Paper ID: SUPEHR'19-79

SHIP2FAIR – Martini & Rossi: integration of Solar Heat in Industrial Process – Preliminary evaluation

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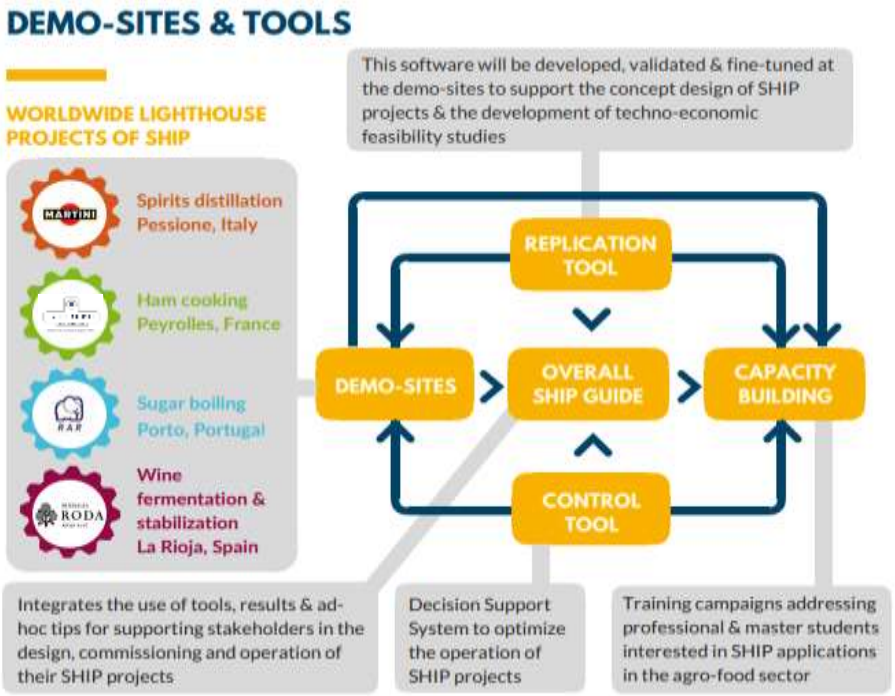
SUPEHR'19

SHIP2FAIR

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

Concept

Fostering the integration of solar heat in industrial process (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.



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.

SHIP2FAIR

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

Challenges

- Data gathering & ICT treatment
- Integration of SHIP in existing industrial processes
- Engineering and commissioning process

Solutions

- Increase of industrial plants sustainability by **developing 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**.

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

CIRCE leads **SHIP2FAIR** team, with a perfect balance of main partners from key sectors and areas of expertise:

The Agro-food field

Solar technologies providers

R&D and Consulting

Dissemination & Training

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Pessione M&R Demosite

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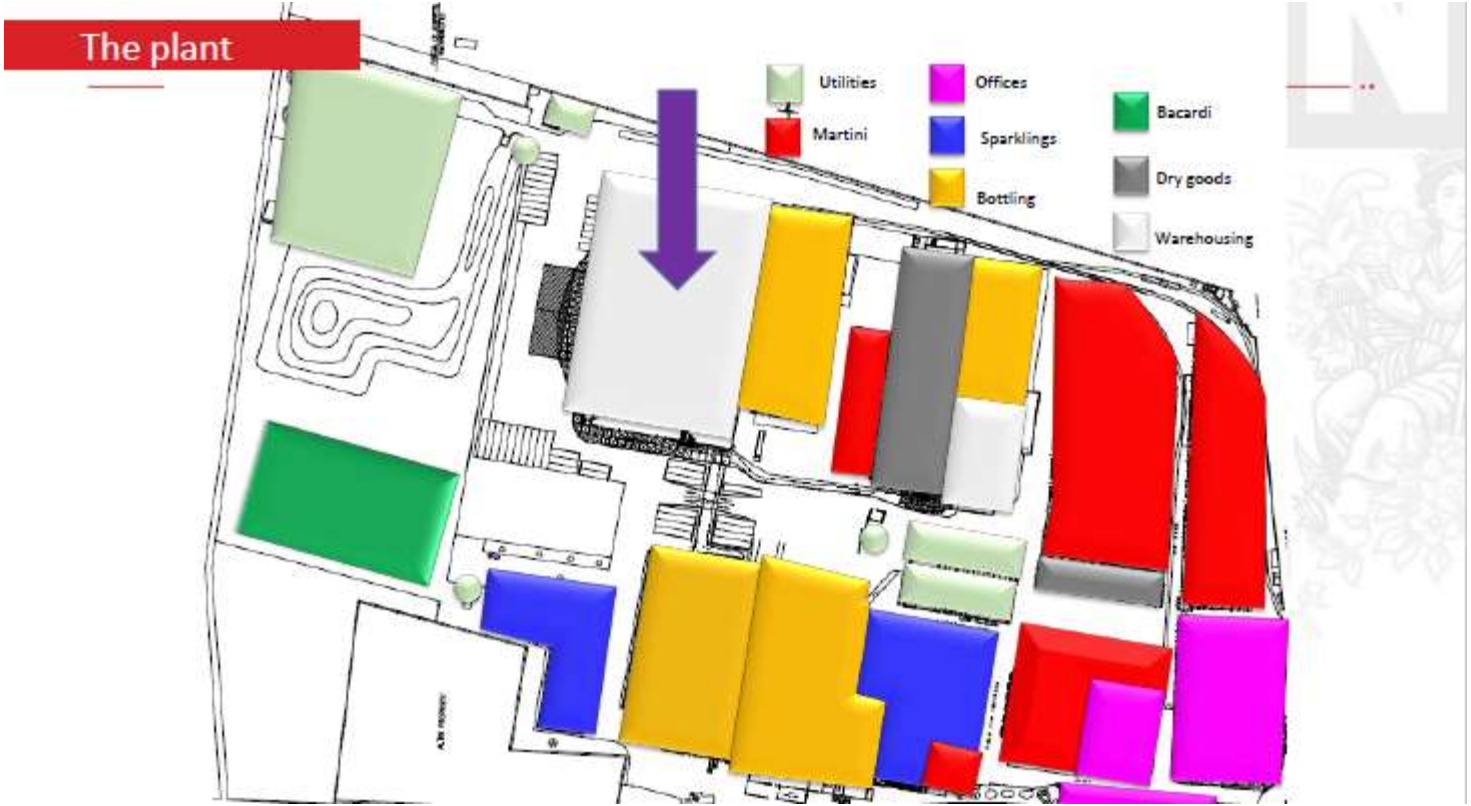


Pessione M&R Demosite

Current thermal energy generation

MARTINI & ROSSI Pessione plant heat demand (hot water and steam) is satisfied by:

•A local thermal power plant: 3 LOOS (BOSCH) boilers with a total power capacity of 11,71 MW (3 x 3,905 MW) able to produce 6 ton/h of steam at 10 bar.

•A CHP unit integrated in the company: Caterpillar CHP Internal combustion engine, Natural Gas fed at 860 kW_{th} and equipped with an evaporator able to produce 700 kg/h of steam at 3 bar.

One of the three boilers is always used as backup solution or to manage peak power.

There are three energy carriers serving the end users processes (sanitary water, heating, washing in production) are:

(1)3 bar steam

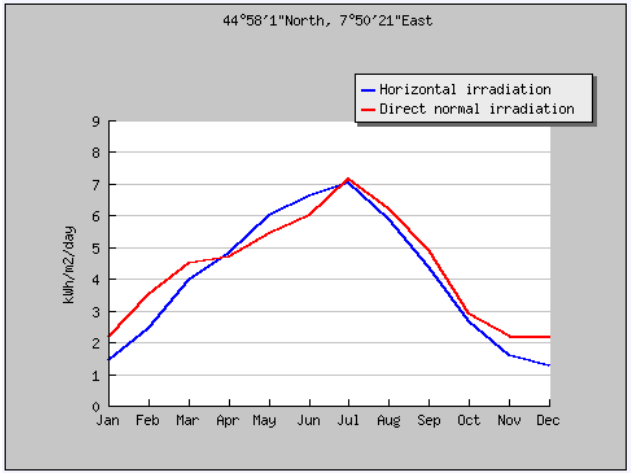
(2) 8 bar steam

(3) hot water at 60° C

Solar Potential and Climate

Good Summer potential even for DNI

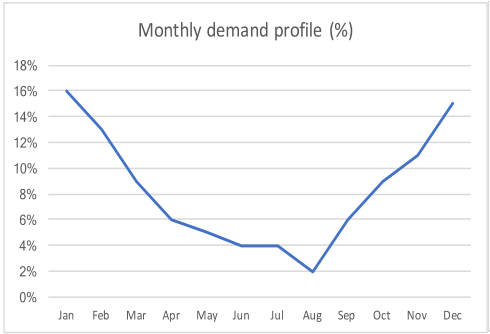
Available Surface: around 2500 m2

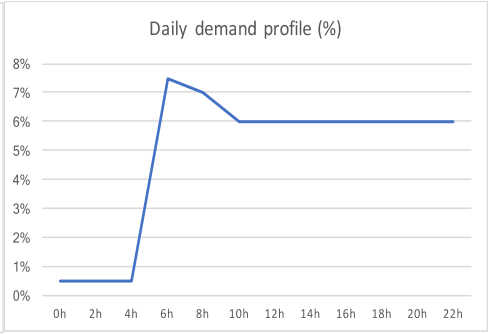


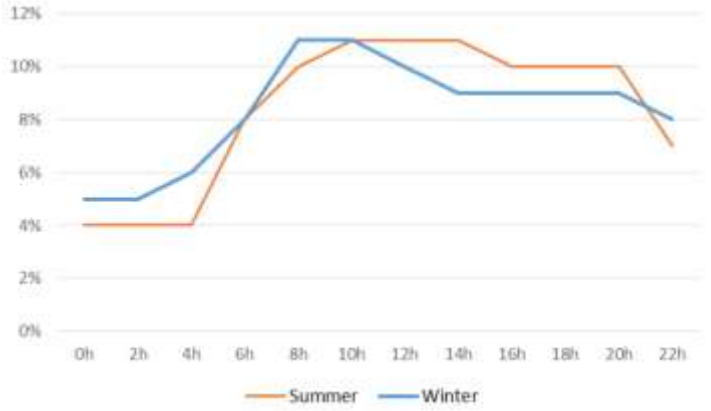
Pessione M&R Demosite

Heat demand

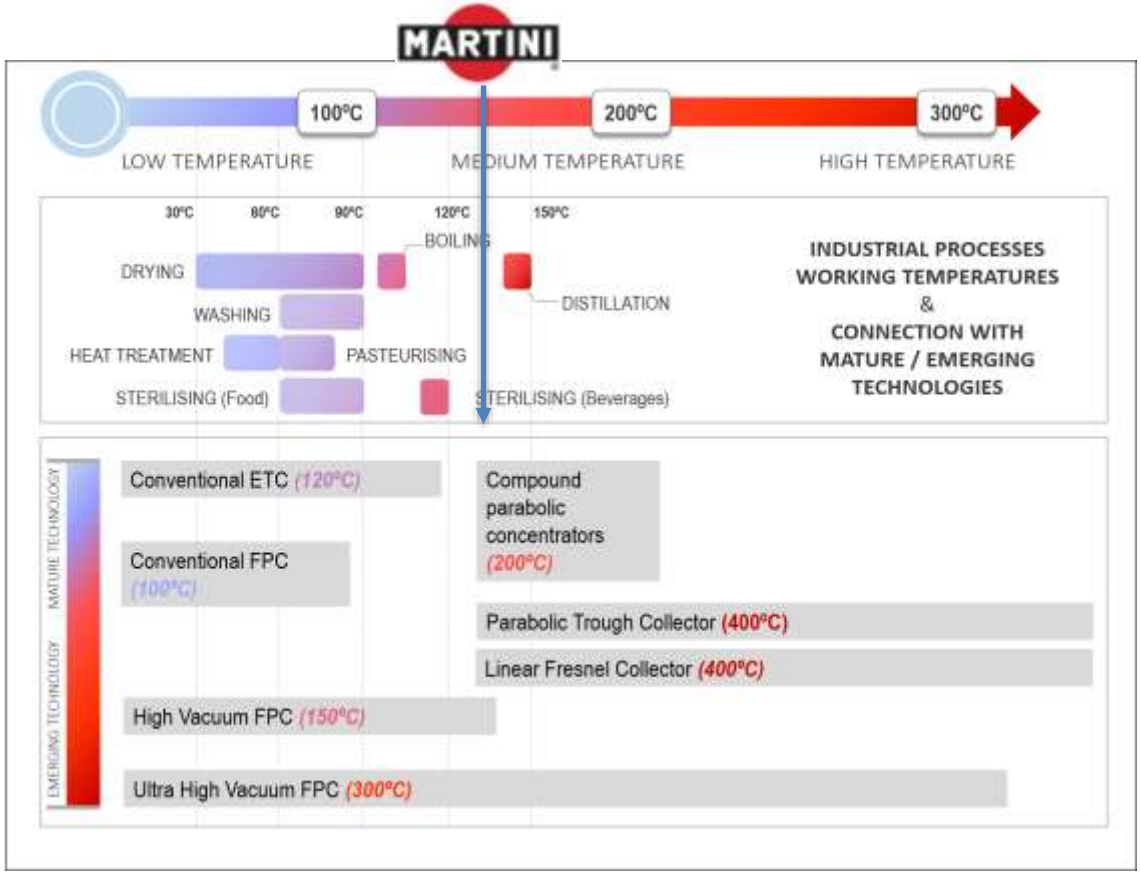
The thermal demand is quite constant during the whole year, while the variation of fuel consumption is caused by weather conditions. The process work full operative 16 hours per day during the working days and it is at base load (mostly for anti-icing purpose particularly in winter) during Saturdays and Sundays.







Identification of the solar technology



Identification of the SHIP2FAIR best solar technology

Ultra High Vacuum FPC

- ✓ No concentration of sunlight, thus no moving parts
- ✓ Make use of diffuse sunlight
- ✓ Able to works even when the glass cover is dirty
- ✓ Simple installation
- ✓ Higher efficiency - depending on temperature, lower for higher temperatures

X Limited power range of several 100 kW to single-digit MW
X Small size of the panel: increases the installation works and higher probability for leakages due to high number of connection
X Small piping diameter - higher pressure losses
X Risk of stagnation / overheating

Fresnel Collector

- ✓ Large modular size allowing several MW.
- ✓ No north-south alignment necessary
- ✓ Precise temperature and power control
- ✓ Direct steam generation

X Concentrating system - moving parts
X Can only make use of direct irradiation
X Can only be installed on flat rooftops
X Not suitable for projects below 130 kW
X Stronger effect of dust on the mirrors

TVP SOLAR

INDUSTRIAL SOLAR
renewables onsite

Techno-Economic Evaluation and Scenario

The preliminary expected solar production has been therefore calculated taking into account the average local irradiation value (DNIavg), an average solar collector thermal efficiency (η), an operating factor (OF) and the available surface (S) also targeting 1 MWth as power input to avoid any type of losses from the subsidized CHP unit.

$$E_{sol} = DNI_{avg} * \eta * S * OF$$

Net Aperture Area: 1760 m^2

Gross Area: 2464 m^2

DNI_{avg} [kWh/m^2 year]	1580
η	0,65
Net Surface [m^2]	1760
Operating Factor	0,7
Turnkey surface cost [€/m^2]	270
Natural gas cost [€/m^3]	0,3

Techno-Economic Evaluation and Scenario

The distillation and bottling processes heat demand is 5,542 MWh/year, composed by: 1-bottling process (81%), 2-bottling process (7%) and distillation (12%), which is fed by 759,526 m3 of natural gas per year. It is therefore easy to calculate that the solar plant could cover **around 30% of heat demand of such process** guaranteeing a relevant NG saving/GHG saving and reasonable PBP.

Yearly Production [MWh]	**1780**
GHG Savings (t/yr of CO2)	420
NG savings (m3/yr)	243947
Estimated PBP (yrs)	8,82

Challenges and Opportunities

Also for replication….

- Interaction and integration of SHIP with local subsidized CHP
- Storage Integration (for both not working days/cloudy moments/buffer-smoother)
- Weight of Panels in case of rooftop structure
- Proper Control strategies to be optimized (particularly with larger installation)
- Industrial scepticism in process innovation (even if energy is half of their OPEX!)

Conclusion

- This preliminary evaluation performed taking into account the needs and the peculiarities of Martini & Rossi plant shows that solar installation with PBP of about 10 years can be achieved even without external incentives and even considering limited installation in terms of power, but that can be dedicated to specific processes covering a significant amount of their thermal demand.

- Moreover, the foreseen solar fraction, which is not greater than 20% on average has two major consequences: firstly, the control logic is quite simple as the solar heat produced can be in principle directly injected in the high pressure steam loop and, secondly, the storage size can be reduced as its main role would be to smooth the solar production and not managing the thermal load.

- As a matter of fact, in many EU and non-EU countries there are national subsidies on RES installation, industrial energy efficiency and avoided GHG that could incentivise this kind of plants.

- It is also worthy to underline that the production of flat solar thermal collectors at a lower temperature and pressure could be potentially integrated in the low pressure operating loop

- Even if located in Italy, Pessione demosite is an example of a quite common solar situation in EU

Timeline


2018
2020
2022 SHIP2FAIR's end
2023
2025
2027
• SHIP2FAIR's kick off
• Replication & Control Tools development
• Demonstration campaign at demo-sites
• Tools ready
• Capacity building with the SHIP guide
• Scale-up & replication in demo-sites
• Identification of barriers & measures
• Feasibility studies in 10 additional sites
• SHIP2FAIR results ready to market
• Promotion of the SHIP2FAIR results in the identified EU markets
• Application of business strategy & SHIP2FAIR tools to other industries
• Beyond SHIP2FAIR: Ground ready for implementing 100 SHIP projects

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THANKS FOR YOUR TIME

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