TECHNOLOGY

PHILOSOPHY

The central idea of the project has been transferred into each stage of the development:

- **Intensive Research and Development for the optimum solution of Software and Electronics. More than four years of Research and Development. Result: A mobility platform which monitors each element of the Bus and issues the corresponding parameterized information to the exterior.**

    - User interface (HMI) for a mobility platform with a 100% electric base adapted for urban buses.
    - Fleet management system (AGF), including bus shelter control recharging points, communication, etc.
    - Optimum integration of the combined equipment: electronics, traction system, energy storage and bodywork. Ultimately, an optimum integration of technologies

- **New design of the traction system to obtain an optimum relation between physical variables (weight and size) and the performance (range, torque, power).**

- **New design of the energy storage system concerning three elements: battery, fuel cells and ultracapacitors.**

- **Optimization of materials and suppliers along the entire chain: three years of trials and simulation tests of our own design.**

- **Versatility of the mobility plataform (a more electronic traction system), adaptable to any type of bus.**

- **A new experience for the user: more comfortable buses, with neither noises nor vibrations.**

- **Long service life of the buses.**
- **Clean garage concept.**
- **Integration with recharging network.**
    - Design of the Intelligent Recharging Point for mobility platforms.
- **Telecommunications and online exchange of information with the exterior.**

ANALYSIS OF CURRENT EXISTING TECHNOLOGIES

In the attached chart, a comparative analysis has been made of the available energy technologies for their implementation in the traction of urban buses with their relative strong and weak points.

TECHNOLOGY	STRONG POINTS	WEAK POINTS
Internal combustion	Cost of competitive acquisition and capacity to travel long distances and generate great powers	Bad utilization of the energy Issues CO2 Vibration greater wear
Mild hybrid	20% saving of energy in an urban environment	Electric motor not very powerful Less efficient than hybrids Can not propel with the thermal engine switched off.
Non-pluggable hybrids (HEV)	Aprox. saving of 30% in energy Can work by only using the electric motor.	Low range with the electric motor
Plug-in Hybrid (PHEV)	Reduced cost in the used energy Superior range to the 100% electric vehicle	Double use of motors and batteries
Battery driven electric vehicle (BEV)	Zero emissions Reduced maintenance Longer vehicle service life Allows the appearance of a new range of services surrounding it.	High cost of the battery Limited Range
Electric vehicle with extended untime	Greater range than the BEV	High costs of the batteries
FuelCell (FCEV)	More efficent than Fuel Bus No waste (only water vapor)	Short duration of the hydrogen batteries Absence of hydrogen station network to refuel.

Robustness, to guarantee mechanical reliability during its life span;

Security, always adopting excellent solutions from a dynamic vehicle point of view and the control of the vehicle;

Economy, understanding that the development of the urban busses should impact the results of the activity in the least burdensome way.

Flexibility, which facilitates the adoption of specifics solutions which are adapted to the needs of each user.

The criteria for the components are as follows:

- **Base Frame.**
  The three-dimensional structure, its stiffer and more robust than the traditional ladder frame, constructed with high strength steel to guarantee the utmost security of all its occupants, as well as the answer to the load and ground requirements.

- **Bodywork.**

The bodywork is made up of different materials, such as steel, aluminium and the composites, finding the balance between the robustness of the elements and the reduction of the weight which decreases the energy consumption. In future designs, we are studying the use of carbon fibre in some components, the same way we manufacture for the aeronautical industry.

- **Chassis.**
  The steering and braking are electrically assisted to reduce physical effort on the driver, it also has a regenerative braking system which allows it to recuperate part of the kinetic energy to charge its batteries during the reduction of speed.

  Disc brakes are installed to maintain higher levels of braking and the suspension is a full independent set up for more precise driving, with higher directional stability as a package.

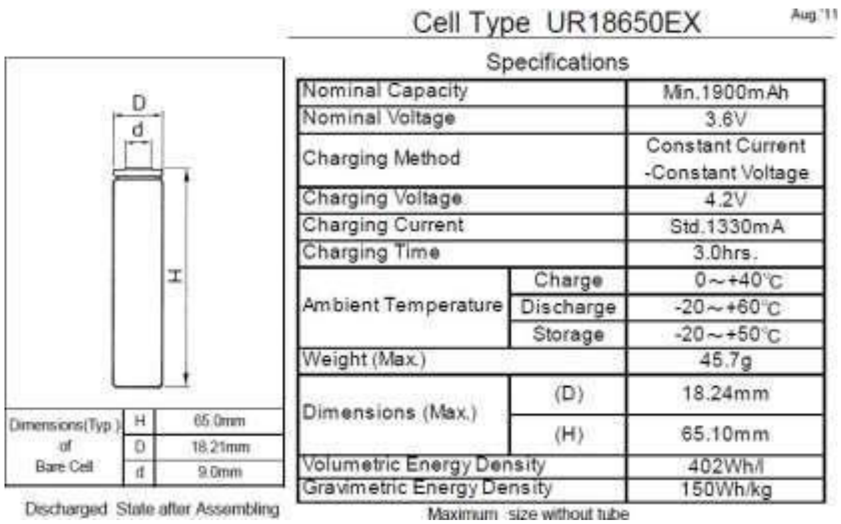
- **Transmission.**
  The traction capabilities of its electric motors and the practical independence of its rotation and its high start-up torque which can offer the possibility of eliminating the gearbox in determined modalities of the vehicle, increasing the efficiency of the system and reducing its overall weight.

- **Propulsion System.**
  Given the importance of the propulsion system of the vehicle and its innovative condition, this will be discussed in much greater detail under its specific section.

Energy Storage System

The properties of the lithium-ion batteries, such as the lightness of its components, its high energy level capacity and its discharge resistance, the absence of memory effect or its capacity to operate a high number of regeneration cycles, has permitted to design lightweight accumulators, of a small size and in diverse forms, with a high efficiency, especially adapted to applications in the electronics industry with high consumption. The cells used on our first prototype were cell type UR18650EX by Sanyo.

The characteristics of these batteries are:



Cell Type UR18650EX

Aug.'11

Specifications

Nominal Capacity		Min.1900mAh
Nominal Voltage		3.6V
Charging Method		Constant Current -Constant Voltage
Charging Voltage		4.2V
Charging Current		Std.1330mA
Charging Time		3.0hrs.
Ambient Temperature	Charge	0～+40℃
	Discharge	-20～+60℃
	Storage	-20～+50℃
Weight (Max.)		45.7g
Dimensions (Max.)	(D)	18.24mm
	(H)	65.10mm
Volumetric Energy Density		402Wh/l
Gravimetric Energy Density		150Wh/kg

Maximum size without tube

Dimensions(Typ.) of Bare Cell	H	65.0mm
	D	18.21mm
	d	9.0mm

Discharged State after Assembling

The buses can be equipped depending on the KW/h we want to store, but they will always go in the combinations series/parallel to achieve the 400 VDC typical voltage and 430 VDC maximum voltage.

Our design will be equipped with a minimum of 300 modules of 1,25 KW/h each and a nominal tension of 21,6V, which give its a stored
energy capacity of 360KW/h. This battery pack can be dimensioned to each bus, depending on how much autonomy we want to equip it with.

The prices for the batteries have suffered a significant fall since our first tests. The price of the battery pack set of these characteristics is around 700€/KWh of capacity.

The optimization of the designs and materials, the integration of different elements and the development of a software expressly focused on the traction performance and its efficient use of the energy, this has resulted in the VL buses showing variables at a maximum level of competitiveness.

- Range: 250 kilometers
- Tare Weight: 12 500 kg
- Maximum Torque: 900Nm
- Power: 200Kw
- Sitting Capacity: 28, the maximum number of passengers is determined by the maximum authorized weight (19Tm). Taking into account that it can take a payload of 6.500Kg, the number of passengers could be 95 by weight, but this would reduce the space available and the commodity of the passengers.

2.3.4. Communications System

As mentioned before, the origin is the electronics. There lies the essence of their firm commitment and differential capacity. The project presents a strong development in software and electronics. Its base is Control Station E-BUS, designed and manufactured entirely by us, through which the whole of the system is managed.

The objective of the control station is to centralize and to manage the existing flow of information in the electric bus and interact with the rest of the control stations according to the needs which might present any system at each moment.

The control station communicates with its different sub-systems (traction control, battery control unit, brakes control unit, suspension control unit and the user interface). Both the hardware and the software are adapted to the specifications of each client, which gives flexibility in design, made to measure functionality, an open management system which simplifies the traditional control scheme of the vehicle at a CAN bus level and information flow.

To be able to control all the information flow, the control station has the following ports of communication:

6 Ports for CAN communication 1 RS-

232 Port

1 RS-485 Port

24 digital I/O

8 Analog signals

As a whole, the communications system presents the following modules:

Traction control system.

The E-BUS control station interacts with the traction control, managing the torque and speed control, sense of rotation and electric brake, concordant with the instructions of the electric brake/accelerator pedal and the status of the signals involved in the traction of the vehicle. To close the control loop, the control station will collect data of the speed, voltage, temperature, torque, electricity…of the motors at all time and will give orders in function of what state the system finds itself in.

To carry out a precise control of the electric vehicle, as well as the data from the motor controller, the control station will collect data from other systems, like the data from the suspension system (CAN Chassis) and the data from the inclinometer (RS-485).

Energy Storage System Control (BMS).

The control station is tasked to manage the energy storage system.
For the battery packs, the control station will control the status of the different cells at each moment, for which it will monitor a set of data at each moment, like voltage, intensity, SOC, DOD, etc.

The Regenerative Electric Braking System.

The regenerative braking process in any electric vehicle converts the kinetic energy from the mass movement to electric energy through its traction motors, acting like generators. The function of the regenerative brakes is to collect all the kinetic energy produced by the vehicle while braking and converting it into electric energy, in a way it can be used to recharge its batteries, therefore achieving a greater range for the vehicle. The control station controls and manages the regenerative brakes.

Instrument Panel Display System

The control station interacts with the display system (main screen + auxiliary) with the aim to visualize the system status in real time and that the conductor can act accordingly to the needs of the vehicle.

The parameters are shown on the display system and are totally configurable by the client. Furthermore, the instrument panel can be designed to the needs of the user.

Diagnosis.

The control station includes a diagnosis function of the whole system which allows it to carry out maintenance work in a fast and precise way. All the faults, alarms and incidents that are produced in the system are recorded in the control station which allows the corresponding analysis to be made of the causes which created them.

2.3.5. Tracking System

The vehicle tracking system which is also monitored by the E-BUS control station, monitors the whole of the vehicle. The rest of the system modules are as follows:

Communications Computer.

The communications computer controls the driver's interface as the communications between different components of the vehicle. The computer is an industrial designed PC for the automotive industry, being able to support environmental conditions like vibration, a wide range of temperatures and levels of humidity. The computer, which works under the operating system Linux, requires a certain amount of power, because it needs to support video and the communication of the rest of the components in real time.

G.P.S - Global Positioning System.

The GPS on the VL-BUS uses an orbiting satellite network to calculate: latitude, longitude and height, for a precise time. This function enables the administrator to know at all time the situation of its fleet, announce the next stop in the vehicle, calculate the time to the next location, give information on consumption at each point of the route, or know the state of traffic.

GPRS - General Pocket Radio Service.

The GPRS of the VL bus uses the mobile telephone network to send messages, be it SMS or email, also to access web pages. The GPRS widens and guarantees the coverage of the vehicle. The vehicle will use the GPRS to communicate with the main server, such as to transfer a necessary information or receive information from the server. As the GPS, the GPRS is the main channel of communications whilst the vehicle is out of coverage of any Wi-Fi points. Depending on coverage and area, the use of 4G communications or future standards.

Wi-Fi - Wireless Connection.

Wi-Fi is a wireless internet system allowing connection to other systems within an operating range. This connection will be a useful resource when the bus finds itself stopped. The Wi-Fi bandwidth is greater than the GPRS so its main function will be the mass transfer of data.

RFID Reader - Radio Frequency Identification.

The RFID reader will allow each employee of the fleet owning company to take a personal identification card in the system area.

Cameras.

The bus can take one or various video cameras on-board.

Microphone.

The bus conductor can also dispose of a microphone to send oral messages to the main server, therefore avoiding having to write any message on screen.

Speakers.

The connected speakers serve to give audible messages to the driver, for example when the autonomy of the batteries is low or when a fault appears in the system.

Interfaces.

There will be two basic interfaces: the driver´s interface allowing access to the necessary information needed to use the bus correctly. The other interface will be the administrator´s allowing remote access to the buses status in real time. The system maintains communication between the main server and the vehicle, being able to send messages in both directions.

The VL-BUS electric bus destined for controlled routes in urban and metropolitan surroundings.

VL-BUS

2.3.7. Data sheet

- Regular use bus in urban surroundings.
- Flexible number of seats.
- Market: Public bus companies and private fleets of buses.
- Mobility platform (bus without a body): the bodybuilders sector is an important market for the sale of bus components (communication systems, traction and energy storage)

FICHA TÉCNICA	
Max load	19.000 kg
Tare weight	12.500 kg
Batteries weight	3.500 kg
Maximum passengers	95
Length	12.000 mm
Width	2.550 mm
Height	3.100 mm
Max speed	80 km/h
Slope circulation	18%
Autonomy	250 km
Maximum power	200 kw
Torque	900 nm

COMPETITIVE ADVANTAGES, BENCHMARKING AND COMMERCIAL ANALYSIS

LEVEL OF COMPETITION IN RELATION TO THE ELECTRICAL BUS

Operating costs.

Diesel BUS 12m.	Electric BUS 12m.
Oil Consumption 55 lts/100 Km. Fuel Cost 50 €/100Km. Diesel vehicle cost 250.000€. Maintenance Cost 0.3 €/Km.	Energy consumption E Bus 150Kwh/100 Km. Energy cost 18 €/100 Km. Cost of vehicle without batteries 250.000 €. (No SUBSIDIES) Maintenance Cost 0.2€/Km

Example of annual operating costs.

Diesel BUS 12m.		Electric BUS 12m.	
FUEL	..............45.000€	Energy cost	13.500€
Amort. Vehicle	20.834€	Amort. vehicle	20.000€
Maintenance Cost	..............21.000€	Maintenance Cost	14.000€
		Rental Batt...	31.200€
Total Diesel Bus	**86.834€**	**Total EBus...**	**78.700€**

Example of operating costs 12 year life cycle.

Diesel BUS 12m.		Electric BUS 12m.	
Fuel...	540.000€	Energy cost	162.000€
Amort. Vehicle	250.000€	Amort. Vehicle	240.000€
Maintenance Cost	252.000€	Maintenance Cost	168.000€
Total vehicle diesel...........	***1.042.000€***	***Total EBUS (no battery)..........*** ***(no SUBSIDIES)***	***570.000€***
Residual Value	10.000€	Residual Value	40.000€
		Total EBUS (no Batt)...	530.000€.
		Rental Batt...	374.400€
Total lifecycle...............................1.032.000€		***Total lifecycle........................***	***944.400€***

Calculations made for an average of 60,000 km/year, calculating the renting of batteries at approximately 0,52 €/km. No oil changes, no diesel bus servicing, which cheapen the final cost of the electric bus considerably and lower the review times.

Commercial strategy

Differentiated actions in sections.

- Bus body builders (Mobility Platform, components)
- Municipalities and Public Transport Companies(Bus) Associated Services:
  - **Financing for batteries.** Analyses, studies and deal agreements have been made with companies who deal with this type of financing, the selling included in the recharging of Kwxh.
  - **Exterior advertising** *(bus and bus shelters*). Another source of income for the operator apart from the price of the trip. As it is completely programmable, the advertisement can be modified in real time, allowing for a greater offer of advertisement space.
  - **Recharging points (bus), bus shelters.** the capacity to manufacture and sell this additional equipment, thereby diversifying products and increasing turnover.
  - **Maintenance (buses).** There are two types of maintenance: Mechanical and Electric-Electronic. The first will be very scarce, and will consist of the usual in a bus (brakes, wheels, air conditioning, etc.)

CONSIDERATIONS TO THE BUSINESS PLAN

Highlight that at present day:

- We have a chassis for a low floor bus with features approved for any type of current European chassis: Angled front axle ZF, rear axle ZF specific to a low floor chassis with a left shifted differential, steering system ZF, braking system with ABS y EBS Wabco, suspension system ECAS Wabco.

- Capacity to develop software and electrical architecture of their own chassis.

- We could easily convert it into a conventional diesel chassis. With only having to incorporate the thermal engine Euro 6 with its auxiliaries (refrigeration, exhaust, urea installation, etc) and the automatic transmission.

- In the European urban bus market, the offer of chassis is very limited. At present time, only MAN and SCANIA offer low floor chassis, therefore, we understand that the traditional chassis+bodywork market is thretened in Spain.

- This situation could offer a good opportunity to provision part of the market with national product, as in the case of Polaris in Poland, VDL in the Netherlands, VanHoll in Belgium and Alexander Dennis in England.

- We dispose of a bodywork for a light, easy-to-construct urban bus with an attractive modern design. Any bodywork builder could reinforce its presence in the urban bus market for conventional chassis.

- We dispose of a complete electric bus, although a "launch" is needed, and finishing touches to the prototype and its industrialization process, the basic technology is completely finished and tested.

3.4. INITIAL APPROACH

The key questions would be:

1. What do we sell?

2. How much does it cost to manufacture and place in the market?

3. How much do we sell for?

4. How and where do we manufacture?

5. How to sell them and offer a post-sales service?

We will answer these questions briefly, the facts we contribute are contrasted by more than 5 years of Investigation, designs and tests.

3.4.1 What do we sell?

The products are:

1. Electric Urban Buses (VL-BUS)
2. Bus shelters for Smart Cities
3. Mobility platform (Intended to provide for bodywork builders). This would include technological support and the selling of the use of the technology. (Especially intended for foreign bodywork builders).
4. Associated services. (Fleet management, communication, advertising, etc.). The idea is to outsource this product.

3.4.2. How much does it cost us to manufacture?

After carrying out the detail engineering and constructing our prototypes, the estimated costs for manufacturing would be:

Complete bus (Without batteries):	153.000 €
Bus shelters:	We do not evaluate included in the business plan revenue chapter.
Services:	Included in the business plan revenue chapter
Batteries:	They will be financed by leasing, renting o included in the price of the Kw consumption.

3.4.3. How much do we sell for?

Complete bus (Without batteries):	250.000 €
Bus shelters:	They will be offered to measure, and it will depend on the implemented services.
Services:	They will be offered to measure
Batteries:	They will be financed by leasing, renting or included on the price of Kw consumption.

3.4.4. How and where we manufacture?

At present time we dispose of an engineer, industrial boiler works, state of the art electronics manufacturer (with homologation ISO TS- 16949 for automation) and a composites manufacturing company.

We could immediately dispose of rented installations (included in the economic plan) which would give us the capacity to manufacture the target units as mentioned in the plan with an optimum communications level at an international level and a provision of qualified personnel, who could incorporate quickly to the project, with a vast experience in the sector.

There is an ANNEX included with the LAY OUT proposal and a PLAN of the installations. in these there are various painting booths and a factory line to manufacture base frames (which can be outsourced). With three painting booths and 10.000m2 of installations we can ensure the proposed production in the economic business plan adjoined.

3.4.5. How do we sell?

It's important to have an adequate marketing and communications campaign. The product-service is very new and has a positive reception. It's ecological, but above all cheap and reliable, as well as having an attractive design.

We should make the most of the SMART CITIES boom, and the European government aids for demonstration projects. It would be convenient to offer these projects for one or two electric lines to the most representative cities in this field.

We currently have contacts in the Transport Company in La Coruña, to offer them a Demonstration Project, which will be the first in Spain.

With regards to the batteries and recharging points, a financing deal with some companies in the sector can be considered (In Spain some existing companies such as Repsol and IBIL would be willing to participate), which would be financed as fuel,
We must insist that battery technology advances every day, both in the energetic density as in the decrease of its price. All this will help our product, making it more competitive.
We also believe that with the saving of fuel and maintenance, the batteries should be financed completely.

INVESTMENTS:

An investment in the project equivalent to **60.000.000,00 €** is required.

ESTIMATED PRODUCTION:

	YEAR							
UDS	2022	2023	2024	2025	2026	2027	2028	2029
VL- Bus	100	500	1000	1000	1000	1050	1100	1150

ESTIMATED SALES PRICES

The unit selling price per standard bus will be 250.000€. (proposed annual increase of 2%)

NOTE: This information is strictly confidential and does not imply any contractual information. Those interested in more information must sign a confidentiality agreement (NDA) and a prior due diligence. This documentation is commercial and cannot be considered as technical information.