90. Results of the Energy Analysis. Eni SpA, Fano Gas Treatment plant

Results of the Operations Analysis

Area of intervention of the project is the compression unit of the gas. The compression system comprises two compression trains driven by gas turbines that deliver mechanical power. Each turbine drives a two-stage centrifugal compressor. The pressure of the gas supplied to the compressors can vary according to the pressure of the reservoir. The function of the compression system is to raise the inlet gas pressure to the value suitable for injection into the distribution network. Each

compression train has air coolers installed at the end of first and second compression stage.

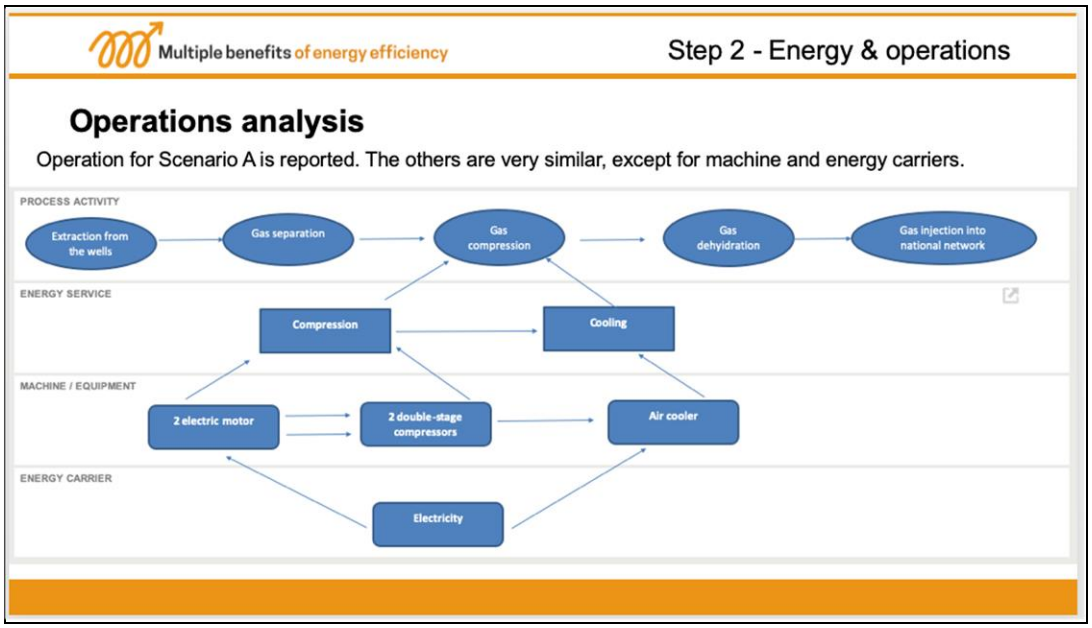


Figure 91. Results of the Operations Analysis-Operational diagram. Eni SpA, Fano Gas Treatment plant

Results of the Strategic Analysis

Evaluation of the NEBs has allowed to link energy efficiency intervention to company's value proposition. For example, the reduced malfunction or breakdown of the equipment (quantified) is a key factor for ensuring the operational continuity, as well as the GHG reduction gives a high contribution for the safeguard of the environment (being Eni an energy company, this is included in their value proposition).

A relevant risk evaluated is that of supply interruption, considering that due to the electrification (foreseen in Scenarios A, B and C) company will be obliged to purchase electricity from the grid to power their equipment. In this sense, given the encouraging historical data about interruption of the nearby power station (from which the company will purchase the carrier) and the fact that a new dedicated line is planned for powering the electric compressors, the reliability of the network is considered adequate.

Non-energy benefits identified are the similar in the different scenarios, they only vary in intensity from one intervention to another. The quantitative differences are kept into account in the financial analysis.

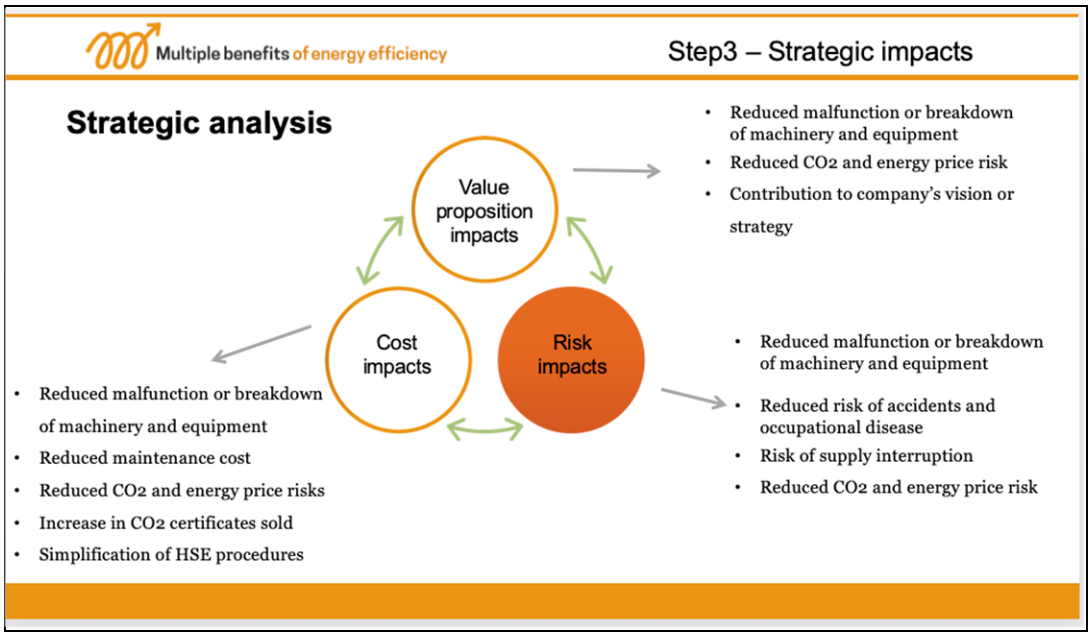


Figure 92. Results of the Strategic Analysis. Eni SpA, Fano Gas Treatment plant

Results of the Financial Analysis

Scenario A presents the best results from non-energy benefits side, in particular for the savings achieved by reduction of the breakdowns. Considering all benefits, it is penalized by the increased purchase of electricity.

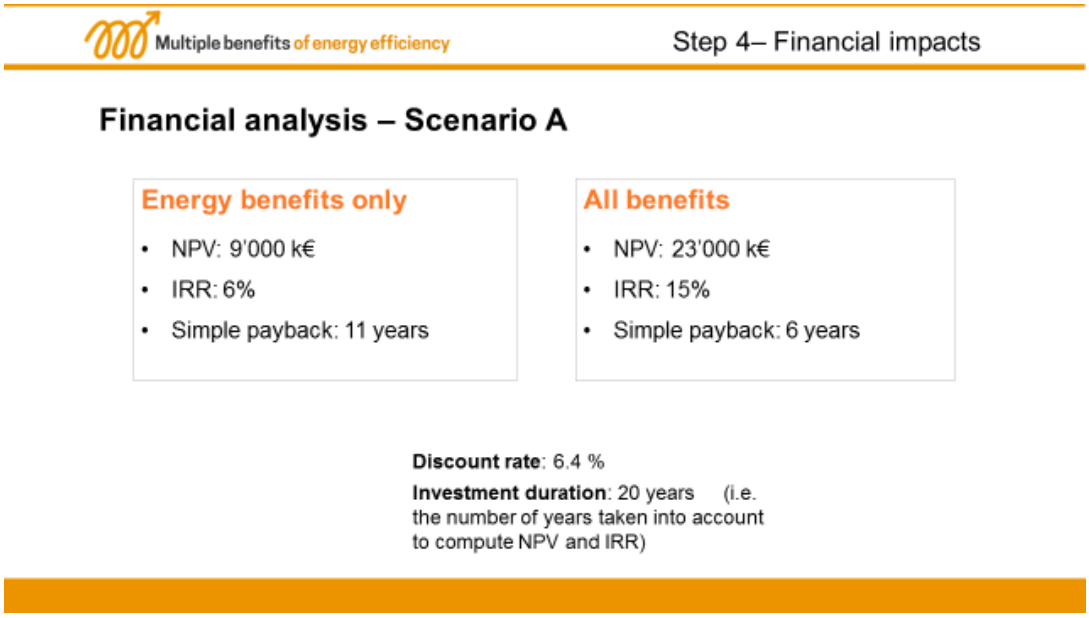


Figure 93. Results of the Financial Analysis- Scenario A. Eni SpA, Fano Gas Treatment plant

Scenario B is still profitable from NEB's side. By including them in the analysis, economics improves significantly.

Multiple benefits of energy efficiency — Step 4– Financial impacts

Financial analysis – Scenario B

Energy benefits only

- NPV: 15'700 k€
- IRR: 8%
- Simple payback: 10 years

All benefits

- NPV: 29'000 k€
- IRR: 15%
- Simple payback: 6 years

Discount rate: 6.4 %
Investment duration: 20 years (i.e. the number of years taken into account to compute NPV and IRR)

Figure 94. Results of the Financial Analysis- Scenario B. Eni SpA, Fano Gas Treatment plant

Scenario C is the best from a financial point of view when considering both energy and non-energy benefits.

Multiple benefits of energy efficiency — Step 4– Financial impacts

Financial analysis – Scenario C

Energy benefits only

- NPV: 23'700 k€
- IRR: 12%
- Simple payback: 7 years

All benefits

- NPV: 34'600 k€
- IRR: 18%
- Simple payback: 5 years

Discount rate: 6.4 %
Investment duration: 20 years (i.e. the number of years taken into account to compute NPV and IRR)

Figure 95. Results of the Financial Analysis- Scenario C. Eni SpA, Fano Gas Treatment plant

Multiple benefits of energy efficiency — Step 4– Financial impacts

Financial analysis – Scenario D

Energy benefits only

- NPV: 20'300 k€
- IRR: 10%
- Simple payback: 8 years

All benefits

- NPV: 29'500 k€
- IRR: 14%
- Simple payback: 6 years

Discount rate: 6.4 %
Investment duration: 20 years (i.e. the number of years taken into account to compute NPV and IRR)

Figure 96. Results of the Financial Analysis- Scenario D. Eni SpA, Fano Gas Treatment plant

Multiple benefits of energy efficiency — Step 4– Financial impacts

Financial analysis – Scenario E

Energy benefits only

- NPV: 6'000 k€
- IRR: 9%
- Simple payback: 15 years

All benefits

- NPV: 11'500 k€
- IRR: 17%
- Simple payback: 14 years

Discount rate: 6.4 %
Investment duration: 20 years (i.e. the number of years taken into account to compute NPV and IRR)

Figure 97. Results of the Financial Analysis- Scenario E. Eni SpA, Fano Gas Treatment plant

Key Arguments for the Project Implementation

The interaction with other company functions was essential to carry out the assessments, as these are the owners of the data. Methodology allowed different departments to speak each other.

Besides the operational and financial results, indicated in the slide above, one of the outputs of the methodology was the identification of indicators to quantify the non-energy benefits of the interventions. Some were used in this analysis; others were not evaluable but constitute a database to be kept in view of replicability for future analyzes.

Other factors for which methodology played a role:

- enhancement of operational aspects that are not considered by the tools normally used for the economic analysis of projects (holistic evaluation).

- it allows to support energy efficiency projects which often, using the traditional methodology, do not produce adequate economic indicators for their approval.
- involvement of top management, that allows to build a value proposition.
- involvement of specialists belonging to several departments allow to have a broader vision of the project (interdisciplinarity);
- dissemination of know-how about energy efficiency and increase in corporate sensitivity / interest towards the issue of sustainability (commitment).

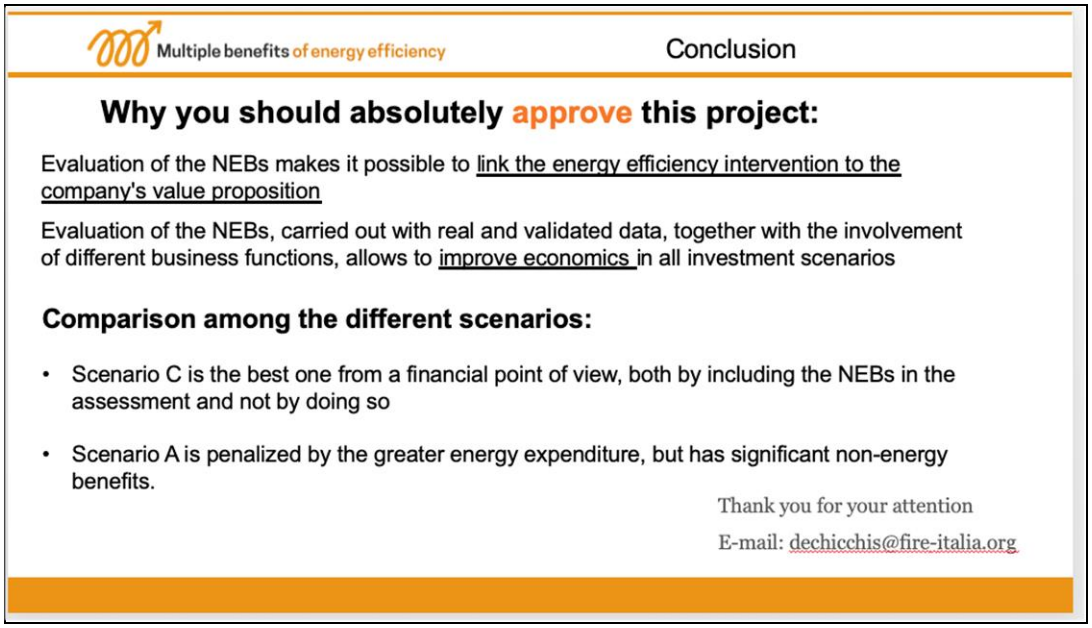


Figure 98. Key Arguments for the Project Implementation. Eni SpA, Fano Gas Treatment plant

Key item and highlights

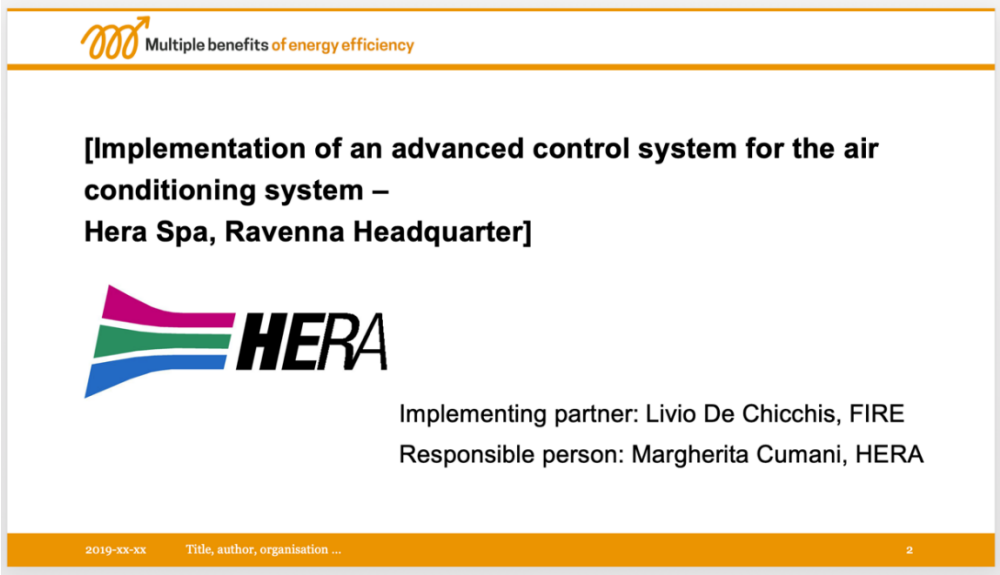
The experience during the pilot project highlighted the following items:

- difficulty to quantify and value some of the expected benefits (some identified NEBs remained qualitative), such as those related to HSE aspects and those related to the corporate strategy.
- need to better customize the Toolkit; in particular the financial analysis, because the value of the of energy and non-energy savings varies over the years.

improved the relationship and interaction among various departments and enhanced synergies between field an

2.4.3 Pilot 3: Implementation of an advanced control system for the air conditioning system

Hera Spa, Ravenna Headquarter



Project Idea and Rationale

The object of the pilot study is the implementation of an advanced automation and control system for air conditioning systems, based on Artificial Intelligence (AI) technologies and capable of implementing predictive and multi-variable optimization logics.

The hypothesized system is able to collect a large number of environmental variables (partly made available by the installation of probes in the field), to integrate them by building a modeling algorithm of the "building-plant" system and to establish, with predictive logic, optimal operating levels to reduce energy consumption and guarantee thermal comfort conditions for the occupants.

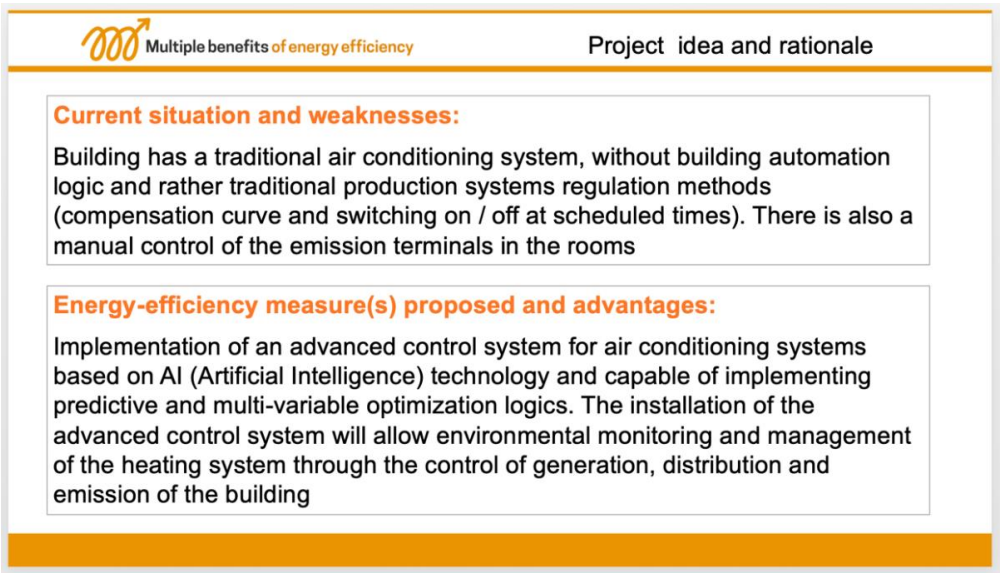


Figure 99. Project Idea and Rationale. Hera Spa, Ravenna Headquarter

Results of the Company Analysis

Hera Group is a leading multi-utility in environmental, water and energy services. It provides energy (gas, electricity), water (aqueduct, sewerage and purification) and environmental services (waste collection and disposal).

Pilot project is realized in Ravenna headquarter building, in particular in the Warehouse-Factory building; this building consists of premises used for offices and work areas organized as warehouses. Ravenna headquarter, and all its offices are managed by the Facility Management structure of HERA S.p.A.

Value proposition of the project is the possibility to ensure safety and comfort to the people working in the environment.

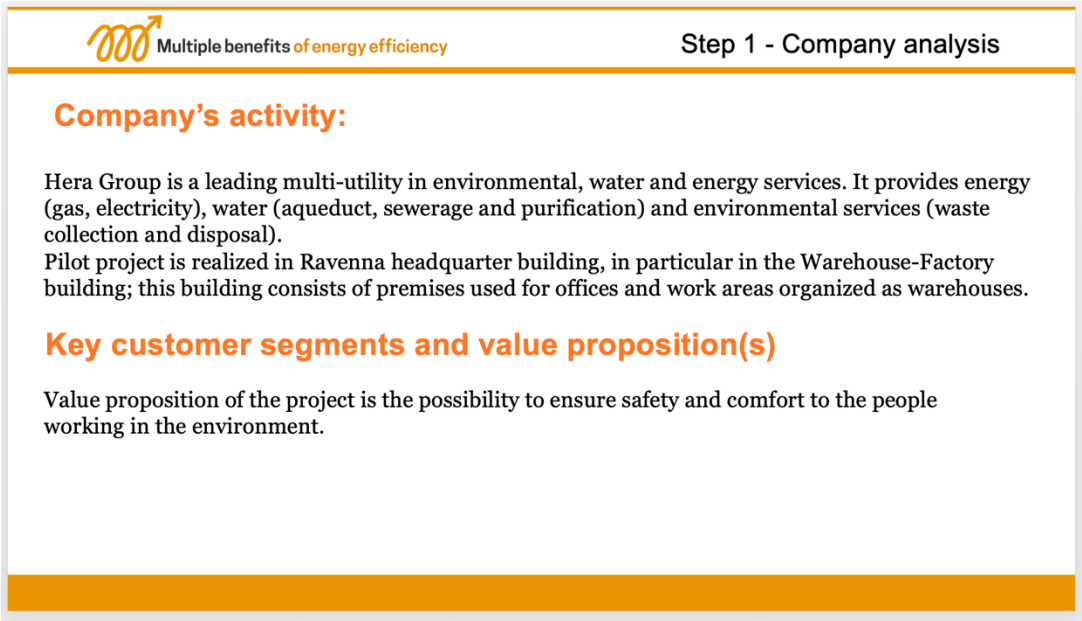


Figure 100. Results of the Company Analysis. Hera Spa, Ravenna Headquarter

Results of the Energy Analysis

The building has an air conditioning system that is not particularly advanced and does not have building automation systems. Heat is produced by traditional boilers, while the distribution / emission is operated through fan coil circuits and / or air heater terminals. The current regulation is carried out by setting the climatic curve in the production systems and, in the rooms, the unit heaters are managed through thermostats located in some areas.

The installation of the advanced control system will allow environmental monitoring and management of the heating system through the control of generation, distribution and emission of the building.

The expected energy saving was estimated at 30% of current consumption, with a greater incidence of the savings share on the natural gas and a lower impact on electricity.

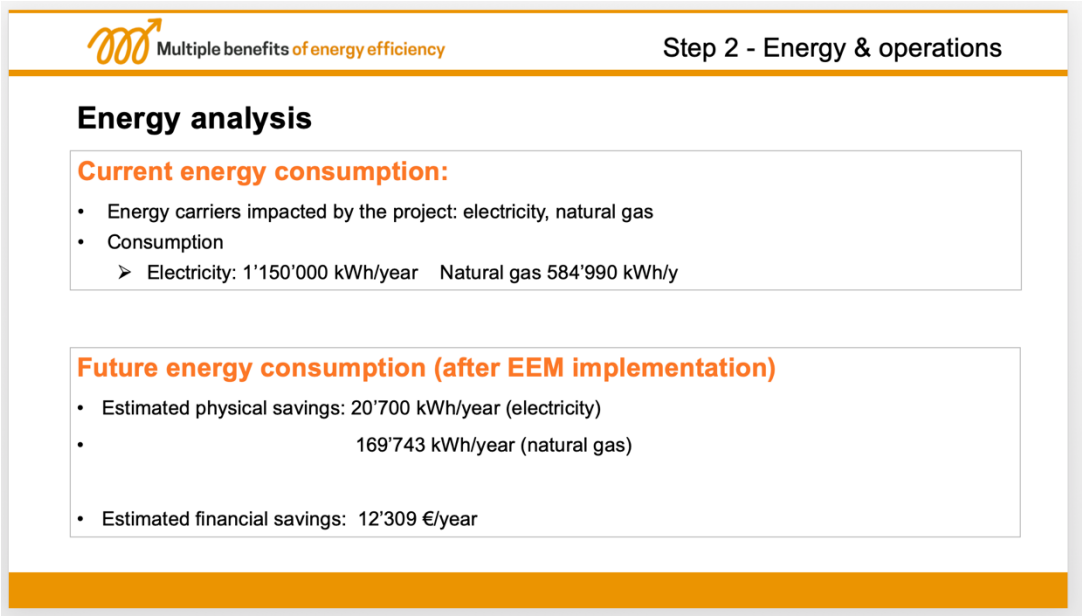


Figure 101. Results of the Energy Analysis. Hera Spa, Ravenna Headquarter

Results of the Operations Analysis

Project has an impact on the climate zones (warehouse, factory, and office) and on the equipment (boilers and distribution system) of the building, through the following activities:

- Climate zones: monitoring of temperature and relative moisture.
- Boilers: ignition management, control of supply water temperature
- Fancoil: control of circuit's mixing valve
- Heaters: switching on and off management

More in detail, monitoring of environmental parameters will be more widespread and extended also to the relative humidity parameter, allowing a more precise determination of the actual thermal load.

The most efficient management of the boilers will provide for the modulation of the delivery temperature based on the feedback acquired in real time in the heated areas and being able to exploit predictive models on the evolution of environmental parameters in the site in question.

Finally, the management of the distribution systems and the emission terminals will be optimized by controlling the mixing valves and switching on / off operated by unit heaters blocks.

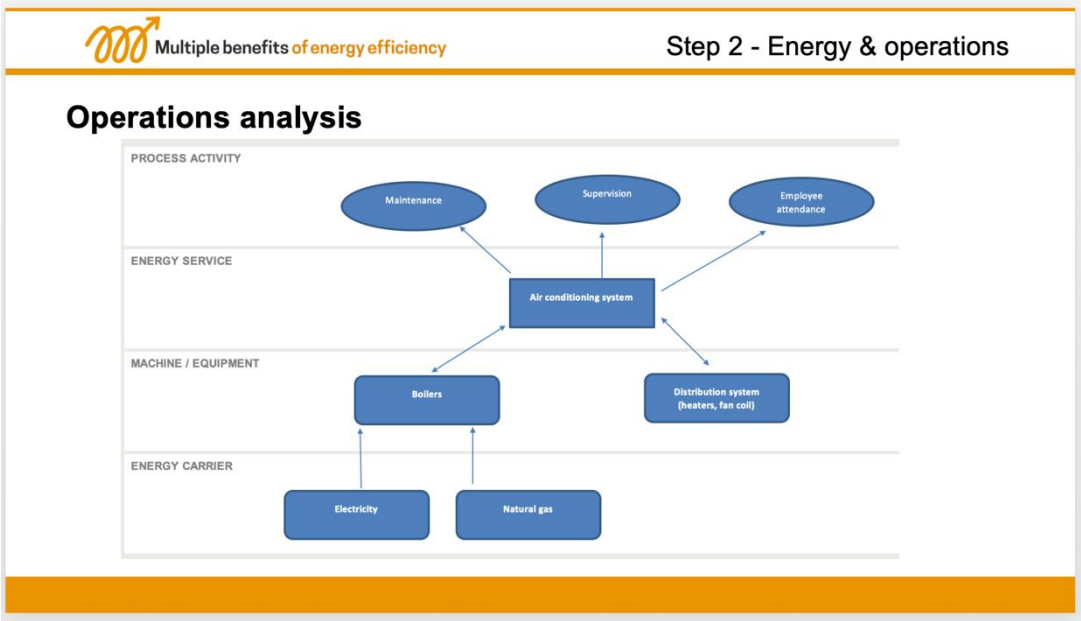


Figure 102. Results of the Operations Analysis- Operational diagram. Hera Spa, Ravenna Headquarter

Results of the Strategic Analysis

Nine potential benefits were identified, some of which are related to each other. A qualitative assessment is provided for each benefit, while an economic quantification has been carried out for three benefits to which, in any case, almost all the other aspects of value identified are attributable.

With regard to value proposition, the improved thermal comfort leads to a better productivity (linked to a greater satisfaction about thermal comfort) and a decrease of ticket for discomfort thanks to the ability of the control system to be more reliable and punctual in maintaining the environmental conditions (temperature and relative humidity) at the required levels, when required (without delays or early shutdowns). A ticket is a report of malfunction that, when opened, requires some time (days) and working hours to be solved.

Another strategic impact on the risk (and on the cost) is the reduction of absenteeism. In technical literature there is much evidence that the environmental conditions of the workplace affect: respiratory diseases, asthma, allergies, and other pathologies that lead to absences, but also on worker productivity and performance. For the case under analysis, it is conceivable that the implementation of the advanced air conditioning control system generates economic benefits attributable to the following aspects:

- reduction of sickness absenteeism by guaranteeing optimal thermal comfort conditions for the workers.
- greater productivity of workers, who perceive optimal environmental conditions and not experience thermal stress during their stay in the workplace.

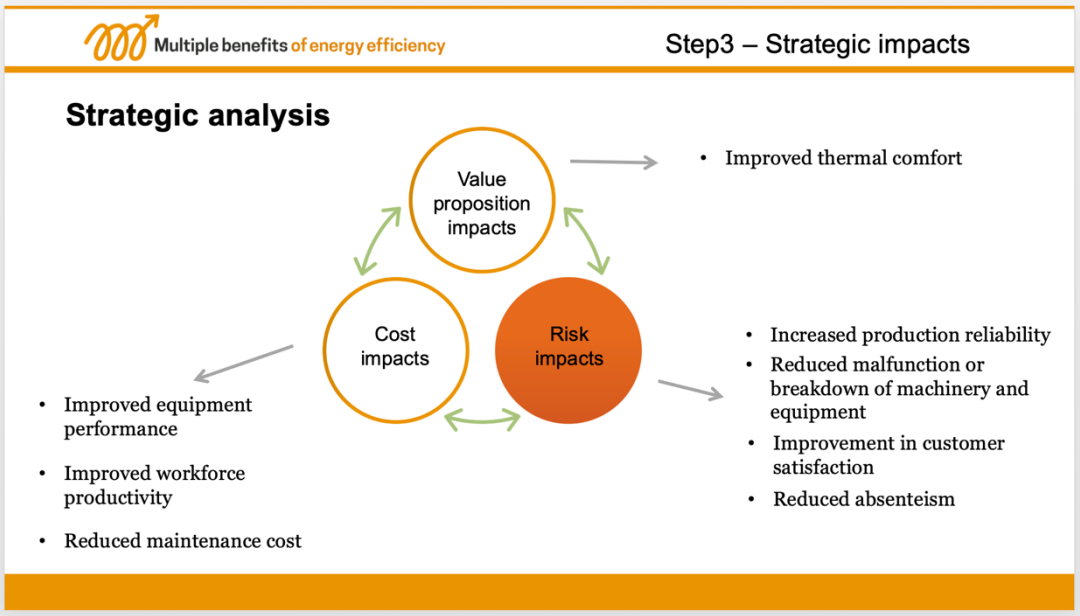


Figure 103. Results of the Strategic Analysis. Hera Spa, Ravenna Headquarter

Results of the Financial Analysis

For the determination of the economic impact of maintenance benefit, an analysis was carried out of all the tickets opened by users in 2019, filtering only the items attributable to dissatisfaction with the thermal comfort conditions or malfunctioning of the system or terminals of the air conditioning. Assuming a ticket reduction target due to the intervention, the lower cost has been quantified.

In this pilot, the potential economic impact of the reduction of absenteeism was evaluated while it was not possible to make a similar quantification for the increase in productivity, given the lack, in literature or in the company data available, of sufficiently certain and indicative parameters and references. The current statistics relating to absenteeism were analyzed with respect to absences due to "illness" in the last two years (2018-2019) for Ravenna headquarter. Then, two other significant parameters have been considered for the purpose: overall data of Hera SpA, and data relating to Bologna headquarters, which houses newly built or recently renovated buildings (years 2018-2020) and therefore represents a reference benchmark as regards the highest implemented plant and technological standards. From the comparison between the rates of absenteeism due to illness of the two offices, an amount of hours of absence "saved" for the Ravenna office is obtained, the cost of which is estimated. Therefore, a lower cost for absenteeism is obtained.

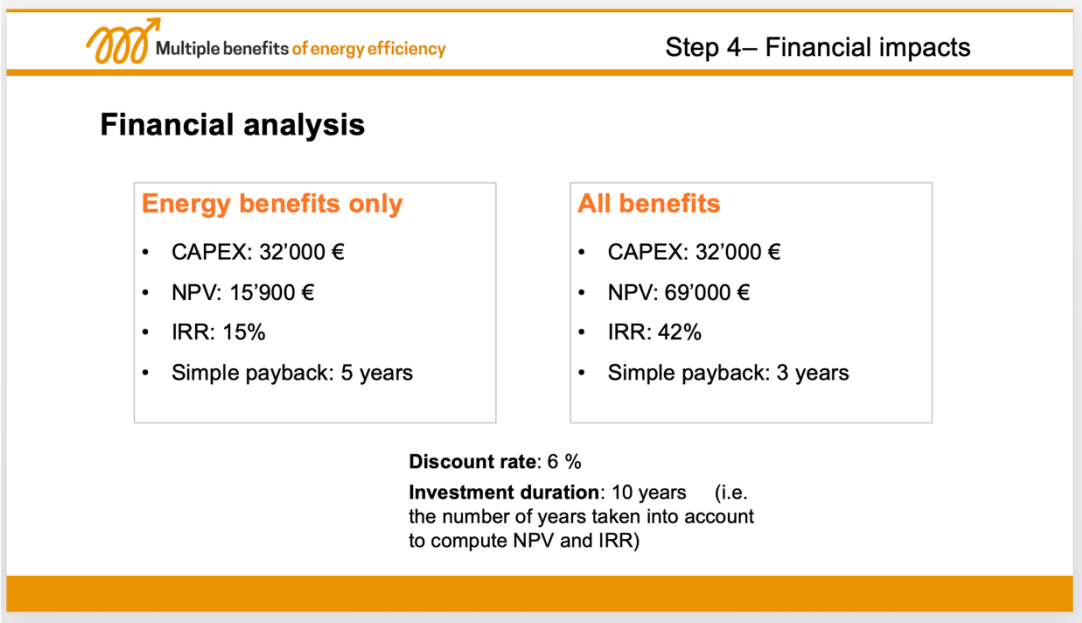


Figure 104. Results of the Financial Analysis. Hera Spa, Ravenna Headquarter

Key Arguments for the Project Implementation

The potential energy savings associated with the intervention was quantified, through a preliminary study by a market technology provider, equal to 30% of current energy consumption (including the economic contribution from white certificates incentives).

An analysis of the strategic levers of the business was then carried out in order to identify areas potentially affected by the intervention. The identified non-energy benefits present strong correlations between them and, since the relative economic impacts cannot be individually assessed, only the benefits of the reduction of maintenance costs and the reduction of the costs of absenteeism due to illness have been quantified, to which also the others could be linked.

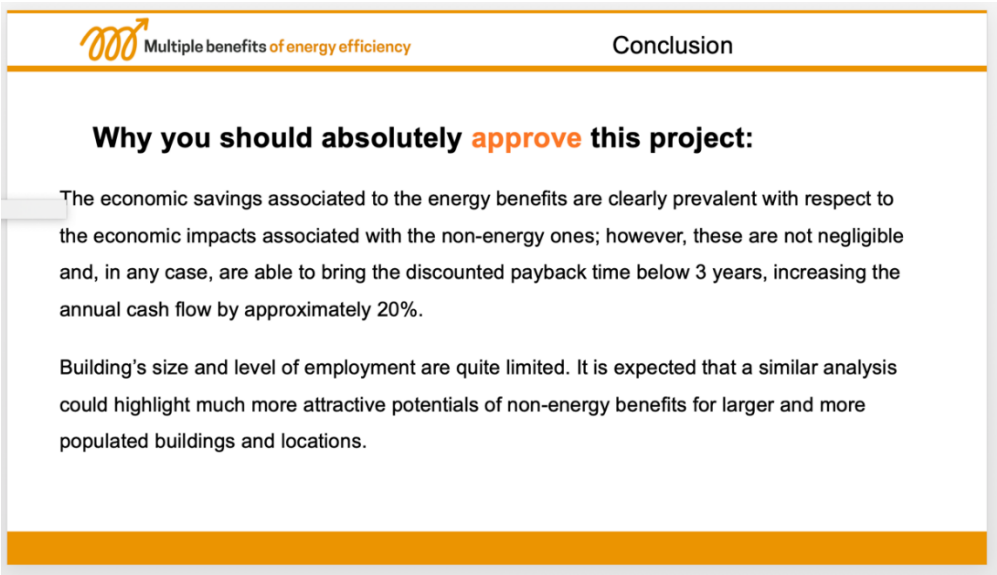


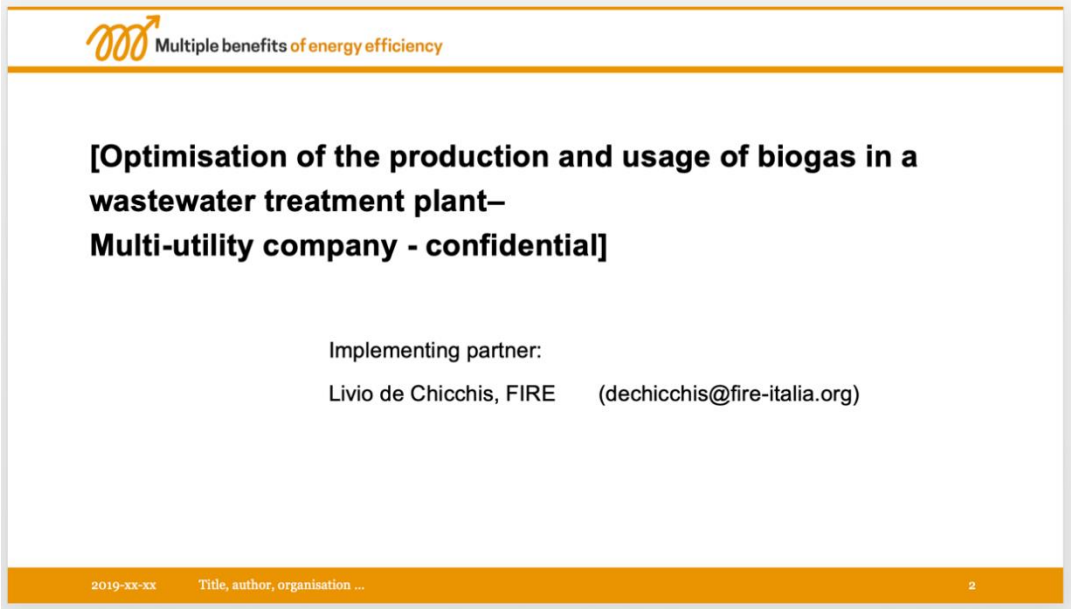
Figure 105. Key Arguments for the Project Implementation. Hera Spa, Ravenna Headquarter

Key Issues and Highlights

As a starting point for future analyzes, the opportunity is suggested to make an economic quantification of the benefit related to the increase in productivity of the occupants who are working in conditions of optimal thermal comfort, an aspect that in this study has only been qualitatively described.

2.4.4 Pilot 4: Optimization of the production and usage of biogas in a wastewater treatment plant

Multi-utility company - confidential



Project Idea and Rationale

The aim of the project is to verify if there are further economic impacts that could modify the preliminary business plan developed for the initiatives aimed at optimizing and enhancing the production of biogas in the company's treatment plant. The preliminary analysis was requested in 2018 by the local environmental authority in the process of renovating the AIA (integrated environmental authorisation) for the plant. This request suggested a broader analysis, which is the object of this work, to consider the whole sludge treatment process.

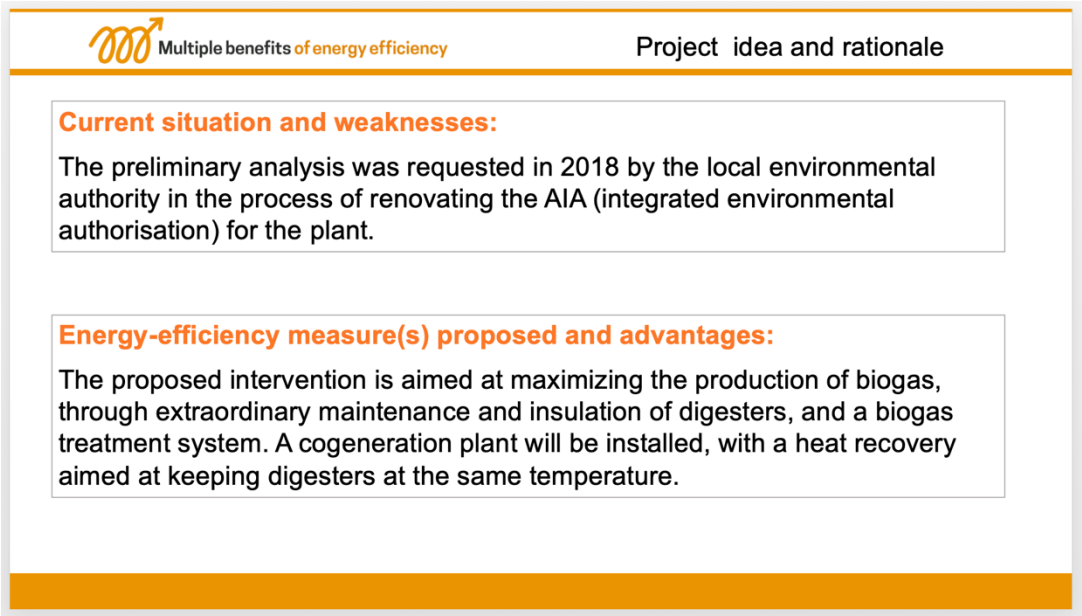


Figure 106. Project Idea and Rationale. Multi-utility company, confidential

Results of the Company Analysis

Company is a multi-utility active in environmental, water and energy services. In particular it provides energy (gas, electricity), water (aqueduct, sewerage and purification) and environmental services (waste collection and disposal).

The plant considered in the pilot project, provides biological treatment of urban wastewater and industrial wastewater coming from chemical-physical treatment.

Being an energy and environmental company, the core of the value proposition is the possibility to ensure reliability, excellence, innovation for the environment, circular economy.

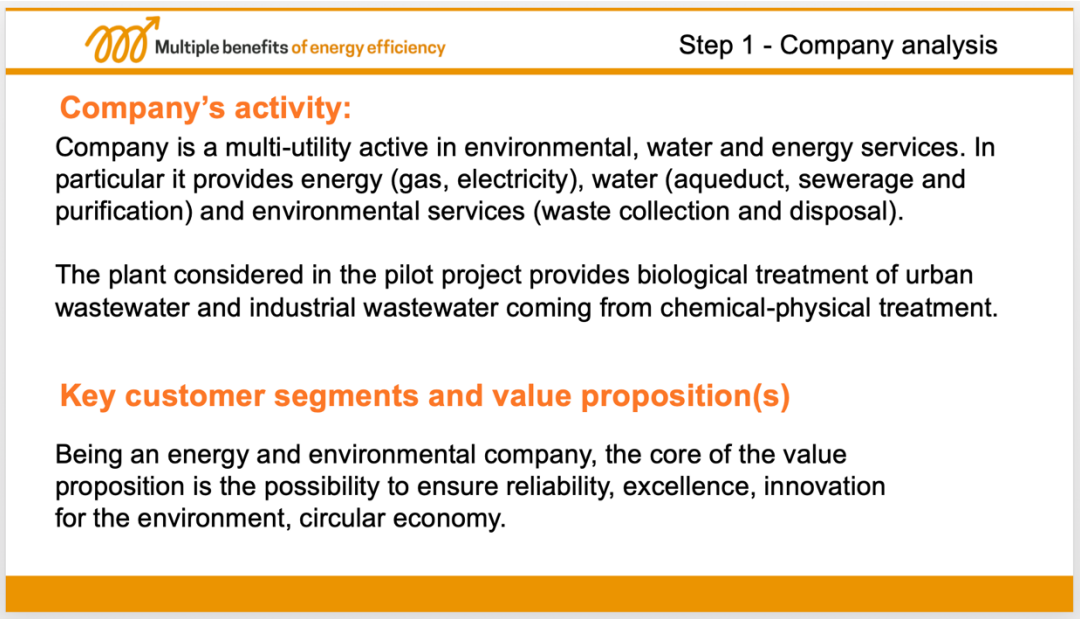


Figure 107. Results of the Company Analysis. Multi-utility company, confidential

Results of the Energy Analysis

Plant's energy consumption is almost totally covered by electricity, that supplies the equipment shown in the next paragraph. In the current framework, the whole electricity is purchased from the grid.

The following measures have been identified:

- maintenance of the primary digester (testing of the blending efficiency and removal of accumulated aggregates).
- implementation of controllers for the management of sludge pre-thickening and anaerobic digestion phases.
- biogas purification.
- installation of a cogeneration unit capable of burning biogas and producing electricity and thermal energy to be used on site.

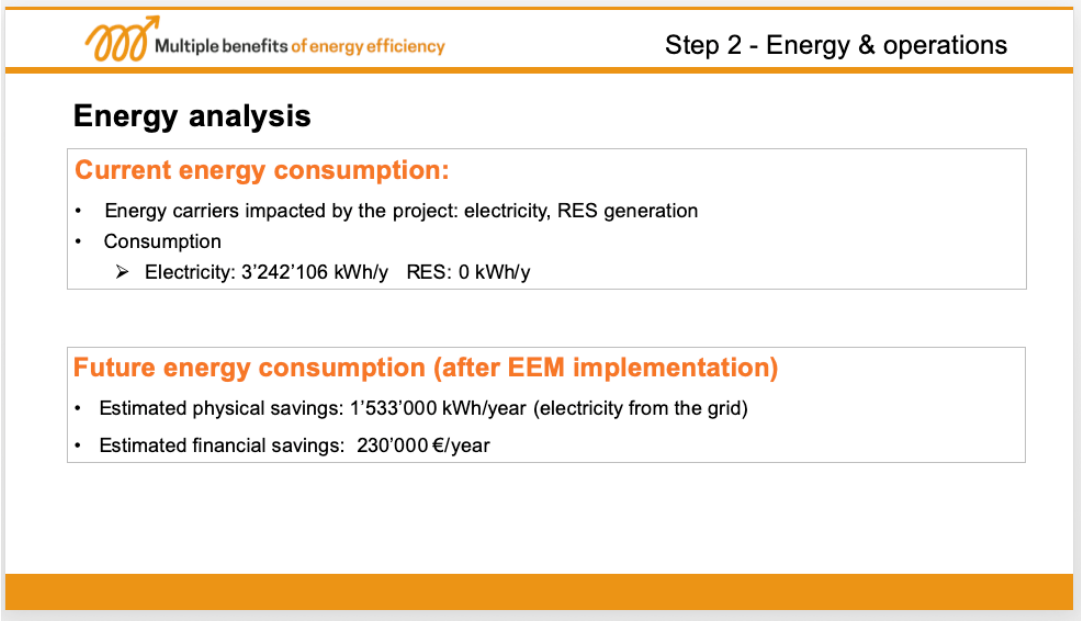


Figure 108. Results of the Energy Analysis. Multi-utility company, confidential

Results of the Operations Analysis

Treatment is realized through three lines:

- water line, main process line consisting of different treatment level.
- sludge line collects all the sludge produced by the plant.
- biological gas line (biogas) manages the biogas produced during the anaerobic digestion of pre-thickened sludge.

Efficiency measures identified in the pilot are related to the sludge line (represented in the process activity in the slide above), in particular in anaerobic digestion phase. CHP plant will support a simple boiler for hot water production for heating. It will burn the biogas produced by the digestor and produce electricity for the whole phases of the process, as well as heat.

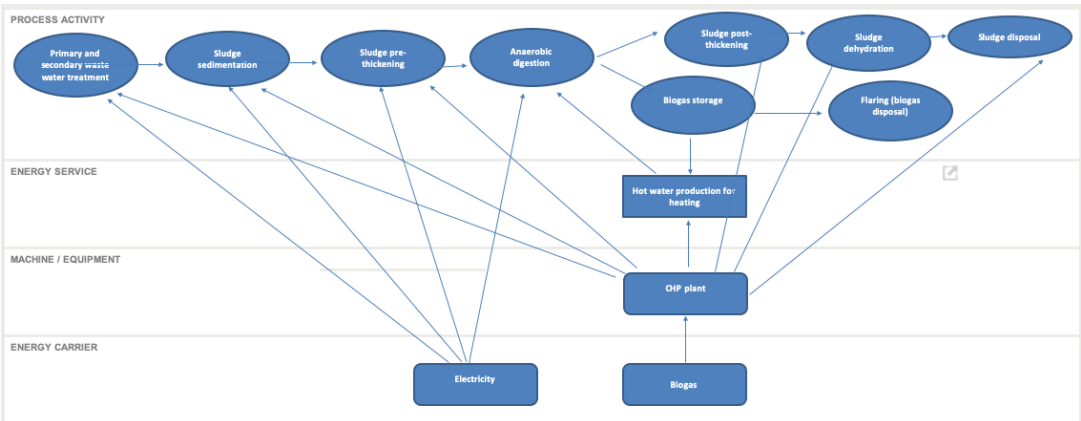


Figure 109. Results of the Operations Analysis- Operational diagram. Multi-utility company, confidential

Results of the Strategic Analysis

The activity was developed starting from a discussion with the structure responsible for the plant, for a survey of the main implications related to the intervention on the digestion system. Subsequently, the issues were explored with the referents of the single units.

Insights emerged from the lineup:

1. reduction of maintenance costs on compressors and boilers following the treatment on biogas, which reduces their corrosive power.

2. reduction of maintenance costs on centrifuges due to the lower volume of sludge to be processed.

3. any additional management costs of the biogas treatment plant and the co-generator to be considered.

4. reduction of the volumes of sludge to be disposed of.

5. possibility of modifying the classification of the sludge produced (in addition to reducing its volume) in order to contain disposal costs.

6. improvements in terms of plant safety thanks to the improvements made during the intervention.

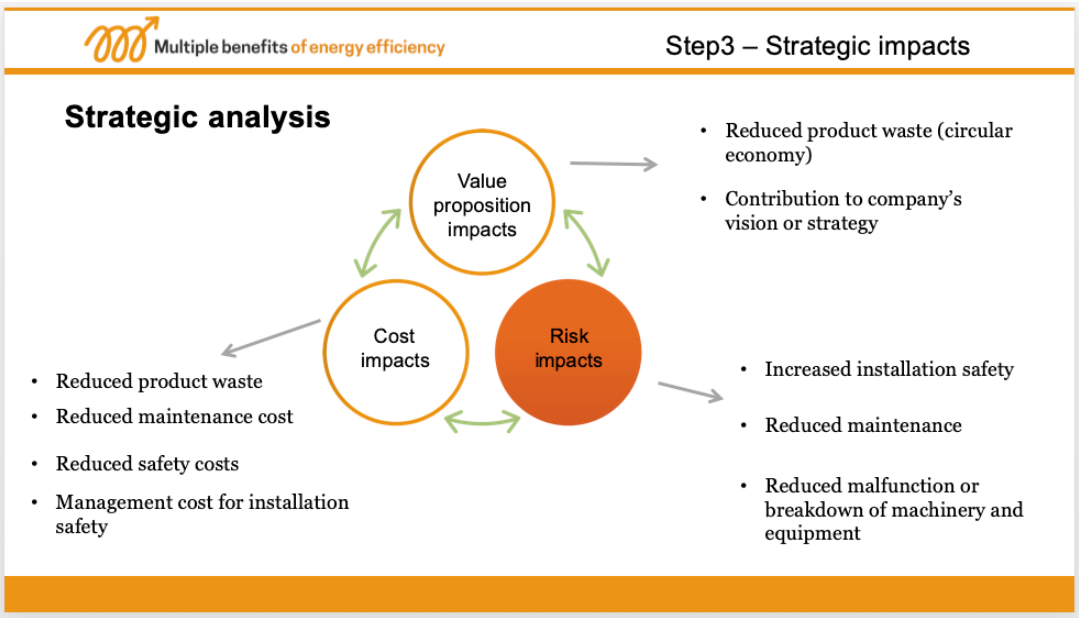


Figure 110. Results of the Strategic Analysis. Multi-utility company, confidential

Results of the Financial Analysis

The maintenance costs incurred in the last three years on the system were analyzed, so as to determine which of these can be reduced with the intervention, and to what extent. The result has been quantified basing on a rate of reduction, in consideration of the fact that not all costs incurred can be eliminated thanks to the intervention.

As regards the operating cost of the biogas treatment system, the experience gained on a similar plant was collected, where in 2017 a treatment system was installed capable of removing sulfur from the treated wastewater.

The same referents also communicated the maintenance costs of the biogas cogenerators of the same size.

With the information available, maintenance costs are expected to increase following the intervention, as a combination of savings on maintenance and higher costs for the biogas treatment plant and, above all, the cogenerator.

Evaluation of the sludge disposal cost reduction determined that there is no possibility to modify the characteristics of the sludge and therefore its classification / destination. At the same time, it is possible to estimate that the volume of sludge to be disposed will yearly drop by with the intervention, guaranteeing an amount of economic saving.

Safety issue was addressed by contacting the company Health and Safety department, which made available an internal study from 2012, also supported by a specific paper from the International Social Security Association (ISSA), from which a quantification of the economic impact associated with investments in safety and prevention is obtained: i.e. installing certain equipment allows lower costs for maintenance of safety facilities.

The next step involved determining the costs for safety, to be foreseen with the single activities. To do this, the aforementioned structure made itself available for an inspection of the plant in order to identify the possible safety upgrades to be made in case the CHP is installed and other energy efficiency measures are adopted. Some aspects emerged, not all of them can be directly quantified in terms of costs. Also in this case, it was decided to apply a coefficient (of extra cost) that takes into account the fact that not all amounts are to be considered exclusively for safety purposes. Through these actions, lower annual operating costs was obtained for safety.

Summarizing the different economic contributions associated with the points introduced above, the following representation is obtained:

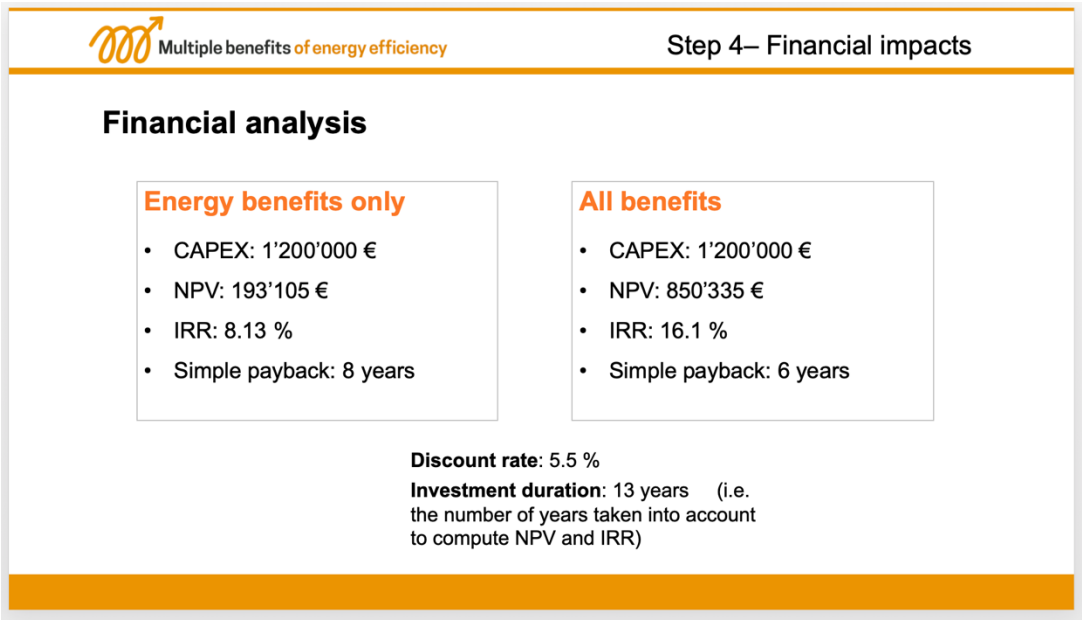


Figure 111. Results of the Financial Analysis. Multi-utility company, confidential

In addition, also the discounted payback time has been evaluated. It reduces from 10.4 years for the *energy benefits only* to 6.5 years for all *benefits*.

It should be noted that the above financial analysis is obtained through a simplified approach and doesn't coincide with the economic impact the project would have for the company. The water sector is a regulated business in Italy: revenues and earnings aren't the same as they are in market businesses but are rather ruled by

the competent national authority (ARERA) and specifically evaluated by the local one (ATERSIR).

Nevertheless, FIRE and the company decided to set out the analysis for a market framework to represent the generic business case.

Key Arguments for the Project Implementation

The project made it possible to have a holistic view of the effects produced by an energy efficiency intervention. It was possible to quantify the effects in terms of maintenance and operating costs of the new components installed (cogeneration, biogas treatment), as well as in terms of safety.

The analysis highlights the economic relevance of a non-energy aspect in particular, the reduction in the costs of disposal of sludge resulting from the lower volumes produced.

It can be stated, based on the information collected within the work described here, that the non-energy aspects are relevant for the project to optimize the production and exploitation of biogas on the treatment plant and focus mainly on reducing the costs of sludge disposal, which account for approximately 20% of the quantified economic benefits.

Non-Energy Benefits evaluation allows to improve economics of the intervention.

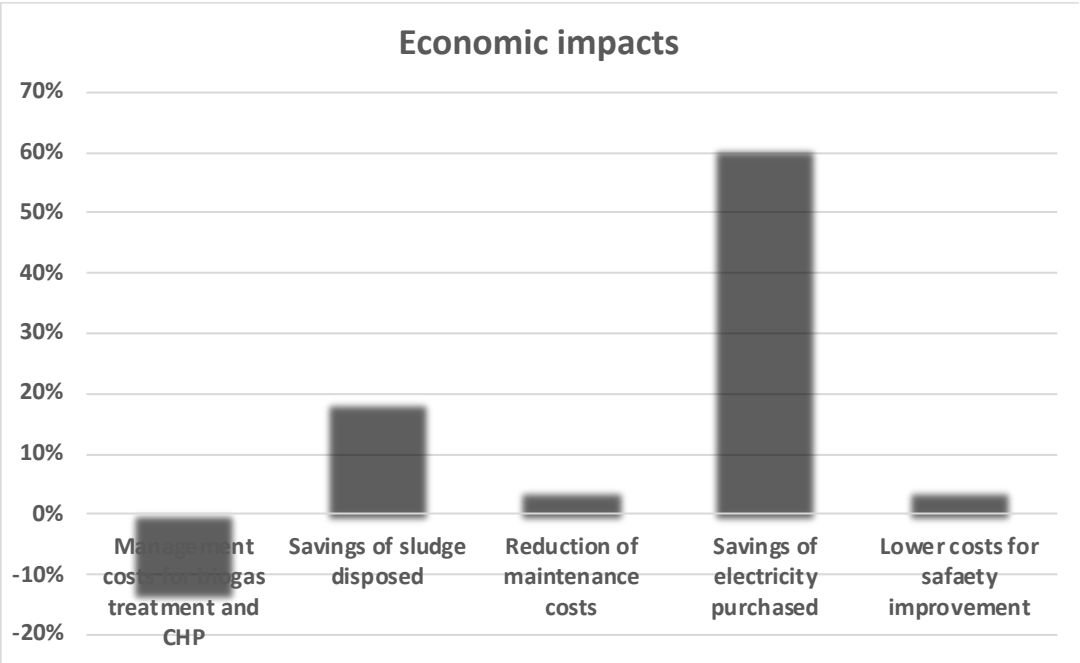


Figure 112. Key Arguments for the Project Implementation- Economics impacts. Multi-utility company, confidential

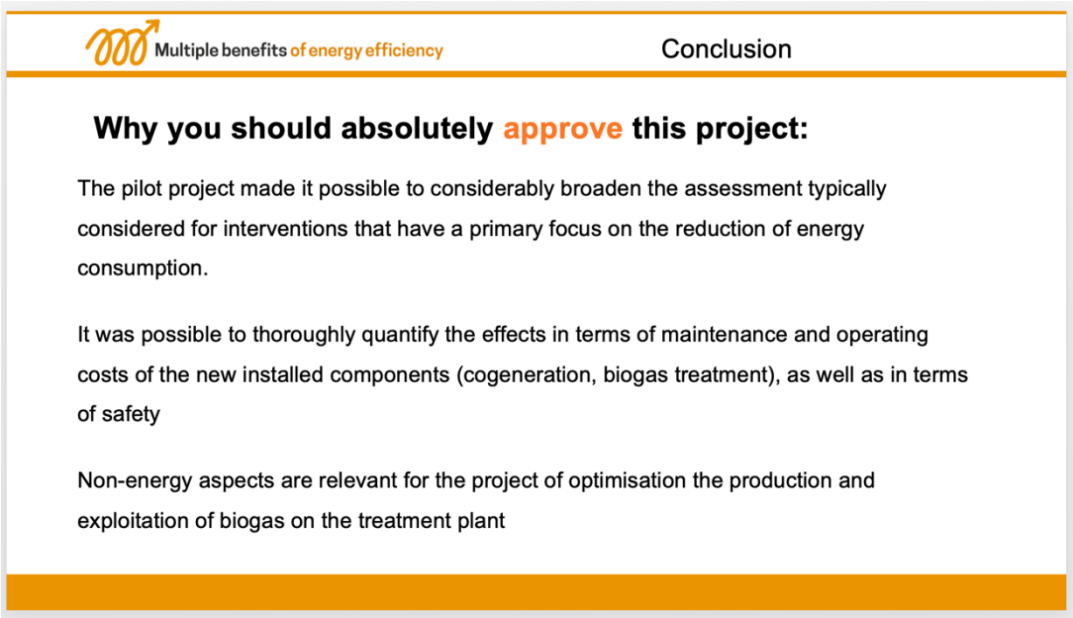


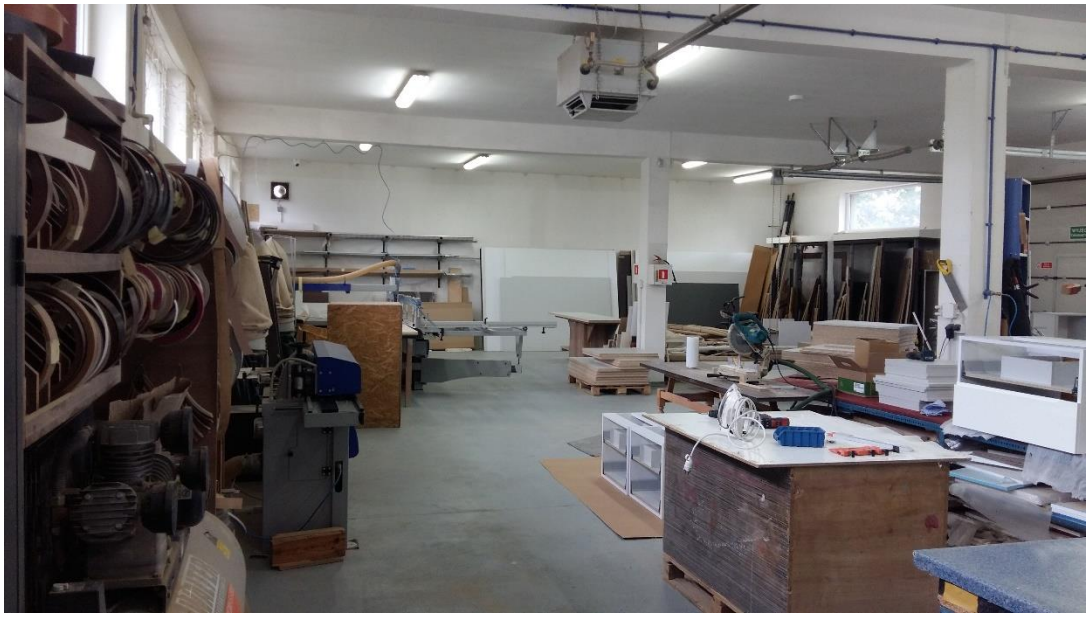
Figure 113. Key Arguments for the Project Implementation. Multi-utility company, confidential

2.5 Reports Poland

Author, Organization (Piotr Nowakowski, Ryszard Wnuk, KAPE)

2.5.1 Pilot 1: Deployment of solar thermal collectors for hot water preparation

DEKOR–MEBLE



Project Idea and Rationale

DEKOR-MEBLE is a micro-scale enterprise which provides custom-made furniture for multiple entities. As the enterprise operates within its own manufacturing facility, it needs individual heating system which provides hot water and space heating. These energy services are provided by an old and inefficient boiler. The boiler provides its services throughout the year due to the fact that the manufacturing facility is integrated with the residence of the owners. Preparation of hot water is problematic especially in the summer, when is no need of space heating. During this season there is a necessity of hot water preparation by one of a high-qualified employee. An employee must devote time for preparation of fuel: coal in winter, wood in summer and keep the boiler working. The situation is undesirable especially in summer, when one of employees has to maintain boiler only for hot water purposes. The situation consumes very precious time, in which high-qualified employee could make a better use of his abilities.

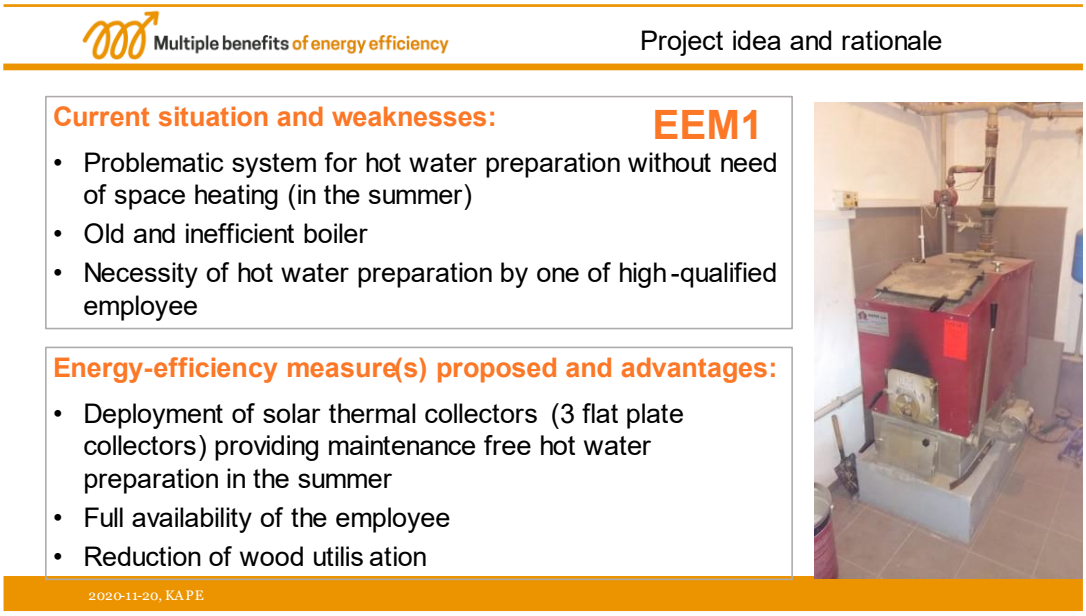


Figure 114. Project Idea and Rationale. DEKOR–MEBLE

In order to solve this inconvenience, it was proposed to deploy solar thermal collectors that provide maintenance free hot water preparation in summer. KAPE elaborated
a prefeasibility study of solar domestic hot water preparation. The study resulted that 3 flat solar collectors fully cover hot water demand in a summer period.

The *F-chart* method was utilized to execute calculations of energy gains and determine number of collectors as above, assuming system location and energy needs.

The results and assumptions, as a scan of Excel sheet based on *F-chart*, are presented in the table below.

	Π=	3,14159							0,976857		cp	4190	J/kgK
Dane:	**Stopni**	**Radiany**			Dane kolektora		FRUL	3,171855	3,247		kolektorów		powierzchnia
pochylen	**30**	**0,523598**	**pochylenie kolektorów, β**				Frτα	0,807861	0,827		liczba	3	
szerokoś	**52,27**	**0,912283**	**szerokość geograficzna, ϕ**				Ap	5,34	m2	m	powierzch	5,34	
				V/A	75		V	300	l	ψs	1,074906		
	numer	deklinacja słoneczna, δ		Kąt godzinny, ω_{wsch}		Kąt godzinny, ω_{wsch}' (1)				Min. kąt godzinny, ω_{wsch}		R_b (wzór 6.6)	nr dnia
	[-]	[°]	[rad]	[°]	[rad]	[°]	[rad]	[°]	[rad]	[°]	[rad]	[-]	
styczeń	15	-21,2695	-0,3712	59,7940	1,0436	59,7940	1,0436	80,8272	1,4107	59,7940	1,0436	**3,111487565**	15
luty	47	-12,9547	-0,2261	72,7040	1,2689	72,7040	1,2689	84,5946	1,4765	72,7040	1,2689	**2,187107854**	16
marzec	75	-2,4179	-0,0422	86,8717	1,5162	86,8717	1,5162	89,0093	1,5535	86,8717	1,5162	**1,605592727**	16
kwiecień	105	9,4148	0,1643	102,3749	1,7868	102,3749	1,7868	93,8937	1,6388	93,8937	1,6388	**1,23340344**	15
maj	135	18,7918	0,3280	116,0899	2,0261	116,0899	2,0261	98,0101	1,7106	98,0101	1,7106	**1,038452743**	15
czerwiec	162	23,0859	0,4029	123,4288	2,1542	123,4288	2,1542	100,0528	1,7462	100,0528	1,7462	**0,964702382**	11
lipiec	198	21,1838	0,3697	120,0587	2,0954	120,0587	2,0954	99,1320	1,7302	99,1320	1,7302	**0,996478848**	17
sierpień	228	13,4551	0,2348	108,0122	1,8852	108,0122	1,8852	95,6228	1,6689	95,6228	1,6689	**1,142336609**	16
wrzesień	258	2,2171	0,0387	92,8682	1,6209	92,8682	1,6209	90,9085	1,5867	90,9085	1,5867	**1,435478104**	15
ıaździernik	288	-9,5992	-0,1675	77,3743	1,3504	77,3743	1,3504	86,0286	1,5015	77,3743	1,3504	**1,960282604**	15
listopad	318	-18,9118	-0,3301	63,7173	1,1121	63,7173	1,1121	81,9346	1,4300	63,7173	1,1121	**2,770865062**	14
grudzień	344	-23,0496	-0,4023	56,6377	0,9885	56,6377	0,9885	79,9651	1,3957	56,6377	0,9885	**3,438213605**	10
	ta	Hb	Hd	Hβ	X	Y	f		N	Qsł	Qkonw	η	Qpadające
	oC	kJ/dzień/m	kJ/dzień/m2	kJ/dzień/m2						MJ/miesiąc	MJ/miesiąc		MJ/miesiąc
styczeń	-1,2	730	2464	4570	4,912911	0,52280095	0,19817759	0,198	31	232	937	0,306	757
luty	-0,9	1189	3286	5665	4,885004	0,64807758	0,29525151	0,295	28	312	744	0,368	847
marzec	4,4	2114	5727	8737	4,391986	0,99948471	0,55443104	0,554	31	648	521	0,448	1446
kwiecień	6,3	3255	8271	11731	4,215244	1,34203838	0,74965579	0,750	30	848	283	0,451	1879
maj	12,2	5697	10806	15999	3,666413	1,83021287	0,98030593	0,980	31	1146	23	0,433	2648
czerwiec	17,1	6782	11734	17491	3,210603	2,00091429	1,06014572	1,000	30	1131	0	0,404	2802
lipiec	19,2	6195	11768	17153	3,015257	1,96225191	1,0586184	1,000	31	1169	0	0,412	2839
sierpień	16,6	5117	10247	15406	3,257115	1,76242868	0,97761365	0,978	31	1143	26	0,448	2550
wrzesień	12,8	2488	7383	10459	3,610599	1,19654793	0,70608363	0,706	30	799	333	0,477	1676
ıaździernik	8,2	1220	4256	6362	4,038502	0,72777969	0,39426006	0,394	31	461	708	0,438	1053
listopad	2,9	435	2163	3224	4,53152	0,36879435	0,08965917	0,090	30	101	1030	0,196	516
grudzień	0,8	238	1806	2504	4,726867	0,28650557	0,00818048	0,008	31	10	1159	0,023	415
		35460	79909	119301				**0,581**		**7999**	**5765**	**0,412**	19429

Figure 115. Results and assumptions, as a scan of Excel sheet based on F-chart. DEKOR–MEBLE

In the figure below the solar gains by months of representative year are shown (yellow bars). The grey bars refer to energy that should be delivered by conventional energy carrier.

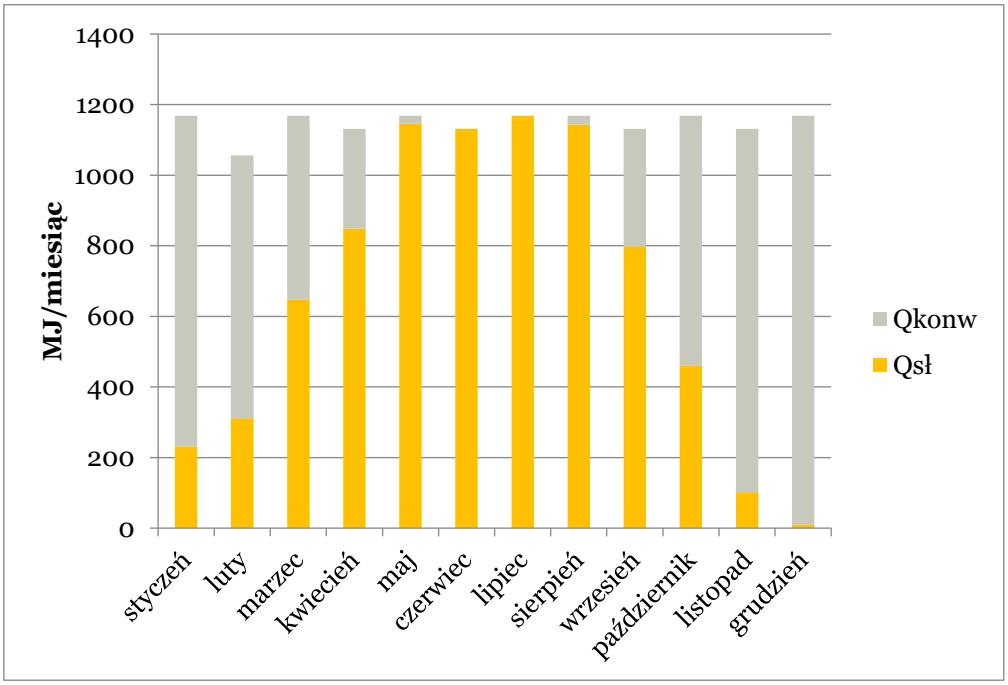


Figure 116. Project Idea and Rationale. DEKOR–MEBLE

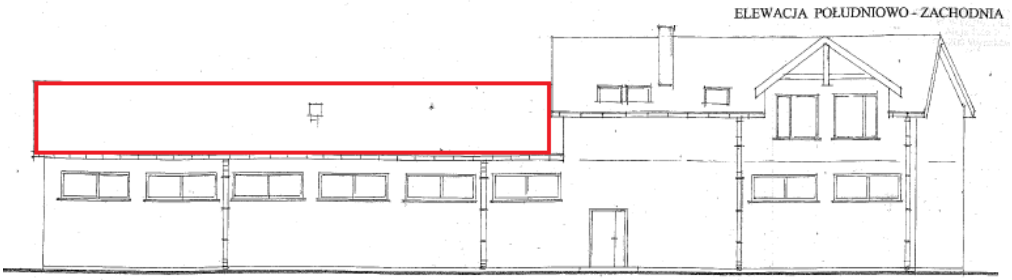


Figure 117. The south oriented facade and roof of the factory building. DEKOR–MEBLE

Results of the Company Analysis

DEKOR-MEBLE has been manufacturing custom-made high-quality furniture since 2005 and hires staff of 12 people. During this time, the enterprise has designed and made furniture for hundreds of premises for private and institutional clients. In 2009 they developed own manufacturing facility which enables to furnish virtually any interior. The enterprise designs and manufactures its own furniture to a specified room based on original projects. They always tailor solutions to individual needs of each client. They design considering not only the distribution of furniture, but also the distribution of electrical, water and ventilation systems, so they create truly functional interiors. They are looking for inspiration in modern interior design trends, as well as in classic designs.

DEKOR-MEBLE's motto: **"Maximum functionality and original unique design"**.

In addition to raw materials, energy carriers, subcontractors, high-qualified staff is a major cost factor. Due to the fact that the company produces unique, high quality, custom made products, an appropriate exploitation of high-qualified staff is essential.

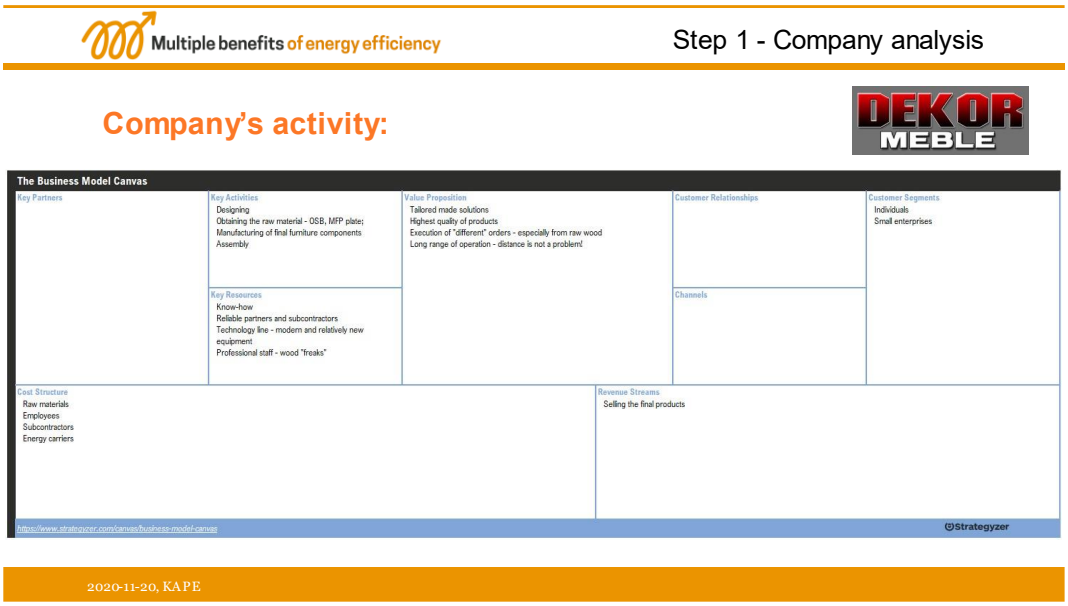


Figure 118. Results of the Company Analysis. DEKOR–MEBLE

Figure 119. A taste of a few custom-made products- DEKOR–MEBLE

DEKOR-MEBLE cooperates with a number of partners as below:

Results of the Energy Analysis

Energy carrier which is impacted by the energy efficiency measure is wood. The energy consumption in 2019 was as follows:

Useful energy: 3'418 kWh/a, which is relevant to 1.5 m^3 consumed/a.

The system of solar thermal collectors is designed to fully cover energy demand for hot water preparation in summer and ultimately to reduce wood consumption to zero. Therefore the estimated annual wood savings are equal to the consumption: 3'418 kWh. However this result corresponds to relatively low reduction of fuel costs: 222 PLN/a, due to low price of wood. Nevertheless the implementation of the measure results in 58% share of self-produced, emission and maintenance-free renewable energy of total energy used for hot water purposes.

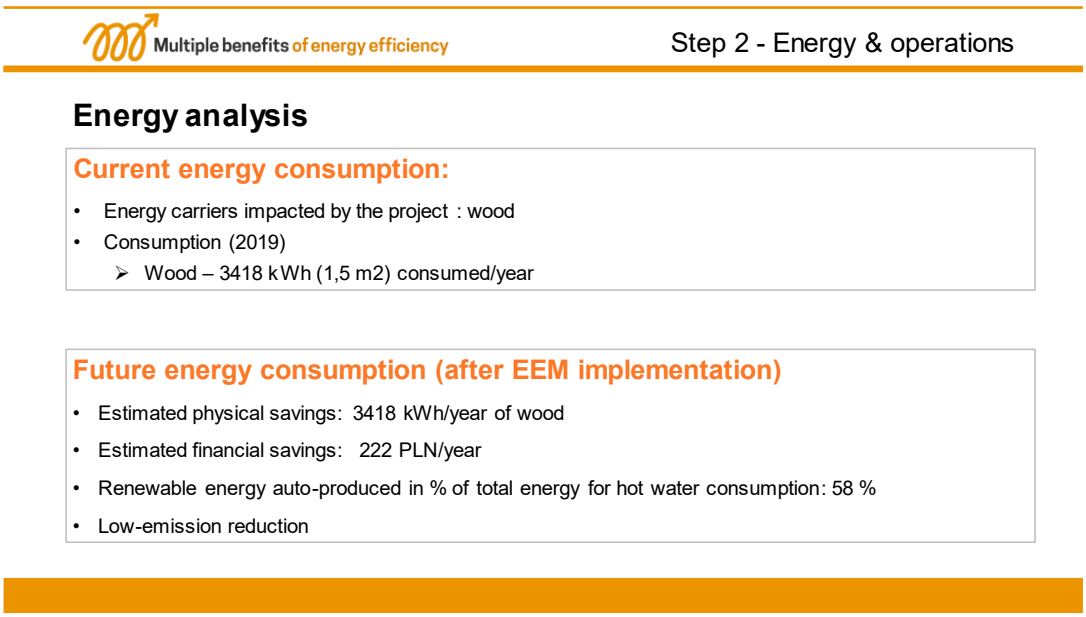


Figure 120. Results of the Energy Analysis- DEKOR–MEBLE

Results of the Operations Analysis

The production workflow and the layout of the enterprise are not purposeful to be analyzed as a whole due to the fact that energy process activities impacted by the proposed measure are not directly related with any production process. In the operational analysis a process of providing hot water and space heating was presented. The hybrid heating system utilizing solar thermal collectors and multi-fueled boiler provides hot water and space heating. Preparation of hot water in summer is maintenance-free due to utilization of solar thermal collectors.

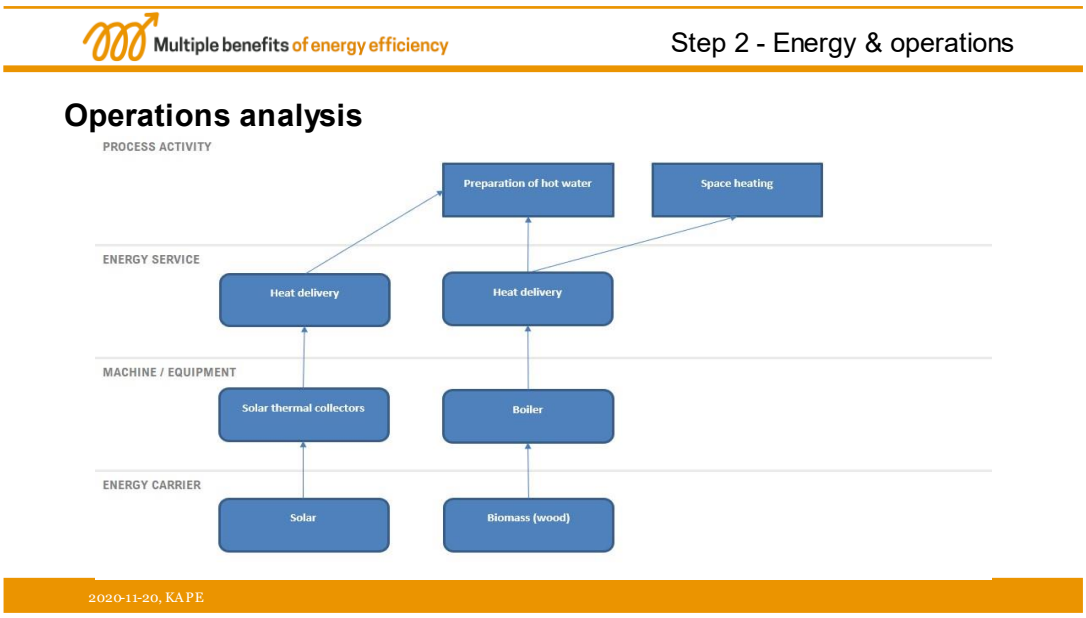


Figure 121. Results of the Operations Analysis-Operational diagram. DEKOR–MEBLE

Results of the Strategic Analysis

The multiple benefits analysis lead to the following results:

Cost Impacts:

a) Reduction of fuel (wood) utilization: The reduction of wood combustion corresponds to the savings of 222 PLN/a (summer period).
b) Reduction of CO_2 and energy price risk. At the time of making the analysis the price of wood was relatively low, however utilization of solar energy lowers dependency on wood and its prices. There are no fees for CO_2 emissions for micro-scale enterprises in Poland. Therefore, emission of CO_2 has no impact on costs.
c) Reduction of qualified staff engagement in boiler operation. This aspect is essential and the most impactful from the strategic and the financial point of view. This benefit was quantified using the assumptions as follow:
    - 1 hour per working day has to be devoted to boiler maintenance by an employee (5 days a week);
    - 4 summer months taken into account (preparation of hot water only);
    - Hourly rate of a high-qualified employee.
    - Total annual savings of 3'200 PLN.

Utilization of a clean renewable energy has also several implications on value propositions of the company:

a) Improved image and reputation – the enterprise is received as an environmentally friendly, which can lead to improved customer satisfaction;
b) Better organization of working space – no need of wood storage;
c) Increase in turnover due to full devotion of all employees to products manufacturing, instead of taking care of energy issues in summer;

Implementation of the proposed measure results in reduction of the following risks:

- CO_2, CO, NO_x, SO_x and dust emissions;
- Installation safety – much higher reliability compared to the old boiler;
- Risk of accident and occupational disease.

Deployment of solar thermal collectors leads to a cleaner, healthier working environment and decrease probability of an accident.

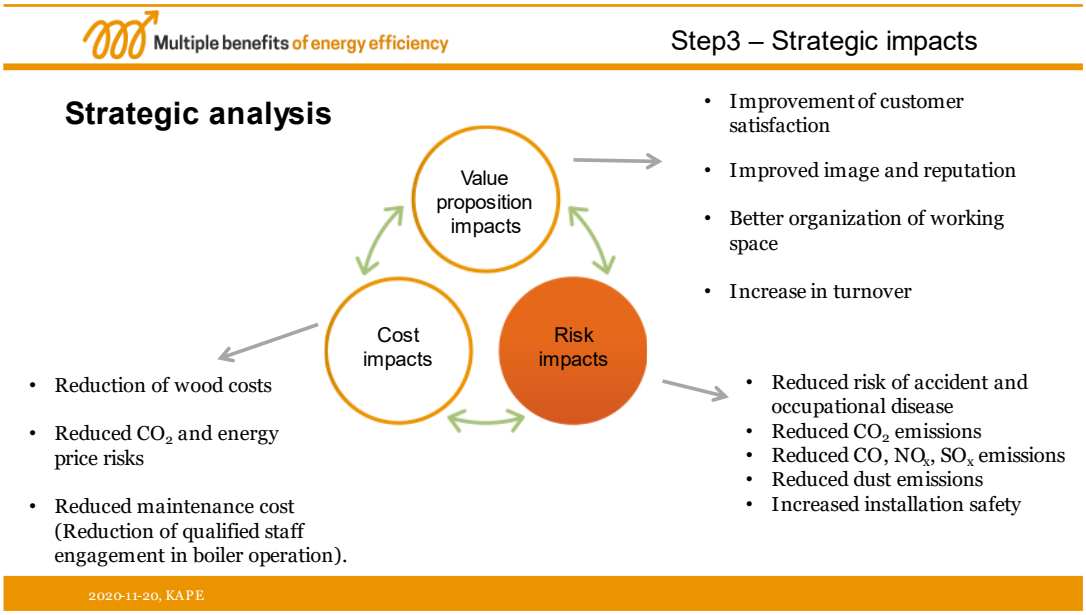


Figure 122. Results of the Strategic Analysis- DEKOR–MEBLE

Results of the Financial Analysis

The results of the financial analysis considering energy benefits only (left hand side) and all benefits (right hand side) are shown below. In both cases capital expenditures (CAPEX) amount to a total of 10'600 PLN (year 0). CAPEX consists of: three flat-plate solar thermal collectors with control system, 300 l tank, 25 meters of elastic pipe, clamping system and assembly. No subsidy is considered.

Recurring multiple benefits are:

a) Fuel (wood) savings – 222 PLN;
b) Reduce boiler maintenance cost in summer – 3'200 PLN.

The other multiple benefits listed above are important from the strategic point of view. Nevertheless, their impacts cannot be translated into monetary values, but they can positively influence the project acceptance.

The capital budgeting results are shown below for the discount rate of 5% and an investment duration of 20 years. The rationale behind the proposed measure was to modify existing heating boiler and create maintenance-free system that provides hot water in summer. This is a mandatory requirement for any energy efficiency measure solving that problem.

However, the more positive results of financial evaluation the better. The M-Benefits methodology contributed to showing the whole spectrum of benefits resulting from the proposed measure. Consideration of only energy savings leads to extremely long payback time of more than three decades and accordingly to negative values of dynamic indicators of economic efficiency – NPV and IRR. Taking into account multiple benefits of the energy efficiency measure leads to significant improvement of economic performance.

Multiple benefits of energy efficiency — Step 4– Financial impacts

Financial analysis

Energy benefits only

- CAPEX: 10 600 PLN
- NPV: - 7 102 PLN
- IRR: - 5,42%
- Simple payback: 38 years

All benefits

- CAPEX: 10 600 PLN
- NPV: 25 200 PLN
- IRR: 26,87%
- Simple payback: 4 years

Discount rate: 5%

Investment duration: 20 years (i.e. the number of years taken into account to compute NPV and IRR)

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Figure 123. Results of the Financial Analysis- DEKOR–MEBLE

Key Arguments for the Project Implementation

The key arguments for the implementation of the energy efficiency measure (see slide below) are therefore the resulting non-energy benefits.

The annual energy savings show a value of only 222 PLN. However, the annual savings from non-energy benefits are a game changer and represent the annual value of 3'200 PLN. Overall, these financial figures result in a payback period of only 4 years. Besides the financial benefits, the measure contributes to the aspects as follow:

- Creation of maintenance free preparation of hot water in summer and full availability of a high-qualified employee.
- Image of environmentally friendly enterprise due to utilization of RES (58% share of RES in total energy for hot water preparation. It could be utilized in promotion of the company.

Multiple benefits of energy efficiency — Conclusion

Why you should absolutely approve this project:

- Significant share of renewable energy in % of total energy for hot water consumption: 58%
- Image of modern and „green" company – potential for marketing activities
- Very positive results of financial analysis: SPBT: 4 years, IRR: 26,46%
- Full availability of the high -qualified employee in the summer
- Maintenance free preparation of hot water in the summer – no need of boiler usage

2020-11-20, KAPE

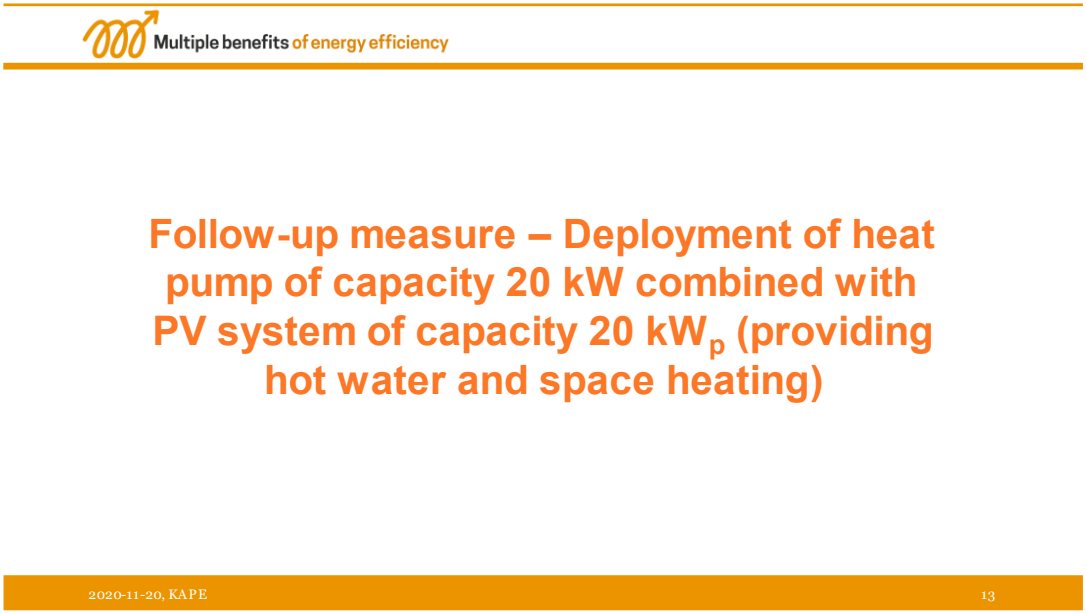
Figure 124. Key Arguments for the Project Implementation- DEKOR–MEBLE

Key Issues and Highlights

The key arguments for the implementation of the energy efficiency measure are the identified non-energy benefits, as the payback period improves from more than 38 years to 4 years. Besides the benefits that could be monetarized, the comprehensive analysis according to the M-Benefits methodology enabled to identify many other positives aspects of the considered modernization that had also leverage on investment decision. In the end the proposed measure was accepted by the owners and successfully implemented. The results obtained in this pilot project are a prominent example how the consideration of multiple benefits can boost investment in energy efficiency that improves operation of enterprise.

Follow-up measure - Deployment of air heat pump combined with PV system

DEKOR–MEBLE



Follow-up Project Idea and Rationale

As the previous measure of solar thermal collectors was accepted by the owner and successfully implemented, we all agreed upon an extension for our analyses. The modernization of heating system was well received by the owners and employees who emphasized maintenance free hot water preparation in summer as the most relevant advantage. Thus, we thought:

Why don't we go beyond and consider providing not only maintenance free hot water, but also space heating?

This question led us to an idea of a hybrid heating system consisting of:

- Solar thermal collectors (already implemented);
- Air heat pump with capacity of 20 kW;
- PV system with total capacity of 20 kW_p – the proposed capacity is limited by available rooftop area.

A creation of the system as above provides maintenance free heating system throughout a year and ultimately full availability of all employees.

Multiple benefits of energy efficiency

Project idea and rationale

Current situation and weaknesses: **EEM2**

- Problematic and time-consuming system of hot water preparation and space heating
- Old and inefficient boiler
- Necessity of boiler operation by one of high-qualified employee

Energy-efficiency measure(s) proposed and advantages:

- Deployment of air heat pump and PV system providing maintenance free hot water preparation and space heating
- Full availability of the employee
- Reduction of wood and hard coal utilisation

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Multiple benefits of energy efficiency

Pre-feasibility study of heat pump + PV system

Jednostkowe obciążenie grzewcze		50	W/m2	
powierchnia użytkowa		476,42	m2	
Moc grzewcza	P	23,821	kW	
Moc grzewcza przyjęta dalej	P	20	kW	
Wielkość stopniodni	Sh	3885	stopniodni	
Maks. Różnica temperatur	Δtmaks.	40	oC	
Zapotrzebowanie na energię	Zn	46620	kWh	
Brakujące zapotrzebowanie na c.w.u.		1601,389	kWh	
Całkowite zapotrzebowanie		48221,39	kWh	24110,69
Sprawność systemu grzewczego		0,8		
Współczynnik wydajności cieplnej pompy cie		3		
Zapotrzebowanie na energię elektryczną		20092,25	kWh	
Wydajność systemu PV		1100	kWh/kW	
autokonsumpjca		0,25		
opust		0,7		
Napromieniowanie powierchni pochylonej		1200	kWh/m2	
Sprawność instalacji PV		0,87		
Moc systemu PV		24,83283	kW	
koszt jednostkowy energii elektrycznej		0,5	zł/kWh	
Koszt uniknięty energii elektrycznej		10046,12	zł	Nie wzięte pod uwagę ze względu na rozpatrywanie układu PV+pompa ciepła
Koszt jednostkowy PV		4200	zł/kW	
Koszt inwestycyjny PV		**104297,9**	zł	
Moc instalacji PV wynikająca z pow. Dachu		**20**	kW	
Uzysk roczny		**22000**	kWh/rok	
Energia na pokrycie zapotrzebowania		**17050**	kWh/rok	
Oszczędności		**8525**	zł/rok	
Zakup energii brakującej z sieci		**3042,245**	kWh/rok	
Koszt zakupu		**1521,123**	zł/rok	
Koszt inwestycyjny		**84000**	zł/rok	

$$Z_n = \frac{P \cdot Sh}{\Delta T_{maks.}}$$

$$P = \frac{\frac{E_z}{0 + a - o \cdot a}}{H \cdot \eta_{inst.}} \cdot STC \ [\mathrm{kW_p}]$$

2020-11-20, KAPE 16

Figure 125. Follow-up Project Idea and Rationale- DEKOR–MEBLE

Results of the Energy Analysis

Energy carriers which are impacted by the energy efficiency measure are wood and hard coal. The energy consumption in 2019 was as follows:

- Wood: 42’948 kWh
- Hard coal: 46’366 kWh

The hybrid system is designed to provide maintenance free hot water preparation and space heating throughout a year. Such solution leads to complete erase of wood and coal from utilization. Therefore, energy savings are equal to the current consumption as above. It needs to be noted that despite the fact that the system is equipped with PV installation, the heap pump needs also electricity form the local grid. Due to significant electricity demand of heat pump the consumption of electricity ultimately increase of 20’092 kWh. Electricity demand, in majority is covered by PV system (17’050 kWh) and 3’042 kWh will supplied from grid network.

Multiple benefits of energy efficiency

Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Energy carriers impacted by the project: wood and coal
- Consumption (2019)
  - Wood – 42 948 kWh (16,5 m^3) consumed/year
  - Coal – 46 366 kWh (6,4 tonne) consumed/year

Future energy consumption (after EEM implementation)

- Estimated physical savings: 42 948 kWh of wood/year and 46 366 kWh of coal/year
- Estimated increase of electricity consumption by 3042 kWh/year
- Estimated financial savings: 8 288 PLN/year
- Renewable energy self-produced in % of total energy for hot water and heating consumption: 85 %
- Reduction of low -emission

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Figure 126. Results of the Energy Analysis. DEKOR–MEBLE

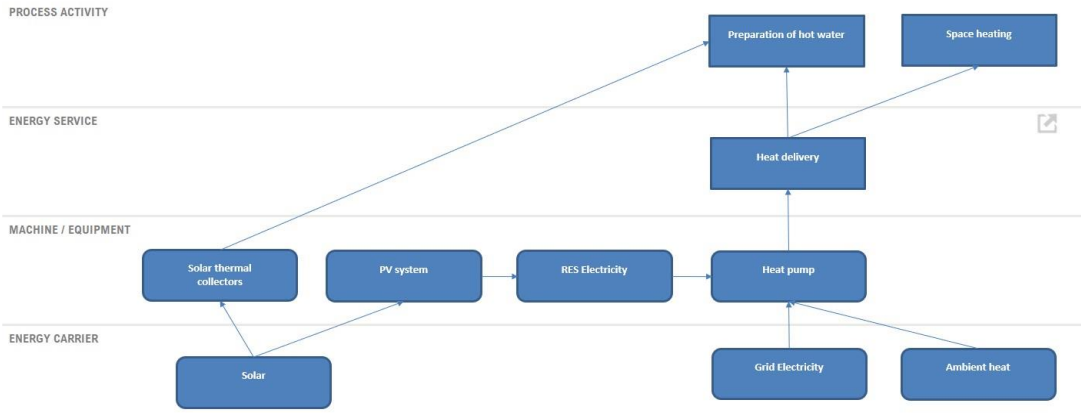
Results of the Operations Analysis

The production workflow and the layout of the enterprise are not purposeful to be analyzed as a whole due to the fact that energy process activities impacted by the proposed measure are not directly related with any production process. In the operational analysis a process of providing hot water and space heating was presented. The hybrid heating system utilizing solar thermal collectors, heat pump and PV installation provides hot water and space heating. Preparation of hot water and space heating is maintenance-free throughout a year.

Multiple benefits of energy efficiency

Step 2 - Energy & operations

Operations analysis



2020-11-20, KAPE

Figure 127. Results of the Operations Analysis-Operational diagram. DEKOR–MEBLE

Results of the Strategic Analysis

The multiple benefits analysis leads to the following results:

Cost Impacts:

a) Complete reduction of fuel (wood) utilization.
b) Complete reduction of hard coal utilization.
c) Increase of electricity consumption – 1'521 PLN/a.
d) Reduction of CO_2 and energy price risk. At the time of making the analysis the price of wood was relatively low, however utilization of solar energy lowers dependency on wood and its prices. There is no fees for CO_2 emissions for micro-scale enterprises in Poland. Therefore, emission of CO_2 has no impact on costs.
e) Reduction of qualified staff engagement in boiler operation. This aspect is essential and the most impactful from the strategic and the financial point of view. This benefit was quantified using the assumptions as follow:
    - 1 hour per working day has to be devoted to boiler maintenance by an employee (5 days a week).
    - 8 months taken into account.
    - Hourly rate of a high-qualified employee.
    - Total annual savings of 6'400 PLN.

Utilization of a clean renewable energy has also several implications on value propositions of the company:

a) Improved image and reputation – the enterprise is received as an environmentally friendly, which could lead to improved customer satisfaction.
b) Better organization of working space – no need of wood and hard coal storage.
c) Increase in turnover due to full devotion of all employees to products manufacturing, instead of taking care of energy issues throughout a year.
d) Improved employees' satisfaction due to cleaner local environment and no need of boiler operation.

Implementation of the proposed measure results in reduction of the following risks:

- CO_2, CO, NO_x, SO_x and dust emissions.
- Installation safety – much higher reliability compared to the old boiler.
- Dependency on wood and coal suppliers – reduced time for delivery arrangements.
- Reduced risk of breakdown and disruption of heat supply.

Implementation of the measure leads to a cleaner, healthier working environment and decrease probability of an accident or breakdown.

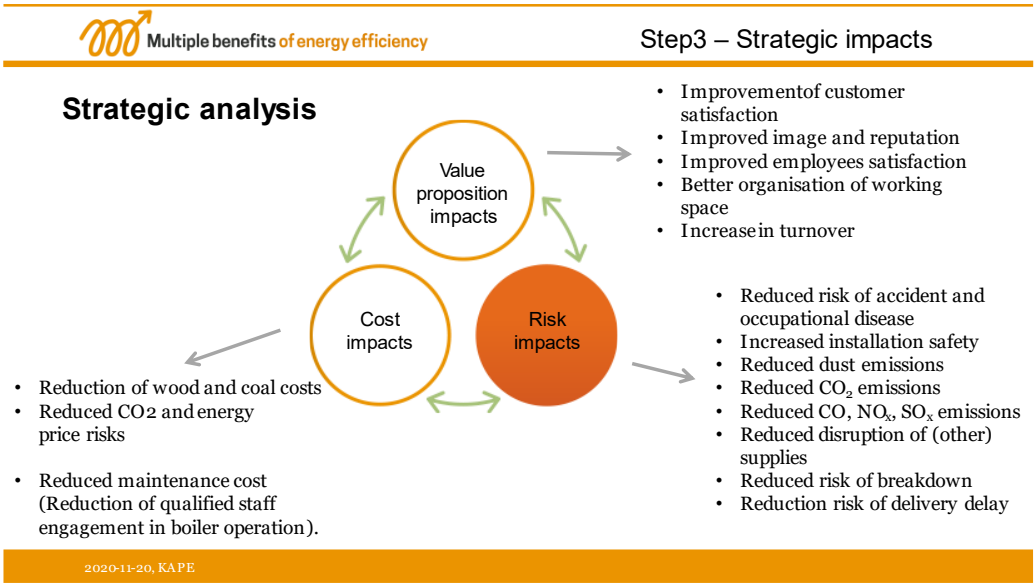


Figure 128. Results of the Strategic Analysis- DEKOR–MEBLE

Results of the Financial Analysis

The results of the financial analysis considering energy benefits only (left hand side) and all benefits (right hand side) are shown below. In both case capital expenditures (CAPEX) amount to a total of 144'000 PLN (year 0). CAPEX consists of: air heat pump with capacity of 20 kW, PV system with capacity of 20 kW_p. No subsidy is considered.

Recurring multiple benefits are:

a) Fuel (wood and hard coal) savings – 10'834 PLN;
b) Reduce boiler maintenance cost in throughout the year– 6'400 PLN.

Recurring negative implications from the economic point of view:

- Additional cost of electricity: 1'521 PLN.

The other multiple benefits listed above are important from the strategic point of view. Nevertheless, their impacts cannot be translated into monetary values, but they can positively influence the project acceptance.

The capital budgeting results are shown below for the discount rate of 5% and an investment duration of 20 years. The rationale behind the proposed measure was to modify existing heating boiler and create maintenance - free system that provides hot water and space heating throughout a year. This is a mandatory requirement for any energy efficiency measure solving that problem. However, the more positive results of financial evaluation the better. The M-Benefits methodology contributed to showing the whole spectrum of benefits resulting from the proposed measure. Consideration of only energy savings leads to long payback time of more than 20 years and accordingly to negative values of dynamic indicators of economic efficiency – NPV and IRR. Considering multiple benefits of the energy efficiency measure leads to improvement in economic performance and position the measure as worth consideration.

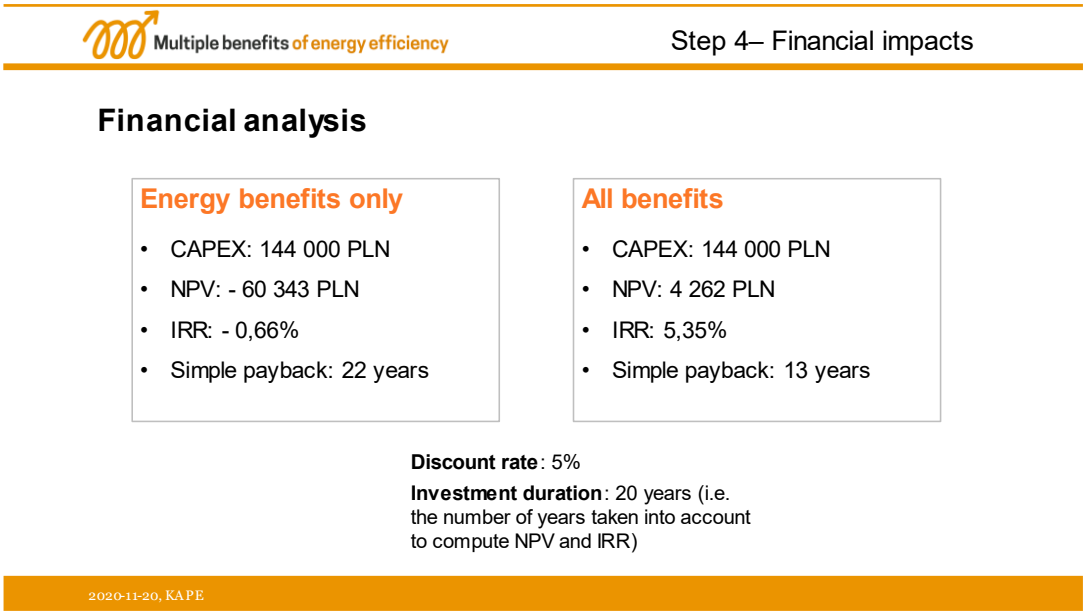


Figure 129. Results of the Financial Analysis- DEKOR–MEBLE

Key Arguments for the Project Implementation

The key arguments for the implementation of the energy efficiency measure (see slide below) are therefore the resulting non-energy benefits.

The annual energy savings show a value of only 9'313 PLN. Annual savings from non-energy benefits are significant and represent the annual value of 6'400 PLN. Overall, these financial figures result in a payback period of 13 years. Besides the financial benefits, the measure contributes to the aspects as follow:

- Full availability of all the employees throughout a year.
- Risk reduction of boiler breakdown and disruption of heat delivery.
- Creation of maintenance free preparation of hot water and space heating throughout a year and full availability of a high-qualified employee.
- Image of environmentally friendly enterprise due to very high share of RES utilization (86% share of RES in total energy for hot water and heating consumption). It could be utilized in promotion of the company.
- Significant reduction of low emission.

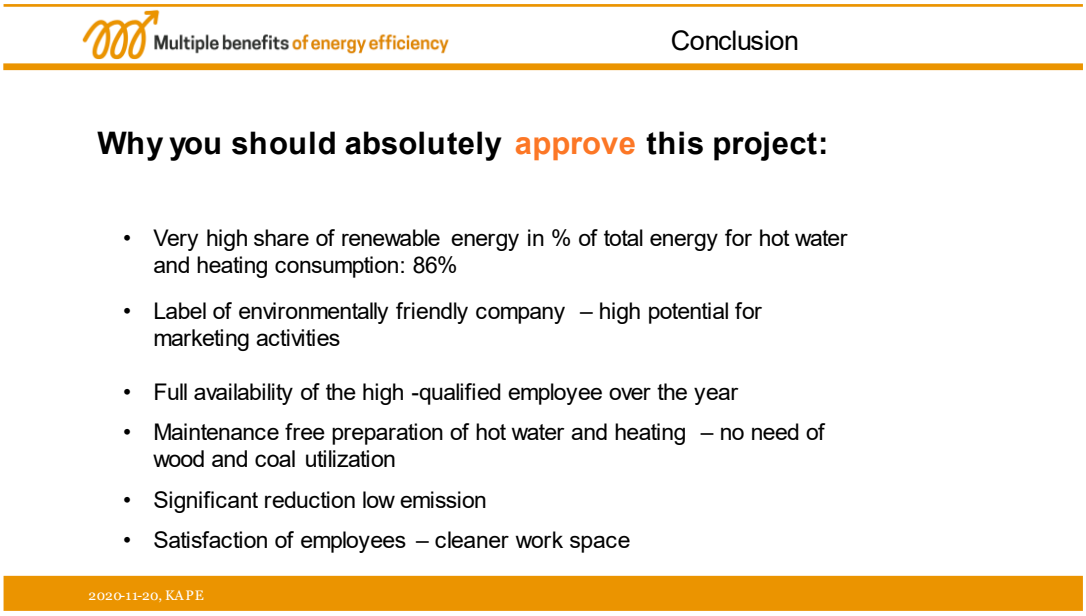


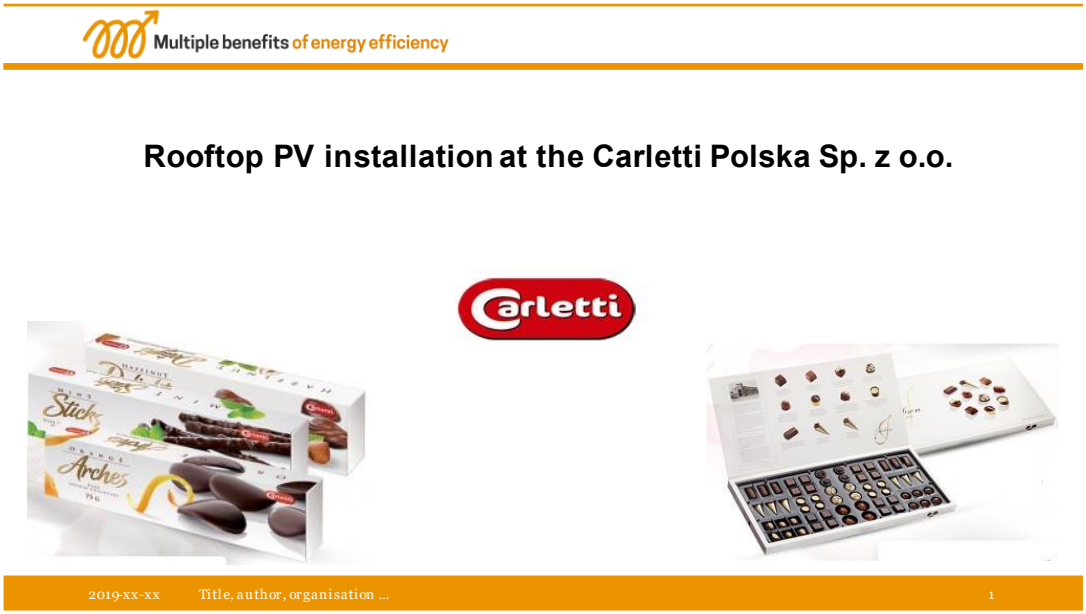
Figure 130. Key Arguments for the Project Implementation. DEKOR–MEBLE

Key Issues and Highlights

The key arguments for the implementation of the energy efficiency measure are the identified non-energy benefits and energy benefits. Considering all kind of benefits the payback period is reduced from 22 years to 13 years. Besides the benefits that could be monetarized, the comprehensive analysis according to the M-Benefits methodology enabled to identify numerous positives aspects of the considered modernization that have also leverage on investment decision. The results obtained in this pilot project are a prominent example how the consideration of multiple benefits can boost investment in energy efficiency that improves operation of enterprise.

2.5.2 Pilot 2: Deployment of a rooftop PV installation

Carletti Polska Sp. z o.o.



Project Idea and Rationale

Carletti Polska Sp. z o.o. is a medium-sized enterprise which produces dozens of different chocolate products. Due to the fact that the company is owned by Danish shareholders, it is expected to follow the global trends in the aspect of energy transition and sustainable development. There is a tendency in Poland of electricity prices growth caused mainly by the global situation of higher costs of CO_2 emissions allowances for energy supply companies. The costs of CO_2 emissions allowances are reflected in electricity tariffs for end users. Big-scale end users (e.g. industry) usually have negotiated prices due to significant volume of electricity consumed. The growth of electricity prices has been seen first in the sector of small and medium enterprises. The electricity tariffs for individuals were frozen by the government to protect them from a significant growth of electricity bills' values. There is urgent necessity to build new power plants, which can replace inefficient and outdated old electricity generated units being close to the lock down. That is also reflected in electricity tariffs. In 2019, *electricity prices* for the industry in *Poland* exceeded 10-euro cents per kilowatt-hour, an *increase* of 14 percent compared to the previous year.

In order to decrease dependency from electricity prices growth enterprises starts looking at RES technologies providing self-sufficiency in some extend. It was proposed to analyze and consider deployment of PV system, which addresses the issue as above and is also in line with the company's policy development.

Current situation and weaknesses:

- Uncertainty regarding electricity prices
- Price growth is foreseen in upcoming years especially for SMEs
- Concern for company's image
- The will of following the global trends

Energy-efficiency measure(s) proposed and advantages:

- Deployment of PV installation of total capacity 230 kWp
- Reduction of conventional electricity consumption
- Electricity generation from RES - 209 804 kWh
- Security against predicted rise in electricity prices

Figure 131. Project Idea and Rationale- Carletti Polska Sp. z o.o

KAPE elaborated a prefeasibility study of a rooftop PV installation. The available space allows the installation of a photovoltaic generator with a capacity of approx. 230 kW_p, composed by 767 modules with a capacity of 300 W_p each, using the full possible technical potential of the company's premises.

Due to the relatively high consumption of electricity in the enterprise and even distribution of electricity demand in individual hours throughout the year, a model assuming full use of energy produced in the PV installation for own needs without selling surplus to the grid was proposed. This will allow to maximize the economic effect of the project.

Figure 132. The rooftop area proposed for deployment of PV modules. Carletti Polska Sp. z o.o

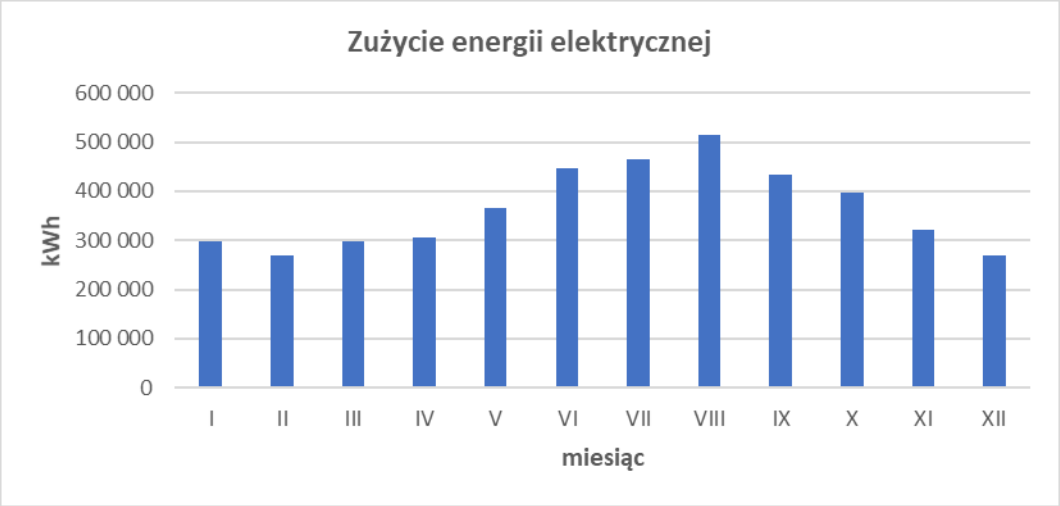


Figure 133. The electricity consumption of individual months in 2019. Carletti Polska Sp. z o.o

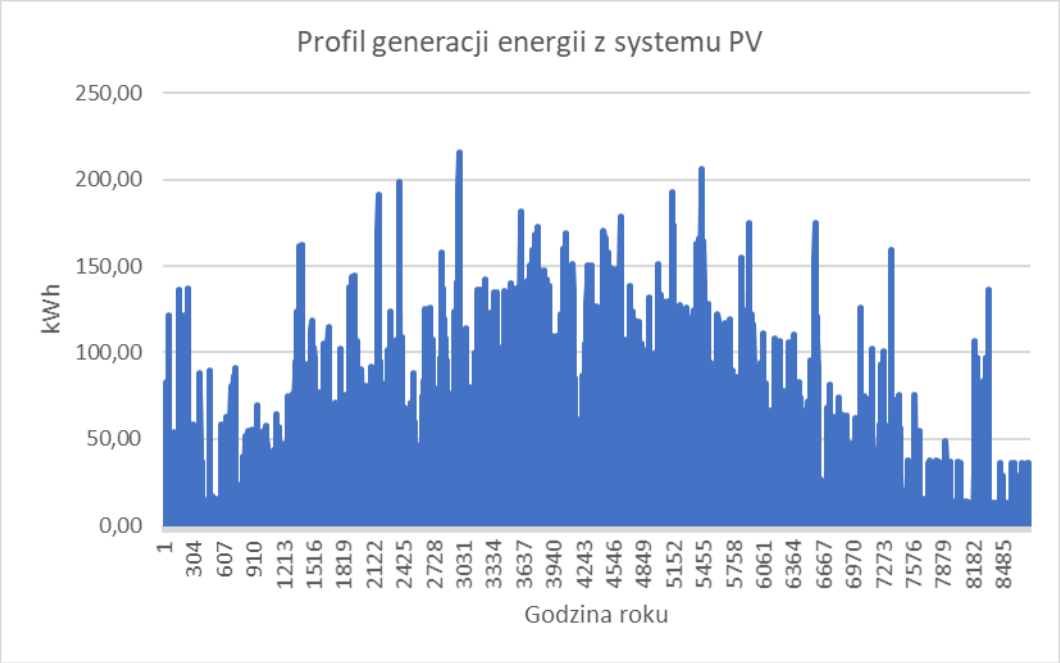


Figure 134. The electricity generation profile of the proposed PV system. Carletti Polska Sp. z o.o

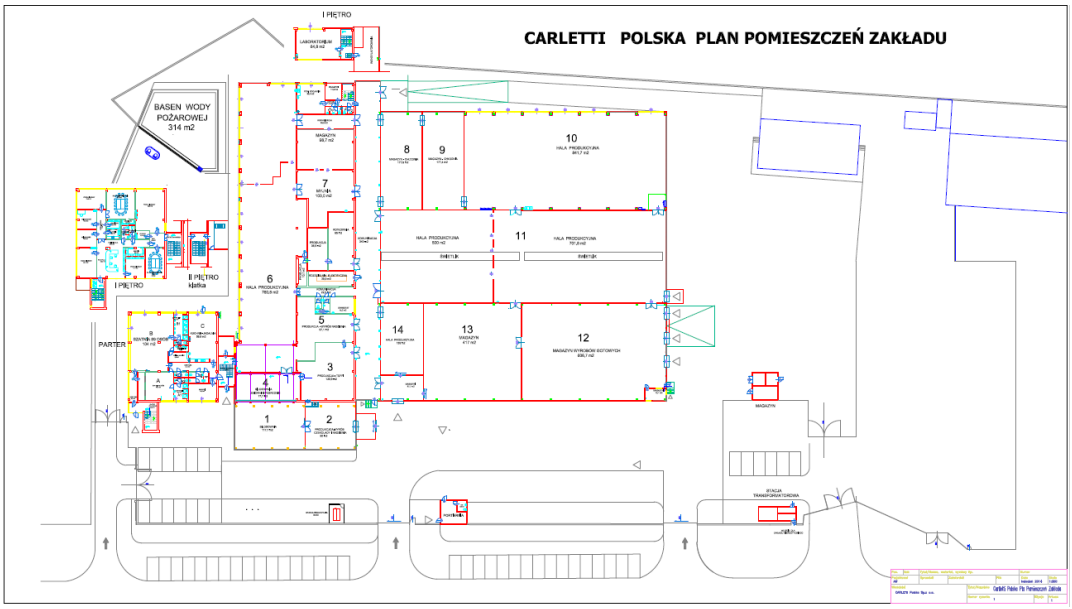


Figure 135. Factory layout. Carletti Polska Sp. z o.o

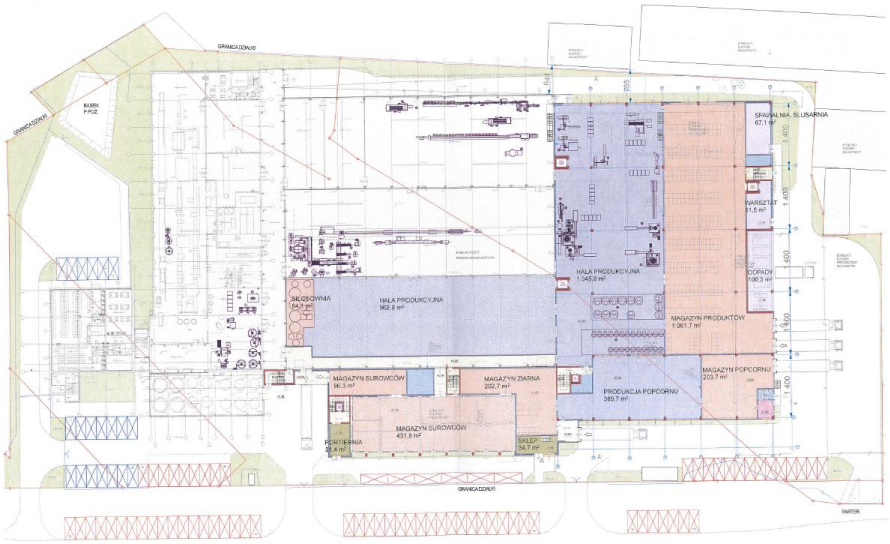


Figure 136. Factory layout. Carletti Polska Sp. z o.o

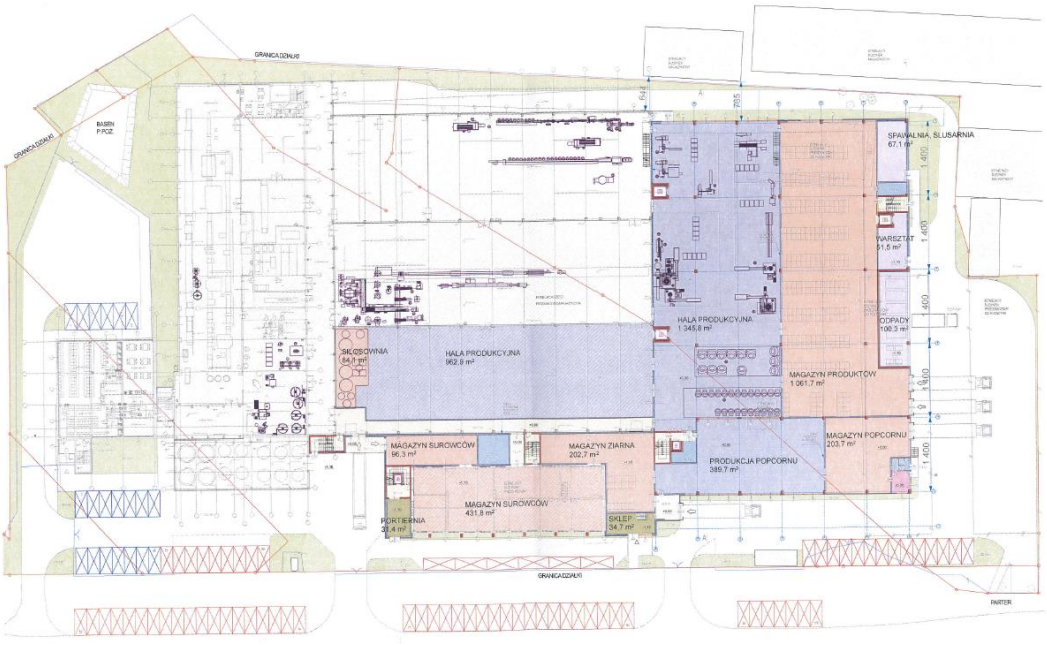


Figure 137. Factory layout. Carletti Polska Sp. z o.o

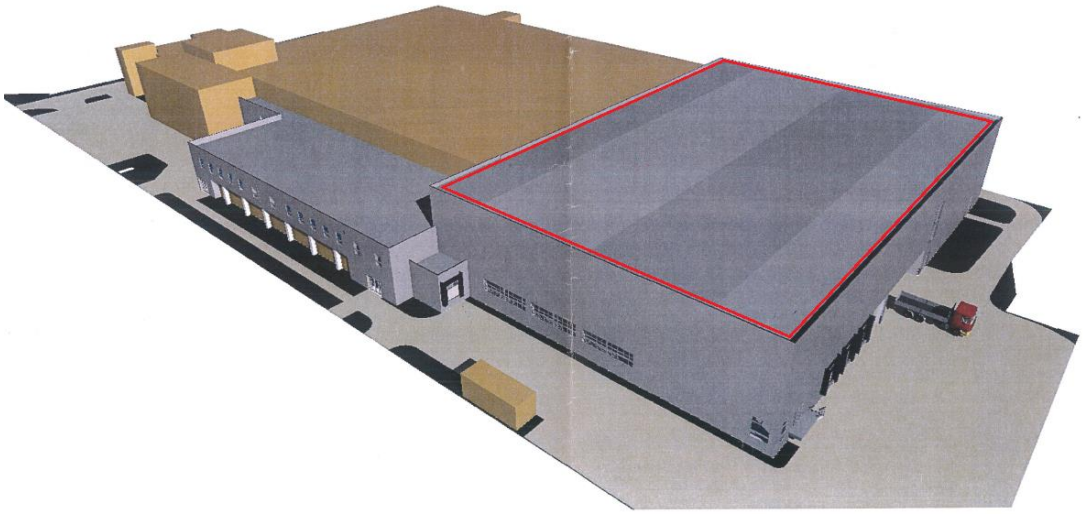


Figure 138. Area of level 0 schematic view of buildings of the plant. Carletti Polska Sp. z o.o

Results of the Company Analysis

Carletti Polska Sp. z o.o. started its business in 1992. Initially, the company dealt with the import of corn, the production of popcorn and other salty snacks. In 1995, thanks to Carletti's first investment, the lines for the production of stuffed chocolates and toffee candies were installed.

In 1999 the decision to extend the company was taken. The project included the construction of new production halls and also warehouses.

In the following year, the production lines of chocolates, stuffed bars, marzipan products, chocolate and rolled chocolate were installed. In this way Carletti Polska Sp z o.o. was able to multiply the number of manufactured products and increase sales on both Polish and international markets.

Currently, the sales proposal includes dozens of different chocolate products, including unique handmade chocolates in a whole range of fillings and shapes. Despite having such a wide choice, Research and Development Department, in close cooperation with customers, continues to broaden production with new flavours.

It should not be forgotten that Carletti Polska still deliver the highest quality imported from US corn for roasting, microwave popcorn and roasted maize.

Regardless the type of product, the common feature of the products manufactured by Carletti Polska Sp. z o.o. is the high quality. The best proof for it is, introduced in 2001, the HACCP system and also the BRC and IFS safety standards which have been kept up since 2005.

For the company is the most important to maintain smooth production without any breakdowns at any costs.

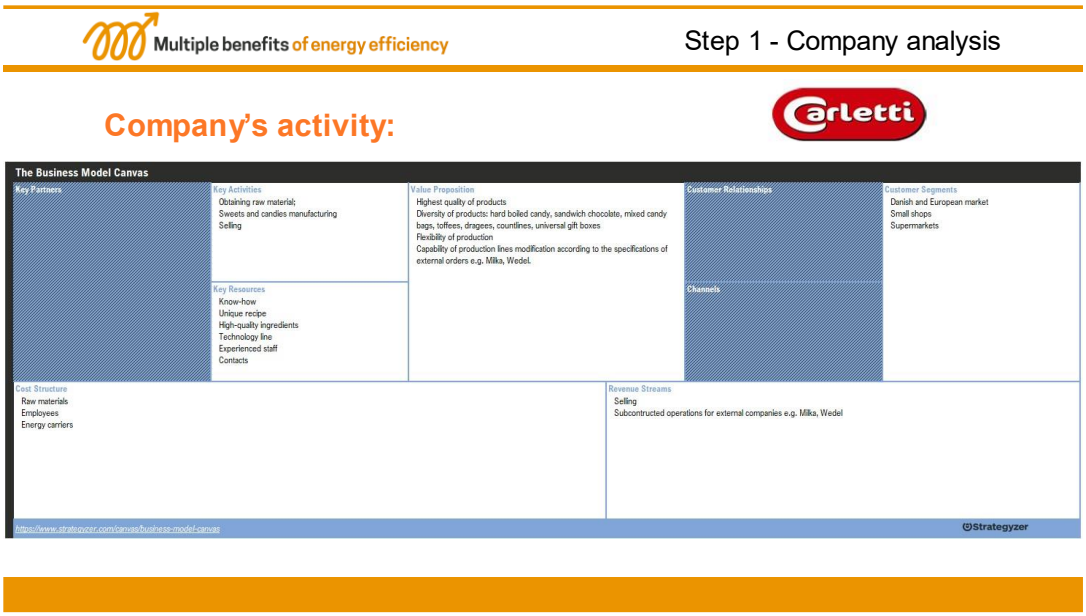


Figure 139. Results of the Company Analysis. Carletti Polska Sp. z o.o

Results of the Energy Analysis

Energy carrier which is impacted by the proposed measure is electricity. The electricity consumption in 2019 was as follows:

Electricity: 4'417'259 kWh/a.

The PV system is designed according to the electricity consumption profile with the assumption to fully self-consume electricity generated in PV installation without any surplus. Estimated electricity generated in PV system equals to 209'804 kWh/a, which corresponds to financial savings of 83'229 PLN/a. The share of renewable electricity generated and directly self-consumed is 4,7% of total electricity consumption. Calculated reduction of primary energy (629 412 kWh/a) is three times higher than the energy generation (final energy) due to the energy mix in Poland, which is mainly based on hard coal and lignite.

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Energy carriers impacted by the project: electricity
- Consumption (2019)
  - Electricity – (4 417 259 k Wh consumed/year)

Future energy consumption (after EEM implementation)

- Estimated physical savings: 209 804 kWh/year
- Estimated financial savings: 83 229 PLN /year
- Renewable energy auto-produced in % of total energy consumption : 4,7%
- Reduction of primary energy : 629 412 kWh/year

Figure 140. Results of the Energy Analysis. Carletti Polska Sp. z o.o

Results of the Operations Analysis

The production workflow is composed by many process activities. Electricity is used to provide the following energy services:

- Motion power;
- Cooling;
- Lighting;
- Air conditioning.

These energy services contribute to maintenance of process activities as grinding, conching and refining, tempering, moulding.

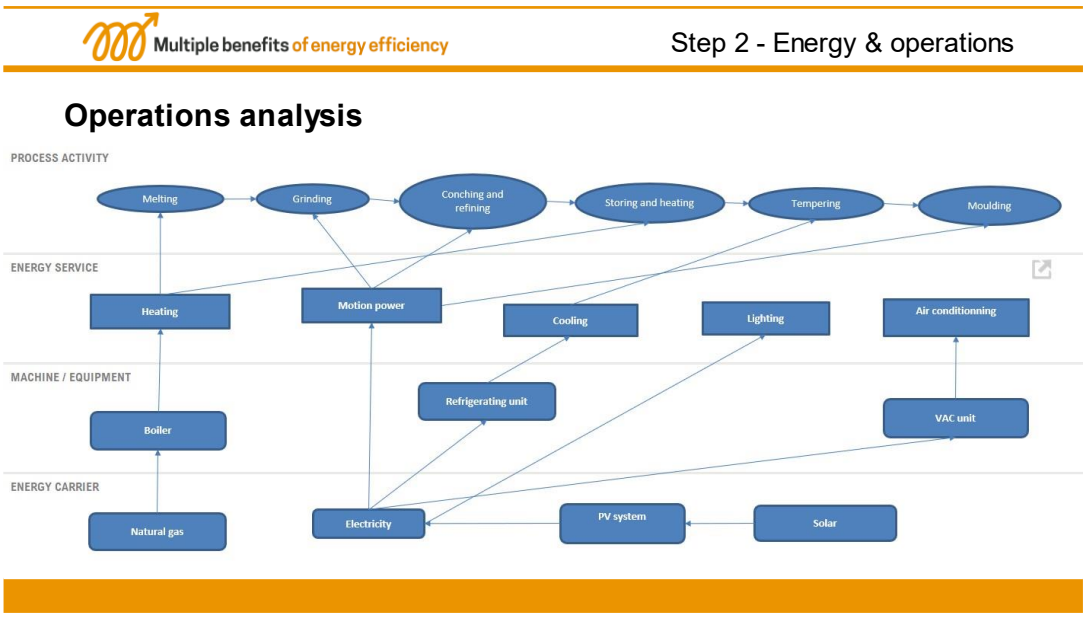


Figure 141. Results of the Operations Analysis-Operational diagram- Carletti Polska Sp. z o.o

Results of the Strategic Analysis

The multiple benefits analysis leads to following results:

Cost Impacts:

- Reduction of electricity consumption: The reduction of electricity corresponds to the savings of 83'229 PLN/a.

Value proposition impacts:

Utilization of a clean renewable energy has also several implications on value proposition of the company:

- Improved image and reputation – the enterprise is received as an environmentally friendly, which can lead to improved customer satisfaction.
- Contribution to company's vision and strategy.

Implementation of the proposed measure would result in reduction of the following risks:

- Reduction of electricity price growth risk due to increased energy self-sufficiency.

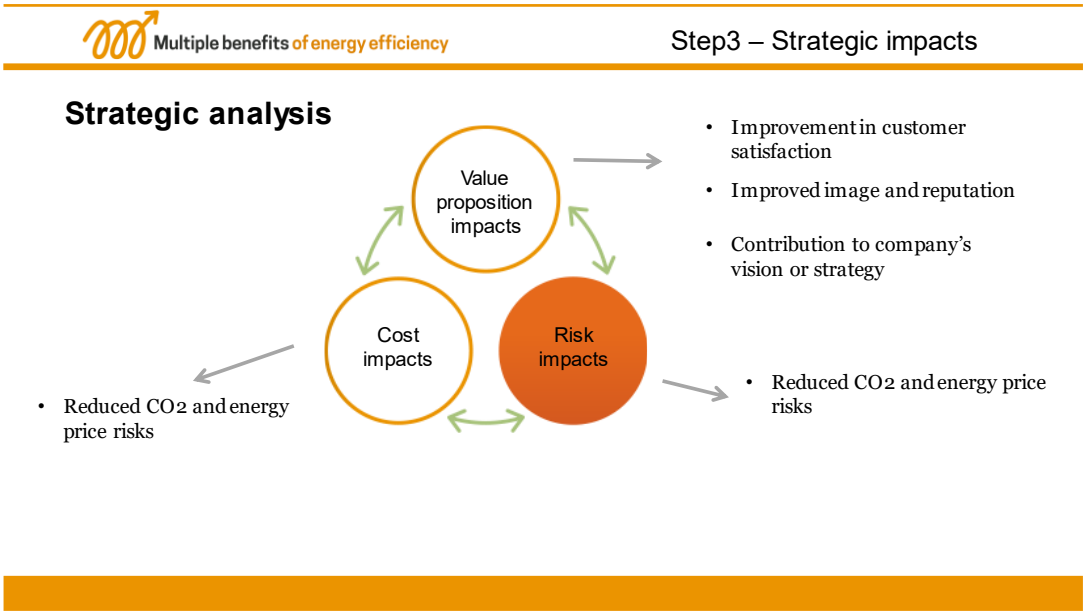


Figure 142. Results of the Strategic Analysis. Carletti Polska Sp. z o.o

Results of the Financial Analysis

The results of the financial analysis considering energy benefits only (left hand side) and all benefits (right hand side) are shown below. In both cases capital expenditures (CAPEX) amount to a total of 847'600 PLN (year 0) plus non-capital expenditures – construction permit of 1'694 PLN. CAPEX consists of: PV modules, inverters, solar wires, assembly. No subsidy is considered. Annual PV modules degradation of 1% was taken into account in the analysis.

Recurring multiple benefits are:

- Decreased electricity consumption – 83'229 kWh.

The analysis considered the impact of electricity price growth.

In the "Energy benefits only" scenario the analysis was performed based on the assumption that electricity price stays on the same level. The results show a negative net present value of the investment (-59'831 PLN) and payback time of 14 years.

In order to visualize and measure the impact of electricity price growth a simulation was performed. The "All benefits" scenario assumes growth of electricity prices of 2% per year. In this scenario NPV of the investment shows positive value of 95'274 PLN and payback time is reduced to 12 years.

The capital budgeting results are shown below for the discount rate of 6% and an investment duration of 25 years.

The simulation as above presents how electricity price strongly influences a profitability of the investment.

Multiple benefits of energy efficiency — Step 4– Financial impacts

Financial analysis

Energy benefits only

- CAPEX: 847 000 PLN
- NPV: - 59 831 €
- IRR: 5,21%
- Simple payback: 14 years

All benefits

- CAPEX: 847 000 PLN
- NPV: 95 274 PLN
- IRR: 7,10 %
- Simple payback: 12 years

Discount rate: 6 %

Investment duration: 25 years (i.e. the number of years taken into account to compute NPV and IRR)

Growth of electricity prices: 2% per year

Figure 143. Results of the Financial Analysis. Carletti Polska Sp. z o.o

Key Arguments for the Project Implementation

The key arguments for the implementation of the energy efficiency measure (see slide below) are therefore the resulting both non-energy and energy benefits.

The annual energy savings show a value of 83'229 PLN. However, even a minor growth of electricity price will increase a profitability of the investment significantly. Thus, the measure increases a security against predicted electricity price growth.

Besides the financial benefits, the measure contributes to the aspects as follow:

- Delivery of "green", environmentally friendly product, developed in sustainable conditions utilizing energy generated form RES.
- Image of environmentally friendly enterprise that follows sustainability standards – reduction of primary energy: 629'412 kWh/year.

Multiple benefits of energy efficiency — Conclusion

Why you should absolutely approve this project:

- Delivery of "green", environmentally friendly product, developed in sustainable conditions using energy generated from RES.
- Contribution to better, "green" image of the company following sustainability standards. Potential for using this advantage in marketing actions. The measurable advantage strongly depends on the expectations of the customers .
- Significant reduction of primary energy: 629 412 kWh/year
- Security against predicted rise in electricity prices

Figure 144. Key Arguments for the Project Implementation. Carletti Polska Sp. z o.o

Key Issues and Highlights

The key arguments for the implementation of the energy efficiency measure are both energy and identified non-energy benefits. Electricity price growth has a key impact on profitability of the project. Besides the benefits that could be monetarized, a comprehensive analysis according to the M-Benefits methodology enabled to identify other positives aspects of the considered investment.

Investment that provides electricity from RES generally do not contribute to increase of quality of energy services. Quality of electricity stays the same whether it comes from a local grid or PV system. Therefore, the potential for identification of non-energy benefits for PV investments is limited.

2.5.3 Pilot 3: Deployment of a ground-mounted PV installation Medium scale dairy in Poland

Due to the confidentality reasons and the policy of the company, the pilot project do not reveal the name of the dairy, however all the data and information used in the pilot project are real.

Project Idea and Rationale

The company is a medium-sized county dairy cooperative that produces various types of cheeses.

There is a steady tendency in Poland of electricity prices growth caused by the global situation of higher costs of CO_2 emission allowances for energy supply companies. The costs of CO_2 emission allowances are reflected in electricity tariffs for end users. Big-scale end users (e.g. industry) usually have negotiated prices due to significant volume of electricity consumed. The growth of electricity prices has been seen mainly in a sector of small and medium enterprises. The electricity tariffs for individuals were frozen by the government in order to protect them from a significant growth of electricity bills' values.

There is urgent necessity to build new power plants, which are able to replace inefficient and outdated old electricity generated units being close to the lock down. That is also reflected in electricity tariffs. In 2019, *electricity prices* for the industry in *Poland* exceeded 10 euro cents per kilowatt-hour, an *increase* of 14 percent compared to the previous year.

In order to decrease dependency from electricity prices growth enterprises start looking at RES technologies providing self-sufficiency in some extend. It was proposed to analyze and consider deployment of PV system, which addresses the issue as above and is also in line with the company's policy development.

Many SMEs in Poland are seeking for RES and EE technologies that will mitigate the impact of electricity price growth.

Multiple benefits of energy efficiency — Project idea and rationale

Current situation and weaknesses:

- Uncertainty regarding electricity prices
- Price growth is foreseen in upcoming years especially for SMEs
- Concern for company's image
- Will of following the global trends

Energy-efficiency measure(s) proposed and advantages:

- Deployment of PV installation of total capacity 380 kWp
- Reduction of conventional electricity consumption
- Electricity generation from RES - 317 426 kWh/year
- Security against predicted rise in electricity prices

Figure 145. Project Idea and Rationale. Deployment of a ground-mounted PV installation in Poland, confidential

KAPE elaborated a prefeasibility study of a ground-mounted PV installation.

The total annual electricity consumption in the company in 2019 was 3,453 MWh. Due to the relatively high consumption of electricity in the enterprise and even distribution of electricity demand in individual hours throughout a year, a model assuming full use of energy produced in the PV installation for own needs without selling surplus to the grid was proposed. This allows to maximize the economic effect of the project.

The available space allows the installation of a photovoltaic generator with a capacity of approx. 380 kW_p composed by 1,267 modules with a capacity of 300 W_p each using the full possible technical potential of the company's premises.

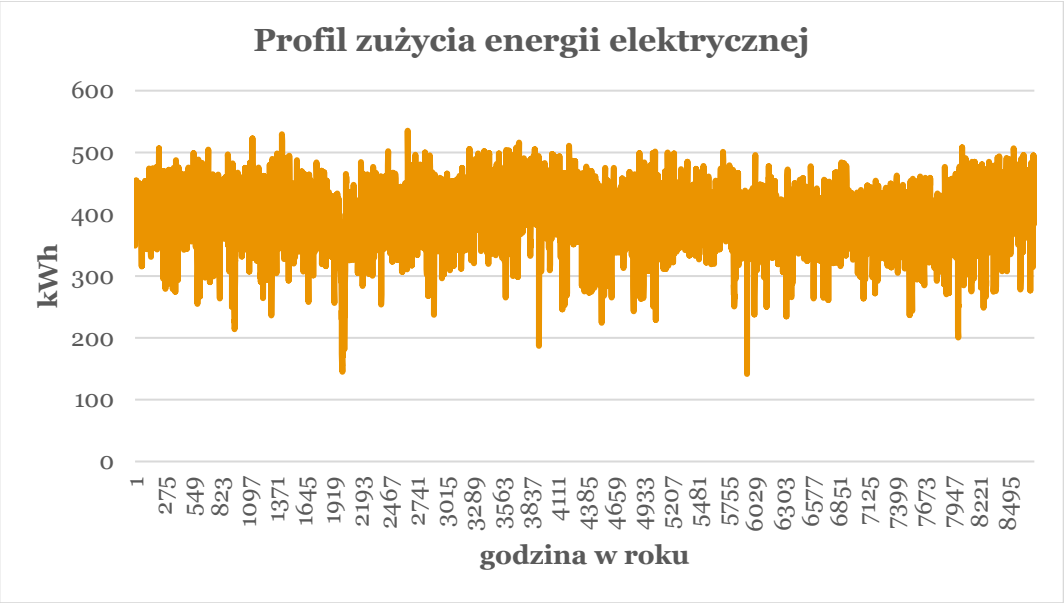


Figure 146. The electricity consumption hourly profile of 2019. Deployment of a ground-mounted PV installation in Poland, confidential.

Results of the Company Analysis

The county dairy cooperative has over 90 years of experience, excellent taste and the trust of its Polish customers. It all began in 20's, when the local farmers and landowners joined forces to establish the dairy.

Initially, the cooperative specialized in the production of high-quality butter and thick cream. For decades it has been famous for various types of cheese.

Over the years the cheesemakers have been honing their skills and improving the taste of their products. Their passion for their trade has resulted in the creation of a unique recipe that has been appreciated in millions of Polish homes.

The high quality of the products is confirmed by numerous titles awarded in the contest organized by the "Good, because its Polish" label, and the ISO certification encompassing all the dairy products.

For the company is the most important to maintain the highest quality of the products at any costs.

Company's activity:

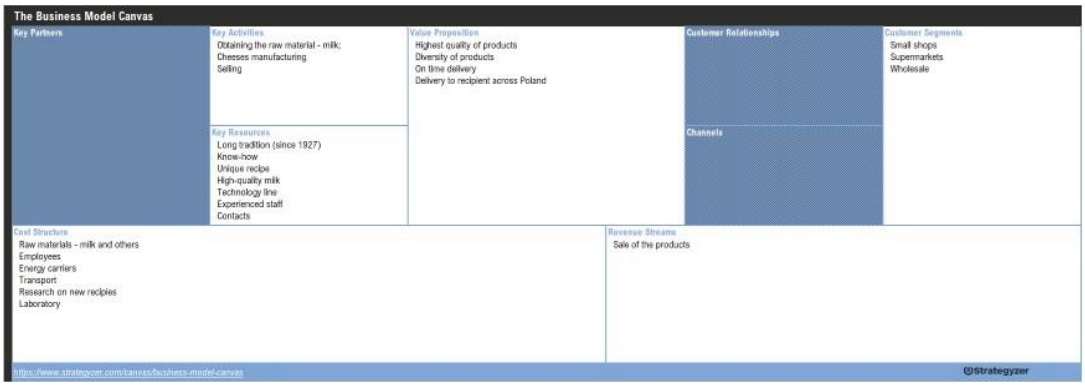


Figure 147. Results of the Company Analysis. Deployment of a ground-mounted PV installation in Poland, confidential

Results of the Energy Analysis

Energy carrier which is impacted by the proposed measure is electricity. The electricity consumption in 2019 was as follows:

Electricity: 3'453 MWh/a.

The PV system is designed to fully utilized available area with the assumption to fully self-consume electricity generated in PV installation without any surplus. Estimated electricity generated in PV system equals to 317'426 kWh/a, which corresponds to financial savings of 126'970 PLN/a. The share of renewable electricity generated and directly self-consumed is 9,2% of total electricity consumption. Calculated reduction of primary energy corresponds to 952 278 kWh/and is three times higher than the energy generation (final energy) due to the energy mix in Poland, which is mainly based on hard coal and lignite.

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Energy carriers impacted by the project: electricity
- Consumption (2019)
  - Electricity – (3 453 122 k Wh consumed/year)

Future energy consumption (after EEM implementation)

- Estimated physical savings: 317 426 kWh/year
- Estimated financial savings: 126 970 PLN /year
- Renewable energy auto-produced in % of total energy consumption : 9,2 %
- Reduction of primary energy : 952 278 kWh/year

Figure 148. Results of the Energy Analysis. Deployment of a ground-mounted PV installation in Poland, confidential

Results of the Operations Analysis

The production workflow is composed by many process activities. Electricity is used to provide the following energy services:

- Chilling water
- Compressed air
- Lighting
- Technological steam (only for the boiler control).

These energy services contribute to maintenance of process activities as cooling, pressing (pneumatic cheese press) and pasteurization.

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Operations analysis

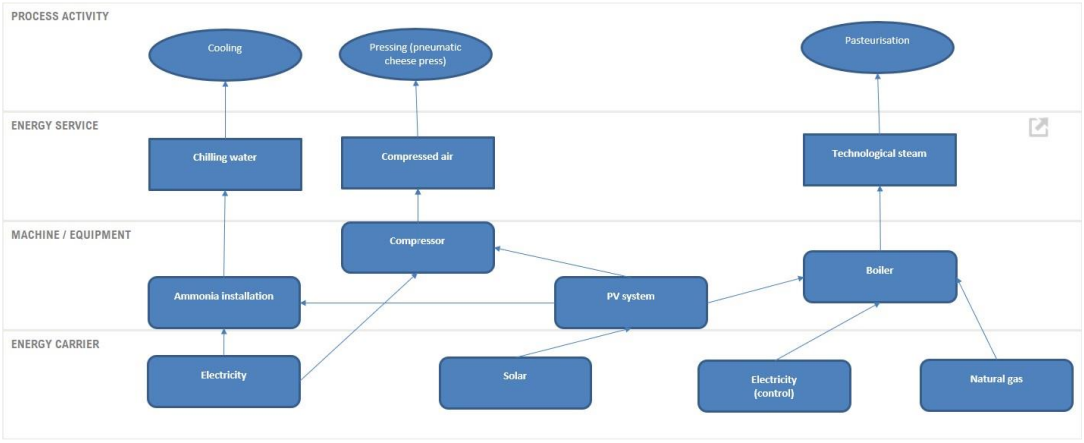


Figure 149. Results of the Operations Analysis-Operational diagram. Deployment of a ground-mounted PV installation in Poland, confidential.

Results of the Strategic Analysis

The multiple benefits analysis leads to following results:

Cost Impacts:

f) Reduction of electricity consumption: The reduction of electricity corresponds to the savings of 126'970 PLN/a.

Value proposition impacts:

Utilization of a clean renewable energy has also several implications on value proposition of the company:

- Improved image and reputation – the enterprise is received as an environmentally friendly, which can lead to improved customer satisfaction.
- Contribution to company's vision and strategy.

Implementation of the proposed measure results in reduction of the following risks:

a) Reduction of electricity price growth risk due to increased energy self-sufficiency.

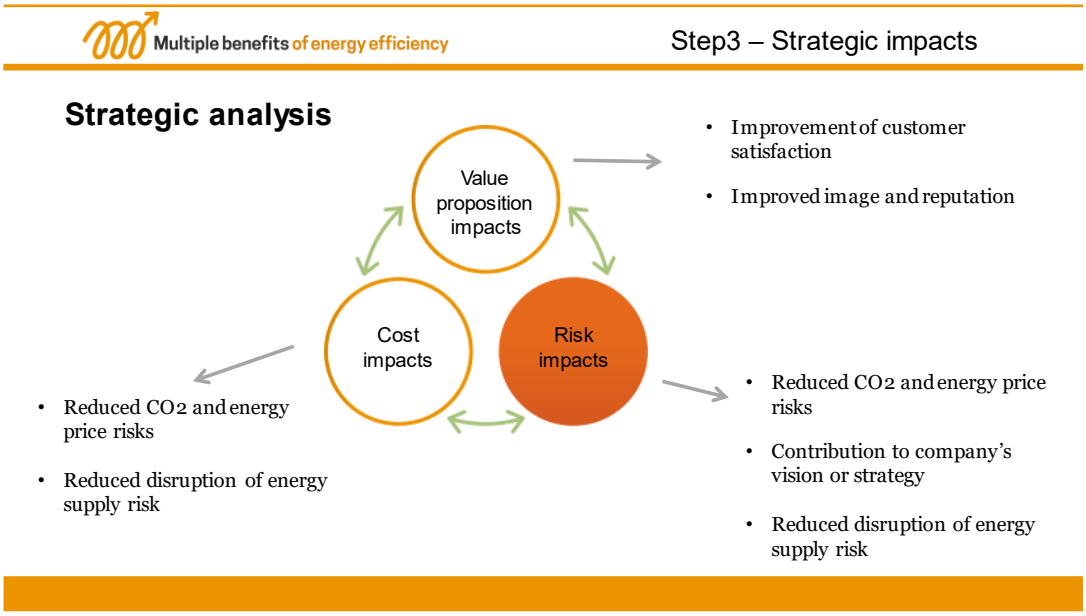


Figure 150. Results of the Strategic Analysis. Deployment of a ground-mounted PV installation in Poland, confidential.

Results of the Financial Analysis

The results of the financial analysis considering energy benefits only (left hand side) and all benefits (right hand side) are shown below. In both cases capital expenditures (CAPEX) amount to a total of 1'330'000 PLN (year 0) plus non-capital expenditure – construction permit of 2'660 PLN. CAPEX consists of: PV modules, inverters, solar wires, assembly. No subsidy is considered. Annual PV modules degradation of 1% was considered in the analysis.

Recurring multiple benefits are:

c) Decreased electricity consumption – 317'426 kWh.

The analysis considered the impact of electricity price growth.

In the “Energy benefits only” scenario the analysis was performed based on the assumption that electricity price stays on the same level. The results show that NPV has value of only 18 PLN and payback time of 13 years.

To visualize and measure the impact of electricity price growth a simulation was performed. The “All benefits” scenario assumes growth of electricity prices of 3% per year. In this scenario NPV of the investment shows positive value of 380’689 PLN and reduced payback time to 11 years.

The capital budgeting results are shown below for the discount rate of 6% and investment duration of 25 years.

The simulation as above presents how electricity price strongly influences a profitability of the investment.

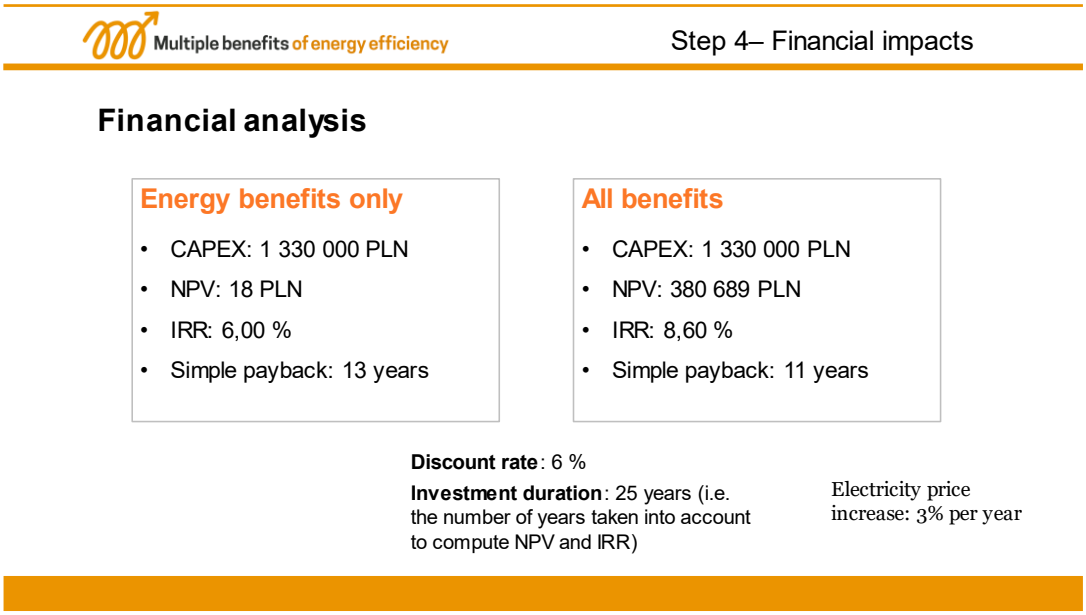


Figure 151. Results of the Financial Analysis. Deployment of a ground-mounted PV installation in Poland, confidential.

Key Arguments for the Project Implementation

The key arguments for the implementation of the energy efficiency measure (see slide below) are therefore the resulting both non-energy and energy benefits.

The annual energy savings show a value of 126’970 PLN. However, even a minor growth of electricity price will increase a profitability of the investment significantly. Thus, the measure increases a security against predicted electricity price growth.

Besides the financial benefits, the measure contributes to the aspects as follow:

- Delivery of “green”, environmentally friendly product, developed in sustainable conditions utilizing energy generated form RES.
- Image of environmentally friendly enterprise that follows sustainability standards – reduction of primary energy: 952’278 kWh/year.

Why you should absolutely approve this project:

- Significant share of renewable energy auto-produced in % of total energy consumption: 9,2 %.
- Security against predicted rise in electricity prices.
- Image of modern and „green" company – potential for marketing activities.
- Positive results of financial analysis NPV: 380 689 PLN, IRR: 8,60 %.

Figure 152. Key Arguments for the Project Implementation. Deployment of a ground-mounted PV installation in Poland, confidental.

Key Issues and Highlights

The key arguments for the implementation of the energy efficiency measure are both energy and identified non-energy benefits. Electricity price growth has a key impact on profitability of the project. Besides the benefits that could be monetarized, the comprehensive analysis according to the M-Benefits methodology enabled to identify other positives aspects of the considered investment.

Investment that provides electricity from RES generally do not contribute to increase of quality of energy services. Quality of electricity stays the same whether it comes from a local grid or PV system. Therefore, the potential for identification of non-energy benefits for PV investments is limited.

2.6 Reports Portugal

Author, Organization: (Joao Fong, ISR - University of Coimbra)

2.6.1 Two Reports missing

Number of missing reports on pilots: 2

The implementation of the pilot projects was seriously delayed by the COVID-19 pandemic, with companies which were cooperating shutting down temporarily or working only in partial capacity. Some companies ceased their cooperation due to the impact of the pandemic. In general, energy efficiency was found to be in a low position on the priority list of the companies contacted, which was made worse by the current COVID-19 situation.

Although stakeholders were initially receptive to the project concept and were willing to collaborate, as time went by and as they realised there was the need for their staff to spend some time with MBenefits and get involved with the serious game, their enthusiasm was waning, and the arrival of the pandemic further aggravated this situation. Although very interested in energy efficiency, in a broad sense, and recognising that the multiple benefits (e.g. air renewal) were even more perennial amid COVID pandemic, concerns about the economic situation and financial crisis overtook all agendas.

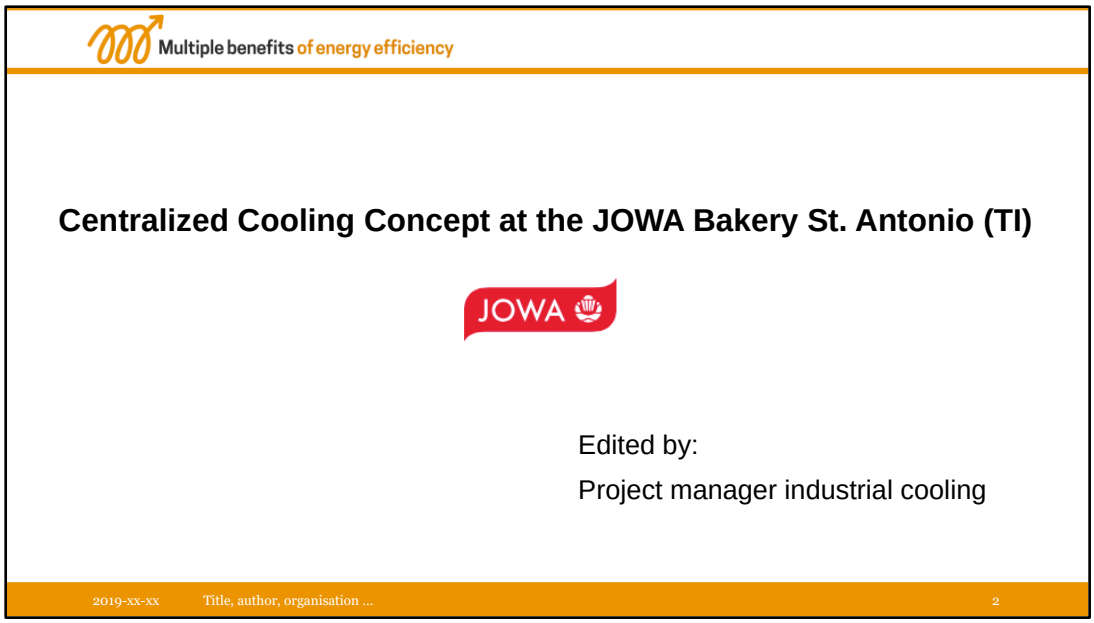
Time to dedicate to the pilot project (collection of data to fill in the spreadsheets) was very limited and it was difficult to schedule meetings, which were sometimes postponed due to the emergence of more pressing issues. Even when simple energy audit based on measurements in the installations was offered as an incentive, it became very difficult for us to maintain collaboration with some pilots. Even companies that had shown their interest with a LoS, failed to collaborate with us in due time. Because of this ISR-University of Coimbra was not able to meet the agreed deadlines for the Pilot Implementation reports.

2.8 Switzerland - HSLU

Author, Organization (Ingo Schneider, HSLU)

2.8.1 Pilot 1: Centralized Cooling Concept

JOWA Bakery St. Antonio (TI)



Project Idea and Rationale

The JOWA bakery employs 19 individual cooling systems using HFC coolants with high Global Warming Potential (GWP). The cooling systems supply different consumers like fermentation stop ovens, cooling chambers, and warehouses with cold. Some of the cooling systems were installed in the early 1970s: recurring leakages lead to production downtimes due to necessary repairs and supply with spare parts is not secured. Due to regulations, the coolant in 8 refrigeration systems (GWP> 2500) must be replaced until 2030. The coolant strategy aims to eliminate HFC coolants with a total GWP of 1'800t CO_2eq. at the JOWA bakery in St. Antonio with CO2 cooling agent. At present the storage capacity for frozen goods is too small. In addition to the bakery's freezing chamber, one fermentation stop oven is employed as a cooling chamber and cannot be used for production. Moreover, external freezing capacity is rented by the bakery for storing frozen goods. An extension of the existing freezing chamber would require the replacement of the respective cooling system (Power >30kW) because of legal restrictions.

Multiple benefits of energy efficiency — Project idea and rationale

Current situation and weaknesses:

- System age: 19 individual cooling systems using HFC refrigerants (partly from the 1970s) supply different consumers (fermentation stop oven, cooling chamber, warehouses)
- Operational safety: Recurring leakages in plants (fermentation stop oven) with production downtimes due to repairs, spare parts supply not secure
- Legal requirements :
  - From 2030, no coolant (GWP> 2500) may be refilled in 8 refrigeration systems.
  - For an extension of a freezer room the existing (decentralized) refrigeration system would have to be replaced (ChemRRV, power > 30kW).
- Refrigerant strategy: Refrigerant in use with total GWP = 1'800t CO_2eq. (location St. Antonio)

Figure 153. Project Idea and Rationale. JOWA Bakery St. Antonio (TI).

The bakery plans to install a new centralized cooling system. This energy efficiency measure would not only lead to much lower electricity consumption, but its implementation promises several additional advantages, thereby solving several of the present issues stated above:

Multiple benefits of energy efficiency — Project idea and rationale

Energy-efficiency measure(s) proposed and advantages:

- Centralized cooling plant (CO_2 based coolant with GWP=1)
- High operational reliability and integrated redundancy
- Almost 100% implementation of the coolant strategy at the site
- Lower electricity and maintenance costs
- Waste heat utilization leads to lower gas and oil consumption
- Reduction of repair-related production downtimes
- Enables an extension of a cooling chamber
- Avoided investments until 2030 (refrigerant change, replacement of air conditioning unit)
- Incentives 75'000CHF

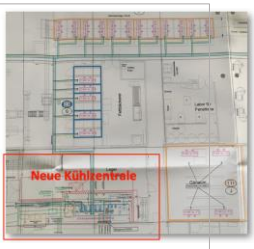


Figure 154. Project Idea and Rationale. JOWA Bakery St. Antonio (TI).

Results of the Company Analysis

The JOWA bakery St. Antonio is producing a variety of frozen partially baked breads and Panettone cakes. The bakery offers 'Daily Freshness' and best price-value ratio 'Best Quality at the Best Price'. They supply the MIGROS stores in Ticino with baked goods, thereby helping the MIGROS cooperatives to present themself as a full-service provider. JOWA is an industrial bakery, however, they also operate the in-store 'home bakeries' in the MIGROS stores. Besides MIGROS the wholesale supplier Saviva and other discounters in Switzerland are among the JOWA

customers. In addition to raw materials, personnel cost and rent, energy is a major cost factor.

Figure 155. Results of the Company Analysis. JOWA Bakery St. Antonio (TI).

Results of the Energy Analysis

Energy carriers which are impacted by the energy efficiency measure are electricity, natural gas, and heating oil. The energy consumption in 2019 was as follows:

Electricity: 1'846'723kWh/a

Natural gas: 2'642'721 kWh/a

Heating oil: 6'449 kWh/a

The centralized cooling unit is operated with electrical energy. The estimated annual electricity savings are 193'000kWh, which results in lower energy cost of 28'950CHF/a. In addition, the possibility of waste heat utilization results in savings of 100'000kWh/a of fossil fuels, i.e. natural gas and heating oil. The respective cost savings are 8'000CHF/a, which are considered by the Excel tool as multiple benefits of the energy efficiency measure. After implementation, the total energy consumption of the production site improves by 4.29% (6.52% incl. savings in fossil fuel).

Energy analysis

Current energy consumption:

- Energy carriers impacted by the project: electricity, natural gas, heating oil
- Consumption (2019)
  - Electricity : 1'846'723kWh/a (natural gas: 2'642'721 kWh/a, heating oil: 6'449 kWh/a)

Future energy consumption (after EEM implementation)

- Estimated physical savings: 193'000 kWh/a (plus saving of natural gas and heating oil: counts as "multiple use waste heat utilization" 100'000kWh/a)
- Estimated financial savings: 28'950 CHF/a
- Improvement of total energy consumption: 4.29% (6.52% incl. fossil)
- Impact on indicators of energy performance: 0.2% (energy intensity)

Figure 156. Results of the Energy Analysis. JOWA Bakery St. Antonio (TI).

Results of the Operations Analysis

The production workflow and the layout of the bakery are shown below. The raw materials are delivered to the left-hand side of the factory and there they are stored in a warehouse. Finished goods leave the factory on the right-hand side. Due to limited warehouse capacity, part of the frozen finished goods must be stored in an external warehouse (rental costs: 15'000CHF/a). For production of baked goods, the raw material is weighted and then mixed to produce the dough. The dough is then brought into a defined shape and put into fermentation stop ovens for fermentation and baking. The fermentation stop ovens are connected to a cooling device, which deliver the cold for the process step. The baked goods are then decorated and packed. The partially baked breads are frozen. The centralized cooling device is operated by electricity and delivers the energy services 'cooling/freezing' and 'air conditioning'. Cooling/freezing affects the process steps storage of raw materials/finished goods, fermentation stop and cooling/freezing of finished goods. Air conditioning affects the kneading and shaping of the dough and the decoration and packing of baked goods.

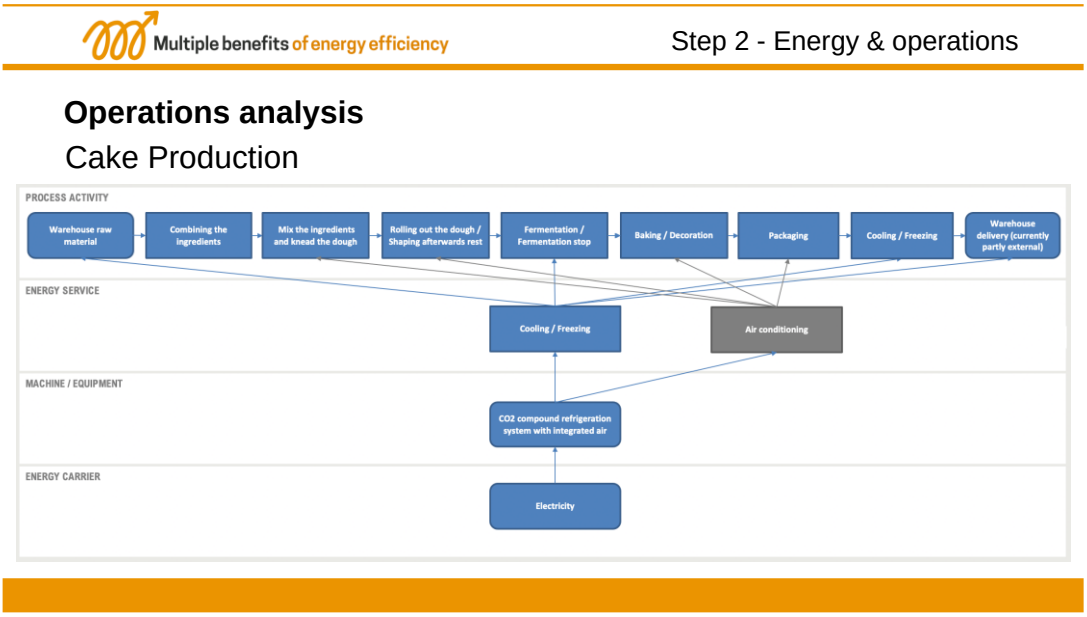


Figure 157. Results of the Operations Analysis-Operational diagram. JOWA Bakery St. Antonio (TI).

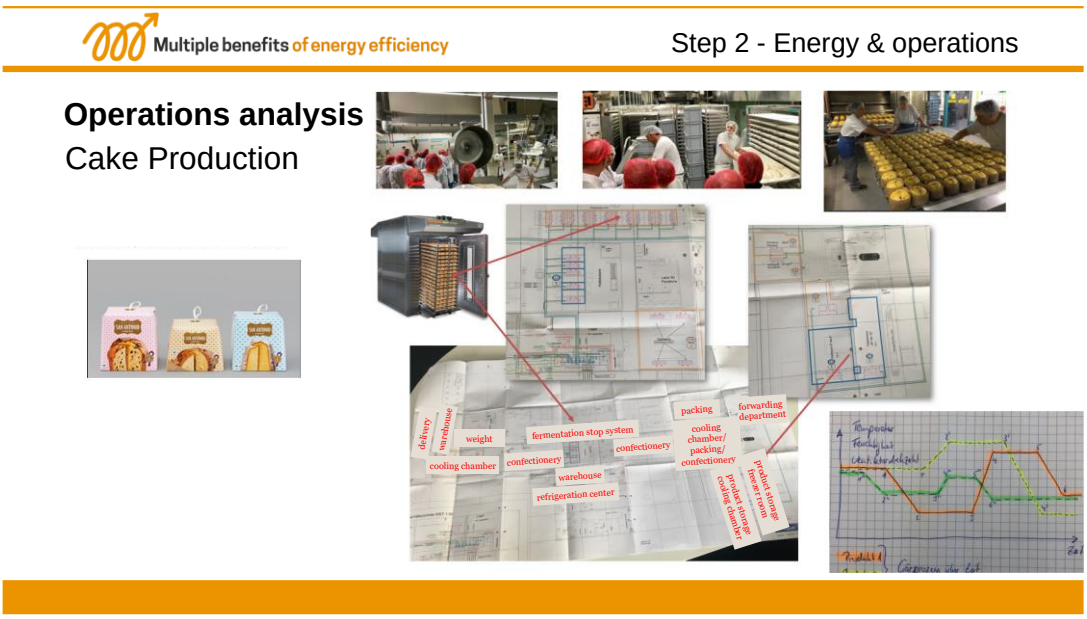


Figure 158. Results of the Operations Analysis-Operational diagram. JOWA Bakery St. Antonio (TI).

Results of the Strategic Analysis

The multiple benefits analysis leads to following results:

Cost Impacts: i) Reduction of unplanned downtimes: The fermentation-stop ovens had leaks, which lead to production interruptions of about 10 hours per year. As a result 4-6 workers had to work overtime (5'000CHF/a), ii) Reduced maintenance cost: Number of compressors reduces from 15 to 5 (10'000CHF/a), iii) Reduced malfunction or breakdown of machinery and equipment: Fermentation stop ovens had leaks (internal working hours and external service cost results in avg. cost of 8'000CHF/a), iv) Reduced warehousing costs: The cooling chamber can be extended (65m2) at low cost (20'000CHF for masonry work), thus eliminating external storage costs (15'000CHF/a), v) improved workforce productivity: The extension of the cooling chamber allows larger batches as one fermentation stop oven is no longer

blocked as a cooling chamber, and can be used for production. According to the site manager, the larger batch size will save six man-hours of set-up time per week (30'000CHF/a), vi) Waste heat utilization results in savings of 100'000 kWh of fossil fuels (8'000CHF/a), vii) Contribution to regulatory compliance/reporting: Due to regulations, the HFC coolant of 8/19 cooling systems (GWP> 2500) must be replaced until 2030 (cost 100'000CHF). Operation of the eight units will be discontinued with the installation of the centralized cooling unit, resulting in cost savings of 100'000CHF, viii) Delayed or reduced capital expenditure: A replacement of the present air-conditioning system is budgeted for 2024 (260'000CHF). This investment is no longer needed, as a new air conditioning unit is part of the centralized cooling solution, viiii) Reduced CO, CO2, NOx, SOx emissions: cost included in energy cost.

Value proposition impacts: i) The coolant strategy aims to eliminate HFC coolants with a total GWP of 1'800t CO_2eq. at the JOWA bakery in St. Antonio with CO2 cooling agent. This target can be met with the installation of the centralized cooling unit, ii) improved image and reputation, iii) improved product consistency: The fermentation process will be automized as the energy efficiency measure is implemented, but this measure is not part of the investment considered here.

Risk impacts: i) Increased production reliability (due to better control): The new cooling system offers centralized monitoring and some redundancy: 'Only a forklift truck can drive into the cooling pipes'. A new central refrigeration system (redundancy by reserve) replaces many small systems, ii) reduction of HFC emission risk: Greenhouse gas potential in refrigeration plants at the site approx. 1'800t CO2 eq. (approx. 10% of total JOWA), iii) reduction of unplanned downtimes: a) risk of production loss: Ensuring the operational safety of refrigeration systems with regard to shortage of refrigerants (legal requirements ChemRRV); b) fermentation stop cells: risk of further leakages, iv) reduced malfunction or breakdown of machinery and equipment: a) fermentation stop cells: risk of further leaks; b) control of fermentation stop cells: spare parts risk, v) reduced CO2 and energy price risks due to an overall lower energy consumption, vi) improved product consistency: Automation eliminates the risk of manipulation and offers more transparency.

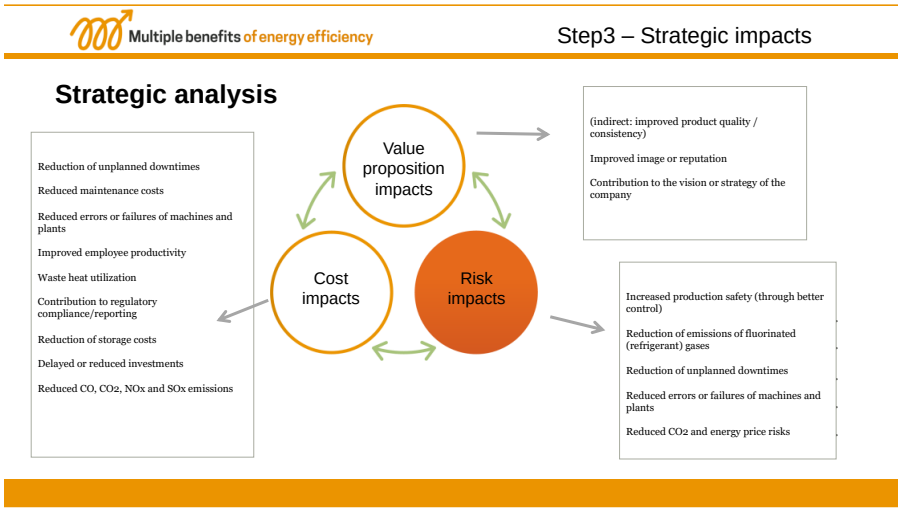


Figure 159. Results of the Strategic Analysis. JOWA Bakery St. Antonio (TI).

Results of the Financial Analysis

The results of the financial analysis considering energy benefits only (left hand side) and all benefits (right hand side) are shown below. In both case capital expenditures (CAPEX) amount to a total of 930'000CHF (year 0). CAPEX consists of: Cooling unit 315'000CHF, cooling distribution 80'000CHF, conversion of all consumers 185'000CHF, disassembly of old plants 20'000CHF, alarm and gas monitoring 50'000CHF, building for cooling plant 40'000CHF, electrical installations, ventilation, sanitary 240'000CHF, the cost for the automation of the fermentation process (80'000CHF) and for the masonry work for the expansion of cooling chamber (20'000CHF) are not part of the energy efficiency measure and they are not considered here. Subsidy is 75'000CHF.

Recurring multiple benefits are: 0) electricity savings (28'950CHF/a from year 1), i) reduction of unplanned downtimes (5'000CHF/a from year 1), ii) reduced maintenance cost (10'000CHF/a from year 1), iii) reduced malfunction or breakdown of machinery and equipment(8'000CHF/a from year 1), iv) reduced warehousing costs (15'000CHF/a from year 1), v) improved workforce productivity (30'000CHF/a from year 1), vi) waste heat utilization (8'000CHF/a from year 1). Non-Recurring multiple benefits are: i) Contribution to regulatory compliance/reporting (total 100'000CHF: 20'000CHF each in years 1,3,5,7,9), ii) delayed or reduced capital expenditure (260'000CHF in year 4).

The capital budgeting results are shown below for the discount rate of 9% and an investment duration of 15 years. Any energy efficiency measure with a payback period of at least 8years will be approved by the management of the company. This mandatory requirement for implementation is only met if all benefits are considered, while the consideration of the energy benefits alone leads to an extremely long payback time of more than three decades and accordingly to strong negative values for NPV and IRR.

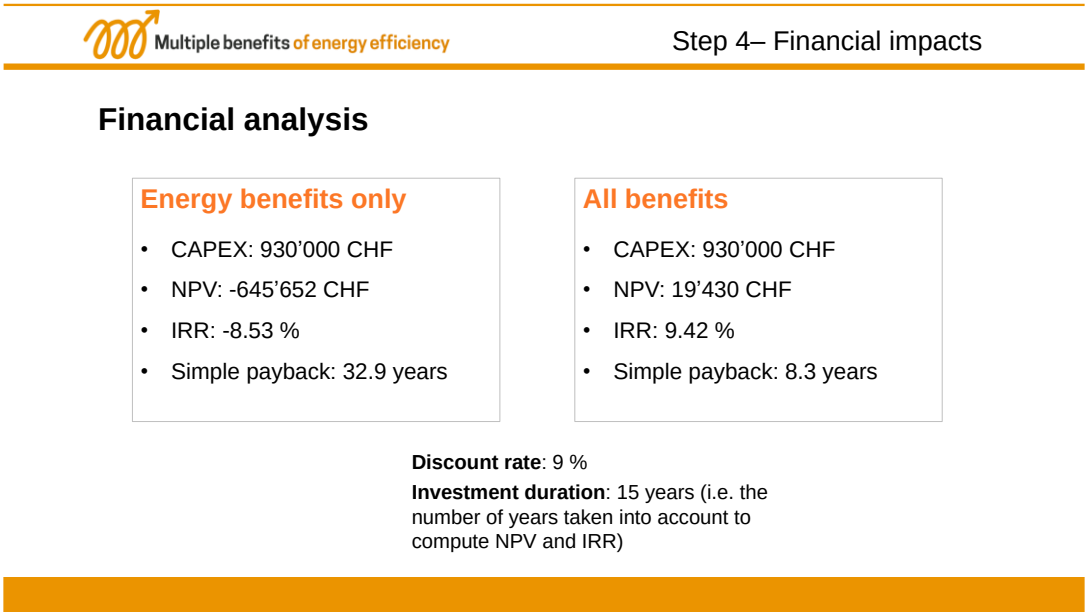


Figure 160. Results of the Financial Analysis. JOWA Bakery St. Antonio (TI).

Key Arguments for the Project Implementation

The key arguments for the implementation of the energy efficiency measure (see slide below) are therefore the resulting non-energy benefits. The annual energy

savings show a value of 35'000CHF, already including the additional savings from waste heat utilization. However, the annual savings from non-energy benefits, i.e. reduced warehousing, repair, maintenance and personnel cost are almost twice as high (68'000CHF). These annual savings occur in addition to avoided investments in the order of 360'000CHF (over 9years) and a subsidy of 75'000CHF. Overall, these financial figures result in a payback period of 8 years. A payback period of at least 8years is, however, the only argument needed for the implementation of the energy efficiency project at the JOWA bakery.

Multiple benefits of energy efficiency — Conclusion

Why you should absolutely approve this project:

- Central refrigerating plant offers high operational reliability, reduces maintenance costs and avoids continuous repair-related production downtimes.
- Almost 100% implementation of the JOWA refrigerant strategy at the site.
- Expansion of the cooling area: Avoided external storage of products and improved batch size (less set-up time) reduce storage and personnel costs by 45'000CHF/a
- Electricity costs savings and waste heat utilization reduce energy costs by 35'000CHF/a
- Avoided investments of 360'000CHF until 2030 (refrigerant, air-conditioning cold water)
- Grants 75'000CHF and amortization period of about 8 years

Figure 161. Key Arguments for the Project Implementation. JOWA Bakery St. Antonio (TI).

Key Issues and Highlights

The key arguments for the implementation of the energy efficiency measure are the identified non-energy benefits, as the payback period improves from more than 30years to 8years if all non-energy benefits are considered. Any energy efficiency measure with a payback period of at least 8years is approved by the management of the company. This mandatory requirement for implementation is only met if all energy and non-energy benefits are considered. The results obtained in this pilot project are a prime example how the consideration of multiple benefits can boost investments in energy efficiency.

2.8.2 Pilot 2: New Heat Concept ‘Project Lakewater’

MIDOR Food Factory Meilen (ZH)

Multiple benefits of energy efficiency

Heat concept for MIDOR Meilen (ZH)
'Project Lakewater'

Edited by:

Project manager industrial heat

2019-xx-xx Title, author, organisation ... 2

Project Idea and Rationale

The MIDOR food factory operates four production plants in the city of Meilen which is situated at Lake Zurich. A review of the current situation has identified several opportunities for improving energy efficiency at the production site:

i) the existing heat pump is connected to the re-cooling network of plant 1. The heat pump requires a minimum temperature of 20°C. As the temperature drops below the required minimum value during winter, the running time is relatively short, ii) low pressure steam is required in plant 1 for humidifying the maturation room. The steam is currently generated with the 110°C hot water network, iii) the heating temperature must be kept at a comparable high level of 80°C, to guarantee a hot water temperature of 60°C, iv) low pressure steam is required in plant 4 for cleaning purposes. The steam is currently generated with the hot water network 110°C. The long pipes cause losses of approximately 10 MWh/a. v) The existing Midor heating system is oversized (see slides below). The boilers are not efficient and at the end of their lifetime.

Multiple benefits of energy efficiency — Project idea and rationale

Current situation and weaknesses:

1. The existing heat pump is connected to the re-cooling network of plant 1. The heat pump requires a minimum temperature of 20° C. In winter, the temperature drops below the required minimum. Consequently, the running time is relatively short.
2. Low pressure steam is required in plant 1 for humidifying the maturation room. The steam is currently generated with the 110° C hot water network.
3. The heating temperature must be kept at 80° C, in order to guarantee a hot water temperature of 60° C.
4. Low pressure steam is required in plant 4 for cleaning purposes. The steam is currently generated with the hot water network 110° C. The long pipes cause losses of approximately 10 MWh/a.

Figure 162. Project Idea and Rationale. MIDOR Food Factory Meilen.

Multiple benefits of energy efficiency — Project idea and rationale

Current situation and weaknesses:

5. The existing Midor heating system is oversized. The boilers are not efficient and at the end of their lifetime.

	T = 65/50° C	T = 100/85
Peak performance:	2'000 kW	1'000 kW
Standard performance:	1'000 kW	600 kW
Heat production:	2'000 MWh/a	2'000 MWh/a

Figure 163. Project Idea and Rationale. MIDOR Food Factory Meilen.

A new heat concept 'Project Lakewater' shall be implemented to improve the efficiency of the heat supply. This project proposes several energy efficiencies measures to address the issues stated before: i) The total annual operating time of the heat pump in plant 1 can be extended by 1000h, if the temperature is kept above 20°C by re-cooling on the internal seawater network. This means that the heat pump can be used more efficiently, especially in winter, resulting in an additional heat production of 380MWh/a at the expense of an additional 85MWh electricity consumption, ii) instead of steam, simple cold water fogging can be employed for humidifying the maturation room in plant 1, resulting in savings of 33MWh/a of fossil fuel (natural gas).

Multiple benefits of energy efficiency — Project idea and rationale

Energy-efficiency measure(s) proposed and advantages:

1. Optimization heat pump plant 1:

The temperature can be kept above 20° C by recooling on the internal seawater network. This means that the heat pump can be used more efficiently, especially in winter.

Current:	Qo = 370 kW;	t = 3'000 h	Q = 1'100 MWh/a
New:	Qo = 370 kW ;	t = 4'000 h	Q = 1'480 MWh/a
Efficiency increase: Q = 380 MWh/a		(el. energy W = – 85 MWh)	

2. Steam generation plant 1:

As an alternative, cold water fogging should be used.

Savings: Thermal energy (natural gas) 33 MWh/a

Figure 164. Project Idea and Rationale -Energy - efficiency measures proposed and advantages. MIDOR Food Factory Meilen.

iii) installation of an additional heat exchanger for boiler charging allows lowering the heating temperature of the boiler by 15°C. With the employment of the new heat exchanger a temperature of about 65°C is sufficient to heat the hot water to 60°C. The lowering of the temperature is a prerequisite for using the heat pump for heating the boiler water. As a result, employment of the heat pump and lower losses in the piping system, the expected energy savings are estimated to be of the order of a total of 200MWh/a.

Multiple benefits of energy efficiency — Project idea and rationale

Energy-efficiency measure(s) proposed and advantages:

3. Lowering the heating temperature:

The boiler can be charged with an external heat exchanger, so a temperature of about 65° C is sufficient to heat the hot water to 60° C.

The lowering of the temperature to 65° C is fundamental for the connection to the heat pump in the return of the internal seawater network.

Increase of the running times of the heat pumps (summer operation additionally approx. 150 MWh)

Efficiency increase (estimate) total additional: 200 MWh/a

Figure 165. Project Idea and Rationale -Energy - efficiency measures proposed and advantages. MIDOR Food Factory Meilen.

iv) in plant 4 steam is generated using hot water at a temperature of 110°C. The replacement of the natural gas based steam generating system by an electrical heater results in fossil fuel savings of 25MWh/a and reduces line losses (110°C pipes) by

10MWh/a at the expense of an additional electrical energy consumption of 20MWh/a.

Multiple benefits of energy efficiency — Project idea and rationale

Energy-efficiency measure(s) proposed and advantages:

4. Steam generation plant 4

Steam generation electrically, thus eliminating the line losses (110C)

Savings:	heat energy (natural gas)	25 MWh/a
	less line losses	10 MWh/a
Additional consumption:	el. energy	-20 MWh/a

Figure 166. Project Idea and Rationale -Energy - efficiency measures proposed and advantages. MIDOR Food Factory Meilen.

The existing oversized MIDOR heating system delivers 4000MWh/a heat energy (90%efficiency). This system is replaced by a much more efficient flexible solution (see below). A new heat pump (1'600MWh/a) covers the base load on the 65°C grid at the expense of 400MWh/a electrical energy. Heating pellets (1'000MWh/a) are employed to cover the band load of 800MWh/a on the 100°C grid. A natural gas boiler covers only peak loads up to 1'600MWh/a (90% efficiency) and can deliver the full power in case that the heat pump or pellet boiler fail.

Multiple benefits of energy efficiency — Project idea and rationale

Energy-efficiency measure(s) proposed and advantages:

5. Replacement of the heating system incl. heat pump

Energy balance:	**Heat energy**	**Energy supply**
Heat old heating system	4'000 MWh/a	4'400 MWh/a natural gas
Energy balance new:		
Heat with natural gas	1'600 MWh/a	1'800 MWh/a natural gas
Heat new heat pump	1'600 MWh/a	400 MWh el. energy
Heat pellet	800 MWh/a	
Total heat production	4'000 MWh/a	

Comments:

- The heat pump covers the base load on the 65° C grid.
- The pellet heating covers the base load (band load) on the 100° C grid.
- The gas boiler covers the peak loads (load fluctuations) and can deliver the full power if the heat pump or pellet boiler fails.

Figure 167. Project Idea and Rationale -Energy - efficiency measures proposed and advantages. MIDOR Food Factory Meilen.

Results of the Company Analysis

For more than 90 years Midor AG has stood for high quality biscuits, ice creams and snacks. As a proven specialist for needs-oriented concepts, Midor supplies customers in Switzerland and around the world with delightful specialties for the whole day. It develops and produces numerous private labels for Migros and for quality and consumer-oriented trading partners at home and abroad.

Midor understands and lives quality comprehensively for all its activities and sees it as a strength of its Swiss origin. Its quality policy is based on seven themes (product safety, quality, ethics, customers, suppliers, recipes, certificates). 'The world of Midor makes you happy.' In addition to raw materials (flour, sugar, chocolate, spices, water), personnel cost and rent, energy (natural gas, electricity) is a major cost factor.

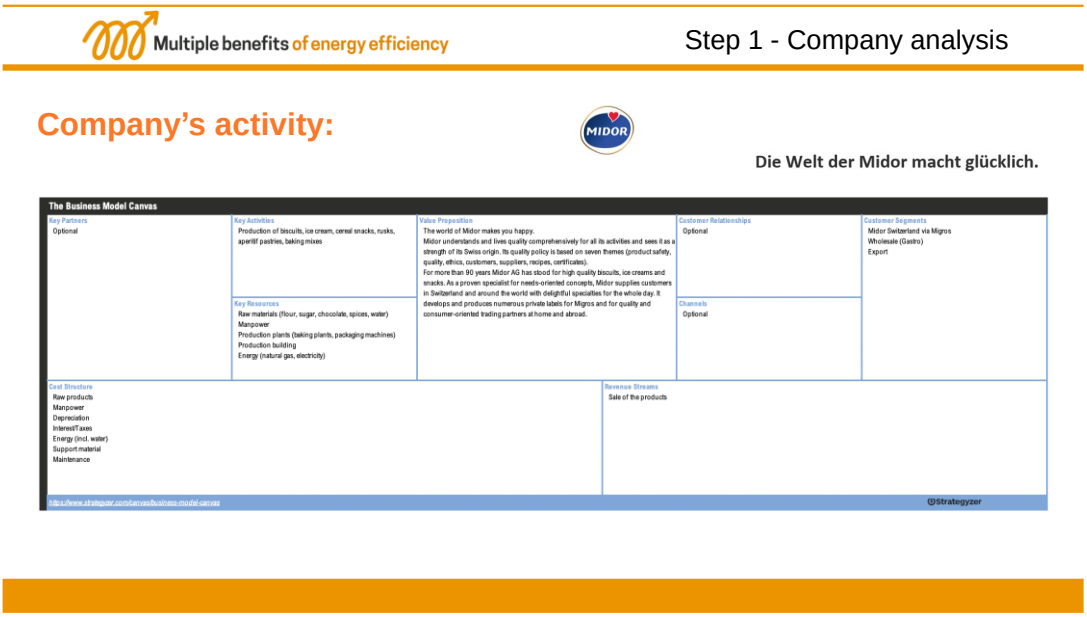


Figure 168. Results of the Company Analysis. MIDOR Food Factory Meilen.

Results of the Energy Analysis

Energy carriers which are impacted by the energy efficiency measure are electricity, natural gas, and heating oil. The energy consumption in 2019 was as follows:

Electricity: 20'100MWh/a

Natural gas: 12'510MWh/a

Heating oil: 63 MWh/a

The existing natural gas-based heating system is replaced by an efficient flexible solution. This reduces the natural gas consumption significantly. In addition, efficiency measures for steam production (plant 1 and 4) and optimizations contribute to the overall reduction of natural gas consumption of approx. 3'500 MWh/a. The natural gas boiler of the new heating system covers only peak loads, yet it can deliver the full power in case that the heat pump or pellet boiler fail. The heating oil (63MWh/a) is consequently no longer needed for emergency supply. The electricity consumption increases by approx. 500MWh/a.

The new heat pump of the heating system (400MWh/a), the longer annual run time of the heat pump in plant 1 (85MWh/a), and electrification of steam production (plant 4) contribute to this increase in electrical energy demand. Heating pellets replace natural gas for production of 800MWh/a heat (heating system). Overall, the energy consumption improves by 9.52%. The changing mix of energy carriers estimated financial savings are in the order of 250kCHF/a (avg. value over 15years). These savings include the benefit of CO2 emission reduction by 738t/a, which are valued 0.15CHF/kg at MIDOR.

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Energy carriers impacted by the project: electricity, natural gas, heating oil, renewables (electricity)
- Consumption (2019)
  - Electricity: 20'100'000kWh/a (natural gas: 12'510'000kWh/a, heating oil: 63'000kWh/a)

Future energy consumption (after EEM implementation)

- Estimated physical savings: electricity: -500'000kWh/a (natural gas: 3'547'000kWh/a, heating oil: 63'000kWh/a, CO2 emissions from natural gas : 738'380kg/a (valued at 0.15CHF/kg))
- Estimated financial savings: 248'446CHF/a (average value over 15a, not discounted)
- Improvement of total energy consumption: 9.52%
- Impact on indicators of energy performance: N/A (energy intensity)

Figure 169. Results of the Energy Analysis. MIDOR Food Factory Meilen.

Results of the Operations Analysis

The company concluded that the implementation of the 'new heat concept' at MIDOR will not affect the quality of the energy service 'heat'. As a result, the operations analysis was not considered relevant in this pilot project.

Results of the Strategic Analysis

The multiple benefits analysis leads to following results:

Cost Impacts: i) Reduced waste heat: MIDOR must pay a fee for dissipating waste heat into Lake Zurich. As more waste heat is utilized at MIDOR, the 'lake water fee' is reduced (15'000CHF/a), ii) CO, NOx, SOx emissions are reduced since no heating oil is burned and the employment of modern natural gas burners result in better combustion iii) maintenance cost are reduced (20'000CHF/a) since the new equipment allows monitoring and automation, iv) the heating oil tank is no longer needed and can be removed, the additional space can be used to enlarge the access for truck delivery, i.e. two trucks can be unloaded in parallel, which may affect future cost v) the spare parts stock can be reduced and leads to reduced warehousing costs (5'000CHF/a), and finally MIDOR expects reduced machinery and equipment wear and tear (long life components, lower temperature, control pump operation time is reduced), resulting in an extended life cycle of the system (20'000CHF/a).
Value proposition impact: improved image and reputation: flagship project, i.e. 'MIDOR heats and cools with lake water'.

Risk impacts:

i) Increased installation reliability due to new equipment with extended lifetime.
ii) Reduced CO2 and energy price risks due to an overall lower energy consumption,

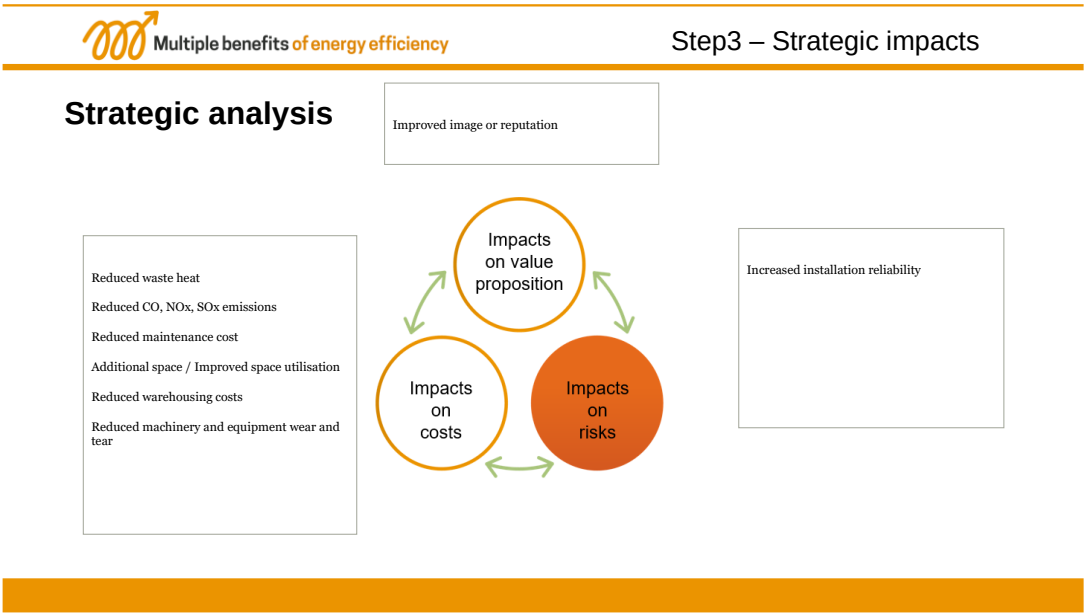


Figure 170. Results of the Strategic Analysis. MIDOR Food Factory Meilen.

Results of the Financial Analysis

The results of the financial analysis considering energy benefits only (left hand side) and all benefits (right hand side) are shown below. In both cases capital expenditures (CAPEX) amount to a total of 1'670'000CHF over a period of 3 years (year 0, 1, 2). CAPEX (year 1) consists of: optimization of heat distribution 100'000CHF, optimization of the heat pump in plant 1 20'000CHF, and heat concept phase 1 50'000. In addition, non-capital expenditures for the disassembly of installations amount to 20'000CHF in year 0. CAPEX (year 1) consists of: steam generation plant 1+4 100'000CHF, heating concept: heat pump 800 kW 600'000CHF. CAPEX (year 2) consists of: boiler replacement 700'000CHF, chimney replacement 100'000CHF.

Recurring multiple benefits are: 0) energy savings (annual energy savings increase gradually from year 1 to year 15 from a value of 210'877CHF to a value of 257'339CHF), i) Reduced waste heat, as more waste heat is utilized at MIDOR, the 'lake water fee' is reduced (15'000CHF/a), ii) reduced maintenance cost (20'000CHF/a) iii) reduced warehousing costs (5'000CHF/a), and reduced machinery and equipment wear and tear (20'000CHF/a).

The capital budgeting results are shown below for the discount rate of 9% and an investment duration of 15 years. Any energy efficiency measure with a payback period of at least 8years will be approved by the management of the company. This mandatory requirement for implementation is only met if all benefits are considered. However, the consideration of the energy benefits alone leads already to a payback time of nine years and accordingly, the effect of the non-energy benefits on payback, NPV and IRR is rather small, although important.

Financial analysis

Energy benefits only

- CAPEX: 1'670'000 CHF
- NPV: 202'575 CHF
- IRR: 12.11%
- Simple payback: 9 years

All benefits

- CAPEX: 1'670'000 CHF
- NPV: 528'308 CHF
- IRR: 16.89 %
- Simple payback: 7 years

Discount rate: 9 %

Investment duration: 15 years (i.e. the number of years taken into account to compute NPV and IRR)

Figure 171. Results of the Financial Analysis. MIDOR Food Factory Meilen.

Key Arguments for the Project Implementation

A key argument for the implementation of the energy efficiency measure (see slide below) is therefore the resulting energy cost savings of up to 250kCHF/a, which include the CO2 fee. However, the annual savings from non-energy benefits are also important, i.e. reduced waste heat, reduced maintenance cost, reduced warehousing costs, and reduced machinery and equipment wear and tear result in total annual savings of 60'000CHF.

There are also two important strategic arguments for the implementation of this project: i) this project is a lighthouse project for MIDOR: 'MIDOR uses seawater for heat production and cooling'. The heat concept is a showcase for the future heat supply of MIDOR, which is based on the 'Climate Energy Strategy MIGROS 2030/40'. The goals are: 100% renewable energy, efficient heat generation including waste heat utilization, heating without fossil fuels (except of process heat), ii) another important strategic argument is the possibility to supply the city of Meilen with heat (in cooperation with company energie360°) produced at MIDOR.

In the end, it is the payback period of less than 8 years, which is decisive for the implementation of the project. No additional argument is required for approval.

Why you should absolutely approve this project:

- Lighthouse project for Midor: Midor uses seawater for heat production and air conditioning. The heat concept is representative for the future heat supply of Midor, which is based on the 'Climate Energy Strategy MIGROS 2030/40'. The goals are: 100% renewable energies, efficient heat generation with waste heat utilization, heating without fossil fuels (only process heat by fossil fuels).
- Reduced seawater charges, maintenance costs and wear
- Increased reliability (existing heating system is at the end of its service life)
- Possibility to enlarge the access road for truck delivery, as the tank for mineral oil is no longer needed and removed
- Heat network Meilen as an option (heating system for E360 located at Midor)
- Payback period seven years (max. 8 years), NPV positive: 528'308CHF

Figure 172. Key Arguments for the Project Implementation. MIDOR Food Factory Meilen.

Key Issues and Highlights

Any energy efficiency measure with a payback period of at least 8years is approved by the management of the company. This mandatory requirement for implementation is only met in this pilot project if all energy and non-energy benefits are considered during capital budgeting. The results obtained in this pilot project show that even small contributions of non-energy benefits can be important. By considering the savings resulting from non-energy benefits, the payback decreases from 9years to 7years, thereby meeting the requirement for approval.

2.8.3 Automation Concept for Meters

Federation of MIGROS Cooperatives (TI)

Multiple benefits of energy efficiency

Automation concept for meters
Federation of MIGROS Cooperatives(TI)

MIGROS TICINO

Edited by:

Project manager energy

2019-xx-xx Title, author, organisation ... 2

Project Idea and Rationale

The federation of MIGROS cooperatives MGBTi operates 34 MIGROS stores in Ticino. Seven janitors take care of the 34 MGBTi stores and their facilities. The janitors regularly visit the assigned stores. On this occasion they read the meters 'manually'.

By the end of each month, all meter readings must be read manually, recorded on a tablet and stored in a database. In the database, the monthly consumption of the meters is calculated based on the meter readings and visualized in the Excel tool. A verification of the data should then also be carried out by the energy manager.

The reading, verification and processing of the data is, however, not done regularly or not at all.

Due to the lack of automation, there is currently no possibility for a systematic monitoring and possible intervention, i.e. after an optimization measure, energy consumption slowly drifts back to non-optimal values (see figure on slide below).

Multiple benefits of energy efficiency — Project idea and rationale

Current situation and weaknesses:

Process of manual reading

- Seven janitors take care of the 34 MGBTi stores and their facilities. The janitors regularly visit the stores assigned to them. This also includes manual meter reading.
- By the end of each month, all meter readings must be read manually, recorded on a tablet and stored in a database. In the database, the monthly consumption of the meters is calculated based on the meter readings and visualized in the Excel tool. A verification of the data should then also be carried out by the energy manager.
- The reading, verification and processing of the data is actually not done regularly or not at all.
- Due to the lack of automation, there is currently no systematic monitoring with possible intervention, i.e. after an optimization measure, energy consumption slowly drifts back to non-optimal values (see figure on right hand side).

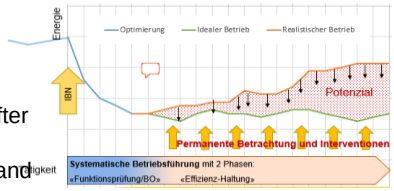


Figure 173. Project Idea and Rationale- Current situation and weaknesses. Federation of MIGROS Cooperatives (TI).

The employment of automatic meter reading in the stores shall improve the current situation. For this purpose, a measurement concept and meter pictorial schematic is created: This defines which type of meter is to be used at which location for which purpose and which quantities it measures. In addition, the hierarchy of the meters are defined, e.g. main meter, sub measurement, etc.

The meters are connected to a data bus system for communication, i.e. they are part of a network (e.g. M-Bus). A data logger reads the data from the meters and sends the data via the network to the server. The meters are integrated in the MIGROS EDM system so that the energy data can be stored in the database and also visualized.

The data is checked for plausibility every day and, in the event of failures/gaps, investigations are made, or a replacement value is created. For this service, an annual fee is due per data point.

Multiple benefits of energy efficiency — Project idea and rationale

Energy-efficiency measure(s) proposed and advantages:

Measure: Automatic meter reading in the stores

- A measurement concept and meter pictorial schematic is created: This defines which type of meter is to be used at which location for which purpose and which quantities it measures. In addition, the relationships between the meters are defined, e.g. main meter, sub measurement, etc.
- The communication capable meters are part of a network (e.g. M-Bus).
- Installation of a data logger, which is in the central distribution and reads the data from the meters and forwards them via network to the server.
- Meters and plants are integrated in the MIGROS EDM system so that the energy data can be stored in the database and also visualized.
- The data is checked centrally for plausibility every day and, in the event of failures/gaps, investigations are made or a replacement value is created. For this service, an annual fee is due per data point.

Figure 174. Project Idea and Rationale- Energy-efficiency measures proposed and advantages. Federation of MIGROS Cooperatives (TI).

A new automation concept for meters shall be implemented to improve the current situation and to address the issues stated before. Direct benefits of the automation energy efficiency measure are: i) time saving compared to manual readout (incl. driving time and fuel), ii) GMTi does not has to check the plausibility of the data in the database, i.e. the risk of incorrect data is reduced by automatic readout, iii) better data quality (saving time for data QA before the preparation of the Climate and Energy Strategy (CES) every year), iv) higher data resolution (15 min intervals vs. monthly values), v) remote analysis of the operation is improved, vi) the plausibility check of the data causes the GMTi cost per data point, and vii), the installation requires a larger initial effort for the system setup.

Multiple benefits of energy efficiency — Project idea and rationale

Energy-efficiency measure(s) proposed and advantages:

Direct advantages and disadvantages

- Time saving compared to manual readout (incl. driving time and fuel)
- GMTi does not has to check the plausibility of the data in the database, i.e. the risk of incorrect data is reduced by automatic readout
- Better data quality (saving time for data QA before the preparation of the Climate and Energy Strategy (CES) every year)
- Higher data resolution (15 min intervals vs. monthly values)
- Remote analysis of the operation is improved
- The plausibility check of the data causes the GMTi cost per data point
- The installation requires a larger initial effort for the system setup

Figure 175. Project Idea and Rationale- Energy-efficiency measures proposed and advantages. Federation of MIGROS Cooperatives (TI).

Secondary (indirect) benefits of the automation energy efficiency measure are: i) with the high-resolution data, the alarm function can be used for quick remote identification of suboptimal operation modes (also for syst. portfolio analysis). GMTi can also manage the alarm management itself, ii) a more precise monitoring of the operating times can reduce suboptimal operation, which extends the lifetime of equipment, iii) energy saving potentials can be identified quickly, i.e. with less effort (reduced payback period for operation optimization projects), iv) in the case of new stores or remodeling of stores, the new systems can be dimensioned more precisely to the requirements, which leads to lower investment costs, v) better measurability of energy savings, vi) energy savings could be used as a marketing tool (e.g. journal articles)

Energy-efficiency measure(s) proposed and advantages:

Secondary advantages and disadvantages

- With the high-resolution data, the alarm function can be used for quick remote identification of suboptimal operation modes (also for syst. portfolio analysis). GMTi can also manage the alarm management itself.
- A more precise monitoring of the operating times can reduce suboptimal operation, which extends the lifetime of equipment.
- Energy saving potentials can be identified quickly, i.e. with less effort (reduced payback period for operation optimization projects)
- In the case of new stores or remodeling of stores, the new systems can be dimensioned more precisely to the requirements, which leads to lower investment costs
- Better measurability of energy savings
- Efficiency savings could be used as a marketing tool (e.g. magazine articles)

Figure 176. Project Idea and Rationale- Energy-efficiency measures proposed and advantages. Federation of MIGROS Cooperatives (TI).

Results of the Company Analysis

With their consumer and service products, the federation of MIGROS cooperatives (MGB) covers the needs of the daily life of a broad section of the population. Customers are 'Kundula Felber' (family man, mother, sustainability), seniors who want to enjoy life, lunch guests with little time, people with a small budget (pupils, students, etc), but also wealthy customers with a claim to exclusivity.

MGB is committed to a sustainable future and a broad range of cultural offerings. MGB Ticino operates 34 stores. Key ressources are their own production facilities, employees and, the good store network. Migros sells products via self-service platforms (online shop, store, etc). For this purpose, they negotiate with suppliers, operate logistics, provide trading platforms, do marketing, produce products, and assure quality. Major cost are wages of employees, logistics, maintenance of real estate, marketing (advertising, sponsoring, engagement, etc), costs for purchase, storage, packaging and transport of products, cost savings through large quantities in purchasing and in-house production. MGB generates revenue via the sale of products & services with fixed prices. The prices are adapted to the types of customers (M-Budget, Classic, Sélection), the MIGROS production facilities also sell their products to third parties.

Multiple benefits of energy efficiency — Step 1 - Company analysis

Company's activity:

MIGROS TICINO

The Business Model Canvas

Key Partners
- Suppliers and producers like farmers, nurseries, dairies,...
- Transport companies
- Associations and organizations
- Shopping centers
- Cooperative members

Key Activities
- Negotiations with suppliers
- Logistics
- Provision of trading platforms (branches, online, ...)
- Marketing
- Production of products
- Quality assurance

Key Resources
- Good suppliers with good products
- Own production facilities
- Employees
- Good store network

Value Proposition
- "With our consumer and service products, we cover the needs of the daily life of a broad section of the population."
- "We are committed to a sustainable future and a broad range of cultural offerings."

Customer Relationships
- Cumulus Coupons
- M-Magazine
- Personal support at problems (customer service)
- Cooperative members

Channels
- Sponsoring & advertising campaigns corresponding to the types of customers (M-magazine, tv spots, social media, openairs, ...)
- Customer service, online, telephone hotline, sales stores
- Purchase of products on self-service platforms (online shop, store, ...)

Customer Segments
Population like:
- Kundula Felber (family man, mother, sustainability)
- Seniors who want to enjoy life
- Lunch guests with little time
- People with a small budget (pupils, students,...)
- Wealthy customers with a claim to exclusivity

Cost Structure
- Wages of employees
- Logistics
- Maintenance of real estate
- Marketing (advertising, sponsoring, engagement, ...)
- Costs for purchase, storage, packaging and transport of products
- Cost savings through large quantities in purchasing and in-house production

Revenue Streams
- Sale of products & services with fixed prices
- Prices adapted to the types of customers
- M-Budget Classic Sélection
- Production for third parties

https://www.strategyzer.com/canvas/business-model-canvas ©Strategyzer

Figure 177. Results of the Company Analysis. Federation of MIGROS Cooperatives (TI).

Results of the Energy Analysis

Energy carriers which are impacted by the energy efficiency measure are electricity, natural gas, and heating oil. The energy consumption (MGBTi, average values per store) in 2019 was as follows:

Electricity: 625'000kWh/a

Heating oil: 112'500 MWh/a

The estimated average energy savings per store are as follows: electricity: 16'797 kWh/a, heating oil: 3'023 kWh/a. This results in financial savings of 2'929 CHF/a (not discounted) and an improvement of total energy consumption by 2.69 %

Details which lead to these estimated values are shown in a table in the chapter 'strategic analyses.

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Energy analysis

Current energy consumption (avg. values per store):

- Energy carriers impacted by the project: electricity, heating oil
- Consumption (2019)
  - Electricity: 625'000 kWh/a, heating oil: 112'500 kWh/a

Future energy consumption (after EEM implementation)

- Estimated physical savings: electricity: 16'797 kWh/a, heating oil: 3'023 kWh/a
- Estimated financial savings: 2'929 CHF/a (not discounted)
- Improvement of total energy consumption: 2.69 %
- Impact on indicators of energy performance: N/A (energy intensity)

Figure 178. Results of the Energy Analysis. Federation of MIGROS Cooperatives (TI).

Results of the Operations Analysis

The operations analysis comprises two layers:

- 1st level: Benefits resulting from the automation of meter reading.
- 2nd level: Benefits resulting from the systematic use of energy data.

The respective generic process steps (manual or automized reading) are shown below. The process steps are self-explanatory. Most of the steps are affected by the automation (energy service: automatic processing of information and communication ICT). Direct benefits result from the automation of readout, storage, and verification of data acquisition (1st level) and secondary benefits result from the availability and employment of reliable ('trustworthy') digital data (2nd level). However, only the systematic use of the energy data may lead to more efficient use of energy carriers such as electricity, oil, and gas. The benefits are discussed in the next chapter.

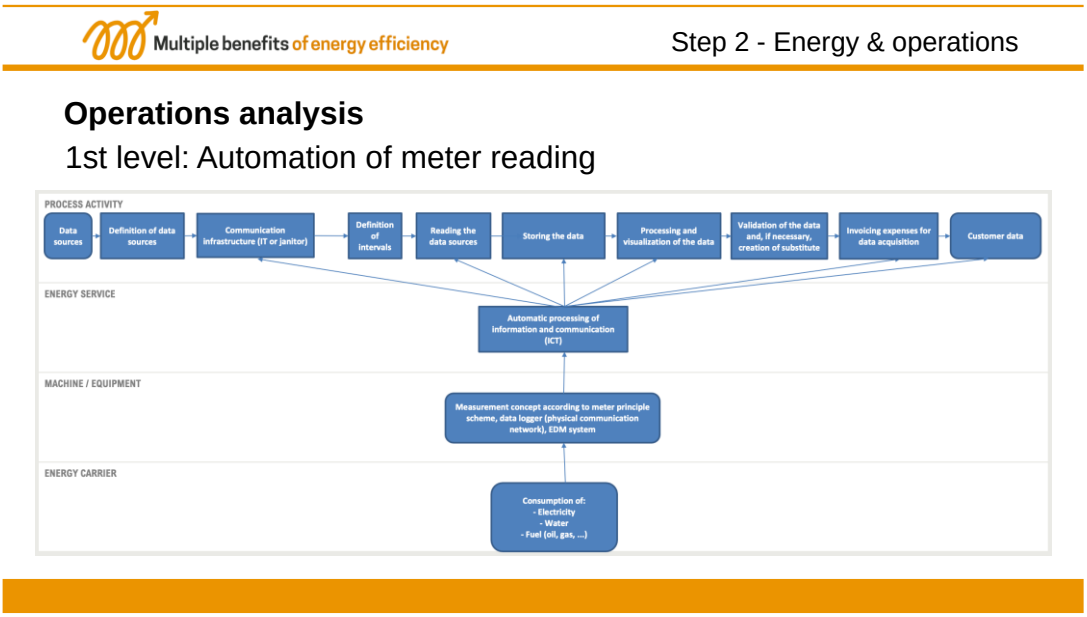


Figure 179. Results of the Operations Analysis-Operational diagram. Federation of MIGROS Cooperatives (TI).

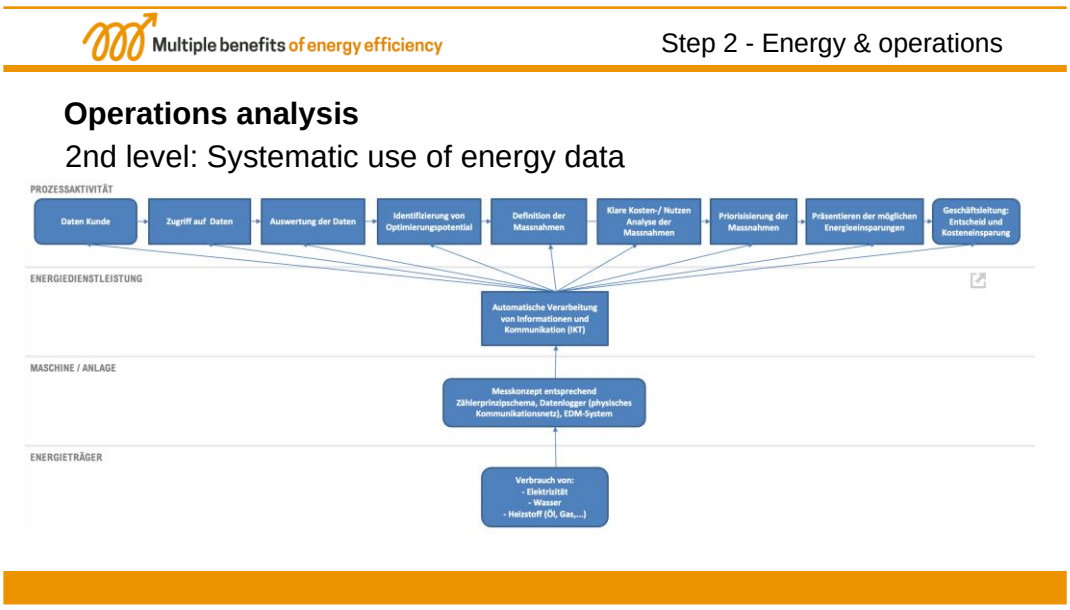


Figure 180. Results of the Operations Analysis-Operational diagram. Federation of MIGROS Cooperatives (TI).

Results of the Strategic Analysis

The direct benefits resulting from the automation of readout, storage and verification of data acquisition (1st level) and secondary benefits resulting from the availability and employment of this data (2nd level) as well as the required investments are shown and discussed in detail in the table below. The table is self-explanatory: assumptions and data which are used for quantification are shown. Note that energy savings in the stores result from the employment of the data and consequently, they are therefore secondary benefits.

Benefits		Data per year and store			
	Eligibility	Quantification automatic readout	Basic principles/assumptions		
1st level (readout, storage and checking of data)					
Reduction of effort for the caretaker (manual reading, error correction and travel time)	recurring	-1'067	2h/per store and month; CHF 80'000 wage costs		
Reduction of vehicle costs	recurring	-360	Small reduction (30.-/month/store) of travel costs for extra trips		
Elimination of effort checking the consumption data (QA), error correction in own Excel tool	recurring	-207	14d/year; CHF 100'000 wage costs		
Elimination of maintenance by IT (import data from tablet to Excel), adaptation of Excel for new meters, etc.	recurring	-73	Blanket 5 days/year (total); CHF 100'000 wage costs		
Inaccuracies of the data (is rather considered on level 2)		n.q.			
Reduction of effort for the development of annual statistics (provided by Silvio)	recurring	-148	10d/year; CHF 100'000 wage costs		
Current expenditure for recording the key figures, billing for external (apartments, ...)		n.q.	(see C 34)		
		Quantification		Savings in kWh	
	Eligibility	automatic readout		Electricity	Heat
2nd level (use of data)					
Ensure optimal adjustment (IBS to target value) [data acquisition facilitates this process].	75%	-2'453		14'063	2'531
Lower energy consumption through (targeted) optimization (because the consumption is visible)	75%	-368		2'109	380
Lower maintenance / service costs through reduced external (technical) support		n.q.	Depending on the service contracts you have with externals		
Support for future planning specifications and identification of concept optimizations		n.q.			
Permanent system monitoring (alarms) to quickly identify failures and prevent an increase in consumption through handling	100%	-109		625	113
Better basis for investment decisions		n.q.			
				16'797	3'023
Investition					
		Quantification automatic readout	Basics		
Development of infrastructure (bus/radio, data logger, Enacto)	non-recurring	12'106	approx. 15'000 for new construction, service life approx. 15 years		
Establishment of the process of systematic operational management (including on-site training)	non-recurring	298	10d initial effort (total)		
Handling of data (P&E, QA, share of support)	recurring	291	13 data points / store		
Optimal adjustment of new plants (IBN)	non-recurring	1'904	2d for adjustment (one-time, i.e. amortization over 25 years)		
Alarm management (maintaining optimal operation) & finding solutions by testing in the MSR	recurring	546	60min/week for alarm management for all stores total & 120min/week for check in MSR, instruction caretaker,		
Alarms: clarification, correction and maintenance by GMTI caretakers	recurring	747	2d/year (per store)		
Data QA: Information by GMTI, in case of meter failures / constant meter readings	recurring	74	5d/year (all stores)		
Targeted and regular optimization of operations (evaluation of the measurements; selective on-site based on the analyses)	recurring	298	10d/year (total for all stores); usual approach (internal)		
Maintenance of the system (modifications, key figures), use of the data for allocations		n.q.			
Assumptions		Defensive estimation			
Total energy costs GMTI	CHF	109'000	per year and per store		
Ensure optimal adjustment (IBS to target value)		3%	(only according to IBS: StartEnergieScan; but annual savings (for 25 years)		
~~Conversions per year with building park renewal cycle=25y~~		~~4%~~			
Savings possible by tapping the potential of existing buildings (3rd year and following)		0.5%	Each of the 25 years		
Savings through system monitoring: increasing consumption and failure of components is identified immediately		0.1%	Each of the 25 years		
Number of stores GMTI		32			
Cost kWh electric		0.16	CHF/kWh		
Costs kWh thermal		0.08	CHF/kWh		
Total electricity GMTI supermarket (kWh)		20'000'000	kWh_el		
Total heat GMTI supermarket (kWh)		3'600'000	kWh_th		
Electricity GMTI per store (kWh)		625'000	kWh_el		
Heat GMTI per store (kWh)		112'500	kWh_th		
(Sales arguments EDM from manufacturers)					
(look up ISO 50000)					
SM Quantity	32				
Number of stores (locations) (Anche con centrale, incl. FM, Gastro)	34				
SM Quantity					
Store consumption (locations) (Anche con centrale, inkl. FM, Gastro)	27'300'000	kWh el			
Store consumption (locations) (Anche con centrale, inkl. FM, Gastro)					

Figure 181. Results of the Strategic Analysis. Federation of MIGROS Cooperatives (TI).

The strategic analysis includes energy savings and leads to following cost Impacts: i) reduction of effort for the janitors (manual reading, error correction and travel time) results in recurring savings (1067CHF/a), ii) reduction of travel costs (360CHF/a), iii) elimination of effort for checking the consumption data (QA), error correction in own Excel tool (333CHF/a), iv) elimination of maintenance by IT (import data from tablet to Excel), adaptation of Excel in case of installation of new meters not required, etc. (90CHF/a), v) Reduction of effort for the preparation of the annual statistics (148CHF/a), vi) reduction of the energy cost due to a) ensure optimal

adjustment (IBS to target value) [data collection facilitates this process] and b) and c) permanent system monitoring (total 2929CHF/a).

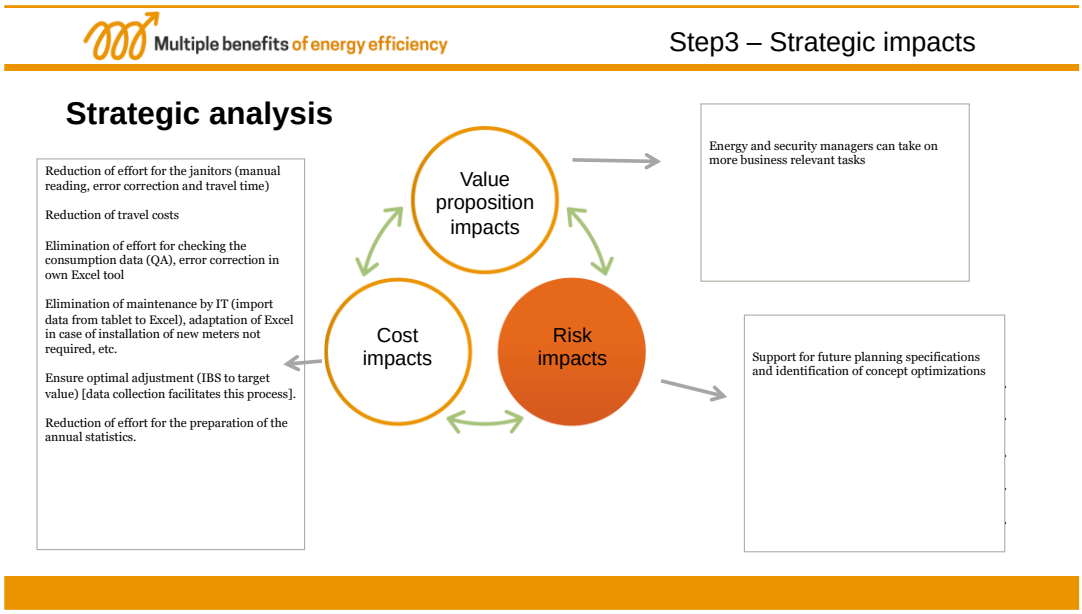


Figure 182. Results of the Strategic Analysis. Federation of MIGROS Cooperatives (TI).

Results of the Financial Analysis

The results of the financial analysis considering energy benefits only (left hand side) and all benefits (right hand side) are shown below. In both cases capital expenditures (CAPEX) amount to a total of 18’159CHF. The CAPEX include i) setup of infrastructure (bus, data logger, Enacto) cost 12'106CHF (year 0) and ii) replacement of measuring components (logger, meter) cost 6'053CHF (year 16).

In addition non-capital expenditures must be considered: i) data handling (QA, P&E, Support) (291CHF)/a, ii) development of SBF (incl. training) and Optimal Adjustment (IBN) of the store (2'202CHF, non-recurrent), iii) alarm management and targeted/regular operational optimization (844 CHF/a), iv) clarification/correction of failure messages from alarms; data QA and selective information on data (821CHF/a).

Recurring multiple benefits lead to total annual savings of 1638CHF, in addition to the estimated annual energy cost savings of 2929CHF.

The capital budgeting results are shown below for the discount rate of 9% and an investment duration of 25 years. Any energy efficiency measure with a payback period of at least 8years will be approved by the management of the company. This mandatory requirement for implementation is only met if all benefits are considered, while the consideration of the energy benefits alone leads to an extremely long payback time of more than two decades and accordingly to a negative value for the NPV and a poor IRR.

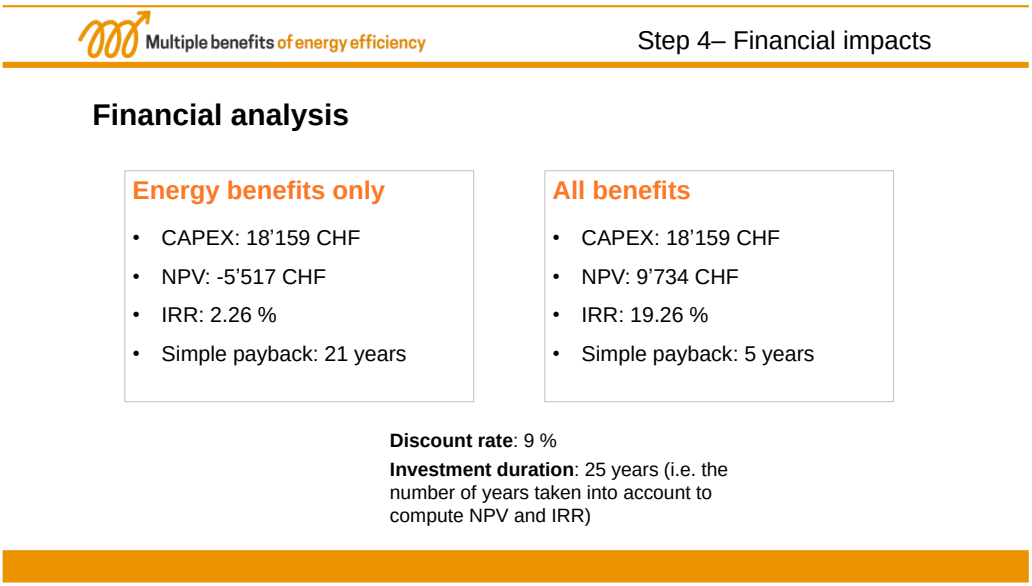


Figure 183. Results of the Financial Analysis. Federation of MIGROS Cooperatives (TI).

Key Arguments for the Project Implementation

Key arguments for the implementation of the energy efficiency measure (see slide below) are the following: i) automation excludes the possibility of data manipulation: high data quality, high resolution and plausibility check of the data with central data processing.

The possibilities for consistent monitoring and intervention ensure optimal adjustment, which can lead to significant energy savings, ii) the high-resolution data is an enabler for the alarm function, which can be used for rapid remote identification of suboptimal operating modes.

In addition, remote analyses are possible: energy saving potentials can be quickly identified. Monitoring of operating times can extend the lifetime of the systems, iii) reliable data also enables the support of future planning specifications and identification of concept optimizations, i.e. new systems to be installed can be dimensioned more precisely to the requirements. Finally, the initial investment (year 0) is small per store (12'106 CHF), while the amortization of the total investment occurs already in the first five years. In the end, it is the payback period of less than 8 years, which is decisive for the implementation of the project. No additional arguments are required for approval.

Why you should absolutely approve this project:

- Automation excludes the possibility of data manipulation: high data quality, high resolution data and plausibility check of the data with centralized data processing.
- The possibilities for consistent monitoring and intervention ensure optimal adjustment, which leads to significant energy savings.
- With the high-resolution data, the alarm function can be used for rapid remote identification of suboptimal operating modes.
- Remote analyses are possible: energy saving potentials can be identified quickly. Monitoring of operating times can extend the lifetime of the systems.
- Reliable data enables the support of future planning work and the identification of concept optimization potential, i.e. the dimensioning of new systems to be installed can be adapted more precisely to the requirements..
- Low CAPEX of 12’106 CHF (2020) per store: amortization of the total investment already in the first five years (max. 8 years), NPV positive: 9’734 CHF

Figure 184. Key Arguments for the Project Implementation. Federation of MIGROS Cooperatives (TI).

Key Issues and Highlights

The key arguments for the implementation of the energy efficiency measure are the identified non-energy benefits, as the payback period improves from more than 20years to 8years if all non-energy benefits are taken into account. Any energy efficiency measure with a payback period of at least 8years is approved by the management of the company. This mandatory requirement for implementation is only met if all energy and non-energy benefits are considered. The results obtained in this pilot project are a prime example how the consideration of multiple benefits can boost investments in energy efficiency.

2.9 Switzerland - UNIL

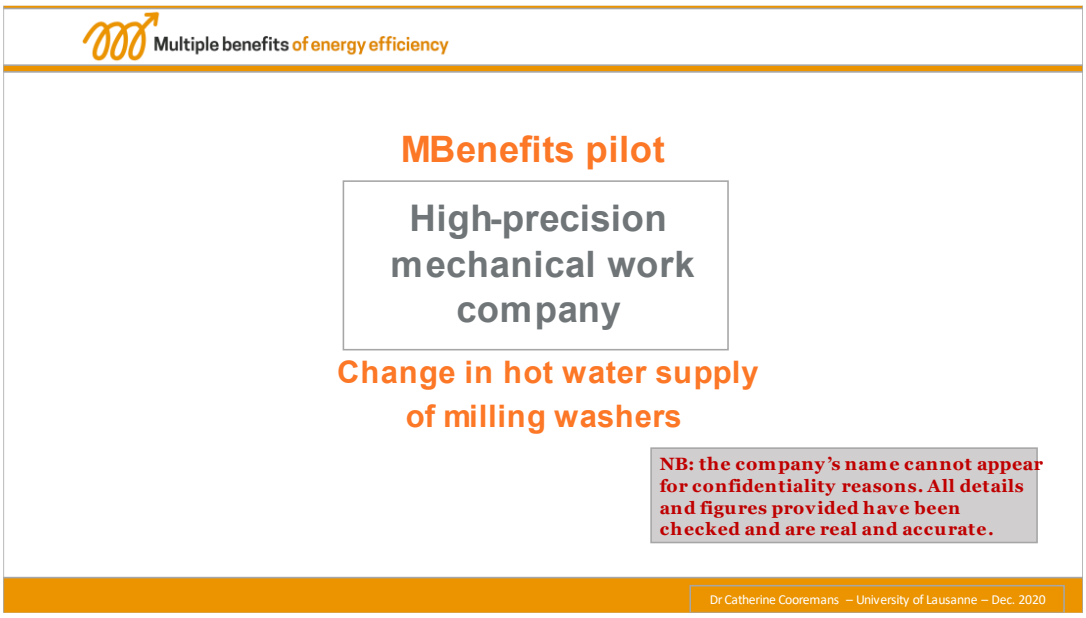
Author, Organization (Dr Catherine Cooremans, Université de Lausanne)

2.9.1 Pilot 1: Change in hot water supply of milling washers (CONFIDENTIAL)

Manufactures Cartier Horlogerie

NB: THE NAME OF CARTIER MUST NOT APPEAR IN ANY COMMUNICATION EXTERNAL TO THE MBENEFITS PROJECT.

THIS IS WHY THE COMPANY, ALTHOUGH ACTIVE IN HORLOGERIE, IS DESCRIBED AS ACTIVE IN HIGH-PRECISION MECHANICAL WORK (see slide below).



Project Idea and Rationale

The energy performance action concerns the washing and rinsing of metallic pieces after machining. It consists in changing the hot water supply of the washing machines, using the internal water circuit, heated by means of the waste heat of the air conditioning production, instead of city water.

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Current situation and weaknesses (see diagram on the next slide) :

- After milling , metallic pieces are cleaned and rinsed by passing through tanks whose water temperature varies from 75 ◦c to 20◦c.
- 2 storage tanks, 4 washing tanks and 2 rinsing tanks are supplied with city water at 20◦c. The water is then brought to the desired temperature (45 to 70 ◦c) by electrical resistors located in the bottom of each tank.
- The 2 storage tanks store water at 75 ◦c and supply it to the first 2 cleaning tanks, to save time on water -heating.
- 1-2 times a day cleaning tanks are emptied and cleaned with cold water, then re - filled with cold water. This causes thermal shocks, which can induce tank splitting and the need for emergency replacement.
- The storage tanks are cleaned once a month using formic acid, a lethal chemical, to remove the limestone accumulated.

Dr Catherine Cooremans – University of Lausanne – Dec. 2020

Figure 185. Project Idea and Rationale- Current situation and weaknesses. Change in hot water supply of milling washers, confidential.

Multiple benefits of energy efficiency — Step 2 - Energy & operations

Energy-efficiency measure(s) proposed and advantages
(see diagram on the next slide) :

- The 6 hard-water tanks (75 to 50 ◦c) are supplied with the site domestic water at 55 ◦c, heated by recovery of waste heat from the compressed air production. The tank water is then raised to the desired temperature using electric resistances located in the bottom of each tank.
- The 2 storage tanks are no longer necessary.
- Formic acid and protection equipment are no longer necessary.
- Risk of tank splitting and tank replacement cost are eliminated (there are no more thermal shocks since tanks are now cleaned with a water at 44 ◦c instead of a water at 20 ◦c).
- Water and energy consumption is reduced.

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Figure 186. Project Idea and Rationale- Energy-efficiency measures proposed and advantages. Change in hot water supply of milling washers, confidential.

Results of the Company Analysis

Activity:

The company is active in the field of luxury watches

Key customers segments:

Wealthy customers, middle class, female clients mostly, international customers

Value proposition

Luxury - Appearance, image - Quality

Multiple benefits of energy efficiency

Step 1 - Company analysis

Company's activity:

Cartier is active in the field of luxurywatches.

Key customer segments and value proposition:

- Wealthy customers, middle class, female clients mostly, international customers.
- Luxury - Appearance, image – Quality.

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Figure 187. Results of the Company Analysis. Change in hot water supply of milling washers, confidential.

Results of the Energy Analysis

The energy carrier impacted by the envisaged energy measure is the electricity consumed by the 3 washing machines, i.e. 130'500 kWh/year. The energy-efficiency measure savings amount to 63'000 KWh/year, i.e. 48% of the previous consumption of the machines.

The corresponding monetary savings amount to 2'400 CHF/year.

Multiple benefits of energy efficiency

Step 2 - Energy & operations

Energy analysis

Current energy consumption:

- Energy carriers impacted by the project: electricity.
- Consumption for the 3 washers concerned: 130'500 kWh consumed /year.

Future energy consumption (after EEM implementation)

- Estimated physical savings for the 3 washers: 63'000 kWh/year.
- Estimated financial savings (energy only): 2'400 CHF/year.
- Improvement of total site energy consumption: *undisclosed for confidentiality reasons*.
- Impact on indicators of energy performance: *undisclosed for confidentiality reasons*.

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Figure 188. Results of the Energy Analysis. Change in hot water supply of milling washers, confidential.

Results of the Operations Analysis

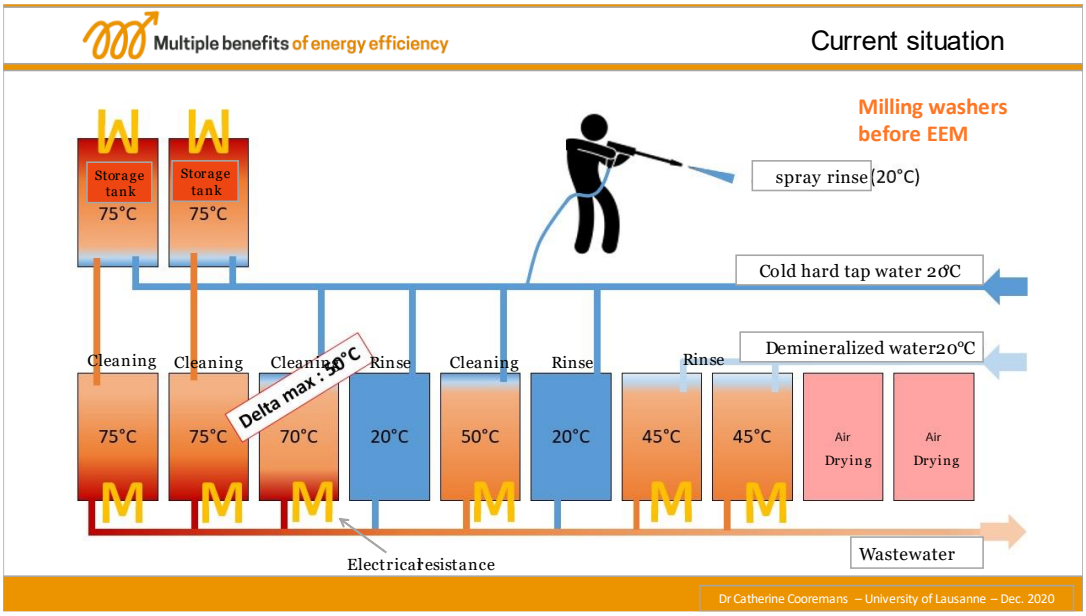


Figure 189. Results of the Operations Analysis-Current Situation. Change in hot water supply of milling washers, confidential.

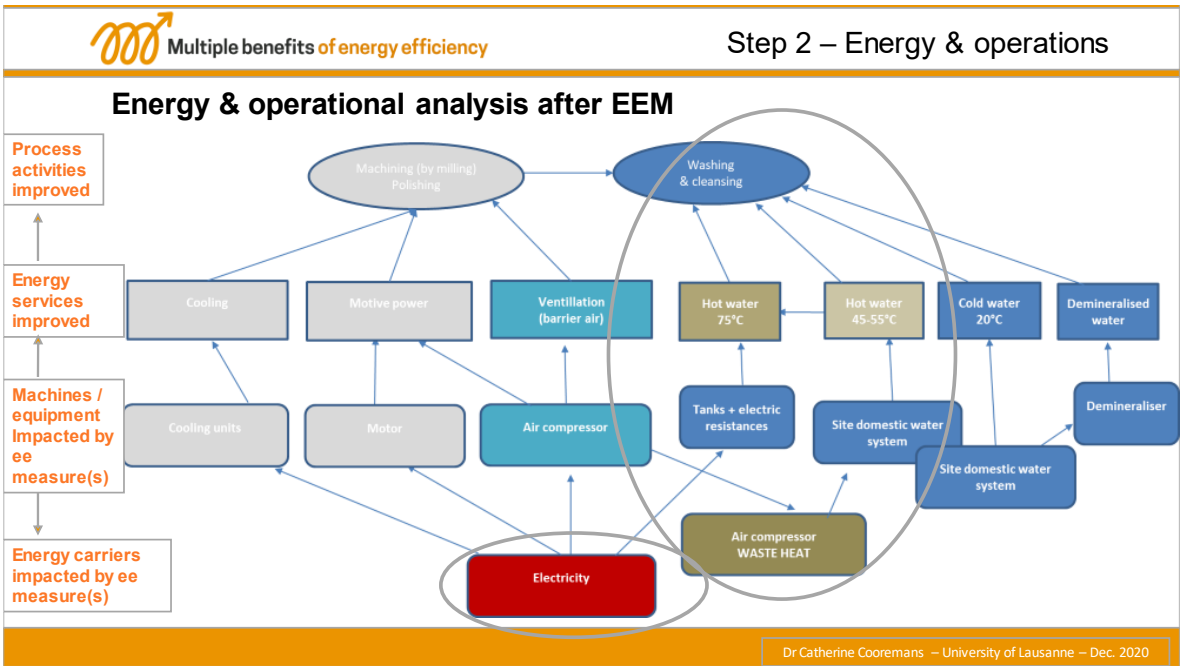


Figure 190. Results of the Operations Analysis – Energy Operations. Change in hot water supply of milling washers, confidential.

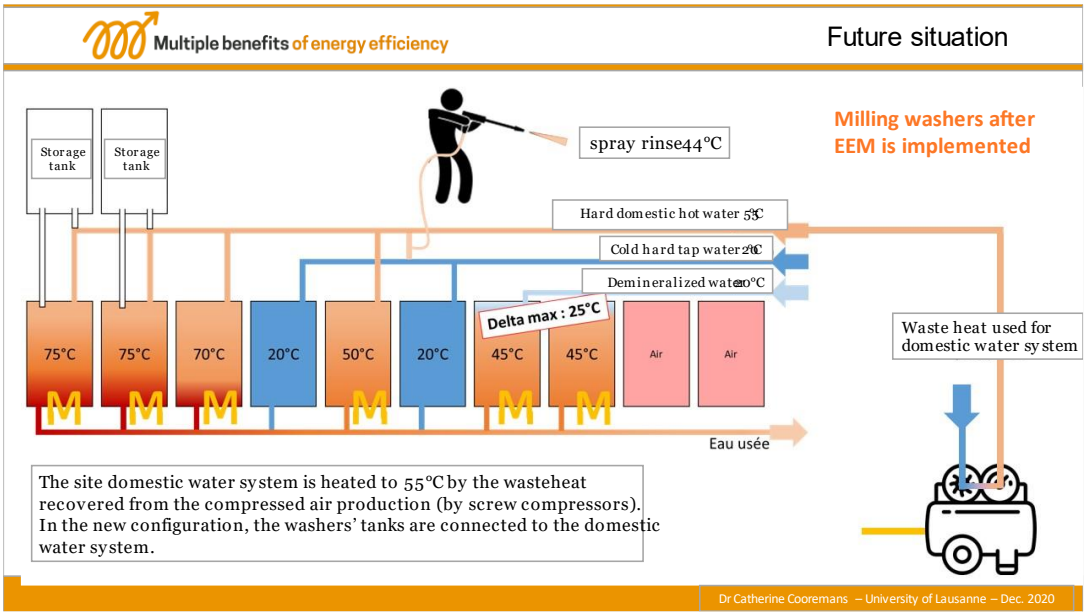
The measure consists in changing the water supply of the 3 machines washing and cleaning the watch parts after machining.

As shown in the diagrams above, in the current configuration the water is supplied, at a temperature of 20 degrees, by the city network, and then raised to the different temperatures needed for washing and rinsing by means of electrical resistances located in the bottom of the tanks. 1-2 times a day the cleaning tanks are emptied and cleaned with cold water, then re-filled with cold water (at 20 degrees). This

causes thermal shocks (because the temperature of the tanks is 50 to 75 degrees), which can induce tank splitting and the need for their replacement in emergency.

The storage tanks are cleaned once a month using formic acid, a lethal chemical, to remove the limestone accumulated.

After implementation of the energy-efficiency measure, the energy service "Hot water" will be significantly improved because thermal shocks are prevented and the storage tanks, which were used to storage hot water in order to keep heating time, are no longer necessary, as shown in the diagrams below.



Results of the Operations Analysis- Future situation

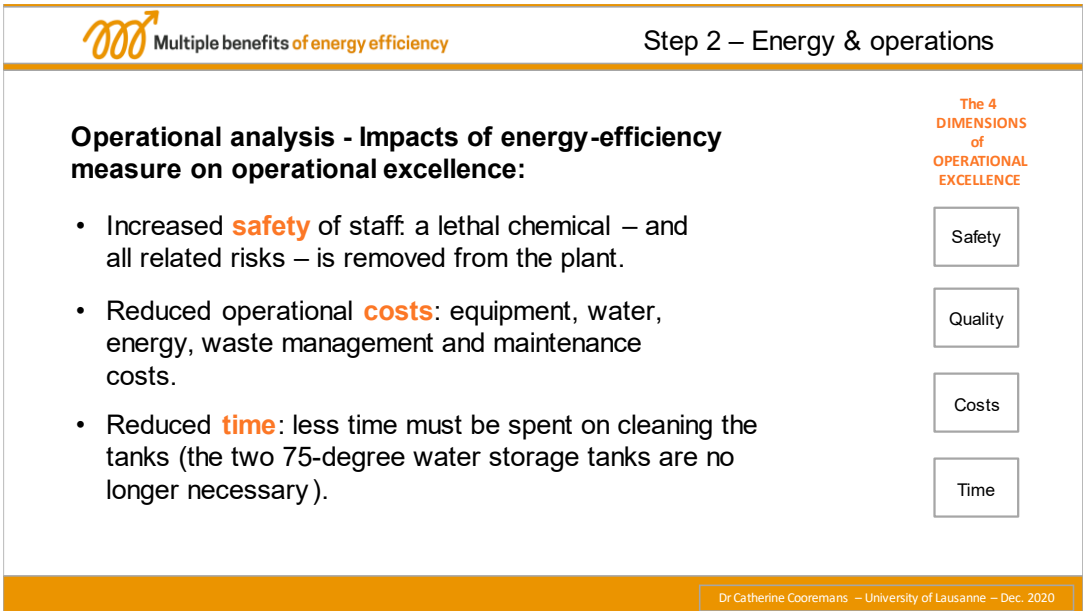


Figure 191. Results of the Operations Analysis- Operational analysis. Change in hot water supply of milling washers, confidential.

As shown in the slide above, the energy-efficiency measure positively contributes to 3 dimensions of operational excellence: safety, operational costs and time.

Results of the Strategic Analysis

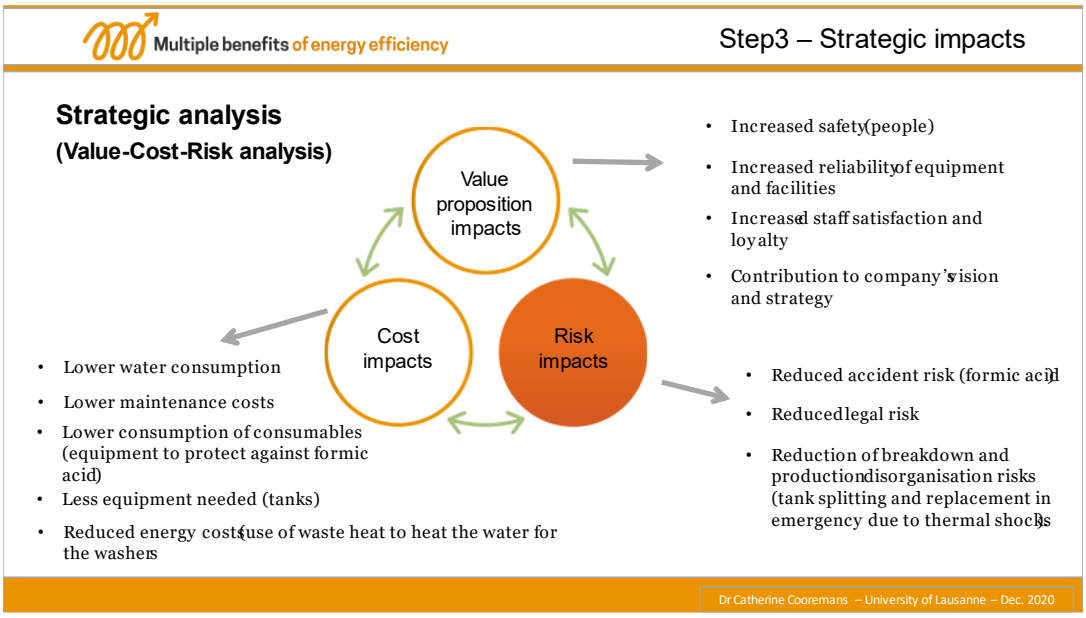


Figure 192. Results of the Strategic Analysis. Change in hot water supply of milling washers, confidential.

In the future configuration, formic acid (a lethal chemical which was used before to remove the limestone accumulated in the storage tanks) is no longer necessary and protection equipment are therefore no longer necessary either.

Risk reduction impacts: since formic acid is eliminated from the plant, the risk of accident and the associated legal risk is reduced. The risk of breakdown and production disorganization due to tank splitting and replacement in urgency is eliminated.

Value proposition impacts: increased safety and better working conditions (a lethal chemical is removed from the plant) entail increased staff satisfaction and loyalty, and therefore people work better. This measure also contributes to the company's vision and strategy.

Cost reduction impacts: thanks to the elimination of formic acid, consumables cost (formic acid) and protective equipment costs are reduced. Less equipment is needed (on average one tank has to be replaced every 3 years because of thermal shock in the current configuration). Water and energy consumption costs are reduced.

Results of the Financial Analysis

Multiple benefits of energy efficiency

Step 4 – Financial analysis

Total annual investment income before taxes energy benefits

TOTAL ENERGY COST REDUCTION IN CHF					0	2 415	2 415	2 415
NON-ENERGY BENEFITS (NEBs)								
NON-ENERGY BENEFITS	Amount in CHF	Start period	Duration		Year 0	Year 1	Year 2	Year 3
Reduced consumable costs (formic acid)	405	Year 1	Recurrent		0	405	405	405
Reduced water costs	303	Year 1	Recurrent		0	303	303	303
Reduced maintenance costs (tank change)	240	Year 1	Recurrent		0	240	240	240
Reduced equipment costs (tanks)	3 000	Year 1	Recurrent		0	3 000	3 000	3 000
Reduced equipment costs (protection clothes)	50	Year 1	Recurrent		0	50	50	50
TOTAL NON-ENERGY COST REDUCTION IN CHF					0	3 998	3 998	3 998

NB: 3 tanks had to be replaced in the last 10 years due to thermal shocks, for a total cost of 30'000 CHF (10'000 CHF/ tank), thus on average 3'000 CHF /year.

Total annual investment income before taxes non energy benefits

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Figure 193. Results of the Financial Analysis. Change in hot water supply of milling washers, confidential.

Multiple benefits of energy efficiency

Step 4 – Financial impacts

Financial analysis

Energy benefits only:

- CAPEX: 30'000 CHF
- Investment income before taxes: 2'415 CHF
- NPV: -11'483 CHF
- IRR: -7.5%
- Simple payback: 13 years

All benefits included:

- CAPEX: 30'000 CHF
- Investment income before taxes: 3'998 CHF
- NPV: 5'895 CHF
- IRR: 11.5%
- Simple payback: 4.7 years

Discount rate: 6 %
Investment duration 8 years (i.e. the number of years taken into account to compute NPV and IRR).

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Figure 194. Results of the Financial Analysis. Change in hot water supply of milling washers, confidential.

The strategic impacts identified and quantified in the Value-Cost-Risk analysis translate into the financial figures shown in the slides above: the annual pre-tax investment income increases from 2'415 CHF to 3'998 CHF when non-energy benefits are included. The net present value (NPV) and the internal rate of return (IRR), which were negative, change to positive at, respectively, 5'895 CHF and 11,5 % (the IRR becomes significantly higher than the discount rate of 6% required by the company). The payback is divided by 3, from 13 years to 4.7 years.

For this type of investment, the company applies an investment period of 8 years.

Key Arguments for the Project Implementation

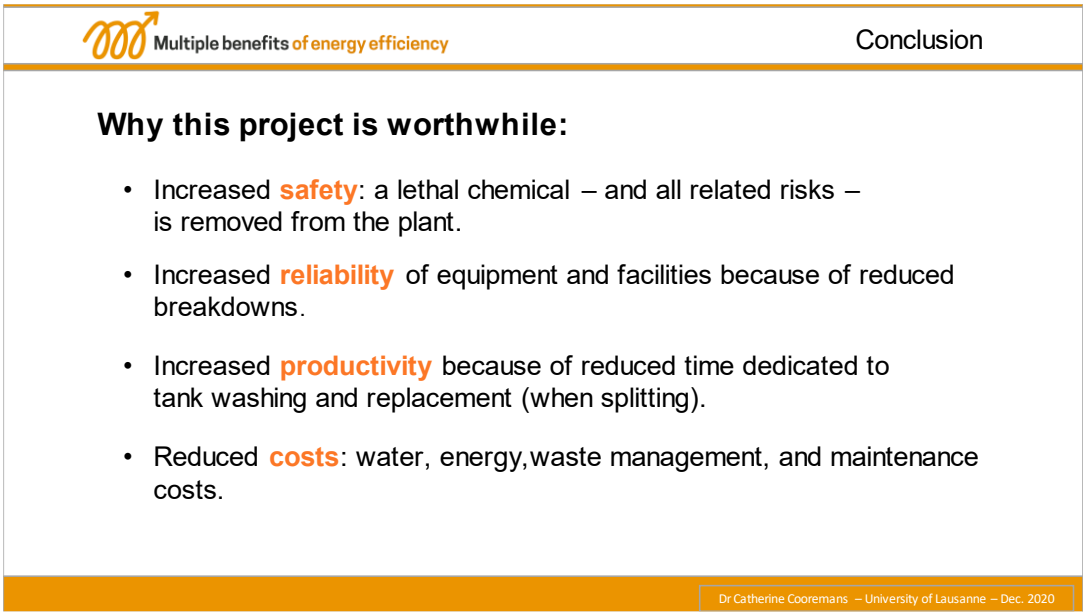


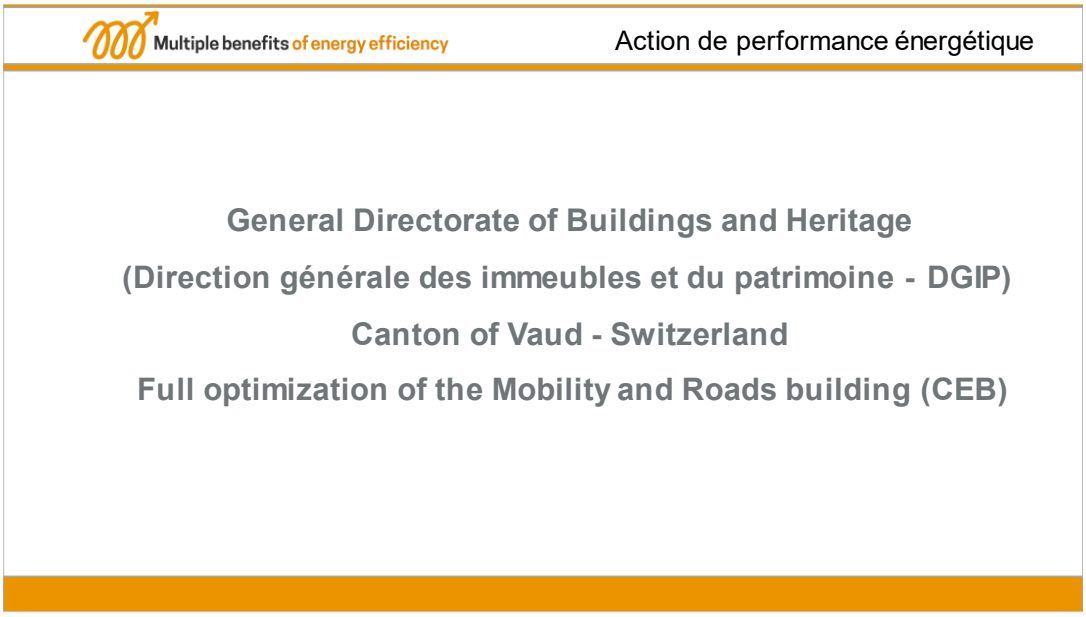
Figure 195. Key Arguments for the Project Implementation. Change in hot water supply of milling washers, confidential.

Key Issues and Highlights

As a result of this analysis, the energy efficiency measure was accepted by the company's management. However, it was presented as part of a global project, in which the MBenefits method and its results were "diluted". A few months later the person responsible for the project "Change in hot water supply of milling washers" project left the company. It is therefore unfortunately unlikely that the MBenefits method will be applied by this company in the future.

2.9.2 Pilot 2: Direction Générale des Immeubles et du Patrimoine (DGIP) - General Directorate of Buildings and Heritage

Full optimization of the Mobility and Roads building (CEB)



Project Idea and Rationale

The Centre Blécherette, located in the municipality of Mont-sur-Lausanne, is made up of the Centre d'Entretien des routes de la Blécherette, known as the "CEB", and three buildings used by the cantonal police, known as "CB1, CB2 and CB3".

The CEB is the largest of the four CERNs (Centres d'Entretien des Routes Nationales) in the canton. About 100 people work there (technical staff: 68; administrative staff: 33). It is used by the following entities of the General Directorate of Mobility and Roads (DGMR):

- Administrative and logistic centre for the maintenance of the Cantonal Roads (RC) of the Centre region;
- Centre Cantonal d'Entretien des Véhicules (CCeV): administrative offices and workshops for the repair of vehicles (bodywork premises, locksmith's shop, paint oven, sandblasting, etc.);
- Centre d'Entretien et d'Exploitation de la Signalisation routière (CeES): administrative offices, signalling workshops (including paint stripping and painting facilities), storage of marking and signalling equipment, and a public shop for signalling;
- Garages for vehicles and machinery, and storage of maintenance equipment for the cantonal roads of the Centre region;
- Depot, changing rooms and living quarters for the road workers.

The CEB suffers from significant obsolescence. It was built in 1973 and, since then, very little renovation work has been carried out, its technical installations are mostly original and a complete energy refurbishment is now essential, also to improve heating comfort as well as air and lighting quality for the employees. The site is the second largest energy consumer in the State of Vaud, Switzerland.

Pending a complete renovation, which would include the removal of the boilers and connection to the district heating network, the energy-efficiency project described in this report focuses on a complete optimisation of the building's energy services. This full optimisation would include the 7 following actions:

- EEM1 - Optimisation of boiler operation
- EEM2 - Optimisation of the operation of heating and ventilation systems
- EEM3 - Optimisation of the operation of ventilation monoblocs
- EEM4 - Optimisation of the operation of the painting room
- EEM5 - Optimisation of compressed air production operation
- EEM6 - Replacement of light sources with LEDs
- EEM7 - Improvement of the distribution of domestic hot water

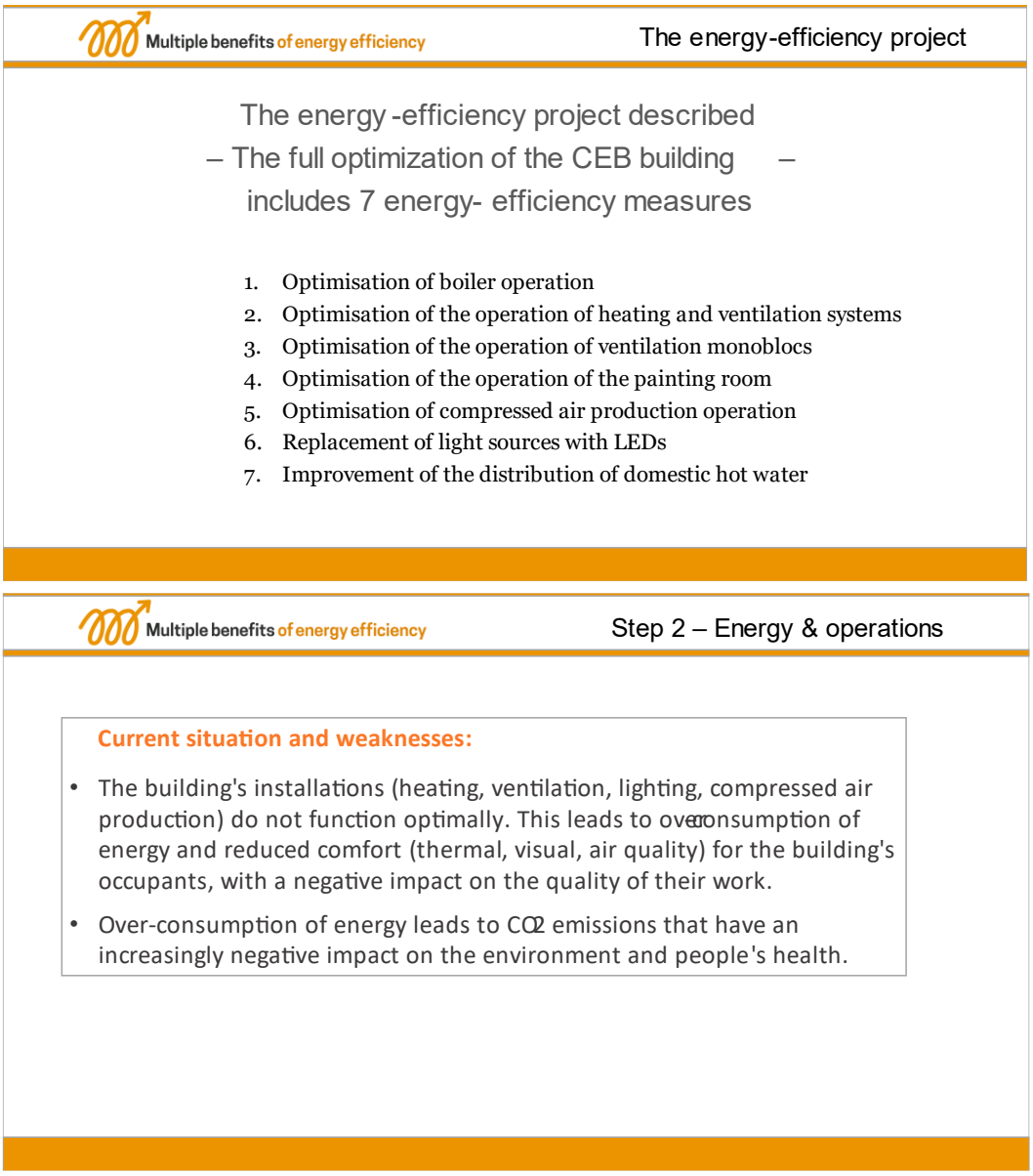


Figure 196. Project Idea and Rationale- Current situation and weaknesses Full optimization of the Mobility and Roads building (CEB).

Multiple benefits of energy efficiency — Step 2 – Energy & operations

Proposed energy-efficiency measures (7 in total) and their benefits:

- **Optimization** of the building's energy services (thermal quality, air quality, visual quality, hot water) through adjustments and, in some cases, minor equipment replacements.
- **Improved** working conditions for the occupants.
- **Reduction** of CO2 emissions and contribution to the canton's energy strategy.
- **Time saving.** The extension of the service life (3 years) of certain equipment thanks to optimization gives time to analyze in good conditions the future of the site (in depth renovation of the building, or demolition and reconstruction).

Figure 197. Project Idea and Rationale- Proposed energy-efficiency measures. Full optimization of the Mobility and Roads building (CEB).

Results of the Company Analysis

The activities of the Centre Blécherette are as follows:

- Management of the maintenance, snow removal and salting of cantonal and national roads.
- Maintenance of rolling stock (trucks, etc.)
- Communication with the General Management

Customers of the Centre are all road users who drive on the roads of the State of Vaud.

The value proposition of the Centre is a fast, flexible, quality and cost-controlled (preventive and corrective) maintenance of cantonal and national roads in State of Vaud.

Multiple benefits of energy efficiency — Step 1 – Company analysis

Activities of the Centre d'Entretien de la Blécherette (CEB) of the Canton of Vaud General Directorate of Mobility and Roads (DGMR)

- Management of the maintenance, snow removal and salting of cantonal and national roads.
- Maintenance of rolling stock (trucks, etc.).
- Communication with the General Management.

Customer segments and value proposition:

- Road users are the "clients" of the DGMR.
- The value proposition is a fast, flexible, quality and cost-controlled (preventive and corrective) maintenance of cantonal and national roads in canton of Vaud.

Figure 198. Results of the Company Analysis. Full optimization of the Mobility and Roads building (CEB).

Results of the Energy Analysis

The energy carrier impacted by the envisaged energy-efficiency measures are electricity and natural gas.

The total natural gas consumption of the equipment impacted by the optimization is 1'700'000 KWh/year. The estimated energy savings are 246'000 KWh/year, i.e. 15%.

It is not possible to estimate the reduction in electricity consumption compared to the previous situation because there is no individual meter for the building (but only for the whole site).

The total monetary savings estimated amount to 63'000 CHF/year.

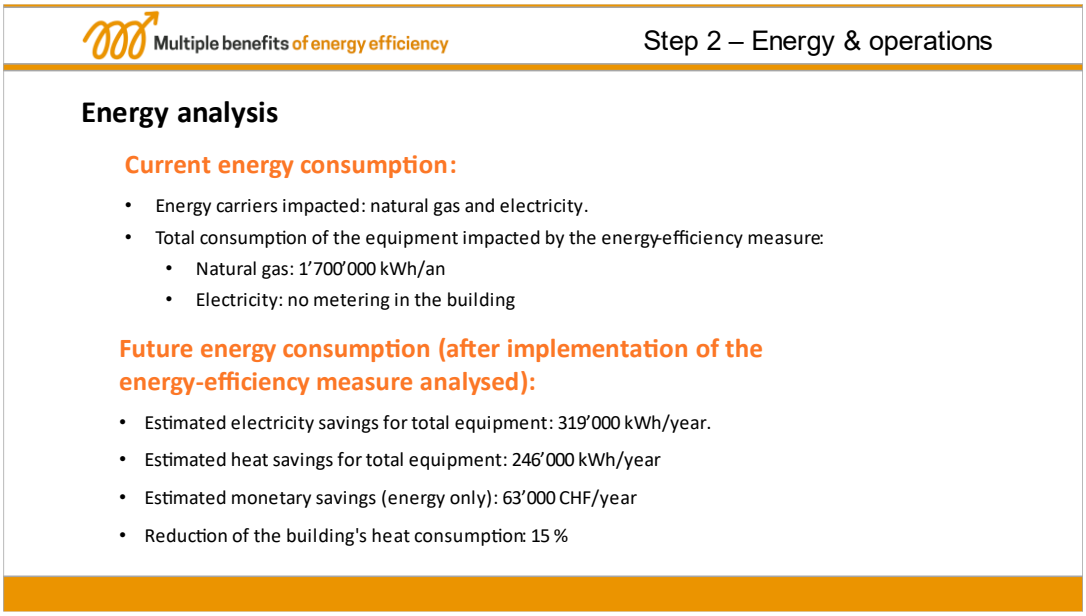


Figure 199. Results of the Energy Analysis. Full optimization of the Mobility and Roads building (CEB).

Results of the Operations Analysis

As shown in the chart below, the energy-project (including EEM1 to EEM7) consists in the full optimization of the installations providing the building main heating, ventilation, compressed air, lighting and domestic hot water to the offices and to paint shops and road equipment repair shops.

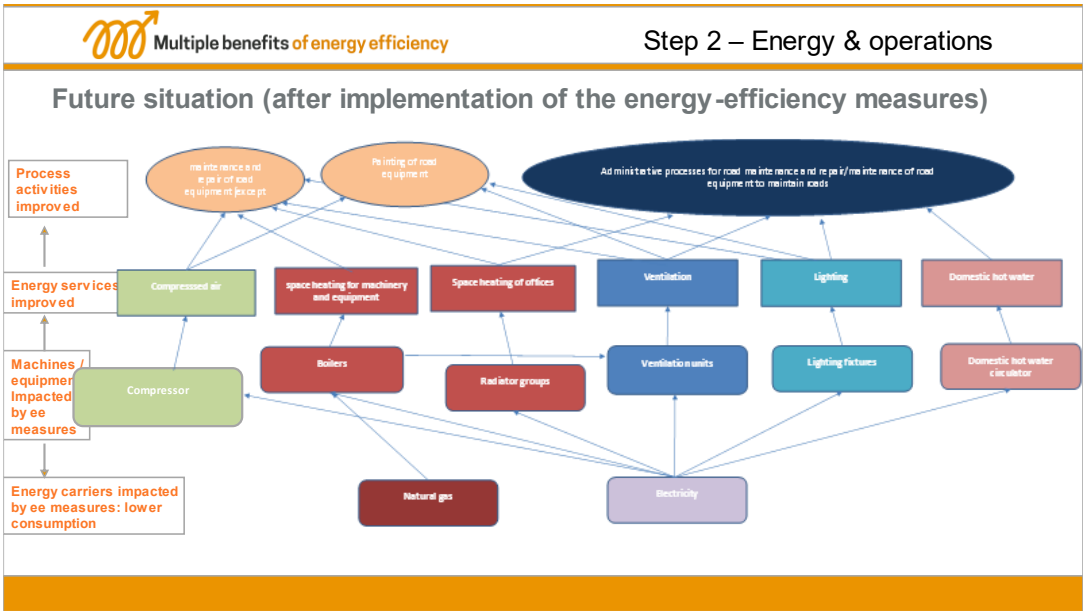


Figure 200. Results of the Operations Analysis- Operational diagram. Full optimization of the Mobility and Roads building (CEB).

As shown below, the energy-efficiency project positively contributes to 2 dimensions of operational excellence: safety and costs.

Employees' **safety** is improved thanks to better thermal, lighting and air quality conditions. **Costs** reduction include salary costs thanks to increased productivity of employees (due to better thermal, lighting and air quality conditions), reduced maintenance and CO2 costs, deferred investment in equipment.

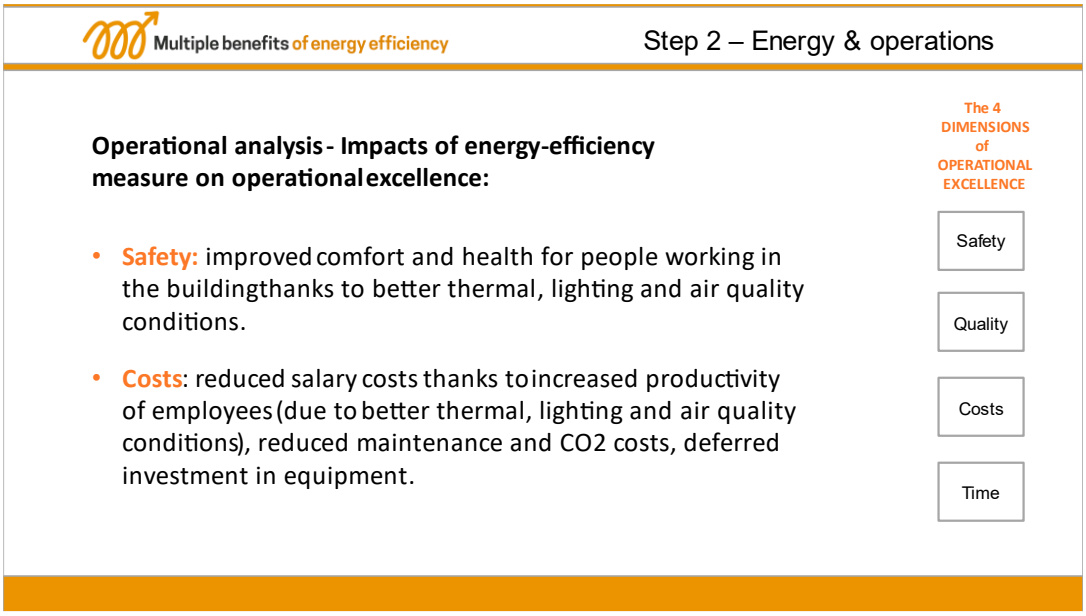


Figure 201. Results of the Operations Analysis. Full optimization of the Mobility and Roads building (CEB).

Results of the Strategic Analysis

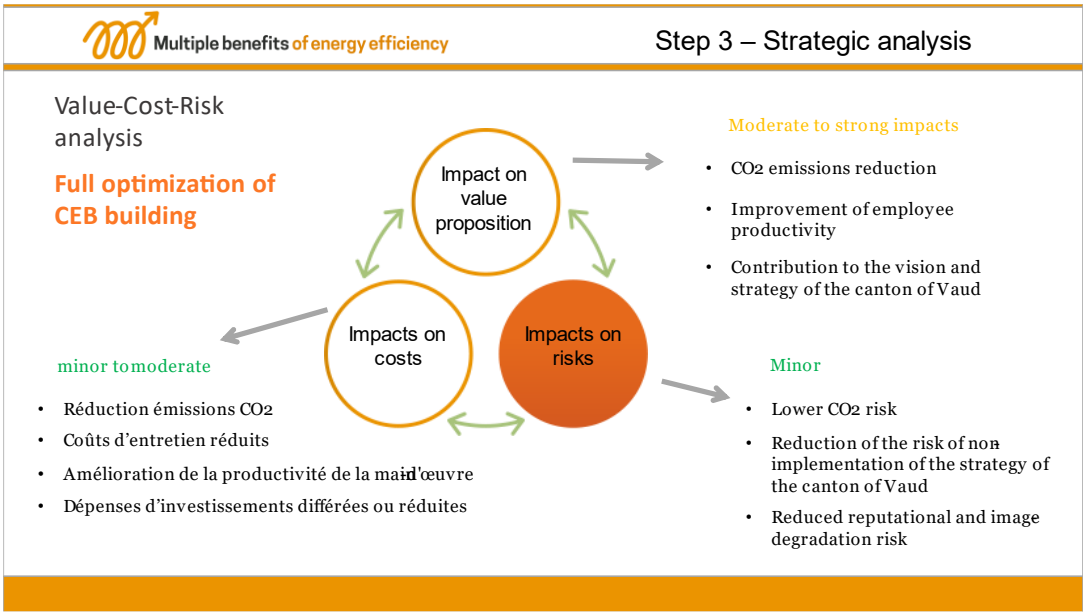


Figure 202. Results of the Strategic Analysis. Full optimization of the Mobility and Roads building (CEB).

The Value-Cost-Risk impacts of the full optimization of the building's energy services (including EEM1 to EEM7) are the following:

Risk reduction impacts: the CO2 risk is (slightly) reduced thanks to the reduction in natural gas consumption. The risk of not implementing the canton's energy strategy and the reputational risk (damage to the image of the authorities and the State of Vaud) are also reduced.

Value proposition impacts: The reduction in CO2 emissions is seen as a success and proof of public administration efficiency by the people of Vaud and also contributes to the realisation of the canton's energy strategy. The image of the State of Vaud is strengthened.

Cost reduction impacts: The optimisation of the building reduces CO2 costs (less CO2 tax to be paid), maintenance costs (replacement of bulbs and light tubes of old lighting fixtures is no longer necessary with LEDs). It also improves the productivity of employees -and therefore reduces salaries- thanks to improved comfort. In this respect, an assumption of 1.25% improvement in productivity (i.e. equivalent to 6 minutes of improvement per 8-hour working day) has been made. Finally, optimising the operation of equipment makes it possible to extend its life span and avoid costly investments (a hypothesis of deferring expenditure for 3 years has been made). These 3 years also allow more time to think about the future of the site: demolition or complete renovation.

Results of the Financial Analysis

Detailed financial calculations

Step 4 – Financial analysis

Total annual energy benefits

TOTAL ENERGY COST REDUCTION IN CHF				0	59 865	59 865	59 865	59 865
NON-ENERGY BENEFITS (NEBs)								
NON-ENERGY BENEFITS	Amount in CHF	Start period	Duration	Year 0	Year 1	Year 2	Year 3	Year 4
Reduced CO2 emissions /VP								
Improved workforce productivity /VP								
Improved workforce productivity /Cost	60 374	Year 1	Recurrent	0	60 374	60 374	60 374	60 374
Delayed or reduced capital expenditure	71 080	Year 1	Non recurrent	0	71 080	0	0	0
Delayed or reduced capital expenditure	71 080	Year 2	Non recurrent	0	0	71 080	0	0
Delayed or reduced capital expenditure	71 080	Year 3	Non recurrent	0	0	0	71 080	0
Reduced CO2 emissions /Cost	10 836	Year 1	Recurrent	0	10 836	10 836	10 836	10 836
Reduced maintenance cost	2 540	Year 1	Recurrent	0	2 540	2 540	2 540	2 540
TOTAL NON-ENERGY COST REDUCTION IN CHF				0	144 830	144 830	144 830	73 750

Total annual non energy benefits

NB: capital expenditure being deferred for 3 years, there are no non-energy benefits for this item from the 4th year onwards

Figure 203. Results of the Financial Analysis. Full optimization of the Mobility and Roads building (CEB).

Multiple benefits of energy efficiency

Step 4 – Financial analysis

Financial analysis

Energy benefits only:

- CAPEX: 107'000 CHF
- Annual investment income before taxes: 59'865 CHF
- NPV: 380'665 CHF
- IRR: 72,8 %
- Payback : 2 ans

Energy + non-energy benefits:

- CAPEX: 107'000 CHF
- Annual investment income before taxes: 144'830 CHF (3 1st years)
- NPV: 1'176'097 CHF
- IRR: 334 %
- Payback : 1 ans

Discount rate : 4 %
Investment duration: 10 years (= number of years used to calculate NPV and IRR).

Figure 204. Results of the Financial Analysis. Full optimization of the Mobility and Roads building (CEB).

The strategic impacts (for the full optimization, including EEM1 to EEM7) identified and quantified in the Value-Cost-Risk analysis translate into the financial figures shown in the slides above: the annual pre-tax investment income increases from 59'865 CHF to 114'830 CHF when non-energy benefits are included (for the first three years, when deferred investment is included, then it goes down to 73'750 CHF). The net present value (NPV) is multiplied by 3 and the internal rate of return (IRR) by almost 5. Payback decreases from 2 years to 1 year.

For this type of investment, the State of Vaud applies an investment period of 10 years.

Key Arguments for the Project Implementation

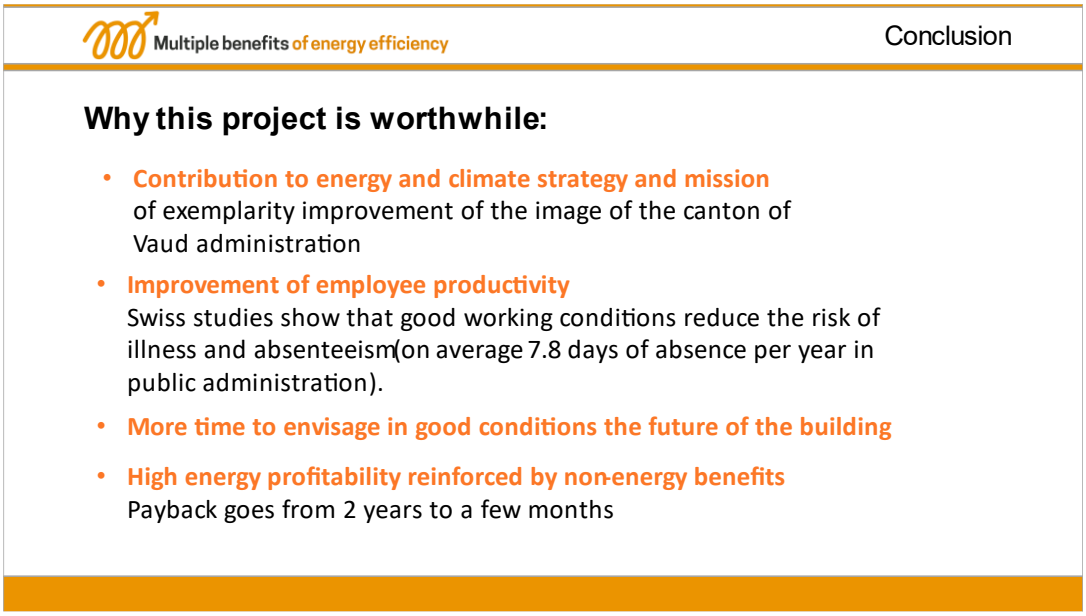


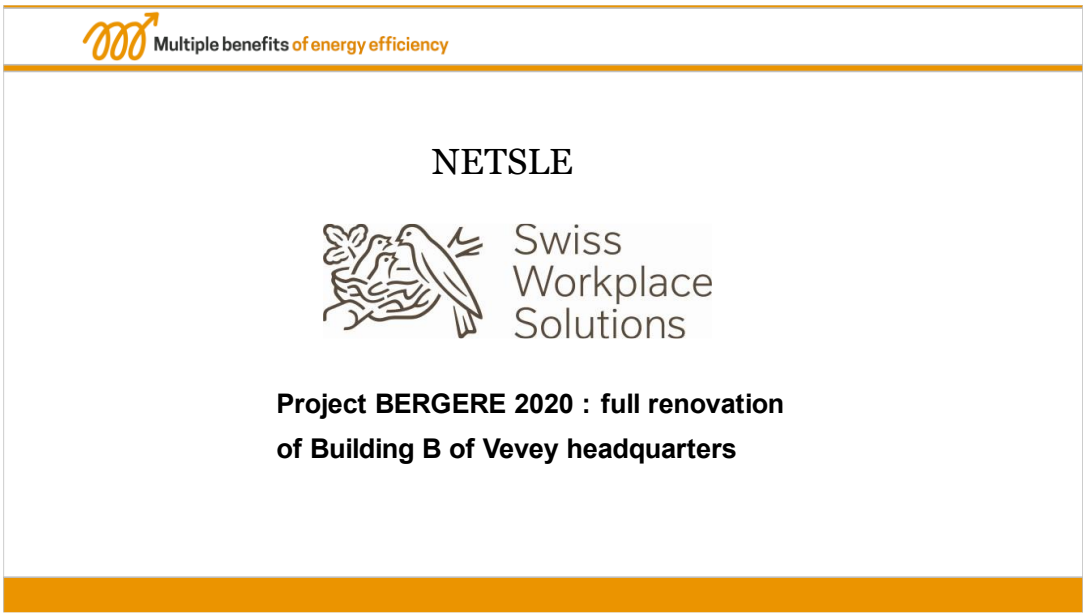
Figure 205. Key Arguments for the Project Implementation. Full optimization of the Mobility and Roads building (CEB).

2.9.3 Pilot 3: Project BERGERE 2020: full renovation of Building B of Vevey headquarters

Nestlé

(partially confidential: see below)

NB: THE NAME OF NESTLE MUST NOT APPEAR IN ANY COMMUNICATION EXTERNAL TO THE MBENEFITS PROJECT.



Project Idea and Rationale

The energy-efficiency project described in this report focuses on a complete renovation of Nestlé's historic headquarters in Vevey, Switzerland. The full renovation of the building would include the 5 following actions:

- EEM1 – Total renovation of the building envelope (without windows)
- EEM2 – Zero CO2 heating and air conditioning
- EEM3 – Replacement of light sources and windows and self-generation of electricity
- EEM4 – Real-time attendance-controlled ventilation
- EEM5 – Unassigned "Activity-based working" workspaces

NB: a detailed analysis (i.e., including energy & operations, strategic and financial impacts) is available for every energy-efficiency measure in the software (V20) but the global project impacts are only described in this report. Please refer to the Excel software for more details.

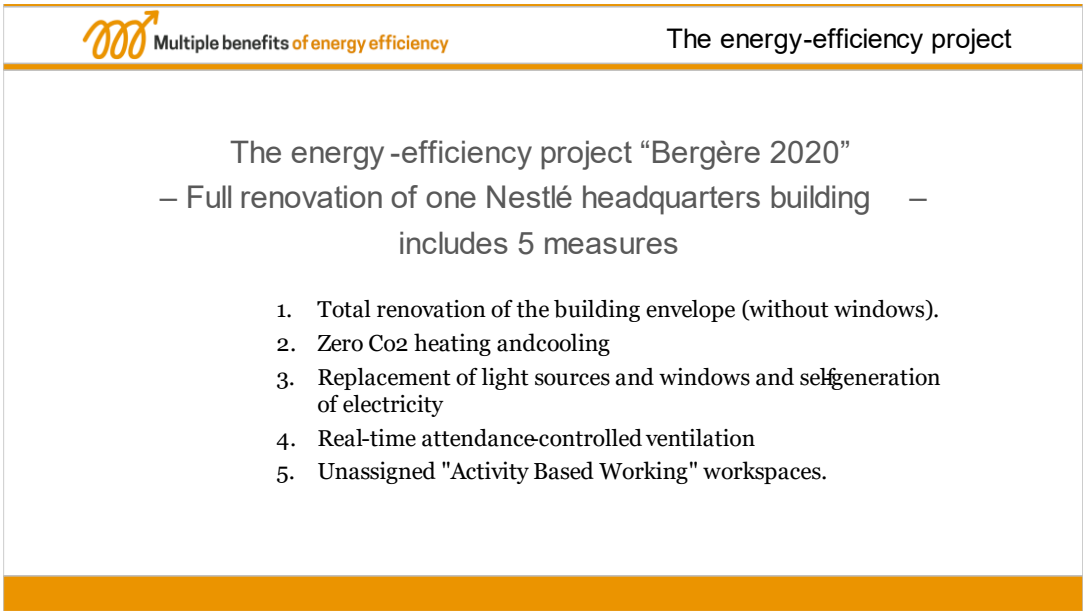


Figure 206. Project Idea and Rationale. Project BERGERE 2020: full renovation of Building B of Vevey headquarters, partially confidential.

Results of the Company Analysis

Swiss Workplace Solutions (SWS) is the division of Nestlé in charge of all Swiss buildings of the company. This includes administrative, industrial and R&D buildings, but not the production (process) activities that take place there.

As such, SWS carries out all activities necessary for the development and maintenance of Nestlé's building portfolio in Switzerland and makes these buildings available to Nestlé employees, so that they can carry out their work in the best possible way.

We can consider that Swiss Workplace Solutions must take into account the needs and wishes of two broad customer segments:

- Internal customers: Nestlé General Management - Factories in Switzerland (building envelope) - Head office departments - R&D - Pension funds - Nestlé employees on administrative sites.
- External customers: all Nestlé customers (image impact) - NGOs - Public authorities (legal compliance, exemplarity) - External service providers.

SWS's value proposition consists of : a safe, healthy and environmentally friendly working environment for Nestlé employees in Switzerland; quality services at a competitive cost; an optimal building portfolio that respects the environment and legal standards, and takes into account the expectations of the consumer-customers.

Multiple benefits of energy efficiency — Step 1 – Company analysis

Swiss Workplace Solutions:

- carries out all activities necessary for the development and maintenance of Nestlé's building portfolio in Switzerland.
- Makes these buildings available to Nestlé employees so that they can carry out their work in the best possible way. .

Customer segments and value propositions:

- **Internal customers:** Nestlé General Management - Factories in Switzerland (building envelope) - Head office departments - R&D - Pension funds - Nestlé employees on administrative sites. **External customers:** all Nestlé customers (image impact) - NGOs - Public authorities (legal compliance, exemplarity) - External service providers.
- **Value propositions:** a safe, healthy and environmentally friendly working environment for Nestlé employees in Switzerland. Quality services at a competitive cost. An optimal building portfolio that respects the environment and legal standards, and takes into account the expectations of the consumer-customers.

Figure 207. Results of the Company Analysis. Project BERGERE 2020: full renovation of Building B of Vevey headquarters, partially confidential.

Results of the Energy Analysis

The energy carriers impacted by the global building renovation are the electricity consumed by many various equipment, as well as the natural gas consumed for space heating. The renovation would involve a 29% reduction of the yearly total consumption of the building, corresponding approx. to 5'650'000 KWh/year.

The corresponding monetary savings amount approx. to 380'000CHF/year.

Multiple benefits of energy efficiency — Step 2 – Energy & operations

Global energy analysis

Current energy consumption:

- Energy carriers impacted: electricity / natural gas / (heating oil)
- Total electricity consumption of the equipment concerned: 12 GWh/an *(BER total)*
- Total thermal consumption of the equipment concerned : 8 GWh/an *(BER total)*

Future energy consumption (after implementation of the EE measures)

- Estimated physical savings for total equipment: 5'648'679 kWh/year
- Estimated monetary savings for total equipment (energy only): 379'849.40 CHF/year
- Reduction of the total consumption of the site: **- 29%**

NB: the elimination of fossil fuels from Bergere B leads to an increase of around 21% in the site's electricity consumption.

Figure 208. Results of the Energy Analysis. Project BERGERE 2020: full renovation of Building B of Vevey headquarters, partially confidential.

Results of the Operations Analysis

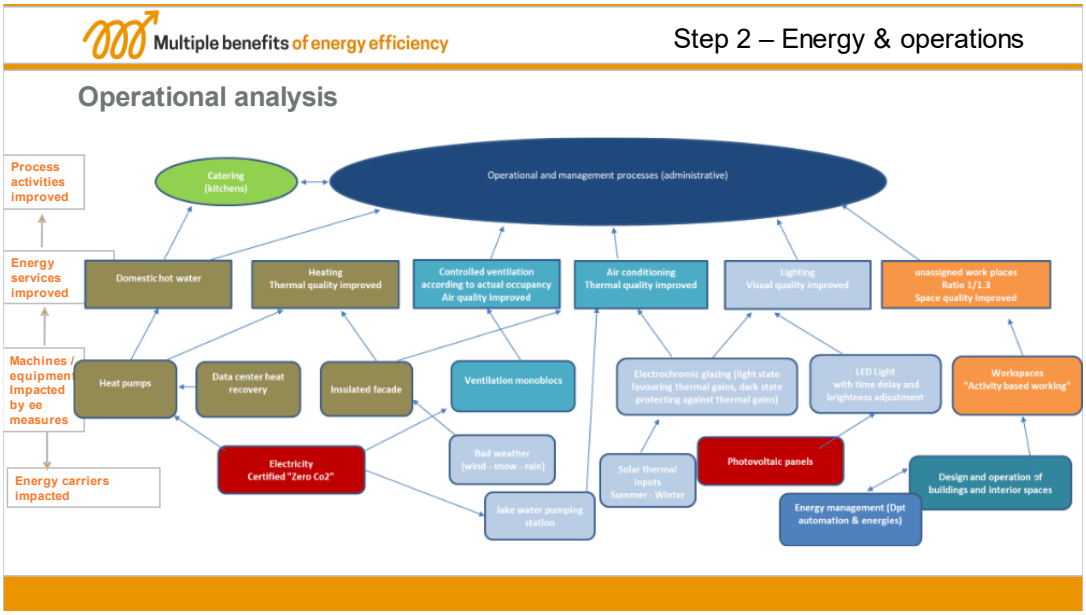


Figure 209. Results of the Operations Analysis-Operational diagram. Project BERGERE 2020: full renovation of Building B of Vevey headquarters, partially confidential.

As shown in the slide above, the main building's energy services are significantly improved by the energy-efficiency measures, i.e., thermal quality (thanks to the renovation of the façade and replacement of the light sources and windows); air quality (renovation of the ventilation); visual quality (replacement of light sources by LEDs with presence detection and self-regulated light intensity, windows with electrochromic glazing) and noise quality (better insulation of the façade).

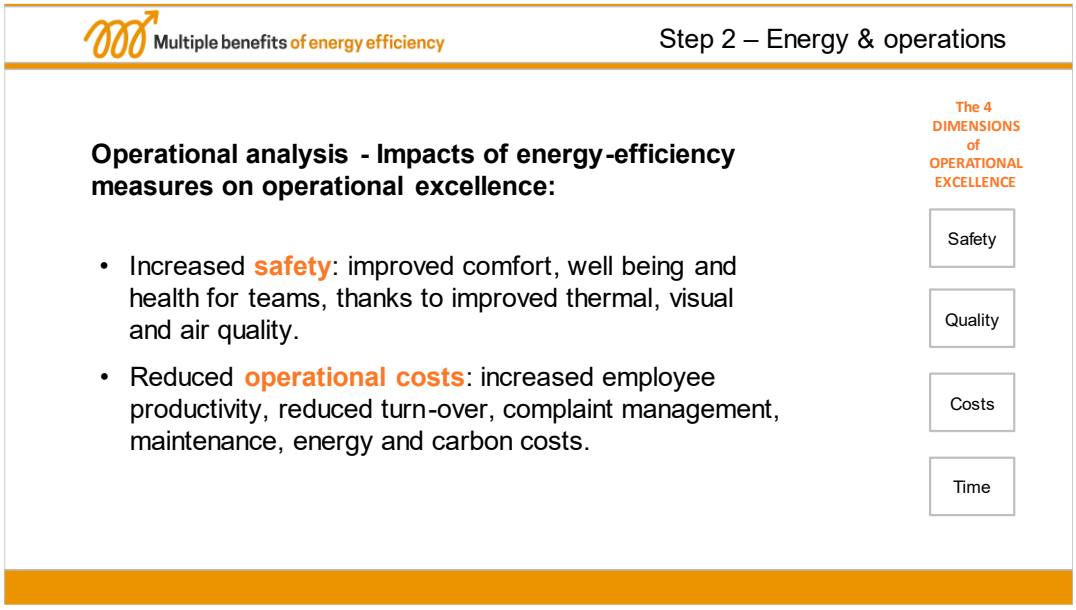


Figure 210. Results of the Operations Analysis. Project BERGERE 2020: full renovation of Building B of Vevey headquarters, partially confidential.

The global building's renovation positively contributes to 2 dimensions of operational excellence: safety & health (thanks to improved employee comfort and

well-being) and operational costs (increased employee productivity, reduced turnover, reduced maintenance costs and complaints management, reduced CO2 tax, reduced energy costs).

Results of the Strategic Analysis

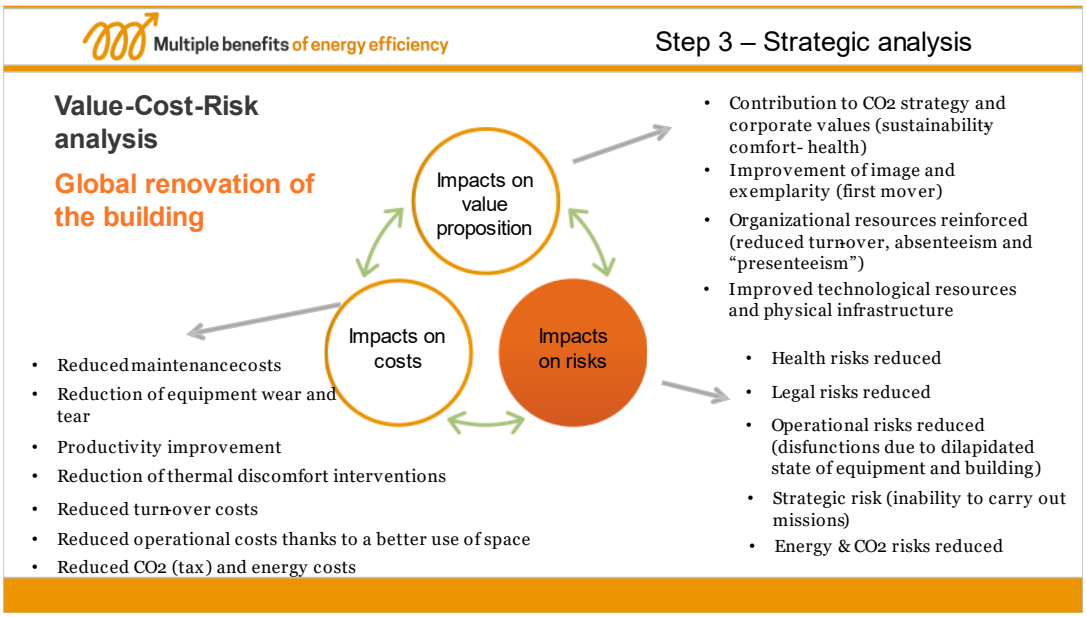


Figure 211. Results of the Strategic Analysis. Project BERGERE 2020: full renovation of Building B of Vevey headquarters, partially confidential.

The building's renovation positively impacts WPS and Nestlé value propositions, risks and costs:

Risk reduction impacts: thanks to improved comfort of working environment, health risks and their associated legal risks are reduced. Operational risks related to an old building (disfunctions due to old equipment) are reduced, as well as CO2 and energy risk. The strategic risk for the company of being unable to carry out the missions defined is reduced.

Value proposition impacts: increased safety and better working conditions entail increased staff satisfaction and loyalty, and therefore people work better. Organizational resources are reinforced thanks to reduced turnover and talent loss, reduced absenteeism and "presenteeism". This measure also contributes to the company's vision and strategy, and to a better image and reputation.

Cost reduction impacts include reduced maintenance costs (less replacement of light sources, no more façade blinds); reduction of equipment wear and tear (ventilation adjusted to building occupancy); reduced turnover and salaries costs (thanks to productivity improvement), reduced space costs per employee (the total capacity of the building is increased thanks to activity-based working); energy & carbon costs.

Results of the Financial Analysis

Multiple benefits of energy efficiency — Step 4 – Financial analysis

Detailed financial calculations

Total annual energy benefits

RÉDUCTION DU COÛT TOTAL DE L'ÉNERGIE EN CHF				0	379 849	379 849	379 849
BÉNÉFICES NON ÉNERGÉTIQUES (BNE)							
BÉNÉFICES NON ÉNERGÉTIQUES	Montant en CHF	Période de début	Durée du projet	Année 0	Année 1	Année 2	Année 3
Réduction des coûts d'entretien	30 000	Année 1	Récurrent	0	30 000	30 000	30 000
Réduction des coûts d'entretien	270 000	Année 1	Récurrent	0	270 000	270 000	270 000
Réduction usure	45 000	Année 1	Récurrent	0	45 000	45 000	45 000
Réduction taxe CO2	144 000	Année 1	Récurrent	0	144 000	144 000	144 000
Amélioration productivité (1.25%)	1 312 500	Année 1	Récurrent	0	1 312 500	1 312 500	1 312 500
Gain de place et réduction coûts opérationnels Plan Dessus	1 385 200	Année 1	Récurrent	0	1 385 200	1 385 200	1 385 200
Réduction des interventions confort thermique	12 000	Année 1	Récurrent	0	12 000	12 000	12 000
Réduction du roulement du personnel (turnover)	192 500	Année 1	Récurrent	0	192 500	192 500	192 500
Réduction de l'absentéisme	0	Année 1	Récurrent	0	0	0	0
LA RÉDUCTION TOTALE DES COÛTS NON ÉNERGÉTIQUES EN CHF				0	3 391 200	3 391 200	3 391 200

Total annual non energy benefits

Figure 212. Results of the Financial Analysis. Project BERGERE 2020: full renovation of Building B of Vevey headquarters, partially confidential.

Multiple benefits of energy efficiency — Step 4 – Financial analysis

Financial analysis

Energy benefits only:

- CAPEX: 23'809'280 CHF
- Investment income before taxes : 379'849 CHF
- NPV: -20'171'266
- IRR: -11.69%
- Simple payback: 49 years

Energy + non-energy benefits:

- CAPEX: 23'809'280 CHF
- Investment income before taxes 3'391'200 CHF
- NPV: 4'836'840
- IRR: 11.03%
- Simple payback: 8 years

Discount rate: 8 %
Investment duration: 25 years (= number of years used to calculate NPV and IRR)
Depreciation: 50 years.

NB: Non-energy benefits figures do not take into account an increased value of the real estate assets or possible increases in energy and CO2 prices.

Figure 213. Results of the Financial Analysis. Project BERGERE 2020: full renovation of Building B of Vevey headquarters, partially confidential.

The strategic impacts identified and quantified in the Value-Cost-Risk analysis translate into the financial figures shown in the slides above: the annual pre-tax investment income increases from 379'849 CHF to 3'391'200 CHF when non-energy benefits are included. The net present value (NPV) and the internal rate of return (IRR), which were negative, change to positive at, respectively, 4'836'840 CHF and 11% (the IRR becomes significantly higher than the discount rate of 8% required by the company). The payback decreases from 49 to 8 years.

For this type of investment, the company applies an investment duration of 25 years.

Key Arguments for the Project Implementation

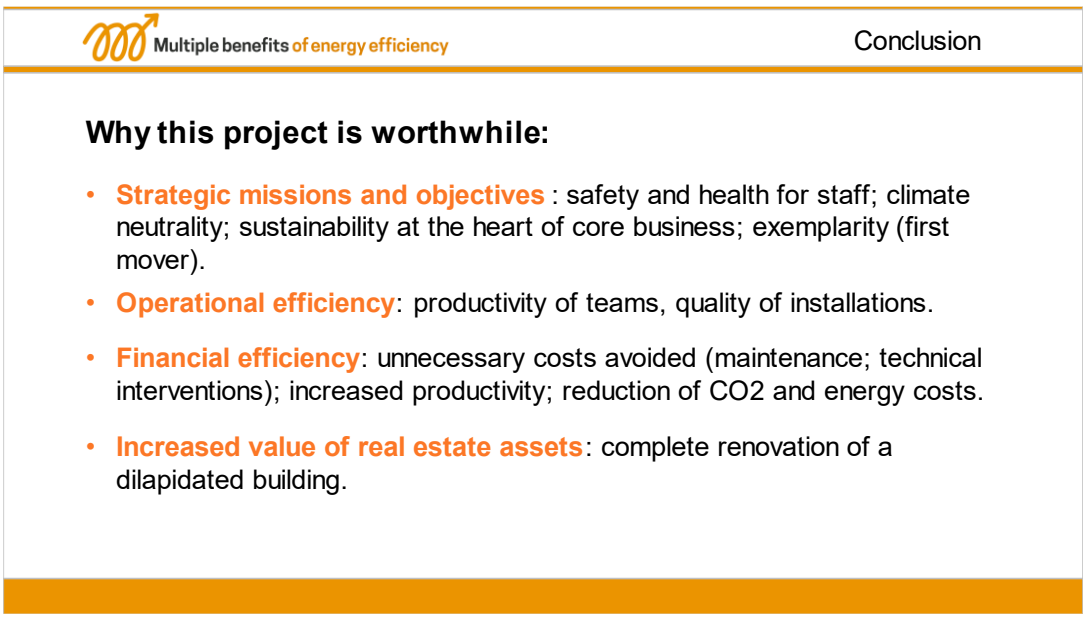
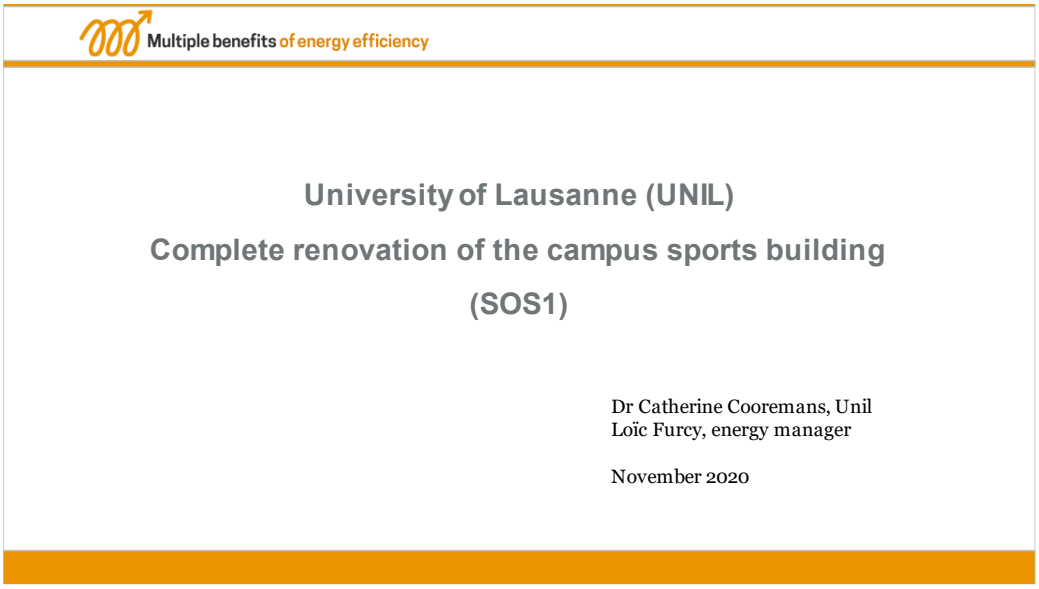
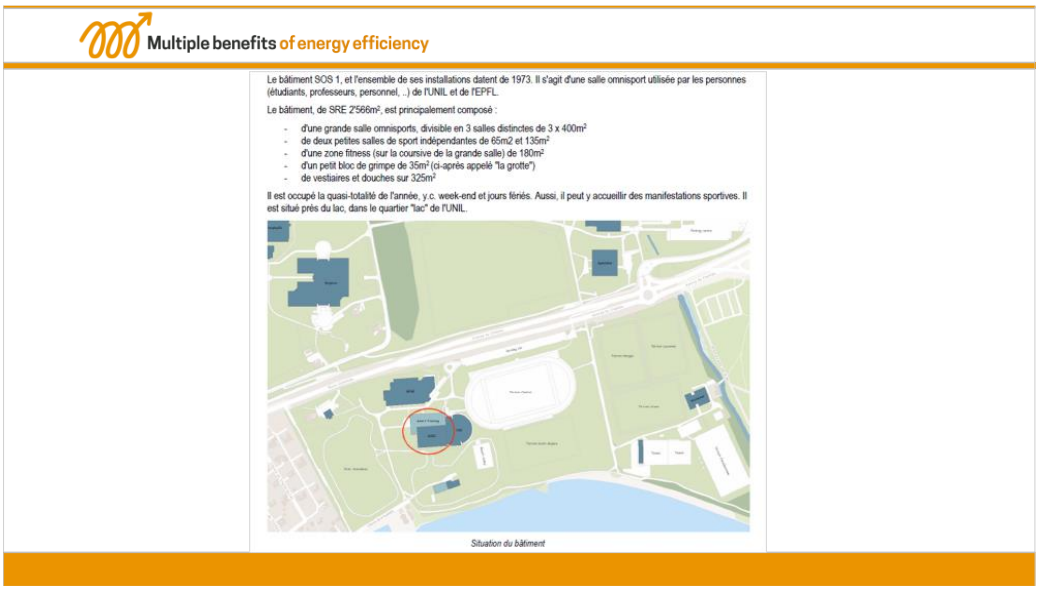


Figure 214. Key Arguments for the Project Implementation. Project BERGERE 2020: full renovation of Building B of Vevey headquarters, partially confidential.

2.9.4 Pilot 4: Full Renovation of the University of Lausanne sports building (SOS1)

University of Lausanne - Sport building (SOS1)





Project Idea and Rationale

The SOS 1 building and all its installations date back to 1973. It is an omnisports hall used by the people (students, professors, staff, ...) of University of Lausanne (UNIL) and EPFL.

The building, of energy reference surface (i.e. heated surface) 2'566m2, is mainly composed of:

- a large omnisports hall, divisible into 3 distinct rooms of 3 x 400 m2
- two small independent sports halls of 65m2 and 135 m2
- a fitness area (on the corridor of the large hall) of 180 m2

- a small climbing block of 35 m2
- changing rooms and showers on 325 m2

SOS1 is located near the Leman lake, in the "lake" district of the UNIL campus. It is occupied most of the year, including weekends and holidays. It can also host sports events.

In the summer of 2020, the building was used to organize the end-of-year exams, as it was the only one on campus to offer the necessary space, imposed by the distance between tables due to the covid situation. The decision to use the building was risky because, due to its obsolescent state, the internal temperature can be very high in summer and, therefore, it was not sure that the building could be used for exams. Fortunately, the summer of 2020 was quite cool.

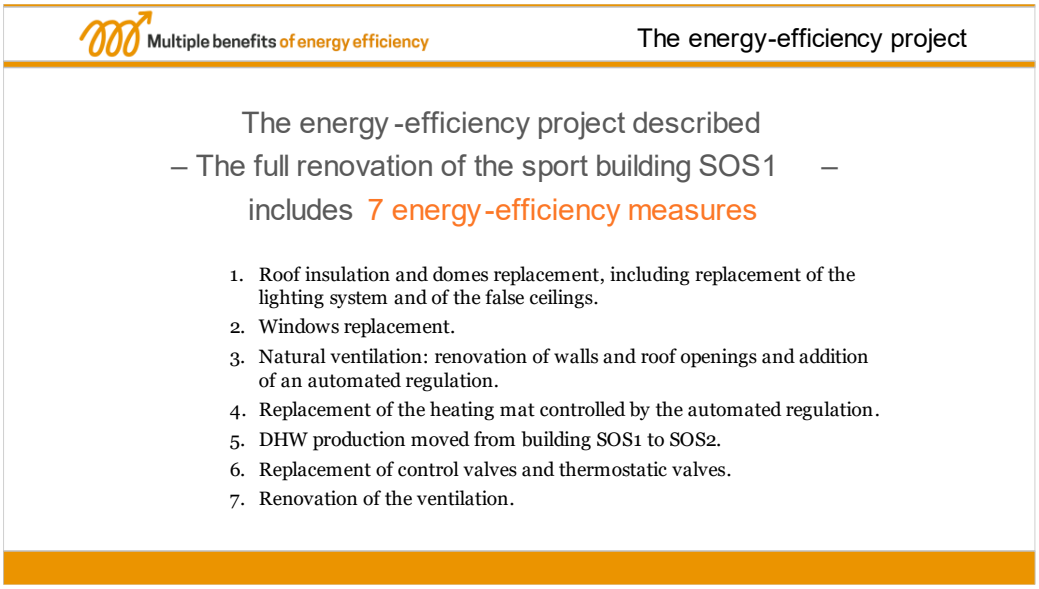


Figure 215. Project Idea and Rationale. University of Lausanne - Sport building.

As shown in the above slide, the energy-efficiency project described in this report focuses on a complete renovation of building, which would include the following actions:

- EEM1 - Roof insulation and domes replacement, including replacement of the lighting system and of the false ceilings
- EEM2 – Windows replacement
- EEM3 - Roof insulation and domes replacement, including replacement of the lighting system and of the false ceilings
- EEM4 - Roof insulation and domes replacement, including replacement of the lighting system and of the false ceilings
- EEM5 - Roof insulation and domes replacement, including replacement of the lighting system and of the false ceilings
- EEM6 - Roof insulation and domes replacement, including replacement of the lighting system and of the false ceilings
- EEM7 – Renovation of the ventilation

Multiple benefits of energy efficiency — Step 2 – Energy & operations

Current situations and problems:

- The SOS1 building, intended for the practice of various sports by students and staff, is in a dilapidated state (the windows are 47 years old).
- A large part of the building is glazed (glazed facades and roof domes), in single glazing. Thermal inertia is almost non -existent. The condition of the building causes comfort problems for users: excessive heat in mid -season and summer, poor ventilation, insufficient lighting, humidity levels.
- The dilapidated state of all the installations leads to unnecessary maintenance costs (heating, ventilation, sanitary facilities) and material replacement costs (false ceilings).
- The dilapidated state of sanitary facilities (showers) leads to risks of deterioration in health and hygiene conditions, which are detrimental to the health of users.

Figure 216. Project Idea and Rationale-Current situations and problems. University of Lausanne - Sport building.

Multiple benefits of energy efficiency — Step 2 – Energy & operations

Proposed energy-efficiency measures (8 in total) and their benefits :

- Complete and in -depth renovation of the building (envelope and interior technical installations).
- Installation of triple glazing on the facade and roof, controlled by an automatic regulation; replacement of lighting and false ceilings; renovation of ventilation; optimisation of heating; renovation of hot water production and sanitary installations.
- Significant improvement in the thermal quality, air quality, sanitary quality and visual quality of the building with a reduction in the risks of impact on the comfort and health of users.
- Reduction of many unnecessary maintenance and engineering costs (related to obsolescence).

Figure 217. Project Idea and Rationale-Proposed energy-efficiency measures. University of Lausanne - Sport building.

Results of the Company Analysis

In 2019, 15'900 students were enrolled at the University of Lausanne, with a total staff (administrative, research and teaching) of 3'900.

In the broadest sense, the University's client segments include students; teachers and researchers; PATs; cantonal and federal public authorities; research funds; event organizers; sportsmen and women; and society as a whole.

UNIL's value propositions are quality teaching and cutting-edge research; a high international ranking; a stimulating environment for students and staff; a comfortable and healthy work and leisure environment.

Sustainability is at the heart of UNIL's mission

Figure 218. Results of the Company Analysis. University of Lausanne - Sport building.

Results of the Energy Analysis

The energy carriers impacted by the envisaged energy-efficiency measures are electricity and district heating.

The total consumption of the equipment impacted by the renovation project wasn't communicated by UNIL's energy management. The estimated electricity savings are 60'800 kWh/year and the estimated heat savings are 288'500 kWh/year.

The total monetary savings estimated amount to 43'200 CHF/year.

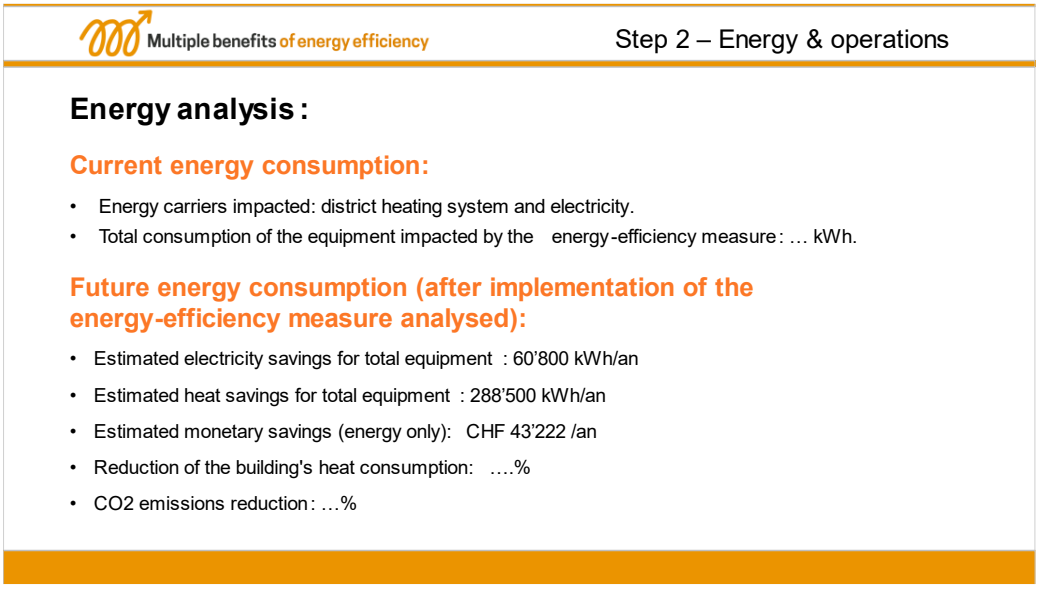


Figure 219. Results of the Energy Analysis. University of Lausanne - Sport building.

Results of the Operations Analysis

As shown in the chart below, the energy-project (including EEM1 to EEM7) consists in the full renovation of the installations providing the building main heating,

ventilation, lighting and domestic hot water services to sports facilities, changing rooms and sanitary facilities.

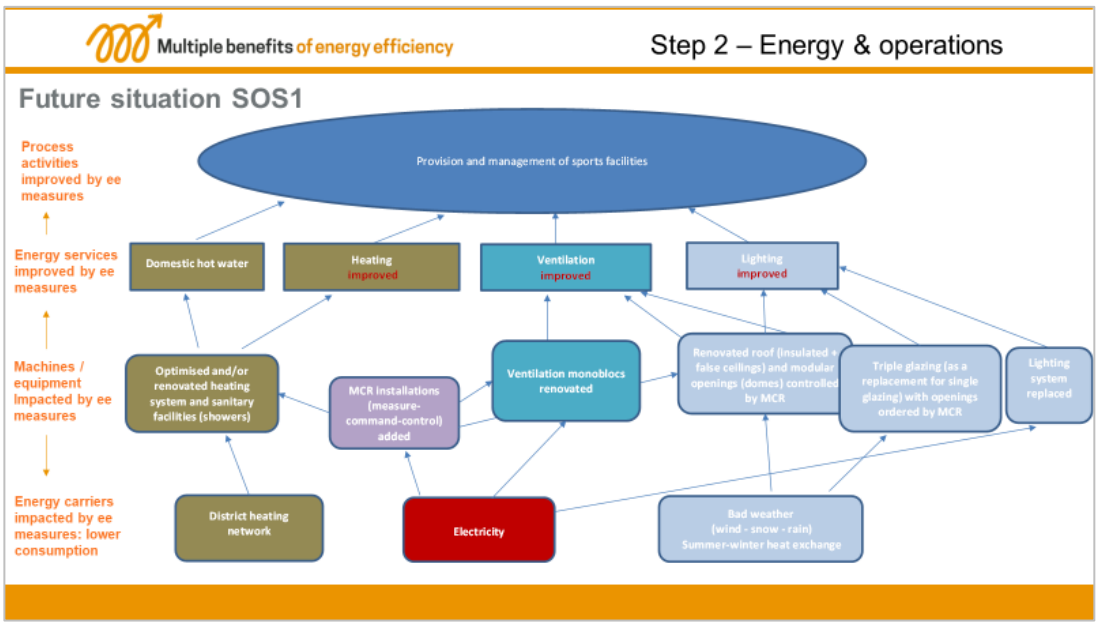


Figure 220. Results of the Operations Analysis- Operational diagram. University of Lausanne - Sport building.

As shown below, the energy-efficiency project positively contributes to 3 dimensions of operational excellence: safety, quality and costs.

Users' **safety** and **quality** are improved thanks to better thermal, lighting and air quality conditions. **Costs** reduction includes unnecessary engineering and maintenance costs caused by the general poor condition of the building.

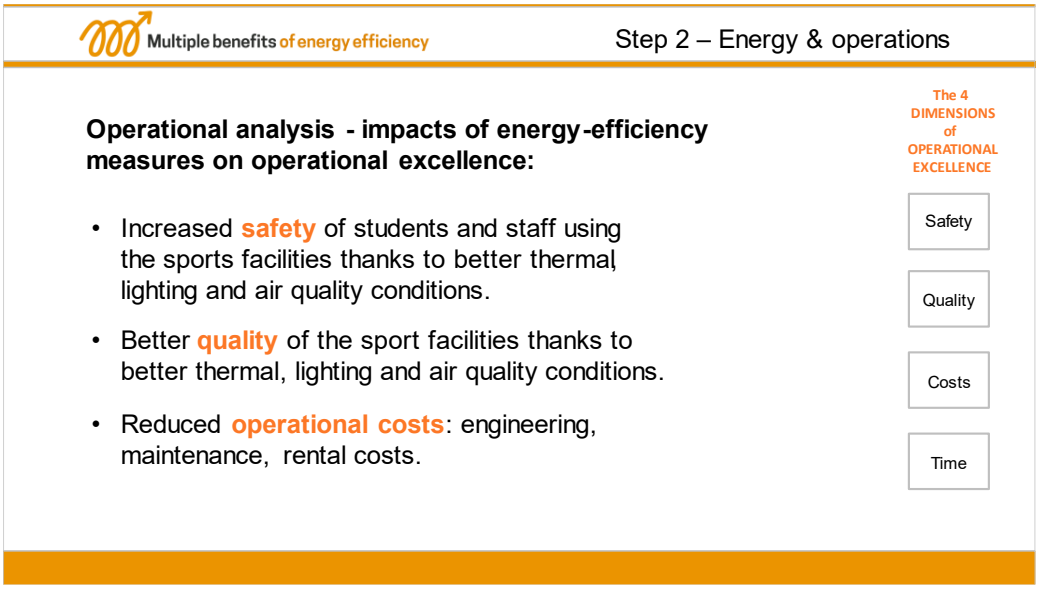


Figure 221. Results of the Operations Analysis. University of Lausanne - Sport building.

Results of the Strategic Analysis

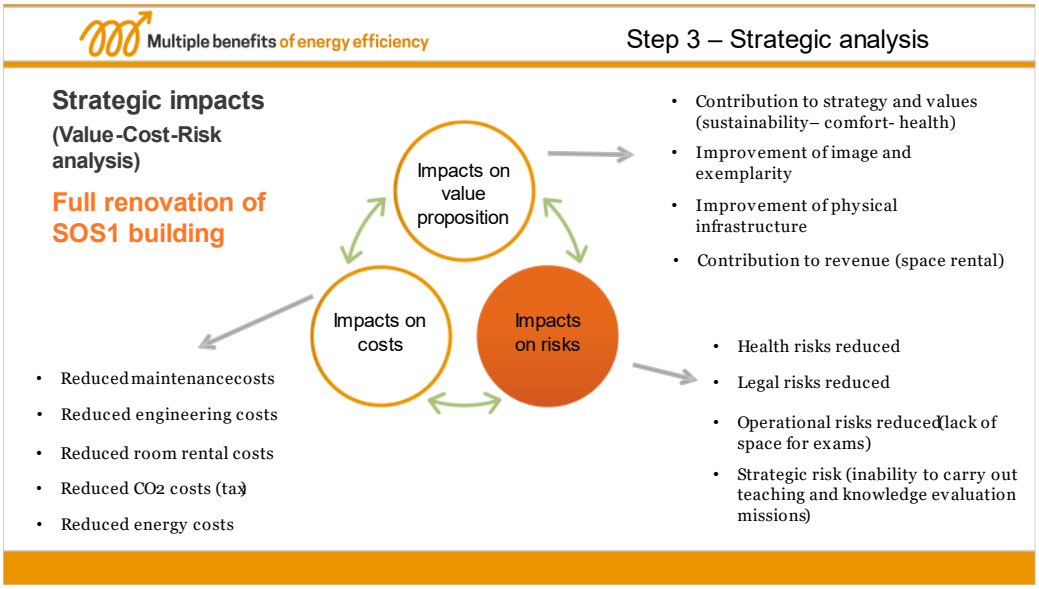


Figure 222. Results of the Strategic Analysis. University of Lausanne - Sport building.

The Value-Cost-Risk impacts of the full renovation of SOS1 building are the following:

Risk reduction impacts: health risks for the sportswomen and men, and associated legal risks, involved by the poor condition of the building. Operational risks related to a possible inability to organize year-end exams at the scheduled time and the associated strategic risk for Unil to be unable to carry out its mission of teaching and evaluating knowledge.

Value proposition impacts: The renovation of the building would contribute to UNIL's core values of sustainability, comfort and health for students and staff, and would strength its image and exemplarity. It would also contribute to the realisation of UNIL's energy strategy. Finally renting the renovated building to event organizers would increase the revenue.

Cost reduction impacts: The renovation of the building reduces important unnecessary engineering and maintenance costs entailed by the poor building's condition, as well as energy and CO2 costs (less CO2 tax to be paid). It would also reduce rental costs in the event that the poor condition of the building prevents examinations from being held there, resulting in rental costs outside the institution.

Results of the Financial Analysis

Detailed financial calculations I

Step 4 – Financial analysis

Total annual energy benefits

TOTAL ENERGY COST REDUCTION IN CHF				0	43 199	43 199	43 199

NON-ENERGY BENEFITS (NEBs)

NON-ENERGY BENEFITS	Amount in CHF	Start period	Duration	Year 0	Year 1	Year 2	Year 3
Additional space / Improved space utilisation /VP	30 000	Year 1	Recurrent	0	30 000	30 000	30 000
Increased assets value							
Reduced engineering control cost	9 101	Year 1	Recurrent	0	9 101	9 101	9 101
Additional space / Improved space utilisation /Cost	56 000	Year 1	Recurrent	0	56 000	56 000	56 000
Reduced maintenance cost	47 534	Year 1	Recurrent	0	47 534	47 534	47 534
Reduced CO2 emissions /Cost	2 054	Year 1	Recurrent	0	2 054	2 054	2 054
TOTAL NON-ENERGY COST REDUCTION IN CHF				0	144 689	144 689	144 689

Total annual non energy benefits

Figure 223. Results of the Financial Analysis. University of Lausanne - Sport building.

Multiple benefits of energy efficiency

Step 4 – Financial analysis

Financial analysis

Energy benefits only:

- CAPEX: 3'394'909 CHF
- Investment income: 43'199 CHF
- NPV: -3'043'724 CHF
- IRR: -26.54 %
- Simple payback: > 50 years

Energy + non-energy benefits:

- CAPEX: 3'394'290 CHF
- Investment income: 144'689 CHF
- NPV: -1'870'352 CHF
- IRR: -9.52 %
- Simple payback: 19 years

Discount rate: 4 %
Investment duration: **10 years** (= number of years used to calculate NPV and IRR).

Figure 224. Results of the Financial Analysis. University of Lausanne - Sport building.

The strategic impacts of the full renovation of SOS1, as identified and quantified in the Value-Cost-Risk analysis, translate into the financial figures shown in the slides above: the annual pre-tax investment income is multiplied per 3 when non-energy benefits are included, from 43'199 CHF to 144'689 CHF. The net present value (NPV) and the internal rate of return (IRR) are much less negative, and the (simple) payback decreases from more than 50 years to 19 years.

It must be noted that, for the replacement of the equipment concerned by EEMs 1 to 7, UNIL applies an investment period of 10 years, which is very short since the final result is actually the complete renovation of the building. With an investment duration of 20 years, current in the field of real estate investments, the IRR turns positive. In addition, the financial evaluation presented here does not take into account the increase in the asset value of the building.

Key Arguments for the Project Implementation

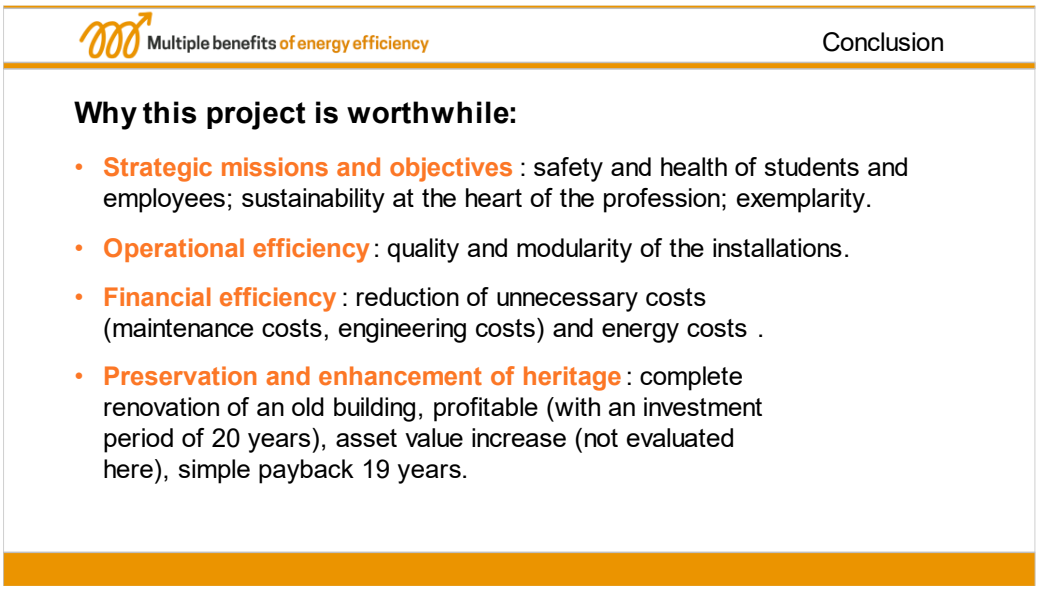


Figure 225. Key Arguments for the Project Implementation. University of Lausanne - Sport building.

2.9.5 Pilot 5: Renovation and optimization of the chromium plating shop facilities

First Industries Lausanne Crissier

Project Idea and Rationale

First Industries is a small SME (38 employees), located in an industrial zone of Lausanne, active in surface treatment of metal parts (hot and electrolytic zinc plating, painting, powder coating, nickel plating, chromium plating, blackening, etc.).

Major problems penalize the proper functioning of the chromium plating shop: ventilation is oversized, poorly adjusted and outdated; the performance of the cooling system must be improved, including an outside supply of cold air. Cooling heat from the rectifiers, which is sent into the ambient air, results in unnecessary

work for the refrigeration system (which cools the circuit water that keeps the rectifiers at optimum temperature). The cables that bring electricity to the chrome plating baths have power losses. These losses lead to a drift in the electricity supply which has an impact on the quality of the chrome plating.

Due to these technical deficiencies, the working conditions in the chromium plating shop are bad: the ambient temperature is often above 30 degrees centigrade in spring and summer, and the air quality is poor.

The full optimisation considered would include the 3 following actions:

- EEM1 – Renovation of the ventilation system
- EEM2 – Optimisation of the refrigeration system including free cooling
- EEM3 – Optimisation of the chrome plating baths and of rectifiers cables and bath pipes

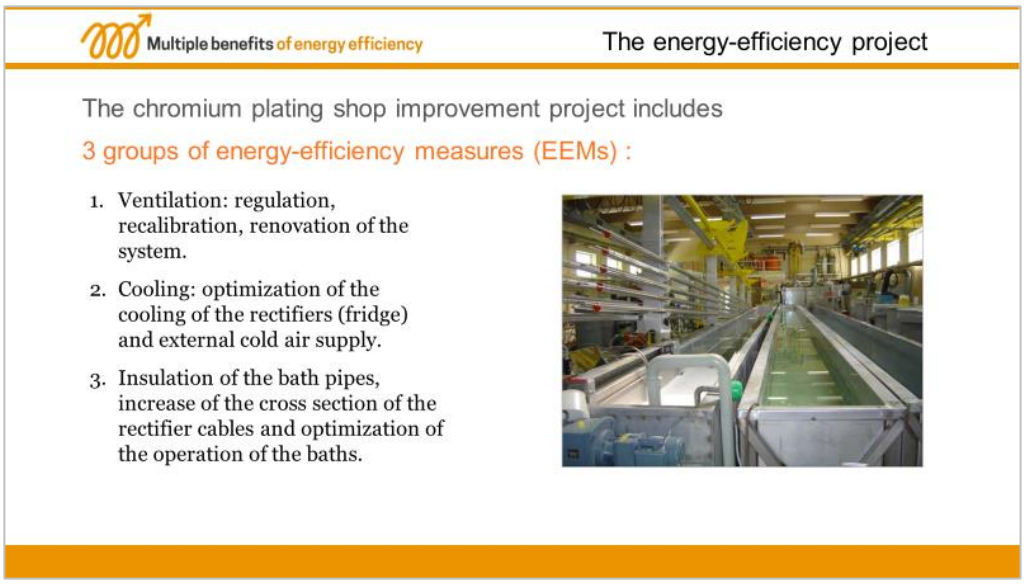


Figure 226. Project Idea and Rationale. First Industries Lausanne Crissier.

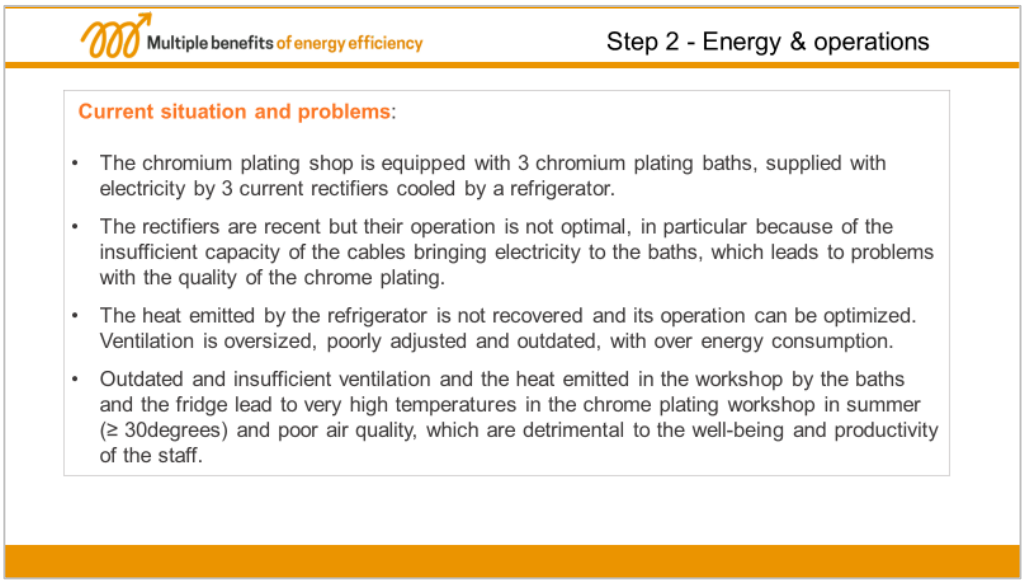


Figure 227. Project Idea and Rationale- Current situation and problems. First Industries Lausanne Crissier.

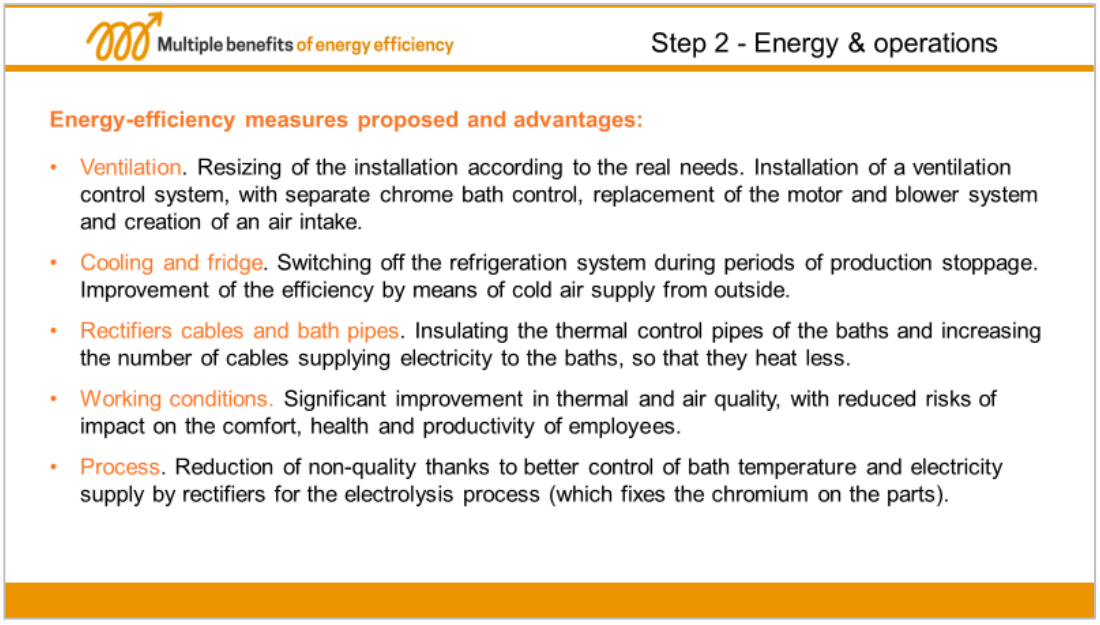


Figure 228. Project Idea and Rationale-Energy-efficiency measures proposed and advantages. . First Industries Lausanne Crissier.

Results of the Company Analysis

First Industries is active in surface treatment of metal parts (

- hot and electrolytic zinc plating
- painting
- powder coating
- nickel plating
- chromium plating,
- blackening

Customers are all companies wishing to apply a surface treatment on new or used metal parts.

The value proposition of First Industries is customized work, on demand; quality and flexibility; respect of deadlines.

Figure 229. Results of the Company Analysis. First Industries Lausanne Crissier.

Results of the Energy Analysis

The energy carrier impacted by the envisaged energy-efficiency measures is electricity.

The total electricity consumption of the equipment impacted by the optimization is 892'000 kWh/year. The estimated energy savings are 145'600 kWh/year, i.e. 16.3%.

The total energy monetary savings estimated amount to 21'800 CHF/year.

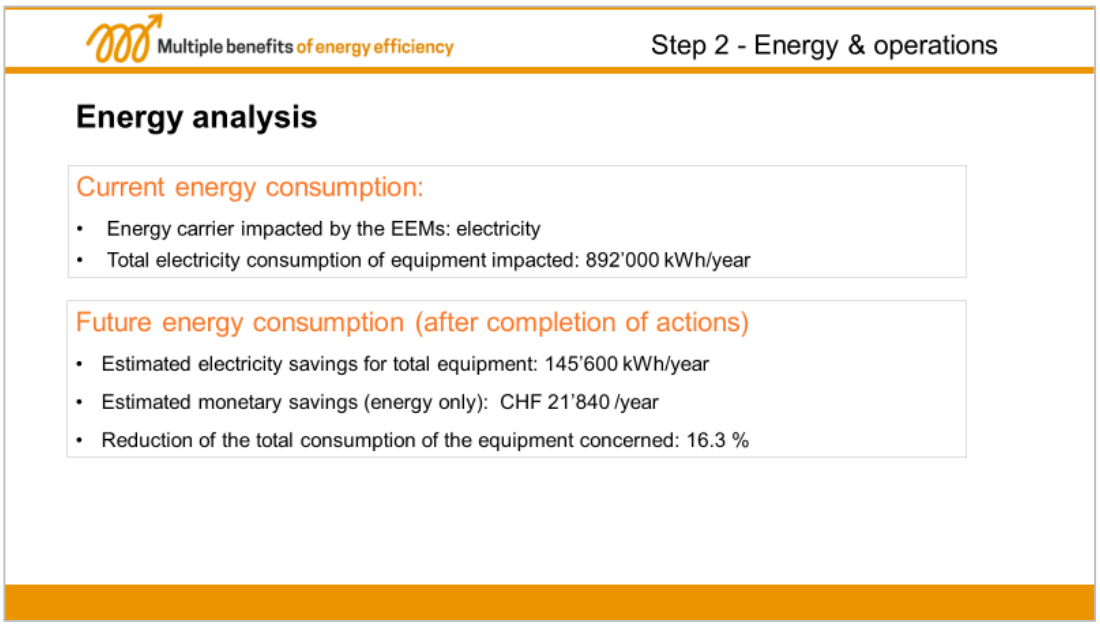


Figure 230. Results of the Energy Analysis. First Industries Lausanne Crissier.

Results of the Operations Analysis

As shown in the chart below, the energy-project (including EEM1 to EEM3) consists in the partial renovation and optimisation of the chromium plating shop facilities: renovation of the ventilation; optimization of the refrigeration system including free cooling; optimisation of the chrome plating bath and of rectifiers cables and bath pipes.

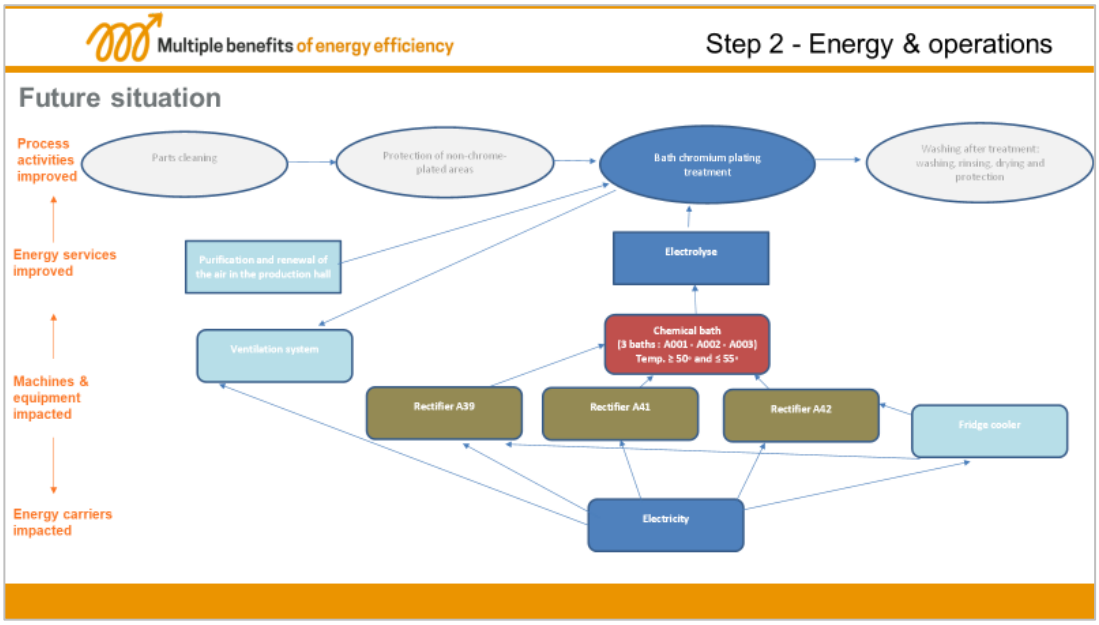


Figure 231. Results of the Operations Analysis, Operational diagram. First Industries Lausanne Crissier.

As shown below, the energy-efficiency project positively contributes to all 4 dimensions of operational excellence: safety, quality, costs and time.

Employees' **safety** is improved thanks to better thermal and air quality conditions. **Costs** reduction include salary costs thanks to increased productivity of employees (due to better thermal and air quality conditions), non-quality costs and customer problems; energy costs. **Quality** is improved thanks to reduction of non-quality and unplanned downtime. Less **time** is spent on re-do due to quality problems.

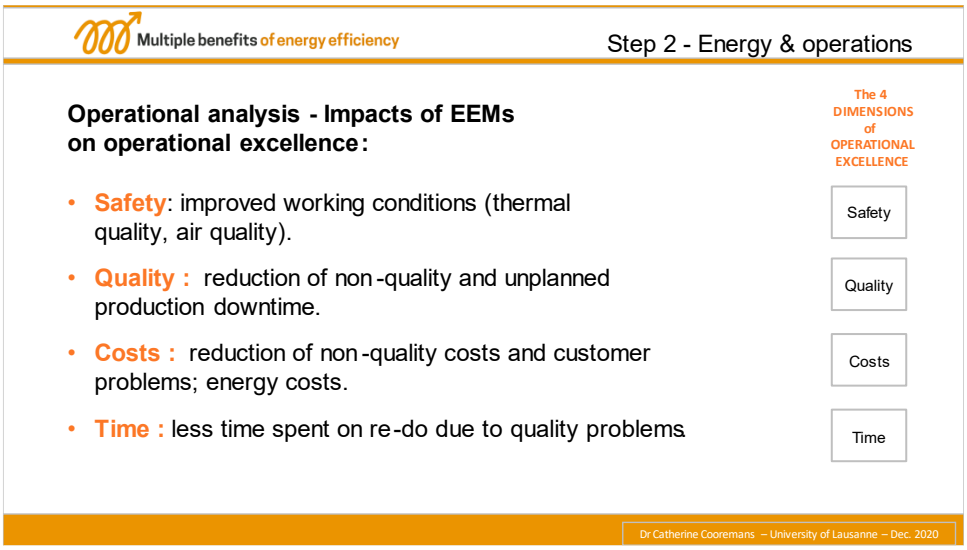


Figure 232. Results of the Operations Analysis. First Industries Lausanne Crissier.

Results of the Strategic Analysis

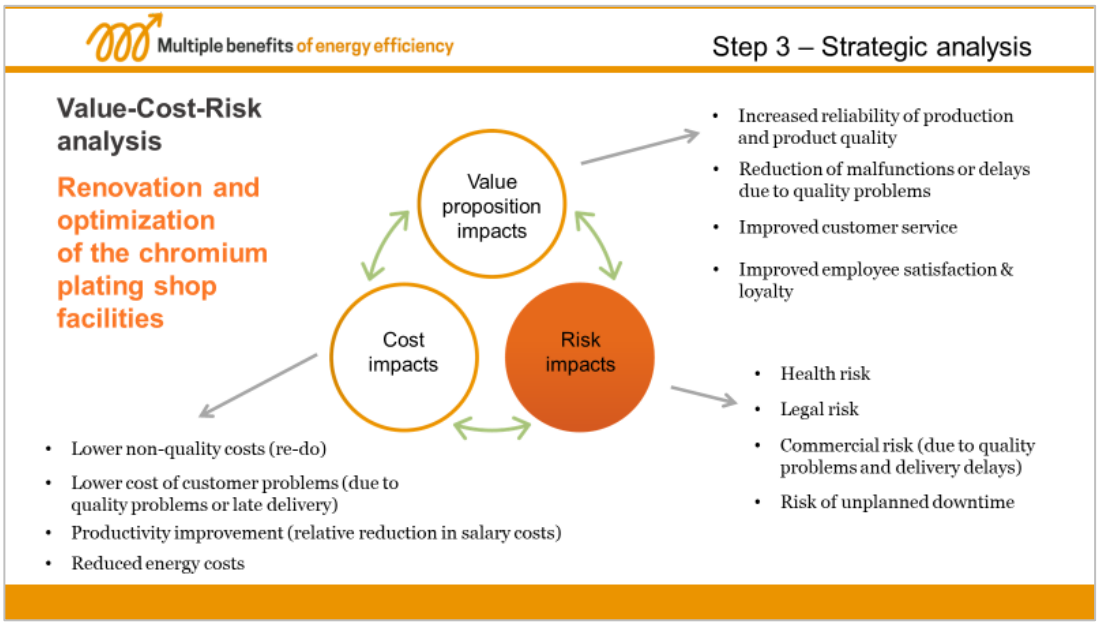


Figure 233. Results of the Strategic Analysis. First Industries Lausanne Crissier.

The Value-Cost-Risk impacts of the renovation and optimization of the chromium plating shop facilities (including EEM1 to EEM3) are the following:

Risk reduction impacts include a reduction of employee health risk and the associated legal risk. Reduction of the risk of unplanned downtime and of commercial risk (related to quality problems and delivery delays).

Value proposition impacts include increased reliability of production and product quality; reduction of malfunctions or delays due to quality problems and, therefore, improved customer service; improved employee satisfaction & loyalty, thanks to better working conditions, which improve the general working quality.

Cost reduction impacts include lower non-quality costs because of a better control of the electricity supply to the chromium plating baths and thanks to better employee comfort; lower cost of customer problems (which were due to quality problems or late delivery); productivity improvement (relative reduction in salary costs); energy costs.

Results of the Financial Analysis

Detailed calculations

Total annual energy benefits

TOTAL ENERGY COST REDUCTION IN CHF				0	21 840	21 840	21 840
NON-ENERGY BENEFITS (NEBs)							
NON-ENERGY BENEFITS	Amount in CHF	Start period	Duration	Year 0	Year 1	Year 2	Year 3
Reduction of non-quality /VP							
Improved workforce productivity /VP							
Improved workforce productivity /Cost	10 590	Year 1	Recurrent	0	10 590	10 590	10 590
Reduction of non-quality /Cost	1 000	Year 1	Recurrent	0	1 000	1 000	1 000
TOTAL NON-ENERGY COST REDUCTION IN CHF				0	11 590	11 590	11 590

Total annual non energy benefits

Figure 234. Results of the Financial Analysis. First Industries Lausanne Crissier.

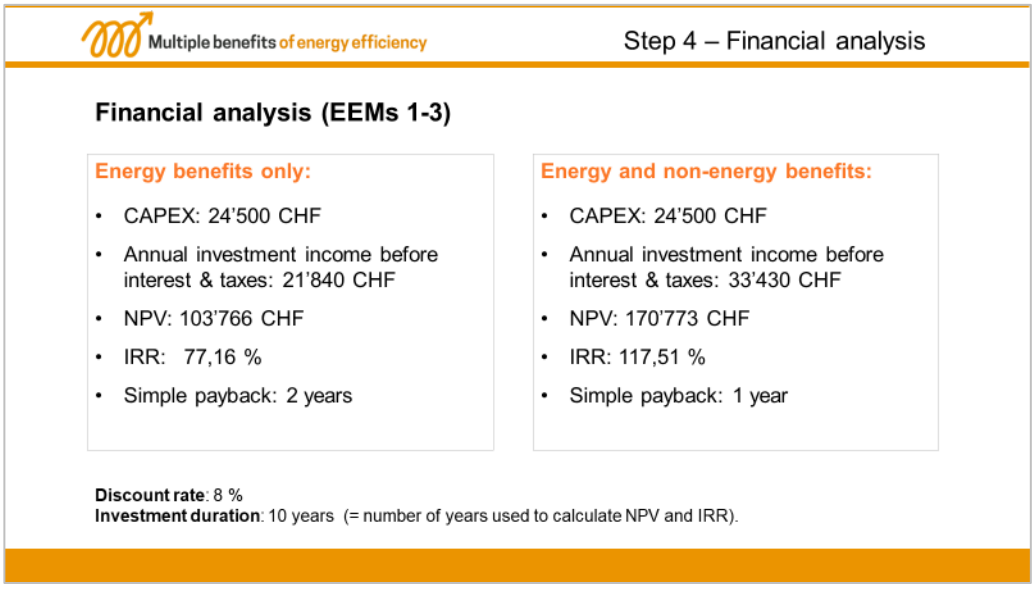


Figure 235. Results of the Financial Analysis. First Industries Lausanne Crissier.

The strategic impacts of the global renovation/optimization of the chromium plating shop facilities (EEM1 to EEM3) translate into the financial figures shown in the slides above: the annual pre-tax investment income increases from 21'840 CHF to 33'430 CHF when non-energy benefits are included. The non-energy benefits include:

- A reduction of the cost of non-quality of the hard-chromium plating. For 2020 this cost was estimated by Mrs Goncalves, the quality manager, at 20'000 CHF[1] and an annual 5% reduction - i.e. 1'000 CHF - has been assumed.
- Productivity improvement thanks to better working conditions: in 2020, wage costs for chromium plating were 353'000 CHF (4.2 x HR)[2]. A 3%

[1] Mail of Mrs Goncalves of 23.12.2020.
[2] Mail of Mrs Goncalves of 23.12.2020.

workforce productivity improvement was assumed, i.e. 10'590.- CHF per year.

The net present value (NPV) increases by about 70% and the internal rate of return (IRR) increases from 77% to 117%. The payback decreases from 2 years to 1 year. For this type of investment, First Industries applies an investment period of 10 years and a discount rate of 8%.

Key Arguments for the Project Implementation

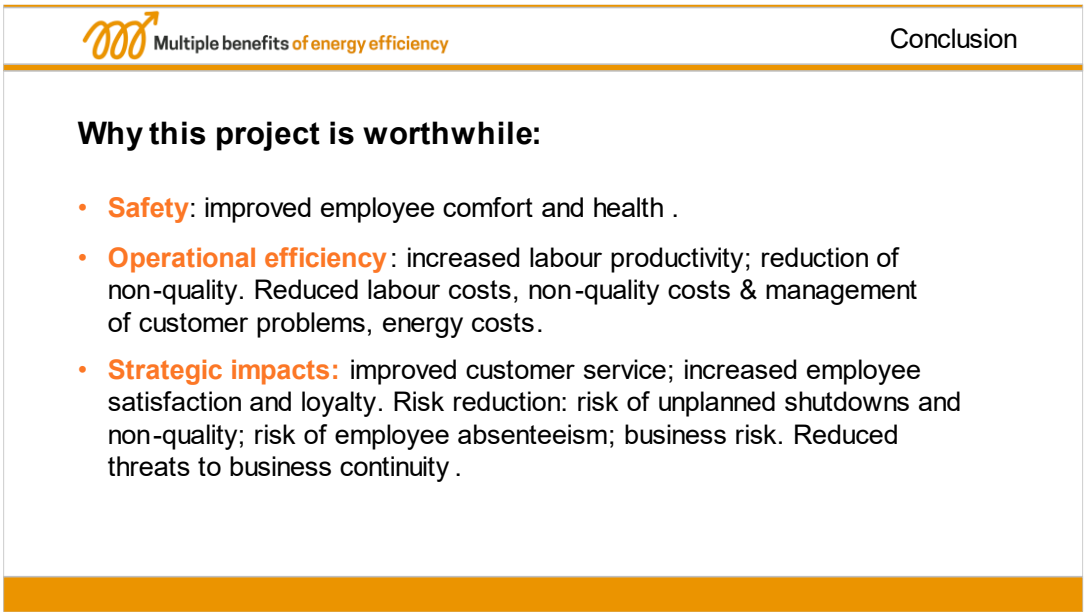


Figure 236. Key Arguments for the Project Implementation. First Industries Lausanne Crissier.

3 Conclusion

The Mbenefits project is a primer with the implementation of a methodology for multiple benefits within industrial and buildings related energy efficiency measures and set up the ground to highlight important data required within companies to quantify these aspects. Some of the projects and energy managers used these results to obtain projects approvals which were successful, while others expanded their perspective on how an energy efficiency measure should be evaluated from a strategic point of view, as not all the energy efficiency measures were formally presented to an investment board for a final decision.

Although there was interest in the methodology developed by the project, multiple benefits were not top priorities for most of the pilots, and many of the companies do not include non-energy benefits in their decision-making processes. However, a few stakeholders recommended that energy audits could include the identification of non-energy benefits. On that point, some stakeholders mentioned that the expression 'non-energy benefits' better represented the context of the work than 'multiple benefits'.

In some cases, it was new for the energy managers to extend their technical analysis of the measure towards a broader understanding of their company activities and relationship to major customers. These aspects were covered within the implementation of the business canvas model for describing the company activities as well as to the coupling of the energy efficiency measures to the delivered energy services to the production and the relationship to production requirements (energy and operational analysis). In this respect, this proved to be a useful step towards understanding energy efficiency measures in more detail while highlighting the impact the measures have on critical aspects for production such as safety, quality, time-to-markets and costs.

Overall, considering that the application of the methodology is a time-consuming process, high levels of commitment from the management team of the company are required to ensure successful implementation.

Key findings across the consultation process:

- Multiple benefits are not yet widespread knowledge for stakeholders working in companies and therefore are not a top priority for investment.
- Introductory webinars and trainings using the serious game can significantly increase the interest and attract stakeholders in adapting the M-Benefits methodology.
- It is important to emphasize the resulting benefits for the company and show some numbers on how multiple benefits can improve the work beyond energy efficiency.
- Communication and personal contact are key to attracting the right stakeholders and keeping them interested.
- High commitment from the management team is required to successfully adopt the M-Benefits methodology.

The team is very thankful to all the companies that accepted our invitation to participate in this project and the proactive actions of many of the energy managers made it possible to improve the tools provided and advance further in this respect.