Performance of BIPV and BAPV Installations in Norway
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Introduction

The number of building integrated (BIPV) and building applied (BAPV) photovoltaic systems is rapidly increasing, both worldwide and in Norway. The research community and stakeholders in the building sector seek information on the performance and reliability of PV systems in the built environment and the best solutions for maximum energy production.

This work presents results from collected information on performance characteristics and operational experiences for a representative selection of existing BIPV and BAPV systems in Norway. The work is part of a national research project [1] in collaboration with several industry partners that aims at developing robust BIPV-solutions suitable for a Norwegian climate. The project also aims at identifying the main building-technical and architectural integration challenges for BIPV, and is developing a database to disseminate the information.

Data collection

Norwegian grid-connected BIPV and BAPV systems range from small residential systems (1-10 kWp) to commercial systems (up to 370 kWp). From a total of more than one hundred systems, the table below shows a shortlist of cases evaluated in more detail during the project. Different geographical regions, sizes, and technologies are represented. The systems are evaluated in terms of yield, specific yield, and performance ratio (PR). The analysis follow recommended guidelines in the literature and the IEA PVPS Task 15 [2] and Task 13 [3] programs.

Results

The data collected and analysed so far indicates some spread in performances, partly as expected due to differences in system design and the available solar resource, but also due to non-optimal site conditions and shading challenges. Current installations predominantly employ well-known crystalline silicon technology, and rooftop BAPV installations are still more common than BIPV. Comparing measured with the estimated specific yield (usually determined by software simulation in the design phase), the deviation varies from a few percent to above 20% in the different cases, where both over- and underestimation is seen. Typical measured annual specific yield is in the range 700-900 kWh/kWp. For one case of a rooftop BAPV system with slightly tilted modules, an annual PR of 0.86 was achieved in 2015. This is comparable with values seen elsewhere in Northern Europe [4]. Much lower PR is seen for systems severely affected by shading.

Conclusion

The results and lessons learned so far point at the importance of including knowledge about PV system design and operation into the early planning process of a building project. This may help to avoid shading problems and added costs during the installation phase caused by difficult weather conditions, complex surface curvatures, layout changes, or deviations between actual and planned dimensions.

The performance evaluation is currently limited by scarce irradiation data. In new installations, the project partners are encouraged to install basic monitoring instrumentation that allows evaluation of performance parameters. This will provide better estimates of PV performance for planning purposes, and give valuable input for the development of new guidelines and robust solutions for the growing BIPV market.

A questionnaire has been developed to interview key personnel involved in the design, installation and operational phases. The current work presents five selected cases in more detail, which provide valuable lessons learned in terms of system performance and architectural or building-technical integration issues.

References