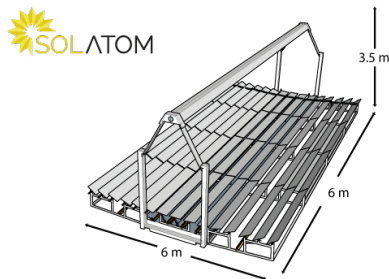


Summary of results

Energy bill: 93745 €	Average savings: 50432 €/year	% Savings: 34.422%
Investment: 166688 €	IRR: 23.38 %	Payback: Year 5
Solar field: 792 m ²	Solar production: 409758 kWh/year	CO₂ saved: 110 Ton/year

Solar production

The solar field is designed combining solar collectors in arrays. In each array, solar collectors are connected together in series. Arrays are connected in parallel. The number of collectors in each array has been designed in order to reach the design temperature delta (**70.0 °C**). The number of arrays of the plant depends on the energy demand.



Collector simulated: SOLATOM [Ref:www.solatom.com]

Type of optics: Linear Fresnel

Weight of the collector: 900 kg/module (25kg/m²)

Number of collectors: 20 (Overall surface 792 m²)

Pattern: (2x10) 10 collectors in 2 arrays

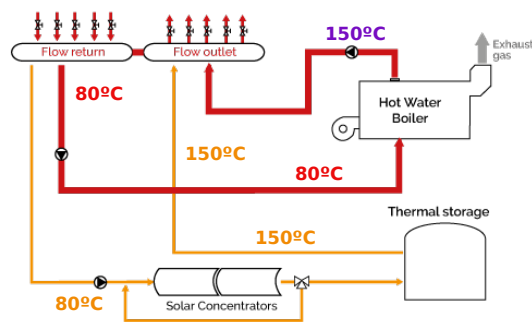
Type of terrain: clean_ground

Foundation: Not necessary

Data monitoring: Included (online)

O&M required: It is recommended to clean the mirrors once a month.

Integration concept



Integration concept: "SL_L_PS"

[Ref: IEA SHC Task 49 - Integration Guideline - Feb 2015]

Description: The solar field is connected in parallel to the boiler. The solar collectors heat the fluid up to the same temperature as the boiler do, and therefore they can be connected directly to the output header

Storage: Thermal storage included

Volume of the storage: 10000.0 liters

Capacity of the storage: 780 kWh

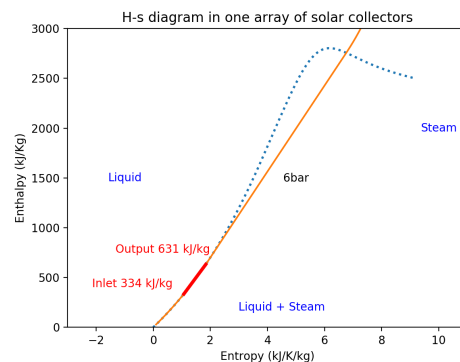
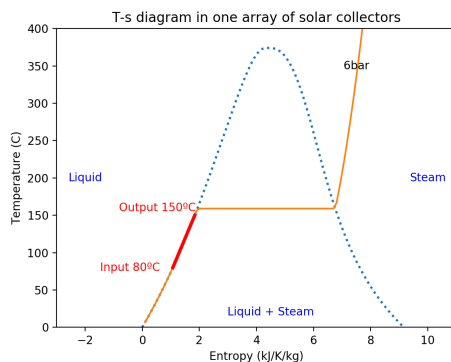
Temperature of the storage: 150 °C

Values of flow per array of 10 collectors

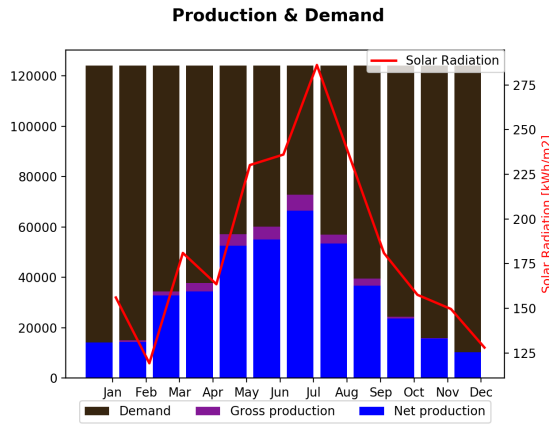
Mean: 0.25 kg/s **Max:** 0.61 kg/s **Range:** 0.53 kg/s **Std:** 0.11 kg/s

Properties of the fluid and design: water

Description: The entire circuit is in liquid phase, there is no evaporation. At the entrance of the solar field the fluid enters in liquid phase at **80°C**. The solar field heats the fluid to a temperature of **150°C**, corresponding to the outlet temperature of the boiler. Since the solar field output temperature is the same as the boiler output, the solar field can be directly connected to the network of the factory



Solar production during one year



Meteorological file: "Sevilla.dat" (Meteonorm v.7)
Solar energy on location: 2221.76 kWh/year

Annual solar production (gross): 438554 kWh
Annual solar production (net): 409758 kWh
Annual demand of energy by the industry: 1488024 kWh

% between solar energy gross and total demand: 29.47%
% between solar energy net and total demand: 27.54%
Annual production per module: 21928.0 kWh

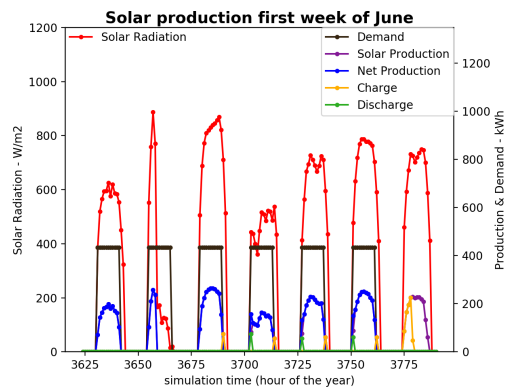
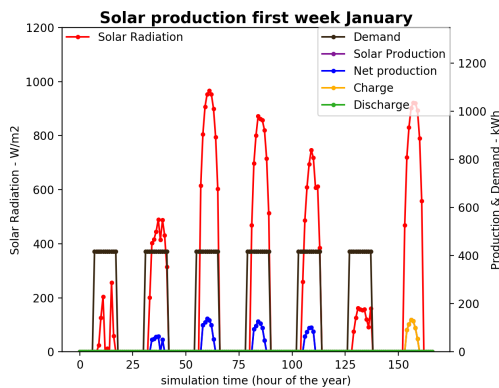
Solar production in kwh per month:

Month	Production Ratio	Month	Production Ratio	Month	Production Ratio
Jan	14189.07 11.4%	Feb	14962.05 11.6%	Mar	34477.3 26.5%
Apr	37812.39 27.8%	May	57104.65 42.4%	Jun	60063.99 44.4%
Jul	72854.24 53.6%	Aug	56953.18 43.1%	Sep	39531.44 29.5%
Oct	24331.08 19.1%	Nov	15916.61 12.7%	Dec	10358.07 8.4%

Details of the solar production during winter and summer

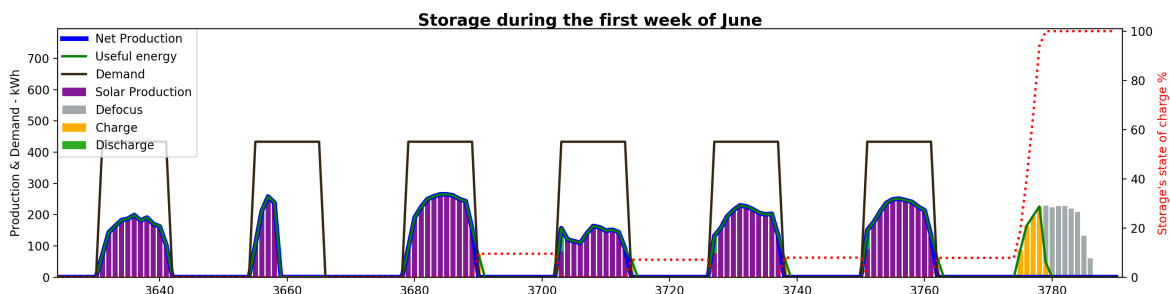
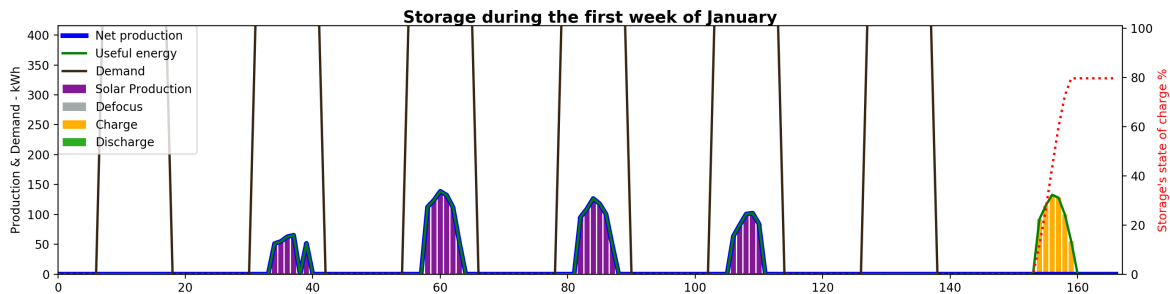
The graphs shown below represent the behavior of the solar plant during the first week of January (that corresponds with the range of hours 0 and 167 of the year) and the first week of June (that corresponds with the range of hours 3620 and 3791 of the year).

The integration concept integrates thermal storage, in this case, when the **solar energy produced is greater than the industry demand**, the excess of energy is stored (orange line) to be used later (green line). The blue line represents the net energy that is finally provided to the industry. When there is an excess of energy and the storage is full, the solar system defocuses its mirrors to avoid overheating.



Details of the behavior during the weeks of winter and summer

"Storage charge" - Solar energy that is stored in the deposit in one year: 38027 kWh
"Storage discharge" - Stored energy that is provided to the industry in one year: 38027 kWh
"Defocus" - Solar energy that cannot be stored nor consumed in one year: 28795 kWh
Percentage of defocus: 6.6 % (Percentage of defocused energy)
Increase of energy due to storage: 10.2 % (Increase compared to the option without storage)



Economic results

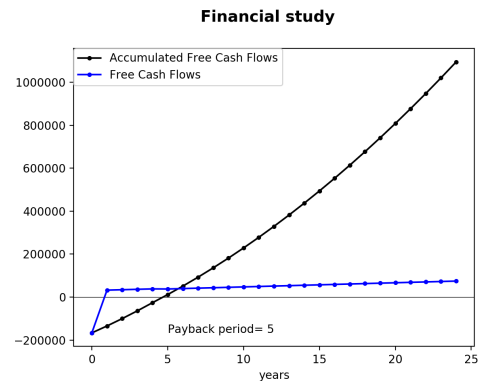
Total investment: 166688 € Payback: Year 5

IRR for the client: 23.38 %

Business model: turnkey

Annual savings per cost of CO₂: Not taken into account

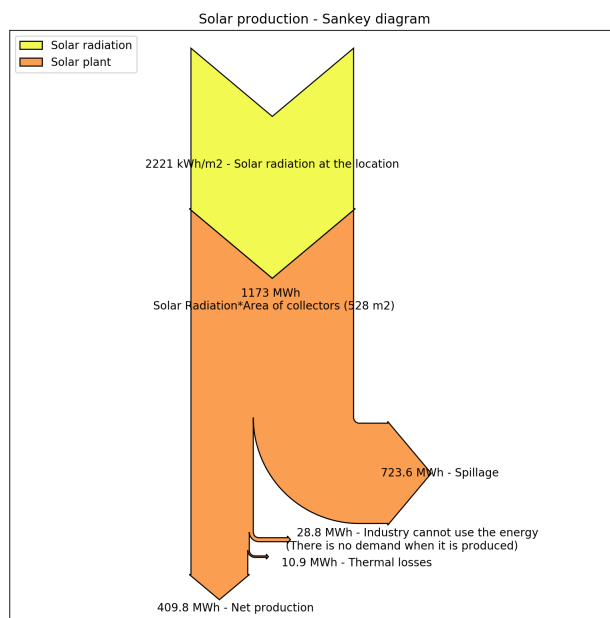
Year	Accumulated Cash Flow	Solar savings + CO2 savings	Energy bill of industry
Year 0	(166688.0) €	0 €	93745 €
Year 1	(134419.0) €	32269 €	93745 €
Year 2	(100214.0) €	34205 €	99370 €
Year 3	(64074.0) €	36141 €	104994 €
Year 4	(25997.0) €	38077 €	110619 €
Year 5	11616.0 €	37613 €	116244 €
Year 6	51165.0 €	39549 €	121869 €
Year 7	92650.0 €	41485 €	127493 €
Year 8	136072.0 €	43421 €	133118 €
Year 9	181429.0 €	45357 €	138743 €
Year 10	228723.0 €	47294 €	144368 €
Year 15	494232.0 €	56974 €	172491 €
Year 20	808144.0 €	66655 €	200615 €



Hypotheses taken into account during the economic study:

Installation price per m²: 315.7 € [Includes: collectors, installation of the connection and the monitoring system. Does not include the storage]. Price per ton of CO₂: 0.0 € [Ref: Ind]. Boiler efficiency: 80% [Ref: Ind]. Annual increase of the price of fossil fuel: 3.5 % [Ref: Forecast to 2022 IEA]. Annual increase of the IPC: 2.5 % [Ref: National Institute of Statistics].

Sankey diagram of the energy production of the system



Breakdown of the annual energy production of the system:

1) Solar radiation: 2221.76 kWh/m²

The solar radiation is the available energy on the selected location.

2) Energy on the surface: 0 MWh

Solar radiation that can be reflected by the mirrors

-> 2.1) Not concentrated energy (spillage): 0 MWh/year

Radiation that geometrically is not able to concentrate on the receiver and is therefore lost

-> 2.2) Energy not used: 0 MWh

Solar radiation that arrives on the receiver, but it cannot be used by the industry (as a storage does not exist or the industry does not need energy when there is solar production)

-> 2.3) Energy lost to the environment: 0 MWh

Thermal losses of the system to the environment

3) Energy transmitted to the industry: 0 MWh

Solar energy that is finally provided to the industry

Information of the client - 2018-11-04

Name: Example

Company: Example

Sector: Food_beverages

Financial information

Current fuel type: Gasoil-B

Price: 0.063 €/kWh

Business model: turnkey

Solar system

Location: Sevilla

Available surface: 1200 m2

Type of terrain: clean_ground

Orientation: NS

Inclination: flat

Shadow: free

Distance to the gas distribution network: 35 m

Thermal process -

Temp. boiler outlet: 150.0

Temp. boiler inlet: 80.0 °C

Fluid: water

Pressure: 6.0 bar

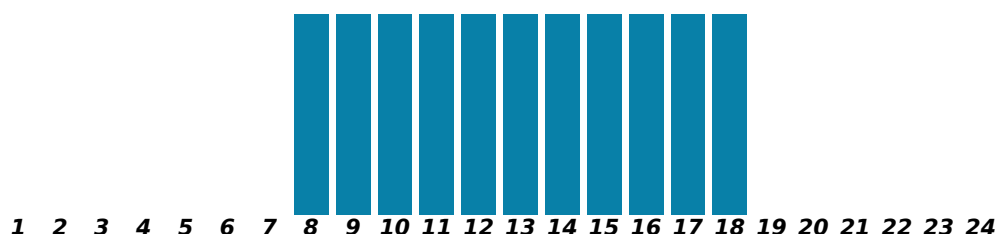
Integration type: SL_L_PS

Energy consumption

Annual consumption of energy: 1488024.0 kWh

Daily consumption profile: -

Demand



Weekly consumption profile:

Demand



Annual energy consumption:

Demand

