La decarbonizzazione dei trasporti: è un obiettivo possibile?

a cura di Romeo Danielis

EUT

Impaginazione
Gabriella Clabot

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Indice

The academic literature on electric vehicles in the social sciences

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1. INTRODUCTION

Growing populations, economic development, and urbanization are factors contributing to increasing demand for transportation services, particularly on roads. This demand triggers severe environmental and energy challenges, particularly for countries with large economies. Leading energy consuming countries are increasingly concerned about establishing energy security and reducing pollution from transportation (Travesset-Baro et al., 2015; Zhao and Heywood, 2017). Countries are considering encouraging the mass adoption of electric vehicles (EVs) as a strategy to meet these objectives. The goal is to mitigate some of the energy and environmental challenges to a greater extent (Degirmenci and Breitner, 2017; Mersky et al., 2016).

It is important to note, however, that any policy implementation to make EVs more attractive should be evidence-based. Policymakers, therefore, need to be informed about the current evidence base related to EVs, prior to making any decision. Two recent studies have reviewed the literature on EVs (Liao et al., 2017; Rezvani et al., 2015). These reviews include studies related to EV adoption published after 2005 (Liao et al., 2017) and 2007 (Rezvani et al., 2015), respectively.

Such overviews can be provided by systematic literature reviews (SLR), which involves searching for, selecting, critically appraising and summarizing the results of research (Cook et al., 1997). The overall objective of our study is to expand the current body of knowledge on EVs by conducting an SLR of EV-articles published within the field of social sciences from 1995 to 2018. Consequently, this study includes a broader set of EV topics and of articles published during a longer time period than those covered in the two abovementioned studies.

More specifically, the aim of this book chapter is twofold. First, we review the literature on electric vehicles to identify (i) how the frequency of published articles in the field has evolved, (ii) their focus and (iii) the researchers, journals, research institutions, and countries being most active. The review will focus on the social sciences to highlight the effects on society from the evolution of research on electric vehicles. Second, we identify the most influential works on electric vehicles and rank these based on how often they were cited. It has been argued that the most cited articles are those with the greatest impact on that particular field (Ibrahim et al., 2012).

The findings are useful to both policymakers and the research community in at least four ways. First, it illuminates which research topics related to EV that is most frequently covered by existing literature. Second, under-researched topics can be identified. Third, we can shed light on how the research-field is developing. Fourth, the most influential articles on EV, to which both researchers and policymakers ought to familiarise themselves with, are identified.

The remainder of this book chapter is structured as follows: in Section 2, we describe the methodology used and the data source applied, Section 3 accounts for the historical development of academic research regarding electric vehicles, the important works within this field of research are presented in Section 4, and conclusions and implications are presented in Section 5.

2. Methodology

The data presented in this book chapter were gathered from Scopus, the world's largest abstract and citation database of peer-reviewed literature (www.scopus.com). The database was searched for entries containing the term "electric vehicle". To be included in the search result, these two words had to appear either in the title, the abstract or in keywords defined either by the author or by Scopus. The search was further restricted to journal articles written in English and within the social sciences between 1995 and 2018. These criteria resulted in 1312 articles. The historical entries in Scopus could change somewhat over

time because of updates in underlying sources. The data set for this study was extracted in August 2019.

The term "electric vehicle" or "EV" refers to a type of alternative fuel vehicles in which partial or entire propulsion power is generated from electricity stored in electric battery packs (Rezvani et al., 2015; Egbue and Long, 2012). The EV categories usually include vehicles with different technologies such as battery electric vehicles (BEV), plug-in electric vehicles (PHEV), and hybrid electric vehicles (HEV). Despite having a small battery pack, it is argued that HEV is mainly a fuel-efficient conventional vehicle as all of its propulsion energy generates from the liquid fuel (Schuitema, 2013). PHEVs are equipped with both internal combustion engine (ICE) and electric battery but mostly run on battery which can be recharged from the external electric supply as well as via ICE and regenerative braking (Egbue and Long, 2012). BEVs are recognized as pure electric vehicles or all-electric vehicles, where battery stored energy powers the electric drivetrain (Campanari et al., 2009).

Social science is, in its broadest sense, a discipline that studies social interaction, society or culture and is composed of sociology and social psychology, linguistics, cultural anthropology, political science, economics, aspects of geography, and even business and management studies (Baker, 1964; Theodorson and Theodorson, 1969).

Despite its extensive range of journals related to the social sciences, the Scopus database does not present a complete picture of the body of literature. Hence, the selection of articles would be different if based on other sources. The data set was compared to the data set delivered by ISI Web of Knowledge provided by Thomson Reuters when using a similar procedure. ISI included fewer journals, and there were fewer observations. However, the majority of the articles found in ISI were present in Scopus, which indicates that the most important works are present in the data set applied in this chapter. The use of a more extensive search engine, such as Google Scholar, would include many observations that are not peer-reviewed and are perhaps of lower scientific quality (Aguillo, 2012). The different scope of the databases also influences the number of reported citations.

A disadvantage of Scopus relates to older articles. Reportedly, the database is not complete for the years prior to the mid-1990s. Consequently, this study excludes data predating 1995. Nevertheless, one should be aware that figures regarding the earliest period are somewhat uncertain and must be treated with caution. The idea of electric vehicles is not new, electric cars were introduced more than 100 years ago. But the growing interest of EVs has been experienced at the beginning of the current century (Daziano and Chiew, 2012; Matulka, 2014). Hence, the relevant part of the rapidly expanding body of literature over the last 24 years is covered at a satisfactory level in this database.

A particular advantage of such a structured approach to a literature review as the one applied in this study is the high degree of reliability due to the ability to replicate the results. Consequently, it is important that SLR studies contain a methodology section describing in detail how the data extraction was conducted (Denyer and Neely, 2004), thus allowing readers to assess the appropriateness of the procedure used and, as such, the degree to which the conclusions drawn are trustworthy. SLRs are conducted to provide evidence-based policy recommendations in various policy fields. They are, for example, used to review the evidence on the effects of physical activity on health and behavior among school-age youth (Strong et al., 2005) and cloud computing (Jula et al., 2014). SLRs are also done on transportation topics, including air transport (Ginieis et al., 2012) and intermodal freight transport (Mathisen and Hanssen, 2012).

3. ACADEMIC RESEARCH ON ELECTRIC VEHICLES

This chapter presents our findings with regard to the historical development of academic research on electric vehicles and identifies the most productive researchers on the topic.

3.1 *Publishing frequency*

The search procedure presented in Section 2 identified 1312 articles. The distribution over time is illustrated in Fig. 1, in which the horizontal and vertical lines represent publication year and percentage of publications, respectively. It is evident from Fig. 1 that the majority of articles were published at the end of the time period. In fact, more than half (57%) of the articles were published during the last three years of the period, from 2016 to 2018. In the years prior to 2010, the annual publishing frequency was 10 papers or fewer. Fig. 1 illustrates how the field is clearly emerging.

The annual number of publications in Fig. 1 was 36 times higher in 2018 relative to 1995. However, during the same period the overall number of publications within the social sciences, as registered by Scopus, grew by 188%. This indicates that there has not only been an absolute increase in the research focus on electric vehicles during the period investigated but also that the focus on electric vehicles has grown relative to other research areas within the social sciences.

Figure 1 – Proportion of articles in the data set published each year
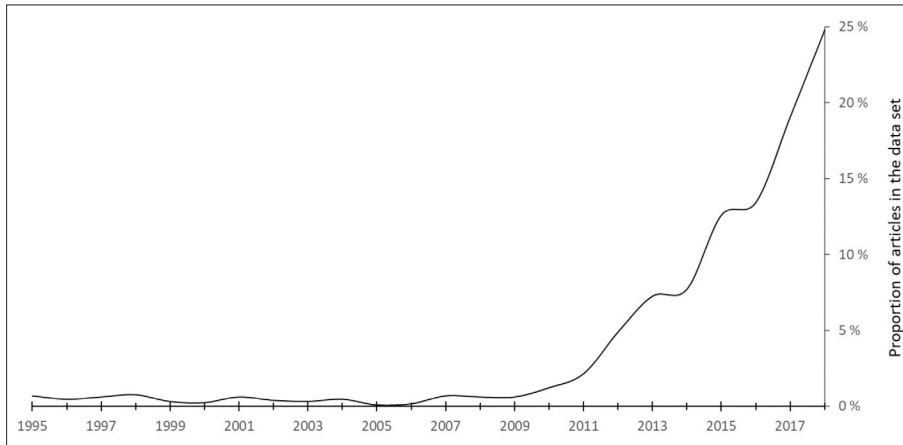
3.2 *Publication channels*

The articles addressing electric vehicles were published in 162 different scientific journals. These journals cover a wide range of research topics including transportation, sustainability, policy, and statistics. Of the 162 journals, approximately half were represented only once in the data set. The journals most frequently publishing articles on this topic can broadly be categorized as being within the tradition of transport economics. The 10 journals with most EV articles are presented in Table 1. Because of the rapidly increasing publishing frequency, we present the last four years separately.

Clearly, the most relevant journal for research on electric vehicles is Transportation Research Part D with 210 articles. This is not surprising as the journal publishes research on the environmental impacts of transportation, policy responses to those impacts, and their implications for the design, planning, and management of transportation systems. Five journals published 80 or more articles on this topic. In addition to Transportation Research Part D, Parts A and C in this series stand out as having the most publications in the first part of the studied time period, from 1995 to 2014. By contrast, the publications during the last five years were more equally distributed among the 10 journals in Table 1. Finally, it is worth noting that six out of the ten journals listed in Table 1 published more articles on EVs in 2018 alone than they did in the 20-year period from 1995 to 2014.

Table 1 – The journals most frequently publishing articles on electric vehicles between 1995 and 2018

	Journals	1995-2014	2015	2016	2017	2018	Total
1	Transportation Research Part D Transport and Environment	69	21	21	32	67	210
2	IEEE Transactions on Transportation Electrification	0	23	20	45	21	109
3	Sustainability Switzerland	6	8	11	18	48	91
4	Transportation Research Part A Policy and Practice	32	14	10	18	16	90
5	Transportation Research Part C Emerging Technologies	22	11	18	14	18	83
6	International Journal of Sustainable Transportation	6	3	11	13	10	43
7	Transport Policy	11	2	10	6	6	35
8	Transportation Research Part B Methodological	6	1	6	14	7	34
9	Sustainable Cities and Society	2	1	3	4	22	32
10	Iet Intelligent Transport Systems	8	4	5	2	9	28
	Total (for top 10 Journals)	162	88	115	166	224	755

3.3 Topics treated

Throughout the years, a number of topics related to electric vehicles have been addressed. Each article contained a number of keywords that were part of broader categories. Based on the keywords, Table 2 presents the categories that were most frequently used to describe the articles. Three example keywords are provided to better clarify the content of each category. Because each article included several keywords, the total number of keywords exceeds the number of articles.

The focus on different topics has changed over the studied time period. Whereas for example, "Technology and innovation" accounted for a relatively higher proportion of the early articles, "Policy" appears to be an increasingly important topic of interest for current researchers. "Models and analytical approach" and "Economic theory" remained stable over the last 24 years. "Environment" was the most addressed topic throughout the entire period, peaking at

Table 2 – The most frequently addressed topics within articles addressing EVs

Topic/Category	# keywords	Example keywords
Environment	1599	Greenhouse gases, Energy use, Sustainability
Types of EV	1461	Hybrid, Battery electric, Fuel cells
Policy	1102	Regulation, Planning, Infrastructure
Models and analytical approach	762	Optimization, Numerical model, Surveys
Economic theory	625	Costs, Competition, Cost-Benefit Analysis
Technology and innovation	392	Technology adoption, Innovation, Traffic control
Regions	371	United States, China, Germany
Energy sources	337	Electric utilities, Alternative energy, Smart grid
Behavior	285	Consumption, Travel behavior, Range anxiety
Business and management	238	Commerce, Sales, Investment

approximately 2002-2006 and accounting for more than 50% of the keywords. Within this category, the studies most frequently addressed "Energy use", followed by "Greenhouse gases and other emissions". However, focus on each of the topics varied over the studied time period.

The second most frequent topic given in Table 2 relates to the "Type of EV". "Hybrid" vehicles are addressed most frequently and account for approximately 21% of the keywords in this category, followed by "battery electric" with 12%. "Internal combustion engines" are mentioned about equally often as "Hydrogen/ Fuel cells". The third most-used category is "Policy" and includes "Regulation", "Planning" and "Mobility". Among the remaining categories, we address "Regions" separately in Section 3.4. Evidently, there seems to have been less focus on "Behaviour" and "Business and management". This can be somewhat of a concern if the aim is to increase EV adoption.

3.4 Countries

The number of countries from which researchers have addressed EVs has grown considerably during the past 24-year period (see Table 3). In 1995, researchers from only 2 countries (United States and Sweden) addressed the topic. By 2018, this number had grown to 56. It is evident that the major focus of attention is

from researchers in Europe, North America, and Asia; researchers from Africa and South America appear to have less frequent publications within this field. Such country distribution can be argued to provide valuable information for researchers to find where colleagues are located and possibly to help to establish research collaboration (Xie, 2015).

Furthermore, according to Table 3, the majority of the top 10 countries are members of the Electric Vehicle Initiative (EVI). The EVI is a multi-government policy forum established in 2009 under the Clean Energy Ministerial, with a motivation to accelerate the deployment of EVs worldwide (IEA, 2016). The EVI aims at global deployment of 20 million electric cars by 2020 (Clean Energy Ministerial, 2016). According to IEA (2016), the EVI includes 16 member governments (these countries are Canada, China, France, Germany, India, Italy, Japan, Korea, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, the United Kingdom, and the United States, of which China and the United States are co-chairs of the initiative) representing the majority of the global EV stock and the largest and most rapidly growing EV markets worldwide.

Table 3 – The ten countries with the most articles on electric vehicles

	Countries	1995-1999	2000-2004	2005-2009	2010-2014	2015-2018	Total	Proportion of data set
1	United States	16	10	15	102	254	397	23 %
2	China	0	0	2	27	159	188	11 %
3	Germany	0	1	0	24	102	127	7 %
4	United Kingdom	2	3	0	32	75	112	7 %
5	Canada	1	1	0	13	65	80	5 %
6	Netherlands	2	3	0	21	33	59	3 %
7	Australia	0	0	0	15	42	57	3 %
8	Italy	0	0	2	6	41	49	3 %
9	Sweden	2	4	0	5	38	49	3 %
10	South Korea	0	0	0	6	37	43	3 %
	Total top 10	23	22	19	251	846	1161	68 %

3.5 *Institutions*

Using information regarding the authors' affiliation, the data set enables us to identify the research institutions focusing on electric vehicles. The ten most frequently affiliated institutions are presented in Table 4 with publications over the last four years in separate columns. A total of 36 institutions published at least ten articles on the topic. It is evident that University of California (United States) represented by two campuses in the list is the most frequent affiliation for authors publishing articles on electric vehicles, followed by Delft University of Technology (The Netherlands). Table 4 further demonstrates that except Tsinghua University (China), all the top affiliated institutes are from the US and Western Europe (the Netherlands, Germany, Denmark and Sweden). According to IEA (2017), the US, Norway and the Netherlands accounted for 40% of the global electric car stock in 2016.

A major aspect of the most frequently publishing universities identified in Table 4 is that they are technically oriented, e.g. Delft University of Technology, Danish Technical University, and Chalmers. A likely explanation is that these technical universities not only focus on the development of technologies but also address how these technologies are shaping societies. As such, these universities employ not only engineers but also social scientists.

Table 4 – The ten most frequently publishing academic affiliations on electric vehicles

	AFFILIATION	1995-2014	2015	2016	2017	2018	TOTAL	PROPORTION OF DATA SET
1	University of California, Davis	17	5	2	2	4	30	2.6 %
2	Delft University of Technology	12	4	4	4	4	28	2.4 %
3	Tsinghua University	3	1	6	12	5	27	2.3 %
4	Technische Universität Chemnitz	8	4	4	6	2	24	2.1 %
5	University of California, Berkeley	4	1	7	4	6	22	1.9 %
6	Danmarks Tekniske Universitet	3	2	6	7	3	21	1.8 %
7	Carnegie Mellon University	7	2	3	2	3	17	1.5 %
8	Karlsruhe Institute of Technology	1	3	2	2	9	17	1.5 %
9	Chalmers University of Technology	6	0	3	4	3	16	1.4 %
10	Clemson University	5	2	3	3	3	16	1.4 %
	Total top 10	66	24	40	46	42	218	19 %

3.6 *Authors*

The ten authors who have written the most articles on electric vehicles between 1995 and 2018 are listed in Table 5. At the top of the list is Josef Krems, who contributed to 17 EV-articles. Krems is a professor of cognitive and engineering psychology at the Chemnitz University of Technology in Germany. Several of Krems' articles are co-authored by Thomas Franke. Franke is a professor of engineering and cognitive ergonomics at the University of Lübeck, and he contributed to 15 EV-articles. Finally, the third most published author on electric vehicles is Jonn Axsen, an associate professor at the Simon Fraser University in Canada.

Evidently, the countries and affiliations with the most published articles on electric vehicles are also well represented on the list with the most productive researchers on the topic. According to Table 3, authors from the United States produced almost one-quarter of all articles on electric vehicles within the social sciences. The United States is also home to three of the most productive researchers, only surpassed by four researchers from German affiliations.

Investigating the number of times the EV articles produced by the most productive authors were cited, the publications by Ken Kurani from University of California, Davis, are ranked first. His 12 articles on the topic were cited 670 times, at an average of 55.8 citations per article. The highest number of citations per article has Yafeng Yin from the University of Michigan, Ann Arbor.

Table 5 – The ten most frequently publishing researchers in the data set

Name	Affiliation	No. of articles on EV (1995-2018)
Krems, J. F.	Chemnitz University of Technology, Germany	17
Franke, T.	University of Lübeck, Lübeck, Germany	15
Axsen, J.	Simon Fraser University, Burnaby, Canada	14
Kurani, K. S.	UC Davis, Davis, United States	12
Lin, Z.	Oak Ridge National Laboratory, United States	11
Jochem, P.	Karlsruhe Institute of Technology, Germany	9
Plötz, P.	Fraunhofer ISI, Germany	9
He, F.	Tsinghua University, China	8
Sovacool, B.K.	Aarhus Universitet, Denmark	8
Yin, Y.	University of Michigan, Ann Arbor, United States	8

His eight articles were cited 545 times, with a corresponding average of 68.1 citations per article.

It is also worth noting that four of the ten most productive researchers on EVs within the social sciences are associated with four of the institutions listed in Table 4 (UC Davis, Chemnitz University of Technology, Karlsruhe Institute of Technology and Tsinghua University).

4. MOST-CITED ARTICLES ON ELECTRIC VEHICLES

Research quality is a latent construct (Bornmann and Williams, 2017) and can, as such, only be measured using proxies (Hug et al., 2014). One common proxy for research quality is the number of times an article has been cited, which captures an important component of the quality of research, namely its impact (Martin and Irvine, 1983). Although an article might receive a high number of citations due to it being massively promoted among colleagues or dealing with a popular topic, we believe, as did the Norwegian Productivity Commission (NOU 3, 2016), that there is a positive association between citation counts and research quality. This assumption is further strengthened by the failure by Bertocchi et al. (2015) to find systematic differences between bibliometric ranking of articles and their peer review evaluation by experts. Moreover, papers of the highest quality, as measured by independent experts, is 10 times more likely to be in the most cited quintile than in the least cited one (Patterson and Harris, 2009).

Based on the above arguments, we believe that the most cited articles on electric vehicles are the ones who have had greatest impact on this particular research topic, and that they have high quality. The 10 most cited articles on electric vehicles are listed in Table 6 ranked according to the accumulated number of citations for each article. It can be seen that the most cited article is cited 699 times and the 10th most cited article has received 200 citations. Compared to many other fields, such as epilepsy (Ibrahim et al., 2012), software engineering (Garousi and Fernandes, 2016), and neurosurgery (Ponce and Lozano, 2010), these numbers are relatively low. This is probably due to the novelty of this field of research. As can be seen from Figure 1, the annual number of publications on this topic in the social sciences were rather modest prior to 2010.

The most cited article on electric vehicles, with 699 citations, is a review of battery cost estimates (Nykvist and Nilsson, 2015). The second most cited article, with 508 citations, provide environmental life cycle assessments of electric and conventional internal combustion engine vehicles (Hawkins et al., 2013). The third most cited article, with 299 citations, explore range requirements for electric vehicles in the United States (Pearre et al., 2011).

Table 6 – The ten most cited articles on electric vehicles[1]

Rank	Title	Author(s)	Journal	Citations (per year)
1	Rapidly falling costs of battery packs for electric vehicles	Nykvist and Nilsson (2015)	Nature Climate Change	699 (175)
2	Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles	Hawkins et al. (2013)	Journal of Industrial Ecology	508 (85)
3	Electric vehicles: How much range is required for a day's driving?	Pearre et al. (2011)	Transportation Research Part C	299 (37)
4	The electric vehicle-routing problem with time windows and recharging stations	Schneider et al. (2014)	Transportation Science	253 (51)
5	Advances in consumer electric vehicle adoption research: A review and research agenda	Rezvani et al. (2015)	Transportation Research Part D	240 (60)
6	Mainstream consumers driving plug-in battery-electric and plug-in hybrid electric cars: A qualitative analysis of responses and evaluations	Graham-Rowe et al. (2012)	Transportation Research Part A	234 (33)
7	Optimal deployment of public charging stations for plug-in hybrid electric vehicles	He et al. (2013)	Transportation Research Part B	214 (36)
8	Potential Impacts of Plug-in Hybrid Electric Vehicles on Regional Power Generation	Hadley and Tsvetkova (2009)	Electricity Journal	205 (21)
9	Potential Impacts of Plug-in Hybrid Electric Vehicles on Regional Power Generation	Gruber et al. (2011)	Journal of Industrial Ecology	201 (25)
10	Charging infrastructure planning for promoting battery electric vehicles: An activity-based approach using multiday travel data	Dong et al. (2014)	Transportation Research Part C	200 (40)

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[1] The number of citations was counted in August 2019. Citations per year are measured by the total number of citations divided by the number of years since publication.

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2	Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles	Hawkins et al. (2013)	Journal of Industrial Ecology	508 (85)
3	Electric vehicles: How much range is required for a day's driving?	Pearre et al. (2011)	Transportation Research Part C	299 (37)
4	The electric vehicle-routing problem with time windows and recharging stations	Schneider et al. (2014)	Transportation Science	253 (51)
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Table 7 – Details on the most cited articles on electric vehicles

Rapidly falling costs of battery packs for electric vehicles (Nykvist and Nilsson, 2015) reviews cost estimates of battery packs for battery electric vehicles and find that industry-wide cost estimates declined by approximately 14% annually between 2007 and 2014.
Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles (Hawkins et al., 2013) provides a life cycle assessment of conventional internal combustion engine vehicles and electric vehicles. The authors find that EVs can offer a 10% to 24% reduction in global warming potential, compared to conventional vehicles.
Electric vehicles: How much range is required for a day's driving? (Pearre et al., 2011) analyzes daily driving data from gasoline vehicles in the US and found that 9% never drove more than 100 miles in a day and that 21% never drove more than 150 miles in a day. The authors conclude that electric vehicles with limited battery range can, if marketed correctly, find a large enough market to generate substantial sales.
The electric vehicle-routing problem with time windows and recharging stations (Schneider et al., 2014) applies a hybrid heuristic that combines a variable neighborhood search algorithm with a tabu search heuristic to solve the electric vehicle-routing problem.
Advances in consumer electric vehicle adoption research: A review and research agenda (Rezvani et al., 2015) presents an overview of drivers for and barriers against consumer adoption of plug-in EVs. Moreover, it gives an overview of theoretical perspectives used in research on consumer intentions and behaviors towards electric vehicles.
Mainstream consumers driving plug-in battery-electric and plug-in hybrid electric cars: A qualitative analysis of responses and evaluations (Graham-Rowe et al., 2012) identifies potential barriers for mainstream consumers adopting plug in hybrid cars. Among these are the prioritization of personal mobility needs over environmental benefits and the belief that rapid technological development make current models obsolete.
Optimal deployment of public charging stations for plug-in hybrid electric vehicles (He et al., 2013) proposes a mathematical program to solve the problem of optimally allocating public charging stations. The model is solved using an active-set algorithm and has, according to the authors, proven effective and efficient.
Potential Impacts of Plug-in Hybrid Electric Vehicles on Regional Power Generation (Hadley and Tsvetkova, 2009) finds that increasing market penetration of plug in hybrid electric vehicles can create changes for the electric grid. Among other consequences, electricity prices are expected to rise and emissions from utilities will likely increase, if nothing is changed.
Global lithium availability: A constraint for electric vehicles? (Gruber et al., 2011) addresses whether global lithium supply can support demand from electric vehicles. The authors conclude that resources can support demand to at least the end of this century.
Charging infrastructure planning for promoting battery electric vehicles: An activity-based approach using multiday travel data (Dong et al., 2014) assesses the impact of different public charging infrastructure levels on reducing rage anxiety among users of battery electric vehicles.

Looking at the number of citations per year, it can be seen that the two most cited articles also has the highest number of citations per year since publication. It should, however, be noted that when calculating citations per year, we did not take into account their exact date of publication, i.e. whether an article was published early or late within a given year. Further information about the ten most cited articles on electric vehicles is provided in Table 7.

The ten most cited articles were published in eight different journals. Two journals have more than one article on the top-10 list; two articles on the list were published in Journal of Industrial Ecology, and two articles were published in Transportation Research Part C: Emerging Technologies. Only the latter is included in the top ten list of journals (see Table 1).

5. Conclusions and implications

Electric vehicles' replacing vehicles with internal combustion engines is considered an important contribution to reducing some of the negative external effects of transportation. Research on electric vehicles can, therefore, contribute to reducing climate change. This chapter investigates the evolution of research on electric vehicles from 24 years ago when it was a marginal research topic to it currently being addressed globally by researchers. The data source used is Scopus, which is the world's largest abstract and citation database of peer-reviewed literature. Articles written in English and published in social science journals between 1995 and 2018, containing the term "electric vehicles" were identified and included in the analyses.

During the period investigated, the environment was the most frequent topic of the articles on electric vehicles. It is not unexpected that the environment is often an important reason for conducting research on electric vehicles. It is also worth noting that within the environmental topic there has been an increasing focus on "CO_2 and greenhouse gases".

The findings presented in this book chapter have implications for researchers, funders of research and policymakers. The study of how frequently different topics are treated in the academic literature on electric vehicles can be used to identify under-researched topics, i.e., knowledge gaps. The data gathered in this study do, for example, indicate that relatively less attention has been given to "Behaviour" than other topics related to EVs, which can be somewhat of a concern as it is a stated policy aim in many countries to increase the EV market share. In addition, by identifying the most influential works on electric vehicles, this book chapter provides a list of classic articles with which researchers in the

field should be familiar, that should be components of the curriculum for courses in electric mobility and that provide insight into the evolution of research on electric vehicles within the social sciences and how that research may develop in the future.

Finally, it is worth noting that this study, consistent with all empirical studies, has some weaknesses. These weaknesses relate primarily to the fact that the database from which our data are drawn, i.e., Scopus, does not include all types of research publications. This may be a particular problem in new and quickly emerging fields of research such as electric vehicles. The primary reason is that the process of publishing research in scientific journals is time-consuming because of extensive peer review processes. Therefore, a greater proportion of the research conducted in such emerging research fields will not have had sufficient time to be published in peer-reviewed scientific journals. This study is also limited to studies published in the last 24 years. However, because the field of research only began to grow in the last 10-year period, we believe that our dataset provides a trustworthy picture of the most important topics and most influential articles on electric vehicles in the social sciences.

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