



<b>Evento</b>	Salão UFRGS 2018: SIC - XXX SALÃO DE INICIAÇÃO CIENTÍFICA DA UFRGS
<b>Ano</b>	2018
<b>Local</b>	Campus do Vale - UFRGS
<b>Título</b>	Energy and emission impacts of liquid fueled engines compared to electric motors for small size motorcycles based on the Brazilian scenario
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# Energy and emission impacts of liquid fueled engines compared to electric motors for small size motorcycles based on the Brazilian scenario

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## INTRODUCTION

Brazil benefits from a diversified renewable energy matrix with a growing introduction of intermittent sources. The role of electric vehicles in the Brazilian fleet, and in particular electric two-wheelers, led to perform dynamometric tests with Brazilian market motorbikes fueled with different gasoline to ethanol mixtures and submitted to a standard traffic routine, in order to evaluate and assess their energy efficiency and pollutant emissions. The paper described in the present summary is based on that report and extends the assessment by a proposed bottom-up method to take into account the energetic chain performance for electric and liquid fueled motorcycles, committed to greenhouse gas emission standards, willing to represent the country's energy system for a given period. It aims to identify the most suitable methodology for the Brazilian scenario, also adapted to other developing countries. The Primary Energy Factor PEF was chosen as the efficiency parameter to compare motorcycle energy consumption. PEF estimates the amount of primary energy needed to satisfy the final demand, either electricity, gas, gasoline or heat.

## METHODOLOGY

Direct energy losses and greenhouse gas emissions were accounted throughout each fuel's proposed energy chain. Assessment starts at the motorcycle with data collected along dynamometric essays. The last point of the chain corresponds to the primary energy source conversion.

Electricity chain starts by calculating the electric motorcycle efficiency. Distribution and transmission efficiency throughout the electric network is next, followed by power generation, where the proposed energy chain ends up.

The first point at the gasoline chain accounts for the internal combustion motorcycle efficiency. Conversion of petroleum into gasoline and other products are next, followed by oil extraction.

For the ethanol chain, the first point also accounts for the motorcycle's efficiency followed by the losses related to all the processes involved in ethanol production.

## RESULTS

PEF average values for electric and liquid fueled motorcycles are 3.5 and 7.1 respectively. The experimental tank-to-wheel efficiency ratio of 3 to 1 from dynamometric essays turns to be a well-to-wheel 2 to 1 ratio whenever the enlarged energy chain is considered. PEF method applied to dynamometric results shows that electric driven motorcycles are still more energy efficient than liquid fueled similar vehicles for the Brazilian matrix. Emissions from electric conversion are still less harmful, nevertheless battery impact must be better studied.