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# 2.6: Looking Ahead

# Future Oriented and Sustainable Green Roofs in Germany

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## Abstract

In this article, future-oriented and sustainable green roofs are being understood as roofs which offer innovative technological features and/or additional use which is usually possible on 'normal' ground. Combined with extensive or intensive greening these roofs reduce the use of building land. Of course, these green roofs must be built to last the lifetime of the building – provided there is proper care and maintenance. Moreover, green roof systems in the 21st century shall be made of recycled and environmentally friendly material. The actual green roof build-up is to provide not only a permanent location for the vegetation, but also offer further possibilities of utilization, i.e. additional thermal insulation, fall protection systems or even constructions for solar power facilities.

## The development of green roofs in Germany

The German Roof Gardener Association (DDV) was established approximately 20 years ago. Its main focus was to replace the billions and billions of square feet of bare or gravel flat roof areas, which existed in Germany at that time; back to nature by applying an "ecological protection layer" in form of an extensive green roof. Many seminars and meetings, in particular for and with local authorities, but also the development of instructions for the planning and execution of greening on flat roofs and two international green roof symposiums in 1989 in Germany were carried out. Ever since then, green roofs in Germany are supported and made mandatory by local authorities.


Figure 1: ”Freight distribution centre“ near Stuttgart, Germany.

In a second step, approximately 10 years later, the main focus was on the economical benefits of extensive green roofs and on the other hand, their contribution to a sustainable urban development. “Green roofs as an economical form of replacement” was the slogan of numerous events where the following topics were mentioned: Extended life expectancy of a roof, savings on storm water tax, thermal values for insulation calculations, etc. The DDV in the 90s started ‘Ecological guidelines’ with regards to the systems and components being used in green roof constructions, starting from the raw material to the production and the transport of the material all the way to the possible recycling of the material after demolition. In other words, a complete never ending cycle of reuse of material. Ever since then, green roof substrates and drainage elements are being produced from recycling material.


Figure 2: Green roof substrate made of recycled clay tiles

A very important value of the DDV always has been and always will be the long life expectancy of a green roof. This can only be achieved, when the single components of the green roof build-up correspond to the relevant roof build-up, the load bearing conditions, the slope of the roof, the

building height, etc. Also, the requirements of the vegetation which is to establish need to be considered. Last, but certainly not least is the professional and regular care and maintenance of the green roof.

## The Trend Towards Intensive green roofs in Germany

Meanwhile in Germany, the percentage of green roofs with high maintenance, intensive green roofs such as private roof gardens with lawn, perennials and shrubs in combination with ponds or water features is constantly increasing. Moreover, representative green roofs on corporate roofs, on which meetings take place or lunch breaks can be spent, are more and more built in heavily built-up areas. Department stores use the roof space for cafes, even pre-schools and playgrounds are installed on roofs. The same goes for fitness centres which are using flat roofs for outdoor training units and relaxation.

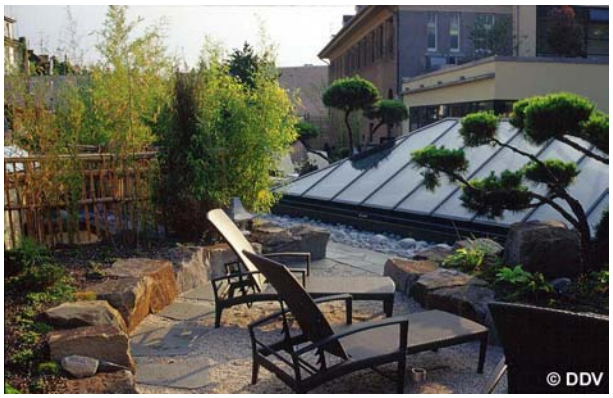


Figure 3: “Japanese sauna landscape”, Cologne, Germany

These ways of using a roof – normally in connection with an intensive green roof build-up – have got their price, but compared to the land prices in the densely populated areas, these costs stay clear. Furthermore, roof areas are most of the times well accessible, whether from the office, from the penthouse apartment or from the classroom. Roof areas are safe and there is no disturbing traffic. The use of roof areas keep the limited resources of building land, give the city centres more “green“ and reduce the exodus from the cities – overall, a substantial contribution to a sustainable urban development.

## A new trend: Extensive green roofs in combination with solar power

Of course, Germany will continue in having – partly very largely sized - extensive green roofs. In recent years, the green roof used to be in competition with other ecologically oriented forms of use such rain water use or solar power facilities. Today, a combination of different forms of use is preferred to even mix synergy effects.


Figure 4: Photovoltaic installation combined with extensive green roof on a school near Stuttgart

Today, green roofs represent an important element within storm water management. The green roof build-up slows down, filters and diminishes the run-off. The excess water is guided into cisterns and used for the irrigation of the roof gardens and for flushing toilets.

Most forms of solar facilities have preferably been installed on flat roofs. Today's specifically designed green roof systems provide these facilities with the necessary ballast and subsurface construction without penetrating the waterproofing. In addition, the use of these "solar bases" avoids dangerous high point loads on flat roofs. As a rule of thumb, medium weight green roof build-ups (~20 lb/ sq ft) offer enough ballast for solar modules within the center area of flat roofs (on buildings < 33 ft height).

The green roof with its lower air temperature even enables a higher efficiency of PV panels in hot summer months. The rated power of PV panels is fixed under Standard Test Conditions (STC) at a temperature of 25°C. Based on this standard, a temperature increase of 1°C leads to a 0,5% decrease of the electricity output. On first sight this seems to be a moderate drop. But we have to consider that the temperatures on gravel roofs are easily exceeding 50°C (-> uncovered roofs surface >70°C) on hot summer days whereas the temperatures on green roofs are

normally below 35°C. In this context the synergy benefits of the green roof / solar power combination are very noteworthy.

For care and maintenance works on flat roofs, there are fall protection systems in form of large surface nets or canvas cover, which are stabilised by the extra load of a green roof. These safety features can even be installed on flat roofs by a landscape gardener, as there is no penetration of the waterproofing and no attachment to the roof surface.

## Green roofs as additional thermal insulation

Particularly for refurbishments of flat roofs, green roof systems, which may officially be credited as “additional thermal insulation”, are very interesting. In 1990, these exceptional green roof build-ups were certificated by the “German Institute for Construction Engineering”. The core element of these systems is a hydrophobic drainage element with official values for the thermal resistance (‘R-values’). Depending on the type and height the drainage elements are reaching thermal resistance values which correspond to 4-10 cm (1,6 – 4 in) of common thermal insulation material. Of course the substrate and vegetation layer are providing additional thermal insulation and energy savings. At present, however, these positive effects can not be exactly quantified and qualified.

The thermally insulating drainage element is made from expanded polystyrene (CFC-free) and has water retaining pockets on the upper side with openings for ventilation and evaporation. Underneath are multidirectional channels which ensure an excellent drainage. The elements don’t need to have more depth than 3-4 inches. In addition the weight of a complete extensive green roof build-up is comparable with 2 inches of standard gravel material (~ 18 lb/ sq ft). With regards to the roof statics the subsequent installation of thermally insulating green roofs on former gravel is therefore no problem. Using these tested and authorized elements allows saving quite an amount of energy – whether in summer or in winter. In many cases the strict German energy-saving regulations (“U-value” < 0,25 W/m²K) can be met on old and poorly insulated flat roofs just by upgrading the thermal resistance value with an insulating green roof build-up. Both extensive and intensive green roofs can be built with these thermally insulating drainage elements if the structural requirements are met and the waterproofing is in good condition or renewed.


Figure 5: These elements are draining and thermally insulating at the same time

Further information about the innovative and registered green roof build-ups can be obtained from the German Roof Gardener Association (DDV, address see below).

## Key take-home points:

Future oriented and sustainable green roofs are based on energy-saving production technologies and the economical (re)use of resources.

The combination of green roof technology with solar power facilities or storm water management systems (e.g. cisterns, roof garden irrigation) offers attractive fields of application for the future.

## Authors

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include seminars, press releases, informational brochures and the organization of symposiums and workshops on green roof topics.

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