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Photovoltaic Rooftop Gardens - a building integrated, space-saving solution for energy production, rainwater storage and human well-being.

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Spare use of space and reduced emissions, are a strong aim in city-planning processes. But how to combine several aspects those are important for sustainable cities - like rainwater harvesting, green energy production, preparation of food and recreation areas, providing clean air - on just a few square meters?

One possibility for a multifunctional building integrated concept was developed by an interdisciplinary team within the project “Photovoltaic Rooftop Garden”. It combines an intensive green roof with a canopy of translucent photovoltaic (PV) panels creating a comfortable shelter. The roof garden as an extension of the house helps inhabitants to stay healthy by offering an on-site relaxing zone or a place for urban gardening [1]. Additionally to other advantages of green roofs, like storm water retention, CO_2 sequestration, noise and particular reduction and habitat function, CO_2 emissions are reduced because of clean photovoltaic energy production.

For a holistic testing of the concept an examination site was constructed on a rooftop terrace at University of Natural Resources and Life Sciences, Vienna. Therefore, 60 m2 of translucent PV-panels were installed on a pergola-like sub construction. Underneath two intensive green roof fields were built, and a resting zone with table and benches was set in-between. The terrace also contains extensive and intensive green roof - fields and sitting areas which are unsheltered.
For a detailed investigation of this prototype model, shortwave and longwave radiation, air temperature, humidity and wind speed, were measured, energy production was recorded, as well as different plant species and their water demand were surveyed over three years.

By calculating mean radiant temperature and Universal Thermal Climate Index (UTCI), using the collected data from a full year, it is shown, that the diurnal amplitudes were decreased below the PV, leading to a better thermal comfort, compared to a bare flat roof. This gains relevant, focusing urban heat stress for humans in summer, when thermal stress is reduced on a very hot day from very strong heat stress to one class lower under the shelter. According to this, the combination of PV-panels and green roof works as a puffer-layer against heating up of the building′s inside.

The on-site energy production by 60 m2 photovoltaic panels generated 5816 kWh over one year, which is almost the annual power consumption of one household [2].
The water demand of the intensive green roof fields was 6,6 m3 in spring, summer and autumn. Plants were not irrigated in winter, although the monitoring showed that evergreens would prefer watering from time to time. Next steps of investigation should focus on a solution for providing water in winter and tests of the designed rainwater integration.

Summarized, the collected data showed clearly, that the Photovoltaic Rooftop Garden concept is adding an eco-social, holistic solution, as a further component for sustainable urban planning, regarding energy, water and elemental fluxes in cities.

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[2] Statistik Austria (2017): Gesamteinsatz aller Energieträger 2003 bis 2016.