100% RENEWABLE HEAT FOR INDUSTRY:THE GREEN DREAM

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Summary

The need for renewable energy supply is as important as ever, with temperatures rising all around the world. However, industry applications that achieve 100% renewable energy are still rare and are considered difficult to achieve. Thus, to show that this “green dream” can be indeed made into reality, the authors report on their experiences at the industrial facility of Ball Beverage Metal Containers in Fairfield, California. The plant is currently being converted from a gas boiler steam system to a 100% renewable heat supply - based on solar heat for the base load and heat pumps to provide the complementary heat. The conversion has drastically improved the overall system efficiency, as the existing, aged steam system was both oversized and had high heat losses. The combination of solar heat and heat pumps while improving the efficiency of the distribution system made it possible to create a favourable business case. The pattern has a huge potential for replication, and follow-up projects are in development.

Background

Ball Packaging is producing Aluminium cans for beverages. As part of the process, hot water is required for cleaning and spraying the cans as well as for cleaning the wastewater streams. The facility was built in the 1970ies and has a heating system based on three natural gas steam boilers. A steam distribution system delivers the heat to the integration points, heating up water via heat exchangers. Most processes require between 50° and 75°C, so the overall temperatures are favourable for solar thermal heat.To meet the sustainability targets, a solar-thermal plant was commissioned in 2023 by SOLID Solar Energy Systems and TIGI Solar, as part of a Heat Purchase Agreement. The scope included a solar collector field of 3.957m²/2.770 kW with collectors from TIGI and Sunrain, a container hosting the mechanical equipment, a storage tank of 110m³ and a new hot water distribution system including heat transfer stations towards the integration points.

In addition, the integration of heat pumps is currently investigated, to reach a renewable share of 100%.

Pic. 1: Overview on Solar System, with collectors, Container and storage tank.

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OPERATING EXPERIENCE

Within the first month of operation, it turned out that the solar fraction was much higher than expected. That was due to the underestimated losses in the steam system. As an example, for a key process, the size of the new hot water supply pipe is 1 ½" while the previous pipe was 6". Having a pipe with a 4 times bigger size and being operated at 150°C instead of today's 80°C results in a factor of 8-10 on pipe heat losses.

So, the remaining demand for the gas boiler was less than expected resulting in several emergency shut-offs of the boiler. As a consequence, SOLID started considering if by integration of heat pumps a full replacement of the boilers is feasible.

For the heat pump, three low-grade sources are available. First, there is the availability of a wastewater stream with around 45°C hot water with constant flow. This is an easily accessible integration but was limited by around 40% (based on the output of the heat pump) of the facility's demand. As a second source, SOLID studied to use of the solar storage tank for the low-grade heat. This results in lower collector temperatures and thus increases the output of the solar field. Detailed simulation shows that a smart controlled operation of these two heat pumps can provide 98% of the facility's annual demand (see Figure 1). For redundancy, and covering eventual deficits, another heat pump or direct electric heater will be added.

ECONOMIC CONSIDERATIOn

To cover the last part of the heat demand is always the most expensive, and thus renewable projects often tend to cover only a certain percentage. However, shutting down a natural gas steam boiler plant creates significant savings by eliminating fixed costs on the steam system (certifications, inspection, constant supervision, etc.) as well as significant side costs of operation (make-up water, electric energy for running the vans, …). The savings on the fixed costs allow to create a business case despite relatively low energy costs.

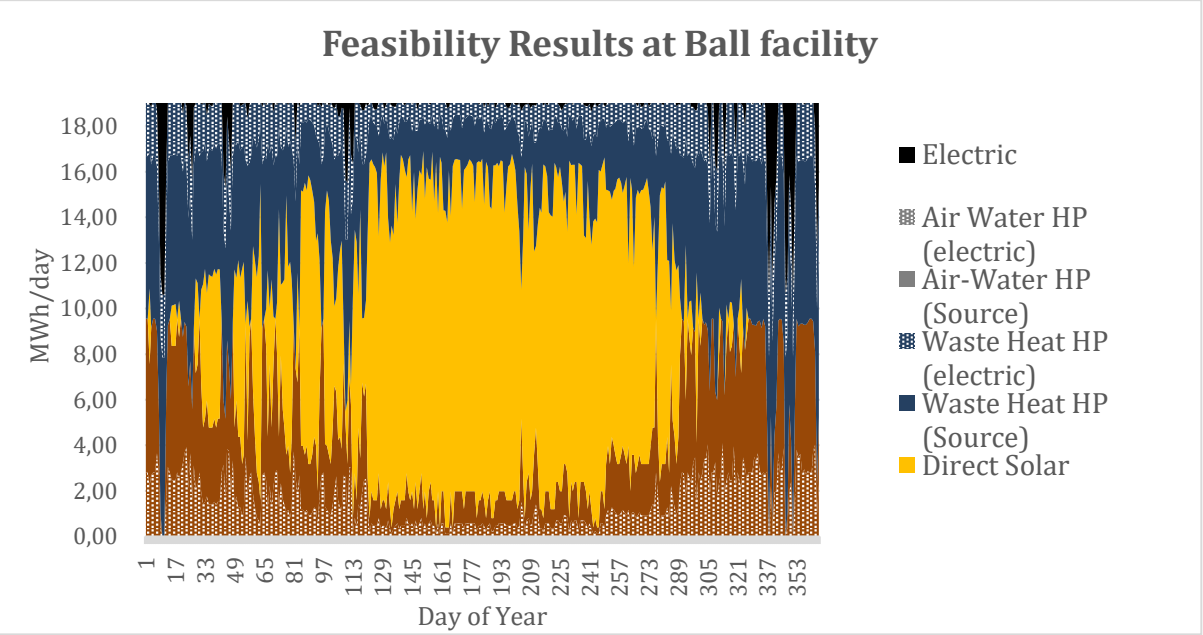

Fig. 1: Feasibility results for Ball Packaging in Fairfield, California, considering the solar field, a heat pump connected to the thermal storage of the solar plant, and a heat pump using the waste heat of the facility.