



## FOTOVOLTAIC TECHNOLOGY IN CONDITIONS OF THE CZECH REPUBLIC IN 2010

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### **ABSTRACT**

*There is an extraordinary development and faith nowadays in the field of photovoltaic technology, due to its parameters. This kind of technology is perfect to use in the conditions of an isolated operation network, because of its independence from power grid, usage of primary fuels or other means to power it. In principle, the only thing you really need is a sun shine*

### **1. INTRODUCTION**

Nearly all the energy we have on the planet Earth comes from the Sun. Upon the territory of the Czech Republic impinges every year a million times bigger amount of energy than we use per year. The most effective way how to use this sun shine is to convert it into heat, because the conversion into electricity is more expensive. The direct way how to generate the electrical power from the Sun is by means of photovoltaic panels or solar power plants and on the other hand the indirect way is by using hydroelectric power plant, wind power plant or a power plant using biomass or biogas.

The installed capacity in the Czech Republic in the beginning of this year exceeded 411 MWp. We can be expecting another 1000 MWp during this year, perhaps even more. The Energy Regulatory Office prepared a novel of a law, which will cut the development of photovoltaic technology in the coming years.

### **2. PHOTOVOLTAIC TECHNOLOGY**

This technology uses the direct conversion of solar energy into electrical energy by the means of semiconductor device, called photovoltaic cell or solar cell.

#### **2.1 Solar cells**

A solar cell is a large-area diode with at least one PN junction. When the sun shine hits the solar cell, elements with electrical charge are emitted (couple hole-electron). Electrons and holes are separated by the inner electric field of PN junction. This separation causes the difference between two contacts, plus and minus, of a solar cell. Therefore in the secondary circuit there is a direct current, which is directly proportional to the surface of solar cell and to an intensity of solar radiation.

The voltage of 0,5 V per solar cell is too small for a general usage. Because of this we use the series connection of solar cells, which can be then used in many applications of solar cells. Normally there are used systems with 12 or 24 V of rated operational voltage. The structure like this is hermetically closed in a final solar cell.

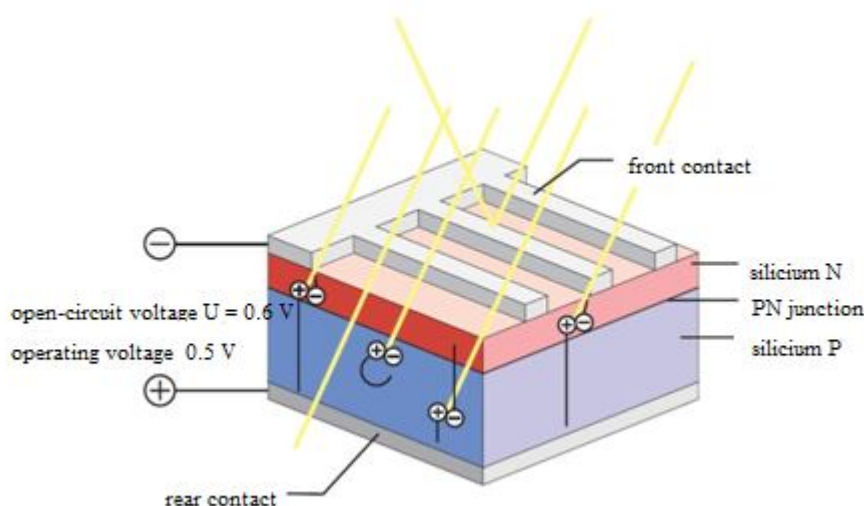


Figure 1 – Principle of solar cell

Photovoltaic cells are developed for over 50 years now. Overall we can distinguish 4 generations:

- **First generation:** Made from the plates of mono-crystalline silicon, nowadays still the mostly used type.
- **Second generation:** From poly-crystalline, micro-crystalline or amorphous silicon. Compared to the first generation, these are cheaper, due to using a smaller amount of silicon. Can be used on flexible bending (cloths, roofing, etc.).
- **Third generation:** It does not use the silicon, but organic polymers. Until now they have not been used much
- **Fourth generation:** Composite cells made of various layers, able to use the solar spectrum; each layer uses a different wave length.

Table 1 – Efficiency of various types of solar cells

	General efficiency	max. efficiency in lab
<i>Mono-crystalline</i>	14-17 %	25%
<i>Poly-crystalline</i>	13-16 %	20%
<i>Amorphous</i>	5-7 %	12%

## 2.2 Photovoltaic Systems

To use the energy produced by the solar cell, we must add not just the consumer but also other technical parts, such as accumulator battery, recharging control device, tension chopper, indicating and measuring equipment and in some cases also Sun movement tracking device. All these devices together are called the photovoltaic system. The number and lay-out of these devices depends on the usage of the system. We can differentiate 4 photovoltaic systems:

- **Small application:**

This is the least but certainly not the last part on photovoltaic market. These small applications are, for example, cells in calculators or solar chargers for accumulators.

- **Isolated systems (off-grid):**

They are used in areas, where it is not economical or it is impossible to build the power grid. For example the costs to build a new connection are equal or higher than the photovoltaic system (distance from the power grid is more than 1000 m, cottage, traffic signals and telecommunication device).

- **Network systems (on-grid):**

These belong to an area with dense power grid. In the case of sufficient solar radiation, devices in the building are charged by the energy coming from solar cells and if there is more that can be used, this electrical energy is fed to the grid. But if there is not enough of radiation, these devices are supplied from the regular power grid. This system works on its own thanks to micro-processor controlling of a grid chopper.

- **BIPV - Building Integrated Photovoltaic:**

As the name suggest, this is the photovoltaic integrated into buildings, for example in the façade of a building or on its roof. This way of usage contributes to its popularity and has significant impact on cost reduction.

### 3. ACCESSIBILITY OF SOLAR ENERGY IN THE CZECH REPUBLIC

Above the Earth’s atmosphere, on each square meter of an area vertical to solar radiation strikes about 1.36kW – this is called a solar constant. Part of this radiation is glanced aside while going through the atmosphere and a part is absorbed and dispersed. Because of this just a little amount of solar radiation actually makes it thought to the surface of Earth. Apart from this direct radiation, there is also a dispersed radiation and radiation glanced by clouds. At the surface the performance is not higher than 1kW/m<sup>2</sup> if the sky is clear. If there are clouds the efficiency is way lower (around 10× lower).

The conditions of solar power plant in the Czech Republic are influenced by various factors:

- latitude,
- season,
- cloudiness,
- inclination of surface where the solar radiation falls.

The website PVGIS Solar Irradiance Data includes a map of solar radiance in Europe. In the Czech Republic there are insignificant differences between the radiations impacted.

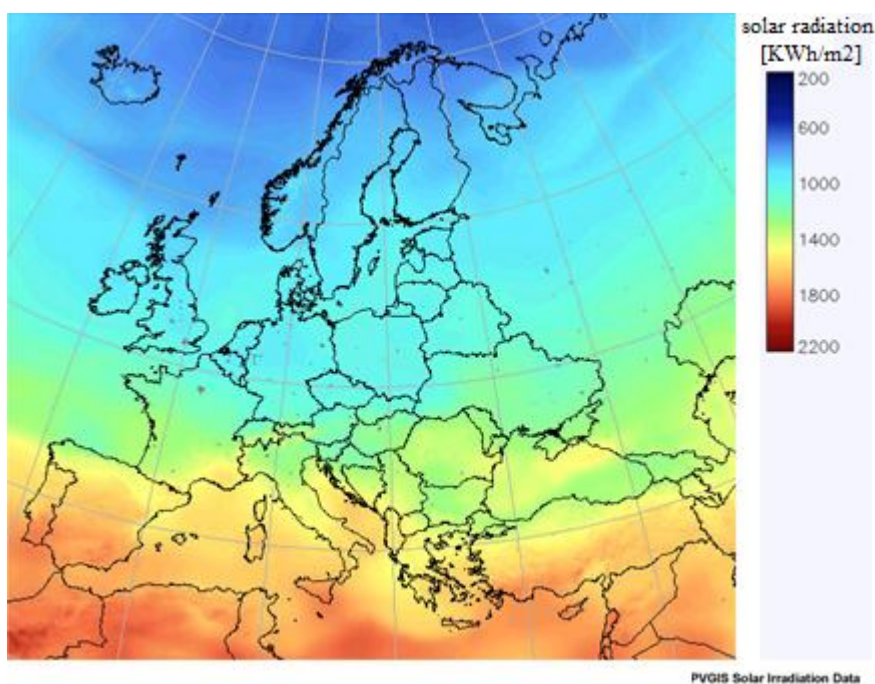


Figure 2 – Distribution of amount of solar radiation in Europe

#### 4. DEVELOPMENT OF PHOTOVOLTAIC TECHNOLOGIES IN THE CONDITIONS OF THE CZECH REPUBLIC

The Czech Republic promised to generate 8% of its brutto generated power from renewable sources until the year 2010 and together with this to create market conditions so the investors can put their trust into technologies of renewable sources (OZE). This is said in direction 2001/77/ES, which was implemented into our law system with the law Nr. 180/2005 Sb. Nevertheless this direction does not say how to manage it and leaves the decision on the governments of each and every country.

##### 4.1 Laws

The development of photovoltaic power plants was supported by the law 180/2005 Sb. dealing with the support of power generation from renewable sources.

Other laws dealing with this issue are for example

- Direction 2001/77/EC of European parliament from 27. 9. 2001 about the support of power generation from renewable sources
- Ordinance Nr.475/2005 and its novelization Nr. 364/2007 Sb. This one gives a change of indicative numbers of technical and economical parameters, for example that the life period of solar cells was increased from 15 years to 20 years.
- Ordinance 150/2007 Sb. and its novelization Nr.140/2009 Sb. about the regulation of prices in power engineering. From the point of view of photovoltaic, the significant part is § 2 paragraph (9) : „The office sets prices and green bonuses of electricity from renewable sources according to special prescript. These prices are fixed during the lifetime of a facility.” The newest one for the year 2010 in Nr 5/2009.
- Novelty in electricity buy-out is a novelization of ordinance 51/2006 Sb. which sets the conditions of facility connection to power grid in 2010. There are also more terms for concessions. For example in the case of power source between 30 kV and 5 MW there must be a proof that the project corresponds with the territorial plan. After contraction the connection should be finished in 180 days in case of 30 kW and in a year by bigger sources. By the word of authors it should be clear then who is a serious investor and who is a speculator.

##### 4.2 Economical Parameters in the Czech Republic

Buy-out prices are set by Energy Regulatory Office and every year they are different. It is guaranteed by the law that the price will not change for 15 years.

Table 2 – The purchase price of electricity given to power grid and green bonuses

Date of commissioning	The purchase price of electricity in Kč/MWh		Green bonuses in Kč/MWh	
	source with an installed capacity up to 30 kW including	source with an installed capacity over 30 kW	source with an installed capacity up to 30 kW including	source with an installed capacity over 30 kW
1. 1 2010 - 31.12 2010	12250	12150	11280	11180
1. 1 2009 - 31.12 2009	13150	13050	12180	12080
1.1 2008 - 31.12 2008	14010		13400	
1.1 2007 - 31.12 2007	14370		13400	
before 1.1 2006	6850		5880	

- **Principle of Purchase Prize**

According to law Nr. 180/05 Sb. there is a statutory duty of transition or distribution network operator to connect a photovoltaic source to transition network and to buy the energy generated by this facility. The purchase is for the prize set for the year by Energy Regulatory Office and this prize will be the minimal prize (it is multiplied by PPI index) paid for generated energy in next 20 years (the producer must handle in the amount of generated power every 6 months).

- **Principle of Green Bonus**

Investor of photovoltaic system can choose between various types of support, for example green bonus. In a simple ways we can say that the energy it self is being consummated by the producer it self, too. The rest of the energy is being sold to a distributor. The buy-out prize is a little lower, but the producer will have lower costs of power consumption. Green bonus is an amount that is added to a prize of a kWh and which reflects the environmental issues. The producer must find a vender, to who he will sell generated electricity for a normal prize. This prize is a little lower, because it includes instability of delivery and it differs for various renewable sources. The producer gets a green bonus for generating electricity of renewable source. This is called a green bonus. The Energy Regulatory Office sets this bonus, so the producer gets a higher prize than in the case of classical sources. This system is compulsory for those who will use the generated energy as a source of energy for them-selves.

We can not say for sure, which principle is the best one in general. It depends on the place of installation. For example in the case of family house, where is the power consumpt during the whole year it is better to use the system of green bonuses. But if it is a bigger photovoltaic system, it is better to use the system of buy-out prices.

- **Tax relief**

From the point of view of capital investment, the law Nr. 586/1992 Sb., about income tax is very important. It says that incomes from renewable sources are free of the profit tax at the year of initiation and during the next 5 years (§ 4 letter e).

## **5. ADVANTAGES AND DISADVANTAGES OF PHOTOVOLTAIC TECHNOLOGY**

This technology has a lot of advantages:

- Solar energy has a most dense efficiency of all known sources of renewable energy.
- This kind of production can be installed near the place if consumption, so we can avoid the losses due to distribution and transition.
- The magnitude of installation can be easily adjusted for the needs and possibilities of sources nearby.
- During the process of power generation of photovoltaic cells there is no pollution of environment.
- Low costs and needs for maintenance and repairs, because the system does not have moving parts.
- The electricity can be produced in a small amount directly in the place of its need, this supports the individuality, decentralization and independence in society.

Among disadvantages we can name:

- This kind of electricity if expensive compared to other sources of power generation.
- Solar energy is not available at night and in the case of bad weather (fog, rain). Therefore it is essential to install some backup device, which can stand for this blackout.

- Instalation of photovoltaic cells is very expensive. There are a lot of possibilities how to support the construction of this kind of technology. It could be a tax relief or guarantied prize.
- Solar cells produce direct current, so there must be invertors to change it to an alternating current. This, of course, increases lost.
- Photovoltaic cells in the time decrease its efficiency and therefore its performance.
- Ecological liquidation of photovoltaic cells is very expensive.

## 6. CONCLUSION

Because of the inexhaustible source as the solar radiance is, and because of its minimal impacts on environment it self this kind of technology is promising and it is clear that it will be used a lot in the future. From this point of view for many people the photovoltaic system is promising technology for the future and its valid alternative to classical sources of energy. Nevertheless we must also consider that there are still some questions about the regulation of huge solar fields and their cooperation with power grid.

What matters is that due to its popularity and massive production, photovoltaic cells are cheaper and cheaper and hopefully in 10 or 15 year the photovoltaic will be a capable to competing with other ways of power generation and the installed performances will be in bounds of giga watts in the world scale.

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