Advanced Battery for Electric Vehicles in CEGASA.
What is CEGASA
<table>
<thead>
<tr>
<th>Main figures</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>200,000,000 Euros</td>
</tr>
<tr>
<td>Facilities</td>
<td>124,000 m2</td>
</tr>
<tr>
<td>Factories</td>
<td>4</td>
</tr>
<tr>
<td>Employees</td>
<td>1014 People</td>
</tr>
</tbody>
</table>
CEGASA GROUP

More than 75 years developing new storage technologies

1934

Components

EMD (cathode)

Deep ironing (colector)

Zn powder (anode)


Consumer battery

1934

Leclanché

Alkaline

Superalkaline

Evolution

Industrial battery

2011

Battery pack
Packaging plant: 900 million alkaline cells / year
Manufacturing plant: 450 million alkaline cells/year
Production plant: 11,000 Tn / year of EMD
High qualification staff with long experience about battery manufacturing world:
- high speed on line testing
- massive electrochemical and safety characterization
- components purchasing
- materials handling
- processes designing
- battery transportation
- etc.

Industrialization capability demonstrated
Global Manufacturer of Consumer batteries

First Global manufacturer of Air-alkaline batteries

First Spanish manufacturer of Fuel Cells

Second European producer of Electrolytic Manganese Dioxide

Only alkaline manufacturer with European capital

14 International Offices. Presence in 46 countries

Company leader in the energy storage market
The most important retail companies in Spain and Europe rely on CEGASA.
Challenges for the electric storage
Energy domains

- Portable
- Transport
- Stationary
Portable applications

**Primary consumer battery (non-rechargeable)**
- CEGASA only manufacturer with European capital
- Mature market ruled over multinationals (US, Japan)
- China ruled the low cost market
- Rechargeable batteries are only in a partial competition
- New technologies needed keeping the same standards (voltage, dimensions, environmentally friendly materials...)

**Lithium-ion batteries for portable electronics**

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>JAPANESE</td>
<td>4.2 B$</td>
<td>+8%</td>
</tr>
<tr>
<td>CHINESE</td>
<td>1.6 B$</td>
<td>+13%</td>
</tr>
<tr>
<td>KOREAN</td>
<td>1.1 B$</td>
<td>+27%</td>
</tr>
<tr>
<td>REST OF THE WORLD</td>
<td>0.1 B$</td>
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</tbody>
</table>

Market share by country, %

![Graph showing market share by country from 1993 to 2006](chart.png)
Automotive industry as a tractor of electric vehicle

- Motorbike
- EV car
- Industrial vehicles
- Bus
- Tram without power grid
- New concepts
Renewable Energy and Smart Grid
Intermediate electrical storage is needed

Stationary storage

Support to generation
Stability of electric grid
Integration of renewable energy

Management of electric substations
UPS and APU
Domestic and industrial management of electricity
DC-DC rapid charge stations
Answer of CEGASA GROUP
Answer of CEGASA: GREEN technologies

New technologies of storage are need with improved performance but this new technologies have to be respectful to the environment

3 proposals:

- Lithium ion battery
- Fuel cell
- Zinc air battery
Lithium ion batteries for transport applications
The opportunity in Europe and USA

- CEGASA: Manufacturer of cells and battery packs
- CEGASA: Industrialization capability demonstrated
- CEGASA: European manufacturer with European capital
- CEGASA: Collaborating with companies leaders in battery recycling. CEGA is a company of the group specialist in logistics.

Recommendations
CEGASA's target

- Anodic material
- Cathodic material
- Electrolyte/separator
- Current collectors
- Aditives
- Other materials

- Control electronics (BMS)
- Other structural components

- Battery pack

- Automotive
- Stationary applications

- Other applications:
  - Tram without power grid
  - Efficient lift
  - City car
  - Electric bus

- Recycling
- Secondary use
Green Cell

Cathode: LFP
Anode: Graphite
Green solvents

Aqueous processing for electrodes
No use of NMP
Modular battery pack

Using a modular system allows quick and easy integration into a wide variety of applications:

- **City cars** (2 modules)
- **PHEV** (4 modules)
- **FEV** (8 modules)
- **MCVs** (10 modules)
- **Trucks** (30 modules)
- **EV Buses** (50 modules)
Technology in CEGASA
Chain value

Research and Development | Innovation/production | Commercialization

R + D + i → market

External collaborations for the product and process technical development [research centers, companies]

External collaborations in basic/applied research [universities, research centers]

Laboratory (technology)

Prototype (product)

Pilot plant (process)

Production

Comercialization

Clients information

Suppliers information
Electrode development

Controlled temperature room for battery components testing, equipped with 200 channels for charge/discharge and electrochemical testing
Pilot plant for electrode production

CEGASA facilities Pilot Plant for electrode manufacturing

Automated coater for sample electrode manufacturing

electrodes made in Cegasa pilot plant after Cidetec technology
Cell development

Dry room

Prototypes
Pilot plant for cell production

- Calendering
- Lamination
- Welding
- Bag moulding
- Pre-sealing
- Electrolyte filling and final sealing
Testing labs

Battery Testing Laboratory:
- up to 70 channels for battery testing
- 5 climatic chambers
- Adiabatic Calorimeter

1 m³ climatic chamber + cycler for Battery Packs up to 20 kW with grid feeding

340 liter climatic chambers+ cyclers with 20 channels for cells up to 60 A

THT Adiabatic Calorimeter for cell thermal performance testing and abuse testing (thermal & mechanical)

600 liter climatic chamber + 6 channel cycler for cells up to 240 A equipped with Impedance Analyzer
### Products in development (transport)

#### Cell

<table>
<thead>
<tr>
<th><strong>Datasheet</strong></th>
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<tbody>
<tr>
<td>Energía específica (Wh/Kg)</td>
<td>105</td>
</tr>
<tr>
<td>Densidad Energía (Wh/L)</td>
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<tr>
<td>Potencia específica (W/Kg)</td>
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<tr>
<td>Densidad potencia (W/L)</td>
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<td>Corriente máxima descarga (C)</td>
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<tr>
<td>Corriente máxima carga (C)</td>
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<td>Ciclos de vida 80% DOD (nº)</td>
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<td>Temperatura mínima carga (ºC)</td>
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<tr>
<td>Temperatura mínima descarga (ºC)</td>
<td>-20</td>
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<tr>
<td>Temperatura máxima descarga (ºC)</td>
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<tr>
<td>Seguridad (1 a 5)</td>
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</tbody>
</table>
Products in development (transport)

Module

- Voltage (V): 29.6V
- Energy (E): 1.2 kWh
- Peak Power (Pmax_D): 9.4 kW
- Peak Power (Pmax_C): 5.9 kW
- Weight: 11.8 kg

Energy density:
- 100 Wh/Kg
- 130 Wh/l
Future plant in CEGASA Spanish facilities
Cell and module manufacturing
Future
Next step

Fuel cells as "range extender"
In hybrid vehicles, compared to internal combustion engine, the fuel cell provides electricity directly implying greater efficiencies with zero emissions.

New battery technologies (Metal-air)
The next generation of batteries beyond lithium ion are now developing. Metal air batteries are a very promising possibility.