Agents and artefacts in the emerging electric vehicle space

by
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Acknowledgments
This paper is part of the research project "Geopolitical and technological challenges for the automotive global value chains", PI Annamaria Simonazzi, funded by INET.
The application on Mexico was developed under the complementary project "Digital transformation in the automotive supply chain in Mexico", PI Jorge Carreto Sanginés, funded by UNAM PAPIIT IN309620.
We are indebted to Dr Johannes Kern for his suggestion to refer to the electrive.com newsletter for the daily update on the ongoing changes in the world of the electric industry and mobility, and for his comments on a preliminary version of this paper. The authors wish to thank Benedetta Acerbi and the team of internship students for their collaboration on entity disambiguation.

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Abstract

Subsequent to COP 21, the targets for reducing CO2 emissions have boosted the commitment of governments and companies to developing alternative technologies for the mobility of people and goods. Electric vehicles are at the heart of this transformation, which is profoundly affecting the characteristics of agents and artefacts. The aim of the paper is to identify the relevant domains of this transformation, and to identify what characterizes the space of the agents and artefacts of the electric vehicle and their interactions, as oriented by the public policies promoted by the various countries.

The paper presents the results of a multidimensional textual analysis of the news published in English by electrive.com, a daily newsletter covering a wide range of relevant information on developments in electric transport in Europe and beyond. These results are a preliminary step for the analysis of the social, economic, organizational and technological changes related to sustainable mobility.

Keywords:
sustainable mobility; electric vehicle mobility; agents and artefacts space; text analysis; multidimensional clustering

1. Introduction

After the 2015 United Nations Climate Change Conference in Paris, the targets for reducing CO2 emissions entered the policy debate. Four years later, China's green policy (2018), the approval of the EU Green Deal (European Commission 2019) and the new plans of the US Administration on climate change (2021) combined to boost the commitment of companies and governments to developing technologies alternative to the use of fossil fuels in the mobility of people and goods. Work on several alternative technologies is now in progress - such as hydrogen fuel cell, full electric vehicles, hybrid vehicles - involving an array of specific developments in complementary technologies including production of chemical compounds to improve the performance of batteries, electronic devices and software applications to improve efficiency of energy consumption and engine performance, materials for the body and the components of the vehicles, and design of the models of vehicles. Technological developments involve incumbents and new subjects emerging ad hoc in the many domains of activities involved. In addition, they have different impacts on different types of vehicles - from airplanes and ships to buses, trucks, cars and scooters – and the need to develop efficient solutions integrating collective and private mobility. The intricate web of technologies, business companies with their supply chains, consumers, and contexts of use result in non-linear changes, with many potential trajectories that may lead to the solution to fulfilling the requirements of sustainable mobility.

The great attention paid to the production of electric vehicles is prompting a set of new regulations, production technologies, types of new vehicles, mobility systems, and energy production and delivery infrastructures to achieve these goals.

Several studies address one or more of the dimensions of "sustainable mobility" to define the socio-economic characteristics of the ongoing changes and their impact on the economy and society. The Gerpisa international colloquia host sessions dedicated to many dimensions characterising the complexity of the automotive sector, and in particular the past four editions (GERPISA 2018; 2019; 2020; 2021) have debated contributions and cross-country analyses on sustainable mobility, state regulation, electrification of transport, changes in the supply chain, transition to greener cars, the battery value chain, mobility as a service, and the challenges and contradictions of the greening of the industry. As a specialised journal in the automotive analyses, IJATM has published several papers on specific issues, such as the scarcity of raw materials and the centrality of China (Jetin 2020); autonomous driving and driving on demand (Fournier et al. 2020), connected autonomous vehicles (Nikitas, Njoya, and Dani 2019), the technical requirement of electromobility (Schindlbeck, Müller, and Störmer 2020), and the strategic investments needed to support the expansion of electric vehicle market (Alochet and Midler 2019). The policy dimension is also a relevant topic in the debate: from China (Alochet and Midler 2019) to European policy in the green new deal (Pardi 2021).

On the one hand, the many scientific contributions in this field do not offer a systematic definition of the dimensions to be considered while, on the other hand, the ongoing development in sustainable mobility technologies cannot be studied simply by using official data on companies, production activities or trade flows because the classification standards (such as NACE and ISIC for activities, and CPC, SITC and HS for goods) are not as yet aligned to detect them. Moreover, the pace of acceleration in the field of electric mobility is exponential, as demonstrated by the many companies increasingly engaged in the development and production of new models of vehicles and crucial components, such as batteries and electric engines.

The companies involved in sustainable mobility are incumbent companies (e.g. carmakers and suppliers of components and parts), but also companies in other supply industries (such as chemicals, plastics, electronics). On the product side, interrelations become critical in addressing both the potential implied byers' mobility needs and companies' potential economies of scale and scope.

As observed by Billing and Bryson (2022) in a study on the space industry in the UK, the issue of identification of emerging industries is a core topic in industrial analysis and policy design, and some pointers for analysis emerge on adopting a systemic perspective in technical innovation systems. In their study on optical science in the USA, Feldman and Lendel (2010) observe that the fact that the emerging industries do not fit into the existing classifications is a feature that characterises all emergent technologies, thus making empirical analysis complex and fuzzy, calling for new data sources and methods of analysis.

In our analysis we consider the emerging domain of sustainable mobility characterised by new agents (companies, associations, institutions) and artefacts (products and technologies), new systems of relationships between agents and artefacts (such as new

models of business activities, new patterns of use, new regulations). In this perspective, the analysis demands for the identification and interpretation of other types of information. In addition to case studies based on interviews with experts in the various domains under analysis (as the recent paper by Schröder 2021), study of specialised sources and/or automatic text analysis are increasingly being adopted for exploratory and classification purposes (Krzywdzinski 2021; Pavone and Russo 2017).

To embark upon any empirical analysis, the need is to identify the sources of information and the analytical framework in which the research questions can be answered. The aim of this paper is to contribute with the creation of an appropriate dataset to be used in the identification of the dynamics of the transformations taking place in sustainable mobility. In particular, we focus on what characterizes the *electric vehicle agent and artefact space*, with identification of the relevant domains. The agents are business companies, non-profit organisations, research centres, associations and institutions (governments, regulatory bodies, etc.). The artefacts are technologies and related products; components and parts in the production of vehicles; energy production technologies and related storage and distribution techniques; patents, IPR; standards/regulations). Agent-artefact interactions contribute to/aim at affirming a new mobility model that should be sustainable from the point of view of emissions.

In this strand of research, the contribution by Rossi et al. (2009), who explored the emergence of distributed control system automation in Europe, is relevant to our investigation. They apply the conceptual framework of "agent-artefact space" - proposed by Lane and Maxfield (1997; 2005) - to address innovation processes characterised by the emergence of new agents, new business models, new identities of incumbent agents, new artefacts, new functionalities for existing artefacts, and the generative relations between agents and artefacts that define their specifically targeted space of interactions. In this conceptual framework, the institutions play a specific role – for example, by setting rules for companies operating in the production of new technologies, or standards to be met by the new artefacts, or targets to be reached at the national level, to which companies are incentivized to contribute. Operating at the micro, meso and macro levels, the institutions are scaffolding structures that impact on the formation and development of the agent-artefact space, and they themselves may change over time to address, for example, new societal and technical needs induced by the innovation process (Bonifati 2010; 2013; 2021).

In our analysis of the *electric vehicle space* we start by addressing the question of the topics that characterise this space (such as mobility models; technologies and organisations; economic, social and production dimensions). Without standard classification, topics can be detected through the information available in collections of written texts about the area of interest. These may be very general sources, such as newspapers, or specialised sources, such as scientific journals, patent registers or business reports. In a seminal research on the imaginaries of auto and electric mobility in Germany and the UK, Rogge (2018) refers to 12 newspapers (six per country), over the period 1990-2017 and identifies the main topics and the trends they show over time, highlighting the main differences found in the two countries. In times of rapid change, scientific journal and patent analysis can be of use in characterizing potential trajectories in research and technology, but they

are of little use in identifying the agents currently involved in such transformation. Specialised sources, such as the numerous news agencies in the US and Europe that provide information to the business community on "what is happening in the electric mobility and beyond", can better respond to the problem of identifying the field of investigation. Some of these sources provide free access to information for web download in text format, thus allowing for the use of automatic text analysis techniques.

In this paper, we perform a multidimensional textual analysis of news published in English by electrive.com, a daily newsletter covering a wide range of relevant information on developments in electric transport in Europe, US and China. In Section 2 we describe the data source that embraces most of the dimensions under analysis and the complementary sources that we adopt. Text mining techniques and multidimensional methods of analysis are briefly presented in Section 3. The results obtained so far are discussed in Section 4. The paper concludes by pointing to further steps in research.

2. Data

As an exploratory step, we analysed the data source "electrive.com", provided as a service offered online by a private publishing company (Rabbit Publishing GmbH). It covers a wide range of relevant information on the developments in electric transport across Europe and beyond, and its daily newsletter is created and made available for download by using an API access to Twitter.

Tweets from September 12, 2018 to August 20, 2021 were downloaded from the timeline of the electrive.com Twitter page[1]. Within each tweet, we identified the link to the news URL. From the news page, with a web data extraction procedure (web scraping), we extracted the following information of each item of news: title, full text, associated tags, category, date of publication and links to the information sources[2].

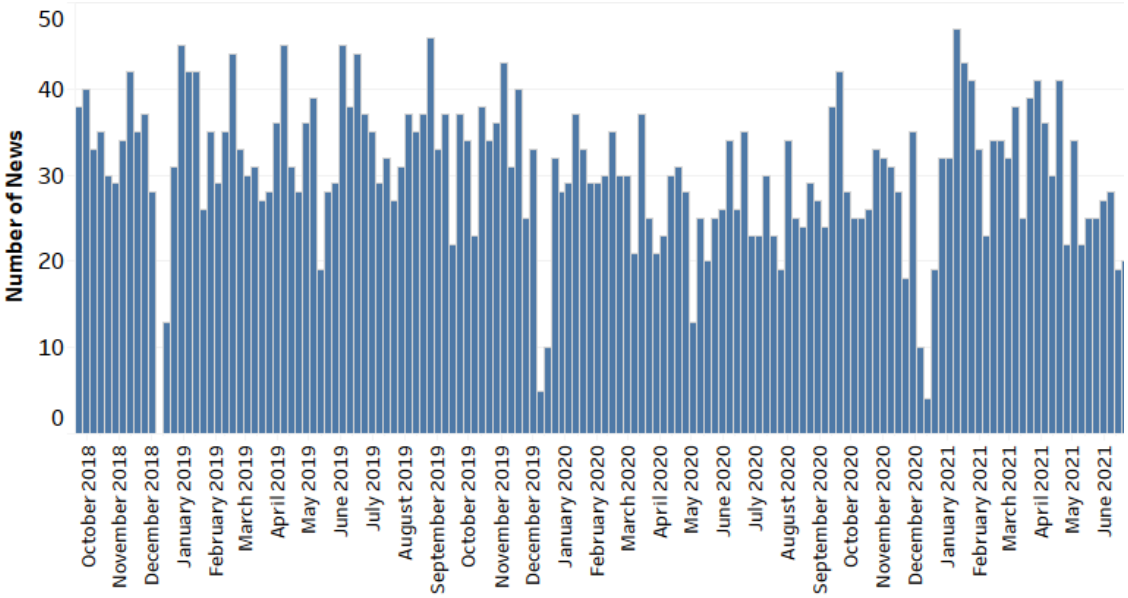
Of the ten categories proposed by electrive.com - Air, Automobile, Battery & Fuel Cell, Energy & Infrastructure, Fleets, Politics, Short Circuit, Two-Wheeler, Utility Vehicles, Water - the major category, "Automobile", encompasses nearly 38% of the news, followed by "Battery and fuel cells" and "Energy & infrastructure", each with nearly 14% of the news.

The daily news, plotted on a weekly base in Figure 1, shows a reduction in overall weekly number of news items, a variability that seems to be accounted for by the reduced number of news items in the "Automobile" category (Annex 1).

Figure 1 – Number of weekly news items, September 12, 2018 - August 20, 2021

[1] The selection of the last three years is conditioned by the number of news items that can be freely downloaded using the Twitter API, which we started on August 2020 and incremented with two further downloads.

[2] The data sources of news are not generally available from other publishers, such as electrek.co, which provides news for the USA.



Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

3. Methods

Automatic analysis of textual data, increasingly used in all fields of research, is a method of analysis which allows us to identify systematically (rather than anecdotally) the emergence of new entities (agents, artefacts and institutions) and of new systems of relationships between entities. It allows us to extract information of interest from a collection of texts, i.e. from a corpus, which in our case is composed of a collection of news items. Each piece of news (which represents the textual unit of analysis) corresponds to a text describing an event related to the world of electric vehicles. A text is therefore composed of a series of sentences which in turn are composed of several words, used to describe the narrative fact. Each word consists of a sequence of characters between two separators and represents the elementary lexical analysis unit. Words have different functions within a sentence. There are words with a language structure function (articles, prepositions, conjunctions, etc.) and words with semantic content. Among the latter, we can identify terms that describe and qualify objects and events (common nouns and adjectives), terms that indicate actions (verbs), terms that indicate places (toponyms), and terms that indicate proper nouns.

The aim of our analysis is to classify and group the different news items exclusively on the basis of their similarity in terms of the objects and events described. On the evidence of the linguistic characteristics of these similarities we will then be able to identify the general theme on which the news items are grouped. Once the news items have been grouped according to their semantic contents, it will also be possible to highlight *a posteriori* the agents, the artefacts, the verbs and places characteristic of each group of news items.

Text mining strategy and news classification

The first step to be able to proceed to analysis of the texts consists in structuring the textual information in a lexical and textual database. This step was carried out using TaLTaC2 software.

The electrive.com corpus is composed of 4,619 news items (title and full text) published in the period 12/09/2018-20/09/2021[3] and consists of a vocabulary of 49,795 different words (i.e. types) for a total size of 1,920,846 word occurrences (i.e. tokens).

By means of grammatical tagging of the vocabulary words, it was possible to distinguish between the different grammatical types of words (structure words versus content words) and also to lemmatise them, i.e. to relate each word to its canonical form, resulting in a reduction of the forms under analysis. Furthermore, thanks to the use of a lexical-textual model, it was possible to recognise the multiword expressions present in the texts[4]. The recognition of these forms yielded lexical analysis units with less semantic ambiguity.

Thanks to the specific characteristics of news writing, it was also possible to distinguish easily between common nouns and proper nouns. In fact, the news was clearly and carefully written; use of uppercase and lowercase tallows to identify proper nouns (of people and companies) and acronyms (defined by all capital letters). It was also possible to recognise all the words identified by the electrive.com magazine as TAGs of individual news items. At the same time, all the types (simple and compound) referring to nations (and national adjectives) mentioned in the text were identified.

In order to classify the news items on the basis of their similarity in terms of content, only common nouns (simple words and multiword expressions) and adjectives were selected for each news item. A vector space model representation was then generated, in which each news item is defined as a vector composed of the selected keywords. Exploratory multidimensional analysis was performed in R on the matrix <news × keywords> (Benzécri, 1973 and 1992; Greenacre, 2016)[5], in order to reduce the dimensionality of the analysis and visualise the main characteristics of the phenomenon studied on a factor map. By means of Correspondence Analysis, the information contained in the matrix is represented on different factorial axes, each of which represents a part of the total variability.

[3] A set of 36 news items were not included in the corpus because they were characteristic of two specific categories - a symposium and "premium" - that have been excluded from the analysis.

[4] The most frequently used multiword expressions in the texts are: electric car, electric vehicle, charging station, joint venture, electric motor, charging point, fuel cell, battery cell, combustion engine, press release, commercial vehicle, kwh battery, electric mobility, electric model, battery pack, battery system, car manufacturer, electric scooter, charge point, market launch, top speed, electric van, production capacity, charging capacity, production line, production facility, supply chain, new model, fuel cell truck, charging network, hybrid drive, electric bus, fuel cell system, fuel cell vehicle, raw material, public transport, battery production.

[5] Only terms with more than 5 occurrences have been included in the matrix *new* × *active forms*, considered in the correspondence analysis.

The dimensionality reduction produced with the Correspondence Analysis allows for a further step in clustering its results. This is an unsupervised and unambiguous classification of news items reflecting the semantic similarity that exist in each cluster of news items. A hierarchical clustering was implemented on the results of the first ten factors by applying the Ward method (Greenacre, 2016 pp.120; Murtagh & Legendre, 2014; Ward, 1963), using Euclidean distance.

Once the news items were grouped into different clusters, we proceeded to identify the characteristic keywords of each group using the test-value[6]. On reading the characteristic terms of each group we were able to define the semantic context of each news group[7]. In addition, the test-value calculation was also applied to the other previously identified word classes. Thus, characteristic verbs, acronyms and TAGs were identified for each news group.

Entity disambiguation

Entity disambiguation contributes to defining the specific categories of agents and artefacts relevant to electric vehicle mobility which have not been defined a priori. Even though there might be broad agreement on the relevant categories to be considered in the various domains, from batteries to types of vehicles, we decided to create the relevant set of categories building on the actual categories found in the corpus[8].

Entity disambiguation was implemented with manual cleaning and automatic matching with specialised repositories[9]. We focused on the tags that the electrive.com editors associated with each item of news. In order to take into account their relative frequency, we detected the occurrences of these 3348 tags in the texts.

In our taxonomy, agents (organisations and individuals) and artefacts are categorised at progressively increasing levels of detail. Organisations are classified as associations, business companies, institutions. Associations are detailed according to the ends they pursue, business companies with respect to structure processes undertaken (mainly defined

[6] Test-value for qualitative categorical variable is a statistical criterion associated with comparison of two portions within the framework of a hypergeometric law. It "is approximately a standardized normal variable under the hypothesis of random distribution of the categories under consideration in the groups. However, since this calculation depends on a normal approximation of the hypergeometric distribution, it is only used when the counts within a grouping a bar-graph re not too small with respect to the total count" (Lebart et al., 1998, p.137).

[7] Cluster labels are assigned on the evidence of the vocabularies of characteristic terms encompassed in each cluster: they are identified by ordering terms in decreasing order of their test-value and by considering only terms with p-value less than 0.001.

[8] Using text descriptions of activities contained in the official Company Registry, a similar strategy was adopted by Pavone and Russo (2017) in classification of the domains of activities of Italian companies specialised in the production of automotive components and parts. On the basis of the results it was possible to arrive at a classification that was not defined a priori on a given level of pre-selected codes of economic activity.

[9] Google Knowledge Graph was able to disambiguate less than 10% of the terms under analysis. Specialised data sources used for disambiguation are the one on cities, regions, countries (https://simplemaps.com/data/world-cities), car makers (https://www.supercars.net/blog/all-brands/), car models (https://www.fueleconomy.gov/feg/ws/index.shtml); automotive acronyms and abbreviations (https://www.smmt.co.uk/automotive-acronyms/; http://www.ukautotalk.com/abbreviations.htm), last accessed on 21st May, 2021. Manual disambiguation was performed for tags defined by electrive.com by browsing each specific page at www.electrive .com/TAG/searched-tag/.

by the product/service they produce), functions (in the activity in which they operate, such as supplier), country of headquarters. Institutions are classified according to the level of government they represent (international, national, subnational) and the domain of their action (such as, economic, transport, regulation, research). Artefacts are categorised with respect to materials and components and functions in the context of use. In addition to agents and artefacts, tags were related to geographical entities and activities. Geographical entities (countries, cities, districts/counties/regions) were associated with country ISO3. A set of 38 tags that refer to activities (aviation, delivery, economic, general, motorsport, production, research, sharing, training, transport) were detailed according to their specific domain. We excluded from further analysis a set of 13 tags that show semantic ambiguity in the various news items.

Visualisation

Finally, a dashboard to visualize the results was created with Tableau. With this procedure it is possible to visualise several elements used to interpret the results: (a) the *f1-f2* factorial map with the distribution of news items classified by the cluster analysis and the centroids of the clusters; (b) a bar graph with characteristic terms of each cluster. Characteristic terms can be selected according to one or more specific types (keywords, verbs, geographical entities, TAGS_agents/artefacts/institutions). Terms can be ranked by test-value to assess their relative importance over topics (one or more may be selected), either listed in alphabetic order or searched for using a wildcard. A tooltip for each term complements information on their categorisation and their test value.

Querying terms in the contexts

In order to be able to define a coherent narrative of the results obtained, in some cases it is necessary to explore the texts through a targeted search for information. This exploration takes place through the entity search function in TaLTaC2, by means of which it is possible to search for words or phrases directly in the text using complex queries (regular expressions) that lead to identification and display of all the fragments that present one or more words or sequences of words. Queries can be made by searching directly for a type, or by searching type through the meta-information defined during the lexical analysis phase. It is also possible to search for classes of types on the basis of semantic or grammatical annotations in the vocabulary DB. These queries can also be targeted only to a specific part of the corpus, filtering them solely to a mode of a predefined categorical variable.

Alongside this possibility of information retrieval, the function offers the opportunity to create a new variable, serving to categorise those fragments that satisfy the query. By doing so, the fragment matrix is enriched with additional information derived directly from the text, with the possibility to produce much more interesting and precise results in the multidimensional analysis carried out with statistical software (for example, the possibility of a questionnaire on customer satisfaction to which a 'not satisfied' variable can be added for all those records that present a high level of satisfaction).

In the analysis phase of the results, it is possible to search for certain characteristic terms of certain clusters (at this point the belonging of a news item to a cluster is a new categorical variable of the corpus), in order to display the news texts in which these terms are used.

4. Results

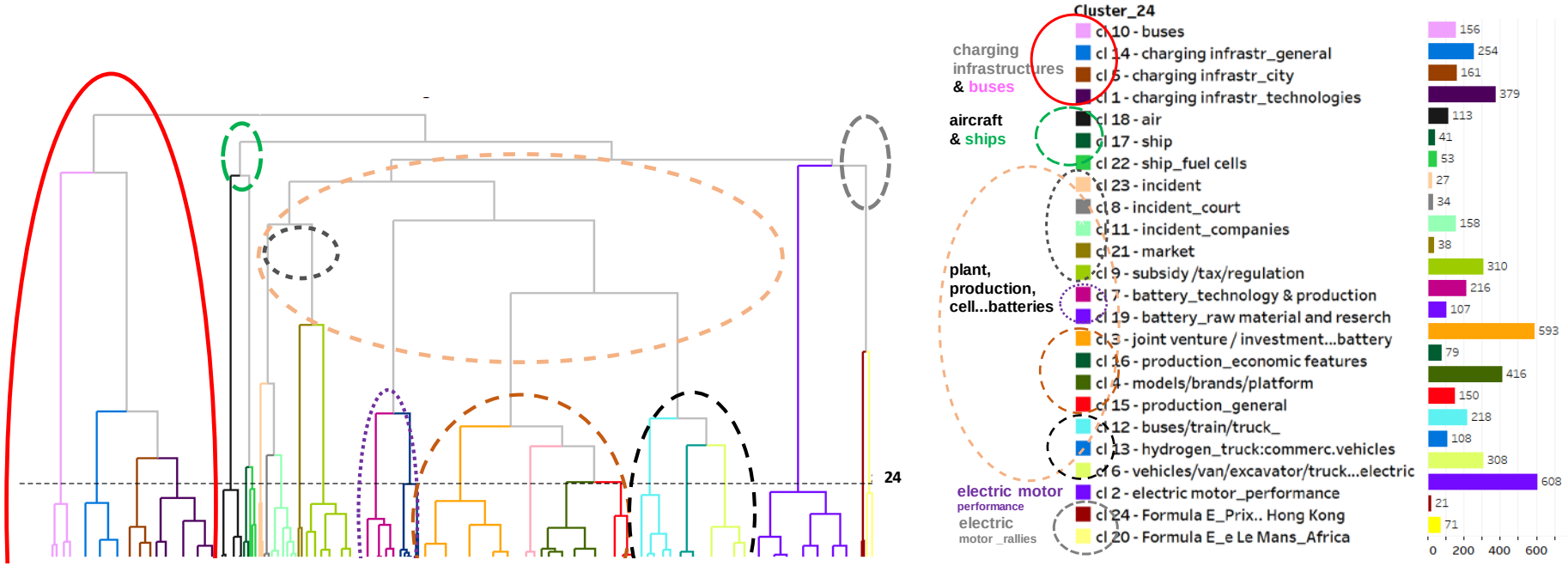
In this section, we first describe the results obtained in topic detection (section 4.1), and then go on to present the taxonomies of entities in relation to the detected topics in the electric mobility agent-artefact space (section 4.2); finally, we focus on paths of analysis emerging from the results by cluster (section 4.3).

4.1 Topics in the electric mobility agent-artefact space

From the correspondence analysis of the matrix *news × keywords (4619 x 7327)*, we selected the first ten factors to perform cluster analysis; we then selected the optimal number of 24 clusters[10]. For identification of the topics, we refer to the characteristic terms of each cluster, i.e., terms that present a significant number of occurrences in the cluster relative to all the other terms under analysis. From examination of the most relevant characteristic terms we defined a label summarising the topic of each cluster[11]. Figure 1 shows the dendrogram, the list of the 24 topics and their proportions in terms of number of news items. The coloured circles highlight groups of news items according to three different cuts of the hierarchical classification, at 5, 8 and 24 clusters).

[10] We used the R Package "NbClust" to determine the relevant number of clusters (Charrad et al. 2014). The different optimal results (at 5, 6, 9, 10, 13, 14, 24 and 25) were interpreted to bring out significant aggregations in the hierarchical branching. The decision to select 24 clusters instead of 25 was prompted by the further split of a smaller specific cluster with only 15 news items. Details are available on request.
[11] Details are available in Annex 2.

Figure 2 – Dendrogram, clusters' labels and number of news items by cluster



Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

The branches of the dendrogram show a particular structure of the topics that we detect in the corpus. First of all, the main branches highlight a major split into two parts. On the left side, we observe two main branches that encompass, respectively, buses (cl-10) and charging infrastructures (in general, cl-4; in cities, cl-5; technologies of the infrastructures, cl-1). The other main branch of this classification splits into two main groups: one specifically focused on aircraft and ships (air, cl-18; ship, cl-17; ships using fuel cells, cl-22), the other referring to a broad variety of topics on automotive vehicles and batteries. In particular, there is a main group (at the centre of the dendrogram) on plant, production, and cell batteries, and two other branches, respectively on electric motor performance (cl-2) and electric motor races and rallies (the various types of Formula E identified in cl-24 and cl-20).

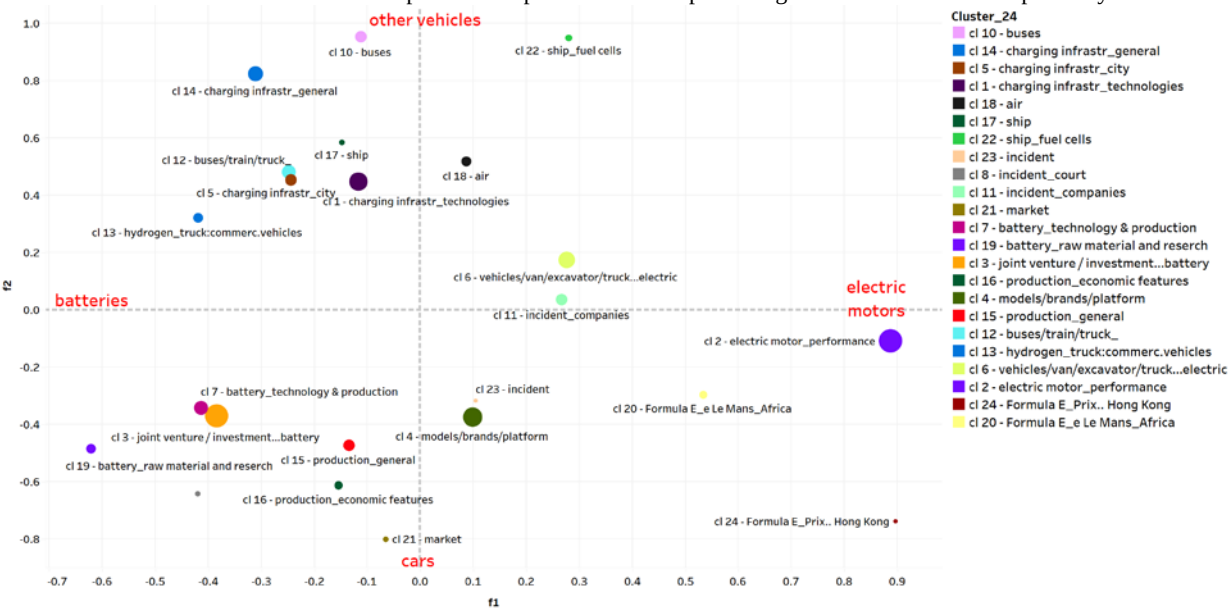
The core of production has a specific subgroup of news items embracing topics on accidents occurring with vehicle use (cl-23), on legal disputes debated in court (cl-8), some involving specific companies (cl-11). Another subgroup of news deals with market issues (cl-21) and state intervention (cl-9). Building blocks of production are:

- batteries: battery_technology & production (cl-7) and battery_raw material and research (cl-19);
- joint venture / investment…battery (cl-3), production_economic features (cl-16), models/brands/platform (cl-4), and production_general (cl-5)
- other vehicles and technologies: buses/train/truck (cl-12); hydrogen_truck and commercial vehicles (cl-13); vehicles/van/excavator/truck…electric (cl-6)

Interpretation of the contents of the various clusters of news items helps in interpreting the factors resulting from the correspondence analysis on which they were computed. The visualization of results, Figure 2, plots the 24 topics in the factorial map f1f2 (*news* × *keywords*). Each node represents a cluster, with colour according to the cluster list, size proportional to the number of news items in the cluster, and position in the f1f2 plan based on the average f1f2 coordinates of the news items in each cluster. Factor 1 and factor 2 clearly represent the two main dimensions in the narrative on the new mobility: production, the first factor, vs. types of vehicles, the second factor. Following along each of these factors we can read a polarisation, respectively, between batteries and electric motor, along f1; and car and other vehicles, along f2.

Figure 3 – The topics of electrive.com in the factorial map f1f2 *news x active forms*

Legend: each node represents a cluster with colour according to the cluster list, size proportional to the number of news items in the cluster and position in the f1f2 plan based on the average f1f2 coordinates of the news items in the cluster The labels on the axes refer to the interpretation of polarization of topics along factor 1 and factor 2 respectively



Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

Table 1 presents the cross-tab of the news items according to the 24 topics described above and the ten categories assigned by electrive.com. As expected, the expert categorisation is consistent with the non-supervised one proposed with our analysis: in most cases there is a broad overlap, but our classification forms more homogeneous groups in big categories defined by electrive.com, such as "Automobile" and "Battery & Fuel cells", "Energy & Infrastructures".

Table 1 News items by cluster and categories

		Category_electrive.com									
Cluster_24_Descr	Grand Total	Automobile	Fleets	Utility Vehicles	Two-Whee..	Air	Water	Battery & Fuel Cell	Energy & Infrastructure	Politics	Short Circuit
Grand Total	4,619	1,683	444	373	148	104	81	609	622	287	268
cl 1 - charging infrastr_technologies	379	24	48	4	14			8	277	1	3
cl 2 - electric motor_performance	608	489	5	46	54			1	1		12
cl 3 - joint venture / investment...battery	593	304	5	46	16		2	201	10	3	6
cl 4 - models/brands/platform	416	367	7	19	3			16	1	1	2
cl 5 - charging infrastr_city	161	5	74	3	21				23	25	10
cl 6 - vehicles/van/excavator/truck...electric	308	86	40	121	23		1	15	12		10
cl 7 - battery_technology & production	216	22		4	3	2		170	5	9	1
cl 8 - incident_court	34	9		1				6			18
cl 9 - subsidy /gov.t/ tax/regulation	310	41	18	3	6			1	10	211	20
cl 10 - buses	156		128	11					13		4
cl 11 - incident_companies	158	20	5	6	4			3	5	3	112
cl 12 - buses/train/truck_	218	3	98	66				23	11	16	1
cl 13 - hydrogen_truck:commerc.vehicles	108	4	5	36		3		42	8	8	2
cl 14 - charging infrastr_general	254		4						240	6	4
cl 15 - production_general	150	125	2	1	1			3	2	1	15
cl 16 - production_economic features	79	65		3	1			10			
cl 17 - ship	41	1					32	5	2	1	
cl 18 - air	113		1	2		99					11
cl 19 - battery_raw material and research	107	3						103		1	
cl 20 - Formula E_e Le Mans_Africa	71	52	2	1	1				1		14
cl 21 - market	38	38									
cl 22 - ship_fuel cells	53						46				7
cl 23 - incident	27	6	2					2	1	1	15
cl 24 - Formula E_Prix.. Hong Kong	21	19			1						1

Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

4.2 Entities: identification and disambiguation

Overview

Although not yet completed, the entity disambiguation allows also a clearer view on the data source. Figure A2 in Annex 1 shows the sources so far disambiguated and their categorization according to the taxonomy of agents, with a specific list of news and commentaries. Results of this analysis highlight the variety of sources and the broad worldwide coverage.

Table 2 summarises the types of terms identified in the grammatical tagging of the corpus and the selected terms that prove characteristic in one or more clusters. So far, the keywords have not been disambiguated, while all the toponyms (detected both as nouns and as adjectives) have been disambiguated[12]. The tags assigned by electrive.com include many nouns, proper nouns and acronyms. All the tags that are characteristic terms in at least one cluster have been disambiguated,

Table 2 – Summary description of term types and disambiguation

Term Types	types	characteristic terms**	disambiguated
Keywords*	7327	4894	0
Toponyms_adjectives	69	50	50
Toponyms_nouns	131	91	90
TAG_electrive.com	5347	3564	1203
Verbs	1104	358	0

* nouns + adjective + multiword expressions
** Test value greater than 2
Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

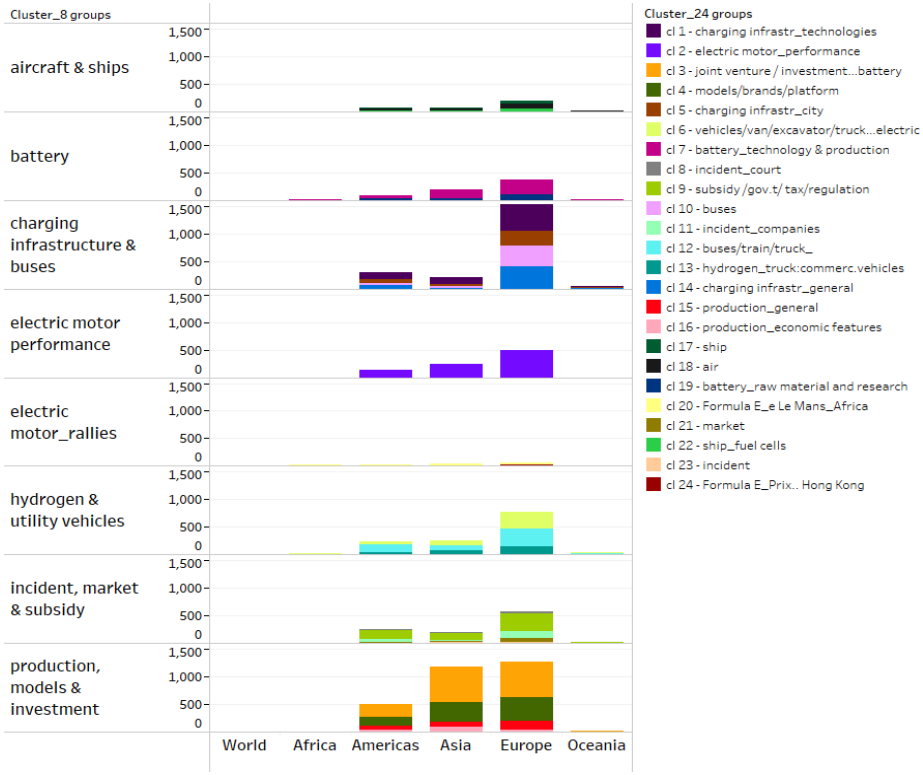
The geography of the sustainable mobility agent-artefact space

From the disambiguation of the geographical entities mentioned in the data source, we can identify the geography of the sustainable mobility agent-artefact space. 121 countries and 383 cities have been identified.

Data by continent and cluster, Figure 3, highlights that the narrative of events in this space embraces Europe, but it has a large importance in the US and in China. In Europe, news is strongly focused on Germany, but also on the United Kingdom, France, Netherlands, Norway, Sweden, Spain, Check Republic, Poland, Switzerland, Italy. The most mentioned cities are London, Berlin, Shanghai, Paris, Munich, New York, Hamburg, Amsterdam.[13]

[12] For the spatial analysis, an ad hoc variable has been created that integrates toponyms_nouns and toponyms_adjectives that have been associated to the corresponding nouns.
[13] 171 cities are mentioned only in one news item. Data by country and city are available online

Figure 4 – Number of news by country and cluster



Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

Agents, artefacts

Alongside the topic detection, the identification of entities has produced a significant improvement in our understanding of each cluster.

The classification of agents and the artefact mentioned in the news has identified 1849 agents and 1084 artefacts.

The largest group of agents is made of organisations (1680), with only 9% of agents that are individuals. Agents have been grouped in the following macro categories (in italics, below) and categories:

- *individuals (169*), half of them specified with respect to their role in the organisation (such as CEO, CTO, …);
- *associations (49)* are mainly groups *of companies* in various sectors (automotive, batteries, charging infrastructure providers, chemical & oil recovery, individual mobility, interoperability, vehicle and component manufacturers, information providers about roads and vehicles, motor sport) and *professional associations*;
- among the organisations, the large majority are *business companies* (1507). Combining the classification of product for which a company is mentioned in the news with the corresponding NACE REV.2 code we have assigned each company a code NACE code at 2 and 3 digits. For each company we have manually identified the country in which its headquarter is located.
- *20* organisations are national research institutes.

– *95 organisations are institutions at different levels of government (EU, national, subnational), international bodies (such as, IOC, IMO, OECD), higher education institutions.*

More than half of artefacts (621) are *models of various types of vehicles*. The remaining artefacts have been grouped under the following categories, still under review to finalise their classification: *types of vehicle*, *technologies*, policy programs, company programs, projects, *plants*, components and parts, materials, standards.

Verbs

The majority of verbs that prove characteristic terms (262 out of 358) appear in only one cluster. Table 3 lists the top 20 verbs according to the number of clusters in which they turn out to be characteristic.

While the classification of verbs is in progress, we may observe here that, although the lemmas of verbs do not have the same potential as verbal phrases, nonetheless they outline the area of the actions related to the various contexts, while the specific meaning can be very different when the temporal analysis is considered, as for example in the case of "to invest" vs. "it invests/will invest/would invest" or "does/did not invest".

With regard to "say", its presence as characteristic in 8 clusters underlines a specific feature of our data source: a collection of news items in which statements are a primary source of information. The verb "would" makes clear a conditional status of the action, which must be interpreted in context.

Although the analysis of verbs is still in progress, they add meaning in interpreting the various topics, as we discuss below in section 4.3.

Table 3 Frequency of characteristic verbs, by number of clusters

n. of clusters in which they are characteristic	n. of lemmas	Top 15 lemmas (by test-value)
1	262	compete, invest, receive, differ, propose, rely, recover, adopt, subsidise, sue, amount, fight, acquire, get, specify, agree, give, commercialize, hint, collide, …
2	53	overtake, should, recycle, have, award, correspond, follow, become, decline, seem, vote, opt, believe, manage, qualify, apply, appear, reveal, slump, participate, …
3	21	install, be, account, grant, enable, base, electrify, intend, replace, connect, continue, score, encourage, take, arrive, cause, add, promote, establish, reach, …
4	12	expand, build, grow, win, provide, allow, deploy, may, do, improve, achieve, integrate
5	4	would, deliver, reduce, found
6	3	operate, include, equip
7	1	can
8	2	develop, say

Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

Focus on Electrive.com' sources

Although not yet completed, the entity disambiguation also allows for a clearer view of the data source, in so far as the identification of the different sources of information used by electrive.com becomes effective. Annex 1 shows the sources so far disambiguated and their categorization according to the taxonomy of agents, with a specific list of news and commentaries. The results of this analysis highlight the variety of sources and the broad worldwide coverage.

4.3 Paths of analysis emerging from the results by cluster

Building on the interpretation of topics and the entity disambiguation presented above, we can now describe the clusters by combining all these pieces of information. A detailed list of terms by clusters is available in Annex 2 and can be browsed with the online tool which we have implemented in Tableau Public. Comparison of the terms across topics – according to the results of the hierarchical classification (Figure 2) - brings out the significance of the specific domain under analysis. In interpreting these results, let us recall that the clusters were identified only by using keywords (the first column in the tables in Annex 2), while all the other terms enter into the analysis as characteristic terms of the various types: verbs, tags_electrive categorised according to the agents-artefact-institution taxonomy, toponyms, at different levels of spatial granularity (world, continent, country, region/city). The tables in Annex 2 do not list all the terms in each class, but only the most relevant ranked in decreasing order of their test-value. An overall selection of the top 2k terms in the entire group of characteristic terms was made for display. All the terms can be viewed using the online tool.

In what follows we will not summarise the terms, nor comment on each cluster: the aim pursued with the results presented in the paper is to outline the analytical framework for sound in-depth investigation into the transformation in the agent-artefact space. In the remaining part of this section we focus on specific issues emerging by observing the characteristic terms in a cross-topic perspective with a macro group lens.

Macro groups are significant in a cross comparison of topics

Using the main groups discussed in sections 4.1, we can read the top keywords of the various clusters in each group. For example, for the main group "buses, electric buses, charger, charging city" it makes clear why the non-supervised classification combines buses with the three groups of news items on charging infrastructures (in general, in cities, and the specific technologies). The verbs tend to be recurrent – operate, include, install – but their specific use must be further explored. The most relevant companies are largely the same for charging, and specific for buses. Different places are characteristic of the three charging infrastructures: countries in Europe vs. North America, and also specific set of cities.

Verbs frame the context of actions

For example, among the characteristic verbs in clusters, Aircraft and ships (air, cl-18; ship, cl-17; ships using fuel cells, cl-22), "believe" appears in the news on air [cl-18] and is used to present the perspective of the agents with respect to potential developments. The same holds true in cl-13 on the development of applications of hydrogen on commercial vehicles and buses. Interpretation of verbs is the first preliminary result obtained: its full analysis is part of further development of the research project.

Latent thematic emerging from further analysis

In cluster 8, the top keywords refer to incidents debated in courts[14]. Among the keywords there is "trade secret", highlighting a topic of dispute, and "employee", which proves ambiguous in the domain of incidents debated in courts. Through search in the corpus it emerges that some news items underline accusation of employees disclosing industrial secrets as a company's weapon against a competitor, as in the case of LG Chem, or violation of employees' rights, as in the case of the German Tesla subsidiary (Grohmann Automation) investigated by the state government authority in the Rheinland area on possible violation of the Working Hours Act. Despite the very different contexts, the texts of those news items can be interpreted around a common issue - competition between companies – that does not emerge as a distinct topic in our analysis, but is one of the exploration paths that can be traced through the news items, and indeed relevant in defining who is competing with whom and in which context/domain.

False positive instances

Analysis of cluster 11 shows which specific companies are "involved in incidents", and here we find a false positive with respect to 'incidents, company-name, police'. In fact, in the same cluster, ‘police force’ controls the proper use of cars, for example those with autonomous drive, but ‘police force’ is also a contractor of Tesla cars Cybertruck "which is said to be very popular for the police force in Ciudad Valles, Mexico, the Kansas Highway Patrol in the US, and the Dubai police force in the UAE". False positives can be detected by reading the texts, and Taltac2 allows for fast and effective reading to disambiguate categorization of fragments/documents.

Same characteristic terms: where is the difference?

The top 15 characteristic terms of the two clusters on battery production Batteries (battery_technology & production (cl-7) and battery_raw material and research (cl-19)) are the same but they are not ranked in the same order, i.e. the terms have different relative importance in the two clusters: this makes the distinction between the groups of news items significant (in this case, with respect to a relatively greater focus on production vs research).

As in the case of the production clusters, supplementary terms reveal nuances in the importance of the various dimensions to be considered: different actions, different actors and geographical areas characterize them.

The geography of companies by cluster

As expected in the light of the results on the geography of electrive.com discussed above, the companies identified in the news items are mainly located in Europe (868) and the Americas (323) and Asia (263). Only 23 in Oceania e 7 in Africa. With a focus on

[14] court, complaint, case, ruling, investigation, clearing, damage, man, ad, lawsuit, leak, problems, legal, dispute, advertising, story, document, filed, ruled, trade.secret, risk, claimed, misleading, update, injunction, ongoing, appeal, advertised, banned, question, employee, permission, logo, favour, action.

Europe, the Americas and Asia, Table 4 shows the list of companies by country and cluster, with countries ranked by continent and number of companies mentioned in the data source, while 371 companies are mentioned in news items classified in different clusters.

Twenty countries encompass the largest number of companies (1366) identified in the news items: United States (273), Germany (242), Great Britain (180), China (114), France (70), The Netherlands (66), Japan (50), Sweden (48), Switzerland (44), Norway (43), Italy (41), Canada (37), Spain (31), South Korea (29), India (22), Austria (21), Denmark (19), Israel (14), Belgium (12), Check Republic (10). Twenty more countries have from 2 to 9 companies, while fifteen countries have only one company mentioned in the data source.

Table 4 – Companies by cluster and by country of the headquarter

1471 companies with a single headquarters, 321 of which are in more than one cluster. Countries ranked by continent and number of companies mentioned in the data source

Continent	country details ISO3	Grand Total	charging infrastructure & buses				aircraft & ships			incident, market & subsidy					battery		production, models & investment				hydrogen & utility vehicles			electric motor..	electric motor_rallies	
			cl 10 - buses	cl 14 - charging infrastr_ge..	cl 5 - charging infrastr_city	cl 1 - charging infrastr_tec..	cl 18 - air	cl 17 - ship	cl 22 - ship_fuel cells	cl 23 - incident court	cl 8 - incident_company	cl 11 - incident_company	cl 21 - market	cl 9 - subsidy/gov.t/tax/re..	cl 7 - battery_technology & ..	cl 19 - battery_raw material..	cl 3 - joint ventures/ in..	cl 16 - production_economics..	cl 4 - models/brands/platform	cl 15 - production_general	cl 12 - buses/train/truck_	cl 13 - hydrogen_truck k:com..	cl 6 - vehicles/excavato..	cl 2 - electric motor_perfor..	cl 24 - Formula E_Prix.. Hon..	cl 20 - Formula E_le Mans..
Grand Total		1,471	100	146	98	182	100	48	50	13	17	35	4	28	112	58	204	13	106	25	145	108	176	99	21	34
Americas	USA	273	7	14	29	29	33	4	2	2	7	11	1	8	18	13	41	1	18	10	29	21	37	21	1	
	CAN	37	3	3	1	4	1	3	3						2	3	1			1	12	6	1	2		
	BRA	7					3								1		1				1		1			
	MEX	3															2				1					
	CHL	1														1										
	ECU	1	1																							
	PAN	1		1																						
Asia	CHN	114	4	5	2	12	4	1		1	1	1	2		4	3	50	7	26	3	4	6	6	9	1	1
	JPN	50		1		2	2	4	2		1	1		2	2	3	9	1	9		6	5	6	9	1	1
	KOR	29		1		5			1	1	4			1	8	5	9		1	1		4	1	2		1
	IND	22		1	1	4			1					1	1		5		2		4	1	1		2	
	ISR	14		2	1	3	2								2		1					1	3			
	TWN	9			1	3		1							2		1		1				1	1		
	SGP	6		1		1	1							1	1						1		1			
	TUR	5	2														2				2		1			
	IDN	3			1												2									
	THA	3				1			1										2							
	MYS	2															1				1					
	VNM	2													1		1				1					
	ARE	1					1																			
	GEO	1															1									
	QAT	1	1																		1					
	SAU	1																				1				
Europe	DEU	242	17	22	13	34	17	10	7	4	2	3	1	5	28	7	42	4	12	9	25	20	32	15	11	13
	GBR	180	10	48	23	24	8	2	1	1		4		5	7	7	8		8	1	12	3	33	9	3	5
	FRA	70	8	7	4	8	10	2	3	1	1	2			1	1	4		4		4	11	6	10	1	2
	NLD	66	7	12	9	9	2	3	4			4		2	4	1	3		2		11	7	9	2		
	SWE	48	6	3	3	5	3	3	3		1	4			9	2	6		3		5	6	7	1		
	CHE	44	4	5	2	5	1	1	2			1			5	2			2		5	8	10	3		2
	NOR	43	2	3		1	4	11	13	1					7	1	1		1		2		2			
	ITA	41	2	7			2		2			1		1	1	1	4		8		2	3	5	6		4
	ESP	31	5	5	3	6	1		2			1			1		2		3		3		3	3		2
	AUT	21	1	1	1	6	1		1			1		1	3	1	2		1			1	3			
	DNK	19	4	1	3	6		2	1	2											1		1	1		
	BEL	12	2			1		1						1	2	2					2	3	1			
	CZE	10		1		3	1												1		2		1	1		1
	FIN	8	1	1		1	1									3	2						1			
	POL	8	5	2																	2					
	RUS	8	2			1									1	2	1				1		1	1		
	IRL	6	1	1		2													1		1		1			1
	PRT	5		1	1	2																1				
	EST	4	1			1															1			1		
	SVN	3	1				1		1												1					
	BGR	2																			1		1			
	HUN	2	1			1																				
	LUX	2	1			1																				
	SVK	2				1									1		1									
	BLR	1	1																							
	HRV	1															1									
	ISL	1					1																			
	LIE	1													1											
	LTU	1																						1		
	MCO	1										1													1	1
	ROU	1																	1					1		
	SRB	1																			1					

Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

Companies by Nace code and cluster

Table 5 shows the 2-digit Nace codes that are associated with the activities of the companies identified in the data source. Two thirds of companies are classified in manufacturing activities: Manufacture of motor vehicles, trailers and semi-trailers (384), Electricity, gas, steam and air conditioning supply (213), Manufacture of electrical equipment (162), Manufacture of other transport equipment (126), Transport, in general of section H (92), Land transport and transport via pipelines (58), Architectural and engineering activities; technical testing and analysis (58). An ad hoc 2-digit code was created (34) to encompass all the unconventional types of vehicles and electric vehicles (excluding cars)

that are produced - or so far only conceptualised - by 30 companies: unconventional vehicles (such as drones used for delivery services, vertical take-off aircraft (VTOL), two-seater “folds” at the push of a bottom, a hydrogen-powered Formula 1 flying car; autonomous driving vehicles, electric bikes and electric cargo bikes, electric motorbikes.

Besides the obvious association with clusters of production (vehicles, batteries and components) of NACE codes related to manufacturing activities, detailed analysis of the data by cluster also highlights the array of other specialised activities that are part of the sustainable mobility agents-artefacts space.

Table 5 - Companies by cluster and by NACE code (2 digit)

	Grand Total	charging infrastructure & buses				aircraft & ships			incident, market & subsidy					battery		production, models & investment				hydrogen & utility vehicles			electric m..	electric motor_rall..		Null
		cl 10 - buses	cl 14 - charging i..	cl 5 - charging in..	cl 1 - charging in..	cl 18 - air	cl 17 - ship	cl 22 - ship_fuel ..	cl 23 - incident	cl 8 - incident_c..	cl 11 - incident_c..	cl 21 - market	cl 9 - subsidy/go..	cl 7 - battery_t..	cl 19 - battery_r..	cl 3 - joint v entu..	cl 16 - produ ctio..	cl 4 - models/br..	cl 15 - produ ctio..	cl 12 - buses/trai..	cl 13 - hydro gen..	cl 6 - vehicle s/va..	cl 2 - electri c mo..	cl 24 - Form ula E..	cl 20 - Form ula ..	Null
Grand Total	###	105	151	100	186	106	48	50	13	17	35	4	29	112	61	208	13	106	25	151	112	184	99	22	38	1
29 Manufacture of motor vehicles, trailers a..	384	38	1	8	9	8	3	3	6	13	14	4	10	15	3	88	8	88	18	61	31	75	67	11	16	1
35 Electricity, gas, steam and air conditioni..	213	5	88	22	96	1	2	1	1	1	6			6	4	9		2		5	10	8	2			
27 Manufacture of electrical equipment	162	2	1	1	9	6	13	4	1				1	38	15	52	3	3		20	24	13			2	
30 Manufacture of other transport equipme..	126	1		5	11	44	11	26			2			3		6	1	1		5	1	10	16			
H Null	92	48	2	7		3	1	1	2		1		4	1		2				28	1	2				
49 Land transport and transport via pipelines	58	2	6	20	19	2			1		1			3	2	3		1	2	4	4	8		1	2	
71 Architectural and engineering activities; ..	58	1	4	3	3	2	3	2	1				2	9	3	11	1	1	2	4	6	9	1	1	1	
28 Manufacture of machinery and equipmen..	35				1		1	3			2			6	7	5		1		1	2	10				
20 Manufacture of chemicals and chemical p..	34						4			1				8	7	3		1		2	12	1				
34 added category: unconventional and oth..	30			4		4		1			1		1			2		1		1		8	10		2	
64 Financial service activities, except insura..	22		4	4	2	3							1		1	5		1	1	1						
47 Retail trade, except of motor vehicles an..	21		10	2	3						1					2		2		2	1	3				
77 Rental and leasing activities	19		3	4	5	1					2					1		1		2	1	2	1			
52 Warehousing and support activities for t..	17	4	1			7	3	2												1						
93 Sports activities and amusement and rec..	17		3		1										1									8	10	
26 Manufacture of computer, electronic and..	15			1	3	1	1							2	2	6						1				
38 Waste collection, treatment and disposa..	15			1										3	8					3	1					
51 Air transport	15	1		1	1	14														1		1		1		
78 Employment activities	15			1	2	2	1						2			1				4	1	8				
C Null	15	1	1	1		2	1			2	1		1	5	2	3				1	2	1			1	
10 Manufacture of food products	12	1	3	1							1									1	1	4				
19 Manufacture of coke and refined petrole..	12		8		5									1							4					
53 Postal and courier activities	12			4	2								1			1			1			5			2	
50 Water transport	10						2	4												1	3					
J Null	8				3									1	2	1		1		2		2				
58 Publishing activities	7		2		3	1										1						1				
45 Wholesale and retail trade and repair of ..	6				1													1		1		3				
72 Scientific research and development	6													2	1	2						1				
24 Manufacture of basic metals	5												1	2	2	1					1					
65 Insurance, reinsurance and pension fund..	5		2	1	2																1					
86 Human health activities	5										2					1		1	1			1				
42 Civil engineering	4		2																			2				
61 Telecommunications	4		3	1																						
79 Travel agency, tour operator and other r..	4							3														1				
23 Manufacture of other non-metallic miner..	3				1									1								1				
25 Manufacture of fabricated metal product..	3	1				1										1					1					
22 Manufacture of rubber and plastic produ..	2																				1				1	
32 Other manufacturing	2								1														1			
36 Water collection, treatment and supply	2			2																						
55 Accommodation	2		2																							
63 Information service activities	2				2																					
66 Activities auxiliary to financial services a..	2				1	1								1												
68 Real estate activities	2		1											1												
74 Other professional, scientific and technic..	2						1															1				
94 Activities of membership organisations	2			1										1												
17 Manufacture of paper and paper products	1													1												
21 Manufacture of basic pharmaceutical pr..	1			1																						
41 Construction of buildings	1																						1			
46 Wholesale trade, except of motor vehicle..	1				1																					
56 Food and beverage service activities	1		1																							
60 Programming and broadcasting activities	1																								1	
82 Office administrative, office support and..	1			1																						
88 Social work activities without accommod..	1												1													
91 Libraries, archives, museums and other c..	1					1																				

Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

In Figure 5, we focus on the NACE (2-digit) codes that are characteristic of the various clusters[15], represented in the factorial plan that summarises the relative positions of topics. As in Figure 3, coloured dots represent the clusters, with size proportional to the number of news items in the cluster, while the other dots represent - for the 24 clusters - the characteristic Nace codes[16]. The position of the dots in the factorial map helps in visualising the statical significance of companies that overlap the 24 domains of sustainable mobility, detected with the cluster analysis. The largest group of companies is in division 29-manufacturing of motor vehicles, trailers and semitrailers. Its position is in the lower part of the map (interpreted with respect to the polarisation of news items related to "cars"), and significantly close to the centroid of cluster 4-models/brand/platforms: as observed above: the majority of artefacts mentioned in the news items refer to models of

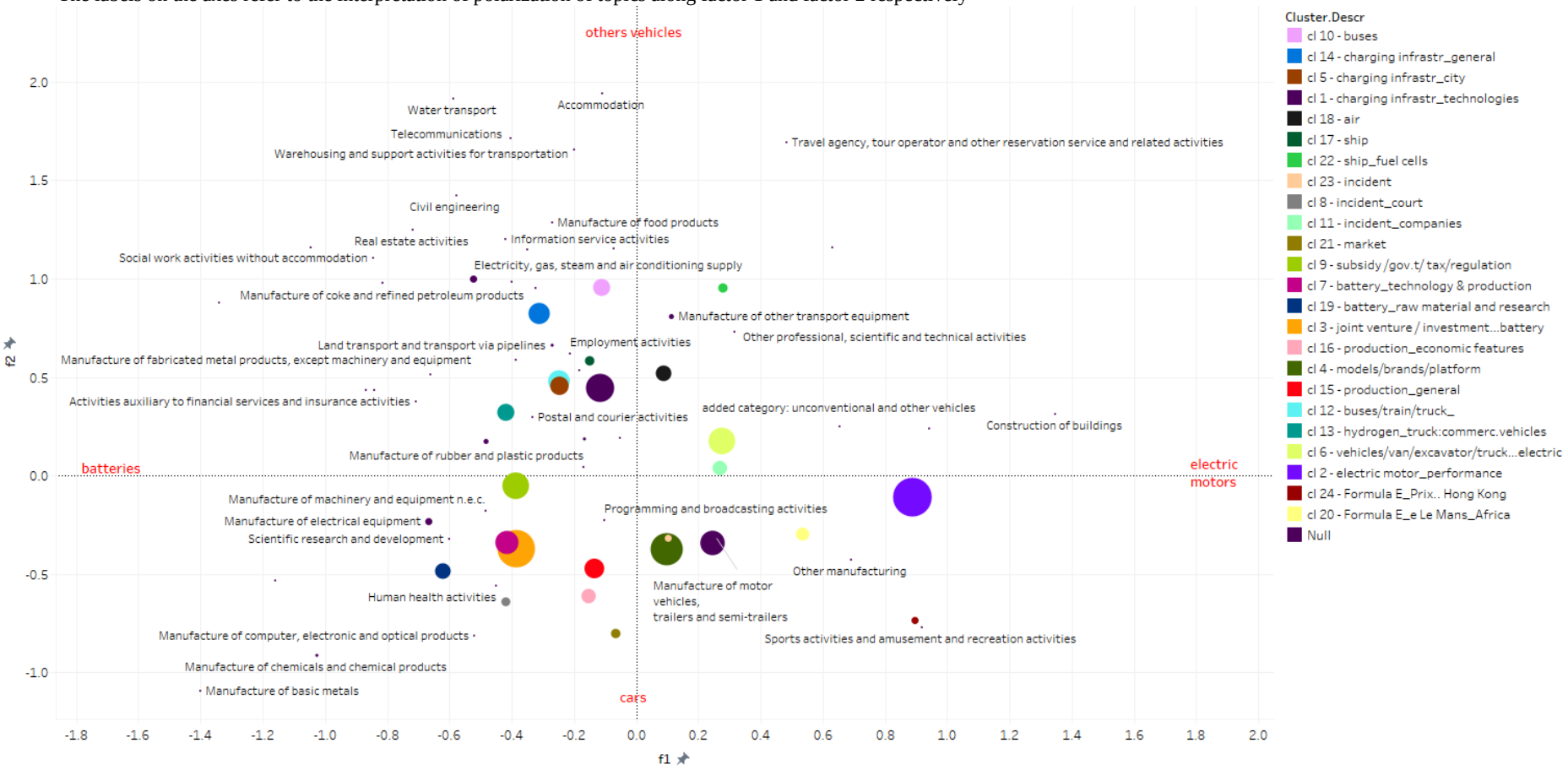
[15] Test value greater than 2.

[16] 2-digit Nace codes were formulated as supplementary categorical variable for each news item. Their position in the factorial map derives from their coordinates in the f1f2 plan.

vehicles and the majority of companies producing cars are generally mentioned when these artefacts are mentioned. More central in the factorial map are companies in section J-Information and Communication, and in the divisions 28-Manufacture of machinery and equipment n.e.c., 22-Manufacture of rubber and plastic products, and 71-Architectural and engineering activities; technical testing and analysis. Other divisions concern activities that are more cluster-specific.

Figure 5 - The topics of electrive.com and the NACE codes (2-digit) in the factorial map f1f2

Legend: coloured nodes represent clusters, with colour according to the cluster list, size proportional to the number of news items in the cluster and position in the f1f2 plan based on the average f1f2 coordinates of the news items in the cluster. Other dots (with labels) represent - for the 24 clusters - the characteristic Nace codes
The labels on the axes refer to the interpretation of polarization of topics along factor 1 and factor 2 respectively



Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021] CORRECT ‘other vehicles’

5. Conclusions and next steps

We conclude the presentation of these preliminary results by summing up and pointing to further steps in the research project.

From text mining strategies applied to data source electrive.com we draw topic detection and entity recognition: an important preliminary step that allows us to define the domains to be analysed, to identify all the business companies by activities, the artefacts, the institutions involved in the ongoing transformation, and all the places that are mentioned by electrive.com.

Although highly detailed, the results on topics do not highlight social issues related to the huge transformations associated with a new paradigm in mobility; in the specific information source we analyse, we cannot find other such topics because they are not at the core of electrive.com perspective: geopolitics is not a core issue, there are no vehicle retrofitting issues (even though the classification of companies highlights those specialised as "electric car converters"), there is little talk of rare earths, product life cycle and energy issues related to the development of sustainable mobility that should be considered in any analysis of the long-term impact of the current energy transformation of mobility. More focused analyses call for exploration of texts, which can now be carried out, having created the analytical framework to orient exploration. The topics detected with the analysis are those more strictly of interest to incumbent and new agents in electric mobility and associated domains, and this viewpoint can help identify some of the crossroads in the current transformation of sustainable mobility.

With complementary research investigation is being made into the public policies (at the national level) guiding and regulating those transformations. In our analytical framework, a new model of sustainable mobility is not a purely economic or technological matter. The possibility for a model of the sort to be established and developed in the long term requires a qualitative change in the relationships between producers of new artefacts, users of these artefacts and the institutions. The action of the latter, in particular, cannot be limited to top-down policies of incentives and environmental regulations. Public action should include, as a qualifying element, the promotion of greater awareness of the nature of the problem they intend to respond to among the beneficiaries of the policies. To achieve the desired long-term effects, public policy should accompany interventions and spending commitments with educational policies that increase the beneficiaries' awareness of the systemic dimension of change, an aspect generally not considered in economic analysis of change.

The analysis of companies cannot be limited to classification of their activities but has to be deepened with respect to their role on the demand side of the final products, such as all the transport utilities or companies in different sectors (e.g., IKEA or Astra Zeneca and Uber) that are mentioned in the news items because they are going to install electric fleets for their activities. The analysis is still ongoing.

In addition, the disambiguation of entities allows for a more focused interpretation of the centrality of agents, artefacts and institutions in each cluster, and identification of the overlapping nodes between topics. These, in fact, constitute a space of specific actions

undertaken by agents in their interactions with other agents and artefacts, aiming at transformation (expansion/reduction, control, innovation, …) of these domains.

The classification of news items encompassed in the various topics will allow for a temporal analysis that will be used in mapping paths of changes in the dimensions characterising the topics over time, in the three-year span under analysis, and in further downloads we intend to implement. In particular, while the entity disambiguation highlights an array of companies in electric mobility, some of the suppliers have already been swept out and consolidation in certain segments of production activities seems to characterise, for example, the Chinese industry (CGTN 2021; KGM 2021; Reuters 2021). In further steps in the research project, other sources of information will be analysed and results compared; in particular, the entity disambiguation of agents will be used to collect economic and organisational information from other sources, such as Orbis and the companies' reports.

In our exploratory paper we claim that systematic survey of academic papers does not help in addressing the specific goal of the analysis, i.e. identification of the agents populating the emergent technical and market domain of sustainable mobility. Now that the topics and the data set of agents and artefacts have been defined, another strand of research is addressing the scientific literature through the Web of Science (WOS). In fact, for any query made in WOS needs it is necessary to have a preliminary expert idea of topics delimiting the search. For example, in the case of electric mobility, after selecting the due domains (excluding, for example biology, where the terms are used to refer to cells), the analysis has to consider searching the main text to identify the various agents (business companies, associations, institutions, individuals in the various organisations) involved in the emerging domain. But the ongoing changes range from hydrogen to the chemical transformation needed to enhance battery performance; and vehicles range from electric cars to the many electric vehicles now under development (from ships to air vehicles, up to the new entry in everyday life, namely the electric two-wheeler with no seat, a scooter, which until one year ago had been a term used for a completely different vehicle, with a seat – not a trivial detail). Text mining methods implemented in our exploration on electrive.com will be used in the search on WOS, for such further analysis.

While this paper presents data, methods and results on topics, and on the identification of the relevant entities in the electric mobility agent-artefact space, a critical step in the research project is investigation into the types of relationships that have been created/changed between agents and between agents and artefacts, and - possibly - the way the structure of the space of agents and artefacts in sustainable mobility space changes over time. Modelling this relational dimension relies on complex system analysis and multilayer network models.

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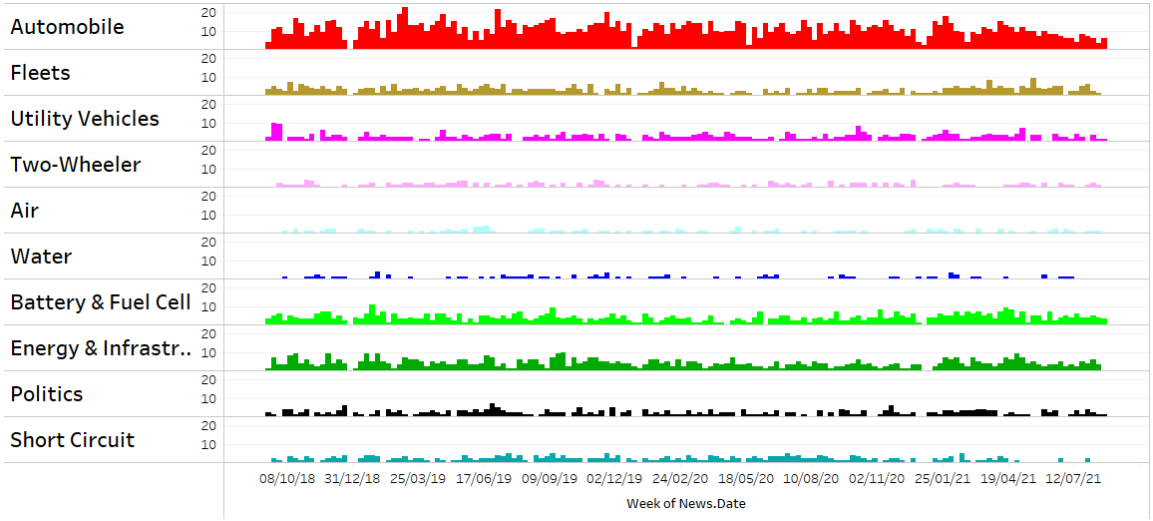
ANNEX 1

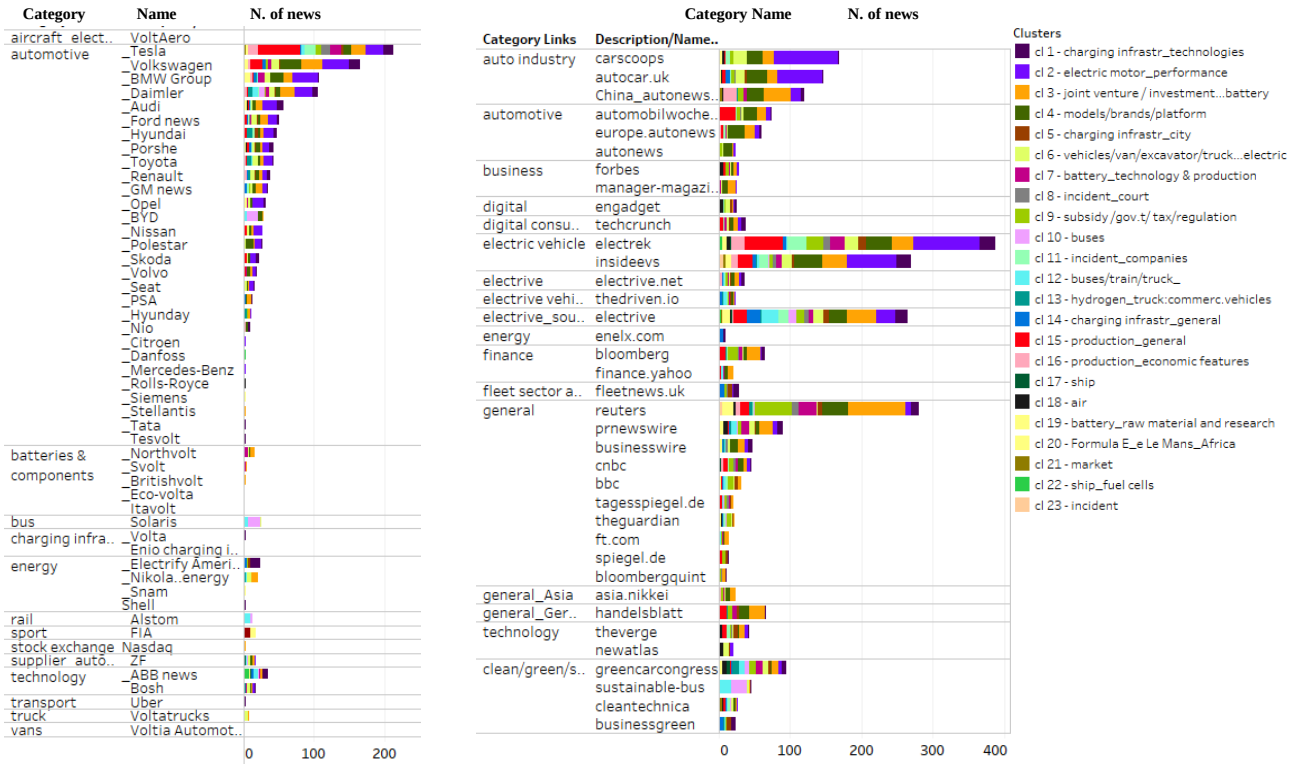
Figure A1 – Number of weekly news items by electrive.com category, September 12, 2018 - August 20, 2021



Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

Figure 2– Sources by category and cluster

Companies _ news & commentaries



Source: Authors' elaboration on data downloaded from electrive.com [12.09.2018-20.08.2021]

In addition to the categories listed in the Figure, two news and blogs – Twitter and Linkedin – have been specifically classified, and they are mentioned, respectively, in 112 and 12 news.

ANNEX 2 - Results by cluster

Legend:
keywords (nouns + adjectives + multiword expressions): multiword expressions are written with a dot between the terms, as in "electric.buses"
Companies' names are written with a "_" before the name
Detailed exploration of results is available online at [anonymised url], using the visualisation created with Tableau Public

Charging infrastructures and buses [10_14_5_1]

	Agents/artifacts/institutions/et al. / macro category (Decla)								
	keywords	Verb	AGENTS_organisation	AGENTS_individual	ARTIFACTS				macro_geographical entity
Cluster_24..			company	person	charging	model	technology	vehicle type	geographical entity
cl 10 - buses	buses electric.buses charger charging city station service charging.infrastructure charge fleet public operator installed bus country ordered trial order pantograph depot transport.operator ...	operate include tender equip electrify replace deliver award deploy have comprise arrive opt place win team	_Solaris _BYD _BVG _Keolis _ADL _Yutong _VDL _TfL _Irizar _ABB Airport _Siemens _eCitaro _Bolloré _Hochbahn _RATP _XCharge _Nobina _Qbuzz _TMB _Van Hool _Alstom ...	Alexander Dennis		Transit Urbino 12 eCitaro G Enviro200EV Urbino 12 electric		trolleybuses e bus	London Hamburg Paris Ireland Madrid Berlin Spain Gothenburg Bucharest Copenhagen Denmark Ostrava Auckland New Zealand Romania Netherlands Scandinavia Czech Republic France ...
cl 14 - charging infrastr_ general	charging.station charger charging charging.point network station service charging.infrastructure charge app charge.point public charging.network location access provider operator user installation installed ...	install operate include expand provide enable allow equip add connect deliver encourage grow comprise found improve score	_Electrify America _EVBox _ChargePoint _Hubject _NewMotion _Tritium _Shell _Fastned _Vattenfall _Enel X _EVgo _Iberdrola _Pod Point _BP _EnBW _Electrify Canada ...		HPC CCS Combined Charging System		Charging DC CHAdeMO AC Superchargers Plug Charge	EV	United Kingdom London Ireland Madrid Spain Amsterdam Bucharest Denmark Scotland Romania Austria Tasmania Scandinavia Italy Czech Republic Lyon France Luxembourg Portugal ...
cl 5 - charging infrastr_city	charging.station city service charging.infrastructure charge app fleet public provider operator user driver infrastructure initiative parking scooter trial utility electric.scooter ...	install operate include expand allow add electrify replace encourage improve may fuel	_Electrify America _EVBox _ChargePoint _Uber _NewMotion _BVG _Gogoro _Vattenfall _Voi _Lime _TfL _Bird _BP Chargemaster _Gridserve _Sixt _Tier Airport _Ikea ...			Renault Zoe Segway Spark Air Zoe		e scooter light electric vehicle	United Kingdom London Hamburg Paris Ireland Madrid Berlin Spain Amsterdam Gothenburg Bucharest Copenhagen Scotland New Zealand Vienna Lyon Lisbon Rome Portugal New York ...
cl 1 - charging infrastr_ technologies	charging.station charger charging charging.point network city station service charging.infrastructure charge app fleet charge.point public charging.network location access ...	install operate include expand plug provide enable allow equip add connect grow deploy found say integrate	_Electrify America _EVBox _ChargePoint _Hubject _Uber _NewMotion _Tritium _Shell _Fastned _Gogoro _Vattenfall _EVgo _Iberdrola _Pod Point _BP _EnBW _Electrify Canada ...		HPC CCS Combined Charging System Wallbox	Renault Zoe I Pace Nissan Leaf Semi	Charging DC V2G CHAdeMO AC Superchargers Plug Charge Supercharger	EV	United Kingdom Hamburg Ireland Berlin Amsterdam Denmark Austria Netherlands Vienna Prague Utrecht India North America Europe Slovenia

Aircrafts and ships [18_17_22]

	Agents/artifacts/institutions/et al. / macro category (Decla)								
	keywords	Verb	AGENTS_organisation	AGENTS_individual	ARTIFACTS				macro_geographical entity
Cluster_24..			company	person	model	project	technology	vehicle type	geographical entity
cl 18 - air	aircraft flight propulsion propulsion.system passenger electric.aircraft fuel.cell aviation knot flying hydrogen air.taxi test.flight propeller fly drone plane wing airport maiden.flight certification ···	fly develop complete believe found integrate connect achieve	_Volocopter _Airbus _Lilium _ZeroAvia _Boeing Airport _Pipistrel _Siemens _Bye Aerospace _HyPoint _Rolls Royce _Urban Aeronautics _Ehang _MagniX _Wright Electric _Cessna _Universal Hydrogen ···	CEO	CityHawk VoloCity Air	EU initiative Urban Air Mobility		VTOL eVTOL	Alice Dubai Singapore Los Angeles Australia New Zealand Paris
cl 17 - ship	ship ferry vessel boat propulsion propulsion.system water shipping yacht fuel.cell marine maritime knot hydrogen shipyard electric.ferry system shipping.company emission operation electric.boat ···	develop decarbonise reduce team say vote promote	_Torqeedo _ABB _Danfoss _Corvus Energy _Ballard _Havyard _Siemens _Ballard Power Systems _Norled _Templar Marine _Volvo Penta _Toyota _PowerCell _AFC Energy		Mirai		Deep Blue LOHC		Norway Denmark Freudenberg European Union Amsterdam
cl 22 - ship_fuel cells	ship ferry vessel boat propulsion propulsion.system passenger water shipping yacht marine maritime knot flying propeller shipyard electric.ferry wing system nautical.mile shipping.company emission operation ···	equip reduce say operate	_Torqeedo _ABB _Danfoss _Corvus Energy _Havyard _Norled _Templar Marine _BC Ferries _ZF _Nidec				Deep Blue Hybrid		Norway Denmark Sweden British Columbia Lisbon Iceland Scandinavia Gothenburg South Korea

Incidents [23_8_11] (false positive!! commentare nell'11)

			Agents/artifacts/institutions/et al. / macro category (Decla)					
	keywords	Verb	AGENTS_organisation	AGENTS_individual	ARTIFACTS			macro_geographical entity
Cluster_24..			company	person	charging	model	technology	geographical entity
cl 23 - incident	fire recall police problem complaint incident case affected investigation twitter damage man driver defect leak problems explosion accident caught story document owner safety software.update risk claimed update affect ongoing fault repair ···	cause can	_Tesla _Hyundai H2 Mobility consortium _ESWE _Jaguar _eCitaro _BMW _WM Motor			Kona Electric Model X Kona I Pace Bolt		Norway Oslo South Korea Korea
cl 8 - incident_ court	court complaint case ruling investigation clearing damage man ad lawsuit leak problems legal dispute advertising story document filed ruled trade.secret risk claimed misleading update injunction ongoing appeal advertised banned question employee ···	defect may grant win fell continue lift	_Tesla _SK Innovation _LG Chem _Artega _Ford _Polestar _LG Energy Solution _Volkswagen _Byton _Mitsubishi _LG _Lordstown _Nikola Motor _Rivian _Karma Automotive _Citroën	Elon Musk Jörg Steinbach Joe Biden		Microlino F 150		USA Brandenburg Grünheide Nevada Bavaria
cl 11 - incident_ companies	fire court police problem complaint incident case affected twitter video damage man driver defect ad problems legal advertising accident caught story document owner safety software.update claimed misleading update affect carriage repair ···	cause may can seem feature take do	_Tesla _Rosenbauer _Nextmove _Polestar _Nissan _Jump _Harley Davidson _Jaguar _Fastned _Venturi _Aston Martin _Arcimoto _Uber _Volvo Penta _Lime _Volvo _EVBox _Audi _Allego	Elon Musk	CCS Combined Charging System	Model X Model 3 Harley-Davidson first unveiled the LiveWire electric motorcycle Model S I Pace Leaf Tesla Model 3 Nissan Leaf iX3 Audi e tron	Supercharger Superchargers CHAdeMO	Police USA Norway Dubai Vienna

Market [21] and state [9]

			Agents/artifacts/institutions/et al. / macro category (Decla)					
	keywords	Verb	AGENTS_organisation	AGENTS_individual	ARTIFACTS			macro_geographical entity
Cluster_24..			company	person	model	technology	vehicle type	geographical entity
cl 21 - market	cent new.registration emission registered registration market.share car new.car electric.car compared hybrid grams increase decline bonus vehicle electric.vehicle passenger.car number association month car.sales force quarter year increased sold road figure recorded hybrid.car study new.electric.car drive.type share drop place effect amendment diesel malus fell unit slump car.market ...	account decline benefit slump continue overtake grow show follow climb reach correspond	_BYD _BAIC _Tesla		Tesla Model 3 Audi e tron Renault Zoe Nissan Leaf Model 3 RAV4 EQC Model S	Hybrid	PHEVs battery electric vehicle NEV PHEV	European Union Norway USA Netherlands France Germany Sweden China
cl 9 - subsidy /gov.t/ tax/ regulation	cent subsidy government emission registered registration car new.car tax electric.car euro compared state grant bill hybrid grams incentive ban increase account regulation administration target measure bonus apply rebate limit law budget vehicle electric.vehicle passenger.car draft number emission.standard exempt subsidised purchase eligible association programme ...	grant account apply exempt benefit vote would receive reduce win may promote encourage include lack side range	_FedEx _Chrysler _GM _General Motors _DHL _Fiat _Toyota _Deutsche Post	Donald Trump Joe Biden Herbert Diess	Air Bolt Mokka e		PHEVs battery electric vehicle NEV ZEV EV FCEV	California European Union USA Netherlands India France Minnesota Scotland New York British Columbia Russia New Zealand South Korea Singapore Denmark Brussels Korea London Alliance Canada Luxembourg United Kingdom Austria Belgium Ireland

Batteries [7_19]

			Agents/artifacts/institutions/et al. / macro category (Decla)				
	keywords	Verb	AGENTS_organisation	AGENTS_individual	ARTIFACTS		macro_geographical entity
Cluster_24..			company	person	model	technology	geographical entity
cl 7 - battery_ technology & production	cell battery material cobalt lithium recycling nickel battery.cell raw.material cathode process cathode.material electrode energy.density research researcher electrolyte metal supply.chain project battery.material anode mining fraunhofer manganese recycled battery.recycling new.battery technology graphite pilot.plant chemical density sustainable tonne lithium.hydroxide separator cycle battery.cell.production transparency chain ···	recycle improve develop achieve can reduce say establish enable	_BASF _Northvolt _Umicore _CATL _LG Chem _Johnson Matthey _Posco _Solid Power _Panasonic _Tesla _Glencore _Maxwell _Samsung SDI _Nornickel _BMW _DLR _Battrion _Volvo Buses _Saft _LG Energy Solution _InoBat _LG _SK Innovation _FEV _Bye Aerospace _Tier Mobility _Microvast _WiTricity _Freyr _Britishvolt _Lilium _Tier _Bosch _Siemens _Voltabox	Jeff Dahn Peter Altmaier Elon Musk	Model Y Model 3	Blockchain	Congo Finland Salzgitter Skellefteå Poland Nevada Fremont Brazil Alliance Germany Erfurt Berlin Brandenburg Bavaria Saarland
cl 19 - battery_raw material and research	cell battery material cobalt lithium recycling nickel battery.cell raw.material cathode process cathode.material electrode energy.density research researcher electrolyte metal supply.chain project battery.material anode mining fraunhofer manganese recycled battery.recycling new.battery technology graphite pilot.plant chemical density sustainable tonne lithium.hydroxide separator cycle transparency chain battery.research membrane method ···	recycle improve develop achieve can reduce deposit comprise would	_BASF _Northvolt _Umicore _Li Cycle _Johnson Matthey _Posco _Solid Power _Glencore _Samsung SDI _Nornickel _BMW _DLR _Fortum _Valmet _Valmet Automotive _Great Wall	Jeff Dahn		Blockchain	Congo Finland Rio Tinto Albemarle Salzgitter Dresden Rochester Chile Morocco Serbia Canada Bolivia European Union

Production [3_16_4_15]

	Agents/artifacts/institutions/et al. / macro category (Decla)							
	keywords	Verb	AGENTS_organisation	AGENTS_individual	ARTIFACTS			macro_geographical entity
Cluster_24..			company	person	model	technology	vehicle type	geographical entity
cl 3 - joint venture / investment... battery	plant production build factory report year brand joint.venture profit employee billion.dollar platform plan company planned billion billion.euro produced planning production.line ···	build would can intend invest become reach found expand develop establish inch	_Volkswagen _CATL _Akasol _Geely _Byton _Faraday Future _Evergrande _Rivian _PSA _Dyson _Ford _Xpeng _Voltabox _FAW _Northvolt ···	CEO Herbert Diess	StreetScooter Endurance FF 91 Continental EQ	MEB	NEV	China Shanghai Zwickau Lincoln USA Emden Sion Dingolfing Indonesia Erfurt Salzgitter Saarland Turkey Skellefteå Tennessee Hungary South Korea
cl 16 - production_ economic features	production sales quarter report delivery year sold profit billion.dollar billion delivered unit produced cent figure market electric.car loss million.euro week reported end growth ···	build continue decline account top result amount slump grow reach arrive deliver hand speed	_Tesla _Nio _CATL _Akasol _Xpeng _Voltabox _BYD _Paragon	Elon Musk	Model Y Model 3 Model S Q3 Model X Semi Tesla Semi		NEV PHEVs	China Shanghai Fremont Texas Norway
cl 4 - models/ brands/ platform	plant production build sales factory report year brand sold model platform plan planned unit billion.euro produced planning production.line confirmed announced market produce ···	build would can intend be become hint do base follow mention	_Volkswagen _Nio _Geely _Byton _Rivian _PSA _Ford _FAW _Polestar _GM _Porsche _Mini _Huawei _Lordstown _Stellantis _Lotus _Lordstown Motors _GAC _Kandi _Audi _Chery ···	CEO	EQC Macan Renault 5 i3 XC40 Polestar 2 Mokka e Microlino A8 iX3 F 150 i4 Zoe Q4 e tron	MEB EMP2	SUV battery electric vehicle	China Shanghai Zwickau Lincoln Emden Sion Ghent Dingolfing Leipzig Wolfsburg Europe Cadillac
cl 15 - production_ general	plant production sales factory quarter report delivery sold employee billion.dollar planned delivered planning production.line confirmed figure investor electric.car week reported end ···	build would deal restart can start be do arrive tweet seem grant appeal	_Tesla _Volkswagen _Nio _Byton _Faraday Future _Porsche _Evergrande Health _Audi _Kia _Share Now _Spin _Karma Automotive	Elon Musk Herbert Diess Jörg Steinbach	Model Y Model 3 Model S EQC Model X XC40 Kona Electric e tron e Niro Golf Mustang Mach E Enyaq Niro			China Shanghai Fremont Zwickau Grünheide Brandenburg Texas USA Ghent Leipzig Wolfsburg Alameda County Europe Berlin Nevada Brussels America Hamburg Serbia Czech Republic Dresden

Hydrogen for buses and commercial vehicles [12_13_6]

	Agents/artifacts/institutions/et al. / macro category (Decla)							
	keywords	Verb	AGENTS_organisation	AGENTS_individual	ARTIFACTS			macro_geographical entity
Cluster_24..			company	person	model	technology	vehicle type	geographical entity
cl 12 - buses/ train/truck_	truck hydrogen fuel.cell buses electric.truck fuel.cell.truck train electric.buses bus transport vehicle project electric.bus testing commercial.vehicle system test fleet heavy solution rail fuel.cell.vehicle operation city fuel.cell.buses ton ...	say deploy deliver award integrate provide replace electrify operate include hand	_Hyzon Motors _DPD _MAN _BYD _Alstom _Lion Electric _Wrightbus _Arrival _Temsa _Nexport _UPS _Volvo Trucks _Daimler Trucks _VDL _Stagecoach _DAF _Scania _ADL _Ballard _New Flyer _Symbio _NFI _Amazon _Fuso _Solaris _Arcola Energy _MCI ...	Alexander Dennis	eActros Coradia iLint Transit Tesla Semi Urbino 12 Urbino 12 electric Enviro200EV eCitaro G Semi		e bus trolleybuses	Switzerland Canada Australia Aberdeen Rotterdam North America Groningen California Qatar Israel Mannheim Brazil Manchester Scotland New Zealand Mexico City Ireland America Hamburg Chile Netherlands Copenhagen India Singapore Sweden ...
cl 13 - hydrogen_ truck: commerc. vehicles	truck hydrogen fuel.cell fuel.cell.truck train transport project testing commercial.vehicle system test stack green.hydrogen fuel.cell.system heavy solution rail fuel.cell.vehicle development applications ton heavy.truck hydrogen.filling.station ...	develop say deploy provide found promote establish achieve believe intend	_Hyzon Motors _Nikola _MAN _Toyota _Hyundai _Cummins _Bosch _Plug Power _Daimler Trucks _VDL _Faurecia _Kenworth _Ballard _Hydrospider _H2 Energy _Iveco _Air Liquide _Schaeffler _Volvo Group _Symbio _Navistar ...	Peter Altmaier	Nikola Tre i Hydrogen Next Mirai	LOHC	FCEV ZEV	Switzerland Australia Rotterdam North America Groningen California Freudenberg Utrecht Alliance Europe Japan Rochester France European Union Bavaria Saudi Arabia
cl 6 - vehicles/ van/ excavator/ truck... electric	truck fuel.cell electric.truck transport vehicle electric.bus testing commercial.vehicle system test fleet heavy solution van operation city development electric.van excavator applications ton goods technology tractor range transporter chassis concept autonomous ...	develop say deliver integrate should equip base reveal	_Nikola _DPD _MAN _Toyota _Cummins _Bosch _Arrival _UPS _Volta _Daimler Trucks _DAF _ElectReon _Kenworth _Scania _Rinspeed _Schaeffler _Volvo Group _LEVC _Amazon _Fuso _Navistar _Canoo _ZF _Energica _Webasto _DHL _Nikola Motor ...		eActros Voltia Transit Nikola Tre i Hydrogen Next Segway StreetScooter FF 91 Continental Vivaro e eVito	MEB	FCEV light electric vehicle e scooter	Australia Israel Oslo London Lyon Prague Geneva

Electric motor_performances [2]

			Agents/artifacts/institutions/et al. / macro category (Decla)					
	keywords	Verb	AGENTS_organisation	ARTIFACTS				macro_geographical entity
Cluster_24..			company	charging	model	technology	vehicle type	geographical entity
cl 2 - electric motor_ performance	kw version range kilometre model euro price kwh electric.motor kwh.battery interior drive variant rear front mile km feature litre display top.speed brake metre seat wheelbase large.battery trim design function. torque kph headlight system.output mode acceleration mph electric.range small.battery rim wheel kilogram steering.wheel offer ...	be brake should correspond reveal base allow have apply equip ensure opt	_Peugeot _Opel _Kia _Mercedes _BMW _Citroën _Audi _Lexus _Fiat _Dacia _Volkswagen _DS _Mini _Renault _Seat _Nissan _Vauxhall _Honda _Harley Davidson _Aiways _Cupra _Mazda _Polestar _Xpeng _Daymak _Skoda _Karma Automotive _Toyota _PSA _Artega _SAIC	CCS Combined Charging System	EQV EQA AMG Taycan iX e 208 Q4 e tron EV6 Enyaq e tron e tron Sportback Ariya Mirai Harley-Davidson first unveiled the LiveWire electric motorcycle Zoe i4 Golf eVito Vivaro e Niro Leaf e Niro Microlino Mustang Mach E XC40 Model X Polestar 2 iX3 EQ A8 i3 Model S RAV4 Kona F 150 Model 3 Audi e tron Bolt Tesla Model 3 ...	AC Hybrid DC EMP2 MEB Charging	SUV PHEV battery electric vehicle light electric vehicle e scooter PHEVs	United Kingdom Geneva Cadillac USA

Formula E [24_20]

	Agents/artifacts/institutions/et al. / macro category (Decla)					
Cluster_24..	keywords	Verb	AGENTS_organisation company	AGENTS_individual person	ARTIFACTS model	macro_geographical entity geographical entity
cl 24 - Formula E_Prix.. Hong Kong	race season team driver win racing racing.series lap championship motorsport podium car place qualifying point track racer winner weekend flag victory customer.team safety.car circuit finish fan finished calendar title teammate fight tyre autosport finish.line held end pit result rain career virtual drove twitter yellow factory.team damaged lead time tough minute permitted energy.management standing collision man start pic battle position top accident weeks temperature degree wet lost ⋯	race win score fight take end result overtake start battle climb do show cause wave	_Audi _Abt _DS _Venturi _Jaguar _Mercedes _Porsche _Mahindra _Schaeffler _Bird _ABB _Nissan _BMW Airport	Daniel Abt Pascal Wehrlein Andretti Lucas di Grassi Stoffel Vandoorne Sam Bird Antonio Felix da Costa Nyck de Vries Maximilian Günther	BMW i EQ	World Saudi Arabia Berlin Santiago Rome Mexico City Paris Morocco Chile
cl 20 - Formula E_e Le Mans_Africa	race season team driver win racing racing.series lap championship motorsport podium car place qualifying racing.car track racer winner weekend world flag race.car customer.team rally safety.car circuit fan calendar title series electric.racing.series event tyre autosport held pit.stop pit racing.team rain career virtual drove twitter yellow factory.team damaged time powertrain tough permitted energy.management man chassis manufacturer drive allowed climb new.drive cockpit ⋯	compete score take develop say	_Audi _Abt _DS _Venturi _Jaguar _Mercedes _Porsche _Schaeffler _ABB _Cupra _Opel _AFC Energy _Alfa Romeo _Energica _Lamborghini	Daniel Abt Pascal Wehrlein Andretti Lucas di Grassi Alejandro Agag Nyck de Vries Maximilian Günther	Spark Model S Taycan Endurance i Hydrogen Next	World Le Mans Saudi Arabia Berlin Africa