

# IRIZAR S. Coop.

## i2e: 12 m urban bus with 100% electric traction and climate control

**Irizar** has designed and developed the **i2e**, the Irizar Group's first 100% electric 12-m urban bus.

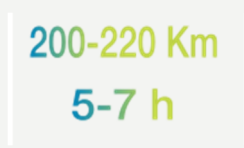
Developed and manufactured using own technology and a **life cycle approach**, it is the outcome of the Irizar Group's strategic commitment to innovation, in order to become a benchmark in sustainable urban mobility.

The **100% electric vehicle** is designed to achieve the greatest energy efficiency (lower consumption) and range of the vehicle possible, along with optimum management of its end-of-life.

With a **carbon footprint of 845 gr CO2 eq./km.p** (for each kilometre travelled and passenger), the i2e model is the result of the joint work of the companies in the IRIZAR Group, along with technology centres of the Basque Technology Network.



**0% direct emissions in the urban environment. 86% cut in the carbon footprint** compared to a conventional diesel bus.



**Range** of 200-220 km with a single charge of 5–7h (15-17 km/h)



**Recoverability and recyclability rate** of materials and equipment over 90%.

### ENVIRONMENTAL RESULTS



#### Emissions & pollutants

Elimination of direct emissions in the use phase (CO<sub>2</sub>, NO<sub>x</sub>), along with the absence of noise and vibrations for passengers.



#### Energy

The efficiency of an electric traction system is around 70% compared to a maximum of 35% with a conventional diesel one.



#### Raw materials and waste

New modular bolted system and 100% recyclable batteries. Less maintenance and longer service life.

### BUSINESS RESULTS



#### Relation with the value chain

Developed using own technology of the IRIZAR Group in conjunction with the Basque Technology Network.



#### Market share

A new business line based on sustainable urban mobility is opened up.



#### Ground breaking

First electric bus complying with R66 roll-over safety regulations

#### Flexibility

Very flexible seat distribution and wheel chair areas, adapted to the customer's requirements.

## BACKGROUND

Combustion engine vehicles are the cause of 40% of the CO<sub>2</sub> emissions and 70% of the other pollutants in urban centres. Europe's leading city councils (Paris, London, etc.) are demanding more sustainable urban transport models, with lower emissions and noise.

IRIZAR, a company committed to the European programme to drive the use of electricity as an alternative fuel, has designed and developed a **100% electric 12-metre urban bus, known as i2e, with an emphasis on maximising energy efficiency throughout its lifecycle and the first of its class in the IRIZAR catalogue.**

There are currently hybrid bus models (fossil fuel + electricity) on the market, but the IRIZAR i2e bus incorporate a 100% electric model as a differentiating feature, both in terms of traction and climate control.

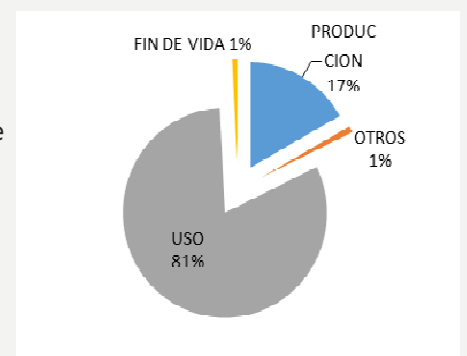
Thanks to this vehicle, developed using own technology, has opened up new market segments for IRIZAR both nationally and internationally and places it at the cutting-edge of the technique.

## RESULTS AND KEY ASPECTS

- \* The i2e is a **100% electric 12-m bus** with 3 double doors, low continuous floor, large glazed surfaces (it has a back window and translucent windows run along both sides from the front to the back of the bus) with optimised environmental impacts.
- \* It exceeds the **R107 type approval** regarding accessibility for people with reduced mobility (possibility of electric and manual ramp for people with a disability) and complies with the highest passive and active safety requirements, as it is the **first and only** electric bus on the world market that complies with the **R.66 rollover safety standard**.
- \* It offers great flexibility to design the seat distribution and areas for wheelchairs thanks to its electric technology **that eliminates the direct greenhouse gas emissions (GHG) and toxic substances (NO<sub>x</sub> and particles) when operating**. The only GHG emissions are indirect, from obtaining raw materials and the electricity consumed when charging batteries, along with the end of service life processing of the vehicle.
- \* The i2e project is an **example of cooperation** with the industrial fabric of the Basque Country. Gipuzkoa companies of the IRIZAR Group, such as JEMA, DATIK and CREATIO, along with HISPACOLD and MASATS, have been key in the development and implementation of **the innovative technology developed** (energy storage management system, automatic climate control technology, batteries with ultracaps, regenerative energy, etc.).
- \* The Basque Science and Technology Network has had a fundamental presence and involvement. From the point of view of social sustainability, the development of this vehicle using basically Basque workers and own resources has strengthened local and regional synergies and competences.

The **Life Cycle Assessment (LCA)** performed (analysis of impacts arising from obtaining materials, manufacturing, use and end-of-life of the vehicle, according to the UNE-EN ISO 14040:2006 and UNE-EN ISO 14044\_2006 standards), allowed the main aspects to be identified when action was needed, with the following outcome:

- \* The **i2e bus has a very low carbon footprint of 8.45 gr CO<sub>2</sub> eq/km.p** (kilometre travelled and passenger). Compared to a conventional combustion bus, the **emission of around 800Tn of CO<sub>2</sub> eq** is prevented during its service life (difference between the emissions associated to the electricity consumption of batteries and fuel consumption). If the carbon footprint of the whole life cycle is taken into account, the i2e **prevents the emission of around 35Tn of CO<sub>2</sub> eq/p**.



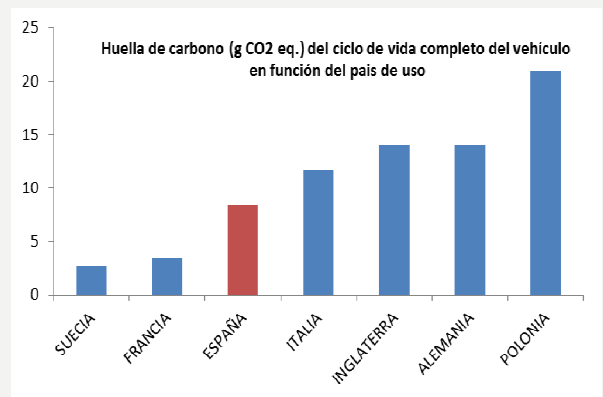
## DESCRIPTION OF THE CASE STUDY

Irizar has focused its endeavours on **optimising the efficiency of the 3 key aspects** that contribute to the global environmental impact of the bus: (1) the traction system and the batteries, (2) the raw materials used and (3) the management of all its components at the end of its service life.

The key technical characteristics of the i2e are:

The **electric traction system** with **energy efficiency** of around **70%** compared to 35% with the conventional diesel bus. Therefore, half the consumption is needed to do the same journey.

The electric mix used in the use phase determines the final impact of the vehicle, as the larger the share of renewable energy in the production of the electricity used to charge the batteries, the lower the environmental impact of the charging and, consequently, the lower the environmental impact of the life cycle of the vehicle. Fostering the use of renewable energies in the cities and by the public sector will reduce the environmental impact of electric urban transport considerably.



It has **So-Nick Batteries** to supply energy to the climate control and traction system. The batteries are very light and compact:

- \* **40% smaller and lighter** than the conventional Pb batter and 26% than the Ion-Lithium battery, it saves raw materials and reduces the weight of the vehicle, which is directly related to energy consumption..
- \* **Better specific energy**, which increase by 6% the energy installed for each kilo of battery.
- \* They can operated at higher temperatures, which means that they can be installed in the roof of the vehicle and the passenger compartment is designed to create greater flexibility, accessibility and visual comfort.
- \* The manufacturer guarantees a **service life of the battery of over 5-7 years** and guarantees that each full charge only reduces the efficiency by 1%, (each charge ensures 99% efficiency of the battery). The battery only needs to be changed a couple of times in the service life of the vehicle (15 years).
- \* The lower efficiency of these batteries compared to the Ion-Li ones is offset, given that the i2e has a greater quantity of energy onboard (376kWh), its operating C-rate is relatively low and it does not need an auxiliary cooling system, with is necessary with Ion-Lithium batteries.



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**Ultracaps systems:** the ultracapacitors are charged and discharge thousands of cycles very quickly without losing output as they operate by polarizing an electrolyte solution, instead of by means of slower chemical reactions as in conventional batteries. The ultracaps mean that the system can be fully charged in just 5 hours.

Furthermore, they release their load very quickly, which, together with the special traction system designed for the vehicle, means that the i2e attains the power and torque that allows it to adapt to any type of urban terrain and gradient without any problem.



The **energy storage management system**, designed in-house using own algorithms to manage the relation between the battery and super-capacitors (added to maintain the charge status of the two components in an optimum range, extend the life cycle of the components and improve the operational cost).

The direct **regenerative energy consumption system** by means of braking to use the energy without a need for storage.

The **automatic climate control technology** regulates the temperature to achieve the comfort level while achieving the most energy efficient point, using algorithms developed by the IRIZAR Group. This system allows 8% savings in energy compared to a manual control system and can be increased by up to 30% by means of fitting an electric compressor to the climate control system.

The **Eco- Assist Technology** provides real time information on the consumption, range, route, etc., and which allows the driver to modify the vehicle's operations to achieve the greatest efficiency possible.





## DESCRIPTION OF THE CASE STUDY

IRIZAR has changed its way of manufacturing buses by prioritising the **removability and recyclability** of its components, by changing the traditional welding system for a **new modular bolting system**, with recyclability and recoverability rates of the vehicle **of over 90%** as per the ISO 22628 "Road Vehicles. Recyclability and recoverability calculation method" standard.

- \* The aluminium structure bolted to the chassis eliminates permanent welding and makes it easier to separate and independently manage at the end-of-life of the vehicle.
- \* The sides and roof (making up the body) are aluminium and the most important parts of the structure are bolted together. The rest of the chassis is bolted to the body forming up to 10 interbolted subsets, which make up the structure of the vehicle.
- \* The majority of the storage and traction elements are bolted to the structure, which also facilitates the process to assemble and dismantle those elements.



- \* The batteries are 100% recyclable compared to 60% ratios that are being achieved, for example, with Ion-Lithium batteries, according to the data of the "ReLionBat" LIFE project funded by the European Commission to develop techniques to allow this type of batteries to be recycled.

The bus has a **very long service life and needs less maintenance** as reducing the number of moving mechanical parts increases the life of the traction system. In the i2e, only the motor rotor is turning as there is not gearbox or clutch, while a conventional bus has a large number of parts turning or moving, apart from the gearbox and the engine.

The inverters and the other parts of the **i2e traction system has a service life equal or greater to that of the bus**, while the gearbox, engine, turbochargers, gas recirculation valves, antipollution and antiparticle filters, etc in combustion

## NEXT STEPS

After developing this bus, IRIZAR has taken a **further step** in its commitment to implement **LCA methodology and the assessment of the environmental profile** in the road passenger transport sector. It is currently involved in developing **Product Category Rules (PCR)** to draft and certify **Environmental Product Declarations (EPD)** in the road passenger transport sector, for the International EPD System verification system.

This PCR will be the **international benchmark** document to develop LCAs and EPDs for this type of project. IRIZAR's participation in this process is key for its positioning in the Life Cycle Assessment area of the sector. This work will end with the **preparation, verification and certification of an Environmental Product Declaration** by IRIZAR for the i2e bus.

“The Irizar Group’s 100% electric urban bus is a great step forward in developing the brand strategy, by positioning Irizar as a benchmark in innovation, sustainability and at the technological cutting edge of the market.”

- Jose Manuel Orcasitas. General Manager

## IRIZAR S. Coop.

Business group whose main activity is to design manufacture and market buses and coaches, as well as being present in the communications and electronics sectors.

Irizar, S. Coop. is a global project employing over 2,500 people and has bus and coach production plants in five countries (Spain, Morocco, Brazil, Mexico and South Africa), along with five investee companies in Spain. It has a commercial presence in over 90 countries on the five continents. The headquarters are in Ormaiztegui in Gipuzkoa (Spain).

Founded in 1889, and with a track record of over 125 years, it is a leading company in the sector in Spain and one of the most important benchmarks worldwide.



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This Case Study in Excellence has been published through the 2014 call to submit Practical Cases of Environmental Excellence in Basque Companies.

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