Energy-generating road infrastructures

Highways are of undoubted value to the economic development of a region, underpinning activities as essential as trade, communication and supply. In recent years, they have also become a potential resource for economic savings and ecological conservation. Jean-Claude Roffé, Ambassador of the European Highway Federation, gives us the keys to a promising and certain future in which to take advantage of road infrastructures in pursuit of economic and environmental sustainability.

The transition toward a sustainable market–economically and environmentally–has made all sectors apply their innovation resources in the quest for new technologies that enable the development of more profitable activities that do not generate harmful emissions. A field as important as communications and transport has not been exempt from this trend, and for years road infrastructure experts have been working to make them more than just transport and communication channels. Jean-Claude Roffé, Ambassador of the European Highway Federation, tells us about two of the most significant advances in this field: the energy highway and the electric highway. Although both are intended to generate energy, he points to an essential difference: “In the case of energy generation, it is not *a priori* a means of large-scale production, for we are talking about a few tens of kilowatts/hour per kilometer of road; while for the electric highway we are considering several megawatts/hour/kilometer”.

The energy-generating highway

Sunlight is, especially at European latitudes, an extraordinary source of energy. As Roffé tells us, “each square meter of the land surface can emit as much as 1000W of energy in good weather”, reaching 1 to 1.5MWh in countries such as France (as compared to 4.8MWh of energy consumption by an average household in that country). Although solutions have been developed in recent decades in places such as the Netherlands, England and Belgium, such as concrete plates equipped with photovoltaic cells protected by a transparent coating, they have proven to be unfeasible due to a variety of factors. “Since 2017, new innovations have been deployed in the recovery of energy from asphalt paving,” says the expert, who points to three developments:

– The *EUROVIA PowerRoad*, which works on the principle of using the asphalt paving of a road as a thermal solar collector to return the stored heat to surrounding buildings and infrastructures.

– *WattWay by COLAS*, which works on the premise of recovering the solar radiation energy from a

photovoltaic road surface and transforming it into electricity to supply highway equipment in areas not connected to the power grid.

– And, lastly, a combination of the two systems, developed by the Gustave Eiffel *University (formerly IFSTTAR-LCPC) RA2ROAD or ROSHY*, which adds to the generation of energy through a layer of recycled glass and heat recovery by means of a fluid that circulates within the paving layer.

“Following the design of these projects, studies were carried out on the resistance of these materials to the different mechanical stresses due to traffic, as well as analysis of the life-cycle of the various materials that were going to be used in each project,” with the aim of assessing the production of energy. Although there were no difficulties during their application, the tests revealed that “the photovoltaic slabs had problems under heavy traffic in terms of durability and fatigue,” so they should be reserved for places that are not subject to much stress. The asphalt paving, however, was a success “as the tubes are protected by a layer of asphalt and do not come into mechanical contact with the tires”.

Jean-Claude Roffé affirms that the conclusions obtained so far with energy-generating infrastructures are very positive: the measurements of the energy produced were in line with expectations and the energy yields seem good, although both depend on an intermittent energy source like the sun. He also points out the requirement for a significant investment, as “they use specific and very expensive materials, such as photovoltaic plates and fluid pipes, with regulation and distribution systems,” which entails significant additional costs, as compared to conventional highways. “Large-scale use and industrialization of the manufacturing processes of these new materials could reduce costs,” he says. Regarding the safest prospects for these asphalt applications, he recommends reserving “these solutions for areas with little stress due to vehicle traffic, such as parking lots, sidewalks or bicycle lanes”.

The electric highway

The decarbonization of road traffic is a pressing challenge worldwide, and compliance with this purpose in mind could lead to other problems, such as “a colossal demand for electric power.” To try to tackle this scenario, work is being done on the so-called electric highway, which is capable of powering vehicles while they are running. In Europe, tests with three types of technology have been carried out, according to Roffé: catenary, ground conduction and induction. The latter could also be used in cars. “What will differentiate these systems will be the costs, the ease or difficulty of installing them on the highways’ right of way and, of course, with the condition that the production of the electricity is decarbonized,” he affirms.

These methods are already being tested on small stretches of road in Sweden and Germany, in collaboration with the automotive industry, as they directly depend on advances being made in electric motors and the deployment of the equipment. “A recent study by Gustave Eiffel University and VEDECOM shows that if we were to equip between 8000 or 9000 kilometers of highway, i.e. the main arterial roads of the network, this would be enough to permit the autonomy of heavy

vehicles, on the one hand, and on the other, to reduce and divide the size of batteries by almost three times, as well as providing the necessary network of recharging stations," explains Roffé. "Goods transport professionals, equipment manufacturers and builders are very involved in these projects, and at an even more advanced stage than the automobile industry, because these are critical issues for both the economy and the survival of the transport companies. Induction solutions are ideally suitable for freight transport, although trucks must be equipped with suitable electric motors, probably hybrid", he concludes.

Contributing to this article...

Jean-Claude ROFFE is an engineer and has been involved in the road infrastructure sector since 1968. He currently serves as an International Advisor and ambassador of the ERF (European Highway Federation), and is an expert in international affairs with Routes de France (French Highway Association), as well as a member of the AIPCR, a global association. In recent years, he has led an international working group on the impact of new mobility and connected, electric and automated vehicles on road infrastructure.

He is the author of several papers on road processes and paving conservation, which have been published each year at major international congresses and seminars since the 1980s.