R-ACES
Energy Cooperation Platform

Harmonized overview

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Technical References

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Contributing beneficiary(ies)	S-ISPT, CLEAN
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[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
CO = Confidential, only for members of the consortium (including the Commission Services)

[2] R = Document, report
DEC = Websites, patent fillings, video, etc.
DEM = Demonstrator, pilot, prototype
OTHER = other

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Document history

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Project Summary

The R-ACES project is an initiative promoted by 8 partners from 6 European countries, with the vision to support high-potential industry parks and clusters to become fully fledged ecoregions that reduce emissions by at least 10 %. R-ACES means a step-change in the contribution of European Industry to the climate targets of the EU. The industry sector after all represents 25% of all energy demand – and 50% of the total cooling and heating demand on the continent; yet only 16% comes from renewables. By focusing on collective measures and clustering, the efficiency of industry can be drastically increased.

The focus of R-ACES therefore is to turn high-potential, high-impact industrial clusters into ecoregions that achieve at least a 10% reduction in emissions. They do so by exchanging surplus energy, making extensive use of renewables and tying everything together with smart energy management systems. An ecoregion is a geographic area where energy and information exchanges occur between various companies and actors to reduce waste and energy consumption. Ecoregion can be centred on an (eco-)industrial park or (eco-) business park, linked to its surroundings by a 4th/5th generation district heating/cooling network.

R-ACES is the capping stone, condensing the knowledge and experience gathered throughout EU and national projects into a set of three focused tools, namely a self-assessment tool, a legal tool and a smart energy management platform. The tools are embedded in support actions built around peer-to-peer learning, more formal coursework and webinars, and serious games. Together they enable a cluster to really become an ecoregion and set up meaningful energy collaboration. The entire package of tools and support is aimed at the high-potential clusters identified in the European Thermal Roadmap. It will be validated in three ecoregions, actively deployed in another seven regions, and disseminated to identified ninety regions European wide. In addition, the tools and support methodology will be made available to third parties in a sustainable way after the end of this project.

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Partners:

Institute for Sustainable Process Technology	https://ispt.eu/
Condugo	https://www.condugo.com/
DOWEL MANAGEMENT	https://www.dowel.eu/management_en/
Spinergy	http://www.spinergy.it/
clean	https://www.cleancluster.dk/
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ESCI European Science Communication Institute	https://www.esci.eu

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Executive Summary

The R-ACES project intends to pave the road for effective energy exchange in industrial clusters and business parks in Europe by providing a self-assessment tool, legal tool, and energy management tool. To develop these tools, we can use the insights of previous European projects on energy cooperation. In this report, we will make a step by making a harmonized overview of the literature. This will result in an overview of barriers/ solutions/KPIs and relevant tools. The results were reviewed by several experts. In the end, we make some suggestions for the development of the R-ACES tools.

Key words

R-ACES keywords

Industrial Symbiosis, Energy System Integration, District Heating and Cooling, Energy Cooperation, Ecoregion, Eco-Industrial Parks

Deliverable keywords

Literature review, Tool, Barriers

Disclaimer

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Abbreviations

Abbreviation	Description
CHP	Combined heat and power production
CSA	Coordination and Support Action
DH	District Heating
DHC	District Heating and Cooling
EBP	Eco-business park
GHG	Greenhouse Gas
LESTS	Legal, Economic, Spatial, Technical, Social/Managerial
KPI	Key Performance Indicator
LC	Learning Community
RE	Renewable Energy
RES	Renewable Energy Strategy
SME	Small Medium Enterprise

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Introduction

Objective of the work package

'Condense'

In the scope of the work package 'Condense', we aim to condense the insights of previous European projects regarding district heating and cooling (DHC) and joint energy services as well as academic literature. Special attention is given to the identification of associated technical and non-technical barriers/drivers and ways to overcome them. The identification process is the start of a longer effort to address barriers in a more effective way. A crucial step in this process is the classification and harmonization of barriers in a single framework. This is done in the scope of D1.2 'Harmonization'. Later in the project, the harmonized knowledge is used to develop three tools: a self-assessment tool, a legal tool, and an energy management platform. The three tools together form a R-ACES Tool Box that aims to support practitioners in ecoregions to come to energy cooperation. In order to realize this goal, the tools have to be tested. Therefore, we will also start with the selection of seven ecoregions. First, a long list will be created (D1.3). Afterwards, we define a short list by using strict selection criteria (D1.4).

Objective of the deliverable

In D1.1, almost 500 barriers of energy cooperation have been identified in various research programs such as H2020 and InterregNWE (for a full list of projects, see Annex 1). Furthermore, various solutions and existing tools have been collected. The barriers were classified in five different perspectives: legal, economic, technical, spatial and social-managerial (LESTS). Some of the barriers within these perspectives discuss similar topics but use a different taxonomy. And sometimes solutions or tools are suggested in one project for a barrier that is identified in another project. The main objective of D1.2 is to identify such relations and to 'harmonize' the taxonomy. The result is a shorter list of barriers within the LESTS classification framework with consistent taxonomy and associated solutions and tools. This is the next step towards capturing the insights of previous research in a legal tool, self-assessment tool and energy management platform.

A second objective in D1.2 is to assess the relevance and impact of the barriers and associated solutions on the success of energy cooperation. This helps to focus the tools on the most important issues and solutions. For that, several experts have been asked to review the list of barriers and propose solutions of their own. The review process consists of two-steps: a questionnaire and an optional semi-structured interview. The second step of the expert review has not concluded yet. We therefore only report on the first step here. The results of the second step will be discussed in the results of work package 2.

A third objective in D1.2 is to define the scope of the R-ACES Toolbox. The target group and applications of the tools are conceptualized here, before the prototypes are further developed in work package 2.

The steps are summarized below.

- **Create a uniform reporting structure** for presenting the insights of previous projects. The structure covers the following topics:
  - Taxonomy of barriers/drivers
  - Solutions to barriers
  - Already existing tools that might support the R-ACES Toolbox
  - Key performance indicators that might be useful for the ecoregions to use (Ecoregion KPIs).

  Moreover, the structure should ensure compatibility between the three R-ACES tools developed further on in the R-ACES project.
- **Validate the results** through a two-step expert review progress
- **Input for the R-ACES Toolbox**

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By going through these steps, we form a basis for the development of the three R-ACES tools.

Chapter structure

- **Description of the methodology used**
- **Section 1: Uniform reporting structure**
- **Section 2: Validate results through an expert review**
- **Section 3: Input for the R-ACES Toolbox**

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Methodology

Within this section, three methodological issues are further elaborated (see figure 1). First of all, a detailed description is given of the harmonization template, which will be used to structure the further harmonization process. Afterwards, more information is given on the way we organized the expert review process and the input that will be given for the R-ACES Tool Box.

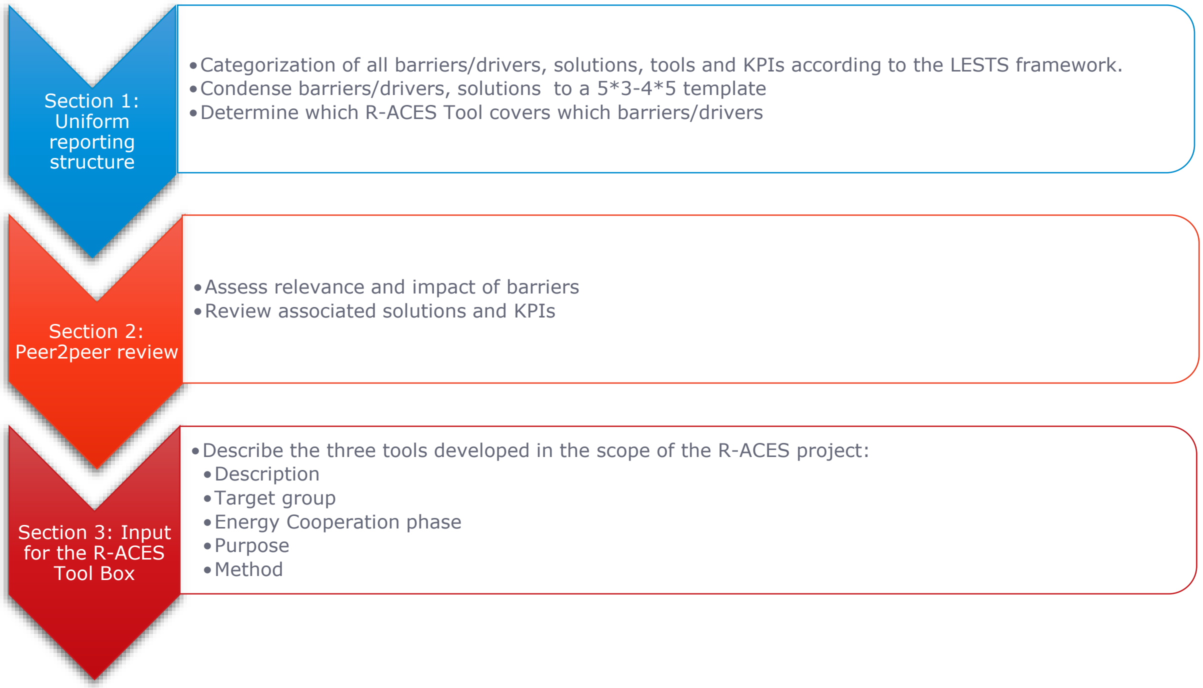

Figure 1: Process of coming to a harmonized overview

Uniform reporting structure

In order to reach a uniform reporting structure for barriers, solutions, tools and key performance indicators (KPIs) identified in previous projects, a harmonization strategy is used. The strategy consists of three steps:

1. **Classify longlist of barriers according to Legal, Economic, Spatial, Technical and Social-Managerial perspectives (LESTS)**.
2. **Condense barrier into shortlist.**
3. **Associate solutions, existing tools and key performance indicators (KPIs) to shortlist of barriers.**

In the first step, the LESTS framework is used to classify barriers. See D1.1. for a more detailed description on why this framework was selected.
In the second step, the goal is to determine similar themes between barriers on a more detailed level. To this end, two levels of subcategories were added to the classification model. The lowest level is created by grouping barriers that are very similar, often with minor alterations to the barrier description. The highest level is created by identifying relations between barriers. To help the condensation process, we added a constraint to our model: each LESTS category can have 4 first-level subcategories and each first-level subcategory can have another five subcategories. That means that we could have a maximum of 5 (LESTS) x4(first level) x5(second level) = 100 barriers. Or in other words, the task was to condense 500 barriers into 100.

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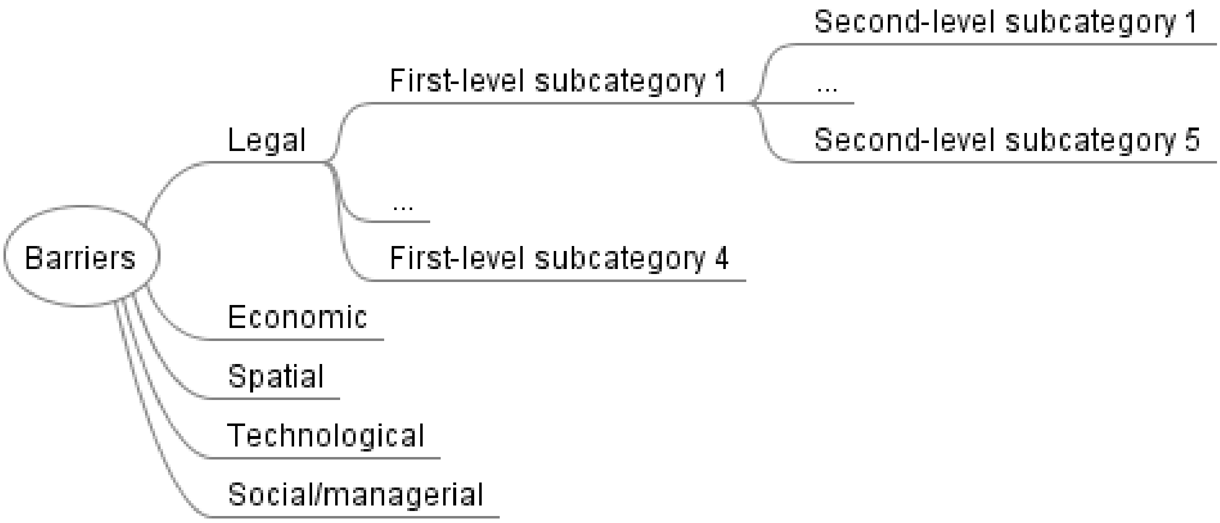

Figure 2: Barrier identification structure

In the third step, proposed solutions, tools, KPIs and R-ACES tools are associated to the 100 barriers in step 2.

Peer2peer review process

For the validation of the harmonization process, key persons of successful long-running industrial symbiosis projects and of industrial cooling/residential heating cooperation have been involved. A two-round review was conducted in the spirit of the Delphi method (see box). In the first step, the experts received a questionnaire (annex 3). The questionnaire was aimed to identify those barriers that are most important to the success of energy cooperation. In addition, the experts have the opportunity to suggest solutions.

In the second step of the review, a semi-structured interview is conducted. The idea here is to present the list of barriers selected by the experts themselves, including the suggested solutions, and discuss this result more in-depth. This is the so called ‘group response’ in the Delphi method.

The following research questions were used to structure the interview (see Annex 3 for the full questionnaire):

- **How relevant is the list of harmonized barriers?**
  - Does the expert recognize the barrier from his/her own experience?
  - How important is the barrier relative to the other barriers to the success of industrial symbiosis?
- **How applicable are the solutions proposed in previous projects?**
  - Is the expert familiar with the proposed solutions?
  - Are the solutions expected to work?
  - Are the solutions feasible for the expert to apply?

The following results are obtained this way:

- **Identification of barriers that are not recognized by the experts.** This could mean that the barrier is not present everywhere and may be region-specific. However, it could also mean that an expert is not aware of the existence of a certain barrier.

> The Delphi method was developed by RAND in the 1950s, originally to forecast the impact of technology on warefare. The idea is to use a group of experts who receive a questionnaire and reply anonymously. The researchers then analyze the feedback and formulate a group response. The group response is given back to the expert group and the process is repeated until a consensus is reached.
>
> In a two-step Delphi method, the process is repeated twice; this means that the experts receive the group response once and provide feedback twice.
>
> Source: https://www.rand.org/topics/delphi-method.html

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- **Identification of which barriers that are recognized by the experts.** These barriers will be important to address in the self-assessment or legal tool.
- **Identification of solutions that are not recognized/ applicable.** This may mean that alternative solutions need to be sought.
- **Identification of applicable solutions.** These solutions are included in the self-assessment tool and enriched with methodologies to implement the solutions.

Input for the R-ACES tools

In work package 2, three R-ACES tools will be developed. Within this work package also the target groups (groups of users) of the R-ACES tools are identified and asked to evaluate the prototypes. To stimulate the development of the tools, the R-ACES tools are conceptualized at the end of this deliverable. Provided are:

- **a description of the expected target group.**
- **a description of the tool and its purpose.**
- **application phase of the tool: exploration, implementation or operational.**
- **methodology of the tool.**
- **information regarding barriers/solutions/KPIs/Tools**

This conceptualization is further discussed in work package 2 where the prototyping takes place.

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Section 1: Uniform reporting structure

For this deliverable, we dived into the results of previous European and academic projects. Most of these projects were selected in the scope of D1.1, but we added some additional reports as a response to new insights. A full list of the selected reports can be found in Annex 1. From these reports, we gathered the following information: barriers/drivers, solutions, tools and KPIs. We did this by using the harmonization template. Below, we will describe the harmonization process. Afterwards, attention will be paid to the considerations regarding barriers/ drivers & solutions, considerations regarding found tools, and the considerations regarding often mentioned KPIs. These considerations will be discussed per LESTS category.

Actual harmonization process

We used the harmonization template as a guide through the harmonization process. First, we categorized all barriers/drivers, solutions, tools and KPIs mentioned in the reports according to the LESTS framework. This resulted in an excel file with 500 quoted barriers/drivers, many solutions, 20 tools, and 55 KPIs[1]. The file contained very useful information, but the information was not organized enough yet. One main issue was that many described barriers/drivers overlapped with each other. To further harmonize the results, we printed the excel file and started marking all barriers/ drivers according to predefined sub categories:

- **Legal:** (Knowledge of) regulations, Permits, Contracts
- **Economic**: Capital available, Costs & Benefits; Risks, Payback period
- **Spatial:** Geographic proximity, Spatial planning, Geographic information system
- **Technical:** Existing infrastructure, Fitting heating/cooling supply and demand, Readiness of technology
- **Social/ Managerial:** Culture/priorities, Communication/collaboration, Time, Available expertise

Afterwards, we merged the overlapping barriers together in such a way that every sub category would include a maximum of five barriers. As this was done, we collected all solutions described in the literature for a certain barrier. Last but not least, we gathered KPIs and tools described in the selected projects. An overview of this information can be found in Annex 2.

Figure 1: Visualization of the harmonization process

[1] If you are interested in the content of the excel file, please contact the main author of this deliverable.

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Legal

In the previous section, the general harmonization process was described. Within this section, more attention will be given to considerations regarding the barriers/drivers, solutions, tools, and KPIs within the legal category.

In the selected reports, 70 legal barriers/drivers were mentioned. These barriers/drivers differed from legal difficulties regarding cross border exchanges to disorderly legislation to confidentiality issues in contracting (In Deal, 2016; Arentsen, Klok & Bruck, 2016; Scaler, 2017). Some barriers/drivers referred to a situation in a specific country. In Romania, for instance, a legislative framework is lacking (In Deal, 2016). Such barriers/drivers were not taken into consideration. As a closer look was given to the different barriers/drivers, it became clear that there were three sub categories: (Knowledge of) regulations (mentioned 29 times), permits (mentioned 4 times), and contracts (mentioned 8 times). For each sub category, specific barriers/drivers are defined (see Annex 2). This was done by merging barriers/drivers mentioned in the literature, for example, the quoted barriers 'Uncertainty in national legislation', 'Legal uncertainty', 'Uncertainty of future policy', and 'Uncertainty of approach taken by new regulations' were merged into one barrier 'Legal uncertainty'.

After all barriers were merged into a set of non-overlapping barriers, we investigated the provided solutions. It should be noted that solutions regarding barriers in the '(Knowledge of) regulations' section often included solutions that should be applied on a national governmental level. These solutions do not fit the R-ACES scope, because we focus on the regional level. We focus more on solutions that can be used at a regional level. However, the solutions are still presented in the table in Annex 2.

No relevant KPIs were mentioned in respect to the legal category. Regarding tools, only one already existing tool was mentioned. This was a tool of the CoolHeating project (CoolHeating, 2016) in which examples are given of potential legal contracts. Another legal tool will be developed by the So What project, but this tool is not publicly available yet (So What, 2019).

Economic

The selected reports mentioned a total of 177 economic barriers/drivers. Some of these barriers were rather country specific. In some Eastern European countries existing DHC networks are rather old, therefore large investments are necessary to upgrade the networks (In Deal, 2016). We excluded the barriers that were really related to the situation in one specific country. Afterwards, we further categorized the different barriers/drivers into capital available (mentioned 27 times), costs and benefits (mentioned 49 times), risks (mentioned 19 times), and payback period (mentioned 8 times). Of course, the payback period partly has to do with the amount of capital available. However, the specific nature of the investments with a high CAPEX and a relatively low OPEX make it extra hard to find capital for energy cooperation projects. Another issue of consideration is the fact that business parks are often quite unstable (meaning that the companies change fast). The chance of fast changing companies makes it harder to have long running projects with long payback times. Therefore, the payback period is added as an additional sub category.

For each sub category, we defined a set of three to five barriers. These barriers are not completely disjunct due to the fact that the complex economic reality of energy cooperation does not allow non-overlapping barriers. The available capital is inherently connected with the foreseen costs and benefits, the risks, and the payback time. Instead, we based the barriers on the amount of times a specific barrier was mentioned in the literature.

Fitting heat/cooling demand & supply

As one can see in Annex 2, we did not include fitting heating/ cooling supply and demand to the set of economic barriers/drivers. We are aware that matching heating/ cooling supply and demand is one of the main requirements for a sustainable business case. However, it is also a technical requirement. Since we did not want to mention the barrier in both the economic and the technical category, we decided to only include it as a technical one.

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As the barriers were defined, we looked at the solutions proposed in the different studies. We matched these solutions to a specific barrier. In the literature, many different kind of solutions are described for the economic barriers. Solutions diverge from 'smart billing' to 'energy management at park level' to 'integration of different kinds of values: reduction of fuel poverty, local economic growth and carbon reduction' to 'digital transformation of energy data'. In annex 2, one can see which solutions we assigned to different barriers.

We then looked into the KPIs that might be useful in dealing with economic barriers. Within the literature, we found many potential economic KPIs, among others KPIs related to:

- **Investments**
- **Risks**
- **Costs & Benefits**
- **Profitability**

Many of the KPIs are in one way or the other related to another one. Which KPI is most useful depends on the specific energy cooperation context. To give more insight in the usefulness of the different KPIs, we placed them in a cause-effect diagram (see figure 3). Within the diagram, the goal is to create an economically feasible project. The feasibility is organized in multiple potential issues: investments, costs & benefits, risks and profitability. For every issue, we identified multiple potential KPIs. All in all, the diagram might be useful to help stakeholders selecting the right KPIs within their context.

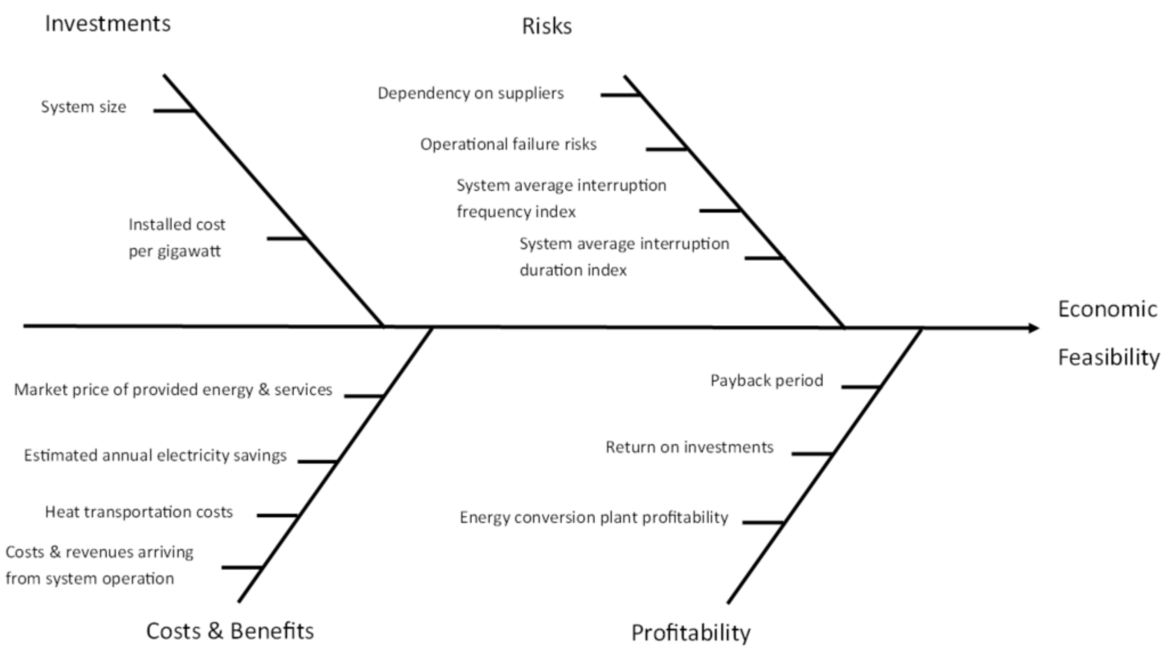

Figure 2: Cause effect diagram of economic KPIs

We also looked at tools that might support stakeholders when dealing with economic issues. In the literature, we found many potential existing tools. Three examples:

- **A business planning tool (waste heat project) that gives useful instructions on how to develop a business plan.**
- **EnergyPRO, a commercial modelling software used to carry out integrated detailed technical and financial analysis of both existing and new energy projects. The tool provides the user with a detailed financial plan in standard format, accepted by international banks and funding institutions. This includes a presentation of the operating results for the project, monthly cash flows, income statements (P&L), balance sheets and key investment figures such as NPV, IRR and payback time. The software enables the user to calculate and produce a report for the emissions (CO2, NOX, SO2, etc.) by the proposed project (Upgrade DH, 2018).**
- **An economic calculation tool for small modular district heating and cooling projects. It can be used to perform a feasibility analysis for implementing new district heating units/systems. The tool is a Microsoft Excel based spreadsheet and is easy to use. It uses macros and Visual Basic for**

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Applications programming. It is intended for district heating utilities, local governments and policy makers (UpgradeDH, 2018).

The three tools differ from each other in ease of use, the costs, and the potential outcome. The EnergyPro tool <from €3600 onwards> provides, for example, a detailed financial plan, whereas the business planning tool <free> gives only instructions on how to develop a business model.

Spatial

In regard to the spatial aspect of energy cooperation, less barriers were mentioned in the selected reports. In total, only 18 mentioned barriers had to do with spatial issues. These barriers were all rather generic and could be applicable within the scope of any energy cooperation project within Europe. The barriers can be divided into three categories: geographic proximity (mentioned 6 times), spatial planning (mentioned 5 times), and Geographic Information System (mentioned 1 time). For each category, one specific barrier was identified in the literature. Afterwards, potential solutions were matched with the identified barriers. We also looked at potential KPIs and we found three of them:

- **On site heat ratio**
- **Relative importance of losses**
- **Distance to nearest existing DHC network**

Moreover, we found two tools that might help stakeholders to deal with spatial issues:

- **The Thermos software tool helps to create a heat and cold map. The tool also has a demand estimation method operating with limited data inputs in any location.**
- **Thermal imaging via airplane to create more detailed data on heat clusters.**

The two tools can both be used as complements during the planning process. Of course, we are aware that more tools (like VR/AR tools) are developed. However, we did not find any expert evaluation of such tools in the selected literature. Therefore, we did not include them in the tools list. We will, in the scope of work package 2, look at other tools that might be of interest.

Technical

The selected reports mentioned 47 barriers related to the technical dimension of energy cooperation. The barriers were divided into three sub categories: existing infrastructure (mentioned 4 times), fitting <heating/cooling> supply and demand (mentioned 12 times), readiness of technology (mentioned 13 times). As one can see, the categories do not cover all identified barriers. This has to do with the fact that some barriers were very situation specific, for example, a barrier if you want to co-generate with bio-methane. Such very specific barriers were excluded from the final list of barriers.

Each sub category was divided into 2 – 3 specific barriers. Afterwards, potential solutions were assigned to each barrier. Often the proposed technical solutions were formulated very general. The S-PARCS project mentioned for example that an ESCO management could fix issues related to lacking infrastructure (S-PARCS, 2019). This might, of course, be an option, but it remains to be seen how feasible such solutions are.

Similar to the economic category, a lot of potential KPIs were found to deal with issues in the technical domain, for example:

- **Energy losses in kWh/year**
- **Maximum hourly surplus deficit**
- **Availability factor**

The manifold of available technical KPIs makes it difficult to decide which KPI is the best option in a

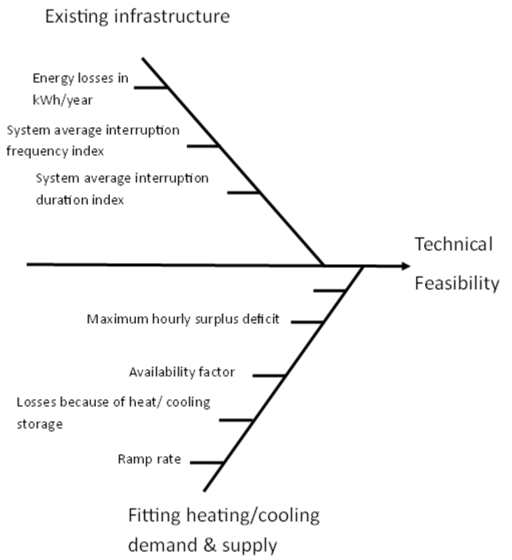

Figure 3: Cause effect diagram of technical KPIs

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certain situation. Therefore, we made a cause effect diagram (see figure 4).

Like for the other categories, we looked at the different tools available to help stakeholders to deal with technical issues. We found multiple tools that are partly overlapping with the tools found in the economic and spatial category. However, these tools have special features that also make them useful to deal with technical issues:

- **Thermal imaging via airplane can also be used to discover heat leakages in the existing infrastructure. This can help stakeholders to investigate the status of the current (DHC) network.**
- **Heat solution by ENFOR is an integrated tool specialized in the forecasting and optimization for district heating. By using weather forecasts, the tool provides heat demand forecasts. These forecasts can be used to optimize the supply temperature.**
- **The Waste heat potential tool strengthens energy planning. The tool helps to identify waste heat potential.**
- **The thermos software is an optimization model to optimize supply for identifying a cost-optimal network design by allowing users to take into account energy output over time through varying demand profiles and different tariffs.**

Social/ Managerial

The most barriers/drivers were found in the social/ managerial domain. We found a total of 184 potential barriers/drivers. Most of them were applicable in many contexts. We identified four sub categories: culture/ priorities (mentioned 39 times), communication/ collaboration (mentioned 81 times), time (mentioned 5 times), and available expertise (mentioned 21 times)[2]. For each category 3 or 4 concrete barriers are identified. Afterwards, we looked at the solutions that would fit specific barriers. Most solutions are concerned with better communication, used communication techniques, used managerial structures, external consultants, or responsibility structures.

We also identified multiple KPIs. The KPIs in this are not always directly related to the barriers found. Instead, they are sometimes related to the proposed solutions. Thermal comfort, for example, is a way to support the solutions related to the potential barrier of lacking community acceptance (for more information see Annex 2). Below, an overview of the different KPIs is given (for more information to which barriers/solutions a KPI is coupled, see Annex 2):

- **Thermal comfort**
- **Improved access to online services**
- **Public safety**
- **Degree of users' satisfaction**
- **Reduction of the number of communication channels**
- **Number of direct competitors in the network**
- **List with information that is still missing/ not up to date**
- **Share of relevant stakeholders involved in the process**
- **Power differences between stakeholders**

As for the other categories, we looked at potential tools. Below, a short description is given of the three identified tools:

- **The Esteem tool aims to create acceptability among project members. The ESTEEM process works through a path composed of the step by step application of small tools.**
- **Oxfam Novib trust tool measures the level of trust between stakeholders. The tool can help stakeholders to get insight in the amount of trust available in the consortium.**
- **The EnergyPro tool can help to create a good information base among different stakeholders.**

[2] The categorization is a little different as foreseen in the first deliverable. This is due to the fact that we did not take available expertise and time into consideration. However, it turns out that these factors are considered to be very important. Moreover, it turned out to be difficult to make a clear distinction between collaboration and communication, and between culture and priorities.

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Section 2: Peer2peer review

In D1.2 we present the results of the first part of the peer-to-peer review: a questionnaire in which experts were asked to assess the relevance of the barriers. In total, five experts participated from the Netherlands and Denmark with experience in research, engineering, project management and policy making and backgrounds in (municipality-owned) district heating companies, network organizations and university. The results are shown in the table below:

Category	Most important (at least mentioned 3 times)	Least important (mentioned less than 2 times)
Legal	Complexity of regulations Uncertainty about developments of legislation Complexity of multi-stakeholder partnerships	
Economic	Energy exchange is not core business Cost/Benefit asymmetry: the party making the costs is not always the party receiving the benefits Fear of security of supply High CAPEX and low OPEX Payback is too long for private investors Complexity of calculation of return on investments	Existing plants are not correctly depreciated Limited access to external capital Uncertainty about price development (e.g. of heat due to seasonal demand) Energy costs are not considered in the plant/business park Concerns about the long-term viability of district heating Lock-in of selected technology Fear of hidden cost Fear of competitive disadvantages from sharing information and data
Spatial	Lack of existing infrastructure in direct environment	
Technical	Lack of infrastructure Quality of heating and cooling (e.g. temperature) supply does not meet demand	Outdated existing infrastructure Advanced ICT infrastructure is required Heating & Cooling supply quantity does not meet demand Most potentials have already been realized Technical feasibility uncertain
Social-managerial	Lack of adequate planning Lack of trust between stakeholders	Consumer concerns Fear of change for core business Some stakeholders have larger influence over the project (power asymmetry) Limited time to assess costs and benefits

This table is the 'group response' of the experts in the Delphi method. The group response is used in work package 2 where we further assess why certain barriers are considered less important. E.g. it is possible that the experts have already solved these barriers or maybe they are problematic in some projects and not in others.

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Section 3: Input for the R-ACES tools

The knowledge gained from previous H2020 projects will be used for the development of three tools: a self-assessment tool, a legal tool, and an energy management platform. Below, more detailed information is given on the three tools (table 2). The overview includes information on the foreseen target group, the applicable energy cooperation phase for which the tool seems mot suited, the purpose of the tool , and the used method.

Table 1: Scope of R-ACES tools

	Self-assessment tool	Legal tool	Energy management platform
Description	A tool that helps eco-regions to determine the steps they have to take in the energy cooperation process. The tool exists of a number of questions practitioners have to answer. Based on the answers, the practitioners will get a score and some practical considerations they should take into consideration	A tool that supports practitioners by giving the legal decision support for joint contracts. A low threshold for usage is a critical requirement. The tool is self-explanatory, application oriented, using well-defined and clear terminology. The tool should be able to deal with a high diversity of local situations.	The energy management platform is an ICT-tool that makes energy flows transparent; allows energy consumption and production to be allocated to specific installations, stakeholders and nodes; and identifies anomalies and opportunities. A key feature is that it is very easy to use for a wide range of stakeholders. In this way, it is possible to deploy it in a cluster and give access to the different company and cluster managers – each at their level of detail and with the information they should have access to. On the ecoregion level, there will be a dashboard that shows different energy flows.
Target group	Regional managers	Legal staff	(Regional) energy managers
Energy cooperation phase	The tool can be used for all energy cooperation phases	Implementation & Operational	The tool can be used in the exploration, implementation, and operational phase. During the exploration, historical data is used. The resulting dashboards are a powerful way to quickly discover the fruits of energy cooperation. In the course of the implementation and operational phase, the platform is coupled to sensors and used to follow which partner delivers energy, uses energy, and has to pay. In addition, the tool can be used to discover new potential energy projects.
Purpose	Giving insights in the steps to be taken in energy cooperation	The tool helps practitioners to set up the contracts necessary to come to a fruitful energy cooperation	The purpose is to optimize energy flows and cut inefficiencies.
Method	Questions – Radar chart	Examples of contracts	Lean development

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		Support questions/ remarks for drafting a contract	

As we gathered a lot of input for the three R-ACES tools within section 1, we will now couple this information to the three tools. In table 3, an overview is given of how each of the three tools can contribute to solve issues identified for each LESTS-category. The table should be interpreted as an input suggestion for the tools. This table symbolizes an important step forward in the creation of the three R-ACES tools. This journey will be continued in work package 2, where the requirements for the tools defined.

Table 2: Input from the literature for the R-ACES Tool Box: Some suggestions

	Self-Assessment Tool	Legal Tool	Energy Management Platform (EMP)
Legal	The tool could give advice to regional managers on how they can deal with barriers regarding legislation, permits & contracts.	The tool will help the legal staff with drawing up contracts with the various relevant stakeholders. This could be done by providing examples of contracts or by making lists of issues that should be taken into account. Another issue that could be covered by the tool is confidentiality issues.	During the development process the legal requirements will be defined for the EMP. This can be used as input for the legal tool. The legal tool can in this way support the EMP to reflect the legal context/constraints of an ecoregion.
Economic	The tool could give advice to regional managers on how they can deal with issues regarding capital available costs & benefits, risks & payback period.	The tool could help the legal staff to include clauses about future price development, equal split of costs and benefits & contractual agreements for sharing (energy) data.	The EMP will give input regarding the price development. It underpins the precise insight offered to energy managers and highlights the impact of energy costs.
Spatial	The tool could give advice to regional managers on how they can deal with barriers regarding geographic proximity, spatial planning & Geographic Information System.	-	The EMP will provide a way to gather data on the amount of available heat/ cooling supply & demand.
Technical	The tool could give advice to regional managers on how they can deal with barriers regarding existing infrastructure, fitting heating/ cooling supply and demand & readiness of technology.	-	The EMP will provide an ICT infrastructure that incorporates inputs from different installations and meters. An added benefit is in its helping to assess the state/functioning of those installations.
Social/Managerial	The tool could give advice to regional managers on how they can deal with barriers regarding culture/ priorities, communication/	-	The EMP offers transparency and therefore engenders the trust that is crucial for actual energy cooperation to take place.

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	collaboration, time & available expertise.		

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Annex 1: Full list of selected reports

Related project or academic study	Focus area	Selected deliverables/ studies	Selected reports
CE-HEAT **(Interreg)**	Aims to improve the governance of energy efficiency by focusing on field of **waste heat utilization in Central Europe space and through increased exploitation of endogenous RES** – waste heat	2	1) Brochure: Business case to energy sector 2) Developing District Heating in North Western Europe
CoolHeating **(H2020)**	Supports the **implementation of small modular renewable district heating and cooling** (DHC) grids in south-east Europe.	6	1) Five reports on the framework conditions and policies in diverse European countries 2) Guideline on drafting heat/cold supply contracts between actors
District heating Scotland **(Scottish project)**	aims to boost the uptake of **low carbon heat technologies** in Scotland and focuses the efforts of a number of agencies working in this area	1	1) JRC scientific and policy reports
ENTRAIN **(Interreg)**	Wants to encourage the adoption of a **systematic and efficient energy planning** able to reduce the local carbon footprint	3	1) DELIVERABLE D.T1.2.2 2) DELIVERABLE D.T1.2.1 Italy 3) DELIVERABLE D.T1.2.1 Germany
EPOS **(SPIRE 2030)**	**Barriers for industrial symbiosis** implementation	1	1)#Insight 11
Firece **(Interreg)**	Plan territorially based **low-carbon strategies** in the frame of Regional Energy plans	1	1) D.T.1.1.1-State-of-the-Art-Analysis
FISSAC **(H2020)**	**Fostering industrial symbiosis** for a sustainable resource intensive industry across the extended construction value chain	1	1) D1.2 Best Practices
Flexynets **(H2020)**	Deploy a new generation of **intelligent DHC networks** that	2	1) D6.4 2) Guide book

	reduce energy transportation losses		
Go ECO **(IEE)**	**Apply a co-operative approach** to reduce energy consumption and CO2 emissions in existing business parks	1	1) Project summary
Heatnet NWE **(Interreg)**	will address the challenge of reducing CO2 emissions in North West Europe by creating an integrated transnational NWE approach to the **supply of renewable and low carbon heat**	1	1) A guide for energy companies 2) Guide to finance 4 DHC
IN DEAL **(H2020)**	Will offer an innovative platform that will impose a fairly **distribution of heating and cooling among the network's buildings**	1	1) Deliverable 3
Magnitude		1	1) D 6.1 : KPIs and assessment procedure
Maestri **(SPIRE)**	Aims to advance the sustainability of European manufacturing and process industries	1	1) D1.1
progRESsHEAT **(H2020)**	Supporting the progress of renewable energies for heating and cooling in the EU on a local level	1	1) D 3.2 Barriers
RELaTED **(H2020)**	Will provide an innovative concept of decentralized **Ultra-Low Temperature (ULT) network** solution with substantial efficiency and environmental benefits	2	1) Deliverable 2.3 2) Deliverable 2.5
REUSEHEAT **(H2020)**	Show case replicable models **enabling the recovery and reuse of excess heat** available at urban level	1	1) Scientific publication (Lygnerud)
RiConfigure **(H2020)**	By bringing different voices together in new types of collaborations we avoid blind spots	1	1) Deliverable 6.5

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	because every actor has specific competences and focus points		
Scaler (H2020)	To identify best practices and lessons learnt for scaling up **industrial symbiosis**	3	1)T2.3 "Incentives Assessment" 2)Deliverable 2.2 3)Deliverable 2.1
Sirene	Analysis of three Dutch cases of regional energy networks using semi-structured interviews and focus groups. With a focus on social-organizational barriers.	1	1) Final report 2016 (confidential)
Sofie	Investigation of the feasibility of local system integration to accelerate the energy transition through social labs	1	1) Final report 2016: Eindrapport Systeemintegratiestudie naar Open Flexibele Energienetwerken
SO WHAT (H2020)	Develop and demonstrate an integrated software which will support industries and energy utilities in comparing alternative Waste Heat and Waste Cold exploitation technologies	2	1) D3.1 - REPORT ON CURRENT BARRIERS TO INDUSTRIAL WH/C RECOVERY AND EXPLOITATION 2) Report-on-current-contractual-arrengement-for-for-WHC-exploitation
S-PARCS (H2020)	Identify, summarize and cluster the manifold barriers associated with various solutions of **energy cooperation** and mutualized energy services	2	1)Deliverable D1.2 2)Barriers assigned to solutions inventory
Stratego (IEE)	Support local authorities in taking action so that they can help their national authorities in **preparing and developing NHCPs**.	1	1) Deliverable 3.D
TEMPO (H2020)	**Crowdfunding as a financial tool** for DHCs	1	1) D6.4 Crowdfunding report
THERMOS (H2020)	accelerate the development of new **low-carbon heating and cooling systems** across Europe	2	1) Baseline Replication Assessment Report 2) Module 5
Upgrade DH	**Enabling the upgrading of district heating systems**	2	1) Handbook 2) Best practice instruments and tools for diagnosing and retrofitting of district heating networks
Academic	**Drivers and barriers of industrial symbioses/ ecoregions**.	9	1) Bush, R.E. (2016). *Governing low carbon socio-technical transitions – a case study of district heating in Great Britain.*

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			2) Palm, J., Gustafsson S. (2018). *Barriers to and enablers of district cooling expansion in Sweden*. 3) Asfari, H., Farel, R., Peng, Q. (2018). *Challenges of value creation in Eco-Industrial Parks (EIPs): A stakeholder perspective for optimizing energy exchanges*. 4) Vansteenbrugge, J., Van Eetvelde, G. (n.d.). *DISTRICT HEATING NETWORKS IN THE FRAMEWORK OF SPATIAL PLANNING* 5) Busch, J., et al. (n.d.). *Emergence of District-Heating Networks; Barriers and Enablers in the Development Process.* 6) Meneghetti, A., Nardin, G. (2012). *Enabling industrial symbiosis by a facilities management optimization approach.* 7) Bolton, R., Hannon, M. (2016) *Governing sustainability transitions through business model innovation : towards a systems understanding*. Research Policy. ISSN 0048-7333 , http://dx.doi.org/10.1016/j.respol.2016.05.003 8) Bruck, R. (2016). *Recommendations for a successful European IS strategy*. 9) Bush, R.E., Bale, C.S.E., Taylor, P.G. (2016). *Realising local government visions for developing district heating: Experiences from a learning country*.

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Annex 2: Overview of barriers, solutions, KPIs, already existing tools, and R-ACES Tool

Category ***(Legal, Economic, Spatial, Technical, Social/ Managerial)***	Topic ***(Sub category that is often mentioned in the literature)***	Specific barrier ***(Description of specific barrier as mentioned in the literature)***	Solution ***(Proposed solution in the literature)***	KPI ***(KPI that is suitable to get more insight in barrier/ support the given solution)***	Existing tools ***(Tools that can help to overcome this specific barrier)***	R-ACES Tool ***(This barrier will be covered by this specific R-ACES tool)***
Legal	(Knowledge of) regulations (29x)	Complexity/ inconsistency of regulations (SCALER, 2017; In Deal, 2016; S-PARCS, 2019; ProgRESsHEAT, 2015; FISSAC, 2015; RELATED, 2019, REUSEHEAT, 2017)	Special case exemptions for pilot projects			Self-assessment tool
		Cross border exchanges (Arentsen, Klok & Bruck, 2016)	Comprehensive European Database			Self-assessment tool
		Legal uncertainty (SCALER, 2017; In Deal, 2016; S-PARCS, 2019; ProgRESsHEAT, 2015; FISSAC, 2015; RELATED, 2019, REUSEHEAT, 2017)	On country level: Stability of legislation. Funneling information upwards and downwards through regional governments Development of stimulating models such as EEIA in Italy			Self-assessment tool
	Permits (4x)	Slow administration (ENTRAIN, 2019; ProgRESsHEAT, 2015)				Self-assessment tool
		Unclear administrative framework (EPOS, 2015; ProgRESsHEAT, 2015)				Self-assessment tool

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	Contracts (8x)	Lack of standardized contracts (THERMOS, 2016; So What, 2019, RiConfigure, 2018; Busch et al.; REUSEHEAT, 2017)	Development of standardized contracts. Most important contract is between owner of heat and owner of DHC network. Key aspects of contract: shared incentives, details of supply, what resources are needed for heat recovery, communication channels, operational activities, renegotiation, mitigation, maintenance periods/stops		Contract examples	Self-assessment tool Legal tool
		DH requires a set of contracts with different stakeholders (UpGrade DH, 2018)	Good overview on contractual issues for small DH systems is provided in a guideline by Laurberg Jensen et al. (2017)			Self-assessment tool Legal tool
		Confidentiality issues in contracting (SCALER, 2017)	Establish individual data (safety) guidelines on industrial park level			Self-assessment tool Legal tool
Economic	Capital available (27x)	DH is not core business: hard to assign own funds (S-PARCS, 2019; So What, 2019)	Funding mechanisms to support business collaborations in resource management	1) Estimated Annual Electricity Savings 2) Energy conversion plant profitability	Business plan tool	Self-assessment tool
		Existing plants are not depreciated today, which hampers the investment in new ones (S-PARCS, 2019; In Deal; 2016)	Important role for local government: can think beyond commercial approaches. Integration of different kinds of values: reduction of fuel poverty, local economic growth, and carbon reduction	1) Fuel poverty reduction 2) GHG emission reduction 3) Energy Efficiency 4) Share of electrical	Business plan tool	Self-assessment tool

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			On country level: Policy can influence this issue by setting or changing requirements for the energy system	energy produced by renewable energy sources 5) City/ region's unemployment rate		
		Limited access to external capital (THERMOS, 2016; So What, 2019; ENTRAIN, 2019; FISSAC, 2015; Firece; 2017; EPOS, 2015; TEMPO, 2018)	The right investor, e.g. local authorities and national governments; Crowdfunding campaign focused on 'patient' capital		Business plan tool	Self-assessment tool
	Costs & Benefits (49x)	Uncertainty about price development (RELaTED, 2019; S-PARCS, 2019; So What, 2019)	Smart billing If the value of heat/cold is linked to seasonal demand, it should be accounted for in the contract. To manage heat extraction during summer, it can be written into the contract that the heat receiver must receive at least a fixed amount of heat all year around.		EnergyPRO	Self-assessment tool Legal tool
		Competition with other alternatives (f.e. low electricity prices) (ENTRAIN, 2019; SCALER, 2017; ENTRAIN, 2019; In Deal, 2016; Bush, Bale & Taylor, 2016)	Important role for local government: can think beyond commercial approaches. Integration of different kinds of values: Reduction of fuel poverty, local economic growth and carbon reduction Country level solution: CO_2 taxation on fossil fuels	1) Return on investment	Business plan tool	Self-assessment tool
		Energy costs are not considered to be a crucial factor (S-PARCS, 2019)	Energy management at park level/ Common energy audits/ Smart monitoring systems for energy facilities and	1) Estimated Annual Electricity Savings		Energy management platform

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			plants/ Digital transformation of energy data	2) Energy conversion plant profitability		
		The party who bears the initial costs might not benefit at all from the savings (Paul & Gustofsson, 2018; ProgRESsHEAT, 2015)	The optimization problem should be extended to include the required investments and operation costs as well as expected gains for each stakeholder and provide a cost-benefit analysis	1) Analysis of cost and revenues of the service per actor with network constraints	Business plan tool	Legal tool Self-assessment tool
		High investment costs (S-PARCS, 2019; In Deal, 2016; So What, 2019; UpGrade DH, 2018; Paul & Gustafsson, 2018; ProgRESsHEAT, 2015)	Leasing Energy management system at park level	1) Return on investment 2) Payback time	Business plan tool	Self-assessment tool
	Risks (19x)	Fear of security of supply (S-PARCS, 2019)		1) Operational failure risk 2) System average interruption frequency index 3) System average interruption duration index 4) Dependency of system on certain suppliers		Self-assessment tool
		Concerns about long term viability of DH (Bush, Bale & Taylor, 2016)			Economic calculation tool for small modular district heating and cooling projects	Self-assessment tool

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		Lock-in of selected technology (SIRENE, 2016; S-PARCS, 2019)	Modular systems			Self-assessment tool
		Fear of hidden costs (S-PARCS, 2019)	Leasing for energy efficient equipment/ Raising awareness and training activities	1) Operational failure risk		Self-assessment tool
		Fear of competitive disadvantages through exchange of information, knowledge and data (S-PARCS, 2019)	Contractual agreements for sharing energy data	1) Estimated Annual Electricity Savings		Self-assessment tool Legal tool
	Payback period (8x)	High CAPEX and low OPEX (TEMPO, 2018)	The right investor, e.g. local authorities and national governments; Crowdfunding campaign focused on 'patient' capital Energy Saving certificates	1) Payback period 2) Returns on investment 3) Market price of provided energy & services	EnergyPRO	Self-assessment tool
		Payback period is too long for private investors (ENTRAIN, 2019; So WHAT, 2019; REUSEHEAT, 2017; EPOS, 2015; S-PARCS, 2019)	Involvement of governmental organizations that invest in DHC	1) Payback period 2) Returns on investment	EnergyPRO	Self-assessment tool
		Complexity of calculation of return of investments (SCALER, 2017)			EnergyPRO	Self-assessment tool
Spatial	Geographic proximity (6x)	Long physical distances between enterprises (S-PARCS, 2019; ProgRESsHEAT, 2015; So What, 2019; SCALER, 2017)	Heat mapping: Heat potential study to determine future dh areas	1) On site heat ratio 2) Relative importance of losses	THERMOS Software	Self-assessment tool
	Spatial planning (5x)	Lack of required infrastructure in the direct environment (f.e. district heating network) (RELaTED, 2019; SCALER, 2017)		1) Distance to nearest existing DHC network		Self-assessment tool
	Geographic Information System (1x)	Lack of data for heat mapping (Bush, 2016)	Planes can help to get better insights in amount of heat available (see tools)	-	Thermal imaging via air plane	Self-assessment tool

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					THERMOS Software	Energy Management Platform
Technical	Existing infrastructure (4x)	Outdated infrastructure (S-PARCS, 2019; So What, 2019)	Maintenance	1) Energy losses in kWh/year 2) System average interruption duration index 3) System average interruption frequency index	Thermal imaging via air plane	Self-assessment tool Energy management platform
		Lack of infrastructure (S-PARCS, 2019; EPOS, 2015)	ESCO management Local governmental plans			Self-assessment tool
		ICT infrastructure: advanced communication infrastructure is needed (S-PARCS, 2019)	ICT sector engagement			Self-assessment tool Energy Management Platform
	Fitting heating/cooling supply and demand (12x)	Most potentials have already been realized (S-PARCS, 2019)	Continuous improvement of energy management Engaging symbiosis with non-park entities	1) Energy losses in kWh/year 2) System average interruption duration index 3) System average interruption frequency index	Heat Solution™ by ENFOR™	Self-assessment tool
		Quantity of heat/cooling demand/supply does not fit (RELaTED, 2019; S-PARCS, 2019)	More complicated installations Use of more advanced DHC networks to be able to cover longer distances	1) Maximum hourly surplus deficit 2) Availability factor	Waste heat potential	Self-assessment tool

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		Quality of heat/cooling demand/supply does not fit (f.e. temperature level, continuity profile) (S-PARCS, 2019; REUSEHEAT, 2017; Arentsen, Klok & Bruck, 2016; SCALER, 2017)	More complicated installations Presence of storage facilities for resource flexibility In case of low temperature waste heat: create direct recovery incentives. Have long-term guarantees regarding future volumes (preferably in long-term contracts) of heat to increase the predictability, and thus reduce the risk of the investment.	1) Losses because of heat/ cooling storage solutions 2) Relative importance of losses 3) Availability factor	Waste heat potential	Self-assessment tool
	Readiness of technology (13x)	Lack of knowledge about successful demonstration projects and / or references (S-PARCS, 2019)	Technical and engineering consultancy Promoting training activities among professionals Machine manufactures' engagement Increasing investments in R&D			Self-assessment tool
		Technical feasibility (S-PARCS, 2019; FISSAC, 2015; REUSEHEAT; 2017; EPOS, 2015)	R&D to detect technical challenges early on in the project, provide solutions. Trials are important. Data & indicators		THERMOS Software	Self-assessment tool
Social/ Managerial	Culture/ priorities (39x)	Community acceptance – consumer concerns (EPOS, 2015; UpGrade DH, 2018; ENTRAIN, 2019; CE-HEAT, 2016; TEMPO, 2018; THERMOS, 2016; In Deal, 2016)	Communication is key: inform local communities Create awareness on time. Use a DHC ambassador, info-events. Once a network is running: regularly inform consumers. Set up a complaint procedure. For corporate actors: use personal approach	1) Thermal comfort 2) Improved access to online services 3) Public safety 4) Degree of users' satisfaction 5) Reduction of the number of		Self-assessment tool

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				communication channels		
		Fear of distortions to core business (S-PARCS, 2019; SCALER, 2017)	Environmental and energy awareness campaign starting at company/department level, possibility also leveraging park/consortium/ category bodies Step-by-step approach, energy cooperation starting from non-critical processes Health and safety analysis Energy cooperation on top of existing utilities in order to guarantee a backup system			Self-assessment tool
		Companies are direct market competitors – no interest in cooperation (S-PARCS, 2019)	Energy cooperation on non-product related processes and focus on mutual/equal benefit solutions Ideation/ co-creation workshops with expert facilitation Intermediaries help identify synergies, opportunities and technological needs	Number of direct competitors around in the network		Self-assessment tool
		Business as usual paradigm in which heat is seen as a waste material (S-PARCS, 2019; SCALER, 2017)	Step-by-step approach, starting from easy to implement measures Incorporation of human drivers with high leadership capacity			Self-assessment tool
	Communication/ Collaboration (81x)	Lack of coordination (SCALER, 2017; Bush, 2016; Arentsen, Klok & Bruck, 2016; Bush, Bale & Taylor, 2016, SIRENE)	External intermediaries with a coordination role; or self-organizational approach		Esteem tool	Self-assessment tool

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			Intermediaries/ knowledge brokers/ coordinating bodies Appointment of energy manager			
		Lack of trust between stakeholders (SCALER, 2017; S-PARCS, 2019; Busch et al., n.d.; SIRENE)	Meetings at park level to promote communication and collaboration between companies/ Energy cooperation starting at demo level (small scale)/ External entities (consultants, public authorities, manufacturer organizations, etc.) to facilitate and promote cooperative measures Construction of learning networks and forums to form enduring relationships		Esteem tool Oxfam Novib trust tool	Self-assessment tool
		Lack of relevant information (Go ECO, 2013; FISSAC, 2015; SCALER, 2017; SIRENE)	Best practices: Stakeholder dialogue, training of the personnel involved, raising awareness A result of lack of energy management systems as well as energy monitoring tools in general	1) List with information that is still missing/ not up to date	EnergyPRO	Self-assessment tool
		Involvement of a wide range of <competing> stakeholders (early on in the process) with potential power asymmetry (SCALER, 2017; Stratego, 2013; ProgRESsHEAT, 2015; Menegheti & Nardin, 2012, SIRENE)	An early involvement of a wider range of stakeholders smoothens the path for the implementation of projects Networks of companies have proved effective Participation process	1) Share of relevant stakeholders involved in the process 2) Power differences between stakeholders	Esteem tool	Self-assessment tool

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			Participants reflect and represent the complete stakeholder field Short mental distance assures convergence of goals and visions			
	Time (5x)	Lack of adequate planning (In Deal, 2016)	ESCO management		Esteem tool	Self-assessment tool
		Limited time to assess costs and benefits of the project (Stratego, 2013)	Stratego's list of categories gives good guidance			Self-assessment tool
		Lack of time and resources invested by key stakeholders (f.e. local authorities) (Bush, 2016; S-PARCS, 2019)	One solution was to establish activities at the regional authority level, such as the local enterprise partnership. The pooling of resources at this stage enabled work to be undertaken on behalf of local authorities that could not have been able to take place otherwise			Self-assessment tool
	Available expertise (21x)	Lack of knowledge about financial matters (S-PARCS, 2019; Asfari et al., 2018; TEMPO, 2018; SCALER, 2017)				Self-assessment tool
		Lack of knowledge and/ or skills related to DHC (S-PARCS, 2019; Bush, 2016; SCALER, 2017; ProgRESsHEAT, 2015)	Appointment of energy manager Create solid knowledge base in your own project management team. Peer networks to enable knowledge sharing Role of intermediary activities Involvement of knowledge agents (universities, specialist, consultancies) Energy advice services			Self-assessment tool

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		Lack of knowledge on legal matters				Self-assessment tool

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Annex 3: Questions

9/15/2020 R-ACES screening: barriers for energy exchange

R-ACES screening: barriers for energy exchange

The R-ACES project is an initiative promoted by 8 partners from 6 European countries, with the vision to support high-potential industry parks and clusters to become fully-fledged ecoregions that reduce emissions by at least 10%. An ecoregion is a geographic area where energy and information exchanges occur between various companies and actors to reduce waste and energy consumption. Ecoregion can be centered on an (eco-)industrial park or (eco-) business park, linked to its surroundings by a 4th/5th generation district heating/cooling network.

R-Aces aims to condense the knowledge and experience gathered throughout EU and national projects into a set of three focused tools: a self-assessment tool, a legal tool, and a smart energy management platform. A list of hundreds of barriers and solutions was identified from research projects on energy exchange (e.g. H2020, Interreg NWE, and other research programs). As a first step of our research, we have attempted to group barriers that are similar, giving us a shorter list to work with.

The list currently consists of 49 barriers. For our self-assessment tool, we would like to focus on the most important and relevant barriers and their solutions. For that, we hope that you can help us by filling in this questionnaire. It will take about 5-10 minutes of your time. We will treat the results anonymously. In the end of the questionnaire we would also like to ask you if you would consider doing a video call with us in which we can discuss the barriers and solutions you have selected more in depth.

We thank you for your time and participation,

Max Brouwer and Christa de Ruyter, ISPT
* Required

1. What kind of experience do you have with energy cooperation? *

Mark only one oval.

- ◯ Project management
- ◯ Engineering
- ◯ Research
- ◯ Policy making
- ◯ Other: ____________________

https://docs.google.com/forms/d/1hfsVnxSKfh936v7_8G1n8uPPSe_m1zQS0Bfyd7Q0LWw/edit 1/5

2. Within energy cooperation projects, I have expertise with the following categories of barriers. Please tick the boxes that apply. *

Check all that apply.

- [ ] Legal barriers
- [ ] Economic barriers
- [ ] Spatial barriers
- [ ] Technical barriers
- [ ] Social/Managerial barriers
- [ ] None of the above

3. (1/5) From the list below, please select the legal barriers that you recognize and consider important to the success of energy exchange. *

Check all that apply.

- [ ] Complexity of regulations
- [ ] Conflicting regulation for cross-border exchange
- [ ] Uncertainty about developments of legislation
- [ ] Slow administration of permits
- [ ] Unclear administrative framework of permits
- [ ] Lack of standardized contracts (e.g. heat purchase / supply agreements)
- [ ] Complexity of multi-stakeholder partnership contracting
- [ ] Confidentiality issues in contracting

4. Can you share us a best practice to deal with legal barriers?

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5. (2/5) From the list below, please select the economic barriers that you recognize and consider important to the success of energy exchange. *

Check all that apply.

- [ ] Energy exchange is not core business
- [ ] Existing plants are not correctly depreciated
- [ ] Limited access to external capital
- [ ] Uncertainty about price development (e.g. of heat due to seasonal demand)
- [ ] Competition with alternative energy carriers (e.g. fossil, electricity)
- [ ] Energy costs are not considered in the plant/business park
- [ ] Cost/benefit asymmetry: The party making the costs is not always the party receiving the benefits
- [ ] High capital investment costs
- [ ] Fear of security of supply
- [ ] Concerns about long-term viability of district heating
- [ ] Lock-in of selected technology
- [ ] Fear of hidden cost
- [ ] Fear of competitive disadvantages from sharing information and data
- [ ] High CAPEX and low OPEX
- [ ] Payback period is too long for private investors
- [ ] Complexity of calculation of return on investments

6. Can you share us a best practice to deal with economic barriers?

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7. (3/5) From the list below, please select the spatial barriers that you recognize and consider important to the success of energy exchange. *

Check all that apply.

- [ ] Long physical distances between enterprises
- [ ] Lack of existing infrastructure in direct environment
- [ ] Lack of data for heat mapping

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8. Can you share us a best practice to deal with spatial barriers?

9. (4/5) From the list below, please select the technical barriers that you recognize and consider important to the success of energy exchange. *

Check all that apply.

- [ ] Outdated existing infrastructure
- [ ] Lack of infrastructure
- [ ] Advanced ICT infrastructure is required
- [ ] Most potentials have already been realized
- [ ] Heating & cooling supply quantity does not match demand
- [ ] Quality of heating & cooling (e.g. temperature) supply does not match demand
- [ ] Lack of knowledge about successful demonstration projects
- [ ] Technical feasibility uncertain

10. Can you share us a best practice to deal with technical barriers?

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11. (5/5) From the list below, please select the social-managerial barriers that you recognize and consider important to the success of energy exchange. *

Check all that apply.

- [ ] Consumer concerns
- [ ] Fear of change for core business
- [ ] No interest in cooperation with direct market competitors
- [ ] Heat is seen as a waste product
- [ ] Lack of project coordination
- [ ] Lack of trust between stakeholders
- [ ] Lack of information on energy flows
- [ ] Some stakeholders have larger influence over the project (power asymmetry)
- [ ] Lack of adequate planning
- [ ] Limited time to assess costs and benefits of the project
- [ ] Lack of time and resources invested by key stakeholders
- [ ] Lack of financial knowledge
- [ ] Lack of knowledge and / or skills related to district heating and cooling
- [ ] Lack of legal knowledge

12. Can you share us a best practice to deal with social-managerial barriers?

13. Would you be willing to participate in a 1-on-1 video call with us to discuss the topic further? If so, please share your e-mail adres below.

https://docs.google.com/forms/d/1hfsVnxSKfh936v7_8G1n8uPPSe_m1zQS0Bfyd7Q0LWw/edit 5/5

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