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PREDICTION OF THE ELECTRICAL PRODUCTION OF A PHOTOVOLTAIC MODULE ON-BOARD A VEHICLE

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ABSTRACT

Transportation is a high greenhouse gases emission sector that needs to be decarbonised to reduce its impact on the environment. Electric and hybrid vehicles are a solution to reduce greenhouse gases emission. To increase the autonomy of these vehicles, there is a growing interest for the development of efficient electric vehicles powered by powered by photovoltaic (PV) panels. Depending on their route, the vehicles are subject to continuous environmental variations. Therefore, any predictive model needs to take into account the vehicle itinerary.

Different studies have been carried out to analyze the impact that these constraints will have on the output of the PV panel. However, none of the previous studies deals simultaneously with the impact of the position of the sun, the temperature, the wind speed on the electrical production of a solar panel on board a vehicle.

The main objective of this paper is to provide a model for estimating the electrical production of the PV on board of the vehicle according to the environmental conditions, the installation constraints of the PV module, and the route travelled.

This model was implemented using Matlab/Simulink software. Taking a file containing a given route (position and time) as an input, the model calculates first the evolution of the angle of incidence of the sunlight on the photovoltaic panel during the route. Then, the model determines the electrical power produced by the PV module, knowing the instantaneous angle of incidence, the irradiance, the outside temperature, and the wind speed. The electrical energy produced by the PV panel is finally determined by integrating the power over the route duration.

The model is composed of various blocks. The functionality of the model and each block has been validated using experimental data provided by CAPSolar. Using the model, we that 147.9 Wh can be produced by a 745.3 W PV module for a 34 minutes 6.7 km trip in Sherbrooke on 11/07/222 at 12 p.m. This corresponds to approximately 16.5% of additional autonomy for a Hyundai IONIQ I5 with a consumption of 15.5 kWh/100 km and 28 kWh of battery capacity in this use case. This model can therefore be used by designers and developers of electrified vehicles with integrated solar panels.