Training Guidebook

Deliverable 9.4

WP9. Dissemination, Training and Showcases

SHIP2FAIR - Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

Grant agreement: 792276
From April 2018 to June 2023

Prepared by: CEA

Date: 10/03/2023

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

DELIVERABLE FACTSHEET

Deliverable no.:	Deliverable 9.4
Responsible Partner:	CEA
WP no. and title:	9. Dissemination, Training and Showcases
Task no. and title:	9.3. Training activities for the agro-food sector
Version:	13
Version Date:	10/03/23

Dissemination level	
X	PU = Public
	PP = Restricted to other programme participants (including the EC)
	RE = Restricted to a group specified by the consortium (including the EC)
	CO = Confidential, only for members of the consortium (including the EC)

Approvals

Author/s	**CEA, CIRCE, RODA, RAR, LARNAUDIE, M&R, BEST, RINA, TVP, IS, EUREC**
Task Leader	CEA
WP Leader	EUREC

DISCLAIMER OF WARRANTIES

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 792276".

This document has been prepared by SHIP2FAIR project partners as an account of work carried out within the framework of the EC-GA contract no. 792276.
Neither the Project Coordinator, nor any signatory party of SHIP2FAIR Project Consortium Agreement, nor any person acting on behalf of any of them:

(a) makes any warranty or representation whatsoever, expressed or implied:

(i). with respect to the use of any information, apparatus, method, process, or similar item disclosed in this document, including merchantability and fitness for a particular purpose, or

(ii). that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or

(iii). that this document is suitable to any particular user's circumstance; or

(b) assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if the Project Coordinator or any representative of a signatory party of the SHIP2FAIR Project Consortium Agreement has been informed of the possibility of such damages) resulting from your selection or use of this document or any information, apparatus, method, process, or similar item disclosed in this document.

ABREVIATIONS

SHIP: Solar Heat for Industrial Processes

PARTNERS SHORT NAMES

CIRCE: FUNDACIÓN CIRCE CENTRO DE INVESTIGACIÓN DE RECURSOS Y CONSUMOS ENERGÉTICOS
RINA-C: RINA Consulting S.p.A.
CEA: Commissariat à l'énergie atomique et aux énergies alternatives
LINKS: Links Fundation
SOLID: S.O.L.I.D. Gesellschaft für Solarinstallation und Design mbh
TVP: TVP Solar
IS: Industrial Solar GmbH
BEST: Bioenergy 2020+ GmbH
M&R: Martini & Rossi S.p.A.
RODA: Bodegas Roda S.A.
RAR: RAR – Refinarias de Açúcar Reunidas S.A.
ABC: ABC Industrie SAS
EDF: Electricité de France
EUREC: EUREC EESV
SPANISH CO-OPS: Cooperativas Agro-alimentarias de España, U. de Coop.

PUBLISHABLE SUMMARY

The SHIP2FAIR (Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables) project aims to foster the integration of solar heat in industrial processes of the agro–food industry. With this purpose, SHIP2FAIR has been developing and demonstrating a set of tools and methods for the development of industrial solar heat projects during their whole life cycle.

This training guidebook has been produced to serve that purpose. The main intended audiences of this deliverable are industry stakeholders, technicians, and engineers (through training and learning sessions for professionals), students (through training sessions for Master students), and policymakers (through a policy brochure).

In the aforementioned trainings, project partners explained the thermal energy needs in industry and how SHIP can be a relevant solution to reduce overall energy consumption and decrease energy costs in the long run. The training sessions gave an overview of the different technologies available and showed different SHIP examples. The sessions also explained the Replication and Control tools developed in the SHIP2FAIR project and how they are relevant for the sizing and optimisation of a new solar plant.

TABLE OF CONTENTS

1 INTRODUCTION

The Deliverable 9.4 Training Guidebook is under the activities of the following tasks within the Document of Action of SHIP2FAIR:

- Task 9.1 Dissemination and Communication Actions
- Task 9.2 Website, stakeholders' engagement and showcases
- Task 9.3 Training activities for the agro-food sector
- Task 9.4 Interaction and exploitation of synergies with other H2020 funded projects

This Training Guidebook describes the activities undertaken to promote SHIP projects both at European and global levels.

Apart from the required technical improvements and innovations, one important bottleneck regarding the deployment of SHIP technologies is the **lack of a qualified, expert workforce in the field**. Even though the technology is proven and advanced, if there is not a critical mass of expertise in companies, its implementation would be significantly delayed. This situation can lead to a standstill in SHIP system development: since SHIP systems are not very widespread, there is a lack of training in the field, meaning limited expertise and minimal investment and development in SHIP installations.

The capacity building program is therefore one of the cornerstones of SHIP2FAIR, as it complements the demonstration of the technical developments made during the project to guarantee a strong promotion of the SHIP systems.

The objective of the Training Guidebook is to be a reference to train professionals and students and to significantly increase the public awareness regarding SHIP. The guidebook gathers a standardised version of the training materials with a wide applicability.

The Training Guidebook has been created to enable the agro-food industry and students in the field to better understand the design and development of the Replication and Control Tools, the solar technologies involved, the solar heat integration into industrial processes, and the capacity building program linked to the SHIP2FAIR project.

2 Project goals and structure

SHIP2FAIR's main goal is to foster the integration of solar heat in industrial processes, specifically in the agro-food sector, which is the largest manufacturing sector.

The project has been developing a complete demonstration program up to TRL 7 involving different sectors, processes and SHIP technologies, addressing the main challenges of agro-food sector. As a result of the demonstration, SHIP2FAIR aims to achieve up to a 40% of solar fraction with a total of 2.9 MW of installed power for producing 4.04 GWh.

The project partners designed simple solutions which are easy to install and operate by SMEs due to ad-hoc financial schemes, business models and training.

SHIP2FAIR validates two tools:

- The Replication Tool is a software to support the concept design of SHIP projects and the development of techno-economic feasibility studies; this tool combines both data from solar generation and process features to provide a first outlook on SHIP integration and optimise the system according to user's needs.
- The Control Tool is an online Decision Support System to optimize the management of process heating systems through a live monitoring-oriented approach, able to evaluate performance also to better predict maintenance interventions and maximize solar power production also considering weather forecast.

Additionally, a Capacity Building Program took place during SHIP2FAIR: training campaigns addressed professionals and Master students interested in SHIP applications. Finally, an Overall SHIP Guide integrates the use of SHIP2FAIR tools, results, and ad-hoc tips for supporting end-users during the design, commissioning and operation of their SHIP projects.

The Control and Replication Tools have been validated and fine-tuned at the demo-sites. The capacity building program will take advantage of the tools' use, of the Overall SHIP guide and of the relation with the demo-sites.

SHIP2FAIR promotes an uptake in energy efficiency, and lowered process heat temperature when industrial plants' sustainability is increased. Decreased fossil fuel use will bring a strong emission reduction. Besides, the project enables higher private investments thanks to a reduction in operative costs. SHIP2FAIR contributes to the removal of regulatory barriers related to promote RES heating and SHIP, and additionally fosters job creation and improves the capacity and skills of stakeholders and students.

The four demo-sites are: M&R in Italy (distillation bottle warming and sanification), Bodegas Roda in Spain (winemaking and wine selling), Larnaudie in France (meat transformation), and RAR in Portugal (boiling and sugar crystallization).

SHIP2FAIR promotes the penetration and affordability of higher temperature technologies. It aims to validate the technological and economic reliability of SHIP technologies for the agro-food sector with process temperatures in the range between 50°C and 250°C. SHIP2FAIR proposes technologies and control schemes applicable to both newly built and already existing industrial plants which are able to cooperate with traditional process heating systems.

3 Dissemination strategy

Task 9.3 Training activities for the agro-food sector includes face-to-face and online trainings for professionals from the agro-food sector and students.

The content and format of the training activities have been adapted to a wide audience. Therefore, the SHIP2FAIR partners have decided to create different content for agro-food professionals and Master students:

- Since professionals can have different background and/or interests, we decided to hold two series of three webinars in May-June 2021 and March 2023. The content of each webinar was related to the technical level of the attendees (beginners, intermediate and advanced). The duration of each webinar was around 90 minutes.

- The Master students have a defined curriculum and therefore a scientific and technological background. The content of the training has been provided according to their knowledge and the format was a 2-hour class. These education sessions integrated the knowledge developed within the project and were offered at local and international level to students (undergraduate and postgraduate) and researchers in high level Energy Engineering courses.

The targeted audiences for dissemination activities were:

- EU energy utilities
- Solar Thermal Manufacturers and O&M companies
- Industries interested to SHIP (chemical, agro-food, pharmaceutical, process, petro-chemical industries, textile, pulp, and paper, etc.)
- Utilities operating as ESCO
- Financial organisations
- European Technology Platforms
- The research community
- The media

4 Training sessions for professionals

As mentioned above, SHIP2FAIR partners organised a first series of three webinars during the second quarter of 2021.

The webinar series were recorded and are available on SHIP2FAIR project's website:

- Webinar 1
- Webinar 2
- Webinar 3

4.1 Webinar 1

SHIP2FAIR's first webinar was the opportunity to learn how the project uses thermal solar technologies to improve the efficiency of four companies working on the Agro-food sector. The target audience of this webinar was the general public.

The learning objectives of this webinar were to:

- Give a general overview of the SHIP2FAIR project
- Explain SHIP and its benefits
- Share testimonials of the demo-sites
- Introduce the Replication Tool and the Control Tools which are presented in the second webinar

This webinar was dedicated to introducing the SHIP system. The general public is usually not aware of the fact that thermal solar technologies are able to provide a wide share of the thermal needs in an industry.

At the beginning of this webinar, the coordinator introduced the SHIP2FAIR project, its objectives and different phases of the project:

- Development of a Replication Tool
- Development of a Control Tool
- Set 4 demo-sites and validate the Replication Tool by an onsite measurement campaign
- Development of training materials and capacity building
- Release of a SHIP guidebook

After this introduction, each demo-site (RODA, RAR, Larnaudie, Martini & Rossi) presented:

- Their company and their activities in agro-food sector
- Their specific process
- Their energy needs (heat and cold)
- The SHIP process already (or to be) implemented
- Why SHIP is relevant for them

At the end of the first webinar, a brief introduction to the second webinar was given, and the participants were invited to subscribe to the next session. A total of 18 participants followed this first webinar.

The presentations and recordings are available here.

4.2 Webinar 2

SHIP2FAIR's second webinar gathered the creators of two of the key assets of the project.

RINA Consulting, BEST-Bioenergy and Sustainable Technologies presented:

- an innovative software to evaluate the techno-economic potential of Solar Heat Industrial Processes (SHIP)
- a software to determine the optimal SHIP operating strategy and existing heating producers so that emissions and costs are kept low while the process quality remains high

This webinar is ideal to learn to produce better and cheaper systems in an automated and flexible way.

The target audiences of this webinar were engineering companies.

The learning objectives of this webinar were to explain the benefits of:

- the Replication Tool
- the Control Tool

The second webinar was dedicated to SHIP tools (Replication Tool and Control Tool) developed in the frame of the SHIP2FAIR project. After an introduction explaining SHIP and its benefits to agro-food sector, we addressed the basic questions related to the relevant tools developed in the SHIP2FAIR project:

- How do these tools help to elaborate a SHIP project?
- What is their scope?
- What do you need, as a business owner, to use the tool?
- What are the advantages, outputs and next steps towards a more sustainable production?

RINA presented the online Replication tool. This tool is constituted by five modules:

- General information

  In this module, the user fills basic information (company information, contact name, email address, production information).

- Solar Mapping

  In this module, the user fills the information needed for an estimation of the solar resource (the location of industrial site, the panel azimuth and slope, the area available for the collectors, the kind of collectors, the type of installation, the shading). The output of this module is the solar resource, meteorological data (wind, temperature, …), usable area and optimized angle (slope and azimuth).

- Thermal demand characterization

  The Thermal demand characterization module aims to define the energy needs from the industrial process. For that, the user must provide some basic information:

  - The energy sources (type, consumption, costs)
  - The equipment inventory (type, power, load factor, …)
  - The process definition (thermal use (heat/cold), working fluid, operating temperature, …
- Simulation module

  This module provides the yearly solar heat delivered by the solar plant to the process and several KPIs (technical, environmental and economic) selected by the user. For that, the user is asked to choose one solar technology and other basic features of the desired solar plant. The output will be the solar energy production, the collector surface, thermal efficiency, size of the thermal storage, ROI, payback, CO2 saved, ….
- Integration module

  The integration gathers the output of the simulation module in one pdf file that can be downloaded.

The advantage of the Replication Tool is that even a non-specialist person can use this tool. It also takes into account all kind of collectors/technologies like High Vacuum Panels or Linear Fresnel.

The second part of this webinar was dedicated to the presentation of the Control Tool by BEST. The Control Tool aims to optimize the control of the solar plant and the process itself from the low-level aspects (temperature control) to the higher level aspects (forecast, fault detection, …) regarding the level of automation available. The Control Tool has been designed to be flexible. The tool is composed by five modules:

- Control of thermal solar plant. This module aims to provide a stable outlet temperature from the solar plant.
- Control of integration of solar energy into the process. This module aims to provide heat in a stable hydraulic condition to the process.
- Optimal interaction on plant level (by rule or Model Predictive Controller). This module provides an optimized overall control on the whole system (solar plant & industrial process).
- Forecasting methods. This module aims to forecast the heat that the solar plant will produce.
- Distribution learning features. This module provides an efficient and smart monitoring.

A detailed presentation for each module has been done.

At the end of the second webinar, a brief introduction to the third webinar was presented and the participants were invited to subscribe to the next session. A total of 60 participants followed this second webinar.

The presentations and recordings are available here.

4.3 Webinar 3

SHIP2FAIR's last webinar was the perfect occasion to meet the technology providers involved in the project: TVP Solar, Industrial Solar and Solid.

The target audience of this webinar was industry professionals.

The learning objectives of this webinar were to:

- Give an overview of the thermal solar technologies
- Focus on the technologies used in SHIP2FAIR

Choosing the right technology for the industry is not always easy. With this webinar, participants learned about the current options proposed by solar heat technologies. It also addressed how to integrate these technologies in industrial plants.

This webinar started with a general overview of the energy needs in order to show the potential interest of SHIP. The thermal needs are very important (50% of the energy), and industry represents a third of the energy consumption. Only 25% of the industry energy consumption is addressed by electricity. Therefore, solar heat can play a key role in industry decarbonisation.

Solar technologies can easily produce heat at a temperature range of 50°C-250°C. An analysis of the temperature range by industrial process shows that agro-food sector is particularly relevant for implementing solar technologies.

Different technologies exist and they can be used according to the level of temperature required by the process. For low temperatures, flat plate collectors or evacuated tubes are relevant. For medium temperatures, High vacuum flat panels are a very good option and for higher temperatures, concentration technologies (Linear Fresnel, parabolic through …) are required.

After a brief presentation on all the existing solar technologies (flat plate, vacuum tube, CPC, High vacuum flat panel, parabolic through, linear Fresnel, dish), the different ways to integrate solar heat in an existing process were explained:

- Water preheating
- Process heating
- Direct steam generation
- Solar thermal cooling (simple effect and double effect absorption chiller)

In the second and third parts, the technology providers (TP and IS) presented in detail their own technologies:

- High Vacuum Flat Panels
  This technology aims to provide heat at a temperature range of 65-180°C with a cost of 0,03 $/kWh. The panels are Solarkeymark certified. The advantage of these panels is that the high vacuum dramatically reduces the thermal losses. They can be used in the agro-food sector, but also in the paper, textile, oil &gas, pharmaceutical, and chemical industries as well as for district heating. The standardisation of modules makes their integration simple and reduces cost. A brief description of their integration in SHIP2FAIR demo-sites has been completed.

- Linear Fresnel
  This technology aims to produce direct steam in an affordable way. Industrial Solar presented in a detailed way the method to concentrate the sun on a receiver by using Fresnel mirrors. They detailed the main components (mirrors, structure, absorber tube, control system, steam drum, …). Industrial Solar also demonstrated the ability to produce saturated steam constantly at the pressure and temperature required by the process, regardless of fluctuating solar irradiance.

A total of 69 participants followed this third webinar.

The presentations and recordings are available here.

A second set of webinars is scheduled from March to May 2023.

5 Training sessions for Master students

The project includes dedicated trainings for Masters students. The aim of these classes is to give to the students a good overview of the SHIP potential market, but also to give them technical details about the various technologies, their strengths and their limitations. These sessions also went in detail about the Replication and the Control Tools, and their powerful ability to set new projects.

The training sessions explained in detail the various ways to implement a thermal solar plant in an industrial process and provide worldwide current examples of SHIP.

In these classes we presented in a more detailed way the following items:

- General context of the energy policy
  This section developed the recommendations given by the main policy makers (IEA, EU, OECD) in order to meet the UN objectives for reducing the Global Warming. Each policymaker agreed to reduce dramatically the fossil fuel consumption.
  The second aspect is the long-term tendency of the energy price increase (+100% for the natural gas price; +200% for the electricity price between 2000-2018). The Russo-Ukrainian war has only accelerated this tendency. The EU has dramatically reduced its fossil fuel importation from Russia and prices have increased from more than 300%. The conclusion is that the industry needs to produce locally green energy with a long-term, stable and affordable price – SHIP can play an important role in this target.
- General overview of the energy needs in industry
  This section is based on the presentation done in Webinar 3. Some details like the Global thermal solar production or the SHIP size and their repartition by technology have been added.
- Why and how SHIP can be relevant?
  This section is based on the presentation done in Webinar 3.
- The different technologies
  This section is based on the presentation done in Webinar 3.
- The different ways of Solar Heat integration in an existing process
  This section is based on the presentation done in Webinar 3.
- Examples of SHIP
  This section presented various example of SHIP through the world. Various technologies like Flat panels, Linear Fresnel, Parabolic Through have been shown and different size as well (small, medium and large-scale plants). A web link with a database of the existing SHIP has been provided.
- The SHIP2FAIR project – general presentation and objectives
  After general information about SHIP, a general presentation of the SHIP2FAIR project took place, explaining the structure of the project with the four demo-sites, the Control Tool, the Replication Tool, the capacity building and the SHIP Guide
- The four demo-sites in SHIP2FAIR project
  This section detailed each demo-site, including the technology used, the energy needs for the process (heat, cold), the quantity of solar energy to be produced, the surface of the plant and the target energy price.
- The replication tool developed by SHIP2FAIR

The presentation done in this section is based on the one done in Webinar 2.

- The control tool developed by SHIP2FAIR
  The presentation done in this section is based on the one done in Webinar 2.

The presentation is available here.

6 Training modules

6.1 Module 1: Energy consumption and SHIP technologies

Learning objectives of this module:

This module aims to provide insights into the energy consumption globally and in industry. It also addresses the relevant thermal solar technologies for producing affordable heat.

Intended users for this module:

The intended users of this module were members of the general public.

Structure of the module:

This module contains two documents:

- A presentation of the energy needs in industry and thermal solar technologies. The document presented the energy price trend and the importance of decarbonised industry, as well as an overview of the energy needs in industry is given. The different solar technologies able to produce heat at a range of temperature were also addressed, and worldwide SHIP examples using different technologies were presented.
- A detailed presentation of the technologies used in SHIP2FAIR project and the different ways of integrating Solar Heat in Industrial Process. This document explained why SHIP is relevant, and examined its challenges and potential solutions to those challenges. Then, the different technologies used in the demo-sites were presented:
    - Evacuated tubes – RODA
    - High Vacuum Flat Panels – M&R and Larnaudie
    - Linear Fresnel – RAR

This document explains the different ways for integrate Solar Heat in Industrial Process.

The presentation is available here.

6.2 Module 2: Pre-sizing a SHIP plant

Learning objectives of this module:

This module aims to provide insights for using the Replication Tool developed in SHIP2FAIR project.

Intended users for this module:

Engineers, General Public

Structure of the module:

This module contains two documents:

- A video of the Replication Tool. This video contains a demonstration of a SHIP pre-sizing by using the Replication.
- A user's manual. This written document gives a step-by-step explanation of each of the five modules of the replication tool.

The presentation is available here.

6.3 Module 3: Control strategies

Learning objectives of this module:

This module aims to provide insights for using the Control Tool developed in SHIP2FAIR project.

Intended users for this module:

Engineers

Structure of the module:

This module contains a video of the Control Tool which demonstrates the Control Tool. It gives a step-by-step explanation of each module of the Control Tool and their possibilities regarding the level of automation available in the industrial process.

The presentation is available here.

6.4 Module 4: Demo-sites

Learning objectives of this module:

This module aims to provide real example of SHIP.

Intended users for this module:

Industrial professionals, General Public, Engineers

Structure of the module:

This module contains a set of testimonial videos from the end user. These videos show:

- Installations of two demo-sites (RODA and M&R),
- the process and its environment,
- the solar plant

The presentation is available here.

6.5 Module 5: Suitable business and financing schemes for SHIP installation

Learning objectives of this module:

This module aims to provide insights about financing schemes for SHIP installations.

Intended users for this module:

Industrial stakeholders, Engineers, Investors

Structure of the module:

This module contains a presentation of the financing schemes, including:

- A summary of the market analysis,
- A SHIP project value chain
- The three possible business models:
  - Build and handover,
  - Build and operate,
  - Hybrid model
- A list of Funds and Incentives, organized by country

The presentation is available here.

7 Policy recommendations

As part of the European Commission's public consultation on the EU solar energy strategy, SHIP2FAIR submitted in April 2022 a policy paper focused on the promotion of solar heat for industrial processes (SHIP). The EU solar energy strategy, which will take the form of a Commission communication, is aimed at ensuring that solar energy achieves its full potential in helping to meet the European Green Deal's climate and energy targets.

The public consultation specifically requested feedback related to:

- Barriers to solar energy use
- Proposed measures to accelerate solar energy rollout
- Expanded competitiveness and resilience of EU solar energy systems

SHIP2FAIR's policy submission was focused on these topics, presenting recommendations to policymakers to facilitate SHIP's expansion as well as present the current status of SHIP technology and the desired future of SHIP development.

SHIP2FAIR policy recommendations are the following:

- A mandate in each Member State for industrial companies to generate 10% of their process heat needs from solar thermal by 2030 in line with Solar Heat Europe's position
- New funding sources, particularly CAPEX subsidies for SHIP
- Innovative business models, including third-party ownership and -financing of systems
- Promoting standards, guidelines and tools for SHIP certification (i.e. SHIP2FAIR's replication tool)
- Promoting digitalization in SHIP in order to optimize the energy production and its integration in the process (i.e. SHIP2FAIR's control tool)

The policy paper further illustrated SHIP's advantages and enormous potential for growth, noting that the aforementioned support policies would be essential to reinforce the adoption of energy efficiency measures in industrial enterprises and allow for a greater deployment of SHIP across Europe.

You can read SHIP2FAIR's input to the solar energy strategy consultation here.

The policy brochure is also available in Annex 5.

8 CONCLUSIONS

This document contains the guidelines for training different categories of audiences such as industrial stakeholders, technicians, engineers, and students.

The content of each presentation has been adapted to suit the background of the audience.

The trainings explained the thermal energy needs in industry, and particularly how SHIP is relevant and beneficial to the industry by reducing energy consumption and lowering energy costs in the long term. Each training gave an overview of the different technologies available and identified different examples of SHIP. They furthermore explained the Replication and Control Tools developed in the SHIP2FAIR project and how they are relevant for the sizing and the optimisation of a new solar plant.

These presentations are given in Annexes 1 to 4.

In the frame of the project, SHIP2FAIR's partners will continue to give webinars and training sessions.

ANNEX 1: Webinar 1

SHIP2FAIR OBJECTIVE

Unveiling the untapped potential of solar heat for agroindustries in EU

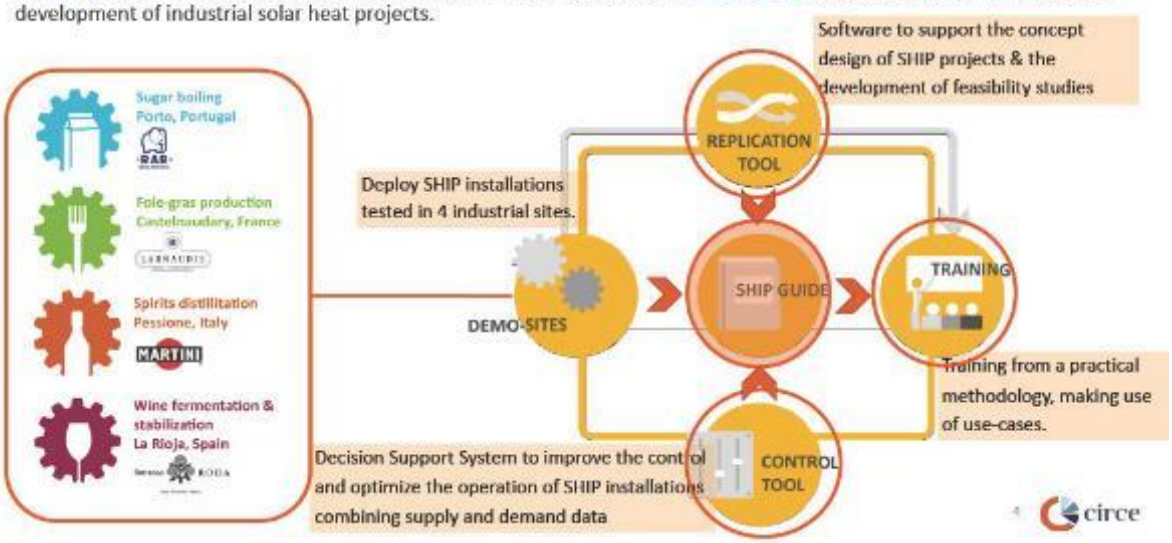
Fostering the integration of solar heat in industrial processes (SHIP) from agro-food sector, by developing and demonstrating a set of tools and methods.

BUDGET: 10 M€
DURATION: 2018-2023

3 circe

SHIP2FAIR TOOLS & METHODS

SHIP2FAIR develop & demonstrate, in a minimum of 4 real industrial sites - demo-sites, a set of tools & methods for the development of industrial solar heat projects.



4 circe


SHIP2FAIR Partners
Coordination
circe
Solar technologies providers
INDUSTRIAL SOLAR
SOLID
TVP SOLAR
R&D and consulting
BEST
cea
EDF
LINKS
RINA
Agro-food field experts
cooperativas agro-alimentarias
LARNAUDIE
MARTINI
RAR
BODEGAS RODA
Dissemination & Training
EUREC


Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables
circe


Sugar boiling
Porto, Portugal
RAR
Spirits distillitation
Pessione, Italy
MARTINI
Wine fermentation & stabilization
La Rioja, Spain
BODEGAS RODA
The experience of the demo sites
Hand-on experience & challenges in solar thermal adoption in the Agro-food sector from the four industrial pioneering cases.
circe


SHIP2FAIR
RODA
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.
Disclaimer: The sole responsibility for any error or omissions lies with the editor. The content does not necessarily reflect the opinion of the European Commission.
The European Commission is also not responsible for any use that may be made of the information contained herein.

D.O.Ca. RIOJA

- More than 60.000 hectares.
- Influence of 3 climates (Continental, Atlantic and Mediterranean)
- Amplitude of soils and heights, which gives an incredible diversity

Bodegas RODA

- 1987 marks the starting point
- Owners: Mario ROtllant & Carmen DAurella
- The technical team has a very important weight in the winery
- A modern construction (built in four stages, 1991, 1996 and 2000, 2019)
- In the heart of the most traditional neighborhood of Rioja: El Barrio de la Estación.
- The classic and the modern (a 19th century draft on which a winery was built 21st century)

PHILOSOPHY

- We want our wines to show the essence of the place. Rioja landscape.
- SUSTAINABILITY
- Elegance
- RODA is committed to R + D + i as the engine of progress..

VINEYARD

- Goblet or bush vine systems: traditional viticulture methods in Rioja
- 120 hectares, 70 of them ours. They are classified in different vineyards
- Sustainability
- 550 clones of Tempranillo
- Two Tempranillo ripening profiles: red fruit and black fruit
- We mostly work with vineyards over 30 years old
- R + D + i

SHIP2FAIR

BODEGAS RODA

SUSTAINABLE VITICULTURE

SHIP2FAIR IS BORN

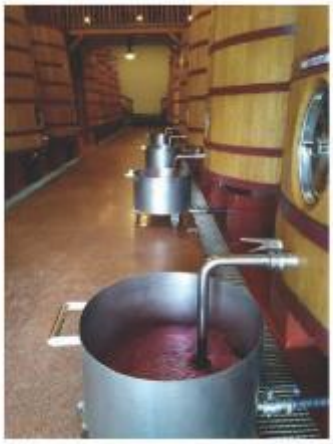
- RODA´S ROLE IN THE PROJECT: DEMOSITE
- WHY - WHAT DOES RODA BRING:
- RENEWABLE ENERGY.
- USE OF SOLAR-THERMAL ENERGY TO GENERATE HEAT and COLD.
- INTEGRATION OF VACUUM TUBES IN THE WAREHOUSE ARCHITECTURE: CARING FOR THE AESTHETIC OF THE FACILITIES.
- DECREASE IN ENERGY EXPENDITURE.


SHIP2FAIR
Diagrama flujo vinificación
BODEGAS RODA
COLD SOAK 7°C
ALCOHOLIC FERMENTATION (Exotérmica30°C)
MALOLACTIC FERMENTATION 20°C
AGEING 14°C -80%hr
STABILIZATION (5°C)
CLEANING & DISINFECTION

ALCOHOLIC FERMENTATION

BODEGAS RODA

- COLD soak
- Wild yeasts
- French oak vats. Great thermal inertia



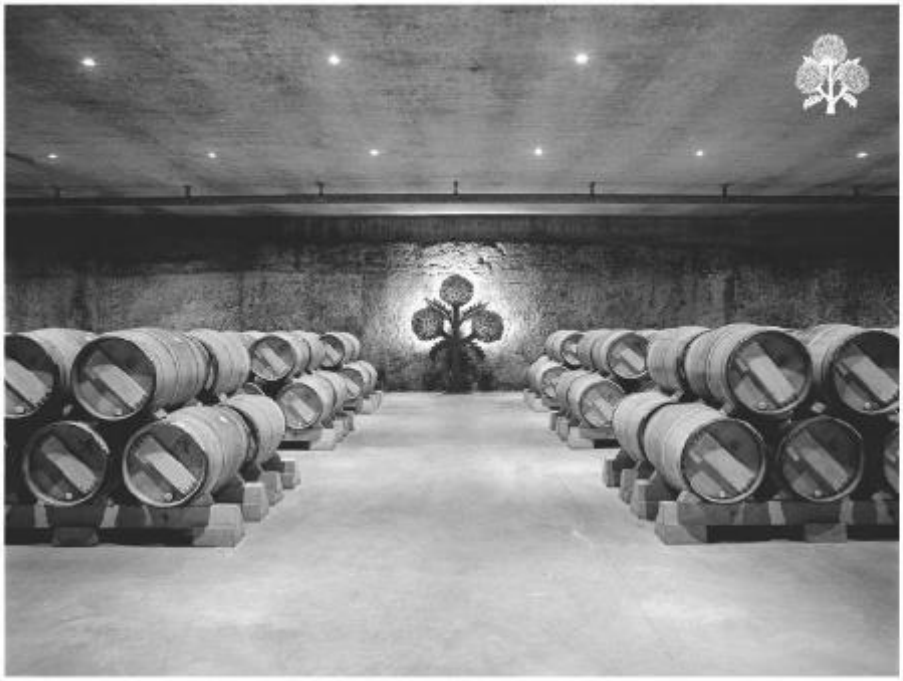
SHIP2FAIR

BODEGAS RODA

MALOLACTIC FERMENTATION

All our wines undergo Malolactic Fermentation in French oak.
We installed a UNDERFLOOR heating system to have a temperature of 20ºC.
Once the malolactic fermentation is finished, the windows are opened and the north wind enters to lower the temperature (stabilization).

AGEING



AGEING

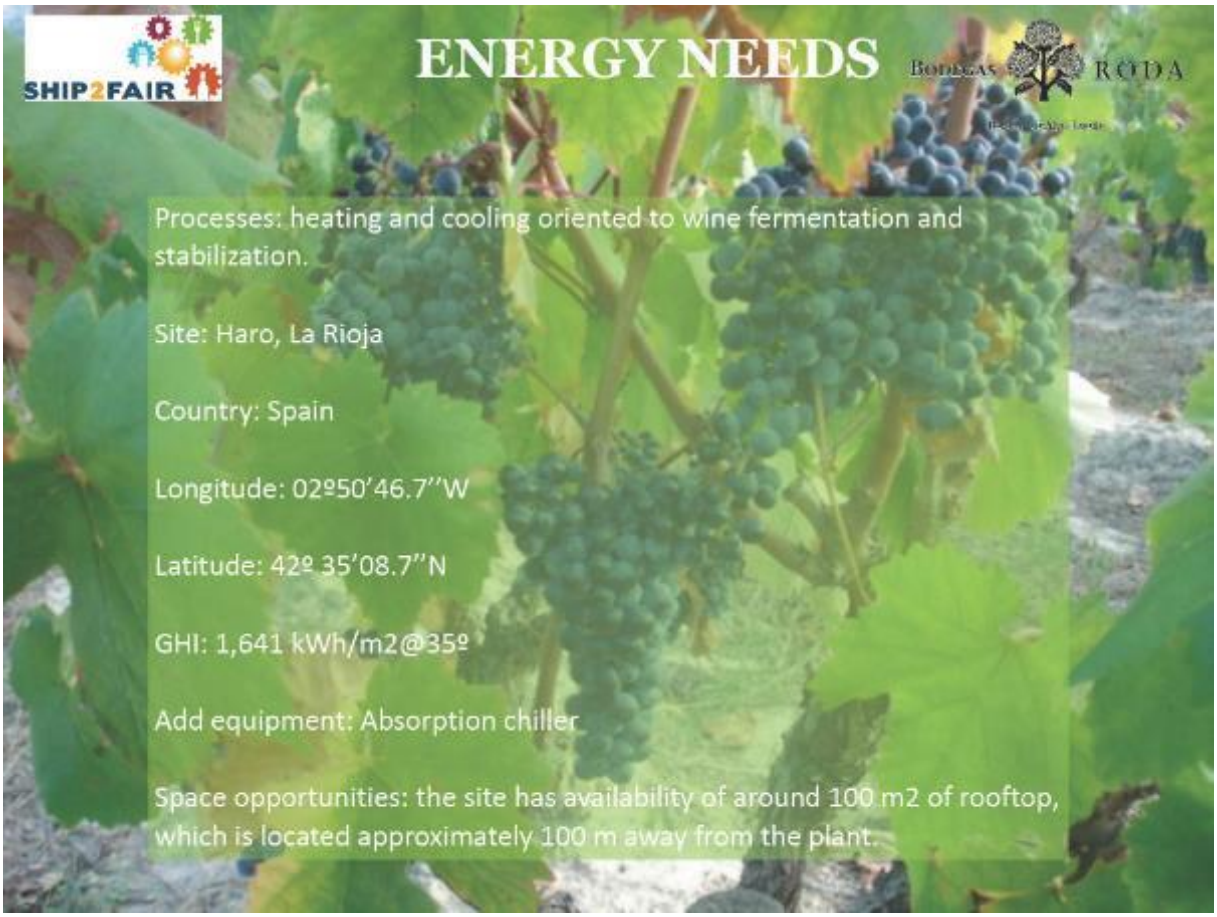
Instalamos un sistema de refrigeración por SUELO REFRESCANTE para tener una temperatura de 13ºC en el periodo estival (estabilización).

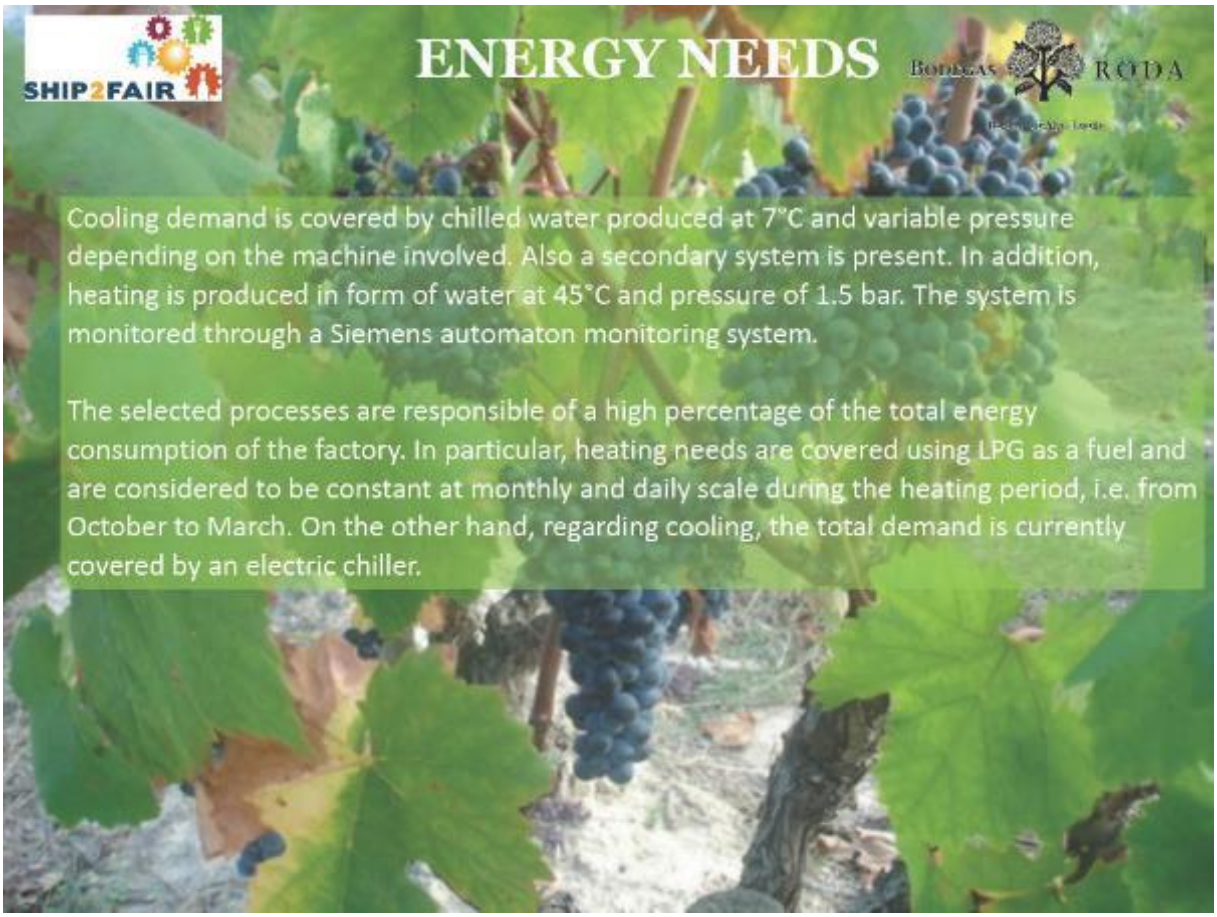
SHIP2FAIR

CONTROLLED HUMIDITY

AGEING

BODEGAS RODA


SHIP2FAIR
ENERGY NEEDS
BODEGAS RODA
Processes: heating and cooling oriented to wine fermentation and stabilization.
Site: Haro, La Rioja
Country: Spain
Longitude: 02º50'46.7''W
Latitude: 42º 35'08.7''N
GHI: 1,641 kWh/m2@35º
Add equipment: Absorption chiller
Space opportunities: the site has availability of around 100 m2 of rooftop, which is located approximately 100 m away from the plant.

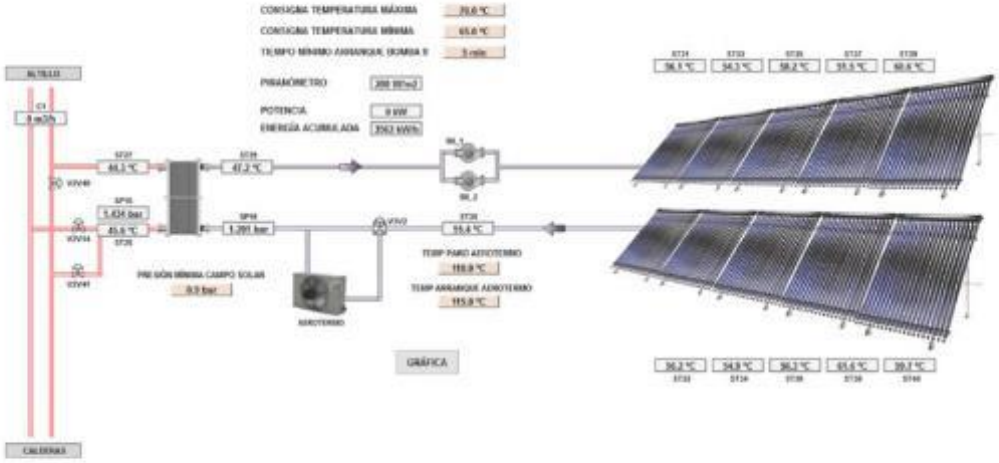

SHIP2FAIR
ENERGY NEEDS
BODEGAS RODA
Cooling demand is covered by chilled water produced at 7°C and variable pressure depending on the machine involved. Also a secondary system is present. In addition, heating is produced in form of water at 45°C and pressure of 1.5 bar. The system is monitored through a Siemens automaton monitoring system.
The selected processes are responsible of a high percentage of the total energy consumption of the factory. In particular, heating needs are covered using LPG as a fuel and are considered to be constant at monthly and daily scale during the heating period, i.e. from October to March. On the other hand, regarding cooling, the total demand is currently covered by an electric chiller.

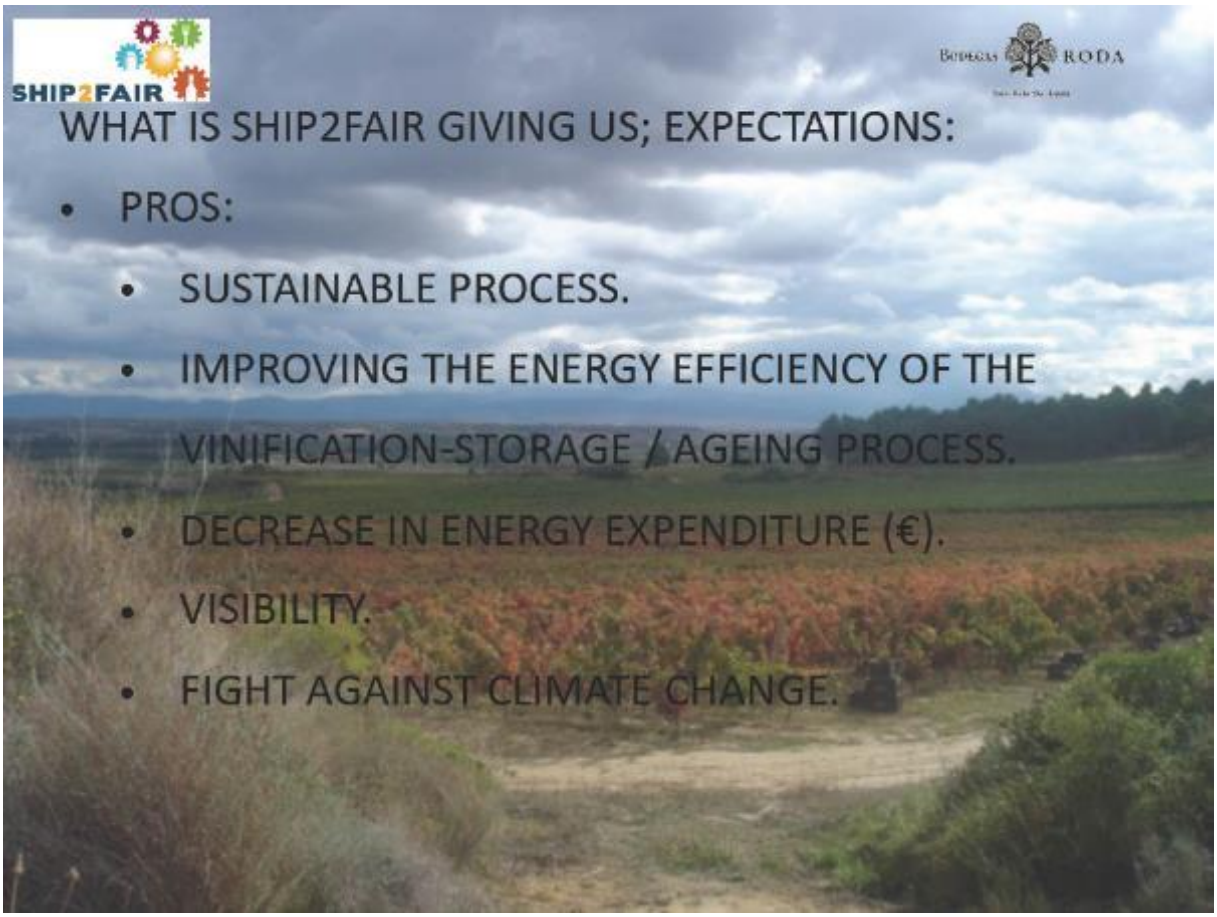
SHIP2FAIR

BODEGAS RODA

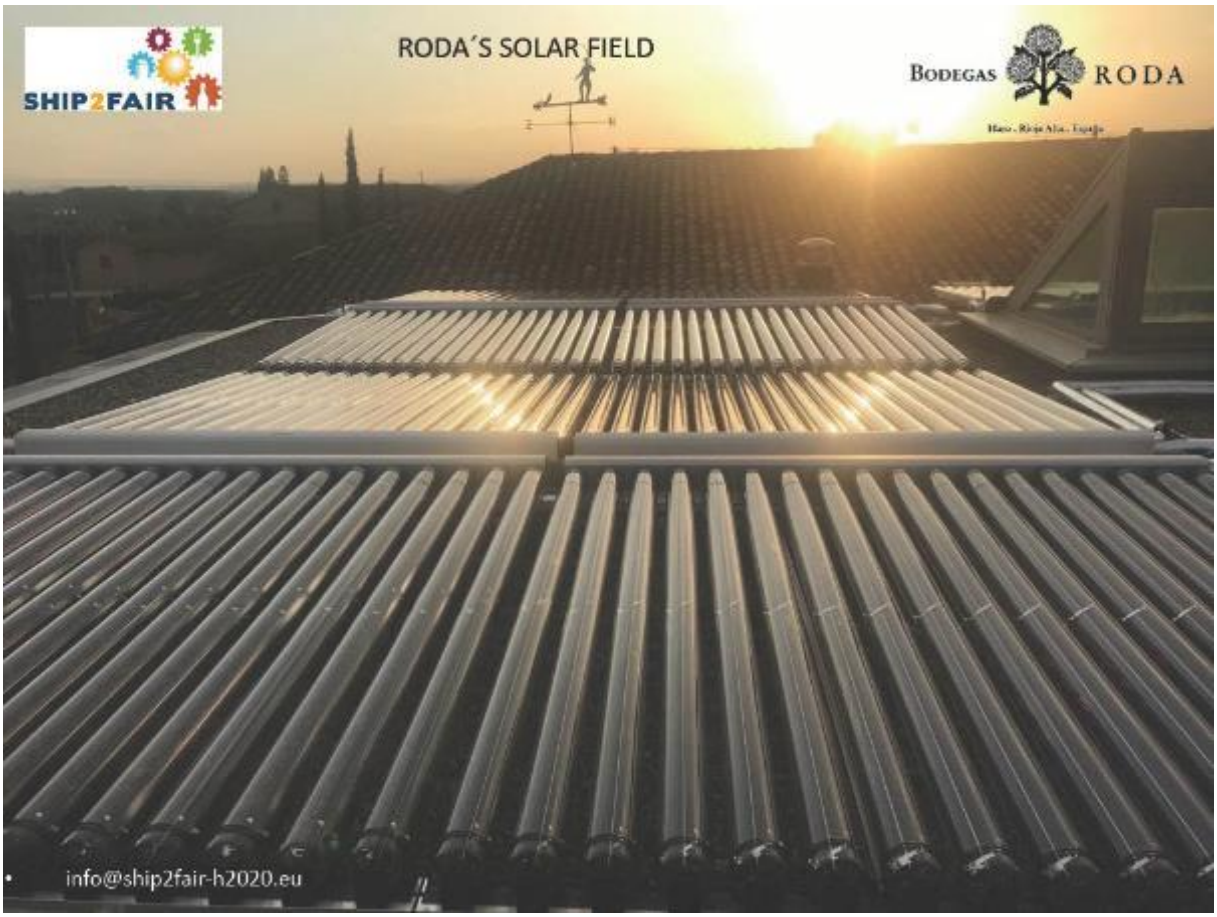
SOLAR PRODUCTION

PRODUCCION SOLAR



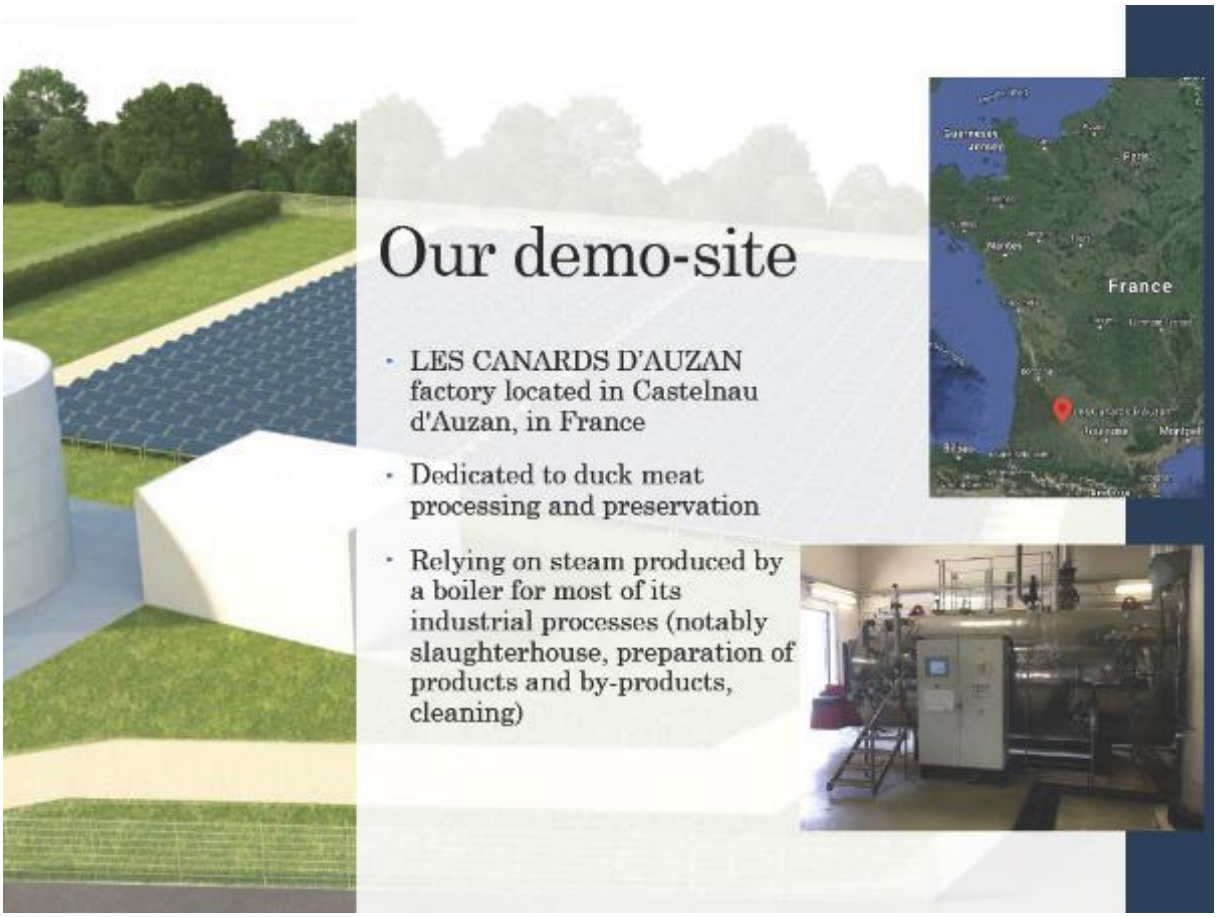

SHIP2FAIR
BODEGAS RODA
WHAT IS SHIP2FAIR GIVING US; EXPECTATIONS:
PROS:
SUSTAINABLE PROCESS.
IMPROVING THE ENERGY EFFICIENCY OF THE VINIFICATION-STORAGE / AGEING PROCESS.
DECREASE IN ENERGY EXPENDITURE (€).
VISIBILITY.
FIGHT AGAINST CLIMATE CHANGE.


SHIP2FAIR
BODEGAS RODA
WHAT IS SHIP2FAIR GIVING US; EXPECTATIONS:
CONS:
ECONOMIC DISBURSEMENT FOR INVESTMENT.
CONCEPTUAL DIFFICULTIES. WE ARE NOT ENERGY EXPERTS.
DIFFERENT "TIMINGS" AMONG THE PROJECT PARTICIPANTS.


SHIP2FAIR
RODA´S SOLAR FIELD
BODEGAS RODA
info@ship2fair-h2020.eu

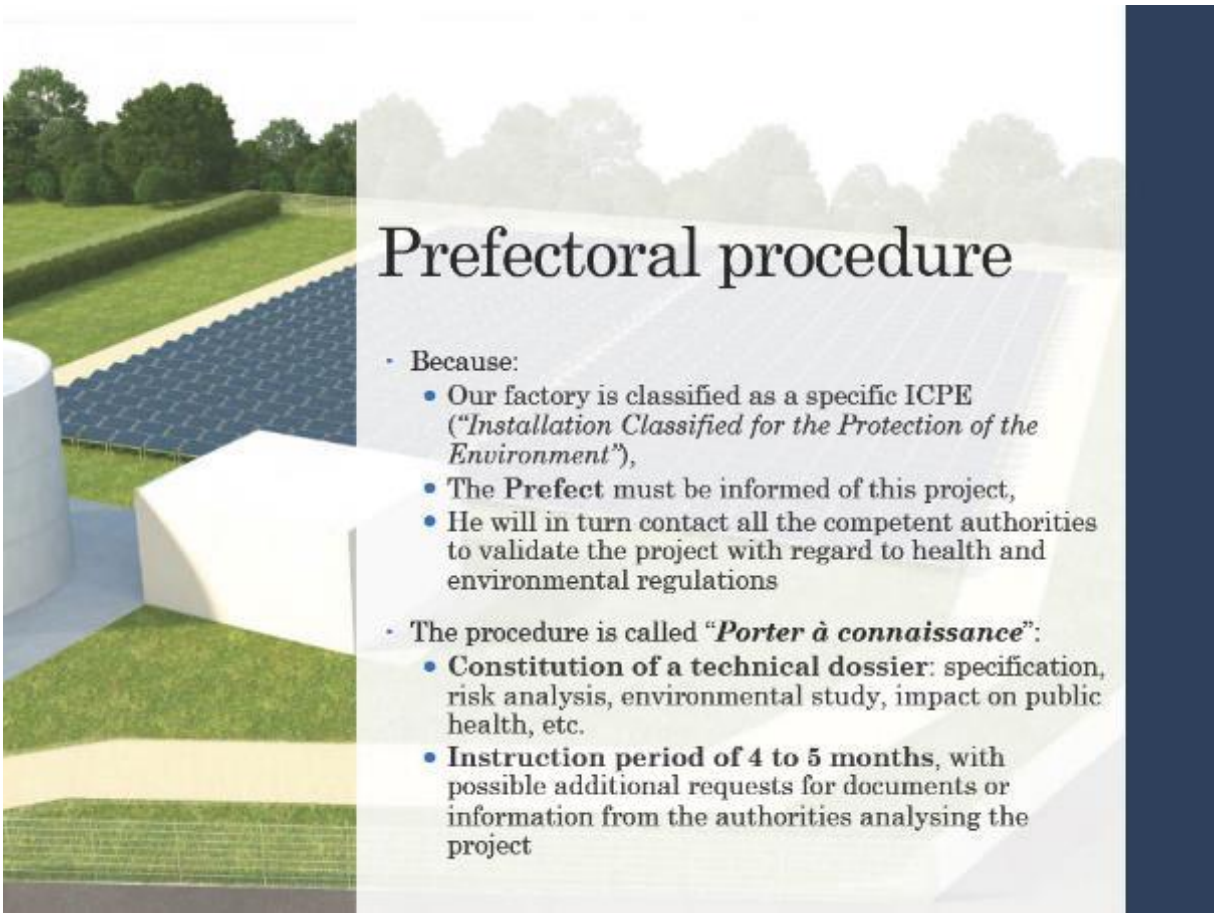

SHIP2FAIR
GRACIAS
THANK YOU
MERCI
DANKE
estomas@roda.es

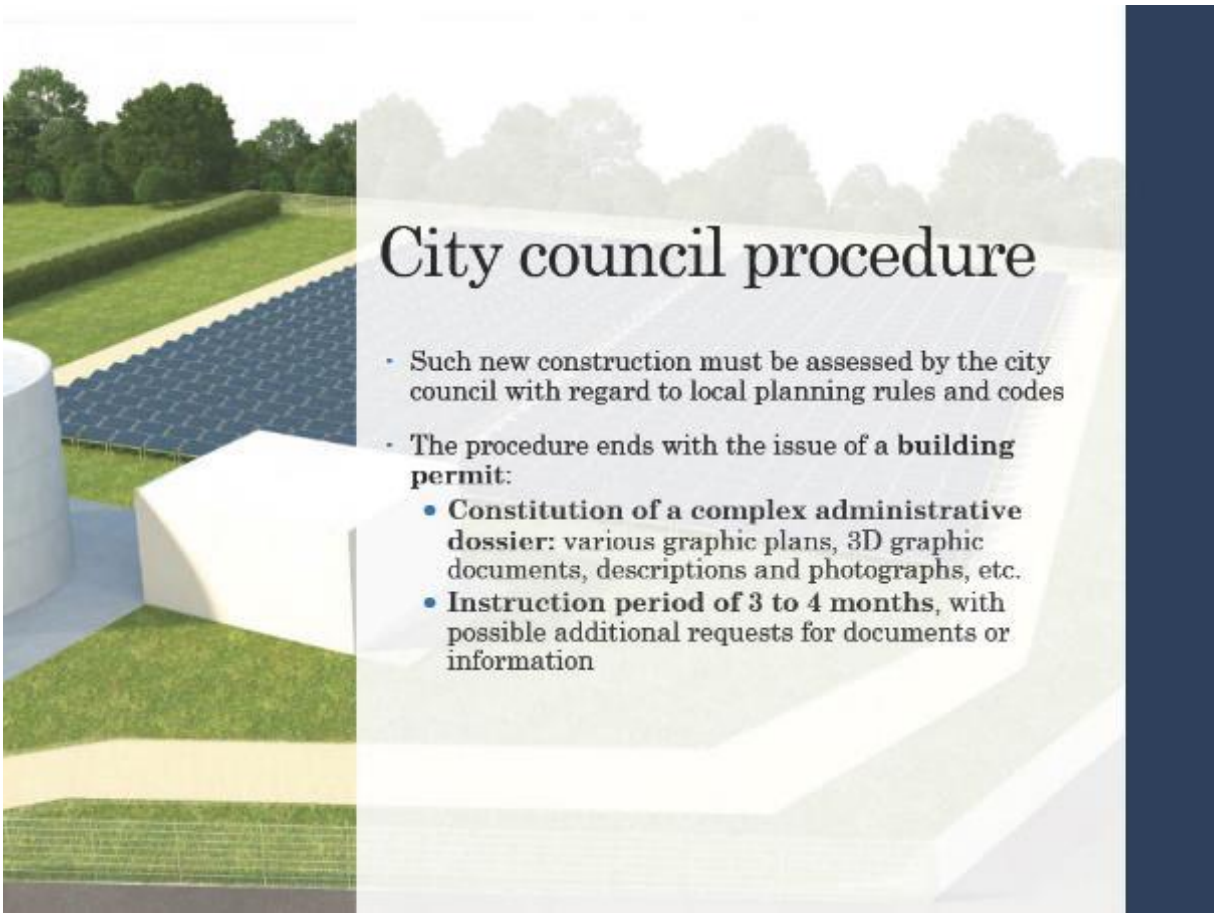

SHIP2FAIR
Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables
Canards d'Auzan
Jean LARNAUDIE
DEPUIS 1951
Status of our project

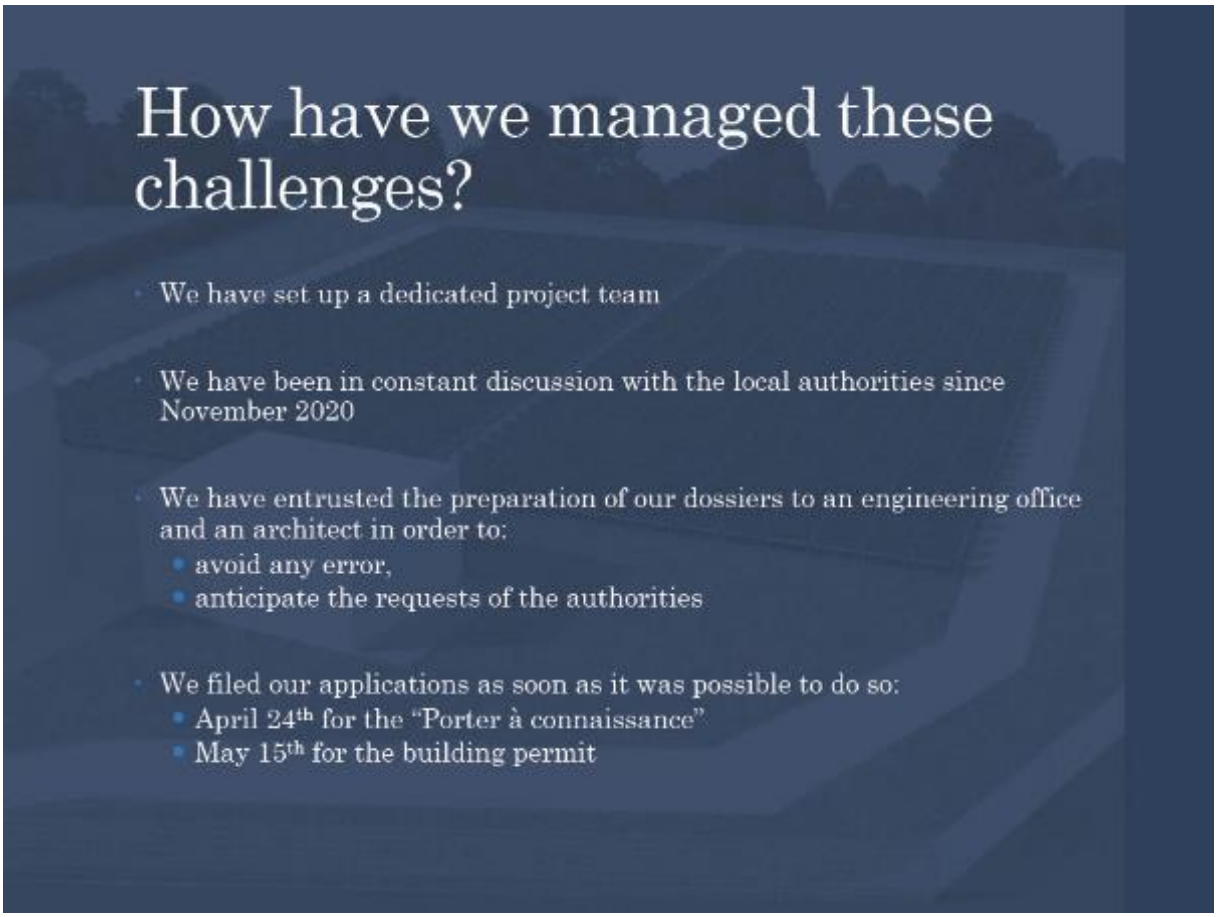

Our demo-site
LES CANARDS D'AUZAN factory located in Castelnau d'Auzan, in France
Dedicated to duck meat processing and preservation
Relying on steam produced by a boiler for most of its industrial processes (notably slaughterhouse, preparation of products and by-products, cleaning)
France


Our project
Installation of solar panels mounted on studs and deployed on an area of approximatively 3000 m², located near the boiler room
Constant production of 969 thermic kW of solar thermal energy to supply the boiler room
15% reduction in gas consumption


Challenges encountered so far
Impossible to start construction work without complying with French urban planning and construction regulations
Two legal requirements:
Prefectoral authorisation
City council authorisation
Both procedures are:
Complexe administrative process
Time consuming
→ As a result, the installation of the solar panels has been significantly delayed


Prefectoral procedure
Because:
Our factory is classified as a specific ICPE ("Installation Classified for the Protection of the Environment"),
The Prefect must be informed of this project,
He will in turn contact all the competent authorities to validate the project with regard to health and environmental regulations
The procedure is called "Porter à connaissance":
Constitution of a technical dossier: specification, risk analysis, environmental study, impact on public health, etc.
Instruction period of 4 to 5 months, with possible additional requests for documents or information from the authorities analysing the project

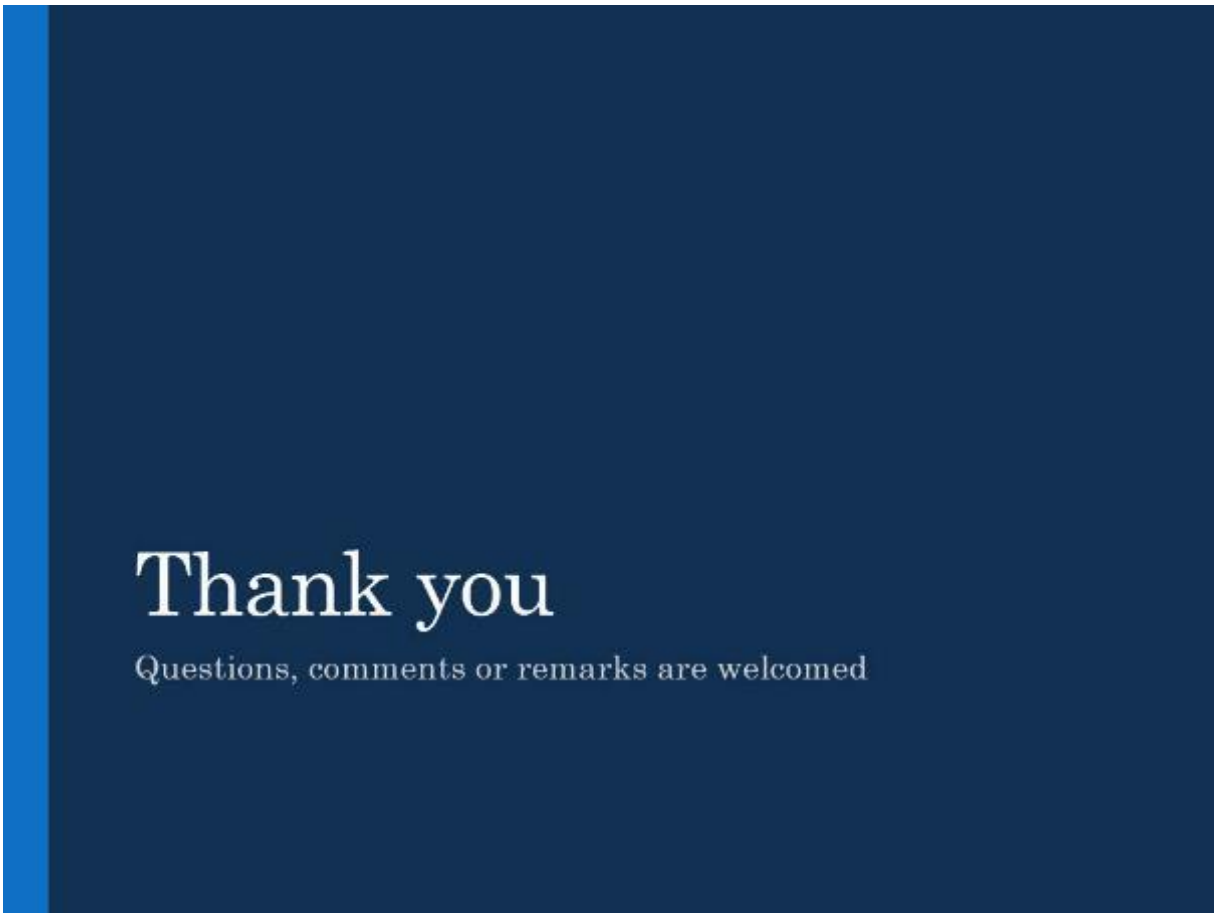

City council procedure
Such new construction must be assessed by the city council with regard to local planning rules and codes
The procedure ends with the issue of a building permit:
Constitution of a complex administrative dossier: various graphic plans, 3D graphic documents, descriptions and photographs, etc.
Instruction period of 3 to 4 months, with possible additional requests for documents or information


How have we managed these challenges?
We have set up a dedicated project team
We have been in constant discussion with the local authorities since November 2020
We have entrusted the preparation of our dossiers to an engineering office and an architect in order to:
avoid any error,
anticipate the requests of the authorities
We filed our applications as soon as it was possible to do so:
April 24th for the "Porter à connaissance"
May 15th for the building permit

How do we plan to move forward?

- We are currently in contact with the Prefect of the Gers to accelerate the procedures
- In order not to lose more time in the project, we will start the earthworks of the site in week 28 (call for tenders in progress)


Next steps
1. Porter à connaissance (4-5 months)
• Prefecture deposit on April 24th
2. Building permit (3-4 months)
• City hall deposit on May 15th
3. Earthwork (4 weeks)
• Start on end of May (week 28)
4. Validation of the project by the administrative authorities
• By the end of October 2021 (estimated time)
5. Installation of solar panels
• Last quarter of 2021


Thank you
Questions, comments or remarks are welcomed

SHIP2FAIR

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

RAR – Refinarias de Açúcar Reunidas

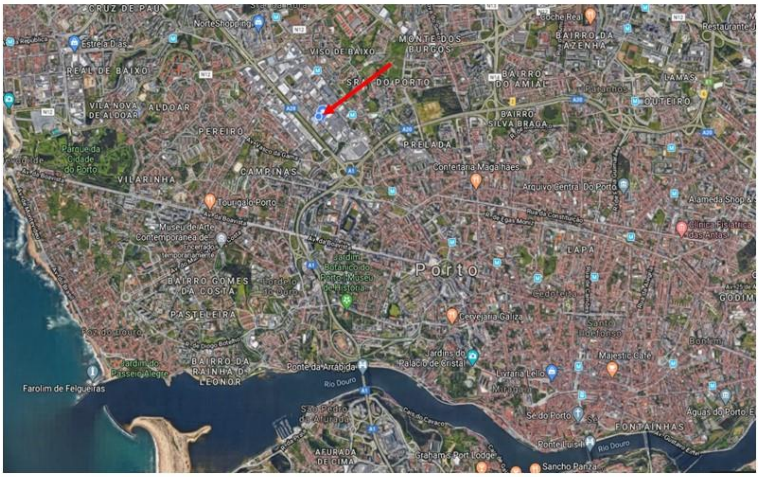
1st Webinar, 20/05/2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

SHIP2FAIR

Location

Porto, Portugal



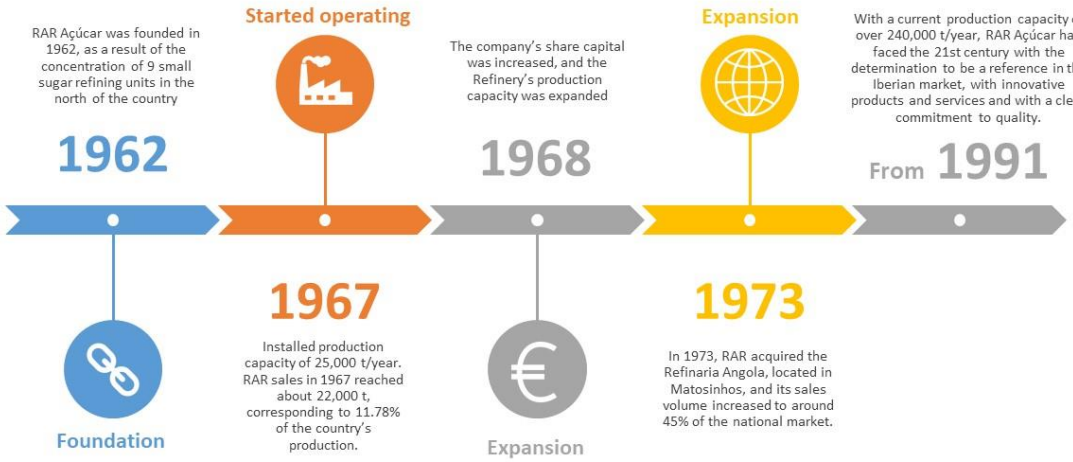
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables

Historical overview

Until the 1960s, the Portuguese sugar refining industry consisted of a few dozen small-scale units, largely functioning in artisanal terms, with very rudimentary equipment, unable to produce quality sugar.

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables

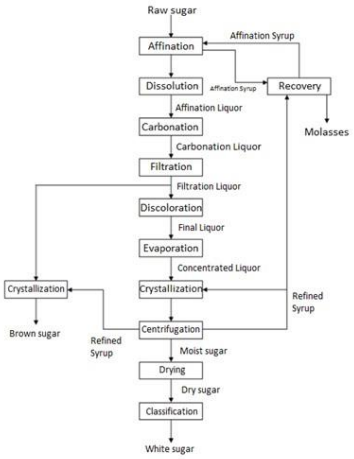
Timeline



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables

SHIP2FAIR

The process



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables

SHIP2FAIR

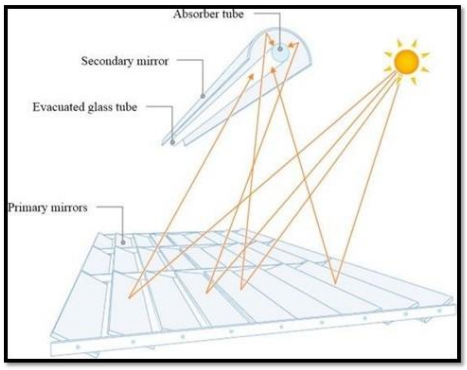
Video

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables

SHIP2FAIR

Energy demands

RAR's steam demand is around 194.000 ton/year and the solar system will produce around 584 ton/year, which represents about 0,3% of our needs.



SHIP2FAIR

Improvements

Since the solar system is going to continuously operate and RAR is not, this steam production will decrease the startup time, which corresponds to approximately 1h of increased production time

SHIP2FAIR

Project analysis

- ✓ RAR is a heavy-duty food company with high energy consumption
- ✓ All actions that lead to a decrease in energy use and CO_2 production will have a positive impact on the city
- ✓ RAR has the perfect and finest location for dissemination activities, since it takes only a 5min drive from the airport, it's next to the city freeways and has connection by bus and metro.

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables

SHIP2FAIR

Thank you!

edc@rara.pt

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

10

SHIP2FAIR

Status

Change of scope 80vs30

- Formal agreement of the 2nd Amendment
- Substructure engineering

SHIP2FAIR

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

SHIP2FAIR Decarbonising agro-food process industries with solar heat

Webinar 1, Zoom (Online), 20/05/2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276. Disclaimer: The sole responsibility for any error or omissions lies with the editor. The content does not necessarily reflect the opinion of the European Commission. The European Commission is also not responsible for any use that may be made of the information contained herein.

SHIP2FAIR

Role of Pessione

- Is the cradle of Martini and the producer of flagship brands within the Bacardi portfolio
- Center of excellence and proficiency for production, development and industrialization of Vermouths, Sparkling wines and Bacardi bottling

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

SHIP2FAIR

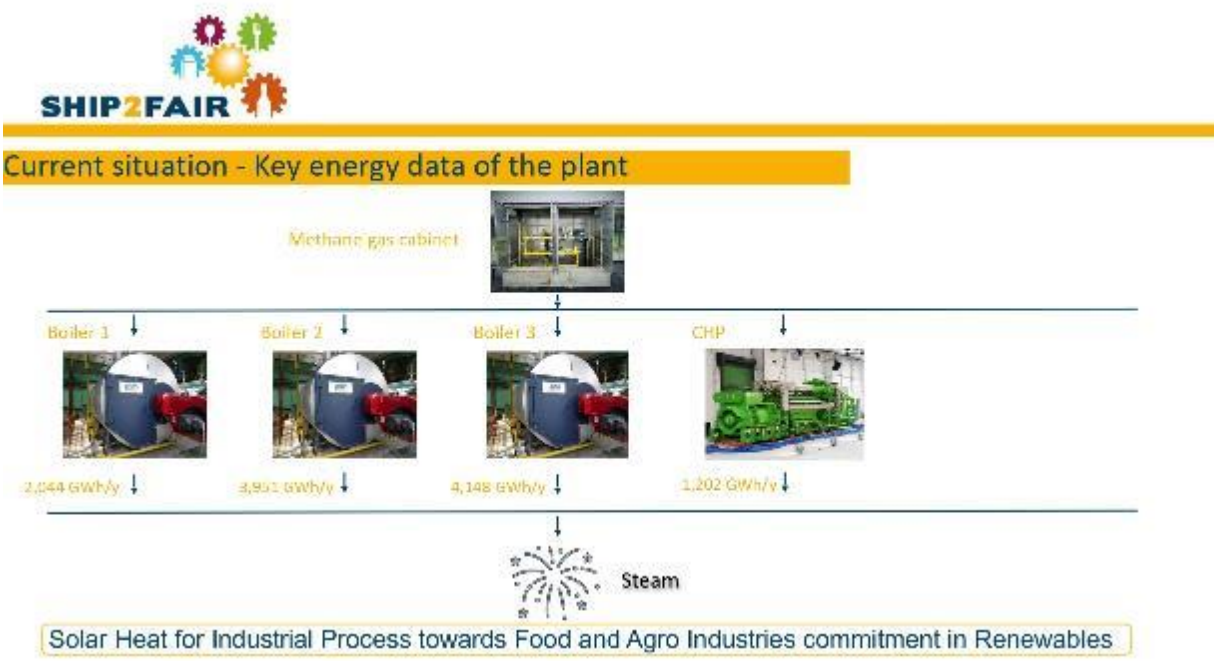
It all began with three men...

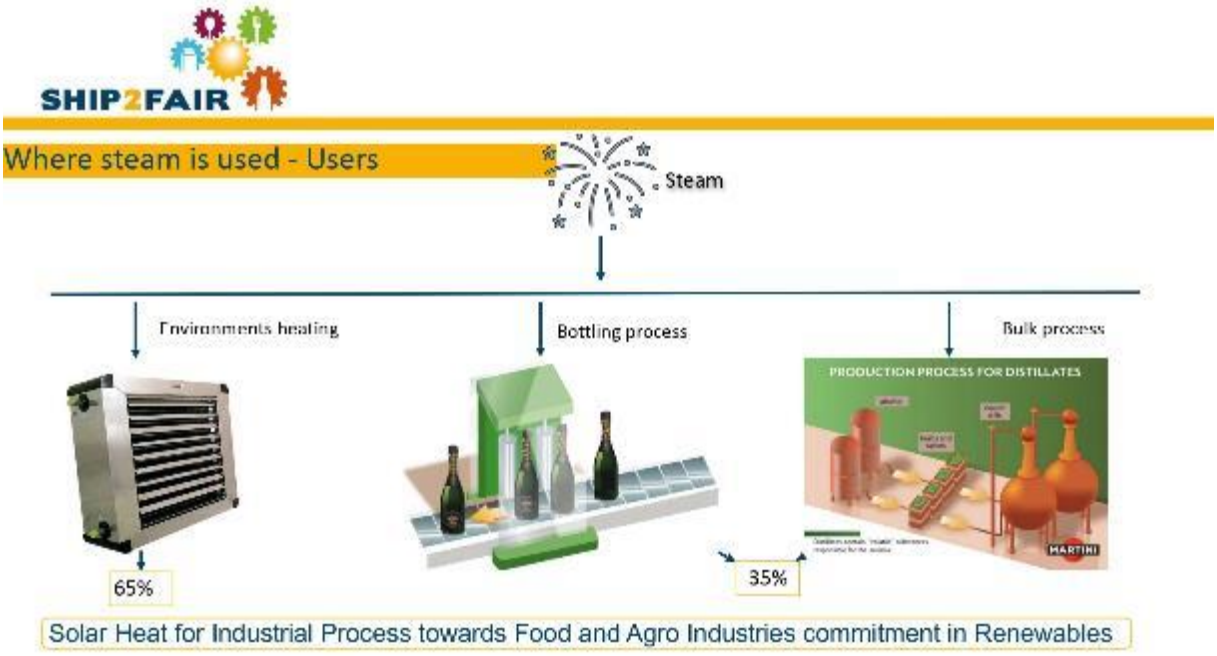
- July 1st, 1863: Martini & Sola was officially born in Turin. Alessandro Martini and Teofilo Sola are the founders
- Luigi Rossi, skilled herbalist and wine technician, enters the company with a participating share
- In 1864 production moves to Pessione, a strategic centre for his closeness to the railway line that links up Turin and Genoa

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables


MARTINI
Key data of the plant


SHIP2FAIR
3 families of products
VERMOUTH
MARTINI
SPUMANTI
BACARDÍ
Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables


SHIP2FAIR
Current situation - Key energy data of the plant
Methane gas cabinet
Boiler 1
Boiler 2
Boiler 3
CHP
2,044 GWh/y
3,951 GWh/y
4,148 GWh/y
1,202 GWh/y
Steam
Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables


SHIP2FAIR
Where steam is used - Users
Steam
Environments heating
Bottling process
Bulk process
PRODUCTION PROCESS FOR DISTILLATES
MARTINI
65%
35%
Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

SHIP2FAIR

New energy source

SOLAR FIELD SPECS

Hot Water Density	812.5 kg/m3
Hot Water Specific Heat	4.8 kJ/kg/K
Solar Field Peak Efficiency	56%
Safety Factor	115%
# Of Panels	286 #
Gross Area	536 m²
Installed Area	1.075 m²
Solar Field Peak Power	326 kW
Panels Tilt Angle	36 °

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

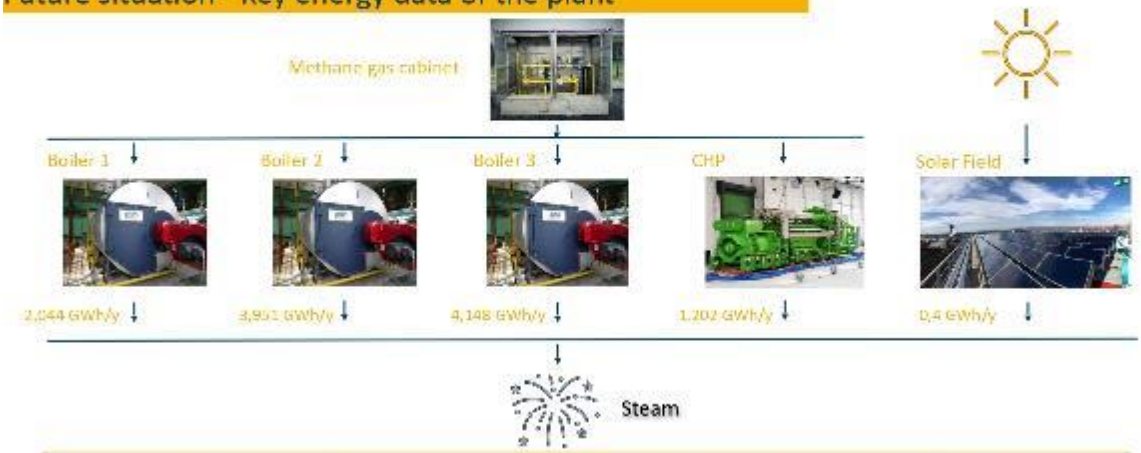
SHIP2FAIR

Where

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

SHIP2FAIR

Future situation - Key energy data of the plant



Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

SHIP2FAIR

How the system will work: 2 different operation modes

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

SHIP2FAIR

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables

The SHIP2FAIR Control Tool
Webinar, 20/05/2021

Viktor Unterberger,
BEST – Bioenergy and Sustainable Technologies

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

SHIP2FAIR

Control Tool

CONTROL TOOL

GOAL

The Control Tool is a tool able to **optimize and improve the** integration of solar heat into industrial processes **during operation, regarding**

- from **low-level control aspects** (e.g. control of temperature)
- through an **high-level optimization of the whole system**
- to advanced **data-mining techniques** (e.g. fault detection, forecasts, …)

DESIGN

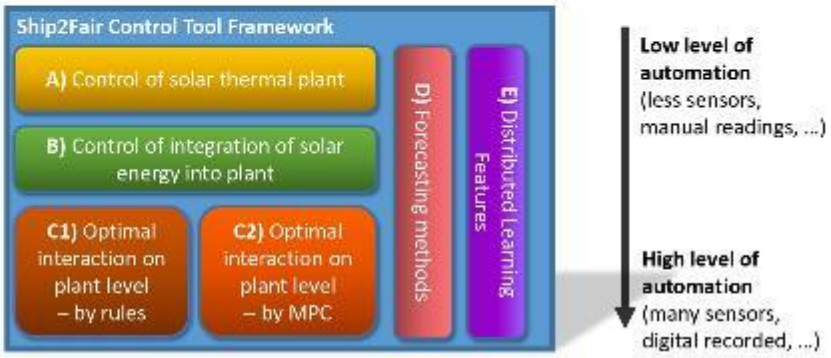
The design of the tool **aims to be as flexible as possible** in order **to be applied to a multiplicity of systems**, depending on

- **user needs** (e.g. control of only solar thermal system),
- **plant design** (e.g. available heat producers, storages) and
- **level of automation** (e.g. many sensors, digital recorded)

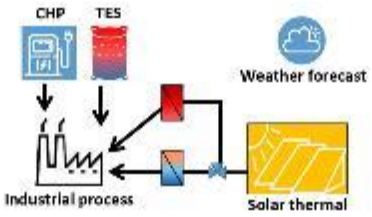
Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

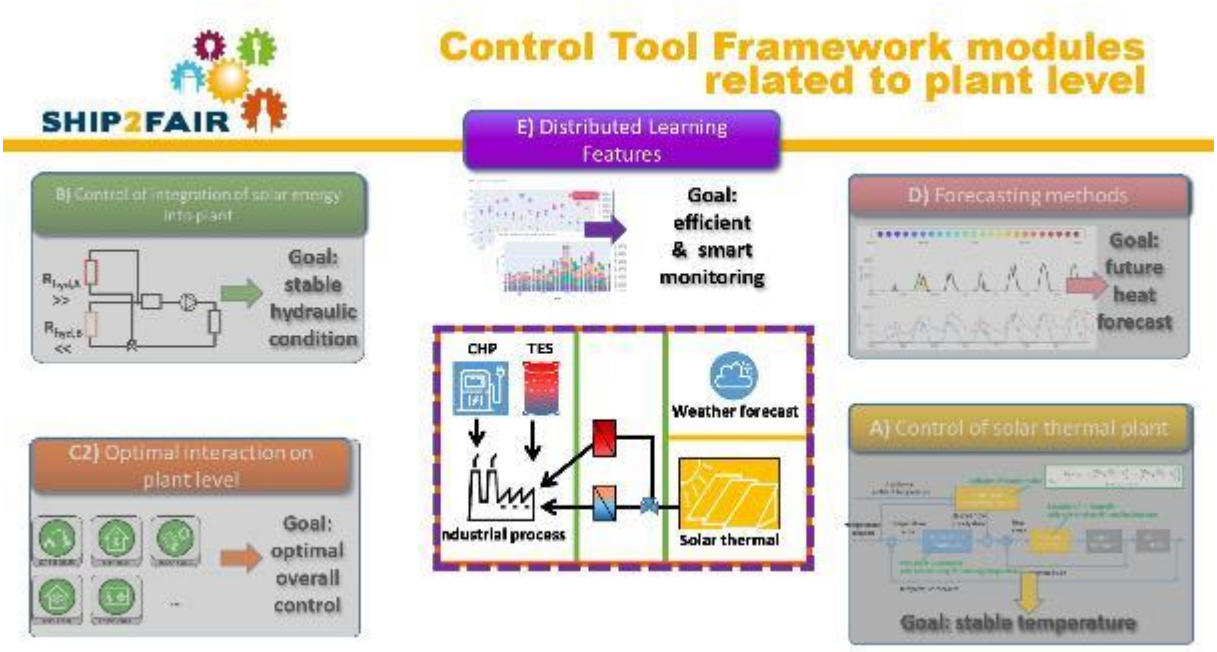
Design of the Control Tool

- **Consists of a Framework of 5 MODULES which allow to make the most of the solar production.**
- MODULES are chosen based on the possibilities available on-site
- Chosen MODULES form specific CONTROL TOOL for a plant



Control Tool Framework modules related to plant level





- Tool with the goal to optimize the system in operation and therefore addresses different control levels.

- Tool is based on a flexible design in order to be applied to a multiplicity of plants based on the possibilities on site.

- Level of implementation of Tool depends on the chosen modules (either on a programmable logic controller (PLC) or on a Server, resulting in a Web-Tool).

SHIP2FAIR

Thank you!

Viktor Unterberger
BEST – Bioenergy and Sustainable Technologies
viktor.unterberger@best-research.eu

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

SHIP2FAIR

Thank you!

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

ANNEX 2: Webinar 2

The SHIP2FAIR Replication Tool

Webinar, 19/05/2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

SHIP2FAIR
Replication Tool

The Replication Tool is a software able to evaluate the **techno-economic potential** of SHIP solution, starting from **local solar potential** and current **process heat demand**.

This tool is able to provide a first outlook on the SHIP **integration within the process** and to **optimise the system** according to the user's needs.

It provides:

- Evaluation of **solar field parameters** (sizing, technology, thermal storage requirements, etc.)
- Expected **energetic and environmental results** (solar fraction, energy savings, avoided emissions, etc.)
- Preliminary **economic figures**.

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 2

SHIP2FAIR
Replication Tool

ADVANTAGES:

- Not specialised tool
- Interactive interface
- Default values suggested
- Inputs required available to the user
- Optimisation of the solar field based on a selected parameter
- Possibility to compare alternatives

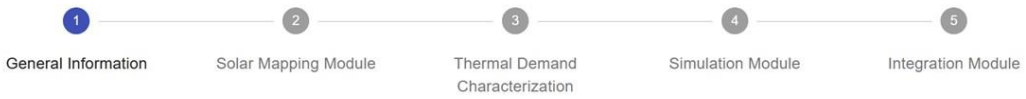
USER:

- Professionals to develop feasibility studies
- Technical department of interested companies
- Consultants
- Students

SHIP2FAIR
How does the RT work?

The Replication Tool (RT) is a **web tool**, which allows registered users to **run 5 modules** in sequence:

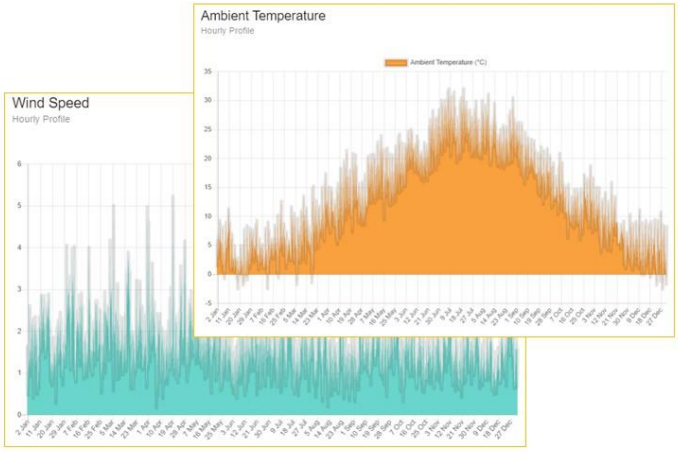
- General Information Module
- Solar Mapping Module
- Industrial Process Demand Characterization Module
- Simulation Module
- Solar Integration Module



SHIP2FAIR
Module 2/5

Outputs:

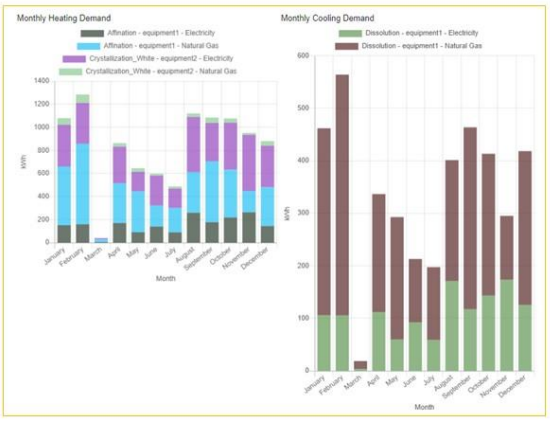
- Solar irradiance (hourly profile)
- Optimized angles (slope and azimuth)
- Usable area
- Total corrective factor
- Ambient temperature (hourly profile)
- Wind speed (hourly profile)



SHIP2FAIR
Module 3/5

Outputs:

- Total thermal demand
- Heating demand & Cooling demand
- Monthly demand distribution
- Process operating temperature
- Details of the thermal demand for each single process



Simulation Module [CEA]

This module provides the **yearly solar heat** delivered to the process by **the user-defined solar plant** (solar field and thermal storage).

Several **Key Performance Indicators** are calculated to help the user evaluate the benefit of the solar plant from a **technical**, **environmental** or **economic** point of view.

Outputs:

- Yearly results
- Optimal area and volume for the solar design
- Monthly results
- The best combination of processes to be fed by the solar energy (in monthly basis)

Thank you!

SHIP2FAIR
Where do I find the Replication Tool?

https://replicationtool.ship2fair.cloud
(Currently in Beta testing)

Francesco Peccianti - RINA Consulting
francesco.peccianti@rina.org

SHIP2FAIR

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables

The SHIP2FAIR Control Tool

Webinar, 20/05/2021

Viktor Unterberger,
BEST – Bioenergy and Sustainable Technologies

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

SHIP2FAIR

Control Tool

GOAL

The Control Tool is a tool able to optimize and improve the integration of solar heat into industrial processes during operation, regarding

- from low-level control aspects (e.g. control of temperature)
- through an high-level optimization of the whole system
- to advanced data-mining techniques (e.g. fault detection, forecasts, ...)

DESIGN

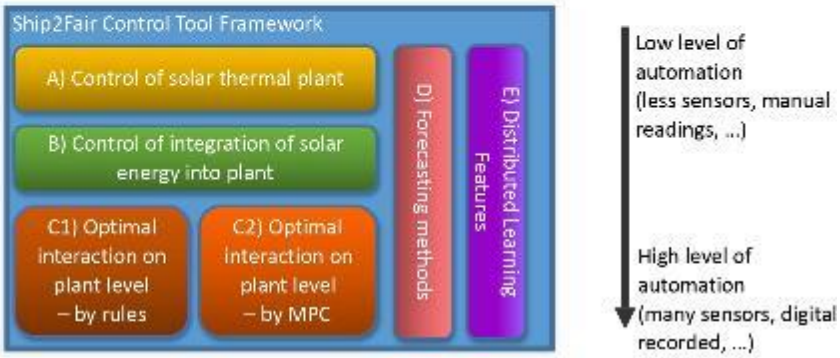
The design of the tool aims to be as flexible as possible in order to be applied to a multiplicity of systems, depending on

- user needs (e.g. control of only solar thermal system),
- plant design (e.g. available heat producers, storages) and
- level of automation (e.g. many sensors, digital recorded)

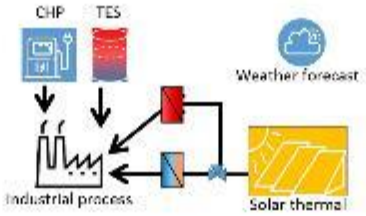
Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

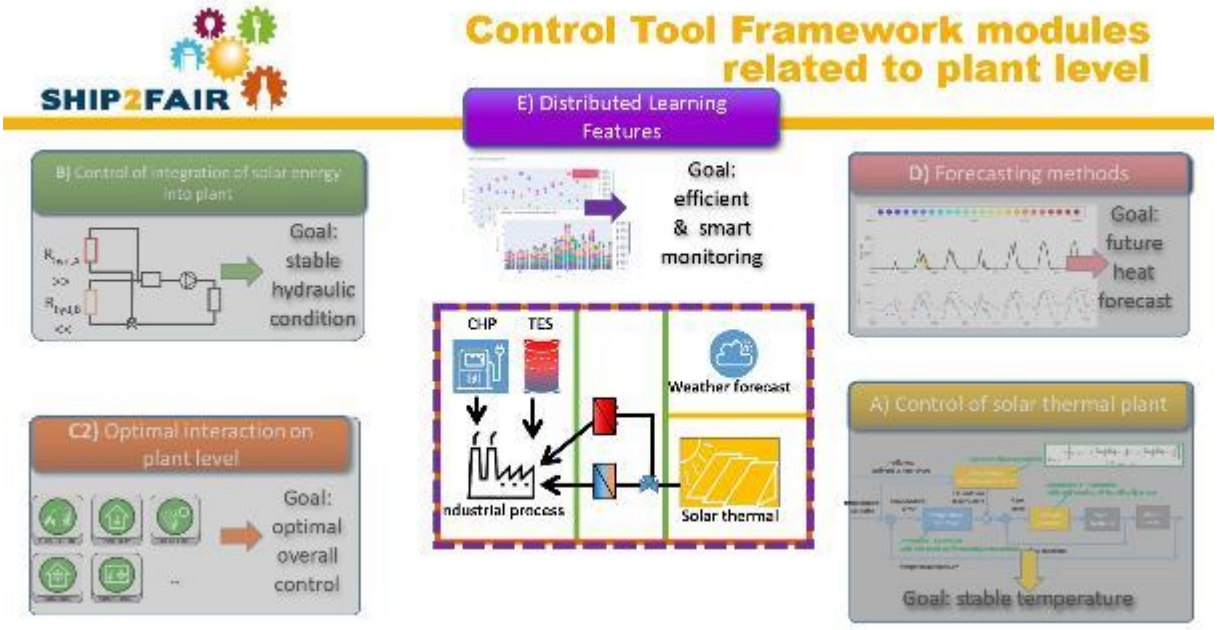
Design of the Control Tool

- Consists of a Framework of 5 MODULES which allow to make the most of the solar production.
- MODULES are chosen based on the possibilities available on-site
- Chosen MODULES form specific CONTROL TOOL for a plant



Control Tool Framework modules related to plant level





- Tool with the goal to optimize the system in operation and therefore addresses various control levels.
- Tool is based on a flexible design in order to be applied to a multiplicity of plants based on the possibilities on site.
- Level of implementation of Tool depends on the chosen modules (either on a programmable logic controller (PLC) or on a Server, resulting in a Web-Tool).

SHIP2FAIR

Thank you!

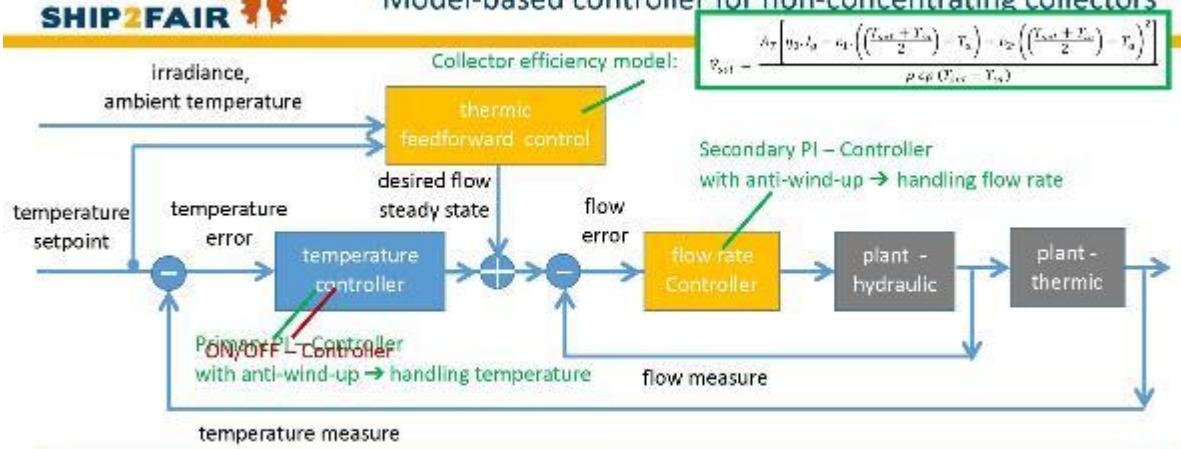
Viktor Unterberger
BEST – Bioenergy and Sustainable Technologies
viktor.unterberger@best-research.eu

SHIP2FAIR

Further explanation Module A and Module C

Further explanation of Module A – Control of solar thermal plant

Model-based controller for non-concentrating collectors



→ MODULE A - focuses on the optimal operation of the solar plant, e.g. control the outlet temperature
handles disturbances (e.g. fluctuating solar radiation), reacts in real time Implemented on PLC

9

Further explanation Module C – Overview

MODULE C focuses on the optimization of the whole plant, based on rules or by a Model Predictive Controller (MPC).

The MPC is

- considers a mathematical models of the whole system (including thermal storages, heat producers, etc.),
- takes into account forecast data (e.g. production and energy demand)
- and calculates the optimal operation strategy for a prediction horizon (e.g. 24h) based on a cost function (e.g. overall costs, CO_2 emissions)

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

Further explanation Module C – mathematical model for MPC

- Models developed for different components of a system and programmed in Julia (LINK)

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

Further explanation Module C – mathematical model for MPC

- Models developed for different components of a system and programmed in Julia (LINK)

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

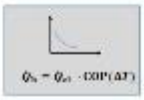
Further explanation Module C – mathematical model for MPC

- Models developed for different components of a system and programmed in Julia (LINK)

➔ for a modular approach these models can be combined to form a model of the whole system (see next slide)

- Models have to have a certain mathematical structure to be used in MPC and consider:

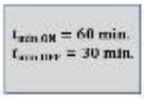
Input/output relationship



Transport delays

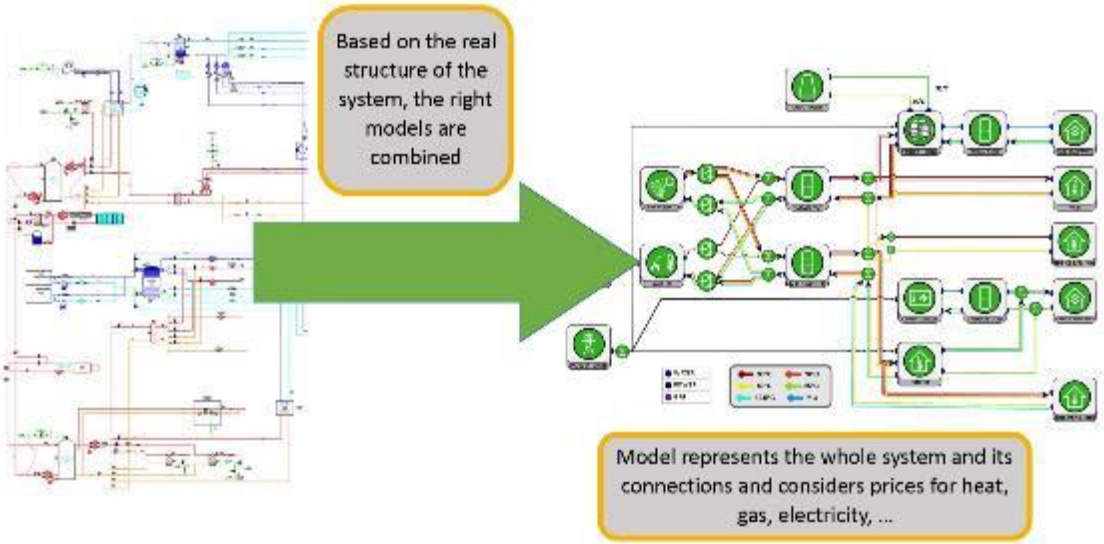
Ramp speed

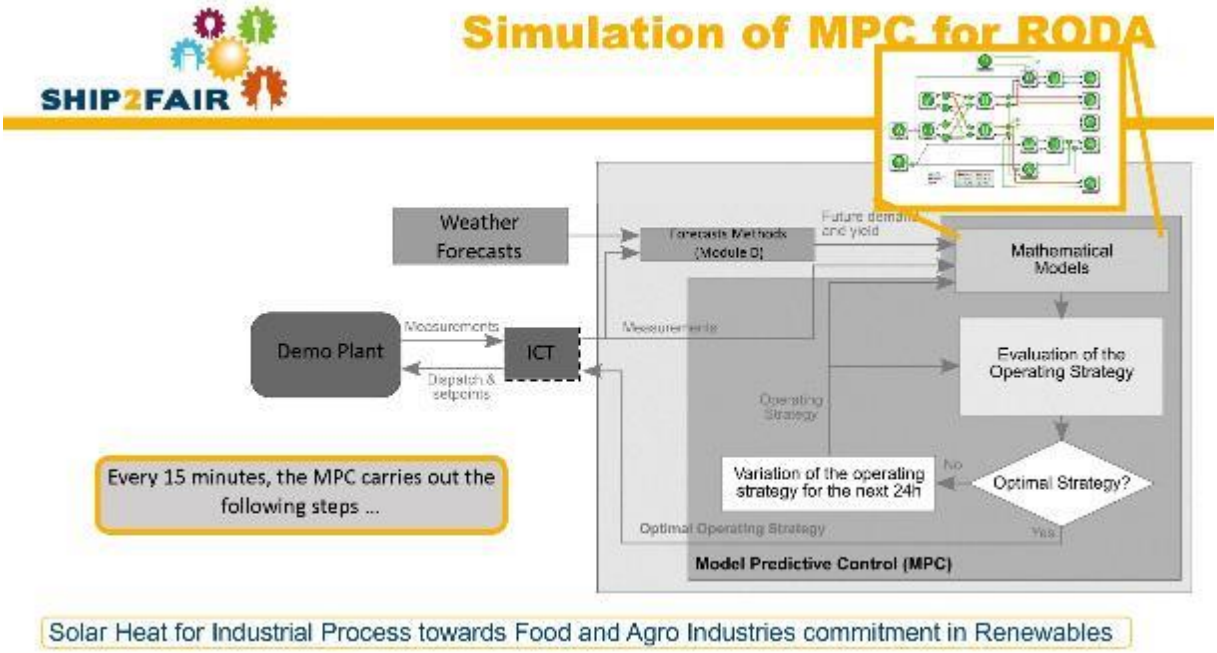
Constraints

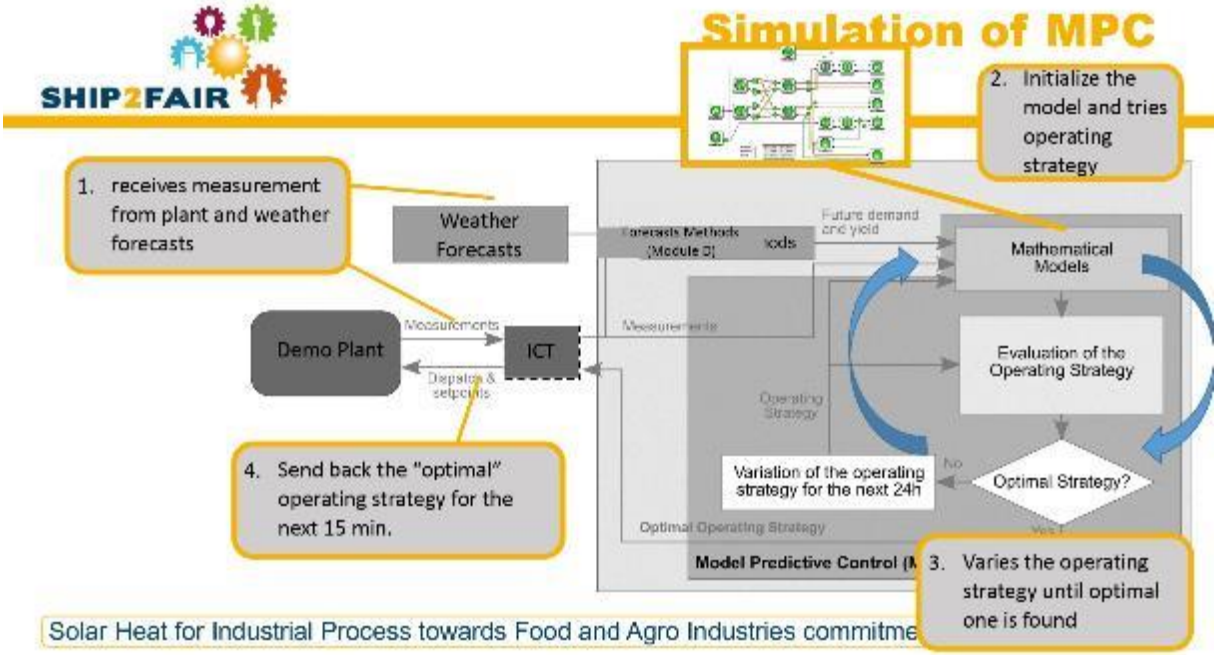


Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

Exemplarily application of the MPC




SHIP2FAIR
Simulation of MPC for RODA
Weather Forecasts
Forecasts Methods (Module D)
Future demand and yield
Mathematical Models
Demo Plant
Measurements
ICT
Dispatch & setpoints
Evaluation of the Operating Strategy
Operating Strategy
Every 15 minutes, the MPC carries out the following steps ...
Variation of the operating strategy for the next 24h
No
Optimal Strategy?
Yes
Optimal Operating Strategy
Model Predictive Control (MPC)
Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

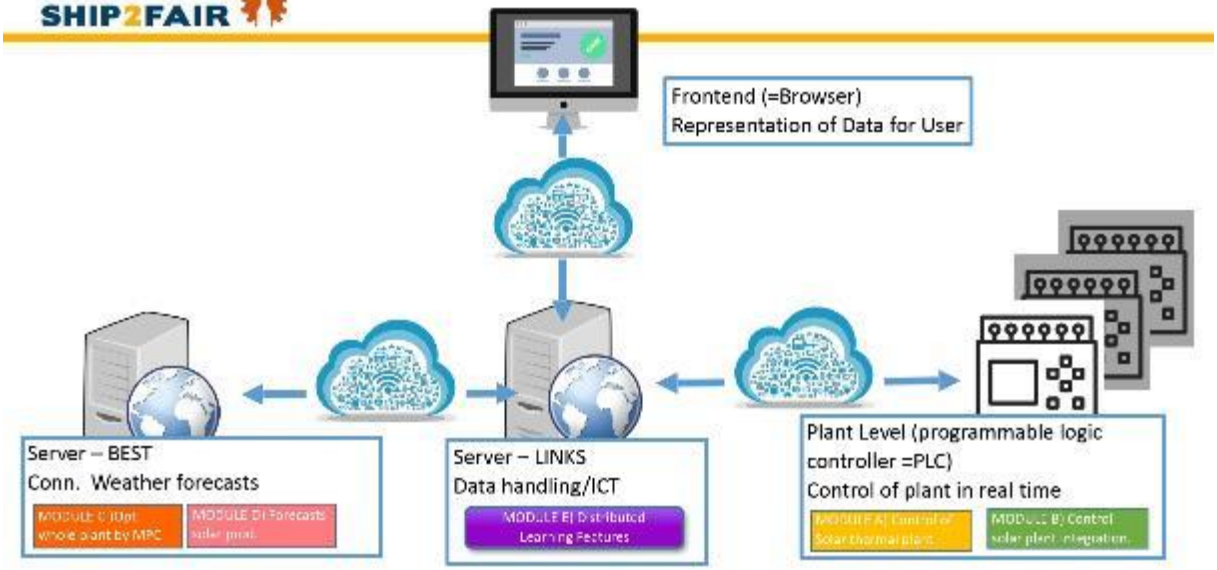

SHIP2FAIR
Simulation of MPC
2. Initialize the model and tries operating strategy
1. receives measurement from plant and weather forecasts
Weather Forecasts
Future demand and yield
Mathematical Models
Demo Plant
Measurements
ICT
Evaluation of the Operating Strategy
Operating Strategy
4. Send back the "optimal" operating strategy for the next 15 min.
Variation of the operating strategy for the next 24h
No
Optimal Strategy?
Optimal Operating Strategy
3. Varies the operating strategy until optimal one is found
Solar Heat for Industrial Process towards Food and Agro Industries commitme

SHIP2FAIR

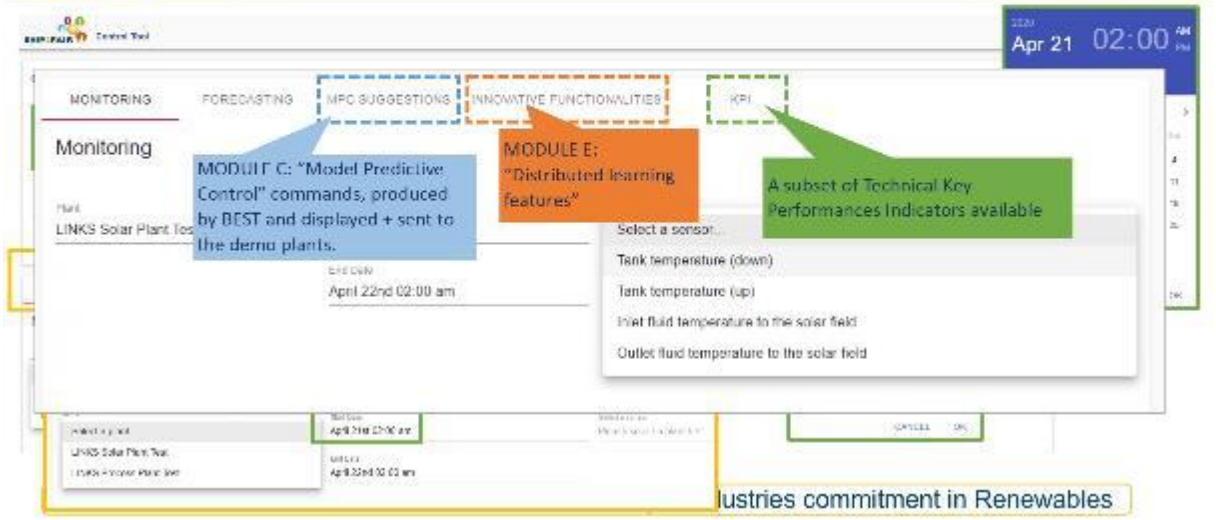
Implementation and Integration of the Control Tool

SHIP2FAIR

Planned integration of Control Tool



Example of Front-end - Current implementation



Summary of the Control Tool

- The SHIP2Fair Control Tool consists of a modular framework of different MODULES A to E
- The different MODULES can be 'plugged together' to form a specific Control Tool tailored to the needs of the demo plants and the possibilities on-site
- Parts of this specific Control Tool has to implemented on plant level and some on a higher level (e.g. a server with access to large amount of data and higher computational resources)
- A front-end (GUI) can be accessed by the demo plant operator to investigate their data, see the forecasts and suggestions by the MPC
- The Control Tool will be implemented in the next months and tested on-site to evaluate its performance in practice.

SHIP2FAIR

Thank you!

Viktor Unterberger
BEST – Bioenergy and Sustainable Technologies
viktor.unterberger@best-research.eu

Solar Heat for Industrial Process towards Food and Agro Industries commitment in Renewables

SHIP2FAIR

Thank you!

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

22

SHIP2FAIR

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables

Solar Heat for Industrial Processes

Webinar Series part 2, 01/06/2021

INDUSTRIAL SOLAR
renewables onsite

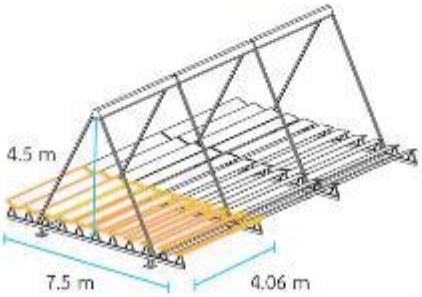
Irapua Ribeiro

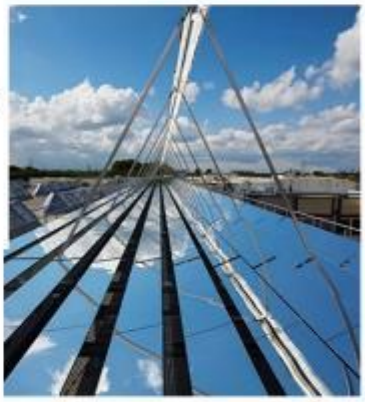
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

Fresnel Collector technology

SHIP2FAIR

INDUSTRIAL SOLAR
renewables onsite

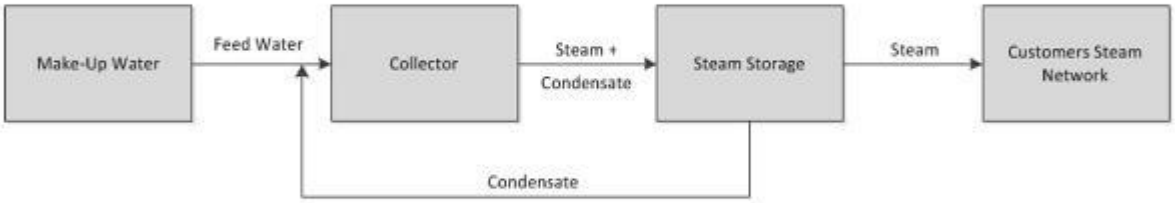




Generates heat up to 400 °C and 120 bar

Fresnel Collector – Steam generation concept

SHIP2FAIR



INDUSTRIAL SOLAR
renewables onsite

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 3

Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR

RAR Açúcar is a company dedicated to the refining and selling of sugar

Solar steam will reduce fuel consumption and avoid emissions from burning fuel oil and natural gas

NEEDS

Heating

- Sugar crystallization process: 125°C
- Solar steam operation modes:
  - Main use: 1 bar(g) grid for all major processes and the degasser
  - Optional: 5 bar(g) grid used for cleaning (in continuous process)

GRUPO RAR

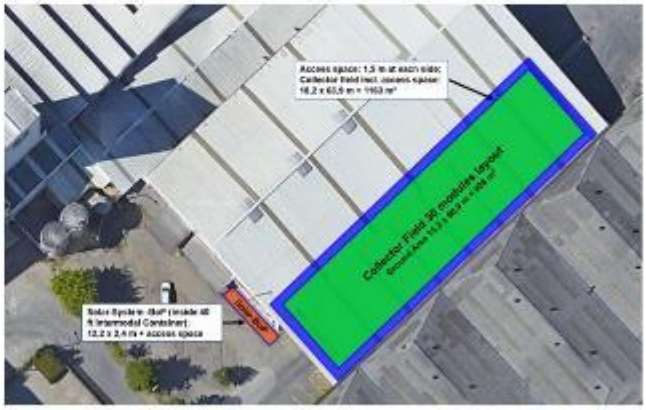
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 4

Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR

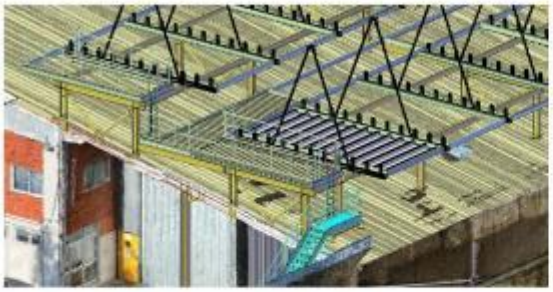
- Technology: Solar Fresnel Collectors
- Solar field: 30 modules
- Orientation: 47° from the N-S-axis
- 660 m² aperture area
- Production: steam @10 bar
- Under execution

INDUSTRIAL SOLAR
renewables onsite



Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR – Roof installation



SHIP2FAIR

Thank you!

info@ship2fair-h2020.eu

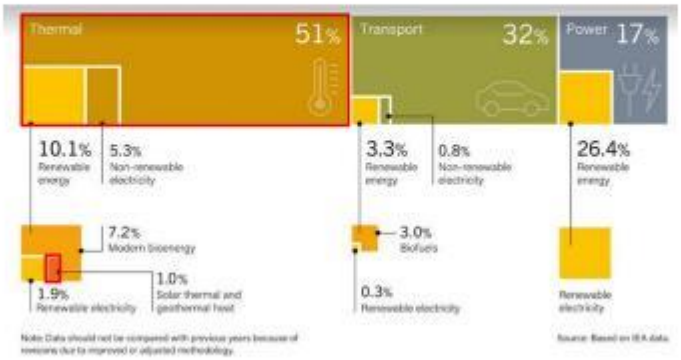
www.ship2fair-h2020.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

ANNEX 3: Webinar 3

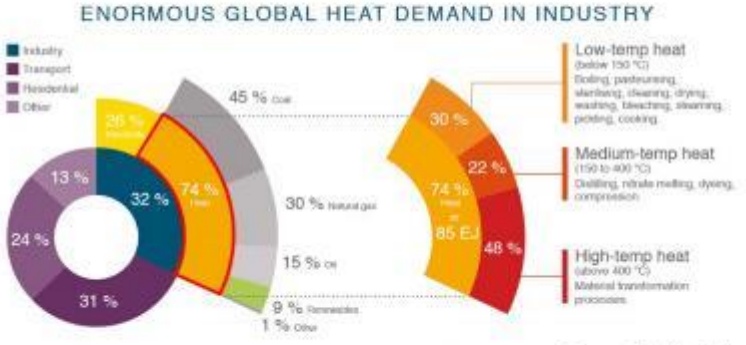
SHIP2FAIR
The energy needs in industry

The global trend has been for electricity to transform the energy sector, while:



With strong growth in demand for cooling

SHIP2FAIR
The energy needs in industry



INDUSTRIAL HEAT DEMAND ON THE RISE

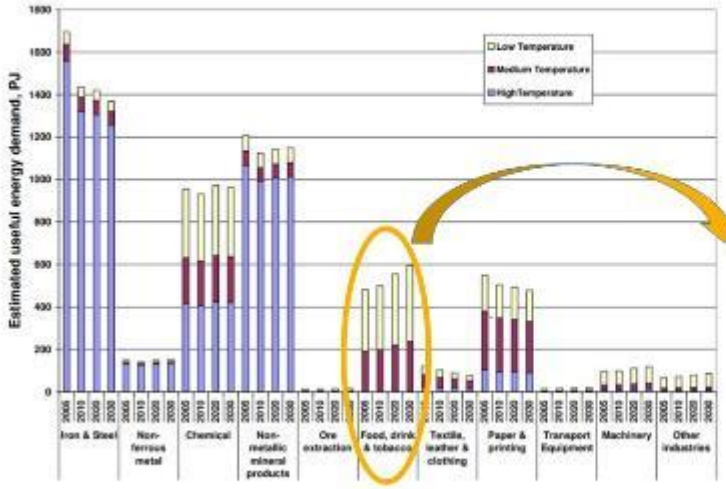
1.7 %

Average annual growth of industrial heat demand until 2030 [4]

90 %

Met by coal, oil and gas

SHIP2FAIR
Targeting the right industries



Fostering the integration of solar heat in industrial processes - SHIP from agro-food sector, by developing and demonstrating a set of tools and methods for the development of industrial solar heat projects during its whole life-cycle.

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 5

SHIP2FAIR
Industrial processes and temperature levels

Industrial Sector	Unit operation	Temperature range (°C)
Food	Drying	30-90
	Washing	60-90
	Pasteurising	60-80
	Boiling	95-105
	Sterilising	110-120
	Heat Treatment	40-60
Beverages	Washing	60-80
	Sterilising	60-90
	Pasteurising	60-70
Paper Industry	Cooking and Drying	60-80
	Boiler feed water	60-90
	Bleaching	130-150
Metal Surface Treatment	Treatment, electro-plating, etc.	30-80
Bricks and Blocks	Curing	60-140

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 6

Industrial Sector	Unit operation	Temperature range (°C)
Textile Industry	Bleaching	60-100
	Dyeing	70-90
	Drying, De-greasing	100-150
	Washing	40-80
	Fixing	160-180
	Pressing	80-100
Chemical Industry	Soaps	200-260
	Synthetic rubber	150-200
	Processing heat	120-180
	Pre-heating water	60-90
Plastic Industry	Preparation	120-140
	Distillation	140-150
	Separation	200-220
	Extension	140-160
	Drying	180-200
	Blending	120-140
Flour By-products	Sterilising	60-90
All Industrial Sectors	Pre-heating of boiler feed water	30-100
	Industrial solar cooling	55-180
	Heating of factory buildings	30-80

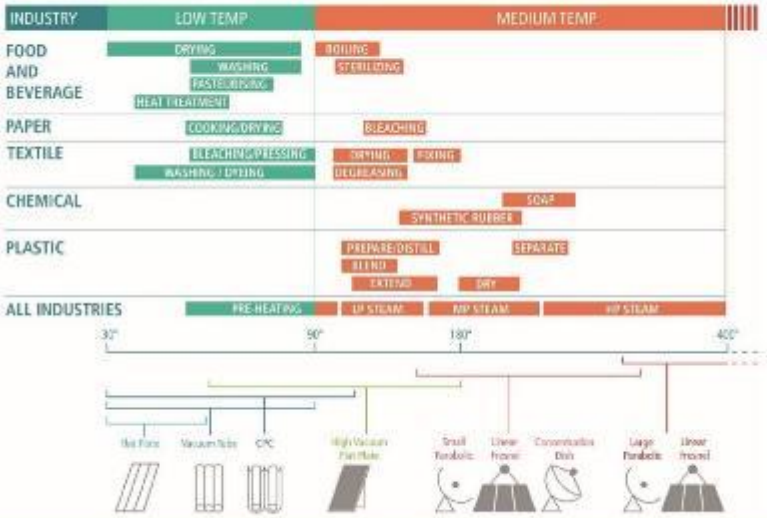
SHIP2FAIR

Industrial processes and temperature levels

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 7

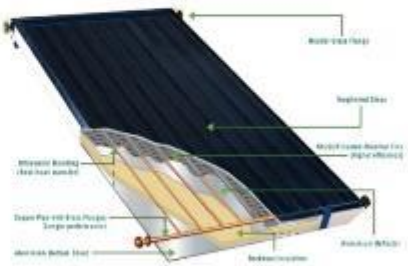
The Solar technologies vs temperature level

SHIP2FAIR

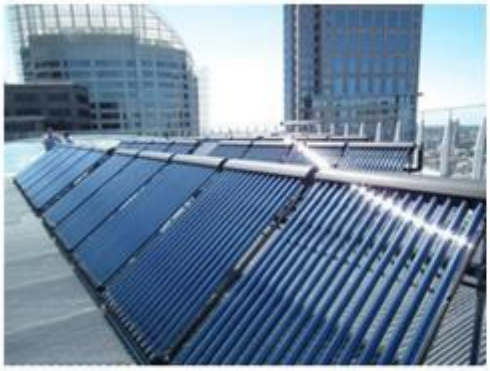


Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 8

SHIP2FAIR
Flat Plate



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 9



SHIP2FAIR
Vacuum tube

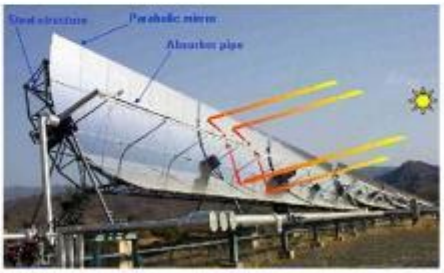
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 10

SHIP2FAIR
CPC

SHIP2FAIR
High Vacuum Flat Panel

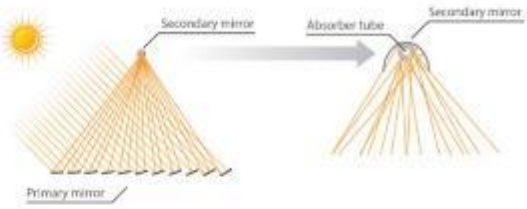
TVP SOLAR

SHIP2FAIR
Parabolic Through



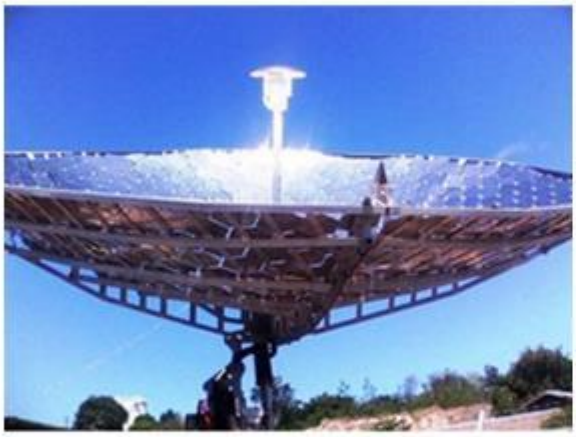
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 13

SHIP2FAIR
Linear Fresnel

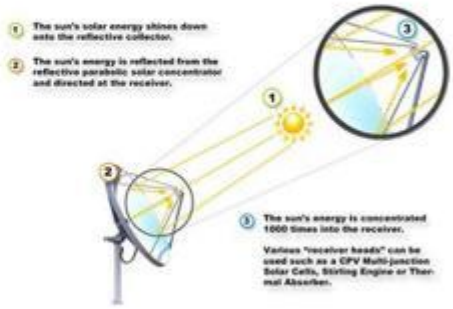


INDUSTRIAL SOLAR
renewables onsite

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 14



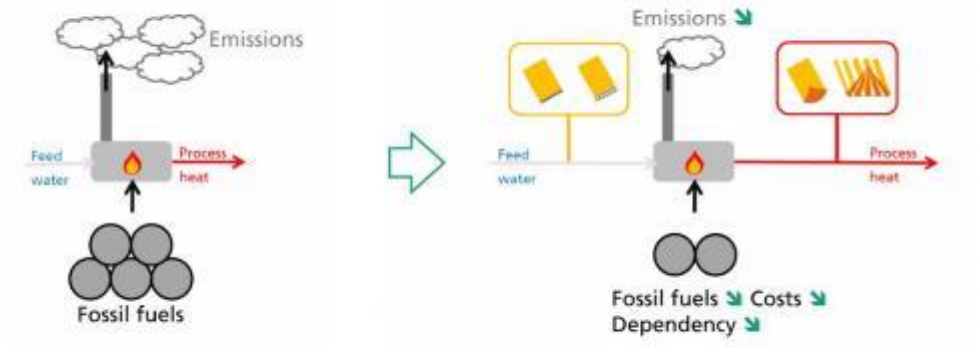
SHIP2FAIR
Dishes



Dish requires dual axis tracking

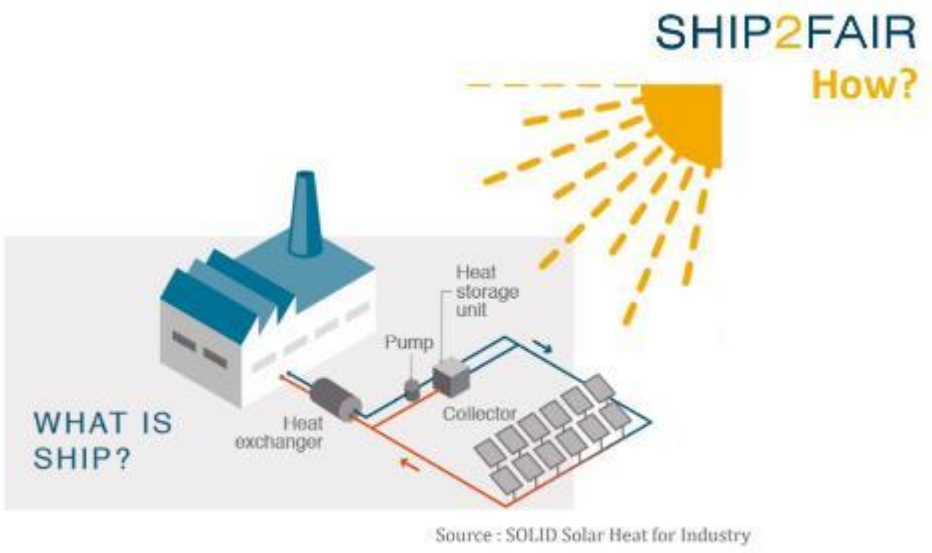
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 15

SHIP2FAIR
Why SHIP?

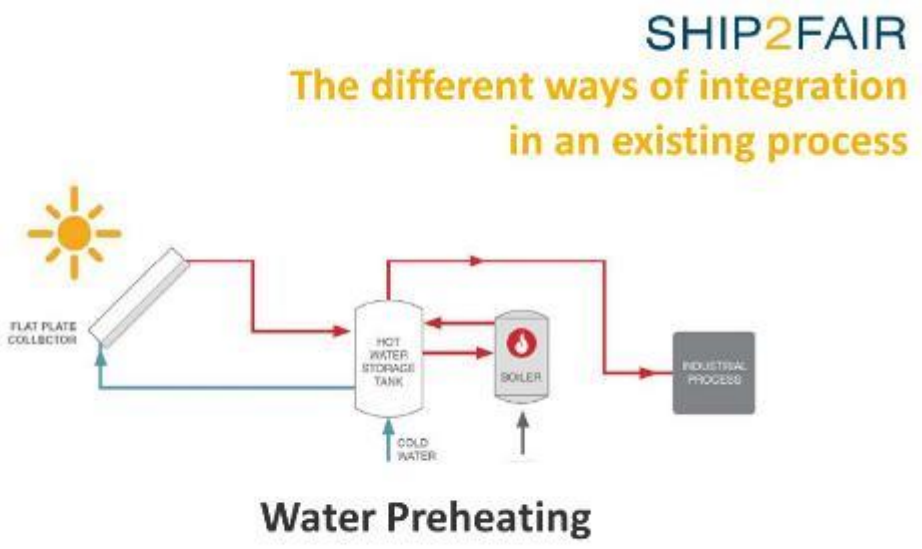


Source : SOLID Solar Heat for Industry

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 16



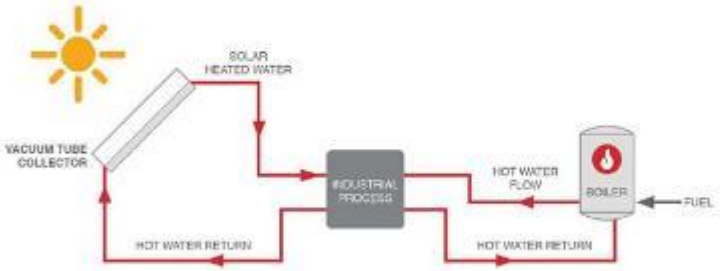
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 17



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 18

SHIP2FAIR

The different ways of integration in an existing process

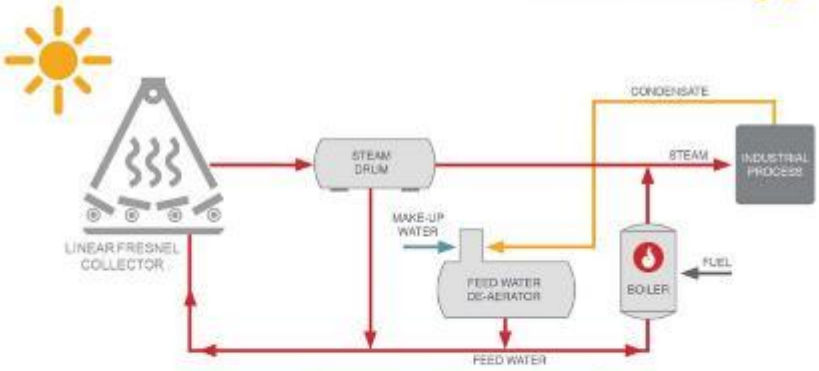


Process Heating

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 19

SHIP2FAIR

The different ways of integration in an existing process

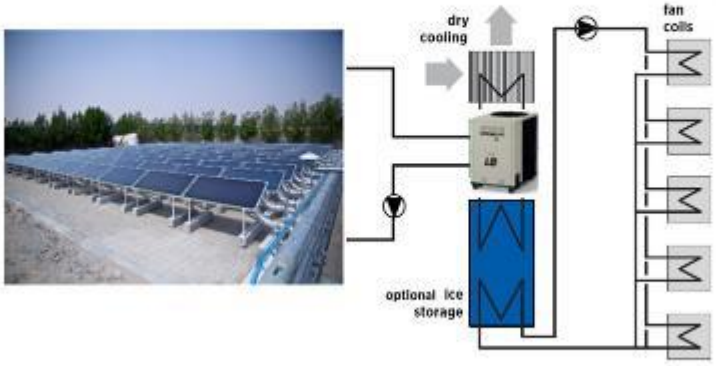


Direct Steam Generation

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 20

SHIP2FAIR

The different ways of integration in an existing process

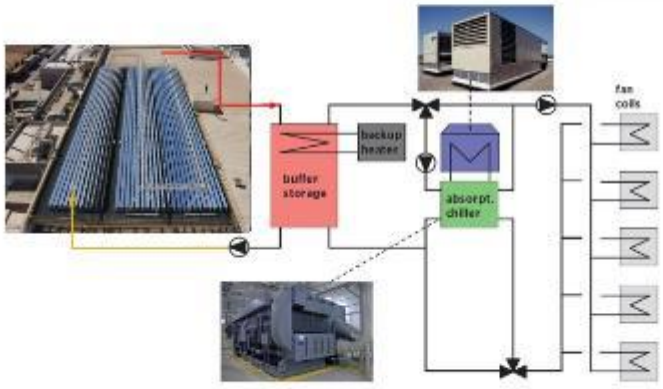


Solar thermal cooling (ammonia-water chiller)

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 21

SHIP2FAIR

The different ways of integration in an existing process



Solar thermal cooling (lithium-bromide-water chiller)

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 22

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

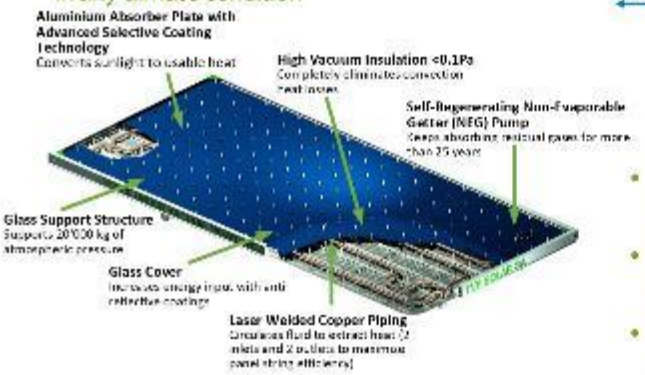
SHIP2FAIR project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

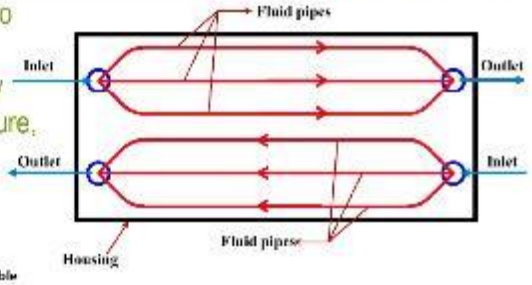
The World Best Solar Thermal Collector

TVP SOLAR Thermal Vacuum Power

SHIP2FAIR

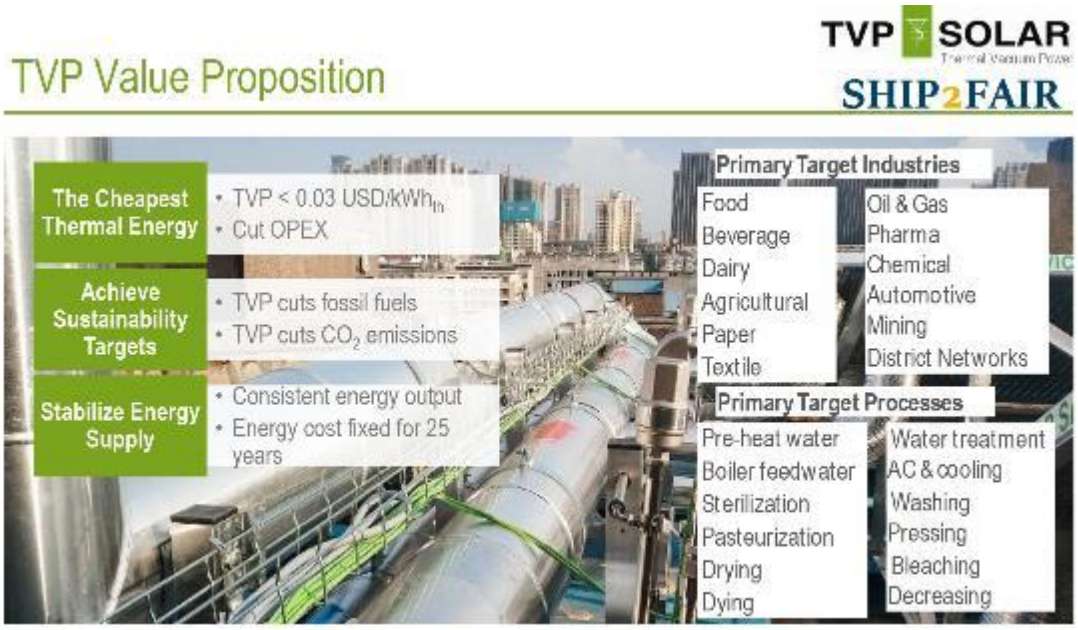
- SolarKeyMark certified best performance 65˚C to 200˚C
- Best efficiency and highest energy production at any operating temperature, with any ambient temperature, in any climate condition

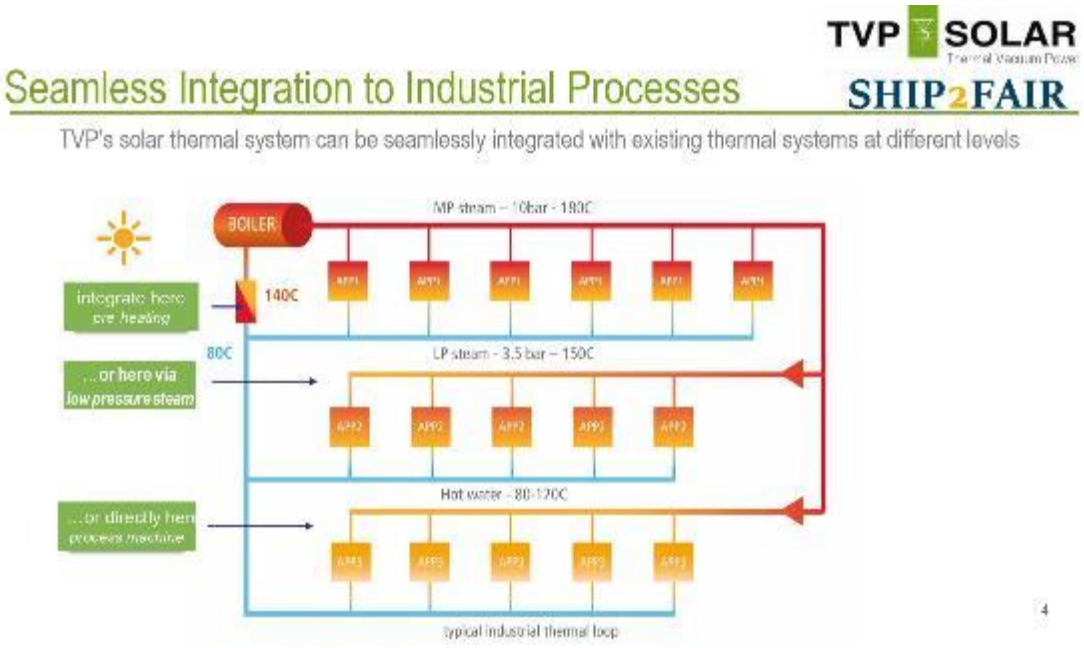


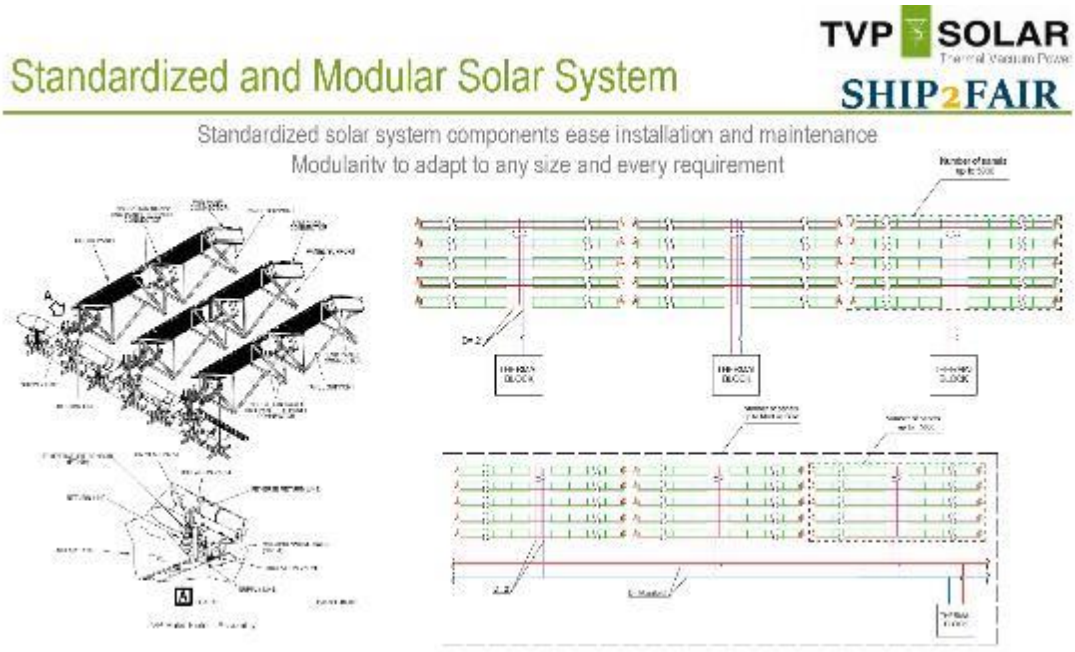


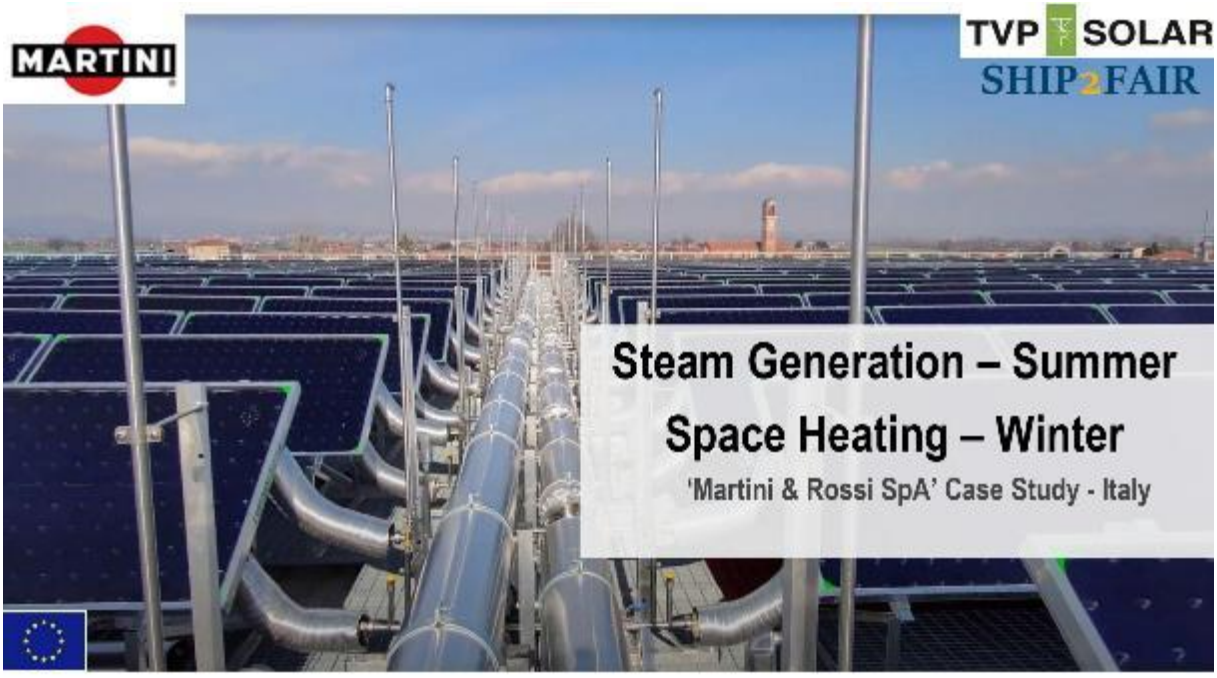
- High-vacuum insulation suppresses thermal losses
- 20 years consistent & predictable performance without any degradation
- Designed for industrial-scale applications

2


TVP SOLAR
SHIP2FAIR
TVP Value Proposition
The Cheapest Thermal Energy
• TVP < 0.03 USD/kWh$_{th}$
• Cut OPEX
Achieve Sustainability Targets
• TVP cuts fossil fuels
• TVP cuts CO_2 emissions
Stabilize Energy Supply
• Consistent energy output
• Energy cost fixed for 25 years
Primary Target Industries
Food
Beverage
Dairy
Agricultural
Paper
Textile
Oil & Gas
Pharma
Chemical
Automotive
Mining
District Networks
Primary Target Processes
Pre-heat water
Boiler feedwater
Sterilization
Pasteurization
Drying
Dying
Water treatment
AC & cooling
Washing
Pressing
Bleaching
Decreasing
3


TVP SOLAR
SHIP2FAIR
Seamless Integration to Industrial Processes
TVP's solar thermal system can be seamlessly integrated with existing thermal systems at different levels
BOILER
MP steam – 10bar - 180C
140C
integrate here pre-heating
80C
...or here via low pressure steam
LP steam - 3.5 bar – 150C
Hot water - 80-120C
...or directly here process machine
Typical industrial thermal loop
4


TVP SOLAR
SHIP2FAIR
Standardized and Modular Solar System
Standardized solar system components ease installation and maintenance
Modularity to adapt to any size and every requirement


MARTINI
TVP SOLAR
SHIP2FAIR
Steam Generation – Summer
Space Heating – Winter
'Martini & Rossi SpA' Case Study - Italy

Solar Process Heat at M&R: Overview

TVP SOLAR
SHIP2FAIR

- **Context**: Demonstration site under the H2020 **SHIP2FAIR** project
- **Solar thermal technology**: High Vacuum Flat Panels (HVFPs)
- **Site & Location:** Alcoholic beverage plant – Pessione, Turin, Italy
- **Global Horizontal Irradiance**: 1332 kWh/m²
- **Installation**: Rooftop
- **Collector surface**: 596 m2
- **Installed Power**: 327 kWp
- **Energy production**: 349,403 kWh/y (586 kWh/m2/y)
- **Configuration:** Oct-Mar: Hot water. Operating T: 90°C (outlet)
  Apr-Sep: Steam. Operating T: 170°C (outlet)
- **Installation completed:** Dec 2020; **Commissioning**: Feb 2021

Upcoming Demo

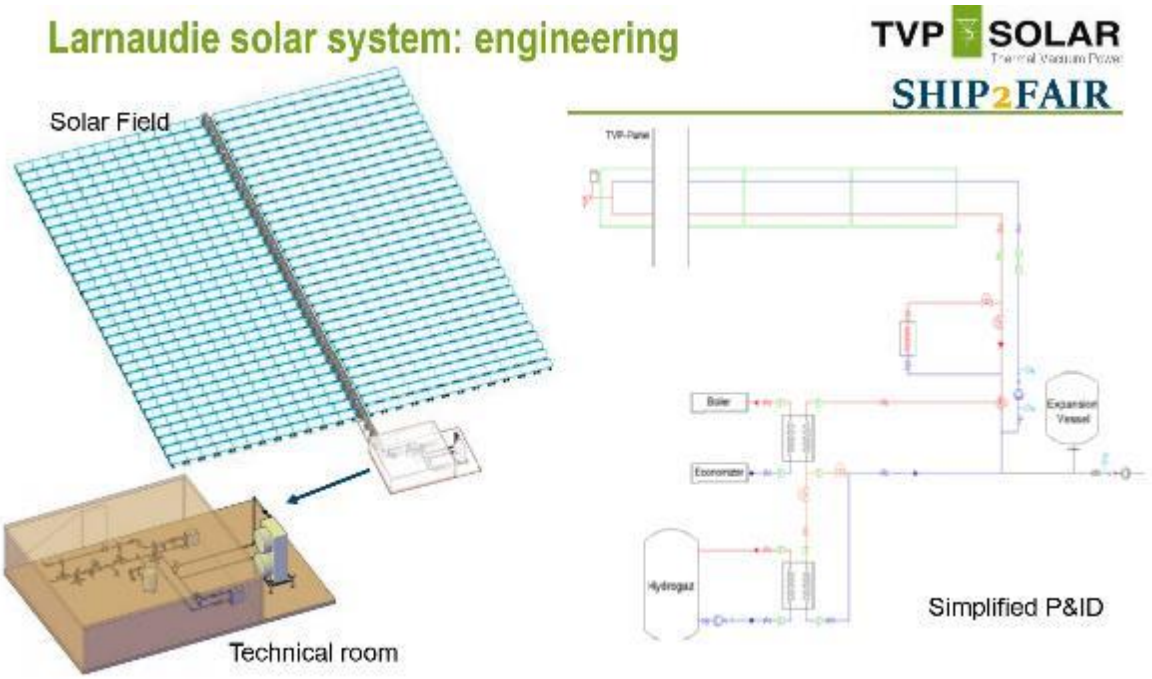
TVP SOLAR
SHIP2FAIR

Jean LARNAUDIE DEPUIS 1951

Foie-gras production
Castelnaudary, France

Technology: HVFP
Solar Field size: 1600 m² – 1MW$_{th}$
Cascade application:

- Boiler feed water pre-heating @140C
- Water tank heating @65C


Larnaudie solar system: engineering
TVP SOLAR
SHIP2FAIR
Solar Field
Technical room
Simplified P&ID


TVP SOLAR
SHIP2FAIR
papageorgiou@tvpsolar.com
Questions?

SHIP2FAIR

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables

Solar Heat for Industrial Processes

Webinar series #3 - Fresnel Collector Technology

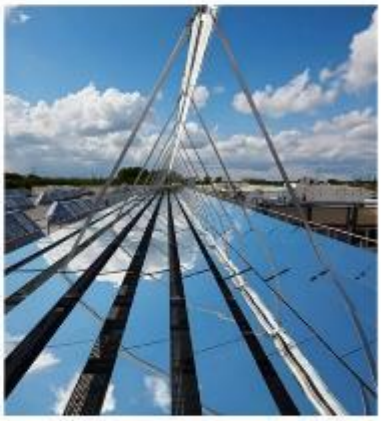
Irapua Ribeiro
17.06.2021

INDUSTRIAL SOLAR
renewables onsite

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

Fresnel Collector technology

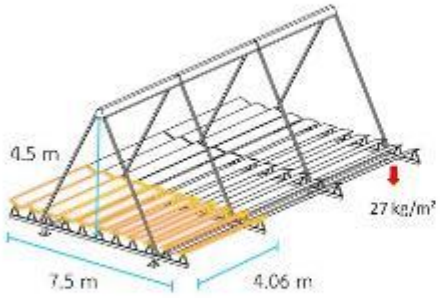
SHIP2FAIR
INDUSTRIAL SOLAR
renewables onsite



Fresnel Collector technology

SHIP2FAIR
INDUSTRIAL SOLAR
renewables onsite

Uniaxially tracked mirrors concentrate sunlight onto an absorber where heat is generated



- ✓ Modular design, easily expandable
- ✓ Lightweight structure allows rooftop installation
- ✓ **Generates heat up to 400 °C** and 120 bar
- ✓ Produces steam, heat up water or thermal oil
- ✓ System lifetime: + 25 years

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 3

Fresnel Collector – Components

SHIP2FAIR
INDUSTRIAL SOLAR
renewables onsite

Mirror system (robust)

Absorber tube (high efficiency)

Support Structure (lightweight)

Control system (smart control)

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 4

Fresnel Collector – Technology overview

SHIP2FAIR INDUSTRIAL SOLAR renewables onsite

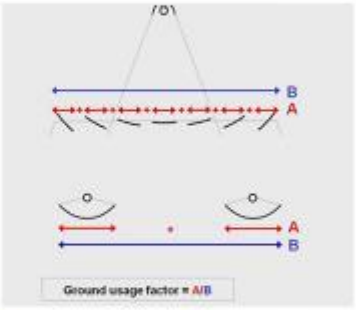
Higher ground usage factor
~65% higher space efficiency (mirror area / ground area)
Space needs: 1 MW_{th} uses ~ 3000 m^2

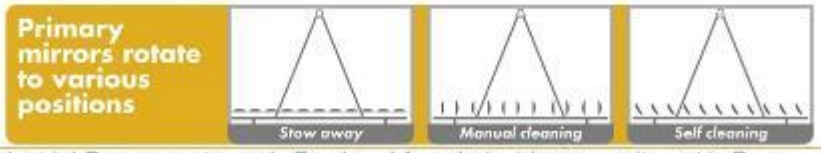
Low wind load
Low exposure to wind → less structural loads

Good weight distribution
Even distribution of the weight on the ground

Automatic operation, from sunrise to sunset
Cleaning designs: automatic or manual

Low dust accumulation: stow position (e.g., 18h to 6h), self cleaning

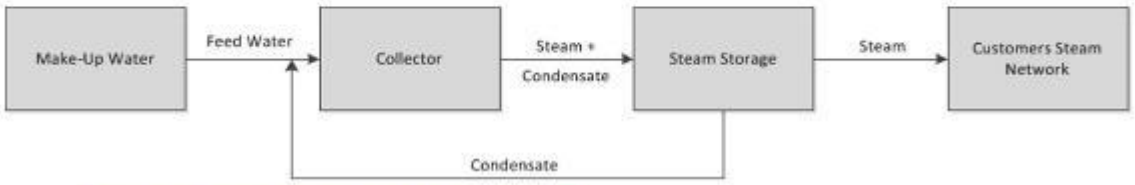


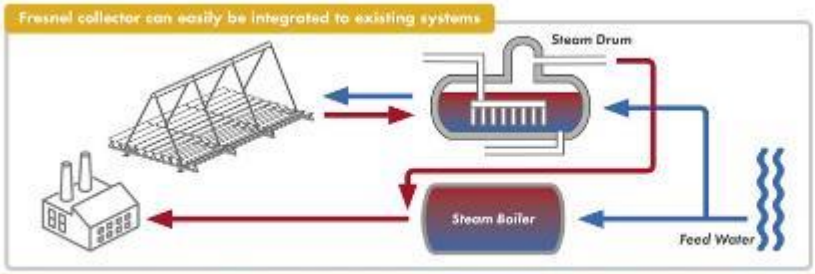


Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 5

Fresnel System – Steam generation concept

SHIP2FAIR INDUSTRIAL SOLAR renewables onsite

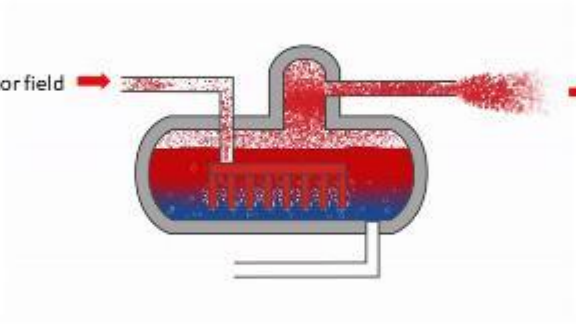




Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 6

Fresnel System – Steam drum

SHIP2FAIR
INDUSTRIAL SOLAR
renewables onsite



Large pressure vessel

mainly filled with liquid water (80% of volume)

partly filled with steam (20% of volume)

Additional Functions of Storage

- Two-phase separation
- Expansion Vessel
- Steam pressurization
- Blow-down
- De-Aeration
- Anti-Freeze protection

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 7

INDUSTRIAL SOLAR
renewables onsite

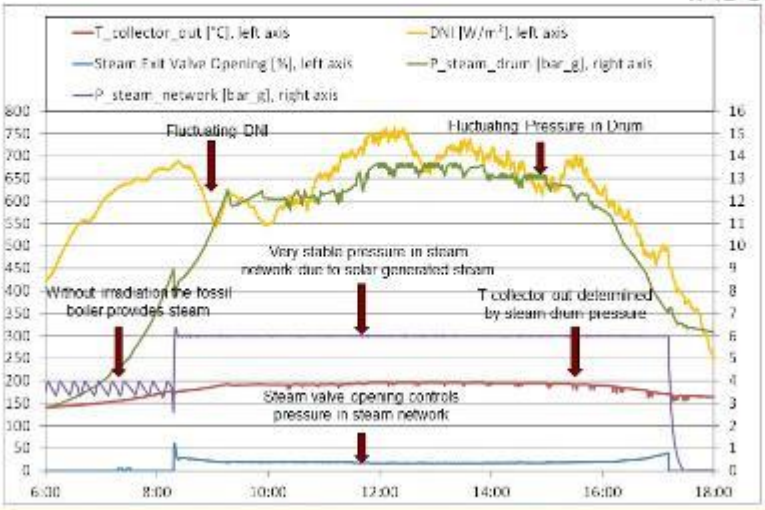
SHIP2FAIR

Fresnel System – Steam drum

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 8

Fresnel System – Operation Diagram

SHIP2FAIR
INDUSTRIAL SOLAR
renewables onsite



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 9

Fresnel System - Applications

INDUSTRIAL SOLAR
renewables onsite
SHIP2FAIR

Several industrial applications
Large energy requirements

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 10

Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR

RAR Açúcar is a company dedicated to the refining and selling of sugar

Solar steam will reduce fuel consumption and avoid emissions from burning fuel oil and natural gas

NEEDS

Heating

- Sugar crystallization process: 125°C
- Solar steam operation modes:
  - Main use: 1 bar(g) grid for all major processes and the degasser
  - Optional: 5 bar(g) grid used for cleaning (in continuous process)

GRUPO RAR

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 11

Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR

- Technology: Solar Fresnel Collectors
- Solar field: 30 modules
- Orientation: 47° from the N-S-axis
- 660 m² aperture area
- Production: steam @10 bar
- Under execution

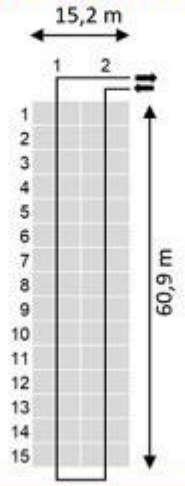
INDUSTRIAL SOLAR
renewables onsite

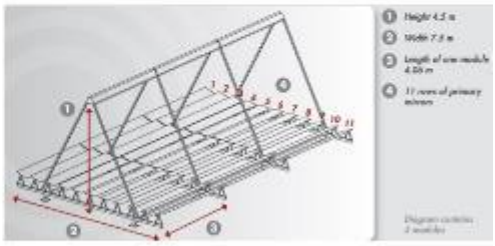
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 12

Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR – System layout

- 30 modules (15 strings of 2 modules each)
- 690 m² aperture area
- 415 kW thermal power at reference conditions
- 926 m² ground space (15,2m x 60,9m)
- + access space of 1,5 m each side
- 75 % ground space efficiency



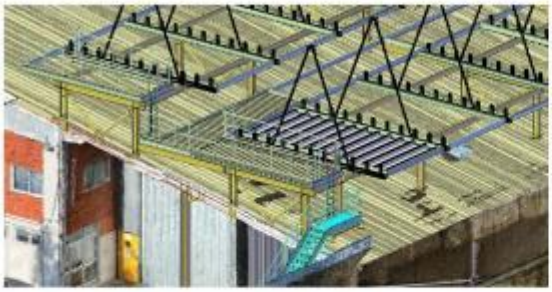


INDUSTRIAL SOLAR
renewables onsite

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 13

Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR – Roof installation



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 14

Sugar boiling Porto, Portugal

SHIP2FAIR

Demo site at RAR – BOP container

INDUSTRIAL SOLAR renewables onsite

Steam storage and BOP Container

- Replicability
- Reduced costs (engineering, planning)
- Pre-manufacturing & tests before shipping
- Reduced installation time onsite
- Short pipe ways from solar field to solar BoP
- Clear definition of solar system interfaces

Storage capacity: **60 minutes and 415 kWh (1,5 GJ)**

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 15

Sugar boiling Porto, Portugal

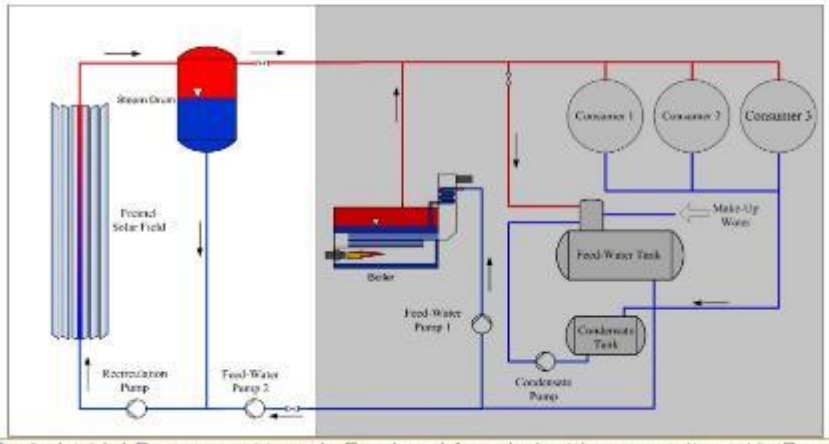
SHIP2FAIR

Demo site at RAR – Steam integration

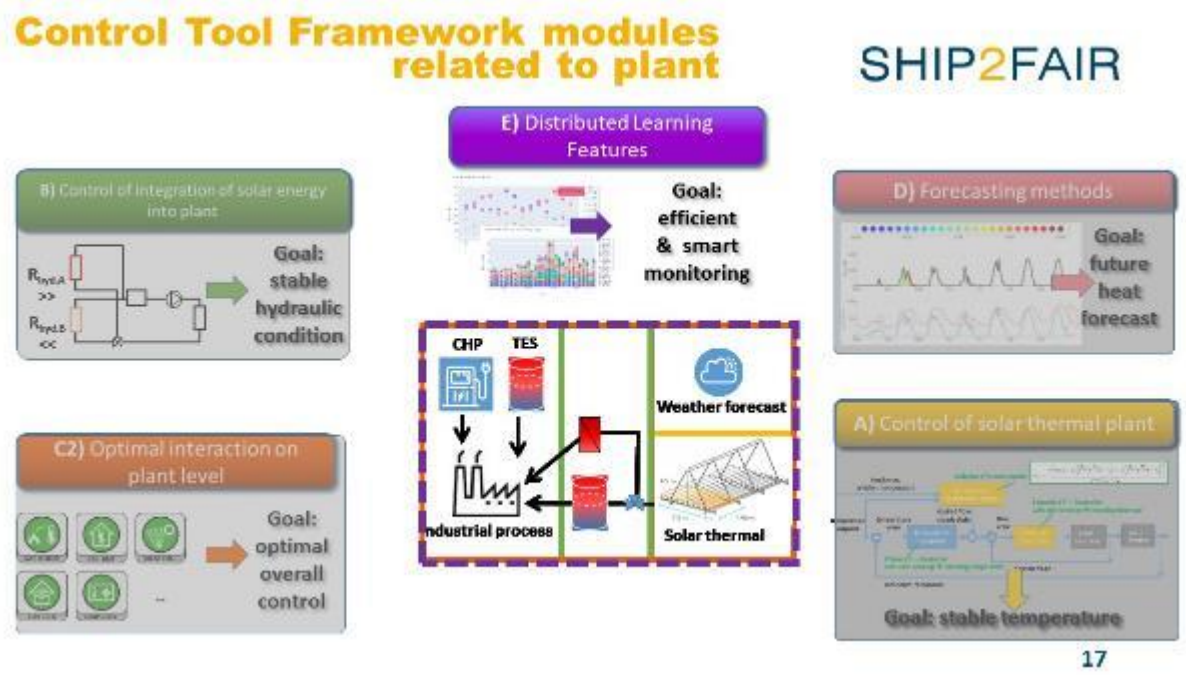
Solar Steam Boiler

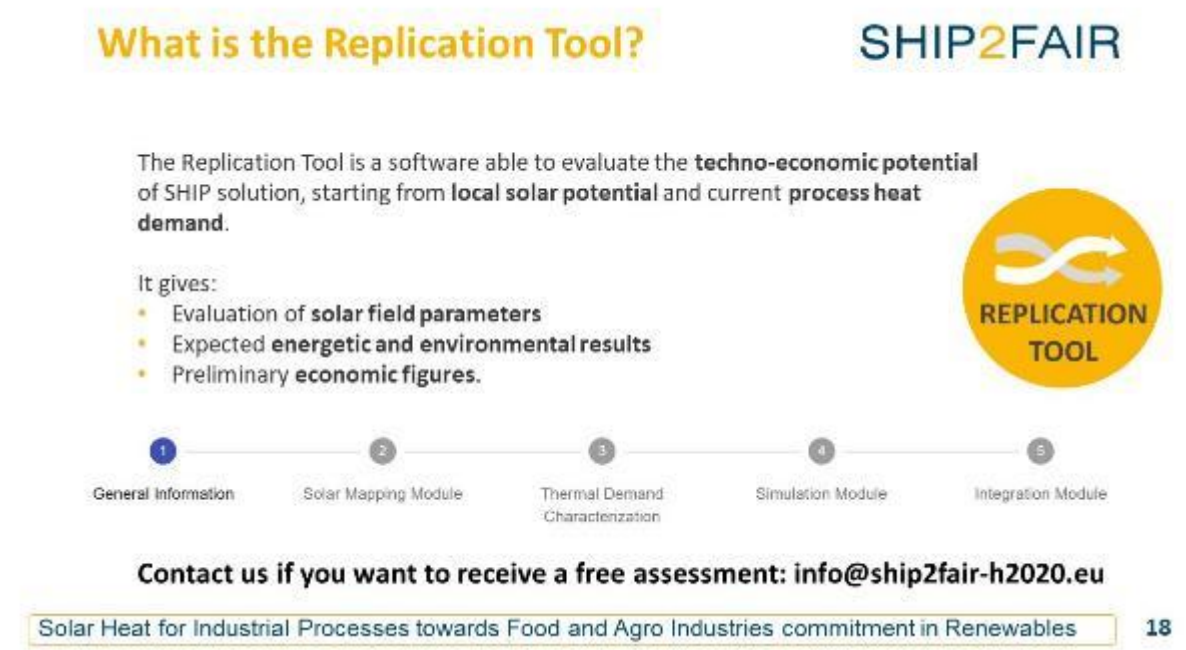
Existing Steam Network

INDUSTRIAL SOLAR renewables onsite



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 16


Control Tool Framework modules related to plant
SHIP2FAIR
E) Distributed Learning Features
Goal: efficient & smart monitoring
B) Control of integration of solar energy into plant
Goal: stable hydraulic condition
D) Forecasting methods
Goal: future heat forecast
CHP
TES
Weather forecast
Industrial process
Solar thermal
C2) Optimal interaction on plant level
Goal: optimal overall control
A) Control of solar thermal plant
Goal: stable temperature
17


What is the Replication Tool?
SHIP2FAIR
The Replication Tool is a software able to evaluate the techno-economic potential of SHIP solution, starting from local solar potential and current process heat demand.
It gives:
Evaluation of solar field parameters
Expected energetic and environmental results
Preliminary economic figures.
REPLICATION TOOL
1 General Information
2 Solar Mapping Module
3 Thermal Demand Characterization
4 Simulation Module
5 Integration Module
Contact us if you want to receive a free assessment: info@ship2fair-h2020.eu
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables
18

SHIP2FAIR

Thank you!

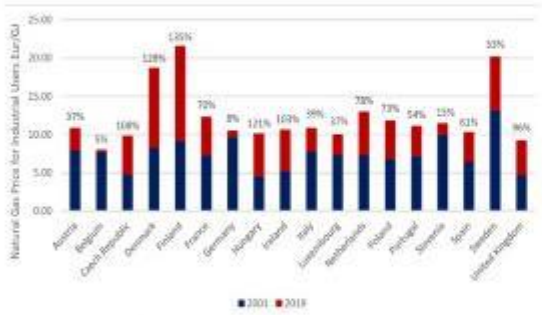
info@ship2fair-h2020.eu

www.ship2fair-h2020.eu

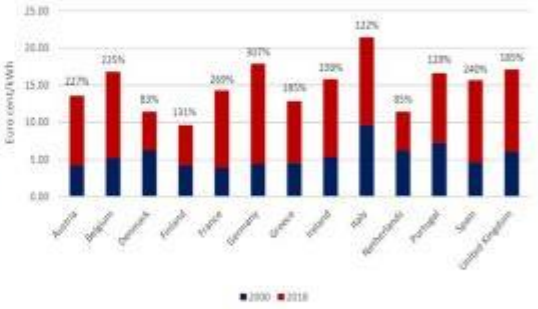
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

ANNEX 4: Student Master Class

SHIP2FAIR
The energy price evolution



Natural gas Price evolution

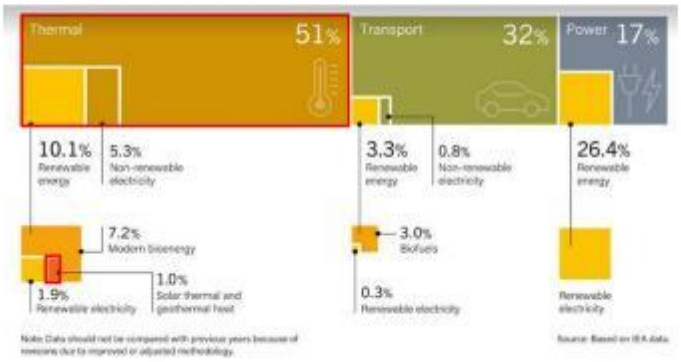


Electricity Price evolution

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 3

SHIP2FAIR
The energy needs in industry

The global trend has been for electricity to transform the energy sector, while:

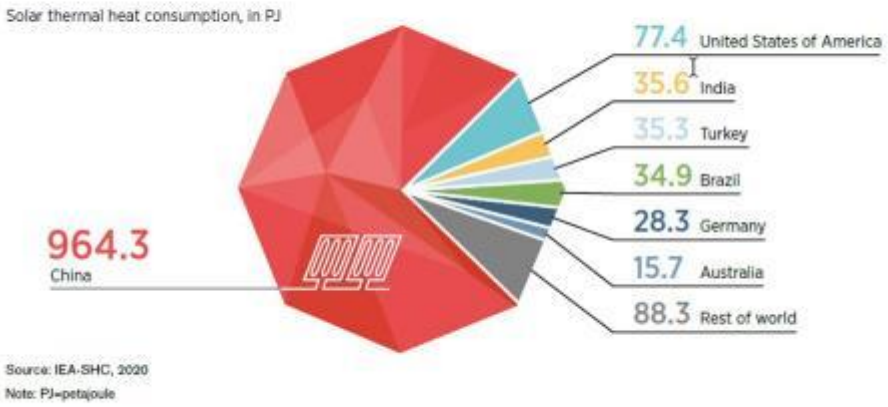


With strong growth in demand for cooling

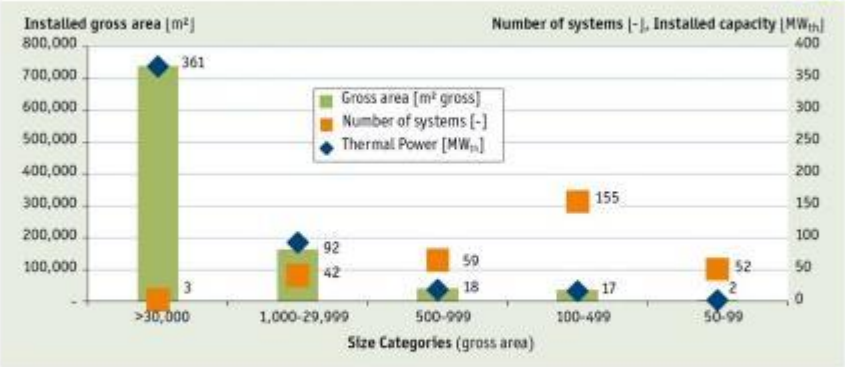
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 4

SHIP2FAIR
The energy needs in industry

SHIP2FAIR
The Solar Thermal Heat Consumption

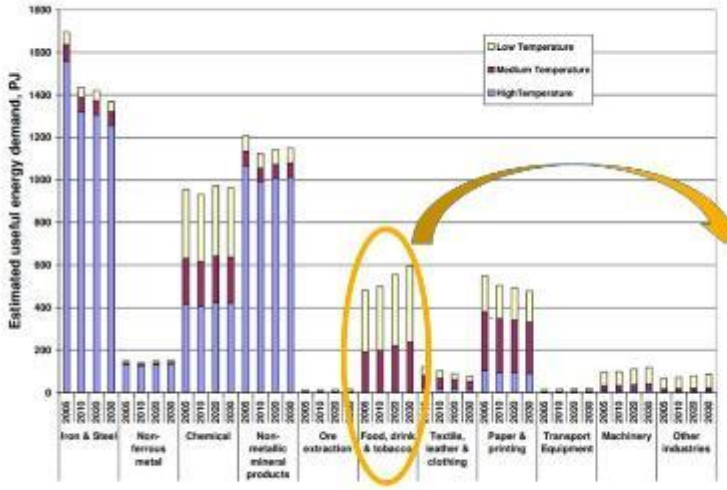


SHIP2FAIR
SHIP sizes



- The world's largest SHIP plant, the Miraah in Oman (300 MWth), produce steam for the extraction of heavy oil from the ground.
- The second largest SHIP application is for a green house in Australia (36.6 MWth).
- The third largest system is installed in Chile (27.5 MWth) for a copper mining process.

SHIP2FAIR
Targeting the right industries



Fostering the integration of solar heat in industrial processes - SHIP from agro-food sector, by developing and demonstrating a set of tools and methods for the development of industrial solar heat projects during its whole life-cycle.

SHIP2FAIR
Industrial processes and temperature levels

Industrial Sector	Unit operation	Temperature range (°C)
Food	Drying	30-90
	Washing	60-90
	Pasteurising	60-80
	Boiling	95-105
	Sterilising	110-120
	Heat Treatment	40-60
Beverages	Washing	60-80
	Sterilising	60-90
	Pasteurising	60-70
Paper Industry	Cooking and Drying	60-80
	Boiler feed water	60-90
	Bleaching	130-150
Metal Surface Treatment	Treatment, electro-plating, etc.	30-80
Bricks and Blocks	Curing	60-140

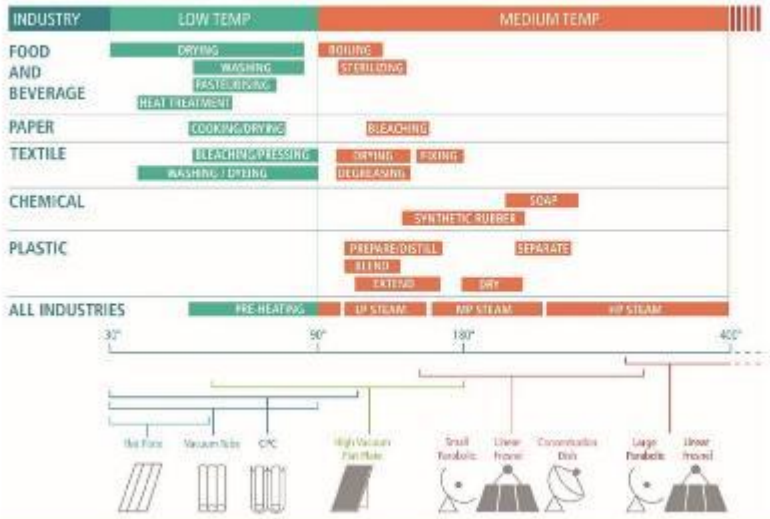
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 9

Industrial Sector	Unit operation	Temperature range (°C)
Textile Industry	Bleaching	60-100
	Dyeing	70-90
	Drying, De-greasing	100-150
	Washing	40-80
	Fixing	160-180
	Pressing	80-100
Chemical Industry	Soaps	200-260
	Synthetic rubber	150-200
	Processing heat	120-180
	Pre-heating water	60-90
Plastic Industry	Preparation	120-140
	Distillation	140-150
	Separation	200-220
	Extension	140-160
	Drying	180-200
	Blending	120-140
Flour By-products	Sterilising	60-90
All Industrial Sectors	Pre-heating of boiler feed water	30-100
	Industrial solar cooling	55-180
	Heating of factory buildings	30-80

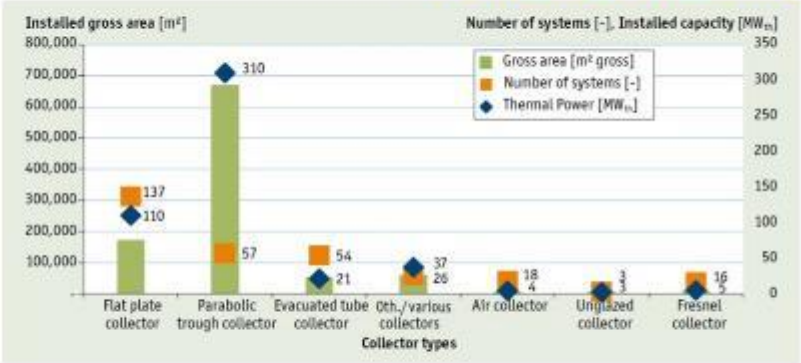
SHIP2FAIR
Industrial processes and temperature levels

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 10

The Solar technologies vs temperature level SHIP2FAIR

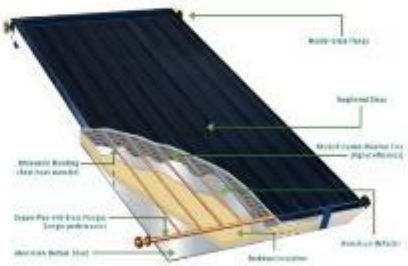


SHIP2FAIR
The plants by technology

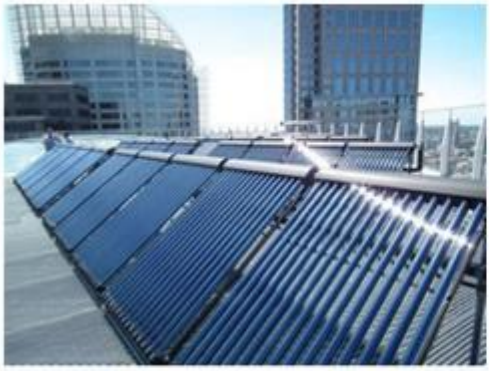


The majority of the systems use **flat-plate collectors** to produce solar process heat, followed by **parabolic trough collectors** and **evacuated tube collectors.**

SHIP2FAIR
Flat Plate



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 13



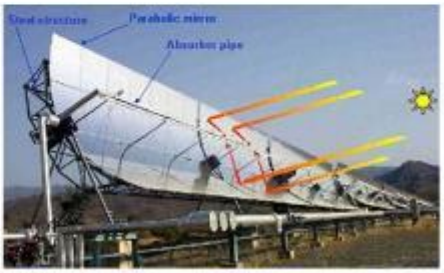
SHIP2FAIR
Vacuum tube

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 14

SHIP2FAIR
CPC

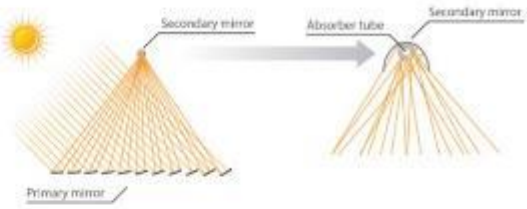
SHIP2FAIR
High Vacuum Flat Panel

SHIP2FAIR
Parabolic Through



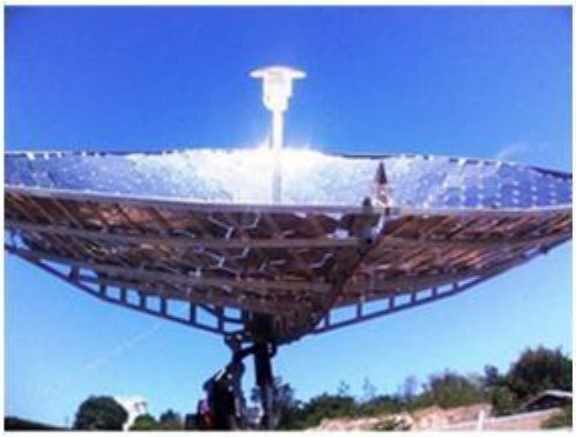
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 17

SHIP2FAIR
Linear Fresnel

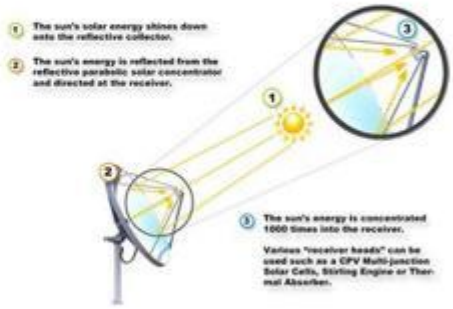


INDUSTRIAL SOLAR
renewables onsite

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 18

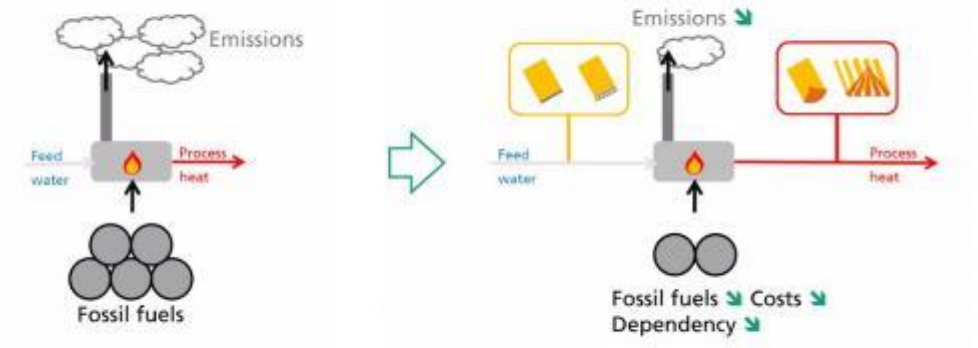


SHIP2FAIR
Dishes

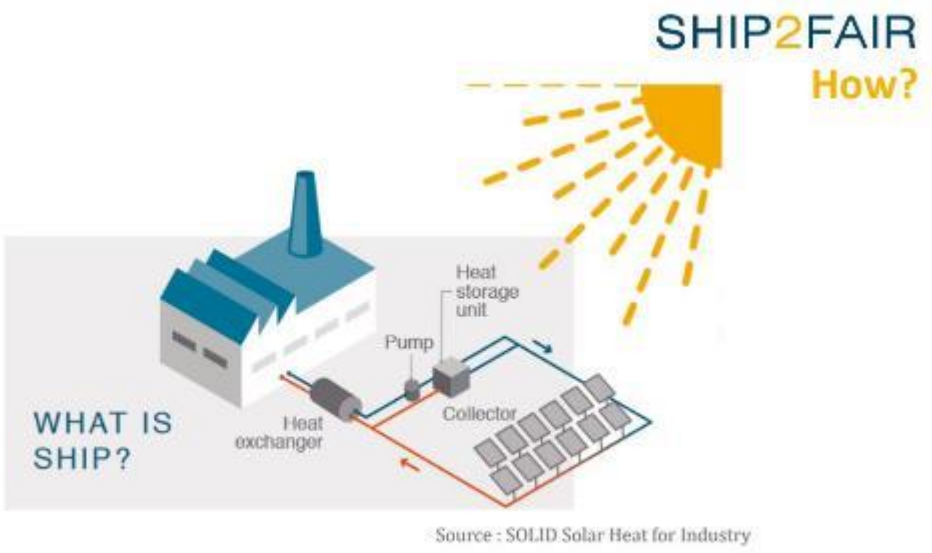


Dish requires dual axis tracking

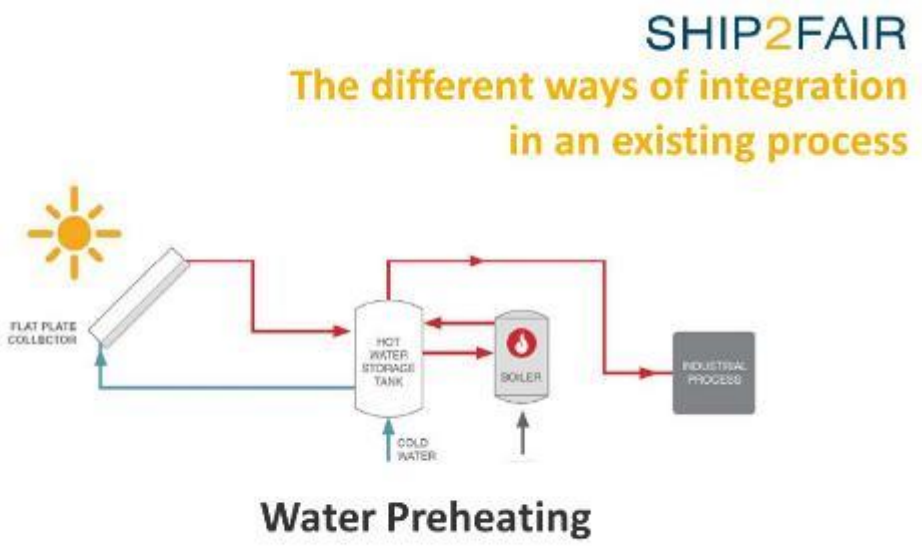
SHIP2FAIR
Why SHIP?



Source : SOLID Solar Heat for Industry



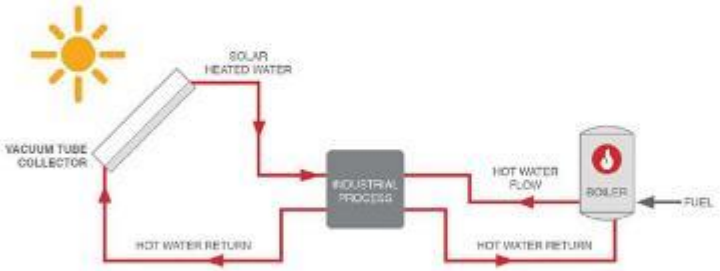
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 21



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 22

SHIP2FAIR

The different ways of integration in an existing process

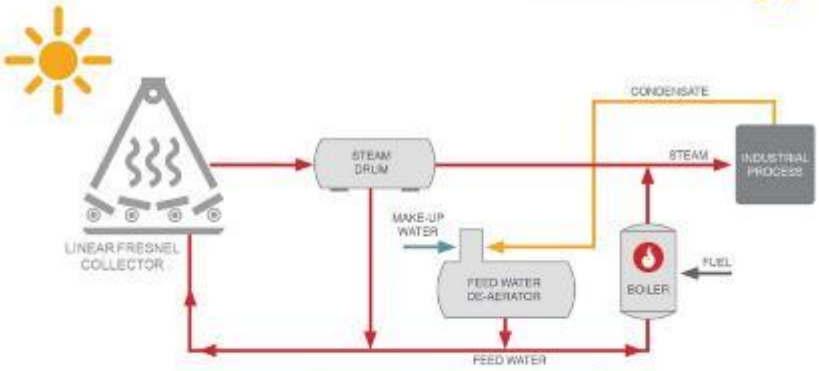


Process Heating

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 23

SHIP2FAIR

The different ways of integration in an existing process

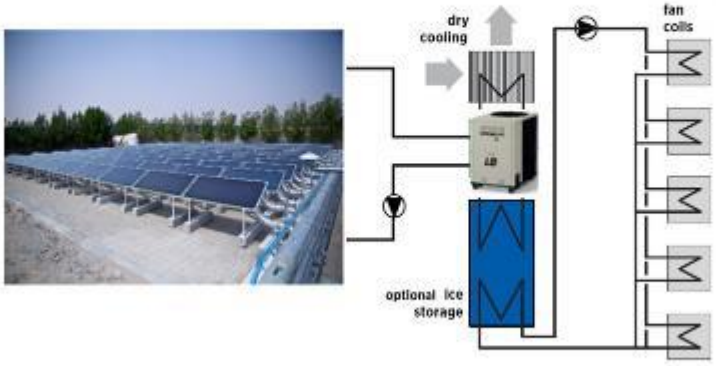


Direct Steam Generation

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 24

SHIP2FAIR

The different ways of integration in an existing process

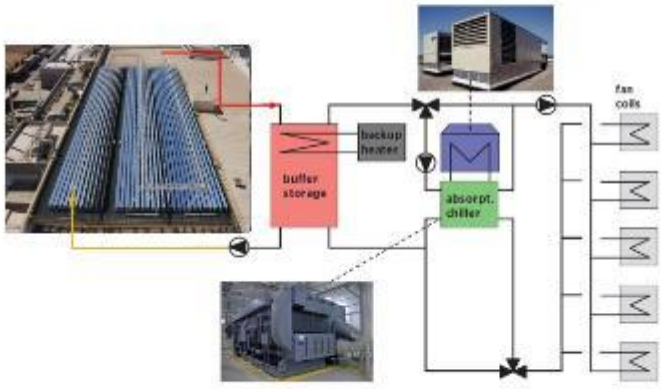


Solar thermal cooling (ammonia-water chiller)

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 25

SHIP2FAIR

The different ways of integration in an existing process



Solar thermal cooling (lithium-bromide-water chiller)

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 26

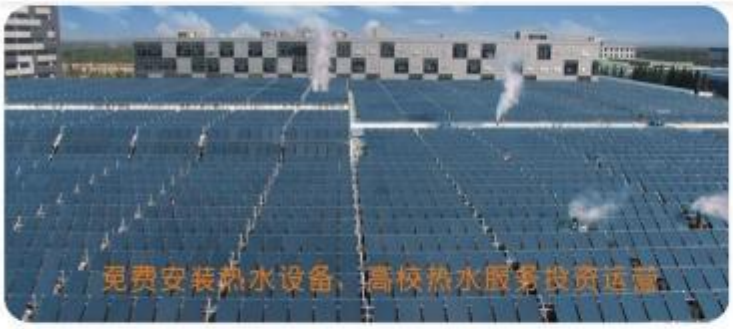
SHIP2FAIR
Example

Brewery – Germany (2000)

- 51 kWth
- 72 m² Flat Plate panels (air)
- Pre-heating air for drying process
- T=60°C
- Investment 32 000 € => 441€/m²

SHIP2FAIR
Example

Textile Factory – China (2007)



- 9 MWth
- 13 000 m² Flat Plate panels
- 900 m³ storage
- Pre-heating water for dyeing process
- T=55°C
- Investment 1 100 000 € => 84,62€/m²

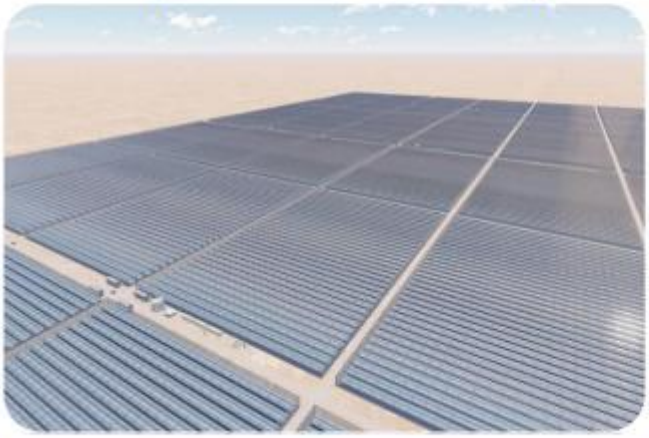
SHIP2FAIR
Example

Greenhouses– Netherland (2019)

- 6,5 MWth
- 9 300 m² Flat Plate panels
- 1 400 m³ storage

SHIP2FAIR
Example

Oil recovery– Oman (under construction)



- 1 GWth
- 3 km² (360 soccer field) Parabolic through
- 6 000 tons of steam / day

Manufacture of Tobacco– Jordan (2017)

SHIP2FAIR
Example

- 705 kWth Steam generation
- 1254 m² Linear Fresnel
- Cooling and heating process
- Feeding the steam network
- T = 225°C, 25 bars

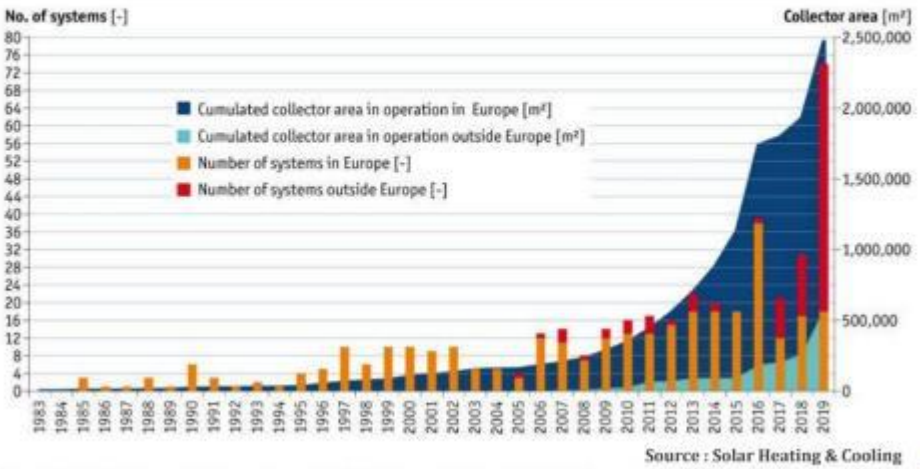
SHIP2FAIR
Example

More informations

http://ship-plants.info/

SHIP2FAIR

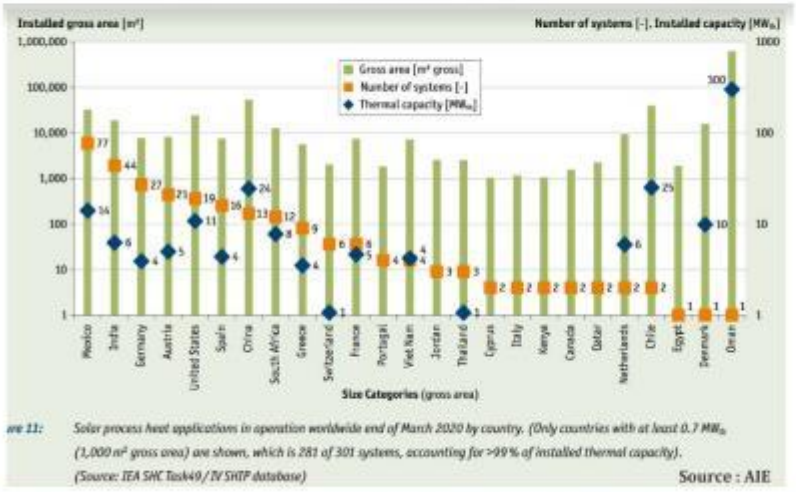
Large Solar Plants (2019)



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 33

SHIP2FAIR

Large Solar Plants by Country (2020)



- 635 SHIP operating
- 905 000 m² collectors
- 441 MWth

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 34

SHIP2FAIR

Barriers to overcome

- High investment costs and lack of finance options
- Fossil fuel pricing (subsidized)
- Public awareness
- Scaling Issues
- Lack of suitable design guidelines and tools

SHIP2FAIR

FOCUS ON SHIP2FAIR PROJECT

SHIP2FAIR Concept

Fostering the integration of solar heat in industrial processes - SHIP from agro-food sector, by developing and demonstrating a set of tools and methods for the development of industrial solar heat projects during its whole life-cycle.

BUDGET: 7.996.793,25 €
DURATION: 2018-2022

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 37

SHIP2FAIR Project

Challenges

Economic competitiveness

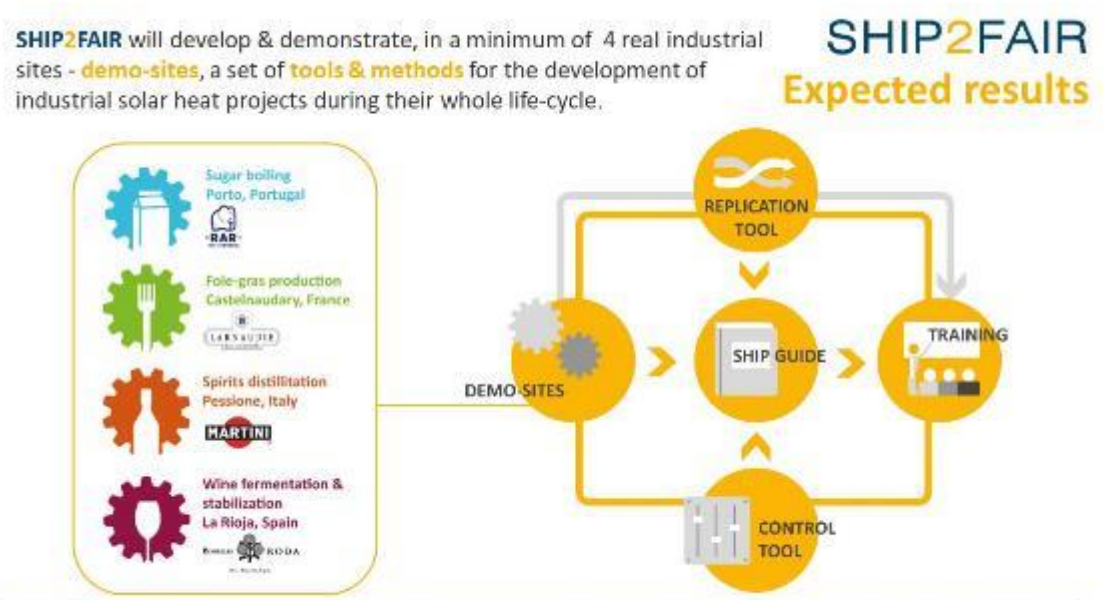
Integration of SHIP in existing industrial processes

Solutions

- **Development of easily replicable solutions** to increase energy efficiency and lower process heat temperature.
- Development of **suitable control strategies** taking into account inertia effects, delays, influence of radiation fluctuations and susceptibility to oscillations.
- Tools validation by continuous feedback from **real-operating systems**.
- Development of **training from a practical methodology**, making large use of ***use-cases***, letting users utilize the software directly within their local environment, thus achieving a **tailored solution to users' local challenges**.

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 38

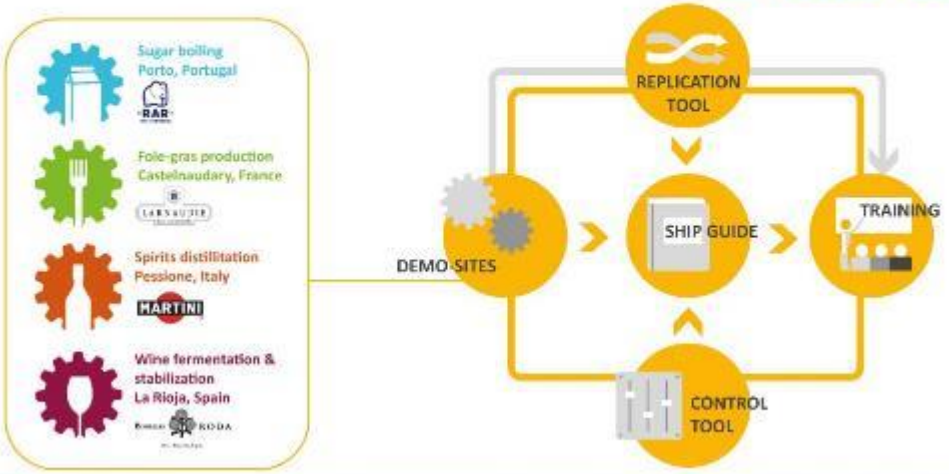
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 39



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 40

SHIP2FAIR will develop & demonstrate, in a minimum of 4 real industrial sites - demo-sites, a set of tools & methods for the development of industrial solar heat projects during their whole life-cycle.

SHIP2FAIR
Expected results



SHIP2FAIR
The demo-sites & the flagship projects

A minimum of 4 SHIP systems fully validated in real processes: new demo-sites joining in 2020

Novel solar collectors demonstrated in average irradiance areas through a 18-month demonstration campaign

- **Total capacity:** 2.9 MWth
- **Solar fraction:** 11.2% (RAR)-39% (RODA)
- **Yearly average solar efficiency:** 37% (M&R)-54% (RODA)
- **Primary energy savings:**
  - 4 GWh/year
  - 1145 tCO_2/year avoided
  - 5.4 GWh/year increase of RES in industrial heating

Wine fermentation & stabilization
La Rioja, Spain

SHIP2FAIR
First demo-site installed

NEEDS

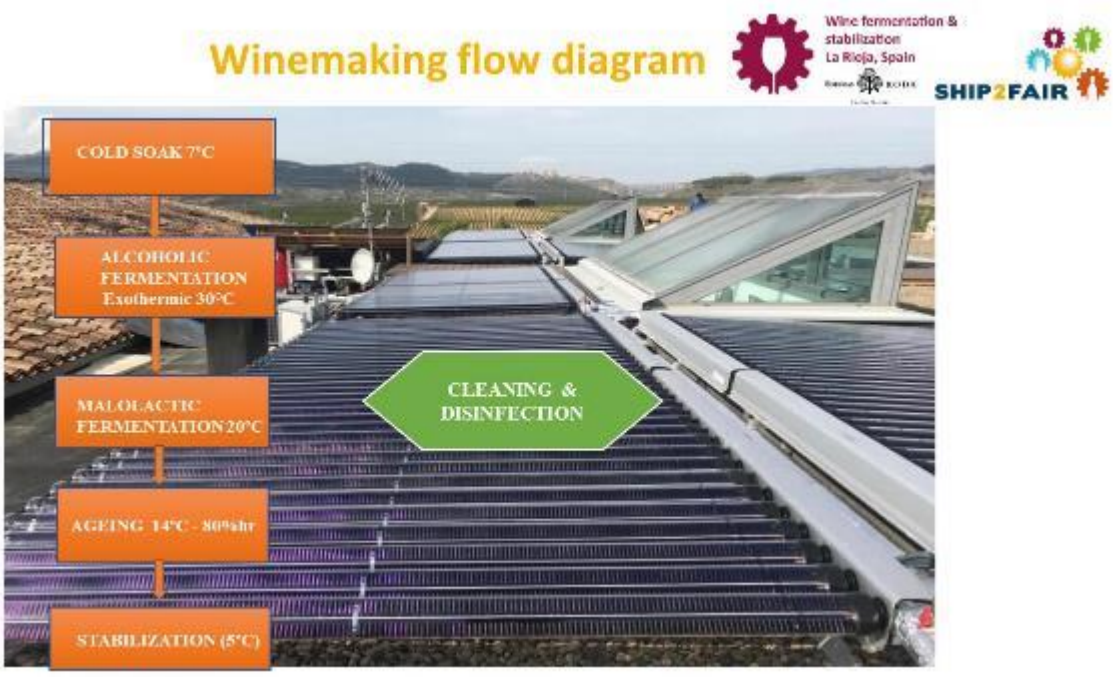
Heating
- Radiant floor heating for malolactic fermentation
- Heat for adsorption process
- Pipe cleaning & desinfecting
- High-pressure cleaning

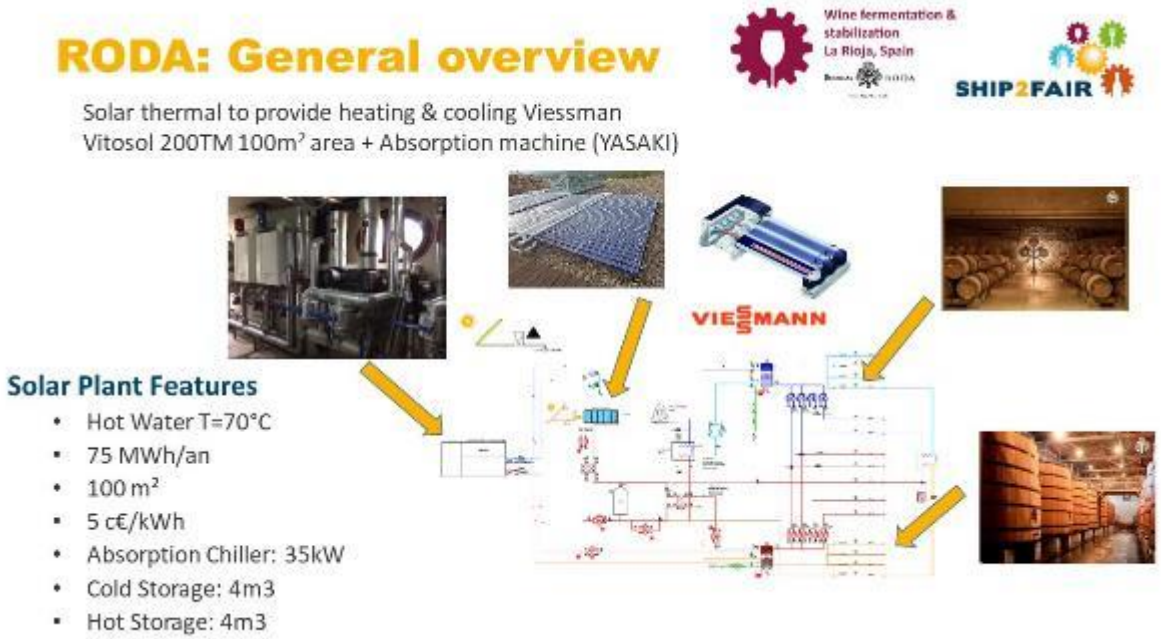
Cooling
- Fermentation process
- Ageing

SHIP2FAIR'S EXPECTATIONS

Wine fermentation & stabilization
La Rioja, Spain
SHIP2FAIR

- BRING RENEWABLE ENERGY
- USE OF SOLAR-THERMAL ENERGY TO GENERATE HEAT and COLD
- INTEGRATION OF VACUUM TUBES IN THE WAREHOUSE ARCHITECTURE: CARING FOR THE AESTHETIC OF THE FACILITIES
- DECREASE IN ENERGY EXPENDITURE

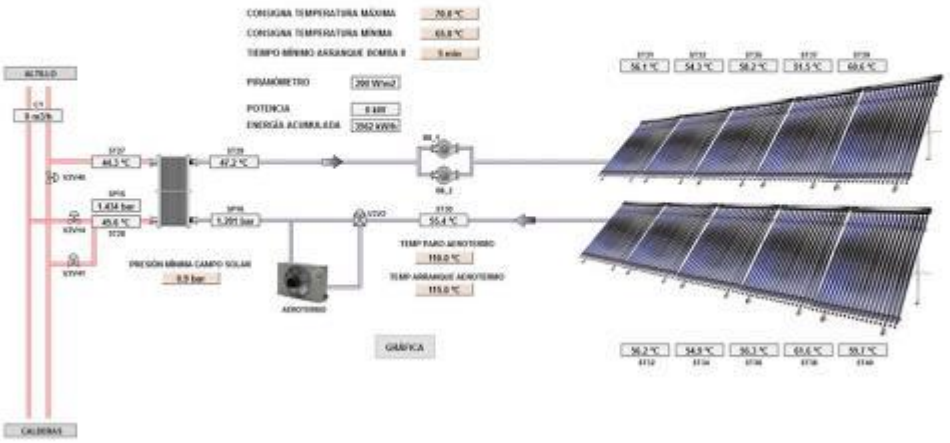

Winemaking flow diagram
Wine fermentation & stabilization La Rioja, Spain
SHIP2FAIR
COLD SOAK 7°C
ALCOHOLIC FERMENTATION Exothermic 30°C
MALOLACTIC FERMENTATION 20°C
AGEING 14°C - 80%hr
STABILIZATION (5°C)
CLEANING & DISINFECTION


RODA: General overview
Wine fermentation & stabilization La Rioja, Spain
SHIP2FAIR
Solar thermal to provide heating & cooling Viessman Vitosol 200TM 100m² area + Absorption machine (YASAKI)
VIESMANN
Solar Plant Features
Hot Water T=70°C
75 MWh/an
100 m²
5 c€/kWh
Absorption Chiller: 35kW
Cold Storage: 4m3
Hot Storage: 4m3

Wine fermentation & stabilization La Rioja, Spain

SHIP2FAIR

SOLAR PRODUCTION



Wine fermentation & stabilization La Rioja, Spain

SHIP2FAIR

SOLAR USE


RODA´S SOLAR FIELD
Wine fermentation & stabilization La Rioja, Spain
SHIP2FAIR
info@ship2fair-h2020.eu


INDUSTRIAL SOLAR
renewables onsite
SHIP2FAIR
Fresnel Collector technology
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables
49


Fresnel Solar Steam Generator
- System Overview -


INDUSTRIAL SOLAR
renewables onsite
SHIP2FAIR
Fresnel Collector – Components
Mirror system (robust)
Absorber tube (high efficiency)
Support Structure (lightweight)
Control system (smart control)
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables
51

INDUSTRIAL SOLAR
renewables onsite

SHIP2FAIR

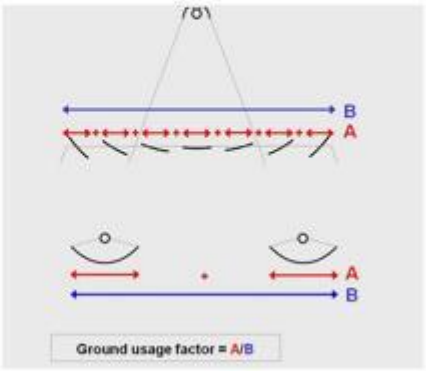
Fresnel Collector – Technology overview

Higher ground usage factor
~65% higher space efficiency
(aperture area / used ground area) Reference: 1
MW = ~ 2500 – 3000 m²

Low wind load
Low exposure to wind

Good weight distribution
Even distribution of the weight on the ground

Flexible design temperature/pressure
up to 400°C, 120 bar

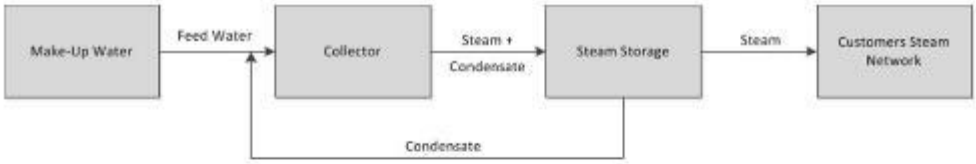


Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 52

INDUSTRIAL SOLAR
renewables onsite

SHIP2FAIR

Fresnel Collector – Steam generation concept



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 53

INDUSTRIAL SOLAR
renewables onsite

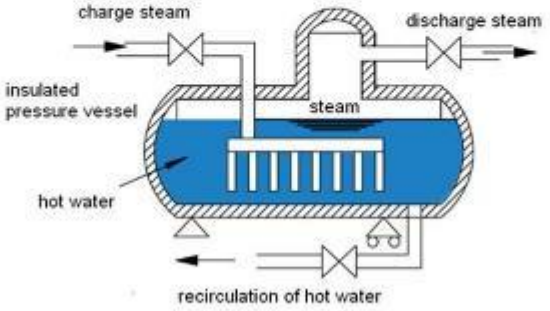
SHIP2FAIR

Fresnel Collector – Steam drum

Large pressure vessel

mainly filled with liquid water (80% of volume)

partly filled with steam (20% of volume)



Additional Functions of Storage

- Two-phase separation
- Expansion Vessel
- Steam pressurization
- Blow-down
- De-Aeration
- Anti-Freeze protection

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 54

INDUSTRIAL SOLAR
renewables onsite

SHIP2FAIR

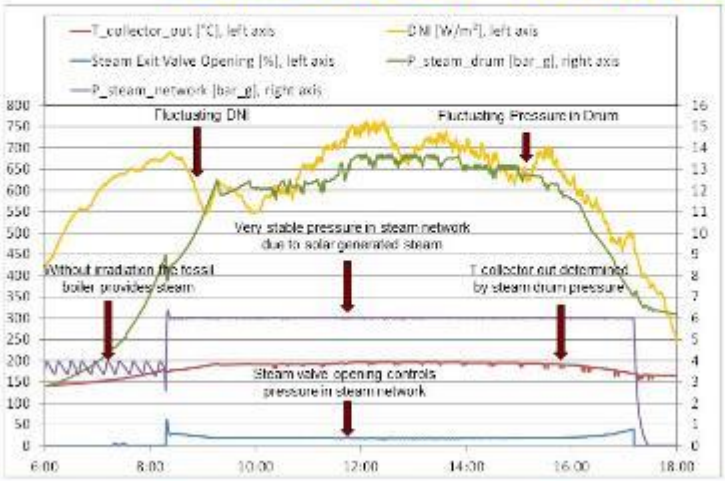
Fresnel Collector – Steam drum

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 55

INDUSTRIAL SOLAR
renewables onsite

SHIP2FAIR

Fresnel Collector – control performance



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 56

Sugar boiling
Porto, Portugal

SHIP2FAIR

Demo site at RAR

RAR Açúcar is a company dedicated to the refining and selling of sugar

Solar steam will reduce fuel consumption and avoid emissions from burning fuel oil and natural gas

NEEDS

Heating

- Sugar crystallization process: 125°C
- Solar steam operation modes:
- Main use: 1 bar(g) grid for all major processes and the degasser
- Optional: 5 bar(g) grid used for cleaning (in continuous process)

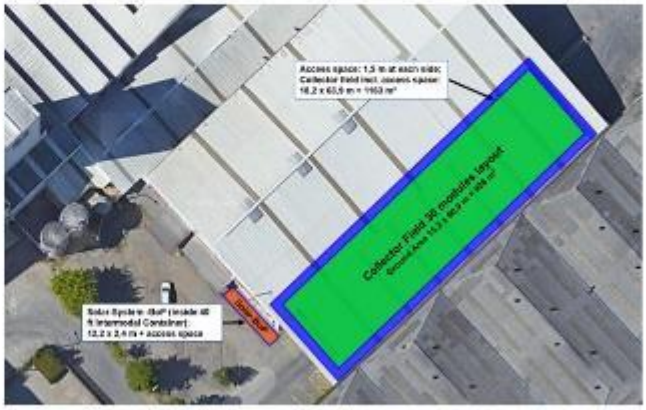
GRUPO RAR

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 57

Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR

Technology: Solar Fresnel Concentrators
Solar field: 30 modules
Orientation: 47° from the N-S-axis
660 m² aperture area
Production: steam @10 bar
Under execution



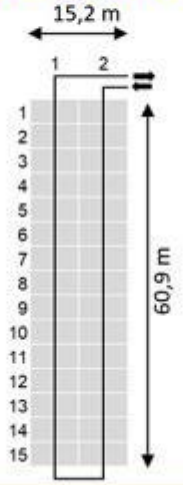
INDUSTRIAL SOLAR
renewables onsite

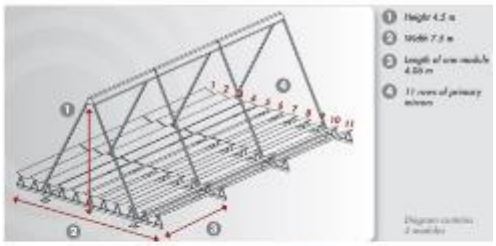
Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR – System layout

30 modules (15 strings of 2 modules each)
690 m² aperture area
415 kW thermal power at reference conditions
926 m² ground space (15,2m x 60,9m)
+ access space of 1,5 m each side
75 % ground space efficiency

465 kWh/an
3 c€/kwh

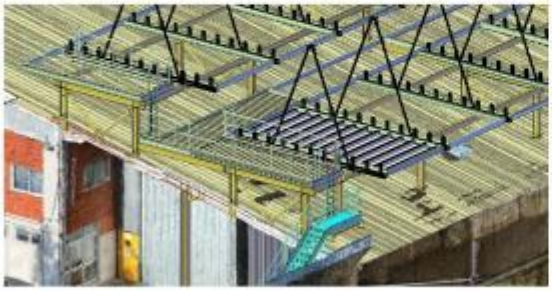




INDUSTRIAL SOLAR
renewables onsite

Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR – Roof installation



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 60

Sugar boiling
Porto, Portugal

SHIP2FAIR
Demo site at RAR – BOP container

INDUSTRIAL SOLAR
renewables onsite

Technology: Solar Fresnel Concentrators
Steam storage and BOP Container

- Replicability
- Reduced engineering efforts
- Reduced planning cost
- Acceleration of engineering
- Pre-manufacturing & tests before shipping
- Reduced installation time onsite
- Short pipe ways from solar field to solar BoP
- Clear definition of solar system interfaces

Storage capacity: **60 minutes and 410 kWh (1,5 GJ)**

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 61

Sugar boiling Porto, Portugal

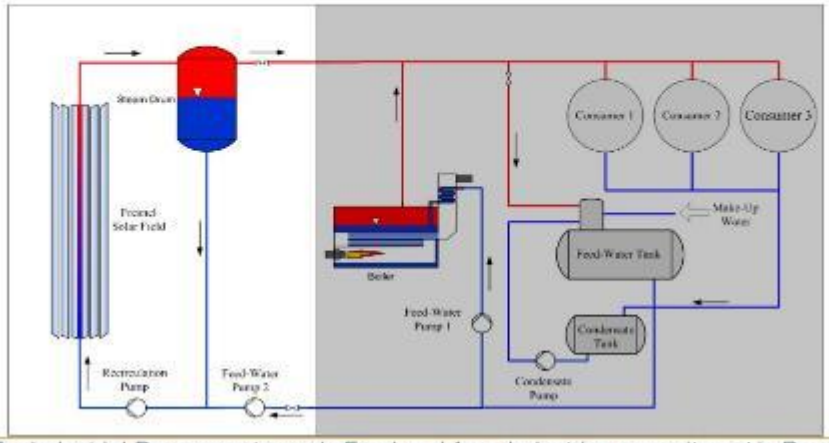
SHIP2FAIR

Demo site at RAR – Steam integration

Solar Steam Boiler

Existing Steam Network

INDUSTRIAL SOLAR renewables onsite

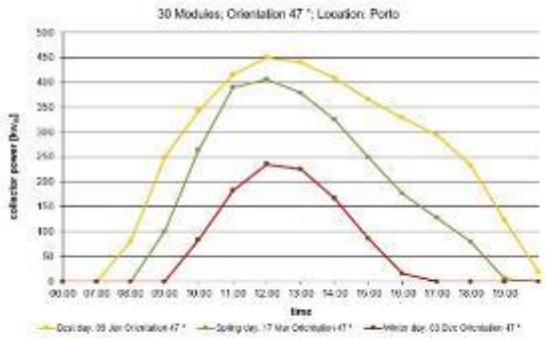


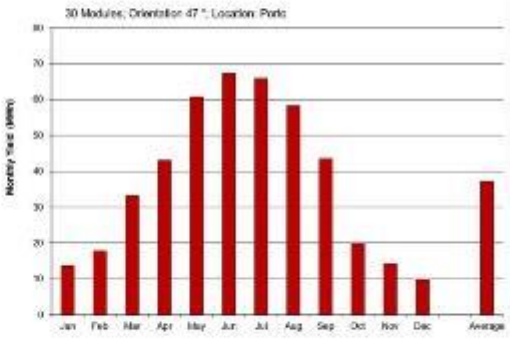
INDUSTRIAL SOLAR renewables onsite

SHIP2FAIR

Sugar boiling Porto, Portugal

Demo site at RAR – Gross energy yield

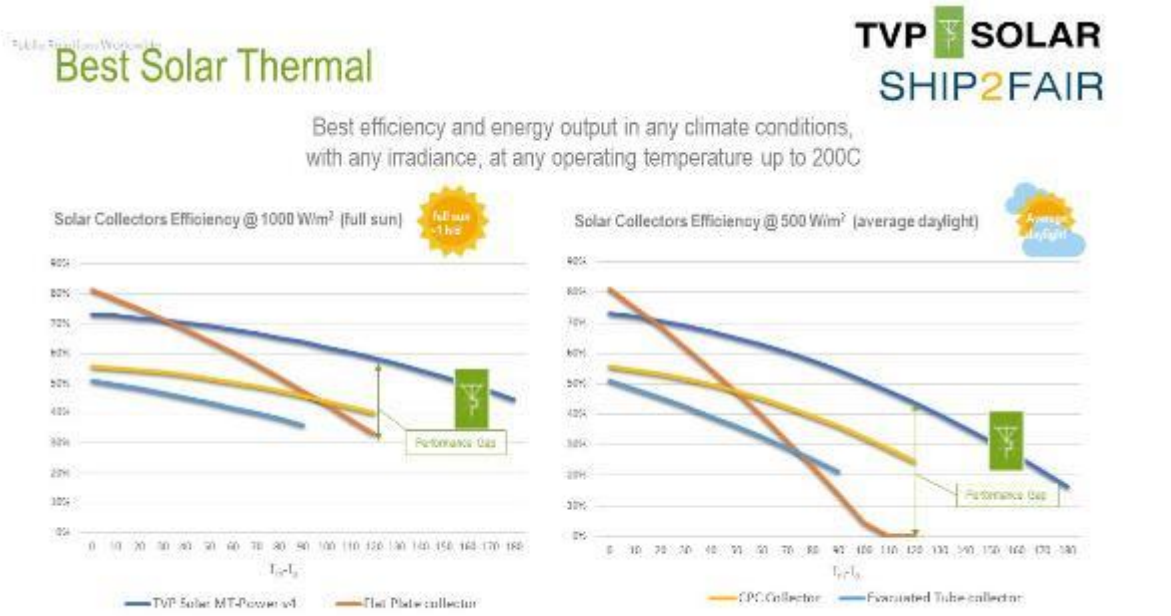





SHIP2FAIR
TVP SOLAR
Thermal Vacuum Power
High Vacuum Flat Panels (HVFPs):
Innovative Solar Thermal Technology for Low-to-Medium Heat Generation


The World Best Solar Thermal Collector (1/2)
TVP SOLAR
SHIP2FAIR
Certified best performance by SolarKeyMark 65°C to 200°C
"A vacuum as empty as interstellar space" as in the Large Hadron Collider at CERN in Geneva, the biggest operational vacuum system in the world
Patented HTF absorber pipe with parallel flow under vacuum
Patented internal pressure indicator
Patented auto-regenerative getter
Patented glass-to-metal seal
Patented lightweight support structure

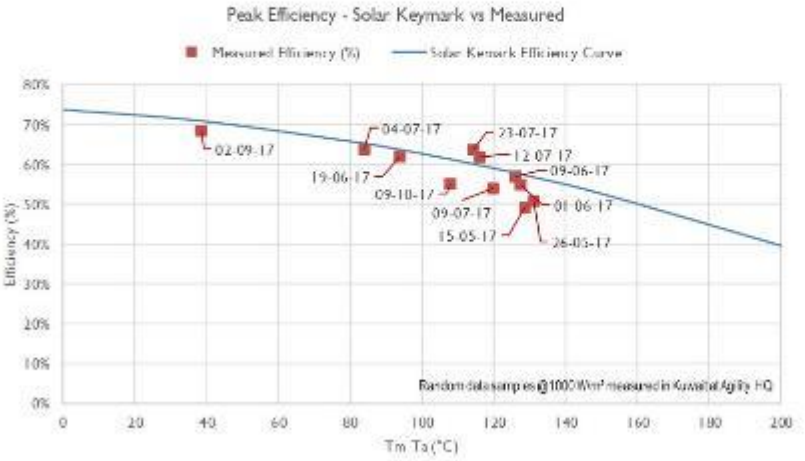

TVP SOLAR
SHIP2FAIR
The World Best Solar Thermal Collector (2/2)
High-vacuum insulation suppresses thermal losses
Best efficiency and highest energy production at any operating temperature, with any ambient temperature, in any climate condition
Fluid pipes
Inlet
Outlet
Outlet
Inlet
Fluid pipes
Housing
Aluminium Absorber Plate with Advanced Selective Coating Technology
Converts sunlight to usable heat
High Vacuum Insulation <0.1Pa
Completely eliminates convection heat losses
Self-Regenerating Non-Evaporable Getter (NEG) Pump
Keeps absorbing residual gases for more than 25 years
Glass Support Structure
Supports 20000 kg of atmospheric pressure
Glass Cover
Increases energy input with anti-reflective coatings
Laser Welded Copper Piping
Circulates fluid to extract heat (2 inlets and 2 outlets to maximize panel temp efficiency)
20 years consistent & predictable performance without any degradation
Designed for industrial-scale applications


TVP SOLAR
SHIP2FAIR
Best Solar Thermal
Best efficiency and energy output in any climate conditions, with any irradiance, at any operating temperature up to 200C
Solar Collectors Efficiency @ 1000 W/m² (full sun)
Solar Collectors Efficiency @ 500 W/m² (average daylight)
Performance Gap
Performance Gap
TVP Solar MT-Power v4
Flat Plate collector
CPC Collector
Evacuated Tube collector

In-Field Results Verified Certification Values

TVP SOLAR SHIP2FAIR

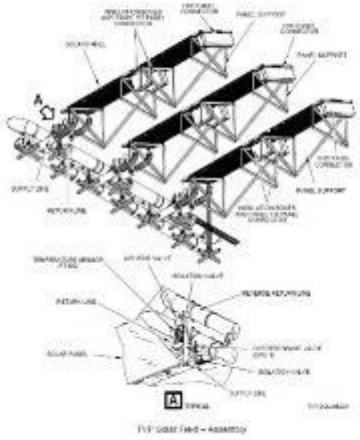
MT demonstrated in-field as world's best performing solar thermal collector up to 180°C

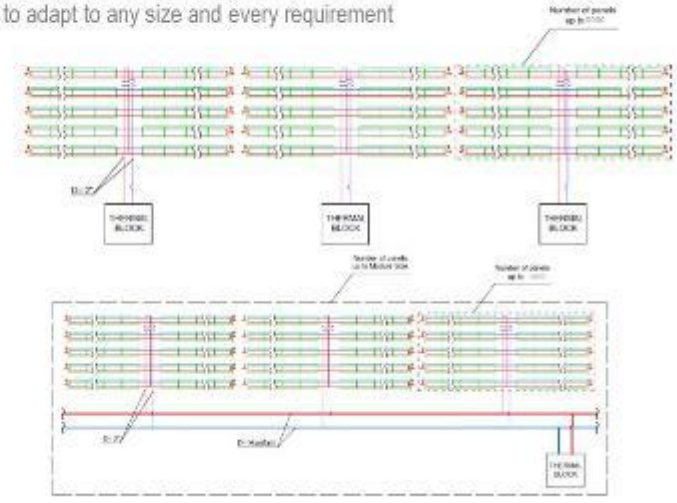


Standardized and Modular Solar System

TVP SOLAR SHIP2FAIR

Standardized solar system components ease installation and maintenance
Modularity to adapt to any size and every requirement





HVFPs for oil processing

TVP SOLAR
SHIP2FAIR

End-client:	Saudi Aramco
Location:	Qurayyah Seawater Treatment Plant, KSA Diesel
Application:	Boiler Feedwater Pre-Heating 1.6 MW; 93 to 164 °C [5,520 lb/h; 24/7]
Project:	1,020 m² solar field; 0.6 MW; 3,410 MMBtu/y
Savings:	138,269 liter/y of diesel and 372 ton/y of CO_2
Energy Cost:	8.5 $/MMBtu
TVP role:	single source contractor, EPC

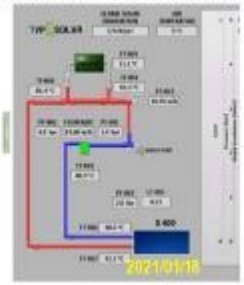
Commissioned December 28th 2020

HVFPs for district heating

TVP SOLAR
SHIP2FAIR

End-client:	Service Industriels de Geneve
Location:	Le Lignon DH Thermal Plant (GE), Switzerland
Application:	District network return flow heating 0.5 MW; 45 to 85 [20 m³/h; 10 h/d 365 d/y]
Project:	816 m² solar field; 0.55 MW; 517 MWh/y
Savings:	59,900 m³/y of NG and 119 ton/y of CO_2
Energy Cost:	38 CHF/MWh
TVP role:	EPC

Commissioned December 16th 2020



HVFPs for industrial process heat

TVP SOLAR
SHIP2FAIR

End-client:	Martini & Rossi Pessione/Chieri
Location:	(TO), Italy
Application:	Indirect steam generation (4 bar) 165°C to 175°C
Project:	800 m² solar field; 0.4MW; 400 MWh/y
Savings:	49,070 m³/y of NG and 96 ton/y of CO_2
Energy Cost:	34 €/MWh
TVP role:	EPC

End-client:	PepsiCo do Brasil
Location:	Sete Lagoas Plant (MG), Brazil
Application:	Process hot water 50°C to 65°C
Project:	400 m² solar field; 0.3MW; 517 MWh/y
Savings:	144,544 m³/y of NG and 287 ton/y of CO_2
Energy Cost:	18$/MWh
TVP role:	tender winner, EPC

SHIP2FAIR
Second demo-site installed

Spirits distillitation
Pessione, Italy

Heat need : 5 542 MWh/year

- Bottling process 1 (81%)
- Bottling process 2 (7%)
- Distillation (12%),
- which is fed by 759 526 m³ of natural gas per year.

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 73

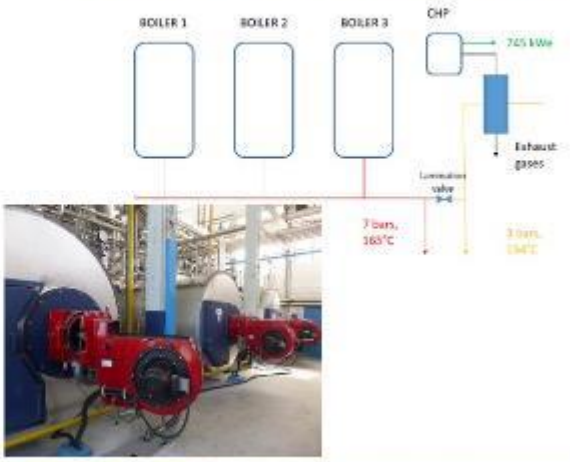
SHIP2FAIR

Second demo-site installed

Spirits distillitation
Pessione, Italy

MARTINI

Consumption: 759 526 m³ /year of natural gas



Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 74

SHIP2FAIR

Second demo-site installed

Spirits distillitation
Pessione, Italy

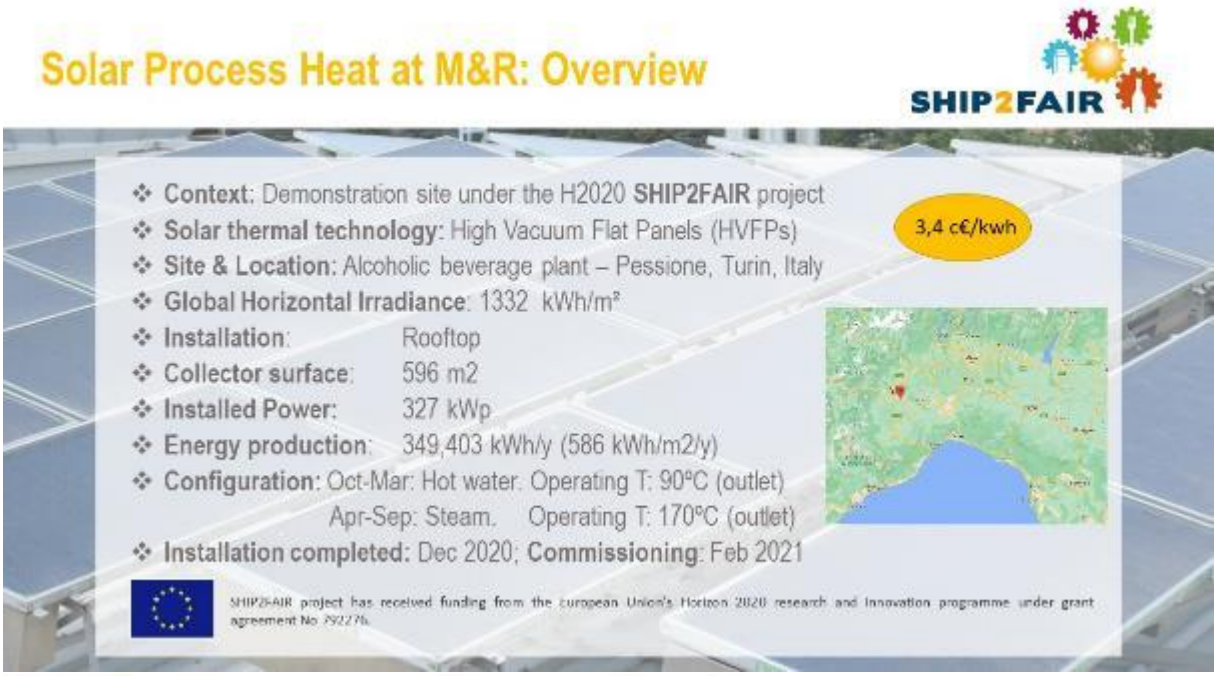
MARTINI

600 m2 gross area **350 kWth peak power**

- *Dual use* of solar heat
  - Summer -> Steam at 3.7 bar – 150C
  - Winter -> Space heating at 70C
- Maximization of solar output -> 0.6MWh/m²/y
- A well designed integration with users thermo-hydraulic circuit
- Reduction of the environmental impact of the entire production
- Technology: High Vacuum Flat Panels

TVP SOLAR

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 75


Solar Process Heat at M&R: Overview
SHIP2FAIR
Context: Demonstration site under the H2020 SHIP2FAIR project
Solar thermal technology: High Vacuum Flat Panels (HVFPs)
Site & Location: Alcoholic beverage plant – Pessione, Turin, Italy
Global Horizontal Irradiance: 1332 kWh/m²
Installation: Rooftop
Collector surface: 596 m2
Installed Power: 327 kWp
Energy production: 349,403 kWh/y (586 kWh/m2/y)
Configuration: Oct-Mar: Hot water. Operating T: 90°C (outlet)
Apr-Sep: Steam. Operating T: 170°C (outlet)
Installation completed: Dec 2020; Commissioning: Feb 2021
3,4 c€/kwh
SHIP2FAIR project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.


M&R solar system: Expected performance
SHIP2FAIR
Martini & Rossi - Italy
Fuel savings: 48.579 m³/year
Solar system efficiency: 45 % (average)
56% (peak)
Budget of the solar system: 500K€ (approx.)
Financial model: CAPEX; EU funding

M&R solar system: feasibility

SHIP2FAIR

Objective: To maximise usable energy production all year round

Actions and results:

- Sizing of solar system: rooftop surface availability
- Energy generation: calculations – simulation on TRNSYS
- Dual operating mode: Hot water during winter period; Steam during summer period
- Sizing of indirect steam generator: calculating summer peak generation and max steam flowrate; 10% safety factor

M&R solar system: construction

SHIP2FAIR

1

Rooftop surface preparation

2

Beams for substructure

5

Indirect steam generator

3

Substructure for panel installation

4

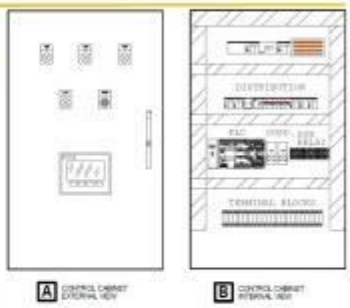
Solar field installation completed

M&R solar system: Control & monitoring

SHIP2FAIR

Control & monitoring system of the solar field:

- To achieve a stable and desired set point despite fluctuations in solar radiation
- To optimize solar system operation for maximum heat generation meeting thermal demand
- To monitor performance and key operational parameters of the solar system



Hybrid operation - hot water or steam generation: Options for system configuration:

- **Pre-set:** Oct-Mar: Hot water. Operating T 90°C (outlet)
  Apr-Sep: Steam. Operating T 170°C (outlet)
- **Advanced:** Dynamically adjusting configuration based on weather forecast

Upcoming Demo

SHIP2FAIR

TVP SOLAR

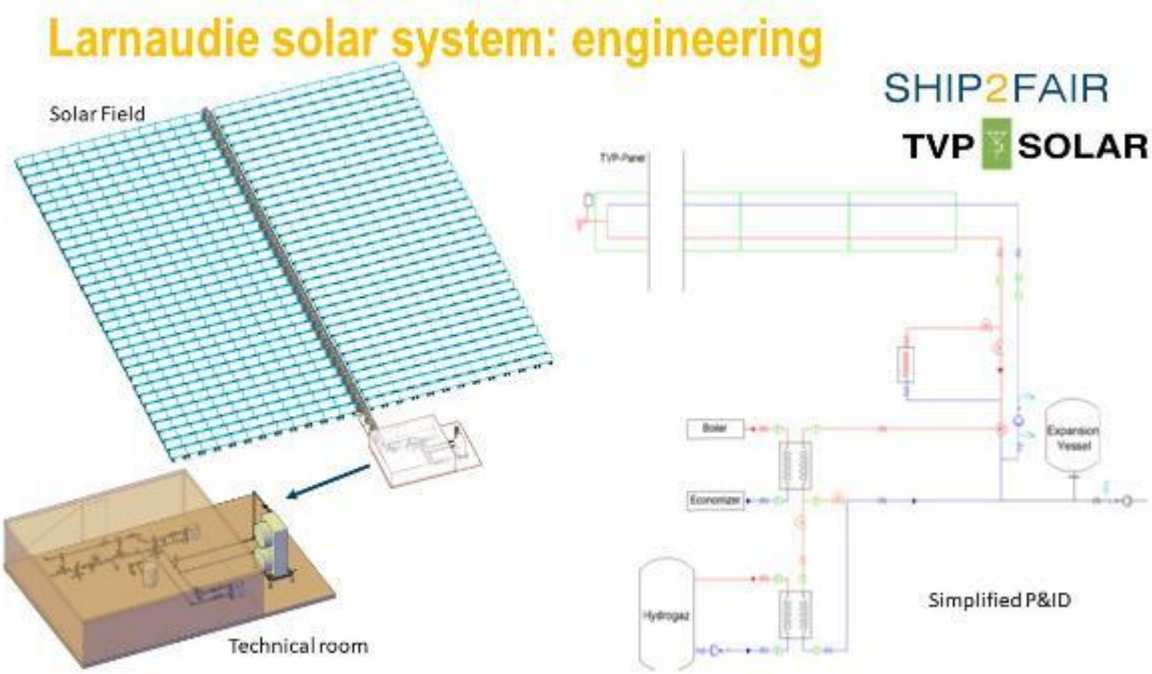
Jean LARNAUDIE DEPUIS 1951

Foie-gras production
Castelnaudary, France

Technology: HVFP
Solar Field size: 1600 m² – 1MW$_{th}$
1069 MWh/an
4 c€/kWh
Cascade application:

- Boiler feed water pre-heating @140C
- Water tank heating @65C

Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables 81



- Authorities not familiarized with industrial-scale solar systems
- Time consuming process with some uncertainty

SHIP2FAIR
Replication Tool

REPLICATION TOOL

The Replication Tool is a software able to evaluate the **techno-economic potential** of SHIP solution, starting from **local solar potential** and current **process heat demand**.

This tool is able to provide a first outlook on the SHIP **integration within the process** and to **optimise the system** according to the user's needs.

It provides:

- Evaluation of **solar field parameters** (sizing, technology, thermal storage requirements, etc.)
- Expected **energetic and environmental results** (solar fraction, energy savings, avoided emissions, etc.)
- Preliminary **economic figures**.

SHIP2FAIR
How does the RT work?

The Replication Tool (RT) is a **web tool**, which allows registered users to **run 5 modules** in sequence:

- General Information Module
- Solar Mapping Module
- Industrial Process Demand Characterization Module
- Simulation Module
- Solar Integration Module

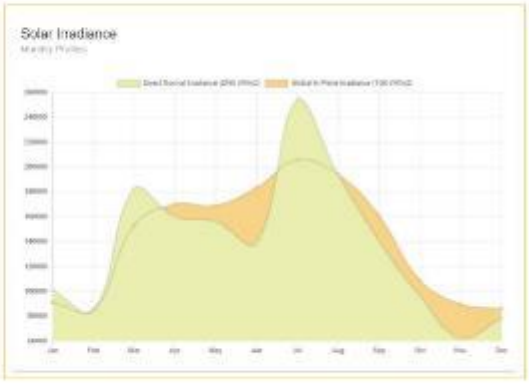
General information

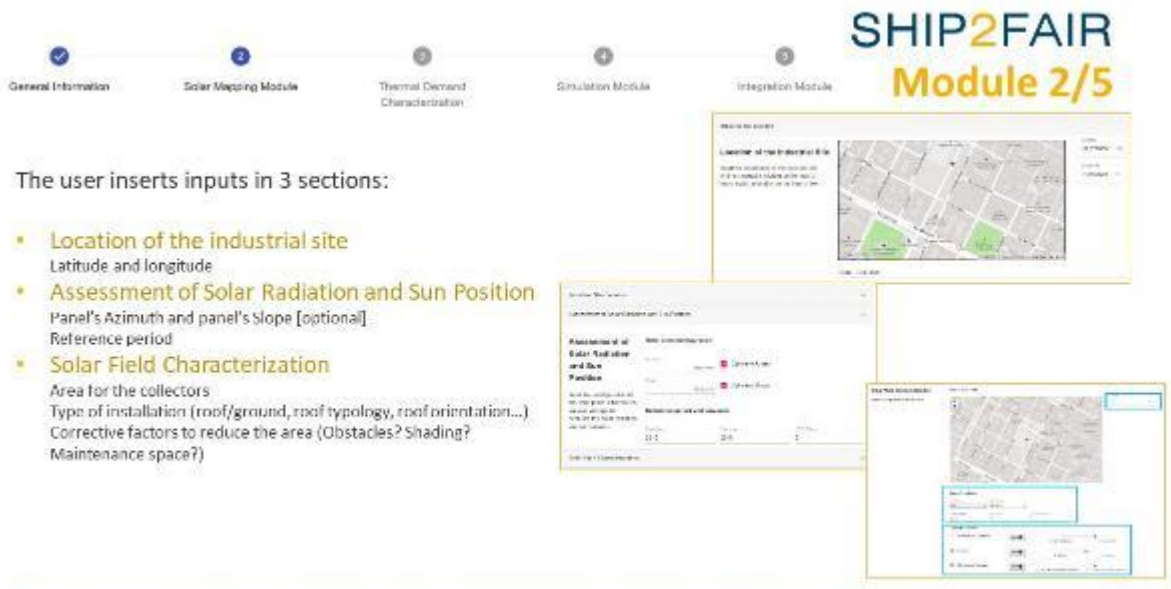
By using this module, the user can insert:

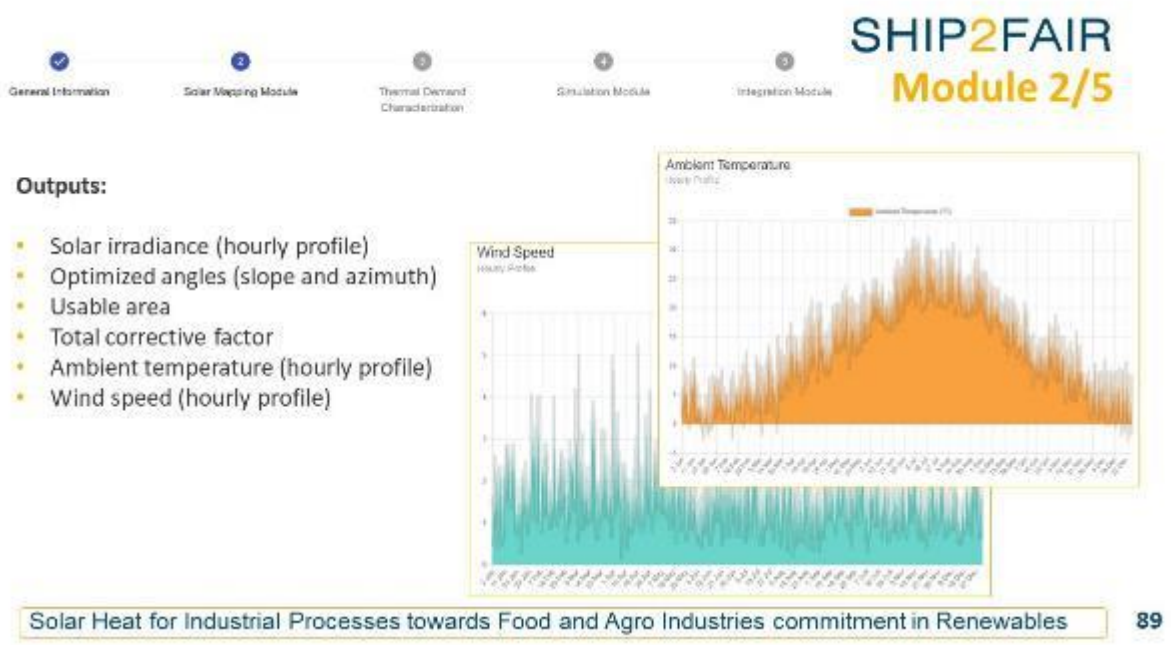
- **Company information**
  Company name, city and country.
- **Contact information**
  Contact name, email, phone.
- **Production information**
  Product name, Production Sector, Year of production, Total production (Tons/Year).

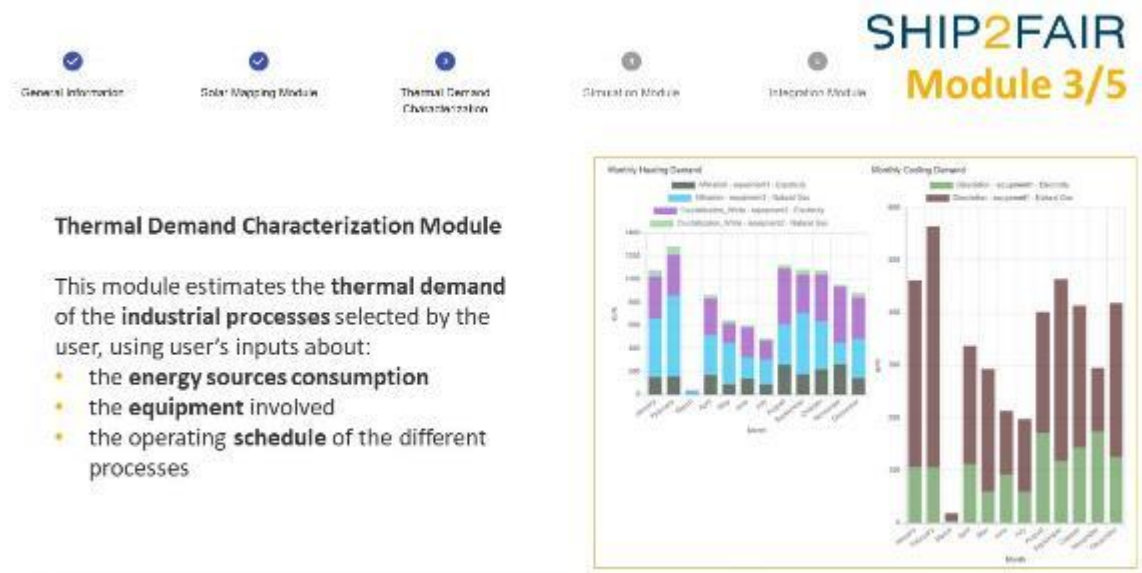
Solar Mapping Module

This module estimates the solar thermal theoretical potential according to local conditions in terms of **solar irradiance** and usable **area** for installing solar thermal collectors.




General Information
Solar Mapping Module
Thermal Demand Characterization
Simulation Module
Integration Module
SHIP2FAIR
Module 2/5
The user inserts inputs in 3 sections:
Location of the industrial site
Latitude and longitude
Assessment of Solar Radiation and Sun Position
Panel's Azimuth and panel's Slope [optional]
Reference period
Solar Field Characterization
Area for the collectors
Type of installation (roof/ground, roof typology, roof orientation...)
Corrective factors to reduce the area (Obstacles? Shading? Maintenance space?)
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables
88


General Information
Solar Mapping Module
Thermal Demand Characterization
Simulation Module
Integration Module
SHIP2FAIR
Module 2/5
Outputs:
Solar irradiance (hourly profile)
Optimized angles (slope and azimuth)
Usable area
Total corrective factor
Ambient temperature (hourly profile)
Wind speed (hourly profile)
Ambient Temperature
Wind Speed
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables
89


General Information
Solar Mapping Module
Thermal Demand Characterization
Simulation Module
Integration Module
SHIP2FAIR
Module 3/5
Thermal Demand Characterization Module
This module estimates the thermal demand of the industrial processes selected by the user, using user's inputs about:
the energy sources consumption
the equipment involved
the operating schedule of the different processes
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables
90


General Information
Solar Mapping Module
Thermal Demand Characterization
Simulation Module
Integration Module
SHIP2FAIR
Module 3/5
The user inserts inputs in 3 sections:
Energy sources
Type (Electricity, Natural Gas, Diesel...)
Consumption data from bills
Equipment inventory
Equipment name; type (boiler, chiller...); simultaneous units; energy source distribution; nominal power & load factor; efficiency; production processes supplied & nominal power.
Process definition
Thermal use (heating/cooling); working fluid (water/steam); operating temperature; consumption profiles to find the process schedule, loading and working hours (typical daily/weekly/yearly profiles).
ENERGY SOURCES
EQUIPMENT INVENTORY
PROCESS DEFINITION
Energy Sources
Energy Source
+ ADD ENERGY SOURCE
Electricity
Natural Gas
Solar Heat for Industrial Processes towards Food and Agro Industries commitment in Renewables
91

Simulation Module

This module provides the **yearly solar heat** delivered to the process by **the user-defined solar plant** (solar field and thermal storage).

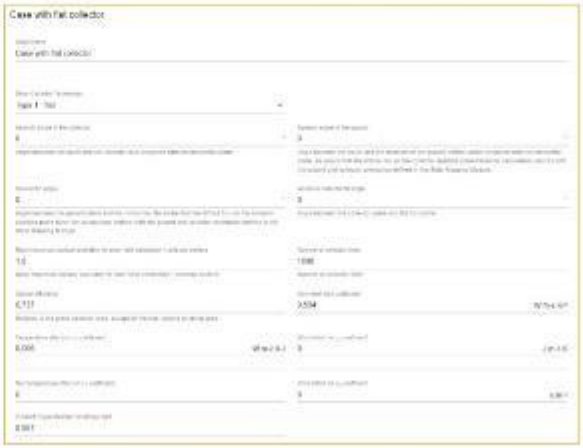
Several **Key Performance Indicators** are calculated to help the user evaluate the benefit of the solar plant from a **technical**, **environmental** or **economic** point of view.

General Information — Solar Mapping Module — Thermal Demand Characterization — Simulation Module — Integration Module

SHIP2FAIR Module 4/5

The user inserts inputs in 2 sections:

- Specific section for each case study
  Solar collector technology; Azimuth angle (Collector/Ground); Tilt angle (Collector/Ground); Ratio collector surface/maximum surface available for solar field installation; Solar plant electricity consumption, lifetime, etc.
- Shared section (common for all cases)
  Storage type; storage fluid density; boiler efficiency; electricity cost; fossil energy cost, etc.



General Information — Solar Mapping Module — Thermal Demand Characterization — Simulation Module — Integration Module

SHIP2FAIR Module 4/5

Outputs:

- Yearly solar energy production
- Entire collector surface
- Optical efficiency
  Relative to the available ground/collector surface
- Thermal efficiency
- Optical efficiency
- Solar plant overall efficiency relative to the collector
- Solar field outlet temperature reached ratio
- Thermal storage diameter
- Energy saving rate
- Return on Investment
- Payback period
- Energy inside the storage tank
- ...

General information · Solar Mapping Module · Thermal Demand Characterization · Simulation Module · Integration Module

SHIP2FAIR Module 5/5

Solar integration Module

This module **identifies** and **ranks** which is the best **solar integration point** within the different process in the industry.

It aims to solve one of the most critical issues of solar technology, which concerns the evaluation of the dynamic **integration** within an industrial process.

It uses a **multi-optimization algorithm** approach based on:

- minimize the energy loss
- maximize the use of solar energy or maximize the ratio energy/losses

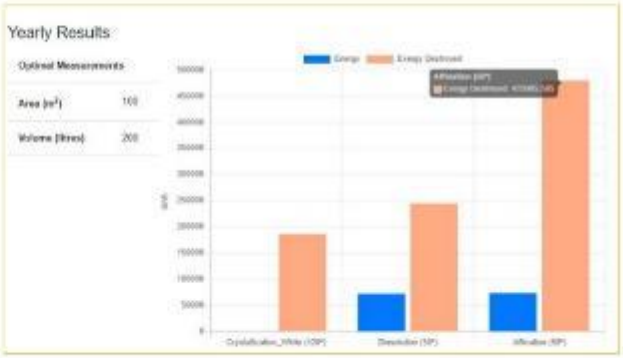
As a result, in a yearly and monthly basis, the **best combination of processes** to be fed by the solar energy is presented, with the **optimal area** and **volume** for the solar design.

General information · Solar Mapping Module · Thermal Demand Characterization · Simulation Module · Integration Module

SHIP2FAIR Module 5/5

Outputs:

- Yearly results
- Optimal area and volume for the solar design
- Monthly results
- The best combination of processes to be fed by the solar energy (in monthly basis)



Outputs:

- Yearly results
- Optimal area and volume for the solar design
- Monthly results
- The best combination of processes to be fed by the solar energy (in monthly basis)

Outputs:

- Yearly results
- Optimal area and volume for the solar design
- Monthly results
- The best combination of processes to be fed by the solar energy (in monthly basis)

SHIP2FAIR
Where do I find the Replication Tool?

https://replicationtool.ship2fair.cloud
(Currently in Beta testing)

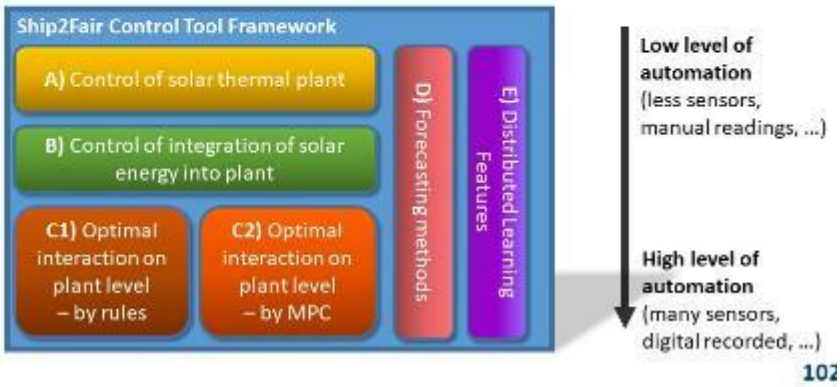
Motivation of the Control Tool SHIP2FAIR

1. Coordinate, monitor and management of the solar heat flow in a production environment, according with the SHIP2FAIR philosophy of **flexibility / simplicity /scalability / replicability** / business appealing.
2. To identify the most convenient control strategies allowing to **make the most** of the **solar production**.
3. To develop a model predictive control (MPC) to **optimize the management** of **solar production** integrated **with thermal energy storages** (TES), already installed **process heating** and **combined heat and power** (CHP) generators.

Structure of the Control Tool SHIP2FAIR

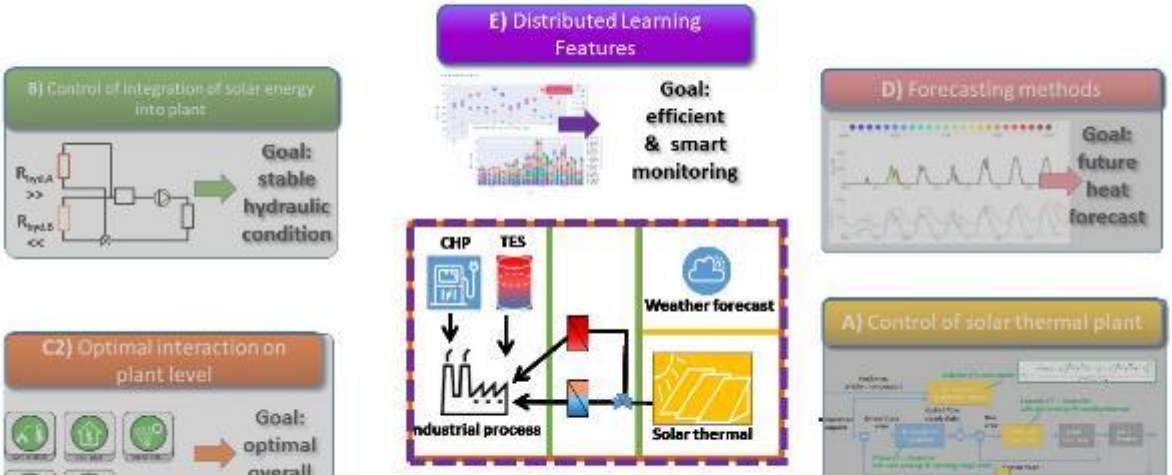
- **Consists of a Framework of 5 MODULES which allow to make the most of the solar production.**

- MODULES are chosen based on the possibilities available on-site
- Chosen MODULES form specific CONTROL TOOL for a plant

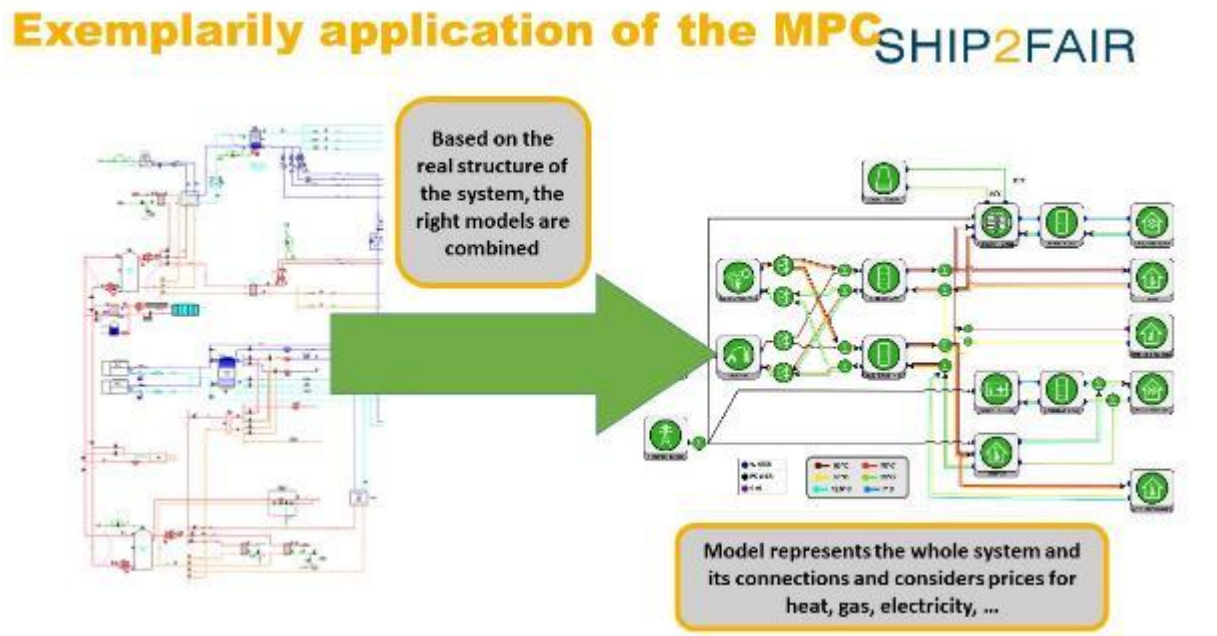


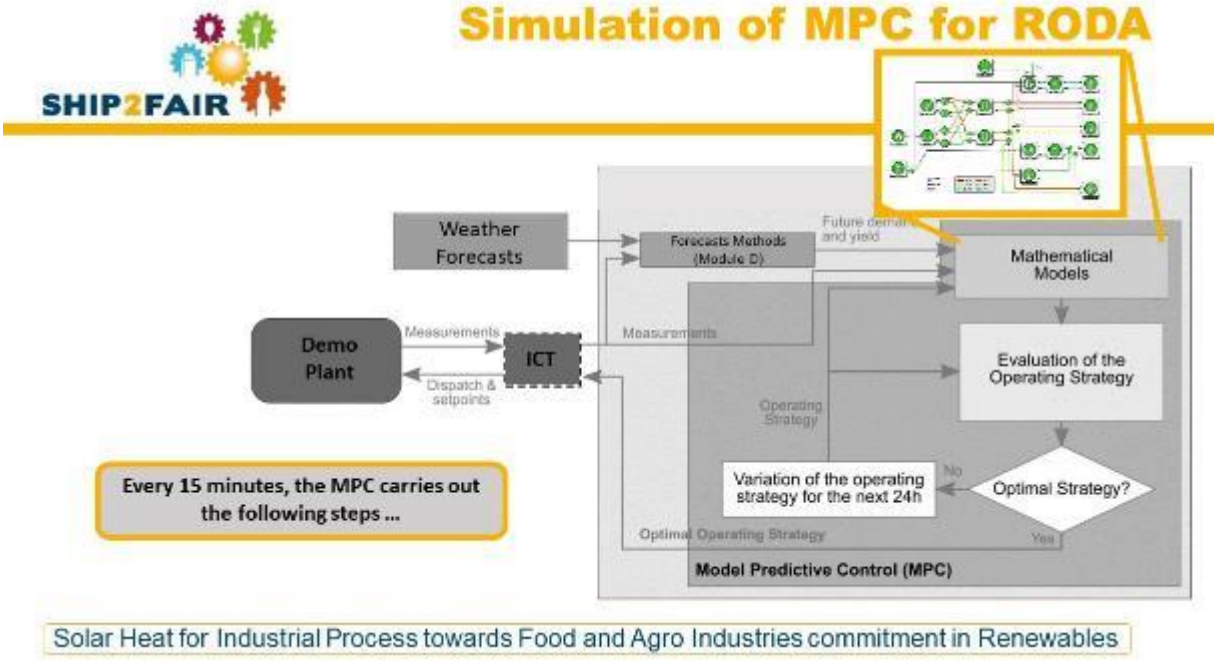
102

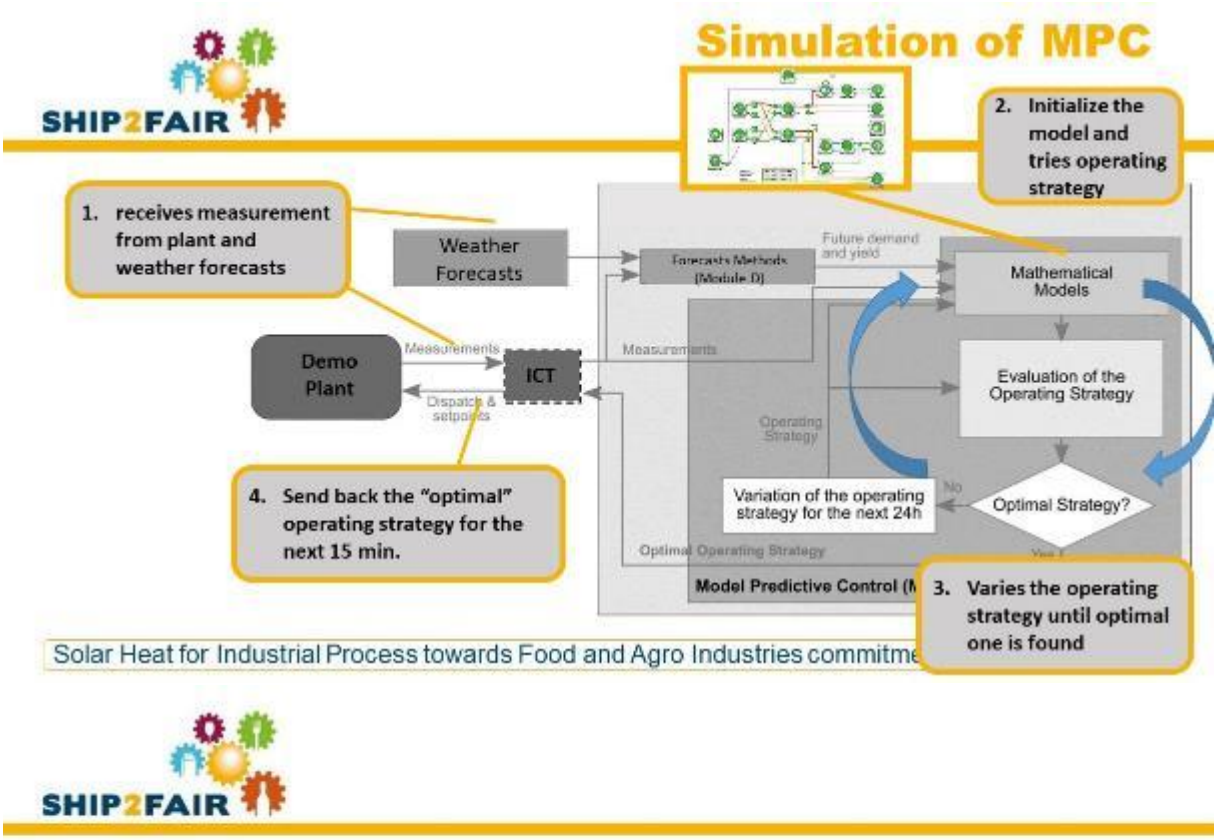
Control Tool Framework modules related to plant SHIP2FAIR



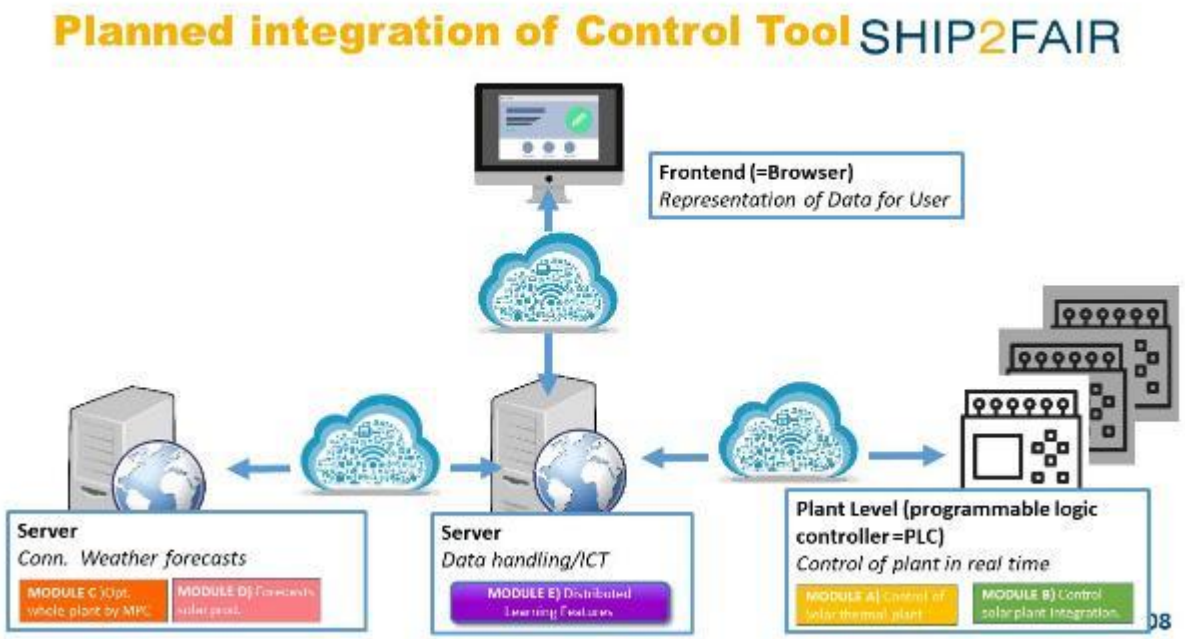
103

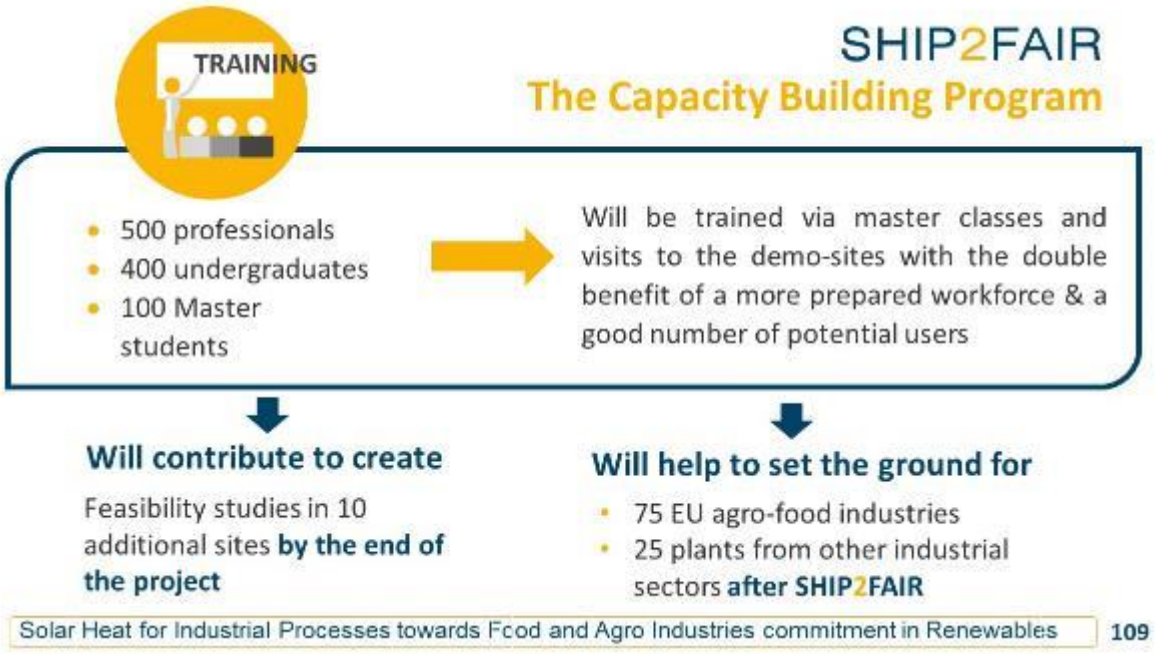

Exemplarily application of the MPC
SHIP2FAIR
Based on the real structure of the system, the right models are combined
Model represents the whole system and its connections and considers prices for heat, gas, electricity, ...


SHIP2FAIR
Simulation of MPC for RODA
Weather Forecasts
Forecasts Methods (Module D)
Future demand and yield
Mathematical Models
Demo Plant
Measurements
ICT
Dispatch & setpoints
Measurements
Evaluation of the Operating Strategy
Operating Strategy
Variation of the operating strategy for the next 24h
No
Optimal Strategy?
Yes
Optimal Operating Strategy
Model Predictive Control (MPC)
Every 15 minutes, the MPC carries out the following steps ...



Implementation and Integration of the Control Tool


Planned integration of Control Tool
SHIP2FAIR
Frontend (=Browser)
Representation of Data for User
Server
Conn. Weather forecasts
Server
Data handling/ICT
Plant Level (programmable logic controller=PLC)
Control of plant in real time


TRAINING
SHIP2FAIR
The Capacity Building Program
500 professionals
400 undergraduates
100 Master students
Will be trained via master classes and visits to the demo-sites with the double benefit of a more prepared workforce & a good number of potential users
Will contribute to create
Feasibility studies in 10 additional sites by the end of the project
Will help to set the ground for
75 EU agro-food industries
25 plants from other industrial sectors after SHIP2FAIR
Solar Heat for Industrial Processes towards Fcod and Agro Industries commitment in Renewables
109

SHIP2FAIR

Thank you!

info@ship2fair-h2020.eu

www.ship2fair-h2020.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

ANNEX 5: Brochure for Policy Makers

SHIP2FAIR

Solar Heat for Industrial Process

Input to Solar Energy Strategy
Public consultation

This policy brochure is part of Deliverable 9.4.

April 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 792276.

SHIP2FAIR

About SHIP2FAIR

SHIP2FAIR is a project developed by 15 partners from all over Europe supported by the European Commission. It aims to foster the integration of solar heat in industrial processes of the agro–food industry including by developing and demonstrating a set of tools (referred to in this input).

We give this input to the public consultation with respect to the solar thermal heat industry.

Policy recommendations

Even if the Solar Thermal technologies (flat plate, evacuated tubes, linear Fresnel, …) are commercial technologies, Solar Heat for Industrial Processes (SHIP) remains in the early stages of development[1]. It has enormous potential for growth, with 280 GW_{th} possible by 2030 according to trade association 'Solar Heat Europe'[2]. One of SHIP's main advantages is its potential to ensure an affordable and constant price of heat during the system's lifetime, typically 25 years.

The industrial sector accounts for approximately 30% of the total energy consumption in OECD countries[3], a share of which is needed for heating and cooling buildings and for performing manufacturing steps requiring temperatures up to 350°C. Globally, half of industry's heat needs are for temperatures up to this level. This temperature range can be addressed with non-concentrated solar thermal technologies (50°C – 180°C) and concentrated solar thermal technologies (>130°C).

Despite SHIP's advantages, its current share of global industrial heat supply is still negligible, accounting for less than 0.02% in 2020[4]. The main barriers to its deployment in industry lie in a lack of policy support and investor awareness and confidence, the latter being due partly to low supply chain maturity[5]. Yet the necessity to tackle global warming and contain skyrocketing energy prices makes SHIP a promising option.

[1] 430 entries worldwide in the SHIP-PLANTS info database
[2] 'Energising Europe with solar heat - A Solar Thermal Roadmap for Europe', Solar Heat Europe, April 2022
[3] IEA Solar Heating and Cooling Technology Collaboration Programme, Technology Position Paper, Solar Heat Integrations in Industrial Processes, May 2020
[4] International Energy Agency, Tracking Industry 2021 Report, November 2021
[5] Ibid.

SHIP2FAIR

SHIP2FAIR, a Horizon 2020 project focused on integrating SHIP to the agro–food sector, makes the following recommendations to facilitate SHIP's expansion:

- A mandate in each Member State for industrial companies to generate 10% of their process heat needs from solar thermal by 2030 in line with Solar Heat Europe's position[6].
- CAPEX subsidies for SHIP: CAPEX of SHIP plants is quite high regarding other competing technologies and there is a need to find new funding sources, especially for SMEs in Europe. Many European countries have already set grants for reducing the investment and/or preferential loans[7].
- Third-party ownership and -financing of systems. Financing has been recognized as major barrier to the uptake of solar thermal technology in industrial processes due to high upfront costs and unaccounted externalities, as well as the continued use of fossil fuel subsidies in many parts of the world[8].
- Promoting standards, guidelines and tools for SHIP certification. Even if each plant is unique, a common standard/rules can be applied in order to reduce the engineering studies and therefore limit the costs. SHIP2FAIR has developed software to support design guidelines and optimize and replicate solar thermal systems in for widespread use in industrial processes (refer to Box 3).
- Promoting digitalization in SHIP in order to optimize the energy production and its integration in the process. For example, the solar resource forecast, a thermal storage and a smart control of the industrial process will reduce the solar thermal energy thrown away. Public bodies should also encourage industrial enterprises to collect valuable data for SHIP project development.

[6] Presented by SHE President Costas Travasaros on 29 March 2022
[7] Collection of available solar process heat related national and trans-national research and funding programs, SHC – IEA, Task 64 IV, Deliverable DE1
[8] REN21, Renewables Global Status Report, April 2022

3

Support policies will be a key factor to reinforce the adoption of energy efficiency measures in industrial enterprises and allow for a greater deployment of SHIP across Europe. As REN21 has shown, political and institutional barriers include weak institutional structures and complex, fragmented markets which are not well understood, inadequate data sources on the types and amounts of energy needed to meet renewable heating and cooling (RHC) needs[9]. Finally, current policy frameworks are built around fossil fuels and policymakers have little awareness about the effects of using fossil fuels in heating and cooling on the climate.

To reach a share of 10% by 2030, we call for obligations for certain industries with heat demand matched to the temperatures and quantities that SHIP can supply to incorporate solar thermal heat into their processes. The campaign Solarise Heat (solariseheat.eu) calls for measures to deliver 200 TWh of solar heat for industry per year by 2030, from an installed capacity estimated at 140 GW_{th}. Indeed, Solar Heat Europe expects industry to be the segment that must see the most growth to reach the campaign's 2030 or 2050 targets (see Figure 1)[10]. The 280 GW_{th} foreseen to be installed by 2030 would meet the needs "of an industrial sector such as food, drinks and tobacco, which uses predominantly low and medium temperature heat"[11].

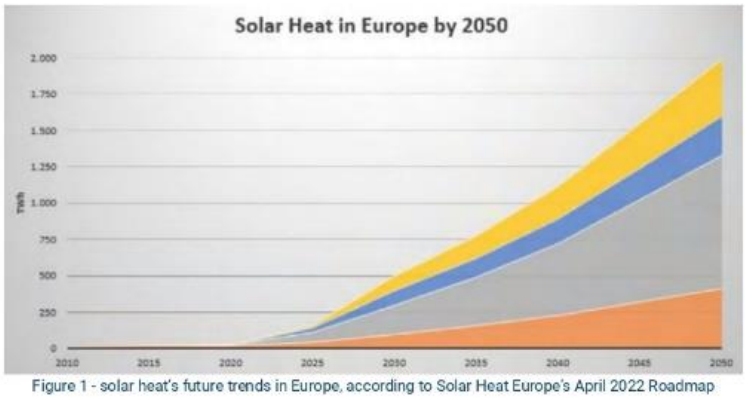


Figure 1 - solar heat's future trends in Europe, according to Solar Heat Europe's April 2022 Roadmap

Through investment grants in France and the solar heat tariff in the Netherlands, several multi-MW SHIP plants have been commissioned over the last few years, and SHIP costs have decreased by two-thirds in six years (see Box 1)[12]. Large-scale projects have low specific costs than smaller projects.

[9] REN21, Renewables Global Status Report, April 2022
[10] Solar Heat Europe, 'Energising Europe with Solar Heat. A Solar Thermal Roadmap for Europe', April 2022
[11] Ibid.
[12] Solar Payback 'Cost Trends of Solar Energy for Heat in Industry', August 2021

CAPEX grants are the most common form of support for SHIP, and according to the IEA Solar Heating and Cooling Technology Collaboration Programme, this form of support is also the most appreciated[13]. The report claims that financial support needs to be specific to a company's precise positioning in the value chain, stating: "[SHIP] has to be become a business case for all relevant stakeholders including the industrial end-users, the technology suppliers but also plant operators and investors" - (see also Box 2)[14].

The solar thermal industry knows it must talk to the financial community better and involve stakeholders to develop and provide information on financing operations for SHIP[15]. Around 79% of turnkey SHIP suppliers also agree that heat supply contracts or ESCO models (also known as third-party financing of system) are an important means of increasing deployment[16].

In 2014, the weighted-average installed costs of 11 SHIP projects were 1,679 USD/kW, while the average of 15 plants commissioned in 2020 dropped to 531 USD/kW, a decrease of 68 %.

Solar heat costs range between 2.57-7.35 EUR-cent cost per kWh, with SHIP on the higher end of the range in comparison with solar district heating.

Box 1 – past and current solar thermal costs. Source: Solar Payback Cost Trends Report; more data in IRENA 'Renewable Power Generation Costs in 2020' Fig 9.2, (2021)

"Compared to other instruments, a CAPEX grant is easiest to include in an economic assessment approach, for communication with end users and by this, to support actual implementation including financing."

Box 2 – the view from an IEA-SHC survey in 2021

Governments must make permitting for SHIP easier. To be deployed at scale procedures must be streamlined. In the SHIP2FAIR project, for example, permitting issues caused significant installation delays at the Larnaudie demo site. The absence of clear permitting procedures, or slow procedures causes delays, which can damage investor confidence and hold back progress in decarbonisation.

SHIP2FAIR has developed two tools to improve SHIP's efficiency. The project's replication tool (see Box 3) can evaluate the techno-economic potential of a solar heat technology based on local solar potential and process heat demand – a useful tool to gauge the applicability of SHIP for a particularly industrial plant. SHIP2FAIR's control tool (see Box 4) uses digitalization to increase the productivity of SHIP systems.

SHIP2FAIR's **Replication Tool** is a software tool which combines data from solar generation and process features to support the concept design of SHIP integration in projects to optimise the system according to user's needs.

Box 3 – SHIP2FAIR's replication tool

SHIP2FAIR has validated a **Control Tool** as an online Decision Support System. This will optimize the management of process heating systems through live monitoring and performance evaluation to better predict maintenance interventions and maximize solar power production also considering weather forecast.

Box 4 – SHIP2FAIR's control tool

Solar Heat for Industrial Processes must be supported to decarbonise industry cost-efficiently. SHIP's current status and potential are explained in more detail below.

[13] IEA SHC TASK 64/IEA SolarPACES Task IV. Deliverable Report D E1 Subtask E. Collection of available solar process heat related national and trans-national research and funding programs. April 2021
[14] Ibid.
[15] IEA SHC Task 64/ SolarPaces IV Subtask E Guideline to Market Presentation
[16] Solar Payback, Solar Heat for Industry, April 2017

SHIP2FAIR

Solar heat: an attractive option for industry

IEA: rapid decarbonisation essential and solar thermal necessary for net-zero

In May 2021, the International Energy Agency (IEA) published a roadmap with the objective of achieving the Net Zero carbon emission by 2050 for the Global Energy Sector and limiting global temperature rise to 1.5 °C.

In order to limit global temperature increase to 1.5°C, the IEA recommends:

- No investment in new fossil fuel supply beyond projects committed in 2021
- All electricity to be zero-emission in the OECD by 2035, and globally by 2040
- No new fossil fuel boilers sold from 2025

The IEA sees solar thermal as part of the solution to meet these conditions. The IEA calls for:

- A 6x increase in collector area is needed (all applications considered) to achieve a solar thermal collector area of 165 million m²/yr
- Solar heat to covers 11% of the industrial heat demand in 2050 globally. Here, we and Solar Heat Europe want Europe to move first and faster, achieving about this penetration by 2030 – see above.

Energy price volatility

Energy prices are a key issue for the economic well-being of the European Union. From 2000-2019, energy prices have dramatically increased.

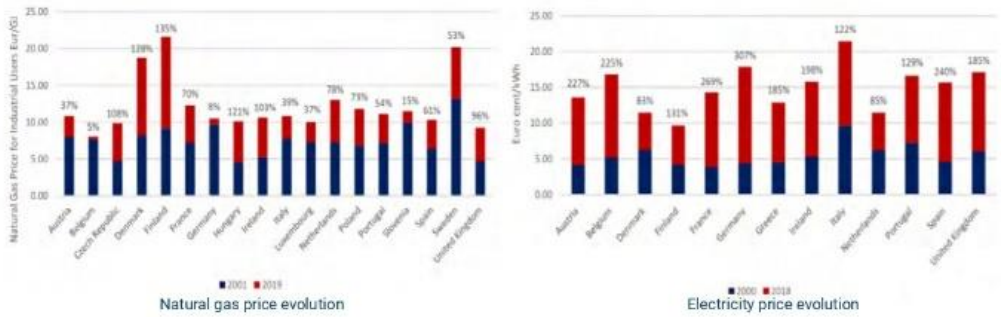


Figure 2 - energy price evolution

This tendency has been accelerated by the economic recovery from the pandemic:

- During the 3rd quarter of 2021: The largest year-on-year price increases were registered in Ireland (+323%), Portugal (+215%) and Spain (+214%), triggered by rising gas prices[17].
- Wholesale gas prices in Europe continued their sharp increase in the 3rd quarter of 2021 as spot contracts rose from 37 €/MWh to 85 €/MWh.

[17] European Commission, Gas and Electricity Market Reports, https://energy.ec.europa.eu/data-and-analysis/market-analysis_en

SHIP2FAIR

Energy insecurity

In addition to the pandemic, Russia's invasion of Ukraine has had a huge impact on the energy market. Due to the economic sanctions against Russia, the EU has decided to reduce by 2/3 the import of Russian oil & gas by the end of year to end dependence by 2027. For that, different actions should be taken:

- Reduce the consumption.
- Diversify the providers.
- Increase the renewable energy share.

The decrease in consumption will affect the economic activity. And the provider for diversification will not be an easy task. Russia is the 1st gas provider and 2nd oil provider worldwide. Russia provides 41% of the European gas and some countries like Finland and Slovakia are more than 75% dependent. Affordable substitution of Russian fuel by other supplies of fossil fuels looks unrealistic, particularly in the long term.

Therefore, it is important to increase the share of renewable energy. Moreover, fossil fuel prices are foreseen to remain at high levels. Solar thermal technology, once installed, operates for little cost. The cost for the owner is the steady repayment of the capital loaned + interest, and/or a return on equity for the initial investment.

Capitalising on SHIP's potential

SHIP technology's advantages as a sustainable source of energy with enormous potential for energy independence, stability, job creation and efficiency are clear. To capitalise on the potential of solar heat in industrial processes, policies must facilitate SHIP's expansion to meet Europe's energy needs.

The energy needs

The IEA has enlightened that the energy needs in industry represents one third of the global energy consumption and 74% of this energy is consumed as heat.

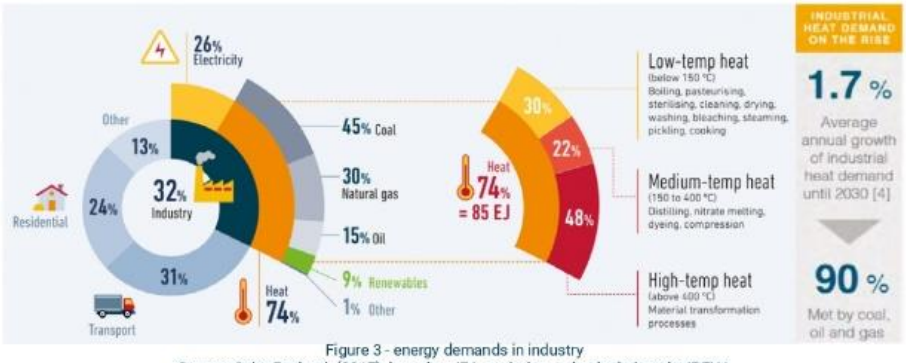


Figure 3 - energy demands in industry
Source: Solar Payback (2017), based on IEA statistics and calculations by IRENA

Zero-carbon solutions for industrial heat must be found:

- Industries are the driving force of economy and there is a need to have affordable and sustainable energy supply.
- The energy needs are concentrated locally.

DISSEMINATION POTENTIAL

(NOT TO BE SUBMITTED TO THE EUROPEAN COMMISSION, this section will only be addressed in technical deliverables associated to WP2 to 8)

To be filled in by the DLV responsible

What´s the confidentiality degree of this deliverable?	**☐ Confidential**	**☐ Partly ***	**☐ Public**
***Being "Partly" the confidentiality, what are the results that might be disseminated?**			
1			
2			
3			

Main stakeholders to be addressed by the results of the deliverable

Type	Sector	Potential replicability in other sectors

Main events and activities related to the results of the deliverable (also organised by third parties)

Title	Date	Press release	Target audience
1			
2			
3			

Dissemination tools: what sort of materials can be created to contribute to disseminate the results? Make suggestions for CIRCE and ICLEI evaluation (consider budget / time)

☐ Photographs	**☐ Video**	**☐ Power point**	**☐ Papers**	**☐ Poster Created by...**
☐ News for project website	**☐ Networking opportunities**	**☐ Training course**	**☐ Seminar**	**☐ Social network**

Potential Paper

Title	Authors

Abstract / Public summary of the paper or the report (500 words)

Other dissemination suggestion or comments from the DLV authors
Exploitation potential
Please report preliminary information on the potential exploitable results and on the potential players which may be affected or linked to the development of such exploitable result. Please address the following points (if applicable): • **Which stakeholders could be affected? (Consumers, public administration, business, etc.)** • **Could this deliverable contribute to standardisation efforts, new business models, technological solutions, etc?** • **What IPR issues need to be considered with these results?**