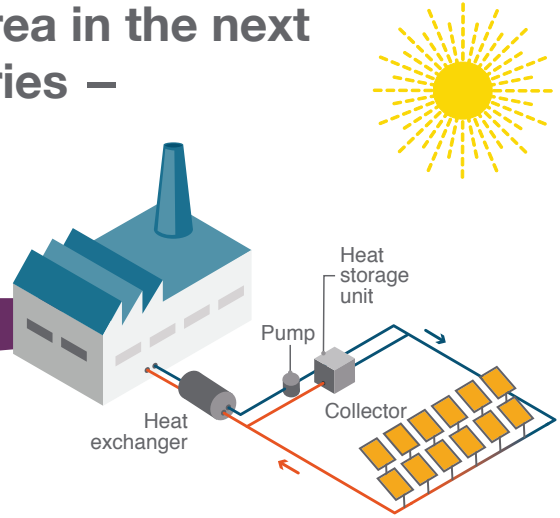
Solar Payback

Brazil: Industrial Solar Heat Strategy

Adding 7.5 million m² of collector area in the next five years in the three major industries – pulp and paper, food and beverage, and chemicals



GENERATE private investment of BRL 14.9 billion

DOUBLE the annual solar thermal market volume

CREATE 45,000 new jobs in Brazil's solar thermal industry*

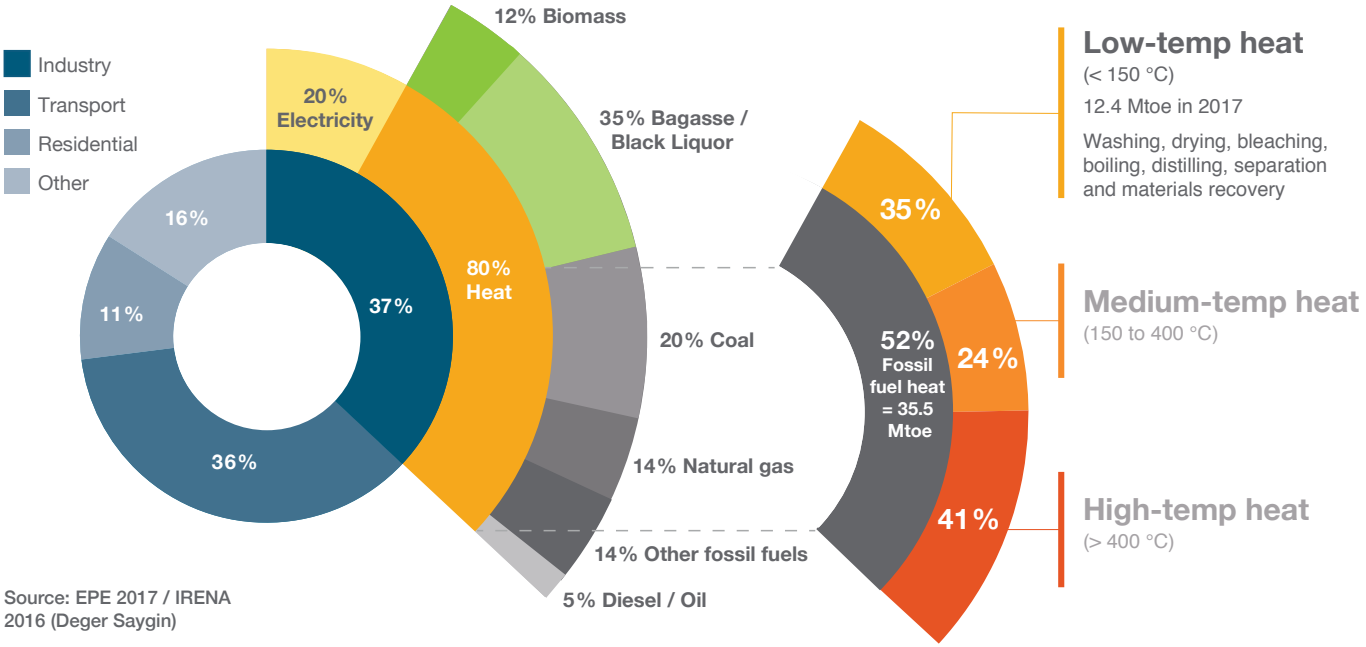
SAVE 1.18 million tonnes of CO_2 emissions

* The annual installation of 1 million m² of collector area creates approximately 30,000 jobs according to Solar Plan of São Paulo 2011.

WHAT IS SHIP?

SHIP is is the acronym for **Solar Heat for Industrial Processes** and describes systems which provide solar heat in a factory.

Fast growing industrial heat demand drives emissions up



Source: EPE 2017 / IRENA 2016 (Deger Saygin)

Fossil fuel-based industrial heat demand grew by 33%, from 26.7 Mtoe in 1990 to 35.5 Mtoe in 2016. Hence, climate protection measures have to focus on the industrial sector. In all, 35% of industrial demand is for heat at temperatures of less than 150 °C and could be supplied efficiently by tried-and-tested solar thermal technologies.

Fast-paced development of industrial solar heat markets (≤ 150 °C) around the world.

Source:
Solar Payback surveys
2017 / 2018 / 2019

125
SHIP SYSTEMS AT THE END OF 2012

>736 **SHIP SYSTEMS AT THE END OF 2018**

2018

104 NEW SHIP SYSTEMS IN 15 COUNTRIES
> BUT JUST ONE SYSTEM UNDER CONSTRUCTION IN BRAZIL!
Countries with the most systems added:
Mexico 51, China 15, India 10

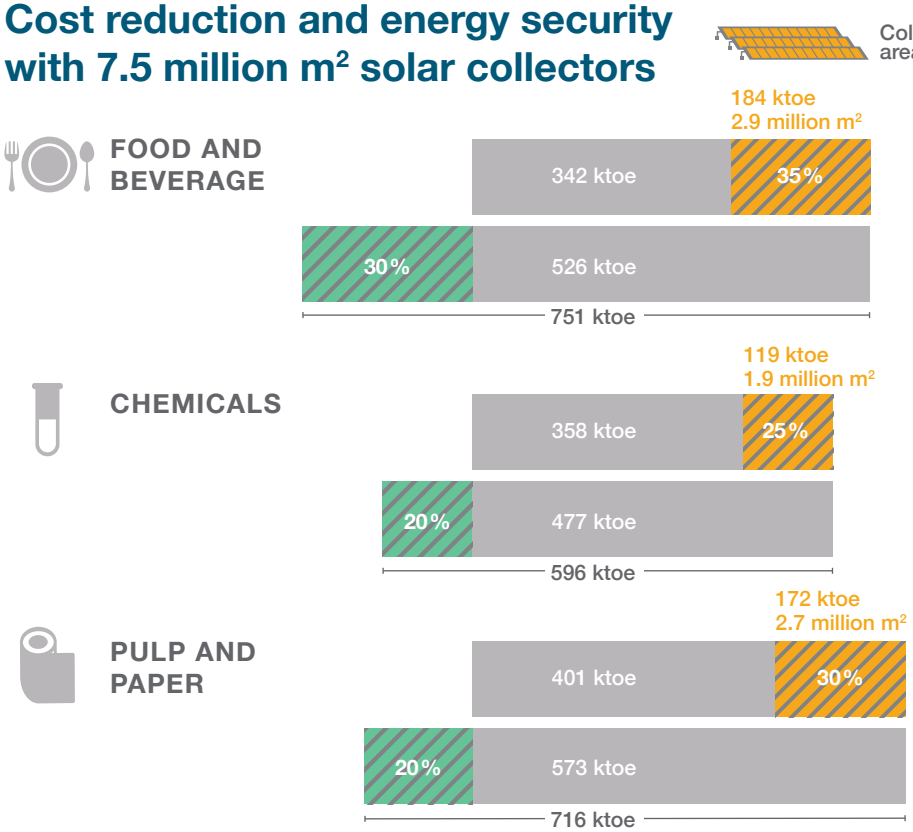
Greater competitiveness in three key industrial sectors

Potential SHIP users can be found in the dynamically growing pulp and paper, food and beverage, and chemical industries.

INDUSTRIES	NO. OF BUSINESSES IN THE 10 MOST POWERFUL STATES ECONOMICALLY	HEAT DEMAND MET BY FOSSIL FUELS Low-temp (< 150 °C)	INCREASE IN HEAT DEMAND BETWEEN 1996 AND 2016
FOOD & BEVERAGE	45,865	751 ktoe	13 %
CHEMICALS	8,727	596 ktoe	24 %
PULP & PAPER	4,960	716 ktoe	146 %

Source: EPE 2017 / CNI 2015 / IBGE 2015

Cost reduction and energy security with 7.5 million m² solar collectors



Oil, gas and LPG

Fossil fuel-based heat (in ktoe) at temperatures below 150 °C. Source: EPE 2017

Energy efficiency

Waste heat recovery potential is between 20% and 30% in manufacturing. Before designing an optimised SHIP system, an analysis of waste energy streams and surface heat loss is required. Source: IRENA 2016 (Deger Saygin)

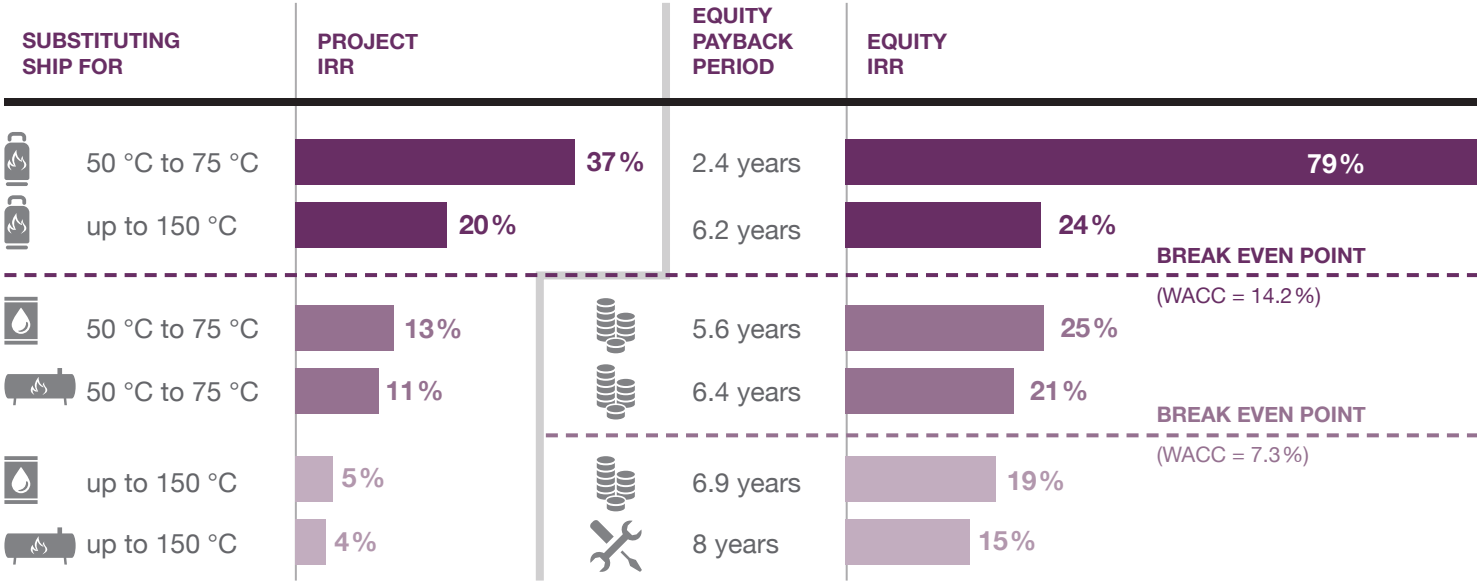
Solar fraction or technical potential

SHIP can meet between 25% and 35% of the remaining demand for heat following waste heat recovery. The solar fraction is restricted because of the limited space available for the solar field and because of the time of day when heat is required (morning or evening) and when there is little or no solar radiation. Source: AEE INTEC / University of Kassel 2018

Considering a collector area of 1,000 m² producing an average of 758 MWh in Brazil and replacing 0.064 ktoe of fossil fuels. Source: Solar Payback Tool

Competitiveness depends on price of fuel substitute

SHIP is already cost competitive in factories that use LPG, but needs support in most others.



THE PROJECT IRR DEPENDS HEAVILY ON ...

... FUEL PRICES, which vary a lot from state to state. The table on the right shows the minimum and maximum prices across every state, as well as the average value used as a basis for assessing profitability.

... LEVEL OF SOLAR IRRADIATION, which is much higher in the northeast (2 MWh per m² and year) than in the southeast (1.6 MWh to 1.7 MWh).

LPG *Fuel/Oil* *Gas*

FUEL	FUEL OIL PRICES INCL. TAX (2,000 m³ of natrual gas a day)	AVERAGE
	165 to 275	220 BRL/MWh
	218 to 258	238 BRL/MWh
	495 to 597	546 BRL/MWh

Source: MEE 2018 / Sindigás 2018

Attractive, short equity payback periods can be achieved by reducing financing costs with the help of concessional credit lines and by producing locally to lower CAPEX.

ACTIONS NEEDED TO REACH PROFITABILITY

Awareness raising campaign

Concessional credit lines from international donors

Local production of concentrating collectors

See back side for more details on the economic feasibility calculations

Using LPG to produce 1 MWh for industrial purposes is, on average, almost twice as expensive (BRL 546) as using fuel oil (BRL 238) or gas (BRL 220). By replacing LPG with solar industrial heat the highest project IRRs are reached even without finanncial support.

SHIP systems that replace gas or fuel oil (50 °C to 75 °C) reach project IRRs of 11% or 13% at medium irradiation sites, which are lower than the WACC of 14.2% (see definition below). However, concessional credit lines, such as the loans offered by Fundo Clima at an effective interest rate of 4%, could cut down payback equity periods considerably to 5.6 or 6.4 years.

Under current conditions, substituting SHIP for gas or fuel oil to produce heat at up to 150 °C is far away from being profitable. Paying back high interest loans over the system lifetime of 20 years is not possible, since all concentrating collectors are being imported. Only a mix of concessional financing and local production could lead to lower CAPEX and attractive equity IRRs of 15% or 19%.

Source: Energetic Solutions

PROFITABILITY

- **THE PROJECT IRR** is the rate of return that the investment is expected to generate over 20 years. The investment is profitable if the IRR is higher than the **WACC** (Weighted Average Cost of equity and dept Capital), i.e., meaning the net rate of return exceeds the cost of finance.
- **EQUITY PAYBACK PERIOD** is the time needed to recover the equity in a project via net annual savings (incl. payback of debt).

KEY FIGURES FOR DYNAMIC IRR CALCULATION IN THE BASELINE CASE

Project duration	20 years
Size of solar field	1,000 m^2
SHIP investment, incl. installation, at 50 °C to 75 °C	BRL 1.7 million
SHIP investment, incl. installation, up to 150 °C	BRL 2.7 million
Effective interest rate on loans	13.9%
Expected return on equity capital	15%
Loan-to-equity ratio	70 : 30
Annual fuel price increase for year 1 to 10*	4.8% p.a.
Annual fuel price increase for year 11 to 20*	2.5% p.a.

*based on long-term compound inflation rate in Brazil

Summary

FOUR REASONS FOR SOLAR HEAT

REDUCE GHG emissions in the fast growing industrial sector

HARVEST three times more energy from the sun than with photo-voltaics

INCREASE competi-tiveness of key industrial sectors

REPLACE imported fuels with local jobs

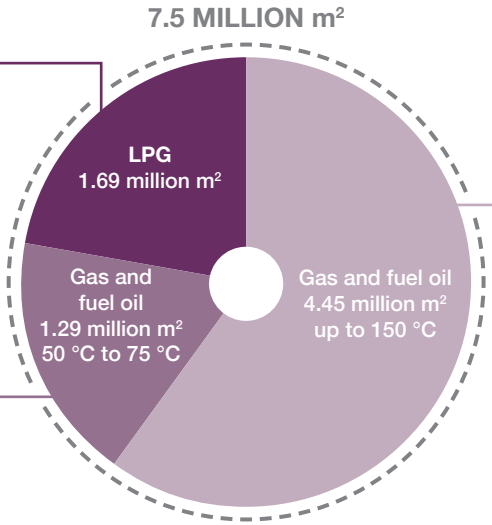
DECARBONISATION POTENTIAL

- Fast growing industrial heat demand drives emissions.
- Solar energy is an emission-free energy source with constant kilowatt-hour prices over at least 20 years.
- SHIP systems ≤ 150 °C grow rapidly world-wide, but only one system under construc-tion in Brazil.
- SHIP can cover 20 % to 35 % of the industrial heat demand after using the waste heat recovery potential.
- Economic feasibility of SHIP is better when substituting high-priced fossil fuels like LPG, fuel oil and natural gas.

Three key actions are needed to implement the Industrial Solar Heat Strategy

RAISE AWARENESS among industrial costumers, because SHIP is already cost competitive for many factories (especially LPG driven processes), but is not known well enough yet.

PROVIDE LOW INTEREST LOANS (4 %) via Fundo Clima with the support of concessional financing for factories that use natural gas and fuel oil.



Profitability even without support

Profitability with concessional financing

Profitability with concessional financing and local collector production

ENCOURAGE LOCAL PRODUCTION of concentrating collectors to bring down CAPEX of SHIP systems for process temperatures up to 150 °C.

Concessional funding sources make SHIP profitable at 50 °C to 75 °C

Concessional financing with an effective interest rate of 4% moves the WACC down to 7.3%, so that more SHIP systems with different fuel prices and irradiation levels are profitable. All economic feasibility calculations consider life cycle costs including operation and maintenance.

Flat plate collectors supply heat to a winery in Israel.

Photo: Tigi

Higher irradiation results in solar yield of 992 kWh/m²a

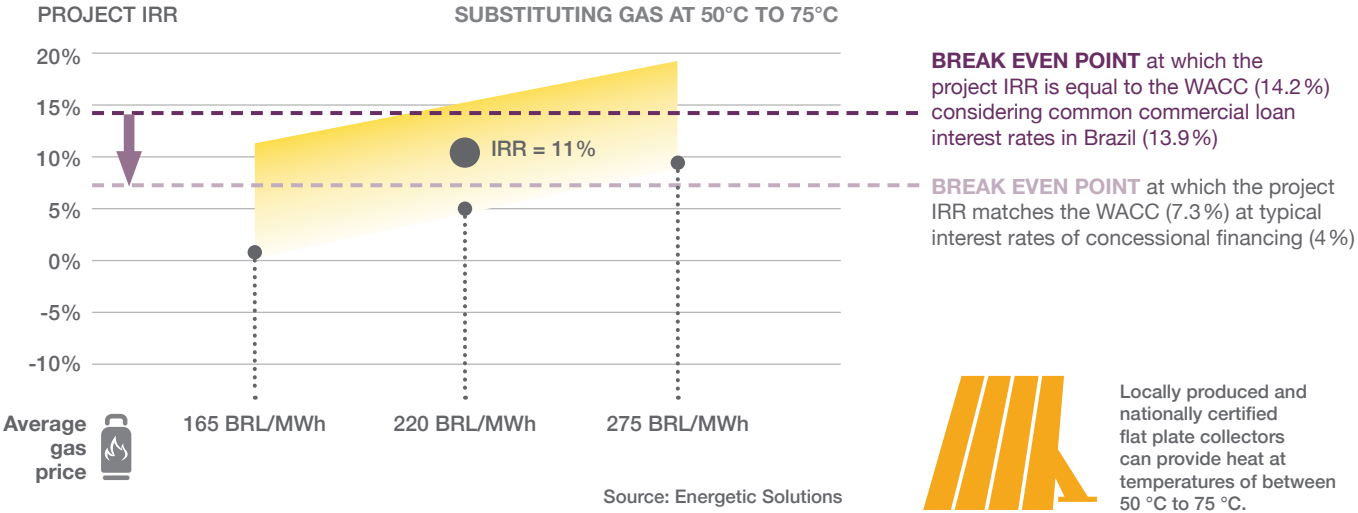
Medium irradiation

Lower irradiation results in 520 kWh/m²a

Shows possible project IRR range based on fuel price and irradiation

Concessional financing

Project IRR when assuming medium irradiation and an average fuel price



Source: Energetic Solutions

Locally produced and nationally certified flat plate collectors can provide heat at temperatures of between 50 °C to 75 °C.

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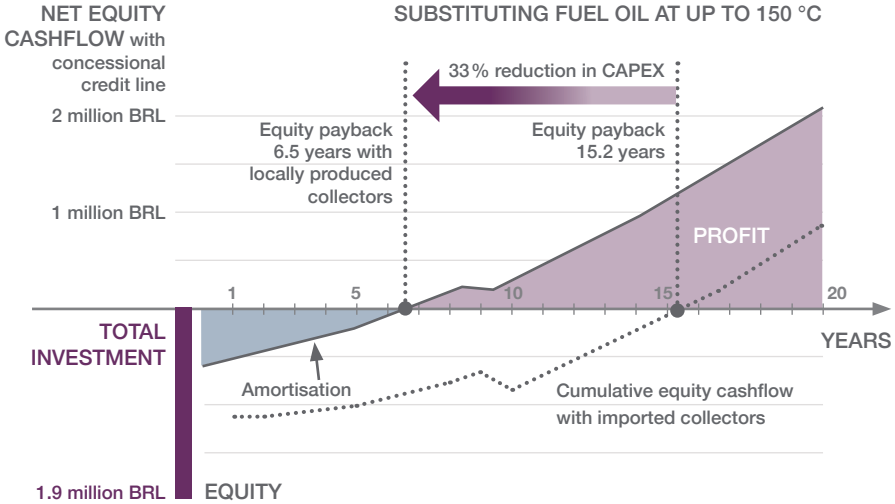
Locally produced concentrating collectors ensure profitability at 150 °C

Concentrating collectors are used to supply heat at temperatures of up to 150 °C. They are orientated towards the sun so they can tap into direct solar irradiation potential.

Currently, all concentrating collectors are being imported to Brazil. Overall, the systems are two-thirds more expensive than locally produced flat plate collectors, which supply factories with heat at temperatures of between 50 °C and 75 °C.

Small parabolic trough (left) and linear Fresnel (right) can provide heat at temperatures of between 100 °C to 250 °C.

Mexico, which has around 100 SHIP systems based on parabolic trough collectors like the one at Nestle on the photo, is a good example of a country where concentrating collectors are produced locally to cut costs. Photo: Inventive Power



Profitability for substituting fuel oil for process heat up to 150 °C requires international financing and the local production of concentrating collectors to save transport costs and duties. A 33 % reduction of the CAPEX reduces the equity payback from 15.2 to 6.5 years.

Source: Energetic Solutions

Local Partners:

ABRASOL
ASSOCIAÇÃO BRASILEIRA DE ENERGIA SOLAR TÉRMICA

www.abrasol.org.br

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