Evolution of Cars that Contribute to a Sustainable Society

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1. Introduction

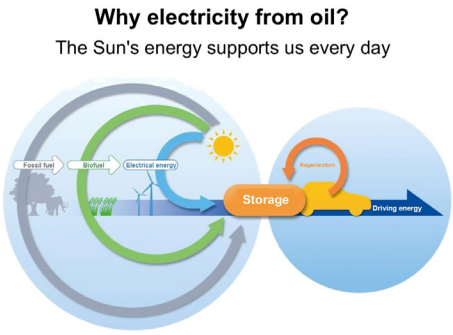
In a society grappling with environmental issues

This special feature, "The Challenge of Sustainable Mobility," reports on Nissan's efforts to address environmental concerns.

Global society is presently facing critical climate change issues. The United Nations Framework Convention on Climate Change was signed in 1992 to address these issues by establishing the Conference of the Parties (COP), which has been held annually since 1995. Delegates to COP21, held in Paris, France, in December 2015, confirmed the necessity of not only aiming for a 2 °C short-term limit of global temperature rise but also a 1.5 °C long-term limit. These goals were adopted in the Paris Agreement, a new international framework.

As the world strives to realize a sustainable society, companies must act as members of that society to address climate change. Nissan has been working hard to address challenges related to climate change and resource depletion. Nissan's medium-term environmental action plan, the Nissan Green Program, was announced in 2002 and has since made ongoing contributions toward the ultimate goal of increasing energy and resource efficiency to limit environmental impacts to what nature can absorb. In January 2021, Nissan announced the goal of achieving carbon neutrality throughout the product life cycle, including business activities, by 2050.

Vehicle electrification represents a critical step in the pursuit of this goal and is vital in the quest to achieve sustainability.



Different solar energy cycles

2. Significance of vehicle electrification

Before the Nissan LEAF was introduced to the world approximately 15 years ago, I considered the significance of vehicle electrification in terms of energy cycles.

Human life depends on the Sun as an energy source. The Sun's energy reaches us through various energy cycles, as shown in Figure 1. In the fossil fuel cycle, the Sun nurtures animals and plants transformed into fossil fuels over hundreds of millions of years. As these fuels have been consumed in large quantities over only the last few centuries, human beings are consuming them faster than they are being produced. In contrast to the fossil fuel cycle, the plant-derived biofuel cycle requires only one year to produce energy, and the electrical energy cycle can be powered by photovoltaics (PVs), which produce energy the moment they receive sunshine, and wind turbines, which produce energy the moment the wind blows past. Therefore, electrification should not only be promoted to achieve carbon neutrality but also to address the rapid depletion of fossil fuel resources and improve the efficiency of energy generation and application. It has been 15 years since I had this vision, but its meaning remains the same and will remain unchanged for the next 100 years.

The Nissan LEAF, which is equipped with a battery that can charge and discharge the significant quantity of electrical energy required to move a car, was launched in 2010, representing Nissan's first contribution to the electrical energy cycle transition.

Nissan believes that the practical application of in-vehicle batteries will not only lead to the electrification of cars but also foster a new relationship between cars and society. Electric vehicles (EVs) are connected to regional electrical power distribution networks and travel widely within those networks. Indeed, from the customer's perspective, one attraction of EVs is the ability to obtain energy in places more convenient to one's daily routine. However, viewing a large group of EVs as a single system suggests considerable potential as a new energy-storage system within the electrical power distribution network.

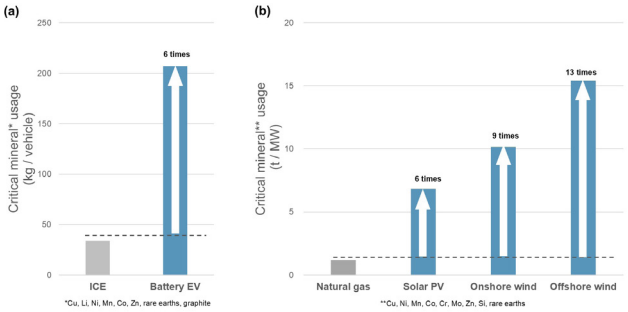
Although work to expand renewable energy sources at the national and regional levels is underway in pursuit of carbon neutrality, the expansion of renewable energy represents a destabilizing factor for conventional electrical power distribution networks, which must maintain backup thermal power generation and energy storage facilities in case of power shortages. Utilizing the

collective energy storage capacity of EVs can help stabilize the power network and reduce the cost and environmental impact of renewable energy generation.

Notably, EVs must contribute to the electrical power distribution network without compromising the convenient mobility inherently provided by car-based transportation. This requires the development of new technologies linking EVs to distribution networks as well as a deep understanding of renewable energy characteristics and EV customer expectations. This strategy can connect cars with society through energy, contributing to the community by providing new value that can change the urban landscape.

3. Wisdom of using resources wisely: Recycling

Another important development contributing to the realization of a sustainable society is the recognition of vehicles as resources and the resulting recycling of their materials for reuse. The necessity of recycling can be demonstrated through an example. As shown in Figure 2, the technologies employed to generate and utilize renewable energy require far more mineral resources than conventional energy technologies. Solar PV, onshore wind, and offshore wind power generation require approximately six, nine, and thirteen times more critical mineral resources, respectively (e.g., lithium, cobalt, nickel, and manganese) than gas power generation. Similarly, the International Energy Agency reports that EVs require approximately six times more critical mineral resources than internal combustion engine (ICE) vehicles. Clearly, these valuable mineral resources must be used carefully to avoid exacerbating their scarcity and hindering the global transition to renewable energy



Critical minerals required for (a) automotive transportation and (b) power generation. Prepared by Nissan based on the International Energy Agency report: The Role of Critical Minerals in Clean Energy Transitions (https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions)

Nissan seeks to extend the service lives of our products and reduce the quantities of materials used to produce them in keeping with our policy of careful resource utilization to prevent depletion. However, these efforts are insufficient to realize sustainable vehicle production; the recycling and reuse of materials are also necessary. Critically, automotive materials that have strict requirements for quality, such as the maximum impurity levels permitted to maintain performance, require supply chain control from the vehicle production to scrapping stages to recover vehicles at the end of their service lives, recycle their materials with the minimum possible reduction in raw material grade, and reuse these materials in the manufacture of new parts and vehicles.

Among the various components of an EV, batteries have the highest recycling value and are the closest to realizing resource recirculation. Therefore, the 4R Energy Corporation was founded by Nissan to develop and deploy technologies promoting the reuse and recycling of EV batteries. Future efforts will extend recycling efforts beyond batteries to realize whole-vehicle recycling.

4. Conclusion

The evolution of car transportation is inevitable as society strives to achieve sustainability. However, the realization of cars that can be connected to the urban power grid during service and later recycled to recirculate their materials is challenging. Addressing these issues requires identifying their true nature to inform pathways to solutions, a task in which the knowledge and cooperation of Nissan's partners outside the automotive sector are invaluable. Nissan is committed to addressing these issues one by one to realize a sustainable mobility society. We hope that this special feature will provide a glimpse of this ideal future and Nissan's efforts to realize it.