PRESS RELEASE

Vertical Farming – A Contribution to Protein Supply for the Growing Global Population

To ensure that food proteins do not become scarce in the future despite extreme weather conditions and increasing environmental stress, six Fraunhofer Institutes are focusing on indoor farming systems in the lighthouse project "FutureProteins" (alternative protein sources). How can wheatgrass, alfalfa, and potatoes be successfully grown indoors without soil, using only artificial lighting? And are these methods not only ecologically sustainable but also economically viable? Fraunhofer IWU is focused on this aspect, as the price tag is crucial for accepting product innovations in the food sector. In regions with significant poverty, high prices could make such products inaccessible.

Vertical Farming: Utilizing Indoor Spaces for Agricultural Production

The automated plant breeding system OrbiPlant®, developed at Fraunhofer IME, demonstrates how agricultural products can be successfully grown without soil in controlled, enclosed systems. An integrated, wave-like conveyor belt system expands the growing area vertically. This highly flexible OrbiPlant® system optimizes the limited space available in urban environments for cultivating various plants independently of weather, time of day, or season.

Fraunhofer IWU Contributes Expertise in Energy Efficiency

Vertical farming will not remain a niche market. Projections estimate the market could reach up to 24 billion dollars by 2030 – reason enough to consider whether the technology is economically viable. A major cost factor in vertical farming is the necessary climate control and lighting. While artificial lighting enables high productivity and independence from weather conditions, it also generates costs and CO2 emissions – even when LED technology comes into play. The specific location, plus the design and dimensioning of the energy supply system, are therefore critical factors for the profitability of the entire facility.
In the "FutureProteins" project, Fraunhofer IWU contributes its extensive expertise in energy-efficient production and integration of renewable energy sources.

Energy Simulations Ensure Maximum Efficiency at Different Locations

Considering the specific site conditions in Berlin, Iceland, Burkina Faso, and India, the research team at Fraunhofer IWU initially developed energy scenarios for these

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locations. Cold weather with long and dark winters prevails year-round in the small town of Dalvík, Iceland. Kongoussi in Burkina Faso was selected to represent rural, hot-dry regions. The Indian megacity Chennai, for example, experienced severe water shortages in 2019. Berlin represents temperate climate zones. Each place requires a tailored concept (scenario) for energy supply technologies, such as local solar and wind energy, and energy storage, such as hydrogen. In Berlin, for instance, a combination of solar energy and battery storage could be effective, while in Iceland, geothermal energy might be a viable option due to the climate conditions.
After creating the scenarios, the Fraunhofer IWU team, with support from Fraunhofer IGB researchers, processed the data to prepare it for subsequent steps. The data included, for example, the power requirements of core components and the amount of biomass produced. The team then built simulation models of several energy supply strategies. These models allowed for a detailed analysis of the various scenarios and identifying the best approach for each region. The researchers then derived the sizing of individual components, considering factors such as energy demand, the availability of renewable energy sources, and local climatic conditions. Finally, they optimized the whole system for costs and greenhouse gas emissions to achieve ecologically and economically sustainable solutions for the energy supply of vertical farming systems.

Location-Specific Recommendations – H2 Power Plant in Chemnitz

In vertical farming, costs of lighting and climate control account for more than two-thirds of the total operating expenses when cultivating wheatgrass. Therefore, it is crucial to reduce energy costs as much as possible, especially in locations like Berlin, where energy prices are very high in international comparison. Here, self-produced photovoltaic (PV) systems combined with energy storage can reduce the amount of electricity that needs to be purchased. In Germany, the cost of electricity generation for a PV system on a building roof and a battery storage unit ranges between €0.10 and €0.20 per kWh, depending on the location and the size of the energy storage system.
In countries like Burkina Faso, other energy storage systems, such as hydrogen, may be of great interest. The power grid there is unstable and frequently affected by outages. In such rural areas, operators should strive for greater energy independence. One promising technology for storing excess energy is water electrolysis using renewable energy. When electric power is needed, the hydrogen produced can then be converted (back) into electrical energy using a fuel cell system.
Fraunhofer IWU demonstrates, at its Chemnitz location, why hydrogen can be a perfect energy storage system. The IWU's compactly designed H2 power plant enables the storage of up to 2.5 MWh of green energy, which could power a vertical farming production facility covering 1,500 m² for more than a day without interruption.

Further information
Link to Fraunhofer lighthouse project “FutureProteins”
Link to H2 Power Plant (in German)

Fig. 1 A growing global population, insufficient access to food for many people, and limitations on the growth of conventional agricultural production – such as land and water scarcity – highlight the need for innovative approaches like vertical farming to ensure a reliable supply of proteins. Image: Wheatgrass in the OrbiPlant® test facility at Fraunhofer IME
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Fig. 2 Wheatgrass in the OrbiPlant® test facility at Fraunhofer IME
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Fig.32 The H2 power plant at the Fraunhofer IWU research factory. For climate-neutral production, the supply of renewable energy, including "green" storage technologies, is a key component. The H2 power plant consists of an electrolyzer, hydrogen storage, fuel cell, and an additional battery storage system.
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The **Fraunhofer Institute for Machine Tools and Forming Technology IWU** is a driver for innovations in the research and development of production engineering. Around 670 highly qualified employees work at our locations in Chemnitz, Dresden, Leipzig, Wolfsburg, and Zittau. We open up the potential for competitive manufacturing in automotive and mechanical engineering, aerospace technology, medical engineering, electrical engineering, and precision and microengineering. We focus on scientific developments and contract research regarding components, processes, methods, and the associated complex machine systems and their interaction with humans – the entire factory. As the leading institute for resource-efficient manufacturing, we bank on highly flexible, scalable cognitive production systems using nature as an example. We consider the entire process chain using regenerative systems and circular economy in this context. We develop technologies and intelligent production plants and optimize forming, cutting, and joining manufacturing steps. Our range of services includes the development of innovative lightweight structures and technologies for processing new materials, functional transfer to assembly groups, and the latest technologies of additive manufacturing (3D printing). We present approaches for large-scale production of essential hydrogen systems, thus contributing to the transition to renewable energies.