Strategies to increase the deployment of PV in façades

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Abstract

Photovoltaic in façades are rare applications until today and there is still a huge unused potential. Photovoltaic in façades permits a maximum on self-consumption of solar energy before using a battery storage system. The direct use of solar energy in buildings gets more and more important to minimize also negative influences on the grid. However, the requirements concerning aesthetic and safety aspects of PV in façades are higher than of conventional PV applications. The process of realization is more complex in consequence of different stakeholder who are typically involved in these kind of projects. The combination of façade constructions and electrotechnical components increases the complexity of technical details. But finally, photovoltaic in façades has an additional benefit by producing electrical energy comparing to a non-productive façade.

1. 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 load profile (fig. 1 + 2). According to the orientation of the photovoltaic panels and the load profile, the direct use of solar energy will rise up to 50% by roof installations with east-west orientation and up to 80% by façade installations. By comparison, a conventional south oriented PV roof installation reaches typically a self-consumption level of 15 to 35% (fig. 3 + 4). The self-consumed solar energy reduces the operating costs of buildings between 23 and 25 cent per kWh.

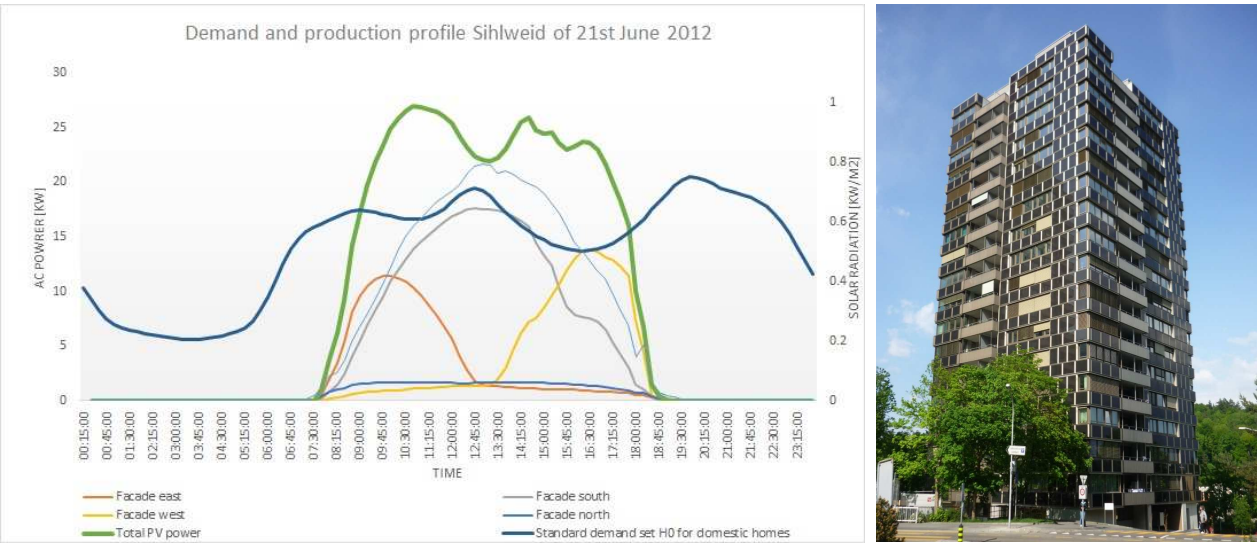
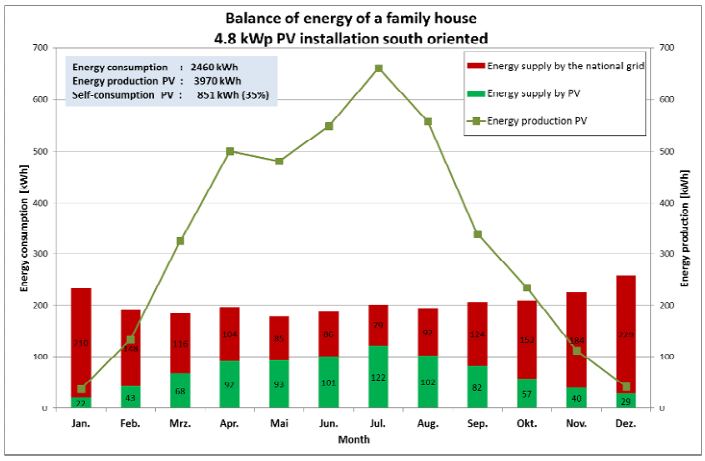


Fig. 1 + 2: PV façades generate more constant solar power and increase the coverage of energy load.



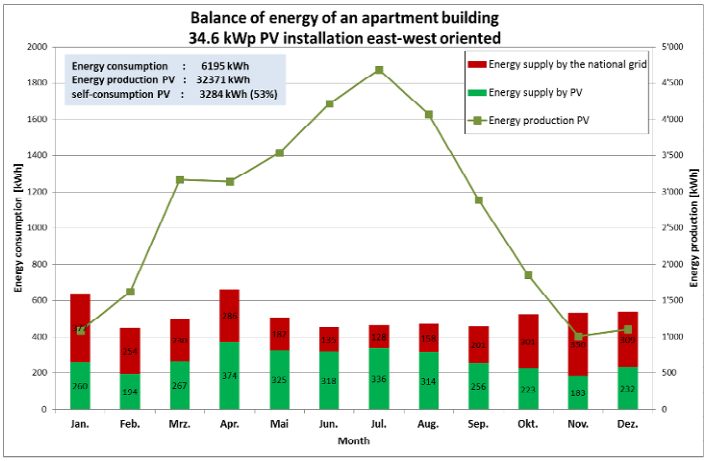


Fig. 3 + 4: Coverage of energy consumption through PV supply with different oriented PV installations. Conventional south oriented installation on a family house and apartment building with east-west oriented PV installation (inclination 45°).

2. PV in façades - aesthetic verses high performance

Photovoltaic in façades change the aesthetical requirements of the solar panels and how to integrate them into the building. Designing of the PV system with different materials and the integration into the architecturally concept of the building becomes more important than the maximization of the energy yield (fig. 5). The challenge of the PV expert is to define the best combination between the criteria of designing and reaching the best price-performance ratio of the PV system. There is a huge variety of technical solutions on the market available and the economic conditions are quite interesting. Important is the definition of the PV façade in an early stage of the project when cost optimization is easier possible. Finally, only aesthetically and functionally PV installations helps to develop the market towards the architects.

Fig 5: PV-Façade CSEM in Neuchâtel (CH), aesthetical and functional applications promote PV in façades.

3. Profitability of PV in façades

In the last years there was a big effort in the reduction of system costs of photovoltaics. Standard products like 60 cells solar panels reach a price level of approx. 140,- CHF / m^2, custom made panels for BIPV applications should be available from 200,- CHF / m^2. The price level of custom made PV panels is already underneath of high-end cladding materials for conventional façades (table 1). Additional costs of the PV installation are caused by the electrical components like inverters, cables, safety devices, etc., and furthermore by engineering and installation expenses. For the assessment of the profitability of PV in façades only the additional costs should be compared with the pay back rate. Nevertheless, façade installations with a low performance ratio and a high rate of self-consumption generate an interest on capital of 1.5% to 2.0% only by reducing the operation costs of buildings continuously over decades (table 2).

Example	Cladding materials	Price per m^2 [CHF]
1	wood	220.-
2	fibre cement	310.-
3	natural stone	360.-
4	coloured glass	145.-
5	aluminium	130.-
6	acryl glass	155.-
7	**PV panel crystalline - glass/backsheet**	**200.-**
8	**PV panel crystalline - glass/glass translucid**	**500.-**
9	**thin film PV panel - fixed dimensions**	**80.-**

Table 1: Comparing of prices of cladding materials for façades

Simulated energy balance	**kWh**	**%**			**Remarks**
Annual energy consumption	86'000	100%			
Energy yield PV façade	42'340	49%			350 kWp/a
Solar coverage of total enery consumption	31'600	37%			
Self-consumption PV		75%			
Energy feed-in to the grid	10'740	25%			
Profitability	**Energy rate CHF/kWh**	**CHF/ year**	**Periode Years**	**Amount CHF**	
Energy costs by the energy provider	0.2485	21'371.00	30	641'130.00	
Reduction of energy costs by self consumption of PV energy	0.2485	7'852.60			
Feed-in tarif	0.08	859.20			0.05 - 0.08 CHF/kWh
Cost reduction		8'711.80	30	261'354.00	
Final energy costs of the energy provider		12'659.20			
Capital investment of PV façade				396'537.42	
Interest on capital		**1.70%**		**261'354.00**	**0% for conventional façades**

Table 2: Pre-investment study of an apartment building with totally 120 kWp PV on all façade orientations.

4. Challenges in the realization process of PV façades

Conventional photovoltaic systems are planned and executed by the solar installer who acts as a general contractor regarding to 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 (fig. 6). To prevent uncontrolled increase of the project costs, coordinated planning and realisation processes by the stakeholders are needed. Technical planning tools [3] and specified products for integrated photovoltaic applications helps to reach professional results.

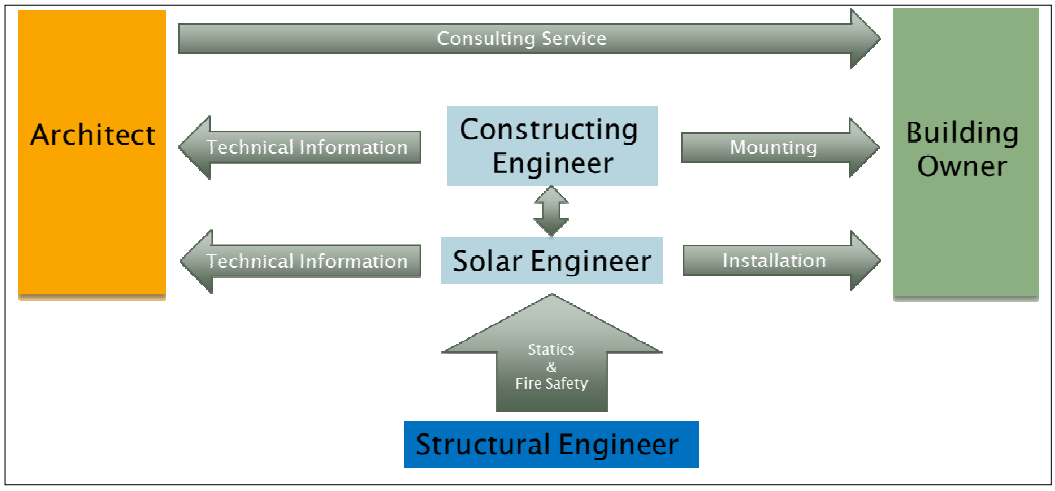


Fig. 6: Stakeholders in the planning and execution processes

4.1 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 *it* should be verified if standard panels with common dimensions or custom-made photovoltaic panels simplify the connection to the façade (fig. 7 + 8). Cost-effective standard photovoltaic panels can cause significant additional costs in the integration into the general concept of the façade. In this case, custom-made photovoltaic panels can be an interesting alternative for simplifying the integration and may gives more flexibility to the architect while safeguarding the overall costs of the system.

Fig. 7 + 8: Photovoltaic integration with standard sized panels or custom-made panels.

4.2 Fulfil of technical requirements of façade constructions and electrotechnical installations

4.2.1 Static certifications 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.

4.2.2 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 have to be specified in detail. Questions about material compositions of the photovoltaic panels or additional safeguards like fire barriers have to be defined in the planning process [4].

4.2.3 Requirements of DC cabling for the façade

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

5. Conclusions

With Photovoltaics in façades the energy yield reaches 400 – 700 kWh/kWp per year but the self-consumption of the energy will get up to 80% before using an additional storage system. The production profile of the solar energy corresponds better with the load profile of the consumers and reduces negative grid influences. The operating cost for electrical energy of buildings will be reduce by the self-consumption and this effectuate an interest of about 1.5% – 2% on the investment of PV installations in façades. Improvement should be done in the planning and execution processes of the projects. Cost reduction will be reached by the collaboration of architects and PV experts in an early phase of the planning process and the efficient coordination of the stakeholders during the realization process. Already today, the investment of PV in façades is a profitable alternative to non-productive conventional façades.

6. References

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