STUDY, ANALYSIS AND DEVELOPMENT OF NEW TECHNOLOGIES IN HYBRID ELECTRIC MOTORIZATION FOR THE URBAN SOLID WASTE COLLECTION TRUCK

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CDTI Centro para el Desarrollo Tecnológico Industrial
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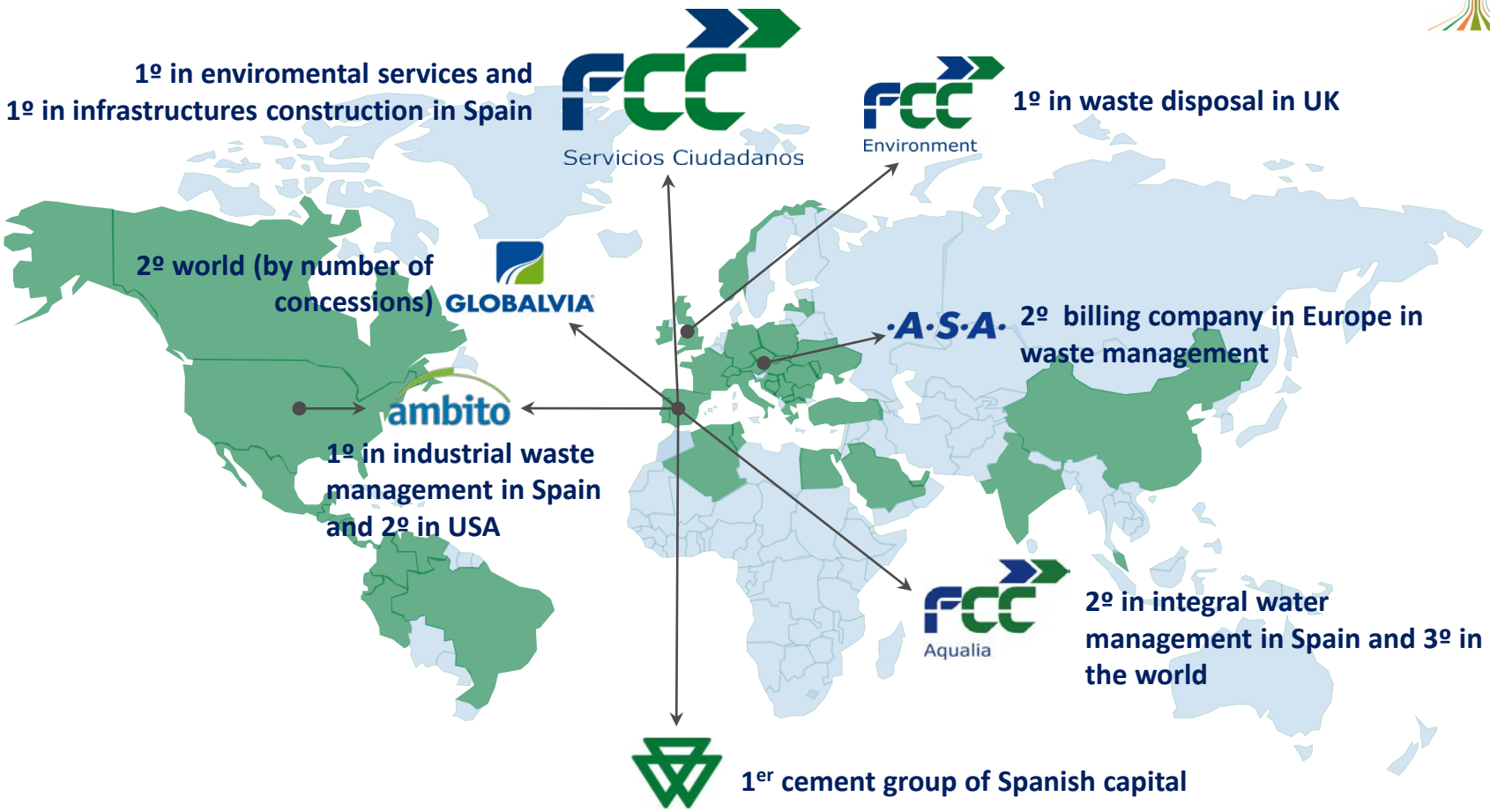
1. The company.
2. Technological evolution from similar projects conducted by FCC.
3. The new generation of urban hybrid-electric vehicles for waste collection with ultra-capacitor system.

1.- THE COMPANY: FCC GROUP



1. THE COMPANY: FCC GROUP

- We are present in **35 countries**, in which we employ more than **60.000 people**.
- We collect and treat **9 million tons** of home waste per year.
- We lend Citizen Services in more than **5.000 municipalities** around the world.
- Aqualia, our water division, serves more than **28 million people** in **17 countries**.
- We are currently building more than **200 km** of high speed train.
- We manage trough Globalvía **22 highways** in Europe and America, a total amount of **1.470 km**.

1.- THE COMPANY: FCC GROUP

Servicios Ciudadanos

The consolidated turnover of the group in July 2.013 was 3.133,9 M€, with an EBITDA of 293,6 M€ and a business portfolio of 32.935,4 M€.

Business model based on activities with a great potential for long term growth.

1. SPECIALIZED COMPANY: FCC MEDIO AMBIENTE

▪Construction and management of Natural Gas charging and compression stations in Madrid.
▪15 Natural Gas compression plants.
▪Total capacity: 28.000 Nm3 / h.

▪ 1.257 Natural Gas-powered vehicles in service.
▪ 18,5 mill. Nm3 /year of gas for automotive.
▪134 tons of NOX emissions avoided per year.

▪ First electric and hybrid truck tank for irrigation and washdown of the historic town of Badajoz.

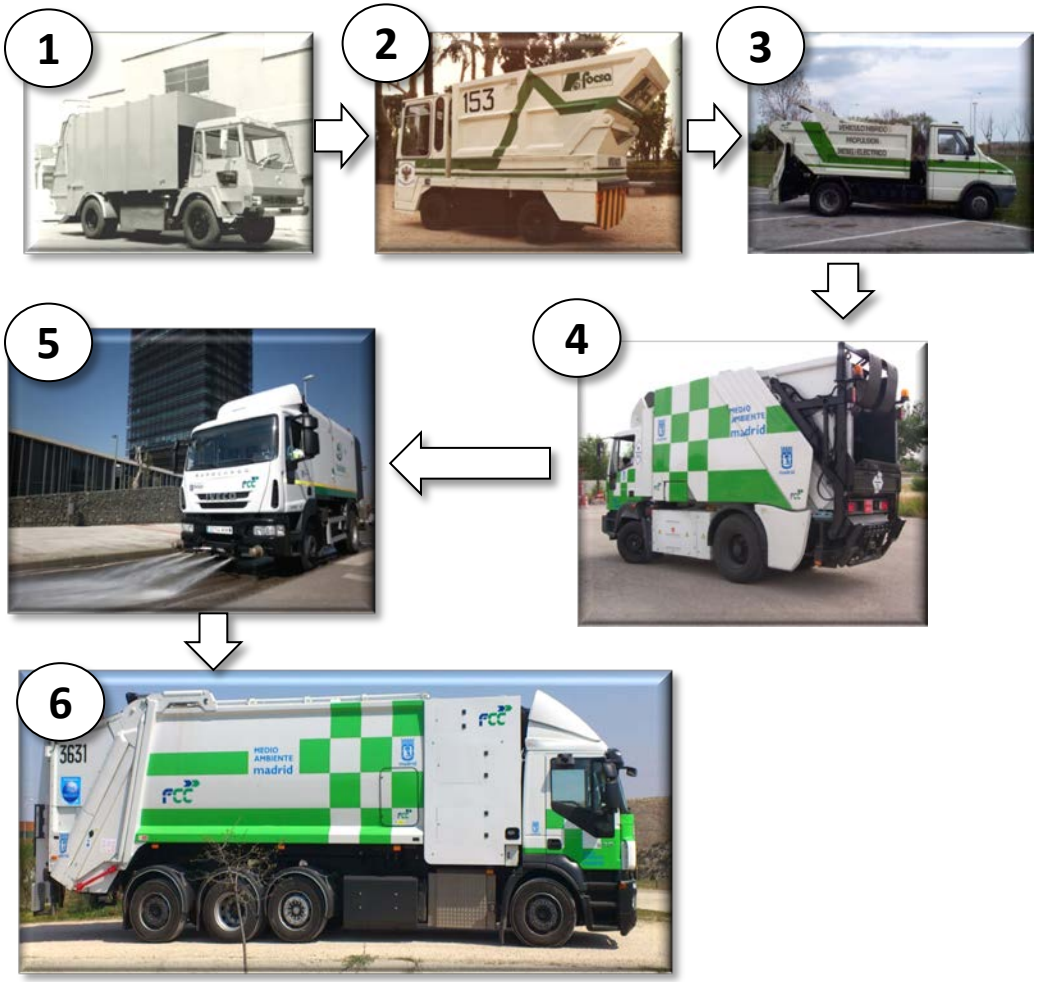
▪Charging station for NiMh batteries in Barcelona.
▪12 charging points of 27 kw each one.

▪Electric-hybrid vehicles for a clean urban waste collection in Madrid and Barcelona among other cities.

1. SPECIALIZED COMPANY: FCC MEDIO AMBIENTE

- Services of collection, treatment and disposal of urban and industrial solid waste, cleaning of public streets, maintenance of sewage networks and conservation of green areas.
- The turnover of this division at the end of 2.013 amounted to more than **2.770 M€**.
- In the last 6 years more than **3.300 vehicles** and machines have been acquired with a total investment of more than **327 M €**.
- The number of vehicles is currently more than **16.500 units** (Spain and abroad) attended by more than **155** own workshops with more than **800 people** dedicated to preventive and corrective maintenance tasks.

2. TECHNOLOGICAL EVOLUTION FROM SIMILAR PROJECTS CONDUCTED BY FCC



1. 1974. Barcelona. First electric vehicle. Lead batteries.
2. 1982 – 1992. Toledo. Collection in historic twon. Lead batteries.
3. 1998. Barcelona. First electric-hybrid vehicle Primer vehículo eléctrico – híbrido. Ni-Cd batteries.
4. 2005. Madrid. First electric-hybrid vehicle. With recharge of Mh batteries.
5. 2011. Badajoz. Electric and hybrid tank for irrigation and washdown. Lithium-ion battery.
6. 2012 First electric-hybrid heavy vehicle Maximum authorised mass 36 Tm. 150 kWh Lithium-ion battery

Aims and improvements made:

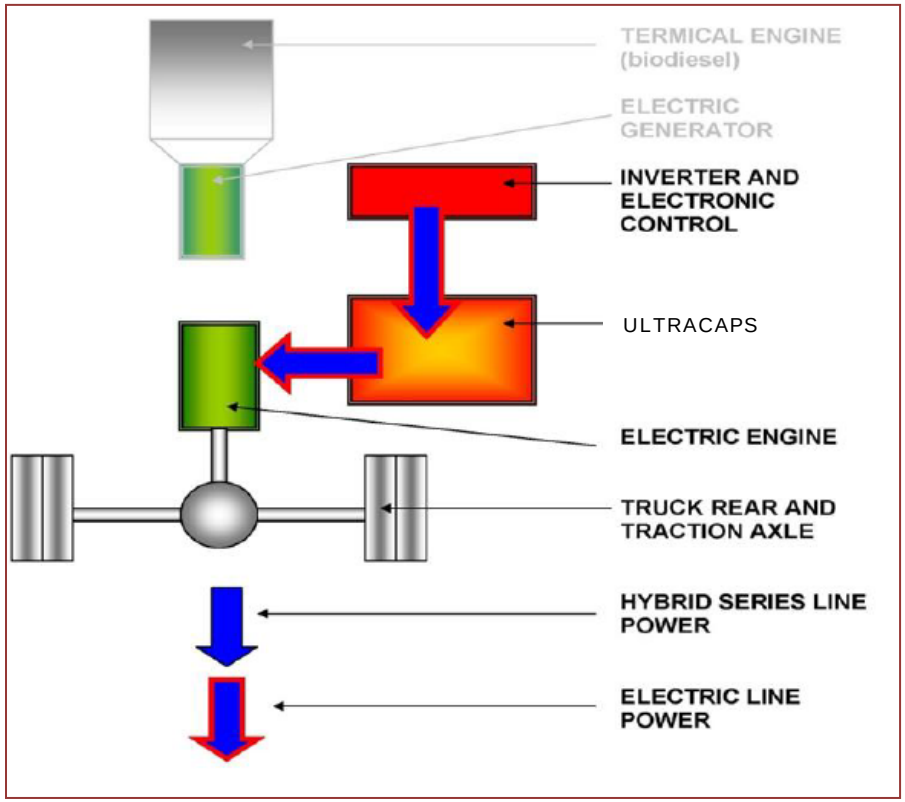
Designing, developing, manufacturing, setting up, testing and placing in service of a large tonnage electric-hybrid vehicle with **ultra-capacitor system** for urban service that will be used for for the collection of waste in large areas of any type of city.

Significant reductions in **emissions** of exhaust gases to the atmosphere (ZEV-Zero-Emission Vehicle) **and noise pollution both** in electric and hybrid mode (natural gas powered).

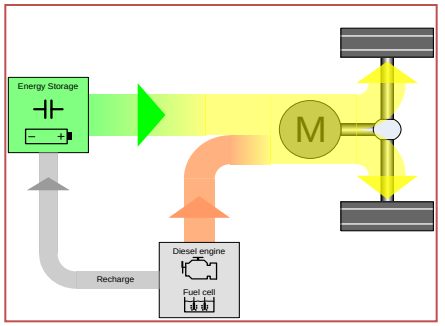
Maximum energy efficiency and savings compared to equivalent vehicle with combustion engine.

Improved **performance and features** compared to the equivalent heat.

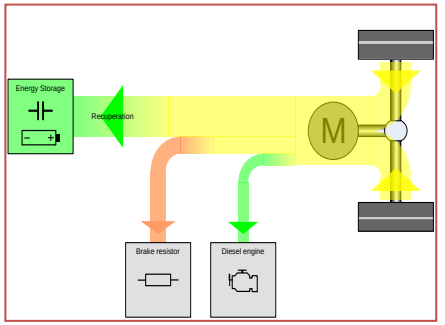
Operating diagram:



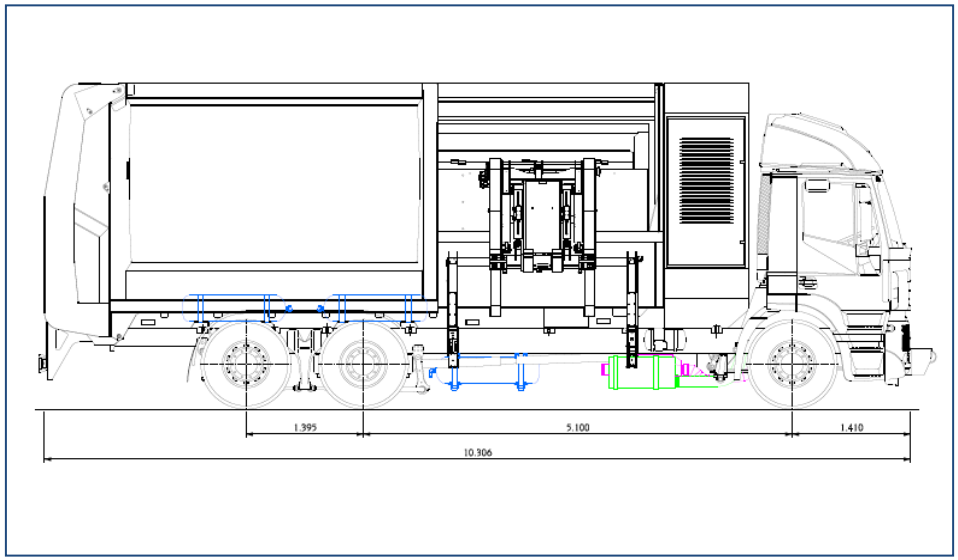
Acceleration phase



Decelerating phase



3. THE NEW GENERATION OF URBAN HYBRID-ELECTRIC VEHICLES FOR WASTE COLLECTION WITH ULTRA-CAPACITOR SYSTEM



Proposal for a new development of hybrid electric side loader vehicle with natural gas engine (2014/2015)

Waste collector EHSR. Years 2012/2013

Differentiating novelties:

Ultra-capacitor system of new technology and design, specifically adapted for this application, allowing **operation as a "series hybrid" in displacement and "pure electric" (with the heat engine off) in compaction** and starting during the urban route, with power and energy enough to cover the entire route of waste collection in the above conditions.

Starting chassis with compressed Natural Gas engine, only to drive the electric generator.

New management control system adapted to the new requirements, specially the **optimization of the braking energy** in a large tonnage vehicle and urban service, with numerous stops and accelerations.

Thanks for your attention

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