EQUIVALENCE OF CONSUMPTION INDEX FOR ECO-RALLY FIA-ENECC YEAR 2020

It is necessary to introduce an index (therefore a numerical coefficient) that allows us to compare the consumptions of all the electric cars involved in the e-rally in an equal way with each other, considering that all the vehicles travel the same route.

The current CI consumption index of the technical regulation in force, does not take into account the parameters of the vehicles that can influence specific consumption. The main ones are: the mass of the vehicle, the quantity and type of batteries on board, the performance (speed, acceleration), etc.
But, if we only consider the weight of the vehicle to make comparisons, give incorrect results. In fact, there are heavy vehicles that consume less than some lighter vehicles.

This fact can discriminate the classification based on the specific consumption of the vehicles, since for example, the heavier or more performing vehicles have a higher specific consumption than that of the lower class vehicles.

Therefore, in order to equate the consumption of all the electric vehicles engaged in the Eco-rallies, it is necessary to create a **comparative factor** that considers the real consumption recorded with the usual standard procedures that we have in use.

TECHNICAL REGULATION FORMULA FOR ENERGY CONSUMPTION INDEX CLASSIFICATION

As described in article 6.2. of the Technical Regulation, in order to establish the true energy used during the event, the following formula must be applied:

TrEn = (NTE + REM) - FRE

With the abbreviations:
TrEn True Energy used in the event
NTE Nominal Theoretical Energy [kWh]
The vehicles must start the event with a fully charged battery pack. This NTE energy value corresponds to the nominal capacity in kWh of the propulsion battery pack.

REM Recharged Energy from the Main

FRE Final Remaining Energy at the end of the event

Consumption Index (C. I.)

In order to establish the consumption index the following formula must be applied:

$$C.I. = \frac{TrEn\ (*)}{km\ (**)}$$

(*) TrEn: Value expressed in kWh

(**) km: Total length of the itinerary (km). The total length of the itinerary as given in the Road Book and/or in the Supplementary Regulations in km.

COMPARATIVE CONSUMPTION INDEX IN ECO-RALLY YEAR 2020

On this regard, a special list of electric vehicles in production and in regular sale will be made available by FIA ENECC which contains all the data relating to the type of vehicle and the official consumption provided by the WLTP protocol or in any case by the vehicle manufacturer.

For vehicles not included in this list, to the registration for the event (*), the official data declared by the vehicle manufacturer must be provided.
(*) The registration for the event must be approved by the organizer.

These data will be the official ones that will be used during the event and that will be published before the event itself. The registration for the event also involves, among other things, the acceptance of these data by competitors. For this reason, no claims or dispute regarding the established data will be accepted.

NEW PERFORMANCE INDEX INSTEAD CONSUMPTION INDEX IN ECO-RALLY YEAR 2020

Each manufacturer officially declares the vehicle data, including the capacity of the battery pack in kWh, autonomy and consumption value expressed in kWh / km or KWh / 100 km. The consumption values have been calculated using the WLTP (*) (Worldwide Harmonized Light Vehicle Test Procedure) protocol which is recognized and adopted in many countries and directly by many manufacturers.
(*)The WLTP has been developed by the EU, India and Japan; the final version is from 2015.
It is in force in the EU, Japan, Iceland, Norway, Switzerland, Liechtenstein, Israel and Turkey, pending its application to be extended by law to other countries, first of all in 2021 to China , to South Korea and India, and then to Russia.

Knowing the consumption values formalized by the WLTP cycle or/and by the Manufacturer , following the data contained by the appropriate list provided by FIA ENECC, we have the possibility to process them with the real values recorded during the Rally and to obtain new values that allow you to write a correct ranking.

In this way we will get a "**Performance Index**" or else "**P Index**"= " **PI**" instead of the **CI** (Consumption Index).

The starting values are those obtained from the CI values. In fact, the C.I. provided by the formula, it is nothing more than the consumption expressed in KWh / km.

To obtain the value expressed in KWh / 100 km, just multiply by 100.

Examples of IP calculation

As mentioned above, we start from the value of CI, which is equivalent to the consumption expressed in kWh / km. In some cases we have to transform it into kWh / 100 km, multiplying the value x 100.

Example 1
The WLTP or the Manufacturer declares that this car consumes 15,6 kWh / 100 km (= 156 Wh / km) and the vehicle during the rally has consumed for example 20 kWh / 100 km (= 200 Wh/km), it gives a corrective index (Performance Index) **PI** of 1,282 (20 : 15,6 = 1,282).

Example 2
If the same model / type of vehicle has consumed 25 kWh / 100 km, the PI will be 1,602 (25: 15,6 = 1,602)
If the vehicle had consumed 15,6 kWh, then the consumption index would be = 1 (15,6: 15,6) and so on.

Example 3
Example for heavy vehicles (Audi e-Tron, Jaguar I-Pace, ecc.) : the official value is 224 Wh/km. In the rally the consumption is 300 Wh/km. The PI will be 1,339 (= 300 : 224).

Example 4
For the same type of vehicle with a rally-consumption of 400 Wh/km the PI will be 1,785 (= 400 : 224), and so on.

Example 5
Last example for a vehicle whose consumption is lower than the official one.
Official value is 156 Wh/km. The rally-consumption is 143 Wh/km. The PI will be 0,916 (= 143 : 156).

In case of a parity value, the value of PI can be approximated beyond the third decimal place.

In all cases the lowest coefficient wins.

In this way, all electric vehicles can be compared with each other.

F.C.E.V. VEHICLES (CARS POWERED BY FUEL CELLS)

If we directly compare their energy consumption by converting hydrogen into kWh (1 kg of H = 33.393 kWh) as written in article 6.2., they are losers compared to pure electric cars.
A conversion factor that takes into account the efficiency of the Fuel-Cells should therefore be used.
A latest generation fuel cell has an efficiency of 70%.

Today a hydrogen fuel cell can reach a maximum theoretical efficiency of 80%, referring only to the generation of electricity. If, on the other hand, heat generation, which can be used for heating the passenger compartment, is also considered, the maximum efficiency can reach 90%.
Often when mentioning automotive fuel cells, the efficiency of the system is considered, not just the fuel cell. The DOE indicates 60% as the performance of an FC for the automotive sector (https://www1.eere.energy.gov/hydrogenandfuelcells/fuelcells/pdfs/fc_comparison_chart.pdf)
The performance of a CF varies with the conditions of use and changes over time due to the aging of the membranes.

So, to compare the energy consumption of vehicles with fuel cell, the consumption recorded during the rally will multiply by the value of 0,7.

Example: if during the rally the vehicle consumed a quantity of hydrogen equivalent to 100 kWh (equivalent to approximately 3 kg of hydrogen) the value to be considered for the general classification will be 70 kWh.

This value, expressed in kWh, can be used in the same way and with the same formulas that concern electric vehicles, as described above.

In this way, vehicles with fuel cell can be classified together with electric vehicles in an equal mode.