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# Solar process steam for pharmaceutical industry in Jordan

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**Abstract**

Solar Heat for Industrial Processes (SHIP) can contribute significantly to a sustainable industrial energy supply. Especially in Jordan, where irradiation and fuel prices are high SHIP is a promising opportunity for industry. Also the pharmaceutical sector, which plays an important role in Jordan, has a substantial heat demand. Industrial Solar installs a first system for SHIP in Jordan at RAM Pharma, a pharmaceutical company in Sahab, Jordan. The system will be comprised of 18 LF-11 Industrial Solar Fresnel collector modules and will be operated for direct steam generation.


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*Keywords:* Solar; Solar process heat; Solar Thermal; Fresnel; Direct Steam Generation; Industrial Solar; RAM Phama;

## 1. Introduction

Solar Heat for Industrial Processes (SHIP) repeatedly has been identified as an important market for solar thermal applications as the industrial heat demand is responsible for around 20% of the total final energy demand. After the introduction of specific supports measures the number of SHIP installations in Europe increases. Also the Middle East and North Africa (MENA) have a great potential for solar process heat. However, in addition to the general challenges of solar process heat, such as very low payback expectations of the industry, in these regions there are further barriers like (i) missing awareness in industry, (ii) insufficient institutional frameworks or (iii) missing pilot projects. Jordan is especially promising for the application of solar process heat due to high fuel prices and high solar irradiation. A first project will be realized at RAM pharma where steam will be directly generated in Fresnel collectors from Industrial Solar.


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## 2. Energy demand in the pharmaceutical industry

The pharmaceutical industry has a substantial energy demand. According to a study [1] about 65% of the energy demand is for heating, ventilation and air conditioning (HVAC). The three major production steps in pharmaceutical manufacturing are (i) research & development, (ii) production of bulk pharmaceutical products and (iii) the formulation of the final product, whereas the largest share of the energy demand accrues for the production of bulk products. In respect to SHIP only the latter two are of importance. The table below lists the processes with relevance for SHIP / solar cooling. The process temperatures depend on the process, the equipment and the specific product. However, most pharmaceutical factories have a central steam system at around 160°C – 180°C which supplies all processes.

Table 1. Overview of processes within pharmaceutical industry with substantial thermal energy demand

| Stage | Process | Heat demand | Cold demand |
|---|---|---|---|
| Production of bulk pharmaceutical products | Chemical synthesis | X | X |
| | Fermentation | X | X |
| | Extraction | | |
| Final product formulation | Granulation | X | X |
| | Coating | X | X |
| | Sterilization | X | |

In Jordan the pharmaceutical industry plays a major role contributing around 20% to the manufacturing GDP. Jordanian pharmaceutical companies export especially to the GCC countries which is one of the fastest growing markets for pharmaceutical products worldwide. At the same time, Jordan pharmaceutical companies experience increasing competition from neighboring countries.

## 3. Industrial energy demand in Jordan

In 2013 Jordan had a primary energy demand of 8,157 ktoe (kilo ton oil equivalent) of which 97% were imported. The major sources of primary energy were oil products (82%) and natural gas (11%), whereas the latter was mainly used for electricity generation. The total final energy demand in 2013 was 5,384 ktoe of which 17% where used in industry [2]. The major fuel sources for Jordan industry are fuel oil (139 ktoe) and diesel (118 ktoe). It is important to note that even though fuel oil accounts for the largest share of the energy diesel is used by 73% of the companies [3]. Thus, while small companies mainly use diesel, fuel oil is especially prominent in medium and large industries. In 2012 the Jordan government cut the energy subsidies which caused an increase in energy prices, diesel prices for example rose by more than 30%. The table below provides overview of the current industrial energy prices in Jordan.

Table 2. Retail Prices of Petroleum [4]; costs in costs in €/ $kWh_{th}$ based on authors own calculations

| Fuel | Costs | Costs in €/ $kWh_{th}$ |
|---|---|---|
| Diesel | 0.65 JD/L | 0.067 |
| Fuel oil | 462.49 JD/ton | 0.043 |
| Liquefied petroleum gas | 888.3 JD/ton | 0.070 |

In most countries of the region, especially the oil rich countries of the gulf, energy is still highly subsidized. Thus, energy costs are becoming an increasing thread for the competitiveness of Jordan industry. At the same time Jordan enjoys very high solar irradiation which even exceeds its neighboring countries due to its altitude and dryness. Thus, solar energy can contribute to overcome the energy challenge of Jordan industry.

Apart from pharmaceutical industry there are also other sectors with high thermal energy demand, especially mining, food and beverage, paper and cardboard, chemical and the textile industries. The total potential for solar process heat in Jordan is estimated to be around 300 GWh/a [5].

## 4. Solar process steam at RAM pharma

RAM Pharma is a pharmaceutical manufacturing company in Sahab, Jordan with a large variety of pharmaceutical products. Currently, the heat demand is covered by a diesel fired steam boiler. To address the continuous rise of energy prices RAM Pharma decided to install a solar process heat system to reduce the fuel consumption. In 2014 Industrial Solar will install 18 LF-11 Fresnel modules [6]. The LF-11 is a linear concentrating solar collector which major components are (i) eleven individually tracked mirror rows, (ii) a vacuum absorber tube and (iii) the support structure (see Figure 1). The total aperture area per module is 22 m². The collector is optimized for the supply of solar process heat as it can be installed on industrial roofs, due to its high ground space efficiency and as it is well suited for direct steam generation.

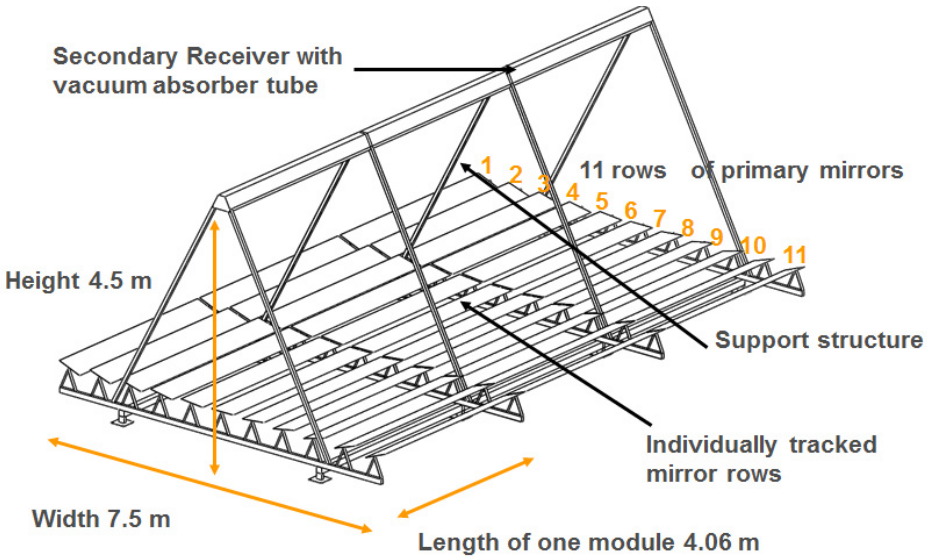


Figure 1. Three Industrial Solar LF-11 Fresnel collector modules with measures and major components

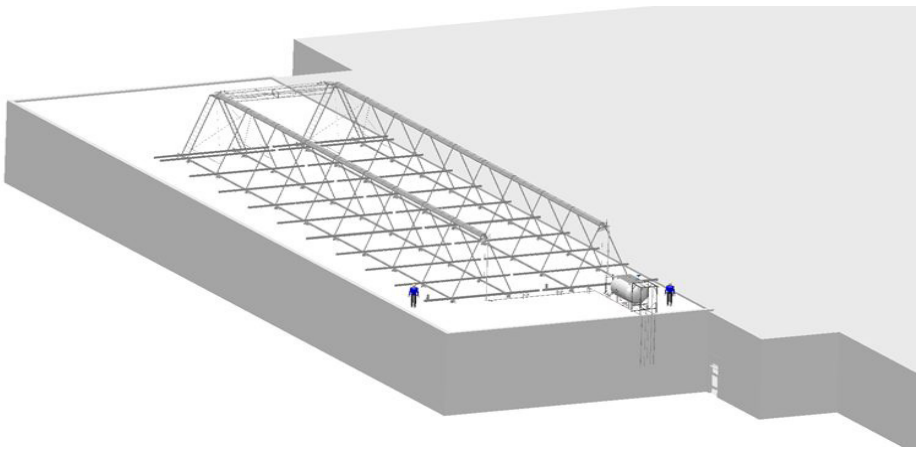

Figure 2. Conceptual drawing of the Fresnel collector system to be installed at RAM Pharma Sahab, Amman

The Fresnel collector modules will be installed on the roof of the factory in two strings with a total aperture area of 396 m² and a peak capacity of 222 $kW_{th}$ (see Figure 2). The system will be operated for direct steam generation. The major components of the system, the solar collectors, steam drum, recirculation pump, feed pump, treated water tank and the steam interface to the factory are depicted in Figure 3.

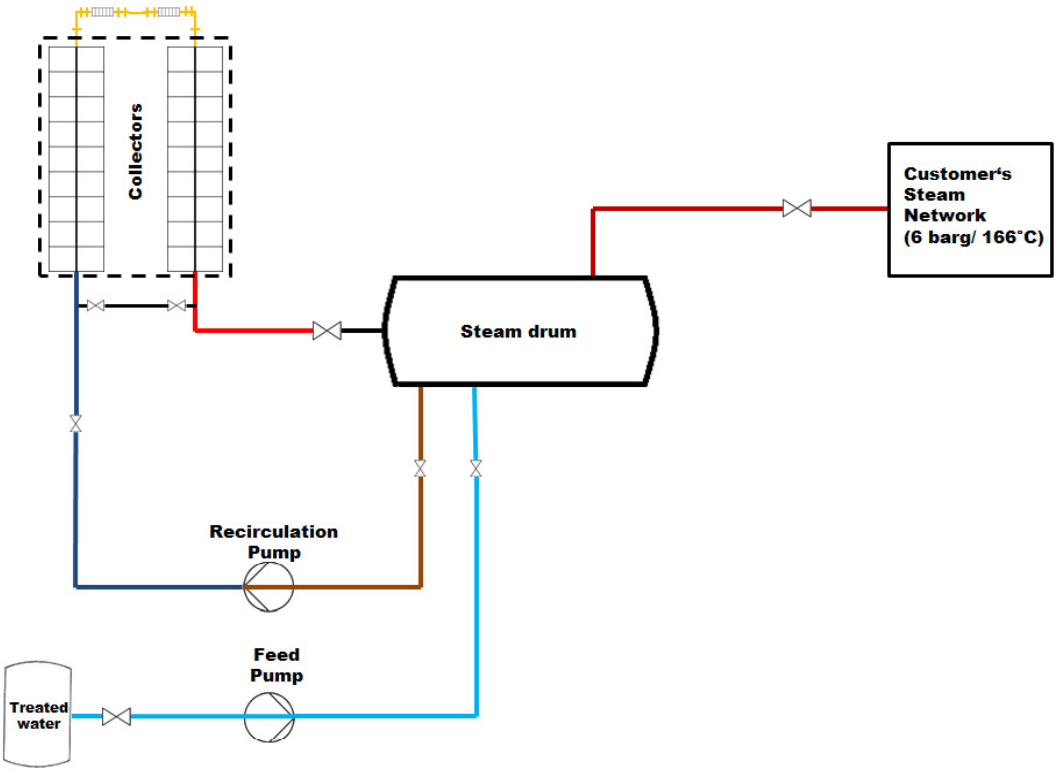


Figure 3. Conceptual P&I diagram of solar process heat installation at RAM Pharma

The collector modules are connected in a U-loop. Water is pumped through the collectors where it is heated and partly evaporated. Afterwards the steam-water mix is transferred to the steam drum where water and steam are separated. While the steam accumulates at the top the water is collected at the bottom. The processes within the factory can withdraw steam directly from the steam drum. Pressure can be regulated with a valve at the steam interface. The water at the bottom of the steam drum is recirculated through the collector modules. To maintain a constant mass inside the system softened water is pumped into the bottom of the steam drum when steam is withdrawn.

The Fresnel collector system will reduce the diesel consumption of the factory by more than 30,000 liters annually. In addition, the cooling load of the storage room below will drop due to the shading of the collectors providing an additional financial benefit.

## 5. Outlook

Apart from process heating most pharmaceutical industries also have a substantial demand for cold which can for example be provided through solar powered absorption chillers [7] whereby the demand for fossil fuel is further reduced. If both, heat and cold are provided by solar thermal collector the integration will be eased as the generation of cold can partly level the fluctuating heat demand of the production processes.

Due to the high fuel costs it is expected that solar process heat will play an increasing role in covering the energy demand of Jordan industry.

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