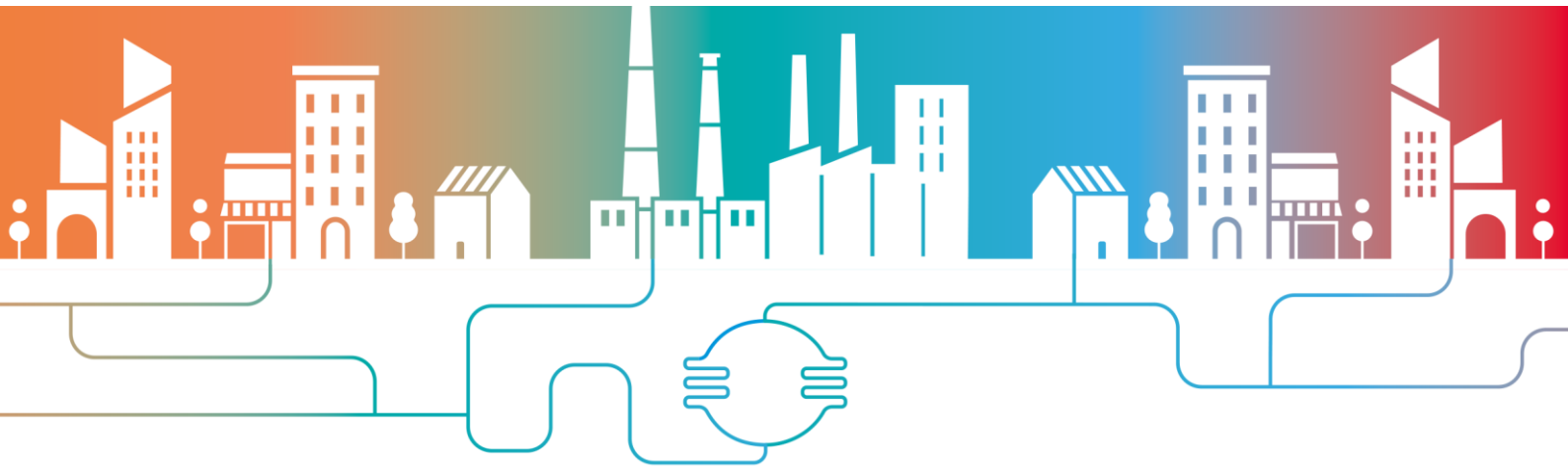
LIFE 4 HEAT RECOVERY

Report on risk assessment and financing schemes elaborated – Action C.5



Low temperature, urban waste heat into district heating and cooling networks

as a clean source of thermal energy

LIFE4HeatRecovery

Project Title: Low temperature, urban waste heat into district heating and cooling networks as a clean source of thermal energy

Project Acronym: LIFE4HeatRecovery

Deliverable Title: Report on risk assessment and financing schemes elaborated.

Lead beneficiary: KWA

Matthias Franz, KWA

Date: June 2022

This document has been produced in the context of the Life4HeatRecovery Project.

The project has received funding from the LIFE programme of the European Union under contract number LIFE17 CCM/IT/000085

LIFE 4 HEAT RECOVERY

Table of Contents

1 Summary

Action C.5 of the LIFE4HeatRecovery project dedicates to business and financial aspects related to waste heat recovery. In particular, sub-actions C.5.2 and C.5.3 are devoted to financing and risk analysis respectively. This deliverable reports the outcomes of the activities carried out in these sub-actions.

As a result of the diversity of the possible waste heat recovery cases, as proved by the project demo sites, rather than providing a single financial model it was decided to offer a variety of approaches. Indeed, a single model could not capture all the options which need to be considered in this context. After an initial screening, the work of C.5.2 about financing and incentives was hence extended, showing several approaches. This report can be seen as a guideline for future adopters where they can choose the most suitable model to access bankability for their projects. Besides traditional approaches like a usual credit, grants or participation models, also more modern approaches like green bonds or crowd-funding have been analysed and weighted in chapter 3.2, through the experiences made in the demo cases and in the past. Thereby bonds, construction cost subsidies, leasing, grants and development loans have shown the highest potential and fitted most of the needs identified. Those approaches got a more detailed analysis in chapter 3.4 in terms of description, advantages, disadvantages and practicability. The report also includes a short view on future needs like tax credits, to push the implementation of more waste heat projects.

But not only the financial aspects have been analysed due to risks and chances. The risks occurred during the implementation have also been investigated. Again, the analysis is first based on a literature review for the method and the approach and is then combined with real-life experience from the demo cases. As a result, a risk management template has been developed, including a template for future adopters, a list of financing and incentive possibilities, and the list of risks occurred, specifying risk triggers and responses/solutions. This template can be used to increase trust in private investors and utility companies by developing a risk management plan to show that they are aware of the risks and already have possible solutions.

All in all, 59 risks have been named, sorted and classified by likelihood of occurrence, strength of impact and category (political, technical, economical). This evaluation gave the first hint on how to act or react. To focus on a group of risks, the risks have also been classified according whether they can occur only in waste heat projects, in energy projects in general, or in any kind of project. The more likely the risks are for waste heat projects, the more detailed was the analysis and the proposed solutions. It was shown that there are four risks which seem to be typical for waste heat projects. On the economical side it is the risk of non-guaranteed supply and demand, as it happened for one of the options initially considered for the Heerlen demo case. The heat source owners could not guarantee a supply over 20+ years, which requires more elaborated contracts and project calculations. For example, the skid as a movable and flexible component usable at different sources might be a solution. On the technical side, two main risks connected to the design and on-site requirements have been identified. While the uncertainties in design and assumptions can be mitigated by research projects like LIFE4Heat Recovery and by project experience over the time, the on-site requirements can be an issue especially at heat sources which come from a sensitive process, like the servers in Aalborg, the production lines in Ospitaletto, or the processes in a first case explored for Heerlen. This risk is also connected to the political risk of not being supported by the management. Therefore, the trust of the management has to be gained, by a proper risk management plan and by showing them the benefits for their companies.

Additionally, the legislative and regulatory framework in relation to the business models of the three countries with demo cases have been analysed. Therefore, several scenarios within the countries have

been developed. As a result, it is shown that the framework and the requirements in the different countries are divers on several levels. Due to different legislations, trading schemes and requirements from the projects, a single approach would have been too limited and the analysis was hence adapted case by case, in order to provide flexible guidelines about financing and risks in this sector.

2 Introduction

Beside the implementation and demonstration of the technology developed inside the demo projects as part of Actions C.1-C.4, within the LIFE4HeatRecovery project the financial and economical aspects are essential as well. Therefore, in Action C.5 a roadmap with business cases, financing possibilities and risk analysis has been developed. The target is to promote the adoption of the demo cases on the market by relying on the experience gained through the development of demo cases combined with the literature and knowledge of the partners.

In this Action, one aim is to develop financing schemes addressing both utility companies and investors. The focus is on developing an economic and financial analysis which can be submitted to local banks as well as to international financial institutions.

Besides, a database about existing funding opportunities and public incentive schemes for energy efficiency by EU, international institutions, public and private investors should be updated and documented.

Combining all the gathered information, an innovative financing scheme based on public private partnerships or participative models should be elaborated.

Therefore, the governance structures of the demo partners will be evaluated and analysed to seek for benefits for future adopters and help to assess bankability of the proposed actions.

Unfortunately, it appears that the overall target to identify a single optimal model is not feasible, as it will be explained in the following.

There is an underlying reason why a single specific model could not fit any future project, and it lies in the definition of *project* itself. "A project is a temporary endeavour undertaken to create a unique product, service, or result" (Project Management Institute (PMI), 2004). Every project is unique. Even if we develop almost the same product (prefabricated skid) in similar situations (urban areas with sufficient waste heat), factors endogenous and exogenous to the project will always constitute substantial differences. During the first presentations and interviews at the beginning of the project it appeared that the demo cases and their environments are very different and other solutions for helping future adopters had to be found.

We also observed that even the skids developed are different in the way they work. Differences in temperature and availability of the waste heat, customers, locations, different governance structures and constantly changing funding and incentive schemes have shown that one model which suites to every waste heat project is not feasible.

Therefore, we had to find another solution to support adopters and demo cases to assess bankability, decrease risks and promote waste heat projects to utility companies, investors and also to the governments and institutions to stimulate the creation of funding and incentives. The suggestions to achieve getting financial support for adopters will be described in chapter 3.

As the risks and chances of the different financing, funding and incentive possibilities will already be described in chapter 3, in chapter 4 the focus will be on the analysis of the risks associated with the adoption of the technology.

As already noticed during the development of the innovative financing model described in Chapter 3, one common risk management plan for every waste heat project is also not suitable. Still the target is to increase trust of private investors and utility companies in integrating waste heat solutions into their DH networks.

Therefore, the first target was to increase the awareness of risk management inside the project, especially inside the demo cases. As there is no project without risks, a template for a risk management analysis was implemented. The template allowed the partners to identify, categorize, analyse and evaluate the risks of their projects.

Most of the time, risks are identified and evaluated by common sense, without a structured, team-based process. Often, the project manager identifies the most common risks qualitatively at an early stage and seek a solution to limit their likelihood of occurrence. Even more often, it happens that the approach to risk is more like *crisis management*. The project team reacts too late and as the risk has already occurred

The better solution would be to see risk management as an ongoing process. Risks have to be evaluated on a periodical basis and solutions should be elaborated before the risks occur. Precaution is always better than cure and on an early stage risks can sometimes be changed to chances.

In the LIFE4HeatRecovery-Project the target was to develop a risk management plan to increase trust. As every project is different and has different risks due to different environments, circumstances and cultures, the target was to identify risks inside the demo cases and early adopter projects which are typical for waste heat projects. In a second step these risks will be analysed, and possible solutions will be shown for future adopters.

With a clear plan to identify risks and an action plan to prevent risks, the trust of investors, utility companies and future adopter will be increased.

3 Financing of the heat recovery measures

3.1 Method

The first approach was to start the work by a preliminary questionnaire for the project partners to learn more about their projects, the companies and the environment which influences their work.

It showed that the timing for the questionnaire was too early as all of the companies where busy by setting up the demo cases and other work packages. As well it was too early as just a little amount of experiences had been made.

Therefore, a different approach showed to be more favourable. To support the partners in giving feedback about governance structures, financing and future needs, the basic knowledge about this fields had to be achieved.

As a new first step a literature analysis about financing models, funding opportunities and incentives has been made and described in chapter 3.2. Three steps were conducted to develop the most suitable models. First step was an open research about financing possibilities for projects, incentives and funding connected with energy projects. The second step was to discuss those points during partner meetings and bilateral telcos and to choose the most suitable models for waste heat projects ; the final step was to go into a deeper analysis of those chosen models and to check which future needs for adopters will occur. During that analysis and the discussions with the partners it was shown that the initial target of the work package was too simplistic for the already mentioned reasons and a more complex and multi-layered solution which can give support and guidelines for different type of waste heat projects had to be developed.

Therefore, all partners agreed that we have to expand the targets. No single model will be developed. Instead several possibilities, which help to assess bankability, to convince investors and also show future needs of such projects, will be presented. The target is also to increase the awareness of politicians and institutions for funding and incentives to support such projects in a useful and efficient way.

3.2 Literature

Every project is a time and cost constrained operation. So are waste heat projects. While financing possibilities and funds usually affect investment costs, incentives influence the running costs during operations, with positive implications for end users and heat suppliers.

3.2.1 Financing Possibilities & Funding

In this chapter the most common financing and funding possibilities are shown. While there is no problem of financing if the equity is high enough, it gets more interesting if it is not. In this case debt capital from investors and partners is needed.

Credit

A credit is an agreement to purchase a service or money with the express promise to pay for it later. It is a flexible form of finance that allows the costumer to access the amount of money loaned, according to the needs at any given time. The credit sets a maximum limit of money, which the customer can use in part or in full. The customer may use all the money provided, part of it or none at all.

There are many different forms of credits. The most popular form is a bank or financial credit. Essentially, when the bank lends to a consumer, it credits money to the borrower, who must pay it back at a future date plus a certain percentage of interests for the service. To receive credit the customer needs to match certain requirements which are set by the lender. Usually, a business case and collateral have to be shown as the lender wants to make sure he receives his money in the future.

In case of the next possibility the requirements are focused on a certain topic.

Green bonds

Bonds are a fixed-income financial instrument to raise finance that represents a loan or credit made by an investor to a borrower. In this case a green bond is an instrument to raise finance for climate change solutions related projects or programs. Other examples of bonds can be environmental impact bonds. Green bonds are designated bonds intended to encourage sustainability and to support climate-related or other types of special environmental projects. More specifically, green bonds financed projects aimed at energy efficiency, pollution prevention, sustainable agriculture, fishery and forestry, the protection of aquatic and terrestrial ecosystems, clean transportation, clean water, and sustainable water management. They also finance the cultivation of environmentally friendly technologies and the mitigation of climate change.

Crowdfunding

Crowdfunding is the raising of amounts of capital from a large number of individuals to finance a new business venture. This option operates on a donation basis, so the company does not have to pay back the investors. Although this option seems to be very easy and profitable, the realization of it is not that uncomplicated. To be able to raise enough money for a waste heat recovery project, many donors must be found and must be convinced of the relevance of the project so that they are willing to donate higher sums. This implies that, again, awareness about these studies has to be raised.

The two most traditional uses of the term reflect the type of crowdfunding done by start-up companies looking to bring a product or service into the world and by individuals who experienced some type of emergency. Many individuals affected by a natural disaster, hefty medical expense, or another tragic event.

Citizen participation model

The participation model is meant as a cooperative, which is an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned enterprise. In this case the citizens can take part to this energy cooperative. This is called public participation, also known as citizen participation or patient and public involvement and it is the inclusion of the public in the activities of any organization or project.

In the participation model the so-called citizen energy cooperatives (often simply referred to as energy cooperatives) are players in the energy industry in the legal form of a cooperative, which mostly pursue the goal of decentralized, group-independent and ecological energy production. They are a form of citizen participation, mainly at the municipal or regional level, and offer the opportunity to actively participate in the energy transition on a local level so the citizens can identify themselves with the transition. They also offer investment opportunities in local and regional energy projects.

Business operations often relate to the construction and operation of plants for the generation of renewable energies or participation in such plants. Other activities relate to the construction and operation of combined heat and power plants (use of combined heat and power), citizen participation in municipal utilities or the purchase and operation of gas and electricity networks. The implementation of energy efficiency measures such as the energetic refurbishment of buildings, the replacement of lighting systems with energy-saving light sources (e.g., LEDs) and advising members on energy issues can also be business models with citizen participation. While some cooperatives pursue broad business models and invest in different technologies in order to spread risk, others specialize in a particular technology, often photovoltaic or wind power plants.

All in all, it can be an idea to include an existing cooperative into a project cooperation to gain capital. But this only makes sense if the waste heat project is a small private project started by the waste heat owner who searches for a financially strong partner. As in this project the focus is on bigger networks and a bigger spread of the systems, the partners are usually strong enough and a participation of a cooperative would only increase administrative effort. Therefore, this model is not preferred for waste heat projects.

Construction Cost subsidy

Subsidies are commonly benefits given to an individual, business, or institution, usually by the government. It can be direct (such as cash payments) or indirect (such as tax breaks). The subsidy is typically given to remove some type of burden, and it is often considered to be in the overall interest of the public, given to promote a social good or an economic policy.

In the case of a construction cost subsidy, the client pays a construction cost subsidy to support the contractor with a one-time payment which results in lower risks for the contractor. In case of energy networks, a construction cost subsidy can also be named connection fee. In order to get this kind of subsidy an entity which is able to spend money on the project has to be connected and must receive some kind of benefit, like cost saving by energy efficiency measures, image enhancement through CO_2-savings, decreased CO2-Footprint, etc.., or connection to network which sells cheaper energy than used before.

Leasing

Leveraged leases are most often used in the renting of assets planned for short-term use. Assets like cars, trucks, construction vehicles and business equipment are typically all available through the option of leveraged leasing. Leasing in general means a company or individual will be renting an asset.

Leasing any type of asset gives an entity the right to use the asset for a limited time. The idea in the LIFE4HeatRecovery projects is to lease the skid, as the target is to build a modular system which can be used at different locations. Therefore, the mother company (e.g. utility company) can invest in a skid and rent it towards the project. This makes a project more flexible, calculatable, and bankable.

Block Grant

A grant is an award, usually financial, given by one entity to an individual or a company to facilitate a goal or incentivize performance. Grants are essentially gifts that do not have to be paid back, under most conditions. These can include education loans, research money, and stock options. Some grants have waiting periods—called lock-up or vesting periods—before the grantee can take full ownership of the financial reward. In this context the grant is a funding opportunity by taking part of a research

or energy project which is funded by public entities or research companies like LIFE4HeatRecovery project.

Development or low interest loans

These programmes offer low-interest loans, venture capital and grants for start-ups and investment in growth. The aim is to support all the phases of starting out in business – from spin-offs from higher education and research establishments to support for expansion and growth in young companies and technologies already on the market.

For example, KfW Förderbank (KfW promotional Bank), the largest business unit of the group, committed €47.6 billion in 2014, mostly for housing and environmental protection in Germany. It is especially active in promoting energy-efficient housing for owner-occupied houses as well as for landlords, both for new houses and refurbishments. Its energy efficiency standards for houses (KfW-60 and KfW-40) have become accepted standards in Germany.

3.2.2 Incentives

Tax credit

A tax credit is an amount of money that taxpayers can subtract directly from the taxes they owe. Unlike deductions, which lower the amount of taxable income, tax credits reduce the actual amount of tax owed. The value of a tax credit depends on the nature of the credit; certain types of tax credits are granted to individuals or businesses in specific locations, classifications, or industries.

Federal and state governments may grant tax credits to promote specific behaviors that benefit the economy, the environment, or anything else the government deems important. For example, a tax credit is available that rewards people for installing solar panels for home use. Other tax credits help offset the costs of child and dependent care, education and adoption. In this case a tax credit for power used by 5th generation network connected heat pumps could be a possibility.

White certificates

In environmental policy, white certificates are documents certifying that a certain reduction of energy consumption has been attained. In most applications, the white certificates are tradable and combined with an obligation to achieve a certain target of energy savings. Under such a system, producers, suppliers or distributors of electricity, gas and oil are required to undertake energy efficiency measures for the final user that corresponds to a pre-defined percentage of their annual energy deliverance. If energy producers do not meet the mandated target for energy efficiency, they are required to pay a penalty. The white certificates are assigned to the producers whenever an amount of energy is saved, but also to companies that voluntarily choose to adopt energy efficiency measures; whereupon, the energy producer gains white certificates through efficiency actions, sell them to other parties if in excess, buy them on the market if in deficit. Quite analogous to the closely related concept of emissions trading, the tradability in theory guarantees that the overall emission saving is achieved at least cost, while the certificates guarantee that the overall energy saving target is achieved.

A white certificate, also referred to as an Energy Savings Certificate (ESC), Energy Efficiency Credit (EEC), or white tag, is an instrument issued by an authorized body guaranteeing that a specified

amount of energy savings has been achieved. Each certificate is a unique and traceable commodity carrying a property right over a certain amount of additional energy savings and guaranteeing that the benefit of these savings has not been accounted for elsewhere. In the case of waste heat usage, the system has to be directly connected to the owner's system to directly use the waste heat. In Italy, the installation of heat recovery components to serve district heating networks falls under energy efficiency interventions for white certificates. As this process is not common yet, especially not with the project partners, there was no further focus on white certificates, but should definitely be observed in the future.

CO_2-Certificates

With the European Union's Emissions Trading System (EU ETS), the European Union has created a market mechanism that gives CO_2 a price and creates incentives to reduce emissions in the most cost-effective manner. It has successfully brought down emissions from power generation and energy-intensive industries by 42.8 percent in the past 16 years. Under the system, companies have to hold allowances corresponding to their CO_2 emissions, making power production from burning coal and other fossil fuels more expensive and clean power sources more attractive. At the same time, firms are incentivized to become more energy efficient because they can then sell their emissions permits on the market.

The EU ETS follows a "cap-and-trade" approach: the EU sets a cap on how much gas pollution can be emitted each year, and companies need to hold European Emission Allowance (EUA) for every ton of CO_2 they emit within one calendar year. They receive or buy these permits – and they can trade them.

Companies face a fine if they emit more CO_2 than they have covered by emission allowances. The fine is 100 euros per excess tons. For context: the world's largest chemical company, BASF, produced 23 million tons of CO_2 equivalents in 2017. Companies have an incentive to reduce emissions by investing in energy efficiency because they can then sell excess allowances. Instead of EU ETS allowances, companies can buy credits from emission-saving projects under the Kyoto Protocol's Clean Development Mechanism (CDM) in developing countries. As waste heat sources getting connected to a network there is the possibility to use heat from the network instead of fossil fuels in the location which can decrease the CO_2 emission immediately which opens up money to support the waste heat project.

3.3 Survey and real-life experience

After the literature research was finished and the results have been presented to the partners it was time to bring in real-life experience from the projects and the companies itself. In bilateral interviews between KWA and the partners it was talked about the governance structures, the decision-making processes, the financing models, incentives and also about the risks.

It was shown that the main part of the partners is owned by public entities as the supply of energy is traditionally an interest of the government. Only in the last few decades many suppliers have been privatized to generate a free and competitive market. Still a lot of companies are owned by public entities but are built up and act like private companies.

In the interviews it was shown that the companies adapted some characteristics from both worlds which is not beneficiary for the projects. The duration of decision-making is often very long as the

public entities and thus the politics want to participate as well and the decisions get mixed up with different interests. On the other hand, the companies are led by managers which want to see the right numbers in the business cases to support the projects.

It was clearly shown that the project managers often sit in between and it is tough to serve the needs of a proper business case and the needs coming from strong stakeholders in and around the companies.

The interviews have shown different challenges of the companies. But a common sense was that there is no lack of dept capital which excluded the standard financing models like credits as well as the more creative ways to gain debt capital, like participation models or crowdfunding. The challenge was more about convincing the management to invest into the projects and get the right amount of revenue. Therefore, investment models were chosen which can help to improve the business caseon different levels.

In Table 1 the models which were selected as interesting and feasible models for future adopters are marked with a green check. If the companies have been unsure if a model is feasible for the project but wanted to keep it in mind for future projects, they have been marked with a question mark.

In one of the partner meetings it was agreed to have a closer and more detailed look in the models which have been chosen from the partners. Additionally, leasing has been elaborated as it seems to be a countermeasure to one of the risks identified at the same time.

Financing Possibilities	Mijnwater	Alperia	Cogeme	KWA
Credit	-	-	-	✓
Green bonds	✓	✓		✓
Crowdfunding	-	-	-	-
Participation model	-	-	-	✓
Construction Cost subsidy	✓	?	?	✓
Leasing	✓	?	?	-
Grant	✓	✓	✓	✓
Tax credit	✓	?	?	✓
Development or low-interest loan	-	✓	✓	✓
White certificates	-	-	-	-
CO_2-Certificates	✓	✓	✓	✓

Figure 1: preferred models to improve bankability

As the partners of Aalborg have been joining the project in the second half of LIFE4HeatRecovery, the interview with these partners was hold on a later date. It pointed out that it was not an issue as the targets and problems of HeatFlow are different as it is a private company which is not owned by public entities. While the other project partners had issues on building a beneficial business case and also to gain partners with usable waste heat sources, HeatFlow chose server farms as a waste heat source and tries to establish a system which can be adapted to other server farms as well.

While the other partners are energy companies which are looking for waste heat as a heat source, HeatFlow is a technological company which identified a new way to cool down servers. Waste heat is a by-product which can be used in the networks which are well established in the Scandinavian countries. This results in two different views. On the one hand, the waste heat is seen as an energy source and thereby as the main product and the companies have to prove that it is beneficial on an

economical way. On the other hand, there is HeatFlow which has to prove that the new cooling system works and the waste heat can be seen as a by-product which improves bankability.

In the interviews it was shown that financing itself is not seen as a problem for all of the companies. The issue is more about convincing management and future partners from the projects by increasing bankability. The most promising models to do so, are described more in detail in chapter 3.4. Additionally, the perception of national, regional and local administration and politics have to be increased as models like tax credits and development loans are based on political decisions. If the project LIFE4HeatRecovery and its successors show the technical feasibility and the environmental benefits of the system, the next step would be the support of the government in several ways. Of course, this can be financial as tax credits and incentives but also to raise the awareness and help future adopters by networking and simplifying administrative processes.

3.4 Suitable financing possibilities and incentives

Bonds

Green bonds may come with tax incentives such as tax exemption and tax credits, making them a more attractive investment compared to a comparable taxable bond. These tax advantages provide a monetary incentive to tackle prominent social issues such as climate change and a movement toward renewable sources of energy. To qualify for green bond status, they are often verified by a third party such as the Climate Bond Standard Board, which certifies that the bond will fund projects that include benefits to the environment.

Advantages of bond are that the borrower can see both financial and environmental benefit, that they are flexible in buying and selling (tradable) and easy to calculate, as they have a fixed interest.

The disadvantages are that they have a small benefit, given that the interests are usually low, the high administrative efforts and the need of interested people or financial institutions.

In terms of applying this solution for a waste heat recovery project, it might be a solution to get cheaper money than with a credit, which makes a project more attractive for the management. But it only seems to be beneficial if the company works with bonds anyway. To emit bonds just for a project might be too much effort especially as the interests are low anyway. Therefore, the bonds are seen as a suitable possibility especially if interests of credits are increasing. The risks are low, but the benefit is as well.

Construction cost subsidy

Construction cost subsidies are a good way to increase bankability but the argumentation and benefits for the connecting company must be high. Otherwise companies are not willing to pay money for the connection.

In a construction cost subsidy, the received money does not have to be returned as it is paid back through other benefits instead. Through the increasing importance of reducing the CO_2-footprint, companies will be more likely to pay for such benefits in the future. At the same time, it is very difficult to find entities which are both willing to pay and also willing to have an intervention in their system. For this model it has to be seen case by case if an entity is willing to pay. This gives the disadvantage that the subsidy cannot be included into the business case from the beginning and usually needs a lot

of communications and effort. But as soon as the subsidy is accepted by the entity the benefits are big and can help to make a project bankable.

Leasing

In order to apply this solution, the lease has to be made company internally, as there are no big producers of prefabricated skids. Therefore, a company has to buy a skid to lease it to the project. This gives the project manager the possibility to calculate a project for a shorter time. Also, through this type of financing option a risk reduction about changing heat sources and demand and about the issues with long-term contracts with prosumers can be aimed at.

The risk reduction together with the interesting investment for the mother company of the network company and the possibility for a company to become more flexible in projects are the main pros of this financing option. On the other hand, there is no guarantee for the mother company that there will be a suitable successor after the end of a first project which can use the same skid again. Additionally, leasing the skid is more expensive for the project than an investment over 20 years. But as it has been shown in the interviews and during the project that the contract duration with heat sources is rather short, the higher costs can equalize the risk.

This is a very new business case which is recommended to be researched in detail. It reduces several of the main risks found in these projects and gives operators of big networks a good chance to make their network more flexible for example by adjusting the location of the skid towards the highest demand.

Grant

A grant, as already explained, is free money which must not be paid back and on which no taxes are applied. Nevertheless, it could only represent a supplement to the own contribution. This appears to be one of the best options, but actually it is very difficult to find and get suitable grants for a project, as they are only for a limited number of projects. For example, the “Natural Capital Financing Facility” offers grants for energy diversity, which are not suitable for our kind of projects. Additionally, it is not easy to abbreviate from agreed parameters as an amendment relates to high administrative effort.

Therefore, this option is only suitable for early innovative (pilot) projects such as LIFE4HeatRecovery. But in a long-term view, they are not suitable for adopters as they are limited.

Development or low interest loan

The utilization of a low interest loan can appear persuasive, because of the very low interests which have to be paid and also because of the possibility of making a long-term loan. This option comes with some negative aspects like the special requirements needed to be fulfilled to receive such a loan, the big administrative effort and the fact that another entity influences the project.

For the specific case of a waste heat recovery project this option can be considered, in case there is a fitting development loan in the country or from the EU. Surely such a financing model would help to make the project more attractive, but if the interests are very small over the last few years, the benefit is questionable compared to the effort.

CO_2-Certificates/ Tax credit (future needs)

To be able to benefit of tax credit and certificates a company has to perform well to be rewarded with them. So, the received benefits are not connected to a costumer effort, but only with the achievements of the company itself. The difficulties of this option are related to the dependency on politics of the rewards and to the fact that customers already using green energy are not interested at the moment.

The possibility to be rewarded for the performance of a project is a very interesting option for waste heat recovery projects. Unfortunately, it is not always easy to get the rewards, as they have strict specifications. Moreover, there are no subsidies which directly benefit waste heat recovery measures.

For that reason, the enlargement of awareness of those projects in politics is a big part of our task. By raising awareness, the possibility rises that specific subsidies will be created, in order to finance waste heat recovery projects.

3.5 Definition of future needs

All in all, several feasible models have been found even if they are not usable for every single waste heat recovery project. It is important to screen the environment and the conditions of the project at the very beginning. As many factors from inside and outside of the project can influence the process of financing, it has to be assessed which models and possibilities are good to use. Therefore, this report will be helpful. Beside the financial aspect, it became clear that the support of the management and stakeholders are extremely relevant for the project and there are more benefits like political support than only financial. It is the task of the project manager to show the right weighting in the mix of benefits for the environment, the image, the bank account and for different stakeholders. One point every partner agreed is that it is important to gain support by management and stakeholders by increasing the awareness and show the potential of waste heat projects. One way to do so are projects like LIFE4HeatRecovery which show the technical feasibility, environmental impact and the potential of such projects.

By raising the awareness of the stakeholder, future needs like incentives which support waste heat projects or a lower business case expectation by the management can be targeted as the awareness includes also the several benefits around the monetary sector.

4 Risks associated with the adoption of the technology

4.1 Method

The target of this topic is to deliver a clear plan for identifying risks and an action plan to prevent risks for all present and future stakeholders, especially to increase trust of investors, utility companies and future adopters.

With that background, the development of the matter started by calling back the knowledge about risk management and risk management plans to the project partners. As a part of a partner meeting the topic was presented independently from the background of waste heat projects. How to identify, analyse and evaluate risks and risk triggers and how to find solutions and create a prevention and reaction plan.

To simplify the process of risk management for the partners, KWA developed a template to start a risk management analysis. The template was made to be used on a periodical basis and fill in all the risks occurred during the project.

With the filled in template and feedback from the project partners during several interviews and partner meetings, a list of 64 risks emerged.

After the analysis of the risks and first collection of solutions, the risks with same topics but different naming have been consolidated. In a next step, the consolidated risks have been sorted into three categories: risks which can occur at every project, risks which are related to the energy sector and risks which are specific for waste heat projects. In Chapter 4.4 those risks will be described in detail and solutions for risks connected to waste heat projects will be shown.

4.2 Literature

In this chapter the theoretical structure of a risk management analysis will be described as a part of the risk management process. Risks are the effect of uncertainty on objectives and they have to be identified, evaluated and prioritized during the entire duration of a project. To do so different standards for the risk management analysis have been developed. Especially in the area of project management, several institutions like PMI, PRINCE and IPMA have developed their own standard. Nevertheless, it is possible to find some common principles despite the different approaches.

The success of a project is usually measured in three dimensions known as the project management triangle. The time, scope and budget dimensions interact with each other and define the quality and success of a project. Risks condition those dimensions and thus they undetermined the success of a project.

To counter those threats, risks have to be identified as early as possible to have enough time to react on the identified risks. There are four main ways how to react as shown in figure 2. The best way is to *avoid* the risks identified. If that is not possible there are two ways to lower the effect if a risk occurs. One possibility is to *mitigate* the risk and lower the strength of impact. The second possibility is to *transfer* the risk comparable to an insurance. And a fourth possibility is to *accept* the risk. This might be the best solution if the likelihood or the impact on the project is very low and the effort to react on the risk is higher than the damage of the risk itself.

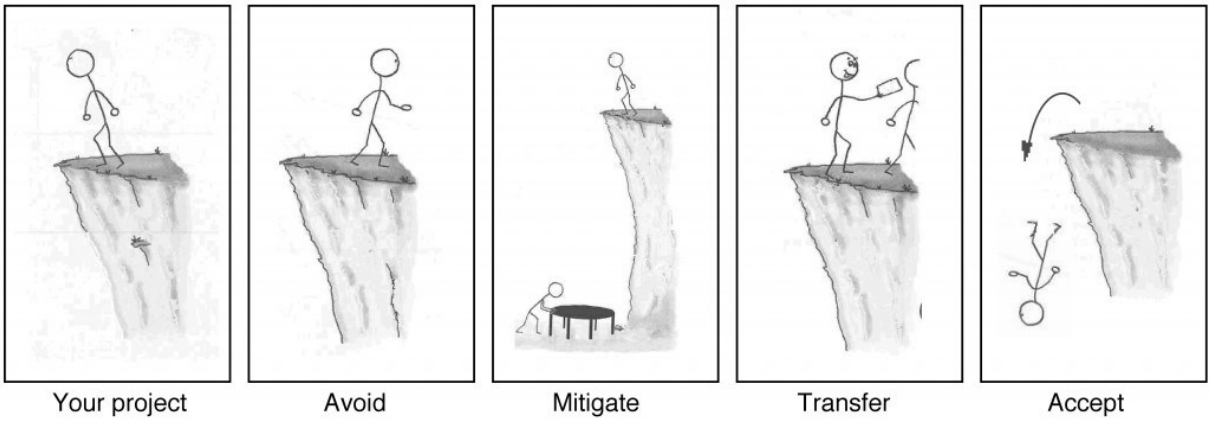


Figure 2: possible responses to risks during a project (http://pm4id.org/11/2/)

But before we can act on risks, we have to identify, document, categorize, analyse and evaluate the risks. To do so, a template can help to keep structure in the process. It is recommended to repeat the process in a periodical way. Depending on the project, it could be weekly or once a month. To start the risk management plan, all known risks will be written down in the template. In a second step those risks should be categorized. This simplifies the process after the analysis and evaluation as it shows which colleague or department have to be contacted to develop the right solution and also to check if two or more risks can be solved by one counteraction. One possibility is to categorize risks into political, economic, social and technical ones. For each project it has to be decided if all categories are needed and if additional ones have to be added. In this work the focus is on economic and technical aspects and, due to governance structures and public entities, the political risks should not be neglected.

After the identification and the categorization, the risks have to be analysed and evaluated. Therefore, a risk management matrix as seen in figure 3 can be used. The identified risks will be evaluated by likelihood and impact. The risk evaluation can be done in different ways. One possibility can be seen in figure 3, as risks can be rated high or low. Medium is also possible but not recommended as it is more difficult to choose the right actions. A more accurate way, but also with more effort, is to evaluate the risks quantitatively. The impact can be quantified monetarily if it is calculated and estimated how big the loss will be if the risk occurs. The likelihood can be quantified in percentage of the probability of occurrence. With the result of the multiplication of the expected impact and probability, a prioritization of different risks can be done. However, some institutions like IPMA are of the opinion that the probability of occurrence should never be higher than 50% as it will not be a risk anymore: They call it an expected fact.

There are different moments inside the projects where the countermeasures for risks can be started. Some measures are preventative others are corrective. Preventative measures must be started before the risk occurs and the target is to decrease the probability of occurrence. The corrective measures must be started after the risk occurs and the target is to decrease the amount of damage. Of course, these measures can be prepared in advance to react fast and do not waste time which could decrease the amount of damage. It is also possible to work with both measures for the same risk. Are the risks too high or not tolerable as there is danger for human beings or the environment, risks can also cause an abort of the project. By checking the risks periodically, slow drifts or radical changes of risks can be recognized early and an abortion or a high damage can be prevented by choosing a suitable counteraction.

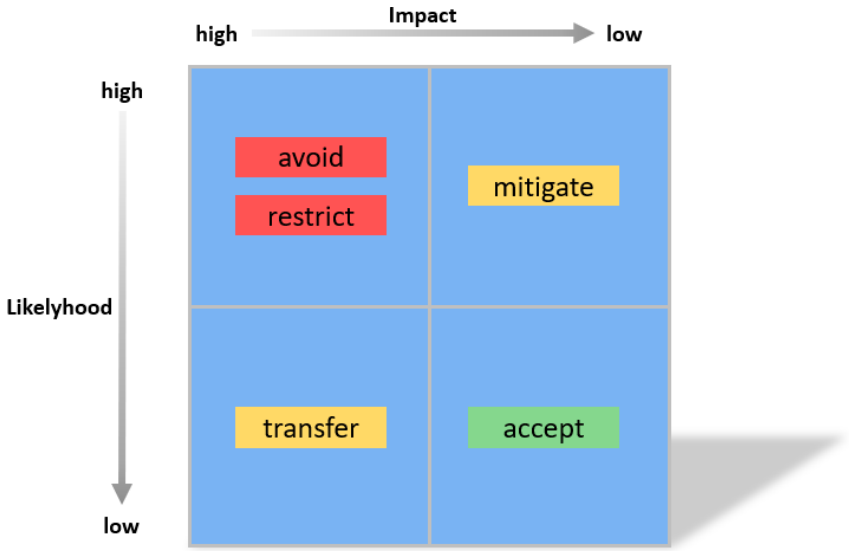


Figure 3: Risk Portfolio

Besides the evaluation of the risks and the graphical representation inside the matrix, the position of the risks can already give a hint how to react on them. As shown in figure 3, risks with high impact and likelihood should be avoided or at least restricted, while risks with low impact and high likelihood should be mitigated and risks with high impact and low likelihood should be transferred. But at the end the actions have to fit the risks and have to be chosen individually depending on the circumstances and environment.

4.3 Survey and real-life experience

After the development of the risk management template by KWA Contracting AG, it was distributed to the partners of the LIFE4HeatRecovery Project. After a first feedback by email, the 64 risks identified and categorized have been reviewed in bilateral telcos and partner meetings. Problems and risks as well as possible solutions had to be clarified and discussed to make sure everyone has the same level of understanding. In that process five risks have been excluded. Two of them have been too general and 3 risks have been categorized as social risks which we decided not to focus on.

At the end a list of 59 risks has been identified and evaluated. They have been categorized in 21 economical risks, 25 technical risks and 13 political risks as shown in figure 4. As plenty of the risks had been named multiple times, the categories have been split up in ten different topics which also include the multiple called risks to reflect the weight.

Economical risks have been related to business cases, length of contracts, administrative issues and the waste heat source itself. Technical risks have been related to the on-site requirements, design of the skids, the market and the change management. Political risks concerned permits and political influence on the external side and administrative and top management on the internal side. In a further step the risks identified and evaluated have been distributed inside the matrix (see figure 4) and as a result a pattern for each category was shown (see figures 5-7).

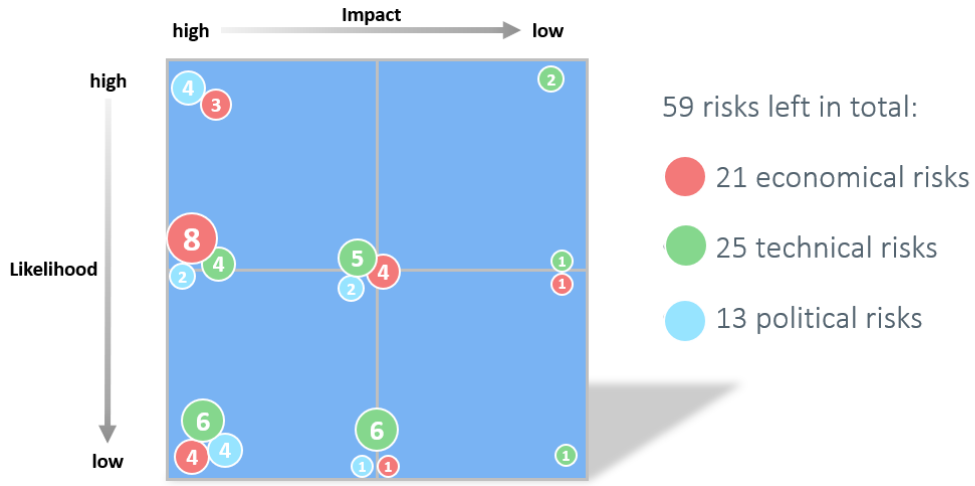


Figure 4: Risk management matrix with all risks identified and evaluated

As shown in figure 5 the majority of economic risks have a medium to high impact even though the likelihood is different. Risks regarding the business case have a low likelihood and a possible solution can be a transfer. Risks regarding the length of contract and the waste heat source itself have been considered to have a high impact and they should to be avoided.

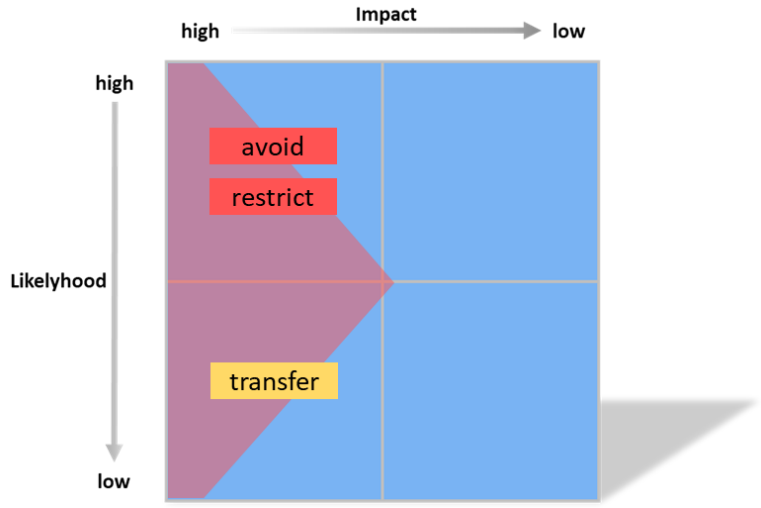


Figure 5: risk matrix of economic risks

The majority of the technical risks are located in the area with high impact and low likelihood even though some risks with low impact are present as well. Most of the risks connected to technical aspects can be transferred or must be accepted by the operating company. The distribution is shown in figure 6.

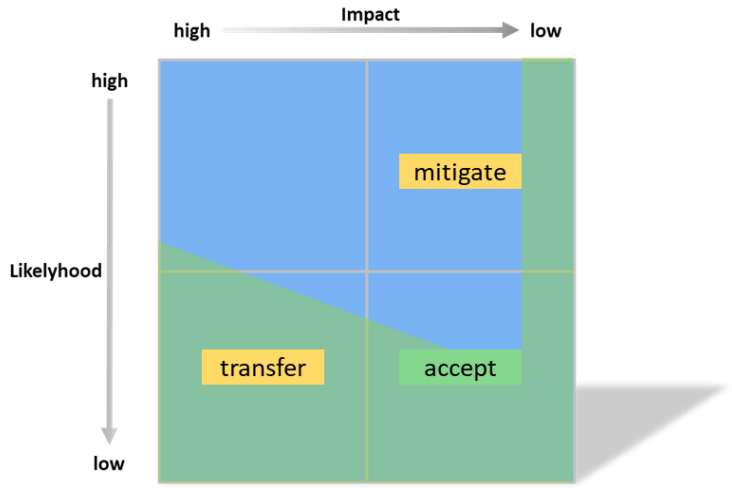


Figure 6: risk matrix of technical risks

Most of the political risks have a high impact. The internal political risks should be transferred or restricted while the external risks have a low likelihood and should be transferred.

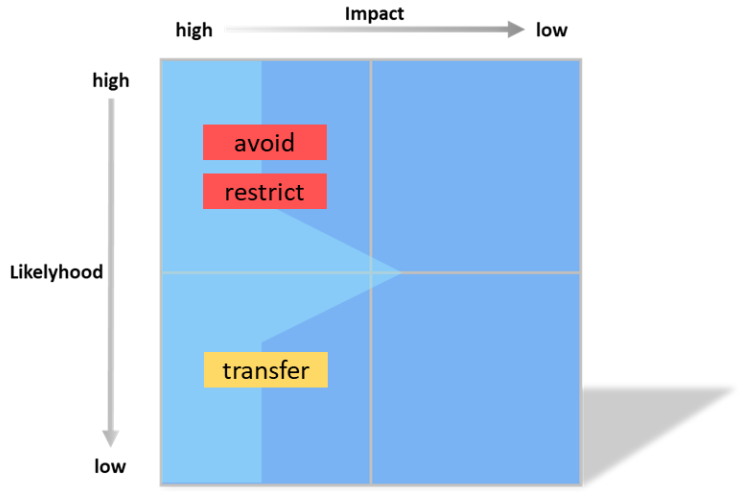


Figure 7: risk matrix of political risks

After that analysis a first hint how to react on different risks was given and even that result could be a big benefit for future adopters. But the project is focused on waste heat projects, so the analysis of the risks went further to identify risks which are special for waste heat projects. It was recognized that some of the risks can occur in every project type, other risks are connected to the energy industry and the risks can threaten all kinds of energy projects. But some of the risks are related only to waste heat projects and they are the critical point for future adopters.

4.4 Definition of typical risks regarding Waste Heat projects and how to react

In this topic a description of all risks identified is placed, so future adopters get an overview about the issues the project partners had to deal with. Even though all risks are mentioned, the focus is on the risks which are special for waste heat projects.

4.4.1 General risks

Most of the general risks have been connected to risks regarding the business cases and administrative and can happen in almost every project. The risks are not typical for waste heat and not even typical for energy projects. But still, these risks are not less important. The most commonly named risks regarding the business case were uncertainties regarding the calculation of investment costs and increasing operating costs. Those are typical in the early stage of a project when information is rare. At the start of a project there are two possibilities. One is to transfer the risk to a subcontractor which guarantees prices and the other one is to accept that information is rare. The second solution is not a solution over the whole project. If the calculations are done internally by the project team the risk have to be mitigated step by step by doing the calculations as detailed as possible over the time. To flatten exceptional curves and cover a couple of small risks, a risk flat rate can be included in the calculation which results in a worse bankability.

Regarding fluctuations of operation costs, it is possible to mitigate the risk by connecting those costs to the heating price with a price escalation clause. This makes it possible to limit the impact, with possible benefits for the end user in the event of lower operating costs than expected.

The risks connected to administration and management are about approval of the project start even with little information. To counter the cautiousness, it is important to work transparent and have good communications. It is important to gain trust into your company as well as it is to gain trust into your product. Hereby it does not matter if the administrative is the one of your own company or the administrative of a public entity.

There are two opposing approaches in project management. There is the so-called frontloading approach, which involves concentrating efforts at the beginning of the project and anticipating all possible knowledge (CON: handover problem). An opposite approach is the flexible/overlapping one: in high uncertainty environments, it is preferred to focus on continuous iteration, with overlapping design and implementation phases that allow greater reactivity to problems (con: expensive, the parties have to stay involved for longer in the project).

It must be understood whether the lack of information is due to the laziness of the parties (in this case a front loading approach would be more suitable, also in order to reduce costs and further risks) or the information referred to is really not available. In the latter case a flexible approach is more suitable.

4.4.2 Energy risks

Typical risks for energy projects are found within all risk categories. Risks regarding the market can either be economical like fluctuating electricity prices or technical with the competition with other technologies. Even projects from other industries also get affected by the electricity price. The operating costs of a system with heat pumps to increase the temperature of a 5th generation network are based by a very big part on the electricity price. So, it can be seen as a typical risk for energy projects including heat pumps. Therefore, two solutions are possible. The solution would be an own electricity production with constant and calculatable production prices like electricity from a solar plant or wind

power. Long-term power purchase agreements might also be a solution. As this is a very big solution and not feasible for every project, a price escalation clause which connects the heat or cooling price to the electricity price is a more flexible solution.

The risk of getting out booted from other technical solutions can be seen as a general risk as well as an energy risk. It is seen rather low as skids and the system should be developed with the best possible technical solution. Except for the situation of Aalborg: here a new technology has been developed which is in competition with the existing and well-known solutions. Participating in projects like LIFE4HeatRecovery gives HeatFlow the possibility to mitigate the risk by getting financial and know-how support. So, both the impact of the solution will not make it to the market as well as the likelihood that the system is not competitive on a technical level can be decreased.

Political risks regarding the permits and political influence can be typical for energy projects as well. Permits regarding the energy sector often take a long time and the decision making is made very accurate and will be double checked as the energy sector is part of the critical infrastructure and has to be highly protected. Herby it is important again to plan well and start communications to the concerned entities early. These risks are close to be an expected fact and not a risk, but to help our successors this definitely has to be mentioned. Rules and laws are changing, so does the political opinion. These topics have to be checked permanently and have to be communicated and done early.

4.4.3 Waste heat risks explanation and identification of solutions

There was one main risk found, connected to two subtopics of economic risks. The risk of non-guaranteed supply and demand. It was shown that one main issue is to find a waste heat source which can guarantee the same supply and if it is a prosumer, the same demand for the next years. The two subtopics are the length of contract and the waste heat source itself. Waste heat sources are often part of production lines and cooling systems. While server farms and supermarkets can be assumed very constant in the supply of waste heat over the next decade or more, waste heat from production lines are not able to guarantee the same supply over such a long time. Products, processes or recipes change as well as locations and ownerships of companies. It is difficult to get long term contracts with the industry if they have to guarantee a long-term supply.

One solution is the invention of the skid by itself. The target is to get a replicable and movable skid, where most of the parts can be reused for other waste heat sources as well. The issue is that the management will hardly support a project if the revenue for a short contract duration is too low. While on a technical and environmental view the skid and the usage of waste heat definitely make sense, the financial aspect always has to be beneficial as well. To face the risk, there are several solutions. One way is to avoid the risk by searching for a waste heat source which can guarantee a long-term supply, like server farms or cooling systems in supermarkets or ice rinks. A second solution could be to transfer the risk away from the project towards the main company by convincing the management to invest into a skid which can be rent to single projects. This gives the opportunity to calculate the projects on a shorter duration, as the investment costs do not have to be paid off by one single project. It can be split over several projects over a long duration. Additionally, it has the benefit for the network operator to be flexible in gaining waste heat. The target to develop a movable skid gives the chance to move the skid as a source inside your network towards areas with higher demands.

Two main risks connected to waste heat sources have occurred with a technical aspect. One is about on-site requirements and the second is about design and assumptions. The on-site requirements are fundamental for the system. Even if the skid is meant to be portable, it needs some space close to the waste heat source. This space is not guaranteed as well as the connections to the skid and to the

network which is also connected to the second risk of design and assumptions. But first we have a look on the location and the connection to the network. For the demo cases, several locations have been evaluated including an underground and a second level solution. Also, the connections from and to the skid have to be planned well. The connection towards the network usually needs a permit from public entities as well as from the source owner, as the connection will be relocated through the ground. Communications and preliminary enquiries have to be made early, as the connection to the network is essential.

The connection from the skid to the waste heat source was also mentioned as a risk. Especially the interference into the customers system if it is a production line is critical. This risk is also connected to design and assumptions. The interference into a production line is always critical and has to be hold as small as possible. Also the connections from the waste heat source to the skid have to be planned well and early. The risk that the management of the waste heat owner will not allow to interfere into their system must be mitigated by transparency and good planning. A second solution would be to move the delivery boarders. Big companies which own industrial waste heat sources usually employ technicians or engineers responsible for the system and also the energy supply. As a solution the waste heat owner can be hired to do the connection from the waste heat source to the skid. This gives them the opportunity that all interactions connected to their system will done by them and in a way they can accept.

Unfortunately, the decision of the management is driven by cautiousness and other influencing factors. The acceptance of the waste heat owner is always needed and even if the benefit of the system is shown to the management, they keep highly sceptical if an extraneous company wants to interfere into their system. The technology of waste heat usage by skids is not a well-known technology and there are no big references which can be shown to convince the owner. At the moment there are too many uncertainties regarding the technical solution, the interference into the systems and the economics. Those risks lead to a very cautious reaction of the internal management (network owner) as well as the external (waste heat source owner) management. This is a risk that must be accepted on the beginning but should be mitigated over the project time, by delivering facts and gaining trust.

All in all, it can be said that the risk of not getting supported by the managements are the biggest risk, so it has to be tackled first. With the support of the management, risks like design, connection and location can be managed as well. To convince the management, projects like LIFE4Heat Recovery are established, where the technological, environmental and economic benefits can be shown and proofed. Therefore, the results of LIFE4HeatRecovery must be shown to raise the awareness and potential in the mind of the stakeholders. Until the technology is established, it is very important to communicate well with the stakeholders and decision makers to gain their trust and support for such projects. And with the demo cases of LIFE4HeatRecovery first references are set to show the feasibility of waste heat recovery.

5 Conclusion

In both topics – financing and risk analysis – the initial targets had to be adjusted due to the characteristics of projects itself. During the LIFE4HeatRecovery-lifetime it was recognized that the projects are just too different to find one single solution which fits to all waste heat projects. Therefore, the consortium decided to evaluate different suitable financing models and incentives which can be used by adopters to gain bankability. For risk management, the report supports early adopters in a combination of giving the instructions on how to set up a proper risk management plan and best practice examples from the demo cases. Both solutions are not the golden path to project success, but they will help adopters to get there.

During the interviews it was shown that none of the project partners had a lack of capital or debt capital to realise the projects, the issue was more about showing bankability to the internal management to get the permission to start. This is the reason why the most suitable models are models which optimize bankability, like bonds, tax credits, construction cost subsidies and grants. Additionally, the report focusses on the more uncommon model of leasing. The idea of a leased skid from the mother company to the project might sound strange at the beginning but it solves some of the risks occurred, brings several chances for the network and an investment possibility for the mother company. By leasing the skid and using it on another place inside the network, shorter project durations can be realised and the network can be optimized by moving the skid to a location with high demand.

Besides the financing models the work also included funds and incentives. As both of them change in a very frequent way and both are dependent on public entities, the awareness on waste heat recovery systems has to be increased first. At the moment there are no programs focused on those systems except research programmes like the one funding LIFE4HeatRecovery. They are helpful to establish knowledge, awareness and set up demo cases, but they are no long-term solution as they support one-time projects. But they give a platform to gain visibility to the topic, both through our communication and dissemination activities (e.g., conferences) and inside the European Commission. This will help to gain awareness and possibly favour the establishment of subsidies directly connected to waste heat recovery systems.

As already mentioned, one of the main risks occurred was the project duration. For waste heat source owners, it is difficult to guarantee a certain amount of energy over 20 years. But that was only one of 59 risks which were identified during LIFE4HeatRecovery. To help the project partners and future adopters, a risk management template has been developed (see C.5.3-ANNEX): an Excel-based tool which helps project owners to go through all points of a project management plan. After identifying the risks, the template and report help to classify, evaluate and document the risks, as well as finding the risk triggers and a suitable solution. Equal to financing, risks and their circumstances are different in most of the projects. But the report showed that similar risks have same characteristics and the reactions to lower the likelihood or the impact of the risks are often the same. In the report the risks occurred are split up in three topics: risks typical for project management, risks typical for energy projects and risks which are typical for waste heat projects. The report is underlined with the risks, their characteristics and possible solutions which will help early adopters to identify them early.

All in all, risk management is an ongoing periodical process which has to be done by the project managers. There is no existing plan which shows all possible risks and reactions if risks occur. The project members have to work on it permanently and as soon as risks are identified the report can be used to search for best practices and possible solutions.