PRESI
Pathways to Resource Efficiency in Santa Cruz Industries

Clean · Kalundborg SYMBIOSIS · Viegand Maagøe · Governo do Estado Rio de Janeiro · GreeNova Hub · Danish Energy Agency

Industrial Symbiosis – Public Version

Screening Report

Conducted by Viegand Maagøe & Kalundborg Symbiosis in collaboration with AEDIN

Santa Cruz Industrial district, Brazil

Funded by: Danish Energy Agency

Content

Background

PRESI
Pathways to Resource Efficiency in Santa Cruz Industries

The project "Pathways to Resource Efficiency in Santa Cruz Industries" (PRESI) aims to help industrial stakeholders in the AEDIN industrial cluster find value in waste streams by creating new partnerships and opportunities.

The main activities in the PRESI project involve providing training and capacity-building activities on industrial symbiosis for members of the AEDIN Industrial Cluster, the State of Rio de Janeiro, and other relevant stakeholders in Rio de Janeiro.

The primary focus of the capacity building in AEDIN companies is to gain knowledge on industrial symbiosis screenings for reducing energy and resource consumption, as well as exploring shared symbiosis projects such as shared wastewater treatment.

The capacity building will be conducted through peer-to-peer training sessions during screenings of selected companies in the industrial area, aimed at strengthening technical competencies related to industrial symbiosis.

The PRESI-project is funded by the Danish Energy Agency

Purpose

This report introduces the concept of Industrial Symbiosis and screening of optimization potentials inside and between production facilities. Furthermore, it describes screening activities performed and derived results and potentials of three selected sites, identified during condensed on-site screening sessions, performed in the AEDIN cluster in Santa Cruz during a 3 days audit in May 2024

The purpose of the screening and mapping work is to uncover the potentials for symbiosis collaborations between companies in the AEDIN Cluster. Mapping is essential to estimate the potential of exploring industrial symbiosis.

The screening covered:

- screening of the process in the company’s production
- discussion

As a result, a review of the company's consumption of materials, water, and energy has been formulated, to get an overview of future potentials for efficiency and cooperation, within the company or together with surrounding companies.

Format of the screenings

The screenings was conducted by Kalundborg Symbiosis, experts in industrial symbiosis cooperation, and Viegand Maagøe, experts in energy efficiency and industrial symbiosis, see further description of the companies next slide.

The screenings included a review of the company's consumption of materials, water, and energy fort an overview of future potentials, for efficiency, and for cooperation, within the company or together with surrounding companies. This is, for example, how residual fractions can be utilized in collaboration with other companies, so that greater circularity and less use of 'new' materials or resources are achieved.

Production manager and/or other relevant employees from the company participate in the idea development with employees from Viegand Maagøe and the Kalundborg Symbiosis.

The screening report for each company will be delivered to the company.
This report covering the screenings on all companies including an overview of potential cooperation projects will be delivered to the AEDIN Cluster. This information will be used in the future facilitating work in the partnership.

The auditor team

Bjørn Skjødt Sørensen, Senior Project Manager, Viegand Maagøe

Bjørn Skjødt Sørensen is an energy efficiency expert and senior project manager at Viegand Maagøe with extensive international experience. As a project manager and technical expert, Bjørn works as a consultant on a wide range of projects, with primary focus on energy optimization in industrial production processes, reducing energy consumption, climate impact and utilization of surplus heat.

In Denmark and internationally Bjørn has performed detailed energy reviews for a range of industrial plants, especially within the food and beverage industry. Often reviews are followed up with detailed project business cases, preparation of technical project tender material and eventually project implementation management.

Bjørn has in-depth knowledge on energy audits, the ISO 50001 Energy Management System, and has been deeply involved in implementing EMS at a range of production sites in the food, dairy, agriculture, plastics and oil processing industry from screening through to final certification.

Furthermore, he has been involved in integration of decentralized industrial waste heat sources from different processes into a centralized district heating system from several different industries, as a consultant, facilitator and trusted partner between private companies and public district heating networks.

Viegand Maagøe (VM) is a Danish consultancy in the front line of sustainability. The company was established in 2006 with core competences within engineering on energy efficiency, supplemented by advice on strategically and operationally areas within, sustainability, climate, environment, social sustainability and governance. VM has huge experience on working with private and public partners in Denmark, Mexico, US etc.

The auditor team

Per Møller, Senior Symbiosis Developer, Kalundborg Symbiosis

Per Møller has +14 years of experience in management, facilitation and development of Industrial and Urban Symbiosis, along with experiences within public and private RTD, pharmaceutical and nutraceutical organizations and as a consultant and company owner. Through his work he has developed and specialization within facilitation of PPPs and PPI.

Per works internationally to support system export of the IS concept and related technologies and governance models. As part of this he has developed international experience also within the exercise of performing on-side screenings of production facilities. He is co-founder og the Nordic Network of Urban- and Industrial, European Community of Practitioners (ECoP) and Symbiosis Network Denmark (SND), and works to support European initiatives via his engagement in ASPIRE and Process4Planet.

Kalundborg Symbiosis, a non-profit association, is a world leading industrial symbiosis with 50 years of experience in generating surplus through a circular approach to production. Kalundborg Symbiosis focuses on how companies, through collaboration, can benefit economically and sustainably, and at the same time cause benefits for the local community. We work across the entire value chain. This includes energy and material optimization within individual companies, the flows between companies, strategies, and large future-oriented solutions that are ambitious and groundbreaking.

Introduction · The concept of Industrial Symbiosis

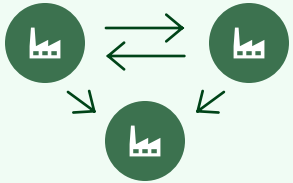
The fundamental concept behind Industrial Symbiosis involves the exchange of materials, energy, and water among two or more companies, effectively transforming waste into valuable resources.

Industrial symbiotic relationships are commonly established in close geographical proximity and may manifest as larger collaborative projects with shared funding.

6 reasons for Industrial Symbiosis:

- Financial savings
- Increased sustainability performance
- Higher productivity efficiency
- Resource reduction – cutting waste & raw material usage
- Better company reputation
- Community strengthening impact

Waste becomes ressource



The concept of Screening

The IS screening methodology can be divided into two parts; a pre-screening part and an on-site screening part. Together they make up the screening approach for new emerging IS initiatives or industrial parks and hubs where there has not previously been IS activities.

Once the pre-screening part has been performed it should be followed up with the detailed onsite screenings performed within individual production organizations and their facilities.

Onsite screenings can be performed directly and without the pre-screening, but without the combined approach of having both a pre-screening and an onsite screening, it often results in internal optimization only of the company in question and not in additional IS synergies. On-site screenings of minimum 3 relevant production sites from the same relevant area should be performed, to be able to identify and realize any IS potentials.

The concept of Screening

Pre-screening

The pre-screening is focused on collecting information and data describing the industrial area, available infrastructure, companies and general information about these, i.e. information and data that does not rely on a direct contact to individual organisations or their production sites, but information that is readily available. For that same reason, this first approach is sometimes referred to as a “desk-top” screening. Sources of information includes homepages, databases, GIS/maps/satellite imagery, reports, obligatory reporting schemes, utilities, business organizations etc.

Selection criteria – Industrial areas

The pre-screening approach could be performed with the aim to identify either industrial hubs, as exemplified in *D3 ‘Selection criteria for identification of Industrial clusters (Activity 2)’*, production sites of relevant companies or both in combination.

Examples of relevant selection criteria when identifying relevant industrial hubs or production sites include:

- Existing local business organization willing to co-facilitate IS capacity building
- Existing initiatives bridging to the IS agenda
- Number of production companies
- Representation of companies from different sectors
- Distance between companies
- Existing infrastructure and utilities
- Knowledge institutions and test and demonstration sites
- Local structural challenges related to resource availability, infrastructure or utilities
- Geographical location and proximity to other industrial hubs

The concept of Screening

On-site screening (1)

Following the pre-screening activity, where a specific area is selected, the more in-depth on-site technical assessment of the most promising production facilities is carried out, referred to as on-site screenings.
On-site screenings significantly benefit from participation of a broader representation of companies from the area during each individual screening.

Prior to the on-site exercise, initial contact to individual companies and their production facilities must be made to onboard and align expectations and outcomes from such an exercise.

The company representatives and relevant staff need to understand the value that this “interference” in their daily routines can bring to them and their business.

The screening agents therefore need to very clearly communicate the value proposition that this represents, the requirements that needs to be met to get the most value out of the site-visit, and they must ensure that the relevant staff members are available during the screening activities.
Therefore, onboarding, agreements and preparations are equally as important as the actual on-site screening exercise.

The on-site activities are typically planned according to a structured agenda where the first points are a round-table presentation of participants followed by a collective preparation meeting, where company and the initial knowledge from the pre-screening is presented.

The concept of Screening

On-site screening (2)

Basic information of the company will already have been collected during the pre-screening or prior to the meeting, but apart from accessing additional information, this serves the purpose of getting the company staff involved in the dialogue from the beginning and for them to proudly present what they do and represent. Beneficially, a Q&A session can be arranged as relevant issues and more detailed information can be shared and discussed, which will create a solid foundation for the rest of the meeting.

The detailed information should be requested prior to the meeting and should also include a more detailed outline and drawings of the resource and production flows (see section 4.4).
At this stage, specific numbers are not likely to be shared and typically it is beneficial not to request information at this level of detail until after the meeting, once trust has been built between participants.

The physical screening is performed as an on-site walkthrough of the facilities accompanied by relevant personnel, focussing on both process and utility areas.

The concept of Screening

On-site screening (3)

The audit team must have the necessary knowledge and technical expertise, and since this covers several resource streams and a variety of processes, the audit team should preferably be arranged to cover this as broadly as possible.

During the walkthrough, the audit team can ask more detailed and technical questions, which possibly cannot be answered by the company staff, and a follow up dialogue may therefore be needed. This dialogue is typically arranged as part of the follow-up meeting immediately after the walkthrough.

Issues that cannot be resolved during this meeting, can be addressed in a follow-up dialogue after on-site screening in the process of writing up the screening report.

The on-site screening should follow the Onion diagram approach, focussing on an optimised baseline internally before determining the residual resources in a Resource Mapping Model. Once the residual resources have been mapped in a resource model, this information should be made available for external companies, thereby creating symbiosis-based business models.

The concept of Screening

On-site screening (4)

To ensure that identified opportunities are further prioritized and investigated, it is highly recommended to use an Action matrix, a simple matrix that outlines the primary identified opportunities, which should be listed as individual projects with relevant information for evaluating the potential of each, including:

- Person(s) responsible in organization/company
- Relevant external stakeholders and technology providers
- Prioritization between optimization actions if more than one are available

The prioritization should include both actions needed for potential internal optimization and for synergies with external stakeholders and organizations (symbiosis projects).

The concept of Screening

Interview guide for screening activities

The following interview guide was sent to the companies in advance, to be the starting point for the symbiosis screening on site.

1. What are the main resources going into the company (water, energy, raw materials). If possible, the volume of these flows, as well as seasonal variation over the year.
2. Which kind of energy does the company / industry primarily use? How big is the consumption?
3. Does the company produce surplus heat, and if so, how much? Is there seasonal variation?
4. Does the company need cooling? Quantity?
5. Name the most important residual streams by volume or expenses for getting rid of it, e.g. residual chemicals, cardboard, or wastewater from the company.
6. What are your needs for infrastructure for supply on power, water, cooling, or heating?
7. Which resources could be provided for you from your neighbor companies? Do you have residues that could be relevant for your neighbors?
   Have you previously had a dialogue with other local partners on resource collaborations?
8. How do you expect your business to have changed in 10 years? Will you still produce the same and use the same inputs for your production, or do you expect major changes in your energy and resource flows?

The concept of Screening

Purpose of on-site tours

Establish a deeper overview

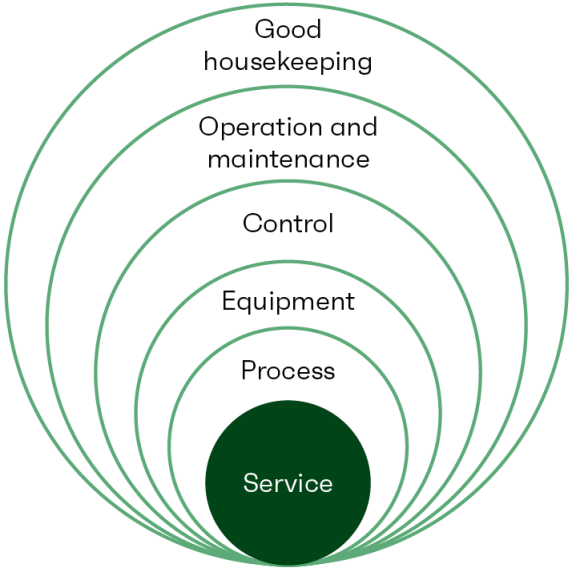
- Get a good overview of the process
- Create a more detailed process flow diagram (block diagram)
- Clarify primary energy and resource streams for each activity
- Consider opportunities for optimized baseline and saving opportunities
- Ask a lot of questions!

The concept of Screening

The ”Onion” Diagram Principle

An inside-out approach to establish an optimized baseline!

- Every usage of resources (”service”) in a facility has a reason – and this reason has to be understood, challenged and finally changed – by the right people
- Optimizing the ”service” changes the need for resources – materials, water, heating, electricity etc.
- The approach might also be called ”inside-out” – much more cost-efficient solutions are identified when the correct ”baseline” is identified
- To identify this ”baseline”, mapping is an important tool
- This approach should be applied before exploring any symbiosis potentials



Energy efficiency

”Energy service” vs. ”Energy bill”

Case: drying of products after rinsing using compressed air :

1. ”Energy Service” = removal of water
2. ”Process” = air drying
3. ”Equipment” = air compressors
4. ”Control” = constant speed, 8 bar setpoint
5. ”Operation & maint.” = state of compressors and distribution system
6. ”Good housekeeping” = idle operation, utilization of waste heat etc.

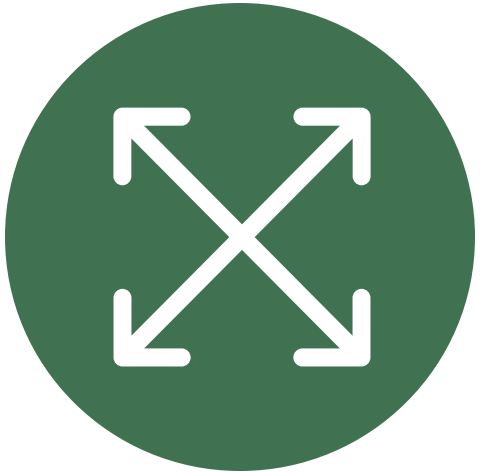
→ **“Chain of losses”**

Energy service **Energy bill**

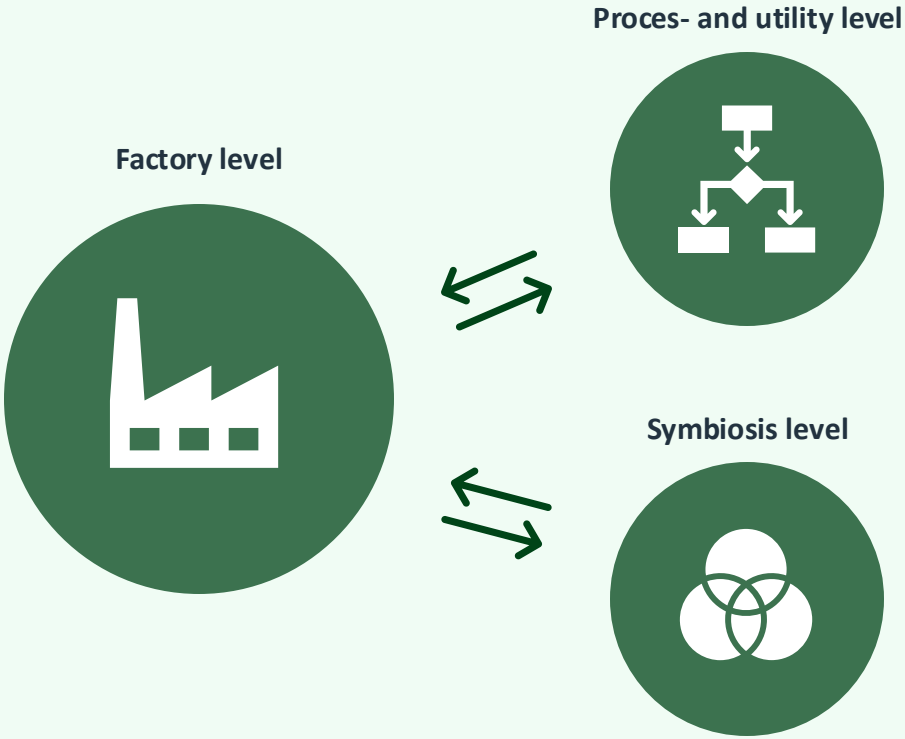
The concept of Screening

Experiences with the inside-out approach

- A powerful approach in many industries
  - Effective on food/beverages, chemicals, pharmaceuticals etc. - more complicated with cement and steel
- If 3 of our 10 good questions are successful we are happy
- At times overall process efficiency is < 5% compared to ideal target!
- In many sectors, deep process understanding represents 80% of energy saving potential
- Energy efficiency needs to build bridge between cultures
  - “White collared” staff and “blue collared” staff to join forces
- The approach is particularly strong when designing new facilities
- The “onion” has been adapted internationally
  - Irish Standard IS393 Energy Efficient Design applies it as mandatory for environmental permits



The mapping process



The mapping process

Approach to mapping

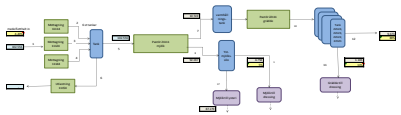
Workflow break down

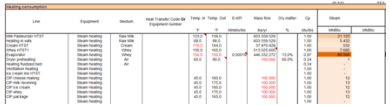
First:

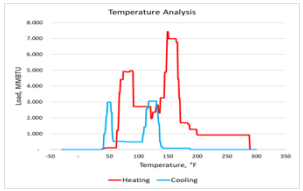
- Create an overview and understanding of the site with relevant personnel
- Establish energy and process flowsheets and diagrams
- Collect data
- Identify end users of energy/resources
- Map consumption
  - By size and end-use (technology)
  - By temperature and volume
  - By time (hour/day/week/year)
- Analyse consumption
  - Identify major processes
  - Determine energy and mass balances
  - Determine efficiency of major plants and processes
  - Perform appropriate analysis
  - Etc.

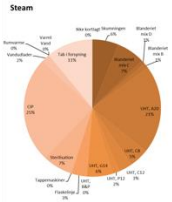
Then:

- Identify business cases for improvements
- Optimize the baseline – projects!
- Identify residual resource streams available for symbiosis





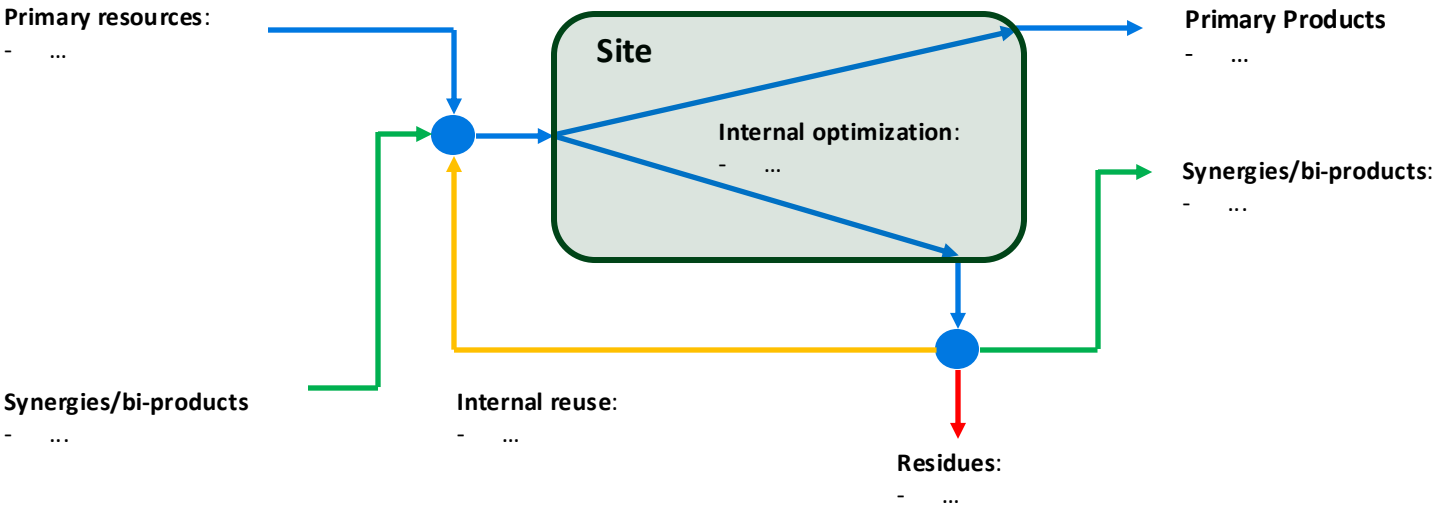




The mapping process

Ressource Mapping Model

Factory level



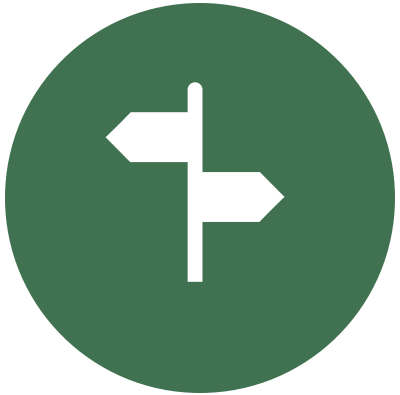
The mapping process

Challenges in Energy Mapping

Energy mapping in industrial settings faces several significant challenges. Firstly, it is a time-consuming process that requires considerable effort to execute thoroughly. Additionally, investing in energy mapping projects often does not yield immediate financial returns, making it less appealing for businesses focused on short-term gains. The process of mapping energy consumption can also be lengthy, delaying potential benefits.

Another major obstacle is the limited functionality and availability of meters, which are typically installed only for billing purposes. This limitation impacts the effectiveness of energy mapping. There is often a high variation in the quality and detail of data collected, affecting the reliability and accuracy of the mapping. The quality of the output from energy mapping heavily depends on the quality of the input data.

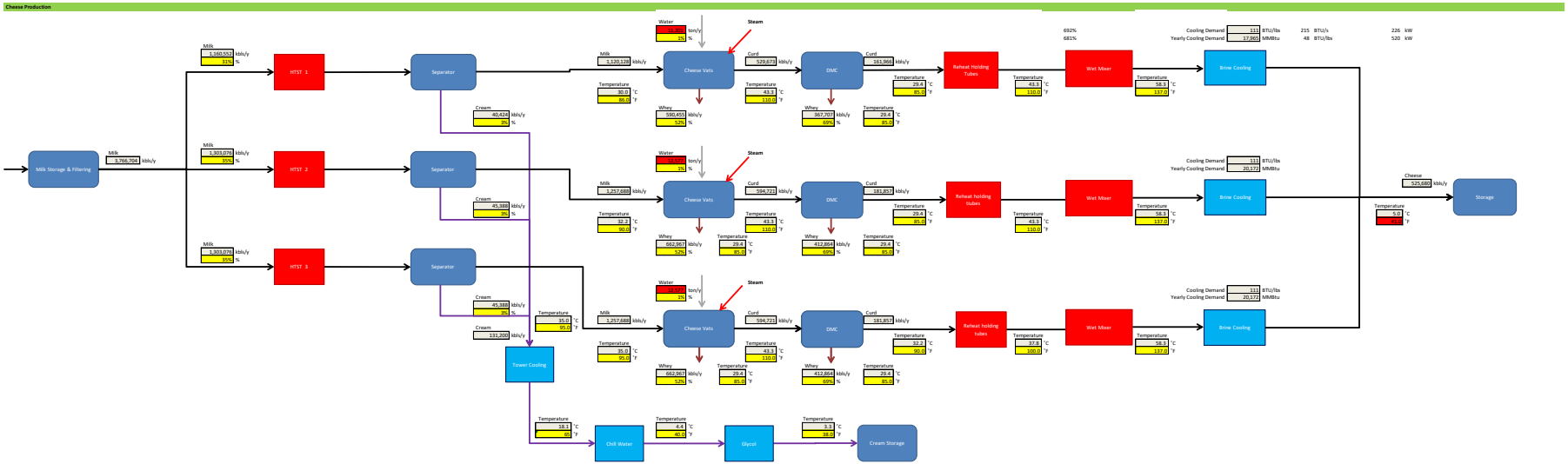
Furthermore, various geographical factors can complicate the energy mapping process, adding another layer of challenge for industrial stakeholders.



The mapping process

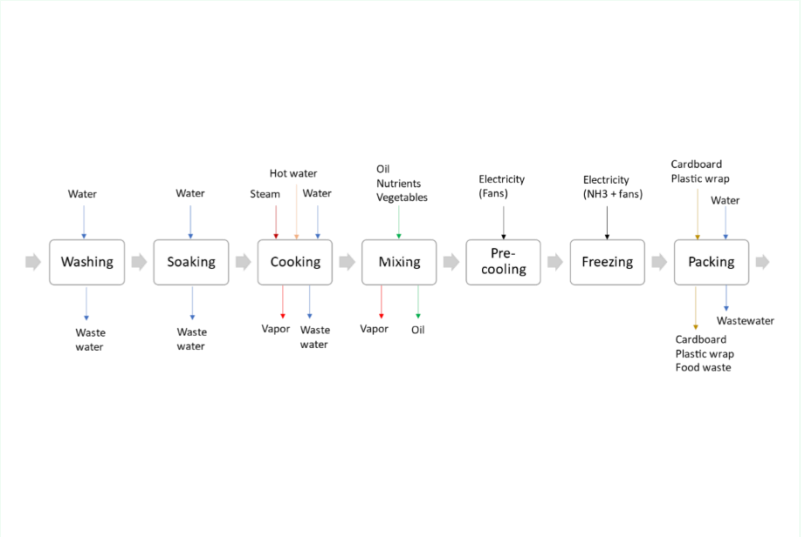
Process Mapping

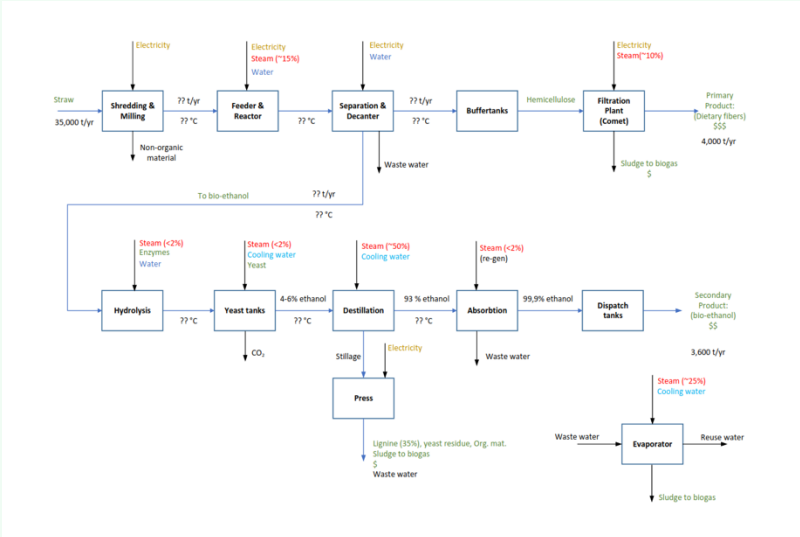
Clarification of mass balances. Getting an overview production flows before ressource consumptions are mapped!



Same exercise can be made for energy, water, materials etc.

Process and resource flow diagram





Simple

Simple process diagram of a production line, indicating each process step and their associated resource flows.

Complex

More complex process diagram, including more production lines and with quantities and qualities of resource flows.

Water efficiency

6'R principle

1. Reduce: Minimize the water consumption at the source
2. Renew: Renew the process with more efficient technology
3. Reuse: Reuse water from one process in another (without cleaning)
4. Recycle: Recirculation of several times in the same process
5. Reclaim: Cleaning of water to a necessary quality for reuse
6. Return: Return water to recipient according to discharge demands

Water efficiency

Water reuse in general · Focus on the “right” quality of water

Where can water be reused?

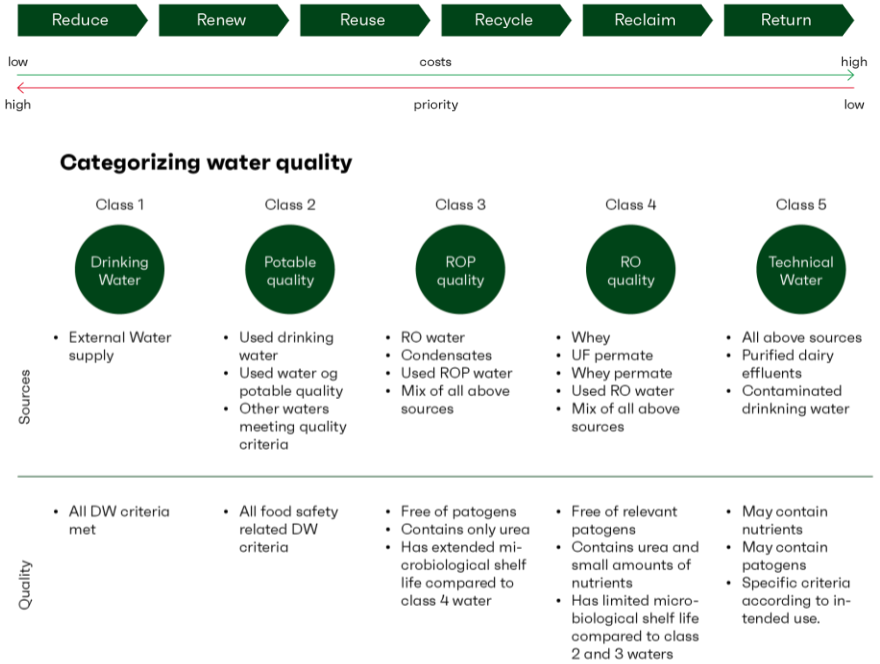
- Process (washing/rinsing)
- Cleaning
- Sanitary use (showers, toilets)
- Utility (cooling towers)
- External users?

How much ”cleaning” is necessary?

- Ultra-/nanofiltration, RO?
- Polishing?
- UV-treatment?

Fit for purpose approach!

Getting the right approvals can be a challenge!



Water efficiency

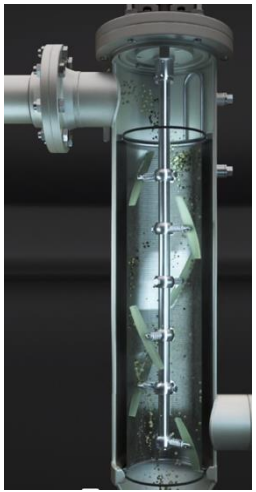
Upgrading water quality

Expensive and advanced filtration solutions are not always necessary

Example of “simple” in-line filter solution

Made in many sizes

- 30 to 2000 µm strainers
- 40 to 8000 gal/min
- Compact solution
- Continuos drainage
- Long service intervals
- Hygienic design
- Low operating cost



Individual screenings

Ternium case

Opersan case

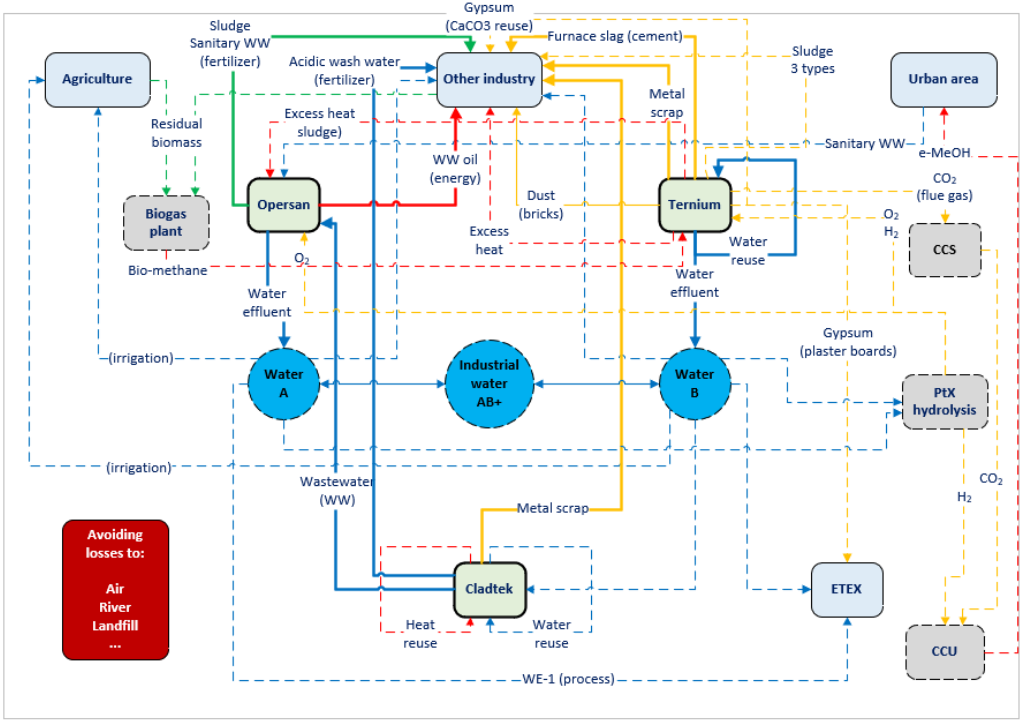
Cladtek case

Screening summary - symbiosis overview

Apart from the internal optimization potentials listed under the individual screenings, the following map summarises existing (solid lines) and potential (dotted lines) synergies identified during the 3 on-site screening.

The three facilities (Opersan, Ternium and Cladtek) are highlighted in ”green”, other present stakeholders present in ”light blue” and suggested future stakeholders that should be attracted to the area in ”grey”. A suggested future water infrastructure in ”dark blue”, was carried into a short workshop session with the AEDIN cluster and a one-pager drafted based on the Kalundborg Symbiosis template.

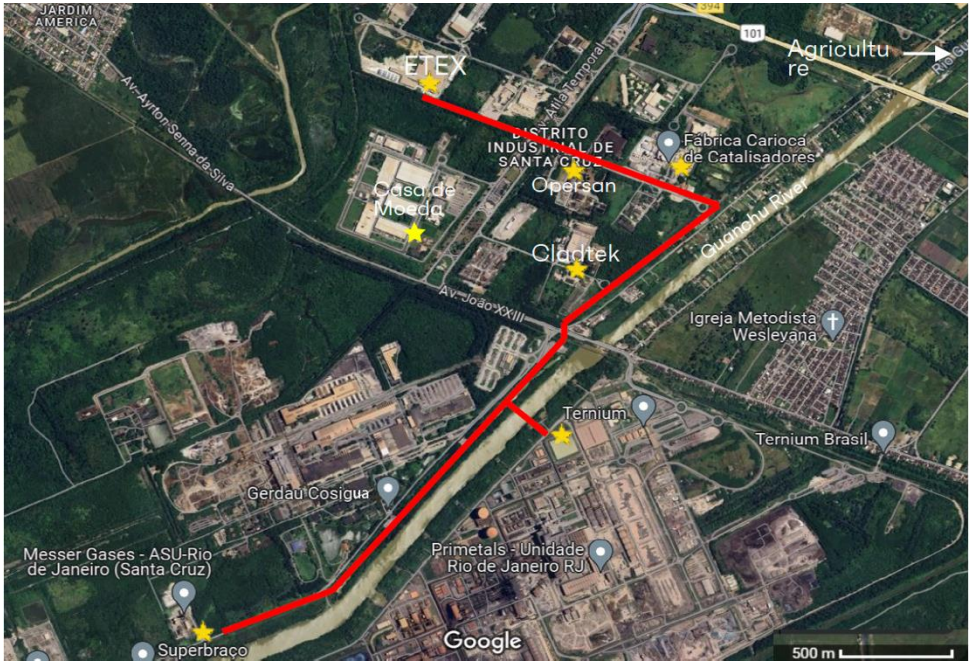
Note: At present, due to matters on confidentiality, no additional information on individual synergies can be shared.



Follow-up activities

On the last day of the 5 day PRESI programme in Rio, May 2024, a follow-up event was held at AEDIN, with the participation of cluster members and other relevant stakeholders, public and private. The purpose was to share insights and outcomes of the activities and to mobilize all relevant stakeholders into next-steps. As part of the event, a short workshop session was held, where an idea of a shared industrial water supply system was presented (as suggested in the symbiosis overview).

Proposed layout of a main pipe to connect the relevant companies, based on the on-site screenings and symbiosis overview



Follow-up activities

Shared industrial water supply system

Based on the three screenings it has become clear that both water consumption and wastewater treatment is a challenge throughout the industrial area of Santa Cruz as well as for the upstream communities.

The main water supply in the area is treated surface water from the nearby Guandu River, but the river also the destination treated effluent from the two wastewater treatment plants visited.

Most companies in the area have significant water needs in the form of process water, evaporative cooling water, sanitary water etc.

By volume, most of the consumed water has sub-potable quality requirements and in many instances this water could be called “technical water”. Technical water is “clean” water with low organic and physical content but has content that does not meet the threshold for potable water.

In use, this water is often not returned from the sites as it is either consumed in the production or is evaporated to the ambient environment.

In Santa Cruz, effluent from wastewater plants is led to the river. The quality requirements to do this are higher than what is typically expected from technical water.

Therefore, a symbiosis potential is identified on technical water.

Follow-up activities

Shared industrial water supply system

In Santa Cruz, most companies have high water consumption of clean but sub-potable quality. Some are consumers, some are producers, and some are both (own wastewater facility).

During the screenings different water uses were discussed and a series of companies were identified who could potentially benefit from connecting to this system.

The result will be reduced water costs for consumers and increased value/reduced treatment cost for producers. At the same time this project could help to secure the supply of fresh drinking water to the local community while improving the environmental impact.

The project is risk-free in terms of production stability as each company will retain the existing water supply as backup.

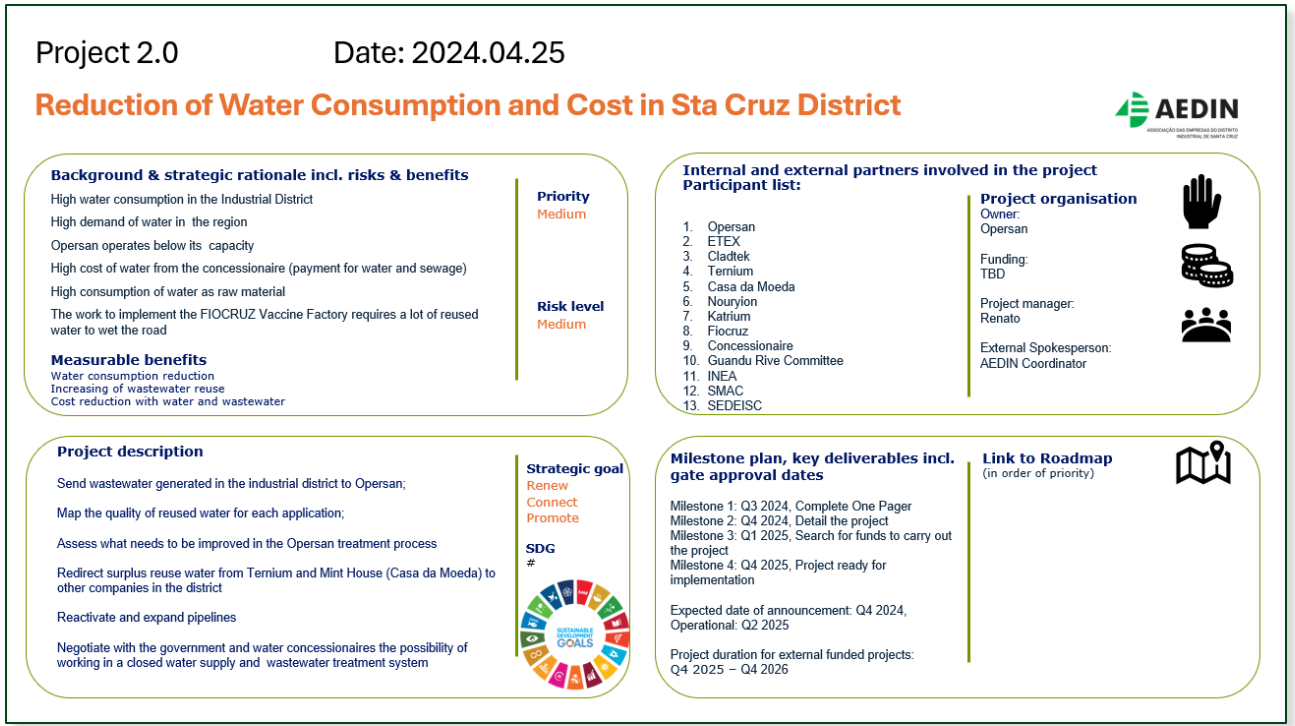
Should there be an excess of water in the system, this could naturally go to irrigation in the local agriculture sector.

Company	Consumer	Producer
Opersan		X
Cladtek	X	
Ternium	X	X
Etex	X	
Carioca de Catalysadores	X	X
Messer	X	
Casa de Moeda	X	X
Nouryon	X	
Katrium	X	
Electrobras	N/A	N/A
…		

Follow-up activities

Shared industrial water supply system

The one-pager produced during the workshop has resulted in the current version with an assigned project organization and the updated project title “Reduction of Water Consumption and Cost in Santa Cruz District “



Project 2.0 Date: 2024.04.25

Reduction of Water Consumption and Cost in Sta Cruz District

AEDIN

Background & strategic rationale incl. risks & benefits

High water consumption in the Industrial District

High demand of water in the region

Opersan operates below its capacity

High cost of water from the concessionaire (payment for water and sewage)

High consumption of water as raw material

The work to implement the FIOCRUZ Vaccine Factory requires a lot of reused water to wet the road

Measurable benefits

Water consumption reduction
Increasing of wastewater reuse
Cost reduction with water and wastewater

Priority
Medium

Risk level
Medium

Internal and external partners involved in the project
Participant list:

1. Opersan
2. ETEX
3. Cladtek
4. Ternium
5. Casa da Moeda
6. Nouryion
7. Katrium
8. Fiocruz
9. Concessionaire
10. Guandu Rive Committee
11. INEA
12. SMAC
13. SEDEISC

Project organisation
Owner:
Opersan

Funding:
TBD

Project manager:
Renato

External Spokesperson:
AEDIN Coordinator

Project description

Send wastewater generated in the industrial district to Opersan;

Map the quality of reused water for each application;

Assess what needs to be improved in the Opersan treatment process

Redirect surplus reuse water from Ternium and Mint House (Casa da Moeda) to other companies in the district

Reactivate and expand pipelines

Negotiate with the government and water concessionaires the possibility of working in a closed water supply and wastewater treatment system

Strategic goal
Renew
Connect
Promote

SDG
#

Milestone plan, key deliverables incl. gate approval dates

Milestone 1: Q3 2024, Complete One Pager
Milestone 2: Q4 2024, Detail the project
Milestone 3: Q1 2025, Search for funds to carry out the project
Milestone 4: Q4 2025, Project ready for implementation

Expected date of announcement: Q4 2024,
Operational: Q2 2025

Project duration for external funded projects:
Q4 2025 – Q4 2026

Link to Roadmap
(in order of priority)

Recommended next-steps

Prior to the final reporting of the PRESI project, a short-list of recommended next-steps is presented below:

- Perform additional on-site screenings to add insights to existing and potential new synergies – update and communicate the Symbiosis Overview map
- Work on existing and new project one-pagers and from this consider to establish relevant working groups with member specialists
- Formulate a joined value proposition for the area and the partnership
- Formulate and establish a shared communication strategy (operating model)
- Communicate identified synergies in simple one-pagers with logos, illustrations/pictures and KPI's (savings)

Note on current progress:

Work on additionally 4 project one-pagers has been initiated with the following titles:

- Organic Waste for Composting - Owner - Vinícius ETEX
- Biomethane / H2 Itabio - Douglas FCC
- NaOH and H2SO4 (arising from new mapping Katrium Chemical Industry) - Renato CM
- FGD Waste - Raíza Ternium