

## EXERCISE 1: OVERVIEW OF RENEWABLE ENERGY

### 1. In-pipe hydropower

The Californian city of Fontini obtains half of its drinking water from a reservoir in the hills above the city and half from groundwater. Water from the reservoir arrives at the town's Sandhill water treatment facility at a pressure of 12 bars and groundwater is pumped electrically to the surface at the same pressure.

The treatment facility requires water at a pressure of 1 bar to operate and the town has replaced its pressure reduction valves with a small hydro turbine that will reduce pressure and generate 2,300 MWh of electricity each year.

What is the annual production of electricity from renewable energy at the facility?



*Lawmakers and water company officials cut the ribbon for the small hydropower project.*

### 2. Wind-powered water pumping

A windmill with a mechanical pump raises groundwater for a cattle farm in South Dakota. When the water tank is full, the windmill charges a battery that is used to power an electric pump when the wind is not blowing.

The power consumption of the electric pump is 15 kW and it operates for 1,000 hours per year. This pumping provides one-third of the water used on the farm and the rest comes from the mechanical pump powered directly by the windmill.

What is the annual production of wind energy on the farm?



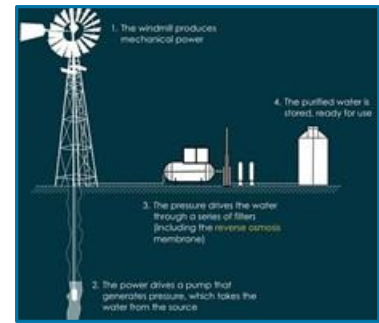
*Windpump in South Dakota, USA.*

### 3. Wind-powered desalination

A wind-powered desalination system has been tested in the coastal village of Ocachu in Mexico. The windmill raises groundwater with a low salt content and creates the pressure required for desalination using reverse osmosis. When the wind is not blowing, a generator is used to operate an electric pump that raises water and generates the pressure for desalination.

In the first year of operation, the windmill provided 90% of the energy required to operate the plant and an additional 50 MWh was provided by the diesel generator.

How much wind energy was produced for desalination?



*Aeolus wind-powered desalination system.*

### 4. Renewable waste

In the city of Kung Wei in China, waste is turned into energy at a large incinerator and various landfill sites (with biogas recovery) around the city. The average composition of the waste (by weight) is:

- Paper and card: 25%
- Hard plastics 25%
- Food: 20%
- Wood: 10%
- Textiles: 5%
- Soft plastics 5%
- Metal 5%
- Glass 5%

The municipal waste incinerator generates 18,000 MWh of electricity each year and electricity generated from biogas at the landfill sites amounts to another 8,000 MWh.

How much bioenergy is produced each year from these facilities?



*Municipal solid waste incinerator, China*

## 5. Animal power

Jim Johnstone Forestry Co. in the United Kingdom recently replaced their forestry tractor with horses. They use these horses at production sites to take cut trees from inside the forest to the main road.

The horses have reduced the annual fuel consumption at the company by 6,000 litres a year, which is equal to about 235 gigajoules (GJ).

Considering the fuel that has been saved, is the company producing renewable energy and reducing its CO<sub>2</sub> emissions now?



Log extraction using horses, Johnstone Forestry, UK

## 6. Variable or intermittent energy resources

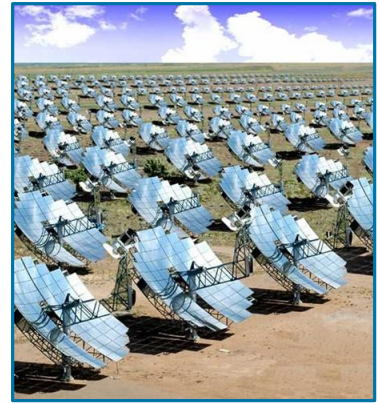
Which of the following types of renewable energy are variable resources? *(tick any that are variable)*

- Hydropower
- Tidal energy
- Ocean energy
- Wave energy
- Wind energy
- Solar PV
- Concentrated solar power
- Geothermal energy
- Bioenergy from bagasse
- Sugar cane ethanol



**7. CSPV, CSP and CST**

What are the differences between concentrated solar PV, concentrated solar power and concentrated solar thermal energy?



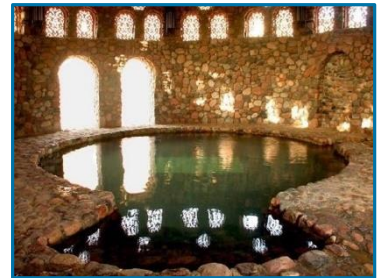
*Stirling Energy System's 300 MW solar power plant in California.*

**8. Geothermal springs (baths)**

A few kilometres outside the city of El Tur, a hot spring flows from the mountain of Gebel El Tur into a carved stone house known as the “*Lord Moses' bath*” or Hammam Moussa. The water from the spring has a constant temperature of 27° C and the bath is a popular tourist destination.

Can the water from such springs be considered as a type of renewable energy?

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*Hammam Musa (Moses' Bath), Egypt*

### 9. Deep water source cooling (air conditioning)

Deep water source cooling occurs when a large body of naturally cold water is used as a heat sink. Deep water in lakes, oceans and rivers has a temperature of 4-10° C all year round and, in summer, this can be pumped to the surface, passed through a heat exchanger and used for cooling. Such systems are already used in a number of large buildings around the World and in a district cooling system in Toronto, Canada (with a capacity of 207 MW).

Can this be considered as a type of renewable energy?



*Excelsior Hotel, Hong Kong, one of several hotels using seawater air conditioning*

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### 10. Electricity from renewables

Rank the main sources of renewable energy in terms of how well they can be used to meet varying electricity demands such as peak loads. (*high/medium/low*)

- Hydropower
- Marine energy
- Solar PV
- Concentrated solar power
- Wind energy
- Geothermal energy
- Bioenergy from solid biofuels
- Bioenergy from biogas

