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Photovoltaic Solar Energy: Key to a Sustainable Energy Future

Summary: *The paper shortly describes the global situation regarding climate change and energy sources and consumption. Thereafter, authors give a couple of examples of successful approaches to implement renewable energy sources in the world and compare them to the situation in Slovakia. The overview of EU and Slovak legislation that can facilitate the implementation of renewable energies is also presented. Finally, the piece provides the recommendations for accelerating the development and implementation of renewable and photovoltaic energy sources in particular in Slovakia.*

In just one hour the sun delivers more energy to the Earth than is currently used worldwide in one year.

The world is facing two major global challenges: climate change and the economic viability of available traditional energy sources in the near future. These challenges are really global and all countries, including Slovakia, have to face them and look for and implement solutions. Both of these challenges are closely linked to the strategic energy security policy of countries. There are two main directions for solving the challenges. These two directions underline the policy for future energy security: efficient energy use and the development and implementation of sustainable energy sources. Photovoltaic solar energy, which is the direct conversion of solar energy into electricity, is expected to play a major role in supplying enough clean and environmentally friendly energy in the 21st century.

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Climate Change

Since the *First World Climate Conference* in Geneva, Switzerland in 1979, a still growing amount of scientific research is spent on a nowadays well-known phenomenon: climate change. This conference, sponsored by the *World Meteorological Organization* (WMO), was the first to identify global warming as a serious problem and was the first to attribute this warming effect to increased concentrations of carbon dioxide in the Earth's atmosphere from the burning of fossil fuels, deforestation and changes in land use.[1] Throughout the 1980s, the scientific community organized more and more international meetings, as both evidence and concern about climate change were growing. This lead to the establishment of the *Intergovernmental Panel on Climate Change* (IPCC) by the WMO and the *United Nations Environment Programme* (UNEP) in 1988, aiming for increased understanding of climate change, its potential impacts and options for adaptation and mitigation.[2] Between 1990 and 2007, the IPCC has published four landmark reports which attempt to quantify the climate change in facts and figures. The differences between the reports lie mostly in an increased scientific consensus for the latter editions (the only scientific organization that does not recognize the predominant opinion is the *American Association of Petroleum Geologists*[3]) and a decreased uncertainty in the projections for future *greenhouse gas* (GHG) emissions and global warming, considering different scenarios for GHG emission mitigation, global warming, use of fossil fuels and population growth. The most recent of the four, the *Fourth Assessment Report* (AR4), could be summarized in the following striking statements:[4]

- Warming of the climate system is unequivocal.
- Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely (> 90% certain) due to the observed increase in anthropogenic GHG concentrations.

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[1] "World Climate Conference: Extended Summaries of Papers Presented at the Conference", World Meteorological Organization. Geneva, Switzerland (February 1979).
[2] "16 Years of Scientific Assessment in Support of the Climate Convention", Intergovernmental Panel on Climate Change (IPCC), December 2004).
[3] American Quaternary Association, Eos **87**, 36 (2006) 365.
[4] S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. Averyt, M. Tignor, H. Miller (eds) *Climate Change 2007: The Physical Science Basis, Summary for Policymakers, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. (Cambridge, New York: Cambridge University Press, 2007).

- The levels of the GHGs carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values and the natural range of the last 650,000 years: the CO_2 concentration as of 2005 was 379 ppm (natural range: 180 ppm– 300 ppm), the CH_4 concentration was 1774 ppb (natural range: 320 ppb– 790 ppb) and the N_2O concentration reached up to 319 ppb (pre-industrial level: 270 ppb).
- The main sources of the increase in GHG levels are fossil fuel use (CO_2 and CH_4) and human agricultural activity (N_2O and CH_4).
- Over the last 100 years, the global average temperature has increased approximately by 0.74 °C and 11 of the 12 years between 1995 and 2006 rank among the 12 warmest years since 1850.
- Over the past 100 years, the average Arctic temperatures increased at almost twice the global average rate.
- The oceans have absorbed more than 80% of the additional heat contained in the climate system since 1961, causing ocean temperatures to rise to depths of at least 3000 m.
- Global warming would likely (> 66% certain) have been worse if not for the cooling effects of volcanic and anthropogenic aerosols.
- Melting ice masses (Greenland and Antarctica) have very likely (> 90% certain) contributed to the sea level rise between 1993 and 2003.
- Snow and ice coverage have decreased on average in both the Northern and Southern Hemisphere.
- Sea levels have risen at an average rate of 1.8 mm/year between 1961 and 2003 and at an average rate of 3.1 mm/year between 1993 and 2003.

The above-listed summary of conclusions is far from complete. All four IPCC reports are very extensive and including all major conclusions and observations here would be too much of a digression from the following sections of this article. Therefore, the interested reader is referred to publication *Climate Change 2007: The Physical Science Basis* [5] for more facts, numbers and figures on the observed climate changes and a number of model-based projections for future GHG levels, surface air warming, sea level rise etc. These projections are based on the *Special Report on Emissions Scenarios* (SRES), which was prepared by the IPCC for the *Third Assessment Report* (TAR). Some conclusions from the SRES include[6]:

- During the course of the 21st century, the surface air temperature rise will be somewhere in between 1.4 °C (1.1 °C – 2.9 °C) and 4.0 °C (2.4 °C – 6.4 °C). A rise of more than 2 °C is considered to be intolerable.
- In the next two decades, a temperature rise of 0.2 °C is expected for all scenarios; this short-term prediction is being confirmed by past model projections and actual observed temperature increases.
- Sea level rise predictions for the 21st century range from 18 cm – 38 cm to 26 cm – 59 cm.
- Heat waves and heavy rainfall will very likely (> 90% certain) be more frequent.
- The number of areas affected by droughts, the intensity of tropical storms and the occurrence of extreme high tides will likely (> 66% certain) increase.

[5] S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. Averyt, M. Tignor, H. Miller (eds) *Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* (Cambridge, New York: Cambridge University Press, 2007).

Energy Resources and Consumption

Since the start of the industrial revolution at around 1750, mankind has relied upon the use of fossil fuels such as oil, natural gas and coal to provide in its energy need. Since recent decades, however, there is a growing awareness and concern about the GHG emission resulting from the use of these fuels, which are predominantly used for electricity generation and transport. The consequences of this style of energy consumption and the possible scenarios, with which future generations will be faced, have been illustrated in the previous section.

In this section, an attempt is made to quantify the use of the several energy resources. Widely used sources for this type of information are the data from the *Energy Information Administration* (EIA)[7], which is a part of the *United States Department of Energy*, *British Petroleum* (BP)[8] and the *Renewable Energy Policy Network for the 21st Century* (REN21)[9]. One should be aware of the significant

[6] N. Nakićenović, R. Swart (eds) *A Special Report of Working Group III of the Intergovernmental Panel on Climate Change Summary for Policymakers, Summary for Policymakers*. (Cambridge: Cambridge University Press, 2000).

[7] *International Energy Annual 2004.* (Energy Information Administration, July 31, 2006).

[8] *Statistical Review of World Energy.* (British Petroleum, June 2006).

[9] *Renewables Global Status Report 2006.* REN21, update, 2006, http://www.ren21.net/globalstatusreport/default.asp.

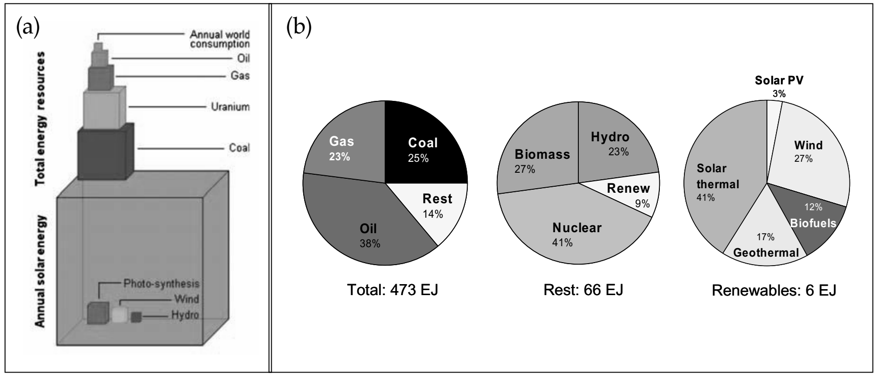

Figure 1: *Estimation of (a) energy resources and (b) power consumption in 2004 subdivided in the different types of energy sources. Figure 1a is taken from* World Energy Council *2004 Survey of Energy Resources* (2004) *and originally from* B. Lomborg, *The Skeptical Environmentalist.* (Cambridge: Cambridge University Press, 2001) *and figure 1b is created from* Energy Information Administration *International Energy Annual 2004,* (2006) *and* BP *Statistical Review of World Energy,* (2006).

uncertainty (at least 10%) in the numbers shown in this section. Estimates on the availability of resources are adjusted frequently (especially the oil and gas reserves), because of newly-gained scientific insights, increased measurement accuracy, and economic stakes, and can therefore only be valued on their orders of magnitude, rather than on their exact amounts. The uncertainty in the energy consumption data is moreover due to the fact that the energy consumption is not equally carefully monitored in each country.

According to the EIA, the currently remaining fossil fuels amount for an estimated 400 ZJ (1 ZJ = 10^{21} Joule), the theoretically available energy from nuclear fuels such as uranium exceed 2.5 YJ (1 YJ = 10^{24} Joule) and the Sun provides the Earth with an energy flux exceeding 3.8 YJ/year. The sheer magnitude of the last numbers, and the last one in particular, becomes clear when comparing them to the average global energy consumption in 2004: 473 EJ/a (1 EJ/year = 10^{18} Joule/year). This is about 8,000 times less than the annual solar energy flux. Still, it seems that the fossil and nuclear energy resources are not very close to depletion, as they can theoretically supply mankind's energy demand for more than six centuries. What is imperative to realize however, is that such a scenario is highly undesirable considering

the consequences for the global climate system and the world economy. A graphical representation of both global energy resources and global power consumption is shown in Figure 1.

What should be clear from figure1 is that only a small amount of the consumed power is currently generated from renewable resources (about 4%, excluding biomass and nuclear), while the energy that could be obtained from renewable resources – and solar energy in particular – is much larger than the annual consumption. Finally, it should be mentioned, however trivial it may seem, that the fossil fuels are depleting and as a whole do not even represent a fraction of the energy available from the renewable resources in a single year.

The Need for Renewable Energy

Global power consumption and the corresponding atmospheric GHG concentration have risen steadily since the start of the industrial revolution in the 19th century, which is strongly related to the temperature and sea level rise and the decrease in global snow cover. It is becoming increasingly certain that the use of fossil fuels will no longer be economically viable in the near future, because of its potential to perturb ecosystems and economies. In addition to this, fossil fuel reserves are shrinking, although it cannot be said with any certainty when fossil fuels, such as oil and coal, will be depleted completely. *The German Advisory Council on Global Change* (WBGU) outlines a roadmap to a sustainable global energy supply, including an extensive list of policy measures necessary for reaching this.[10] The resulting shift in the energy mix can be seen in Figure 2.

A notable difference with other reports containing projections of future energy use[11] is the continuously growing importance that is ascribed to solar power. This role of solar power in the world's energy mix of the future is acknowledged and supported by the photovoltaic (PV) industry, which has become the fastest growing industry in the world with an average growth of 40% in the last 6 years, as demonstrated in Figure 3. By the end of 2006, the cumulative installed capacity of solar photovoltaic (PV) systems around the world had reached more than 6,500 MWp. The solar electricity industry is now worth more than € 9 billion.[12] Worldwide, the PV industry, especially in

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[10] *World in Transition, Towards Sustainable Energy Systems* (London: German Advisory Council on Global Change, 2003).

[11] *International Energy Annual 2004*. (Energy Information Administration, July 31, 2006) or *World Energy Outlook 2006: Summary and Conclusions.* (International Energy Agency, 2006).

[12] *Solar Generation VI*. (European Photovoltaic Industry Association, 2007), p. 8.

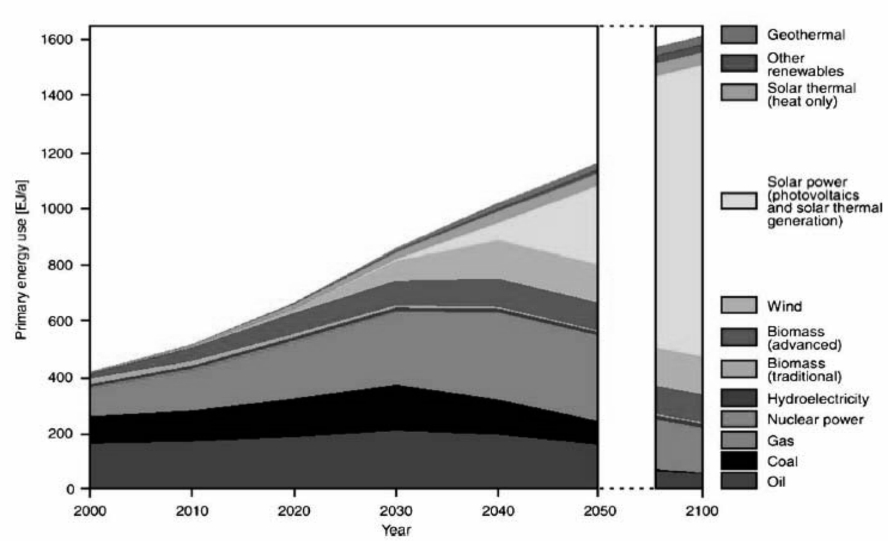

Figure 2: *Transforming the global energy mix: the exemplary path until 2050 and 2100 according to the WBGU. The graph is taken from* World Energy Council, *2004 Survey of Energy Resources* (2004)*, but is originally from World in Transition, Towards Sustainable Energy Systems* (German Advisory Council on Global Change, 2003).

Europe, the USA, China, and Japan, is investing heavily in new production facilities and technologies. Simultaneously, political support for the development of solar electricity has led to various promotional frameworks being put in place in a number of countries, notably Germany, Spain, and the USA. Patterns from these countries should be a challenge for the others that have not yet implemented such exploitable tools in concern with promoting this technology.

Photovoltaic Solar Energy

Photovoltaic literally means light-electricity: **photo** comes from the Greek *phos*, meaning light, and **volt** from the Italian scientist *Alessandro Volta*, a pioneer in the study of electricity. Photovoltaic technology is a term used to describe the hardware that converts solar energy into usable power and generates electricity from light. Initially, this technology was developed for space applications in the 1950s. For its many advantages it is now utilized

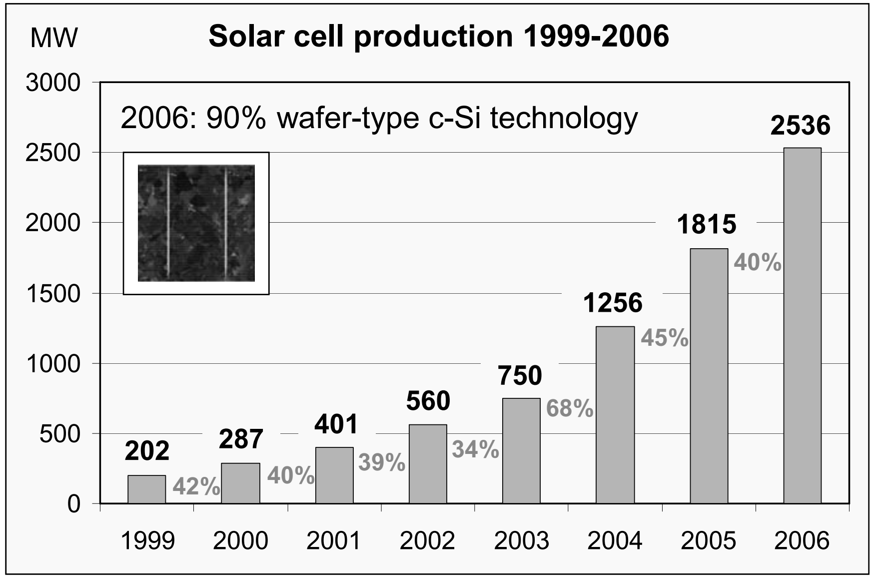

Figure 3: *Growth of global solar cell industry. Data for this graph is taken from* PHOTON International, *Market Survey on Global Solar Cell and Module Production in 2006,* (March 2007).

all around the world. The produced electricity can be used directly, stored locally, or fed into an existing electricity grid. The principal advantages of photovoltaic technology are:

- The fuel (solar radiation) is free.
- There are no moving parts to wear out, break down or replace.
- Only minimal maintenance is required to keep the system running.
- The systems are modular and can be quickly installed anywhere.
- It produces no noise, harmful emissions, or polluting gases.

Solar cells are today made from a range of semiconductor materials, from the traditional (multi)crystalline silicon wafers that still dominate the market, thin-film silicon, cadmium telluride, or copper indium diselenide solar cells to cells built up from organic semiconductors. It has to be mentioned that solar cells generate direct current (dc) electricity.

Solar cells integrated in modules form an important part of a PV system, which further consists of several electronic components and cables to

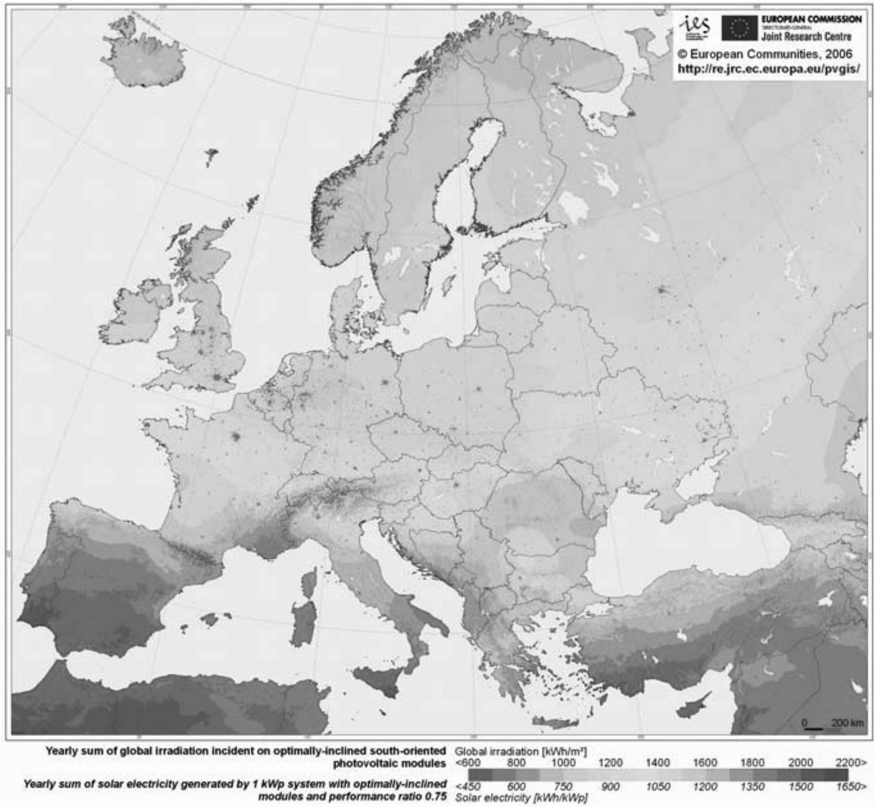

Figure 4: *Solar irradiation map which indicates the PV electricity potential in Europe. Source:* European Joint Research Centre, *Photovoltaic Solar Electricity Potential in European Countries,* (2006), http://re.jrc.ec.europa.eu/pvgis.

process the generated electricity and a load. A photovoltaic system does not need bright sunlight in order to operate; it works also in cloudy weather conditions or under artificial light in interiors. Photovoltaic systems have a great advantage in that they can be operated anywhere, independently of the electricity grid. We distinguish between stand-alone and grid connected photovoltaic systems. Stand-alone systems contain a battery and a power conditioner and the generated solar electricity is directly used by appliances or temporarily stored in the battery. When sunlight is not available, e.g. at night, the battery can deliver the electricity. Common applications of stand-

alone systems are small solar home systems for lighting, or powering a radio or TV set.

However, stand-alone systems can also be installed to cover village electricity supplies, for example by connecting several houses via a local electricity grid. In this case, the solar-generated direct current is transformed into alternating current so that standard appliances can be powered. The electronic inverter generates the alternating voltage and controls the electricity from the solar power system and, if required, from batteries. It is also possible to integrate photovoltaic systems with other energy sources, such as small wind turbines or hydropower plants, into hybrid systems that generate electricity. However, it is grid-connected systems that currently experience the strongest worldwide growth. Using inverters, solar electricity is transformed into grid-compliant alternating current and fed into the public electricity grid.

As was already explained in section 3, there is more than enough solar radiation available to satisfy the global power demand with solar power systems. The proportion of the sunlight energy that reaches the Earth's surface is about 8,000 times more than current global energy consumption. On average, each square meter of the Earth receives annually 1,700 kWh of solar energy.[13] Figure 4 shows European solar irradiation data as published and assessed by the *European Joint Research Centre* (JRC).

Photovoltaic Market

The photovoltaic industry and market is booming in several countries. Germany is at this moment a market leader in installing the photovoltaic systems. In Germany, the market is promoted by means of an attractive and calculable statutory framework. *The Renewable Energy Sources Act* (EEG) guarantees operators a fixed feed-in compensation tariff for 20 years, making the investment in PV systems secure and economically attractive. For a PV system of up to 30 kWp, installed on top of a building and commissioned in 2007, the operator receives 49.21 cents per kilowatt hour of solar electricity fed into the grid, for a period of 20 years. Systems commissioned in 2008 receive a 5 % lower tariff, based on the assumption that prices will also have decreased by 5 %. Due to the rapid technological development of components and production processes, and the massive expansion of the production and the market, the price of solar power systems sank by over 60 % between 1991

[13] Photovoltaic Solar Electricity Potential in European Countries, European Joint Research Centre, 2006, http://re.jrc.ec.europa.eu/pvgis.

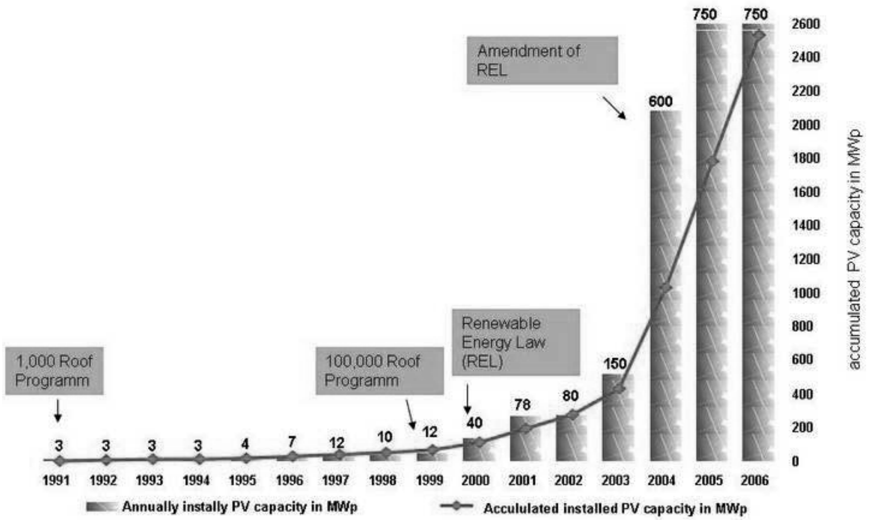

Figure 5: *Photovoltaic capacity installed in Germany, Source: European Photovoltaic Industry Association,* http://www.epia.org, Data&Figures.

and 2003. After a temporary price increase due to a shortage of silicon, prices are now falling once more.

There are already around 1.3 million solar power systems in operation in Germany. In recent years, the German photovoltaics market and industry have seen strong growth. According to data from the German Solar Industry Association (BSW), 750 MWp of solar electricity systems were newly installed in 2006, as a result of which the total solar electricity output increased to 2,500 MWp by the end of that year. The industry generated sales of around € 3.8 billion. The total capacity of solar cells produced in Germany in 2006 amounted to roughly 500 megawatts, which means an annual growth of around 50% (see Figure 5). The industry expects another significant increase in sales figures, partly due to the addition of new global markets.

The development of the photovoltaic market and industry in Germany and other European countries, such as Spain, France, and the Czech Republic, is in huge contrast with the activities regarding support and implementation of photovoltaics in the Slovak Republic. In the original proposal of the Ministry of Economy of the Slovak Republic for a strategy of implementing renewable energy sources in Slovakia, the Slovak government planned no installed

capacity of photovoltaic systems till 2010. The continuous effort of the non-profit *Slovak Renewable Energy Agency* (SkREA) for promoting renewable energy sources – and photovoltaics in particular – in Slovakia has resulted in a changed attitude towards the

The implementation of photovoltaics in Slovakia and according to the latest figures, the government expects a very modest 6 MW installed capacity of photovoltaic systems in 2010, as is demonstrated in Table I. However, the successful implementation of renewable energy sources cannot be expected without implementing stimulating mechanisms which are currently not sufficiently present in Slovakia.

Table 1: *Proposed installed capacity and growth of electricity production from renewable energy sources in Slovakia till 2010. Source:* The Ministry of Economy of the Slovak Republic, *Strategia energetickej bezpecnosti,* www.mhsr.sk.

Estimation of installed capacity and growth of electricity production from Renewable Energy Sources till 2010.			**(Energy Security Strategy, November 26, 2007)**
Till 2010	Production growth [GWh]	Installed capacity [MW]	Investment costs [million €]
Small hydro	100	20	55
Biomass – new sources	120	20	18
Biomass – co-combustion	356	70	42
Wind	80	40	49
Biogas	240	30	127
Photovoltaics	10	6	30
Geothermal	30	4	13
	936	190	334

Renewable Energy Legislation: EU versus Slovakia

We all have to agree – both supporters and sceptics – that the energy that can be produced by renewable energy sources is abundant and that these sources produce much less GHG emissions than fossil fuels. We have to accept that there is a spectacular transformation going on towards cleaner energy as fossil fuels are being exhausted at some point and are not in compliance with climate change mitigation.

Thus, the question here is not whether we like or dislike wind mills or solar modules on our roofs; the question of implementing the renewables is essential in a much more pragmatic manner, and particularly now, when Slovakia is discussing the future use of renewable energy. Certainly, this is a slightly exaggerated statement, but it is partly a reaction to the way Slovak authorities think about renewables: that their time has just not come yet.

In this article we argue, that the *Energy Security Strategy of the Slovak Republic* (SEB) is written tendentiously and is biased in favor of certain energy sources (especially nuclear, coal, and large hydropower plants) and as such largely marginalizes new renewable energy sources. This is happening despite ubiquitous EU tendencies to offer serious incentives for the deployment of renewable energy technology.[14] It is not our task to repudiate traditional – including nuclear – energy sources. However, it is necessary that energy security and sustainable development are attained in a much more open manner and with an emphasis on a non-discriminatory attitude towards particular clean energy sources, which have demonstrated their potential to contribute to a balanced energy mix.

It should be clear now that we do not intend to state that renewables are the one and only solution to reach energy self-sufficiency. However, it is our task to again highlight their undeniable potential, including diversification of domestic energy supplies, decreased dependence on energy sources from politically unstable regions, reduction of local and regional air pollution, and stimulation of local economies.

EU Legislation Hints

In 2004, Slovakia committed herself to achieving the ambitious goal of producing 31% of the national electricity production from renewable sources. This target was set by an EC Directive as a part of the EU accession process and is to be achieved by 2010. However, this indicative goal has already been rejected as "unachievable" by Slovak representatives, including the current Minister of Economy, Ľubomír Jahnátek. This rather reluctant approach to renewables is reflected by the absence of proper steps to support renewables and the lack of respective legislation.[15] In this respect, we argue that there is

[14] Except for the EU legislation, there are also other examples supporting a need for low-carbon technology deployment. One of them is the *Stern Review on The Economics of Climate Change* which includes a clear message that "the benefits of early and strong action on climate change clearly outweigh the costs" (http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm).

[15] Here we refer to the still non-existing independent Act on Renewable Energy Sources. According to the latest information from the Ministry of Economy, the Act is again being

no time for such a hesitant approach and that the country's commitment to increase the renewable energy share should be viewed in the broader context of the complex jigsaw of renewable energy policies at EU level, which are rather explicit.

As is communicated in the Commission's recently issued *Energy Technology Plan*, there is a need for "dedicated policy to accelerate the development and deployment of cost-effective low-carbon technologies".[16] This statement demonstrates a systematic acceleration in the support for renewable energy based on several previous steps and directives in energy policy set by EU institutions.

In March 2007, EU leaders agreed on a unilateral target to cut GHG emissions in the EU by 20% in the year 2020 and a binding target to produce 20% of the primary energy from renewables by the same year[17], while being guided by Commission Directive 2001/77/EC on renewable energy sources.

The message from the EU is very clear-cut. Recently, Tom Howes, an official at the Commission's energy division, stated that "the Commission will propose that all states make an across-the-board increase of 5.75 percentage points, regardless of current national levels of renewables and a further 5.75 percentage point increase would be divided up using calculations based on the countries' GDP in order to accomplish the 2020 goal".[18] This statement reflects the Commission's current thinking, even though the proper legislation will not be published before January 2008. According to Howes, it is, however, clear that "all member states will have to make significant contributions to the target"[19], and so there is no time to relax for anyone.

To conclude this section, let us allude to the latest communication from November 2007, announcing initiatives to be adopted by the Commission in the upcoming year.[20] The communication outlines the main policy objectives of the EU in the energy and environment area. One of the aims is to adapt the incentive role of energy taxation for energy savings and cleaner energy consumption.[21] The reason for these steps is to acknowledge new market-

postponed until March 2008 and we expect that this is not the final delay. However, in the Czech Republic, a comparable act was adopted in 2005.

[16] "Towards a Low Carbon Future: European Strategic Energy Technology Plan", European Commission (press release Memo/07/493), November 22, 2007, p.2.

[17] *EU Energy*, Issue 149, January 12, 2007, p. 5.

[18] J. Mason, "Renewable energy goal based on GDP", Reuters, November 22, 2007, http://uk.reuters.com/article/environmentNews/idUKL2241148420071122.

[19] Ibid.

[20] "Communication on 2nd EU Strategic Energy Review", European Commission, December 2, 2007, http://www.europa.eu/press_room/index_en.htm.

[21] It is expected that the Commission will review the Council Directive 2003/96/EC.

based instruments which have emerged over the last couple of years in EU environmental policy. This is, at the same time, one of several steps announced to acknowledge that renewable energy has become reality in the European Union area.

From these steps probably the most awaited one is the European Parliament's and Council's Directive on the promotion of the use of renewable energy sources, which is to be adopted in the beginning of 2008. It is expected that the Directive will set overall binding targets for the share of renewable energy sources in energy consumption in order to comply with its general purpose. That means a promotion of greater use of renewable energy in each member state, promotion of environmentally friendly security of supply, and provision of new economic opportunities for the European Union.

Slovak Renewable Cataclysm?

Our opinion, based on how the *Strategy of Energy Security* (SEB) presents the Slovak energy strategy and energy mix, is that Slovakia is swimming against the stream operated by EU institutions. We declare, while being aware of our conviction, that the SEB, despite of its capacity, does not clearly set the Slovak position towards European legislation and this is just automatically transmitted into the document.

Accordingly, the SEB on the one hand passively adopts EU legislation, but on the other, it almost completely ignores one of the crucial messages of the latest "renewable" rhetoric of the EU representatives. It is clear also from what has already been mentioned in this article that the European Union considers the support of renewables and active enhancement of their potential a priority. In this context, the SEB still treats renewables only as a complementary source, which can be explicitly demonstrated even by the number of pages devoted to renewables in the Strategy. This argument is further reinforced by the fact that in the outline of measures to support energy security, there is no reference to renewable energy projects and steps to boost renewable energy sources are obscure and specified only marginally.[22]

However, there are also some signs signaling better times for renewables in Slovakia. One of them is an expected *Act on Renewable Energy Sources* which, once adopted, will bring among others a priority to connecting installations for the generation of electricity from renewable energy sources and will thus strengthen the position of such installations in the electricity market.

[22] See the latest version of *Energy Security Strategy*, part 6.4. OZE, www.mhsr.sk, December 12, 2007. The final version of the document is to be adopted at the end of the year 2007.

In the conclusion, it is necessary to express our understanding that the EU imposes her pressures to foster certain sectors and the following implementation by individual member states is not always a result of their strong national political will. However, we consider the potential of renewable energy undeniable and we state that the sooner Slovakia joins the trend the better. This is not only because of huge environmental effects, but also because of significant factors such as employment creation and rural development, investment opportunities, an increase of energy security, and strategic positioning in equipment manufacturing required for harvesting renewable energy sources.

Instead of Conclusion

Development and implementation of renewable energy sources has to be accelerated in order to face the major global challenges; climate change, and shortage of economically viable traditional energy sources. The photovoltaic solar energy is receiving a growing attention as the key sustainable source of energy. Several countries, such as Germany, Spain, and the USA (most importantly California), are successfully implementing PV systems due to an efficient mechanism using attractive feed-in tariffs. Slovakia has been neglecting this form of renewable energy and has to take quick and far-reaching decisions to stimulate the development and implementation of renewable energy sources, and PV in particular.

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