Electrification of Transportation in the European Union

An IEEE European Public Policy Committee Position Statement

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More than in any other period of the modern industrial economy, the public is now concerned with the environmental impact of technology. The use of electricity for transportation is not a new idea. Historically, electric motors were first used in river boats in 1838, while other means like railways around the world have used electricity to drive trains and trams for many years. This was due to the nature of the railway, with defined routes allowing power to be routed effectively along the railway lines. Nowadays electrification has gained interest in all transportation means.

The internal combustion engine gave transportation a degree of flexibility that the railways could not. The ability to travel in an ad-hoc manner, without having access to an energy infrastructure, gave motorised vehicles a freedom to access places where the railway could not. However, this came at the expense of the increased usage of fossil fuels to drive the transportation growth during the 20th century.

This position paper follows publications by the European Union (EU) on Electrification of Transport[2,3], the resolutions of the Paris Convention and the Green Deal, as well as the EU Directives and Recommendations related to the sustainable transformation of all energy related sectors including all types of transport in the era of decarbonisation.

Recommendations

- Investments in an integrated transportation strategy covering more efficient and coordinated transportation of people and goods, with a view to minimising the use of energy and overall carbon emissions.
- Charging infrastructure investment for passenger and goods vehicles; policy makers should focus on enhancing the rollout of a smart-charging infrastructure, including via private sector participation.
- A thorough assessment of the interaction between electric vehicles and the grid with a high proportion of renewables; public policies to encourage e-mobility and smart charging of electric vehicles so that ubiquitous grid-friendly charging can be provided.
- A thorough assessment of the challenges emerged by the electrification of maritime transportation as reflected in the transformation of ports into energy hubs.

[1] This position statement is an update of the 2017 EPPC position statement on electrification of transportation in the European Union.
[2] European Roadmap – Electrification of Road Transport, 2nd Edition June 2012
[3] Electrification of the Transport System, Studies and Report (2017), European Commission Directorate General for Research and Innovation. Directorate H – Transport, Unit H.2 – Surface Transport

- Research and development of higher capacity and longer life battery technology and alternative energy storage systems to increase the range capability of electrified transportation.
- Energy harvesting, waste heat recovery based on electric generators driven by Organic Rankine Cycle thermal engines or based on thermo-electric generators (TEG's), regenerative braking and other recycling techniques based on full or partial electrification should be encouraged to increase the working range of electrified transportation.
- Standardization in these areas to address interoperability, manufacturing economies and distributed sourcing of key components and systems.

Background Information – The Current Situation with Electrified Transportation

Along with the drive towards zero carbon economies, removing coal and gas-fired generation from the supply chain, the use of electricity as the energy source for transportation has grown.

- Many railways globally use electrical power systems to drive trams, as well as local, regional and international rail services.
- Electric cars, vans, trucks and buses are reaching technological maturity for reliable use in urban environments.
- For passenger vehicles, ranges of 600 km are already available, with high-power and the ability to quickly recharge, that allows for long distance traveling; longer ranges still can be achieved by hybrid vehicles.
- Heavy-duty, long-range vehicles present much more of a challenge due to their high-energy requirements.
- Urban public transport has experienced a clear shift towards electric buses due to their substantial increase in energy efficiency and environmental benefits.
- The primary drive for several large ships (e.g., cruise ships) is now an electrical propulsion system, although they may still require environmentally friendly fossil fuels for generating on-board electricity. Moreover, battery based waterborne vessels with electric propulsion are used for short-sea shipping applications like shuttle-ferries, tugboats, port support vessels and offshore plant support vessels. The existing battery technology seems sufficient for ships covering distances of up to 20 n.m. (~33 km). DC network seems a favourable solution for the power distribution network onboard ships. Finally, in big commercial waterborne vessels, there is a series of electrified measures that tend to be exploited along with alternative fuels and other emission reduction techniques (e.g., shaft generators, energy harvesting equipment along with batteries, etc.).
- Aviation is a developing area for electrification. While there are few viable alternatives for the main propulsion unit, most other systems in the aircraft are being electrified. The prospect of an all-electric aircraft is being explored by prototype aircraft, such as the recent flight by a solar powered craft around the globe.

A significant challenge for these technologies is that the cost of energy from a modern battery is higher than that from petroleum fuels. Therefore, a strategic approach is necessary to incentivize the integration of electrified transportation into the overall energy system to reduce carbon emissions.

The rapid development of battery technology has largely been due to progress in lithium-ion batteries, which play a leading role in improving battery storage capability. Moreover, this technology is expected to benefit further from considerable cost reductions. Another alternative solution is the recent development of super capacitors that

have the potential to compete with petroleum-based energy sources, both in terms of cost and performance, with very fast recharging capabilities and long lifespan (~ 20 years). In the meantime, new technologies such as wireless power charging are evolving rapidly (in electric vehicles but to some extent in waterborne vessels, too) to minimise the impact of long battery charging times. Furthermore, battery swapping is considered as an appealing alternative to fast/boost charging as the latter contributes to the faster aging of batteries. The European funded project "Current Direct" (www.currentdirect.eu/) is dealing with this issue.

Investment in more efficient and coordinated transportation of people and goods is necessary to minimise the need for energy. There is a move towards less personal ownership of transportation and vehicle sharing schemes, particularly in urban environments. An integrated transportation strategy is needed that allows these schemes to be incorporated alongside public transport systems. Soon there will be autonomous vehicles, which will need their own charging infrastructure.

Charging infrastructure for passenger vehicles is a key issue and a typical chicken-and-egg problem. Case studies show that having a good network of charging infrastructure in place results in an increased willingness to invest in electric vehicles. In this respect, policy makers should focus on enhancing the rollout of a smart-charging infrastructure, including private sector participation.

The interaction between electric means of transport and the grid should be assessed to fully understand the impact of electric transportation. Public policies to encourage e-mobility and smart charging of electric vehicles should be accelerated to ensure ubiquitous grid-friendly charging. Also in ports, electrification and charging is of major importance, as it can supply electricity to ships via "ship-to-shore electric interconnection" or "cold ironing" principle, charge battery driven ships, host charging stations of EVs, and provide EVs for internal emission-free circulation within the jurisdiction of ports.

Research and development of higher capacity and longer life battery technology should continue to be funded. This will increase the range capability of electrified transportation. Energy harvesting, regenerative braking and other recycling techniques should be encouraged to increase the working range of electrified transportation. Energy harvesting technology collects energy from the environment, such as heat or vibration. Regenerative braking systems are already in use (e.g., on rail systems), using the machine drives in reverse mode to generate electricity, while slowing the vehicle by taking kinetic energy out of the system.

Moreover, better materials, such as dielectrics, magnetics and superconductors should be investigated to improve the power density and/or reliability of all equipment (from the main drive down to signal processing functions).

Finally, standardization in these areas is critically needed to address interoperability, manufacturing economies and distributed sourcing of key components and systems.

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