Feasibility study of tractor electrification using real-world data

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**Abstract.**

In 2020, the European Commission (EC) presented the European Green Deal which is an ambitious package of measures aiming to transform Europe into the first climate-neutral continent. Agricultural mechanisation is responsible for around 70 million tons of CO2 of yearly emissions. To significantly reduce CO2 emissions, hybrid powertrains are under investigation from industry and researchers. This paper aims to investigate a few hybrid powertrain architectures and to report the advantages of such solutions on the basis of real-world data in order to obtain the potential benefits perceived by farmers. Real-world data were collected with a CANBUS data logger on a row-crop tractor rated of approximately 190 kW. In this tractor, engine and transmission operating parameters were recorded for more than 1000 hours of field use. Data were firstly classified into tasks, and then a series of inefficiency index were defined. This permitted to highlight the operational inefficiency of each type of task. Four different hybrid architectures were studied and evaluated with the load-point shifting principles. The studied architectures are engine start-stop, PTO-electrification, accessory electrification, and P4 hybrid powertrain. The most inefficient operations are idling and transportation since the engine operate at a low load which is an operation where the specific fuel consumption is below the optimum. The tractor was run on idle for 25% of the entire use and accessories are responsible of 13% of the used fuel. The hybrid architecture with the greatest advantage is the P4 hybrid powertrain where 15% of the fuel can be saved. The second greatest is the PTO-electrification where 2.4% of the fuel can be saved. The architecture with the lowest fuel saving is the start-stop where 1.8% of the fuel could be saved. However, it is the easiest one to implement on tractors. The methodology adopted permits to outline the potential benefit of hybrid powertrains using real-world data and therefore, to estimate the benefit perceived by farmers and not based on reference cycle such as DLG Power-Mix.