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BUY-BACK RATES FOR GRID-CONNECTED PHOTOVOLTAIC POWER SYSTEMS - SITUATION AND ANALYSIS IN IEA MEMBER COUNTRIES

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ABSTRACT: The buy-back rate offered by utilities for electrical energy produced by grid-connected photovoltaic power systems has recently been considered as an important parameter - among different approaches - for the deployment of such systems. This contribution summarises the different buy-back rate models as observed in the participating IEA member countries. The existing buy-back rate schemes for grid-connected photovoltaic power systems are classified in comparison with the energy price from conventional energy systems. The study focuses on the models that are presently in operation, on their characteristics and on the results achieved so far. The success of the different models as measured by an increased deployment of PV systems is analysed and critical factors are identified.

Keywords: Buy-back rates – 1, Financing - 2, Incentives – 3

1 INTRODUCTION

Financing of photovoltaic power systems is a key issue to the deployment of this energy technology. Many approaches to this important subject have been published [e.g. 1-2]. Buy-back rates for grid connected photovoltaic installations have recently received much interest as they raise a fundamental issue for the cost recovery of the system investment and can be very important for the short-term diffusion of the technology. More generally, "green pricing" schemes which apply for photovoltaics as well as for other renewable energies have been introduced by a number of utilities in different countries [3-4]. This contribution summarises a recent study performed within the IEA PVPS Programme, Task I [5]. The interested reader is referred to this full report.

This study concentrates on the buy-back rate applied for photovoltaic energy fed into the grid and the different models introduced so far. The financing aspects (recovery of system costs for investment and capital) are only touched where they are in direct relationship with the buy-back rate. In many countries, buy-back rate models are accompanied by important investment subsidies.

1.1 Scope

The International Energy Agency (IEA) Photovoltaic Power Systems Co-operative Programme (PVPS), Task I, has performed a study on the issue of buy-back rates for grid-connected photovoltaic power systems in the participating countries of the IEA. The work has been performed through collection of information from the different countries and subsequent analysis by Task I experts.

1.2 Objectives

The main objectives of this study can be summarised as follows:

- To catalogue the different buy-back models.
- To study the advantages and disadvantages of the different models and their success.
- To objectively study the problems encountered.
- To learn from the experience with different models.
- To promote feedback on the buy-back rate models.

1.3 Countries observed

11 countries (FRA, DEU, ESP, GBR, JPN, AUT, ITA, AUS, PRT, NLD, CHE) provided the data that is reported and analysed. 4 countries (DNK, KOR, SWE and CAN) have no specific models for buy-back rates or no grid-connected PV systems. These countries however sometimes do have buy-back rate models for other renewable energies.

2 BUY-BACK RATE SCHEMES

As a first result, a number of different buy-back rate schemes have been identified within the reporting countries. They can be ranked by the level of the rate applied for independent producers of photovoltaic electrical energy fed into the grid compared to the cost for (conventional) electrical energy taken from the grid:

We define r as the ratio between the payment of the PV energy inserted into the grid ($C_{pv\ in}$) and the cost of conventional energy taken from the grid (C_{out}), i.e. $\boldsymbol{r = C_{pv\ in}/C_{out}}$.

Table 1 gives an overview of the different buy-back rate schemes found in the reporting countries.

Table 1: Classification of buy-back rate schemes

Buy-back rate scheme	
a)	No buy back rate schemes for photovoltaics
b)	**very low** buy-back rate schemes, which apply the same conditions as for other producers; consequently, the rates are generally low.
c)	**low** schemes: as b), however, special incentive premiums, (+10 % up to +100 %) are granted on these general buy-back rates. The resulting total energy payment is still low.
d)	**parity** schemes: the price paid for PV electricity is equal to that charged by the utility.
e)	**high** schemes with attractive prices. Restrictions are imposed regarding the length of payment (e.g. high payment during n years/further years at reduced payment).
f)	**very high** schemes, with the highest tariffs, and foreseen strictly for PV.
g)	**other** schemes, where ”green electricity” can be bought by users without a PV-system.

3 SITUATION IN IEA PVPS COUNTRIES

This paragraph illustrates the situation within the countries that do have experience with the different buy-back rate schemes.

Comparing the payment of photovoltaic energy inserted into the grid to the cost of conventional energy taken from the grid, we notice that the ratio *r* between these 2 values varies considerably from country to country. In some countries, PV energy inserted into the grid is paid at 5 - 6 times the amount paid for that taken from the grid whereas in others PV energy has been given little ‘value’.

There are certain countries with similar situations (countries with a similar *r* ratio): Table 2 classifies countries according to this criterion. This table highlights two countries where the ratio *r* is particularly high, Germany and Switzerland. These two countries not only apply the highest payments, but also do it for longer than other countries (Germany 10 to 20 years, Switzerland 12 to 20 years). The total payment is also greater with respect to other countries, since all the energy produced is bought. Moreover, in both countries, the minimum compulsory rate is high. In fact, in Germany the utilities are obliged by law to pay for PV and other renewable energies fed into the grid at a minimum rate of 0,172 DEM/kWh: this corresponds to 90 % of parity (r = 0,9). In Switzerland, the connection authorities for independent suppliers and the Federal Department of Transportation, Communication and Energy recommend a minimum payment of 0,16 CHF/kWh. This corresponds to 80 % of parity (r = 0,8) for the energy generated in plants operated by independent suppliers using renewable energy sources.

Table 2: Countries classified by ‘importance’ of PV energy compared to conventional energy

‘Importance’ of PV energy	Ratio *r*	Country
Very important	≅ 5..6	Germany, Switzerland
⇓	≅ 1..2	Italy
⇓	≅ 1	Japan, Netherlands (CHE and AUS in some cases)
	≅ 0,8	Austria, Germany (by law)
⇓	≅ 0,5..0,7	Australia, Portugal, Spain (NLD in some cases)
⇓	≅ 0,3..0,4	France and United Kingdom
Not important	0 or no models	Korea, Sweden, Denmark, Canada

4 SUCCESS OF THE DIFFERENT MODELS

Following the identified buy-back rate schemes and their application in the reporting countries, the analysis of the success of these schemes in deploying photovoltaic technology is performed. It is very evident that the classification based on ‘success’ coincides almost exactly with that based on the ‘price paid’. In other words, the most recompensed models (Germany, Switzerland, and Italy) are logically the ones with the most success. In those countries where the buy-back rates are based on tariffs which are also valid for other producers (ex. Portugal, United Kingdom, Spain), the models have been more successful for other renewable energies than for PV. In countries with very competitive markets, these models have not been very successful. Australia is a typical example. Table 3 summarises the success of the different models applied so far.

5 ANALYSIS

As many of the buy-back rate schemes have only been introduced recently or are in preparation, a thorough analysis can not yet be performed. The following observations are therefore first indications on the present situation.

5.1 Common characteristics and trends

Of the models identified, 7 are valid on a national level whereas 8 apply on a regional level. There are therefore few or no geographical limits to the validity of the models. The concept of buy-back rates is a recent one with all models coming into force after 1990. The models not only exist on paper, but are also being or have been put into operation. In fact, out of 17 models 13 are presently operating, three have come to an end and one is still under study. On the other hand, only 4 models (DEU, CHE, and ITA) have been reasonably successful.

Table 3: Success of the different buy-back rates models

Success	Coun-try	Name of the model	Nbr inst.	Power kW	Towns	Observations
Very good	DEU	Full-cost rate based models (Aachen)	950	2900	18	Successful, about 5,2 million potential consumers were reached (1996)
	CHE	Burgdorf model Interlaken model	66 85	274 23	5 7	Successful Successful
Good	ITA	CIP act 6/92	N/A	5000	N/A	Successful
	JPN	Buy-back menu for surplus electric power from PV	1437	6113	N/A	Successful
Middling	NLD	Ad hoc	N/A	N/A	N/A	This is an experimental (ad hoc) model (no definite models yet)
Low	AUT	Separate agreement	N/A	N/A	N/A	This model does not work in the field of PV, because the rates are too low.
	AUS	Western Australia New South Wales Victoria Integral Energy model Queensland	0 0 0 0 2	0 0 0 0 N/A	0 0 0 0 N/A	Model finished in Jan. 1996 Model finished in 1994 In operation since 1992: no PV at present, successful for other renewable (25 MW incl. all renewables) Model Launched June 1996; success: too early to judge There exist significant non-technical barriers to the acceptance of this model, including mind-set
	PRT	Dec. law 313/95	1	2	N/A	General model for independent producer, successful for small hydropower and wind plants
	GBR	-	1	N/A	N/A	Success: not relevant, regional
	DEU	Utility buy-back law since 1/91	N/A	N/A	general	Success: difficult to specify for PV, very successful in the area of wind energy and hydropower plants
	FRA	-	60	80	N/A	The model r = 1 is only a project. It is accepted for a limited number of demonstration projects.
Probably low	ESP	Roy. decree 2366/94	N/A	N/A	N/A	The model is not specific for PV, but a law devoted to increasing the role of renewable energy sources

Most models have limitations of time and of power:

- the length of payment for the power varies from between 1 to 12 years (20 in certain cases)
- maximum total power that can be installed varies between 2 kW to 200 MW according to the model
- the size of each installation where a model can be applied is of no importance for about 1/3 of the cases. In the other cases, the limits vary between 2 kWp and 200 MWp.

It is therefore difficult to find a common characteristic regarding these types of restrictions. All the differences concerning length of payment and power limits probably serve to limit the economic impact on the utilities.

The energy taken into consideration is, in the clear majority of cases (12 models), the surplus power inserted into the grid. Only 5 models (CHE, DEU, ITA, AUS) apply to the total energy produced. The latter models also apply the best prices and are the most successful.

5.2 Other factors

5.2.1 The customer

The situation is very similar in all countries in that the electricity fed into the grid is paid by the electrical utility; only rarely is the energy bought by other bodies, like, for example, by a bank in Zurich. However in 3 countries - Switzerland, the Netherlands and Germany - there is a special feature: the contributor can even be the ordinary user or a group of them (Betreibergemeinschaft). In these countries users without a PV system can also purchase ”green electricity” from the grid (see below).

In Germany the payback is financed through a low surcharge on monthly electric utility bills paid by all utility customers. The limit of this surcharge is still in discussion and varies from state to state between 0,6 % and 1 %. Many observers believe that 1 % will be the accepted rate. If a community wants to protect industry, then industrial customers with special rates may continue to pay the old rates.

These types of rate-based models (”kostendeckende Vergütung”) were first proposed in Germany in Aachen in 1992 and implemented on Sept. 1, 1994. The electric utility bill surcharge is limited to 1 %.

A different scheme has been introduced more recently in Switzerland under the name of the ”solar stock exchange” (Electrical utility of the City of Zurich). In this model, utility customers can choose to buy a defined amount of photovoltaic energy at the actual costs. For the producer, this also means full cost recovery (investment and capital) fixed by a long-term contract with the utility. Meanwhile, about 20'000 customers in Switzerland have chosen for this option which has allowed the PV market to expand under market orientated rules. The buy-back rate associated to this model is of course high (r = 5-7), but flexible as demand and offer are matched. This model may also be interpreted as one application of ”green pricing” to the case of photovoltaics.

5.2.2 Structure of utilities and initiatives

An overall conclusion which can be drawn is that, in general, models have more difficulty in establishing themselves in countries which have a centralised structure (like France), than in countries with multi-utility systems (like Germany with more than 1700 utilities). The exception to the rule is Italy, where the model pays well and has been successful. The general picture shows that there are rapidly developing systems such as in Australia (utilities in process of being privatised). On a global scale, there is a general tendency towards a liberalisation of the energy market. This liberalisation can produce both negative and positive effects.

It is also interesting to study who is the initiator of the model; what is noticeable is that a clear distinction can be made between countries and where the initiative comes from:

- the utilities: the models were established and have been operated by utilities companies themselves (ex. Switzerland, Japan and the Netherlands)
- national law: a typical example is given by Italy, Spain and Portugal. In certain countries the utilities are put 'under pressure' (cf. Germany), and are obliged by law to pay for PV energy fed into the grid a minimum (but already high) rate.
- private people organised in promoting associations (Germany)

In some countries it seems that the initiative came from both the utilities and the state: agreement between the Austrian utilities and the Federal Government in Austria; or through the recommendation of the French Ministry of Industry to EDF (Electricité de France, state owned utility).

Only one model emerged through other means, for example through public pressure and private initiative (Aachen model).

5.2.3 Comments and needs

As the field is rapidly changing, the findings of this study represent a momentary picture. The concept of high buy back rates certainly is one method to promote the deployment of grid connected PV systems on a short-term basis. It is however not seen unanimously as the only concept that can reach this goal. Models that are more market oriented or green pricing models are favoured by many utilities.

In certain countries buy-back rates are based upon avoided costs, e.g. Australia. At present, avoided costs tend to be low as they mainly reflect avoided fuel costs. In view of the relatively high cost of electricity from photovoltaic power system plants, high buy-back rates, and therefore not based on avoided costs, will be required until installed system costs decrease significantly. This situation might change in view of energy taxes in discussion in some countries or the incorporation of external costs into energy prices.

Models based on minimal total production costs optimised for highest energy production can be characterised by the fact that there is no need for further subsidies from governments or from utilities. The resulting energy prices nevertheless remain high at the present time. Therefore, further measures such as investment subsidies, tax credits or assessment of the true added value represented by the application of PV systems will have a beneficial effect.

Optimising with respect to energy production during the life cycle of the system rather than on the investment side will benefit to the actual energy produced by focusing on proper system design, operation and efficiency.

Finally, information and publicity will play a further important role for the deployment of PV systems. It would be a waste of time to set up a model that satisfies all the criteria for success without communicating its existence to the general public.

In a period where, in many countries, the liberalisation of the energy sector is advancing very rapidly, these developments will affect the deployment of PV systems. Therefore, not only the identification of the threats but also of the opportunities represented by these general developments in the energy sector will be of primary importance for the development of the different PV market segments. Sustainable solutions regarding the financing of solar electricity will have to be compatible with the general trends in the energy sector.

6 CONCLUSION

High buy-back rates are one possible way among many concepts to increase the market penetration of PV power systems. It is still too early to offer a thorough analysis regarding the development of buy back rates for photovoltaics, since for certain more recent models, not all the necessary data are available. This study has clearly shown, however, that the topic needs special attention in view of the great number of existing models. Another element of interest will be the evolution of this concept as prices for PV systems will decrease and legislation will further progress towards the liberalisation of energy markets.

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