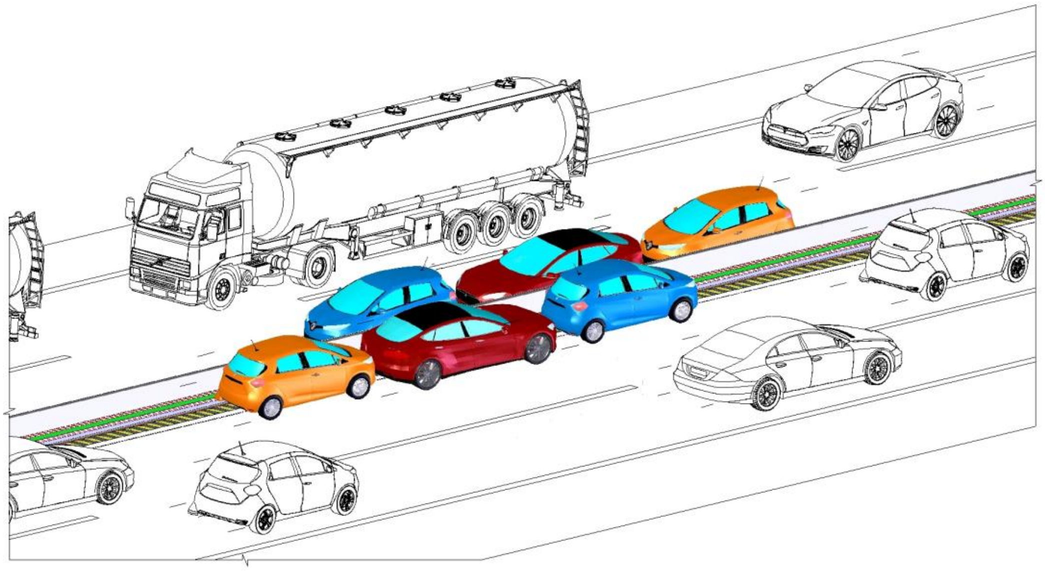


Augmented Electro Mobility for the 2020's

ZE-Drive is based on the **TEMPO ßeta** concept which originates from the participation in the Intelligent Vehicle/Highway System (IVHS) committee established by the **U.S. Intermodal Surface Transportation Efficiency Act of 1991.**

The concept raised the interest of Californian players, however due to electro mobility being in its infancy **TEMPO ßeta** was far ahead of its time.

Since then electro mobility and autonomous driving have come a long way and gained appeal with drivers. Building on some of the foundations set up by **TEMPO ßeta**, **ZE-Drive** technology re-engineered the concept to disruptively combine four innovations:

- an **"all weather"** simplified **level 4 autonomous driving mode** at cruising speed (130 km/h - 80 mph) which is cost effective and highly reliable, thanks to a mechanical back-up guidance: as the left wheels are captured in a curbed path;

- a **sharing of the left lane** between conventional and **autonomous traffic** with a dedicated left wheel curbed path, located on the existing central strip of freeways;

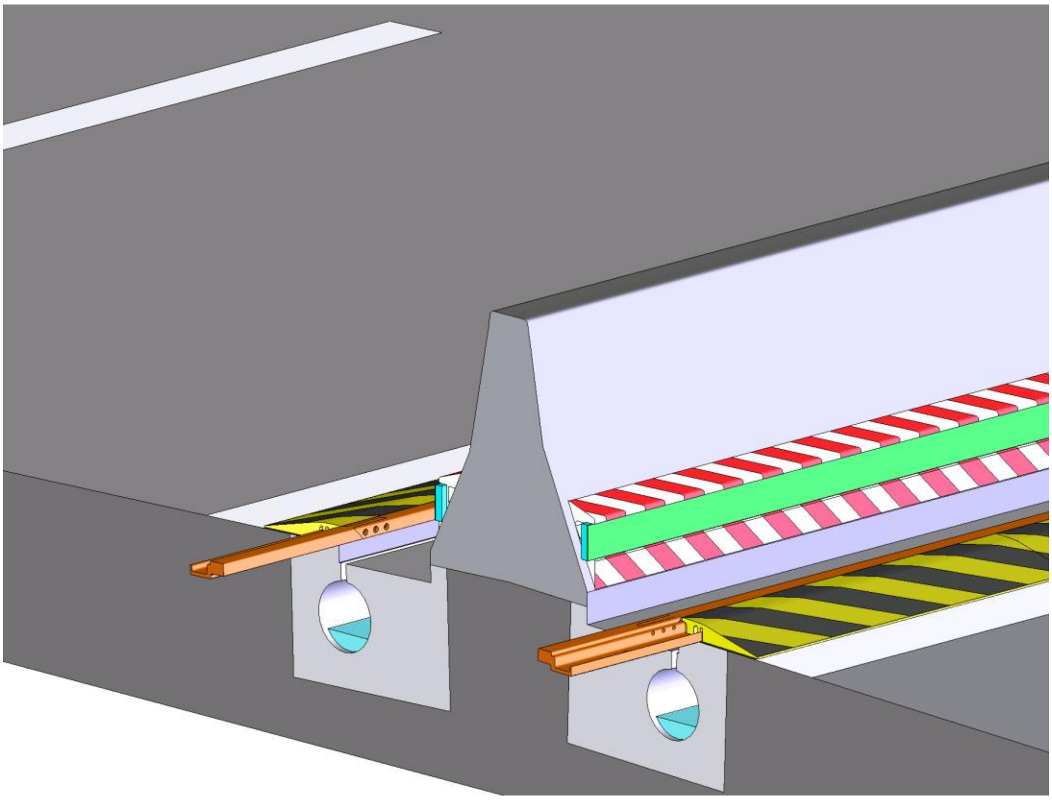
- a **Road Powered EV** for electric or hybrid vehicles with Extra-Low safety Voltage (ELV 120 Volts DC) and medium power ~30 kW, which will (i) resolve the original impediment of electro mobility (i.e. limitation in range) and (ii) reduce in the long term the size and weight of the batteries used in all-electric vehicles; and

- a car **"Platooning"** mode which increases traffic capacity without having to widen the road infrastructure including a robust (~2G) emergency braking system (unaffected by weather conditions) and a back-up inertia braking actuation as pioneered in **TEMPO ßeta.**

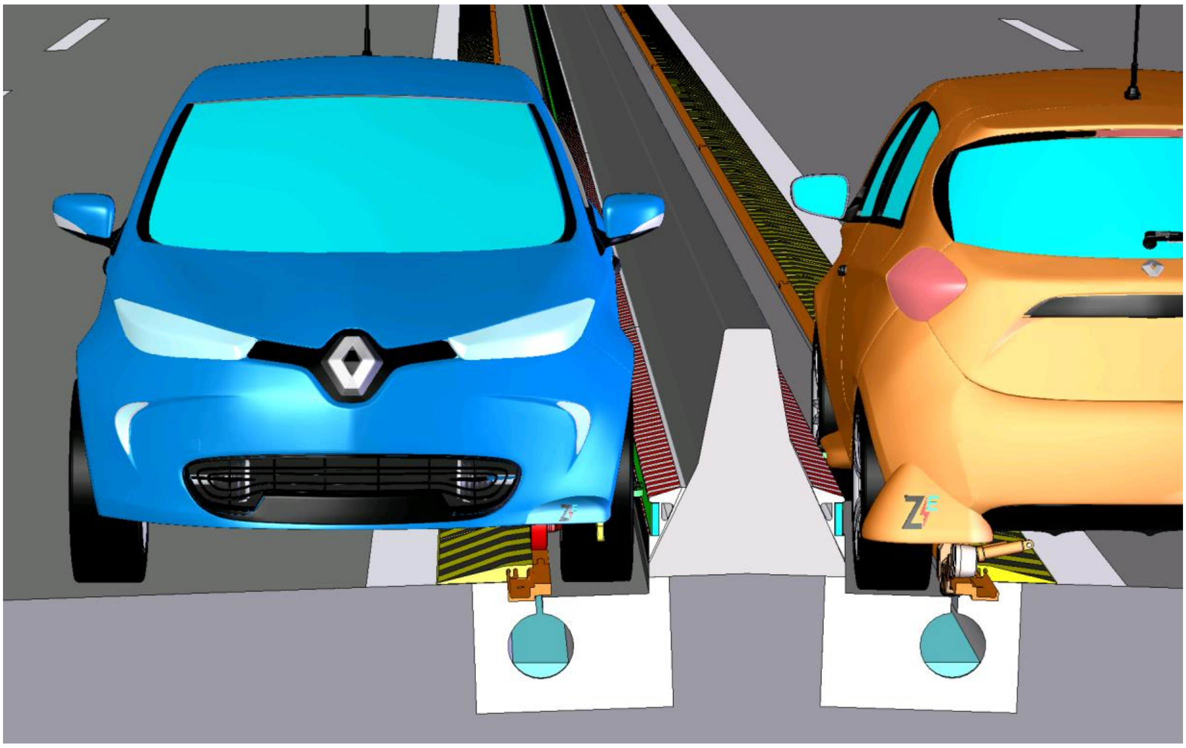
The contactless normal operative mode, not based on image recognition which is therefore **"all weather"** along with a back-up mechanical guidance system provides an effective mitigation of the "manufacturer" liability risk exposure which is one of the major stumbling blocks for a widespread deployment of level 4 autonomous driving for personal cars.

ZE-Drive technology can increase road safety, air cleanliness and noise reduction. It can also increase road fluidity during rush hours, and reduce weight/drag reduction by continuous power supply and platooning. It yields productivity gain in business/professional road journeys.

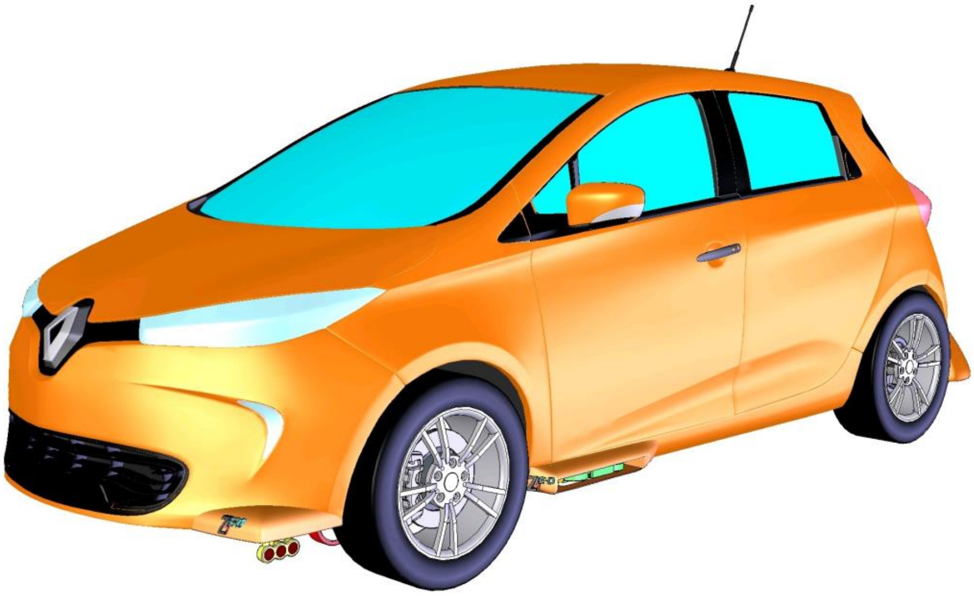
The infrastructure required to deploy **ZE-Drive** technology is minimalist and concentrated on the central separating strip of freeways, made of a Jersey Wall and slotted spillway gutters, and does not interfere with the conventional traffic lanes.



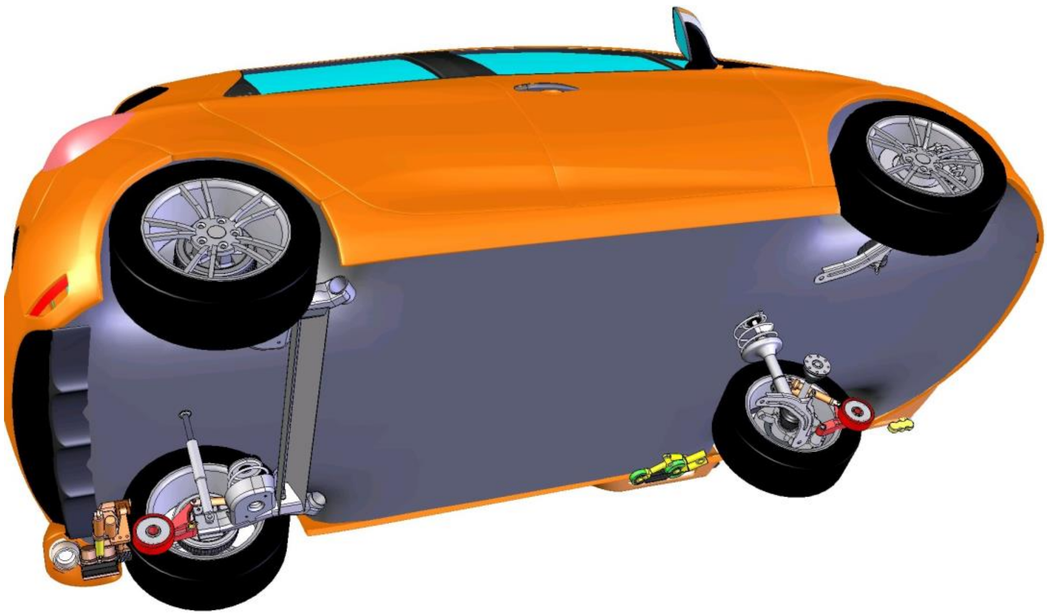
A 24 kg/m (16 Lbs/ft) **steel rail** (in orange above) is anchored to the spillway gutters. **Sloping ramp** sections (striped yellow-black above) connect the pavement to the upper surface of the rail while the **"third rail"** (in green above) provides the ELV 120 Volts DC supply. Cars in **ZE-Drive** mode travel astride the left white line (as depicted below) with left wheels running on a dedicated curbed path bordered internally by the steel rail.



Ahead of the left front wheel a **multi-sensor device** continuously senses the lateral distance of the vehicle from the Jersey Wall and in **ZE-Drive** mode steers the car autonomously in all weather conditions to keep the left wheels at the center of the curbed track in a contactless fashion.



The rail also provides electric ground return (similar to electric railroad) of the **Safe ELV power** supply captured by a **retractable slider** (in green above and below) located at the bottom of the driver's door.



On the inside of the stub axles of the two left wheels **two retractable rollers** (in red above) are attached to take over the load of the left wheels when laterally crossing the rail. The rollers bear temporarily on the rail and smoothly land (or extract) said wheels to (/from) the dedicated curbed track. As an option the suspensions, on the left side, could be of variable height to allow mitigation of the body roll induced from crossing the rail.

Behind the left rear wheel a **swinging brake caliper** (in brown above) attached to the car's body enables the steel rail to be gripped in order to exert a strong deceleration (~2G) independently of the tire/road grip limitations due to weather conditions (rain, snow, ice…).

As a side note, while the required safety distance is 72 m (240 feet) for a speed of 130 km/h (80 mph) (2 seconds of car travel) the 2 G emergency braking capacity allows a stop in 33 m (110 feet) buying sufficient time for computer analysis of the situation to avoid false emergency braking.

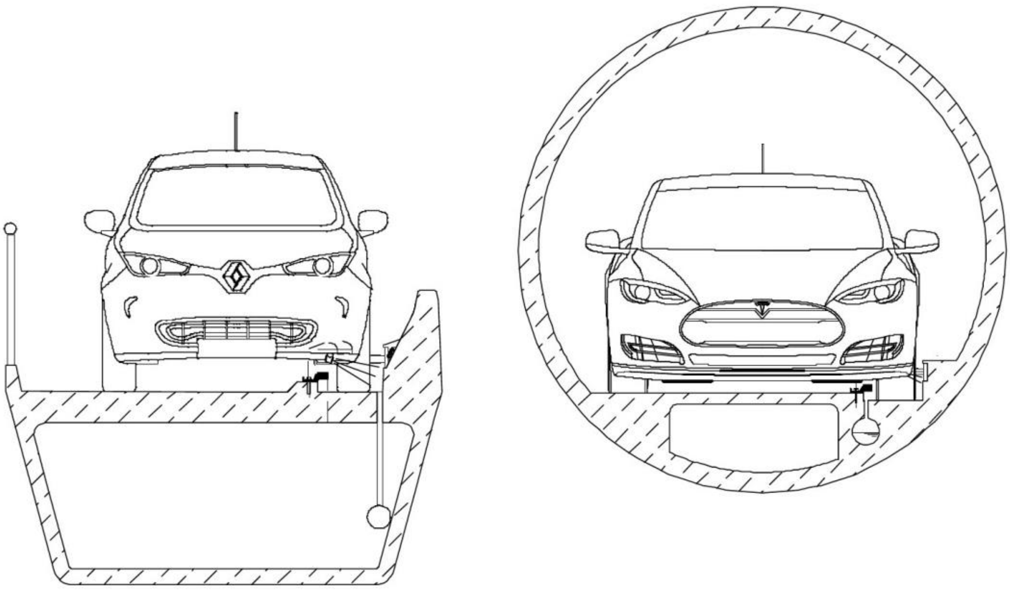
With this emergency braking system groups of 2 to 8 cars can be formed “bumper-to-bumper” (reference: 1997 demonstration on HOV-Lane between Los Angeles and San Diego) doubling and even quadrupling, in the long term, the capacity of a road lane.

An automatic sequence system (similar to **"park-assist")** will assist the driver in entering and exiting the **ZE-Drive** track laterally at cruising speed.

All the technologies forming the **ZE-Drive** system, both in infrastructure and cars, are mature and can deliver now cost-effective reliable level 4 autonomous driving.

In terms of overall energy efficiency (i.e. taking into account not only the energy used to drive the car, but also the extraction and transformation of raw materials for the manufacturing of the car and the production of the battery pack), **ZE-Drive** technology makes it possible to substantially reduce the capacity and consequently the weight of the battery pack. This further limits the quantity of CO^2 generated by the production and the transportation by the car of the extra battery weight, which is no longer needed. A Renault ZOE curb weight could be reduced by 300 kg (650 lbs) and a Tesla S by 540 kg (1,200 lbs) if the reduction of structure and component weights is taken into account.

The emergence of a fleet of reduced weight **EVs** which are **“ZE-Drive Ready”** in the mid 2020’s will permit the design of dedicated light weight road infrastructures (i.e. not accessible to medium or heavy trucks) capable of large span for aerian overpass. **ZE-Drive** will also unable a reduction of the size of underground dedicated roadways.



The Phase 1 **“PoC”** of the **ZE-Drive Joint Industry Project** is aiming to demonstrate the smooth track lateral entry/exit capability of the technology at a Transportation Research Center. Phase 2 will develop the platooning capability and the 120 Volts DC power dynamic feed while Phase 3 will entail an open road pilot installation to collect usage data and show case the technology to users and industry players. A consensual international standard for **ZE-Drive** curbed track should emerge from the JIP.

*Ref: **TEMPO ßeta** June 93 with correspondence Tempo America 92-93*

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