Buletinul Ştiinţific al Universităţii POLITEHNICA Timişoara

Seria HIDROTEHNICA
TRANSACTIONS on HYDROTECHNICS

Tom 59(73), Fascicola 1, 2014

Correlation between water and energy

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Abstract:
The energy sector is a major consumer of water in the world and through this paper we intend to approach the inseparable relationship between water and energy.
The water deficit, the diseases caused by untreated drinking water, population growth, rising costs for energy, stricter legislative changes in water, the need for solid infrastructure are just some of the challenges that are based on water and energy issues. Water is needed in the energy sector for each stage of the extraction, production, and refining, processing, transportation, storage and energy production. It takes energy to pump water from the underground, for the treatment, storage, transportation and distribution of the water. Water's footprint is another important aspect of water resources management that we will refer to in this paper. Water resources and energy have a significant contribution to socio-economic development, the need to find solutions for sustainable management will be one of the biggest problems in the upcoming years.
Keywords: energy, water, water deficit, water resources management, water footprint

1. INTRODUCTION

The water-energy relationship is interdependent and the actions undertaken in a sector affects positively or negatively the other sector. Because the water has a very important role in energy production, water requirement varies depending of the type of the energy industry.

Water is needed in the energy sector for each stage of the extraction, production and refining, processing, transportation, storage and distribution. Population growth and economic development are aspect that puts pressure on water resources.

Energy is used to obtain water in the catchment, treatment, storage, transport and distribution, as shown in fig 1.

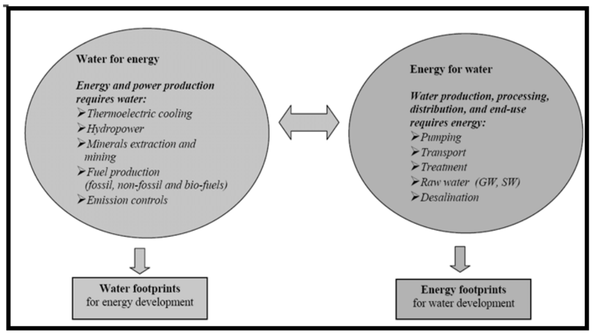

Figure1**.** The relationship between energy and water [4]

2. WATER FOR ENERGY AND ENERGY FOR WATER

The water used in fossil fuels extraction

Energy can be found in abundance in fossil fuels and radioactive minerals. Water is used in surface and underground mines for dust suppression, processing, treatment and cooling process, being transported by tanker or pipelines which can get up to ten kilometers long.

The water used in fossil-fuelled power stations

Water consumption in power plants is given by the amount of water used in the cooling process. The water used for cooling and for heating was discharged into an emissary. This practice is now replaced by reducing pollution of the receiving water through the evaporation of a part of the water and transferring the heat to the air.

Water used in natural shale gas production

Water is a necessary element for the production of natural gas found in bituminous shale formations. It is used in drilling and hydraulic fracturing process that releases the gas. The choice of water type (surface water, treated wastewater or water reuse in fracturing operations) depends on a number of factors, including availability, water quality requirements and characteristics of the formation to be fractured. The protection of groundwater report conducted by the U.S. Department of Energy show that the amount of water used per unit of energy produced from shale gas

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(0.02 l / kWh) is quite small compared with other sources such as nuclear energy (0.17 l / kWh), oil (0.22 l / kWh), coal (0.36 l / kWh), ethanol from corn (245.09 l / kWh) or biodiesel from soybean (690.28 l / kWh). [1]

Water used in uranium production

Uranium is a metal that has played an important role in the development of nuclear energy through its ability to release energy. Uranium is widespread in nature in the form of various types of minerals (pitchblende, uranite, torbanite, etc.). In nuclear reactors it is used as an energy source for power generation.

Uranium production represents approximately 13% of primary energy worldwide. In 2010, there were processed over 60,000 tons of uranium. They supplied the nuclear reactors which consumed about 74 million m3 of water and generated over 2,600 TWh of electricity.

Figure 2. Uranium processing

Water used in biomass energy production

The biomass energy is the energy that can be produced through the use of biomass. The amount of water required for irrigation dependent very much on local conditions and the type of plant. The largest biomass plant in Romania was opened in 2009 in Radauti, having a total capacity of 22 MW from which 17 MW as thermal energy and 5 MW as electricity. The investment was of 20 million Euros. In Romania, there are some other similar plants in Brasov, Sebes and Suceava.

Figure 3**.** Biomass energy

Water used in geothermal energy production

Geothermal energy is used for thousands of years, for space heating, thermal spas, industrial and electricity generation.

As available geothermal potential Romania is in the 3rd place in Europe after Greece and Italy, but the geothermal resources are not fully exploited although the geothermal energy is being used for more than 100 years in the Carpathian Mountains - in Bihor County. This is explained by the lack of financial resources in the energy sector. Currently, approximately 5,500 homes in Oradea and Beius towns are heated by using geothermal energy which is the most common form of alternative energy around the globe. It is renewable and ecological. Although it requires high initial cost, the exploitation costs are low. Considering this, the geothermal energy has the advantage that it can be exploited anywhere in the world if is available.

Figure 3. Geothermal energy

The water used in the hydraulic energy production

Dams are hydro technical constructions that perform multiple functions including power generation and flood control. Hydropower is actually a mechanical energy formed by the potential energy of water given by the level difference between the lake and the power plant and by the kinetic energy of moving water.

Figure 4**.** Hydraulic energy

Energy for water

Pumping, treatment, distribution and use of water as well as collection and treatment of wastewater require high energy consumption. Amounts of energy currently used to capture, treat, store, distribute and purify wastewater is less than about 6% of electricity in the world, which is equivalent to less than 3% of primary energy consumption in the world. This number excludes the Energy end uses (water heated, food, hygiene) and the water used in industrial processes.

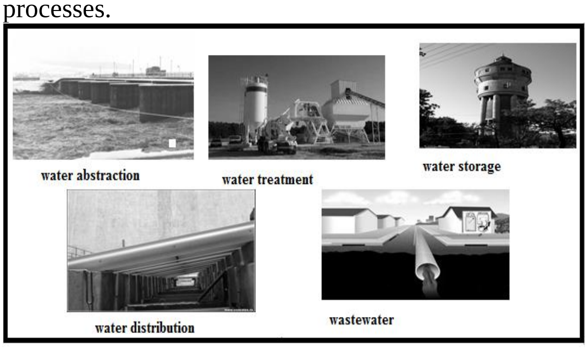

Figure 5**.** Energy for water

Energy for the desalination process

Seawater desalination allows supplementation of freshwater resources and provides a solution to drought and crisis management. Desalination is a process for the separation of salt from water.

It is a necessary process in areas where fresh water is not available. Desalination can be done by distillation, reverse osmosis or electro dialysis reverse. The cost of electricity for desalination, ranging from 0.5 - 8.5 kWh / m^3 and depend on the method used for desalination.

Figure 6. The desalination process

3. RELATION OF WATER CONSUMPTION – ENERGY

According to a report by the Virginia Water Resources Research Center in 2011, the quantity of water in liters to produce 1000 kw are summarized in the tables below.

Table 1. The amount of water to produce energy l/1000 Kw [5]

Fuel Source	Efficiency (liters per 1000 kilowatt-hours)
Natural gas	38
Synfuel: coal gasification	144–340
Tar sands	190–490
Oil shale	260–640
Synfuel: Fisher-Tropsch	530–775
Coal	530–2100
Hydrogen	1850–3100
Liquid natural gas	1875
Petroleum/oil-electric sector	15 500–31 200
Fuel ethanol	32 400–375 900
Biodiesel	180 900–969 000

Table 2. The amount of water to produce energy l/1000 Kw [5]

Power Generation Technologies	Efficiency (L/1000 KWh)
Hydroelectric	260
Geothermal	1680
Solar thermal	2970–3500
Fossil fuel thermoelectric	14 200–28 400
Nuclear	31 000–74 900

As we can see in the table 1, biodiesel is the largest consumer of water, requiring more than 180,000 liters of water to make 1000 kw energy.

In this amount of water is contained the water need for cultures irrigation and the conversion of leguminous plants in the fuels.

In this paper we also refer to an important aspect of water resources management that is water footprint.

Water footprint for a person or for a community is defined as the total volume of freshwater used to produce goods and services consumed by the person or community.

The water footprint can be calculated for any well-defined group of consumers (individual, family, village, city, province, and nation) or producers (a public, private enterprise or economic sector).

Water footprint is a geographic indicator and the volume of water used is dependent on the location of the source.

To illustrate the track parameters in the calculation we used a water footprint calculator developed by the people from National Geographic, available on [3]

The program has 4 sections that are: Section 1 refers to the amount of water used for maintenance (showers, laundry, etc.); Section 2 refers to the amount of water used for food preparation (ranging and water in meat or milk products); Section 3 refers to the amount of water to produce energy and for transportation; Section 4 refers to the amount of water in purchased products (clothes, furniture, appliances). Results are compared with average consumption / day for an US citizen.

Data included were the following:

Section 1

-Code for Timis county 40256
- Number of persons: 3
- Year of construction of the house: before 1994
- No changes (replacements) on tap, toilet, shower:
- Average of showers per week 6 / person
- During a shower: 8 minutes
- Top-loading washing machine: 4 washes / week
- No dishwasher
- House with no yard and no pool

Section 2

- Consumption of beef 4 portions / week;
- 3 portions of poultry meat consumption / week;
- 3 portions pork consumption / week;
- 1 cup milk / day;
- 1 cup coffee / day;

Section 3

- Average fuel-efficiency of the car in miles/gallon (1gallon= 3,785 l): 20 mpg;
- Miles 12,000 miles (1 mile= 1.609,344 m) /year;
- A flight up to 500 miles altitude;
- Electric energy without alternative;
- Normal luminously home;

Section 4

- Shopping for $ 900 / year for clothes and shoes;
- No charges on mobile;
- $ 750 / year for electronics and electrical;
- $ 50 / month for the stationery;

The results obtained are shown in the figure below. It can be seen that the person from the study case consume a larger amount of water than the average US Citizen which is 700 gallon(1 gallon= 3,785 l) / day / person. This can be explained by the inexistence of alternative sources of energy considerate for the study case. If we take into account the existence of alternative sources (solar panels) consumption is reduced to the half.

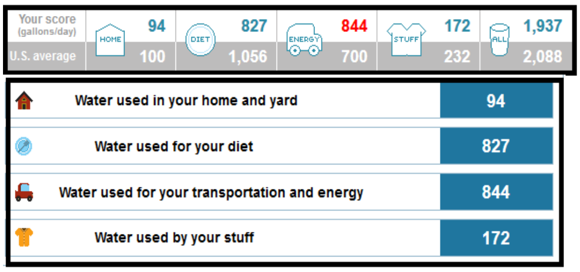

Figure 7. Calculation of the water footprint

4. CONCLUSIONS

The main challenges of the present (drought, climate change, natural resource scarcity, population growth) show up two "critical resources" - water and energy. In this paper we want to emphasize the interdependence of water and energy, "inseparable twins", as are found in the literature.

Without water we cannot produce energy. Even same of as consider that water is an endless resource due to the natural circle of water in nature a bad management or even the careless regarding the water can conduct to water depreciation.

The purpose of work is to highlight this relationship, contributing to a more efficient management of water resources and energy conservation in our country.

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