Renewable Energy and Power Quality Journal (RE&PQJ), ISSN 2172-038 X, No.9, 12th May 2011, Reference Paper: 379

Hydrogen Production for Solar Energy Storage

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Abstract. Using solar energy in photovoltaic power plants is an important method of electricity generation from renewable sources. Its potential is vast and technically easy to utilise. At present, photovoltaic power plants are the fastest-growing renewable energy source (RES) in the Czech Republic. Their installed capacity reached 1390 MWp (December 2010). Only in the last two years more than 1300 MWp was put in operation. This rapid development of photovoltaic sources is having a negative effect on the electric power system control. One option for mitigating this effect is to store the energy generated by photovoltaic in times of excess power in the grid and supply it to the grid when required, i.e., during peak periods of the daily load curve. There are numerous different storage technologies. The hydrogen system can be used to provide for storage of electric power in large amounts as well. This paper describes the state-of-the-art in the field of our research into solar energy storage in the Technical University of Ostrava.

Key words

Hydrogen, Photovoltaic, Solar, Energy Storage

1. PV Power Plants in the Czech Republic

The current situation in the Czech Republic, with respect to the renewable energy sources, is dramatic mainly due to the number of applications for connection of new photovoltaic (PV) power plants into the electric power system. As of 1st December 2010 the electric power system admitted new plants with the total output equal to 1393,86 MWp. Over the year 2009, these plants produced approximately 90 GWh of electric power. [1] That was the year bringing the most significant increase in number of the PV plants constructed, which is documented by the graph in Figure 1.

A. Impact on Electric Power System

If there is a new source (power plant) linked directly into a 110 kV centre or into a MV centre switch house, its production will be only projected into the superior network. However, if the MV switch house is linked to the source with an uncontrollable unit with fairly high fluctuation, e.g. photovoltaic power plant, whereas the load on such output is comparable with the output produced by the source, the network voltage might be difficult to control. Branching on MV/LV transformers are fixed, with no option for automatic control. Any fluctuation of output from the source, which is obviously not relevant on demands from power consumers and their electric power demand diagram, may cause problems due to the failure to maintain the allowed threshold of voltage within MV and LV networks. The quality of electric power supply to end users could then show deterioration and failure to adhere to the required parameters. There have been no significant requirements imposed in relation with compulsory control over these sources and the only threshold values defined refer to the limit values concerning parameter changes, which cannot be interfered with by any output values of the generators linked to distribution channels. [2]

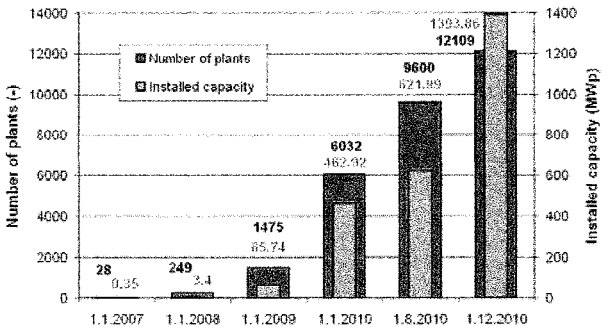

Fig. 1. The progress of installed capacity and the number of PV power plants operated in the Czech Republic [1]

B. Comparison of PV Plants to Other RES

Table I. shows benchmark of particular renewable energy source (RES) parameters with respect to the average period associated with utilisation of their maximum installed capacity throughout the year. The values in this table prove that PV plants are the least effective units compared to other RES in the Czech Republic.

Table I. - Comparison of PV plants to other RES [2]

RES:	SHPS	WPP	Biomass	Biogas	PPP
Average period of utilisation of the maximum of unit´s installed capacity	4700 h/yr	1900 h/yr	5000 h/yr	7500 h/yr	990 h/yr
	54%	22%	57%	86%	11%

Share of particular RES on the total amount of electric power produced in Czech Republic is shown below [3]:
- SHPS (Small hydroelectric power station): 7,3%
- WPP (Wind power plant): 1,7%
- Biomass: 70,5%
- Biogas: 4,6%
- PPP (Photovoltaic power plant): 1,9%
- Others (Bio-fuell for transport, Heat pump): 14%