

Session 43: Solar H&C: Challenges and Opportunities

In partnership with the Clean Energy Solutions Center (CESC)
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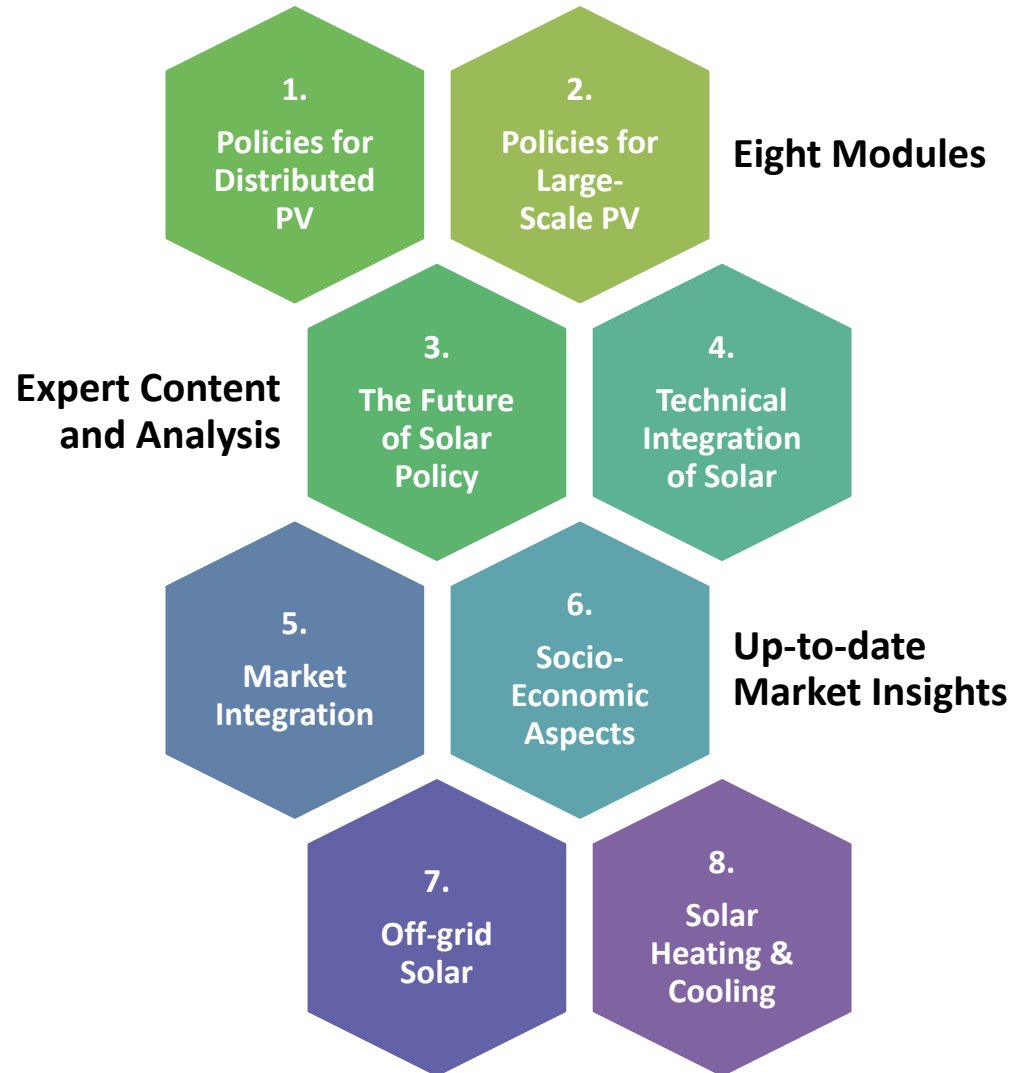
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ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

Overview of Training Course Modules

This Training is part of Module 8, and focuses on the issue of **Solar Heating and Cooling**



Solar H&C

Three topics to cover, spanning three distinct presentations:

1. **Session 43: Solar H&C: Challenges and Opportunities**
2. **Session 44: Solar H&C: Technologies and Case Studies**
3. **Session 45: Policy Options to Scale-up Solar H&C**

Overview of the Presentation

- 1. Introduction: Learning Objective**
- 2. Global Overview: Solar Heating and Cooling**
- 3. Economic Issues and Opportunities**
- 4. Concluding Remarks**
- 5. Further Reading**
- 6. Knowledge Check: Multiple-Choice Questions**

1. Introduction: Learning Objective

Learning Objectives

- ❖ **Analyze the drivers behind recent global market trends**
- ❖ **Understand which technologies are currently most widespread**
- ❖ **Identify the barriers (regulatory, market, contractual) to solar heating and cooling**
- ❖ **Understand the overall market potential for Solar H&C technologies**

2. Global Overview: Solar Heating and Cooling

Definitions: Heating and Cooling

- Wide range of end-use applications and technologies
 - In the **buildings** sector, it includes cooking, water heating, ambient heating, ambient cooling and refrigeration: **Residential & Commercial**
 - In **industry**, it also includes process heating from low temperature applications (e.g. in the food industry) to high temperature applications (e.g. in the cement, iron and steel industries).
- Solar, geothermal and biomass can all be used as direct sources of heat.
- This heat can also be used to drive absorption chillers for cooling.
- In addition, any form of renewable electricity can be used to power heating or cooling appliances: such thermal storage can also add valuable **demand flexibility**

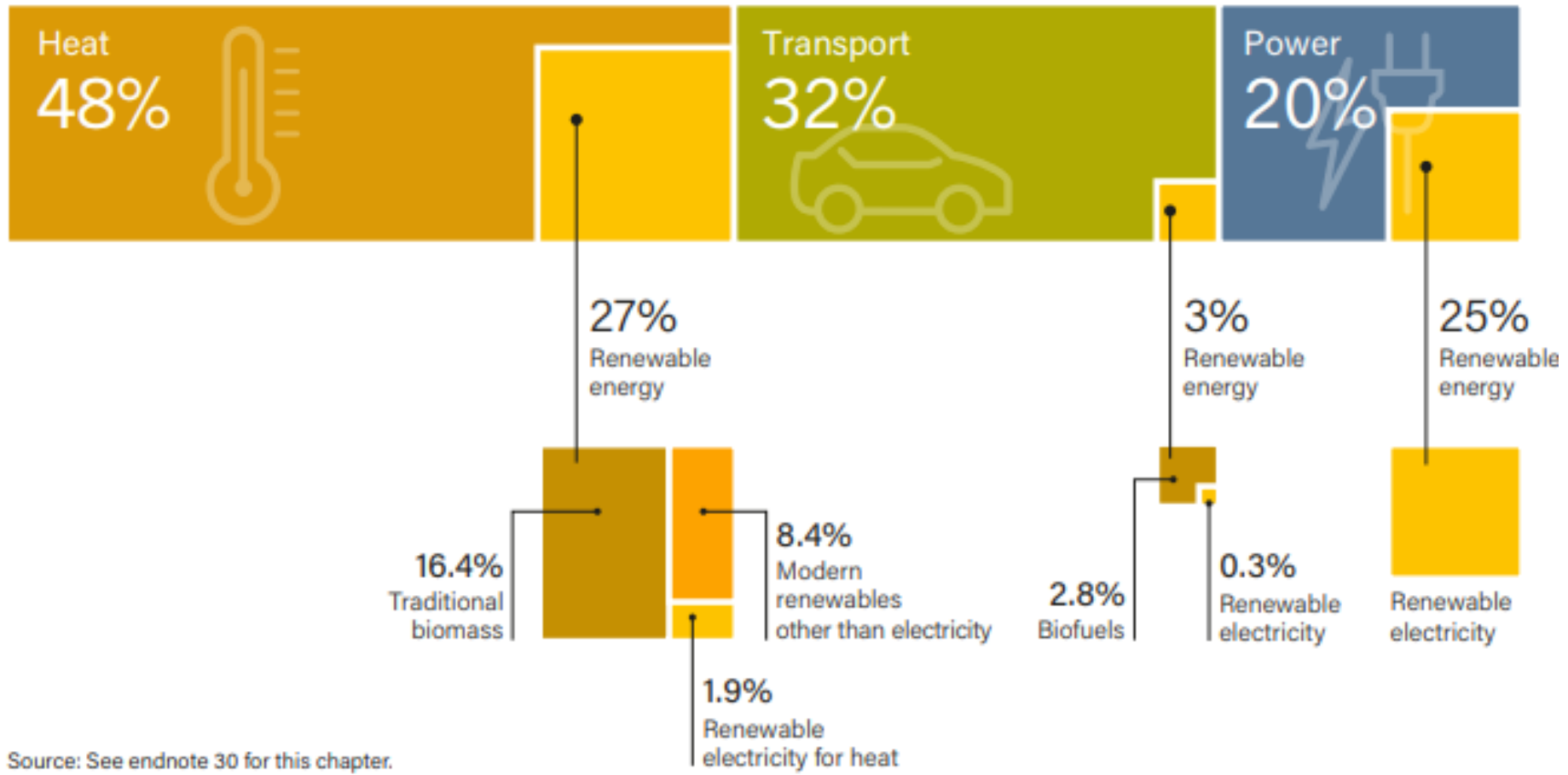
Definition: Solar H&C

- **Solar heating and cooling** technologies collect thermal energy from the sun and use this heat to provide hot water and space heating and cooling for residential, commercial and industrial applications.
- There are several types of technologies in use, including:
 - Non-concentrating solar thermal – with various types of collectors
 - Concentrated solar technologies
 - Open and closed-cycle cooling technologies
- Heat storage is also important to take into account
- Storage can extend operational hours and improve user experience

Overview: Solar H&C

- Renewable energy sources used for heating and cooling purposes have received relatively little attention compared to other sectors (e.g. electricity)
- At the same time, demand for heat consumes the largest share of primary energy supply
- Heat accounts for an estimated 38% of energy-related CO2 emissions.
- Scaling-up RE in the heating and cooling sectors is essential for achieving climate targets and has benefits for air pollution, energy security, etc.
- Renewable technologies can offer a practical alternative to fossil fuels under many circumstances

Importance of the H&C sector in total final energy consumption, 2015



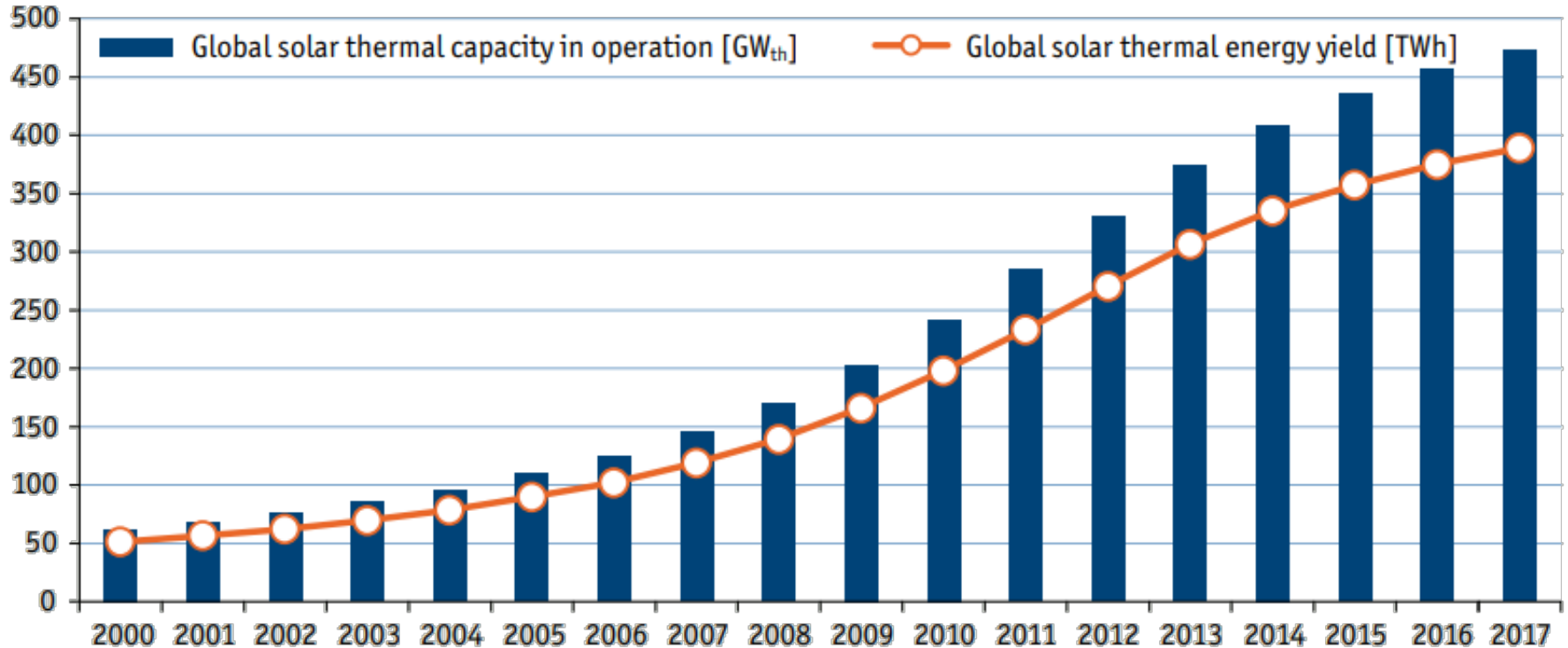
REN21 (2018: 32)

Rationale for Solar H&C

- Important role to play in energy security, economic development and in mitigating climate change
- Compatible with nearly all sources of back-up heat and almost universally applicable
- Replace electricity used for hot water and space heating, especially in countries lacking gas infrastructure
- Reduce electric grid loads at times of peak cooling demand
- Increase resilience against rising energy prices
- Create regional and local jobs – since a large portion of the value chain cannot be delocalised.

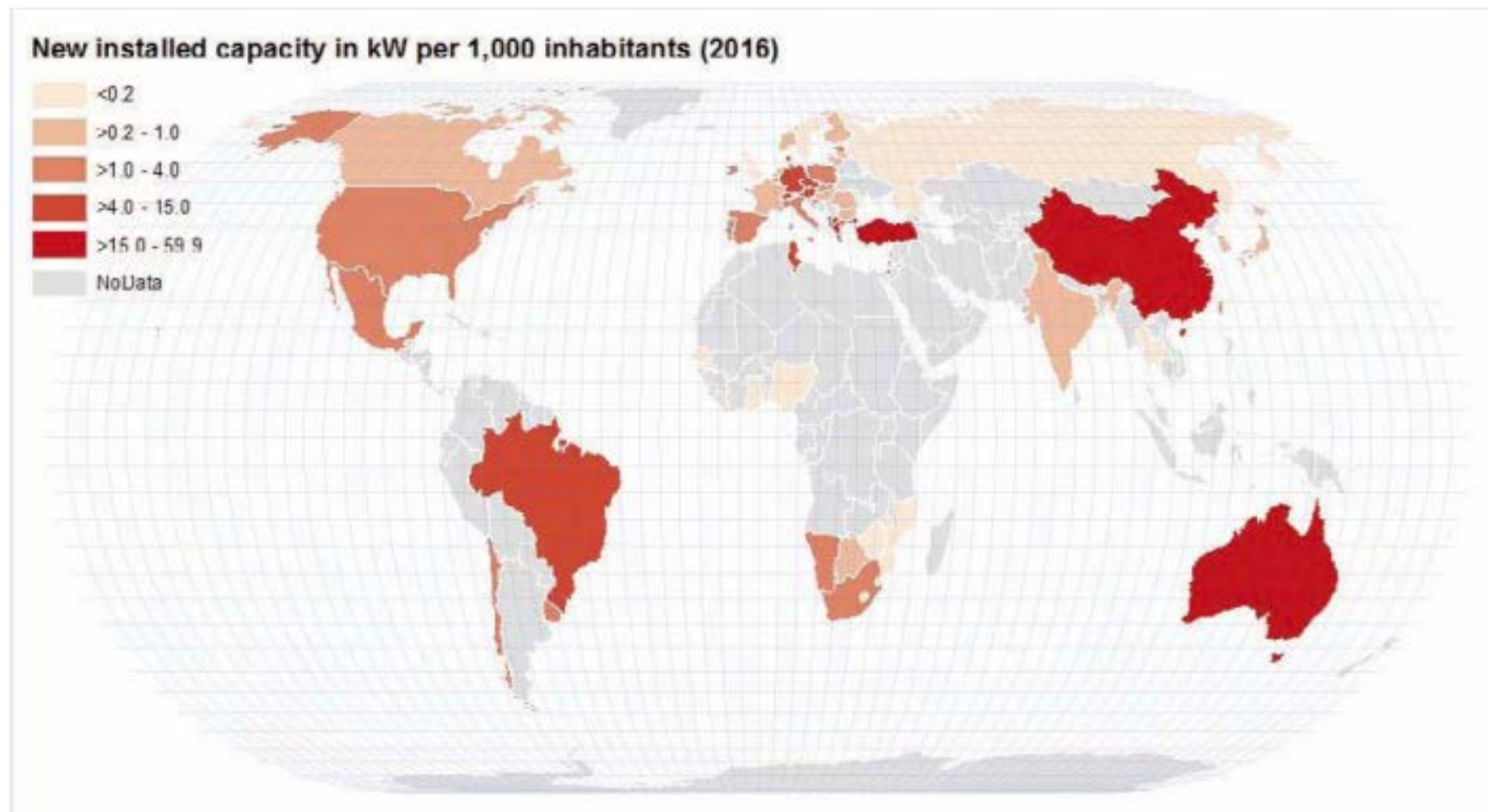
Global solar thermal capacity and annual energy yields (2000 – 2017)

Capacity [GW_{th}], Energy [TWh]



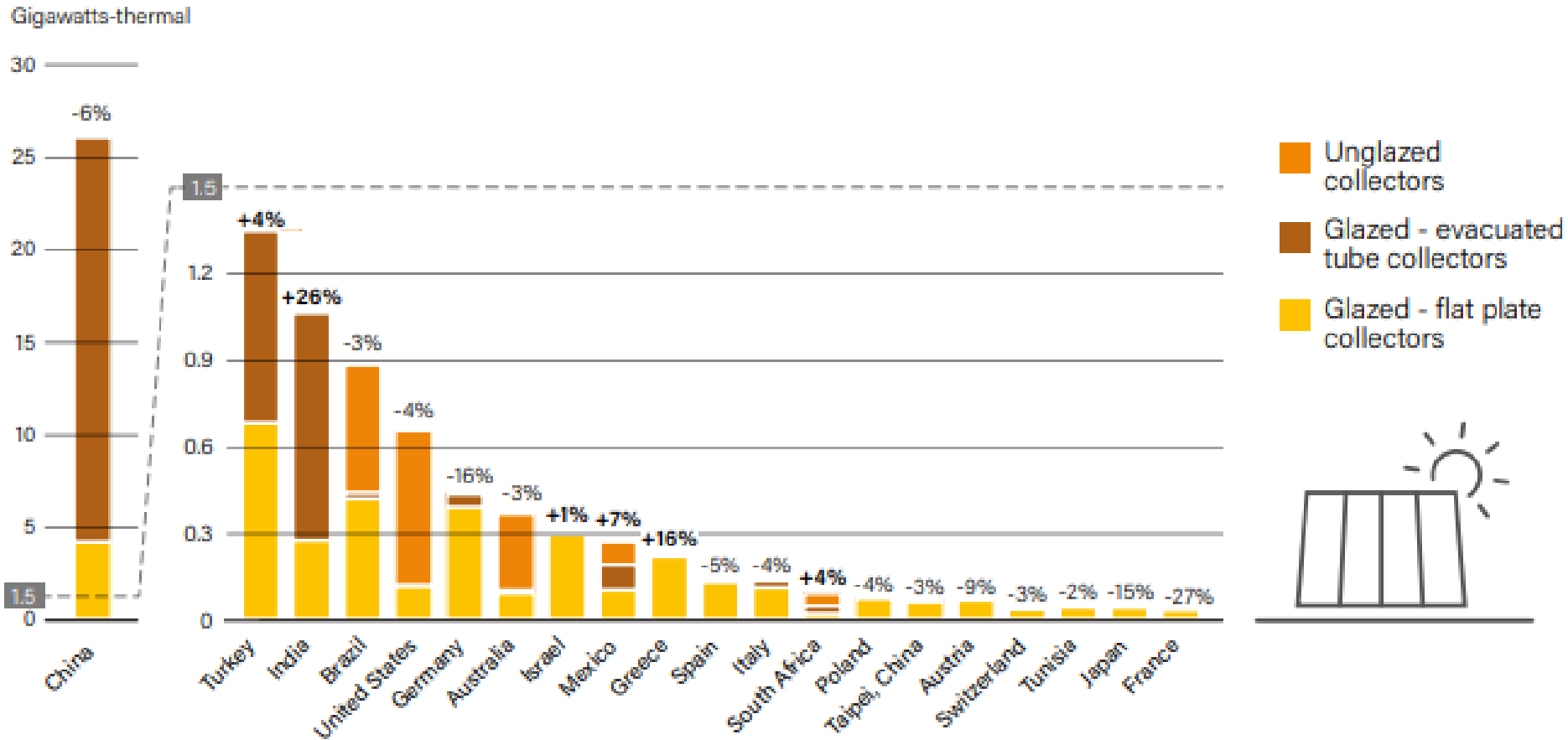
Source: <http://www.iea-shc.org/data/sites/1/publications/Solar-Heat-Worldwide-2018.pdf>

Market growth is uneven, as are associated skills



Source: <http://www.iea-shc.org/data/sites/1/publications/Solar-Heat-Worldwide-2018.pdf>

Solar Water Heating Collector Additions, Top 20 Countries for Capacity Added, 2017



Source: REN21 (2018: 104)

Market Overview

- By the end of 2016, an installed capacity of 457 GWth corresponding to a total of 653 million square meters (653 km²!) of collector area was in operation worldwide
- The vast majority of the total capacity in operation was installed in China (324.5 GWth) and Europe (51.8 GWth), which together accounted for 82.3% of the total installed capacity.



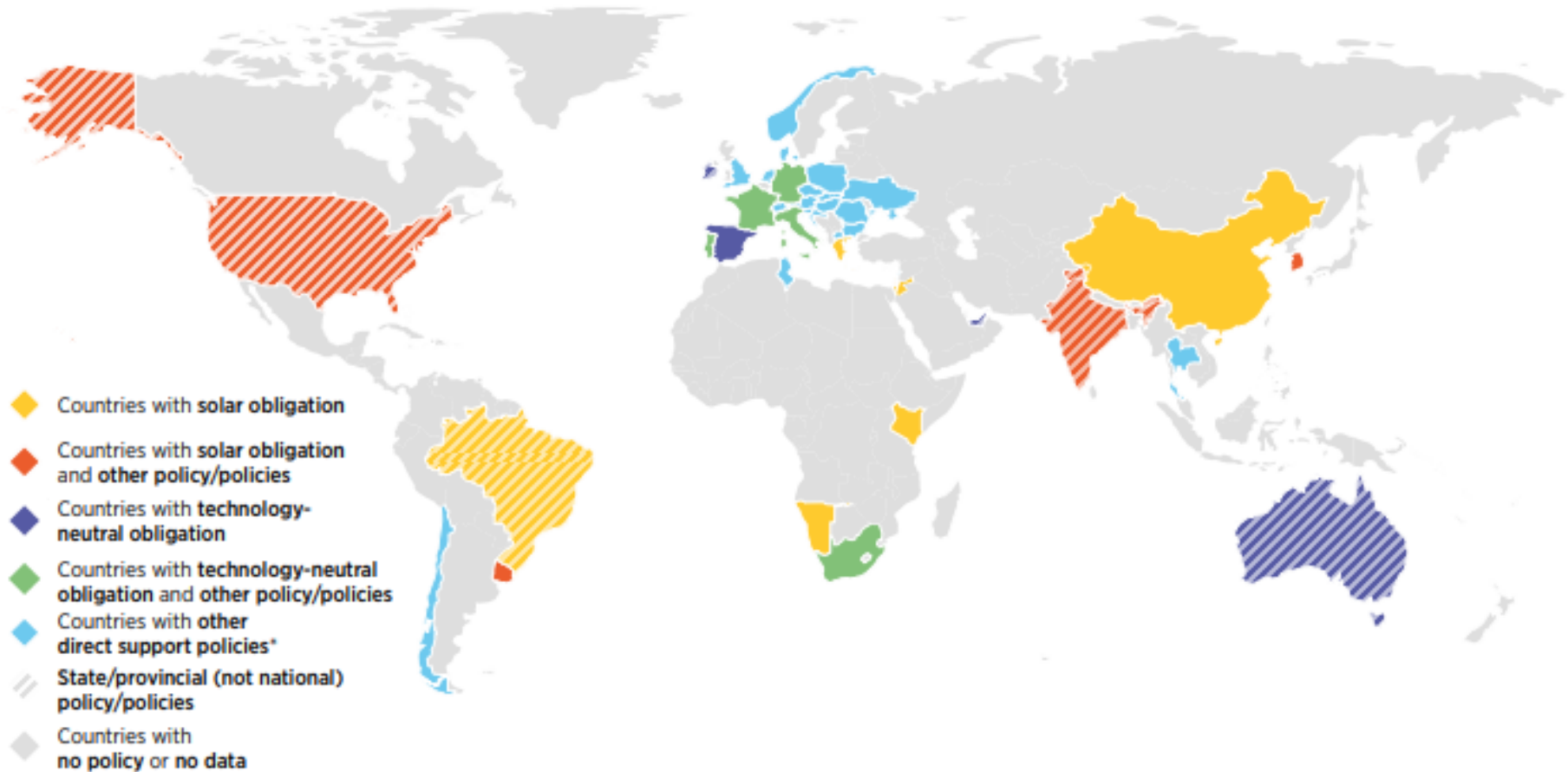
Underlying trends

- Individual solar water heating installations dominate the global market
- However, large-scale solar thermal plants have been expanding in several countries, led by Denmark.
- Currently, demand for cooling is comparatively small. However, it is projected to grow quite fast, especially due to increasing demand for A/C or refrigeration of food.



Explicit solar H&C policies are still relatively rare

Countries with Solar H&C Policies in 2016



Source: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Apr/IRENA_IEA_REN21_Policies_2018.pdf

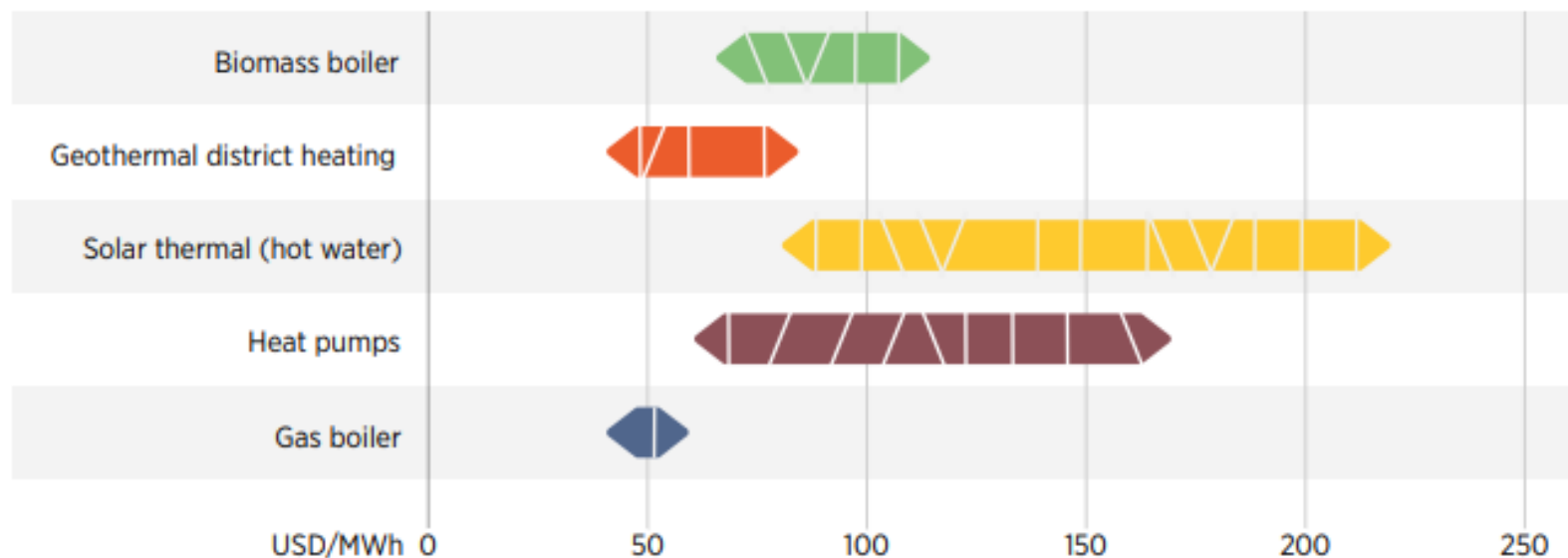
3. Economic Issues and Opportunities

Economic barriers to Solar H&C

- A switch to renewable heat is particularly challenging for countries where:
 - a majority of residential and commercial buildings connect to a gas grid;
 - district heating is scarce; and
 - most homes are single-family units rather than apartment buildings.
- Similarly to renewable electricity, the capital cost of solar heating and cooling is higher than conventional gas boilers
- Investment payback times also tend to be quite long.
- This is especially true for small-scale, residential applications.

Levelized cost of solar thermal generated heat (LCOH)

- Due to higher capital costs, maintenance costs, and relatively low gas prices in many countries, many renewable heat options (including solar) are still uncompetitive with network gas



IRENA, IEA & REN21 (2018: 31)

Slow rotation of building stock and lack of awareness

- Solar H&C systems are most often installed when new buildings are constructed or undergo profound retrofit changes
- Furthermore, decisions on replacing old appliances are typically made under pressure, when the heating system breaks down.
- Comparison of prices between solutions, as well as information on how their existing system performs, is not easily available for most consumers.
- This leads them to continue using older, less efficient technologies.

Other limiting factors

- Cost-competitiveness of solar heating and cooling is sometimes hindered by technical bottlenecks
 - Limited heat storage
 - Unavailability of commercialised cooling machines for solar-cooling applications
- Limited local/regional supply chains: many countries have a shortage of **skilled personnel** able to properly conceive and install solar systems
- Permitting issues, reluctance to manage a more complex or unfamiliar H&C system, and other institutional barriers make many building owners hesitate
- Certain compatibility issues remain (e.g. high temperature requirements in certain industrial processes)

Technological Challenges

- The main challenges to solar H&C are not so much technological per se, but rather political and economic.
- Most of the technologies used are already fairly mature and reliable.
- Nonetheless, several improvements can be achieved in the coming years to reduce both investment costs and system integration costs.



However, new market segments are expanding

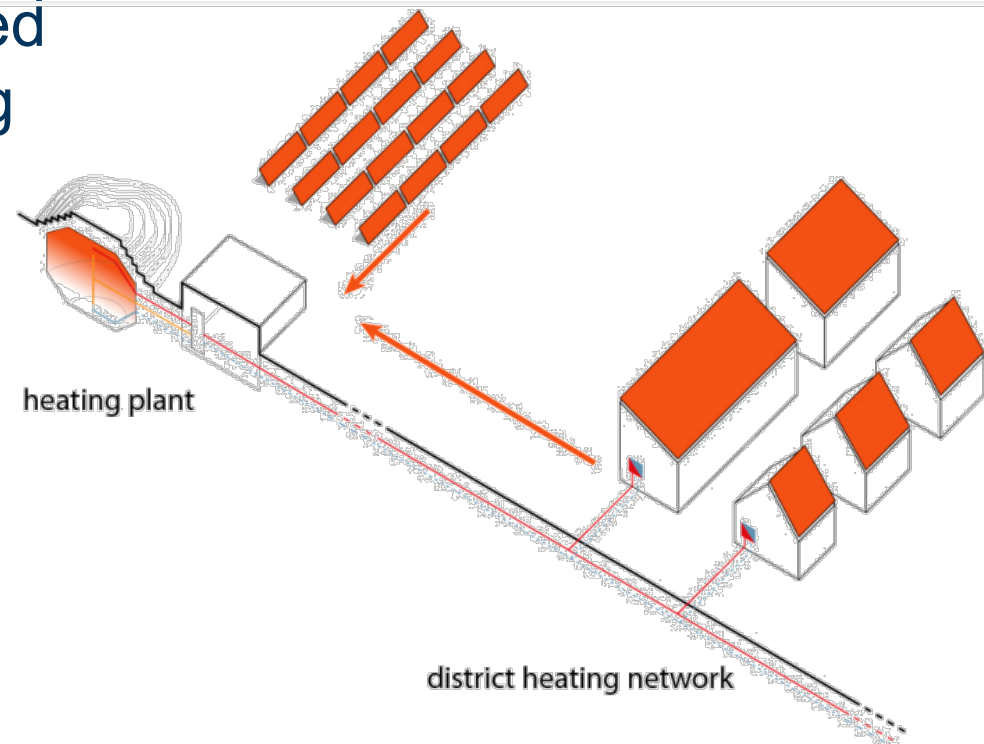
- There is vast potential for using solar thermal in industrial applications, especially in regions in which low-temperature heat demand is growing.
 - This is the case for several industrial uses such as foods and beverages, textiles, agriculture, and chemicals.
 - 2017 was a record year for solar heating in industrial processes, with 124 projects in 17 countries adding over 130 MW_{th}
- In the Middle East, where A/C accounts for the highest portion of household and commercial electricity bills, several countries are gradually removing subsidies for electricity, which in turn is generating demand for renewable cooling solutions.

Government commitment to scaling H&C

- As more countries are becoming aware of the importance to scaling-up heating and cooling, they are adopting more ambitious targets and long-term strategies
 - The EU's 2030 objectives includes a target of 1.3 percentage point increase each year in heating and cooling from renewable sources.
 - In 2016, China established an ambitious target to meet 10% of industrial heat demand with solar thermal energy by 2020
- Targets are often accompanied by enabling policies and schemes (subsidy programs, reduction of fossil fuel support)
- This in turn helps build investor confidence in the sector and more importantly drive down the investment costs.

Solar use for District Heating and Cooling

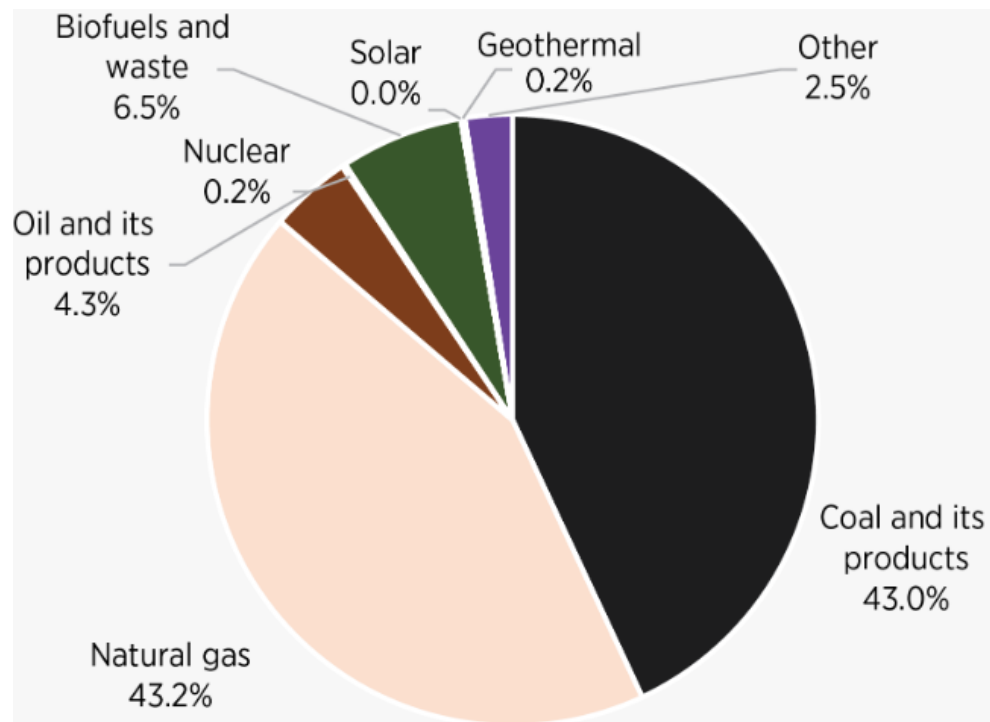
- One possibility for enhanced penetration of solar heating systems is through district heating.
- In these cases, the heat gathered by the solar collectors is fed into a district heating network
- By supplying a larger number of users, DHC enables economies of scale for solar thermal



Central Solar District Plant. Source: SDH (2014)

Solar use for District Heating and Cooling (DHC)

- Most DHC energy is currently provided by fossil fuels, while renewables account for only a small share.
- By the end of 2017 about 300 large-scale solar thermal systems (>350 kWth) connected to district heating networks and in residential buildings were in operation.



Breakdown of fuel use in DHC systems worldwide, 2014 (Source: Irena)

Applications in District Heating and Cooling

- District heating can combine different sources of heat and can play a positive role in the integration of rising shares of renewables
- A switch to renewable energy sources for DHC can help meet rising urban energy needs, improve efficiency, reduce emissions and provide cost-effective temperature control.
- DHC networks also enable project developers to realise economies of scale, thus making investments in solar heating more attractive
- There is significant potential to upgrade existing systems and create new networks using solar technologies (among others).

Expanding district heating and cooling

- With the growing recognition that solar DHC may be the most cost-effective way to decarbonise the heating sector, more countries have engaged with it.
 - Increased awareness among Germany's municipal utilities resulted in the submission of a large number of applications under the country's newly enacted subsidy scheme (District Heating Network 4.0)
 - The scheme provides grants for up to 60% of the costs of feasibility studies and up to 50% of investment in new district heating networks, as long as renewable sources (solar or biomass) or waste meet at least 50% of heating demand

R&D priorities for the years to come

- Several R&D priorities have been identified, such as:
 - Developing cost-effective heating systems (e.g. improved materials) with low operation and maintenance (O&M) costs
 - Developing smart systems based on simplified design, cost-efficient components and optimised control strategy
 - Improved multi-functional solar façade elements and systems with additional functionalities and high flexibility regarding architectural integration
 - Deployment of the ‘Solar-Active House’ with a high solar thermal fraction (e.g. above 50%)

5. Concluding Remarks

Concluding Remarks

- The potential for renewable heating and cooling is tremendous
- Solar H&C is a fairly mature and operational technology
- However, renewable H&C policies lag behind in comparison to power and transport.
- High investment costs, long payback times, and split incentives have constrained market growth
- Increasing **awareness of the potential, combined with improved economics and performance**, bode well for the sector

5. Further Reading

Further Reading

- GSR 2018: <http://www.ren21.net/gsr-2018/>
- http://iea-retd.org/wp-content/uploads/2011/10/Renewables-for-Heating-and-Cooling_book.pdf
- <http://iea-retd.org/wp-content/uploads/2011/09/IREHC-Final-Report-20100726.pdf>
- <http://iea-retd.org/wp-content/uploads/2011/09/IREHC-Best-Practices-Guide-20100726.pdf>
- <https://ec.europa.eu/energy/en/topics/energy-efficiency/heating-and-cooling>
- https://setis.ec.europa.eu/system/files/Technology_Information_Sheet_Heating_and_Cooling.pdf
- IRENA and IEA-ETSAP (2015). Solar Heating and Cooling for Residential Applications. Technology Brief. Report Available at: <https://www.irena.org/publications/2015/Jan/Solar-Heating-and-Cooling-for-Residential-Applications>
- <https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-51-EN-F1-1.PDF>

Thank you for your time!



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6. Knowledge Checkpoint: Multiple Choice Questions