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Market Adoption of BIPV 4.1

What is the target audience for BIPV?

According to a large-scale survey, Swiss homeowners say they are willing to pay more for a well integrated BIPV installation than a standard BAPV installation. So there is a market for this technology that does not seem to be reserved to an elite audience.

In the context of a roof renovation, a private homeowner compares a building integrated (BI)PV solution, a building attached (BA)PV solution, and a roof without any solar PV modules. 57% of respondents are interested in installing solar panels, and nearly half of the potential PV customers would be willing to pay a premium for solar modules' building integration and visual appeal. A general interest in product design and high environmental awareness are the two strongest predictors of willingness to invest in BIPV.

Keywords: Marketing; Segmentation; Target groups; Customer preferences; Market share.
Target audience: Suppliers & companies; Broader public.

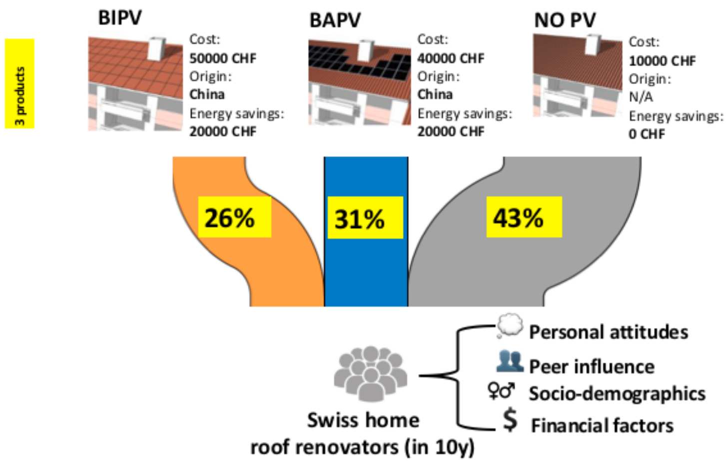

Fig. 1 Customer segmentation of potential residential solar PV adopters in Switzerland (©HSG-IWÖ).

The ACTIVE INTERFACES project investigated these questions through a large representative survey among Swiss homeowners who planned to renovate their roof within the next 10 years [1]. A roof renovation often prompts households to consider adopting a solar system [2], and this is the most likely scenario for a private homeowner to consider purchasing a building integrated (BI)PV solution. Roof renovators compare a BIPV solution to a more traditional building attached (BA)PV solution, and to the status-quo option: a standard roof without any solar PV system.

The survey was designed to investigate the extent to which financial and non-financial factors drive homeowners' preferences for PV in Switzerland. In order to estimate which percentage of future Swiss roof renovators could opt for a BIPV solution, we used a choice experiment: survey respondents had to choose repeatedly between different roof renovation solutions, varying according to the features that can create customer value [3-5]: technology (BAPV, BIPV, no PV), color, total upfront investment cost, origin of the PV modules, expected energy savings over the next 20 years, and a purchasing incentive.

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The resulting customer segmentation (Fig. 1) revealed that 43% of Swiss renovators would not install PV at all on their roof, while the other 57% were almost evenly split between those willing to pay a premium for solar modules with beauty and visual appeal (BIPV potential customers) and those who, at the end of the day, care more about the budget and prefer a standard, even if potentially less visually appealing, solution (BAPV potential customers).

Results show that, on average, private home owners are willing to pay a premium of 22% for a roof with BIPV installation, compared to a roof with a rack-mounted PV installation. BIPV creates additional value thanks to its visual appeal, and this is especially true for people who care about aesthetic features in their general purchasing decisions.

The color and country of origin of solar panels also have an impact on willingness to pay and likelihood of adoption. Black and, especially, red PV panels are a better match for customers' preferences than blue, which is still the standard color used for most PV installations. Swiss homeowners prefer European PV panels to Chinese PV panels, and Swiss-made panels to German ones. Disclosing the country of origin of a module "made in Switzerland" can have a positive impact on BIPV diffusion. Swiss manufacturers could emphasize the origin of the panels in their marketing efforts to differentiate themselves on the basis of the country-of-origin effect.

The study suggests that solar system suppliers should have both solutions in their portfolio: not just an economy model produced by manufacturers who focus on cost leadership, but also a premium, higher-priced BIPV solution for those customers who are willing to pay for design.

Potential BIPV customers are not necessarily wealthier or those who have a higher education. What distinguishes potential BIPV customers from BAPV ones is that they care more about aesthetic aspects in general purchasing decisions and show higher concern for the environment.

Demand for colored BIPV modules is therefore likely to come from product design lovers and from highly environmentally aware customers. Suppliers could target them by placing advertisements for BIPV in design magazines, by promoting colored BIPV in design hotels or galleries, by participating in design exhibitions and furniture fairs, by cross-selling with other green products, or by collaborating with architects when equipping high-profile public buildings with colored BIPV

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Market Adoption of BIPV 4.2

What can policymakers do to support the diffusion of BIPV?

Stakeholders involved in construction or BIPV, especially owners, expect more incentives from public policy to encourage them to install BIPV [1]. Policymakers have several levers at their disposal to convince people to invest in this technology.

Apart from financial incentives that support the adoption of solar photovoltaics (PV) in general – such as feed-in tariffs or investment grants – there are also a number of non-financial policies that can accelerate BIPV diffusion. Policymakers can walk the talk by equipping public buildings with BIPV, they can take advantage of peer effects in solar diffusion, and they can include BIPV in municipal or cantonal building codes.

Keywords: Policy; Incentives; Diffusion of innovation; Peer effects; Awareness.
Target audience: Regulation makers; Owners & other decision makers.

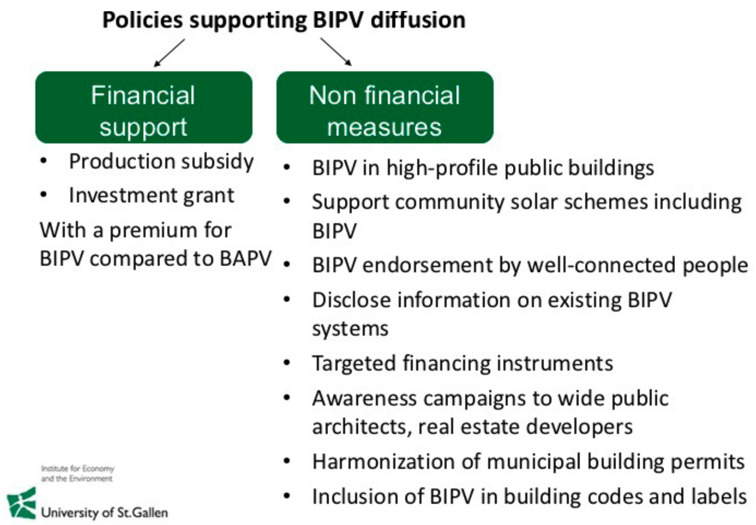

Fig. 1 Policies to support the diffusion of BIPV (©HSG-IWÖ).

A representative survey conducted within the framework of the ACTIVE INTERFACES interdisciplinary research project [2] shows that for some Swiss homeowners, the aesthetics of solar panels plays a key role in determining PV adoption. Well-designed BIPV projects could be a way of overcoming this barrier. There are a number of ways that policymakers can support the diffusion of BIPV, financially or non-financially (Fig. 1).

When it comes to financial support, the same policy instruments that have been used for solar PV in general – such as feed-in tariffs or investment grants – can also be applied to BIPV. To reflect the fact that implementing a BIPV project may require additional planning and coordination efforts, solar policies have usually included a premium for BIPV over building-attached PV projects. This could represent an important incentive for building owners and project developers to consider BIPV in the first place, even though some of the additional cost may already be offset by the dual functionality of BIPV as both a power generation device and a building material.

As for non-financial support, equipping high-profile public buildings with BIPV can send a strong signal to private building owners, thus raising awareness and validating the feasibility of BIPV. Another way to “walk the talk” on solar implementation is for local authorities or municipal utilities to initiate or support community solar schemes including BIPV. This may help overcome financial barriers to BIPV diffusion and can strengthen a sense of community with regard to the regional implementation of energy transition [cf sheet 4.3].

Since strong preferences for PV adoption correlate positively with the perceived number of neighbors, friends and family members who have already installed solar, policy makers should leverage on peer effects [2,3]. For instance, a select group of well-connected and influential people could be stimulated to adopt solar and asked to publicly endorse their choice; local authorities could disclose information on how many people in the community have already installed solar.

When it comes to sociodemographic characteristics of PV adopters, our survey shows that female homeowners appear to be less likely than men to implement solar projects [2]. Reaching this important target group may require dedicated communication efforts, possibly in combination with peer effects as described above. For example, municipalities could support information events where female homeowners share their experiences with other women.

Another factor in successful BIPV policy could be to address liquidity concerns. Either policymakers or financial institutions could address this with targeted instruments, such as a solar supplement on top of a mortgage.

Research based on 43 qualitative interviews with stakeholders across the BIPV value chain [4] shows that awareness and knowledge about the technology are crucial for BIPV diffusion [cf sheet 5.4]. This implies that policymakers and other market players should continue to raise awareness with regard to the existence and feasibility of BIPV solutions. Such awareness campaigns can be targeting the wider public (such as private homeowners), but may also be dedicated to professional decision makers in the real estate sector, e.g. architects and developers. Synergies may be achieved by building on lessons learned in spreading knowledge about other innovation in the building sector, such as the Minergie standard or the integration of wood as a building material.

Harmonization of municipal building permits, as well as inclusion of BIPV in building codes and labels, could also foster BIPV diffusion [4].

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Market Adoption of BIPV 4.3

What is “community solar”, and how can it support the diffusion of BIPV?

Community solar is a new business model offered by different suppliers that allows electricity customers to invest in locally installed (BI)PV installations. This solution seems particularly suitable for tenants who cannot install (BI) PV in their homes because they are not homeowners.

A survey of Swiss electricity customers (n=414) was conducted to determine whether community solar energy can support diffusion of BIPV in urban areas. Results from a survey of Swiss electricity customers (n=414) indicate that about 63% of respondents would be willing to invest in BIPV modules in the context of a local community solar project.

Keywords: Community solar; Marketing; Customer preference; Consumer survey.
Target audience: Suppliers & companies / Broader public.

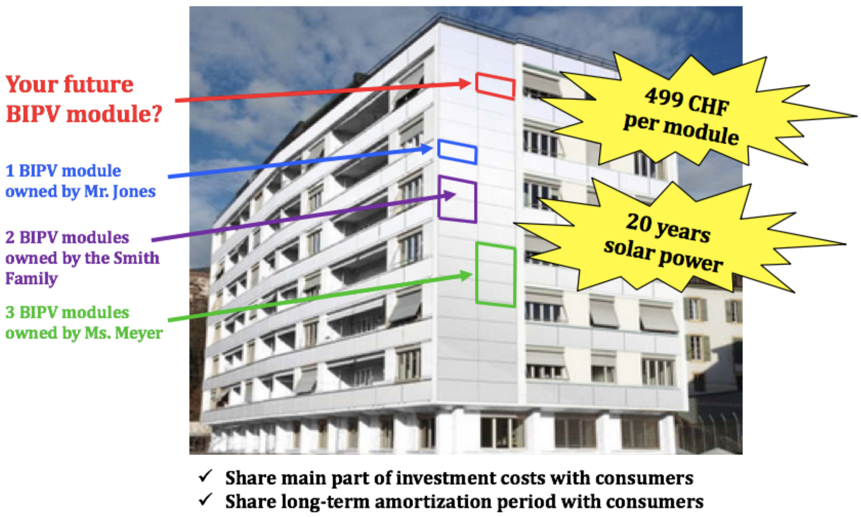

Fig. 1 Community solar illustration with BIPV modules (©HSG-IWÖ).

Many electricity suppliers today are looking for new business models to integrate renewable energy into their product portfolio to satisfy an increasing demand and enhance customer loyalty. One increasingly popular innovative business model is community solar – the idea of allowing retail customers to invest in solar installations that are not situated on their own roof. Community solar offerings have been introduced by a variety of players, including electric utilities, local initiatives, and cooperatives.

This is especially attractive for customers in urban areas, where many people live in rented apartments and hence do not have the possibility of installing solar panels on their own [1]. Community solar allows electricity consumers to initially buy shares of a solar plant in the vicinity. In return, they get compensated either financially or through physical delivery of the solar power from the plant. Fig. 1 illustrates a community solar offer with BIPV modules. Community solar is still at the early stages of diffusion, but enjoys increasing popularity in the US and Europe [2,3,4].

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The increasing popularity of community solar can contribute to increasing the share of power generated in cities. In addition, the continuous development of photovoltaics (e.g. building-integrated PV) is creating an increasingly broader application context. Community Solar offers numerous advantages for suppliers and customers [1,3,5], and additionally creates, through the direct involvement of customers as investors, an increased awareness of regional and sustainable power generation as well as of power consumption and energy system transformation in general [3,4].

Based on that, a representative survey by the University of St. Gallen assessed whether community solar offerings with BIPV could cause the same willingness to invest as when it was offered with building-attached (BAPV) panels only. Consequently, the offers differed in only one aspect, BIPV versus BAPV, while all other factors such as price, contract duration, deliverables, etc. were held constant.

The BIPV offer was evaluated by 210 participants, and the BAPV offer by 204 participants (total sample=414). Results indicate that about 63% of study participants would be willing to invest in BIPV modules as part of a local community solar project, while for the same community solar project offering BAPV instead of BIPV, we found 67% willing to buy at least one panel (Fig. 2). On average, participants would invest in 2.6 BIPV modules (=1’300 CHF) or 2.8 BAPV panels (=1’400 CHF), which was not significantly different (ANOVA of means p=0.267).

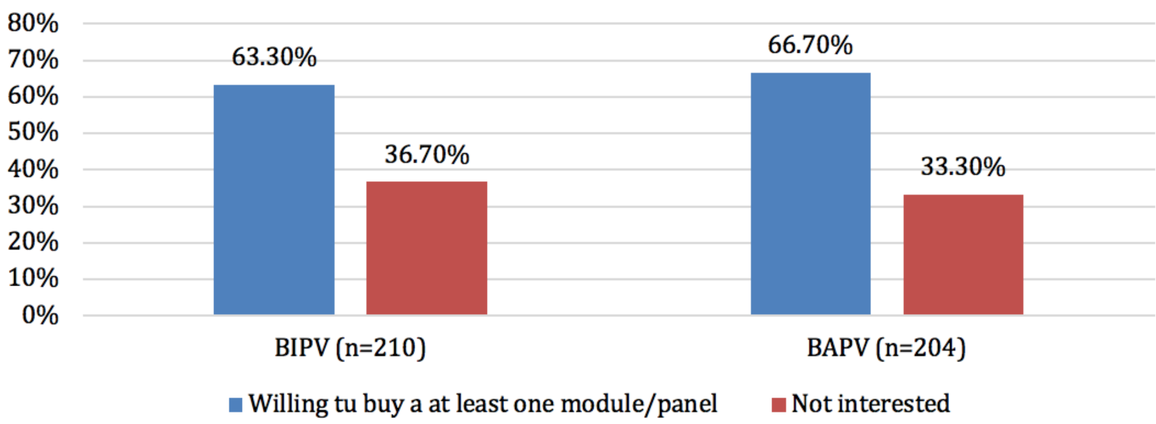

Fig. 2 Community Solar based on BIPV modules compared to Community Solar based on BAPV panels (©HSG-IWÖ).

These findings may encourage market players to offer community solar. In particular, including BIPV rather than just traditional BAPV may increase the number of available projects, especially in urban areas, and increase customer awareness of BIPV as an aesthetic and functional alternative to traditional solar projects.

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Market Adoption of BIPV 4.4

What is the profitability of a BIPV installation?

Because economic performance is a predominant factor in the intention to install BIPV, financial analysis of a retrofit project incorporating BIPV can help overcome certain preconceived ideas that represent barriers to the deployment of large-scale solar energy.

This sheet proposes an in-depth study of the whole life-cycle cost (LCC) analysis of the renovation project with BIPV installation on an archetype built in the 70s. Payback time as well as internal rate of return are calculated for different intervention strategies at the building level and different energy-use scenarios.

Keywords: Installation cost; Payback time; Internal rate of return; Storage strategy; Self-consumption.
Target audience: Regulation makers; Owners & other decision makers; Architects & engineers; Suppliers & companies; Broader public.

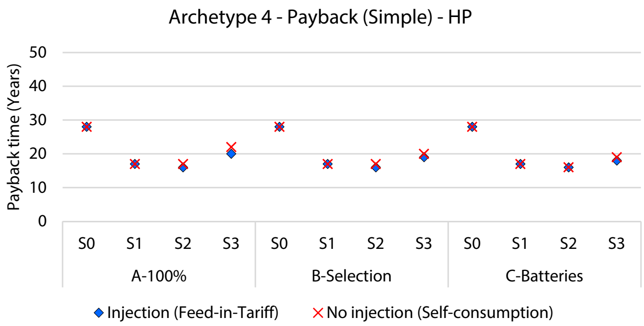

Fig. 1 Estimation of the simple payback time (SPBT) for each renovation scenario, taking into account the energy-use variants A) 100% of potentially active surfaces, B) selected surfaces and C) batteries, and changing out the existing oil-boiler for an electric heat pump [1] (©EPFL-LAST).

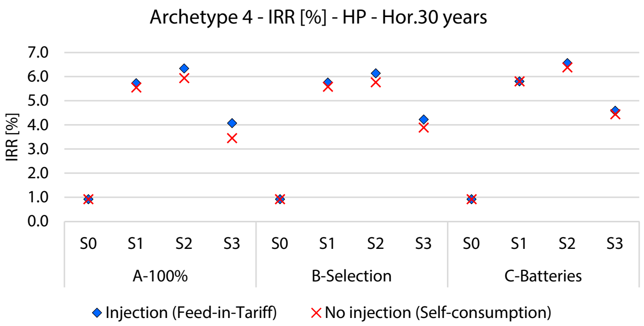

Fig. 2 Internal rate of return (IRR) with 35-year horizon of each renovation scenario, taking into account the energy-use variants A) 100% of potentially active surfaces, B) selected surfaces and C) batteries, and changing out the existing oil-boiler for an electric heat pump [1] (©EPFL-LAST).

Fig. 1 and 2 present the results of the life-cycle cost (LCC) analysis regarding the whole renovation project, including BIPV strategies and the replacement of the existing oil-boiler by an electric heat pump. In addition, we propose three comparative energy-use scenarios related to the sizing of the BIPV installation and the implementation of storage systems.

- **A-100%** takes into account the activation of 100% of the possible surfaces detected during the implementation of each renovation scenario [cf sheet 2.3].
- **B-Selection** takes into account only those active surfaces that allow an equilibrium between self-consumption and self-sufficiency, resulting in an installation that is better adapted to the demand of the building. The rest of the possible active surfaces will present the same visually but without PV cells.
- **C-Batteries** takes into account the selection from scenario B, to which a battery system is added, in order to increase self-consumption and self-sufficiency potential.

Simple payback time (SPBT): number of years necessary to recover the investment cost taking into account as income the annual energy saving cost. Internal rate of return (IRR): interest rate (or discounted rate) that gives a net present value (NPV) of zero. Equivalent to the minimum interest rate that is needed to receive in an alternative investment to equalize the investment in the renovation.

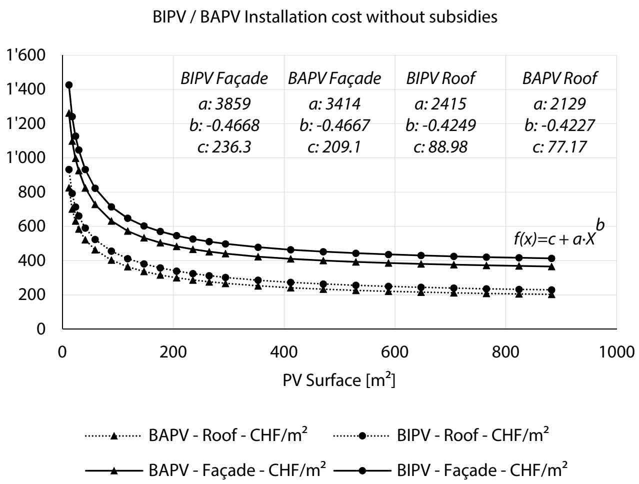

Fig. 3 Parametrization of the photovoltaic BIPV / BAPV installation balance of system (BOS) cost. Prices include all components of the installation (PV panels, junction box, connections, cabling and inverters) [1-4] (©EPFL-LAST).

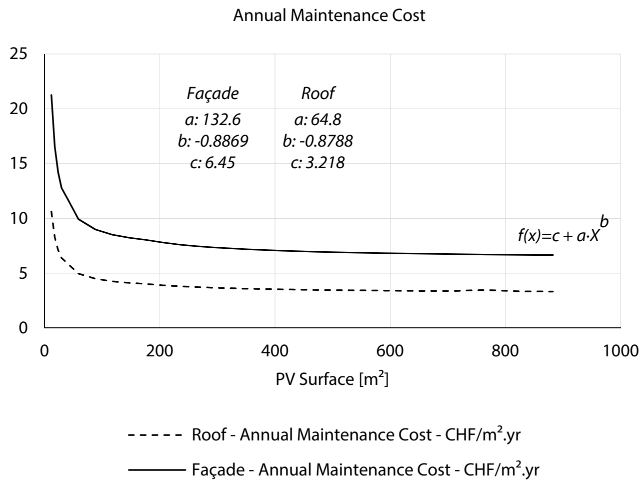

Fig. 4 annual O&M (operational and maintenance) cost . Prices include all components of the installation (PV panels, junction box, connections, cabling and inverters) [1-4] (©EPFL-LAST).

The cost of the BIPV installation is based on the market study conducted by OFEN in 2016 [2] and the web tool [3]. This data was treated in order to obtain a series of curves (Fig. 3) allowing to use the cost value parametrically in function of the active surface selected. The cost includes all installation components (PV panels, junction box, connections, cabling and inverters).

Fig. 1 shows that the three BIPV renovation scenarios have a shorter PBT compared to the one obtained for the shallow renovation of scenario S0 (about 35 years), which corresponds to current practice with the objective of complying with the minimal legal requirements defined by SIA 380/1:2016 [5]. All values for BIPV scenarios S1, S2 and S3 achieve a PBT below 25 years, making this investment very attractive.

In terms of cost-effectiveness, the IRR obtained for the BIPV scenarios (using a 35-year horizon) is higher than 3% in all cases and achieving 5% in some scenarios. These results convey a key message: not only could BIPV strategies help achieve environmental targets for 2050 [6], but BIPV could also help promote the renovation process.

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