R-ACES
Energy Cooperation Platform

Assessment on the Bergamo Eco-Region

[More information about the document]

AUTHORS: FABRIZIO GUARRASI, LE2C

DATE: 07.02.2023

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

Technical References

Project Acronym	R-ACES
Project Title	fRamework for Actual Cooperation on Energy on Sites and Parks
Project Coordinator	ISPT – Institute for Sustainable Process Technology
Project Duration	1 June 2020 – 31 March 2022
Project Website	www.r-aces.eu

Deliverable No.	D3.
Dissemination level[1]	PU
Type Deliverable[2]	R
Work Package	WP3 – Waste heat based energycooperation and transfer pilots
Lead beneficiary	
Contributing beneficiary(ies)	Consortium
Due date of deliverable	31-12-2022
Actual submission date	07-02-2023

[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

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

Project Summary

The R-ACES project is an initiative promoted by 7 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 decision support tool, and a smart energy management platform for clusters. 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 eco-region 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 eco-regions, 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.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

Partners

Institute for Sustainable Process Technology

https://ispt.eu/

Condugo

https://www.condugo.com/

Spinergy

http://www.spinergy.it/

energy CLUSTER DENMARK

https://www.energycluster.dk/

LE2C LOMBARDY ENERGY CLEANTECH CLUSTER

http://www.energycluster.it/en

pom antwerpen

https://www.pomantwerpen.be/

ESCI European Science Communication Institute

https://www.esci.eu

EUROHEAT & POWER

https://www.euroheat.org/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

Executive Summary

The R-ACES project intends to pave the road for effective energy exchange in industrial clusters and business parks in Europe. As a Coordination and Support Action (CSA), the project was designed with the objective of disseminating the project results at a wide extent. This is the reason why a significant number of high priorities regions are targeted in order to reach a critical mass.

In this context, the present report is the '***Assessment of the Bergamo ecoregion***' of the R-ACES project, which describes the setup of the Bergamo pilot case in order to test in realistic environments the waste heat management tools which the project will have designed and developed for industrial actors and other stakeholders.

Stakeholder groups (such as industries, ESCOs, business parks and intermediaries as potential multipliers) were identified to foster their involvement in energy cooperation in general and industrial symbiosis projects in particular. This report will show how all these activities have converged in the realisation of the Bergamo ecoregion.

Key Words

R-ACES keywords

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

Deliverable keywords

Bergamo, Ecoregion, Energy cooperation, Papermill, DHN, Tools, KPIs

Disclaimer

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

Table of Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

Table of figures

Table of tables

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

1 Introduction

1.1Objective of the Work Package 3

The objective of work package 3 (WP3) is to set up the three ecoregions in Belgium, Italy and Denmark. More specifically, it consists of coordinating the efforts leading to the creation and development of the ecoregions and establishing at the same time a comprehensive validation methodology concerning the application of the solutions co-designed in WP2, in the realistic environments provided by the consortium.

As the impact of R-ACES application in industrial sites must be evaluated in the context of:

- Improving the management of energy saving;
- Making profits from the waste heat produced by energy intense industrial production processes;
- Improving at the same time environmental performances.

In the scope of WP 3 "Waste heat-based energy cooperation and transfer pilots", we aim to define a series of validation criteria concerning the application of the three tools developed in WP2.
The three tools are:

- **Assessment tool:** an assessment framework that covers multiple themes. Provides best practices, check lists to users & means to scan energy reduction potentials.;
- **Legal decision support tool:** investigates how to build a practical and simple-to-use decision-support tool for management to decide on the required legal framework for energy cooperation;
- **Energy management platform** (EMP): an ICT-tool that makes energy flows transparent; allows energy consumption and production to be allocated to specific installations, stakeholders and notes; and identifies anomalies and opportunities.

1.2Objective of this deliverable

The objective of this deliverable D3.6 (WP3), Assessment on the Bergamo Eco-Region, is to set up the Ecoregion in Italy, more specifically in the city of Bergamo in the Lombardy region.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

2 General description of the Eco-Region

2.1 Introduction to the Bergamo Ecoregion

2.1.1 Background information and needs of the region

Bergamo is an Italian municipality, with an area of 40.16 km2, the capital of the province of the same name located in the **Lombardy region** of northern Italy, see figure 1.The opportunity given of district heating has been well taken by the province of Bergamo with several plants already built and many more to be built. In fact, in Bergamo there are 30,500 apartments connected to district heating with 7.3 million cubic meters heated by the district heating plant owned by **A2A Calore e Servizi** - a leading Italian multiutility. In Bergamo, thanks to this system, atmospheric emissions of 16,448 tons of CO2, about 0.5 tons of particulate matter, 16.8 tons of nitrogen oxides and 4.2 tons of sulfur dioxide are avoided.

Figure 1: Map of Bergamo region

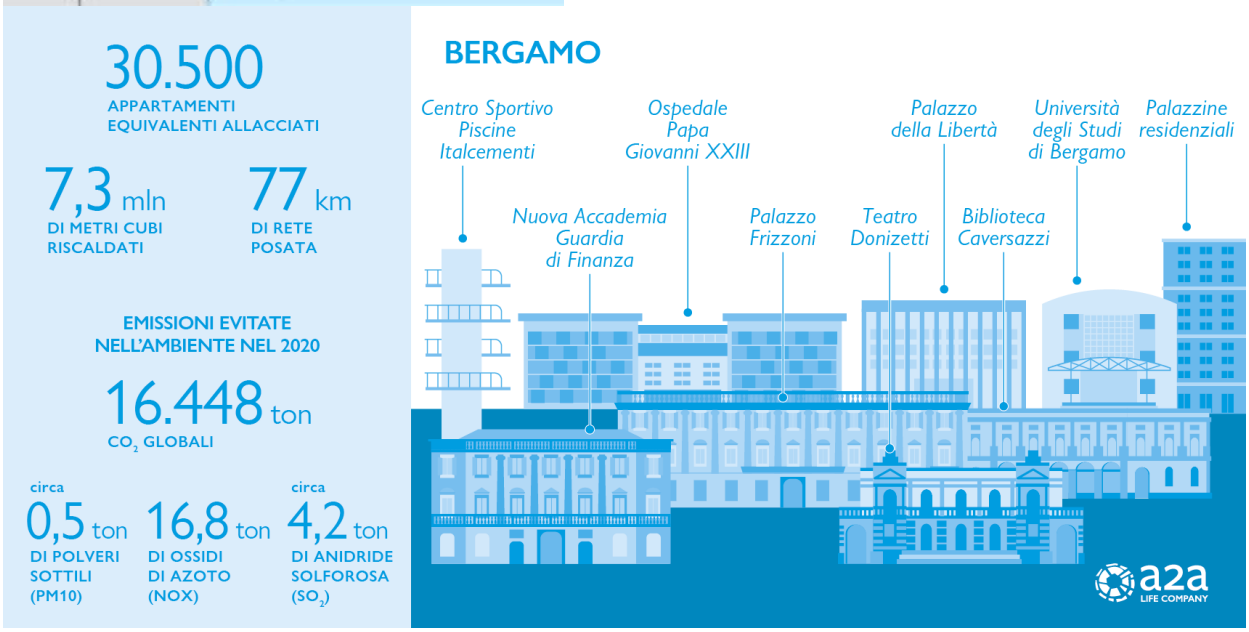


Figure 2: Data of district heating in Bergamo

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

With Bergamo, we started the work, at the beginning of 2021, by focusing on an existing project that was going to be built, called **"Bergamo+Green".** This project, at that time under a feasibility study, envisaged in early 2023 the construction of a new DH pipeline (the green line in the picture) in order to connect a **Dalmine waste2energy plant** (number 1 in the picture) to the existing District Heating Network (DHN) in the city of Bergamo (number 2 in the picture). This project would have brought a **50% increase in available heat** to the City of Bergamo's district heating network, increasing the DHN with 90 GWh.

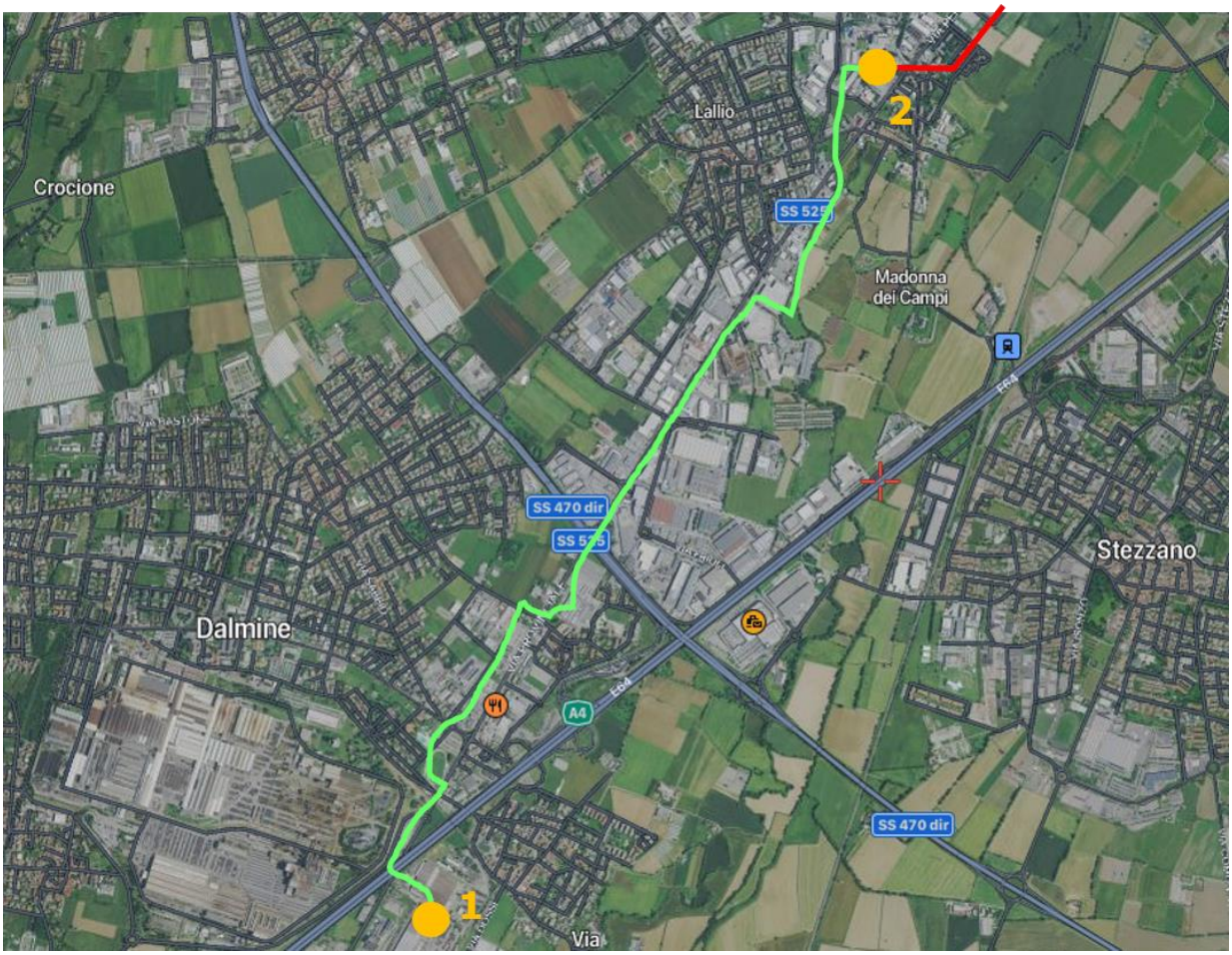


Figure 3: New DHN in Bergamo - Bergamo+Green project

The problem of Bergamo+Green was that at that time the DHN owner, A2A Calore & Servizi, had not considered whether or not there were energy-intensive industries close to the new district heating network so that they could further increase the heat input to the City of Bergamo's district heating network.
In this context, R-ACES offered to support A2A Calore e Servizi to identify whether nearby industries generated waste heat from their production processes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

2.2 R-ACES activities

2.2.1 Summary of the R-ACES activities in chronological order

December 2020

- First exploratory meeting between LE2C and Spinergy. Brainstorming on possible area of interest in Lombardy Region. Highlight the Bergamo Area and the project Bergamo+Green.

March 2021

- First meeting with A2A Calore & Servizi (Bergamo+Green and DHN owner) to understand needs and potential opportunities for R-ACES project.
- Contact A2A engineers to receive the Bergamo+Green project's documents.

May 2021

- Meeting between LE2C and Spinergy to study the new DHN area and possible industries to map.
- Using Google Maps, list of possible industries energy-intensive close to the new DHN to contact and involve in the project.

June 2021

- Contact Confindustria Bergamo (Industrial association) and Innoveas Project in order to contact the industries highlighted and listed in May.
- Using the R-ACES Self-Assessment tool; mapped the industries highlighted in the Bergamo area.

September 2021

- Thanks to the R-ACES Self-Assessment tool, skimming of less energy-intensive companies and selection of best companies based on factors waste energy and proximity from district heating network: focus of interest on CAMA paper mill.
- Contact with Energy Manager of CAMA Paper Mill. R-ACES presentation and energy data requested for better study.

November 2021

- Meeting with engineers from A2A Calore & Servizi in order to present The CAMA Paper Mill's energy data on waste heat produced and propose a possible project to connect the paper mill to the district heating network.

February 2022

- Meeting with engineers from A2A Calore e Servizi. They accepted positively the draft project idea. Decided to hire an engineering company (Enertech Solution) in order to work on the project feasibility study.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

- Contact Enertech Solution to involve them in the project. Start of the feasibility study.

June 2022

- Meeting with LE2C, Spinergy and Enertech Solution. Presentation of first options to make the project and connect the paper mill CAMA to the district heating network. Discussion on possible improvement.

June 2022

- Working group between CAMA and Spinergy to test the R-ACES Legal Tool by mimicking the project agreement

October 2022

- Technical meeting between LE2C, Spinergy, A2A Calore & Servizi and Enertech Solution. Presentation of two options to save the paper mill waste heat and connect the paper mill to the district heating network. Discussion on possible improvement and developments.

November 2022

- Two options defined and completed. A2A Calore & Servizi approved the feasibility study. Enertech solution started to work on economic feasibility and timeline.

2.2.2 Involved stakeholders

For the Bergamo ecoregion, we subdivide two categories of stakeholders: direct stakeholders (i.e. those who contributed to and took part in the Project) and indirect stakeholders (i.e. all stakeholders who were mapped and reached but then did not have a direct role in the CAMA papermill project)

Direct Stakeholders:

- DHN owner – A2A Calore & Servizi
- Industry – CAMA Papermill
- Engineering company – Enertech Solutions
- Plant engineers – AB Impianti
- Industrial Association – Confindustria Bergamo
- ESCO – Spinergy
- Energy Cluster – Lombardy Energy Cleantech Cluster

Indirect Stakeholders:

- 1 Large industry
- 4 Small and medium enterprise

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

3 Added value of the R-ACES tools and materials

3.1 Use of the R-ACES tools in the Bergamo ecoregion

Starting from the new district heating network, to identify the nearby energy-intensive industries close to the new DHN, we made a map of industries – firstly scouting them on Google maps - of the area along the new pipeline (as shown below in red in the picture).

Then, by using the **Self-Assessment tool**, we analyzed around 5 industries - a cosmetics factory, two textile companies, a metalworking company and a paper mill - in the area and assessed their energy potential in terms of waste heat produced. Among them, a paper mill factory located close to the grid (n°3, the blue dot in the picture) was chosen because of the amount of excess heat it could potentially supply to the district heating network and the extreme proximity to the pipeline.

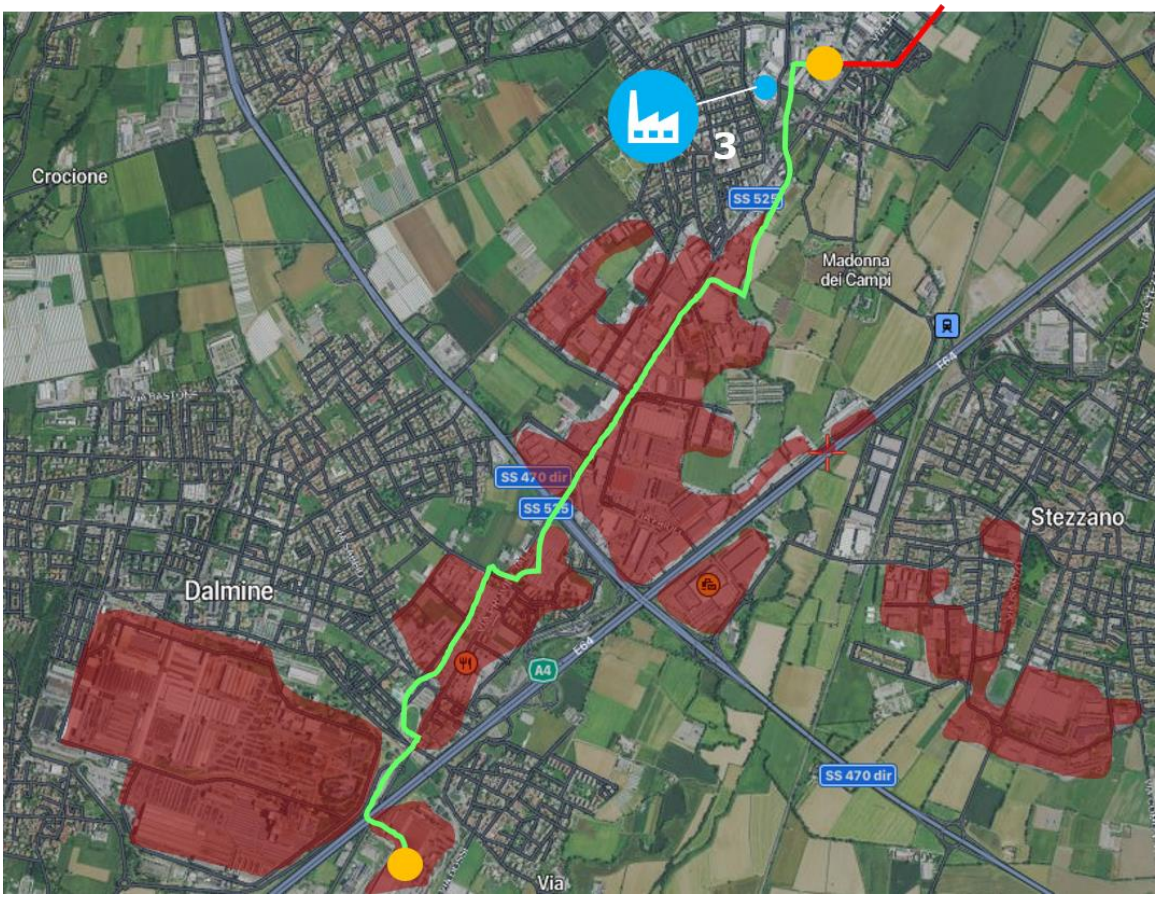


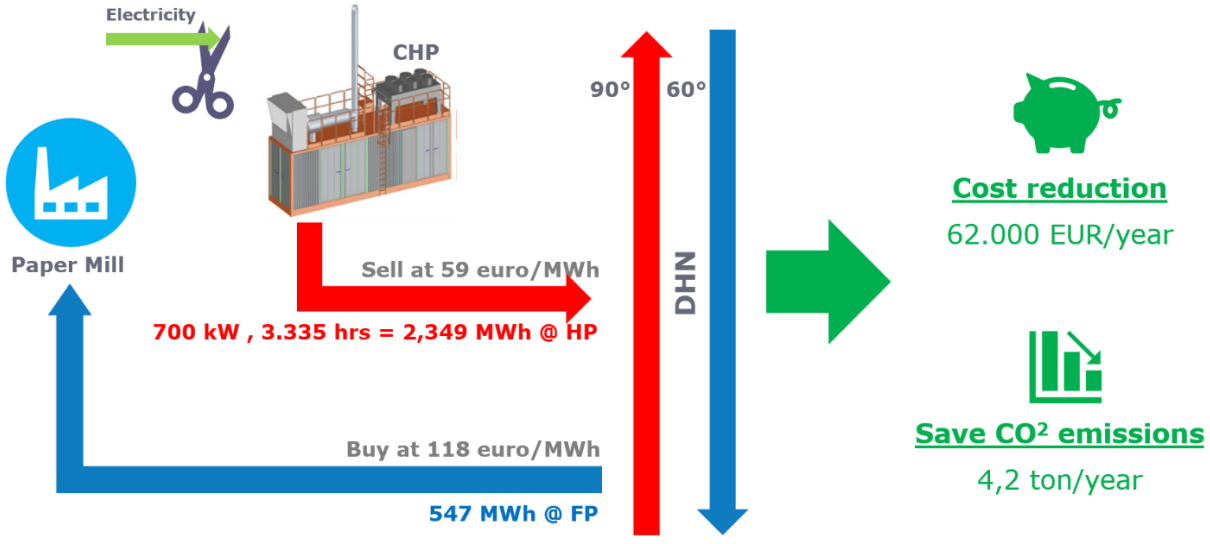
Figure 4: Industrial area mapped thanks to the SA tool

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

Thanks to the Self-Assessment tool, we discovered that this Paper Mill had a Cogenerator Plant (CHP) that produced **2,349 MWh of hot water** during the paper production but just a small part of this - **547 MWh** - was used in the production, so most part was wasted in the environment in the form of steam.

Figure 5: CAMA Papermill and Cogenerator Plant (CHP)

So we presented this potential use case to the multiutility A2A Calore & Servizi (DHN owner) that, after several meetings, took the opportunity and started a feasibility study about the connection of their paper mill to the new DH network.
With this idea in mind, to connect the papermill with the new DHN, the company will **sell the hot water produced at 90°**, equal to 2,349 MWh (700 kW x 3.335 hrs), at **59 euro/MWh** to the DH utility and will buy back from it just the amount needed for the industrial processes equal to **547 MWh at 60°**.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

Figure 6: Scheme project waste heat use

This scenario brings benefits for both sides in a win-win deal such as:

- A significant **cost reduction of 62.000 euro/year** *(average)* for the paper mill
- A **reduction of CO^2 equal to 4,2 ton/year** *(average)* is beneficial for the area of the Bergamo ecoregion

Papermill MWh		Selling price heat €/MWh	€
Sell	2.349	59	138.562
Buy	547	118	- 64.546
Electricity cost			- 5.786
Total			**68.230**

RISP	2.300	MWh
PCI	9,72	kWh/smc
Metano equiv	236.607	smc
ton CO2	4,56	

CLIENTI AD USO TERZIARIO

DESCRIZIONE	COD. COMMERCIALE	TIPOLOGIA DI PREZZO	CODIFICA MARKETING	UNITA' DI MISURA	PREZZO UNITARIO
Formula Binomia Altri Usi	To02	Binomia, su potenza contrattuale ed energia termica			
		- Quota Energia, per potenza contrattuale fino a 700 kW	C_Bi_Ter_04/2012_CE1	€/kWh$_t$	0,118864
		- Quota Energia, per potenza contrattuale superiore a 700 kW	C_Bi_Ter_04/2012_CE2	€/kWh$_t$	0,116157
		- Quota Potenza, per potenza contrattuale fino a 700 kW	C_Bi_Ter_04/2012_CP1	€/anno/kW$_t$	10,371
		- Quota Potenza, per potenza contrattuale superiore a 700 kW	C_Bi_Ter_04/2012_CP2	€/anno/kW$_t$	12,471

Table 1: table with calculations for Bergamo ecoregion

After this first step, Spinergy and CAMA papermill made a working group by mimicking the project agreement and worked on the legal aspects by using the **Legal Decision Support Tool**. Thanks to its structures and its format, the tool helped them to simulate a hypothetical energy cooperation contract by focusing on legal aspects to be handled when the project would start up.

3.2 Perceived benefits of the tools and next steps

R-ACES tools have been extremely important to realize the ecoregion. In Italy, and specifically in the Bergamo area, the main obstacle in starting energy cooperation projects is the lack of mutual trust and knowledge among companies belonging to the same business park.

The **Self-Assessment tool** served to overcome this barrier and enabled companies to learn about the energy potential of their neighbors.

Finally, the **Legal Decision Support Tool** has received a lot of positive feedback from companies and ESCOs as it allows, in a simple and intuitive way, to make a draft legal agreement between two or more companies interested in an energy cooperation project. Indeed, in Italy one of the biggest obstacles in implementing energy cooperation projects was the complexity of making legal agreements. With the Legal Decision Support Tool,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

ESCOs and companies in Bergamo saw how a single tool was able to adapt to various cooperation projects with different energy flows, which was not possible before. Each project had its own specific legal agreement, which was time-consuming.
In the future, and when the project is established, the **Energy Management Tool** (EMP) will also be used in the ecoregion, which is essential for managing the heat exchange between the CAMA paper mill and the district heating network owned by A2A Calore & Servizi. Moreover, the EMP may be implemented in the future: from the feedback received in Bergamo from the companies involved in the project, we understood that there is also a need for a financial tool that can help calculate, besides the amounts of energy streams exchanged, the relative costs of energy.

4 Assessment of the short-term and long-term impact of the developed energy cooperation projects

4.1 Impact in relation to the KPIs

The KPIs required by the project served as a guideline with respect to the targets to be achieved in the ecoregion. Following the KPIs, the work carried out in Bergamo was articulated. In addition to the strictly operational phase related to the industrial symbiosis project of the CAMA paper mill a mix of different activities was initiated such as meetings, working groups with companies, tools testing, serious games and events. This diversity in actions was also made possible by close collaboration with Dissemination (WP5) and Communication (WP6) partners.

Below is a summary of the **KPIs of the Bergamo ecoregion**. For convenience and clarity of data, it was decided to differentiate between what we **achieved** (factual data) and **estimations** (has an uncertainty).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

KPI	Description	Goal
KPI 1	Primary **energy savings** triggered by the project (in PJ/a)	Achieved: - Estimations: **0,00828**
KPI 2	**Investments in sustainable energy** triggered by the project (in Euro).	Achieved: - Estimations: **90.000**
KPI 3	Actors that commit to energy cooperation (**industrial sites, business parks, DHCs, High priority regions**)	Achieved: **16** Estimations: -
KPI 4	Number of **relevant stakeholders** (e.g. ESCOs, industrial park managers) aware of and/or interested in/ implementing joint energy services.	Achieved: **29** Estimations: -
KPI 5	Number of **policies and legal frameworks** created and/ or adapted to facilitate energy cooperation among businesses.	Achieved: - Estimations: **3**
KPI 6	Reduction of the **greenhouse gas emissions** (measured in $MtCO^2eq$)	Achieved: - Estimations: **4,56**

Table 2: Bergamo KPIs

Explanation from estimations:

KPI 1: As shown in table 1, the Bergamo project will result in energy savings of approx. 2300 MWh. To transform MWh into PJ/a, we used a standard conversion factor of **1MWh = 0.0000036 PJ/a**, and the **final result is 0,0028 PJ/a**

KPI 2: The paper mill's cogenerator plant (CHP) is about **180 mt** away from the new A2A district heating network. During the feasibility study, Enertech Solutions estimated that the investment to connect the papermill to the district heating network will be about **90,000 euros**.

KPI 6: As shown in the table of calculations in Table 1, the paper mill project will lead to a reduction of MtCO2eq equal to 4.56.
Since the heat produced by the paper mill comes from natural gas, we found the amount of MtCO2eq based on the **existing conversion table** showing how many tonnes of CO2 are consumed per MWh produced from natural gas.
We then multiplied the heat saved by the project **2,300 MWh** ("RISP" in Table 1) **X 1.983** (the existing conversion factor used to transform MWh produced from natural gas into tonnes of CO2 produced) the result, therefore, leads to **4.56 MtCO2eq**.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

5 Conclusion & success stories

From these few lines, one can already understand how much the R-ACES project, and its methodology applied to the Bergamo context, has played a fundamental role for the stakeholders of the ecoregion in order to develop in them the awareness and benefits that energy cooperation plays in their business.

As mentioned earlier, one of the big problems in the Bergamo area (and in general in the Italian territory populated largely by SMEs) in terms of developing energy cooperation projects, lies mainly in the lack of knowledge with respect to their own energy potential combined with the lack of trust that the individual SME has towards their neighbor.

In fact, during the Self-Assessment Tool phase with the selected companies, we realized how little the individual SMEs knew about their energy potential in terms of energy consumed and possible energy wasted.
The R-ACES project, combined with a constant presence of partners on the ground capable of providing support and assistance, allowed individual entrepreneurs to unlock their energy vision and open up to potential energy cooperation projects.

In fact, we found that, following the presentation on the results achieved in the assessment and the energy potential of their neighbors, SMEs very positively welcomed the idea of investing in industrial symbiosis projects.

The emblematic case of the CAMA Paper Mill and A2A Calore & Servizi is a concrete example. The network created around the project and composed of Clusters, ESCOs, companies, and industrial associations has created a concrete use case that we hope will be replicated in the ecoregion and serve as an example to be emulated in other industrial areas.

The R-ACES toolkits have had and will have a positive impact on the entire Bergamo ecoregion. In particular, the EMP, if implemented with the cost management function, can represent an added value for both energy cooperation projects and new energy communities where it is crucial to managing the different energy flows and the cost factor related to energy exchange.

R-ACES is (and will be) an enabler of knowledge and awareness of energy cooperation, capable of unlocking the energy potential of enterprises.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

6 References

APA Format Citation Guide:
https://www.mendeley.com/guides/apa-citation-guide

Core Components of an APA Reference:
Author's surname, initial (s). (Date Published). Title of source. Publisher Location: publisher. Retrieved from URL

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

7 Annexes

Annex 01

R-ACES definitions

Project Glossary

Definition of Key Concepts in the R-ACES project

Business park:An area of land in which many office buildings are grouped together with a common infrastructure (Wikipedia). Business parks, like industrial sites, often have similarities in heating and cooling demand. Certain businesses may even have residual energy streams, for example data centers. As such, business parks may also organize as an ecosystem or eco business park (EBP) and become an important stakeholder within an ecoregion.

Eco Business Park:*"An eco-industrial park is a community of businesses located on a common property in which businesses seek to achieve enhanced environmental, economic and social performance through collaboration in managing environmental and resource issues. This is known as industrial symbiosis, which is a means by which companies can gain a competitive advantage through the physical exchange of materials, energy, water and by-products, thereby fostering inclusive and sustainable development."* (United Nations Industrial Development Organization)

Communicate:professional and public coverage of the project results and achievements, benefits and potential deployment. This will be realised via the adoption of a large variety of distribution channels, including already existing platforms focusing on energy cooperation in industrial sites and business parks and energy exchange/cooperation at large.

Disseminate:exploitation of the project results to relevant stakeholders in the regions. It intends to ensure a low threshold in accessibility, usage of R-ACES tools and methods. This includes access to the tools, to the use case libraries and to the training and capacity building material and related self-explanatory instruction manuals.

DHC:Abbreviation of District Heating and Cooling. A system for distributing heating/cooling generated in a centralized location through a system of insulated pipes for residential and commercial heating requirements such as space heating/cooling and water heating/cooling.

> 4th generation DHCs:*"4GDH systems provide the heat supply of low-energy buildings with low grid losses in a way in which the use of low-temperature heat sources is integrated with the operation of smart thermal grids. Smart thermal grids consist of a network of pipes connecting the buildings in a neighbourhood, town centre or whole city, so that they can be served from centralised plants as well as from a number of distributed heating and cooling producing units (or decentralised units) including individual contributions from the connected buildings. The concept of smart thermal grids can be regarded as being parallel to smart electricity grids. Both concepts focus on the integration and efficient use of potential future renewable energy sources as well as the operation of a grid structure allowing for*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

distributed generation which may involve interaction with consumers." (adapted from Lund et al, Energy 68; 2014, p1-11).

5th generation DHCs: *"5GDHC is a highly optimized, demand-driven, self-regulating, energy management system for urban areas. Its key features are: 1) ultra-low temperature grid with decentralized energy plants; 2) closed thermal energy loops ensuring hot and cold exchange within and among buildings; 3) integration of thermal and electricity grids."* (D2grids, Interreg NWE)

Ecoregion: An ecoregion within the R-ACES project is a geographic area where energy and information exchanges occur between stakeholders of various types to reduce energy consumption. Geographical size does not matter (the size of an ecoregion can be as small as a business park or as large as a city). Important is that an ecoregion relies on an anchor organization responsible for managing the area (for example park management). Another aspect is the proximity of stakeholders to ensure interconnected energy flows (continuity of supply, quality of supply, quantity). Within an ecoregion, a wide range of assets could be involved: office parks, data centers, multimodal centers, technological centers, agro-centers, science parks, brain parks, lighthouse parks, chemical parks, eco-industrial parks, and cluster/business parks. For the demand of heat, also residential areas could be taken into account. As such, the term ecoregion functions as an 'umbrella term'.

Example of a high priority/ high impact ecoregion

An example of a high priority/high impact ecoregion is the Groot-Rijnmond region in the Netherlands. According to the Heat RoadMap the region belongs to priority group 1. The conventional excess heat is 179.65 PJ and the total heat demand is 35.53. Demand and supply are located close to each other. This means that the region has a high potential impact on primary energy savings (KPI 1). A main anchor organization of the region is 'The port of Rotterdam'. Within the region, there are 28 industrial sites that produce excess heat. There is also a large number of business parks (50+). Considering the large number of industrial sites and business parks present, the region also has a high potential impact on KPI 3.

High priority region: A high priority region is an Ecoregion, as defined above, that has balanced potential match of heating/cooling supply and heating/cooling demand in both quantitative (amount of heating/cooling) and qualitative (temperature, form of heat) terms. The region should be identified by heat roadmap studies (for example, the Heat RoadMap Europe or Stratego) or other research activities. In addition, the regions should have networking possibilities. The regions can include industrial sites, business parks and residential areas.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

The table below gives an indication of the priorities. R-ACES will focus on priority group 1 +2.

Table 2.19. Excess heat ($E_{heat,o}$) and heat demand (Q_{tot}) characteristics for the definition of priority groups to identify heat synergy regions

	Characteristics			
Priority group	**Excess heat[a] [PJ/a]**	**Heat demand[b] [PJ/a]**	**Priority status**	**Comment**
1	$\Sigma E_{heat,o} > 10$	$Q_{tot} > 10$	Very high	High levels of both $E_{heat,o}$ and Q_{tot}
2	$1 < \Sigma E_{heat,o} < 10$	$Q_{tot} > 10$	High	Moderate levels of $E_{heat,o}$ and high Q_{tot}
3	$\Sigma E_{heat,o} > 10$	$1 < Q_{tot} < 10$	Moderate	High $E_{heat,o}$ and moderate levels of Q_{tot}
4	$1 < \Sigma E_{heat,o} < 10$	$1 < Q_{tot} < 10$	Low	Both $E_{heat,o}$ and Q_{tot} at moderate levels
0	$\Sigma E_{heat,o,max} < 2.5$	$Q_{tot,max} < 25$	No priority	Both $E_{heat,o}$ and Q_{tot} at low levels

[a] Maximal theoretical levels of annually available excess heat.
[b] Space heating and domestic hot water preparation in residential and service sectors.

High potential region: Within the project proposal, sometimes the term high potential ecoregion is mentioned. From now on, this term will not be used within the scope of the R-ACES project.

High impact (in R-ACES terms): Regions that have a high potential impact on the R-ACES KPIs. More specifically, regions are meant that have a high potential impact on KPI 1: Primary energy savings, and KPI 3: Number of plant sites and number of industrial parks where businesses commit to energy cooperation.

Energy cooperation:Energy cooperation activities between industries, which include physical clustering (e.g., of buildings and processes, energy exchange, collective production) and/ or service clustering (e.g., joint contracting). Both can deliver a more stable cumulative demand, economy of scale for larger installations with higher efficiencies and smaller spatial footprint and an optimized demand response. Within R-ACES, the focus is mainly on energy cooperation through the exchange of heating and cooling.

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.

ESCO: Abbreviation for Energy Service Company. An ESCO is a business that provides a broad range of energy solutions including designs and implementation of energy savings projects, retrofitting, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management.

Facilitator: someone who helps to bring about an outcome (such as learning, productivity, or communication) by providing indirect or unobtrusive assistance, guidance, or supervision. This task does not include technical expert know-how, instead facilitators are trained to facilitate interaction between multiple actors.

Industrial cluster: Within the project proposal, sometimes the term Industrial cluster is used. From now on, this term will not be used within the scope of the R-ACES project.

Industrial park: Within the project proposal, sometimes the term Industrial park is used. From now on, this term will not be used within the scope of the R-ACES project.

Industrial region: Within the project proposal, sometimes the term Industrial region is used. From now on, this term will not be used within the scope of the R-ACES project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

Industrial site: An area zoned and planned for the purpose of industrial development. An industrial site can be thought of as a more "heavyweight" version of a business park or office park, which has offices and light industry, rather than heavy industry. They may contain oil refineries, ports, warehouses, distribution centres, factories, and companies that provide manufacturing, transportation, and storage facilities, such as chemical plants, airports, and beverage manufacturers (Wikipedia).

(R-ACES) Learning community: Local group of stakeholders that are (a) directly involved with the energy collaboration on a site; and (b) engaging in both organised and informal exchange of knowledge and best practices over the course of the project period. These groups are the first beneficiaries of instruments like serious gaming. Learning communities from different sites in this project will eventually be brought into contact with each other to further stimulate the exchange of best practices.

Learning network: *"Allow for enduring relationships built on trust to develop among companies within an industrial site. In turn these relationships encourage information sharing, creative solutions, long term planning and governance among stakeholders. Social aspects increase interactions among stakeholders and strengthen collaborations and partnerships including industrial ones"* (Scaler, 2018). To establish such learning networks, the R-ACES project will use learning communities.

(R-ACES) Legal support tool: 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. For practical reasons, the name of the legal tool might change during the R-ACES process. In this case, the consortium will be informed.

LESTS framework: Abbreviation for Legal, Economic, Spatial, Technical and Social/Managerial. LESTS is a framework that is used in the project to categorize barriers and drivers in ecoregions. The different categories include:Legal, e.g. liabilities, regulatory requirements, third party contracts, service agreements, rules; Economic, e.g. cost savings, waste/ resource recovery value, funding mechanism, taxes & environmental considerations; Spatial, including geographical proximity, planning rules and environmental considerations; Technical, e.g. sharing and cascading resources, system stability, facilities; Social/Managerial, e.g. with regard to workers, consumers, local communities employment, community engagement, and capacity building.

Lock-in: Exchange of by-products will lead to long term reliance on an outside company, which will restrict flexibility of the involved companies and possibility for innovation, or possibility to relocate the site.

Longlist (for example longlist of regions): Exists of lists of items (rows), for example regions, that have been selected on the basis of loose selection criteria (columns). The long list is a first step in creating a short list. The long list should cover all potential subjects that might be of interest to the short list. Example:

Region	Region	Country	Source	# DHCS	# Industrial sites	# Business parks	Contact person	Contact details
1	Maasvlakt	Nederland	...					
2	Chemelot	Nederland	...					
3	Terneuzen	Nederland	...					

Long-term: Long-term impact of R-ACES is gained after the end of the R-ACES project (in KPI terms).

Peer2peer: A network of peers (R-ACES stakeholders) that perceive each other as equal. The peers interact with each other in order to learn from each other. The peer2peer learning context is a formal or informal setting, in small groups or online. Pear learning

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

manifests aspects of self-organization. By this is meant, that there is no hierarchical structure within a peer2peer network (Wikipedia).

(R-ACES) Self-assessment tool: A tool that helps ecoregions to determine the next 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.

Serious gaming: A method for learning-through-experience that presents participants with a case study in which they have to play pre-assigned roles to each reach a pre-defined objective as quickly as possible. The interactive & competitive gaming element increases the attractiveness and the learning outcome of the case study. Serious gaming addresses cooperation elements among a large variety of practitioners and focus at creating acceptance and awareness, where the learning communities focus at sharing experiences between peers.

Shortlist (for example shortlist of regions): List of items, for example regions, that have been selected from a long list on the basis of (strict) selection criteria. Hereby, the advantages and disadvantages of each item are considered (OpenLearn). The shortlist contains items that have a high potential and likelihood to contribute to the R-ACES goal.

Short-term: Short-term impact of R-ACES is gained during the R-ACES project.

Use case: A written description of the sequence of steps performed by an ecoregion to come to fruitful energy cooperation.

Use case library: A library that contains multiple use cases.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°892429

This project has received funding from the European Union's Horizon 2020
research and innovation programme under grant agreement N°892429