NET ZERO. RENEWABLE ENERGY VERTICAL FARMING

PROJECT OBJECTIVES

This project aims to design, develop and demonstrate renewable energy-based, net-zero energy solutions for urban hydroponic vertical farming systems.

PROJECT SUMMARY

This project explores energy needs and solutions for both indoor and outdoor hydroponic vertical farming systems, in line with the Singapore Green Plan 2030, where Singapore plans to deploy at least 2 GWp of solar and produce 30% of our nutritional needs by 2030. The prototype systems are small-scale but modular so that they can be scalable.

Indoor hydroponic vertical farming systems are energy-intensive due to the requirement for long periods of LED lighting for crop growth. Such indoor systems are typically supplied by a micro-grid system comprising rooftop solar and wind turbines which, via optimised dynamic energy management, provide energy efficiently and reliably. Outdoor vertical farming systems are placed in specially designed solar-powered greenhouses with natural ventilation and protection from harmful UV rays and pests. An Internet-of-Things-based real-time monitoring system has been developed to ensure operational reliability and healthy crop growth by monitoring both energy consumption and conditions inside the greenhouse (such as lighting, water pH and electrical conductivity, temperature and humidity, pump water flow, etc).

The project team has tested that outdoor greenhouse farming systems can be reliably supplied by a standalone bifacial solar PV micro-grid system with energy storage. This project is an on-going collaboration with industrial partners Applied Scientific Technology Pte Ltd (AST) and Green Valley Farms Organic Pte Ltd (GVFO) to optimise energy generation and crop growth through co-location of solar PV generation and vertical farming.

PROJECT OUTCOMES

This project has managed to achieve net-zero energy for small-scale, modular, indoor and outdoor greenhouse vertical farming systems. The indoor vertical farming system that grows 27 plants and consumes 165W of electrical power (mainly for the LED lights as well as the water pump and ventilation) can be reliably supplied by a rooftop solar and wind hybrid micro-grid power system, whereas the outdoor system in the greenhouse that grows 140 plants and consumes 14W of power (for the water pump and IoT system) can be sustainably supplied by a standalone bifacial solar PV micro-grid system.

This net-zero, renewable energy solution is particularly applicable to large-scale urban outdoor vertical farming systems in land-scarce Singapore. Moving forward, this method of combining solar PV generation and food crop production at locations such as rooftops or community open spaces can be a significant step towards the deployment of clean energy and an increase in local food production.

SOLAR AND WIND MICRO-GRID POWERED INDOOR HYDROPONIC VERTICAL FARMING SYSTEM

STANDALONE BIFACIAL SOLAR PV WITH ENERGY STORAGE POWERED OUTDOOR HYDROPONIC VERTICAL FARMING IN THE GREENHOUSE

SINGAPORE POLYTECHNIC

COLLABORATION WITH:

Applied Scientific Technology Private Limited

Green Valley Farms
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