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SOLAR THERMAL ENERGY RESEARCH GROUP

Integration of solar process heat at a South African microbrewery: a feasibility study

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CENTRE FOR RENEWABLE AND SUSTAINABLE ENERGY STUDIES

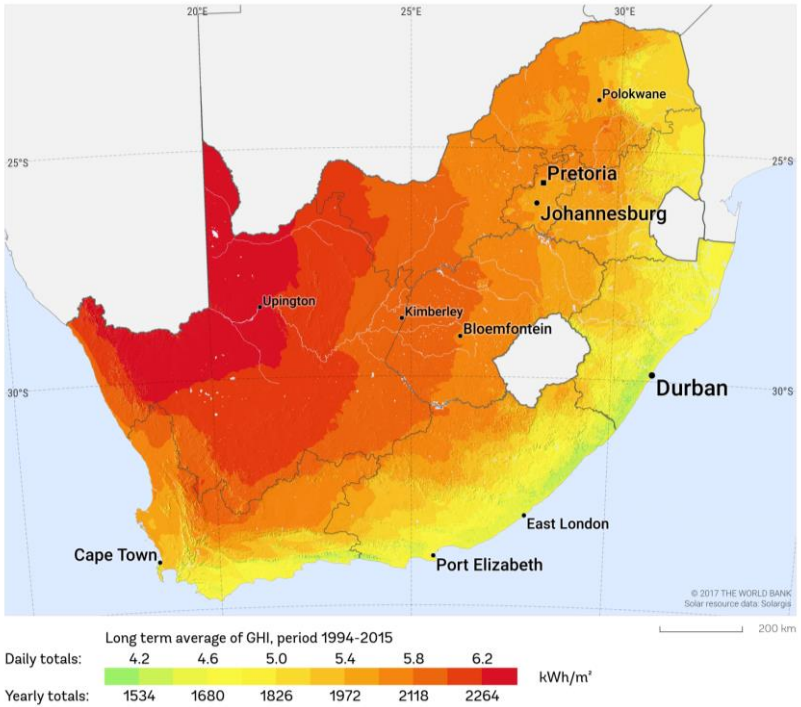
Background

SA Solar Resource in Industrial Areas

Gauteng
- 2000 kWh/m²

Greater Cape Town
- 1800 kWh/m²

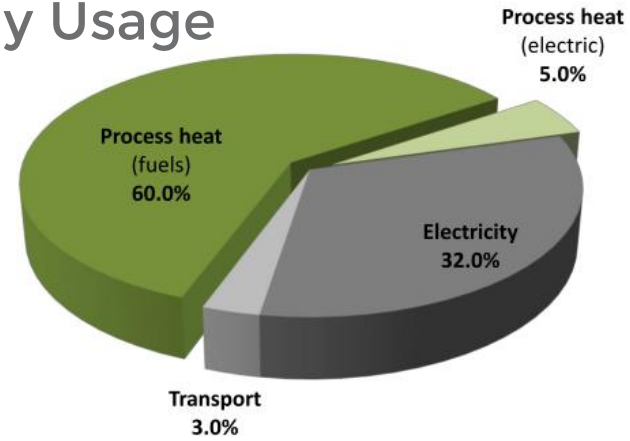
Greater Durban
- 1600 kWh/m²



Background

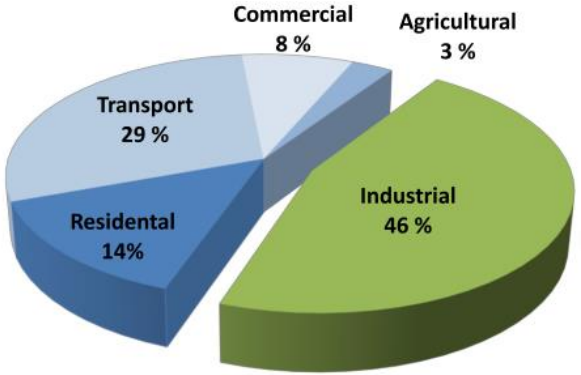
Industrial Heat demand

Industrial Energy Usage

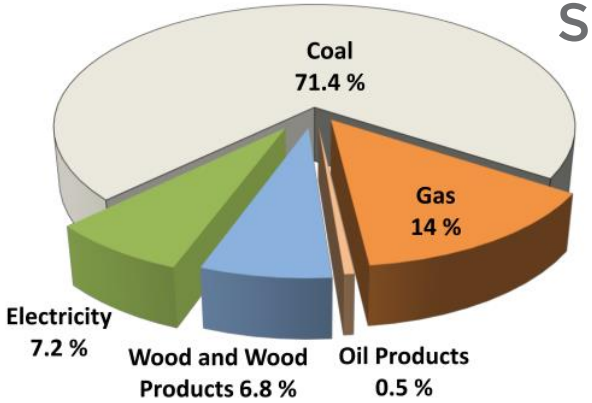


Hess 2015, (Adapted from SATIM 2014)

Sectoral Energy Demand



Fuel Source

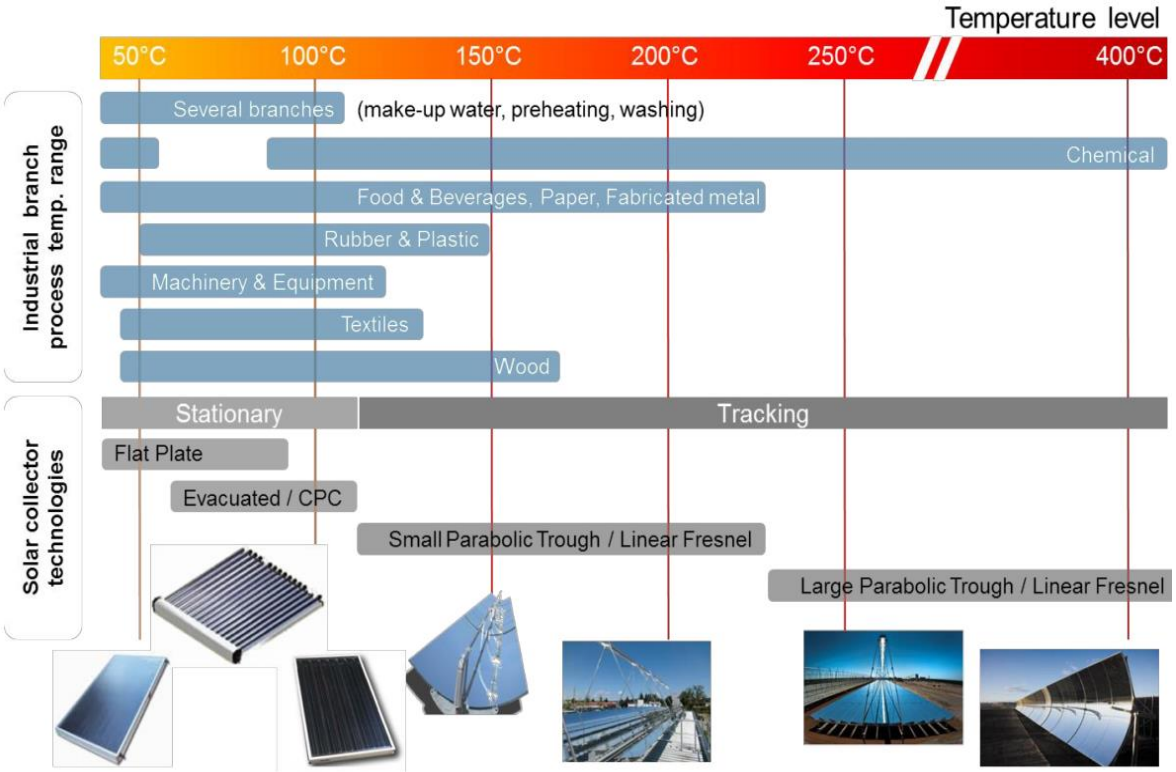


Background

Technology

Temperature Supplied

Stationary vs Tracking



Background

Target industries

- Low temperature heat requirement
- Constant heat demand
- High cost fuel source
- Food and beverage, Textile and agri-processing

Background

Berg River Brewery

- Microbrewery in Paarl, WC
- Established in 2016
- Food and Beverage Industry
- Low to medium Temperature requirement

Motivation

SPH at BRB

- Unbiased assessment of SPH
- SPH for small industrial applications

Thermal Demand

Per Brew

Process	Start Temp. [°C]	End Temp. [°C]	Medium	Specific heat [kWh/m3K]	Volume [L]	Heat Requirement [kWhth]	Percentage of Heat Requirement
Mashing	18	75	water	1.16	300	19.8	23%
Wort filter	18	75	water	1.16	350	23.1	26%
Boiler/Kettle	75	100	sweet wort	1	600	15.0	17%
Boiling/Hot hold	100	100	wort & hops	1.25	600	30.0	34%

Thermal Demand

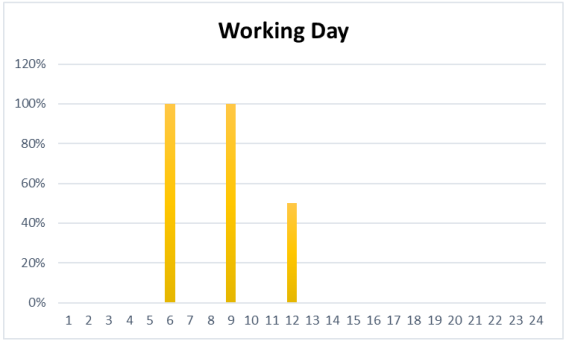
Load Profile

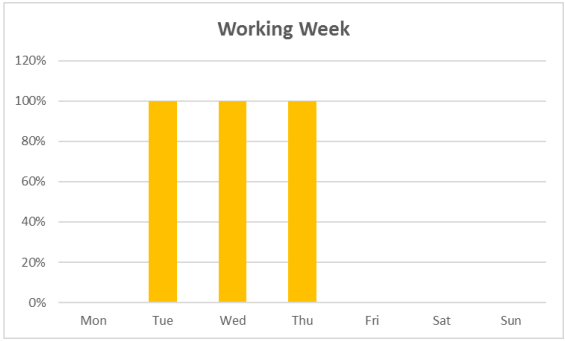
3 Brews per day

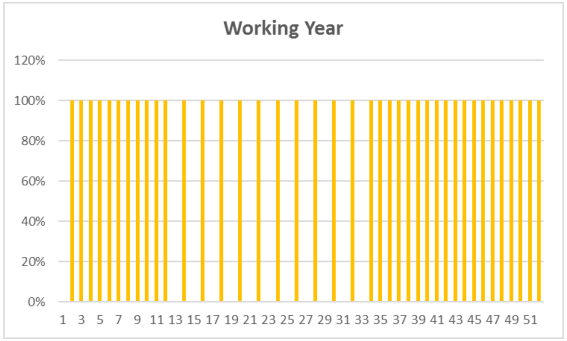
3 Brewing days per Brewing week

Seasonal production variation

Summer vs Winter







System Design

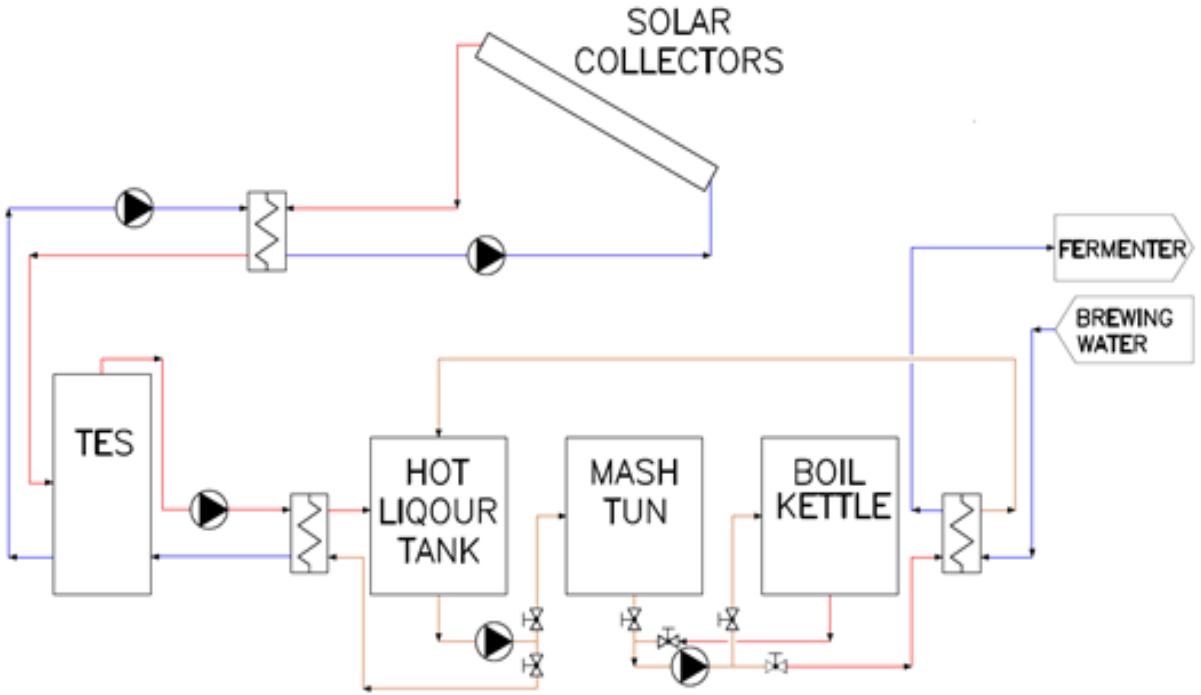
Concept

External heat exchangers

Heat recovery

Preheating strategy

Backup System



System Design

Collector location

North: 180 m² - 23°

South: 250 m² - 21°

System Design

Collector location

North: 180 m² - 23°

South: 250 m² - 21°

Asbestos Roof!!!

System Design

Specifics

- Collector Aperture Area: 18.42 m^2
- Storage Volume: 1500 L
- VSD drives on Solar and tank loops
- Stainless steel food grade components

System Performance Modelling

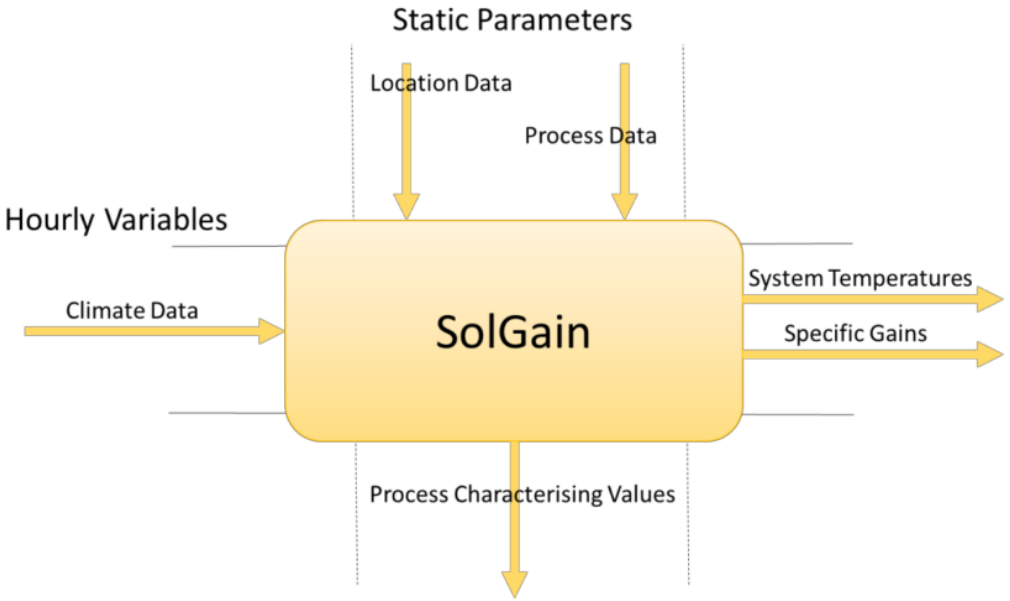
Input

Solar resource

Process characteristics

Heat demand type

SolGain demand profile



System Performance Modelling

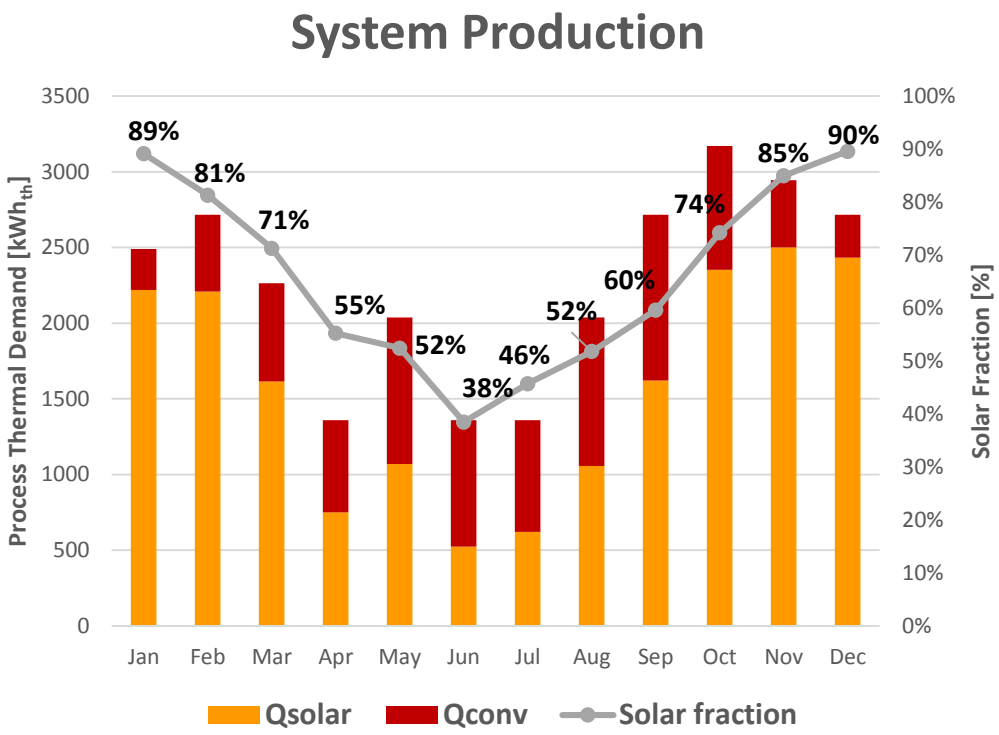
Results

Annual Thermal Demand
- 27 170 kWh_{th}

Supplied by SPH
- 19 020 kWh_{th}

Solar Fraction - 70%

System Efficiency – 27%



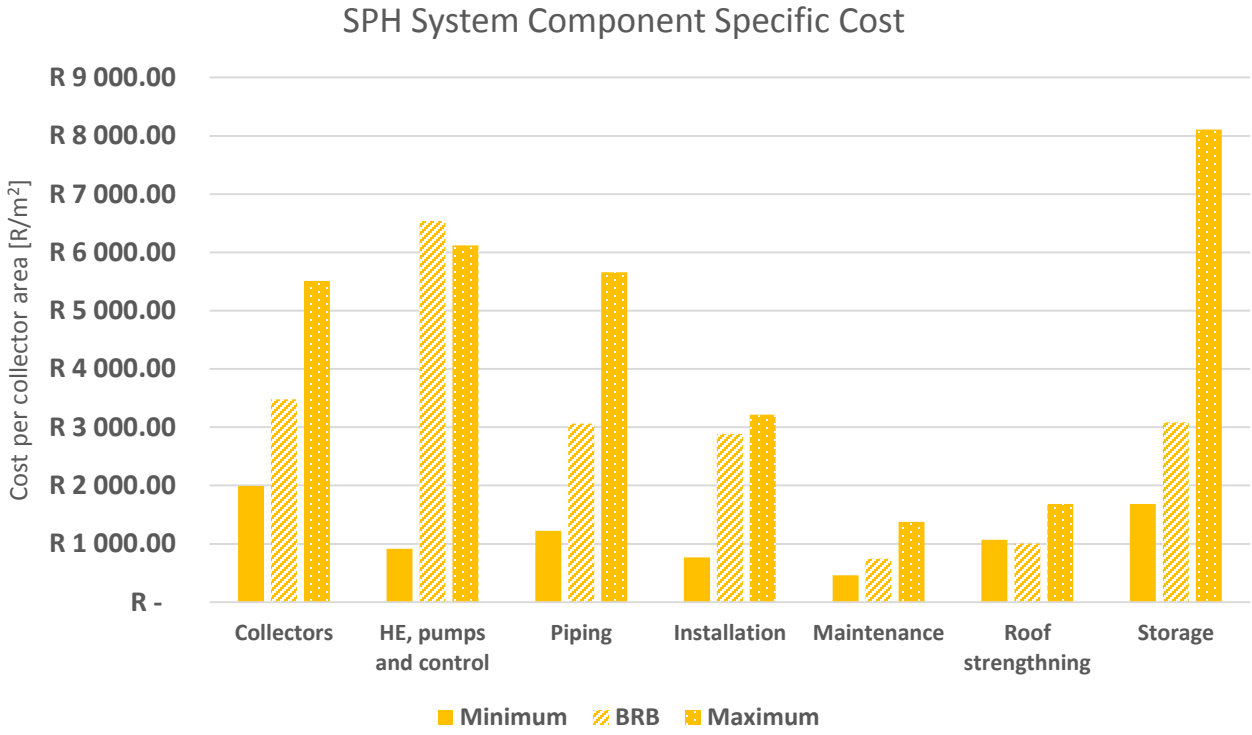
Business Case – To Buy or not to Buy

Capex

System Cost
- R 20 800/m²

Minimum
- R 16 000/m²

Maximum
- R31 600/m²



Business Case – To Buy or not to Buy

LCOH

Period	LCOH - R/kWh$_{th}$
10 years	R 3.43
20 Years	R 2.62

Discount Rate: 4.8%
Degradation: 0.5%
O&M Cost: R 15 000/annum

Business Case – To Buy or not to Buy

LCOH

Period	LCOH - R/kWh$_{th}$
10 years	R 3.43
20 Years	R 2.62

Electricity Cost : R1.775 R/kWh

Discount Rate: 4.8%
Degradation: 0.5%
O&M Cost: R 15 000/annum

Business Case – To Buy or not to Buy

Payback Period

- Berg River Brewery – 12.4 Years
- CBC system – 9.3 Years

Business Case – To Buy or not to Buy

Conclusion

- Low system utilisation
- Low Electricity cost
- High system cost

Business Case – To Buy or not to Buy

Conclusion

- Low system utilisation
- Low Electricity cost
- High system cost

Not Economically Feasible

- Investigate suitability of alternative technologies

Thank You

ACKNOWLEDGEMENTS:

Berg River Brewery
NRF
STERG

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