

Going green : focus on energy

Renewable resources



It's only up to us how we face it.

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1. Introduction

My name is Pavel Kabele, I'm 17 years old. I live in Heřmanův Městec. I am in my sixth year of study at the Josef Ressel Grammar School in Chrudim, Czech Republic. The issue of environment and energy has always been of great interest to me.

2. Renewable energy resources

Going green : focus on energy

Renewable energy resources - sources for the next generations

It is possible to obtain sufficient quantities of clean energy through renewable resources?
It's only up to us how we face it.

3. Total energy consumption

Energy consumption is rising; the living standards of a limited group of people are increasing but the inhabitants of our planet are affected by adverse effects. This situation applies to all of us. According to a statement of the Prime Minister Topolánek, energy consumption in the last year grew by 1.2%. According to Atlantik FT analyst Petr Novák, we can expect a slump in energy consumption for the current year, by 3 per cent in total. The main reason for the expected slump is a lower consumption of smaller businesses because of the crisis.

4. CO₂ greenhouse gas > global warming

Carbon dioxide is one of the factors of the greenhouse effect. It has always been part of the atmosphere of the Earth. Excessive production of CO₂ is a global problem. In the course of the last year, the production grew by 3% globally. The Czech Republic belongs among the greatest producers of CO₂ per person in the EU. Estonia ranked first, with the production of 15.4 tons. The Czech Republic (9 tons) is followed by Finland (8.8 tons), Luxembourg (8.8 tons) and Slovakia (6.6 tons). In Germany, the industry is governed by an upper limit of 6.1 tons per person, and in Austria, the upper limit allowed is 4.1 tons.

Carbon dioxide is a common part of the atmosphere of the Earth; its concentration (on average, 0.038% in 2004) in the atmosphere varies, depending on local conditions, altitude above the Earth's surface, and relative humidity of the air. As a result of industrial emissions, in particular, its average concentration in the air is rising.

Coal plants are in deficit merely by the fact that the fuel coming into the power plants is always produced at the cost of total devastation of the countryside. The effect of the coal combustion process, moreover, is low, ranging from 30 to 41 per cent.

Despite the measures undertaken in the 1990s and significant investment in the process of desulphurisation of the power plants and their surroundings (50 billion Czech crowns), the plants continue to produce CO₂.

5. Production in the vicinity of my place of residence

The whole district has 105 640 inhabitants, and its area is 102 990 ha. The inhabitants are presently scattered in 112 municipalities, most of which are located in the mountains (Železné hory). The main centres of the region are Hlinsko and Chrudim.

The number of cars within the district is 97 600 in total. Currently, there is no significant industrial site in the district. Heřmanův Městec where I live is a minor town, which ranks second as far as the amount of green areas per an inhabitant are concerned.

The production of CO₂ per a car and 1 km of ride is, on an average, 160 grams (cars of minor cubatures are predominant).

Transport: with the average quantity of consumed kilometres amounting to 15 000 km / year, the total production of these cars is 234 240 tons of CO₂.

Power plants: the main supplier of energy and partially also of heat is the power plant in Opatovice. With the annual production of 2 012.4 GWh, the plant produces 2 012 400 tons of CO₂ (unfortunately, the precise share of the produced energy that goes outside the district cannot be specified).

Households: there are 36 950 households within the district. If 40% of all households used gas and 60% of households used coal for heating (provided that only common houses, with up to 75 sq. m of space used, were calculated), then the production would be 210 615 tons of CO₂. The average consumption calculated is 100 kWh per 1 sq. m.

Most damaging is the burning of coal in thermal power plants (production of 1000 kg of CO₂ / 1 MWh of energy derived), the second is oil (of 800 kg CO₂ / 1 MWh of energy derived), natural gas are as already seen from the chemical structure of methane to the least harmful fosilnímu fuel (about 400 kg of CO₂ / 1 MWh of energy derived).

Burning of coal in thermal power plants (production of 1000 kg of CO₂ / 1 MWh of energy derived) is most damaging; then comes oil (production of 800 kg CO₂ / 1MWh of energy derived); one of the least harmful fossil fuels is natural gas, which can be easily seen from the chemical structure of methane (production of about 400 kg CO₂ / 1Mwh of energy derived).

The total production of these main polluters amounts to 2 457 255 tons of CO₂.

6. The consequences of global warming

Global warming has many side effects, such as melting glaciers. In 30 years, the area of the glaciers has decreased from 8 to 5.5 million sq. km. As a consequence, the natural habitat of polar bears and other animal species is disappearing, ocean levels are rising, and the coastal areas are being flooded. Further consequences include large desertification and greater fluctuations in weather.

This is evident even in my surroundings: the groundwater resources decreasing as a result of uneven rainfall, or the occurrence of tornadoes (25.6.2008, a devastating tornado appeared in part of the district).

7. Renewable energy resources again

Renewable energy resources stand for certain forms of energy resources, accessible on the Earth, primarily coming from the nuclear transformations in the bowels of the Sun. Further resources include the warmth of the Earth's bowels, and the inertia of the Earth-Moon system. People can derive the energy from these sources in the form of, for instance, solar radiation, wind energy, water energy, tidal energy, geothermal energy, biomass etc.

The definition of renewable resources according to Czech law on the environment is: *"When consumed gradually, renewable natural resources have the ability to renew themselves fully or partially, either alone, or with the assistance of man."*

EU Summit, held in Brussels on 8th – 9th March of this year, brought along ambitious goals in the field of energy and environment. Representatives of the negotiating parties made a committment to reduce greenhouse gas emissions by at least 20 per cent by the year 2020, as compared to 1990, and to use at least 20 per cent of

renewable resources within the total of energy resources to cover the energy consumption of the European Union.

8. Resources less favourable in our conditions

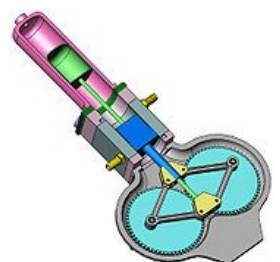
Solar Power: the energy potential in Central Europe is about 1 MWh derived of 1 sq. m of lighted area.

Due to the relatively low efficiency of the conversion, the real amount is significantly lower (almost by an entire order of magnitude if converted to electricity). For an average family house (of some 100 sq. m), this fact does not represent such a crucial limitation; one half of a gable roof facing south gets some 70 MWh a year while the amount of energy consumed in the house is lower than approximately 15 MWh in the form of heat and 6 MWh in the form of electricity.

Stirling engine: the engine has two working chambers, allowing gas to flow freely between them (both are practically of the same pressure within). One of the areas is cold, the second one is hot. This is achieved either by direct heating and cooling of chambers, or, which is more frequent, with the help of an external heater and cooler. There is a regenerator, usually located between the heater and cooler, which accumulates heat from the gas that flows from the heater to the cooler, or vice versa.

The engine

1. Both pistons move together; the heated expanding gas in the hot area works.
2. The managing piston begins to expel the gas from the hot to the cold chamber. The total volume remains unchanged; thus no work takes place. The gas is cooled in the cold area, causing that the pressure of the cylinder decreases.
3. The working piston starts pressing the gas in the cold area. The pressure has decreased because of the cooling, thus the work performed is lower than during the expansion.
4. The compressed cold gas penetrates into the hot chamber in order to expand again when heated.



There are many modifications of the engine - the pistons may be located in separate cylinders or in a single cylinder with one of the pistons working in a double mode.

The main advantage is the fact that this engine can work with a variety of external sources of heat energy. These sources include geothermal or solar energies, as well as fossil fuels or biomass. Thermal efficiency of the engines with power of 1 to 25kW ranges from 25 to 33%. Energy efficiency ranges from 18 to 22%. Other advantages include quiet operation, high durability, and minimal possibility of failure.

In theory, this engine could also operate with greater efficiency, and thus contribute to energy saving and nature protection; however, in practice, the attempts have been failing so far as it is fairly difficult to achieve high operating temperature.

Its disadvantages include poor controllability and low readiness to operate. Furthermore, the engine needs quite a large cooler with a powerful fan, and to achieve high efficiency, it must operate with high gas pressures.

Formerly, the working gas used was air. Today, thanks to their higher thermal conductivity and lower occurrence of turbulent losses, helium or hydrogen are preferred.

Wind power plants: at present, the companies specialized in the construction of wind power plants compete among themselves in acquiring sites for the implementation of their projects, even if the wind conditions are not ideal. The reason is simple: since last August, a new law on renewable resources has come into effect, which grants the producers of wind energy very favourable, firmly set purchase prices for the period of the fifteen following years. However, it is certain that when the period is over, the wind power plants will no longer be profitable, due to low wind speed.

In our region, there is no such place for wind power that would have an average wind speed higher than 6 m per second.

Geothermal power plants: based on the thermal energy of the Earth's bowels, which is created during the decay of radioactive substances. The energy is demonstrated by eruptions of geysers and volcanoes, hot springs or steam outflows. It is used in the form of thermal energy (for heating), or for production of electricity in geothermal power plants. Usually, it is included among renewable energy sources, yet it is not true in all cases, however, as some geothermal energy resources are depletable within decades. Geothermal energy is the oldest energy on our planet because it is a kind of energy that the Earth received in the process of birth from the parent nebula, and from subsequent clashes of cosmic bodies. Today, the energy is partially generated by

radioactive decay of some of the elements in the Earth's body. Under favourable conditions, this energy can be used for heating or for production of electricity in geothermal power plants. Nevertheless, such use is technologically challenging mostly because the hot water from the wells is usually strongly mineralized, clogging the technological equipment, which results in the need of frequent replacement of the pipes and system cleaning. Moreover, a sufficient thermal gradient is usually also linked to the geological instability of the area, which places high demands on quality constructions that can withstand earthquakes. In a larger scale, this energy is widely used for example in Iceland, where it is used for heating of residential buildings, greenhouses, public buildings, swimming pools, heating of sidewalks to make the winter care easier, and even for growing of bananas or other tropical fruits.

In the Czech Republic, geothermal energy is applied, for example, in the town of Ustí nad Labem, where it is used to heat swimming pools, and since 2006, also to heat the town zoo.

Since November 2006, the town of Litoměřice has been drilling a test well for geothermal power, which should go as deep as 2500 m below the Earth's surface. If the measurement results are favourable, another two wells will be drilled – this time already for production. These drills are supposed to go as deep as 5000 m. The power plant is to be based on the HDR method, which has not been applied in Central and Eastern Europe so far. This method consists in the process of water being injected in one well and subsequently pumped out of the other well: the trick is that the water is heated while getting deep under the surface. The process is nothing else but a closed circulation of a medium – of water in this case. Thermal energy can be converted into electric energy. In winter, the energy shall be used particularly for heating, whereas in summer, to produce electricity. The costs of constructing the wells and the geothermal power plant are expected to be around 1, 11 billion Czech crowns; and they will partially be covered with the contribution of the EU.

9. Favourable resources in our conditions

Biogas stations: a reliable source of green energy. For example, the station in New Lhotice (which I visited), with the capacity of 500 kWh, consumes 30 tons of silage for one operation day. This amount stands for less than 1 ha of arable land with average yeald amounting to 35 t / ha. A biogas station can also handle all biological waste including faeces.

Those who are confused by the figures in kWh will perhaps easily imagine that a biogas station with the capacity of 500 kW is able to switch on 6 666 regular light bulbs of 75 W or 33 333 energy-saving light bulbs of same light intensity, but with consumption of 15 W, and at the same time, it can heat up 15 family houses with an average consumption of 30 kW per a house. A station of this capacity can fully supply 33 low-energy houses with an average consumption of 15 kW of electricity.

The station can annually produce the same amount of electricity, which is consumed within a year by 1 000 households with an average consumption of 4 000 kWh / year or else by 16 000 refrigerators with an average consumption 250 kWh per year.

Hydropower plants :

One of the possible sources of green energy are hydroelectric power plants. There are very few sites with at least minimal effect in our region. However, it is still possible to find suitable locations for the construction or rehabilitation of small hydropower plants; the most favourable are locations with high gradient.

Práčov

Hydropower plant in Práčov (which I also visited), located in the heart of Zelezné hory, was one of the first hydropower constructions in our country after the end of World War II. It was put into operation in 1953. Last

year, it produced almost 15 million kWh of electricity, which would be sufficient to supply 4 300 households year-round. "Electricity production from renewable resources helps to save the environment. Water is supplied to the power plant from the dam in Křižanovice over the river Chrudimka through an underground feeder, which flows into the expansion water tower, from where steel pipes lead to the power plant. Expansion water tank serves to level the water pressures in the feeder when the turbine is shut and the turbine system is put out of operation.

Within the modernization process, a new vertical Francis turbine with the capacity of 9 800 KW was installed there in 2001.

The advantages and disadvantages of hydropower plants

1. The advantages particularly include the fact that the energy of water flows counts among renewables – it cannot be exhausted. At the same time, its operation causes least pollution to its surroundings.

2. Water power plants require minimal servicing and maintenance and can be controlled remotely.

3. They may start within a few seconds, and the power plant control room can thus use them as a top source to meet immediate demands for electricity production.

1. The disadvantages include significant cost and time demands for construction and the need for flooding large areas.

2. It must not be forgotten that their operation is dependent on a stable water flow.

3. Dam barrier can prevent smaller floods yet it has almost no influence on major catastrophic floods.

4. Dams and sluices obstruct the normal operation of ship traffic on the rivers; it is necessary to build a system of lock chambers.

Dams and lakes can be used for other purposes, especially for recreational purposes or as a source of drinking and utility water; that is, for water supply purposes; they are often suitable for river fishing.

10. My solution proposal

In the production of CO₂, cars represent some 22% of the total. By reducing the content of the engine and applying appropriate fuels (hydrogen, electricity, air), CO₂ output drops to almost zero.

French company MDI is developing a car fuelled by compressed air. A children's bicycle in the shape of a bubble should produce no emissions at all while being able to last up to 220 kilometres of drive with a single tank of 175 litres of compressed air.

Production of electricity:

The performance (2 012.4 GWh) of the thermal power plant in Opatovice could be replaced by:

1) Hydroelectric power plants -134 plants (9.8 MWh plant Práčov on the river Chrudimka)

Restrictions - Chrudimka is the only major river in the district and its flow is quite weak during certain periods of the year.

2) Biogas stations - 437 stations (500 kWh New Lhotice). Requirement for agricultural land of 159 505 ha.

Limitations – large area of agricultural land required.

Through optimal use of biogas and hydro power stations, if suitably complemented with heat pumps, solar collectors and small water power plants (up to 10 MW), the call for energy from thermal power plants would decrease, which would also reduce the production of CO₂. Due to the low flow of the river, small hydro power plants can operate only on a limited basis; therefore, their production of energy is not constant. They can only be regarded as a supplementary source.

Is necessary to save energy by:

- not overheating the rooms; installing thermal insulation in older buildings. In the future, primarily low-energy houses, passive or so-called 'zero' houses should be built.

- using efficient energy-saving appliances (refrigerators, lamps, ...)

- planting green vegetation (a common tree consumes 6 kg of CO₂ per year)

Global hectare (gha), this figure gives an idea how much of the land is required to ensure common supplies of food, energy, housing, transport, consumer goods and services. The quantity of these global hectares is then the point of departure for assessment of the so-called ecological footprint. The ecological footprint of all countries was 17.5 billion global hectares (2.7 gha per person). The U.S.A. and China can be "proud" to have the greatest ecological footprint in the world: either one of them used up 21% of the biocapacity of the Earth. India ranked third with the consumption of 7% of the Earth's biocapacity.

11. Final summary

The use of renewable energy must go hand in hand with the reduction of electricity consumption. It is very important to convince the public of the necessity to take this step. Common people regard energy as their fundamental right. Methods and consequences of the production are not important to them. They only show interest when the energy supplies are cut off.

Global warming is a problem that concerns all of us. The way we treat the nature in our district has its impact even in distant places, for example in remote arctic areas.

12. Words of thanks

I would like to thank for the possibility to take a visit and for the information provided to: ing. Koblížek from the biogas station in Nové Lhotice, Mr. Doležal, employee of the hydropower station in Práčov, and also the Municipal Office of the town of Chrudim, Traffic Inspectorate and the ČEZ management.

More information:

1) Magazines 21. století ('21st Century') and Vesmír ('Space')

2) Atlas of the climate of the Czech Republic (1961-2000)

3) Following websites

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<http://www.i-ekis.cz/?idp=720&tisk=1>

<http://www.nazeleno.cz/wwf-duvody-proc-cesko-nejvice-zatezuje-planetu.aspx>

<http://press.amic.cz/cs/cez/tiskove-zpravy/mala-vodni-elektrarna-pracov-vyrabi-jiz-55-let-ekologicky-cistou-energii/>

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