WWF BUSINESS CASE ZA 2018

Solar thermal technologies: clean fit for food and beverage industries

Emerging climate-smart business opportunities

Supported by:

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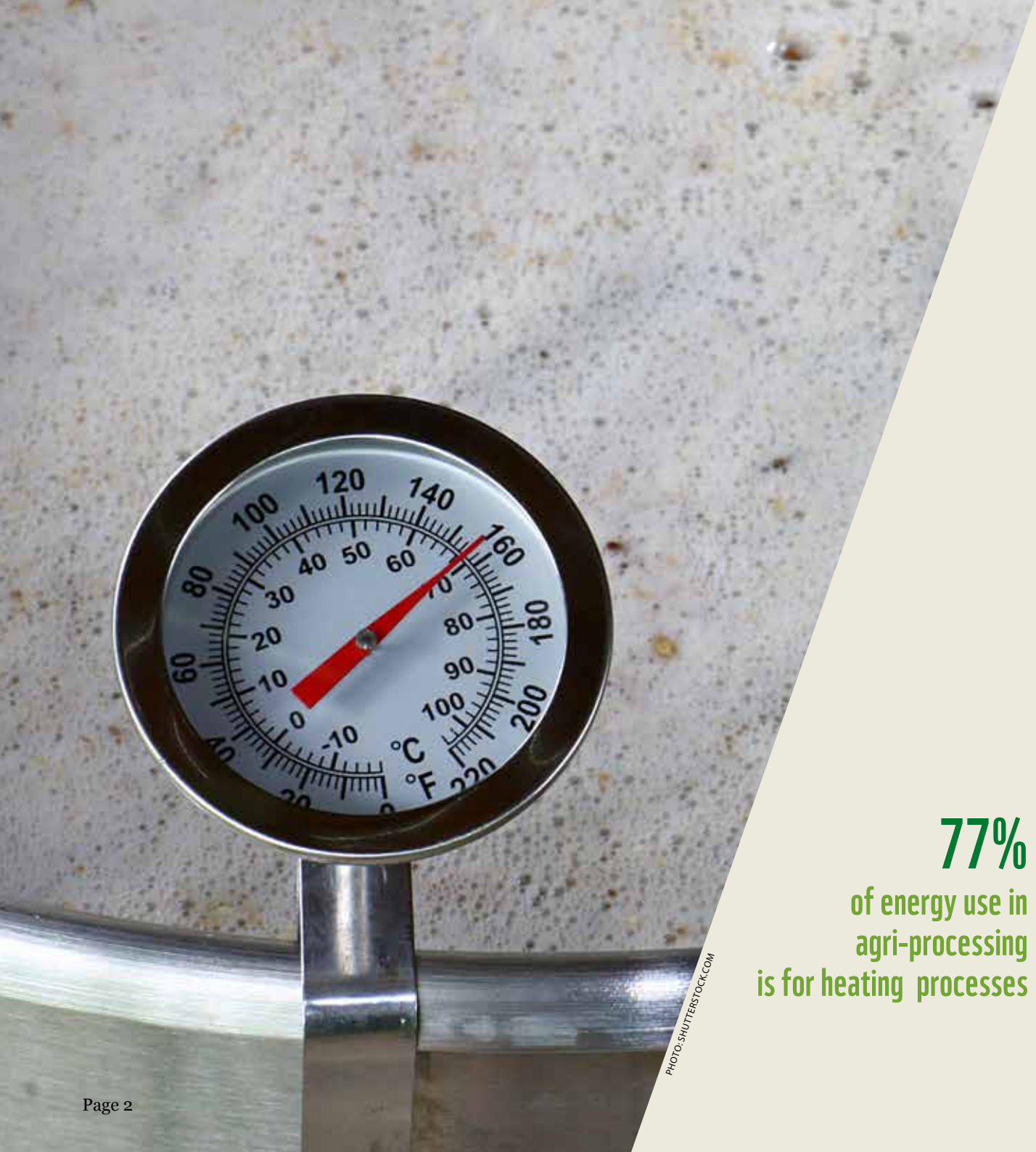

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A snapshot of the opportunity

Solar thermal technologies can best supply the low to medium heat range required for processing in the food and beverage industries. Currently in agri-processing in South Africa, up to 77% of energy use is for heating processes. Most of this energy comes from non-renewable sources, leading to extensive greenhouse gas emissions. There is an emerging climate-smart opportunity for solar thermal technology businesses to capture this market.

77%
of energy use in agri-processing is for heating processes

The case for investment

- **Manage escalating electricity prices**: renewable energy sources can provide certainty in supply and costs.
- **Achieve a healthy Internal Rate of Return:** above 10% over a 20-year period can be achieved when using solar thermal energy to replace existing energy sources for heat processes, other than coal.
- **Reduce carbon regulatory risk**: using solar thermal energy will free up carbon budgets and reduce carbon taxes.

The offtake market

- **Potential market size**: more than 5 000 SARS registered food and beverage firms with total taxable earnings exceeding R10 billion per annum.
- **Immediate viability:** food and beverage firms that are undertaking expansions or with greenfield investments, can design facilities upfront with the technology requirements in mind.

Socio-economic benefits

- **Industrialisation opportunity**: if taken to scale, the opportunity exists to develop a local manufacturing, installation and maintenance industry for industrial solar thermal technologies.
- **Job creation:** solar thermal technologies can lead to enhanced manufacturing capabilities and job creation.

Climate change benefits

- **Without replacing coal-fired heat processes**: a potential reduction of 158 685 tonnes of CO_2e per annum.
- **If coal is also replaced**: a possible reduction of 942 556 tonnes of CO_2e per annum.

PHOTO: SHUTTERSTOCK.COM

Why is solar thermal energy ideal for food and beverage industries?

South Africa's high level of solar potential as a renewable and clean source of energy has been demonstrated in several utility solar projects.[1]

The **greatest potential of solar thermal technologies is in low and medium heat replacement** in manufacturing.

Currently, fuel sources for heat processes vary from industry to industry, and site to site – from electricity, to coal, to gas. Biomass is also used, such as in sugar mills. Most of these fuels are costly, subject to price volatility and supply disruptions, and they increase carbon emissions and air pollution.

The majority of food and beverage firms use heat in their boilers, for processes such as cleaning, sterilisation and cooking.

Roughly **60% of their heat must be below 250 °C, making solar thermal an ideal technology** to replace existing fuels.

250 °C

maximum temperature used in food and beverage processes, making solar thermal an ideal replacement for existing fuels

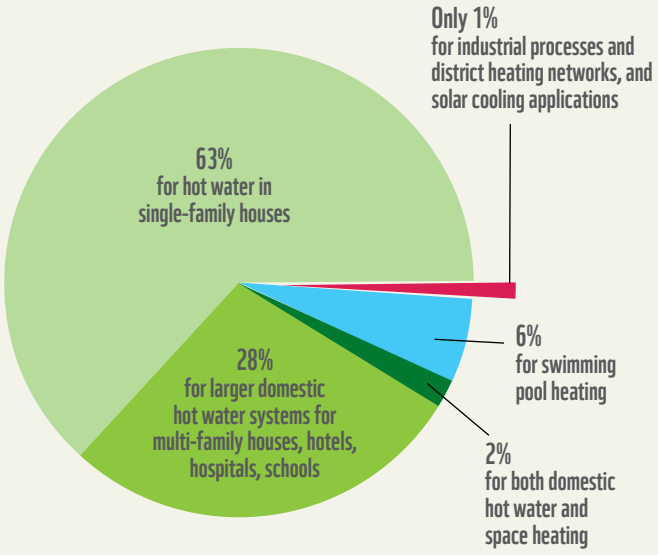
The global solar thermal industry

Globally, the total heat demand by all industries for low and medium temperature applications is about 44 exajoules (EJs).[2] In recent years, global demand for solar thermal technology has grown significantly.

Global demand

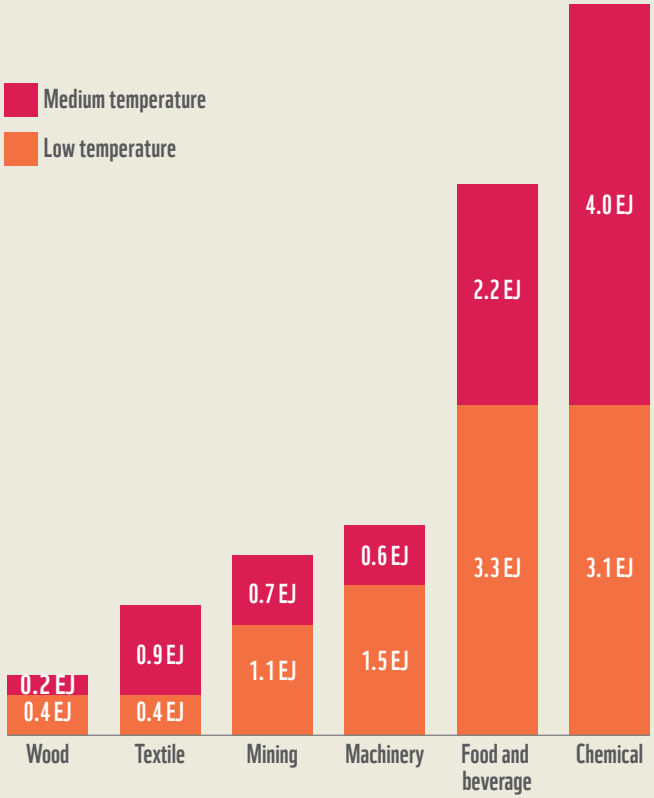
- In 2000, the global solar thermal market was 62 Gigawatt hours (GWh).
- By 2015 it had grown to 434,7 GWh.[4]
- Today approximately 108 million solar thermal systems are in operation worldwide.

The size and capacity of thermal solar applications (2015)[3]



Global total heat demand by all industries for low to medium temperature applications[5]

Note: EJ = exajoules – roughly equivalent to 278 terawatt-hours.



108 million

solar thermal systems in operation worldwide

Global jobs and turnover

- In 2015 there were approximately 714 000 jobs in solar thermal industries worldwide – including in manufacturing, installation and maintenance.
- In turnover terms, these industries together were estimated at US$19.4 bn.[6]

Flat plate collector

PHOTO: ULRICH TERBLANCHE

Which technologies to consider?

The type of technology that is used is determined by the levels of solar irradiation in a country, as well as by various localised factors at the site of installation.

Solar collectors capture solar heat

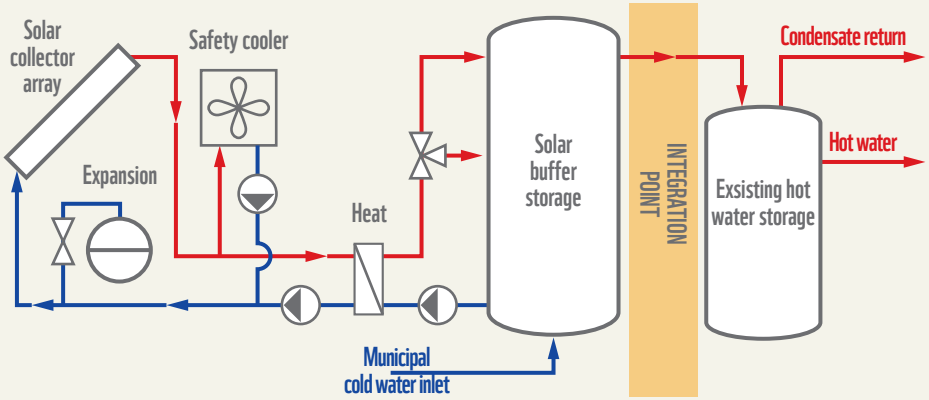
All solar thermal systems have a collector which captures heat from the sun. This is then used to heat water or air – depending on the medium – to produce useful heat for different processes.

Two main types of collectors are used for water heating:

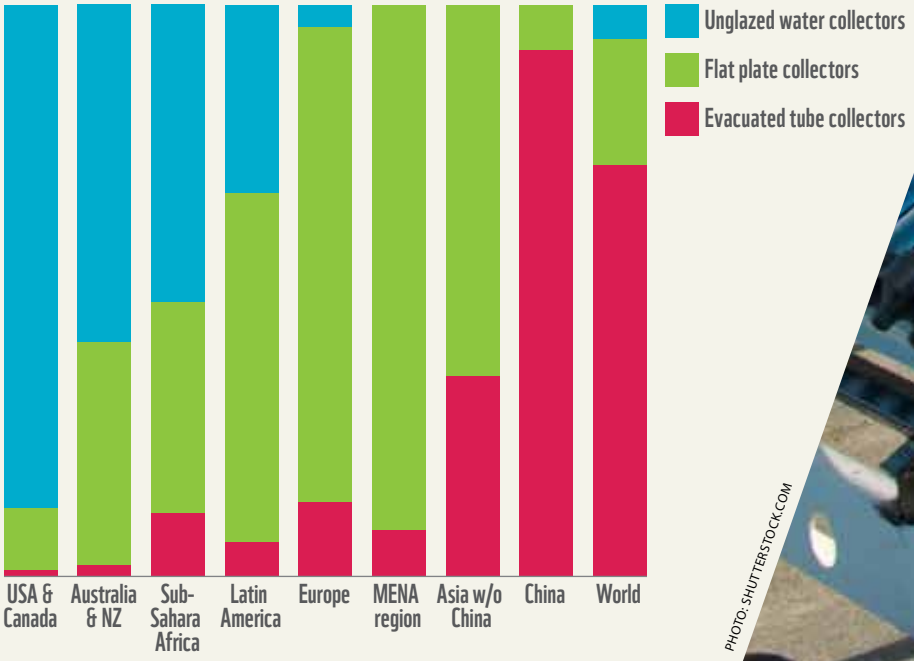
- **flat plates**
- **evacuated tubes** which consist of inner and outer glass tubes, with continuous casting between them.

Flat plate collectors dominate in all regions of the world, except for China which favours evacuated tubes. North America favours unglazed water collectors – a kind of collector without glass.

Possible integration points for solar process heat



Percentage share of solar thermal collectors in use globally by end 2015[7]



Evacuated tube collector

PHOTO: SHUTTERSTOCK.COM

PHOTO: STELLENBOSCH UNIVERSITY, CRSES

The South African solar thermal industry

While a local solar thermal industry exists, much of its application is in the domestic space.

Current installations

- South Africa has many solar thermal systems in operation, but nearly all of these are for single-family solar water heaters. Together they amount to less than 1 055 Megawatt hours (MWh). This is in comparison to Austria's 3 541 MWh and Germany's 12 281 MWh.[8]
- Of the 125 large solar thermal systems, only three fall within the food and beverage industries (including a dairy facility).[9]

> *"The majority of SESSA's members are small and medium enterprises engaged in rooftop installations for domestic customers, with one of the primary aims of the association being to support the 'behind the metre' energy services sector. However, some of its larger corporate members are also involved with industrial and commercial scale installations, often in the mining and hospitality sectors."*
>
> Maki Mothiane, SESSA Chair

Associations and firms

Associations exist in the solar thermal industry in South Africa:

- The Sustainable Energy Society of Southern Africa (SESSA), whose members are mainly installers.
- Solar Water Heater-Manufacturers Cluster of South Africa (SWH-MANCOSA), within the South African Capital Equipment Export Council, represents a number of manufacturers.

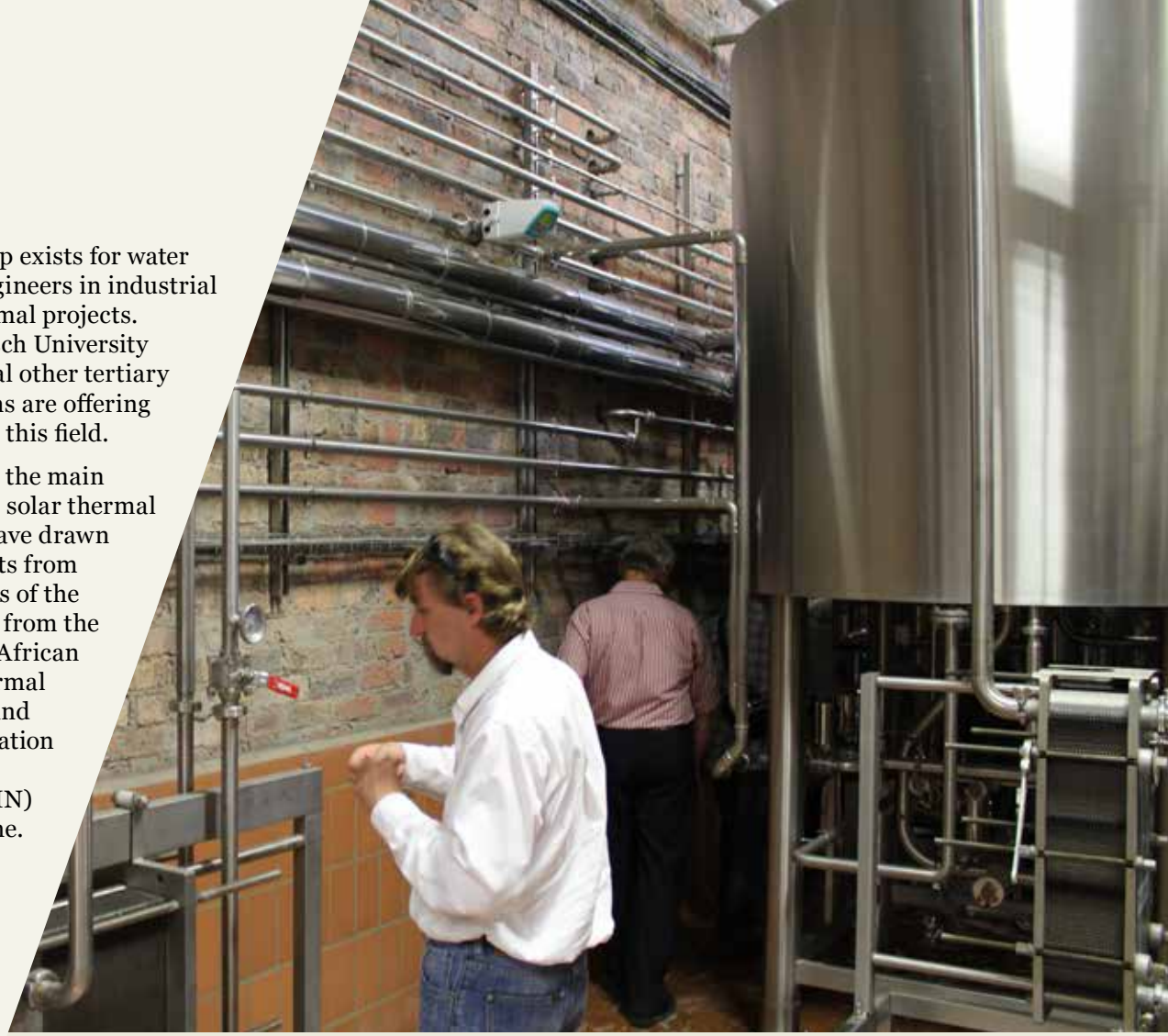
In 2015, SWH-MANCOSA's seven members collectively employed close to 2 000 people, excluding the installation sector. Far more jobs are created in installation, servicing and maintenance than in manufacturing – a ratio of about 5:1.[10]

Size of the sector

- There are currently a handful of flat plate manufacturers. A lack of consistent demand means that these firms are not operating at full capacity.
- Two small manufacturing firms provide the final assembly of components for evacuated tubes.
- There are at least five known installers for industrial-scale solar thermal systems indicating some level of competition within the industry.

Skills

- A skills gap exists for water design engineers in industrial solar thermal projects. Stellenbosch University and several other tertiary institutions are offering courses in this field.
- Currently, the main successful solar thermal systems have drawn on skill sets from other parts of the world and from the Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN) programme.



There is a **minimum local content** stipulation of

70%

for public procurement of domestic solar water heaters.

Industry examples

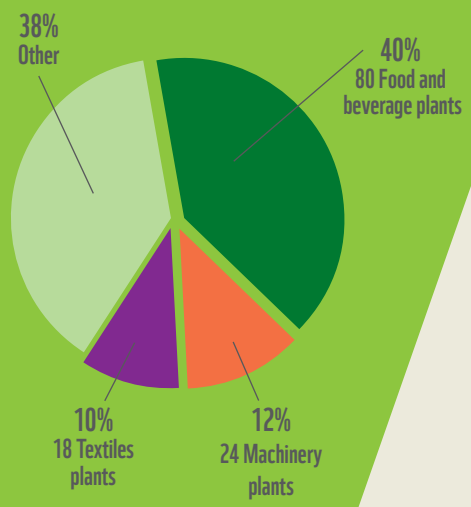
- In 2015, the Cape Brewing Company, a beverage firm in Paarl, installed 120m^2 of flat plate collectors. These provide heat to a boiler with the storage capacity of 10 000 litres of water.
- In 2012, Fairview Cheese Farm in Paarl installed 90m^2 of evacuated tube collectors. These provide heat to a boiler with the storage capacity of 4 000 litres of water.

The offtake market

The Solar Payback brochure indicates that 80 solar thermal plants exist in the food and beverage industries worldwide – far more than in other industries.

The potential for uptake of solar thermal applications for heat processing is considerable across the food and beverage industries in South Africa. These industries also include a range of sub-sectors and constituent processes, expanding the potential uptake even further.

Industry segments with highest number of realised SHIP plants[11]



Economic importance

In recent years in South Africa, food processing has grown more rapidly than other sectors in the economy, and has also outperformed manufacturing as a whole:

- In 2016, the food industries' Gross Value Add was R57 billion, almost double that achieved in 2000.
- Since 2010, the beverage industries' Gross Value Add has remained more constant, averaging around R18 to R20 billion per annum.

The National Development Plan identifies agriculture and agri-processing as key to increasing exports and employment, and to growing small and medium enterprises in South Africa. Their economic importance is mirrored in various government department's plans and programmes, including the Industrial Policy Action Plan and the programme to develop Agri-parks – with an emphasis on the sector's backward and forward linkages and strong employment multipliers.

Standard for domestic systems sets the tone

The national standard SANS 10400-XA 2 states that on new buildings, more than 50% of the electricity that is consumed by an electrical resistance element must be replaced by some form of energy efficiency. This provides a further impetus for the domestic and commercial (though not yet industrial) solar water heating industry.

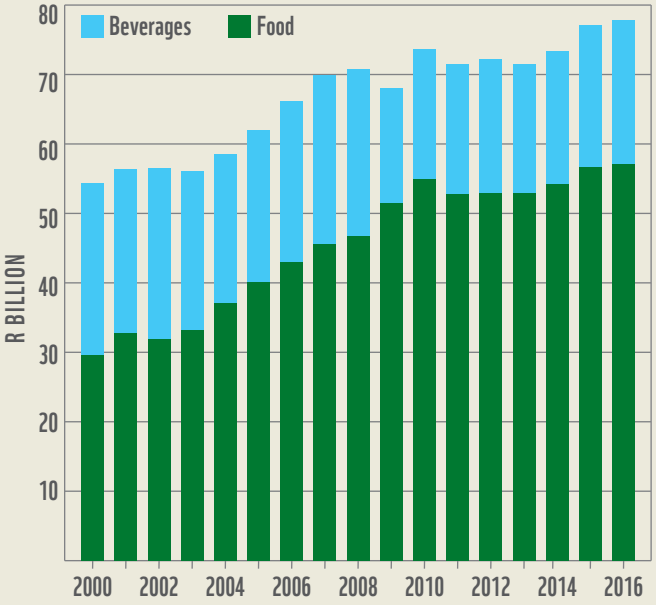
R57 bn

The Gross Value Add of South Africa's food industries in 2016

Expanding the market through strong linkages

- Backward linkages include to farming, fertilisers and other chemical inputs and farm equipment.
- Forward linkages include packaging industries, chemicals industries, and to services such as transport, marketing and retail.

Gross Value Addition in food and beverage industries (R billions)[12]



Firm characteristics

According to the SARS 2015/16 tax statistics, in the food, beverage and tobacco industries there were:

- 5 695 SARS registered companies with total taxable earnings of R10,3 billion
- 938 small business corporations.

The South African agri-processing industry is technically advanced and able to compete with major companies internationally. The sub-sectors are dominated by a few large companies and there is vertical integration between agriculture and agri-processing. Amongst the largest food and beverage firms on the continent are: Tiger Brands, RCL Food, Distell Group, Pioneer Foods, Tongaat Hulett, AVI, Astral Foods, Illovo Sugar.

Firm level sustainability

The major food and beverage conglomerates in South Africa are investing in renewable energy, predominantly in the form of solar photovoltaic panels at head offices, and at certain manufacturing sites. Waste-to-energy is also a focus, albeit a lesser one. Coal still appears to be extensively used to fuel boilers and other heat processes although there are some moves towards other energy sources or reduced coal consumption. Solar thermal technologies do not yet appear to be a major consideration.

- Tiger Brands is considering shifting their boilers from coal to gas.[13]
- Coal is the primary energy source for steam generation on RCL poultry farms, in processing, and in feed and sugar mills. However, between 2016 and 2017 consumption of coal reduced by 2%.[14]
- Pioneer Foods plans to replace existing oil and gas boilers with coal boilers.[15]

Economic outlook

Recovery from the severe drought in various parts of South Africa will take some time. In addition, food and beverage firms appear to be moving into a phase of further consolidation. Productivity, economies of scale, access to cutting edge technology, to finance, to information and knowledge, and to markets, and the ability to manage and mitigate risk, will determine which firms succeed and those that won't.[16]

Given this insecure environment, it may be an attractive proposition for firms to invest in technologies which assure them of energy supply security and mitigate against fuel price input cost increases and volatility. Addressing barriers to solar thermal uptake could move it further up for consideration relative to other potential sources of heat process energy.

Jobs

- In 2016, there were around 216 000 employees in the food industries (the same as in 2000 but up from 186 499 in 2012). Most jobs are in production, preservation and processing of meat, fish, fruit, vegetables, oils and fats.
- In 2016, there were 67 000 employees in the beverage industries (up from 50 091 in 2000).

Employees in the food and beverage industries (2016)[17]

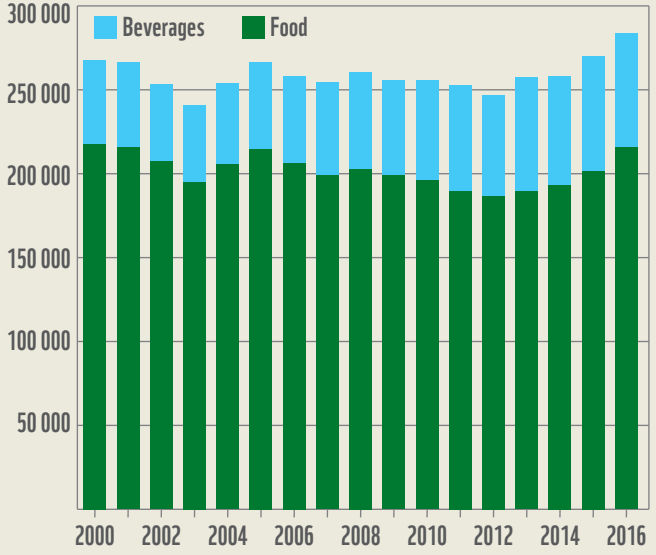


PHOTO: SHUTTERSTOCK.COM

Total market potential

Solar thermal applications can be financially feasible when they replace most fuel sources, other than coal, showing considerable potential for scalability.

The following can be used to estimate the solar thermal potential in South Africa:

- South African Times Model (SATIM) data – helps us estimate overall heat use in the food and beverage sector. This data includes a modelled disaggregation of coal use to the various sectors of the economy[18]
- The SOLTRAIN guidelines of industrial process heating in line with existing solar thermal installations in South Africa
- The assumption that the solar fraction for heat processes is 60%.

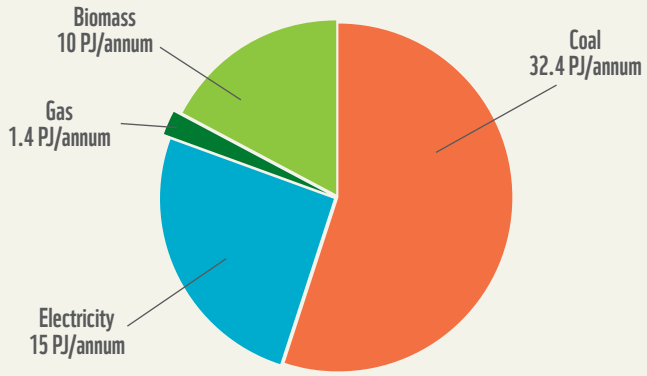
60%
solar fraction

Total solar thermal potential in the food and beverage industries[19]

Based on the SATIM data, SOLTRAIN guidelines and assumptions about the potential share of solar thermal energy of total heat process energy:

- **Estimated average capital cost of existing large-scale solar thermal** (based on 2 000 kilowatt hours per square metre irradiation): EURO603 per m² in 2016/15 (at an exchange rate of R15.30:EURO1, at the time of calculation this was R9 225 per m²). This is the mean average, taken across a range of projects and over a number of years. There were also significant variations across projects in terms of application, quality and planning efforts, as well as across back-up systems and storage.
- **Timing of uptake**: the SOLTRAIN Solar Thermal Road Map suggests an initial 45% growth rate per annum could be achieved across all industries (given the very low current levels). It is therefore a high growth opportunity for investors.

Total current food and beverage energy use



Socio-economic benefits

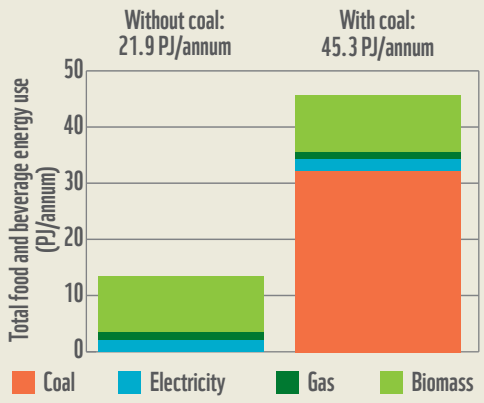
A growing industrial solar thermal industry will support the development of the manufacturing and installation industries, including small and medium businesses, and the creation of new jobs.

Government can better support localisation of solar thermal manufacturing by providing incentives, developing appropriate local content stipulation, and improving regulations. This could lead to a deepening of industrial capabilities, enhancing industrial development and competitiveness for the country.

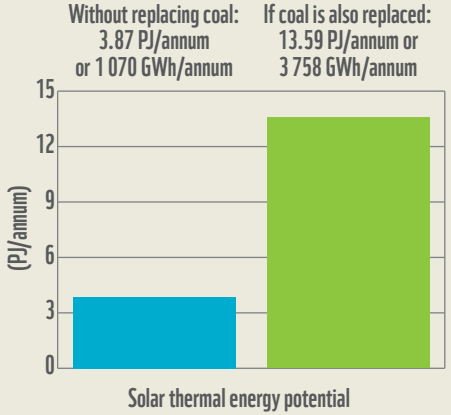
50%

share of process heat that can economically integrate solar thermal (with or without coal)

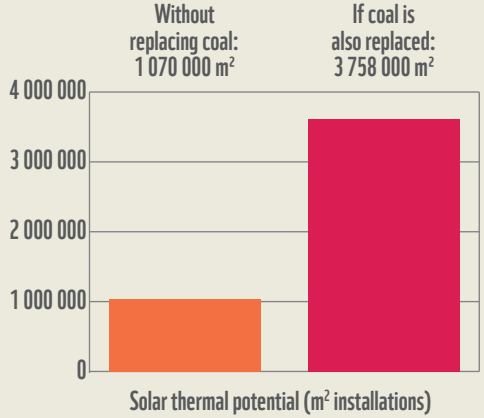
Total current heat energy use



Total solar thermal replacement potential



Potential solar thermal installations



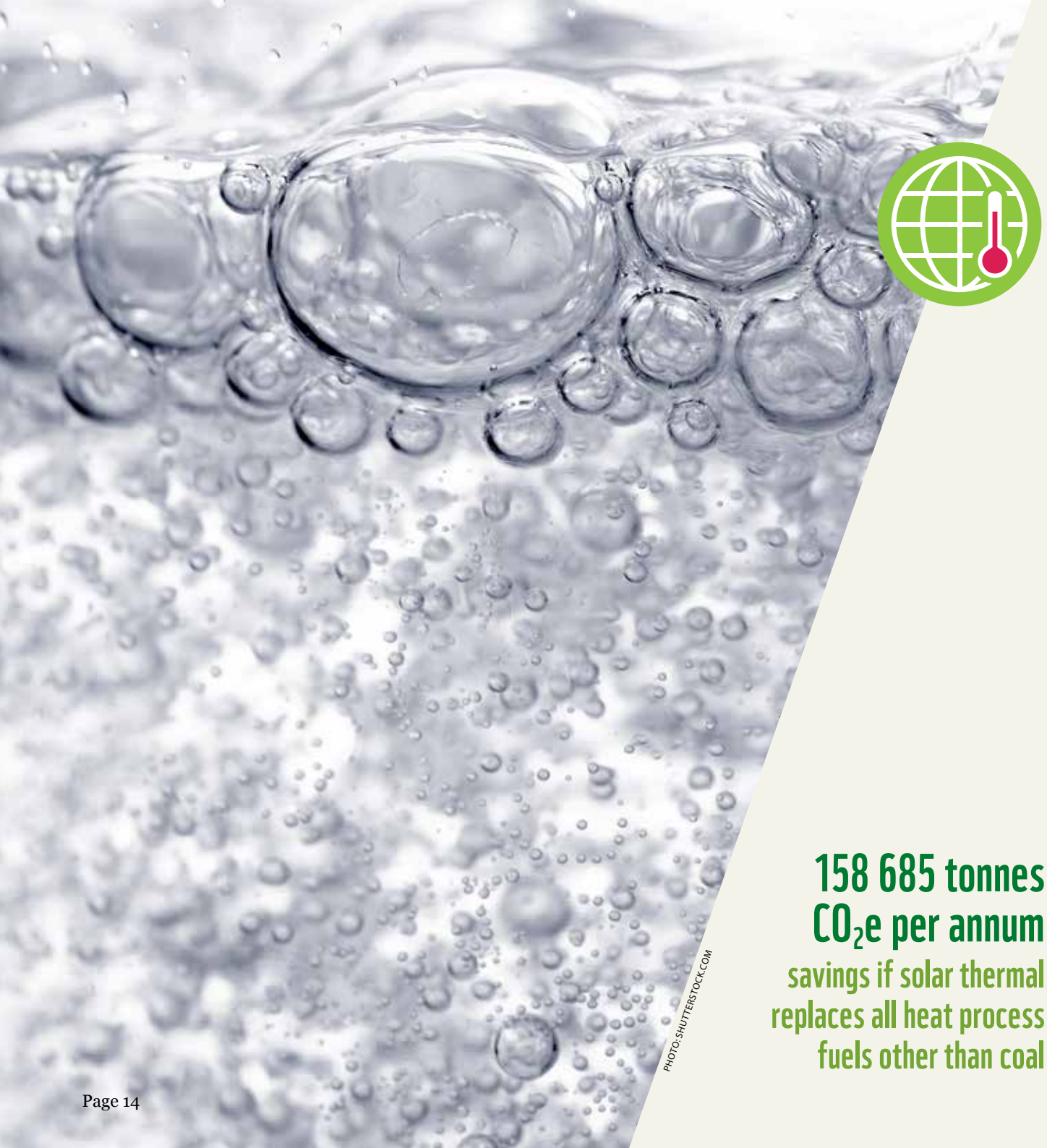


PHOTO: SHUTTERSTOCK.COM

Greenhouse gas mitigation potential

Heat processes in the food and beverage industries emit a total of 942 556 tonnes of carbon dioxide equivalent (CO_2e) per annum.

According to the South African Times Model, coal is used to generate heat for most of these processes.[20] Coal's relative cheapness currently renders it attractive (if we don't count its climate cost to the economy).

Potential CO_2e savings[21]

Potential energy savings per annum	CO_2e savings (tonnes/annum)			
SATIM (2006)	**Coal**	**Electricity***	**Gas****	**Total**
9.72 PJ coal	783 871			942 556
0.45 PJ electricity		133 326		158 685 (without replacing coal)
0.42 PJ gas			25 359	
3 PJ biomass				

Note: PJ = petajoule.

* Emissions factor for 1 kWH of electricity: 1.06 kg CO_2e based on Ecoinvent Database South African energy mix.

** Emission factor of 0.0605 CO_2e per GJ (3 significant figures).

158 685 tonnes CO_2e per annum

savings if solar thermal replaces all heat process fuels other than coal

A total **savings of 158 685 tonnes CO_2e per annum** can be achieved if solar thermal replaces all heat process fuels other than coal. If it also displaces coal, most of the carbon emissions can be eliminated.

Under the Paris Agreement, South Africa has made a commitment that by 2025 and 2030 its emissions, "will be in a range between 398 and 614 Mt CO_2–eq". While the application of solar thermal technologies to heat processes in food and beverage firms might only contribute a small fraction towards this commitment, adoption of this technology by these firms could pave the way for other industries, particularly as the domestic solar thermal industry matures. There exists significant potential for scalability over the medium to long-term.

> *"South African solar thermal manufacturers are not operating at full capacity as there is not consistent demand."*
>
> Herman Weber, Kwikot, September 2017

About CO_2e

To enable us to compare the warming effect of the 17 different greenhouse gases (GHGs), they are converted to a common basis called carbon dioxide equivalent – CO_2e – expressed as 'carbon emissions' for short.

Barriers to solar thermal uptake

Solar thermal industry development

- A lack of sustained demand for solar thermal applications affects the ability of manufacturers and installers to achieve economies of scale.
- Certain parts are imported at a cheaper rate than can currently be manufactured locally – a function of both limited local demand and high investment costs.
- A skills gap exists to optimally design industrial scale solar thermal projects.

Costs and capital investment

- The cost of the average industrial solar thermal system is EURO603/m² (R15.30:EURO1 in 2016). This is more than the costs already achieved in Europe of EURO400/m².[22] This is typical of a relatively new industry. There is also enormous variability across projects due to site specificities and installers' capacities.
- Putting in place backup systems can also result in higher costs.

Non-replicability

- Solar thermal installations must be custom designed based on the particular industrial processes, systems and site characteristics.

Standards

- For industrial systems which are designed to purpose, designers prefer to use internationally certified components, as no local component certification exists.

Funding

- While there are specific funding channels for renewable energy, few financial institutions are familiar with solar thermal technologies. Specific funding lines are required that are deliberately designed for industrial solar thermal applications, and paired with customised risk-related products.
- In the absence of significant industrial demand, an Energy Service Company Model is yet to emerge. Such a model could assist with overcoming the high initial capital costs and longer payback periods, reducing risks for food and beverage firms.

Limited awareness

- Considerable work is required to educate and create awareness amongst industry, government and the finance industry about solar thermal technologies for industrial processes.

Competition

- Other renewable energy sources may be less efficient, but their prices are decreasing. Their applicability is also broader as they can replace electricity altogether, not only heat processes.

Political economy factors

- Policy uncertainty and low economic growth, limit the desire of industry to invest in non-critical projects particularly in new technologies.

Drivers of solar thermal uptake

Global and local support

- SOLTRAIN is investing in several pilot sites in South Africa to help develop the solar thermal industry and to address uptake barriers amongst agri-processing and other firms.
- Solar Payback is also promoting the use of Solar Heat for Industrial Processes across four partner countries – Brazil, India, Mexico, South Africa.

Price and cost drivers

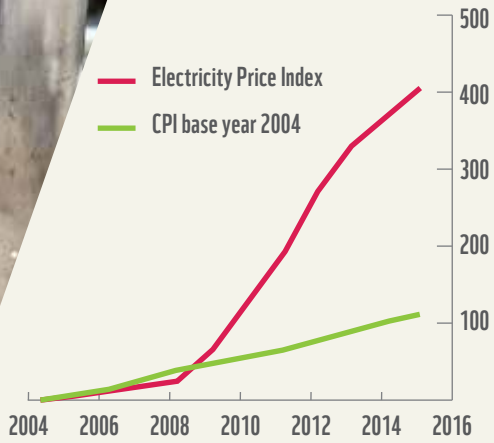
Energy prices and volatility

- Over the past decade, the price of electricity has increased by more than 400%, making the move to renewable energies more attractive.
- Paraffin, LPG, heavy oils, and diesel, are also all relatively costly fuel sources.

SOLTRAIN

SOLTRAIN has trained more than 120 people in various aspects of solar thermal technology, such as in solar heat for industrial applications, and cofunded 127 solar thermal demonstration systems in homes, businesses and industries across the Southern African Development Community. It has also helped develop Solar Thermal Roadmaps for South Africa, Namibia and Mozambique.

Electricity (2004–2015)[23]



Carbon budgets

From 2020, companies emitting over a threshold level will be allocated 'carbon budgets' – a quantum of carbon emissions they are permitted. There will be ways to offset unavoidable emissions and penalties for exceeding this emissions budget – both of which will mean extra costs.

In solar water-heating systems, the heated medium is used to preheat the medium feeding into the collector using a heat exchanger. The heat is then stored in a well-insulated storage container.

Carbon taxes and budgets

The future carbon tax and carbon budgets provide additional impetus for firms to consider a shift to renewable energy.

Incentives, concessional finance, subsidies

- Solar thermal installations can qualify for the 12B tax incentive, allowing for accelerated depreciation of the capital cost for tax purposes.
- The Industrial Development Corporation has designed concessional financing offerings with technical assistance for renewable energy investments, including the Sunref (Sustainable Use of Natural Resources and Energy Finance) line of credit, provided by *Agence Française de Développement*.
- For SMMEs and projects, SOLTRAIN can co-fund or subsidise 50% of the installation costs of solar thermal systems within flagship districts.

Internal Rates of Return and paybacks

The financial feasibility of implementing solar heating is largely dependent on:

- The cost of the fuel replaced
- The assumed price increases in that fuel per annum
- The average cost of the installation (per m²).

Assuming a 6% price increase in fuels per annum, solar thermal could achieve an Internal Rate of Return above 10% over a 20-year period, for all fuel sources *other than coal*. Coal replacement might also become financially attractive if the cost of coal increases sharply, as global dynamics and domestic regulations cause coal to carry more of their social cost (the cost to the economy of climate change and health impacts). Payback periods are in the range of five years for diesel, petrol and LPG; longer for other fuels.

New builds and expansions

- It may be more effective to design for solar thermal applications upfront in new buildings and expansions, rather than to retrofit.
- The orientation of the roof space and its angle, are two important considerations with implications for the suitability and potential of solar thermal (and with cost implications).

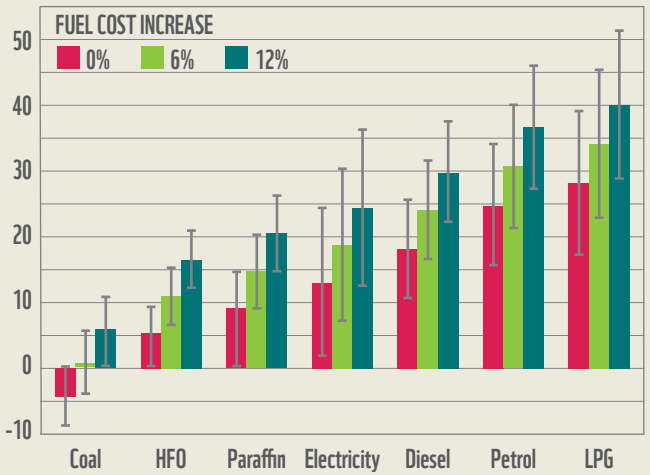
Firm level sustainability

- Particularly for large firms, increasing public and government scrutiny, paired with new compliance obligations, is driving a focus on sustainability. Listed companies now routinely undertake public sustainability reporting and many are part of global initiatives to address climate change in their sector.
- Many firms also see a market opportunity associated with 'greener' and 'cleaner' products.

Key input assumptions in these projections:

- The mean average capital cost for large-scale solar thermal systems installed between 2007 and 2015 in South Africa was EURO603/m² (R15.30:EURO1 in 2016; similar to the current exchange valuation).
- This is based on a 2 000 kWh/m² of collector area and a 45% overall system efficiency.
- The electricity costs are based on those from the City of Johannesburg.
- The deviation bars take into account the variation of energy costs over the country due to transport as well as varying boiler efficiencies and distribution losses.[24]

Internal Rate of Return %[25]



Payback time (years) %[26]

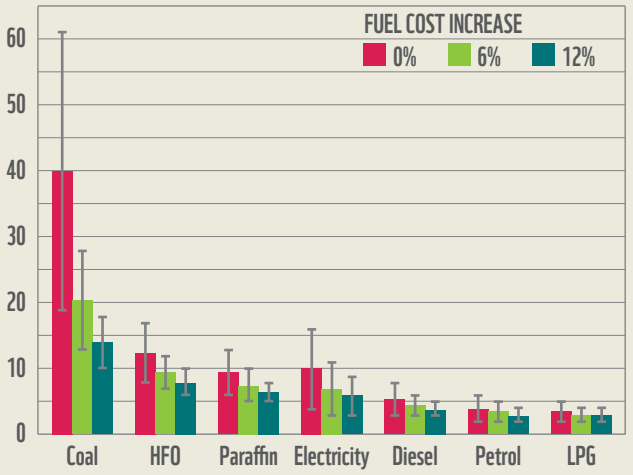


PHOTO: STELLENBOSCH UNIVERSITY, CRSES

“Solar thermal is particularly well-suited to retrofit, expansions, or new facilities where it can be sized to service system requirements in advance.”

Dr. Karen Surridge-Talbot, SANEDI, September 2017

Action points

Investors and lenders

There is an opportunity for financial institutions to develop a better understanding of the technology, and to develop customised risk and finance products to support its roll-out.

Food and beverage industries

Solar thermal technologies appear to be an obvious choice for expansions and new builds, where the various specifications can form part of the design phase. A growing body of research shows that solar thermal applications can be financially feasible for food and beverage firms when they replace most fuel sources, other than coal. As more industrial solar thermal systems come on line, expertise and the costs of these technologies will improve, further strengthening the business case.

Solar thermal manufacturers, installers and maintenance firms

There already exists the capabilities to both manufacture and install (and maintain) solar thermal applications.
A sustained uptake could provide the further impetus needed to build skills and develop the industry to create a stronger manufacturing base for capital equipment in solar thermal, as well as deepen installation capabilities.

Unions

Unions can take up the potential for solar thermal manufacturing, installation and maintenance as an industrialisation opportunity within the Million Climate Jobs Campaign. This campaign investigates and advocates the job creation potential of businesses and activities that reduce carbon emissions and/or build resilience to the impacts of climate change.

The Million Climate Jobs Campaign

Find out more in the booklet, *One Million Climate Jobs*, available at: aidc.org.za/download/climate-change/OMCJ-booklet-AIDC-electronic-version.pdf. This is part of ensuring that the shift to a low-carbon economy is a just transition.

Policy-makers, donors, research houses

Government and its entities can ensure that the policy and regulatory environment is supportive, including designing and implementing tax incentives or allowances, developing standards for systems (rather than components), and developing localisation and procurement regulations which support the growth and uptake of solar thermal manufacturing.

Donor-funded programmes like SOLTRAIN and Solar Payback are demonstrating the potential for industrial solar thermal applications for heat processes and other applications. The ongoing research, feasibility studies and pilot projects undertaken by different institutions are helping to deepen understanding and capabilities.

Insights from industry

In November 2016, WWF South Africa, GreenCape and Stellenbosch University's Centre for Renewable and Sustainable Energy Studies hosted a workshop aimed at gaining a better understanding of the potential of solar thermal energy in the agri-processing industry. Present were representatives from industry, financial institutions, critical government departments and system installers.

Research presented provided a compelling case for the increased uptake of solar thermal technology in agri-processing. This technology holds enormous potential to address energy needs, whilst also opening local manufacturing opportunities.

Critical success factors to ensure higher uptake of solar thermal technology are:

- Increased pre-feasibility studies that demonstrate the business case to agri-processors
- More specific in-depth analyses of the potential in agricultural sectors
- Addressing the outstanding system component certification
- Collaborative development of a template for financial institutions, to ease present difficulties in obtaining loan finance.

Endnotes

1 The potential of both concentrated and photovoltaic solar power have been demonstrated in several utility projects within the Renewable Energy Independent Producer Procurement Programme.
2 Solar Heat for Industry, 2017. Solar Payback Brochure.
3 Solar Heat for Industry, 2017. Solar Payback Brochure.
4 International Energy Association Solar and Heating Cooling Programme Solar Heat Worldwide, 2017.
5 Solar Heat for Industry, 2017. Solar Payback Brochure.
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8 Gulati & Scholtz, 2017. *Solar thermal for decarbonising industrial process heat*.
9 Captured in a database managed by the Centre for Renewable and Sustainable Energy Studies at Stellenbosch University.
10 Solar-geyser manufacturers taking steps to revive flagging sector, 2015. Online: http://www.saceec.com/swh-mancosa/news.
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12 Quantec database, 2017.
13 Tiger Brands Carbon Disclosure Report, 2015. Available online.
14 RCL Foods, 2017, *Sustainable Business Report*. Available online.
15 Pioneer Foods Integrated Report 2015. Available online.
16 Bureau for Food and Agricultural Policy, 2017. Baseline 2017 Report.
17 Quantec database, 2017.
18 Department of Energy data does not disaggregate coal-use to the sectors of the economy and have not been used for this analysis.
19 Adapted from WWF, 2017. *Industrial scale solar-heat in South Africa: opportunities in agri-processing and textiles*.
20 SATIM is a multi-sector energy-economic modelling framework developed by the Energy Research Centre. It is used for energy system planning or the evaluation of climate change mitigation strategies over long-time horizons.
21 WWF, 2017. *Industrial scale solar-heat in South Africa: opportunities in agri-processing and textiles*.
22 Joubert, Hess & van Niekerk, 2016. *Large-scale solar water heating in South Africa: Status, barriers and recommendations in Renewable Energy*, (97) 809–822.
23 WWF, 2017. *Industrial scale solar-heat in South Africa: opportunities in agri-processing and textiles*.
24 Joubert, Hess & van Niekerk, 2016. *Large-scale solar water heating in South Africa: Status, barriers and recommendations in Renewable Energy*, (97) 809–822.
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26 WWF, 2017. *Industrial scale solar-heat in South Africa: opportunities in agri-processing and textiles*.

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The climate change mitigation debate in South Africa needs to move from improving efficiency within a projection of the existing economy, to innovation and options beyond the constraints of the current dispensation and structure of the economy. It may take step changes in the development path to achieve mitigation adequate to South Africa domestic and international commitments, and to maximise economic development and social wellbeing. Business models presently unconsidered may be waiting in the wings.

The 'Low-carbon development frameworks in South Africa' project seeks to deepen understanding of, and reveal opportunities for, transitions to a low-carbon economy. It facilitates and develops contributions at the intersection of climate change mitigation, economic development and socio-economic dimensions, across immediate, medium and long-term horizons.

Working variously with government, business and labour, the project reaches from providing input to emerging government mitigation policies and measures; through investigating the business and socio-economic case for selected mitigation initiatives which hold growth potential in energy, transport, industry, waste, and land use; to analysing potential future economic trajectories and the systemic opportunities offered by these.

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Why we are here
To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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WWF's Policy and Futures Unit undertakes enquiry into the possibility of a new economy that advances a sustainable future. The unit convenes, investigates, demonstrates and articulates for policy-makers, industry and other players the importance of lateral and long term systemic thinking. The work of the unit is oriented towards solutions for the future of food, water, power and transport, against the backdrop of climate change, urbanisation and regional dynamics. The overarching aim is to promote and support a managed transition to a resilient future for South Africa's people and environment. The organisation also focuses on natural resources in the areas of marine, freshwater, land, species and agriculture.

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