Energy sources

References

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2-HANDBOOK OF ENERGY ENGINEERING by Albert Thumann et al

3- RENEWABLE ENERGY A First Course by Robert Ehrlich

4-Energy source by B. Viswanathan 2006.

5-Energy Storage A New Approach by Ralph Zito

1st lecture

Energy is the property that must be transferred to an object in order to perform work on, or to heat the object. Energy is a conserved quantity; the law of conservation of energy states that energy can be converted in form, but not created or destroyed. The SI unit of energy is the joule, which is the energy transferred to an object by the work of moving it a distance of 1 meter against a force of 1 newton.

WHAT ARE THE UNITS OF ENERGY?

The fact that energy exists in many forms is part of the reason why there are so many different units for this quantity—for example, calories and British thermal units (BTUs) are typically used for heat; Joules, ergs, and foot-pounds for mechanical energy; kilowatt-hours for electrical energy, and million electron Volts (MeV) for nuclear energy. However, since all these units describe the same fundamental entity, there must be conversion factors relating them all. To make matters more even confusing, there are a whole host of separate units for the quantity power, which refers to the rate at which energy is produced or consumed, i.e.,

$$p = \frac{dE}{dt} = \dot{E} \quad \text{or} \quad E = \int p\,dt \qquad (1.1)$$

Table 1.1 Some Units of Energy

Name	Definition
Joule (J)	Work done by a 1 N force acting through 1 m (also a watt-s)
Erg	Work done by a 1 dyne force acting through 1 cm
calorie (cal)	Heat needed to raise 1 g of water by 1°C
BTU	Heat needed to raise 1 lb of water by 1°F
Kilowatt-hour (kW-h)	Energy of 1 kW of power flowing for 1 h
Quad	A quadrillion (10^{15}) BTU
Therm	100,000 BTU
ElectronVolt (eV)	Energy gain of an electron moved through a 1 V potential difference
Megaton (Mt)	Energy released when a million tons of TNT explodes
Foot-pound	Work done by a 1 lb force acting through 1 ft

Note: A calorie associated with food is actually 1000 cal by the aforementioned definition or a kilocalorie (kcal). Sometimes 1 kcal is written as 1 Cal (capitalized C). Readers should be familiar with some of the more important conversion factors.

Note that a dot over any quantity is used as shorthand for its time derivative. Many power and energy units unfortunately sound similar, e.g., kilowatts are power, whereas kilowatt–hour (abbreviated kW-h) is energy (Table 1.1).

Electric power plants are rated according to the electric power they produce in Megawatts (MW), but for the most part they charge residential customers merely for the total energy they consume in kW-h, and not the rate at which they use it, or the time of day you use it. The situation is often very different for large consumers, where these factors are taken into account. Moreover, in order to smooth out their demand, some electric utilities actually do allow residential customers to pay a special rate if their usage tends to be very uniform, and in another plan they bill for very different rates for on-peak and off-peak usage. These special pricing options aside, the utility company charges you the same price to supply you with 100 kWh of energy, whether you use it to light a 100 W bulb for 1000 h or a 200 W bulb for 500 h.

The basic unit of power, or flow of energy per unit of time, is the watt (W), which is equivalent to the flow of 1 J of energy per second. Therefore

1 W = 1 J/s

A convenient alternative measure of energy is the flow of 1 W for an hour, which is denoted 1 watthour (Wh). A commonly used measure of electrical energy is the

kilowatthour, which is abbreviated kWh and consists of 1000 Wh. Since both joules and watthours are units of energy, it is helpful to be able to convert easily between the two. The conversion from watthours to joules is calculated as follows:

$$(1\ \mathrm{Wh})\left(3600\frac{\mathrm{s}}{\mathrm{h}}\right)\left(\frac{1\ \mathrm{J/s}}{\mathrm{W}}\right) = 3600\ \mathrm{J}$$

The quantity of energy in an electrical current is a function of the current flowing, measured in amperes (A), and the change in potential, measured in volts (V). The transmission of 1 W of electricity is equivalent to 1 A of current flowing over a change in potential of 1 V, so

1 W = 1 VA

The unit voltampere (VA) may be used in place of watts to measure electrical power.

Sources of energy

Conventional sources of energy are those that have been well-established and form a significant portion of world energy production. Alternative sources are those that have been proposed but are not yet significant producers. Renewable forms of energy are those that are or can be replenished through naturally-occurring processes. Sustainability is another way of looking at the energy usage and depletion problem. Resilience is a term that is also being used in this area to refer to the time-response with respect to an external man-made or natural disturbance.

Or can be categorized such as

1.primary energy

Primary energy is the energy extracted or captured directly from the environment.

Three distinctive groups of primary energy are:

• Nonrenewable energy (fossil fuels): coal, crude oil, natural gas, nuclear fuel.

• Renewable energy: hydropower, biomass, solar energy, wind, geothermal, and

ocean energy.

• Waste.

Primary sources of energy consisting of petroleum, coal, and natural gas amount to about 85% of the fossil fuels in primary energy consumption in the world Projected energy use in the world shows that petroleum, coal, and natural gas will still be the dominant energy sources by 2035 (Fig. 1.1). The principle of supply and demand suggests that as fossil fuels diminish, their prices will rise and renewable energy supplies, particularly biomass, solar, and wind resources, will become sufficiently economical to exploit. Figure 2.3 shows the primary energy flow in the US. The energy content may be converted to ton of oil equivalent (TOE): 1TOE = 11630 kWh = 41870 MJ.

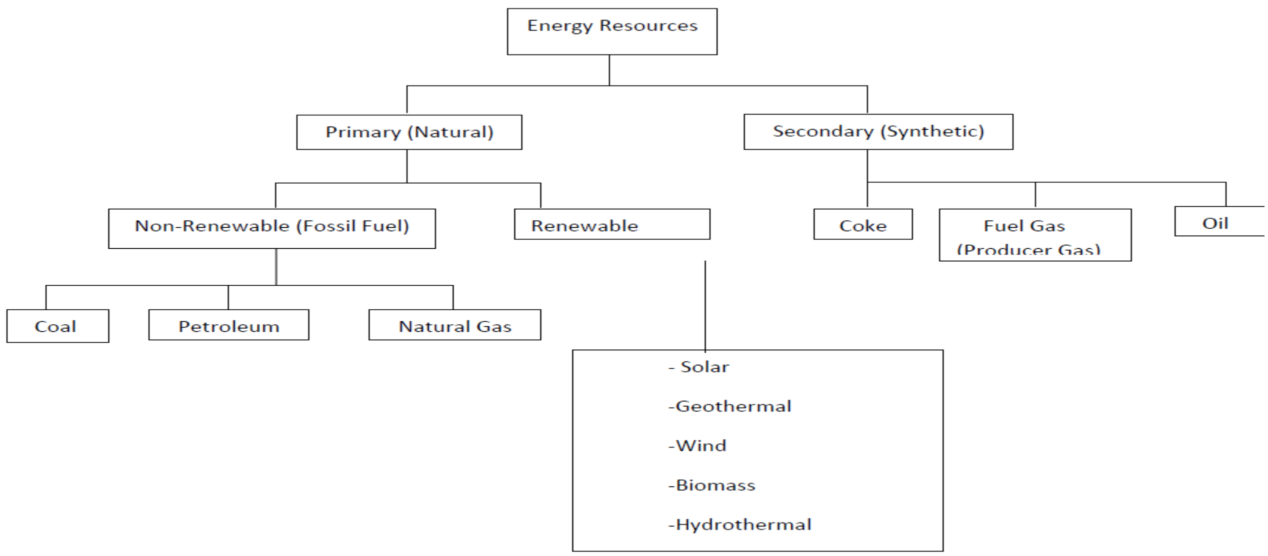

Fig.1.1. Sources of energy

2. Secondary Energy

The primary energy is transformed to secondary energy in the form of electrical energy or fuel, such as gasoline, fuel oil, methanol, ethanol, and hydrogen. The primary energy of renewable energy sources, such as sun, wind, biomass, geothermal energy, and flowing water is usually equated with either electrical or thermal energy produced from them. Final energy is often electrical energy and fuel, which is referred to as useful energy. The selected four types of final energy are electrical, thermal, mechanical, and chemical energy. These types of final energy set a boundary between the energy production and the consumption sectors

Example 1

Suppose during a test of a nuclear reactor, its power level is ramped up from zero to its rated power of 1000 MW over a 2 h period, and then after running at full power for 6 h, it is ramped back down to zero over a 2 h period. Calculate the total energy generated by the reactor during those 10 h.

Solution

We shall assume here that during the time which the power is ramped up and down it varies linearly, so that the power the reactor generates varies accordingly during the 10 h test as shown in Figure 1.2. Based on Equation 1.1, and the definition of the integral as the area under the power–time curve, the energy must equal the area of the trapezoid in Figure 1.2 or 8000 MWh (Table 1.2).

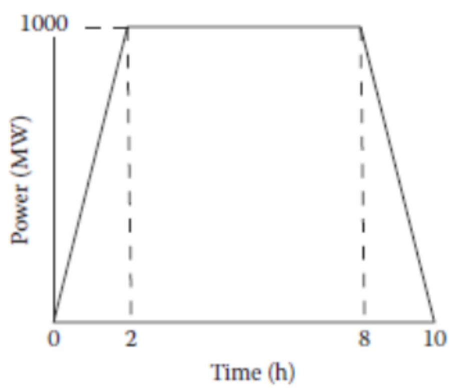

Fig. 1.2 Energy distribution

Table 1.2 Some Common Prefixes Used to Designate

Various Powers of 10 Terra (T) 1012

Giga (G) 10^{+9}

Mega (M) 10^{+6}

Kilo (k) 10^{+3}

Milli (m) 10^{-3}

Micro (μ) 10^{-6}

Nano (n) 10^{-9}

Pico (p) 10^{-12}

Example 2

A portable electric generator that is powered by diesel fuel produces 7 kWh of electricity during a single period of operation. (A) What is the equivalent amount of energy measured in MJ? (B) Suppose the fuel consumed had an energy content of 110 MJ. If the device were 100% efficient, how much electricity would it produce in wh?

Solution

(A) 7 kWh × 3.6 MJ/kWh = 25.2 MJ

(B) 110 MJ/3.6 MJ/kWh = 30.6 kWh

In order for an energy resource to be reliable, it must, first of all, deliver the service that the consumer expects. Secondly, it must be available in the quantity desired, when the consumer wishes to consume it (whether this is electricity from a wall outlet or gasoline dispensed from a filling station). Lastly, the resource must be available at a price that is economically affordable.

WHAT EXACTLY IS THE WORLD’S ENERGY PROBLEM?

1-All sources of energy have some environmental impact, but as you

are aware the impacts of different sources vary considerably.

2-The energy sources people, worry the most about are fossil fuels (coal,

Oil, and gas) as well as nuclear, while the renewable (“green”) energy

sources are considered much more benign—even though they too have

some harmful impacts.

3-Moreover, the environmental impact of fossil fuel and nuclear energy usage has gotten worse over time, as the human population has grown, and the energy usage per capita has also grown—an inevitable consequence of the rise in living standards

Worldwide.

Figure 1.3, shows the consumption of energy

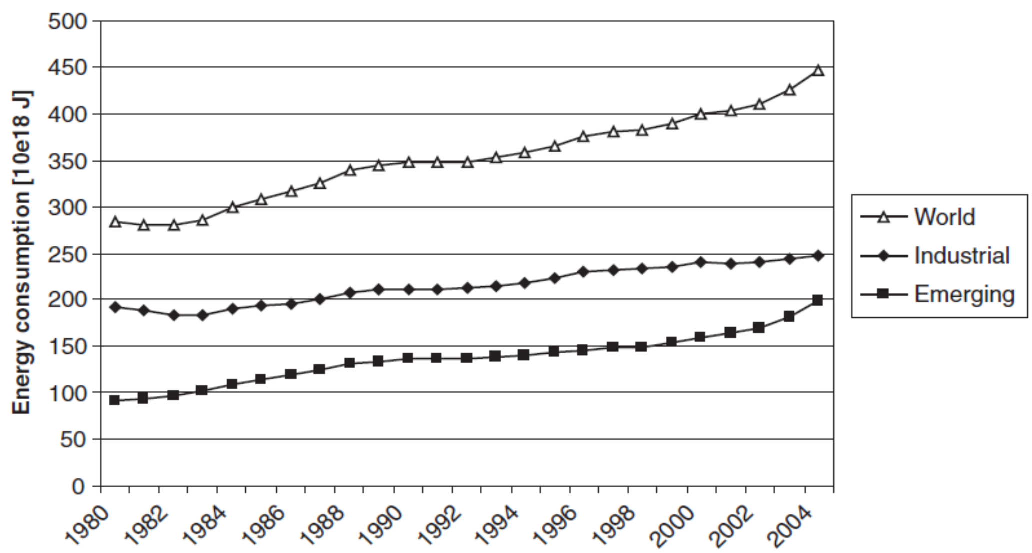

Figure 1.3. Energy consumption classification