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Research at Fraunhofer ISE Investigates Integrated Photovoltaic Modules for Commercial Vehicles

Thanks to considerable cost reductions in photovoltaic modules, solar energy holds increasing appeal for use in the mobility sector. Depending on the type of application, even diesel fuel for trucks can be replaced by photovoltaics to some extent. Fraunhofer ISE has carried out and evaluated yield analyses of PV power supply for commercial vehicles, such as refrigerated transport vehicles, using real-life solar irradiance data. Based on its findings, the institute sees great potential in this field and is working together with partners from the logistics and automotive sectors to conduct research into special PV modules for use in commercial vehicles. The aim is to integrate the modules in the truck roofs to supply power for driving the vehicle or for cooling goods.

Employing photovoltaics in commercial vehicles can contribute to reducing diesel consumption and lowering costs, cutting CO₂ emissions from haulage in the process and thus meeting environmental and climate protection targets within the transport sector. "In developing a solar-active vehicle shell, we want to make photovoltaic technology available to the logistic sector and contribute to lowering the cost of logistics as a result," states Matthieu Ebert, Head of the Team for Module Efficiency and New Concepts at Fraunhofer ISE.

Economic feasibility studies based on real-life solar irradiance data

Whereas other economic sensibility studies conducted on the use of PV in commercial vehicles have, to date, been based on simulations with artificial weather data, working in collaboration with logistics firm Dachser and haulage company Benzinger, Fraunhofer ISE has equipped and commissioned several semitrailers with irradiance sensors, and as a result has been able to measure insolation potential in real-life logistics operations. Irradiance data were collected and analyzed at Fraunhofer ISE for a period of around six months. A total of six 40 tonne refrigerated semitrailers were fitted with appropriate irradiance sensors and travelled their standard routes in the US and Europe – from Prague to Mallorca, Paris to Munich. The data gathered were then evaluated by Fraunhofer ISE according to a range of criteria. The scientists calculated the savings in liters of diesel per vehicle, as the average of liters of diesel across all routes and vehicles, and in liters of diesel for three geographic regions. "When you merge the data collected for the roofs that could potentially be fitted with PV modules, this allows you to make reliable statements about the viability of such systems," says Ebert. "Based on our calculations, we anticipate that a 40 tonne refrigerated semitrailer with a roof area of 36 m² equipped with PV modules (nominal power of 6 kW) could

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save up to 1900 L of diesel fuel per year," he adds. One important finding of the study, which is to be presented at the European Photovoltaic Solar Energy Conference and Exhibition EU-PVSEC 2017 and the 8th "Lkw und Fuhrpark" (Truck and Vehicle Fleet) Conference, is that the fuel savings, and thus the viability of the initiative, are heavily dependent on vehicle deployment regions and usage scenarios. In future, the insights gained from the measurement campaign will allow Ebert and his team to advise logistics companies on questions regarding the economic viability of using PV, and on the PV technology that is most suited to their needs.

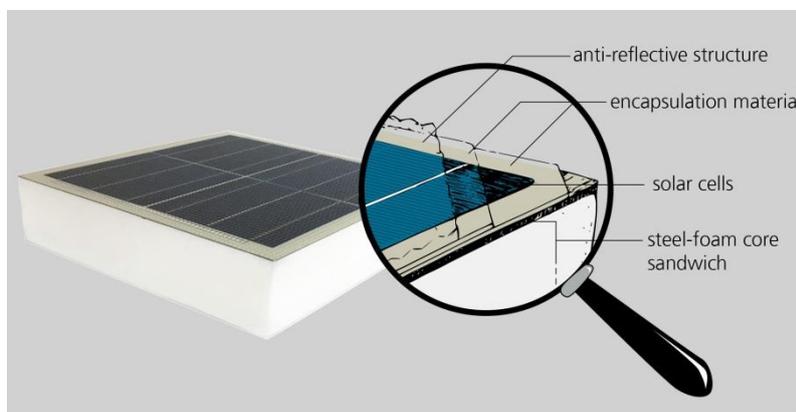
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Custom design for vehicle-integrated PV module

In order to minimize any additional load on the refrigerated semitrailers, vehicle-integrated PV modules need to be developed that are as lightweight and efficient as possible. Furthermore, a unique design will be required to enable the PV modules to be fitted to vehicle roofs without exceeding the maximum vehicle heights permitted under road traffic regulations. Such modules must be extremely compact and able to withstand dynamic mechanical stress caused, for example, by vibrations during travel. Fraunhofer ISE is supporting the development of lightweight modules by contributing its many years of expertise in module technology and testing. Specialist synergies at the research institute in the fields of power electronics and systems technology help in developing all the necessary components, and in ensuring that they interact properly within the overall system. PV modules and systems can also be tested under real conditions in transport operations. Ebert and his team at Fraunhofer ISE offer field tests to interested companies and collaborative partners in the logistics and vehicle construction sectors. The test results can then be used as a basis for individual yield analyses and for calculating savings potential.

The project was funded by the Fraunhofer Zayed Program and carried out in collaboration with Fraunhofer CSE in Boston.



Principle of the vehicle-integrated PV modules for refrigerated semitrailers developed by Fraunhofer ISE.

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In an economic feasibility study Fraunhofer ISE equipped 40 tonne refrigerated semitrailers with irradiance sensors. The semitrailes followed their standard routes in the US and Europe – from Prague to Mallorca, Paris to Munich – for half a year while real-life solar data were gathered and evaluated by Fraunhofer ISE.

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