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Review

Dynamic wireless electric transfer technologies for recharging and powering of electric vehicles in smart cities

Bokolo Anthony Jnr.*

Department of Digital Sovereignty, Institute for Energy Technology, Os Alle 5, Halden 1777, Norway

* **Correspondence:** Email: anthony.bokolo@ife.no; Tel: +4741398239.

Abstract: The electrification of vehicles has been considered as one of the possible alternatives to minimize the dependence on fossil fuel and environmental emissions in smart cities. Although there has been increase in the uptake of electric vehicles (EV) in cities its widespread adoption is impacted by different challenges such as limited battery range, high purchase costs, and improved charging convenience. To address these challenges, an innovative technology is proposed termed as dynamic wireless charging technology (DWCT), which is a type of electric road systems (ERS) infrastructure that allows for the propulsion and charging of EV. DWCT helps to charge the EV while in motion. Although previous research has covered the technical aspects of DWCT, the widespread deployment of DWCT in smart cities is limited by different barriers. Hence, there is a gap in the current research regarding institutional and social perspective regarding the barriers that influence DWCT based ERS adoption. Therefore, this article examines the environmental, social, institutional, economic, and technological barriers that impact the adoption of dynamic wireless electric transfer technologies for charging EV in smart cities. Findings from this study further investigate the feasibility of DWCT by identifying recommendations to support road electrification towards the deployment of ERS in smart cities.

Keywords: sustainable transportation; electrification of vehicles; electric vehicles; passenger vehicles; electric road systems; dynamic wireless electric transfer

1. Introduction

Over the years there has been an increase in transport demand in smart cities with reduced

penetration and consumption of renewable energy within the transport sector [1]. As transport, especially road transport, is a key contributor of Greenhouse gases (GHGs), there is a clear need for the transport sector to reduce CO_2 emissions by adopting low-carbon alternatives [2]. This has necessitated the electrification of urban road transport with the use of electric vehicles (EV) especially for passenger vehicles that contribute to sustainable road transport [3,4]. Thus, EV can be the solution to the imminent environmental concerns associated with the transportation sector [5]. Accordingly, the adoption of EV in smart cities has recently become one of the promising decarbonization alternatives for the transport sector. This is because EVs are more sustainable as compared to conventional oil-powered vehicles, especially if charging of the EV is provided via renewable electricity supply [1,6].

Accordingly, governmental policies are now directed to promote the use of electrified vehicles [7]. For instance, the European Commission Directive on the deployment of alternative fuels infrastructure[1] has specifically high targets for EV charging infrastructure. Simultaneously, leading automotive manufacturers are making substantial longstanding investments into electric mobility [3,8]. Despite the potential of EVs in smart cities, the energy storage capacity of EV batteries is not adequate for long-distance travel [9]. Additionally, EV adoption has been slow due to concerns regarding inadequate charging, infrastructure, the range of EVs, and at times long charging times at charging stations [5,6]. The inclusion of larger batteries in EVs is not primarily the solution since they will require a longer duration to recharge or access to charging infrastructures [9].

Moreover, the battery is an important element in EV that encompasses the total weight and cost of the EV, which minimizes the cargo load capacity, as well as the monetary gain regarding less energy demanding vehicles [9,10]. To make the vehicle to be less dependent on the battery, specifically for passenger vehicles, and at the same time decrease the cost of EV, a viable solution could be to transfer electric power to the EV from the roadway termed as electric roads (eRoads) or electric road systems (ERS) [9,11–13]. ERS supply electric power to the EV while it is moving, like a trolley bus or electric train. The deployment of ERS across major routes in smart cities road networks can enable EVs to recharge from the road instead of solely relying on the on-board battery.

The implementation of dynamic wireless charging technology (DWCT) based ERS can help to significantly reduce the capacity of battery required in the EV [1,14,15]. DWCT offer a cordlessly "dynamic" and "wireless" charging approach that has the ability of supplying EVs with limitless driving range while in motion [5,16]. For users (e.g., EV owners), and fleet operators this could contribute to decreasing the size of EV batteries, which would lessen the weight and the cost of EVs. Also, DWCT can improve battery life with lower discharge cycles and can improve the productivity of EV by minimizing long charging duration [5,17]. To this end, this study aims to examine the following research objectives.

- To identify the main infrastructure and stakeholders needed for effective ERS deployment.
- To examine the barriers that impede the deployment of ERS by stakeholders and users in smart cities.
- To present key recommendations to be adopted to support ERS adoption in smart cities.

To address these research objectives, exploratory research is employed grounded in literature to examine the adoption of dynamic wireless electric transfer technologies for powering electric vehicles in smart cities to overcome the relatively high cost of EV batteries and potentially facilitate the electrification of passenger vehicles. The reminder of the paper is structured as follows: Section 2 is the methodology employed, Section 3 is the findings, Section 4 is the recommendations and discussion,

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32014L0094&qid=1748353661720

and Section 5 is the conclusion and future works.

2. Methodology

To examine the adoption of ERS based on dynamic wireless electric transfer technologies for charging EV in smart cities. This article conducts a literature review grounded on secondary data as suggested by Webster and Watsons [18] and Brocke et al. [19] to support in the selection of relevant sources. Accordingly, the collected data are gathered, reviewed and descriptively presented using qualitative analyses. Data was collected from available online databases to provide information on the status quo of ERS and technologies specifically dynamic wireless charging technology that is currently being deployed on public roads or being developed through prior research studies. To select the suitable sources Web of Science, Scopus, and Google Scholar analogous to prior studies [20,21], were used as the online databases to retrieve suitable articles published from 2000 to 2026. The search strings comprise of road electrification, electrification of roads and electric road system and wireless electric transfer and electric vehicle re-charging or powering of electric vehicles and inductive charging or wireless electric power transmission and electric vehicle adoption or EV adoption and smart cities.

Figure 1 depicts the PRISMA literature screening flowchart used for selecting suitable sources. Using the search strings 72 potential articles were retrieved. Next, the retrieved sources were screened by checking their titles and abstracts to evaluate if the papers are aligned to the study area of wireless electric transfer technologies for recharging and powering of EV. In the next step, the full text of the papers was manually scanned, and possible duplicates were excluded afterwards. Using these online databases articles, such as journal papers, conference proceedings, and book chapters, were included. Due to the nature and novelty of the topic being investigated, research project reports, theses, trial results, dissertations, manufacturer information, and technical reports were also included as sources to provide insight on ERS and dynamic wireless electric transfer technologies for powering electric vehicles in smart cities [3,22]. Additionally, inclusion and exclusion criteria were specified to help select only sources that are more aligned to the scope of the study.

For example, studies that did not provide research problems related to ERS specifically wireless electric transfer technologies, did not provide a credible methodology, and did not provide scientific findings were excluded. Also, the selected papers included peer-reviewed and published materials between January 2000 and March 2026 to include the most current research on wireless electric transfer technologies, with exception to the research by Tesla in 1904 proposed the concept of transmitting electrical energy without wires and paper and Schwind in 1998 was granted a patent for the work on armature induction charging of moving EV with batteries. These works are included since they are pioneering research in the study area of wireless electric transfer technologies. The review of the literature was carried out between January 2026 to March 2026. Also, studies not published in English were excluded from this study.

Furthermore, non-English written papers were excluded due to lack of credible translation capabilities. Accordingly, this current study was centered around finding literature related to the main infrastructure and stakeholders needed for effective ERS deployment. Also, studies that provide discussion on the barriers that impede the deployment of ERS by stakeholders and users in smart cities and offer recommendations to be adopted to support ERS adoption in smart cities are included in this review. Based on the inclusion and exclusion criteria out of the 72 sources, 16 sources were excluded, resulting in 56 sources as seen in Figure 1. At the end of the search and screening a total of 56 sources

were included in this review study to provide evidence on the research objectives stated in the introduction section being investigated.

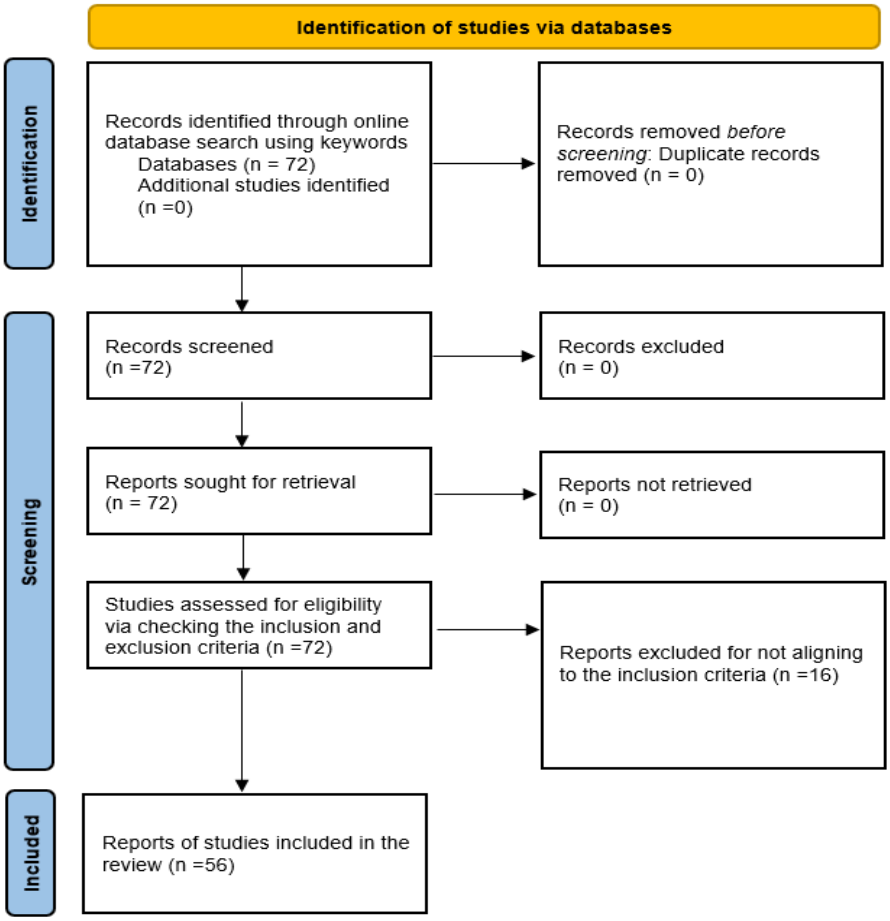


Figure 1. PRISMA literature screening flowchart.

Qualitative data was extracted and synthesized from the selected sources to provide evidence on the adoption of dynamic wireless electric transfer technologies for powering electric vehicles in smart cities.

3. Findings

3.1. Background of road transportation electrification in EU

The climatic ambition for the transport sector within the European Union (EU) is aimed at achieving 65% decrease of CO_2 emissions by year 2050 as compared to the level of emissions within 1990 [23–25]. European countries, such as Sweden and Norway, also have corresponding climatic goals of achieving 70% and 40% reductions respectively in emissions by the year 2030, in comparison to the levels of CO_2 emissions in 2010 and 1990, individually [24,26,27]. Besides, there are other strategies that have been proposed to be employed to reduce the use of fossil-based fuels, such as the use of energy efficient vehicles, use of transport modes that have lower CO_2 emissions per

commuter or goods for freight, and changing to transport means that have low CO_2 emission (e.g., consumption of gaseous fuels, bioenergy-based liquid hydrogen, and electricity) [28,29]. However as mentioned in the literature [24], this current study is more aligned to reduce the use of fossil-based fuel by electrifying the road transport sector.

The electrification of road transport is considered to have a considerable role to play in reaching the EU climate targets [24,25]. As it is projected by the International Energy Agency (IEA) that the number of EV use globally will continue to increase to about 130–250 million by 2030 [24]. The electrification of road transport can lessen the levels of emissions, improve fuel efficiency especially for heavy-duty vehicles (HDVs), and decrease operating costs [5]. The electrification of vehicles (e.g., passenger vehicles, such as electric cars) requires a charging infrastructure at residence, work, and in public places to support charging convenience [30]. Although, the adoption of EVs in smart cities is still slow mainly due to issues such as the driving range capability, specifically for HDVs that consume nearly half of the energy in road transport [5].

Moreover, the widespread adoption of EV is faced with relatively high cost of battery, which typically reduces the affordable range of electric cars to less than 200 kilometers (km). This is a key barrier for the electrification of HDVs in smart cities, such as buses and trucks [1]. Accordingly, over the decade ERS, which deploy dynamic on-road conductive or inductive electric power transfer has been proposed as a technology that enables the EV to charge while it is being driven [24,31], enabling a sustainable alternative charging mode for road transport. Furthermore, the use of renewable energy resources (e.g., hydropower, solar, and wind), deployed in the vicinity of ERS can decrease the electricity costs and associated GHGs [32]. DWCT is one of the types of ERS that provides an alternative charging method while the EV is moving. For electric car users and fleet operators, this could lead to a decrease of the battery size, which also reduces the weight and the overall cost of the vehicle [5].

3.2. Stakeholders' involvement in operationalization of ERS

To fully implement ERS for charging and powering EV, there are system actors and defining users that collaborate and work together to achieve a functional ERS in smart cities. As mentioned in the literature the key actors or stakeholders' involvement for ERS adoption in smart cities can be categorized between suppliers and users of ERS infrastructure as seen in Figure 2.

Accordingly, as shown in Figure 2 the "suppliers stakeholders" comprises of the utility companies, electricity suppliers (e.g., transmission system operators [TSOs]), grid operator or electricity distributors (e.g., distribution system operators [DSOs]), the ERS operator, road owners (both public and private), vehicle manufacturers, original equipment manufacturer (OEM), technology providers (software providers), technology manufacturers (hardware providers), public road administration, road planning authorities, toll companies, insurance company, government bodies/regulators, and ERS service provider [3,8,33]. The "user stakeholders" of ERS involves electric car owners, road owners and operators, the daily operators of HDVs, passenger transport (public bus transport), transport providers such as the road freight operators which transport goods and services (e.g., logistic hubs), freight forwarder, electric taxi services, electric mobility as a service provider (eMaaS), electric car rental service, and electric carpooling service [6,8,33].

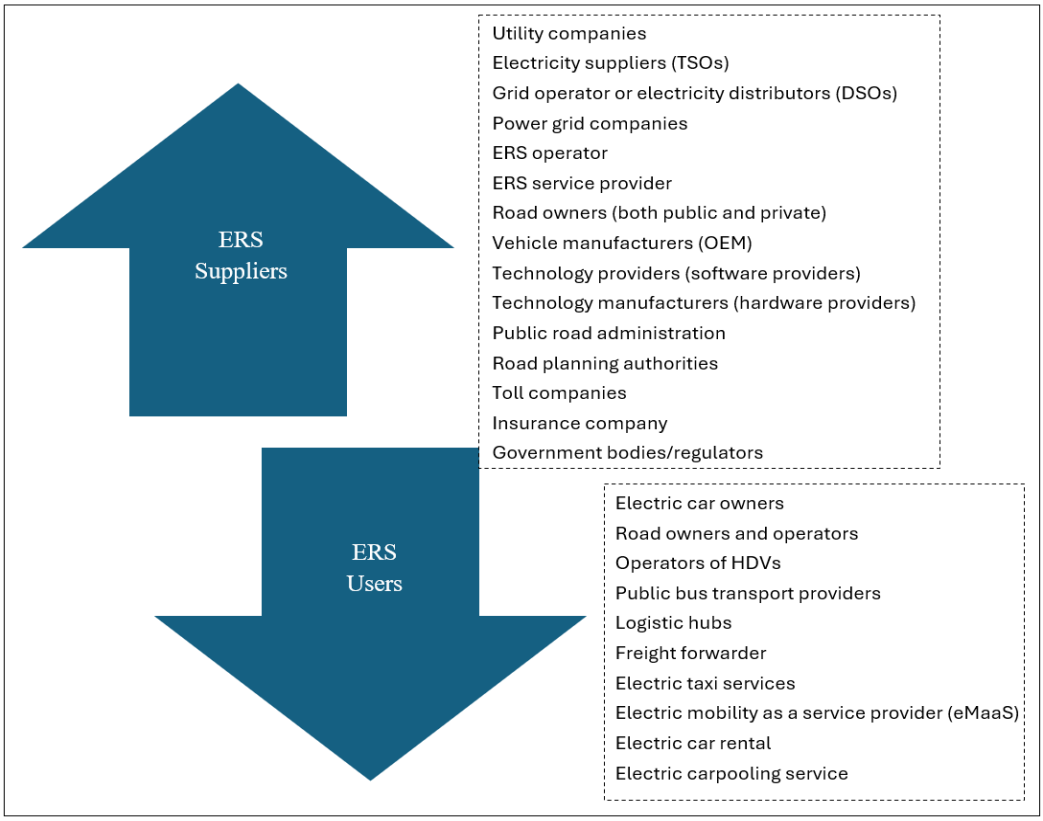


Figure 2. Stakeholders' involvement for ERS adoption in smart cities.

3.3. Applicability of ERS in smart cities

Research and development related to the usefulness of ERS in society have received renewed attention in some countries over the past few years [29,34]. This is because EV battery systems are too heavy for HDVs or long-range vehicles [24,35]. HDVs are projected to be the early adopters of the DWCT due to the higher benefits provided to these vehicles that travel on fixed routes. ERS could generally connect cities enabling the propulsion and charging of EV thereby reducing the need for the vehicle to stop and recharge [9]. This recharges the EV battery and enables the vehicle to leave the electrified portion of the road network with charged battery [36,37]. By doing so, ERS could significantly decrease the capacity of the battery required for an EV [1,38]. Practically, in ERS electric power can be transmitted to the vehicle either from above, from the side, or from under the EV [9].

Within the road network, electric power could also be directly transmitted from an efficient large-scale energy grid through the road directly to the EV [9,39]. ERS is one of the propulsion solutions that contributes to achieve a sustainable transport sector [33]. Although the deployment of a typical ERS infrastructure is presently much costlier more than oil based on data published for 2010 costs from case scenarios in Denmark (see [1]). But due to the increase in CO_2 and fuel costs combined with the decreasing cost of battery and renewable energy. It is projected that in 2050, ERS will be much cheaper than oil based on the plummeting cost of cheaper EV battery [1,32]. Typically, as highlighted in the literature [24,33], ERS infrastructure comprises of three main constituents as seen in Figure 3.

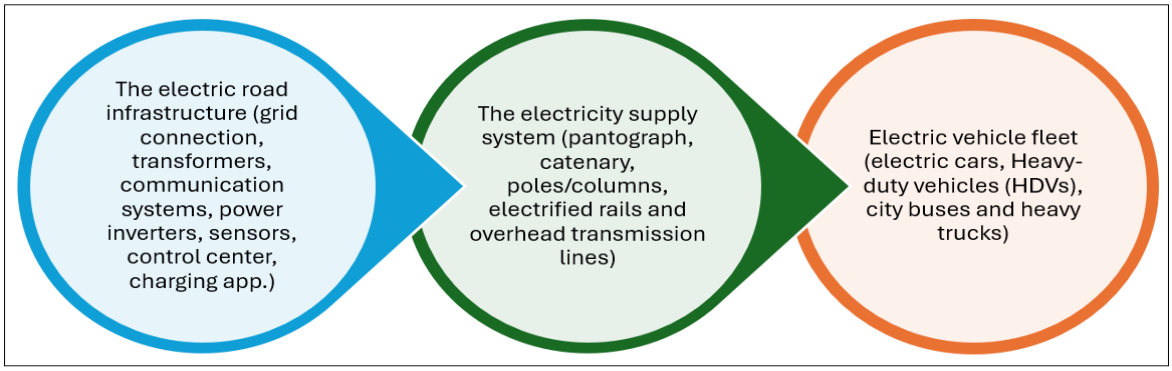


Figure 3. Main constituent of ERS infrastructure in smart cities.

Figure 3 depicts the primary constituents needed to implement ERS in smart cities. Although ERS technologies are still in its early development phase and is being experimented in countries, such as in South Korea, Sweden, Germany, the US, Denmark, etc. [24,27]. As such, there are different types of ERS solutions in the research, development, and testing phases.

3.4. Electric power transfer in ERS

ERS is largely classified into three groups namely inductive (via DWCT), conductive (via catenary or overhead), and conductive (via in-road rail). Both conductive and inductive charging technologies can use different methods to connect to the road vehicle [1,3,5,33]. Originally, prior charging installations connect to the vehicle from overhead, similar with existing tram and rail infrastructure. However, over the years existing charging technologies are now connecting to the vehicle from underneath, enabling both light-and heavy-duty vehicles to utilize the infrastructure [1,5]. The three main ERS technologies use different infrastructures to automatically provide on-demand electrical power transfer for EV, while moving at low and normal traffic speeds (either by quasi dynamic and/or dynamic) [3,24]. Electrical power is either transferred to the on-board battery unit of the EV or can directly powering the EV's propulsion system [3]. The two conductive and inductive charging can be applied to static (stationary) EV charging, each of which is discussed below.

3.4.1. Conductive charging

With conductive charging electric power is directly transferred between the vehicle and the charging system of the road via physical contact making electric power transfer more effective [33]. In a conductive charging, electric power is transferred by establishing physical contact between the EV and a conductor equipment installed onto the road [40]. Thus, in conductive charging the EV is physically connected to the road to receive electric power [1]. As the concept of conductive charging is analogous to many conventional electric trams, trains, and trolley buses. As a result, conductive charging is relatively mature even though it requires some adaptations to be applied to road transport [1]. There are two kinds of conductive charging technologies namely the "over-head catenary lines" and "in-road rail" [5,33]. The "over-head" conductive charging is well-tested and over the years has a high level of technology readiness.

The "over-head" conductive charging uses overhead transmission lines or wires which make

electric power available to vehicles and an active pantograph which is situated on the top of the vehicle and transfers electric power from the contact lines to the vehicle [5,40]. The over-head approach implements constant connection between the moving vehicle and the electric power supply, mostly by using a pantograph that connects to the catenary of the ERS: As over-head technology relies on electric power transmission from a pre-defined distance across the road it is predominantly suitable for HDVs and is not compatible with passenger vehicles [33]. Furthermore, the over-head conductive charging uses an electrical current collector, referred to as a "pick-up", that follows the electrified road acting as the interface between the vehicle and the road [9].

With the moveability of highway vehicles which are HDVs, the pick-up is active in the ERS (which is connected to an electrified rail in the road), with the ability to connect and disconnect depending on the driving behavior of the vehicles and road conditions [5,9,24]. Electricity transfer systems that use overhead transmission lines are mostly conductive. Thus, the dynamic transfer of electric power can be achieved through overhead transmission lines or lines installed into the road. The overhead transmission lines can be utilized by heavy vehicles (i.e., city buses and heavy trucks) [24,41]. This enables the vehicle receiving the electric power to connect to the transmission lines via a type of "pantograph" [24]. Although the over-head conductive charging provides simple way of charging HDVs, the poles/columns and overhead transmission lines are installed on the side of the road installed to the ERS infrastructure which can be considered as a challenge for road safety [41]. Also, there are some challenges related to the roadside maintenance, which are affected by the poles/columns that limits access [33].

Similarly, conductive in-road rail technologies utilize the same electrical power transferring rules as over-head charging by installing rails in the road [5]. Although the in-road rail charging differs from the "over-head" charging as it depends on segmented electrified rails embedded either in or on top of the road surface [33]. However, conductive charging is faced with issues such as the wearing of the charging equipment which is inevitable due to physical contact needed for re-charging of EV [33].

3.4.2. Inductive charging

In inductive charging technology no physical connection between the road and the vehicle is needed [42–45]. Instead of rails in the road, a conductor (akin to the major side of a transformer) installed inside the road creates magnetic field that can be received by the EV which is then converted into electrical current [5,15,46]. Inductive charging technology deploys charging pads or transmitter coils embedded within the roadway that transfer electric power to a pick-up unit under the vehicle without any wired connection between the road and EV [5,47,48]. Hence, to enable the transmission of electric power, inductive charging deploys a type of pick-up, corresponding to the other side of a transformer [9,16].

Additionally, as seen in Figure 3 different roadside technologies, such as power inverters, transformers, grid connection, communication systems, and sensors, are deployed to enable inductive charging. When an EV with compactible receiver coil sensor is detected on the ERS road network, electric power is transferred and delivered actively from the roadside unit [33]. This is managed via a control center that administers the operationalization of the ERS that enables the user to use a "charging app." connected to their EV [14, 33]. Furthermore, inductive charging technology is not only deployed for dynamic charging along the road but can also been exploited to provide static charging at bus stops, parking spots or HDVs loading and unloading areas [33,49].

In inductive charging no coupling and decoupling is required eliminating the wearing on the electrical equipment [5,33]. Similarly, inductive charging makes no visual impact on the physical road surface and does not affect the road safety [33]. Electric power from the connected power grid is converted into high frequency AC power, subsequent resulting in a varying magnetic field that is received or picked up by the receiver coil. The varying magnetic field induces voltage in the secondary coil, leading to electric current in the receiver coil enabling the generation of inductive power. Besides from the receiver coil installed within the vehicle, the vehicle has an electric motor and a battery [33].

3.4.3. Operationalization of dynamic wireless charging technology

In inductive charging electric power is wirelessly transferred from a coil in the road to a receiver coil installed under or in the vehicle as a pickup point [1,24,42], via an electromagnetic field termed in this study as DWCT [1]. DWCT employs wireless power transfer (WPT) system to dynamically deliver electric power to the EV [5]. WPT can be used by different vehicles such as electric cars, electric buses, and trucks [24]. Ground on the literature [5], Figure 4 shows the advantages and disadvantages of associated in deploying DWCT.

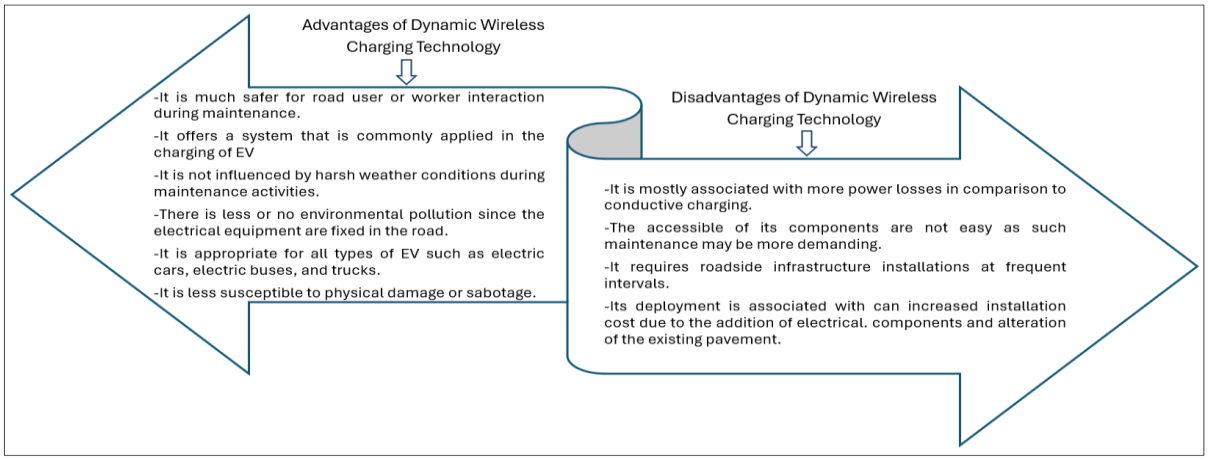


Figure 4. Advantages and disadvantages of DWCT in smart cities.

In DWCT the transmitting coils are placed beneath the road surface or fixed within the roadway pavement and the receiver coil is positioned on the vehicle [5,33]. Electric power is transferred through the electromagnetic field that is generated in the air gap between the transmitter coil and receiver coil for the purpose of charging the vehicle's battery. DWCT requires the receiver coil to be aligned with the transmitter coil for pairing or coupling to occur between the coils and electric power transfer to take place. The transmitter coil uses a power supply to convert between a DC input and the AC transmitter output [5]. The transmitter coils are only energized when a receiver coil equipped within an EV passes on top of each transmitter coil [43–45]. The coupling coefficient between the two coils is a key parameter that determines electric power transfer efficiency and electric power transfer capability of DWCT [5,46]. In recent years, the IPT charging solution has been assessed for charging EVs. For example, Villa et al. [47] demonstrated a 5-kilowatt (kW) IPT system employing a large air gap distance of about 20 centimeters (cm) with an efficiency of up to 95%.

Likewise, Wu et al. [17] tested a 5 kW IPT system to transfer 90% of electric power with an air gap of about 175 millimeters (mm) to about 265 mm. Also, the Oak Ridge National Laboratory (ORNL)[2,3,4] demonstrated an IPT based system with a 270-kW electric power output with a fixed air gap of about 100 mm [3]. The long-range battery energy storage requirement for HDVs is extensive, thus resulting in high costs. The application of DWCT can help lessen this concern [5]. Besides, DWCT can eliminate long charging times thereby improving the EV's battery life with minimal discharge cycles [5]. Although there have been a few pilots and demonstrations showing the applicability of this technology for charging vehicles [1,33]. Many challenges including design of the electrical components, design of the roadway, power distribution, and charging management need to be orchestrated to have a scalable DWCT implementation in smart cities [5]. Also, the integration of DWCT is relatively immature in comparison to conductive charging as such may not be able to support the charging of EVs with high power requirements or highly efficient electric power transfer [1,5,33].

3.5. Barriers that impede the adoption of ERS

Although findings from prior study have identified the requirements that could be drivers or impediments to the deployment of ERS [3]. The adoption of ERS in smart cities is influenced by barriers which have implications on DWCT implementation. Thus, there are numerous environmental, social, institutional, economic, and technological barriers that are to be addressed as seen in Figure 5. Each of the barriers is identified from the literature as shown in Figure 5 and discussed in this section of the paper.

Figure 5 depicts the barriers that hinder the adoption of ERS, such as DWCT, to recharge and power EVs in smart cities. One of the barriers is the lack of initiatives that standardize ERS components can limit higher level of deployment. Thus, standardization work should address applicable interface between the transmitter coil and the receiver coil in DWCT also enabling the transfer of electric power and information between the EV and the roadside infrastructure, required for communication and billing systems [9,33]. Also, the legal and legislative aspects involved in the development of ERS in urban context have not yet been outlined. Such barriers range from electrical safety laws, environmental laws, and land (road network) accesses [9]. Additionally, there is a need for the implementation of standardized interface that supports the ERS to be competitive in future electric mobility market [33]. The implementation process associated with standardization and legal issues should be addressed at the early stage of the ERS deployment [9]. The existence of regulatory framework and legislative instruments for road transport can be a barrier that limits the deployment of ERS. Regulatory framework are initiated to regulate the market and protect the public interest addressing issues related to consumer interest, safety, environmental impacts and business competition [3,50].

[2] https://www.ornl.gov/content/vehicle-charging-goes-wireless

[3] https://www.ornl.gov/news/charging-commute

[4] https://www.ornl.gov/news/polyphase-wireless-power-transfer-system-achieves-270-kilowatt-charge-sets-another-world

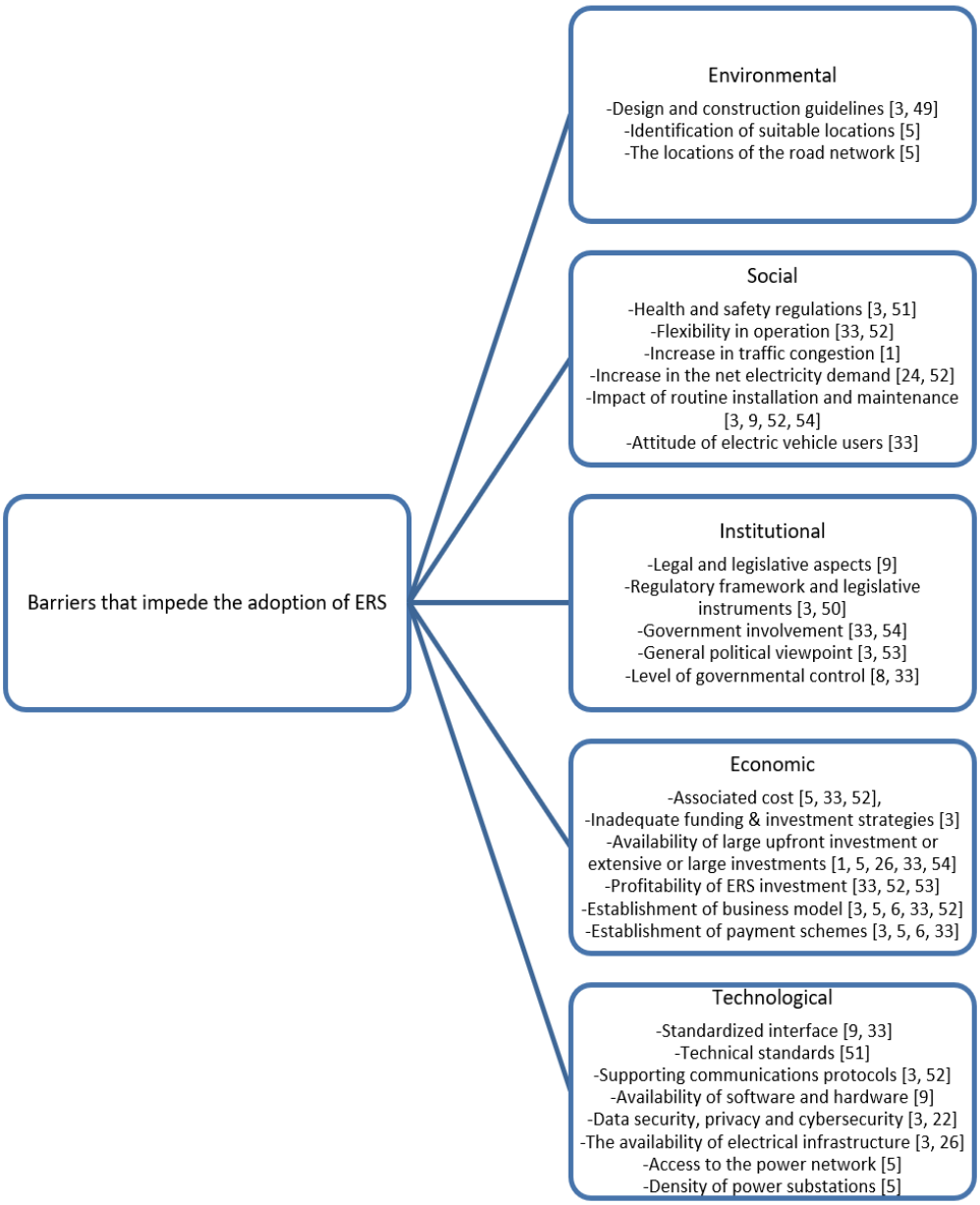


Figure 5. Barriers that impede the adoption of ERS in smart cities.

Furthermore, existing technical standards initiated by respective road administrations are set out to be adopted in the design and construction of roads to govern design specifications for ERS installation [51]. These standards govern what materials and design specification to be adopted for ERS installation enabling structural integrity of the road structure and safe operation of the roads. However, there are lack of design and construction guidelines provided specifically for ERS implementation [3]. The possibility to achieve feasibility of ERS in relation to how the technology is able to deliver high levels of electric power suitable for HDVs use [49]. This relates to how reliable the current ERS systems are not only in enabling seamless electric power transfer but also in supporting communications protocols used by ERS infrastructures [3,52]. The availability of software and hardware infrastructure is a factor that is required to enable the transfer of electric power needed to be developed before the widescale ERS operation. As such, there is need to assess

how the software and hardware systems interact with the power substations differ between high and low voltage components [9].

Evidence from prior studies highlighted that the charging power from prior ERS was mainly diminished due to air gap tolerance and poor alignment or misalignment of EVs with respect to the wireless charging infrastructure [52,53]. Its is suggsted that this issue could be adressed with the provision of accessible driver training with incentives, electronic driving assistance systems, heads-up displays (HUDs) or acoustic systems that provide support for better alignment with the wireless charging infrastructure. Also, it will be helpful if existing wireless charging infrastructure are equipped with a higher air gap and misalignment tolerance [52,53].

The general political viewpoint on the potential of ERS is a factor that determines policies related to the deployment and adoption of this technology [3,53]. Thus, government involvement is needed in a roll-out phase of ERS deployment, but at a later phase the implementation could be supported by private actors. As the road infrastructure systems in European counties, such as in Sweden, are mainly publicly owned and funded as such are regulated by the Swedish Transport Administration who manage the management of national highways [33,54]. On the contrary, the energy market is regulated and typically controlled by private businesses that operate under EU legislation. The integration of regulative forces from the governmental and private sector is a challenge for the widespread of ERS [33]. Therefore, there are uncertainties regarding the level of governmental control regarding ERS system operation. For instance, what role should the public road administration and other stakeholders play in the operationalization of ERS and how will the stakeholder and user ecosystem be designed [8,33].

The identification of suitable locations for deploying ERS typically depends on the road environment (e.g., terrain features), and road characteristics (e.g., proposed length of the electrified road). As such, it is recommended that the deployment of ERS should be situated in existing road network without physical constraints on the road environment [5]. Thus, the locations of the road network can be considered as a factor that can affect the deployment of ERS. For example, the occurrence of flooding or water accumulation can result in risk causing damage to the ERS infrastructure [5]. Another importanct factor relates to health, and safety regulations should be strictly adhered to road users and road owners. This relates to the risks regarding electrocution and the consideration of road workers safety especially during maintenance operations [3]. To help assess the safety issues associated with ERS, there is a need to adhere to electrical safety standards and risk assessment models [51]. For example electrical equipment should not be easily accessible to the public such as roadside equipment should be securely isolated to inhibit deliberate or accidental contact with potentially large electric currents [3].

All these operation can be vulnerable to breaches of users data; hence, data security, privacy and cybersecurity is another factor that has to be considered espcially as all ERS require software systems for energy management, control and optimization, transfer, and billing purposes [3,22]. The flexibility in operation of ERS is a factor that influences the adoption of this technology. For example, EV owners should be able to operate and use the electrified road as many hours of the day as possible [33]. As the deployment of ERS depend on the type of installation and materials of the charging infrastructure [52]. Thus, the availability of electrical infrastructures needed to deploy ERS is a factor that may delay the the development of this technology. As such, there is need to consider procurement and supply issues if the industry has the capability of supplying the needed materials in the quantities required for large scale ERS installations [26]. Likewise, is the automotive industry able to manufacture adequate ERS

compatible vehicles within a short period thereby encouraging uptake of ERS [3].

Deployment strategy should be initiated to ensure the availability of electric power enabling access to the power network (accessibility to the electric power network). Another related factor relates to the identification of optimal locations where ERS can be built. For this finding from the literature [5], suggested that the distance of ERS from power substations should be less than "1 mile" to the roadway to ensure sufficient electric power distribution. Although, this highlighted distance may vary in relation to the density of power substations in the area where ERS is to be built [5]. The anticipated loading/capacity from the power substations should also be anticipated since it will influence the power capability of the ERS thereby determining the suitability of each power substation for connection to the entire electrified road network. One of the major barriers for the deployment of ERS is associated cost [5,52].

For potential ERS stakeholders, costs relate to owning and operating ERS compatible vehicles; thus, vehicle investment, cost of service, and maintenance all create uncertainties [33]. Also, there is electrical infrastructure cost related to the power distribution and charging systems [5]. Accordingly, there are inadequate funding and investment strategies needed to support the finance, ownership, and maintenance of ERS systems [3]. Thus, ERS development is hindered by the availability of large upfront investment or extensive or large investments in infrastructure that are required for achieving fully operational system. As investments cannot be completely covered via government financing, private actors and stakeholders need to be involved in early investments [1,33,54]. For example, evidence from the prior study [33] reported that the Swedish government have committed to support half of the financial costs needed for initial testing of ERS projects, but the remainder must come from private funding. Furthermore, it is expectation that ERS adoption will be economically feasible [5,26].

Findings from the Swedish Transport Administration estimated that transitioning to ERS will contribute to lower costs for fuel as compared to conventional diesel vehicles [33]. Also, evidence from the literature highlighted that the adoption of ERS has the potential to provide competitive advantage for its EV users partly by reducing their operational cost [33,52]. Also, there is an interest among direct users that ERS can support profitable investments for EV owners [33,53]. Nevertheless, EV owners are concerned that ERS compatible vehicles will be inadequate in the early phase of ERS development. It is projected that this will impact on the profitability of ERS investment. Similarly, the investment cost needed for purchasing an ERS compatible vehicle is not established yet, creating further uncertainties [33, 53]. Moreover, there are uncertainties associated with the establishment of business model and payment schemes, such as pay-by-use and other types of subscription models [33,52].

This necessitates the development of innovative business models needed to accelerate the commercialization of ERS [5,6]. The business model will comprise the identification of value proposition, users as customers, revenue sources, expenses, and the stakeholders/actors involved in delivery of ERS [3]. The adoption of ERS could lead to increase in traffic congestion especially in densely populated cities if this technology is accepted by EV road users in the future [1]. Likewise, the electrification of road transport will increase the net electricity demand. Thus, there is need to set up contingencies to manage the amount of electric power (how much), if it correlates with peaks in energy use (when), and how the new load (ERS) will be geographically allocated (where) as the use of ERS increases [24,52].

The deployment of wireless infrastructures comprises of coil embedment and pavement durability for construction site logistics, civil engineering works preparation, coil installation, and asphalt road paving [52]. Also, there are concerns regarding the impact of routine installation and maintenance of

the embeded coils, as well as the for lasting pavement durability, may have an impact on the operation of the wireless charging systems expecially during the rainy and winter seasons [3,54]. Thus, to support proper functioning of ERS there is a need for new routines for winter road maintenance. This may involve maintenance equipment, such as graders and plow trucks, that do not district any raised road installation [9]. However, there is a need for de-icing and snow removal tools that reduce the risk of water accumulation within the joints between the ERS installation on the road surface that can cause frost damage [9]. Also, there is a need for maintenance pavement of asphalt regarding changing electrical installations installed on the road segment which may require the closure of the lanes [9]. The attitude of EV users is a factor as most use may choose to adopt conventional technologies in which they have prior knowledge in. Thus, the lack of knowledge in ERS is a barrier that limits the widespread adoption of this technology [33].

4. Discussion and recommendations

This study explores the state-of-the-art of ERS presenting the types of ERS (inductive [via DWCT], conductive [via catenary or overhead], and conductive [via in-road rail]). Analogous to prior studies [3,5], findings from this article review the main constituent of ERS infrastructure and stakeholders' involvement for ERS adoption in smart cities. The current study contributes to the literature by exploring the main infrastructure and stakeholders needed for effective ERS deployment, identifying the barriers that impede the deployment of ERS by stakeholders and users in smart cities and finally providing recommendations to be adopted to support ERS adoption in smart cities. Key findings from this study present ERS systems in terms of the type of charging technologies they employ (static or dynamic) in relation to the road surface (conductive overhead or catenary, in-road rail, or in-road inductive via DWCT) and the types of EV that can be charged (electric cars, electric buses, HDVs for freight). Findings from this study provide the advantages and disadvantages of DWCT and further present a comprehensive review of barriers that can influence the adoption of ERS, such as DWCT, for re-charging and powering EVs in smart cities. These findings will be beneficial for transportation planners and decision makers who are interested in designing and deploying electrified road networks. Also, to gain public support by creating community engagement strategies with the public informing mainly EV owners of the potential benefits of ERS thereby getting their support for widespread adoption [3,21].

To support the development of ERS technology, government and policymakers should allocate more funding to accelerate projects on the electrification of roads, as a means for the cost-effective decreasing transportation. There is need for collaboration with key stakeholders from the vehicle, electricity, road, and construction/building sectors in combining their skills and backgrounds to enable the implementation of ERS [1]. The involvement of governmental agencies and safety associations by initiating regulatory frameworks and technical standards for ERS can accelerate the acceptance and update of ERS technology [3,20]. Findings from this study presents evidence on the economic feasibility and future competitiveness of ERS, considering infrastructure investment, electricity grid integration, energy losses, and maintenance requirements on deploying wireless electric transfer technologies for recharging and powering of EV in smart cities. Moreover, findings from this study are also analogous with results from prior studies [3,54], which highlighted that the adoption of ERS for powering EVs is faced with barriers ranging from installation, operational, and maintenance costs; impact of the deployment on the road network; and existing regulatory and business models being

employed for charging EVs.

Similar to the results from [53], the findings indicate that technical feasibility, safety and security, ownership, and governmental (political) influence increase in electricity demand and user acceptance, and users' opinion can influence the widespread adoption of ERS, such as DWCT [53]. Although prior studies, such as Wang et al. [55], examined dynamic wireless charging for lane reversal towards achieving a connected and automated EV deployment in highway and Zhang [56] explored eco-driving control towards improving connected and automated EV at signalized intersections deploying wireless charging, there are fewer studies directed to investigate barriers shown in Figure 5 that can help ERS service providers, operators, and other stakeholders (as seen in Figure 2) knowledge in implementing ERS technology. Findings from the literature argued that the initiation of regulations and provision of incentives can support the adoption of ERS in smart cities [5]. Although evidence from the literature mentioned that the investment costs are very high for ERS [1], investment in renewable energy resources (RES) (e.g., solar, hydropower, and wind turbines) in the locality of ERS can decrease the electricity costs and associated GHG emissions. To support the electrification of roads the use of RES can be supplemented with battery energy storage systems for decreasing impacts on the power grid. Also, the application of DWCT has the potential to accelerate the inclusion of autonomous vehicles, in smart cities [33].

There is a need for road vehicles to communicate with one another while connected to ERS infrastructure. This will promote the operation of the electrified road network and enhance traffic flow. Thus, ERS infrastructure could be exploited to improve telecommunication networks, via wireless communication employed by EVs driving along the electrified road thereby facilitating self-driving or autonomous cars [1]. Moreover, DWCT can support the development of autonomous vehicles with the use of road sensors installed on the electrified road network providing tracking and provision of guidance for the positioning of autonomous vehicles [33]. The adoption of ERS might have implications that impact stakeholders within the transport market, as they may have limited resources to adopt DWCT. As such, considerations are to be made regarding the operation and management of ERS. Issues related to ethical consideration, data governance and sovereignty must be addressed to have safe and secure ERS operations in smart cities [22,33].

Furthermore, data governance strategies can contribute to address data leaks or misuse that can result in unsafe for ERS users. For example, the adoption of ERS in current traffic operations might change the traffic behaviors and possibly increase the risk of traffic accidents [33]. Additionally, findings from this study advocate for the applicability regulations, standards, and guidelines that stakeholders, such as road operators, should consider for the deployment of ERS either conductive or/and inductive electric power transfer solutions. To ensure safe use of ERS, especially for DWCT where the main concern is the effect of electromagnetic (EM) exposure on humans and animals due to inductive power transfer via the air gap. The ICNIRP guidelines for wireless charging[5] or IEEE 2867-2024[6] standards can be followed to provide recommendations that are to be complied regarding EM exposure. Likewise, for conductive for in-road rail solutions, the exposure of live rails/wires, the IEC 62128 series[7] which ensures that hazardous live parts should not be accessible. For conductive catenary or overhead, the cable should be out of contact with humans with appropriate clearance [3].

[5] https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf

[6] https://standards.ieee.org/ieee/2867/10179/

[7] https://webstore.iec.ch/en/publication/6496

5. Conclusions

The current increase in demand for the mobility of people, goods, and services within the transport sector necessitates the need for low-carbon solutions, such as ERS, which enable lighter and heavy-duty vehicles road transport to be electrified, such as electric cars, buses freight, and trucks. ERS offers an alternative for decarbonizing land transport. The electrification of passenger cars, private car transport or lighter vehicles, and heavy-duty vehicles can contribute to the reduction of CO_2 emissions from the transport sector. However, for the electrification of the transport sector to be fully successful, certain barriers need to be addressed. Moreover, the institutional and social perspective in the adoption of ERS has not been well explored in previous research as there is a need to build knowledge from this perspective by examining the adoption of ERS from the environmental, social, institutional, economic, and technological lens (as seen in Figure 4). Accordingly, this study aims to explore institutional and social perspective regarding the environmental, social, institutional, economic, and technological barriers that influence DWCT based ERS adoption, thus contributing to existing research in sustainable transport.

The identified barriers can be considered by policy makers to drive ERS adoption in smart cities. Key findings from this study present a review of road transportation electrification in EU, identifies the stakeholder's involvement for ERS. The findings further highlight the applicability of ERS in smart cities and review existing electric power transfer in ERS comprising of catenary or overhead conductive charging, in-road rail conductive charging, and inductive charging based on dynamic wireless charging technology. Findings from this study offer valuable insights on usefulness of dynamic wireless electric transfer technologies for powering electric vehicles in smart cities. These insights are not only valuable for public road administration and road planning authorities but also valuable for ERS operators, ERS service providers, and vehicle manufacturers when designing the future landscape for electric roads networks. Future research can work toward exploring additional requirements needed for upscale development of DWCT-based ERS. Furthermore, primary data will be collected from survey questionnaires to evaluate the identified barriers that influence the adoption of ERS in smart cities.

Use of AI tools declaration

The author(s) declares that Artificial Intelligence (AI) tools were not used in the creation of this paper.

Conflict of interest

The author declares that there are no conflicts of interest.

References

1. Connolly D (2016) eRoads: A comparison between oil, battery electric vehicles, and electric roads for Danish road transport in terms of energy, emissions, and costs. Aalborg Universitet. Available from: https://vbn.aau.dk/ws/portalfiles/portal/237844907/David_Connolly_eRoads_2016.pdf.

2. Ainalis D, Thorne C, Cebon D (2023) Technoeconomic comparison of an electric road system and hydrogen for decarbonising the UK's long-haul road freight. *Res Transp Bus Manag* 48: 100914. https://doi.org/10.1016/j.rtbm.2022.100914
3. Bateman D, Leal D, Reeves S, et al. (2018) Electric road systems: A solution for the future? (No. 2018SP04EN). Available from: https://trid.trb.org/View/1570673.
4. Anthony Jnr B (2025) Enabling intelligent internet of energy-based provenance and green electric vehicle charging in energy communities. *Energies* 18: 4827. https://doi.org/10.3390/en18184827
5. Konstantinou T, Haddad D, Prasad A, et al. (2021) Feasibility study and design of in-road electric vehicle charging technologies. *Joint Transportation Research Program Publication, West Lafayette, Purdue University.* https://doi.org/10.5703/1288284317353
6. Anthony Jnr B (2021) Integrating electric vehicles to achieve sustainable energy as a service business model in smart cities. *Front Sustain Cities* 3: 685716. https://doi.org/10.3389/frsc.2021.685716
7. Aronietis R, Vanelslander T (2024) Economic impacts of the catenary electric road system implementation in Flanders. *Int J Sustain Transp* 18: 46–61. https://doi.org/10.1080/15568318.2023.2197865
8. Anthony Jr B (2023) Data enabling digital ecosystem for sustainable shared electric mobility-as-a-service in smart cities-an innovative business model perspective. *Res Transp Bus Manag* 51: 101043. https://doi.org/10.1016/j.rtbm.2023.101043
9. Olsson O (2013) Slide-in electric road system, inductive project report, phase 1. Scania CV AB, 65. Available from: https://www.diva-portal.org/smash/record.jsf?pid=diva2:1131846.
10. Bakker J, Lopez Alvare JA, Buijs P (2024) A network design perspective on the adoption potential of electric road systems in early development stages. *Appl Energy* 361: 122887. https://doi.org/10.1016/j.apenergy.2024.122887
11. Chen F, Taylor N, Kringos N (2015) Electrification of roads: Opportunities and challenges. *Appl Energy* 150: 109–119. https://doi.org/10.1016/j.apenergy.2015.03.067
12. Connolly D (2017) Economic viability of electric roads compared to oil and batteries for all forms of road transport. *Energy Strateg Rev* 18: 235–249. https://doi.org/10.1016/j.esr.2017.09.005
13. Brown AL, Fleming KL, Safford HR (2020) Prospects for a highly electric road transportation sector in the USA. *Curr Sustainable/Renewable Energy Rep* 7: 84–93. https://doi.org/10.1007/s40518-020-00155-3
14. Suh IS, Kim J (2013) Electric vehicle on-road dynamic charging system with wireless power transfer technology. In *2013 International Electric Machines & Drives Conference*, 234–240. https://doi.org/10.1109/IEMDC.2013.6556258
15. Coban HH, Rehman A, Mohamed A (2022) Analyzing the societal cost of electric roads compared to batteries and oil for all forms of road transport. *Energies* 15: 1925. https://doi.org/10.3390/en15051925
16. Lee S, Huh J, Park C, et al. (2010) On-line electric vehicle using inductive power transfer system. *2010 IEEE Energy Conversion Congress and Exposition*, 1598–1601. https://doi.org/10.1109/ECCE.2010.5618092
17. Wu HH, Gilchrist A, Sealy KD, et al. (2012) A high efficiency 5 kW inductive charger for EVs using dual side control. *IEEE Trans Ind Inform* 8: 585–595. https://doi.org/10.1109/TII.2012.2192283

18. Webster J, Watson RT (2002) Analyzing the past to prepare for the future: Writing a literature review. *MIS Q* 26: xiii–xxiii. https://doi.org/10.2307/4132319
19. Brocke JV, Simons A, Niehaves B, et al. (2009) Reconstructing the giant: On the importance of rigour in documenting the literature search process. *ECIS 2009 Proceedings*, 161. Available from: https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1145&context=ecis2009.
20. Anthony Jr B (2026) Cost-Pricing mechanisms for sustainable rural electrification in local energy communities. In: Walker T, Gramlich D (eds) *The Palgrave Handbook of Sustainable Finance*. Cham: Springer Nature Switzerland, 201–221. https://doi.org/10.1007/978-3-031-98736-6_10
21. Anthony Jr B (2026) Citizen participation and engagement in local energy communities: Governing Sustainable energy transitions through human-centric approaches. *Energies* 19: 917. https://doi.org/10.3390/en19040917
22. Anthony Jr B (2025) Distributed energy prosumer communities and the application of emerging technologies: A systematic literature review. *Sustainable Futures* 9*:* 100794. https://doi.org/10.1016/j.sftr.2025.100794
23. Langhelle O, Bohne R, Nörbech TE (2018) Electric roads in Norway: Summary of a concept analysis. *Electric Infrastructure for Good Transport (ELinGO), PDF Report*. Available from: https://www.sintef.no/globalassets/project/elingo/18-0733-engelsk-sluttrapport.pdf.
24. Taljegård M (2019) Electrification of road transportation-implications for the electricity system. Chalmers University of Technology (Sweden). Available from: https://research.chalmers.se/publication/512771/file/512771_Fulltext.pdf.
25. Hacker F, Jöhrens J, Gather M, et al. (2023) Expansion strategies for electric road systems (ERS) in Europe. Available from: https://electric-road-systems.eu/e-r-systems-wAssets/docs/CollERS-2-Discussion-paper-4-Expansion-strategies_2023-08-04.pdf.
26. Baalsrud Hauge J, Shreenath V, Meijer S, et al. (2015) Feasibility study on societal perspectives towards on road charging and set of current data regarding societal dimension. *FABRIC: Athens, Greece*. Available from: https://cordis.europa.eu/project/id/605405/results.
27. Jelica D, Taljegard M, Thorson L, et al. (2018) Hourly electricity demand from an electric road system—A Swedish case study. *Appl Energy* 228: 141–148. https://doi.org/10.1016/j.apenergy.2018.06.047
28. de Saxe C, Ainalis D, Miles J, et al. (2023) An electric road system or big batteries: Implications for UK road freight. *Transp Eng* 14: 100210. https://doi.org/10.1016/j.treng.2023.100210
29. Flores-Gandur R, Vassallo JM, Sobrino N (2025) Assessing the socioeconomic impacts of an inductive electric road system (ERS) for decarbonizing freight transport: A case study for the TEN-T corridor AP-7 in Spain. *Sustainability* 17: 2283. https://doi.org/10.3390/su17052283
30. Schulte J, Ny H (2018) Electric road systems: Strategic stepping stone on the way towards sustainable freight transport? *Sustainability* 10: 1148. https://doi.org/10.3390/su10041148
31. Othman K, Da Silva D, Shalaby A, et al. (2026) TALe-Bus: An interactive dashboard for electric bus fleet electrification planning. *AIMS Energy* 14: 732–759. https://doi.org/10.3934/energy.2026030
32. Domingues-Olavarría G, Márquez-Fernández FJ, Fyhr P, et al. (2018). Electric roads: Analyzing the societal cost of electrifying all Danish road transport. *World Electr Veh J* 9: 9. https://doi.org/10.3390/wevj9010009

33. Borin F, Tjernlund L (2020) Exploring barriers towards adoption within electric road systems: A Case study of the user perspective. Available from: https://www.diva-portal.org/smash/get/diva2:1461085/FULLTEXT01.pdf.
34. Gustavsson MG, Lindgren M (2020) Maturity of power transfer technologies for electric road systems. In *Transport Research Arena 2020, Helsinki, 27–30 April 2020 (Conference canceled)*. Finnish Transport and Communications Agency. Available from: https://www.diva-portal.org/smash/record.jsf?pid=diva2:1414333.
35. Wang Y, Li S, Zhao Y, et al. (2025) Research on the modeling and simulation of the rural Photovoltaic-Biogas-Storage Direct-Current and Flexible Architecture System. *AIMS Energy* 13: 879–900. https://doi.org/10.3934/energy.2025032
36. Anthony Jr B (2024) Enabling sustainable energy sharing and tracking for rural energy communities in emerging economies. *Renewable Energy Focus* 51: 100633. https://doi.org/10.1016/j.ref.2024.100633
37. Anthony Jr B (2024) Decentralized AIoT based intelligence for sustainable energy prosumption in local energy communities: A citizen-centric prosumer approach. *Cities* 152: 105198. https://doi.org/10.1016/j.cities.2024.105198
38. Tooki OO, Popoola OM, Pam JD (2025) Towards sustainable energy: Implementation framework for a decentralized peer-to-peer transactive energy system. *AIMS Energy* 13: 962–986. https://doi.org/10.3934/energy.2025036
39. Jakobsson N, Hartvigsson E, Taljegard M, et al. (2023) Substation placement for electric road systems. *Energies* 16: 4217. https://doi.org/10.3390/en16104217
40. Karlsson A, Alaküla M (2021) Energy supply to buses on a conductive electric road: An evaluation of charger topologies and electric road characteristics. *World Electr Veh J* 12: 241. https://doi.org/10.3390/wevj12040241
41. Márquez-Fernández FJ, Schuch S, Lindgren L, et al. (2019) Electric safety challenges with a conductive electric road system—chassis potential modeling and measurement. *World Electr Veh J* 10: 30. https://doi.org/10.3390/wevj10020030
42. Tesla N (1904) The transmission of electrical energy without wires. *Electr World Eng* 1: 21–24. Available from: https://www.academia.edu/download/35400414/Tesla_-_The_Transmission_of_Electrical_Energy_Without_Wires.pdf.
43. Schwind JP (1998) Armature induction charging of moving electric vehicle batteries. *U.S. Patent 5,821,728.* Available from: https://patentimages.storage.googleapis.com/pdfs/US5821728.pdf.
44. Abe H, Sakamoto H, Harada K (2002) A noncontact charger using a resonant converter with parallel capacitor of the secondary coil. *IEEE Trans Ind Appl* 36: 444–451. https://doi.org/10.1109/28.833760
45. Mude KN (2018) Battery charging method for electric vehicles: From wired to on-road wireless charging. *Chin J Electr Eng* 4: 1–15. https://doi.org/10.23919/CJEE.2018.8606784
46. Plötz P, Andersson M, Scherrer A, et al. (2024) The possible future of electric road systems in Europe—time to decide and act. *Environ Res: Infrastruct Sustainability* 4: 013001. https://doi.org/10.1088/2634-4505/ad3576
47. Villa JL, Llombart A, Sanz JF, et al. (2007) Practical development of a 5 kW ICPT system SS compensated with a large air gap. In *2007 IEEE International Symposium On Industrial Electronics*, 1219–1223. https://doi.org/10.1109/ISIE.2007.4374772

48. Chawla N, Tosunoglu S (2012) State of the art in inductive charging for electronic appliances and its future in transportation. In *2012 Florida Conference on Recent Advances in Robotics*, 1–7. Available from: https://www.semanticscholar.org/paper/State-of-the-Art-in-Inductive-Charging-for-and-its-Chawla-Tosunoglu/56f78580d7261ac8c8110cbe68a1541c4551d479.
49. Speth D, Funke SÁ (2019) A techno-economic comparison of battery swap and electric road systems for heavy road transport. A German case study. In *Proceedings of the 3rd Electric Road Systems Conference*. Available from: https://publica-rest.fraunhofer.de/server/api/core/bitstreams/75636808-3669-46f2-83c7-77e4607ac87d/content.
50. Wang Q, Berlin D, Meijer S (2019) Uncovering stakeholder influences in electric road systems using two assessment methods: The case of eRoadArlanda. *Res Transp Bus Manag* 33: 100422. https://doi.org/10.1016/j.rtbm.2019.100422
51. Wenander D, Alaküla M (2024) Reducing the environmental impact of large battery systems with conductive electric road systems—a technical overview. *World Electr Veh J* 15: 59. https://doi.org/10.3390/wevj15020059
52. Wendt A, Arnold M, Ezer O, et al. (2024) Wireless electric road systems—technology readiness and recent developments. In *2024 IEEE Wireless Power Technology Conference and Expo (WPTCE)*, 177–182. https://doi.org/10.1109/WPTCE59894.2024.10557264
53. Anthony Jr B (2026) Wireless electric road system for propulsion and charging of electric vehicles in highways. *Renewable Energies*, 4. https://doi.org/10.1177/27533735261453482
54. Anthony Jr B (2026) Adopting electric road technologies and energy systems for the electrification of municipal electric buses. *Energies* 19: 3622. https://doi.org/10.3390/en19153622
55. Wang T, Zhang J, He J (2023) Dynamic wireless charging lane reversal for connected and automated electric vehicles in highway. *Sustainable Energy Technol Assess* 57: 103206. https://doi.org/10.1016/j.seta.2023.103206
56. Zhang J, Tang TQ, Yan Y, et al. (2021) Eco-driving control for connected and automated electric vehicles at signalized intersections with wireless charging. *Appl Energy* 282: 116215. https://doi.org/10.1016/j.apenergy.2020.116215



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