# COMPARISON COUPLING ECONOMIC AND TECHNICAL MODELS OF NISSAN LEAF IN FRANCE AND THE USA IN 2024

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## Overview

The field of transportation is one the largest greenhouse gas emitter sector in developed countries. Hence, it is essential to find a viable alternative to internal combustion vehicles. Electrified vehicles are a good alternative as they emit little to no greenhouse gasses locally. Vehicle users have three main fears regarding electrified vehicles: charging time, range anxiety and vehicle price. In fact, it is true that electrified vehicles have a higher purchase cost compared to internal combustion vehicles. Therefore, applying an economic model such as the total cost of ownership (TCO) is essential to study the economic viability of electrified vehicles [1]. However, the energy consumption figures announced by automotive manufacturers tend to be not representative of those measured in real-world driving. By developing a validated technical model of an electric vehicle we demonstrate a method that obtains energy consumption and an estimated total cost of ownership (TCO) that is closer to reality [2].

The objective of this paper is to develop and apply a method that brings together economic evaluation with refined technical models of an electric vehicle for more detailed evaluation of total cost of ownership. The method is applied to compare the total cost of ownership of a Nissan LEAF in France and USA. This work takes place as a part of the CUMIN (Campus of University with Mobility based on Innovation and carbon Neutrality) program at the University of Lille, which aims to reduce greenhouse gas emissions on the campus and more broadly through sustainable mobility solutions [3].

## Methods

To build the techno-economic model needed, two models are combined. On one hand, a traction model of the Nissan Leaf is built to calculate its annual consumption and on the other hand, a model to estimate the total cost of ownership of the vehicle is built, depending on key parameters such as the retail vehicle price or the electricity price.

The model of the Nissan LEAF is structured thanks to the EMR formalism: the Energetic Macroscopic Representation formalism, [4]. A reflexion has been developed about the cycle used to estimate the energetic consumption of the Nissan LEAF. The cycle finally selected is the WLTP, as the model is previously validated thanks to a real cycle measured on roads. It allows us to compare the simulated energetic consumption with those reported by the Nissan manufacturer. The comparison enables a validation of the technical simulation model.

The model of the TCO calculation [5] takes into account the initial costs for acquiring the vehicle (CAPEX), the salvage value of the vehicle (SV) and the operational costs to use the vehicle (OPEX). Moreover, discounting and the inflation adjustment are also included.

$$TCO = CAPEX - SV + OPEX$$

## Results

The TCO of France and the USA are calculated for 2024, for the duration of ownership of 5 years, in Fig. 1. The TCO values are close but the distribution are quite different between France and the USA. It shows that CAPEX remains one of the key parameters for the economic value of a vehicle. In fact, even if the American OPEX is twice as high as the French one, it does not compensate for the CAPEX difference.

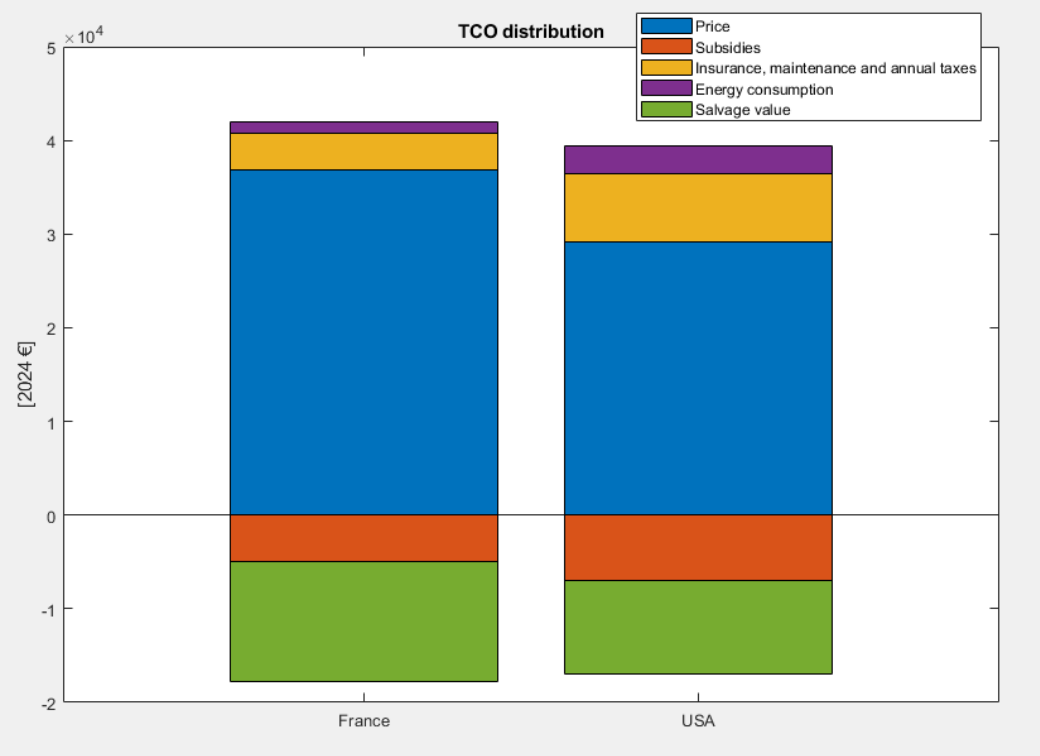


Fig. 1 : TCO distribution for France and USA

## Conclusions

The total cost of ownership for electric vehicles remains highly dependent on regional factors, with CAPEX and electricity prices playing a dominant role. This underscores the need for continued governmental support to make electric vehicles more accessible and competitive, particularly in regions with higher costs. As the electric vehicle market continues to evolve, these findings will be crucial for policymakers and consumers in making informed decisions about electric vehicle adoption.

The coupling between economic and technical models of the Nissan LEAF gives an interesting view of the economic value of an electric car. This interdisciplinary view presents a TCO closer of the reality than a TCO only based on economic parameters.

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