Powerful Advanced N-Level Digital Architecture
for models of electrified vehicles and their components

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Virtual product development and production of
all types of electrified vehicles and components

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Publishable Executive Summary

Climate change is real. Its scientific evidence is undeniable, and its impacts are evident in our communities. Mainly driven by the increasing quantity of greenhouse gases (GHG) in the atmosphere that comes primarily from burning of fossil fuel. The transport sector is among the major contributors to global GHG emissions because its current dominant technologies rely on fossil fuel. This makes the transport sector very important when issues of climate change are discussed. Among the existing alternatives for low-carbon transport technologies, it is the electrification of road transport that has attracted the most interest from EU policy makers. This is evident in the EU targets to electrify over 60% of passenger car transport systems by 2030 and reach 100% CO_2 free by 2050 [EU 2018]. However, the need for such a large-scale transformation poses several challenges, one of which is to estimate the potential environmental impacts of electrified vehicles before full-scale adoption.

There is consensus in the literature that battery electric vehicles (BEV) can significantly reduce impacts on climate change and air quality. However, the literature also shows that BEV could shift environmental burdens across the life cycle stages, e.g. from use phase to material acquisition and production. This is evident in specific impact categories (e.g. human toxicity, ecotoxicity and water consumption) that are linked to mining of critical materials (e.g. copper, lithium, etc.). Likewise, since the availability of mineral resources is not evenly balanced worldwide, EVs could contribute to increasing geo-political tensions. These are all potential threat for electrified vehicles (EV) that should be estimated during the design and development of future EVs to limit potential unwanted impacts.

Most LCA (Life Cycle Assessment) studies are conducted as post-assessment of existing vehicles. In PANDA, we aim to conduct LCA of EVs in a forward-looking or prospective approach. This is justified because it is the potential environmental impact of future EVs that is most relevant for decision-making, and since these technologies are projected to dominate the future passenger car fleet. Therefore, the aim of this report is to develop the PANDA forward LCA framework for electrified vehicles that supports assessments in the early stage of design, while accounting for expected future development in relevant sectors. The methodology to achieve the aim is based on two research steps. Step 1 consist of a literature review to inform our work with the state of art in LCA of electrified vehicles. In step 2, we proposed the PANDA LCA framework for electrified vehicles. We based the framework on the lessons learnt from the literature review, and in line with the ISO 14040 – 14044 standards [ISO 2006a] [ISO 2006b], the ILCD initiative [ILCD 2010], and the guiding eLCAr documentation on vehicle LCA [Del Duce 2013].

The literature review shows that the result of LCA studies of electric vehicles are different and difficult to interpret because of unclear goal and scope definition. Likewise, consistent methodological choices for accounting of future development in key economic sector are lacking. However, recent studies have started to address this issue by considering some features of future development in their work. For example, we noticed that the advances in vehicle performance and the changes in the electricity sector are more represented. On the other hand, aspects like material production, recycling, transportation, uncertainty analysis, and consumption are still lacking.

In the PANDA LCA framework, the development of scenarios is considered the second stage as it supports the integration of future perspective into the LCA; however, in practice we see this as an iterative process with defining goal and scope (stage 1). The generated scenarios are then evaluated against the original LCA stages. Particular attention should be given to the goal and scope definition and the inventory analysis stages. We found that the Life Cycle Inventory (LCI) for future EVs are created by making adequate and justified changes to the LCI of current EVs in the context of future scenarios. Evaluating the traditional LCA framework in light of the future scenarios should help to establish consistency between goal and scope and prospective LCI modelling. This, we argue to be the missing link that could support effective modelling choices between goal and scope definition and the selection of consistent prospective LCI. Thus, we believe the PANDA forward LCA framework could increase transparency, clarity, and consistency in applying LCA to emerging EV technologies in the context of expected future development.

PANDA Partners

Table 1: Project Partners

#	Type	Partner	Partner Full Name
1	UNIV	ULille	Université de Lille
2	IND	SISW	Siemens Industry Software SRL
3	UNIV	VUB	Vrije Universiteit Brussels
4	IND	VEEM	VALEO Equipement Electriques Moteur SAS
5	UNIV	UTCN	Universitatea Tehnica Cluj Napoca
6	SME	TY	Tajfun HIL (Typhoon HIL)
7	IND	TUV	TUV SUD AG
8	UNIV	UBFC	Université Bourgogne Franche-Comté
9	SME	UNR	Uniresearch BV
10	IND	RTR	Renault Technologie Roumanie
11	SME	Bluways	BlueWays International bva

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