What is Energy law?

Energy law is the field of law concerned with creating, enforcing and challenging laws that regulate energy use. Laws exist that regulate the creation and harvesting of energy. There are laws that regulate taxation of energy use. Energy companies and the public alike must navigate energy laws as they relate to the sale, use and conservation of energy resources.

Many people don't realize how much energy laws and regulations impact their daily life. Each time you put gasoline in your vehicle, you're paying energy taxes. When you sell a vehicle or renew your license plate, you pay fees to the state you live in. When you use power in your home, you're using energy from a power plant that complied with regulations to conduct business. There are energy laws at federal, state and even local levels. Energy laws and policies even impact international relations.

The development of federal energy laws

Most energy laws come from the U.S. Department of Energy. Until the 1920s, energy consumption went on largely unregulated in the United States. Beginning in the 1920s with the Federal Power Act of 1920, the United States began to heavily regulate energy use nationwide. Before then, Americans largely saw energy as a unlimited resource. As they began to realize that natural energy resources are limited, public support began to grow for regulations that regulate and ration energy use. Later legislation included the Manhattan Project of the 1940s and the Atomic Energy Act of 1946. Lawmakers also amended the Federal Power Act of 1920 in 1935 and 1986.

The 1977 Department of Energy Organization Act created the Department of Energy and the Federal Energy Regulatory Commission. The U.S. Department of Energy is a run by a member of the U.S. President's cabinet. The purpose of the Department of Energy is to regulate responsible use of domestic energy and protect national security as it relates to energy development and use.

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Areas of energy regulation

Nuclear power

One significant area of federal regulation is nuclear power. Nuclear power is important for the U.S. economy. It's also critically important for national security. The U.S. Nuclear Regulatory Commission oversees the use of nuclear power for energy and nuclear power as it relates to national defense.

Development of clean energy

The Energy Policy Act of 2005 provides for tax incentives and loan guarantees for companies and individuals who develop and produce clean energy. The law also extends daylight savings time in an effort to save energy. The Act extends U.S. policies that offer rebates and incentives for green energy use.
The Car Allowance Rebate System, commonly known as the Cash for Clunkers program, followed the Energy Policy Act in 2009 to incentivize vehicle owners to scrap their gas-guzzling vehicles in favor of more fuel-efficient models. In addition, U.S. federal policy encourages the development of clean energy through the Department of Energy's Office of Energy and Renewable Energy. The office operates with a $2.3 billion annual budget and invests its resources in hybrid technology, research and energy innovations.

A site evaluated for a wind farm is observed to have steady winds at a speed of 8.5 m/s (Fig. 2–10). Determine the wind energy (*a*) per unit mass, (*b*) for a mass of 10 kg, and (*c*) for a flow rate of 1154 kg/s for air.

Solution A site with a specified wind speed is considered. Wind energy per unit mass, for a specified mass, and for a given mass flow rate of air are to be determined.

Assumptions Wind flows steadily at the specified speed.

Analysis The only harvestable form of energy of atmospheric air is the kinetic energy, which is captured by a wind turbine.

(*a*) Wind energy per unit mass of air is

$$e = \mathrm{ke} = \frac{V^2}{2} = \frac{(8.5\ \mathrm{m/s})^2}{2}\left(\frac{1\ \mathrm{J/kg}}{1\ \mathrm{m^2/s^2}}\right) = \mathbf{36.1\ J/kg}$$

(*b*) Wind energy for an air mass of 10 kg is

$$E = me = (10\ \mathrm{kg})(36.1\ \mathrm{J/kg}) = \mathbf{361\ J}$$

(*c*) Wind energy for a mass flow rate of 1154 kg/s is

$$\dot{E} = \dot{m}e = (1154\ \mathrm{kg/s})(36.1\ \mathrm{J/kg})\left(\frac{1\ \mathrm{kW}}{1000\ \mathrm{J/s}}\right) = \mathbf{41.7\ kW}$$

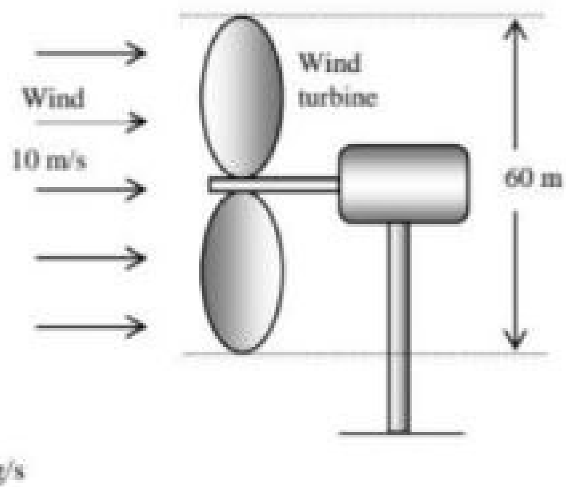
Discussion It can be shown that the specified mass flow rate corresponds to a 12-m diameter flow section when the air density is 1.2 $\mathrm{kg/m^3}$. Therefore, a wind turbine with a wind span diameter of 12 m has a power generation potential of 41.7 kW. Real wind turbines convert about one-third of this potential to electric power.

2-12 Wind is blowing steadily at a certain velocity. The mechanical energy of air per unit mass and the power generation potential are to be determined.

Assumptions The wind is blowing steadily at a constant uniform velocity.

Properties The density of air is given to be $\rho = 1.25\ \text{kg/m}^3$.

Analysis Kinetic energy is the only form of mechanical energy the wind possesses, and it can be converted to work entirely. Therefore, the power potential of the wind is its kinetic energy, which is $V^2/2$ per unit mass, and $\dot{m}V^2/2$ for a given mass flow rate:



$$e_{\text{mech}} = ke = \frac{V^2}{2} = \frac{(10\ \text{m/s})^2}{2}\left(\frac{1\ \text{kJ/kg}}{1000\ \text{m}^2/\text{s}^2}\right) = 0.050\ \text{kJ/kg}$$

$$\dot{m} = \rho VA = \rho V\frac{\pi D^2}{4} = (1.25\ \text{kg/m}^3)(10\ \text{m/s})\frac{\pi(60\ \text{m})^2}{4} = 35{,}340\ \text{kg/s}$$

$$\dot{W}_{\max} = \dot{E}_{\text{mech}} = \dot{m}e_{\text{mech}} = (35{,}340\ \text{kg/s})(0.050\ \text{kJ/kg}) = \mathbf{1770\ kW}$$

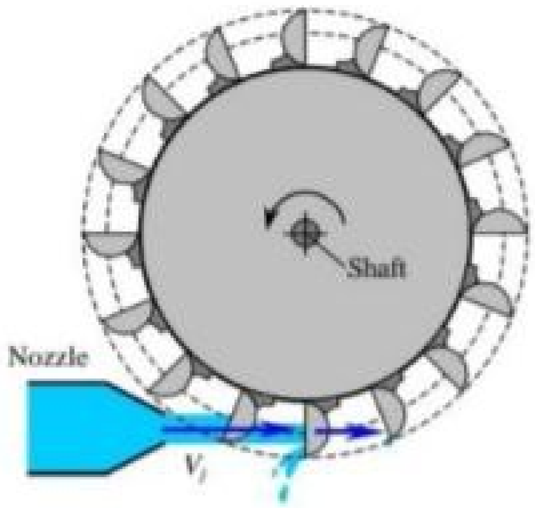
Therefore, 1770 kW of actual power can be generated by this wind turbine at the stated conditions.

Discussion The power generation of a wind turbine is proportional to the cube of the wind velocity, and thus the power generation will change strongly with the wind conditions.

2-13 A water jet strikes the buckets located on the perimeter of a wheel at a specified velocity and flow rate. The power generation potential of this system is to be determined.

Assumptions Water jet flows steadily at the specified speed and flow rate.

Analysis Kinetic energy is the only form of harvestable mechanical energy the water jet possesses, and it can be converted to work entirely. Therefore, the power potential of the water jet is its kinetic energy, which is $V^2/2$ per unit mass, and $\dot{m}V^2/2$ for a given mass flow rate:



$$e_{\text{mech}} = ke = \frac{V^2}{2} = \frac{(60\ \text{m/s})^2}{2}\left(\frac{1\ \text{kJ/kg}}{1000\ \text{m}^2/\text{s}^2}\right) = 1.8\ \text{kJ/kg}$$

$$\dot{W}_{\max} = \dot{E}_{\text{mech}} = \dot{m}e_{\text{mech}}$$

$$= (120\ \text{kg/s})(1.8\ \text{kJ/kg})\left(\frac{1\ \text{kW}}{1\ \text{kJ/s}}\right) = \mathbf{216\ kW}$$

Therefore, 216 kW of power can be generated by this water jet at the stated conditions.

Discussion An actual hydroelectric turbine (such as the Pelton wheel) can convert over 90% of this potential to actual electric power.

1.90E The mass of a substance is given. Its weight is to be determined in various units.

Analysis Applying Newton's second law, the weight is determined in various units to be

$$W = mg = (1\text{ kg})(9.81\text{ m/s}^2)\left(\frac{1\text{ N}}{1\text{ kg}\cdot\text{m/s}^2}\right) = \mathbf{9.81 N}$$

$$W = mg = (1\text{ kg})(9.81\text{ m/s}^2)\left(\frac{1\text{ kN}}{1000\text{ kg}\cdot\text{m/s}^2}\right) = \mathbf{0.00981 kN}$$

$$W = mg = (1\text{ kg})(9.81\text{ m/s}^2) = \mathbf{1 kg\cdot m/s^2}$$

$$W = mg = (1\text{ kg})(9.81\text{ m/s}^2)\left(\frac{1\text{ N}}{1\text{ kg}\cdot\text{m/s}^2}\right)\left(\frac{1\text{ kgf}}{9.81\text{ N}}\right) = \mathbf{1 kgf}$$

$$W = mg = (1\text{ kg})\left(\frac{2.205\text{ lbm}}{1\text{ kg}}\right)(32.2\text{ ft/s}^2) = \mathbf{71 lbm\cdot ft/s^2}$$

$$W = mg = (1\text{ kg})\left(\frac{2.205\text{ lbm}}{1\text{ kg}}\right)(32.2\text{ ft/s}^2)\left(\frac{1\text{ lbf}}{32.2\text{ lbm}\cdot\text{ft/s}^2}\right) = \mathbf{2.21 lbf}$$

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