SHIP2FAIR

TRAINING MODULE 1

How to investigate our energy consumption, and the potential of SHIP technologies

Chapter 3
The different ways of integration in an existing process

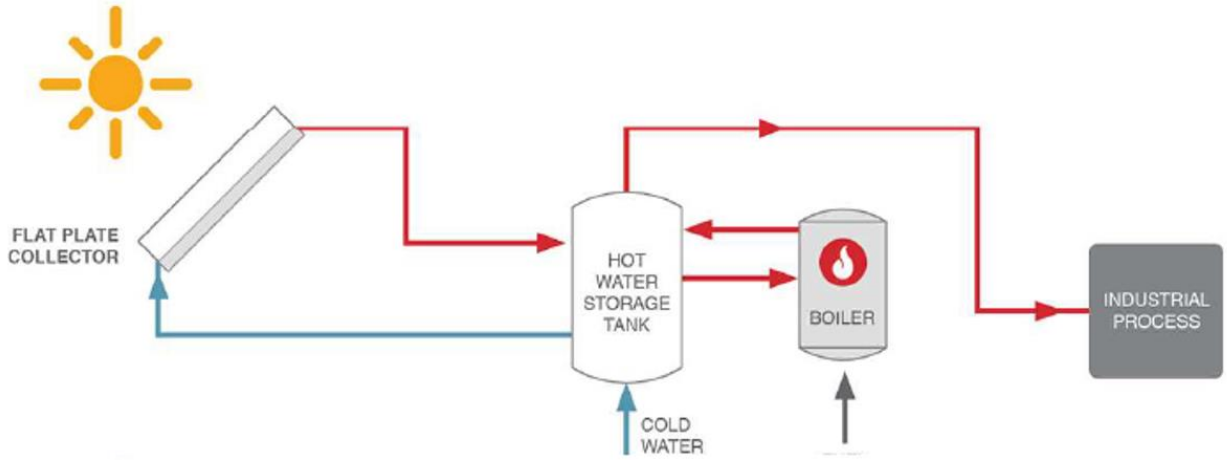
Solar thermal solutions can be integrated in several ways into industrial processes, either at the supply level or process level. At the supply level, the solar thermal system delivers heat in the main heat network that is supplied by the already-in-place are water preheating and direct steam generation. For integration into the process level, the solar-generated heat is then applied in a specific process within the industrial plant, designed to satisfy the specific operating parameters of this process. These most typical methods are further described below, as well as the generation of solar cooling with solar thermal collectors.

3.1 Water preheating

Water preheating is the most common integration of solar thermal heat into industrial processes. This integration method is applicable for low-temperature processes that are fed by a hot water storage tank, typically operating below 90 °C. The solar thermal system, composed of a hydraulic circuit and the collector field (e.g., flat plate or vacuum tube collectors), heats the water in the storage tank, and the conventional boiler guarantees the required temperature according to the industrial plant demand.

In industry, there are numerous types and connection options for hot water storage with solar thermal systems. There are fixed or variable volume hot water storages, as well as buffer storages that are energetically charged and discharged. Solar heat can be used to preheat input streams or to maintain storage temperature depending on the number of storage and their configuration.

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.

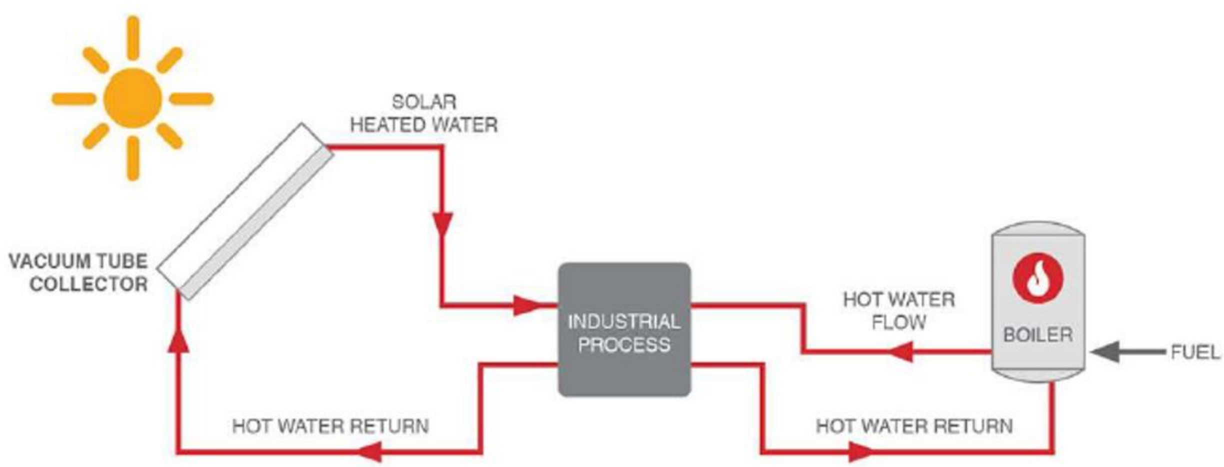


Water pre-heating principle

3.2 Process heating

Solar-generated heat can be integrated at the process level via heat exchangers installed in the referred process. The types and methods of heat exchange depend on the desired characteristics of the processes, for example, direct heat into the products or heating a storage tank that feeds the specific process. In both cases, the conventional boiler system runs in parallel and provides additional heat when the solar resource is unavailable. In cold climates, the heat transfer fluid used in the hydraulic circuit of the solar thermal system is generally a mixture of water and glycol in order to avoid freezing, whereas, in warmer climates, the fluid used can be conventionally treated water.

Different types of solar thermal collectors can be used, but the most typical are non-concentrating collectors such as vacuum tubes or flat plates.



Process heating principle

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.

3.3 Direct Steam Generation

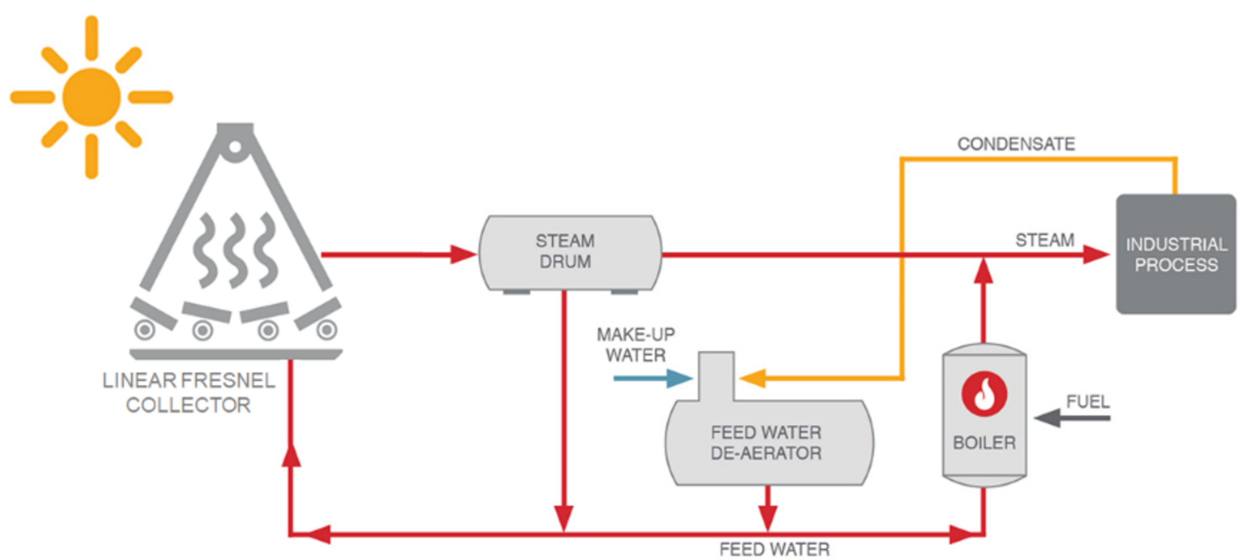
In direct steam integration, feedwater is pumped to the collector field and the generated steam is directly integrated into the end user's main steam grid.

A direct steam generation system is powered with the concentration of solar irradiation onto an absorber tube in which water is recirculated and partially evaporated. The fluid continuously enters the steam drum, where steam accumulates at the top, and high-pressure water accumulates at the bottom. A steam drum is a thermally insulated vessel that receives steam from the solar collector field. The accumulated steam at the vessel's top is vented to the industrial steam network via a control valve. At the same time, hot water from the drum's bottom is constantly recirculated to the collecting field.

This reservoir operates at a higher pressure and temperature, storing thermal energy to compensate for variations in demand. The steam drum also decouples heat generation from a changeable solar resource from process demand, assuring a consistent supply.

Video - Solar Process Heat and Cooling for Tobacco Processing | Industrial Solar GmbH https://youtu.be/Q3iN10MBo5s

When steam is released into the factory, feedwater is injected into the steam drum to maintain mass balance. Sensors are built throughout the system to monitor temperature, pressure, flow rates, and meteorological conditions like irradiation, wind, and rain. This enables continuous, safe, and automatic operation throughout the day.



Direct steam generation principle

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.

3.4 Solar thermal cooling

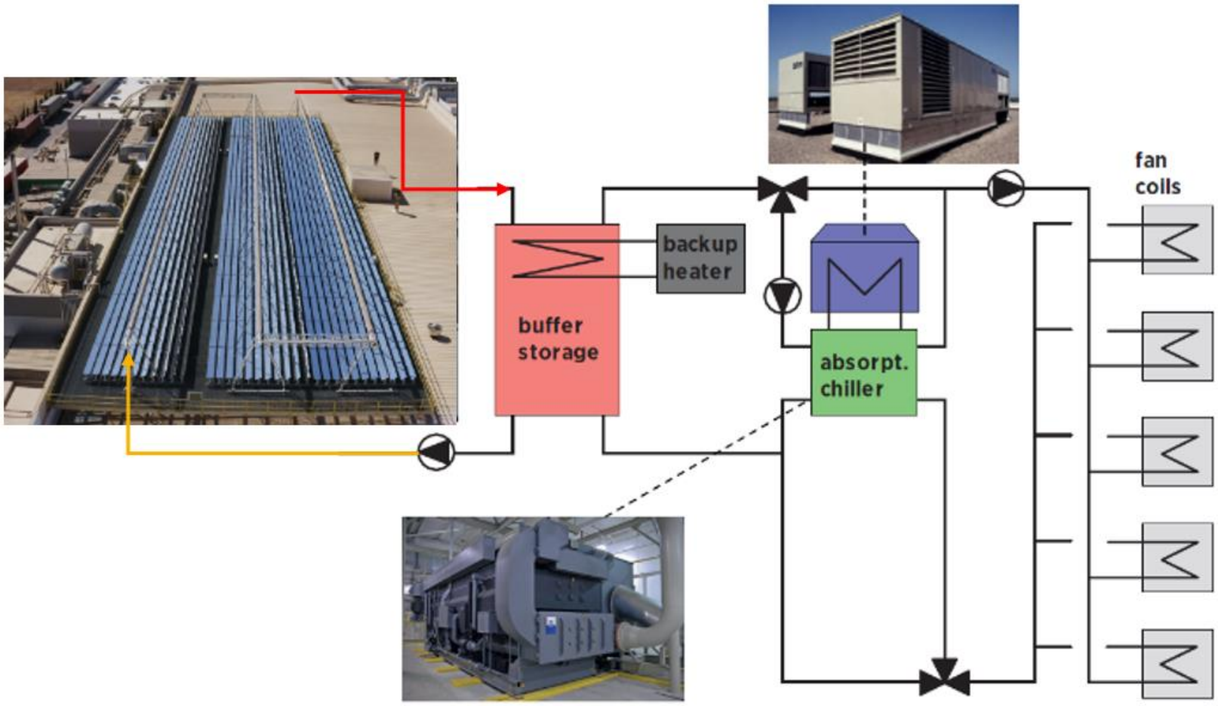
Solar thermal cooling technology uses heat collected directly from the sun (using various types of collectors) in a thermally driven cooling machine such as absorption chillers (as opposed to using electricity generated by solar photovoltaic panels, for example).

Absorption chillers are the main types of thermal machines used and are comprised of four major components: an evaporator, an absorber, a generator, and a condenser. The refrigerant changes phase and proceeds to the next step in each component stage. Fresnel solar collectors or other solar thermal technologies can provide the heat required to regenerate the refrigerant mixture in the generator. The evaporator produces cold by absorbing heat from the environment to be cooled while operating at low pressure. The idea is similar to a standard cooler system, except that the refrigeration cycle is driven by a heating source on the generator/absorber side instead of an electric compressor.

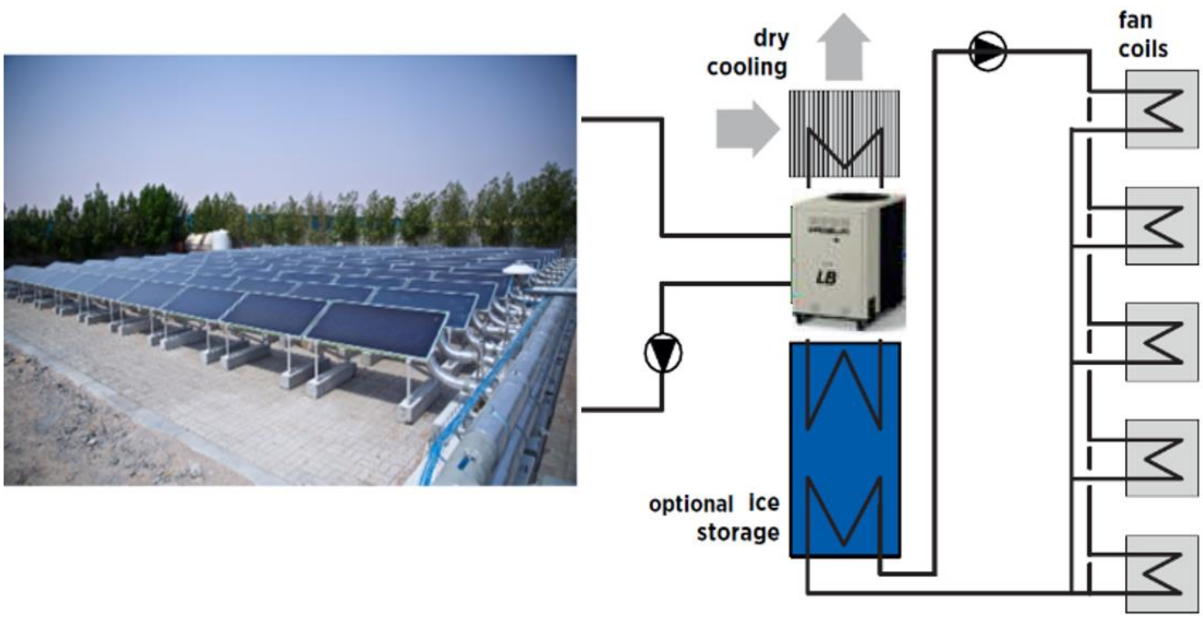
Video - SOLAR COOLING - MTN Fresnel Solar 330 kW Cooling System in South Africa: https://youtu.be/mbwiUlb__gg

Solar cooling can provide chilled water with single-effect or double-effect absorption chillers coupled with solar thermal collectors. Single-effect absorption chillers need a temperature in the heat source at 80-90 °C that can be provided by flat plate or evacuated tube collectors. In contrast, double-effect chillers need a higher driving temperature, typically above 180° C, that can be supplied by concentrating solar technologies such as the Fresnel collector. Although both types of chillers mainly use a mixture of lithium bromide-water as refrigerant, the main difference between them is the COP – Coefficient of Performance, which is typically around 0,7 for single-effect machines and 1,35 for double-effect chillers. Both types of chillers can produce cold water at temperatures from -10 °C to 18 °C. The chilled water produced is then fed to the customer's cooling circuit. To produce cooling below 0 °C, ammonia-water refrigerant mixture is used.

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.



Double-effect absorption chiller integration



Simple-effect absorption chiller integration

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