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SYSTEMS THINKING DURING THE CONSTRUCTION OF PHOTOVOLTAIC POWER PLANTS

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ABSTRACT

Intensive development of industry and individual interests increased demands on energy consumption. The other side of this problem is environmental protection so as to not create sources of energy extraction emissions endangering people's lives. In this context, they take a systematic approach to application design, implementation and impacts of operating photovoltaic power plants in an important place in the market mechanism. It shows the impact of policy decisions on the issue without a rigorous systematic approach.

KEY WORDS

System approach, solar power station.

INTRODUCTION

Systematic approach to solving technical problems is involving not only the realization of system but also estimation of their impact on the practical implementation of economic, environmental and social thinking. In the context of increasing complexity of systems, difficulty of their realization as well as technological possibilities, the systematic approach is becoming topical. Recently there may be mentioned more examples of the positive results of systemic approach to solving problems but also several wrong decisions, unfortunately, on a high political level.

In this article we will focus on analysing one of the areas of electrical engineering, which is being professionally addressed in the Institute of Aurel Stodola. For the humanity it is currently crucial to ensure enough energy for people's lives and for production. There are two parallel paths. To reduce the energy intensity of processes or to start taking advantage of clean energy sources. The contribution will concentrate on the second option that is mostly about alternative energy sources. There are many discussions nowadays about renewable sources of energy particularly connected to photovoltaic water and wind fuelled power plants. Here it should be noted that this is not a clean renewable source of energy because for the operation of these power plants using the energy of the sun, whether direct or indirect solar heating of matter. The sun as an energy source utilizes a form of thermonuclear transformation of matter, which is finite. It is anticipated that this process will stop in about 5 to 7,000,000,000 years. Therefore it is difficult to talk about renewable energy.

Let's examine substance of the implementation of photovoltaic power plants and their impact on economic and social processes in the Czech Republic. A similar situation occurred also in Slovakia.

PHOTOVOLTAIC POWER PLANTS

For clarification ideas about the photovoltaic power plant it is necessary to adduce its basic principle. A photovoltaic panel is the basis of every solar power plant that converts the energy of sunlight directly into electricity. It is based on the principle of semiconductor devices that emit free electrons while being

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illuminated. Energy output, which is applicable in practice, can be obtained with sufficient number of elementary cells.

It is evident that amount of energy depends on_the intensity of solar radiation, the efficiency of converting light energy (ranging up to 20%) and the time duration of the sun. The intensity and length of sunshine is influenced by the seasons and weather conditions. For our conditions, it is possible to count with an average time of five hours of sunshine per day. Another fundamental problem which affects the use of photovoltaic power plants for everyday usage is the emergence of direct electrical current on photovoltaic cells. For distribution electricity in the public network is necessary to use a DC inverter on AC voltage. Before connecting to the distribution network frequency and phase of the generated voltage have to be the same as in the public network.

Small island systems do not have this problem, because each one is a separate power circuit with a separate unit. But there arises a problem how to ensure energy in the absence of sunlight. Therefore, they are mainly used in storage batteries, which supply electricity during troubled periods of time. The analysis of such a system was conducted in (Exnar, 2015).

In Figure 1 is listed a basic diagram of realization of photovoltaic power plants.

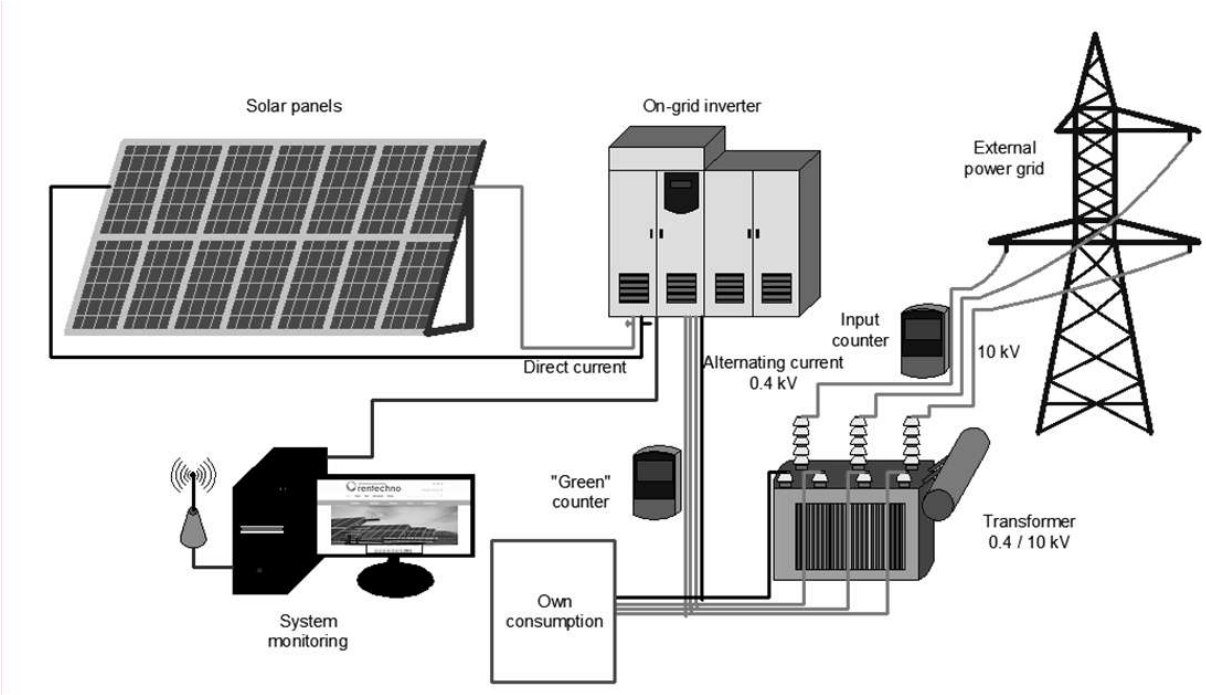

Figure 1 Typical structure of grid PV power plant (Rentechno, 2015)

The technical solution is not complicated. Its implementation is relatively simple and available components are industrially produced in large quantities.

APPLICATION OF PHOTOVOLTAIC POWER PLANTS

With increasing consumption of electric energy in the context of limited conventional energy sources such as coal, natural gas and crude oil it is necessary to seek and use other energy sources. This led the European Union institutions to actively support alternative energy sources. On this level the works plan for renewable energy sources issued by the Commission on 10 January 2007 under the title „Renewable Energy Road Map. Renewable energies in the 21st century: building a more sustainable future" was created. The Road Map sets out the Commission's long-term strategy for renewable energy in the European Union (EU). The aim of this strategy is to enable the EU to meet the twin objectives of increasing security of energy supply and reducing greenhouse gas emissions. An assessment of the share of renewable energy in the energy mix and the progress made in the last 10 years shows that more and

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better use could be made of renewables. In the Road Map, the Commission proposes setting a mandatory target of 20% for renewable energy's share of energy consumption in the EU by 2020 and a mandatory minimum target of 10% for biofuels. It also proposes creating a new legislative framework to enhance the promotion and use of renewable energy. It also proposes the creation of a new legal framework to enhance the promotion and use of renewable energy sources. (EU, 2007).

„Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market". The Directive follows up the 1997 White Paper on renewable energy sources which set a target of 12% of gross inland energy consumption from renewables for the EU-15 by 2010, of which electricity would represent 22.1%. With the 2004 enlargement, the EU's overall objective became 21%. The Directive also constitutes an essential part of the package of measures needed to comply with the commitments made by the EU under the Kyoto Protocol on the reduction of greenhouse gas emissions. (EU, 2011)

Based on these guidelines, the government of the Czech Republic and Slovakia established programs to support alternative energy sources (Kerebel, 2015). It was decided to subsidize the purchase prices of energy and thus creation of an interesting environment for business. This supported a rapid development in the area of photovoltaic power plants. The costs of their construction consist essentially of the price of photovoltaic panels, components for realization of the power plant, the price of land on which they built, a security and control system and its own construction costs. The relatively long lifetime of photovoltaic panels (estimated lifespan is at least 15 years) in connection with the subsidized purchase price of energy from these plants guarantees fast return on investment and the possibility of substantial profit. In doing so the costs of operating a power plant of this type are very low. These circumstances led to an enormous development of photovoltaic power plants (Figure 2).

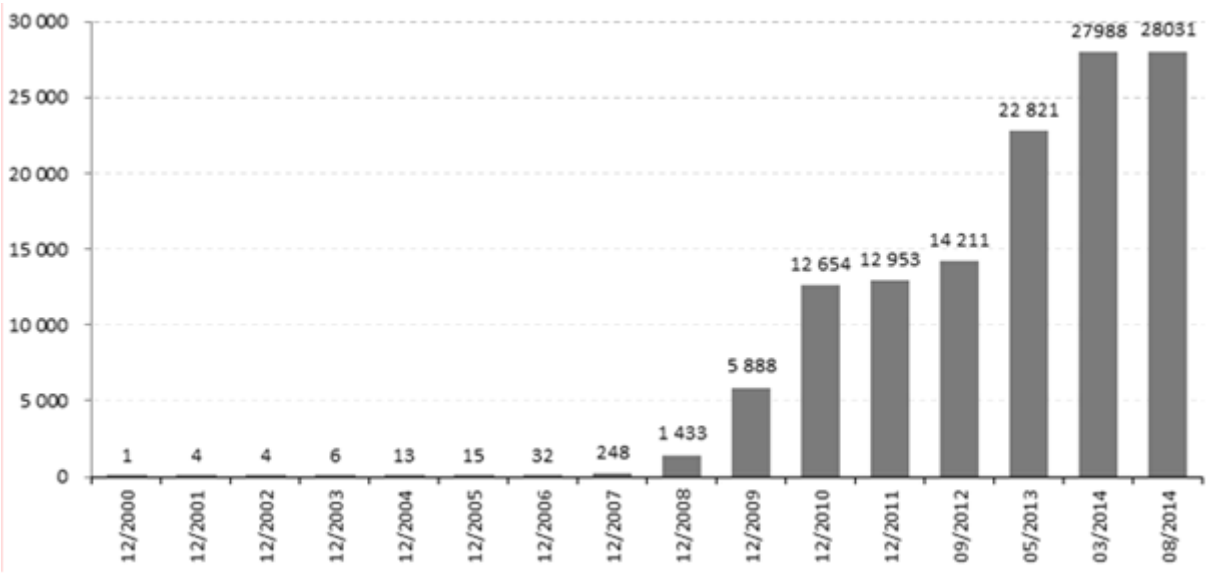

Figure 2: The number of photovoltaic power plants in the Czech Republic [in pieces]

Positive effort on an energy source that does not pollute the environment had in an environment of market mechanism impact on increasing demands for subsidies from the state. These subsidies were reflected in the final electricity prices that negatively influenced the market environment.

There was an uncontrolled development in the field of photovoltaic power plants, which also brought a range of negative manifestations. Besides the increase in energy prices the construction of photovoltaic power plants on land did not require additional costs for construction. They were generally flat land with a high credit rating of agricultural land. From an ecological, agricultural and aesthetic point of view, the created buildings have very problematic character (Illustrative image 3).

Among the negative impacts also we include the impact on energy transmission system. It is the irregularity of electricity production which de pends on the weather, which affects the intensity of solar radiation and thus the performance of these plants. As the weather can change during the day then a big

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outage of power may significantly affect the power grid. Steam or nuclear power plants have a start-up work with a large time delay and therefore must be ready to power plant with rapid start (for example pumped storage power plant).

Figure 3: Implemented photovoltaic power plant

Negative influences, especially from an economic point of view, can be considered influencing of price of energy in the form of subsidies by the state and subsequent reflection of this subsidy in the final price of electricity. Rapid return on investment in the construction of photovoltaic power plants and expected high profits has led to an uncontrolled increase in building of power plants in unsuitable places. The consequences of this situation were extremely burdened state budget and increase in the final electricity price. It was necessary to adopt the solution for restrictive measures. The measures taken are reflected in the decline of installed capacity (Figure 4). After intensive development in 2009 and 2010 the business community has lost interest in this area.

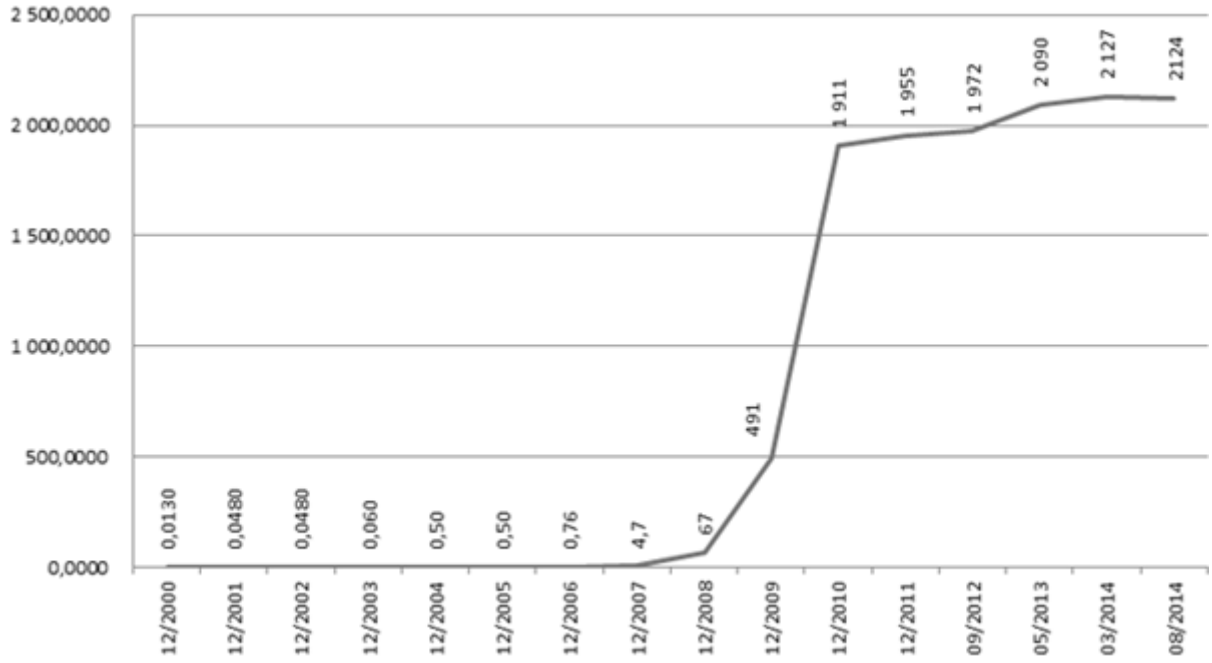

Figure 4: Device of photovoltaic power plant in the Czech Republic [in MW]

The reason was the reduction of subsidies; this implies a reduction in purchase prices of electrical energy from photovoltaic sources. This has the effect on a reduction in annual income and the extension of payback period. The result is a lack of profitability, resulting in a lack of interest in further development

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in this area. Significant manifestation of this process is shown in the number of photovoltaic power plants with an output of more than 1 MW (Figure 5)

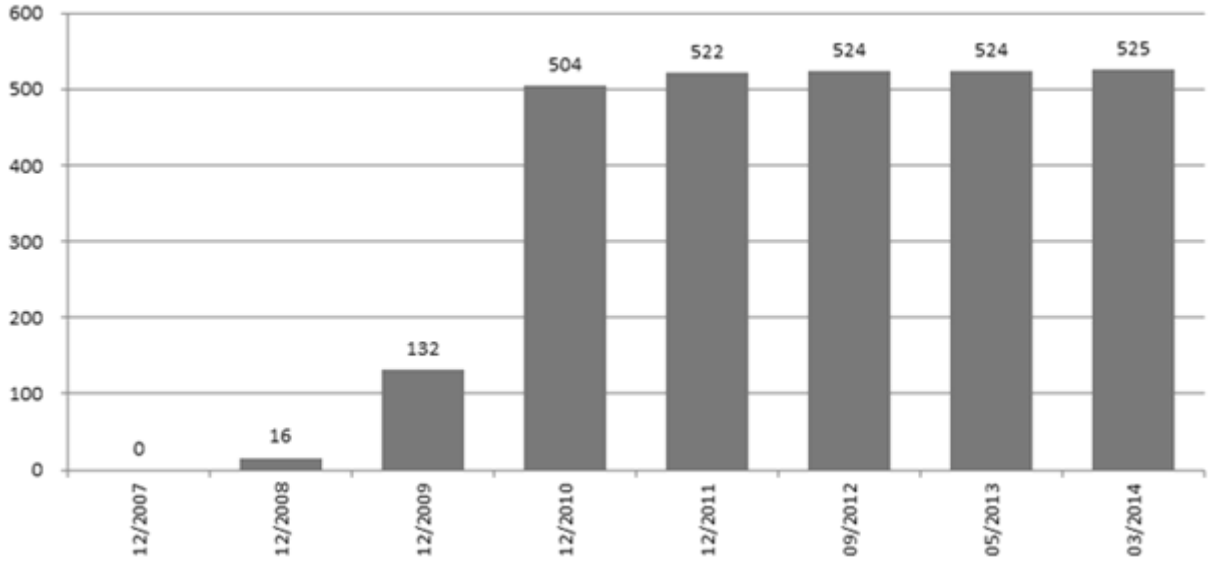

Figure 5: Photovoltaic power plants with an output power greater than 1 MW

CONCLUSION

Statistics show on incompetence of decisions realized / taken in this area. They are the consequence of a lack of systematic approach to solving the problem of photovoltaic power plants. The consequences of the measures adopted were not analyzed and the political decision, albeit in the right direction, did not have corresponding measures. The result is uneven development, which will also be reflected in the future when the service life of photovoltaic power plants built between 2009 and 2010 ends.

Nowadays, the government policy is oriented on small photovoltaic plants on the roofs of buildings instead of giant projects. However, the major problem - complicated legislation which poses difficulties in implementation of the network connection, remains unresolved. There is a need to simplify the rules for the operation of these small energy sources.

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