



Acronym	EDIS		
Titre du projet en français	Données de l'électromobilité pour études interdisciplinaires		
Titre du projet en anglais	Electro-mobility Data for Interdisciplinary Studies		
Keywords (min 5-max 10)	Electromobility, Driving tests, Charging tests, driver's usages, mobility survey		
Main axis	☒ Improving knowledge on the mobility of people and goods ☐ Making progress in mobility data collection and processing ☐ Enabling the development of tools and methods to optimise decision-making		
Secondary axe (s)	☐ Improving knowledge on the mobility of people and goods ☒ Making progress in mobility data collection and processing ☐ Enabling the development of tools and methods to optimise decision-making		
Leading institution	University of Lille		
Scientific coordinator	Last Name, First name, Position		
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Project duration	60 Months		
Requested funding	1 970 094 €	Full cost	4 545 844 €

Partner institution(s) involved in the project

Name of the institutions of higher education and research	Main activity
University of Lille	Driving test and surveys of e-vehicle
Université Gustave Eiffel	Driving test and surveys of e-charging
INSA de Lyon	Data management
Mines Saint Etienne	Data management



Socio-economic support	Activity
MEL (Métropole Européenne de Lille)	Provider of data from e-buses

Research units involved in the project

Research units	Discipline	RNSR *	Type **	Institution
L2EP	electrical engineering	199814201Z	ST	University of Lille
TVES	urbanism & geography	201019090L	SHS	University of Lille
GERiICO	information & communication	200615319E	SHS	University of Lille
CLERSE	humanities	200212693T	SHS	University of Lille
LCIT-ECO7	electrical engineering	199318205Y	ST	Université G. Eiffel
MODIS	Socio-psychology	201320682D	SHS	Université G. Eiffel
LIRIS	computer sciences	200511875R	ST	INSA de Lyon
S2HEP	information & communication	200715392E	SHS	INSA de Lyon
LIMOS	computer sciences	200212221E	ST	Mines Saint Etienne

* RNSR: Répertoire National des Structures de Recherche (French national code for research units)

** ST: Sciences & Technologies; SHS: Social & Human Sciences

Institution / Liste des projets liés :

If applicable: Project links with existing France 2030/PIA entities (e.g. Labex, etc.)	<i>Acronyme du(des) projet(s), préciser le type de projet</i>
If applicable: Project links with other existing projects	CUMIN interdisciplinary programme on e-mobility G4M interdisciplinary programme on energy & mobility

Résumé du projet en français (Non Confidentiel – 4000 caractères maximum, espaces inclus - Vous pouvez utiliser le même résumé (copier-coller) sur le site de dépôt)

La transition vers la mobilité est un défi pour contribuer à la neutralité carbone de l'Europe en 2050. Le programme MOBIDEC français vise à mieux comprendre les pratiques de mobilité afin d'aider les décideurs à conduire des politiques de transition efficaces. L'électromobilité est un levier important de cette transition. Cependant, électromobilité présente des limites techniques, une perception réticente, des contraintes économiques, sociales et politiques. De plus, il manque encore des données sur ce type de mobilité pour fournir des analyses interdisciplinaires pertinentes.

Le projet EDIS vise à fournir une méthodologie interdisciplinaire unique pour collecter des données techniques et socio-économiques sur l'e-mobilité électrique. Elle permettra de déterminer des indicateurs pluridisciplinaires pertinents à partir de données réelles provenant de tests expérimentaux (données techniques) et d'enquêtes (données socio-économiques). Cette méthodologie sera appliquée à un panel varié de véhicules électriques réels (du vélo électrique au bus électrique, en passant par la voiture électrique) et d'infrastructures de recharge (des installations photovoltaïques aux stations de charge rapide) sur lequel seront réalisés des tests expérimentaux permettant d'obtenir des données techniques (ex : profils de vitesse, consommation d'énergie, durée de vie de batterie, etc.). Ces tests expérimentaux seront couplés à des enquêtes afin de capturer les données socio-économiques (ex : perceptions, obstacles, coût, etc.) qui correspondent aux multiples pratiques de mobilité (des déplacements quotidiens aux trajets professionnels). L'ensemble de données recueillies sera intégré dans une plateforme numérique ouverte FAIR (Findable, Accessible, Interoperable and Reusable) pour le calcul et la multi-



visualisation d'indicateurs spécifiques (ex : coût total de possession ou gaz à effet de serre pour un type d'utilisation, de véhicule, et un temps de possession défini).

Le principal défi est de fusionner de manière unifiée, sur une même plateforme numérique, les données techniques et socio-économiques sur l'électromobilité. Les pratiques de collecte des données dans différentes disciplines seront revisitées pour renseigner les indicateurs définis et permettre un véritable couplage de ces diverses données. De plus, l'architecture numérique et la multi-visualisation des données seront envisagées dès la définition du cadre commun pour permettre une gestion idéale et fluide de ces données hétérogènes. Dans une phase descendante, le cadre développé sera appliqué aux cas d'utilisation de conduite et de recharge pour déployer la plateforme de données ouvertes. Dans une phase ascendante, les expériences de collecte et de plateforme numérique permettront d'améliorer le cadre méthodologique développé.

Les principaux résultats seront 1) un cadre méthodologique flexible pour collecter des données sur l'électromobilité et 2) une plateforme ouverte de données sur l'électromobilité avec un premier jeu de données. Les deux outils permettront de compléter a posteriori la plateforme par de nouvelles expériences et indicateurs. Cette plateforme numérique sera également reliée à d'autres plateformes (y compris la « data factory » de MOBIDEC) et utilisée par les projets décisionnels pour aider les autorités publiques à conduire la transition nécessaire de la mobilité.

Pour atteindre cet objectif, un consortium multidisciplinaire a été mis en place à partir de 2 groupes interdisciplinaires : CUMIN (Campus d'Université avec Mobilité basée sur l'Innovation et la Neutralité carbone, Lille) et G4M (Grid for Mobility, région lyonnaise), qui ont déjà des expériences dans des mesures et enquêtes d'électromobilité (plus de 200 tests et entretiens). Le consortium est composé de 4 laboratoires en Sciences & Technologies et 5 en Sciences Humaines et Sociales, soutenus par MEL (Métropole Européenne de Lille) en tant qu'autorité publique intéressée par ces développements.



Abstract (Non Confidentiel – 4000 caractères max, espaces inclus - Vous pouvez utiliser le même résumé (copier-coller) sur le site de dépôt) –

Mobility transition is a great challenge to contribute to the carbon neutrality of Europe in 2050. The MOBIDEC French programme aims to better understand mobility practices to help decision makers to implement efficient transition policies. Electromobility (e-mobility) is an important part of this transition. However, e-mobility has technical limitations, reluctant perception, economic, social and political constraints. Moreover, there are still missing data on e-mobility to provide relevant interdisciplinary analyses.

The **EDIS** project aims to provide a unique and common interdisciplinary framework to collect technical and humanities data on e-mobility. This framework will define various e-mobility indicators before developing experimental tests (technical data) and surveys (humanities data) to comply with these indicators. This framework will be applied to a panel of real e-vehicles (from e-bike to e-bus, including e-car) and charging infrastructures (from photovoltaic-based ones to fast charging stations) for experimental tests to get technical data (e.g., velocity profiles, energy consumption, battery lifetime). Different surveys will also be conducted on the drivers for various practices (from commuting to professional trips) to get humanities data (e.g., perceptions, barriers). The collected dataset will be integrated in an open FAIR (Findable, Accessible, Interoperable and Reusable) digital platform for computing and multi-visualization of the indicators (e.g., total cost of ownership or greenhouse gases for a type of use and a defined possession time).

The main challenge is to merge in a unified way, in the same digital platform, technical and humanities data on e-mobility. The ongoing practices of data collection of the different disciplines will be revisited to comply with the defined indicators and to enable a real coupling of technical and humanities data. Moreover, the digital architecture and the multi-visualization of data and indicators, will be considered from the definition of the common framework to enable a relevant and fluent management of these heterogeneous data. In a top-down phase, the developed framework will be applied on driving and charging use cases to deploy the open data platform. In a bottom-up phase, the collection and digital platform experiences will enable feedback to refine the multidisciplinary framework.

The main outcomes of EDIS are 1) a flexible framework to collect e-mobility data on various cases and 2) an open data platform on e-mobility with a first dataset. Both tools will enable to completed the data platform by new experiences and indicators. This data platform will be linked to datasets from other data mobility platforms (including the data factory of MOBIDEC) and used by decision-making projects to help public authorities to drive the necessary transition of mobility.

In order to achieve this goal, a multidisciplinary consortium has been set up from 2 interdisciplinary groups: CUMIN (Campus of University with Mobility based on Innovation and carbon Neutrality, Lille) and G4M (Grid for Mobility, Lyon area) that already have experiences in e-mobility measurements and surveys (more than 200 tests and interviews). The consortium is composed of 4 Sciences & Technology Labs and 5 Social & Human Sciences Lab and is supported by MEL (Metropole Européenne de Lille) as public authority interested by these developments.



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1. Context, objectives and previous achievements

The mobility sector is a great contributor to greenhouse gases (GHG) and must change. Electro-mobility (e-mobility) will contribute to this transition, but due to limitations and perceptions, it is not developing as expected. E-mobility data are still missing for relevant analyses.

EDIS aims to develop a unique methodological framework to collect together technical and humanities data on e-mobility for better analyses towards mobility transition

1.1. Context, objectives and innovative features of the project

• Scientific challenges

A transition of the mobility is requested to reach the 2050 carbon neutral objective. In France, the transport sector is the main contributor of the GHG emissions and the only sector that it is still increasing [SGPE 2024]. In EU, the same trend is observed [Clora 2022].

As stated in the MOBIDEC programme, the knowledge of mobility data is still a challenge due to its variety and complexity. Mobility has several features (environmental, societal, economic and technical) to combine to succeed a relevant transition towards low emission practices.

Among the different means of transport, e-mobility is playing a crucial role due to its low environmental impacts [Eshani 2021]. However, e-mobility has technical limitations, reluctant perception, economic, social and political constraints. In a MOBIDEC webinar¹, it has been indicated that data on e-mobility are still missing, as a new technology.

The EDIS projects aims to contribute to MOBIDEC by developing a methodology to collect technical and humanities data in the same framework to better understand e-mobility.

• Objectives

The objective of EDIS is to develop a multi-disciplinary methodology for characterizing the driving and charging habits of various electric vehicles on the basis of real-life tests. All the data collected will be stored in an Open Access data base connected to the one developed by MOBIDEC.

E-mobility has been extensively studied in the last decade and many data have been provided. However, no relevant data base is available. Moreover, most of these studies were focused on either technical aspects or humanities aspects². No studies coupling both aspects have been realized yet despite the strong interest of their correlation. EDIS aims to address this gap.

But several challenges should be addressed. First, the disciplinary methods of data collection must be revisited to define a common framework to integrate various types of data. Second, relevant indicators must be included in the data collections to enable different studies from different disciplines or stakeholders (i.e., public authorities). Third, this methodology should be flexible to cover various types of vehicles, usages, areas, etc. and to be extended after the project.

First, a relevant set of e-mobility systems will be defined (vehicles and charging infrastructures). Then multi-disciplinary indicators will be defined, from technical performances to user perceptions. A relevant methodology of tests and surveys will be developed based on real-life measurements and interviews, to characterize these indicators. Finally, a data platform will be established, open to different stakeholders. EDIS will contribute to 2 MOBIDEC thematic axes (more details in § 2.3).

1) Main axis, "Improving knowledge on the mobility of people and goods".

2) Secondary axis, "Making progress in mobility data collection and processing".

¹ FORBAC webinar, 14 June 2024 [On line: <https://pepr-mobidec.fr/forbac-pc1>]

² Social, economic, psychologic and geographic aspects.



- **State-of-the-Art**

Impact of mobility on climate change and air quality

To manage climate change, GHG emissions should be significantly reduced [IPPC 2023]. Major efforts have been made in the EU: a reduction of 20% has been realized from 1990 to 2020 [EEA 2022]. The target is carbon neutrality by 2050 [Clora 2022]. However, transport is a major GHG emitter in Europe and the only sector still increasing [Prussi 2020] [WEF 2022]. To address the problem, many cities will ban fossil-fuel vehicles in few years and the EU proposes to end sales of these cars by 2035 [EP 2022]. The electrification of vehicles must play a key role [Eshani 2021].

Challenges of e-mobility

The transportation sector is developing diverse e-vehicles, from e-bikes to e-trucks (including e-cars) to replace fossil-fuel vehicles and increase public e-transport (e-bus, subway, train, etc.). Different types of vehicles are being developed including pure electric vehicles, hybrid electric vehicles and hydrogen vehicles (with electric motorization). However, despite its environmental benefits, e-mobility is not always considered as a key lever towards sustainable areas: it is related to private individual decisions, difficult to manage by authorities [Filho 2023]. Despite its intrinsic complexity, EDIS directly addresses the question of e-mobility. Given the urgent need for new types of mobility, the e-mobility transition is slow, due to several challenges.

E-vehicles have **technical limitations** such as the driving range, charging time, battery or fuel cell lifetime, etc. New developments are thus required to address these limitations and reduce energy consumption, reduce charging time and increase reliability [Zhou 2023].

The **deployment of charging infrastructure** is another major concern (including for e-buses). First, charging stations must meet the increasing demands for charging energy without perturbation of the electric grid [Mastoi 2022]. Second, supplying energy using local renewable sources is preferred for reducing the vehicle environmental impact, but intermediary energy storage is required to manage fluctuating supply and demand [Bartolucci 2023].

There are still ongoing discussions on the **global environmental impact** of e-vehicles [Cox 2020] [Wanitscke 2020]. Therefore, producing electricity and batteries have significant effects on the vehicle GHGs [Kucukvar 2021].

The development of new vehicles and related charging infrastructures leads to **economic challenges** for both the users (vehicle cost) [Desreveaux 2020] and the service areas (infrastructure cost) [Tsiropoulos 2022]. Public support and economic incentives are used to accelerate this transition in terms of charging infrastructure [Neshat 2023].

User acceptance is another challenge due to resistance to change, the anxiety of new technology, etc. Several studies report a variety of perspectives relating to **reluctance of the users** [Zhou 2023].

To address the cost of the transition and user indecision, public policies using **incentives and regulations** have a strong impact. However, their effects are difficult to analyze [Wong 2023].

A review of consumers concerns about e-cars proposes an inventory (250 papers) where sustainability, charging points, cost and preferences are studied [Secinaro 2022]. However, some societal aspects are infrequently considered despite their importance [Zhu 2023].

All of these challenges have an impact on the transition including e-mobility. But despite their strong interrelations, they are often analyzed and addressed independently.

Tools and methods for e-mobility transition

As stated previously, e-mobility is a well-studied topic but few researchers apply an interdisciplinary approach [Lozano 2015]. A first initial interdisciplinary description has been proposed for studying e-vehicles adoption in [Neshat 2023]. Nevertheless, this approach is mainly focused on SHS models. EDIS will propose an **interdisciplinary framework for relevant collection of e-mobility data**.



In terms of digital research infrastructure, ESFRI³ is charged “to support a coherent, strategy-led approach to Research Infrastructures (RI) in Europe”. In its roadmap [ESFRI 2021], it indicated the “growing need for new types of RI with specific challenges, like climate change and environmental sustainability, cutting across scientific disciplines”. However, on the 63 RI listed by ESFRI, none is related to mobility. However, mobility is listed as a category of high-value datasets in the EU Directive 2019/1024, which led France to open the transport.data.gouv.fr platform. MOBIDEC aims to develop a data factory on mobility and EDIS aims to contribute with a **data platform on e-mobility**, building on local experiences as a background before extension. Moreover, it is noted that the FAIR⁴ philosophy will now be a driver for any digital development [Mons 2018]. A new tendency is the multi-visualization to share the same contents with various stakeholders [Menin 2021].

EDIS will propose a data collection methodology beyond the state-of-the-art to support the e-mobility transition in interconnection with the latest digital facilities

1.2. Main previous achievements

➤ CUMIN (Campus of University based on Innovation and carbon Neutrality)

CUMIN is an interdisciplinary programme on e-mobility developed in 2016 by 6 research labs (3 ST and 3 SHS), MEL (Métropole Européenne de Lille) and some international partners. CUMIN is composed of several projects coupling different disciplines, some will serve as background to EDIS, such as SARA with more 100 driving tests & surveys for an e-car (see linked projects § 8).

➤ G4M (Grid4Mobility)

G4M is a partnership project between universities in the Lyon region (inc. Univ. Lyon 1 and INSA) since 2022. The main objective is to create a shared open platform of smart-grid to study management of energy in grids including transport, building and renewable sources. The consortium includes academic labs in ST (incl. LICIT-ECO, LRIS), and SHS (incl. MODIS, S2HEP) and industrial partners through the CARA cluster. Infrastructures are developing (see linked projects § 8).

➤ Previous collaborations

L2EP (ULille) and LICIT-ECO7 (UGE) have previous collaborations on e-vehicles since 2008. The latest co-supervised PhD was conducted in 2020 within CUMIN on factors impacting the energy consumption of e-cars, including driver practices thanks to TVES. This collaboration involved both universities, 2 ST Labs and 1 SHS Lab, and benefits of an instrumented e-car of CUMIN (Renault Zoe). It demonstrates the capability of these Labs to collaborate in an interdisciplinary project.

2. Detailed project description

2.1. Project outline, scientific strategy

➤ Background

A mobility challenge is to switch from fossil-based cars to low-carbon vehicles. A ULille mobility survey shows that commuting using fossil-based cars is the main contributor of GHG. CUMIN has analysed the commuting trips of a campus using isochore maps (indicating the same travelling time, Fig. 1) [Junker 2023]. This study shows that while it is possible to switch to subway, buses or bikes in urban or suburban areas, it is not yet possible to avoid car for people living in rural areas.

³ European Strategic Forum on Research Infrastructure website, <https://www.esfri.eu/>

⁴ Findable, Accessible, Interoperable and Reusable.

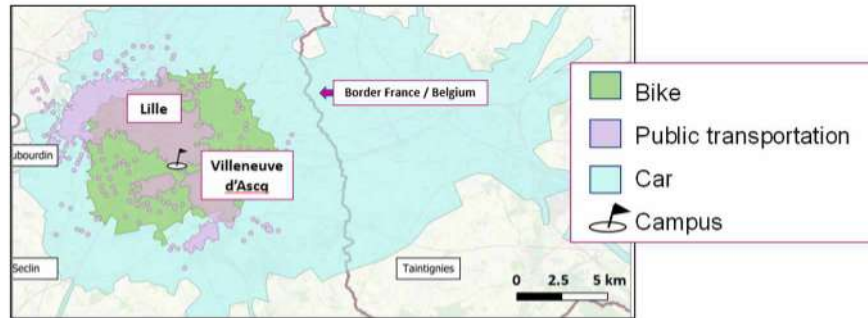


Fig. 1. Isochore map for a 30-min commuting trip of "Cit  Sceintifique" campus of ULille [Juncker 2023]

A significant reduction of mobility change will require a panel of low-carbon vehicles, from bikes to buses, also including e-cars. The research question addressed by our groups (CUMIN and G4M) is how to motivate people to switch to "greener" commuting, considering their social, spatial and economics constraints, their perceptions and aspirations, their practices and needs, but also the vehicle performances and charging capabilities. However, there is a need to understand the e-mobility challenges to define relevant incentives, rules and policy.

EDIS aims to provide a methodology to collect relevant technical and humanities data to supply this thought and will be limited to a panel of e-vehicles and their charging infrastructures.

➤ **Scientific challenge**

As explained previously, EDIS aims to provide a unique methodological framework to collect e-mobility data from experimental tests and user surveys. This data set will be in Open Access to be used by different stakeholders to better understand e-mobility practices, limitations and barriers.

One of the main scientific challenges is to combine technical and humanities data (heterogeneity) in this dataset to provide a global vision. This e-mobility dataset should be FAIR (Findable, Accessible, Interoperable, Reusable) but also extendable by other groups for new vehicles, new infrastructures, new users with others technical tests and humanities surveys.

In that aim, a unique and flexible framework must be defined to collect, organise and store e-mobility data that will be enriched by indicators to enable multi-visualisation depending on the request. The classical ways to collect technical and humanities data must be revised. Each discipline has to revisit its current practices to build this common framework. In addition, the variety of vehicles, charging stations, uses, users, etc. is a major challenge to develop a real common framework.

Four scientific groups will work together to reach this objective in providing a relevant framework for the data organization and a first dataset:

- engineering Labs (or research groups), on technical data,
- socio-spatial-economic Labs, on humanities data,
- computer sciences Labs, on data storage and management,
- information & communication sciences Labs, on data organization and visualization.

The main challenge is to propose a unique interdisciplinary methodological framework for e-mobility data coupling technical and humanities indicators

• **Ambition**

The ambition is to develop a unique and new framework to collect e-mobility data combining technical and humanities indicators. Therefore, a top-down and bottom-up approach is used.

- First, in a methodological layer, a new integrative framework is developed from the previous experiences of CUMIN and G4M, but also in interaction with axis 1 of MOBIDEC.

- Second, in an application layer, the developed method will be applied to e-vehicles and e-infrastructures with experimental tests and humanities surveys (top-down). Feedback on the methodology will improve and refine the methodology (bottom-up).
- Third, a digital layer will deploy a data platform to store and expose the collected data in concordance with the FAIR and Open Sciences philosophies in interaction with axis 2 of MOBIDEC (top-down). Feedback on the methodology will also be ensured (bottom-up).
- Finally, the flexibility of the method will be tested on new vehicles, new infrastructure, other users and extended areas.

A list of data and e-mobility indicators will be defined in WP1. Some examples are given:

- technical data: velocity profile, energy consumption, batterie lifetime, etc.
- humanities data: perception, barriers, travelling time, charging availability, cost, etc.
- e-mobility indicators: GHG during vehicle life, total cost of ownership, etc.

A key characteristic of EDIS is the validation of the methodology with intensive tests on a panel of e-vehicles and e-infrastructures, and intensive surveys of various users on different areas.

The panel of e-vehicles for intensive tests is composed by 1 vehicle per segment (Fig. 2): 1 e-bike (available in CUMIN), 1 e-motorbike (to buy), light e-car (AMI of CUMIN), 1 A-segment e-car (to buy), 2 C-segment e-car (Nissan Leaf of CUMIN and G4M) and 1 e-bus (e-KARSAN of MEL). Moreover, other e-vehicles will be considered in the final step for the flexibility test: 1 plug-in hybrid vehicle (Renault Capture of G4M) and 1 hydrogen car (Toyota Mirai of CUMIN).

A panel of charging stations is also considered for intensive tests: 1 PV-based charging station for e-bikes (CUMIN), 1 standard station of 3,7 kW (to buy), 1 standard station of 7 kW (G4M), 1 50 kW fast charging station (eVBox of CUMIN) and 1 e-bus charging station (in discussion with MEL). Other charging systems will be considered in the flexibility test as a 1 self-plug system (G4M).

Moreover, intensive surveys will be conducted on 2 different areas (Campus Cité Scientifique of ULille, focused on commuting and Transpolis experimental test track of Lyon connected to Bron campus, focus on professional trips). Extended uses and areas will be used in the final step for the flexibility test: a larger urban area can be proposed by MEL and other possibility in the Lyon area.



Fig. 2. Selected e-vehicle in the different segments Europe and related e-infrastructures

• Global organisation

Four scientific work packages are proposed to merge the ST and SHS scientists (Fig. 3):

- WP1 e-mobility framework: all partners to contribute
- WP2 driving uses – ST tests and SHS surveys on driving various e-vehicles by electrical engineering and humanities Labs
- WP3 charging uses – ST tests and SHS surveys on charging various e-vehicles by electrical engineering and humanities Labs

- WP4 data platform – implementation of the common data platform by computer sciences and communication & information Labs.

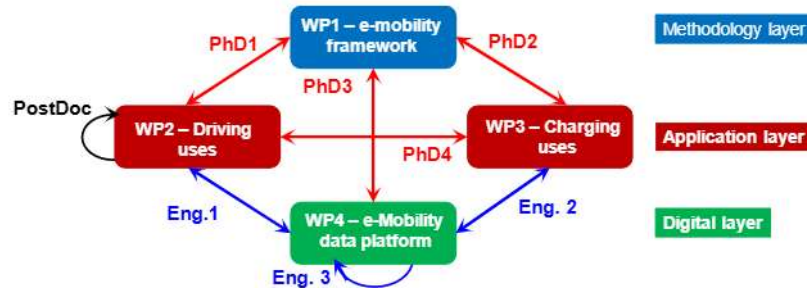


Fig. 3: WP organization and interactions with human resources (PhD students, Engineers, and Post-Doc)

In order to interconnect the scientific WP, dedicated human resources are considered

- 3 PhD students in WP1 (methods) and WP2/3/4 (application and digital layers) to contribute to the framework development and implement it in other WPs
- 1 PhD student to couple the driving and charging usages
- 1 Engineer shared between WP2 / WP4 to collect and publish data from the driving usages,
- 1 Engineer shared between WP3 / WP4 to collect and publish data from the charging usages,
- 1 Engineer to deploy and tailor the data platform
- 1 post-doc to apply the methodology to the MEL e-buses

The first year is dedicated to the development of the framework. The 3 following years are focused on the data collection and publication on the platform. The last year consists on feedback to refine the framework and extent to other e-vehicles, e-infrastructures, areas and usages.

2.2. Scientific and technical description of the project

• Scientific objectives

- **RO1** - How to define a common framework to collect e-mobility multidisciplinary data?
- **RO2** - How to adapt classical technical tests to comply with this new framework?
- **RO3** - How to adapt classical humanities surveys to comply with this new framework?
- **RO4** - How manage, integrate and visualize complex e-mobility data?

In order to avoid mono-disciplinary PhD theses, all the PhD subjects are defined to face several ROs with an interdisciplinary supervision team.

- **PhD 1** - supervision TVES (SHS, ULille), co-supervision L2EP (ST, Lille)
Development of an interdisciplinary framework for coupling technical and humanities data of e-mobility: application on driving uses (RO1/RO2/RO3).
- **PhD 2** - supervision LICIT-ECO7 (ST, UGE Lyon) co-supervision MODIS (SHS, UGE Lyon),
Development of an interdisciplinary framework for coupling technical and humanities data of e-mobility: application on charging uses (RO1/RO2/RO3).
- **PhD 3** - supervision LIMOS (ST, St Etienne), co-supervision GERiiCO (SHS, Lille)
Open data management and visualization for electromobility: navigating regulatory, technical, and social science challenges in multisectoral open data platforms (RO1/RO4).
- **PhD 4** - supervision TVES (SHS, ULille), co-supervision LICIT-ECO7 (ST, UGE Lyon)
Using an interdisciplinary framework to correlate driving and charging uses and practices of various types of e-vehicles (RO1/RO2/RO3).

Despite the difficulty of multi-disciplinary theses, the strategy is to have real interdisciplinary works, with a main discipline and a secondary discipline (as already achieved in the PhD of A. Desrevaux (2020) co-supervised by L2EP, TVES an LICIT-ECO7 leading to 4 co-authored papers in journals). Moreover, a postdoctoral position will apply the common framework to a public authority's use case.



- **PostDoc** - supervision L2EP (ST, ULille), co-supervision TVES (SHS, Lille) in collaboration with MEL. Application of the interdisciplinary framework to collect driving uses of e-buses.

- **Expected results**

- A flexible interdisciplinary framework for collecting technical and humanities data on various e-mobility systems: definition of relevant mobility indicators, for developing experimental tests to compute the technical indicators, the most appropriate survey methods for developing human & social science indicators; method for combining both types of indicators.
- An open-access FAIR data platform, to store, manage and visualize data of various e-mobility systems: method to organize data in a FAIR philosophy; method to structure heterogenous data on the same topic, method to enable multi-visualization of research question.

- **Credibility**

The development of such an interdisciplinary framework is a real challenge because of the great difference between ST and SHS practices. However, previous interdisciplinary works have been initiated in the right way (with CUMIN, within G4M and with both groups, see § 1.2).

The main difficulty is the multidisciplinary PhD theses, but it is a mandatory way to really coupling the activities of different disciplines. PhD 1 and PhD 2 will work together on the development of the framework with 2 different application cases. PhD 4 will combine the results of PhD 1 and PhD 2 to couple driving and charging as in the real life. This decomposition is a way to face the complexity of the challenge ("Divide and Conquer"). PhD 3 will implement the developed framework in a smart and open digital platform with the results of others PhDs.

The main force of EDIS is the availability of real e-vehicles / e-infrastructures and first works on experimental tests and surveys. Even though it was limited to e-cars, these previous experiences can be a relevant background to develop a more general framework.

2.3. Relation with PERP MOBIDEC

As indicate in § 1.1, EDIS will contribute to 2 MOBIDEC thematic axes. EDIS will contribute to complete the knowledge on e-mobility. In particular, different surveys will integrate determinants defined by MOBIDEC. Moreover, EDIS will contribute to develop a data base on e-mobility using the foundation of the data factory of MOBIDEC in order to share all the data with the community.

- **Possible common actions**

After first discussions with these MOBIDEC axes, it has been decided to develop complementarity to strengthen each other without redeveloping existing tools and methods by:

- 1) including a scientific coordinator of each axis in the EDIS advisory board,
- 2) proposing seminars with axis 1 the first year to benefit from its work on the mobility determinants to include them in the e-mobility framework
- 3) providing axis 1 with tests on real vehicles and user's surveys to validate its virtual scenarios
- 4) proposing seminars with axis 2 the first year to benefit of its work on the data factory for interoperability of both platforms, but also benefit of filtering algorithms already developed.

2.4. Planning, KPI and milestones

- **Work programme**

It is decomposed into 4 scientific Work Packages (WPs) and 2 management WPs (Table 1).

Table 1: Synthetic descriptions of the WPs

WP1	e-mobility framework (109 pm)			M0-M60
Lead	GERiiCO (Amel FRAISSE)	Participants	All partners	
Objectives: development of a common framework for collection of e-mobility data				
Technical and humanities indicators are defined (T1.1). Driving and charging scenarios are defined to comply with the indicators (T1.2). Surveys on driving mobility practices and expectations are defined to comply with				



indicators (T1.3). The platform organization is defined to store data and compute indicators (T1.4). Feedbacks from other WPs will refine indicators, scenarios, surveys and the data platform (update of deliverables). T1.1. E-mobility indicators (Lead: L2EP; members: all, M0-M9 / M49-M60, D1.1) T1.2. E-mobility scenarios (Lead: LICIT-ECO7, members: L2EP, TVES, M7-M18 / M52-M60, D1.2), T1.3. E-mobility surveys (Lead: TVES; members: MODIS, CLERSE, S2HEP, M7-M18 / M52-M60, D1.3), T1.4. Data platform (Lead: LIRIS; members: GERiICO, LIMOS, S2HEP, M4-M19 / M52-M60, D1.4),			
WP2	Driving uses	(95 pm)	M10-M60
Lead	TVES (Christelle AUDOUIT)	Participants	L2EP, CLERSE, LICIT-ECO7, MODIS
Objectives: collection of technical data and humanities data on driving uses			
The vehicle specifications are collected for the data platform (T2.1). The vehicles are instrumented and the driving tests are realized to collect technical data (T2.2). The surveys are developed and conducted to collect humanities data (T2.3). First indicators are computed to deliver relevant feedback to WP1 (T2.4). T2.1. E-vehicle specifications (Lead: L2EP, Participants: LICIT-ECO7, M10-M15, D2.1) T2.2. Driving tests (Lead: LICIT-ECO7, Participants: L2EP, M13-M60, D2.2). T2.3. Driving surveys (Lead: MODIS, Participants: TVES, S2HEP, M13-M60, D2.3). T2.4. Driving indicators (Lead: L2EP, Participants: LICIT-ECO7, TVES, MODIS M37-M51, D2.4).			
WP3	Charging uses	(95 pm)	M10-M60
Lead	LICIT-ECO7 (Bilal KABALAN)	Participants	L2EP, TVES, MODIS, S2HEP
Objectives: collection of technical data and humanities data on charging uses			
The charging point specifications are collected (T3.1). The charging stations are instrumented and the charging tests are realized to collect technical data (T3.2). The surveys are developed and conducted to collect humanities data (T3.3). First indicators are computed to deliver feedback to WP1 (T3.4). T3.1. Charging specifications (Lead: LICIT-ECO7; member: L2EP, M10-M15, D2.1) T3.2. Charging tests (Lead: LICIT-ECO7; members: MODIS, S2HEP, M13-M60, D2.2). T3.3. Charging surveys (Lead: MODIS; members: TVES, S2HEP, M13-M60, D2.3). T3.4. Charging indicators (Lead: S2HEP, members: LICIT-ECO7, TVES, MODIS, L2EP, M37-M51, D3.4).			
WP4	e-mobility data platform	(129 pm)	M10-M60
Lead	LIRIS (Yann GRIPAY)	Participants	GERiICO, LIMOS, S2HEP, L2EP, LICIT-ECO7
Objectives: FAIR e-mobility data platform for exploration of heterogeneous data (measurements & surveys)			
The platform is deployed and heterogeneous data are published (T4.1). Semantic descriptions and metadata are defined using relevant ontologies (T4.2). FAIR and Open Science principles are enforced from French and EU strategies (T4.3). Multi-visualization methods are developed for cross-domain explorations (T4.4). T4.1. Data storage & integration (Lead: LICIT-ECO7; members: LIRIS, LIMOS, L2EP, M10-M60, D4.1) T4.2. Semantic data description (Lead: LIRIS; members: GERiICO, LIMOS, S2HEP, M16-M52, D4.2). T4.3. FAIR Dataset (Lead: LIMOS, members: GERiICO, LIRIS, S2HEP, M16-M52, D4.3). T4.4. Data visualizations (Lead: GERiICO, members: S2HEP, LIRIS, LIMOS, M19-M55, D4.4).			
WP5	Dissemination and communication of the project	(60 pm)	M0-M60
Lead	L2EP (Amandine LEPOUTRE)	Participants	All partners
Objectives: dissemination, communication and outreach activities (see §4 for more details)			
T5.1. Communication with stakeholders (Lead: S2HEP, members: all, M6-M60, D5.1) T5.2. Dissemination for scientists (Lead: LIMOS, members: all, M6-M60, D5.2), T5.3. Outreach activities to general audience (Lead: CLERSE, members: all, M6-M60, D5.3) T5.4. Link with education (Lead: GERiICO, members: all, M6-M60, D5.4)			
WP6	Management of the project	(50 pm)	M0-M60
Lead	L2EP (Alain BOUSCAYROL)	Participants	All partners
Objectives: management of the project			
T6.1. Project Management (Lead: L2EP, members: all, M0-M60, D6.1) T6.2. Data Management Plan (Lead: LIMOS, members: all, M0-M60, D6.2) T6.3. Clustering activities (MOBIDEC and others) (Lead: LICIT-ECO7, members: all, M0-M60, D6.3), T6.4. Carbon care action (Lead: TVES, Participant: all, M0-M60, D6.4),			

• Milestones and Deliverables



From previous experiences, the deliverables are distributed all along the project (Table 2) avoiding deliverables at the same time (excluding management WPs). According to a quality process, each deliverable will be reviewed by 2 members. Milestones are reported in Table 3.

Table 2: Deliverable table (R: report / DATA: data / Web: Website --- PU: public / SEN: sensitive, member only)

ID	Deliverable Title	WP	Lead	Type	Level	Date
D1.1	E-mobility indicators	WP1	L2EP	R	PU	M9 -M57
D1.2	E-mobility scenarios	WP1	LICIT-ECO7	R	PU	M16-M58
D1.3	E-mobility surveys	WP1	TVES	R	PU	M17-M59
D1.4	Organization of the data platform	WP1	LIRIS	R	PU	M12-M60
D2.1	Specifications of the e-vehicles	WP2	L2EP	R	PU	M14
D2.2	First data collection of driving test	WP2	LICIT-ECO7	DATA	PU	M21
D2.3	First data collection of driving surveys	WP2	MODIS	DATA	PU	M24
D2.4	Feedback on driving indicators	WP2	L2EP	R	PU	M50
D3.1	Specification of the e-infrastructure	WP3	LICIT-ECO7	R	PU	M15
D3.2	First data collection of charging test	WP3	LICIT-ECO7	DATA	PU	M23
D3.3	First data collection of charging surveys	WP3	MODIS	DATA	PU	M30
D3.4	Feedback on charging indicators	WP3	S2HEO	R	PU	M51
D4.1	Data platform in operation	WP4	LICIT-ECO7	Other	PU	M20
D4.2	Semantic description for e-mobility	WP4	LIRIS	R	PU	M32
D4.3	FAIR rules of the e-mobility dataset	WP4	LIMOS	R	PU	M40
D4.4	Data and indicators visualization tools	WP4	GERiiCO	R	PU	M55
D5.1	Update on communication activities	WP5	S2HEP	Web	PU	M6 to 60
D5.2	Update on dissemination activities	WP5	LIMOS	Web	PU	M6 to 60
D5.3	Update on outreach activities	WP5	CLERSE	Web	PU	M6 to 60
D5.4	Update on education activities	WP5	GERiiCO	Web	PU	M6 to 60
D6.1	Kick-off meeting	WP6	L2EP	Other	PU	M1
D6.2	Data Management Plan	WP6	LIMOS	R	PU	M6
D6.3	Update on clustering activities	WP6	LICIT-ECO7	Web	PU	M1 to 60
D6.4	Update on carbon care action	WP6	TVES	Other	PU	M1 to 60

Table 3: Milestone table

ID	Title	WP	Lead	Date	Means of Verification
Mi-1	First list of indicators	WP1	L2EP	M9	Application to T1.2, T1.3 and T1.4
Mi-2	Data platform deployed	WP4	LICIT-ECO7	M20	Collection of first data set
Mi-3	First set of driving data	WP2	TVES	M24	access to the dataset by partners
Mi-4	First set of charging data	WP3	MODIS	M30	access to the dataset by partners
Mi-5	First dataset in Open Access	WP4	LIRIS	M40	access to a first dataset by MOBIDEC

• GANTT chart

A GANTT chart (Table 4) indicates task activities, Deliverables (D) and Milestones (red circles).

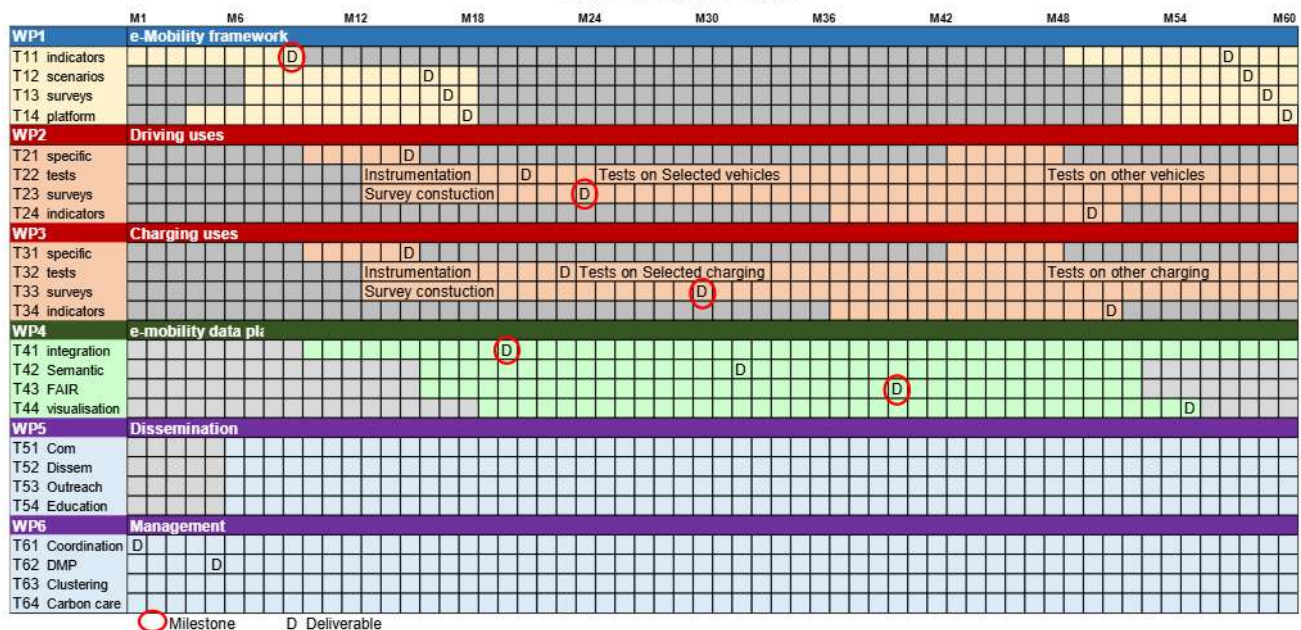
• Key projects Indicators (KPI)

Qualitative KPIs (related to the scientific WPs)

- A flexible interdisciplinary framework:
 - list of multidisciplinary e-mobility indicators,
 - method to develop technical tests to compute technical indicators,
 - method to develop surveys to get humanities indicators,
- An open FAIR data platform on e-mobility, promoting open sciences:
 - first dataset on e-mobility in open access,
 - multi-visualization of the dataset from e-mobility indicators.
- Training of experts in interdisciplinary field with growing interest:
 - 10 Master in internships, 3 Engineers, 4 PhD students, 1 post-doctoral position,

- Seminars in French education programs, tutorials for various stakeholders.

Table 4: GANTT chart



Quantitative KPIs (excellence of EDIS as a truly interdisciplinary project)

- 4 co-supervised interdisciplinary PhD theses,
- 2 regional projects, 2 international projects (inc. Horizon Europe), 2 industrial projects,
- 8 papers in Q1 journals, co-authored at least by 2 EDIS members,
- 1 scientific book with EDIS co-authors in a well-known edition (e.g., Editions HERMES),
- 4 communication events for general audience, 4 dissemination events for scientists.

Risk management

The steering committee will check the risks and propose mitigation measure (Table 5).

Table 5: Risk management

Risk	Description of Risk (likelihood/severity)	WP	Proposed risk mitigation measures
R1	Delay in recruitment of engineers and PhD students (medium/medium)	All	The partner in charge will initiate the work with permanent staff and/or internal PhD students
R2	A WP or task leader resigns before or after starting (weak/low)	All	The lab in charge will propose a new leader with validation by the coordination committee
R3	Difficulty to correlate e-mobility indicators – Mi-1 - (medium/high)	WP1	Two categories of indicators will be proposed and the scenarios and survey will be adapted.
R4	Difficulty to open a data platform in INSA – Mi-2 - (weak/high)	WP4	Use of the data platform of MOBIDEC or recherche.data.gouv.fr. Adaptation of the process.
R5	Late collection of the first driving dataset – Mi-2 - (weak/low)	WP2	The PhD and Engineer related to these tasks will be focused on this priority
R6	Late collection of the first charging dataset – Mi-3 - (weak/low)	WP3	The PhD and Engineer related to these tasks will be focused on this priority
R7	Difficulty to put a first dataset in Open Access – Mi-4 - (medium/medium)	WP4	Only a part of the dataset will be put un open access. Adaption of the methodology for corrective action.

3. Project organisation and management

3.1. Project manager

Professor Alain BOUSCAYROL (University of Lille, L2EP ULR 2697)



Main past experiences related to e-mobility (more details in the CV appendix)

- Since 2004: research on control & energy management of various e-vehicles, including collaborations with MEL, Peugeot, Siemens, SNCF, Canada, China, USA, etc.
- 2005-2019: Coordinator of the MEGEVH national network on e-vehicles.
- 2018-2022: Coordination of the PANDA RIA H2020 project (3.5 M€, 11 partners from 6 countries).

Actual positions related to e-mobility (more details in the CV appendix)

- Since 2016 coordinator of CUMIN interdisciplinary program of ULille (3 ST Labs & 3 SHS Labs).
- Since 2018 Director of international associated lab e-CAMPUS of ULille and Univ. Trois Rivières (Canada) – (2 research Labs in ST and 2 in SHS),
- Since 2019: Chair of the steering committee of IEEE Vehicle Power Propulsion Conference.
- Since 2020: Associate Editor of IEEE Open Journal in Vehicular Technology (Q1).

Main indicators

- Supervision: 20 PhD students, more than 50 Master students
- Production: 13 book chapters, 79 journal papers, 7 keynotes & 8 tutorials in conferences.
- Awards: 2 for best journal paper, 2 for conference paper, 3 awards of scientific societies.
- H-index: 28 (ISI Web of Science, August 2024, 247 Documents, 3209 Citations).

3.2. Organization of the partnership

• **Quality of consortium**

The consortium is composed of 9 research groups from 4 institutions with support of 1 public authority (Table 6). EDIS is a combination of 2 research interdisciplinary programmes on e-mobility (47% from CUMIN, Lille and 53% from G4M, Lyon area). The gender distribution is 47% for woman and 53% for men (and balanced WP lead). The scientific distribution is 58% for ST and 42% for SHS. UGE is one of the coordinators of MOBIDEC.

Table 6: members of the EDIS consortium

	Name	First Name	Gender	Lab	Field	Institution	speciality	Lead
1	C BOUSCAYROL	Alain	M	L2EP	ST	ULille	e-vehicle energy management	WP6/T2.1/T6.1
2	U MAYET	Clément	M	L2EP	ST	ULille	LCA of electrified vehicles	T1.1/T2.4
3	M LEPOUTRE	Amandine	F	L2EP	ST	ULille	Project engineer	WP5
4	I JUNCKER	Lucie	F	TVES	SHS	ULille	Urbanism & Transport	T1.3
5	N AUDOUIT	Christelle	F	TVES	SHS	ULille	Mobility & usage	WP2/ T6.4
6	FRAISSE	Amel	F	GERiiCO	SHS	ULille	Information & communication	WP1/T4.1
7	FAVIER	Laurence	F	GERiiCO	SHS	ULille	Information & communication	T4.4/T5.4
8	DELPY	Léo	M	CLERSE	SHS	ULille	Social-ecological-economics	T5.3
9	BROCARD	Charles	M	MEL	ST	MEL	Transport organization	Adv Board
10	G JEANNERET	Bruno	M	LICIT-ECO7	ST	UGE	EV & charging	T2.2/T3.2/T4.1
11	4 KABALAN	Bilal	M	LICIT-ECO7	ST	UGE	EV & Smart Grid	WP3/T3.2
12	M TRIGUI	Rochdi	M	LICIT-ECO7	ST	UGE	e-vehicle consumption	T1.2/T6.3
13	PHILIPPS-BERTIN	Chrystèle	F	MODIS	SHS	UGE	Psychology of mobility	T2.3
14	LEFRANCOIS	Maxime	M	LIMOS	ST	USME	Knowledge Engineering	T4.3/T6.2
15	ZIMMERMANN	Antoine	M	LIMOS	ST	USME	Knowledge Engineering	T5.2
16	NGUYEN	Céline	F	S2HEP	SHS	INSA	Information & communication	T3.4
17	CHOUTEAU	Marianne	F	S2HEP	SHS	INSA	Information & communication	T5.1
18	GRIPAY	Yann	M	LIRIS	ST	INSA	Databases	WP4/T4.1
19	SERVIGNE	Sylvie	F	LIRIS	ST	INSA	Databases	T4.2

Previous interdisciplinary collaborations have been already achieved:

- L2EP, TVES, CLERSE, GERiiCO and MEL within the CUMIN programme,
- LICIT-ECO7, MODIS, LIRIS, LIMOS, S2HEP within the G4M programme,
- L2EP, TVES (Lille) and LICIT-ECO7 (Lyon) through several co-supervised PhD theses.

• **WP leaders and contributors**



The WP leaders are a mix between men/women, ST/SHS, experienced and young scientists.

- WP1 – E-mobility framework - Dr. Amel Fraisse** (ULille, GERiCO, SHS) – Research in automatic information processing, multilingual information, digital humanities - Co-Pi of ROSETTA, an interdisciplinary digital humanities research project with Sandford Univ. (2018-2020).
- WP2 – Driving uses - Dr. Christelle Audouit** (ULille, TVES, SHS) – Research in data production, processing and analyses on interactions between human and spatial areas. In charge of RGDP process and carbon footprint of TVES.
- WP3 – Charging uses - Dr. Bilal Kabalan** (UGE, LICIT-ECO7, ST) – Research in charging infrastructure of e-mobility. G4M local coordinator at LICIT-ECO7 for charging stations.
- WP4 – E-mobility data Platform - Dr. Yann Gripay** (INSA, LIRIS, ST) – Research in sensor data, databases and semantic web. G4M coordinator at LIRIS for Information Technology.
- WP5 – Dissemination - Amandine Lepoutre** (ULille, L2EP) – WP leader of the H2020 PANDA RIA project, in charge of management, communication, dissemination and carbon care.
- WP6 – Management - Pr. Alain Bouscayrol** (ULille, L2EP, ST, EDIS coordinator, see § 3.1)

- **Complementarity of the partners**

The ST part is composed of 2 groups (Table 7). A first group is focused on electrical engineering with experts on e-vehicles and on e-infrastructure. They will contribute to the testing methods and in the realization of tests. A second group is focused on computer sciences with experts on data management and on knowledge engineering. They contribute to the data platform definition and implementation. Moreover, the transport division of MEL will provide e-bus and e-bike data.

The SHS part also composed of 2 groups. A first group is related to humanities analyses with experts in spatial organization, economics and psychology. They will contribute to the definition of the mobility surveys and their implantations. The second group is focuses on information & communication science with experts in multi-data management and in interactions with engineering. They will contribute to the definition of the organization of the multi-aspect data.

All these skills propose a complete panel of expertise for the EDIS objective.

Table 7: complementary of the EDIS partners

Field	Lab	Discipline	Specialities
ST	L2EP	electrical engineering	e-vehicle drivung test, life-cycle assessment of e-vehicles
	LICT-ECO7	electrical engineering	e-vehicle charging test, energy & buildings
	LIRIS	computer sciences	Semantic web and data-bases
	LIMOS	computer sciences	knowledge engineering
	MEL	Transport enginnering	e-bikes and e-buses energy consumption
SHS	TVES	Urbanism & geography	urban planning and public policies of transport, mobility & usage
	CLERSE	Socio-economics	social-ecological-economics
	MODIS	psychology	psychology of transport, social and environmental psychology
	GERiCO	Information & communication	multilingual information processing, digital humanities
	S2HEP	Information & communication	social and human sciences 'or engineering

3.3. Management framework

- **Coordination committee**

The coordination committee will be composed of the project investigator and a management engineer. This committee is in charge of the implementation of the project. The coordination committee will have a review meeting every 15 days.



- **Steering committee**

The steering committee will be composed of WP leaders and institution contacts. This committee is in charge of any decision related to the project. The steering committee will meet every 6 months but exceptional meetings will be organized if required by at least 50% of its members.

- **Advisory Board**

An advisory board will be composed of external scientists, including some MOBIDEC members. It is in charge of scientific feedback and advice on the project activities during annual meetings.

- Dr. Eric HITTINGER (Rochester Int. Tech, USA, involved in CUMIN, SHS).
- Dr. Valery GYSELINK (Univ. G. Eiffel, France, coordinator of MOBIDEC axis1, SHS).
- Dr. Alexandre CHASSE (IFPen, France, co-coordinator of MOBIDEC axis2, ST),
- Mr. Charles BROCARD (MEL, Head of innovative projects, Transport division),
- Pr. Ali SARI (Univ. Lyon, Coordinator of REMED national project on e-mobility education)
- A member of SYTRAL, transport management of Lyon area (to be defined).
- A member of ESFRI, EU committee in digital research infrastructures (to be defined).

- **Carbon care action**

As has already been done by L2EP for some other projects (e.g., H2020 PANDA project.), a carbon care action will be realized to reduce and mitigate the GHG emissions of EDIS. This action is composed of different steps: awareness, GHG reduction, GHG estimation (including all activities, e.g., commuting, travels, equipment, events), and GHG mitigation [Lepoutre 2022]. EDIS will be an exemplary project in terms of ecological footprint, in agreement with the project objective.

- **Technical management**

The technical management will be ensured by the WP leaders who will present a report every steering committee meeting. In particular milestones and risks will be discussed every meeting.

- **Open Sciences**

All developments of EDIS will be pursued in Open Science: development of method for open access dataset on e-mobility. In that regard, a specific data management plan will be elaborated by the steering committee in M6. The objective is to develop the adapted practice throughout the project. Moreover, TVES and MODIS are used to manage studies and surveys according to GRDP⁵.

In terms of publications, EDIS will adopt the "Open Access" policy of the European Union and use the French repository platform of HAL as already used by most the partners.

3.4. Institutional strategy

- **Strategies of the institution**

The CUMIN interdisciplinary programme of ULille is developed since 2016 with a campus as a demonstrator on e-mobility, funded by ULille, the iSITE ULNE foundation, MEL, regional, national and international funding. It is supported by the "France 2030, Initiative d'Excellence Lilloise" by different funding schemes (see § 8). All these efforts lead to a unique transdisciplinary research group and experimental facilities. EDIS will benefit of CUMIN and will strengthen CUMIN.

The G4M programme is key instrument of UGE and their partners within the Lyon region. The shared and opened platform is essential to facilitate the interdisciplinary studies and build joint answers to research calls. It will address some major questions for the development of sustainable solution to an energy transition adapted to e-mobility: collecting comprehensive data in EDIS will be the first step to understand such a complex system from both a social or engineering point of view.

⁵ General Regulation of Data Protection, <https://eur-lex.europa.eu/>



- **Research infrastructures**

CUMIN has developed first dataset on e-cars that will serve as background for EDIS (s. Moreover, the “eV” (electricity and vehicle platform) will be available for EDIS, including several instrumented e-vehicles and 3 e-infrastructures (see Appendix 8).

G4M is based on 2 demonstrators' campus “La Doua” and Transpolis experimental camp). Preliminary works have been conducted to record e-vehicle and charging station data in an automatic manner. A proof of concept has been successfully conducted to link data with a digital infrastructure at LIRIS. This infrastructure will host the EDIS data platform. G4M has provided the main bricks of the smart-grid: e-vehicles, e-charging station, etc. EDIS program will be an opportunity to use and consolidate the infrastructures.

4. Expected outcomes of the project

- **Potential outcomes**

The first outcome will be a method to extend the data base by other mobility schemes to contribute to a better knowledge on mobility.

A second outcome will be the analyses of e-mobility uses, needs and barriers to propose incentives, rules and actions to speed-up the reduction of fossil-fuel cars. In particular, ULille will benefit of this dataset to develop campus demonstrator within the CUMIN programme. G4M will also benefit of the EDIS results to propose new mobility schemes in the Lyon areas.

Another outcome is the reuse of the method and dataset to develop new collection for the MEL (city of Lille) in order to develop its Sustainable Urban Mobility Plan. MEL has been involved in that objective, and could be an example for other public authorities.

- **Impacts**

The global impact of EDIS is to contribute to the mobility transition in the perspective of the Net Zero target for 2050. The EDIS dataset will enable to speed up the replacement of fossil-fuel cars by various e-vehicles. EDIS will thus contribute to the United Nation Sustainable Development Goals SDG7 – Affordable and clean energy and SDG11 – Sustainable cities and communities.

- **Outreach activities for a general audience**

Social media and website

EDIS social media (X, LinkedIn, etc.) will be developed by the PhD students as actors of the outreach activities to ensure a broad audience of the project. Moreover, a website will be developed including short videos on the first results.

Workshops on e-mobility

CUMIN and G4M has already experiences in awareness workshop on e-mobility. EDIS will contribute in these activities to 1) aware a general audience but also 2) attract potential people for its different tests and surveys. As an example, in 2024, CUMIN contributes to the transition week of ULille by an action on light e-mobility that leads to e-bike tests and surveys with 92 respondents.

- **Communication activities**

Workshops to public authorities

As MEL (Metropole Européenne de Lille) supports EDIS, a dedicated workshop will be organized with its mobility division to present the results. Such a workshop can be replicated with the Lyon metropolis and SYSTRAL its mobility operator. Other relevant stakeholders will be invited.

Contribution to education programmes

CUMIN is strongly involved in education, from Bachelor to doctoral units with seminars and student projects that enable to 1) aware students on the mobility challenges and 2) promote Master



internship (10 expected in EDIS). Moreover, the REMED training program on e-mobility (managed by Pr. Ali SARI) is involved in the Advisory Board to ensure an interconnection between both projects. A training program to public authorities and industries could be jointly developed. Finally, UGE, INSA Lyon and ESME will benefit of the ULille experience to develop education activities on e-mobility.

- **Dissemination activities**

EDIS will first organize seminars with the MOBIDEC axes to share experiences (see § 2.1). Moreover, EDIS will contribute to any MOBIDEC event when contacted. Other activities are planned.

Annual scientific workshop

CUMIN and G4M organize annual workshops where on-going projects are presented. EDIS will organize an annual joint workshop with both groups where MOBIDEC will be invited.

Special sessions in national and international conferences

CUMIN has organized interdisciplinary special sessions in national and international conferences, where CUMIN works are presented, but also international competitors are invited (e.g., IEEE-VPPC'23 in ST, RIOOD'23 in SHS). While these conferences are focused on one discipline, these sessions attract a large number of attendees thanks to the originality of the multidisciplinary presentations. This positive practice will be extended in EDIS to other events.

Final international scientific workshop

At the end of the project, an international workshop will be organized at ULille with an invitation of other key players on e-mobility (e.g., VU Brussels, Argonne National Lab) to share experiences and results. Such an event has been organized in hybrid mode by H2020 PANDA and attracted 282 attendees from 36 countries (53% in presence).

5. Funding justification

- **Budget (only requested funding)**

An approximation of the request budget is given in Table 8 (variations of salaries from the institutions). The exact total budget is provided in the financial Appendix. The most important part is related to human resources (4 PhD students, 3 Engineers for data collection and management, 1 post-doc and ½ project management engineer): 1,39 M€ (85%) as most of the vehicles and charging points are already available. Some investments will complete this panel.

- **Distribution**

The financial coordination will be ensured by ULille (management engineer), knowing each institution will be received its part. The human resources will be distributed to the partners. All funding rules will be defined by the consortium agreement based on the LERU template⁶ to facilitate future international collaborations or applications to Horizon Europe calls

Table 8: Approximated requested budget

Operation Costs	nb	year	unit (k€)	total (k€)
Data base management	2		15	30 k€
Small material	2		25	50 k€
Missions	2	5	2	20 k€
Meetings	10		1	10 k€
Conferences (2 per PhD)	8		2	16 k€
APC publications (2 per PhD)	4	2	2	16 k€
Annual workshop	5		2	10 k€
Operational costs	1	5	11	55 k€
Total				207 k€
Investment				
Vehicle	1		20	20 k€
Computers	8		1,5	12 k€
Charging point	1		15	15 k€
Total				47 k€

Human Ressources	nb	year	unit (k€)	total (k€)
Co-supervised Master	10	0,5	8	40 k€
Project Engineer	0,5	5	50	125 k€
Data collection engineer (WP2)	1	4	50	200 k€
Data collection engineer (WP3)	1	4	50	200 k€
Postdoc MEL	1	1,5	50	75 k€
Data management engineer (WP4)	1	4	50	200 k€
Co-supervised PhD	4		136,5	546 k€
Total				1386 k€

Total requested budget excl. Mgt costs				1642 k€
Management cos	20%			328 k€
Total request cost				1970 k€

⁶ League of European Research Universities (LERU), <https://www.leru.org>

6. Cited references

As requested, the members of the EDIS consortium are underlined.

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7. CV of the project leader

Pr. Alain BOUSCAYROL (University of Lille, L2EP, ULR 2697)

ORCID : <https://orcid.org/0000-0002-7248-939X>

Cursus and positions

1989-1991: Assistant Professor at University Cheikh Anta Diop, Dakar (Senegal),
1991-1995: Assistant Professor at Institut National Polytechnique Toulouse (France),
1995: PhD degree in Electrical Engineering at Inst. National Polytech. Toulouse (France),
1996-2001: Associate Professor at University of Lille (France)
Since 2005: (Full) **Professor at University of Lille (France)**

Education activities

Since 2008: Head of Master degree "Automatique & Systèmes Electriques", 200 students / year.
Since 2015: Responsible of Master option "Véhicules Intelligents Electriques", 20 students / year.
Since 2006: EMR international summer school, creation in 2006, annual since 2011, odd year in Lille, even year aboard (chair of EMR'06, co-chair of the other, 60 attendees per year)

Research activities

Topics: - control & energy management of electrified vehicles,
- creation in 2000 of Energetic Macroscopic Representation (EMR), graphical formalism for organization of models and controls of energy conversion systems (<https://emrwebsite.org/>), now taught in 10 countries and used in several companies.

PhD supervision: 20 PhD defended: 7 in double degree (Belgium, Canada (3), China, Romania, Tunisia) 5 in collaboration (MEL, Peugeot (2), Siemens, Sherpa Eng., Valeo), 5 PhD ongoing.

Main positions on e-mobility

Local: - Since 2014: head of control team of L2EP (8 Prof. & Ass. Prof., 2 Eng., 3 Post-docs, 11 PhDs),
- Since 2016: **coordinator of CUMIN**, interdisciplinary program of Univ. Lille (6 research labs).

National: - 2005-2019: **Coordinator of MEGEVH**, French scientific network on energy management of hybrid and electric Vehicles (9 industrial partners, 10 research labs),
- 2008-2013: member of the steering committee GO1-PREDIT (National French coordination Programme on Transportation Systems),
- Since 2019: Chair of the scientific committee of MEGEVH.

International: - Since 2018: **co-director of the international associated lab e-CAMPUS** of University of Lille and Univ. Trois Rivières (Canada) – (4 research Labs, 3 co-supervised PhD students),
- 2018-2022: **coordinator of the H2020 project PANDA** (Power Advanced N-level Digital Architecture for models of e-vehicles), Grant #824256, 3.5 M€ (11 partners from 6 countries).

Publications and indicators

Production: 13 book chapters, 79 papers in international journals, 256 papers in international conferences, 7 keynotes and 8 tutorials on e-mobility in international conferences.

Awards: 2 for best journal paper, 2 for conference paper, 3 awards of scientific societies.

H-index: 28 (ISI Web of Science, August 2024, 247 Documents, 3209 Citations).

Main collaborations on e-mobility systems:

Public Authorities & Industry: Métropole Européenne de Lille, PSA Peugeot Citroen, Renault TR, Sherpa Engineering, Siemens Mobility, Siemens Software, SNCF, Valeo.



Academy: Harbin Inst. Tech. (China), Rochester Inst. Tech. (USA), Tech. Univ. Eindhoven (Netherlands), Univ. F. Comté (France), Univ. G. Eiffel (France), Univ. Sherbrooke (Canada), Univ. Trois Rivières (Canada).

Main international positions related to e-mobility

2010: General chair of IEEE-VPPC 2010 (Vehicle Power Propulsion Conf.), Lille, 2010.
2014-2019: Chair of the VPP technical committee of IEEE-VTS (Vehicular Technology Society).
2014-2022: Distinguished Lecturer on e-mobility of IEEE-VTS.
Since 2019: **Chair of the steering committee of IEEE Vehicle Power Propulsion Conference.**

Main editorial involvements related to e-mobility

2010-2022: Guest Editors of 6 special sections on international journals (IEEE & Elsevier)
2014-2018: Associate Editor of IEEE transactions on Vehicular Technology (Q1).
Since 2020: **Associate Editor of IEEE Open Journal in Vehicular Technology (Q1).**

Selection of 5 publications

1. C. C. Chan, A. Bouscayrol, K. Chen, "Electric, Hybrid and Fuel Cell Vehicles: Architectures and Modeling", *IEEE transactions on Vehicular Technology*, vol. 59, no. 2, pp. 589-598, February 2010 (L2EP ULille and Honk-Kong University), DOI: 10.1109/TVT.2009.2033605
Arguments: state-of-the-art on e-vehicles, 2013 best land transportation paper award of IEEE Vehicular Technology Society, 510 citations in Web of Sciences.
2. B.H. Nguyen, R. German, J. Trovao, A. Bouscayrol, "Real-time energy management of battery/supercapacitor electric vehicles Based on an adaptation of Pontryagin's minimum principle", *IEEE transactions on Vehicular Technology*, vol. 68, no. 1, January 2019, pp. 203-212, DOI: 10.1109/TVT.2018.2881057 (L2EP ULille and Univ. Sherbrooke, Canada).
Arguments: optimal energy management of hybrid electric vehicle, co-supervised PhD thesis with Canada, 135 citations in Web of Sciences.
3. A. Desrevelaux, E. Hittinger, A. Bouscayrol, E. Castex, G.M. Sirbu, "Techno-Economic Comparison of Total Cost of Ownership of Electric and Diesel Vehicles", *IEEE Access*, vol. 8, November 2020, pp. 195752-195762, DOI: 10.1109/ACCESS.2020.3033500 (common paper of L2EP, TVES, LICIT-ECO7, Rochester Inst. Tech. (USA), Renault Technology Romania, within the CUMIN programme and the PANDA H2020 project GA #824256).
Arguments: Total cost of ownership of e-vehicle, interdisciplinary collaboration with USA, Renault, etc. within CUMIN and PANDA H2020 project,
4. D. Ramsey, A. Bouscayrol, L. Boulon, "Flexible simulation of an EV to estimate the impact of thermal comfort on the energy consumption", *IEEE transactions on Transportation Electrification*, Vol. 8, no.2, pp. 2288-2298, June 2022, DOI: 10.1109/TTE.2022.3144526 (L2EP ULille, Univ. Trois-Rivières within CUMIN and eCAMPUS International Associated Lab)
Arguments: energy consumption of EV in winter, interdisciplinary collaboration, co-supervised PhD thesis with Canada, within CUMIN and eCAMPUS international Lab,
5. A. Bouscayrol, G. M. Sirbu, A. Lepoutre, "Impact Analysis of PANDA", PANDA H2020 GA# 824256, D6.6 Deliverable, public report, June 2022, 28 pages [Online] available: <https://project-panda.eu/> <https://project-panda.eu/> (L2EP ULille, Renault TR).
Arguments: synthesis of the European H2020 Project, reduction of the development time of e-vehicles by 25% using the developed digital tools, coordination of the project.

8. Linked projects

➤ CUMIN (Campus of University based on Innovation and carbon Neutrality)

Since 2010, the carbon footprint of University of Lille shows that the commuting (home-university trips) represents more than 50% of its GHG emissions [ULille 2020]. In 2016, the CUMIN interdisciplinary programme⁷ has been developed to study the transition of campus "Cité scientifique" to e-mobility (from-bike to subways, including e-cars and e-buses) [CUMIN 2017].

CUMIN is an interdisciplinary programme developed by 6 research labs (3 from Sciences & Technologies, 3 from Social & Human Sciences), 2 divisions of MEL (Métropole Européenne de Lille) and 4 international partners (RIT, USA, UGhent, Belgium, Univ. Quebec Trois Rivières, Canada).

CUMIN has a research infrastructure that will be available for EDIS, including

- e-bikes, e-scooters, 1 light e-car - AML, 1 e-car - Nissan Leaf, and 1 h2-car - Toyota Mirai,
- 1 PV-based e-bike charging, 1 normal charging point and 1 fast charging station of 50 kW.

CUMIN is composed of several (interdisciplinary or intersectoral or international) projects coupling different disciplines. Three CUMIN projects will serve as background to the EDIS project.



- **CUMIN-SARA** (Social Acceptance of e-vehicles in Restricted Areas, lead TVES, partner L2EP, funding i-SITE ULNE) – In this project, a Nissan Leaf and a Toyota Mirai have been instrumented to measure commuting data. Moreover, a mobility survey has been developed to analyse the mobility use and the e-mobility perception of campus users [Junker 2023]. To date, more than 100 users, representative of the campus population, have driven the e-car and respond to the survey.
- **CUMIN-TESS** (Techno-Economical Study of Sustainable campuses; lead L2EP; partners TVES & RIT (USA); funding i-SITE ULNE / Région "Hauts-de-France", MEL) – In this project, technical and economic models are coupled to analyse the transition of e-mobility for 1) the users in terms of vehicles [Desrevaux 2020] and 2) the university in terms of charging infrastructure [Hittinger 2021].
- **CUMIN-TESSA** (Techno-Economical Study of Second life batteries for Affordable e-mobility campus, lead RIT(USA), partners L2EP & TVES, funding WILL programme France 2030, 400 k€) – In this project, the second life of batteries are considered from technical, environmental, economic and societal aspects [German 2024].

➤ CUMIN-EVE

L2EP (ULille) and LICIT-ECO7 (UGE) have previous collaborations on e-vehicles since 2008. The latest co-supervised PhD. was conducted within CUMIN on factors impacting the energy consumption of e-cars, including driver usages thanks to the supervision of TVES: velocity profile [Desrevaux 2019], heating in winter [Desrevaux 2021], GHG during the life cycle [Desrevaux 2023]. This collaboration involved both universities, 2 ST Labs and 1 SHS Lab, and benefits of an

⁷ CUMIN programme, <https://cumin.univ-lille.fr/>

instrumented e-car of CUMIN (Renault Zoe). It demonstrates the capability of three Labs to collaborate in an interdisciplinary project.

CUMIN demonstrates ability of ST and SHS labs of ULille to contribute to interdisciplinary projects.

➤ **G4M (Grid for Mobility)**

G4M is a partnership project that brings together several universities in the Lyon region (mainly Université Lyon1, Ecole centrale de Lyon, INSA associated with ENTPE and Université Lyon 2). The main objective is to create a shared and opened platform of smartgrid to study management of energy in grids including transport, building and renewable energy sources. The consortium includes academic laboratories in engineering sciences (Ampère, LIRIS, LICIT-ECO7 ...), laboratories in social sciences (LAET and other labs from LABEX IMU - Intelligence Monde Urbain) and industrial partners through the CARA cluster. Funding from the French ministry, the AURA région and Lyon Metropole were obtained in the framework of CPER (2021-2027). In addition to the acquisition of equipment currently underway, the results of this consortium include:

- the Mobigrid project funded by Université Gustave Eiffel enabled to set up a small-scale system including the instrumentation of a building on a remote site with data storage on an INSA server. This foreshadows what the final demonstrator will do on a larger scale.
- Six theses start in autumn 2024 conjointly funded by some universities of the consortium. The subjects concern batteries, photovoltaic energy and mobility. Links with the EDIS project will be considered where appropriate.

G4M is based on a platform with 2 demonstrators: one is the university campus "La Doua", with demo at buildings scale, prototypes and full-scale experiments, while the other is the Transpolis experimental camp, a secure site to test prototypes (heavy duty vehicles, energy set-up). Some preliminary works have been conducted to record e-vehicle flow of data or charging station energy flux in an automatic manner. A proof of concept has been successfully conducted to link this flow of data with a digital infrastructure at LIRIS in Lyon. This infrastructure will host the future EDIS data platform. The CPER G4M has provided the main bricks of the smart-grid: e-vehicles, charging station, photovoltaic sources, batteries storage. EDIS program will be a good opportunity to use and consolidate the infrastructures.



Fig. 4: Transpolis experiment camp



Acronym	EDIS
Titre du projet	Données de l'électromobilité pour études interdisciplinaires
Project Title	Electro-mobility Data for Interdisciplinary Studies

Publications of the EDIS members since September 2021 (3 last years). Only publications and works related to the skills required to EDIS are indicated. The EDIS members are underlined in the list of authors. Moreover, a dedicated section concerns the collaborative publications and work between the institutions involved in EDIS (including MEL support of EDIS).

OUTLINE

University of Lille	2
Universite Gustave Eiffel	5
INSA Lyon	7
Ecole des Mines de Saint Etienne.....	8
Collaborations	9

UNIVERSITY OF LILLE

Chapter of books

- [CB-1] M. Cauli, L. Favier, J.-Y. Jeannas, "Dictionnaire du numérique", **ISTE Edition**, 368 p., 2022, ISBN: 9781784058180.
- [CB-2] C. Mayet, L. Id-Khajine, "Introduction to Hardware-In-the-Loop (HIL) simulations of electrical power systems", in Garcias, J. (Ed.), **Encyclopedia of Electrical and Electronic Power Engineering**, Elsevier, pp. 590-599, 2023, DOI: 10.1016/B978-0-12-821204-2.00105-7.
- [CB-3] S. Aubry, A. Baneyx, E. Bermès, L. Favier, A. Faye, M.-M. Geroudet, B. Ooghe-Tabanou, "A Network to develop the use of web archives: Three outcomes of the ResPaDon project", **Exploring the Archived Web during a Highly Transformative Age**, vol. 138, no. 1, Firenze University Press, 2024, DOI: 10.36253/979-12-215-0413-2.12.
- [CB-4] L. Favier, S. Dardar, "Psychiatric classifications in the light of bibliographic classifications: an epistemic justice issue", in Milani S., Mustafa El Hadi W., Tognoli N. (Ed.), **Special Issue "Critical and Social Knowledge Organisation"**, Knowledge Organisation, to be published.

International Journals (IJ)

- [IJ-1] D. Ramsey, A. Bouscayrol, L. Boulon, A. Desreveaux, A. Vaudrey, "Energy consumption of a BEV in winter considering preheating. Trade-off between improved performance and total energy consumption", **IEEE Vehicular technology Magazine**, vol. 17, no. 3, pp. 104-112, April 2022, DOI: 10.1109/MVT.2022.3158043 (L2EP ULille and IRH Univ. Trois-Rivières within the CUMIN programme and the eCAMPUS International Associated Lab) [IF 8,1, Q1].
- [IJ-2] D. Ramsey, A. Bouscayrol, L. Boulon, "Flexible Simulation of an Electric Vehicle to Estimate the Impact of Thermal Comfort on the Energy Consumption", **IEEE transactions on Transportation Electrification**, vol. 8, no.2, pp. 2288-2298, June 2022, DOI: 10.1109/TTE.2022.3144526 (L2EP ULille and IRH Univ. Trois-Rivières within the CUMIN programme and the eCAMPUS International Associated Lab) [IF 7.0, Q1].
- [IJ-3] P. Arbolea, C. Mayet, A. Bouscayrol, B. Mohamed, P. Delarue, I. El-Sayed, "Electrical Railway Dynamical Versus Static Models for Infrastructure Planning and Operation", **IEEE transactions on Intelligent Transportation Systems**, vol. 23, no. 6, pp. 5514-5525, June 2022, DOI: 10.1109/TITS.2021.3054777 (Univ. Oviedo, Le Cnam, and L2EP ULille) [IF 8.5, Q1].
- [IJ-4] A. Aroua, W. Lhomme, F. Verbelen, M. N. Ibrahim, A. Bouscayrol, P. Sergeant, K. Stockman, "Impact of scaling laws of PM synchronous machines on the accuracy of energy consumption computation of EVs", **eTransportation**, vol. 18, October 2023, DOI: 10.1016/j.etrans.2023.100269 (L2EP ULille and Univ. Ghent with the CUMIN programme) [IF 11.9, Q1].
- [IJ-5] A. Fraisse, I. Timimi, "Multilingualism and Multiculturalism in Digital Libraries", **Knowledge Organization**, vol. 50, no. 6, 2023, DOI: 10.5771/0943-7444-2023-6 (GERiiCO ULille) [IF 0.6, Q2].
- [IJ-6] A. Ndiaye, R. German, A. Bouscayrol, M. Gaetani-Liseo, P. Venet, E. Castex, "Impact of the User Charging Practice on the Battery Aging in an Electric Vehicle", **IEEE Transactions on Vehicular Technology**, vol. 73, no. 4, pp. 4578-4588, April 2024, DOI: 10.1109/TVT.2024.3356116 (L2EP & TVES ULille and AMPERE Univ. Lyon with the CUMIN programme and MEGEVH network) [IF 6,8, Q1].
- [IJ-7] R. German, T. Kalogianis, A. Bouscayrol, J. He, F. Tournez, M. Berecibar, C. Husar, M. Ciocan, S. Costa, A. Genic, B. Lemaire-Semail, "A flexible cloud-based HIL testing of batteries for various electrified vehicles", **IEEE Transactions on Vehicular Technology**,

vol. 73, no. 4, pp. 4610-4620, April 2024, DOI: 10.1109/TVT.2023.3337655 (L2EP ULille, Vrije Univ. Brussels, Siemens Software Romania, Typhoon HIL withing the PANDA H2020 project, the CUMIN programme) [IF 7.0, Q1].

Keynotes and Tutorials (KT)

- [KT-1] A. Bouscayrol, "Campus of University with Mobility based on Innovation and carbon Neutrality", **Transatlantic Symposium'21**, (Academic Research Institutions Advancing Sustainability), June 2021, Office for Science and Technology of the Embassy of France in USA, virtual symposium (L2EP ULille within the CUMIN programme) (on-line Keynote, 52 attendees).
- [KT-2] A. Bouscayrol, V. Ivanov, R. Tatschl, "Virtual product development and production of all types of electrified vehicles and components", **IEEE-VPPEC'21**, October 2021, Gijon (Spain) (L2EP ULille, Univ. Ilmenau, AVL, within H2020 PANDA) (on-line Tutorial, 84 attendees from 13 countries).

International Conferences (IC)

- [IC-1] B. Le Hen Ortega, R. German, A. Bouscayrol, L. Boulon, "Merging control for the hybrid energy storage subsystem of a Fuel-Cell Vehicle", **EPE'21 ECCE Europe**, Ghent (Belgium), September 2021, DOI: 10.23919/EPE21ECCEEurope50061.2021.9570566 (L2EP ULille and IRH Univ. Trois Rivières within the framework of the eCAMPUS international Lab).
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