Agrophotovoltaics (APV) combines the generation of solar electricity and farming products on the same land and thereby allows an efficient dual use of agricultural land. Valuable resources on fertile arable land are sustained, at the same time power is generated, stored and used locally.

In order to produce solar power and food in the same area, a balanced ratio of light and shade is needed. Fraunhofer ISE has developed a concept to optimize the yields from PV and photosynthesis through targeted light management. This is done by installing the PV modules in a less dense manner than usual, thus allowing sufficient light to shine through for agricultural activities.

**Advantages and Benefits of Agrophotovoltaics**
- defuses the land use conflict
- sustains fertile soils and biodiversity
- increases the efficiency of use of arable land
- promotes added value and development in rural areas
- produces energy decentrally and close to the consumer
- additional income for farmers

**High Land Use Efficiency Proven**
In cooperation with the Innovation Group “APV-RESOLA” Fraunhofer ISE has proven the feasibility of agrophotovoltaics with a 194 kWp APV pilot system realized in Heggelbach near Lake Constance in Germany. The results from 2017 showed a land use efficiency of 160 percent.

The performance of the APV system in the very hot summer of 2018 greatly exceeded this value. The partial shading underneath the photovoltaic modules improved the agricultural yield, and the sun-rich summer increased the solar electricity production. Based on the 2018 potato yield, the land use efficiency rose to 186 percent per hectare with the agrophotovoltaic system in Heggelbach.
International Reference Projects
Together with Fraunhofer Chile, Fraunhofer ISE also tested three 13 kWp APV systems in the Chilean communities of El Monte, Curacavi and Lampa. The projects showed that the partial shading of crops planted underneath APV can reduce their need for water and also offer livestock shelter from the sun. It is also expected that various fruits and berries which normally do not grow well in dry climates with high solar radiation could grow underneath an APV system. At the same time, the generated electricity can be used to operate water pumps or desalination systems.

Fraunhofer ISE is working on several projects to transfer the technology to threshold and developing countries as well as for new applications.

Pilot Study for Indian Farming District
A pilot study that Fraunhofer ISE carried out for the Indian state of Maharashtra showed that shading effects and less evaporation result in up to 40 percent higher yields for tomatoes and cotton crops.

Great Potential and Opportunities Worldwide
By the end of 2018, a capacity of 2.1 gigawatt APV power plants had already been installed worldwide. A single large-scale plant in China even features a capacity of 700 megawatts. Japan, Korea, USA, Italy and France are also installing APV systems in multi-megawatt sizes. In Germany, the state support for agrophotovoltaics has to be established and promoted to increase the number of APV installations.

Fraunhofer ISE contributes worldwide with results and experiences to get the highly efficient agrophotovoltaics on its way.

R&D and Services
Development
- GIS-based potential analysis
- Social and environmental impact studies
- Feasibility studies
- Yield and economic assessment
- Research in the context of WEF-nexus

Implementation
- Design of APV power plant with profound light-mangement
- Technology transfer to other countries and climatic regions
- Prototypes and implementation

Operation and Maintenance (O&M)
- Quality assurance and monitoring
- Optimization of electricity consumption

3 Through the combined land use, the land use efficiency with the APV system is 186 percent at the test site in Heggelbach, Germany. (illustration potatoes © HappyPictures / shutterstock.com)