

Transcript Lesson 1

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Welcome to the course Renewable Energy Integration in the Energy System. This course has been developed by the research group Energy in Transition of The Hague University of Applied Sciences. It aims to help you understand the complexity of integrating renewable energy into the energy system and to perform simple energy-related calculations.

The first lesson of this course, What Is Energy?, will concisely cover the basic concepts related to energy.

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The most used definition about energy is the ability to do work. However, this is just a part of what energy is, to have a more complete definition we could say that energy is the capacity of a system to produce heat, radiation, motion or matter. But if energy is heat, radiation, motion and even matter, then we can say that energy is everything.

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Energy is present in different forms. The energy forms fall in two basic categories, Potential energy (stored energy) and kinetic energy (energy in motion).

Forms of potential energy are:

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Chemical energy, like in food

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or fossil fuels.

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Potential mechanical energy, like in a compressed spring.

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Nuclear energy, the energy that holds the nucleus of an atom together.

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Gravitational energy, energy stored in an object's height.

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Forms of kinetic energy are: Radiant energy, like in electromagnetic waves.

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Thermal energy, the movement of the molecules within a substance.

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Motion energy, the energy related to the movement of objects.

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Sound energy, movement of waves within a substance.

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Electrical energy, the movement of electrons.

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Energy is a quantitative property. What means that we can calculate the amount of energy for each of the energy forms.

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The joule is the unit for energy in the International System on Units. However, many more units are of common use for energy. If we talk about food, we use calories. If we talk about electricity we use kWh, if we talk about energy use for heating in a house with a gas boiler we use cubic meter of gas and if we talk about trading of fossil fuel between countries we use the tonne oil equivalent. All of them are units of energy.

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Energy measurements are often big numbers. That is why often prefixes are used with the energy units.

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Energy allows us to do all kind of things, but as we can not create energy we need to harvest it from its sources. The main energy sources are the heat within the earth. The tidal movement. The sunlight and the heat released when splitting the nucleus of an atom. With this categorisation you probably miss plenty of energy sources, but this is because, sunlight is the origin of a few more energy sources.

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The sunlight heats the earth's atmosphere and surface. Because of the heating of the atmosphere and surface there is wind, and because of the heating of the water surfaces there is evaporation and precipitation. Also because of the sunlight there is biomass, and because of the biomass there are fossil fuels. All these energy sources are therefore a consequence of the sunlight, however as we talk of solar energy we will normally consider only the energy of the direct radiant light and heat from the sunlight.

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The law of conservation of energy states that "Energy can neither be created nor destroyed; energy can only be transferred from one place to another, or converted from one form to another."

This law is also known as first law of thermodynamics. This is a really important principle to understand energy.

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Energy transfer is the movement of energy from one location to another, without changing the energy form.

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For example, sunlight transfers energy from the sun to the earth.

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Energy conversion is when energy changes from one form to another.

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Like your body transform chemical energy of food into motion.

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There are numerous energy converters. Like a combustion engine, a wind turbine or a PV panel.

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The energy efficiency of an energy converter is the ratio between the energy input and the useful energy output. As energy can not be created or destroyed, the maximum energy efficiency is 1 or expressed in percentage 100%. However, most of the energy converters have a lower efficiency because part of the energy is dissipated to the surroundings.

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For example, the combustion engine of a car has an average energy efficiency of 20% when converting chemical energy of the gasoline into motion of the

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In case there is more than one energy conversion the useful energy output of a series of energy conversions can be calculated by multiplying the energy input by the efficiency of each step.

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Energy is not the same as power. Power is the rate at which energy is being converted or transferred.

As an example an old light bulb has a power of 100 Watt. The amount of energy converted during 1 hour is 360000 Joules, what is equal to 0,1 kilo Watt hour.

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The watt is the unit for power in the International System of Units. In the automotive industry horse power is also used as a power unit.

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With this lesson one of the module is finished. Tune in for lesson two on how we use energy and the challenge of the energy transition.

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These books and webpages have been used as a references to prepare this lesson.

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These are the images used on the slides.

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