Renewable Heating and Cooling

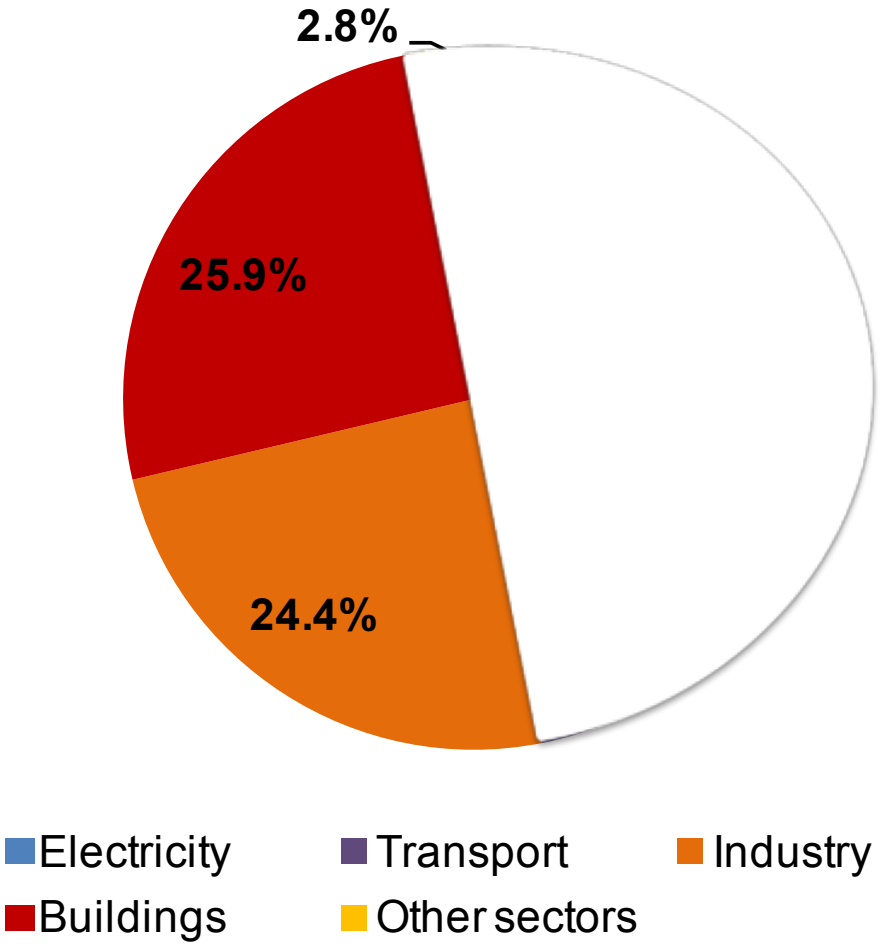
Abundant solutions for buildings and industrial applications

Werner Weiss

AEE - Institute for Sustainable Technologies (AEE INTEC)
A-8200 Gleisdorf, Feldgasse 19
AUSTRIA

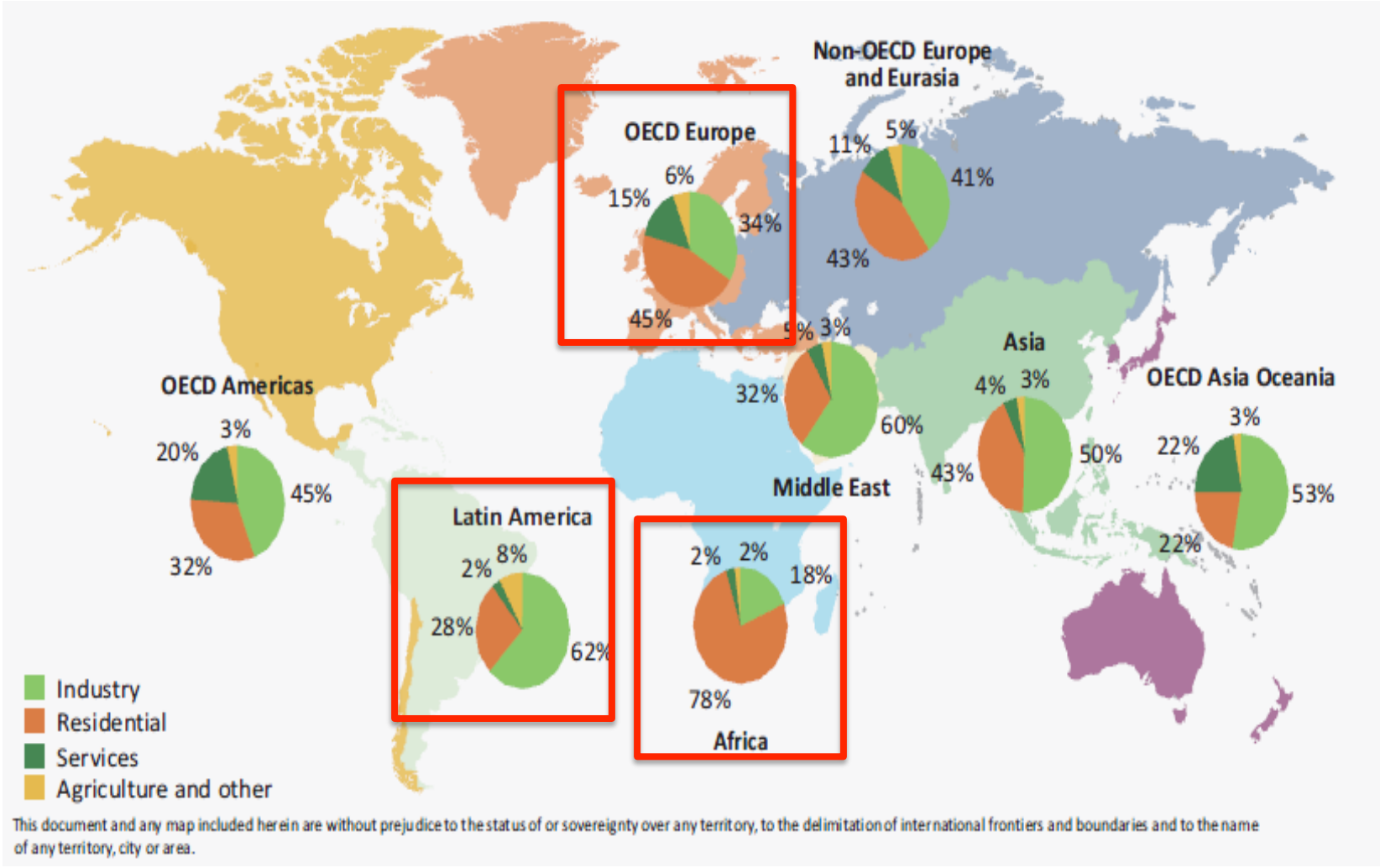
Total Final Energy Consumption Worldwide

World total final energy consumption, 2011 (322 EJ)



Source: Paolo Frankl, IEA, Paris

Heat plays important role worldwide



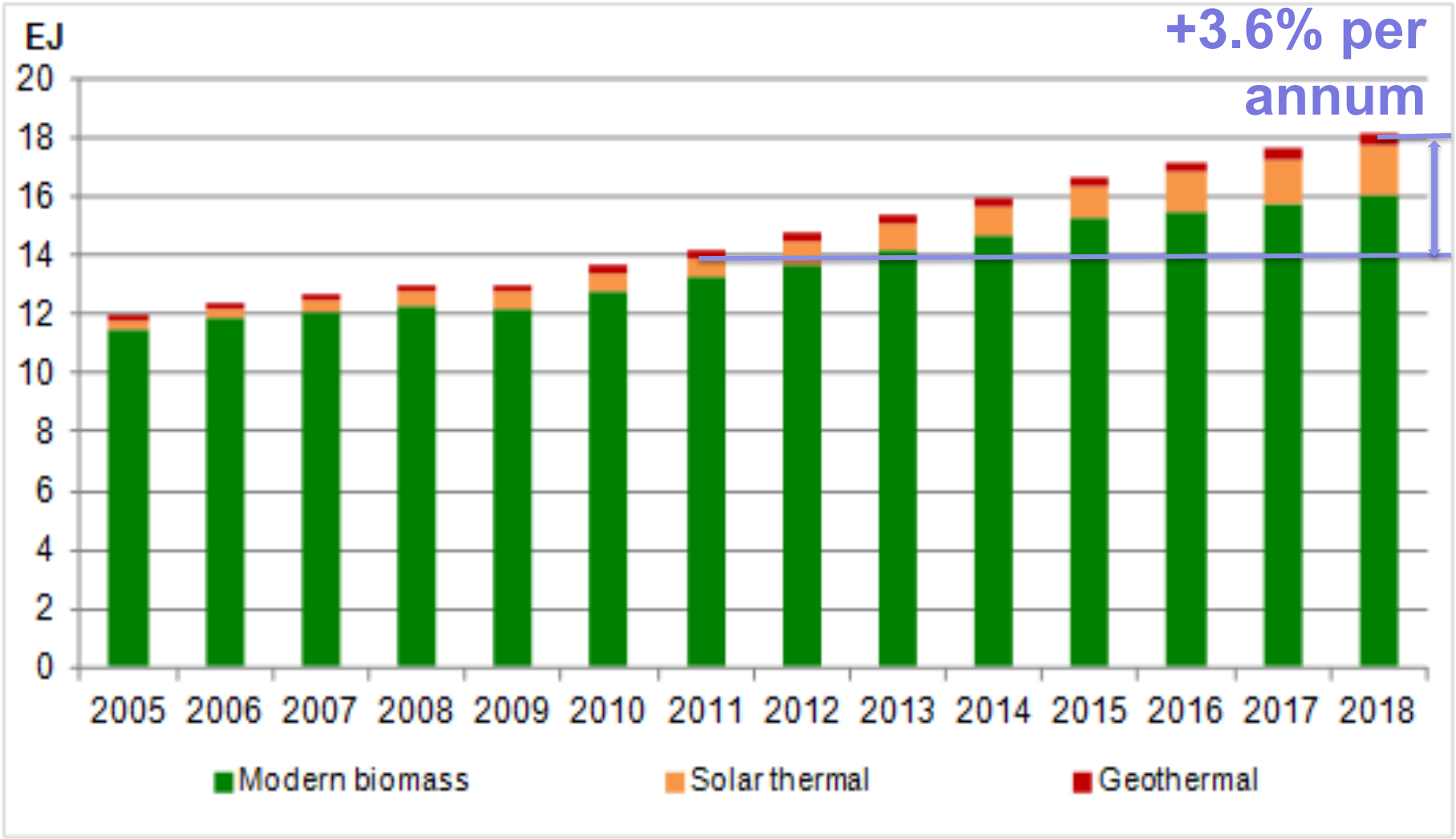
Note: Figure based on 2009 data

Source: Energy Technology Perspectives 2012


The Future of
Heating and Cooling?

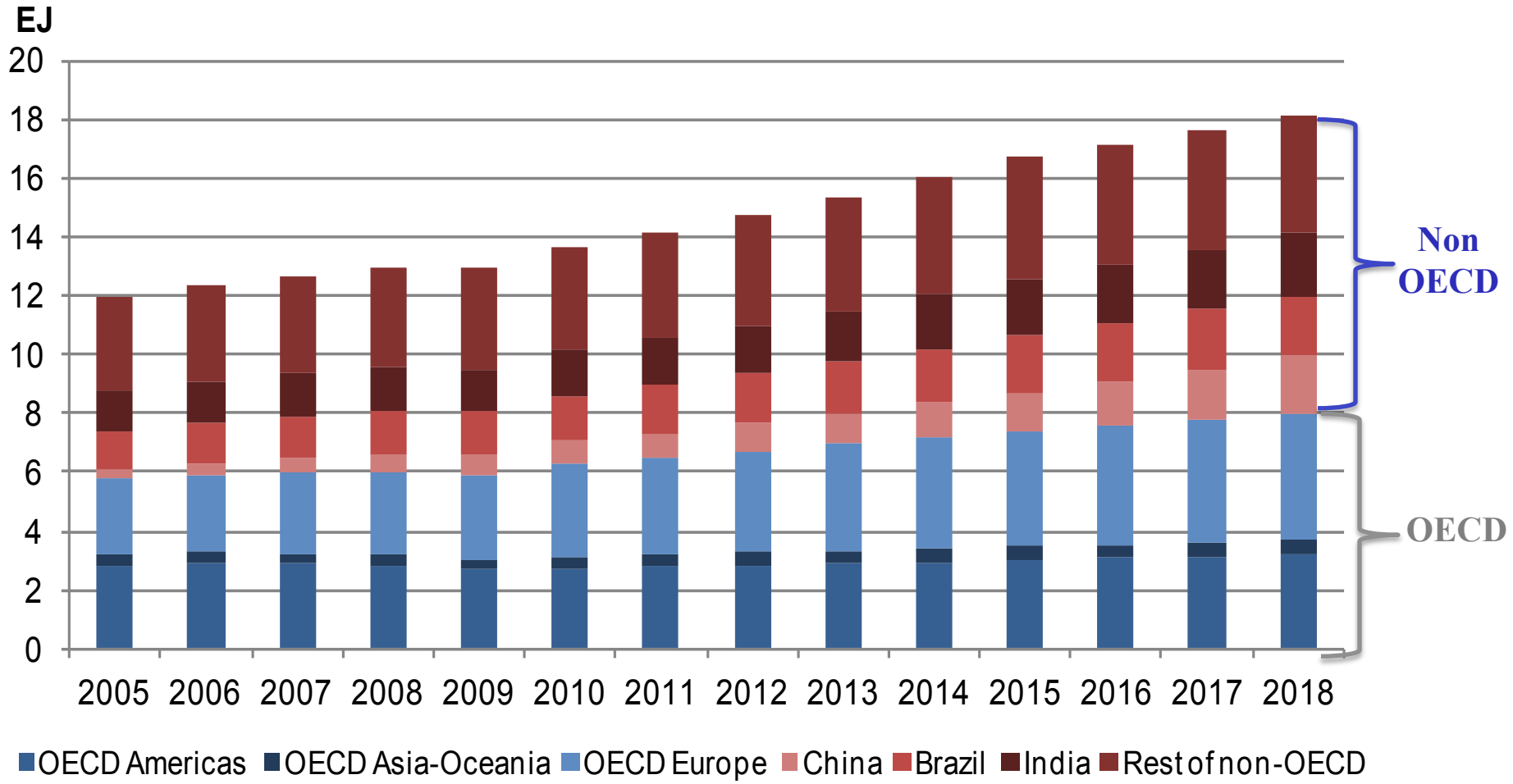
Global Final Energy Use of Renewable Sources for Heat

(including commercial heat)



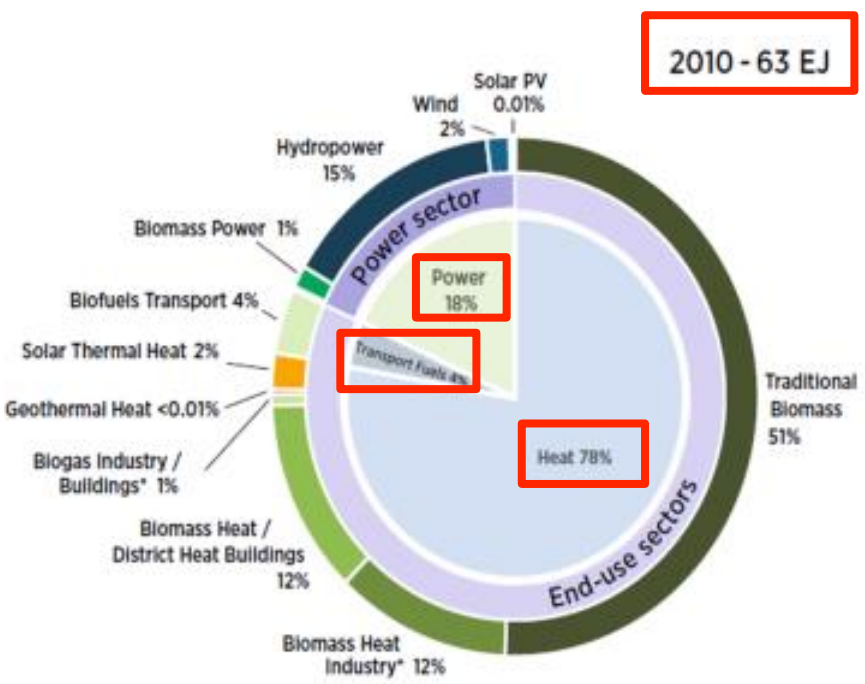
Source: IEA Medium-term Renewable Energy Market Report, 2013

Global Final Energy Use of Renewable Sources for Heat and Projection (Incl. commercial heat)



Source: IEA Medium-term Renewable Energy Market Report, 2013

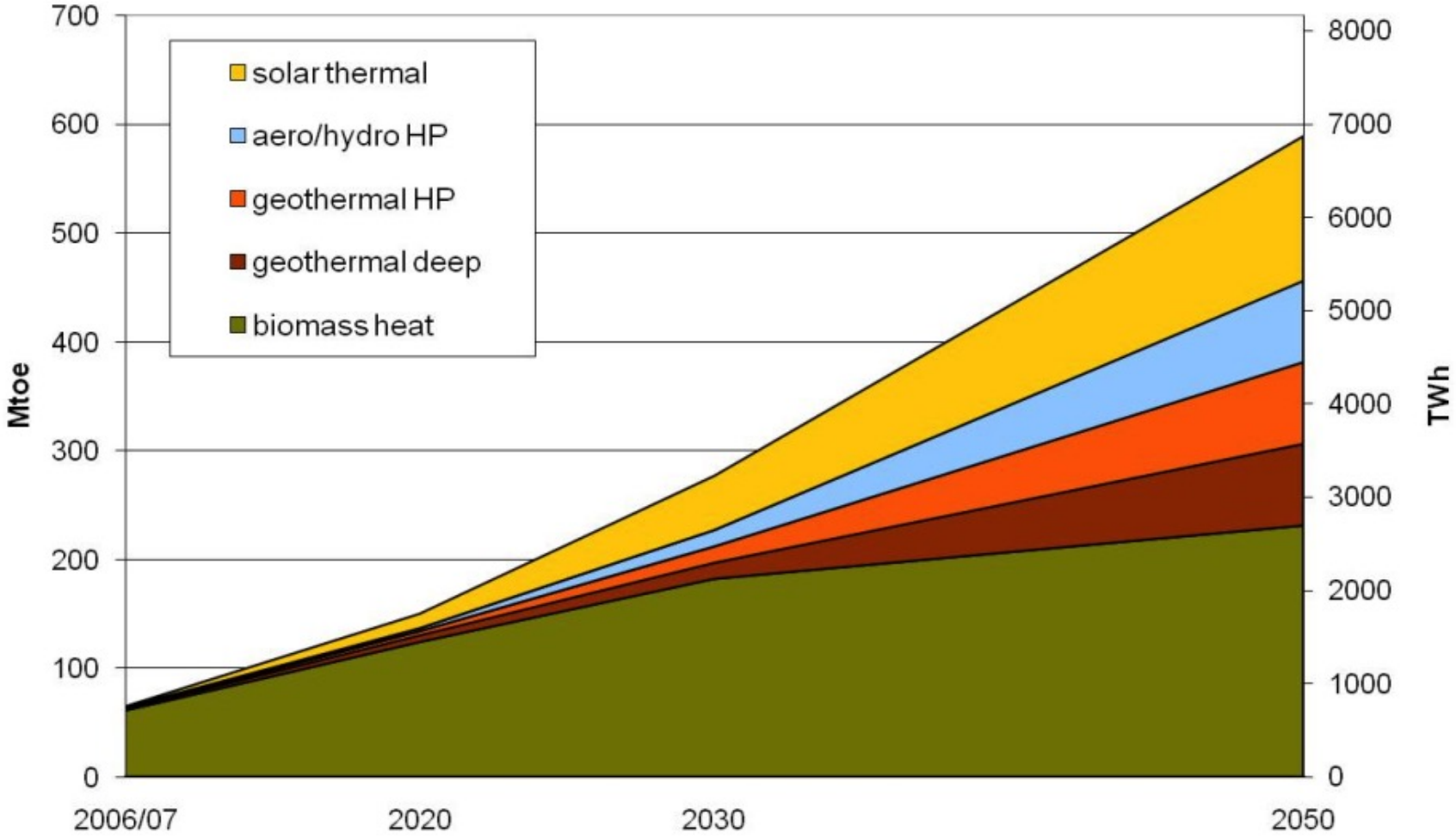
Global renewable energy use by technology and sector, 2010 and in REmap 2030



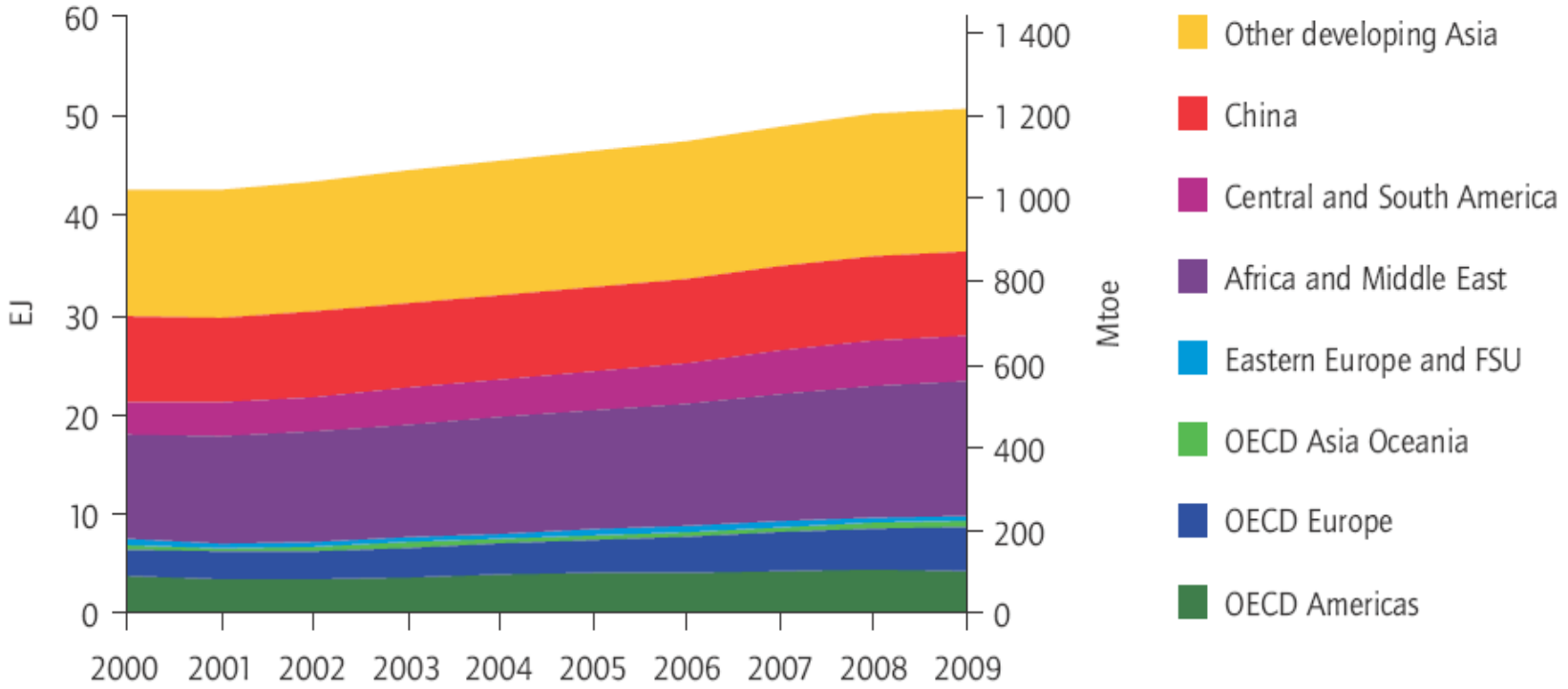
REmap 2030 estimates a total renewable energy use share of 36% for power and 64% for the end-use sectors, including traditional use of biomass. When traditional use of biomass is excluded, the *shares of power and the end-use sectors are 40% and 60%, respectively*

Source: IRENA International Renewable Energy Agency; REmap 2030 A Renewable Energy Roadmap

Potential of RES for Heating and Cooling in Europe

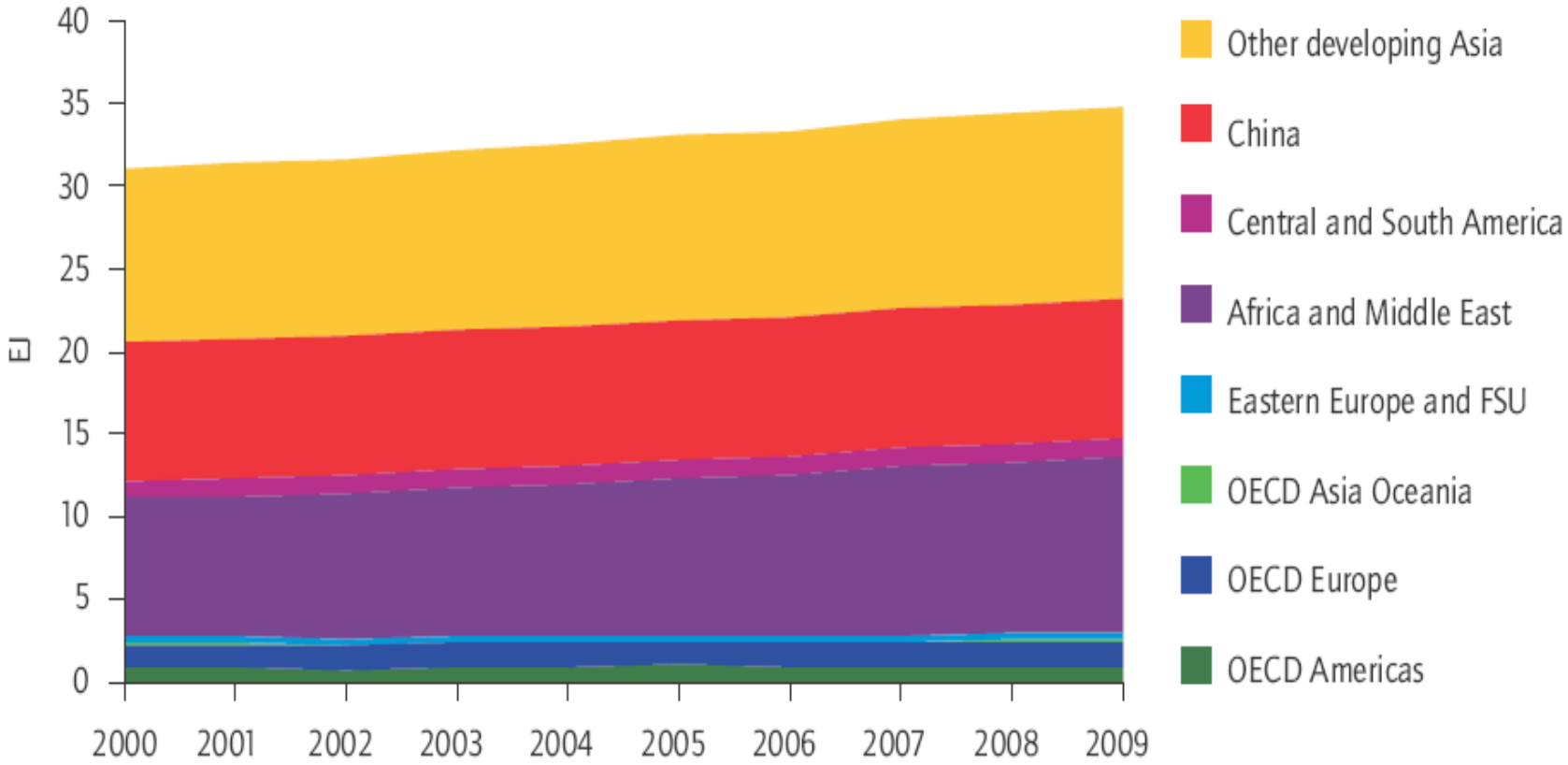


Global primary bioenergy supply 2000 -2009



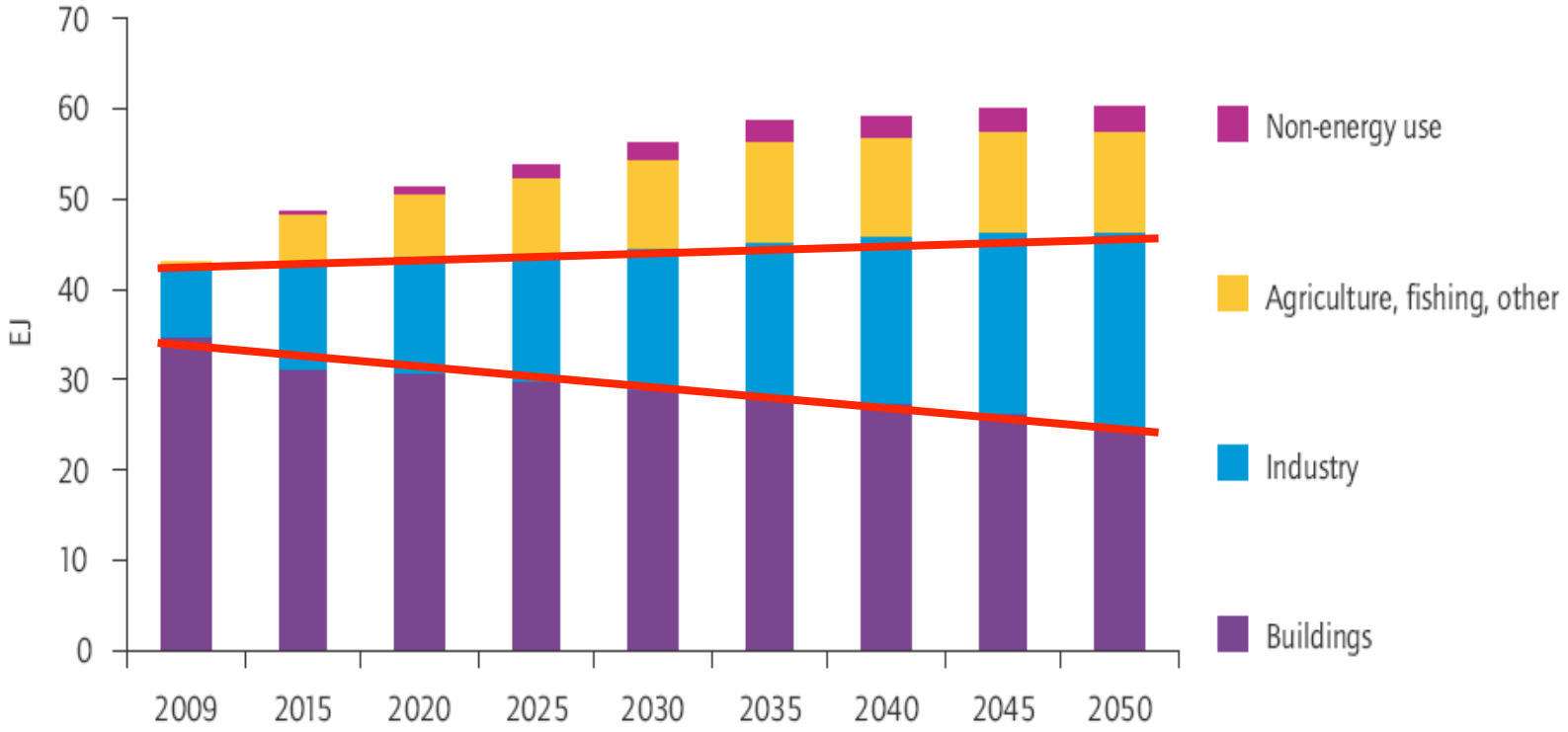
Source IEA, 2012: Technology Roadmap – Bioenergy for Heat and Power

Total final bioenergy consumption in buildings



Source IEA, 2012: Technology Roadmap – Bioenergy for Heat and Power

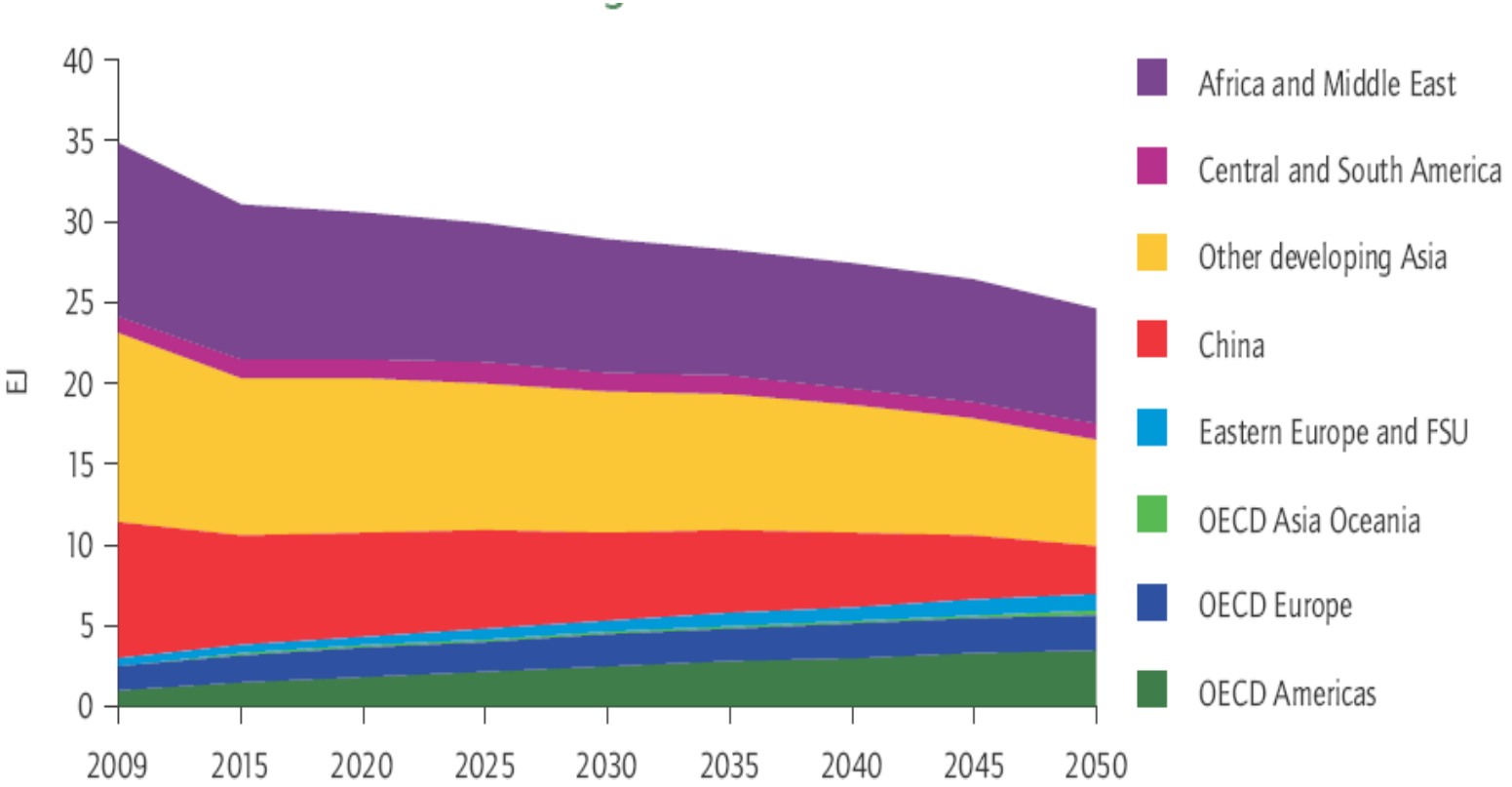
Roadmap vision of world final bioenergy consumption



Note: Bioenergy use in the buildings sector is for both heating and cooking. Demand for transport fuels is not shown here since this has been discussed in a previous roadmap (IEA, 2011b).

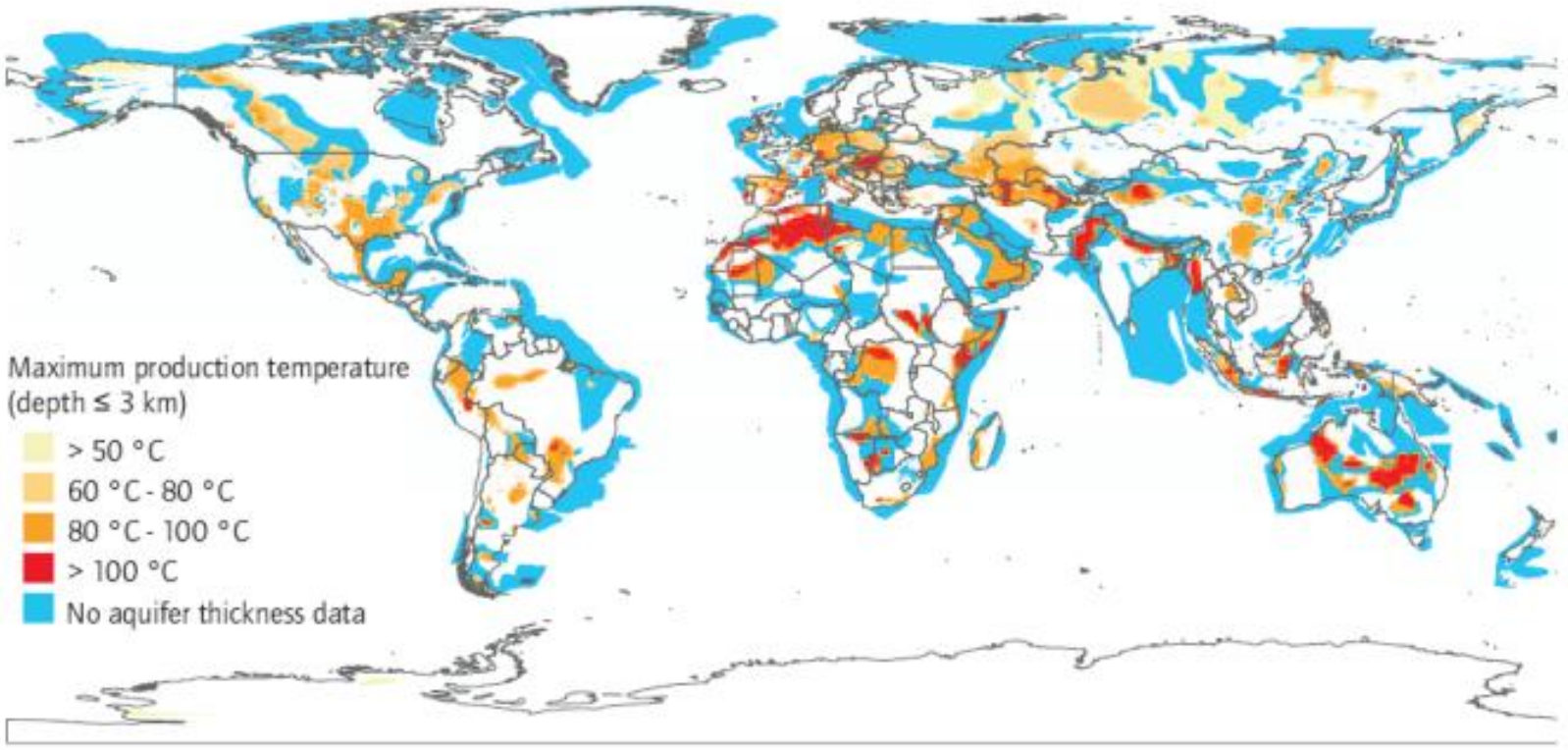
Source IEA, 2012: Technology Roadmap – Bioenergy for Heat and Power

Final bioenergy consumption in the building sector



Source IEA, 2012: Technology Roadmap – Bioenergy for Heat and Power

World map of deep aquifer systems

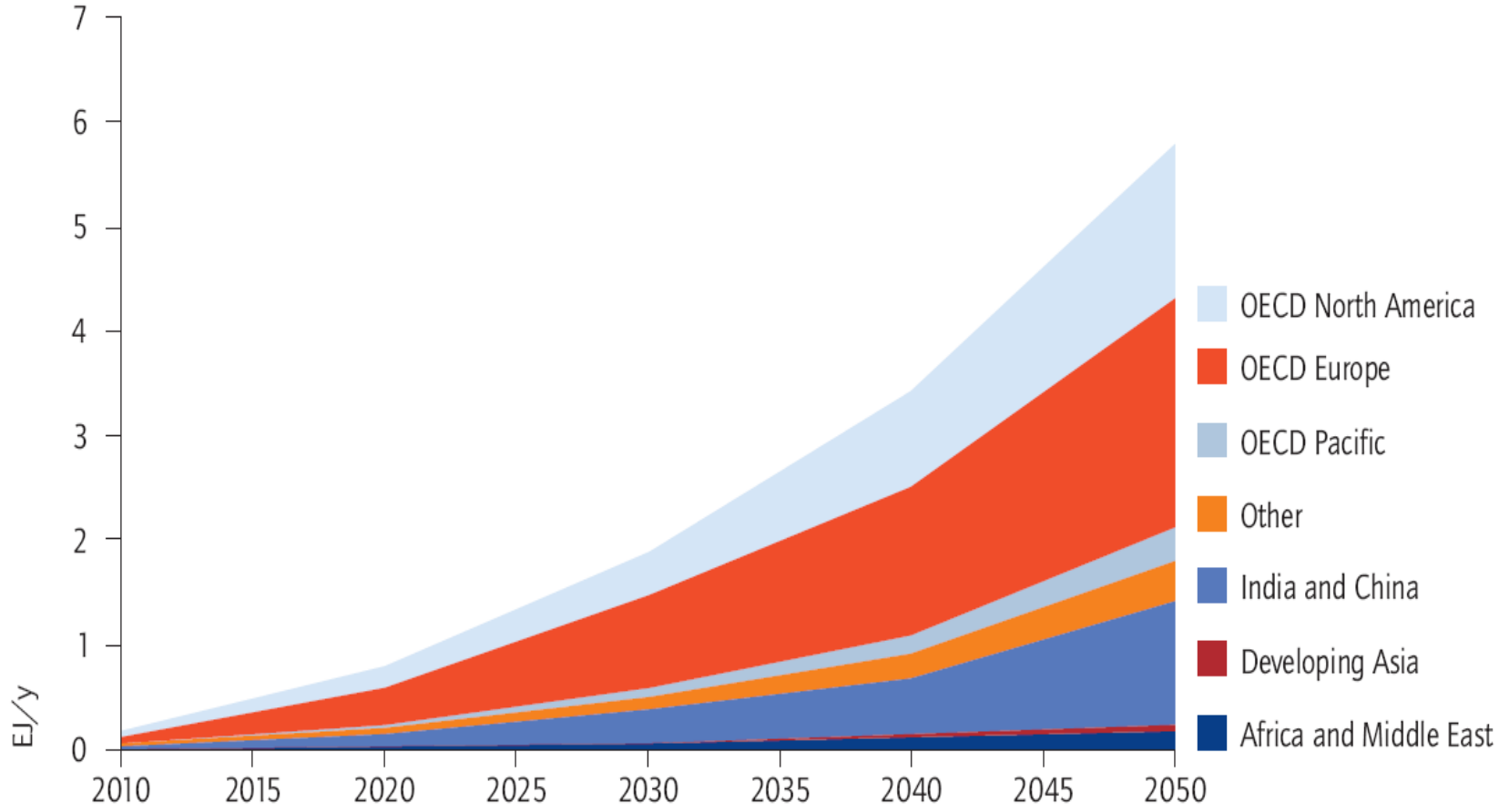


Note: World map of deep aquifer systems modified from (Penwell, 1984). Overlain are expected average production temperatures for a depth interval starting at excess temperatures of 40°C relative to surface, and ranging to a maximum depth of 3 km. The map is based on heat flow data from Artemieva (2006) and sediment thickness information from Laske and Martens (1997). Local performance strongly depends on natural heat flow conditions and surface temperature.

Source: TNO, www.thermogis.nl/worldaquifer.

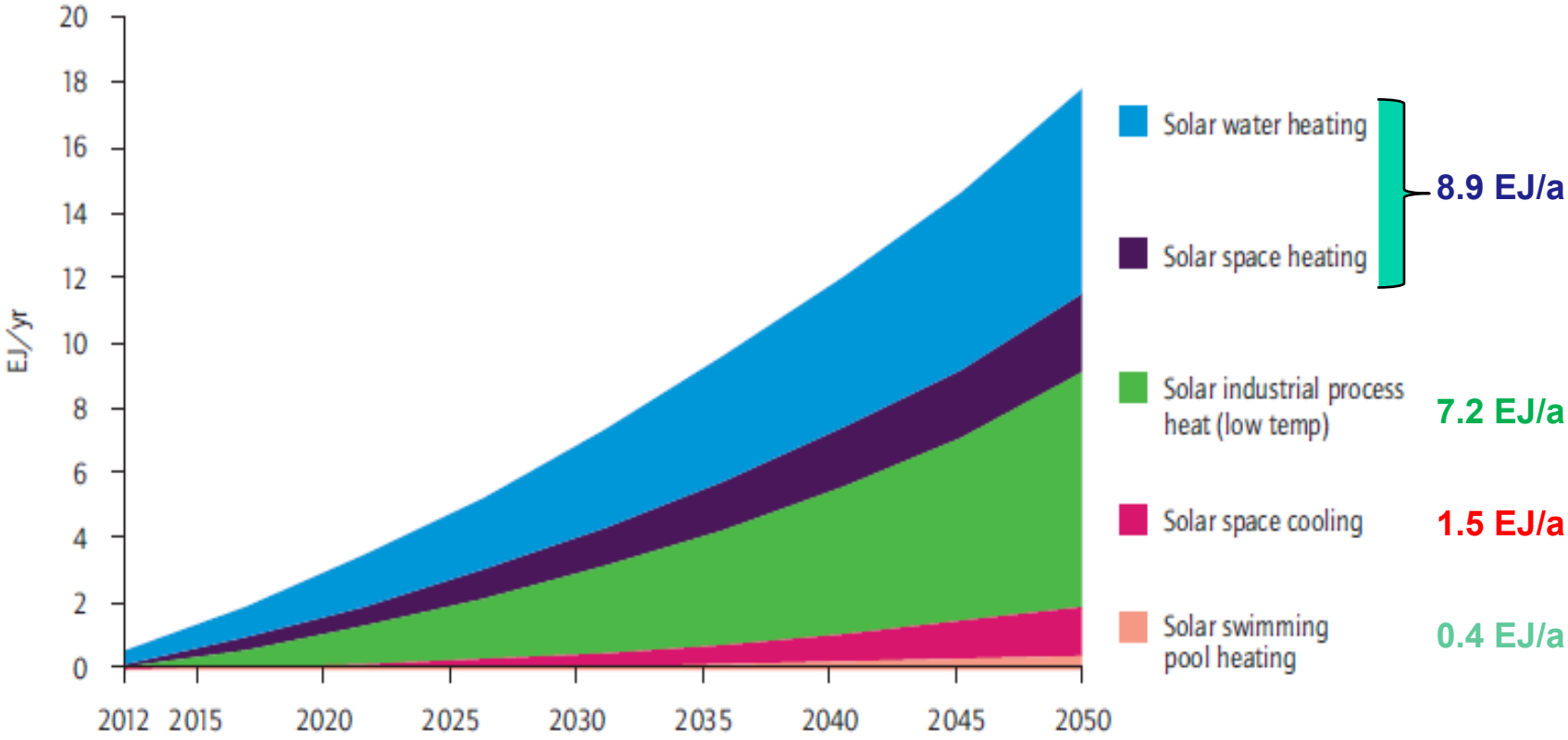
Source IEA, 2012: Geothermal Technology Roadmap – Heat and Power

Roadmap vision of direct use of geothermal heat by region, excluding ground source heat pumps



Source IEA, 2012: Geothermal Technology Roadmap – Heat and Power

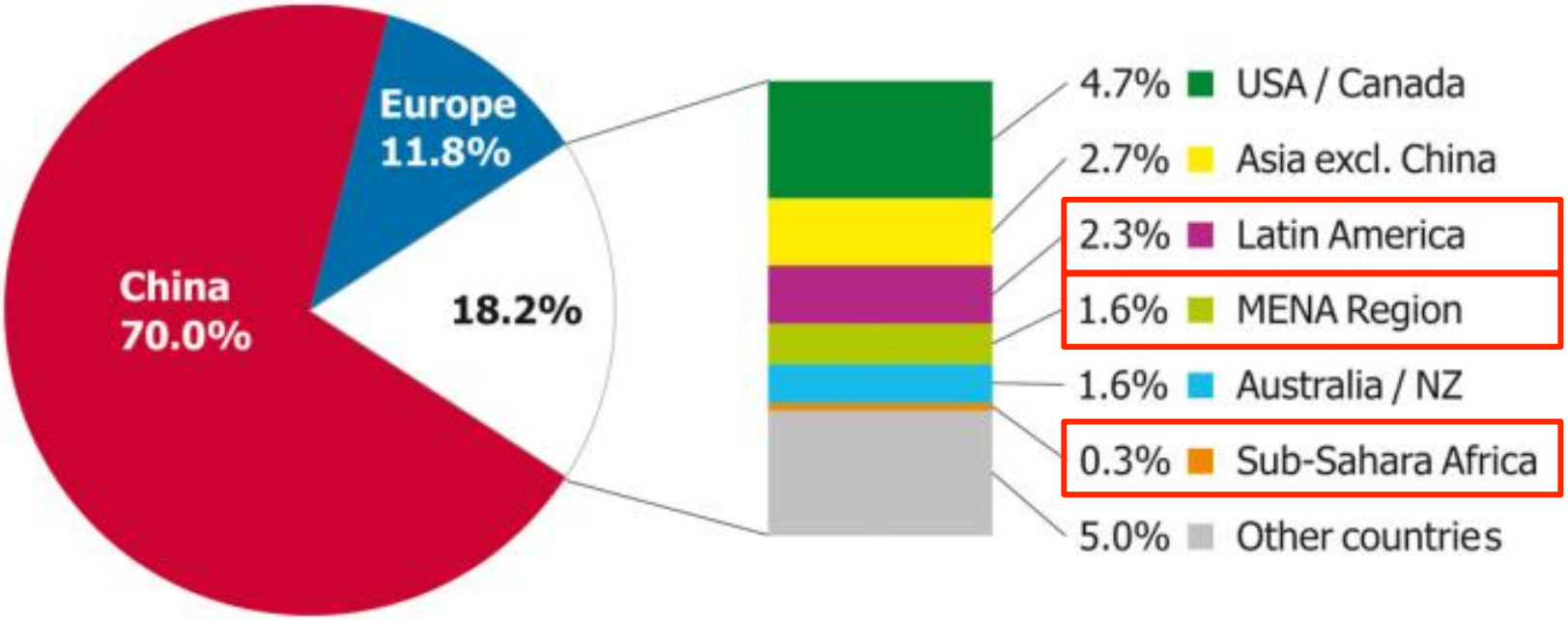
Roadmap vision - solar heating and cooling by sector



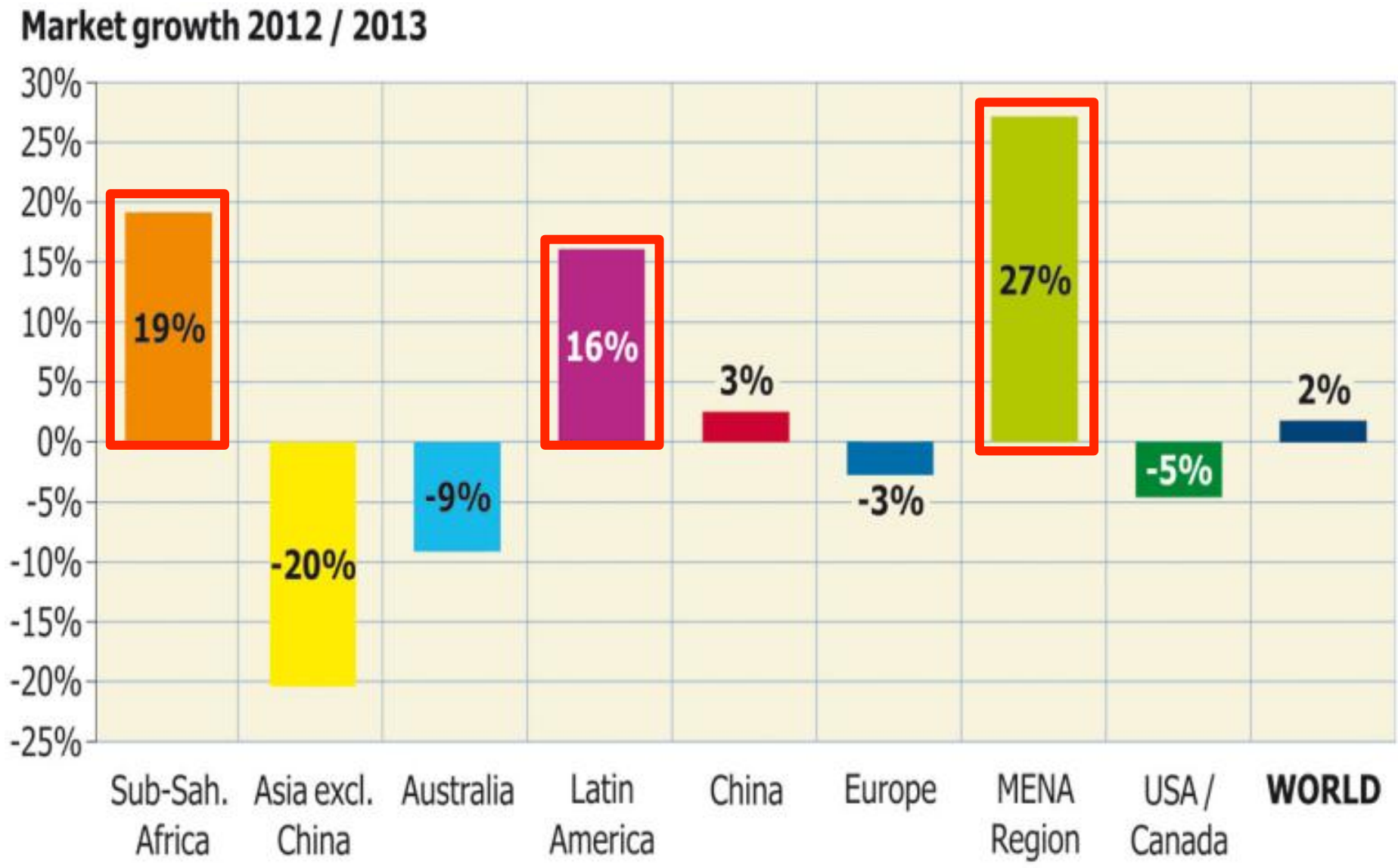
Solar heating and cooling capacity could produce annually by 2050:
- 16.5 EJ solar heat (16% of TFE low temp. heat)
- 1.5 EJ solar cooling (17% of TFE cooling)

Source IEA, 2012: Technology Roadmap – Solar Heating and Cooling

Global Solar Thermal Capacity
in Operation 2013



Market Growth




Renewable
Heating and Cooling
Technologies
www.iea-shc.org

From the three stone fire to advanced cooking stoves

http://www.ips.org/

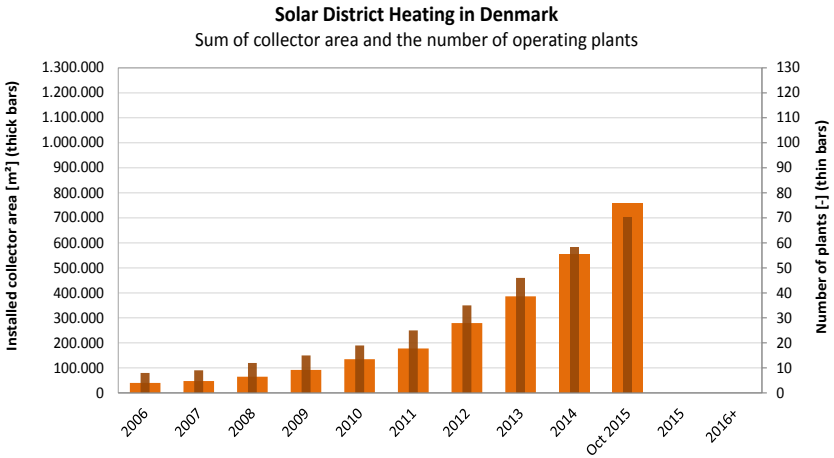
Biomass district heating or co-generation plants

Solar-assisted Biomass District Heating, Austria

Solar District Heating in Denmark

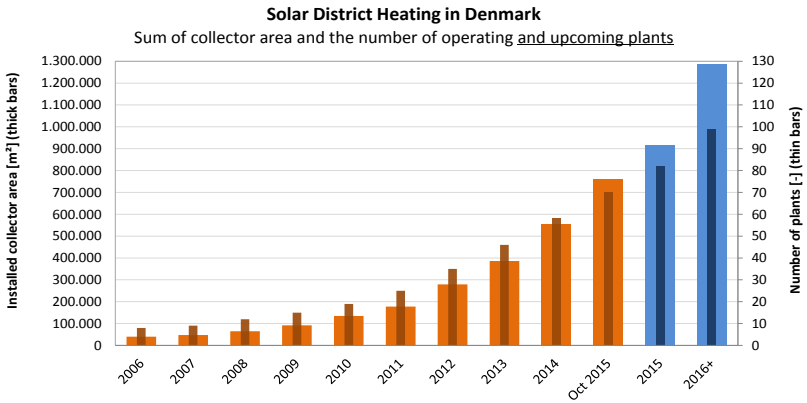
October 2015: 70 Solar District Heating Systems - 531 MW_{th} (759.000m²) in operation in Denmark

Ø system size: 10.850m² (~7 MW_{th})



End of 2016: Another 39 systems with 470 MW_{th} (672.000m²) will be installed

- *Ø system size: 17.000m² (~12 MW_{th})*



China – World leader in Thermosyphon systems

Solar Water Heating Systems

Solar Thermal Systems for hotels and hospitals

Hotel Fortina, Malta

Hammam in Attaouia, Morocco

Coffee and banana drying in Zimbabwe

Commercial Coffee Drying in Costa Rica

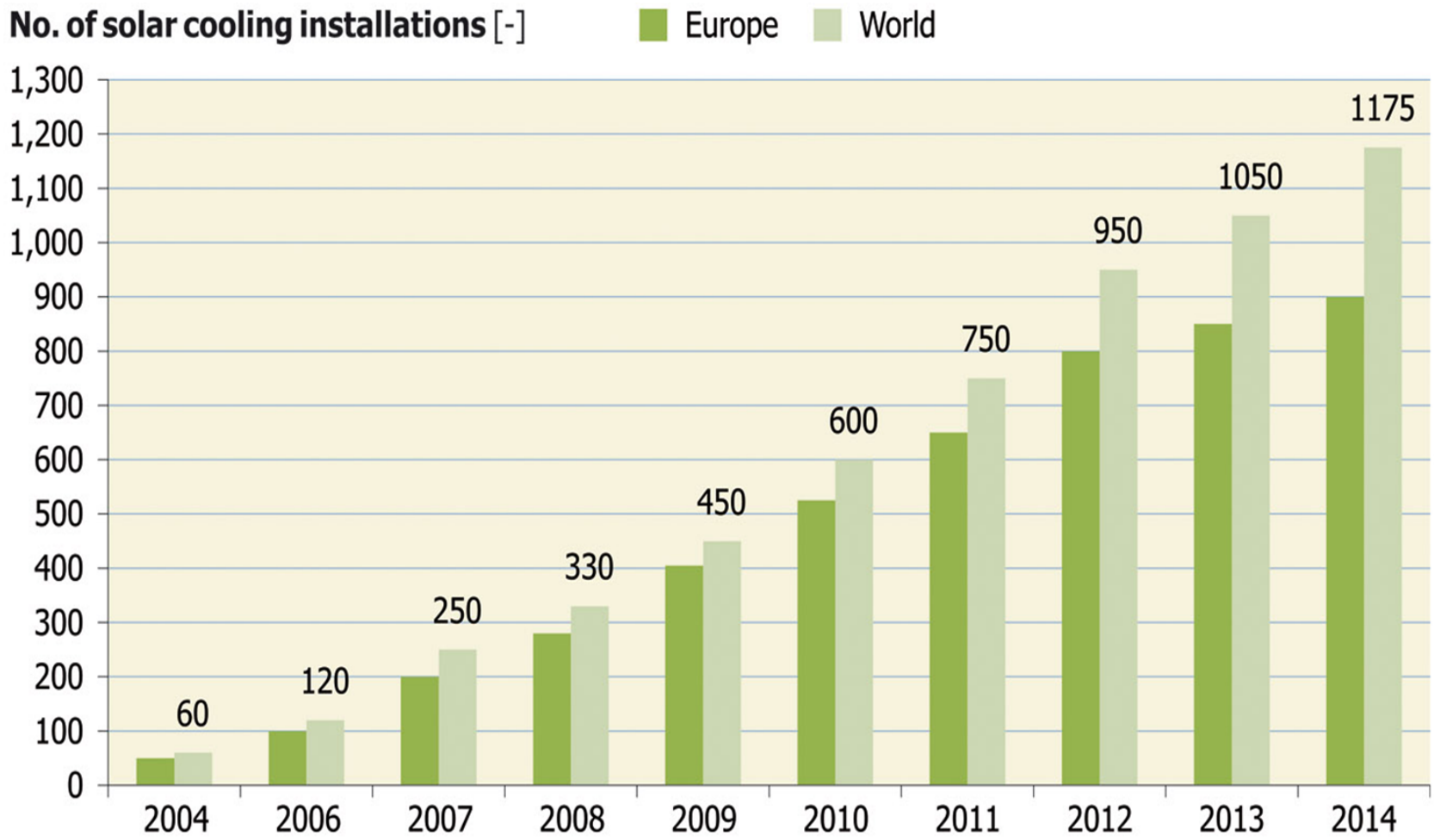
Seawater Desalination – Gran Canaria, Spain

Source: Fraunhofer ISE, Germany

Solar Water Treatment in Mozambique

Source: SoWaDis, SPF

Solar Cooling Systems in Operation



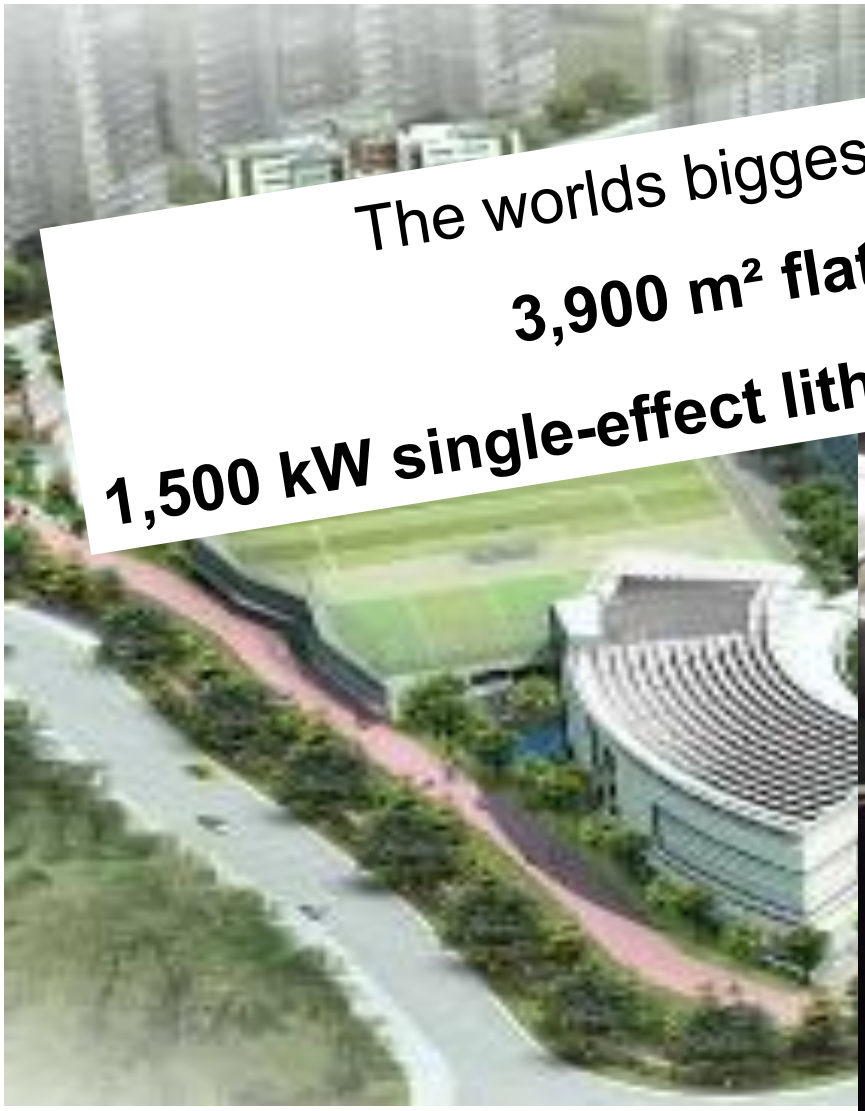
Sources: EURAC, Fraunhofer ISE, ROCOCO, Solem Consulting, Green Chiller, TecSol

The United World Colleges, Singapore

The worlds biggest solar cooling system

3,900 m² flat plate collectors

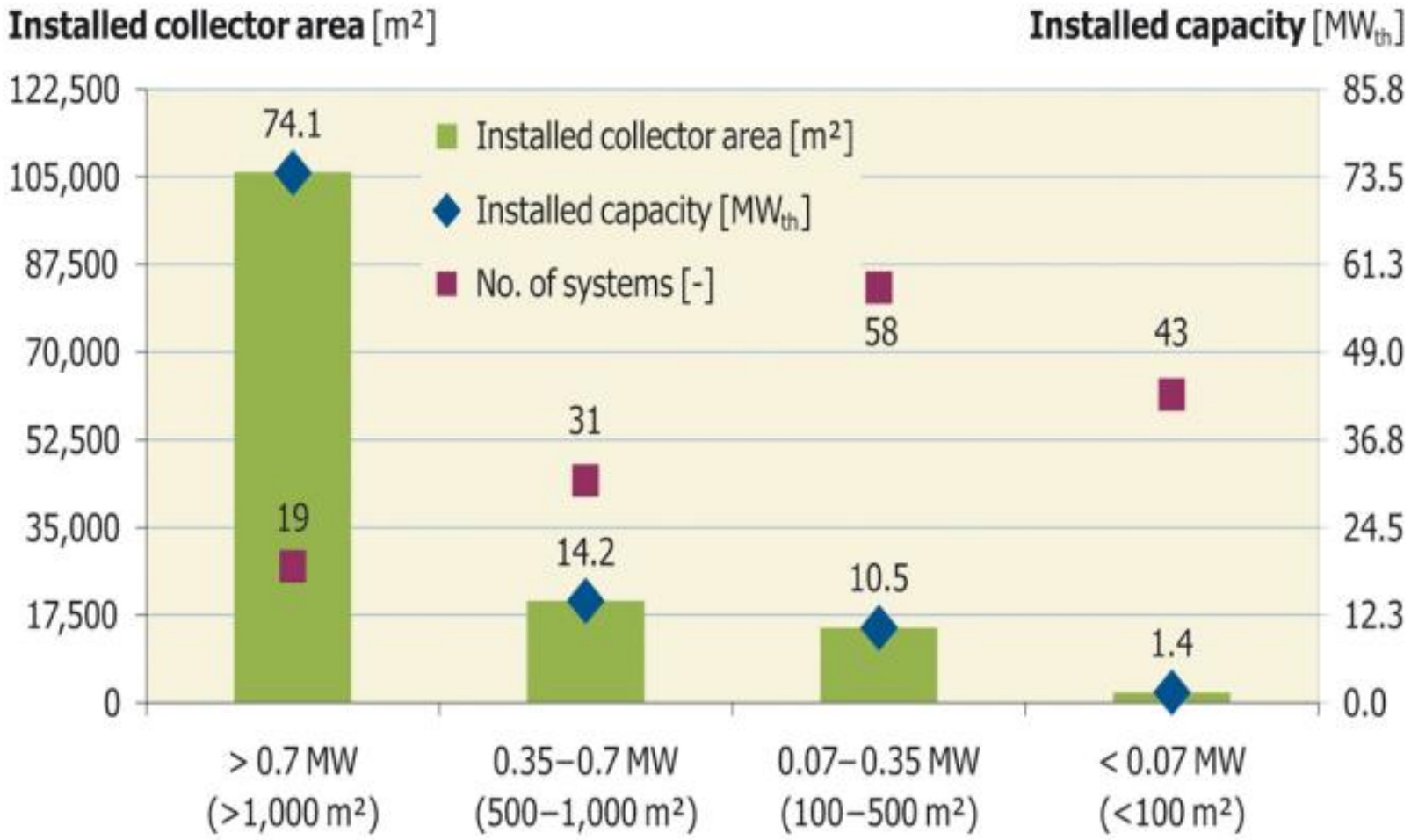
1,500 kW single-effect lithium bromide absorption chiller



Source: SOLID, Graz / Chiller: BROAD

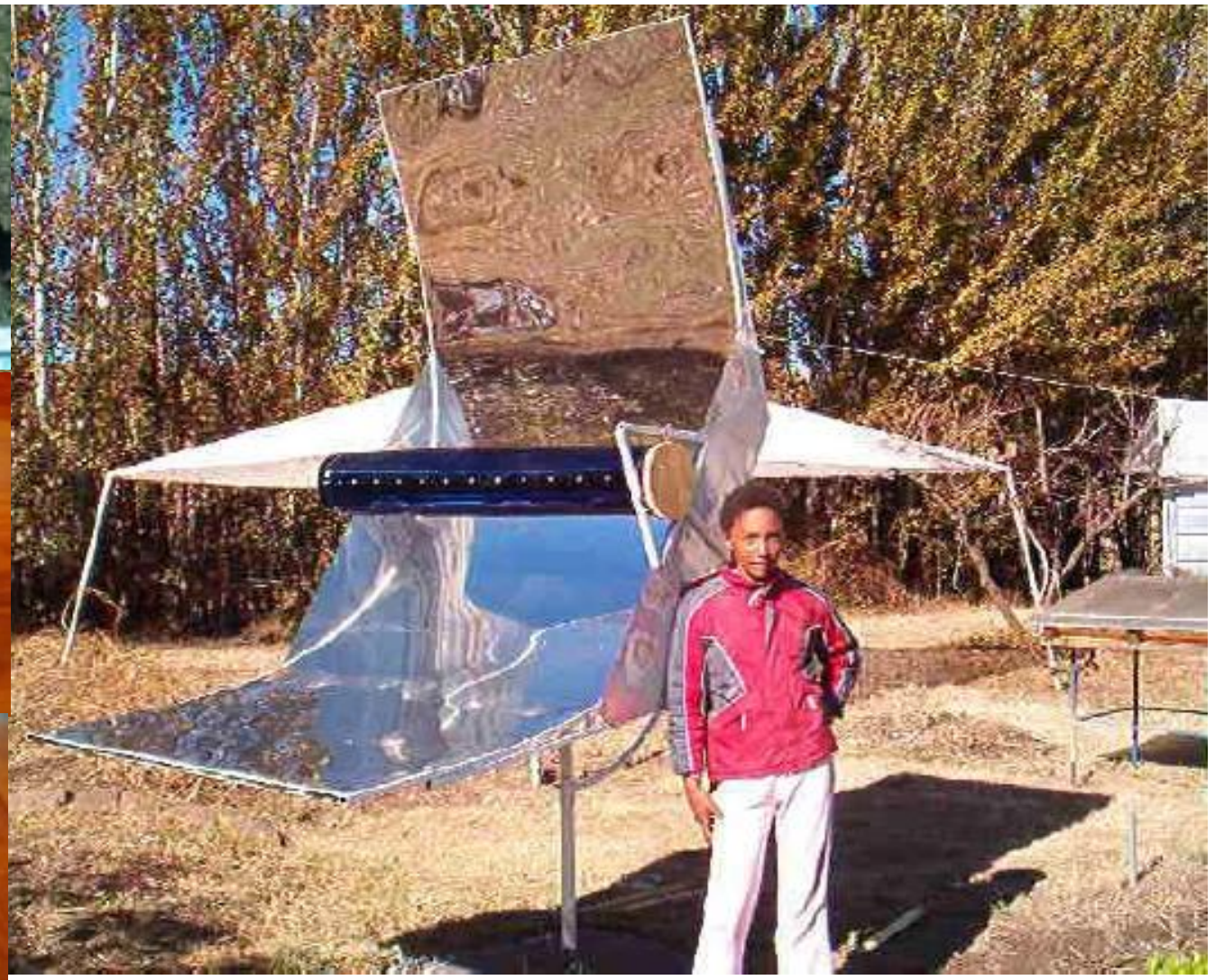
Global solar process heat applications in operation

(Status: May 2015)



Source: IEA SHC Task 49

Parabolic trough baking device in Lesotho



Source: Ivan Yaholnitsky, BBCDC

In-house type solar crop dryer in Ghana

Source: JENSEN, S.O., 2001

Drying Systems for the Leather Industry in India

Brewery, Göss, Austria

Mining

Copper Mine in Chile - 26MW$_{th}$

Copper Mine "Gabriela Mistral", Chile 26MW$_{th}$ (39,300 m²)

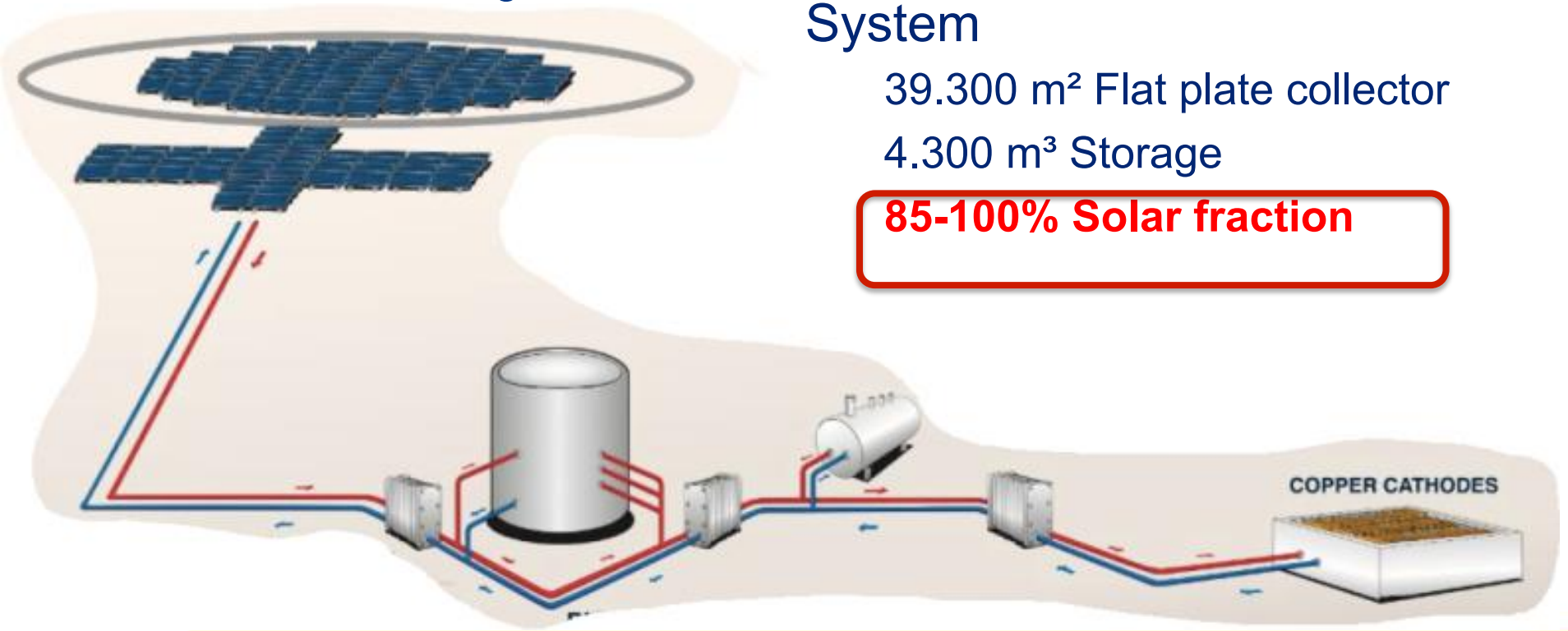
- **Process**
  - ⇨ Electro winning of copper
  - ⇨ Electrolyte is kept on a constant Temp. of 50 °C
  - ⇨ Cleaning Processes

System

39.300 m² Flat plate collector

4.300 m³ Storage

85-100% Solar fraction



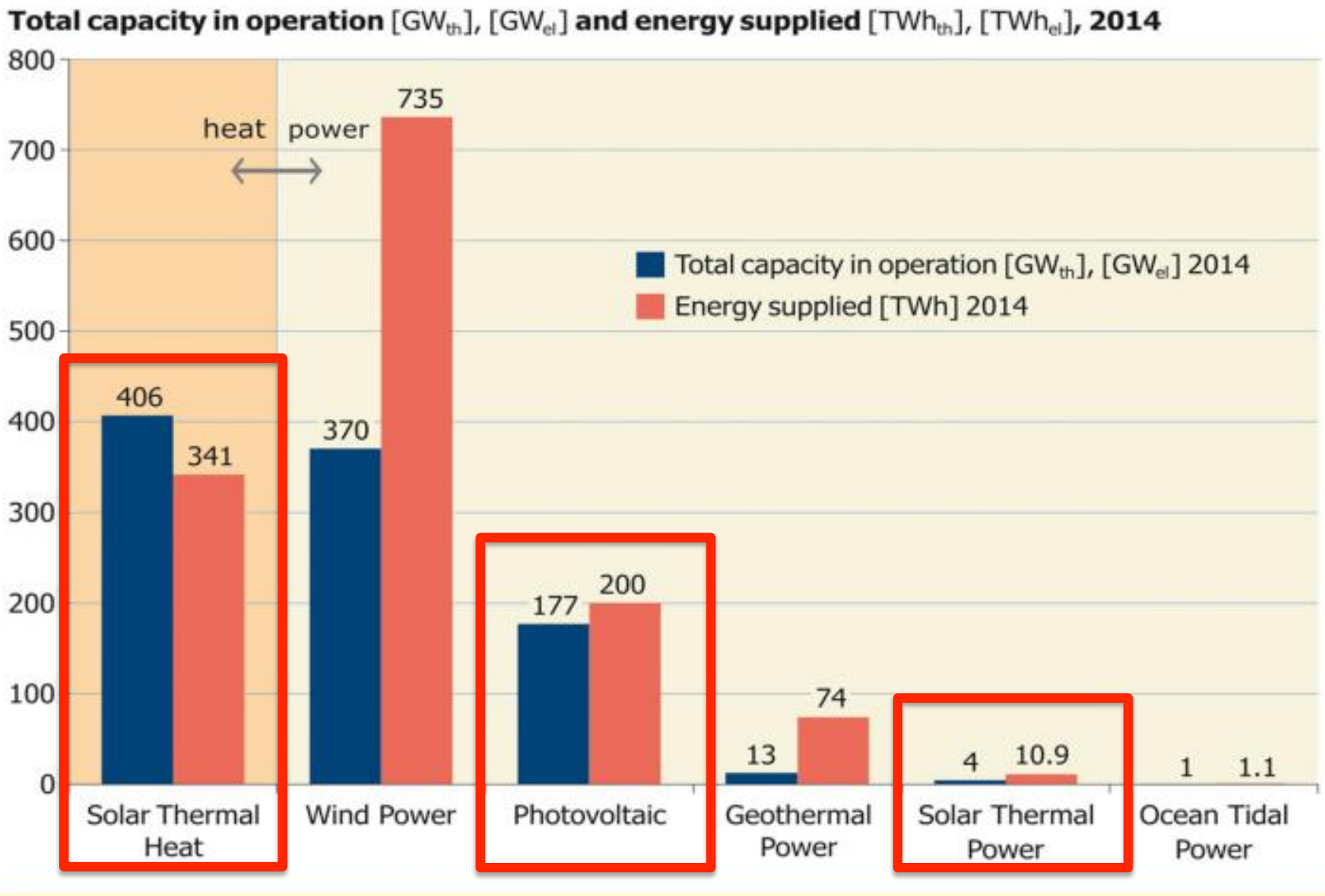
Source: SUNMARK and IEA SHC Task 49

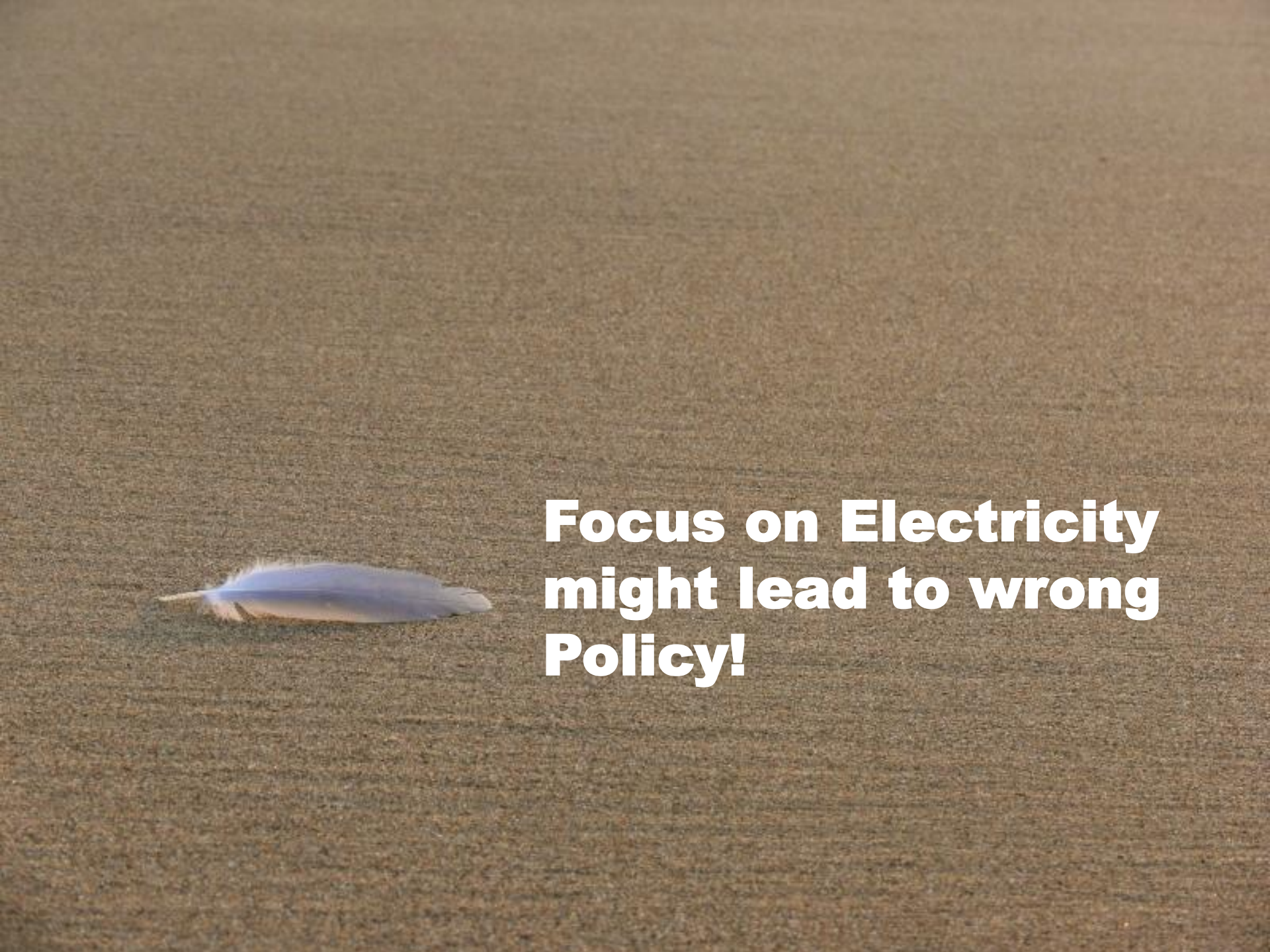
Copper Mine “Gabriela Mistral”, Chile
26MW$_{th}$ (39,300 m²)

Source: SUNMARK

Copper Mine “Gabriela Mistral”, Chile

Status - New Renewables 2014




Focus on Electricity might lead to wrong Policy!

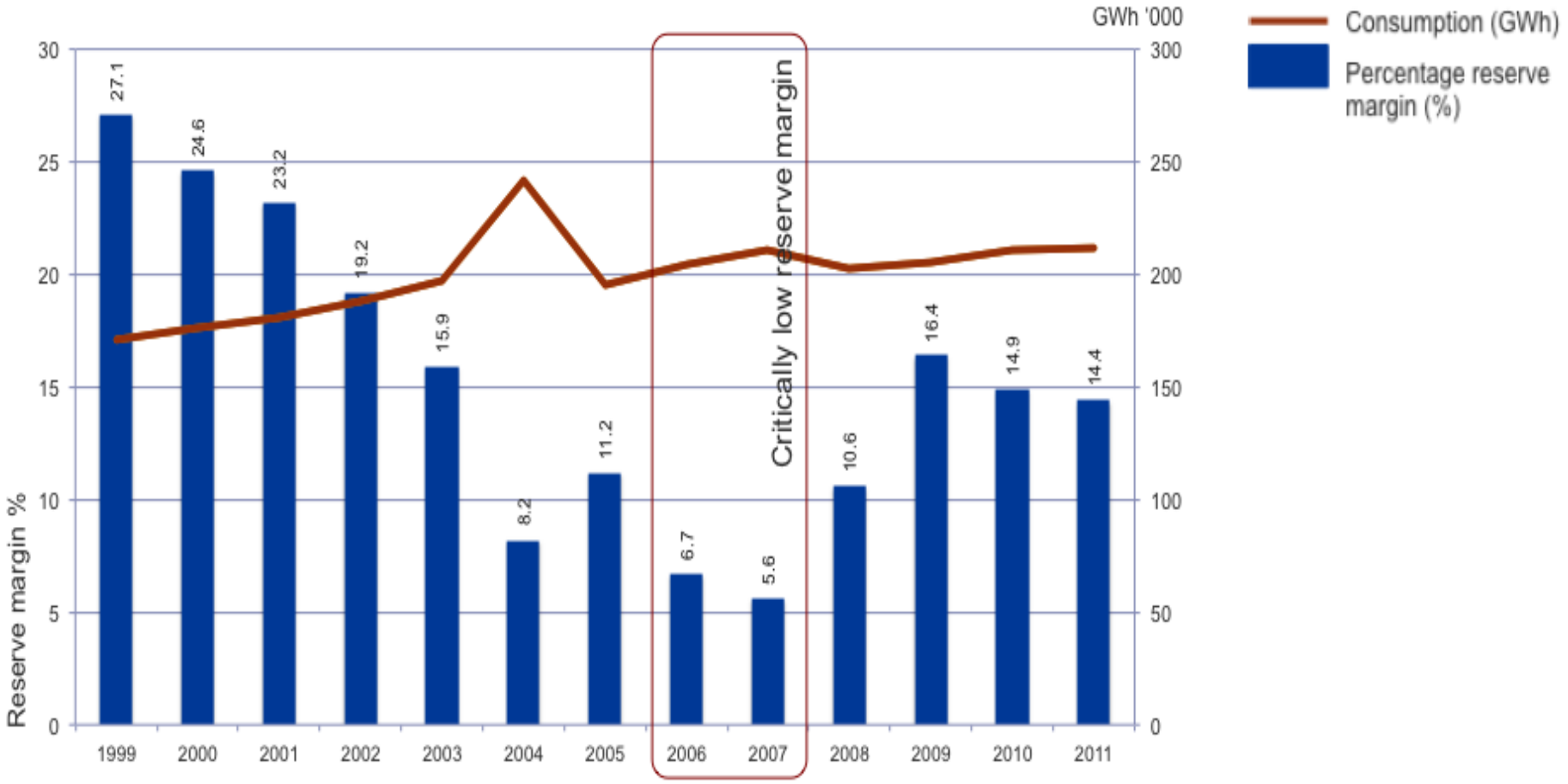
South Africas Electricity Production

Reserve Margin – Electricity Production

Source: Wood Mackenzie (installed capacity), NERSA (peak demand), Eskom
**including data for 2015 year-to-date*

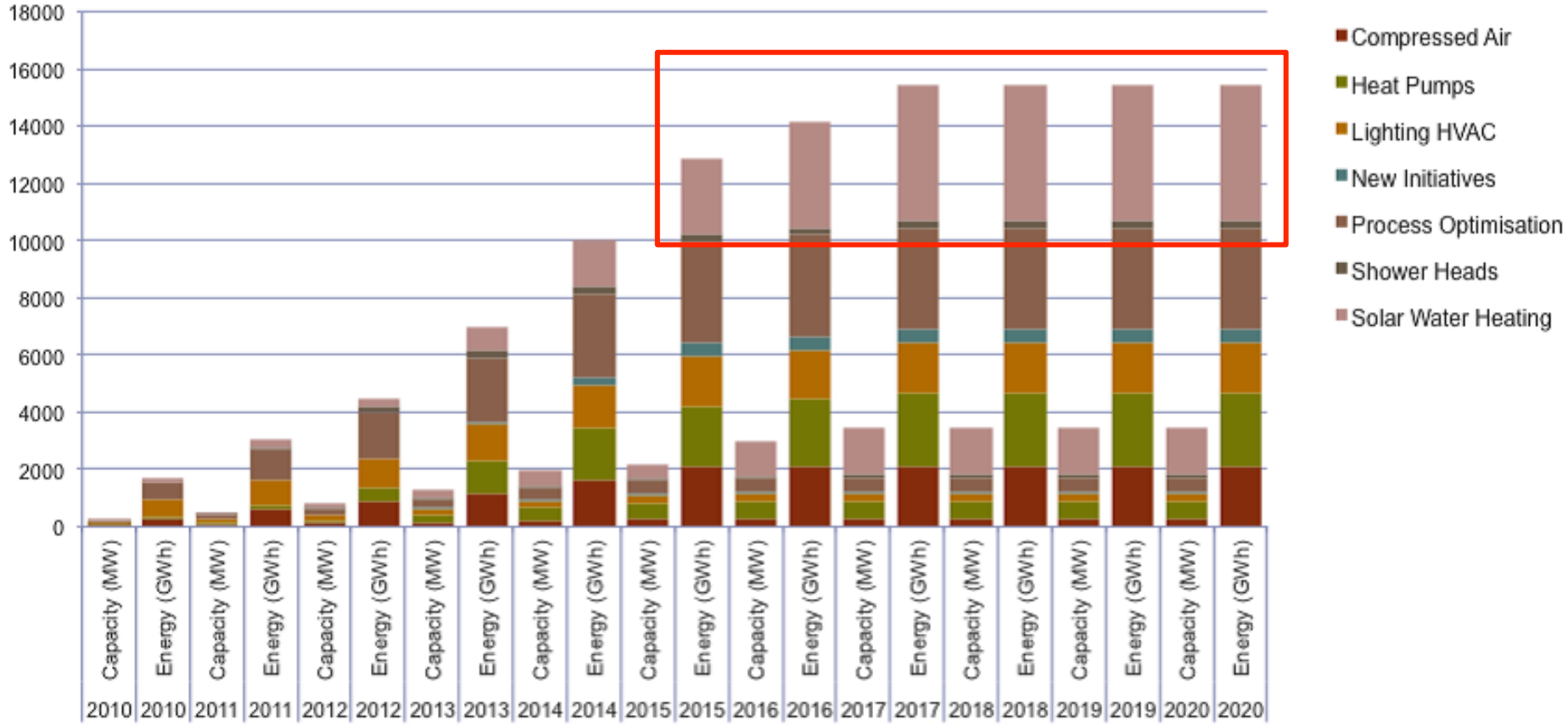
Source: ISGAN Case Book

Reserve Margin – Electricity Production



Source: ISGAN Case Book

The anticipated contribution from IDM interventions to the national electricity plan



IDM = Integrated Demand Management Programme launched by ESCOM 2004

Source: ISGAN Case Book

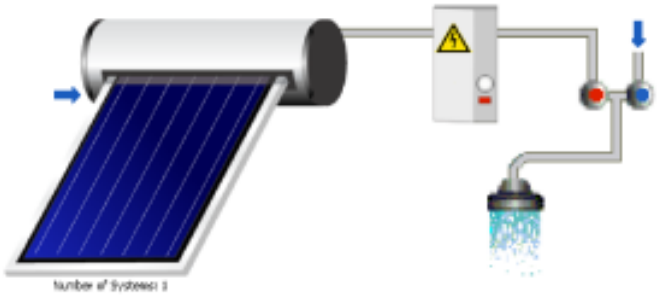
How to solve the problem?

?

In the residential sector
60% of the electricity in South Africa is used for hot water preparation

1 Million Solar Water Heaters Programme South Africa

1 Million Solar Water Heaters Programme South Africa



System parameters

3 m² collector area = **2.1 kW**th

Hot water storage: 200 ltr.

Daily hot water consumption: 150 ltr.

Annual Savings

3400 kWh electricity

CO2: 2300 kg

Market penetration like in Cyprus or Israel

22.05 GW_{th}

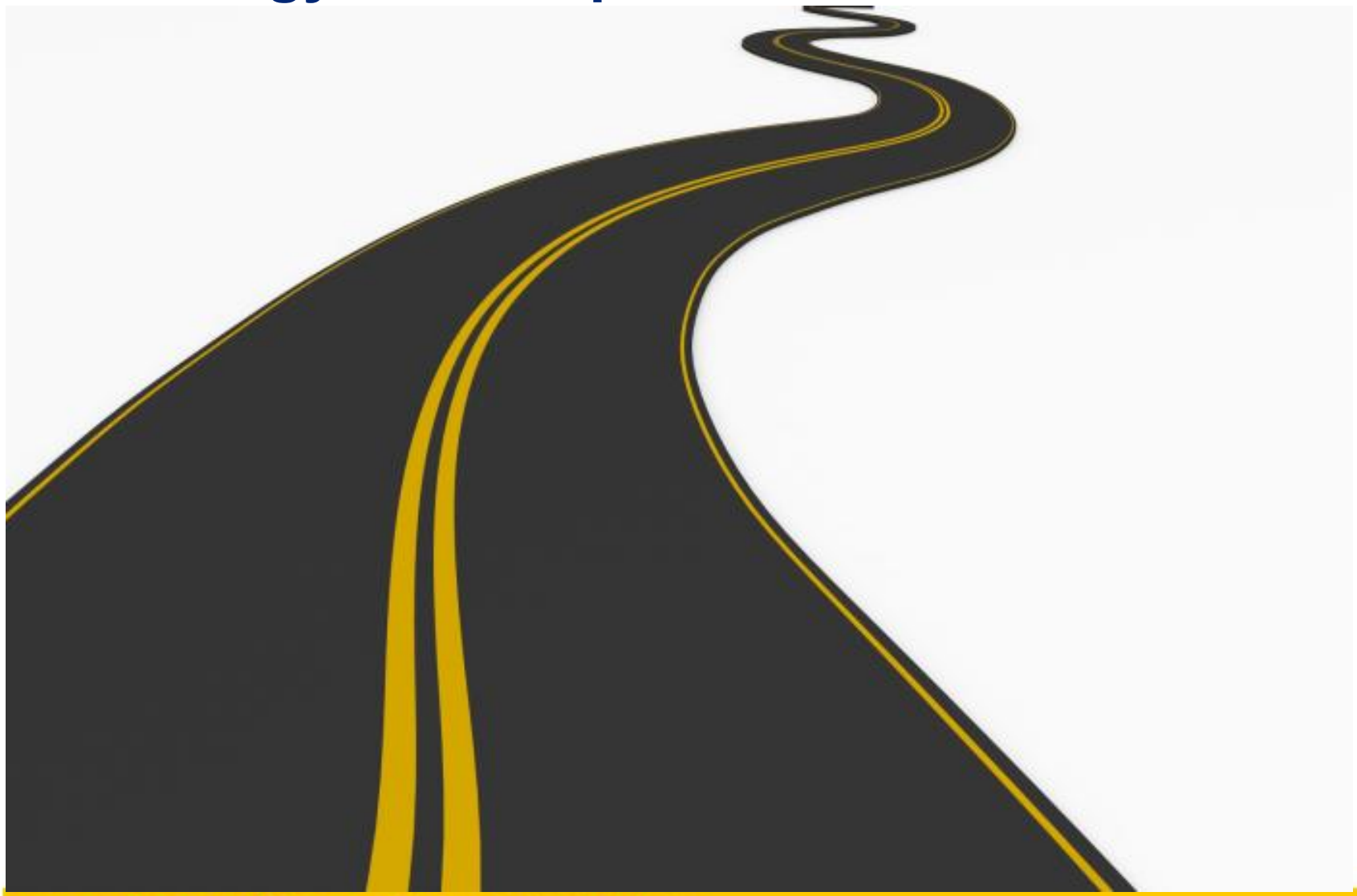
34 TWh electricity

Basic electricity for 3.4 Million people


Recommendations for
Actions
www.iea-shc.org

REN21 Workshop, 13 January 2016

Renewable Heating and Cooling Technology Roadmaps



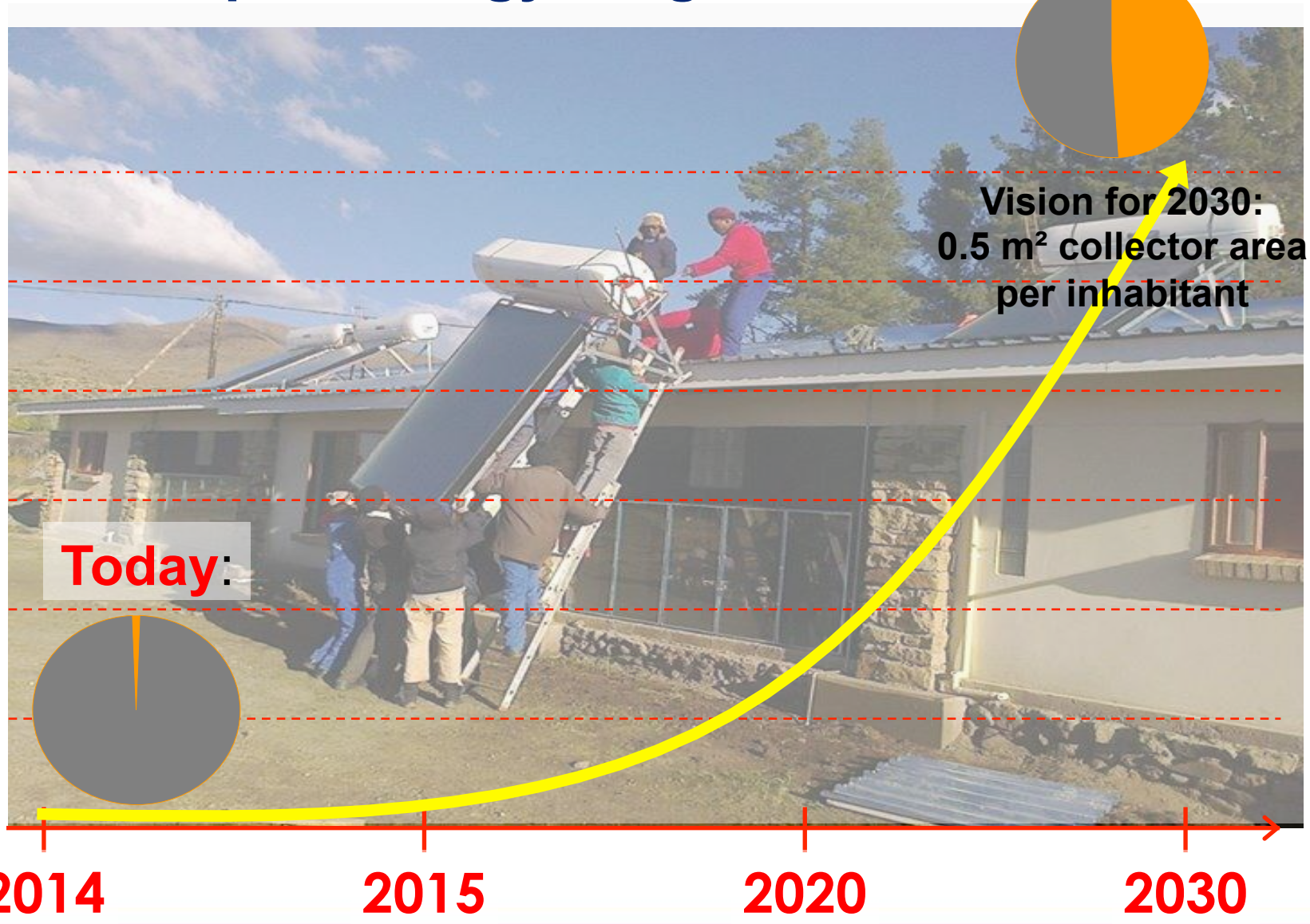
Measures for a successful implementation

Source: ESTIF

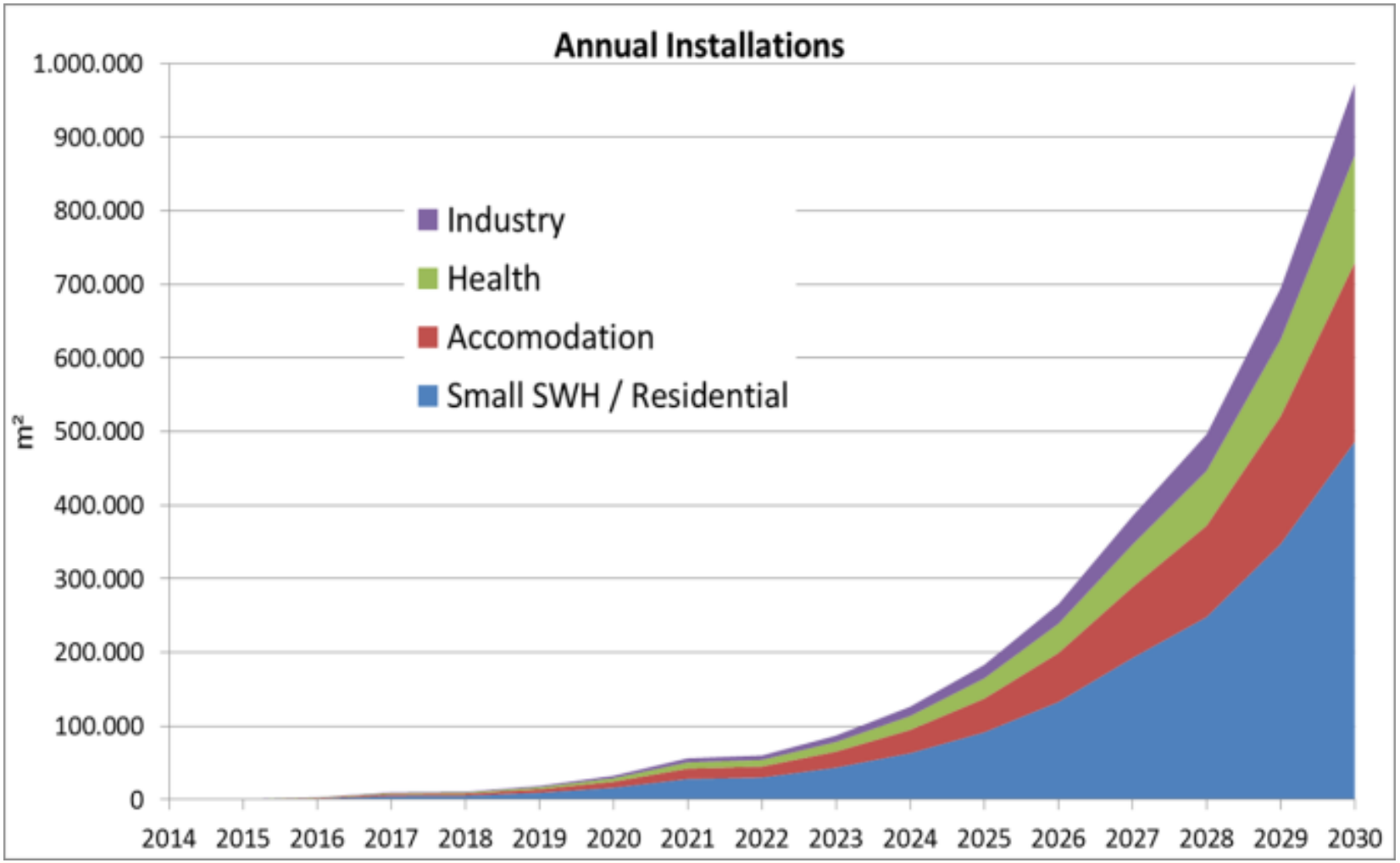
One successful example

SOLTRAIN – Southern Africa

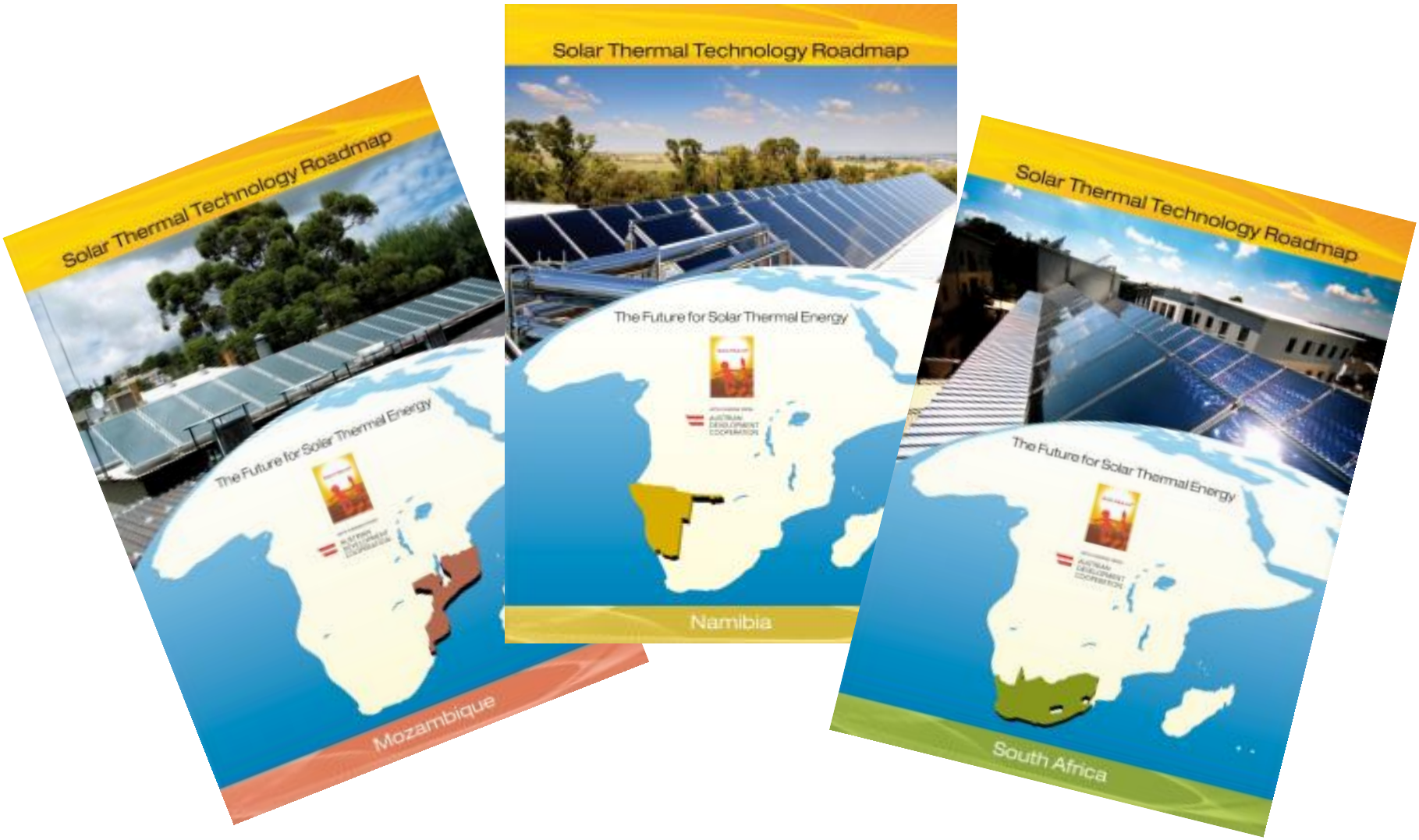
Roadmap - Strategy for growth



Solar Thermal Technology Roadmaps



Solar Thermal Technology Roadmaps



Solar thermal policies and support mechanisms

South Africa:
Department of Energy: 1 Million Solar Water Heaters by 2014
The South African Government's National Development Plan 2030 has a target of 3 000 000 solar water heaters by 2030

Regulation and legislation
SANS 10400-XA Energy Efficiency in New Buildings: A minimum of 50% of the annual average heating requirement for hot water must be provided by means other than electric resistance heating or fossil fuels.

Rebates:
Eskom: Residential solar water heater programme for high pressure solar water heaters.

Programmes
- City of Cape Town Solar Water Heater Programme
- Thekwini: Shisa Solar
- Johannesburg: City Power Solar Water Heating Programme
- Nelson Mandela Bay and Ekhurhuleni Solar Water Heater Pilot Programmes

Solar thermal policies and support mechanisms

Namibia:
Ministry of Mines and Energy (MME), Cabinet Directive in August 2007: all public buildings (government and parastatals) should be equipped with solar geysers.

OGEMP provides a solar revolving fund for solar water heaters, water pumping, and solar home systems.

Namibia introduced a **low cost housing programme** in which 185 000 would be constructed through the National Housing Enterprise (NHE). All these houses should be equipped with solar thermal systems.

Namibia Development Plan – Four (NDP-4), 2012
…an increased penetration of solar water heaters supports the Government's initiative in this field...

Planned and Current Programmes
The demand side management (DSM) study which was commissioned by the Namibian Electricity Control Board (ECB) in 2006 recognised solar water heaters (SWHs) as an effective demand side management measure.

Solar thermal policies and support mechanisms

Zimbabwe:
National Energy Policy was launched in 2012 which identifies the key challenges in the exploitation, distribution and utilization of different energy resources, providing a detailed roadmap on how to address them.
The cross-cutting issues include safety, health, the environment, energy efficiency, access to energy for low income groups, gender, quality assurance and quality standards, research and development, pricing, energy planning, and the need to take cognisance of regional and international energy trade and co-operation.

The Ministry of Energy and Power Development launched the national **Solar Water Heating Programme (SWHP) in September 2015**. It will be a requirement that all new buildings/structures are to be fitted with solar water heaters and not electric geysers. Electric geysers in old buildings must also be replaced with solar thermal systems in the next five years. The programme will compel all new housing programmes to ensure that solar heaters become mandatory at every new house before connection to the grid, with incentives being put in place. During the first year a total of 1 000 households will be targeted.

Solar thermal policies and support mechanisms

Lesotho:
Lesotho Energy Policy: 2015 – 2025: Officially launched on Sept. 3, 2015
Renewable sources of energy and energy efficiency are expected to play a significant role and therefore appropriate programmes and activities will be supported by this policy. The goal is that the share of cleaner fuels in the energy supply mix increases while the share of non-sustainable forms of energy reduces.

Strategies

- Phase out the use of electric geysers in all existing public buildings and ***introduce solar water heating systems*** and heat pump systems
- Compel all new Public buildings which require hot water to install solar water heaters.
- Encourage the replacement of electric geysers with solar water heaters in industrial, commercial, residential and general purpose sectors

Solar thermal policies and support mechanisms

Mozambiqie:
Projected changes in the energy sector include the strengthening of Mozambique's role as an electricity exporter, from electric generation based on the natural gas and hydropower resources, abundant in the North and Centre of the country.
However, the growth in the electric infrastructure and supplies in the convention manner (centralized generation and strengthening of electric networks) does not occur fast enough to respond to the urgent need to provide access to modern sources to the general population and Small and Medium Entrepreneurs (SMEs).

Solar Water Heating (SWH) provides the opportunity to extend access to a renewable energy source while delaying the need for new power generation plants based on fossil fuels. In other words, SWH technologies are part of overall electricity saving strategy (the implementation of renewable technologies will help contain the peak demand growth) and also serve the country's strategic vision of Mozambique's Green Future.

Training

	Number	Participants
Train the Trainer Courses	18	774
Dissemination Courses	50	1076
Workshops for Policy, Administration an Financial Institutions	11	105

Demonstration systems

In order to apply the knowledge gained at the training courses solar demonstration systems

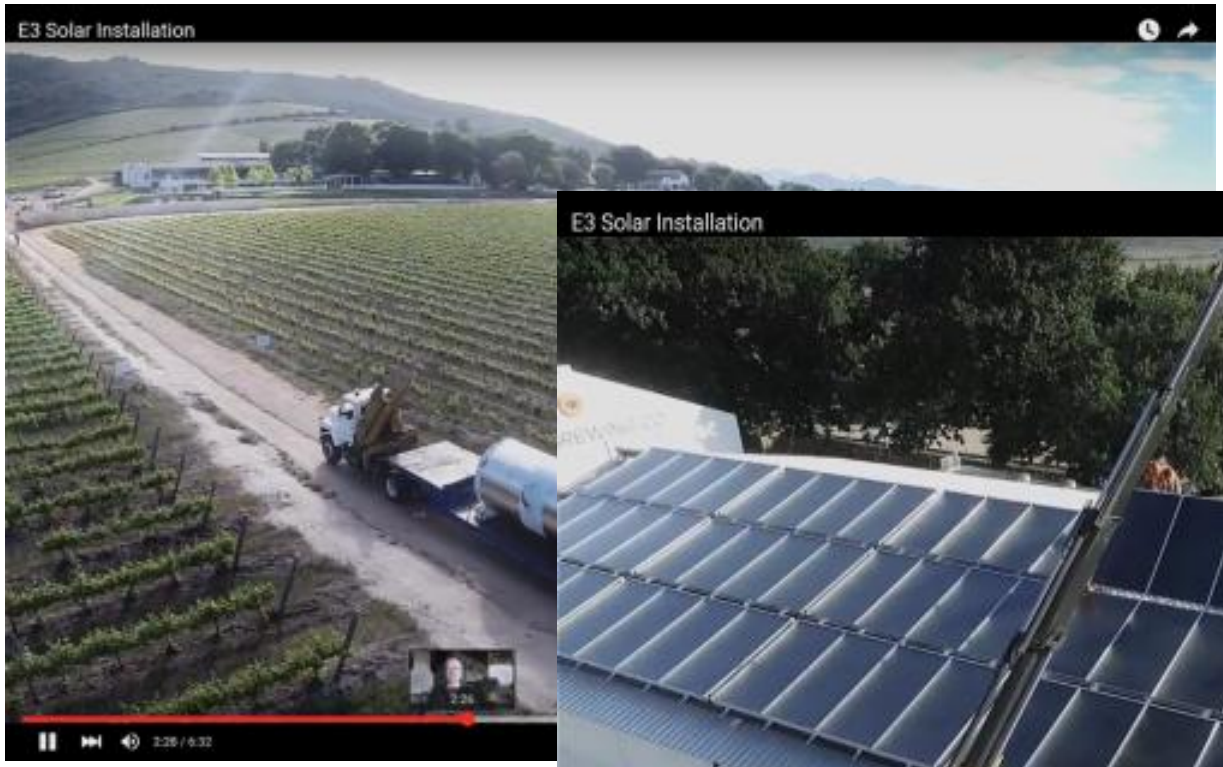
a total of 187 solar thermal systems were installed and handed over to social institutions

Direct Thermosyphon Systems

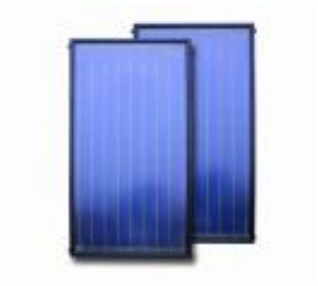
PV - Pumped Systems

Large-scale pumped systems

Cape Brewing Company (120/10.000)



Energy savings and avoided CO_2



Country	Total collector area [m²]	Total capacity [kW_{th}]	Number of systems [---]	Solar yield [kWh/a]	Electricity savings [kWh/a]	CO_2 reduction *) [t_{CO2}/a]
Mozambique	41,4	29	2	30.330	33.363	12
Namibia	228	160	71	207.398	228.138	72
South Africa	1.326	928	85	929.688	1.022.657	323
Zimbabwe	332	232	19	274.441	301.885	95
Lesotho	34,5	24	10	28.527	31.380	10
TOTAL	**1.962**	**1.374**	**187**	**1.470.384**	**1.617.422**	**513**

*) based on oil equivalent

Company Support for Local Production

Awareness Campaigns

Organized 22 stakeholder meetings with 680 participants
Participation at 21 trade fairs and exhibitions

Training Systems for Universities and VTCs

Test Centre at Stellenbosch University

Thank you for your attention

IDEAS to ACTION