UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Solar Heating in Industrial Processes (SHIP) Project

The project "**Utilizing Solar Energy for Industrial Process Heat in Egyptian Industry**" is financed by the GEF and implemented by UNIDO in partnership with the Egypt National Cleaner Production Centre ENCPC. The objective of the project is to develop the market environment for the diffusion and local manufacturing of solar energy systems for industrial process heat. The project results will increase the knowledge and strengthen the awareness among the major stakeholders on the penetration potential of solar technologies in the food, chemical and textiles sectors in the region. The project focuses on improving the energy efficiency of the industrial process heating systems and the introduction of solar thermal technologies mainly in industrial companies that have low and medium temperature heat demand in three industrial sectors, namely the food, chemical and textiles sectors.

Phatrade - Pharaonic Essential Oils Co. – Obour City Plant Case Study

1st Industrial Zone, Obour City, Egypt

Food Sector **Essential Oils**

7,475 kg/year

1,139,970 kWh/year thermal energy consumed

Production Processes Flow Diagram

- Raw material receiving
- Inspection
- Packing raw material in stills
- Steam distillation
- First oil filtration
- Aeration for essential oil
- Second Oil filtration and packing
- Storage
- Final filtration and packing
- Shipping

Phatrade - Pharaonic Essential Oils is part of the food sector for essential Oils products in Egypt. Phatrade has been established in 1975 in the Spices and herbs field and started essential oils and concretes and absolutes products in 1987. The production of Phatrade company is assigned for the local and export markets. Phatrade – Obour City factory is one of the two operating Phatrade factories.

Phatrade – Obour City factory's processes flow diagram exhibits the main processes performed on the raw material to produce Cumin, Neroli, Parsley, Thyme, Chamomile and Anise oils products. General analysis on the thermal energy consumption shows that the average specific **diesel** consumption is about 152.6 kWh_{th}/Kg which is much higher than the average worldwide specific energy consumption benchmark.

Thermal energy system is supplied through **a steam boiler** of 1 Ton/hr capacity and supply steam at **6.5 bar**. The analysis shows that it is operating at part load most of the time and has about 0.43 ton/hr average steam production. Applying the suggested optimization measures will eliminated unnecessary losses and the factory can operate at much lower cost.

- Optimization Opportunities -

- **Thermal Insulation**
- **Boiler Optimization**
- **Waste Heat Utilization**
- **Solar Water Heating**

Thermal Insulation

Insulation of pipes and fittings is a general principle that should be applied in all steam consuming processes in the factories. **The proposed solution** is to fix the insulation at multiple parts of the steam system. The collective saving from proper insulation is usually enormous. Insulation will help **to reduce energy consumption**, **CO_2 emissions**, and **operation costs**. **safety will be enhanced** after **reducing** surface temperature from **170 °C to 45 °C**.

Capex: 21 USD/meter
Energy Savings: 1,800 kWh/year/meter
Payback: 0.26 years
CO_2 Reduction: 0.48 tCO_2/year/meter

Optimizing Boiler's Blowdown Flow Rate

Using a fixed rate of blowdown does not take into account changes in makeup and feed water conditions, variations in steam demand or the actual concentration of dissolved solids in the boiler's water. **The proposed solution** is **to install an automatic control system** optimizing blowdown rates. This will **reduce energy consumption, treatment**, **CO_2 emissions**, and **operation costs**.

Capex: 7,000 USD
Energy Savings: 57,760 kWh/year
Payback: 2.8 years
CO_2 Reduction: 15.5 tCO_2/year

Improvement in Burner Efficiency with an Oxygen Analyzer

The excess air is not automatically controlled in the boiler, thus the air to fuel ratio is not optimal and leads to an increased fuel bill. The **proposed solution** is to **install an online combustion gas analyzer** and manual adjustment of the air damper to improve burner efficiency. This requires **low capital cost** and results in huge **CO_2 emissions** and **operation costs reduction**.

Capex: 1,750 USD
Energy Savings: 9,470 kWh/year
Payback: 4.7 years
CO_2 Reduction: 2.6 tCO_2/year

Integration of Solar Thermal Heating System

Solar heating technologies collect thermal energy from the sun and this heat can be used for heating purposes. Solar collectors are selected based on the range of the operating temperature range and the type of the industrial sector. Heat in the lower temperature range (<100 °C) can easily be provided with systems commercially available, such as flat plate collectors (FPC) and evacuated tube collectors (ETC). The **scenario envisioned** for the factory is to **preheat boiler feed water** by recovering energy from boiler's exhaust gases and blowdown water followed by heating using solar system which will decrease the energy consumed by the boiler. The system will be **installed on the roof** occupying **110 m²** of area. The system is designed to **heat 5.2 m³/day** to **95 °C**. The **system cost** is around **USD 54,950** and the **annual savings** will be **USD 5,945**. Other parameters are shown below.

System Design Area: **110 m² using ETC**

Energy Savings: **151,060 kWh/year**

Capex: **54,950 USD**

Annual Savings: **USD 5,945**

Payback: **9.2 years**

CO_2 Reduction: **40 tCO_2/year**

Water Flow Rate: **5.2 m³/day**

Design Temperature: **95 °C**

Lifetime: **20 Years**

Lessons Learnt

- **Thermal insulation is a quick win. It saves energy with very low upfront costs and have high impact and low payback.**
- **Boiler optimization requires low efforts but have high impact on CO_2 emissions reduction.**
- **Waste energy utilization is not a common measure, however highest energy saving can be achieved by this measure.**
- **Solar thermal integration combines renewable energy resources utilization and energy savings measures.**

The **total proposed solutions** summary:

- **Thermal Energy Savings:** up to **413,340 kWh/year**, representing about **36.3%** savings of the total **thermal** energy consumption (where **13.3%** is due to the integration of SWH systems),
- **Financial Savings: 44,690 USD/year,**
- **Capital Cost**: **~69,270 USD**,
- **Overall Payback Period: 1.55 years**,
- **CO_2 Emissions Reduction: 180 tCO_2eq/year**.

For more information:

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SOLAR Heating for Industrial Process
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