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Acceptance of Ancillary Services and Willingness to Invest in PV-storage-systems

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Abstract

PV-storage-systems play a more and more important role in the energy system, especially in private households. Not only can they be used to increase self-consumption but they can provide ancillary services like peak-shaving or balancing energy. It can be tricky to use private PV-storage-systems for the latter because this could mean economic losses due to reduced self-consumption or there might be acceptance problems. Therefore, we carried out an empirical investigation to analyze acceptance issues and willingness to invest in PV-storage-systems. In a face-to-face interview 500 private PV owners in Germany were questioned regarding their willingness to invest and their acceptance of ancillary services under several circumstances. The survey was conducted during the period from Mai 2014 to August 2014. Results are motivations of willingness to invest in battery storage systems under different funding options and obstacles regarding the purchase of a PV-storage-system. The survey gives also hints on which frame conditions are relevant for acceptance of ancillary services.

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Keywords: Acceptance; PV-storage-systems; Ancillary Services; Willingness to Invest

1. Introduction

Photovoltaic (PV) storage-systems play a more and more important role in the energy system, especially in private households. Not only can they be used to increase self-consumption but they can provide ancillary services

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like voltage control and balancing energy or being used for peak-shaving. It can be tricky to use private PV-storage-systems for the latter because this could mean economic losses due to reduced self-consumption or there might be acceptance problems. Therefore, we carried out an empirical investigation to analyze acceptance issues and willingness to invest in PV-storage-systems.

From another point of view, battery systems can be of social interest if they attain a high market penetration which could not only have an impact for the distribution grid but for the whole energy system. PV-storage-systems can be one of the key factors for the energy transformation if they are managed by an appropriate operating strategy which might include temporary restrictions or external control to account for necessities in the power grid. Therefore, one focus of the survey is to investigate the acceptance of these operating strategies.

2. Methodology

In a face-to-face interview 532 private PV owners in Germany were questioned regarding their willingness to invest in storage systems and their acceptance to provide ancillary services. The PVowners were chosen by a standard random route procedure where the 20 sample points are representative of the PV systems installed in Germany. The survey was conducted during the period from May 2014 to August 2014.

To put the results into an overall context we also collected socio-economic data from the interviewed PV owners. Most of the PVsystems in the survey have been installed in 2011 (35 %) and 2012 (33 %) followed by PVsystems installed in 2010 (22 %) and 2013 (10 %). Only 1 % of the PVsystems have been installed 2014 (in total 6), which is on the one hand due to the fact that the survey period was May to August 2014 and on the other hand due to decreasing number of installed PVsystems after the amendments to the German Renewable Energy Act (EEG) in 2014 and the adjusted feed-in tariffs. Fig. 1 shows that the relative distribution in performance categories between 5, 10 and 15 kWp in the survey approximately matches the German average clustered for the years 2010 to 2014. The largest difference can be found in 2014 where the total number of PVsystems is very small.

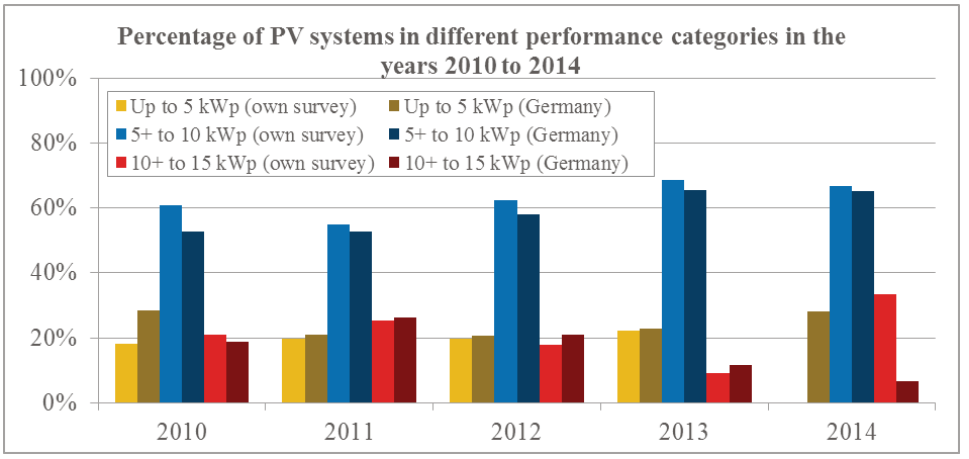

Fig. 1: Comparison of the percentage of PV systems in different performance categories in the years 2010 to 2014 between own survey and Germany (source: Own survey, [1])

Beside the installed PV capacity the PV owners have been questioned about the number of persons per household, house type, electricity consumption and gross household income. The majority of the interviewed PV owners live in a two-person household (32 %). Another large share lives in a three- and four-person household (25 % each). With approx. 76 % are most of the PV owners living in a single family house. The mean value of electricity consumption by number of persons per household in this survey can be seen in Fig. 2 where a comparison with average data in Germany [2] is done.

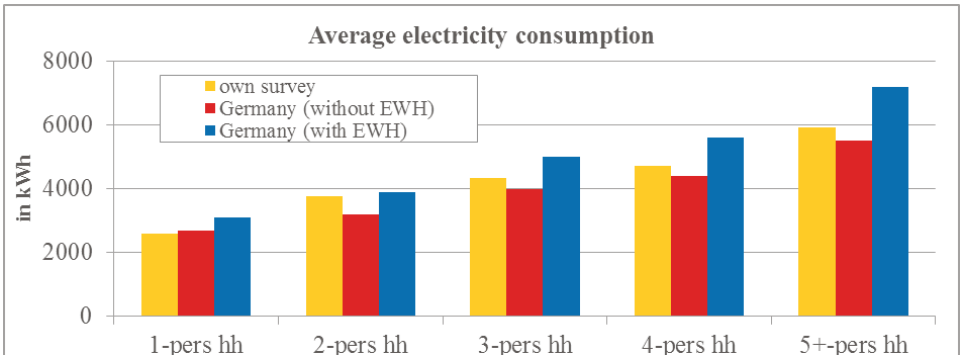

Fig. 2: Comparison of average electricity consumption in the survey and in single and double family households in Germany with our without electric water heating (EWH) (source: Own survey,[2])

The mean value of the gross household income is 3,385 Euro, which is under the mean value in Germany of 3,989 Euro [3]. The difference is rather big and it is not clear whether the interviewed persons might have given their net household income which is 3,069 Euro in the German average [3] or if the results are distorted by the 18 % that did not declare their income.

3. Results and Discussion

The results of the survey shown in this paper focus on two main aspects: The first focus is the willingness to invest in storage systems and the reasons for that. The second aspect is the acceptance of different operational modes that lead to ancillary services.

First of all, the survey shows that there is a big part of PV owners who are generally willing to invest in storage systems (69 % answered 'in all circumstances' or 'more yes', see Fig. 3). 66 % would invest if there was a partial reimbursement of 25 % of the costs of the storage system.

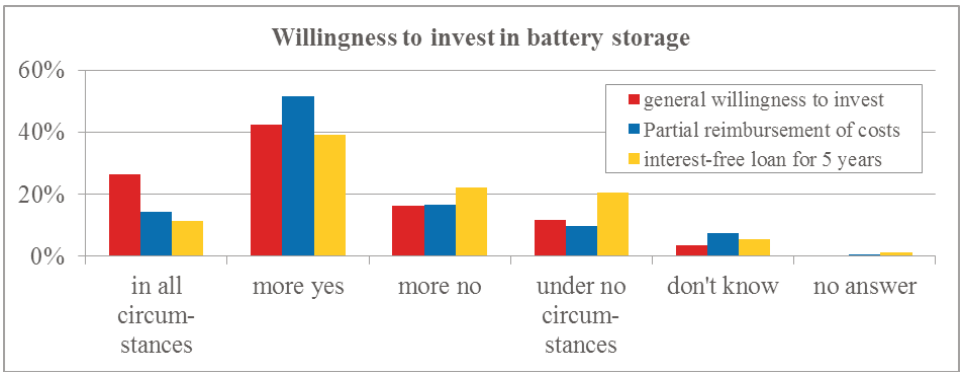

Fig. 3: Willingness to invest in battery storage systems depending on support and funding possibilities

This number decreases to 51 % if there was an interest-free loan over 5 years from public sources. In a survey of EuPD Research [4] only 55 % of the respondents is willing to invest in a storage system. This survey was conducted in 2013 and one could therefore conclude that the willingness to invest increased in the last year. Furthermore, it

should be taken into account that not only PV owners were questioned in 2013 but also people willing to purchase a PV system.

Further investigation in the survey was dealing with the level of information on purchasing a PV-storage-system and on the KfW-funding for PV-storage-systems [5]. The answers show that more than 50 % have informed themselves on purchasing a storage system and 60 % know about the KfW-funding (see Fig. 4). As expected, this number is increasing over the years in which the PV system has been installed. The numbers vary from 18 % for 'yes, I know it well' for PV systems installed in 2011 to 50 % for those installed in 2014.

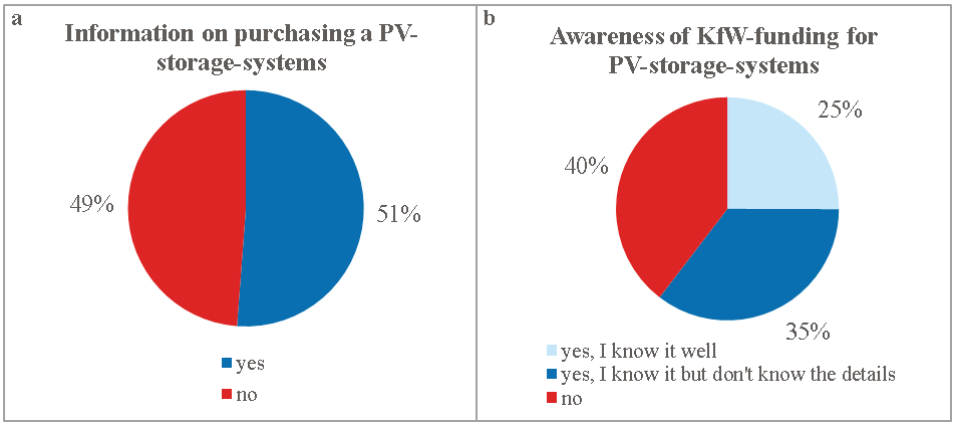

Fig. 4: (a) Level of information on purchasing a PV-storage-system;(b) level of awareness of the KfW-funding for PV-storage-systems

To investigate potential motivations for purchasing a storage system the PV owners were asked to rank the importance of several possible reasons. Almost 50 % of the interviewed PV owners ranked 'independence from the energy supplier' as a very important reason (see Fig. 5), whereas 'maximizing the return' got the lowest importance.

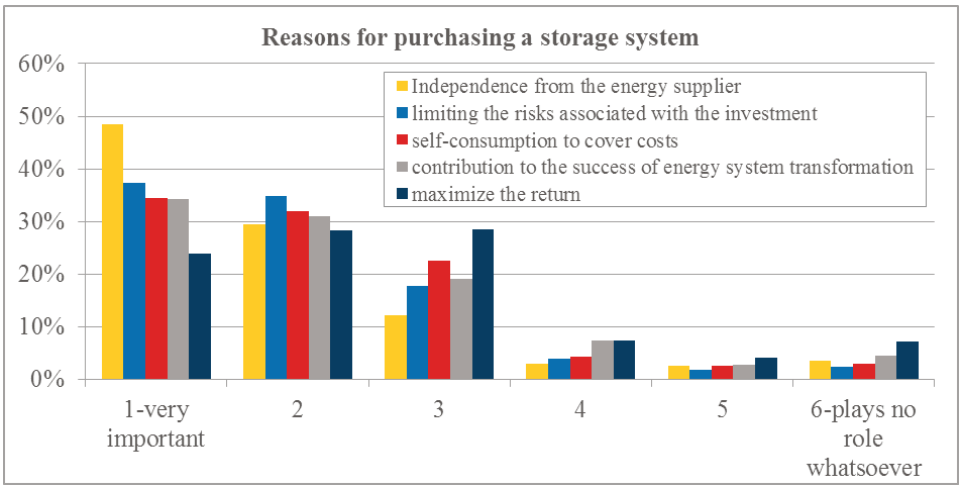

Fig. 5: Relevance of several reasons for purchasing a storage system

However, it seems that all given reasons are of importance, because in all cases at least 80 % (in most cases even 90 %) gave a ranking between 1 and 3. In contrast to the reason for installing a PV system it can be concluded that

in the case of storage systems producing the own energy was more important than becoming independent from the energy supplier with a PV system, the second important reasons for investing in the PV system was contributing to climate protection which seems to be not such important in the case of storage systems. From that it can be expected that with increasing electricity prices the investment in storage systems will also increase. However, with so far around 15,000 installed PV-storage-systems in total in Germany [6], only a minority of 0,01 % of the PV owners (PV capacity ≤ 30 kWp) has storage systems installed.

To have a clue for the major obstacles and concerns the PV owners were asked to rank several reasons that may prevent them from purchasing a storage system (see Fig. 6). The high investment was by far the highest ranked reason against a storage system (over 50 % ranked this reason as 'very important').

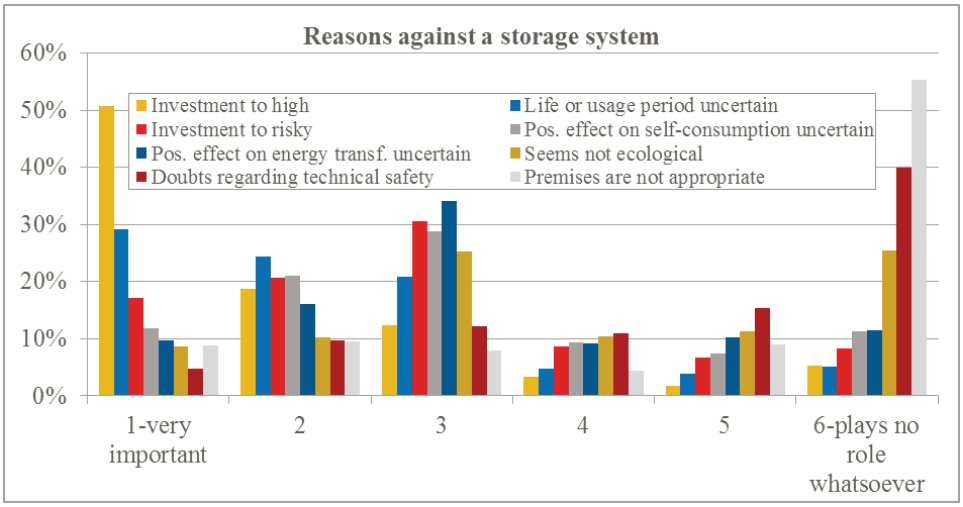

Fig. 6: Relevance of reasons against purchasing a storage system

Further important reasons are the uncertain life or usage period or the risk of the investment. The reasons against storage systems are hence mainly economical. Missing premises, safety, or ecological regards play a minor role. For intervieweeswho know the KfW-funding very well, the share of respondents who ranked 'investment to high' as very important even increased to 60 %.

For a better knowledge of the economic expectations, the PV owners were asked for the payback period they expect for a storagesystem and the maximal investment costs they are willing to pay for a storage system that increases the self-consumption from 30 % to at least 60 % (see Fig. 7).

The majority expects a payback period between 9 and 12 years, which is rather short, but noteworthy is also the big share of 25 % that have no clue which payback period to expect. For the maximal investment costs this share is even bigger (31 %), so one could conclude that especially the ones that have never collected information about PV-storage-systems are not able to estimate the financial situation. Of those who gave an answer, most people would pay at most 3,001 to 6,000 Euro for a storage system that doubles the self-consumption rate. An analysis of the battery storage market in 2014 [7] shows average costs of 2,300 Euro per kWh for PV-storage-systems. Therefore, the desired investment costs of 3,001 to 6,000 Euros would mean 1-2.5 kWh storage capacity, which would increase self-consumption only by around 10 percent points instead of double it. In 2014, the prices dropped by 25 % [8]. If this price degression continues, sufficient storage systems might soon reach acceptable price regions.

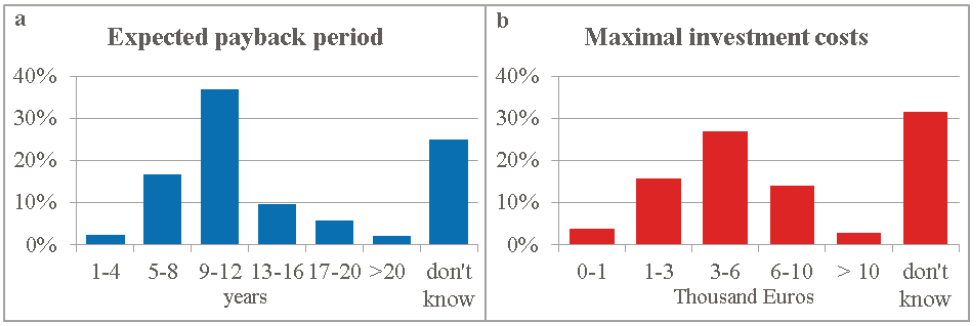

Fig. 7: (a) Expected payback period; (b) Maximal investment costs for storage systems

Another focus of the survey was to take a closer look at different operating strategies that lead to ancillary services and the acceptance of these operating strategies.The PVowners were provided with the information that the PV system without storage has return rates of 4 % for a capital horizon of 20 years. On this basis they are asked to give their return expectations for a PV-storage-system in two cases: In the first case for a system that is operated to maximize the self-consumption, and in the second case for a grid relieving operational mode. The results (Fig. 8) show, that on the one hand there is a wide rage in the return expectations (between 0 % and 80 %), and on the other hand that a huge amount does not know what their expectations are (in total 26.7 % resp. 26.4 %).

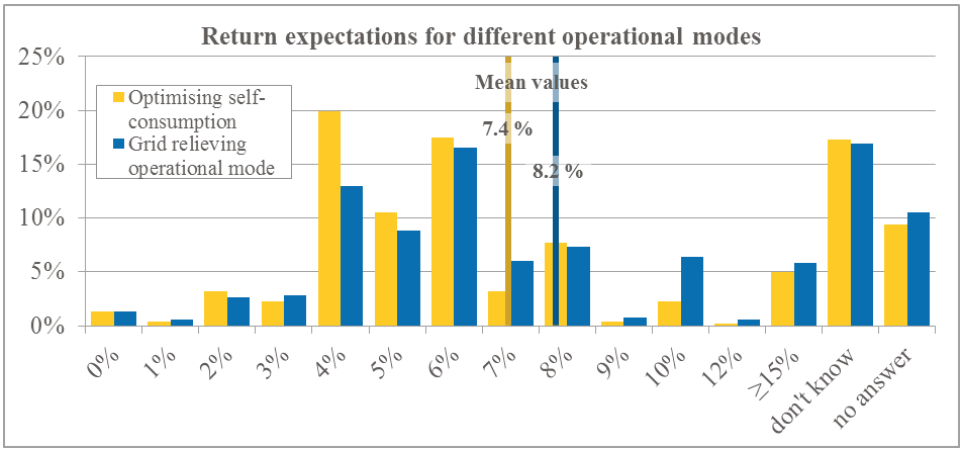

Fig. 8: Return expectations for different operational modes

The mean values of return expectations are between 7.4 % and 8.2 % whereas the median are 5 % and 6 % respectively. If one ignores the answers ≥15 %, which are unrealistic at the moment, the mean values decrease to 5.3 % and 5.8 % respectively. Still, the expectations are higher than 4 % and the respondents therefore expect a higher return rate in the case of PV-storage-systems. The mean value of the difference between the return expectations in the two operational modes “optimising self-consumption” and “grid relieving” is 1.1 %.

The respondents were given two different ideas for “grid relieving operational modes”, which are a common-benefit share of the storage and a communication and data interface that can be used by the grid operator for ancillary services. The Influence of this grid relieving operation modes on willingness to invest can be obtained in Fig. 9.

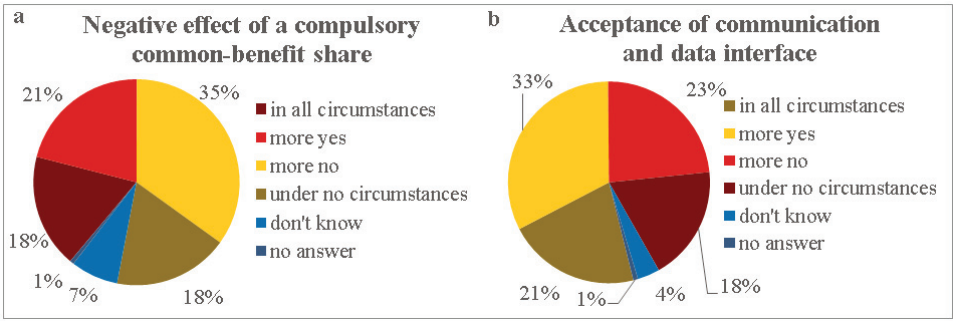

Fig. 9: (a) Negative effect of a compulsory common-benefit share on investment decision; (b)Acceptance of a communication and data interface to the grid operator

The acceptance is in both cases comparably high (about 53 % resp. 54 %). Hence, one can conclude that for more than 50 % a grid relieving operational mode has no negative effect on their willingness to invest.

Further questions focused on the frame conditions, under which grid relieving operating modes might be accepted. Most respondents premise a proper remuneration of ancillary services(Fig. 10). Only 3 % of the respondents reject the possibility of direct external control or a common-benefit operating mode under all circumstances, whereas about 10 % answered ‘more no’ or ‘under no circumstances’ under any frame condition. Therefore, around 90 % might accept it under certain frame conditions. Beside a proper remuneration, sufficient data protection and strong communication encryption are widely presupposed to accept such measures. In addition to that, increased production of renewable energy and the avoidance of regional grid expansion measures seem to be premised to accept external access by the grid operator.

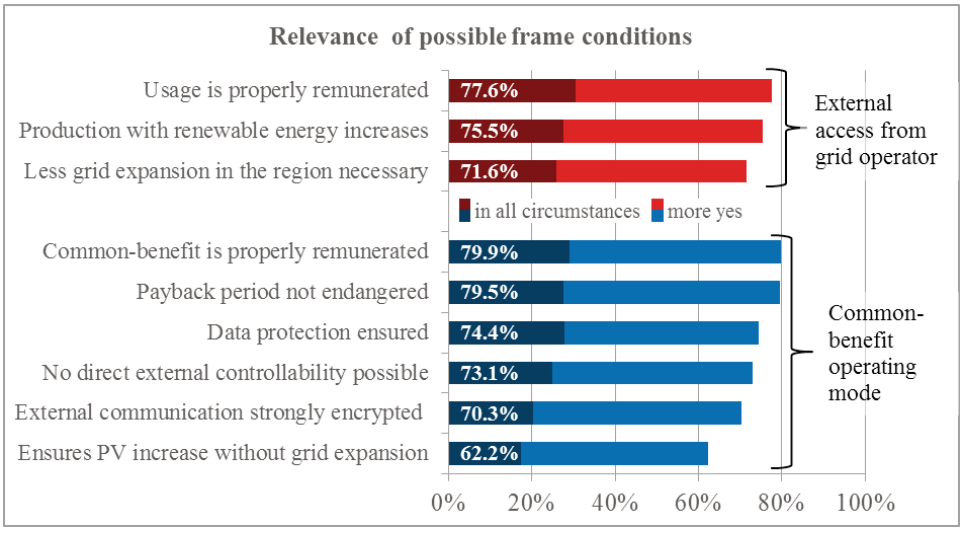

Fig. 10: Relevance of possible frame conditions to accept grid relieving operating modes(Sum of answers ‘in all circumstances’ and ‘more yes’)

4. Conclusion

The results of this survey show that an increasing share of currently around 69 % of the PV owners is generally willing to invest in PV-storage-systems and that a huge majority is willing to accept a grid relieving operational mode for their storage system. This share can even be increased if one remunerates the access to the storage or a common-benefit share of the storage. However, a communication and data interface to the grid operator is quite unpopular by around 51 %. But only 3 % of the respondents reject the possibility of external access from the grid operator under all circumstances, whereas the rest might accept direct control if sufficient data protection, strong communication encryption and proper remunerations are applied. Hence, grid relieving operational modes are widely accepted if the frame conditions match the needs of the PV owners. Assuming that a grid relieving operational mode is necessary in the long term, one should consider these results for future funding measures or legal changes.

Overall, there is still a great uncertainty among the respondents regarding appropriate investment costs or the life and usage period of PV-storage-systems, although 51 % of the respondents already collected relevant information. Hence, potential buyers of PV-storage-systems need more and specific information on storage systems especially regarding economic and technical data.

5. Acknowledgement

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