Potential of Solar Heat for Industrial Processes: A Summary of the Key Findings from Solar Payback

CSIR Energy Centre

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Agenda

1. Introduction to Solar Heat for Industrial Processes (SHIP)
2. Description of the Project Solar Payback
3. Study results: energy analysis
4. Study results: industry structure
5. Conclusions of potential study

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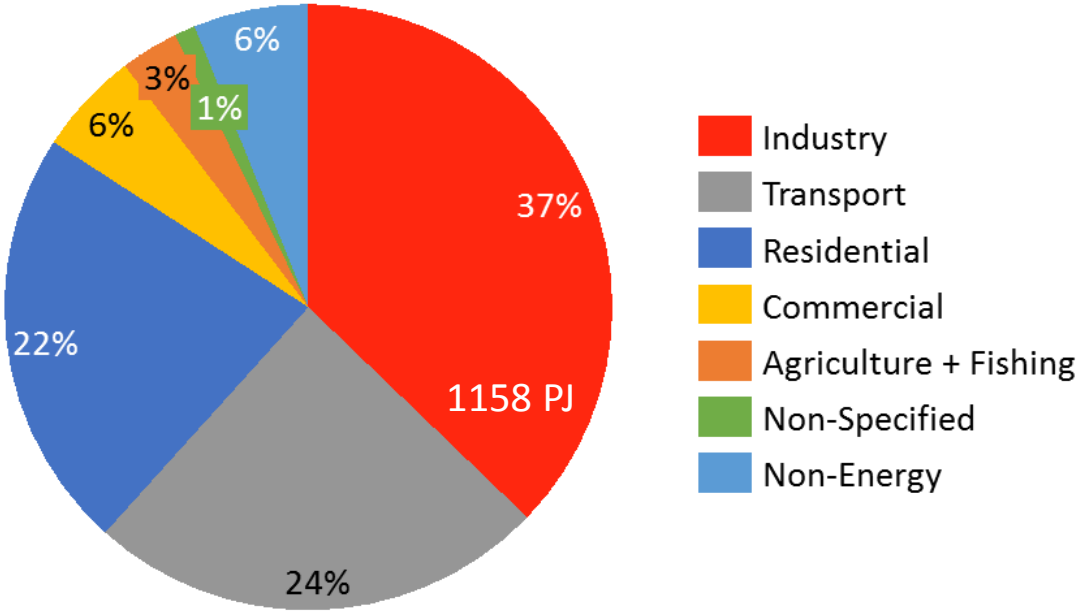
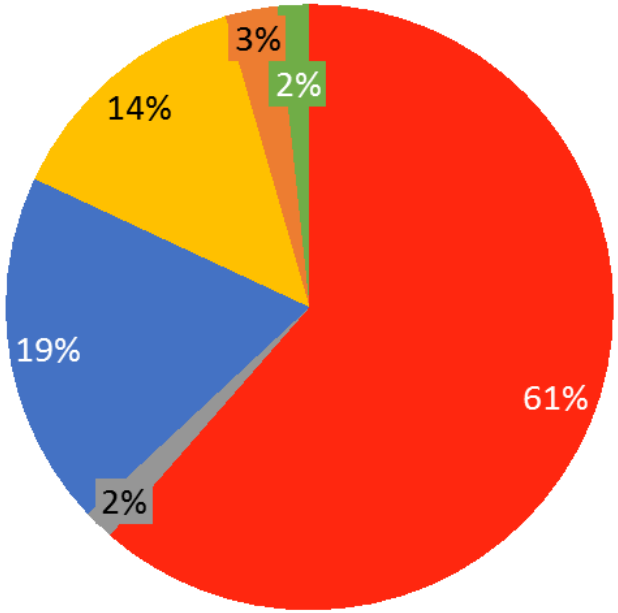
Introduction to Solar Heat for Industrial Processes (SHIP)

Energy usage in the industrial sector

Final Energy Consumption 3131 PJ



Electricity Consumption (199 TWh)



Based on IEA Energy Balances for 2015

Advantages of direct use of solar thermal energy

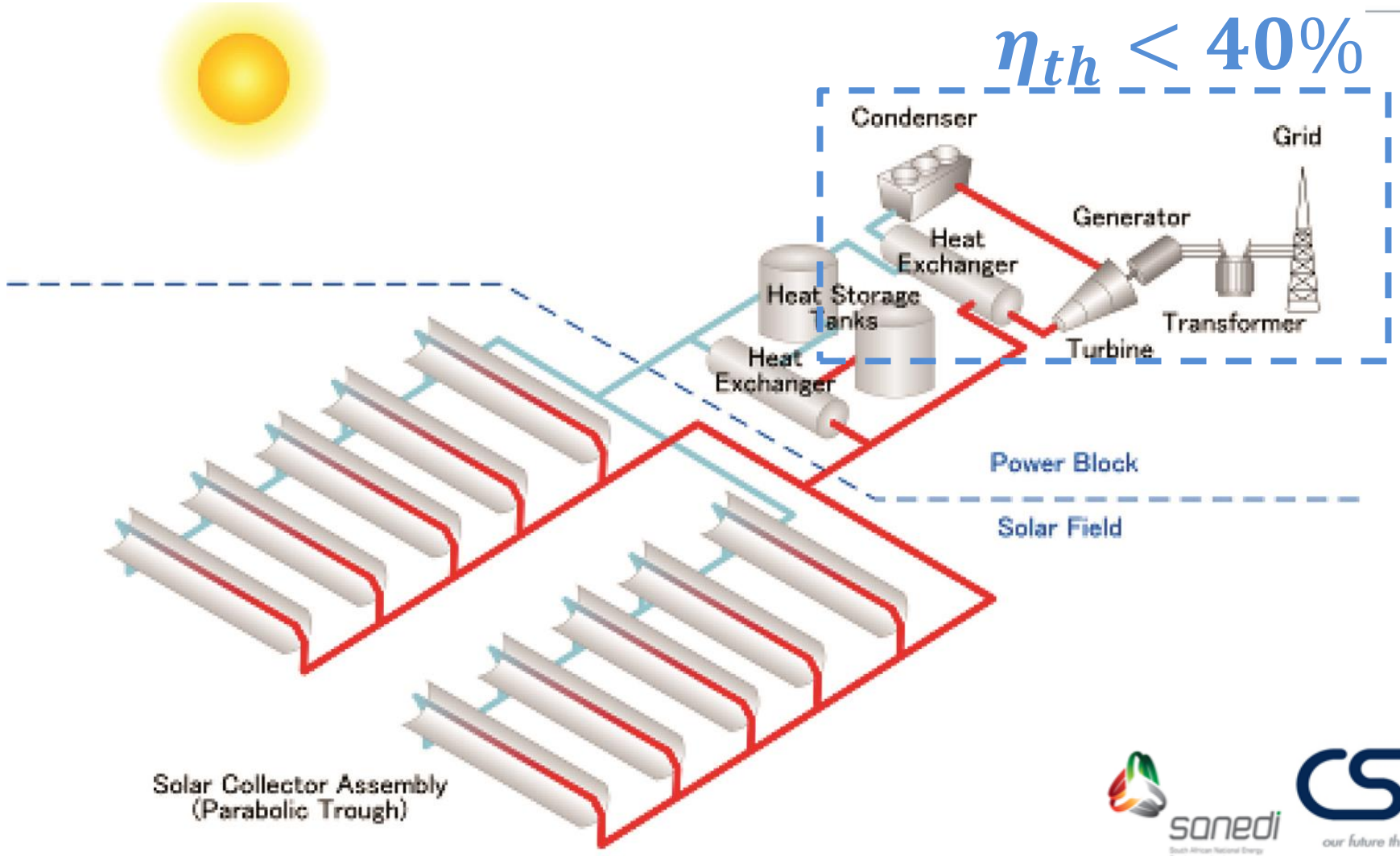
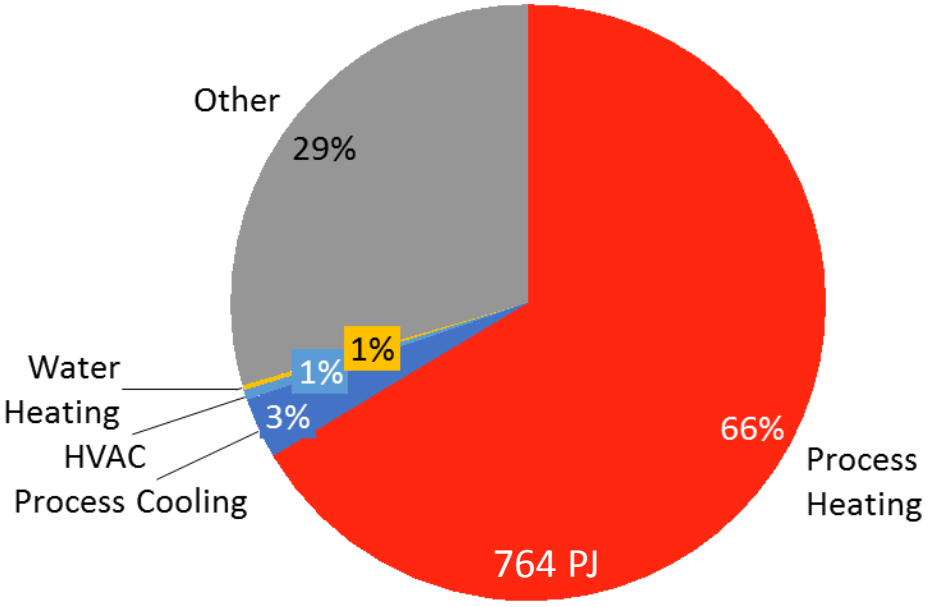


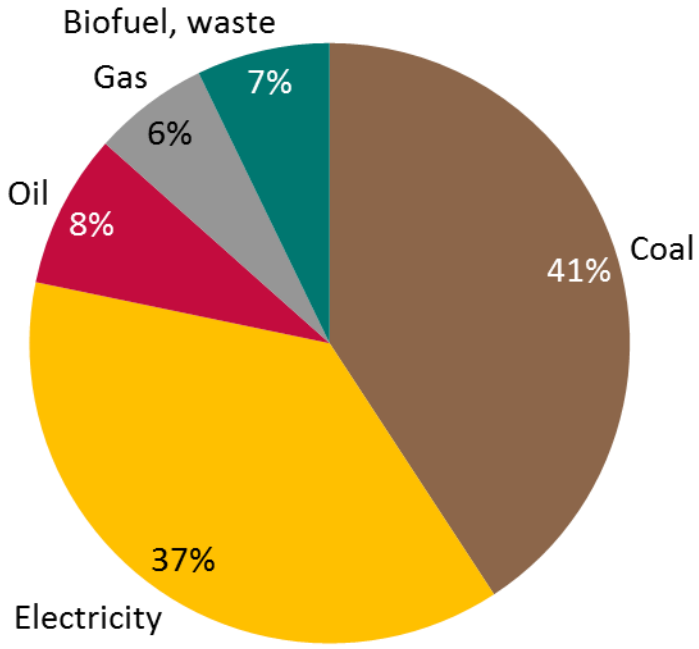
Image modified from http://www.ee.co.za/article/making-solar-thermal-energy.html

Introduction
Energy used for process heating and cooling in industry

Energy end-use within industry[1]

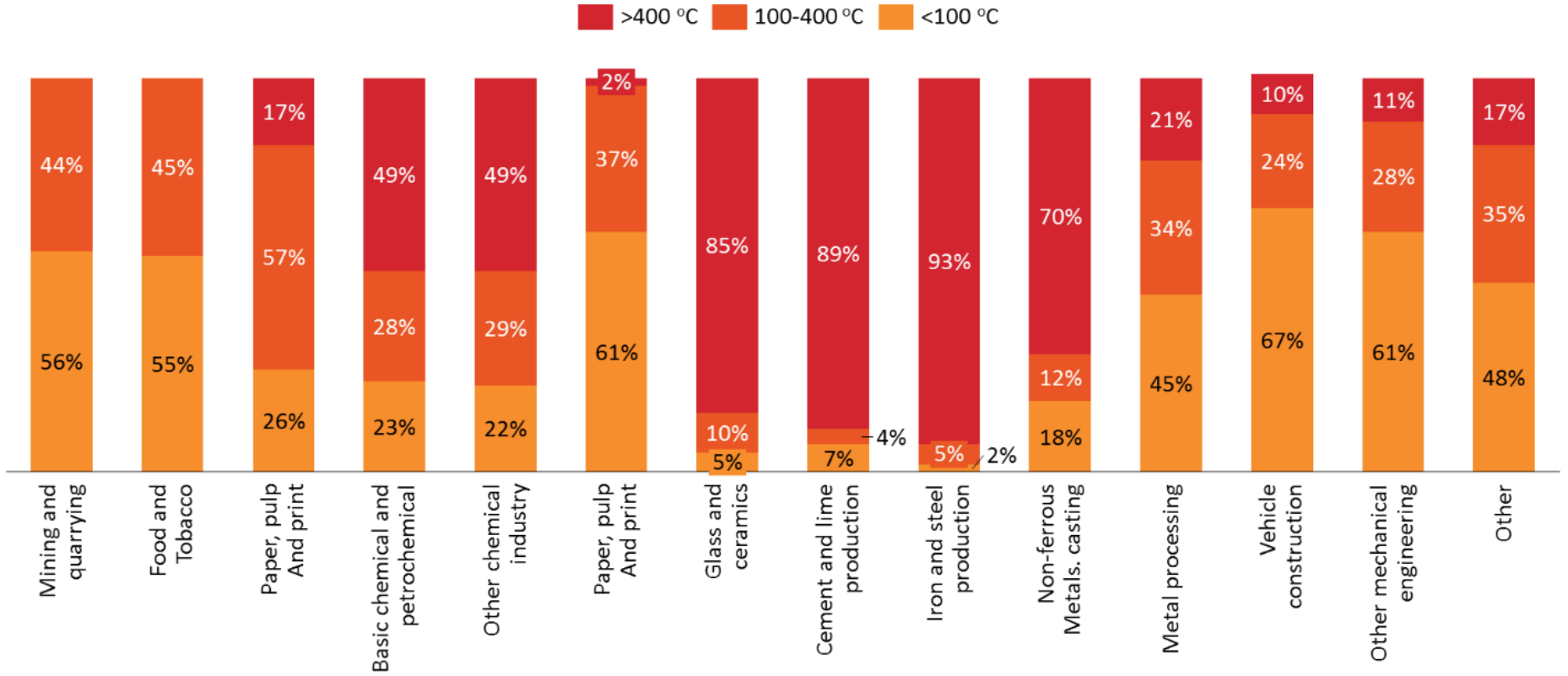


Energy sources for industry[2]



[1]Based on DoE calculations in draft Integrated Energy Plan 2016
[2]Based on IEA Energy Balances for 2015

Introduction
Temperature range of process affects SHIP deployment



<150 °C - Non concentrating solar collectors

150-400 °C - Concentrating solar collectors

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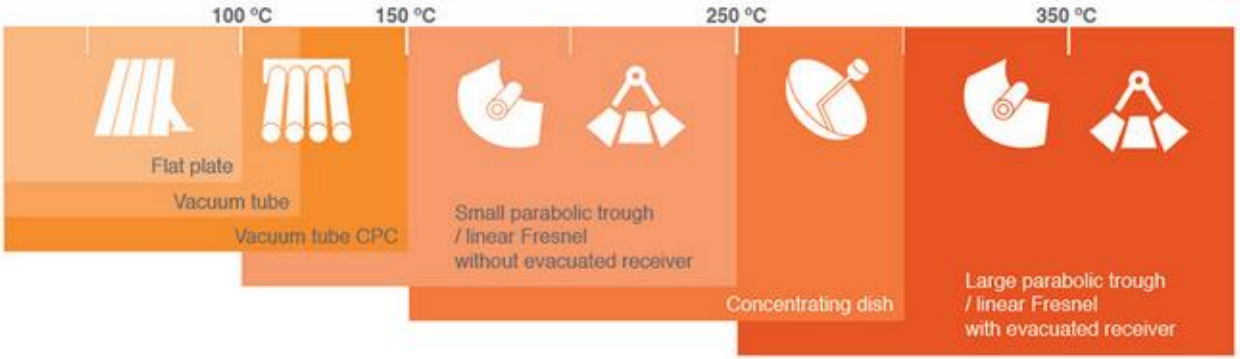
Typical industry temperature ranges based on German Industry research by AGFW

Introduction
Suitable processes and solar collector technologies

INDUSTRY	LOW	MEDIUM	HIGH
	Below 150 °C	150 to 400 °C	> 400 °C
Chemical	• Boiling	• Distilling	
Food and beverage	• Drying • Boiling • Pasteurising • Sterilising		
Machinery	• Cleaning • Drying		
Mining	• Copper electrolytic refining • Mineral drying processes	• Nitrate melting	
Textile	• Washing • Bleaching	• Dyeing	
Wood	• Steaming • Pickling • Cooking	• Compression • Drying	



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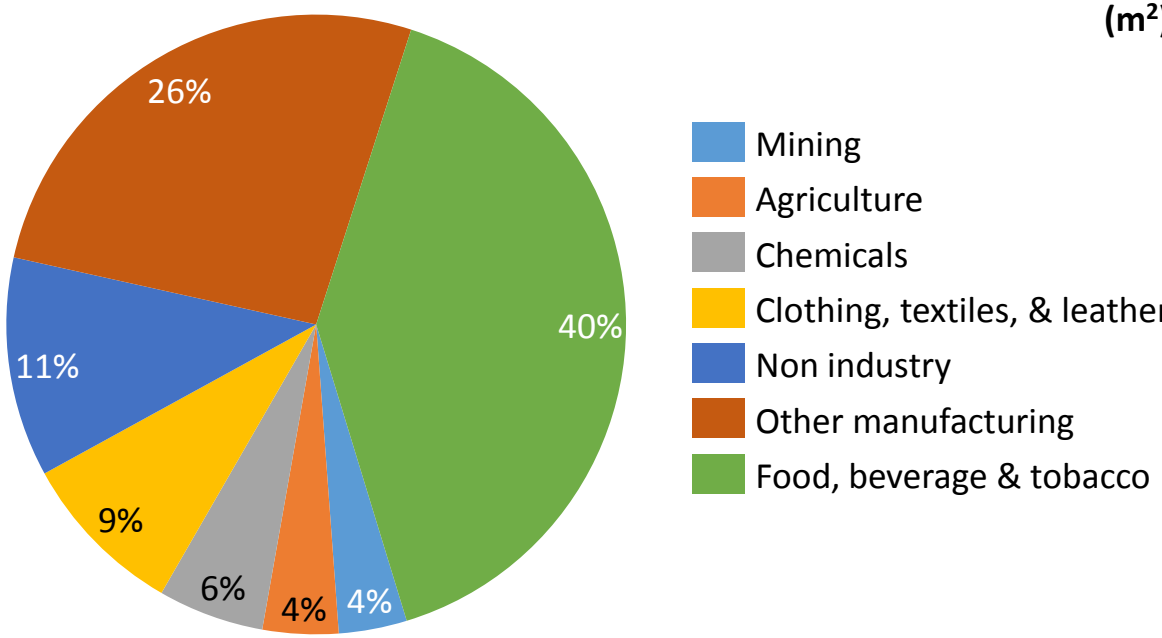
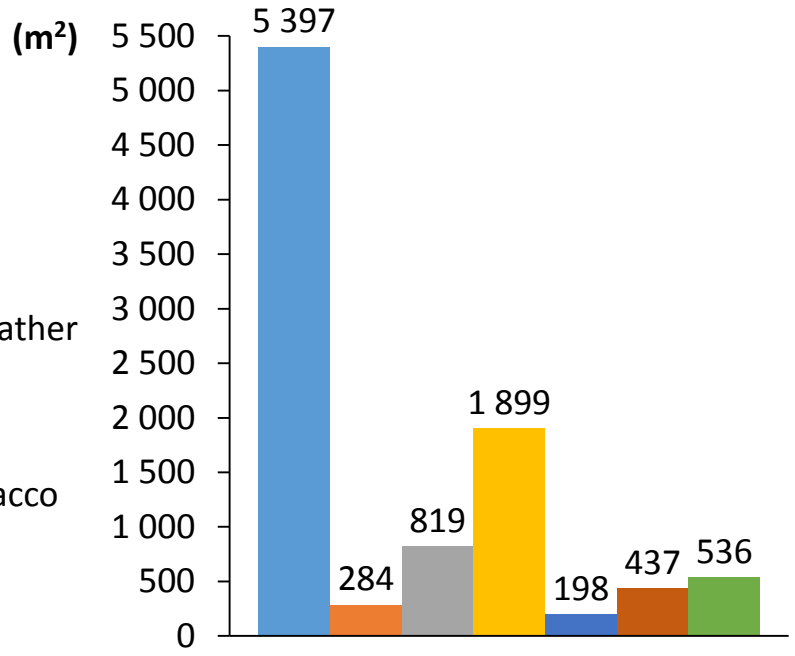
Source IEA Task 49

Introduction
IEA Task 49 database of existing SHIP plants

Number of SHIP plants per sector



Average collector area

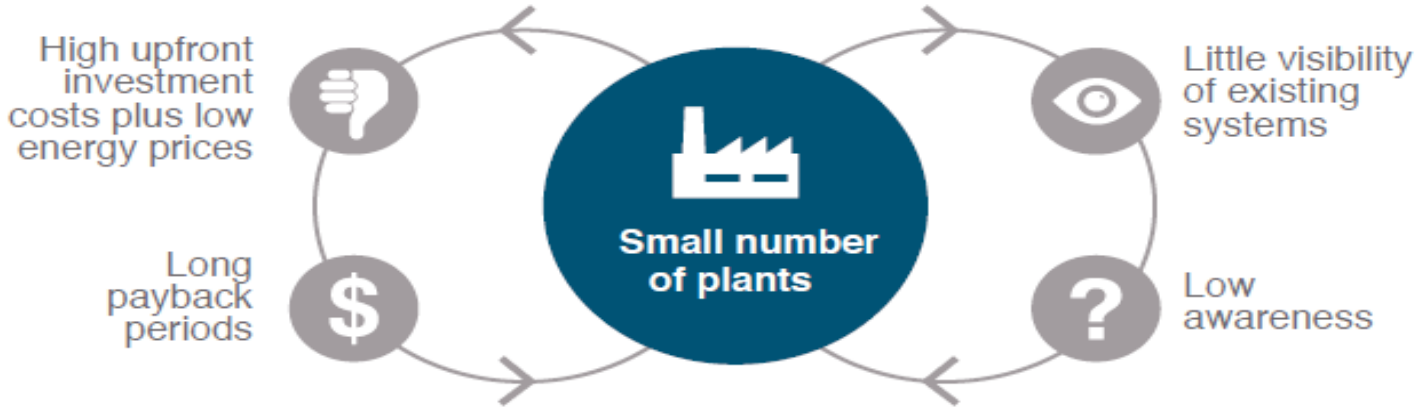


Source IEA Task 49 SHIP plant database http://ship-plants.info/solar-thermal-plants (accessed July 2017)

Description of the project Solar Payback

Solar Payback Objectives

- To increase **awareness of the technical and economic potential** of SHIP-technology
- To increase **willingness to invest** in and to promote this promising technology in four partner countries: Brazil, India, Mexico and South Africa



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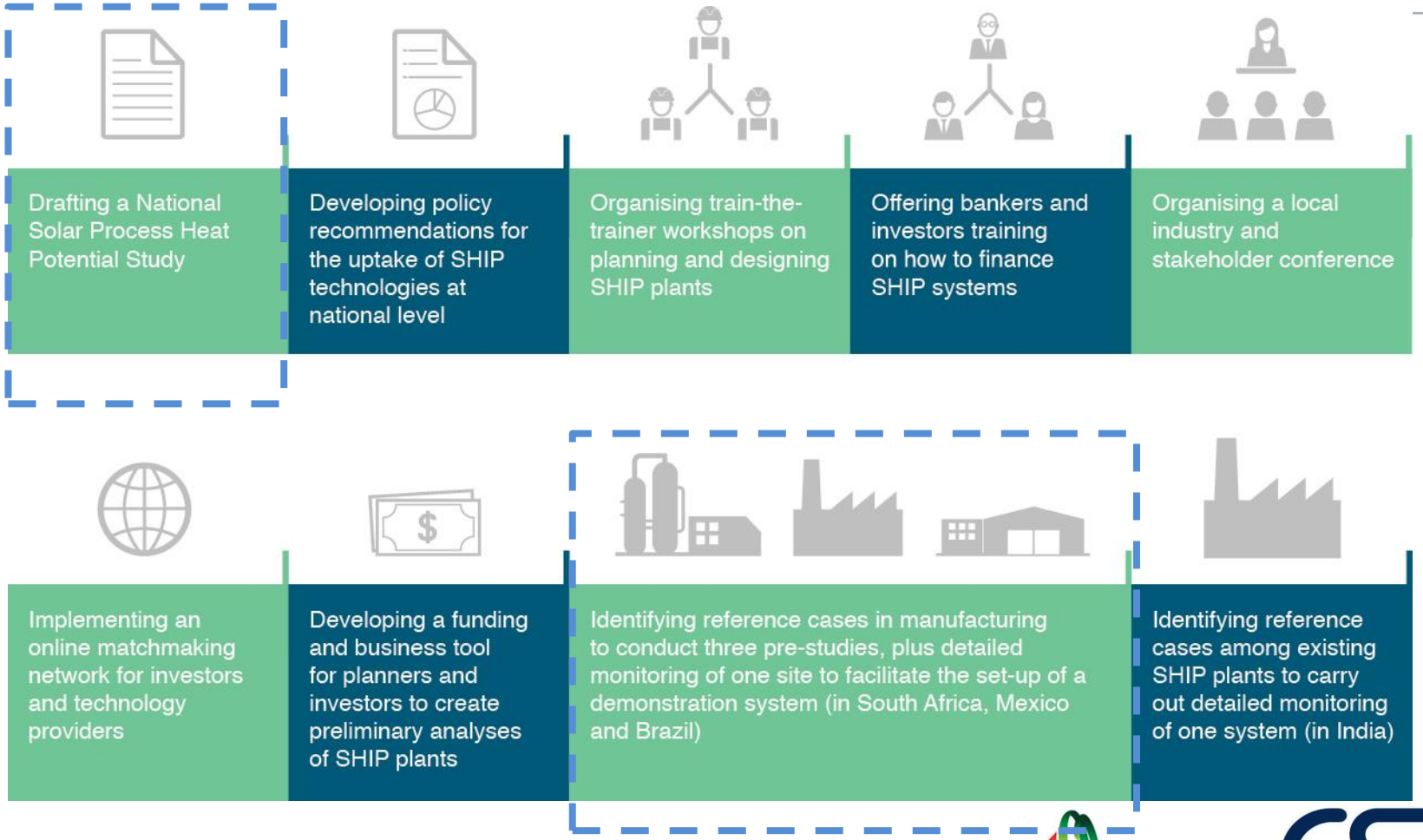
Solar Payback Activities



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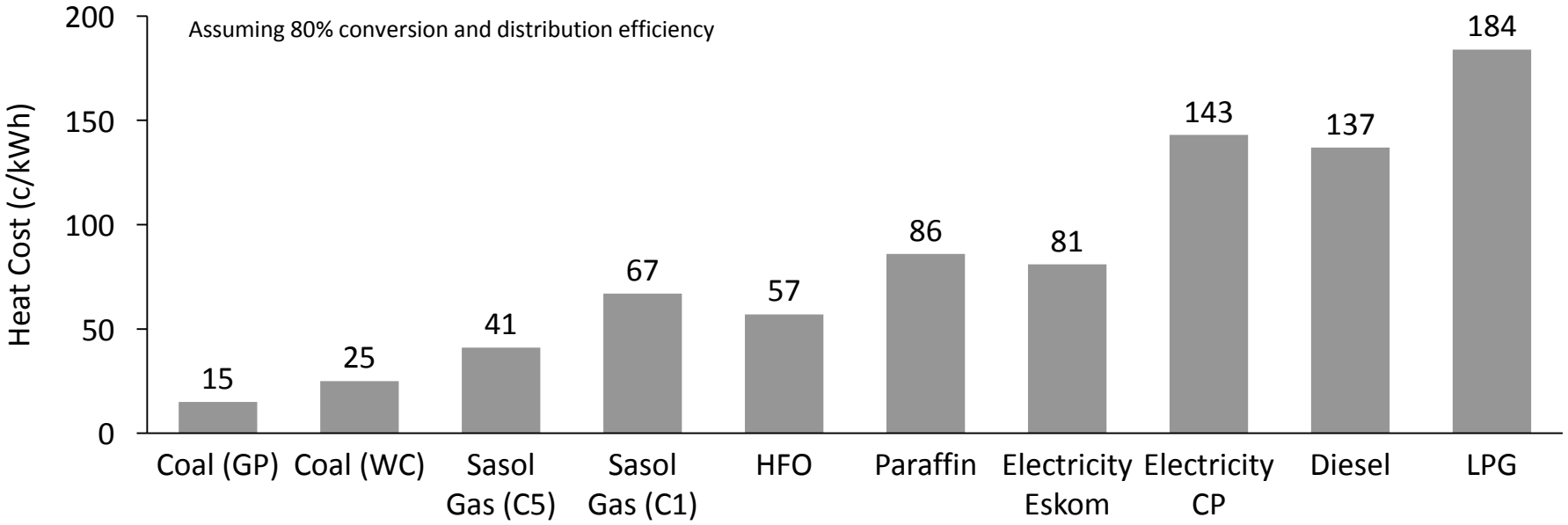
Study Results: Energy Analysis

Potential Study Results
Energy policies and energy use in industry

1. No policies directly targeting Solar Heat for Industrial Processes
2. Carbon budgets and carbon tax policy could be potential drivers for SHIP deployment
3. Carbon tax of R120/tCO_{2e} will increase cost of fossil fuel for process heating (11c/kWh for electricity and 4c/kWh for coal based on input energy)
4. Tax Incentives: Section 12B: accelerated deprecation on SHIP assets
5. dti manufacturing incentives identified that could be leveraged for SHIP deployment

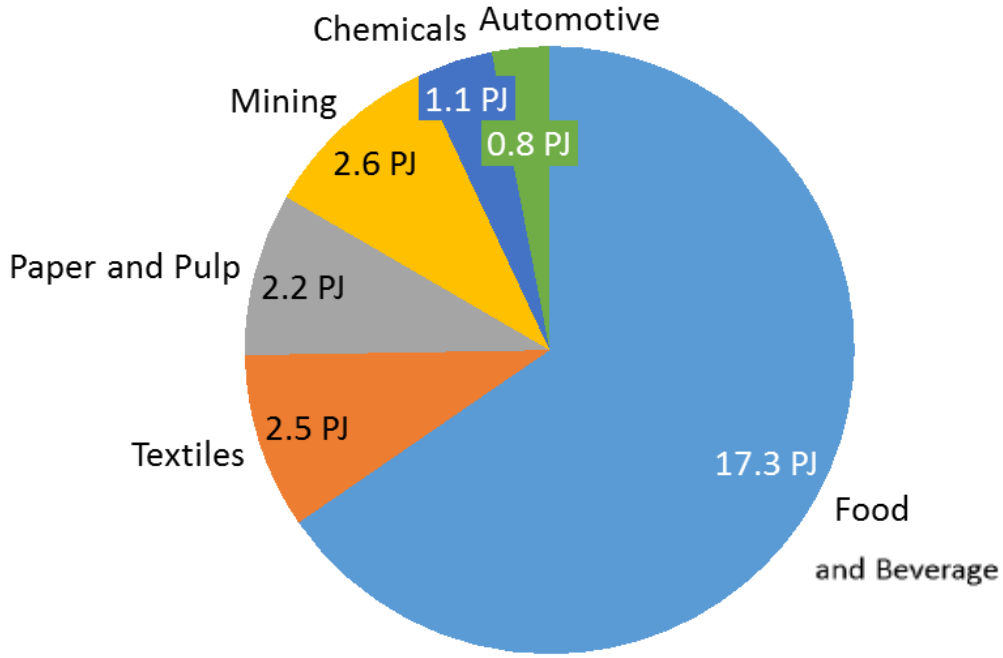


Potential Study Results
Distribution of steam boilers in target industries

- Steam from centralised boiler is used extensively in as the heat transfer fluid heating applications below 400 ^{o}C
- Good indicator of potential demand for SHIP potential in target sectors
- Conservative demand from package boilers of 26.5 PJ steam demand (35.3 PJ input energy)

gamasemesta.com

Steam boiler analysis (26.5 PJ)



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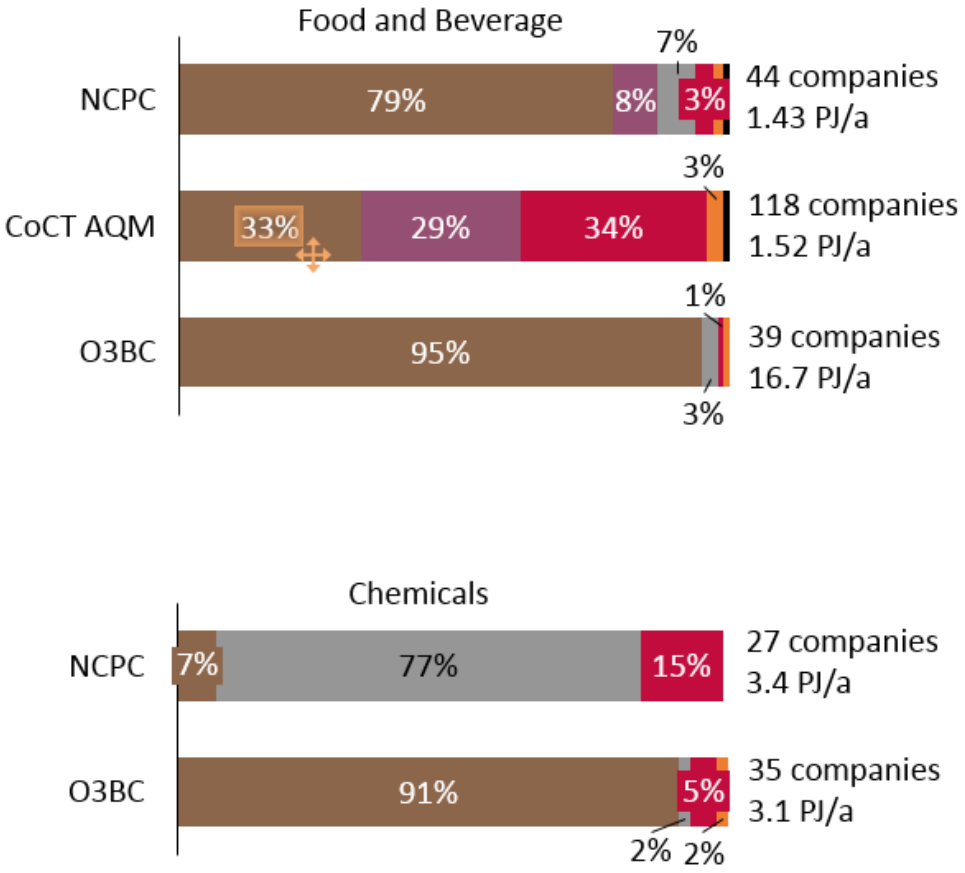
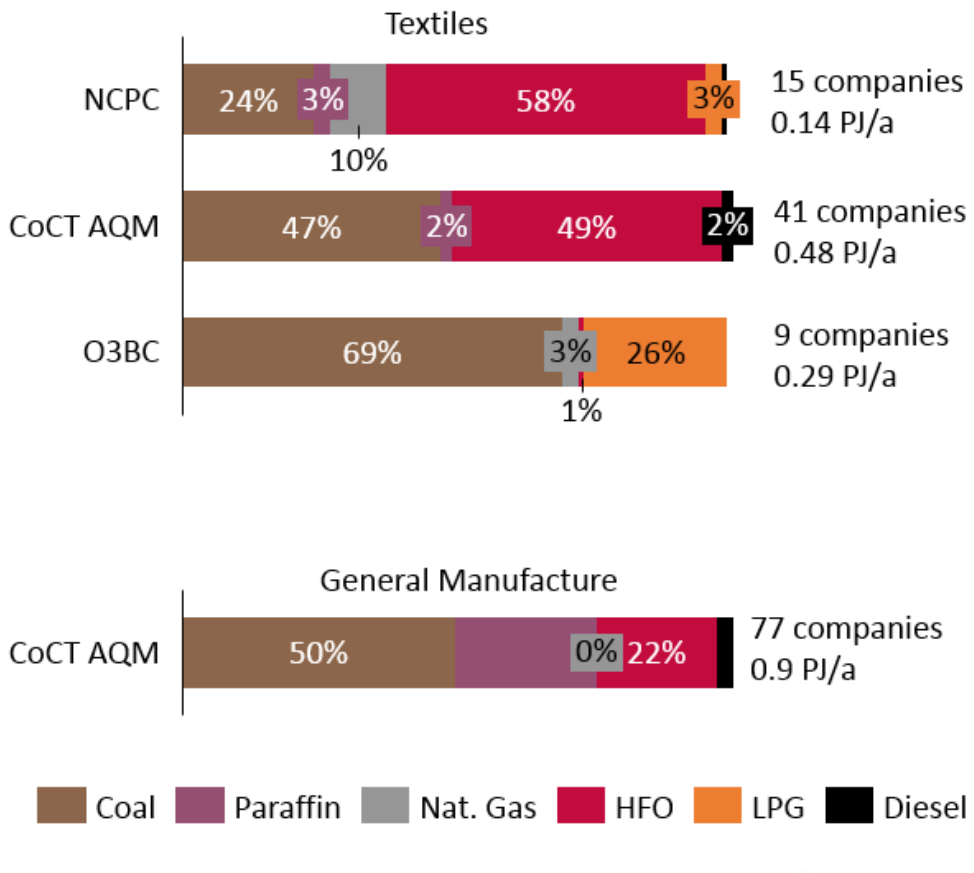
Potential Study Results
Energy sources in target industries





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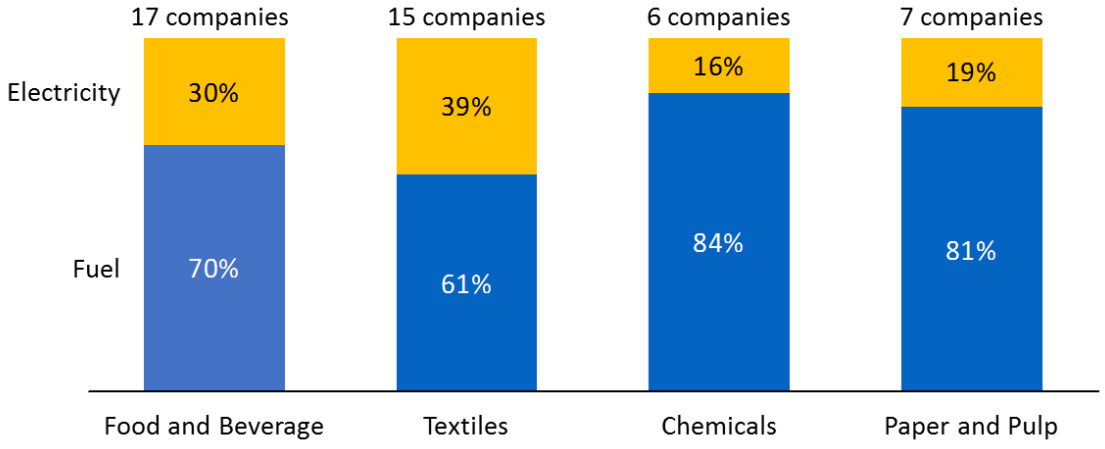
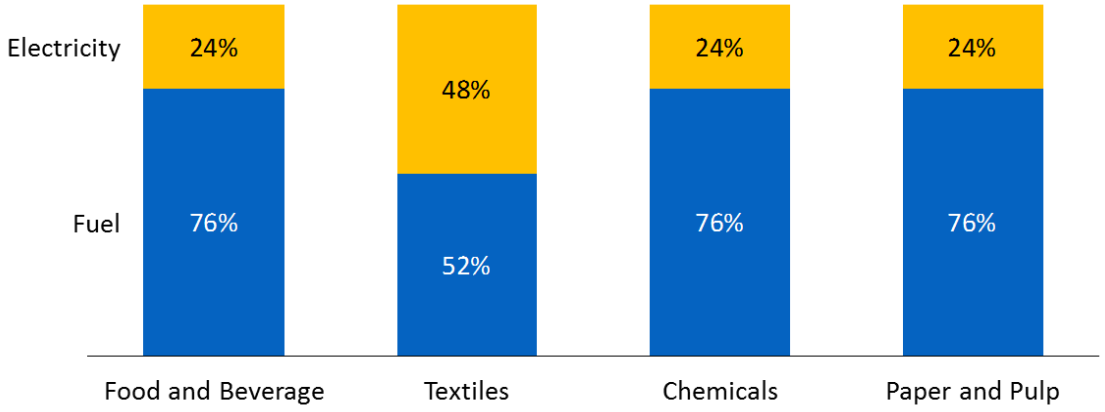
Potential Study Results
Final energy consumption fuel vs electricity

NCPC audit data



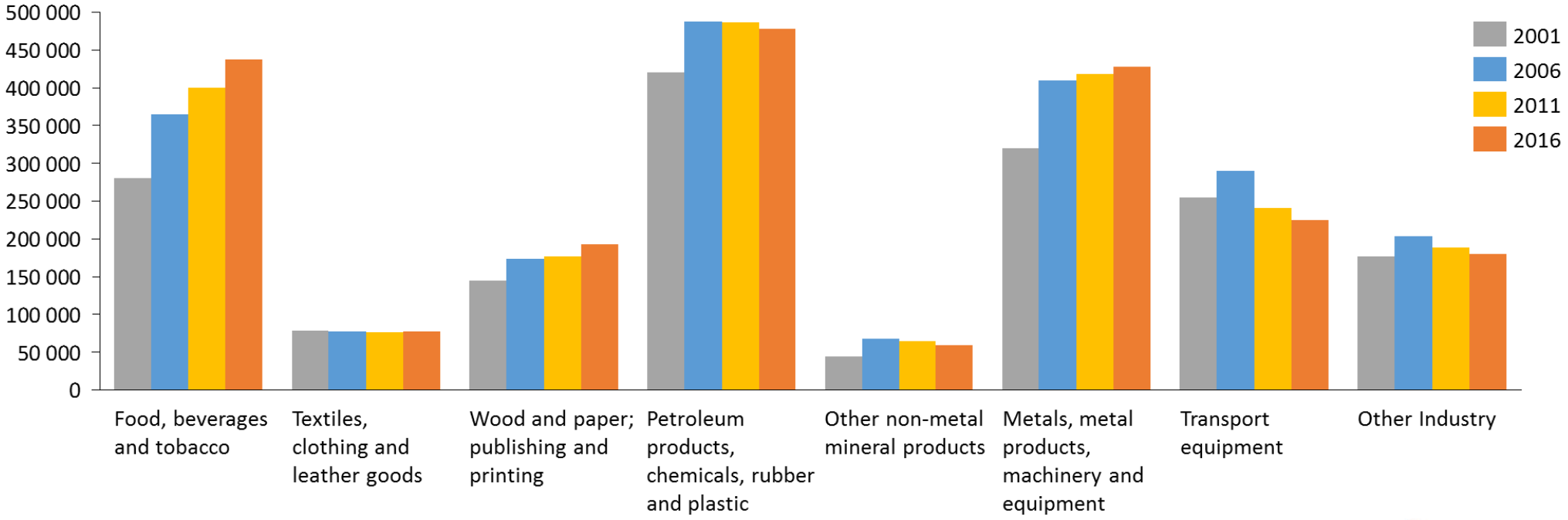
IRENA data



- Energy is predominantly consumed as fuel (mostly coal)
- Therefore need to decarbonize more than just electricity
- Ratio between fuel and electricity is consistent with international data from IRENA

Study Results: Industry Structure

Potential Study Results
Real manufacturing output (2016 million ZAR) in South Africa



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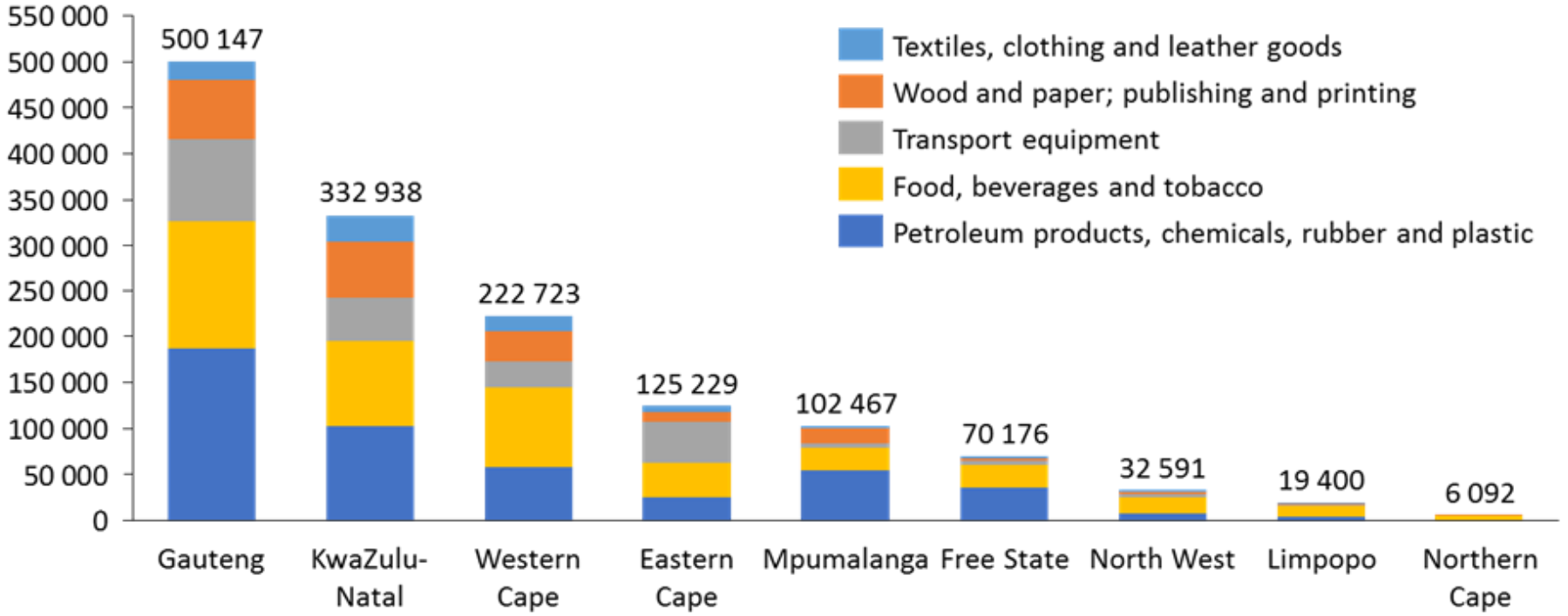
Potential Study results
Regional breakdown of output as proxy for heat demand



Regional breakdown of output for relevant SHIP industries (2016 million ZAR): Source Easy Data

Potential Study Results
Number of companies in active target sectors

Industry Sector	SIC Code	Output* (million R)	Number of Companies		
			StatsSA	SETA**	O_3BC
Food, beverages and tobacco	30	438 319	8977	1892	1149
Clothing, textiles, leather goods	31	78 297	6495	874	1730
Wood and paper; publishing and printing	32	193 201	3999	2376	Not Available
Petroleum products, chemicals, rubber and plastic	33	478 053	6985	2010	1943
Transport equipment	38	223 892	10146	256 (auto)	Not Available

*Data from Quantec Easy Data [9]
**SETAs include FoodBev, Fibre Processing and Materials (FP&M) and CHIETA [9-13]

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Conclusions and Further Work

Conclusions

- Food and beverage has highest SHIP potential in South Africa
  - large number of international case studies in sector
  - largest number of boilers installed in SA (17.3 PJ annual demand steam)
  - showing sustained economic growth
  - Large number of companies active (although high industry concentration)

- Low cost of coal presents challenge to economic adoption of SHIP
- Economic uncertainty plays a major role in companies decisions to implement SHIP
- Financing larger systems difficult (too small project finance, companies reluctant to put on balance sheet)
- Need for innovative models e.g. Heat ESCOs

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