UrbanPV: PV integration in urban and landscape architecture

Food for thought by Dr. E. Merkle, CEO of GridParity AG, January 2023

UrbanPV - the concept

UrbanPV is a concept that initially arose from the need to generate renewable electricity in residential areas, predominantly on sealed surfaces. In other words, in areas where 77% of the German population lives and works and where the demand for electricity is constantly growing due to the imperative need to replace fossil fuels (for transport and air conditioning).
The advantages of such decentralized PV power plants lie in the mostly direct use of the generated electricity, which can be directly integrated into the grids without long lines. Even conservative calculations assume that the potential is immense, at around 60 GW. If innovative concepts such as those briefly described in the article are included, the potential is well over 100 GW, enough to meet the electricity needs of German households or to replace 10 nuclear power plants.
However, the immediate benefit is only one aspect. All of the examples presented have a dual benefit in that they provide protection from the sun and precipitation (rain and hail) and reduce the overheating of large sealed surfaces in cities. In addition, there is the visual enhancement of otherwise often sterile places.
Detailed information as well as cost and yield figures are presented in a detailed study (www.gridparity.ag/urbanPV). The calculations there show that UrbanPV systems usually pay for themselves in a short time.
It also shows in detail how little our urban architecture is up to the challenges of climate change. There is a lack of covered areas and cool spaces. Both can be achieved by integrating transparent PV roofs. The generated electricity can be used directly for the creation of cooling zones but of course also for all other applications.
By intelligently integrating UrbanPV into urban architecture, cities can become more resilient to climate change and create a livable environment.
The examples and case studies presented below are all directly implementable. They are therefore not fanciful sketches of ideas whose realization is often not economically feasible. By integrating robust planting systems, the above-mentioned goals of creating attractive urban spaces are additionally achieved.

The municipalities have a need for action here. Standards should, for example, specify the requirements for the plants and the modules (statics of the structures, mechanical load on the modules, electrical safety of the plants, avoidance of glare, etc.). By using industrially prefabricated parts, planning efforts and costs can be reduced. Broad acceptance can be achieved by integrating model systems into highly frequented events such as garden shows.

Urban PV makes cities more climate resilient

In the following, I try to exemplify the possibilities of integrated PV concepts with image-based case studies. They show the double benefit (e.g. roofing a bus stop with PV modules) and additionally the resulting aesthetic enhancement of areas by using modern semi-transparent modules.

Integration of PV in an office complex

In the figures below, we have illustrated changes in a typical modern office complex. The adjacent figure shows this with several connected buildings. If one wants to increase the quality of life of urban spaces, e.g. by reducing particulate matter and avoiding heat islands, the design of outdoor areas by PV and intensive planting is an obvious solution. This addresses the challenges of a changing climate.
Integrating PV modules on transitions and integrating plants creates areas where people want to stay and linger, even on hot summer days.

Fig. 1

If one considers the energy aspect in addition to the obvious added value in terms of quality of life, the balance is also convincing.
In most examples, the additional expense is financed by the use of the generated electricity in a short time by itself. This also includes the cost of planting, whose irrigation is done by the rainwater collected by the solar system.

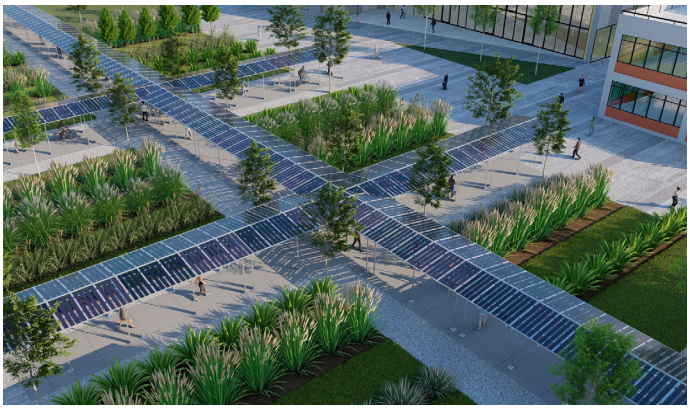

Fig. 2

Fig. 3

Markets and squares

Central square as a recreation center

The figure shows a typical central square with busy streets on all sides.
Again, it is important to use shaded areas and planting to lower the temperature in the summer and create shelter zones during the year. The Agora installation in the center is an aesthetic highlight. Design alternatives could also expand the plaza with a stage for concerts and other events.

Vegetable market with PV roofing with power generation for cold storage

Fruit and vegetable markets are in many cases centralized facilities. Our example shows the possibility of using PV facilities to generate electricity that can be used directly for lighting and cooling but also for a central cold store or fed into the grid.

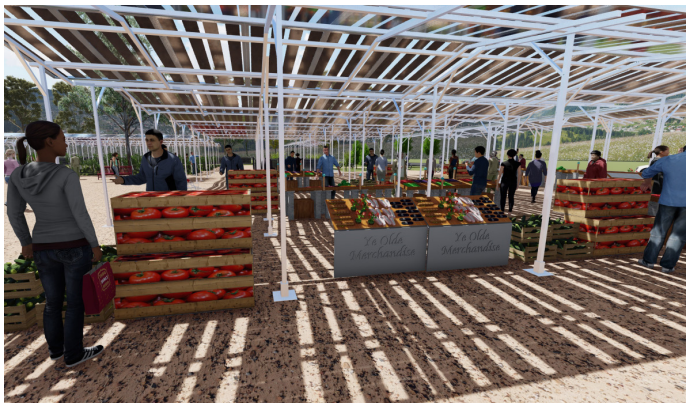

Fig. 4

Fig. 5

Greening with PV

Combining PV with green elements significantly enhances residential rooftops.
The example below produces enough electricity to power all 18 apartments in the block.
PV and planting systems allow for the creation of a green habitat on the 500 m² footprint of an otherwise unused rooftop facility.

Fig. 6

Green mobility
Waiting areas bus stops or (bus) stations

Bus stops are like small islands in cities to which more functions can be assigned. If there is access to electricity through solar panels mounted on the roof, electricity can be generated for lighting and information boards. Through motion detectors, the light is intensified as soon as people are in the waiting area. The electricity can also be used for path lighting. With island operation with batteries, there is security even in the event of a blackout.

Fig. 7

Parking lots

PV roofing of larger parking lots is now mandatory by building codes in almost all states. This obligation can be met creatively, to the extent that the changed function due to e-mobility is taken into account. For example, a commuter parking lot can integrate a relaxation area with a kiosk and a dwell zone (2nd row left in the picture). Display boards tell train passengers about any delays and they can read the newspaper or enjoy a coffee to bridge the waiting time. Waiting for free loading spaces will then also be less stressful.

Fig. 8

Recreation garden center

Garden centers already have experience areas with gastronomy and recreation areas in many cases. In the example below, one such center has been adapted to climate change with PV installations and developed into a plus-energy center. The roofs produce over 850,000 kWh of electricity per year.

Fig. 9

Outlook

UrbanPV is a new application area of photovoltaics for which there are almost no examples so far. The presented examples should be food for thought for municipalities, architects and investors.
Electricity generation by PV close to consumption is the cheapest way of energy production. The PV duty already forces builders to take this into account. If protection against climate change is also included in the considerations, then UrbanPV will gain the importance it deserves.

For more information about UrbanPV see the larger study at www.gridparity.ag/urbanPV.

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About the author
As early as 2006, Dr. Erich Merkle, together with Almaden Glas, developed the first transparent PV double glass modules with 2 mm thin glass. These have since been installed by GridParity AG in more than 1,000 building-integrated PV systems. The first AgriPV applications include two systems installed as early as 10 years ago in Cairo and in the Wahat Desert in Egypt. Since then, he has been lecturing and writing papers on these topics, which have long received too little attention and have now received a significant boost. GridParity is currently developing a large number of plants with a total capacity of over 20 MWp.