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AASRI Procedia 2 (2012) 186 – 191

AASRI Procedia

www.elsevier.com/locate/procedia

2012 AASRI Conference on Power and Energy Systems

Economical Analysis of the Photovoltaic Systems – Case Study Slovakia

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Abstract

Goal of the contribution is to present results of the economical analysis of the photovoltaic systems that fulfill present limits, stated by the legislative of the Slovak Republic. Comparative method is realized on one of the buildings from the state sector in the city from eastern Slovakia with goal to find out optimal using of installed photovoltaic system with performance 100kWp. Comparison is realized and searched from the view of the client and its main task is to determine solution with biggest contribution for the client. Comparison of the systems ON GRID with supplement of leftovers and ON GRID with total supplement to the distribution net is made from the view of state support by the way of repurchase prices for the correspondent installed power plants.

Key words: economical analysis, photovoltaic system, comparative method, system ON GRID

1. Introduction

Present European energetic system is confronted with great number of uncertainties that include not predictable and very unstable prices of fossil fuels, political risks, connected with import and environmental influences of the fossil fuels. By the substitution of fossil fuels for renewable energy sources (RES) we are able to use its sustainable potential in economical, environmental and social area. Installment of technologies for RES using presents most perspective effort that can influence positively change of the climax and air

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 doi:10.1016/j.aasri.2012.09.033

pollution, it can increase local and regional energetic dependence, stimulate top hi-tech branches and create thousands of new working posts.

In present time there are existing two tools at the European level that serve for RES support, mainly European Direction for support of electric power, produced from RES and Direction about bio fuels. Increase of electric power rate, produce from RES – 14% in 1997 to 21% in 2010 in the frame of EU-25 was key element of the previous direction that came into effect in 2001. Direction about bio fuels determined goal of fuel consumption – 5, 75% till 2010. Both mentioned tools that expired in 2011 had been replaced by new direction of parliament 2009/28/EC [1] about support for using of electric energy from RES that is connected with area of electricity, transport, heat and coldness, which determines goals for electric power rate, produced from RES at the final gross energetic consumption. European Counsel decided to increase rate of the total energy consumption in EU countries and by this way it specified also different national goals. Direction 2009/28/ES determines minimal energy rate from RES to 14% [2].

2. Basis for economical analysis of the photovoltaic systems in Slovakia

In present time we distinguish two ways of photovoltaic systems connection, mainly system that is connected to the energetic distribution net (further only DN), so-called ON GRID system with supplement of leftovers or ON GRID system with total energy supplement to DN or system that put produced electric power in batteries with aim of own consumption – so-called OFF GRID system.

Slovak republic transmitted its liability against EU to the law about RES No 309/2009, according with correspondent energetic distribution company is obligate during 15 years to repurchase electric power, produced from photovoltaic system from producer at the price, stated by the Office for regulation of net branches for the correspondent year [5].

Office for regulation of net branches (ORNB) decreases repurchase prices of electric energy, produced through solar power plants. Result of it means that due to the generously stated repurchase prices of electric energy, obtained by solar power plants for 2010 that were approximately 425€/MWh (for equipments with installed performance over 100kW) there was increased number of smaller photovoltaic power plants till 2009 yet over 500MW of photovoltaic [3]. Consequence of the mentioned means that regulation Office suggests in its amendment to decrease maximal repurchase price of electricity, produced with 100kW system, placed on the building approximately about 33,1%.

For 2012 prices of repurchase electric power had been repeatedly decreasing. Price of the electricity, produced from RES in equipments of electricity producers, installed to the service from 1st January 2012 is stated by direct determination of price without value added tax is 194,51 €/MWh.

Producer cash higher mentioned prices during direct sale of produced electric power that means that produced energy is sold to DN. If consumer has installed photovoltaic system ON GRID with supplement of total produced electric power to DN, he cashes sold energy with value 0, 19454 €/kWh.

Price 0, 91454 €/kWh is in reality sum, consisted from the price of electric energy on loss with value and surcharge 0, 13443 €/kWh. Only such consumer has requirement on surcharge that has installed photovoltaic system ON GRID with supplement of leftovers to the DN and he cashes not only full repurchase price 0,19454 €/kWh for sold leftovers, but also mentioned surcharge for consumed volume of own produced energy with value 0,13443 €/kWh.

Increasing of repurchase prices from photovoltaic power plant in 2009 against 2005 over more then 11% and availability of cheaper photovoltaic panels commenced vast interest about this source. In present time there is about 500MW photovoltaic power plants in Slovakia.

In present time legislative of Slovak republic limits construction of big photovoltaic system according law

No 558/2010 that changes and amends law No 309/2009 about RES support and high effective combined production, and state support is determined only for equipment with installed performance to 100kWp that is placed on the roof construction or circuit of one building, connected with earth by fix base, filed in land registry [6]. Therefore comparison is orientated only to the photovoltaic power plants, installed in accord with higher mentioned novelization of the law and its goal is determination of their optimal using according comparative method for ON GRID system with leftover supplement and ON GRID with total supplement to DN in model situation, where building of public sector is object of installed equipment. System OFF GRID is insular system that is used mainly in places with limited access to the DN connection with only one goal to produce own energy. Since its investment costs are too high against ON GRID system, it will not be added to the analysis.

Comparison is made and searched from the view of client and its main task is to determine solution with biggest contribution for client. Comparison of ON GRID system with leftovers supplement and ON GRID with total supplement to DN is made from the view of state support by the way of repurchase prices for correspondent installed power plants, according which there area developed economical indexes, as for example cost, revenue, payback period, cash flow and discounted cash flow. Due to the analysis there is necessary to determine constant and variable indexes for compared connections. As constant indexes there are considered following: building of public sector, consumption of electric power of the searched object, installed performance, luminance, price of photovoltaic system, project and engineering activity, depreciation time, and insurance. Variable indexes are type of system connection and state support by the way of different repurchases prices of electric power.

3. Economical indexes for ON GRID with total supplement to DN in model situation

Cost volume connects closely with calculation of annual production of installed performance. In aim case study of comparing system would be in accord with law novelization and limitation for photovoltaic power plants construction, there was determined photovoltaic power plant ON GRID with total supplement to DN with installed performance to 100kWp on one roof construction of buildings from state sector in the city of eastern Slovakia.

Annual income for sold energy, produced from given 100kWp from ON GRID system, determined for total supplement of energy to DN, installed on the roof construction on the building from state sector presents during ideal conditions and solar radiance at first year of using approximately 18 000 Eur. Income in year N is achieved according produced electric energy that had been sold to the distribution society at the repurchase price of electric power, which was determined by ORNB in newest amending during ON GRID system with total supplement of produced energy to DN with value 0,19454 €/kWh. But such income is gradually decreasing year by year due to inter annual decrease of installed panels effectiveness about 0, 6%. Expended investment was regarded also with every expense, connected with maintenance, financial expenses and last but not least with expenses, connected with overhead of state sector object, on which photovoltaic system had been installed. Consumption of electric energy with value 30 000 kWh annually, withdrawing from the distribution company at stated price for business subject with value 0, 12 €/kWh, had been assumption of overhead costs.

Due to the achievement of real calculation there is necessary to regard during cash flow determination also not predictable influences, time influence, depreciation of photovoltaic panels and any other not predictable influences and risks, as for example risk of panels damaging, climax disfavor and legislative changes, connected mainly change of repurchase price of energy, stated by ORNB. Discounted cash flow shows to the regarding of every mentioned influences and acting to the total annual incomes that have consequently negative impact to the payback period. After regarding discount 4% we recorded decreasing against cash flow

in „common“ year and discounted cash flow had been determined in first year of using with value 13 400 €, which finally lengthened payback period on 34 years.

4. Economical indexes for ON GRID system with leftovers supplement in model situation

Since volume of initial investment for ON GRID system with leftovers supplement to DN is constant against previous searched equipment for our model situation, costs for panel provision, their montage, project and engineering activity together with every other costs, connected with construction and installment to the service remain unchangeable.

During calculation of cash flow and discounted cash flow for search ON GRID system, determined for supplement of leftovers to DN there were used equal methods and processes as during ON GRID equipment, determined for total supplement of produced energy to DN. Due to their determination we resulted from the following assumptions:

- Equal depreciation during 10 years,
- Investor covers volume of investment to 100% from own capital,
- Repurchase price for energy leftover, produced by ON GRID system, determined for leftovers supplement is stated by ORNB to 0,91454 €/kWh,
- Surcharge for consumed energy by such produced installed equipment is 0,13433 €/kWh,
- Insurance,
- Tax from profit 20%,
- Inter annual percentage decrease 0, 6% due to the decreasing of panels effectiveness.

5. Results and conclusion

Annual income in year N for sold not consumed energy (leftover), produced from the given ON GRID 100kWp of photovoltaic system, determined for leftover supplement, installed on the roof construction of the state sector building, presents during ideal condition and solar radiance approximately 12 200 €, which is stated for this area.

But such income is year by year decreasing in proportion to inter annual 0, 6% decrease of installed modules effectiveness. During application of surcharge for consumed own produced electric energy we need to add to the total annual incomes in year N also income that is relevant according conditions about surcharges for own consumed energy with value 0,13433 €/kWh, which presents annually in our model situation and during consumption 30 000 kWh value 4 030 Eur. Building of state sector with determined assumption of 30000 kWh consumption per year, reaches every year savings in volume 3 600 € that needs to be regarded also in cash flow. Cash flow development for ON GRID system for leftover supplement means also in this case cash flow with assumption of proper system acting and even running of the power plant existence and it defines payback period of expended investment in 12th year.

Due to the achievement of real calculation we had to regard during ON GRID system with leftovers supplement also not predictable influences. After regarding of 4% discount we recorded cash flow decreasing against common year and discounted cash flow had been stated to 18 500 €, which means finally payback period to 17 years.

Table 1. Constant and variable indexes for ON GRID with total supplement to DN and leftovers supplement to DN

Constant indexes		
	ON GRID total suppl.	**ON GRID leftover suppl.**
Installed performance [kWh]	92 800	92 800
Luminance [W/m^2]	1 240	1 240
Price of photovoltaic system [€]	209 935	209 935
Project and engineering activity [€]	9 800	9 800
Equal depreciation [year]	10	10
Tax from profit [€]	20%	20%
Consumption of object energy [kWh/year]	30 000	30 000
Purchase price of energy from DN [€]	0,12	0,12
Insurance [€]	574	537
Level of equity [€]	100%	100%
Variable indexes		
	ON GRID total suppl.	**ON GRID leftover suppl.**
Repurchase energy price [€/kWh]	0,19454	0,19454 + surcharge 0,13433

Comparing of the results from the realized calculation is made during 30 years and we compare results of the economical indexes for correspondent systems with goal to determine optimal using for photovoltaic connection in the searching region from stated model situation.

Table 2. Results comparison

Year	**Compared index [€]**	**ON GRID with total supplement to DN**	**ON GRID with leftovers suppl.**
15.	Total income	259717	290205
	Total expense	74691	22891
	Cash flow	185026	267314
	Discounted cash flow	139754	200784
20.	Total income	341208	383502
	Total expense	107530	40092
	Cash flow	233677	343410
	Discounted cash flow	163822	238416
25.	Total income	420284	475164
	Total expense	139887	56965
	Cash flow	208397	418198
	Discounted cash flow	182819	268814
30.	Total income	497015	565239
	Total expense	171775	73522
	Cash flow	325241	491717

Discounted cash flow	197806	293375
Payback period common [year]	18	12
Payback period discount [year]	35	17

From the table there is resulting that ON GRID system with leftovers supplement achieves higher incomes against total incomes of installed ON GRID system, determined for total supplement of produced energy to DN. Considerable savings had been recorded again in the system ON GRID with leftovers supplement that had finally positive impact also to the total cash flow and payback period. Payback period of expended investment of equipment that is determined for sale of whole production to DN in our searched conditions and during ideal conditions of power plant is shorter about 6 years against equipment, determined for own consumption of energy and sale of leftovers to DN. Main reason of rising differences on the side of expenses and incomes and total cash flow was the fact that during ON GRID system for leftovers supplement consumers need not to buy electric energy from DN, but he is using produced energy of photovoltaic for his own consumption, which would bring him considerate savings. Such savings could be even more visible, if determined consumption of electric energy in searching object would be higher and object with such installed power plant would be using higher volume of own produced energy and he need not to buy electric energy from DN. Similarly as cash flow in common year, also in the case of not predictable influences, time influence, deprecation of panels and any other risks, discounted cash flow had been expressively recorded as equipment for leftover supplement to DN and its payback period has positive difference yet 18 years.

Result of the realized analysis and comparison of the individual systems is optimal choice of model situation for using of ON GRID equipment with leftovers supplement to DN. Generally we can say that such system is optimal for objects that consumes electric energy and by this way they can consume own produced energy and to achieve higher profits and decrease costs of consumed energy.

Acknowledgements

The article is a partial output of a research task of Slovakian research agency VEGA No 1/1033/12 - Indicators for social responsible business of small and middle firms in context of regional development.

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