EGEDA
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APEC
Asia-Pacific
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IRENA
International Renewable Energy Agency

Exercise 1. Estimating Renewable Heat (Solar Thermal)

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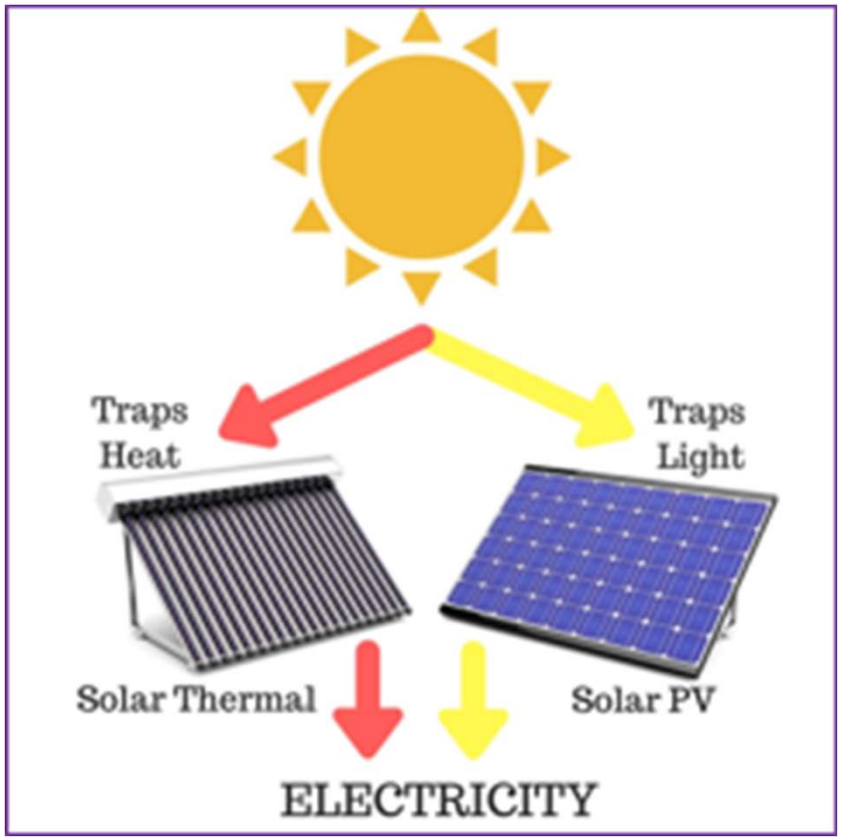
Outline of presentation

1. What is Solar Thermal Energy (STE) or Solar Thermal Systems ?
   - ✓ How Solar Thermal Systems Work ?
   - ✓ Solar Thermal System Classification
2. The Proposed Method
3. How to do the Exercise ??
   - ✓ Mexico Data (by presenter)
   - ✓ Other Economies Data (by participants)

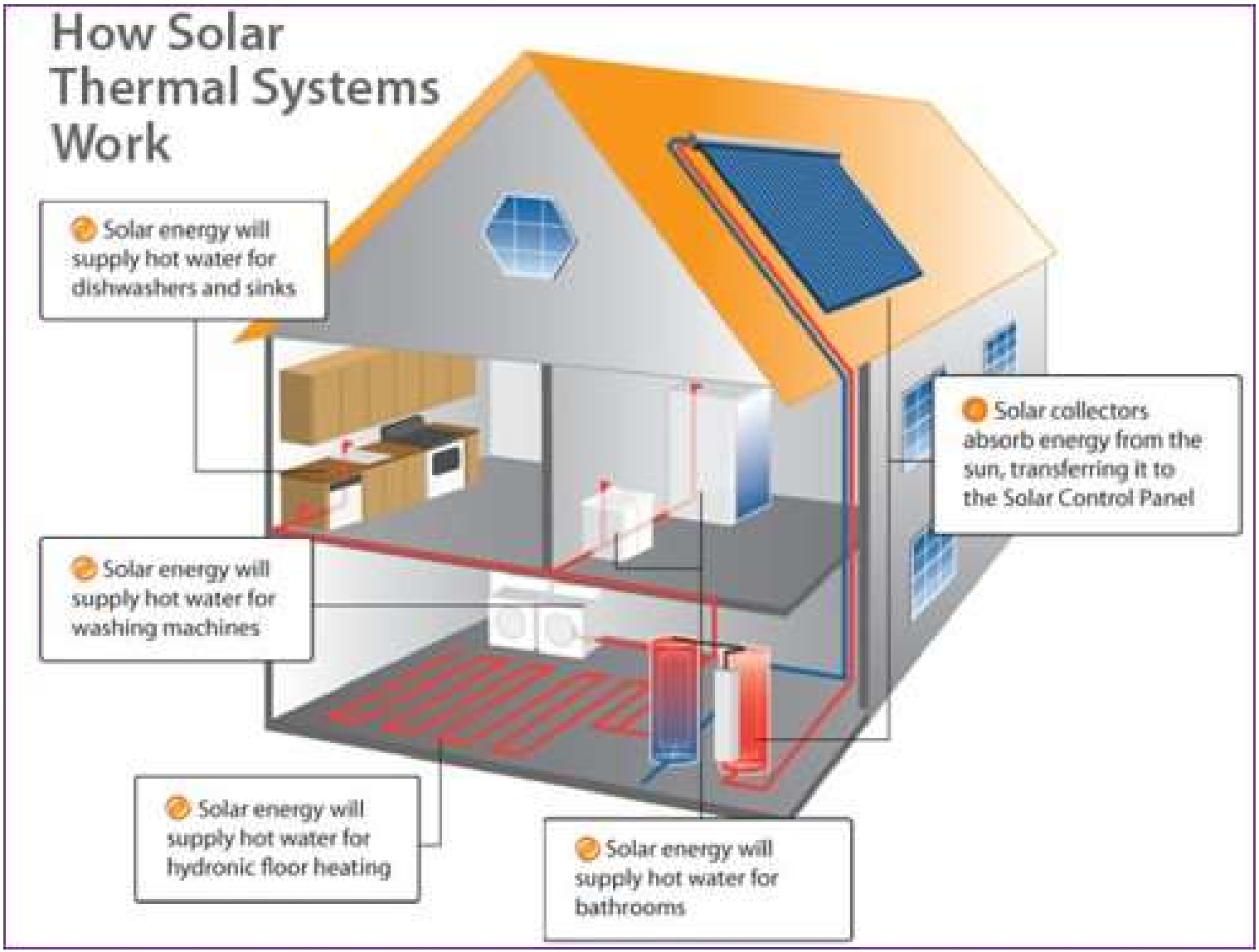
What is Solar Thermal Energy (STE) or Solar Thermal Systems ?

- collects heat energy from sunlight converting the sunlight into usable thermal (heat) energy
- are typically mounted on the roof, with no obstructions (trees, hills, buildings) that would cause shading over solar thermal systems, at any time of the day
- are classified as low-, medium-, and high-temperature collectors



This session will exercise only on solar thermal, not solar PV

How Solar Thermal Systems Work ?



Solar Thermal System Classification

No	Classification	Material	Utilization
1	Low (<110 degrees Fahrenheit)	**metallic or nonmetallic absorbers** (unglazed)	used in such applications as swimming pool heating and low-grade water and space heating
2	Medium (>110 or 140 to 180 degrees Fahrenheit)	• glazed flat plate **using air or liquid** as the heat transfer instrument • evacuated **tube** collectors.	mainly used for domestic hot water heating for residential and commercial use
3	High (>180 degrees Fahrenheit)	**parabolic dish or mirror or lenses** designed to operate at a temperature	primarily used by utilities and independent power producers to generate electricity for the grid • Concentrated Solar Thermal (CST) • Concentrated Solar Power (CSP)

Solar Thermal Energy Statistics

"**Solar thermal production** is the **heat available** to the heat transfer medium **minus the optical and collector losses**" (IEA and Eurostat)

For solar water systems, at the end user (which is the case for most solar systems), **the final energy consumption** is the **solar thermal production** - thus the collector output !

Only if the **solar heat is centrally produced and distributed over a network**, the final energy is **the solar heat output** and therefore in most cases the final energy is the solar thermal production (the primary energy)

In order to calculate the system output, losses from piping, storage, etc. would need to be deducted

The Studies behind the Method

- Several studies were dedicated to the development of a generally accepted method to calculate and monitor the production of solar thermal energy.
- Some of these studies were carried out within the scope of projects that supported by the Intelligent Energy Europe Programme and also IEA

The analysis was performed on four different applications for solar thermal systems (following the categories in IEA-SHC Solar Heat Worldwide):

- Unglazed systems - typically for swimming pool heating
- Domestic hot water systems (DHW) in one-family houses
- Domestic hot water systems (DHW) in multi-family houses
- Combined domestic hot water and space heating systems in one- and multi-family houses (Combi-systems)

The Proposed Method

The annual solar collector output in kWh can be expressed - within reasonable uncertainty - as follows

As a function of the installed solar collector area:

Un-glazed collectors: 0.29 * H0 * Aa

Glazed collectors in DHW systems: 0.44 * H0 * Aa

Glazed collectors in combi-systems: 0.33 * H0 * Aa

As a function of the installed collector nominal thermal power:

Un-glazed collectors: 0.42 * H0 * Pnom

Glazed collectors in DHW systems: 0.63 * H0 * Pnom

Glazed collectors in combi-systems: 0.47 * H0 * Pnom

Being:

H0: Annual global solar irradiation on horizontal the given location in kWh/m²

Aa : Collector aperture area in m²

Pnom : Nominal thermal power output of collector in kW

How to do the Exercise ??

Hands-on Exercise:
Energy Balance Solar Thermal

- The purpose of this exercise is **to take heating data and complete the solar thermal column of an energy balance**.
- Attached is a worksheet showing the solar thermal energy column of the IRENA energy balance template for Mexico. **Use the information about solar water heaters to estimate the consumption and production of solar thermal energy in each country and complete the two columns**.

Data that are needed for Hands-on exercise

- Average of Global Horizontal Irradiance (kWh/m2 per year)
- Solar Water Heater Capacity
  - Total number of systems
  - Average collector are per system (m2)

Domestic hot water systems consist of 2 types:

- Single Family Homes
- Multi Family Homes

Please open the MS.Excel file for exercise !!

Data that are needed for Hands-on exercise (2)

No.	APEC Members	Global Horizontal Irradiance	Total Number of Systems		Average Collector Area per System	
			DHWS - Single Family House (SFH)	DHWS - Multi Family House (MFH)	DHWS - SFH	DHWS – MFH
		kWh/m²			m2	m2
1	Australia	1,674.0	997,961.1	6,451.0	3.5	50.0
2	Brunei Darussalam	NA	NA	NA	NA	NA
3	Canada	1,351.4	6,677.5	6,775.0	6.0	50.0
4	Chile	1,752.7	103,657.1	1,630.0	2.0	50.0
5	China	1,281.9	78,375,375.0	3,376,170.0	4.0	50.0
6	Hong Kong	NA	NA	NA	NA	NA
7	Indonesia	NA	NA	NA	NA	NA
8	Japan	1,175.2	889,241.0	155.0	4.0	50.0
9	Korea	1,161.1	428,663.1	2,815.0	4.0	50.0
10	Malaysia	NA	NA	NA	NA	NA
11	Mexico	1,706.3	486,474.4		4.0	
12	New Zealand	1,401.2	31,929.0	319.0	4.0	50.0
13	PNG	NA	NA	NA	NA	NA
14	Peru	NA	NA	NA	NA	NA
15	Philippines	NA	NA	NA	NA	NA
16	Russia	996.0	909.1	400.0	4.0	50.0
17	Singapore	NA	NA	NA	NA	NA
18	Chinese taipei	1,372.2	340,876.1	3,068.0	4.8	30.0
19	Thailand	1,764.8	35,708.3	147.0	4.0	80.0
20	USA	1,646.1	256,208.2	71,738.0	6.0	50.0
21	Viet nam	NA	NA	NA	NA	NA

Energy Balance of Solar Thermal

- Production of solar thermal (GWh convert to TJ)
- Final consumption, could be assumed equal to production. But you will need to investigate in what sector that the solar thermal is consumed
- If there are data on electricity generation from solar thermal, then the input to electricity generation should be calculated using information on the efficiency of the power plant. The result will then be used to calculate the Final Consumption by subtracting production with the electricity generation.

Supply and Consumption		Solar Thermal
2016		TJ
Production	(+)	
Imports	(+)	
Exports	(-)	
Stock changes	(+)	
International Bunkers	(-)	
Domestic supply	(=)	
Transfers		
Statistical Differences		
Power plants		
CHP plants		
Commercial heat plants		
Charcoal production		
Biomass pellet and briquette production		
Other transformation		
Energy sector and own use		
Distribution losses		
Total final consumption		
Industry sector		
Transport sector		
of which road transport		
Commercial and public services		
Residential		
of which traditional uses		
Other		

We will calculate and input estimated data in yellow cells

Conversion factors

- 1 GWh = 3.6 TJ
- Annual production of solar thermal energy in kWh (as function of installed collector area)

Glazed collectors in DHW: 0.44 * HO * Aa

For further details see IEA Solar Heating and Cooling Programme: http://www.iea-shc.org/Data/Sites/1/documents/statistics/Calculation_Method.pdf

Example: Russia

	Total Number of Systems	Average Collector Area per System (m^2)	Total Collector Area (m^2)	Total Yield of Russia		
				* 0.44 (become $m^{2)}$	* GHI or 996 kwh/m^2 (become kw)	/10^6 (Kwh to Gwh)
DHW-SFH	909.1	4	3,636	3,636 X 0.44 = 1,599.8	1,599,840 x 996 = 1,593,440.6	1.6
DHW-MFH	400	50	20,000	20,000 X 0.44 = 8,800	8,800 x 996 = 8,764,800	8.8
Total			23,636		1,602,205,440	10.36

*10.36 GWh * 3.6 = 37.29 TJ*

Thank you for your attention

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