PHOTOVOLTAIC ORIENTED BUILDINGS (PVOB)

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ABSTRACT

The direct use of solar energy by self-consumption in buildings gets more and more important to minimize negative influences on the grid. Therefore, the photovoltaic laboratory of Bern University of Applied Sciences launched the project PVOB – "Photovoltaic oriented buildings" – that will help to improve photovoltaic applications in building envelopes to match the user's energy consumption needs and reduce negative influences on the grid. Creating a database by measuring and evaluating buildings with PV installations on all four façade sides will be one part of the project. Furthermore, cost optimization in planning and realisation processes as well as improvements of fire protection are aspects which will be integrated.

Keywords: BIPV, solar façade, self-consumption, planning processes, fire protection

DIRECT USE OF SOLAR ENERGY

Photovoltaic panels installed in multiple areas of the building envelope increases the self-consumption of solar energy [1], [2]. Through the allocation of the solar panels on façades with different orientations, the electrical production profile during daytime creates a more uniformly characteristic and enables a higher coverage of the energy consumption profile [6]. According to the orientation of the photovoltaic panels and the consumptions profile, the direct use of solar energy will rise up to 50% with roof installations and up to 80% with façade installations.

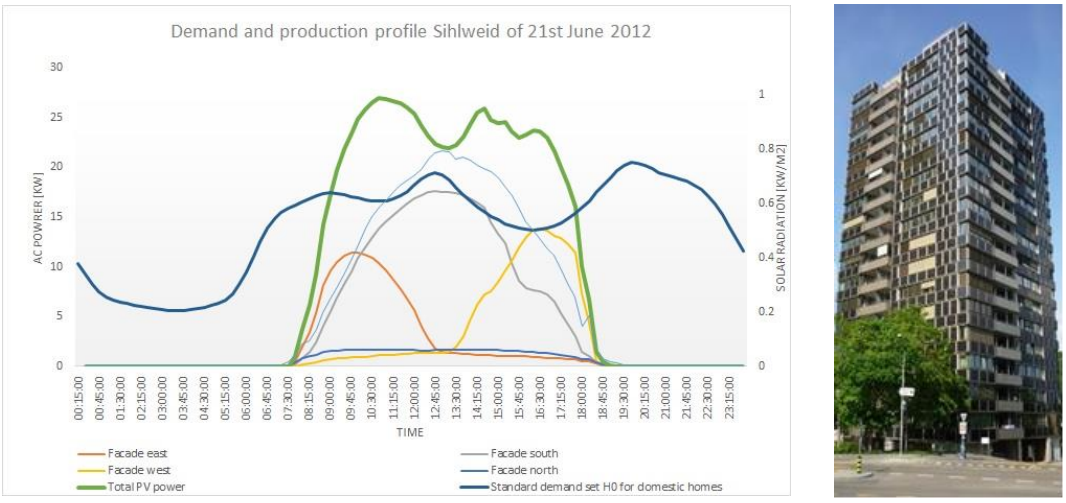

Fig. 1: PV applications for less grid overloads during daytime.

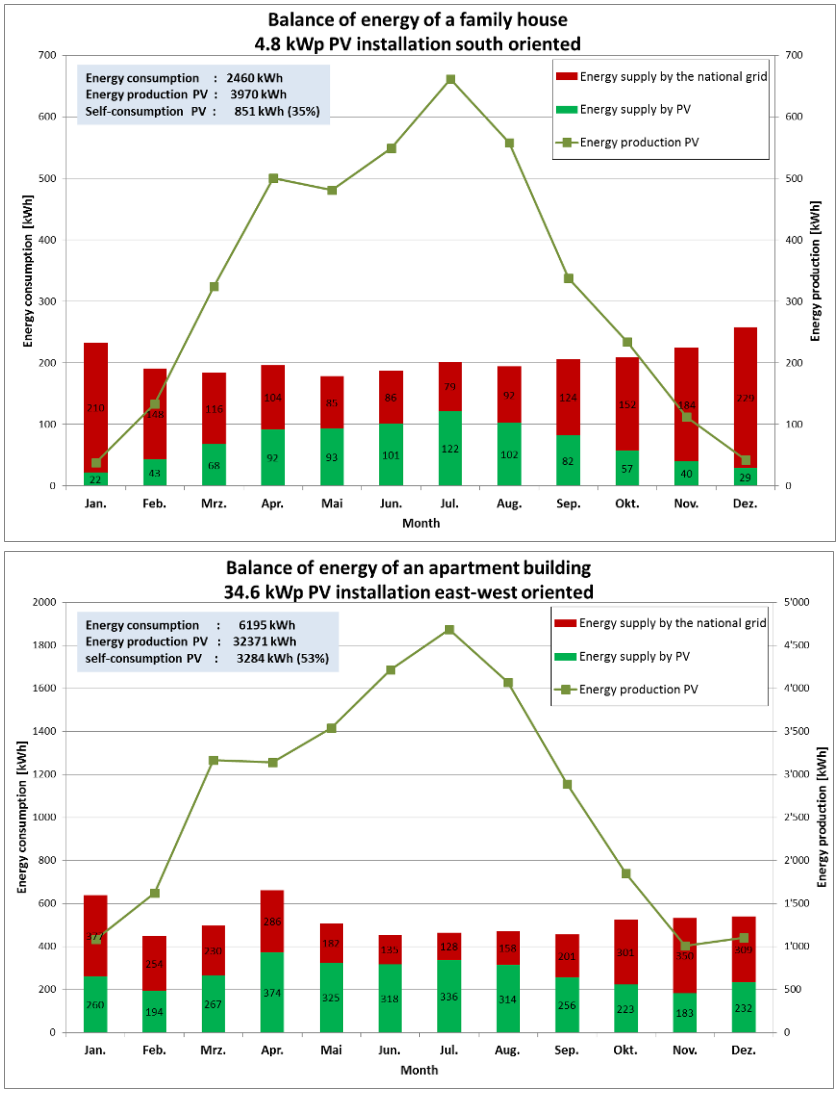

Fig. 2+3: Coverage of energy consumption through PV supply with different oriented PV installations.

For a successful commercialization of photovoltaics in the building envelope, architectural aspects are getting more important. Architects are looking for flexible and aesthetical materials in their design process. Therefore, the solar industries have to offer various solar products which are specified for the integration in the building structure like a building material. Beside aesthetical aspects, the stakeholders have to ensure safety requirements like structural analyses, fire protection and electrical functionality of the photovoltaic application in the planning process.

ECONOMIC INTEGRATION OF PHOTOVOLTAIC IN FACADES

Conventional photovoltaic systems are planned and executed by the solar installer who acts as a general contractor towards the client. In case of implementing the photovoltaic technology in façades, the situation changes completely. Different stakeholders like architect, façade designer, structural engineer, façade- and solar installers are now involved in the project. To prevent uncontrolled increase of the project costs, coordinated planning and realisation processes by the stakeholders are needed. Technical planning tools and specified products for integrated photovoltaic applications helps to reach professional results.

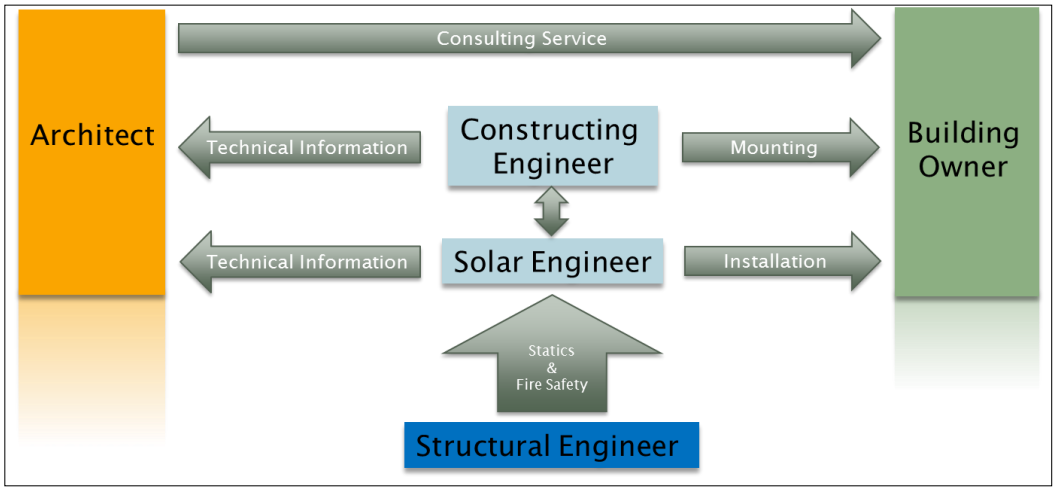

Fig. 4: Stakeholders in the planning and execution processes

DESIGNING OF PHOTOVOLTAIC FACADES

The planning process of photovoltaic facades should start in an early phase of the general project. In this stage, adjustments of the dimensions of the facade, as well as the positioning of windows, doors and balconies in relation to the photovoltaic panels are possible. Furthermore, for each project should be verified if standard panels with common dimensions or custom-made photovoltaic panels simplify the connection to the façade. Cost-effective standard photovoltaic panels can cause significant additional costs in the integration process. In this case, custom-made photovoltaic panels can be an interesting alternative for simplifying the integration and gives more flexibility to the architect while safeguarding the overall costs of the system.

Fig. 5+6: Photovoltaic integration with standard sized panels or custom-made panels.

In order to simplify the processes for architects and increase cost efficiency, the Bern University of Applied Sciences initiated a project between architects and electrical engineers to develop a software-tool as an additional plug-in for CAD software [3]. This tool allows a fast and easy initial estimate of photovoltaic applications in different parts of the façade. The layout of photovoltaic panels can without interruptions be exported to a simulation software like PVSYST to calculate energy yield and shadowing losses. The first results have shown a high potential in cost savings. Therefore, the PVLab targets a continuing project to create a tool for professional applications.

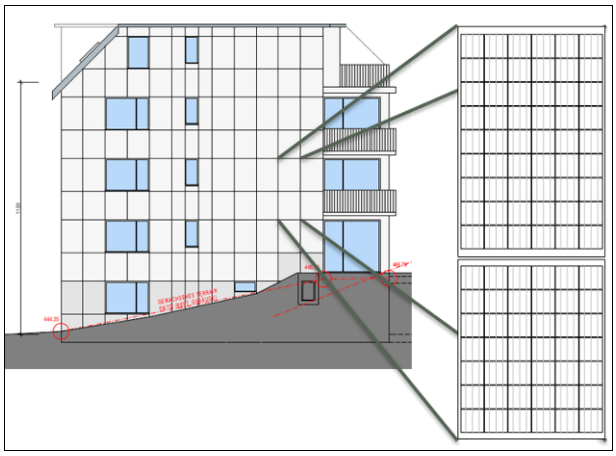

Fig. 7: PV panel modelling in the planning process

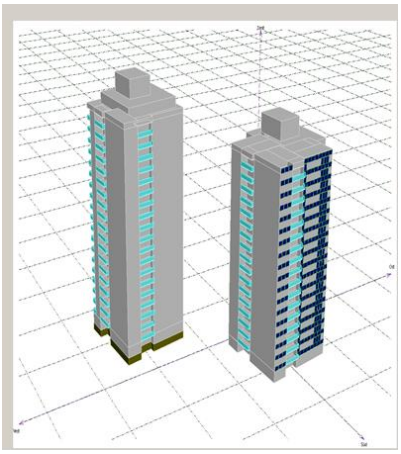

Fig. 8: Data export into PVSYST

STATIC CERTIFICATION OF PHOTOVOLTAIC FACADES

The statics of the photovoltaic system including panels and mounting system have to comply with national standards, such as "SIA261: Impact on supporting constructions". The responsibility for the statics will be taken by the designer of the facade construction. Non-regulated construction products have to be examined individually.

REQUIREMENTS OF FIRE PROTECTION AND MAINTENANCE

The requirements for fire protection according to the regulations for photovoltaic installations by VKF/AEAI (latest version march 2015) have to be verified for each photovoltaic integrated project. Especially the component selection and system configuration of photovoltaic systems in high-rise buildings (in Switzerland from 30 m) have to be specified in all details. Questions about material compositions of the photovoltaic panels or additional safeguards like fire barriers have to be defined in the planning process.

For inspection of defects in photovoltaic modules, the PV-laboratory defined a low priced concept of an IR multi-copter drone to detect hotspots in large free-field and façade photovoltaic installations. The thermography camera installed on a drone records a full-radiometric infrared video. The video, unlike photography, facilitates the evaluation of data. False detections due to reflections and other irregularities can be immediately recognized.

Fig. 9: IR-multi-copter drone of the PVLab

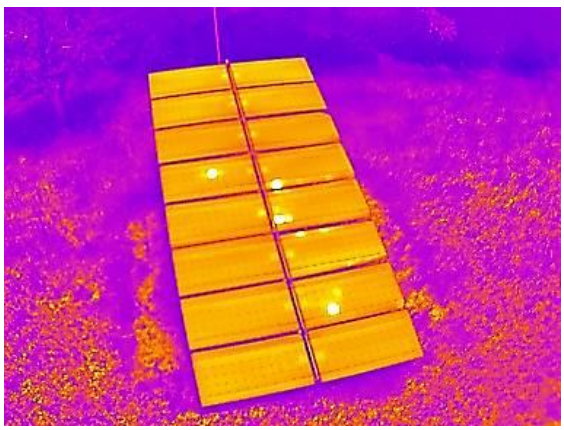

Fig. 10: Hotspot detection of PV panels

REQUIREMENTS OF DC CABLING FOR INTERGRATED PHOTOVOLTAIC

The DC cables in the ventilation space between photovoltaic panels and building have to be protected and a minimum of distance to flammable materials has to be respected. The DC cables have also to be protected against rodents. During the installation of the facade, the solar installer has to take care of the professional treatment of the electrical components.

In a particular ongoing project in the framework of fire protection of photovoltaic installations, the long term behaviour of cross-connections of DC-solar connectors are analysed. In many photovoltaic installations, the DC-connectors of different manufacturers are connected directly together. Usually, the compatibility of connectors of different manufacturers is not guaranteed. Climate chamber tests and testing of the electrical resistance of the connectors should give more insight to this impotent issue of operational safety.

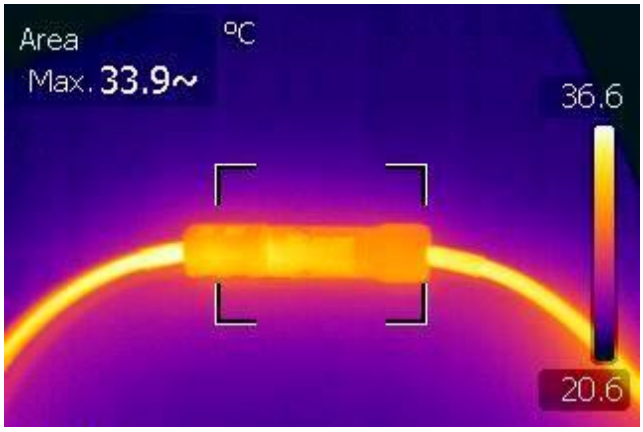

Fig 11: Combination of different DC-solar connectors

CONCLUSION

Standardized planning and implementation processes are one of the main issues to increase the number of photovoltaic installations in façades.

The PV-laboratory of Bern University of Applied Sciences in Burgdorf initiates several projects on this subject in the framework of the competency group PVOB – "Photovoltaic oriented buildings":

In 2014 we started to develop a calculation tool for architects to simplify the designing process of photovoltaics in façades. A new guideline will help architects and installers to perform practical and economic implementation of photovoltaics in façades. Safety requirements, fire protection and the maintenance concept will be included in this guideline. In co-operation with producers, the PV-laboratory will define the necessary specification of the products for easy applications in BIPV. Know-how transfer will be done by organizing workshops for architects and engineers.

ACKNOWLEDGEMENTS

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