

The Status of Large-Scale ST Systems for Industrial Applications in South Africa and the Promotion of Solar Thermal Research at CRSES

2nd Africa-EU Renewable Energy Research and Innovation Symposium 2018 (RESIS 2018)



CENTRE FOR RENEWABLE AND SUSTAINABLE ENERGY STUDIES

Angelo Ian Buckley

22 – 26 January 2018

National University of Lesotho, Maseru, Lesotho





RENEWABLE & SUSTAINABLE
ENERGY STUDIES



The Centre for Renewable and Sustainable Energy Studies was established in 2007 to facilitate and stimulate activities in renewable energy study and research at Stellenbosch University.

The Department of Science and Technology has been funding the Renewable and Sustainable Energy (RSE) Hub at Stellenbosch University since its establishment in August 2006. The aims of the RSE Hub are to develop human capital, deepen knowledge, and stimulate innovation and enterprise in the field of RSE. Currently the DST is still sponsoring the work of the Centre with an annual grant administered by the National Research Foundation.

Stellenbosch University was designated as the Specialisation Centre in Renewable Energy Technology as part of the Eskom Power Plant Engineering Institute (EPPEI). The research and teaching activities sponsored by Eskom focus on concentrating solar power (CSP) and wind energy and also includes the Eskom Chair in Concentrating Solar Power.

The Sasol Technology group sponsored the new facilities for the Centre for Renewable and Sustainable Energy Studies as well as the work and facilities of the Solar Thermal Energy Research Group at Stellenbosch University.



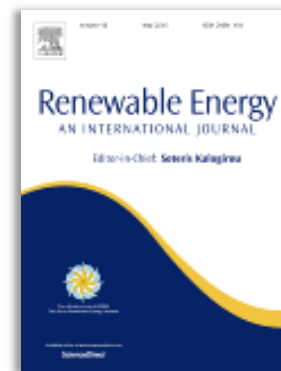


Large-Scale Solar Water Heating in South Africa: Status, Barriers and Recommendations

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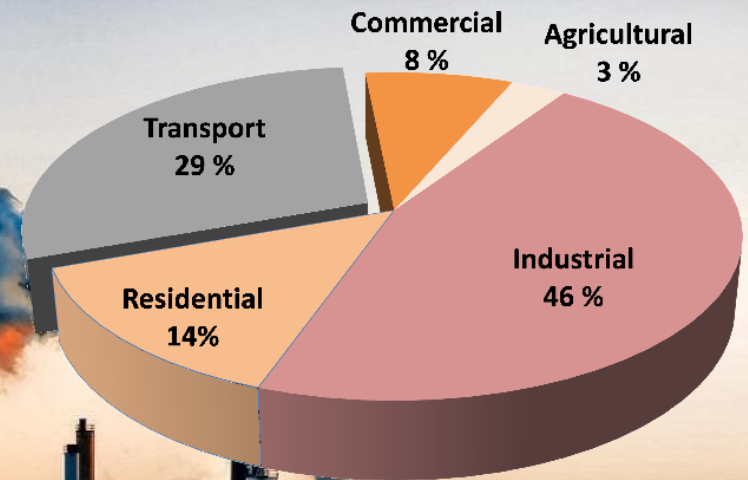
Overview

- Overview of energy needs and solar resource in South Africa
- CRSES Large scale solar thermal installation database
- Solar thermal projects of the CRSES
 - Cape Brewing Company
 - Klein Karoo Tannery
- SOLTRAIN solar thermal monitoring results
 - Huis Horison
- Conclusions

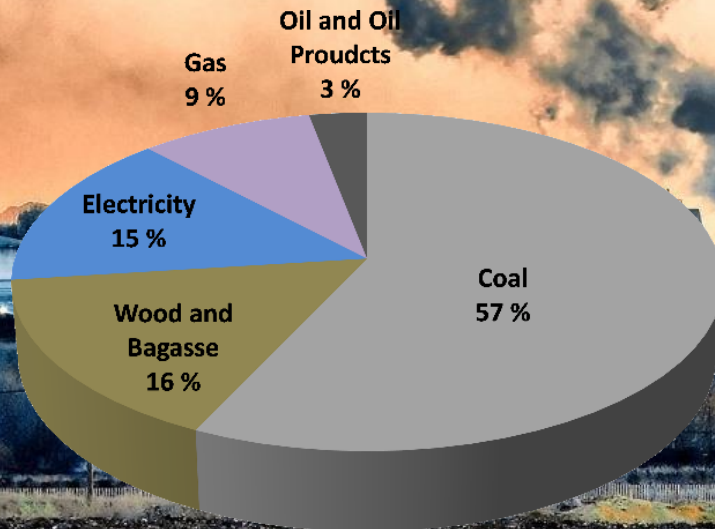
Energy Needs



Total energy 2 539 PJ



Total heat 1 117 PJ (44%)



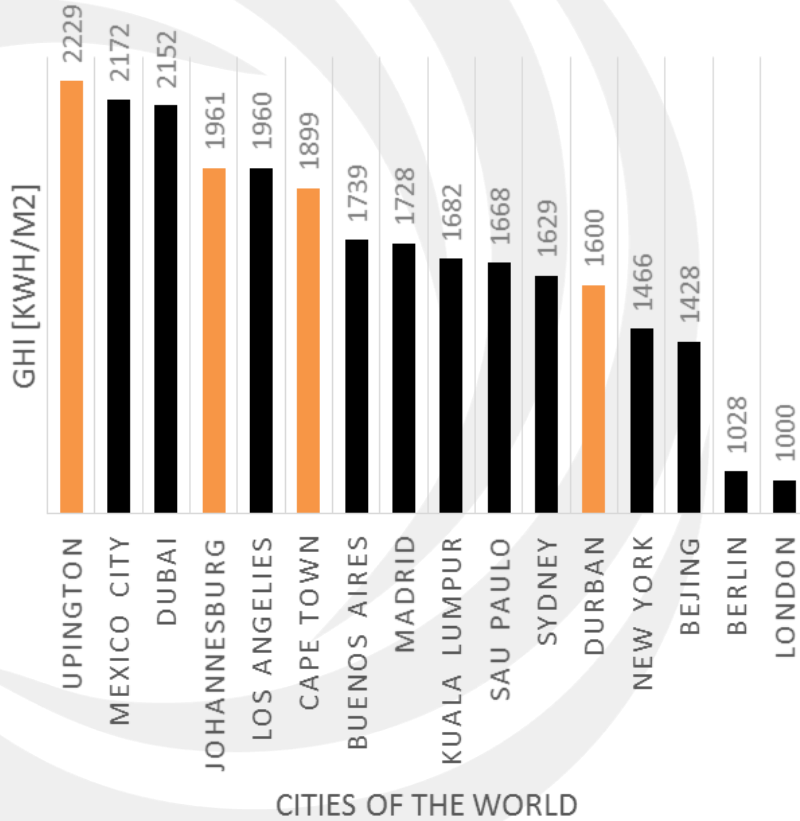
Industrial sector – 67% heat energy demand



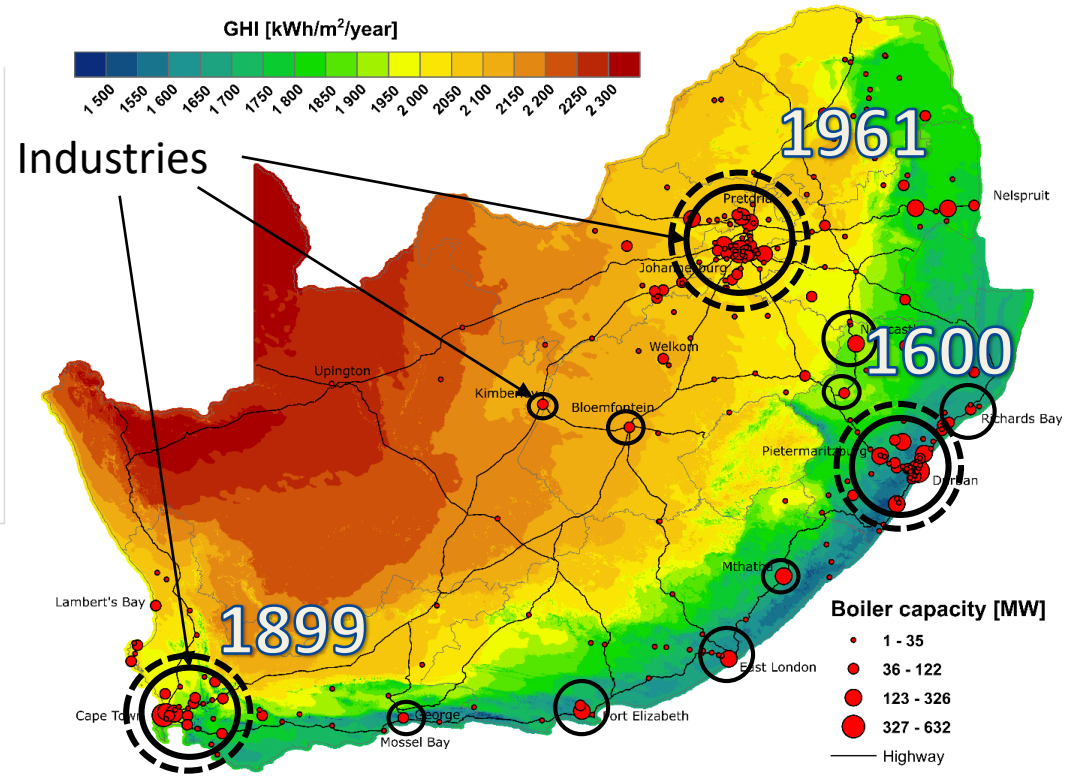
Solar Resource (GHI)



Global



Local



10 548 MW Boiler capacity (database)



Database Overview



• Data

- Installer name
- Beneficiary name + industry
- Application
- Location
- Collector type
- Gross area
- Storage volume
- Backup heating
- Year commissioned
- Total cost
- Subsidy

• Statistics

- Number of systems = 135
- Dates = 2006 to 2017
- Total gross area = 29 058 m²
- Soltrain area = 6%

• Sources

- Blackdot Energy
- Soltrain 1, 2 & 3
- Installers
- Past projects

• Collector gross area > 10m²

• Limitations

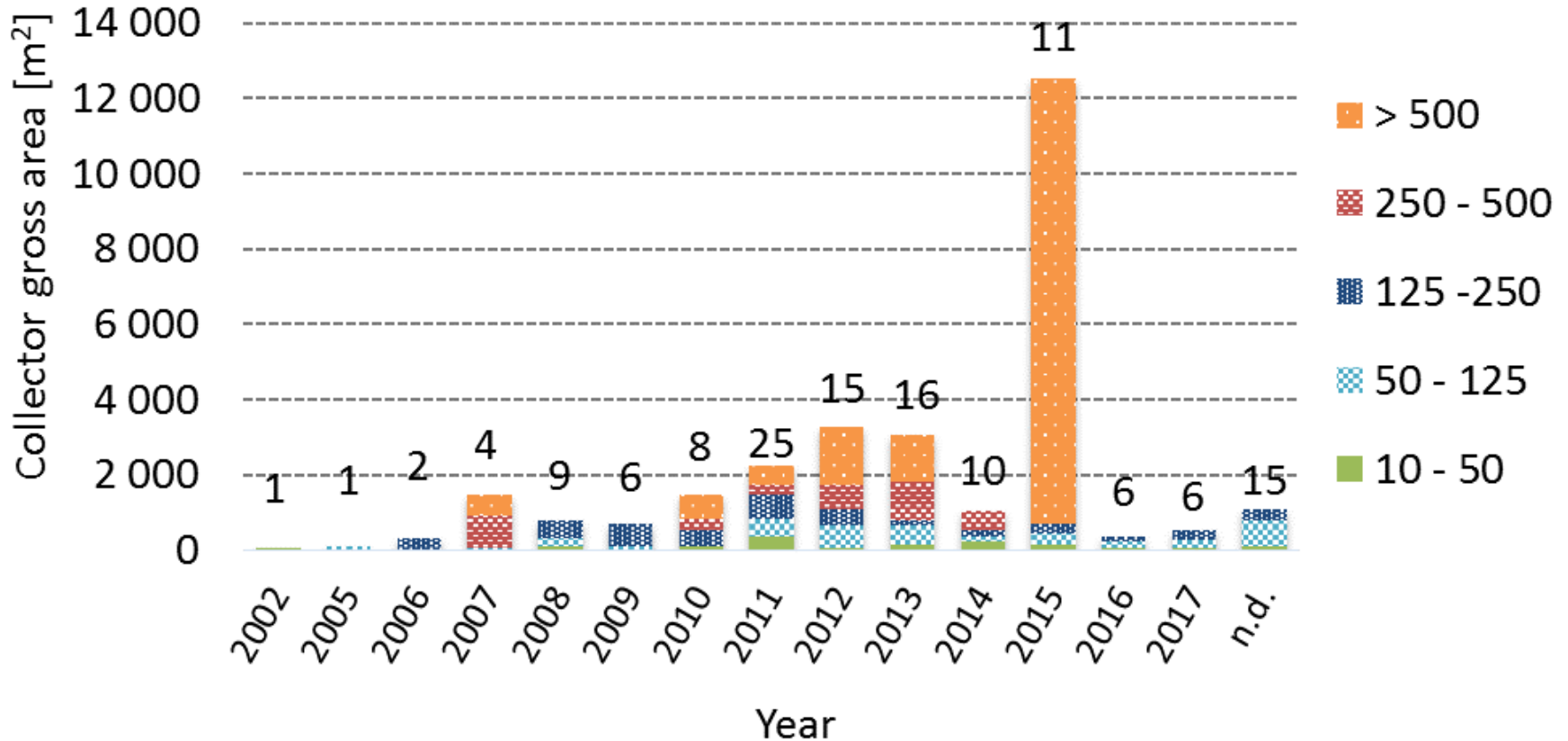
- Little information
- Little cost data
- With/without storage
- With/without backup heating elements
- Work in progress

• Confidence levels

- High confidence > 50m²
- Lower confidence < 50m²



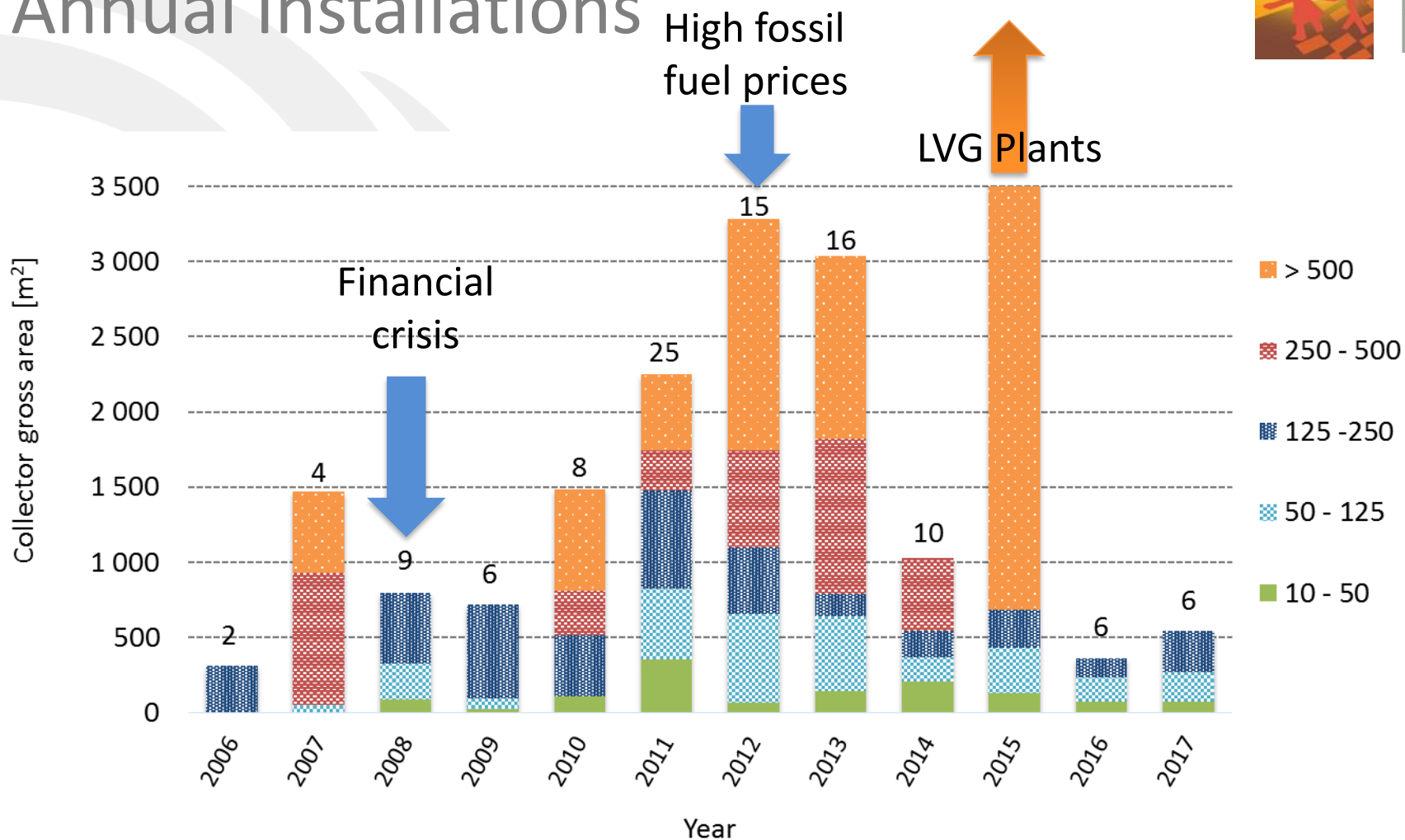
Annual Installations



ST collector gross area (> 10 m²) newly installed in SA from 2002 to 2017. The total number of installations per year are indicated above the data. Legend units are m².



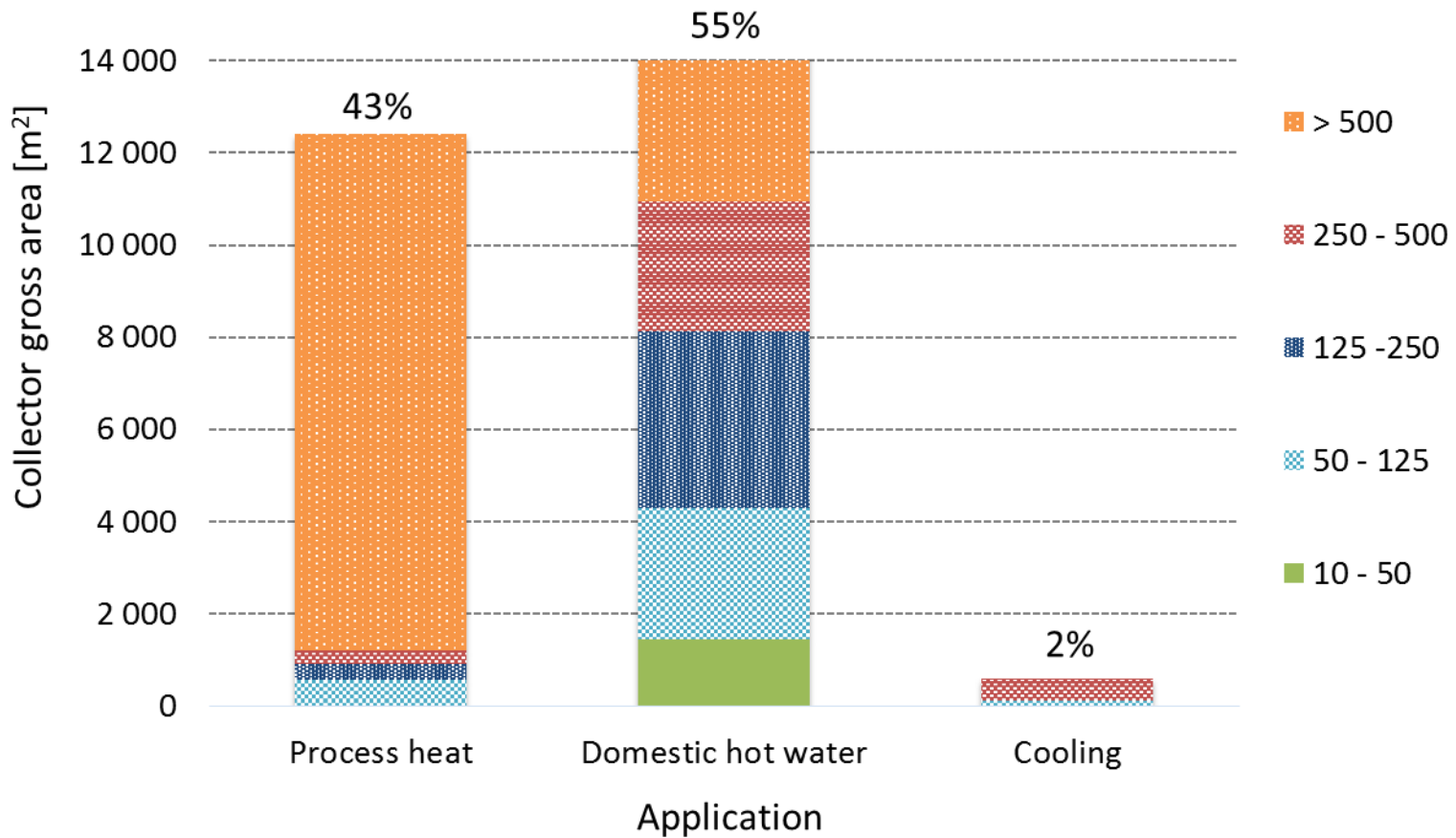
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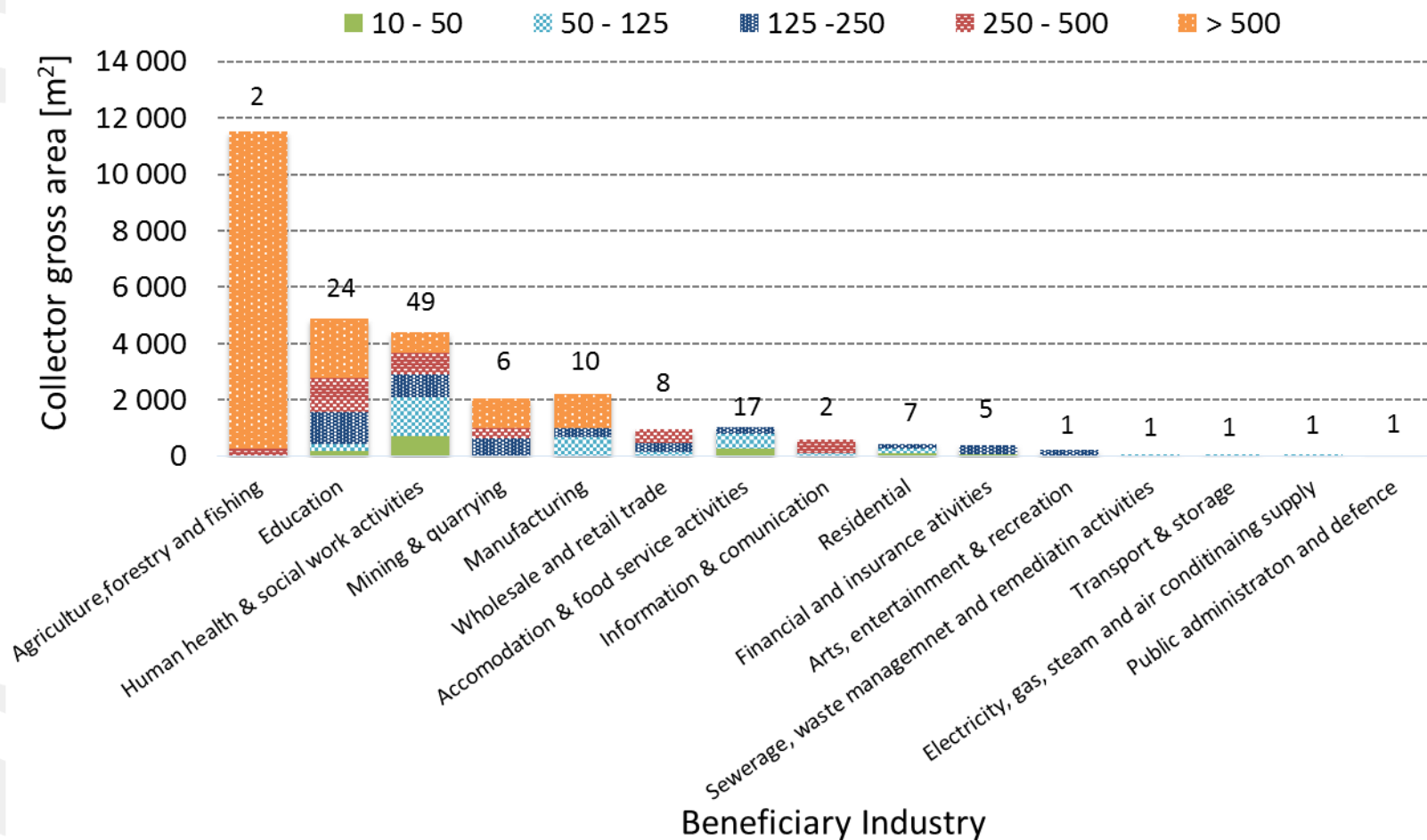
Application



Large-scale solar water heating systems in SA per type of application from 2002 to 2017 (gross collector area > 10 m²). Domestic hot water/staff ablutions represent 123 systems, process heat are 10 systems and cooling 2 systems. Legend units are m².



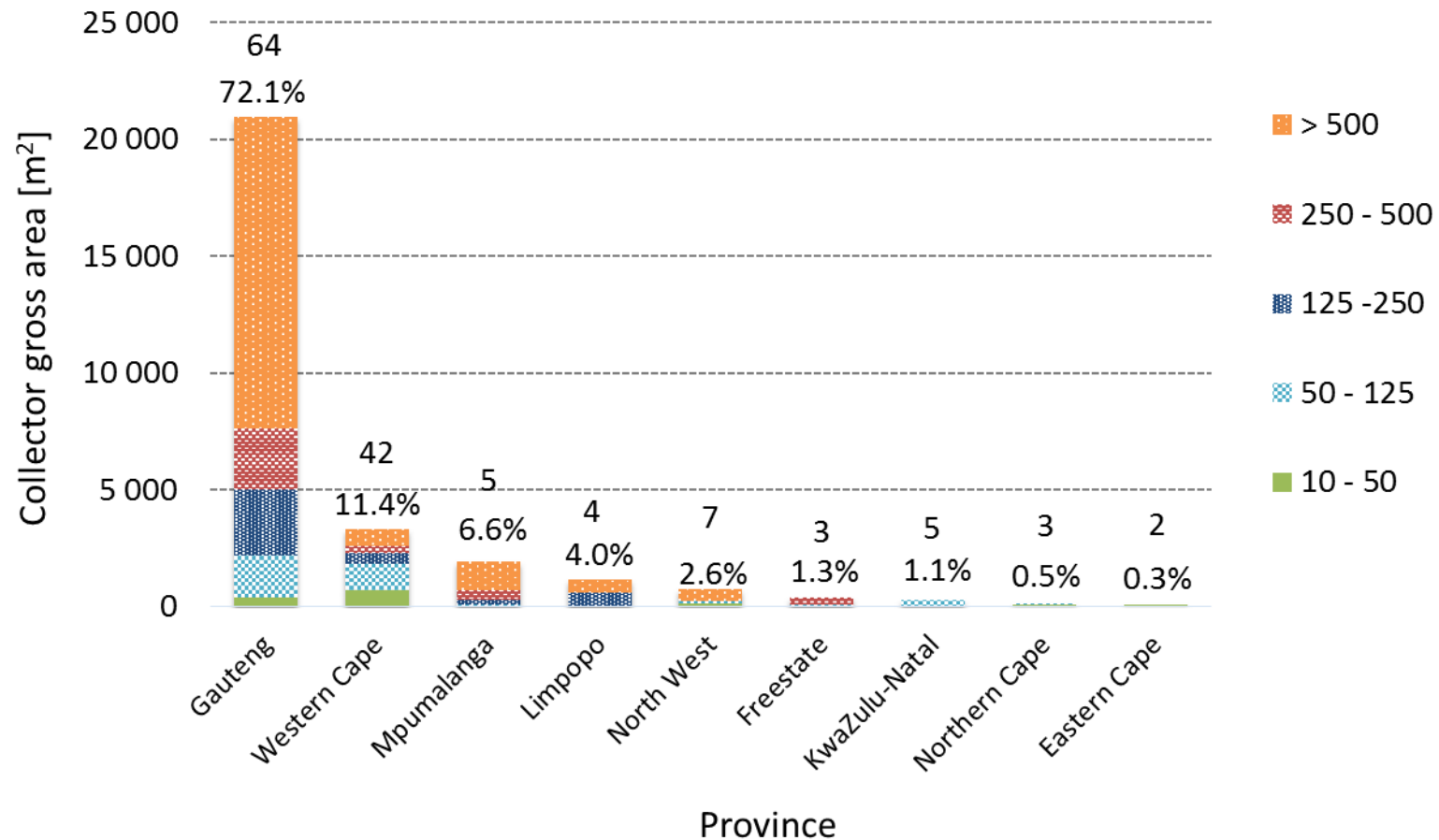
Beneficiary Industry



Large-scale solar water heating systems in SA per beneficiary industry or business category from 2002 to 2017 (gross collector area > 10 m²). Number of systems are indicated above each category. Categorized according to SIC of Economic Activity. Legend units are m².



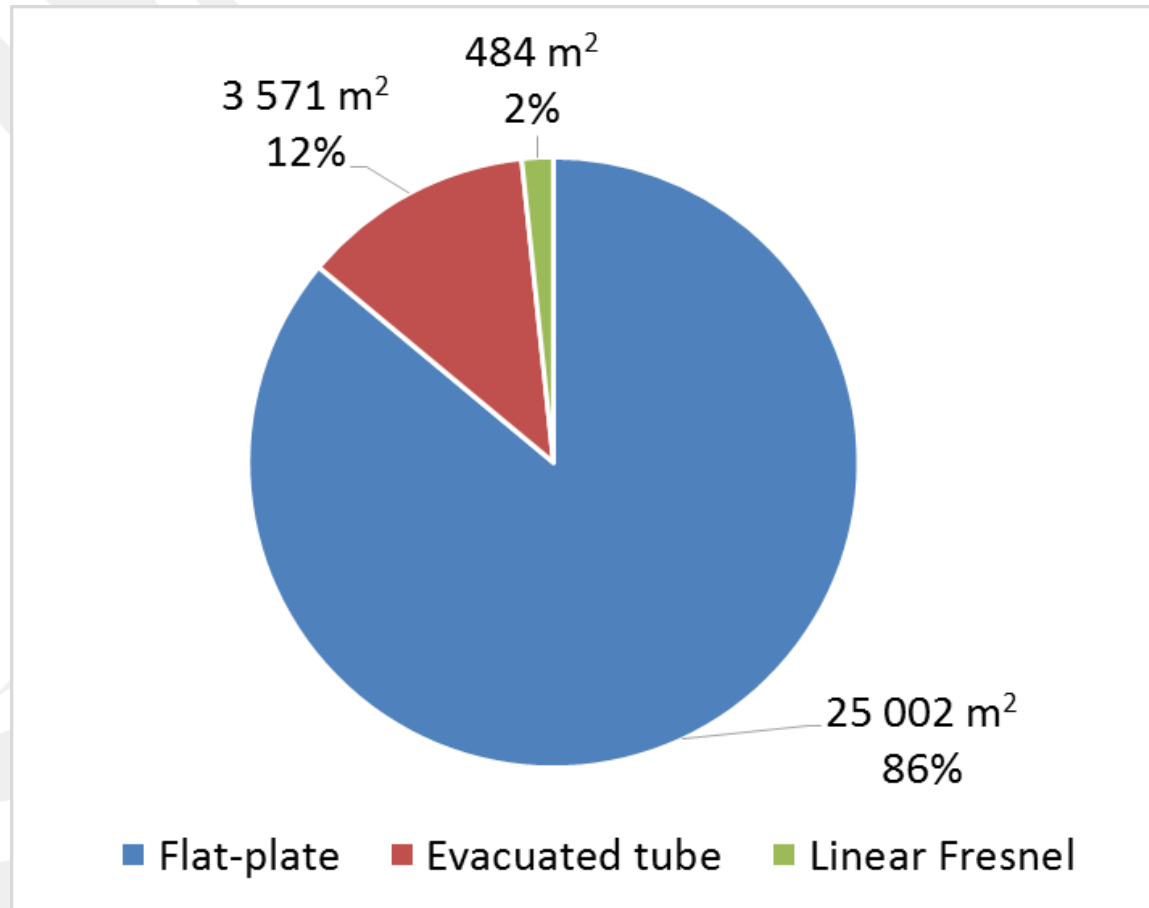
Installations per Province



Large-scale solar water heating systems in SA per province from 2002 to 2017 (gross collector area > 10 m²). The number of systems and percentage contribution of each province are indicated above each province's data. Legend units are m².



Collector type



Collector type used in large-scale solar water heating systems in SA per province from 2002 to 2017 (gross collector area > 10 m²). The number units is the total in m² and represented on a percentage of total collector area installed in SA.



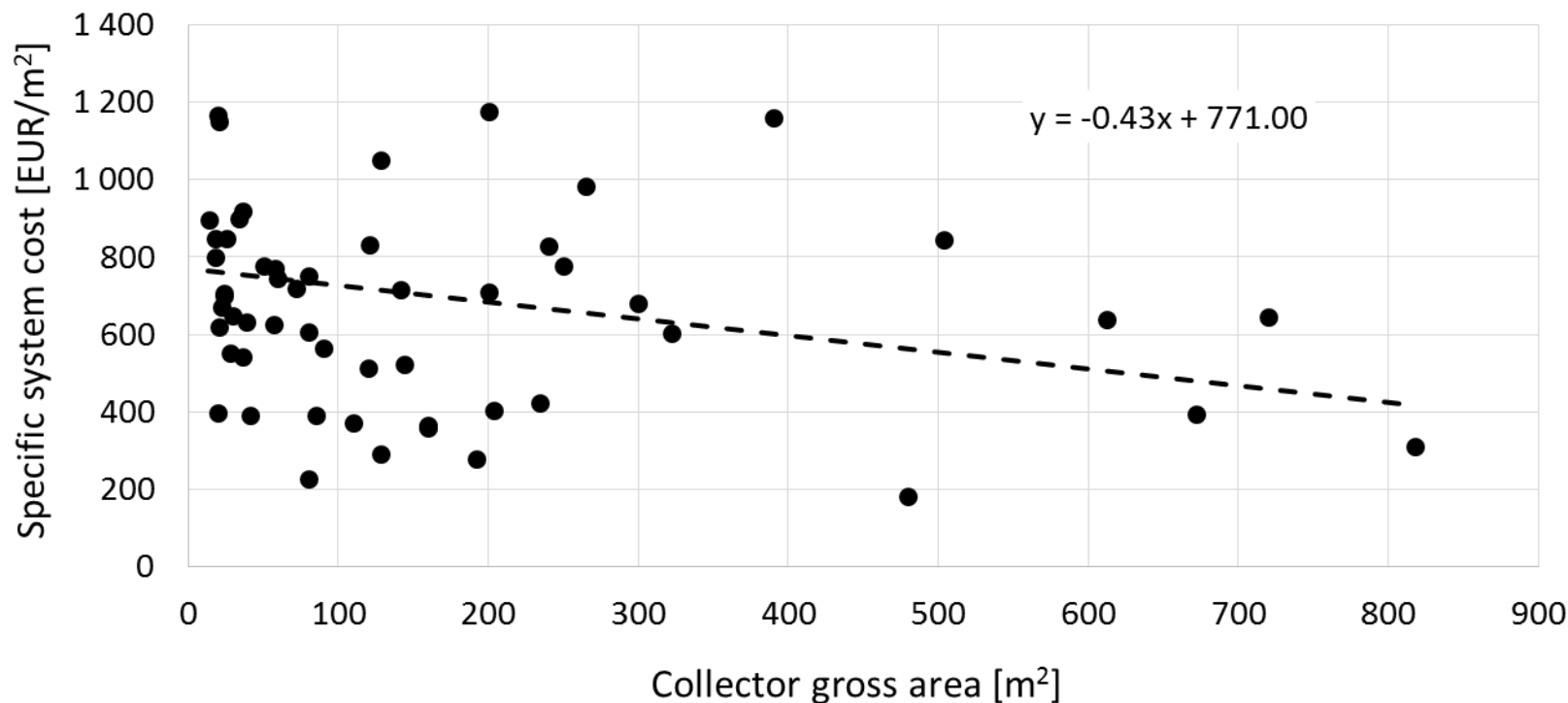
Cost of Systems



2007 – 2015 average (47 systems)
= 603 EUR/m²



2007 – 2017 average (58 systems)
= 606 EUR/m²



The effect of cost relative to collector area (data from Blackdot Energy, 2015, AEE Intec, 2017 and personal communication with installers during 2014 - 2017). The exchange rate at the date of installation was used to calculate the system price ($9.66 < \text{ZAR}/\text{EUR} < 16.29$ from 2007 to 2017).



CRSES Solar Thermal Project Overview



1. Pre-feasibility

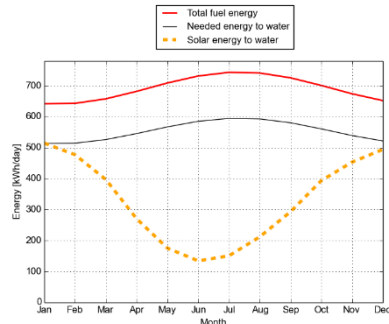
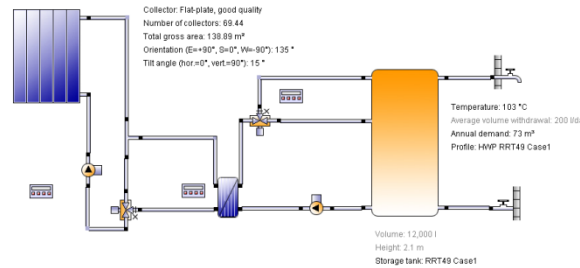
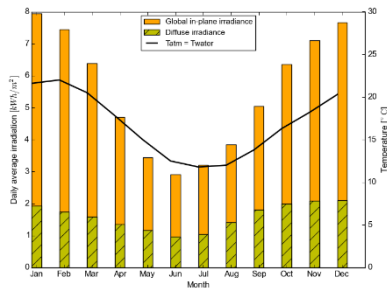
- Data gathering
- Simulations
- Financial analysis
- Reporting

2. Tender process

- Specifications
- Request for proposals
- Evaluations
- Interviews
- Selection

3. Installation

- System details
- **Installation**
- Commissioning
- Inspection



Proposed CBC system

Collector area = 125 m²

Storage volume = 10 000 litre

SF = 60%



Cape Brewing Co. Solar Thermal Project



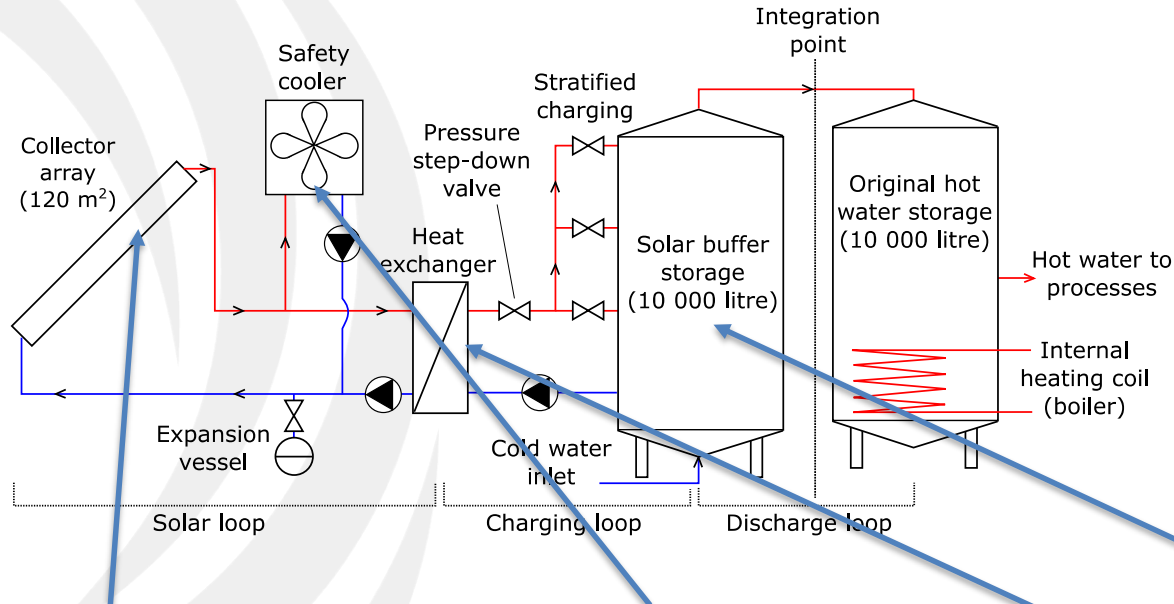
- Beneficiary company: Cape Brewing Company (CBC)
- Location: Paarl
- Application: Brewery (Process)
- Collector Area: 120 m²
- Thermal Storage: 10 m³
- Commission Date: November 2015
- Operating Temperature : 85°C
- Installer: E3 Energy
- Finance: co-financed subsidy from SOLTRAIN 2
- Circulation : Pumped



Cape Brewing Co. Solar Thermal System



Cape Brewing Company



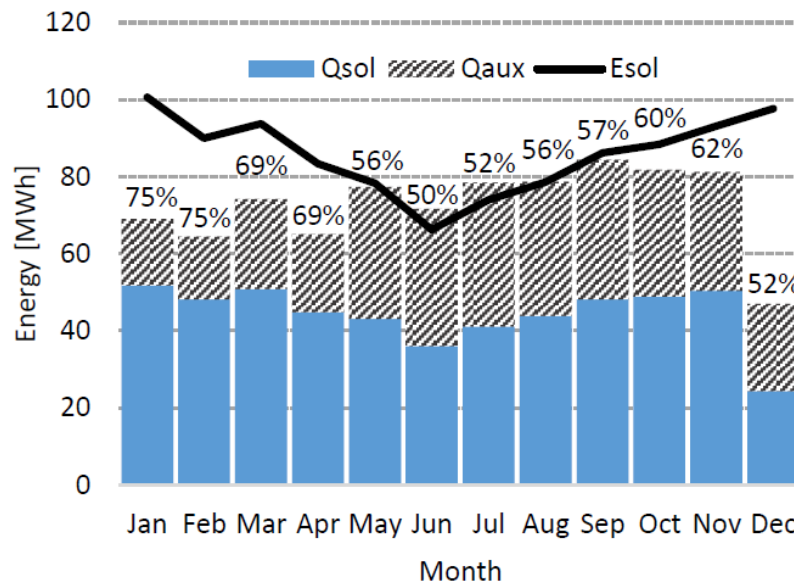
Leather tannery Solar Thermal Project



- Beneficiary industry: Tannery
- Location: Oudshoorn, Western Cape
- Application: Process
- Operating Temperature : 60 °C
- Heat demand: 873 MWh/year
- Commission Date: 2018 (Construction)



Tannery site layout



Monthly heat production and demand offset of the 500 m² ST system

- Collector Area: 500 m²
- Thermal Storage: 60 m³
- Heat supply: 531 MWh/year
- Solar fraction: 61%
- Specific gains: 1 057 kWh/m²/year
- HFO saving: 68 m³ per year
- Cost: R 2 350 000
- Payback & IRR: 7 year, 31%



SOLTRAIN



- Southern African Solar Thermal Training and Demonstration Initiative
- Aimed at capacity building and demonstration ST systems in SADC region
- Implementing agency is AEE INTEC
- Funded by Austrian Development Agency and co-funded by Opec Fund for Industrial Development
- Subsidising of ST systems
- Specialised training workshops
- Installation of monitoring equipment at selected demonstration ST systems



Uniting against Poverty



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SOLTRAIN – Monitoring ST Systems



SOLTRAIN Monitored demonstration systems in Western Cape

- Huis Horison
- SACS Sedale Boys School Hostel
- Warwick Mansions (new)
- Melrose and Gatesville Hospital (new)
- Marie Thahl residential SWH and PV hot water system project (new)
- Klein Groo Tannery (Construction)



Huis Horison 18.4 m² ST system

Huis Horison system design specifications

- Collector area 18.4 m²
- Collector type Flat plate
- Storage volume 1 000 litre
- Expected annual yield 13 380 kWh
- Expected CO₂ offset 4.628 ton/year
- Back-up 11.8 kW heat pump



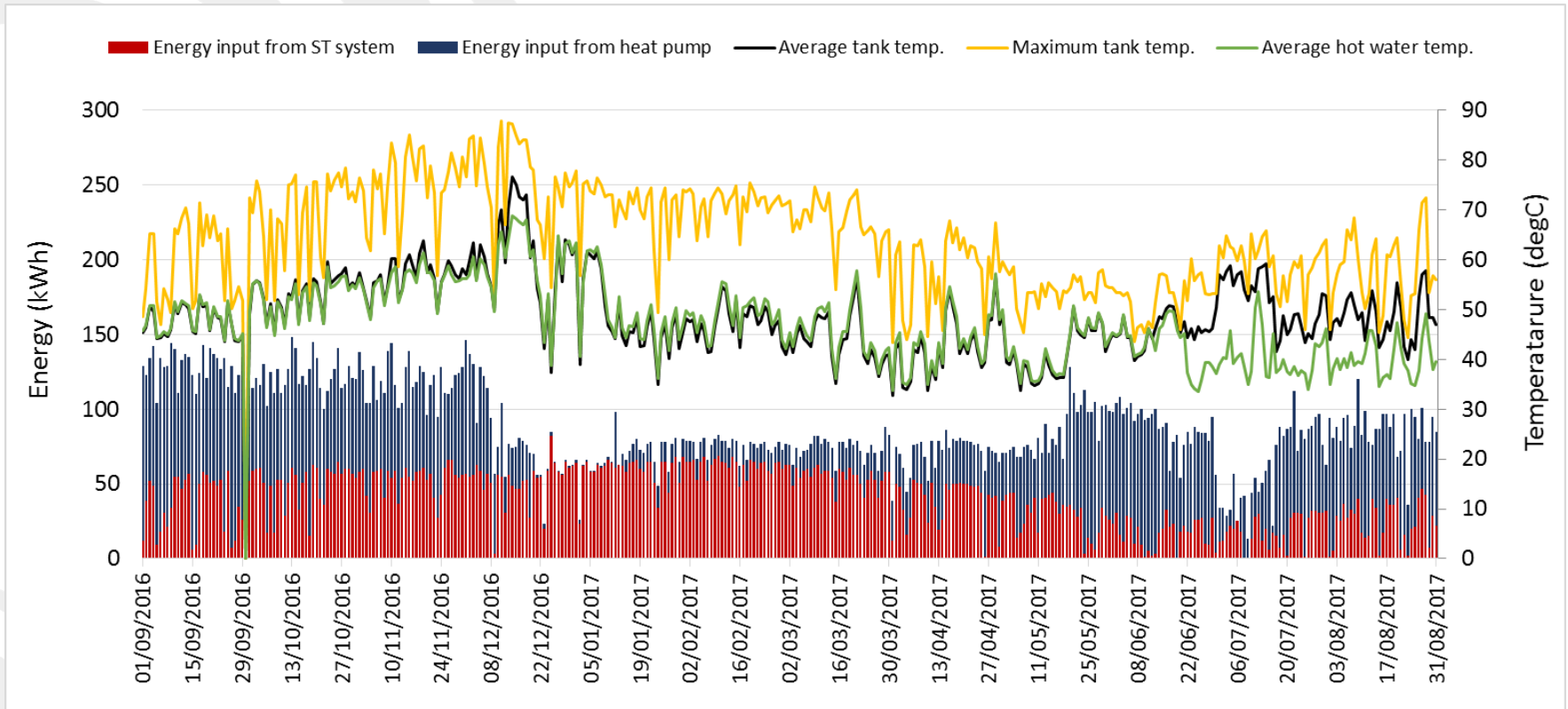
Huis Horison ST performance monitoring equipment



SOLTRAIN Monitoring ST Systems – Huis Horison



Annual performance of solar thermal system from 1 September 2017 to 31 August 2017



Solar energy input	Heat pump energy input	Total heat input	Heat losses	Heat consumption	Electricity consumption	Solar fraction
15 103 kWh	17 070 kWh	32 173 kWh	1 016 kWh	31 157 kWh	5 653 kWh	47%



Conclusion



- CRSES large-scale solar thermal database for improving research outputs
 - Identifying industries and companies with high potential for low temperature ST technologies
 - Identifying regions in SA with good solar resource and large boiler capacity installations for using ST technology for offsetting conventional fuel sources
 - System costs can accurately be forecasted based on system sizes when investigating financial feasibility of systems – improved results
 - Working examples
- SOLTRAIN monitored demonstration ST systems
 - Improving the modelled and simulated ST systems for more accurate production forecasting and financial results
 - Improving the understanding of the operation of ST systems operating in conjunction with heat pumps
 - Allows optimising of combined ST and heat pumps systems
 - Working examples for justifying benefits identical and similar applications in SA

