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KEYNOTE

The railway station as link of electromobilty

Berrios Villalba, Antonio
Martínez Acevedo, José Conrado
Tobajas Guerra, Carlos
Gómez Alors, Antonio

ADIF[1]

Abstract

The railway station aims to become an important link of the electromobility chain within the city.

In order to reach the decarbonisation of transport goal, the electric car will be an important part of the new urban scenario in the urban mobility.

The intermodality between the train and the road will be easier if the electric car is parked in the railway station. During the time that customers are using the train for travelling, the electric car is being charged in the car park. When the customers come back to pick up their electric car, it will be completely charged.

The energy necessary to feed the cars' battery could be available from the breaking energy of trains. The railway energy network is independent from the city's energy network, then it is a good opportunity to create a big area of recharge for electric vehicles without interference with the energy power plan of the city's network.

According to a study of ADIF, in the Sevilla-Santa Justa station occurs an average of 180 passenger train arrivals per day, so the energy generated by braking reaches 9 MW/h per day; this is an annual total of nearly 3 GW/h. Given that an electric car takes 17 KW/h for a 100 km travel, the energy generated would have been used to run nearly 53,000 km per day in electric cars, saving 4.5 tonnes of CO2 per day.

But the technical connection with the catenary in the railway station is not trivial, ADIF developed an experimental research project that provided the necessary experience to:

• Energy storage systems: technologies of supercapacitors and batteries; Energy accumulators, as its name suggests, allow to store energy in any of its forms, so that it can be used later. In this way gets undock the demand of power generation.

• Electric vehicle recharging points: Recharges carried out by type 2 usually do not move from the 16A single phase, for normal recharging. Raising the nominal current of the system until the 32nd for processes fast charge. Where the supply system is three-phase, and for rapid recharging systems power level rises until the 63rd.

• Information and communication technologies: The different subsystems that could be used are: Energy management, User management, Supervision and Control System, E-maintenance,

• Energy efficiency and quality of network The set of power systems installed on micro intelligent network formed by the catenary, quality network and loads, distributed storage system, are intended to extract, modify, store, and manage the electrical energy in the most efficient way possible, always ensuring the quality, reliability, robustness, and security of electricity supply.

• E-maintenance: E-Maintenance as a maintenance strategy, i.e., a method of electronically using real-time data obtained from the equipment using digital technologies (mobile devices, sensors, technology, Internet, etc.) as a maintenance plan (i.e., a structured set of tasks with an interdisciplinary approach that includes the monitoring, diagnosis, prognosis) may be considered (decision and control processes), as a type of maintenance (based on CBM, proactive and predictive maintenance) or as a maintenance support (i.e., resources and services needed to carry out the maintenance).

• Business plan: Development of a methodology that includes the procedures to commissioning technical modules. Also, proposal of different business cases, legal aspects, identifying investment, costs and savings by determining the repayment (payback) period of the facility.

Keywords: Electric Car, mobility, regenerative braking, Ferrolinera, sustainability , CO2 redution, railway, catenary,

1 Berrios Villalba, Antonio. ADIF. Email: aberrios@adif.es
Martínez Acevedo, José Conrado. ADIF. Email: jcmartinez@adif.es
Tobajas Guerra, Carlos. ADIF. Email: ctobajas@adif.es
Gómez Alors, Antonio. ADIF. Email: ag.alors@adif.es

1. The objective

The objective of the project *Ferrolinera 3.0* is the development, experimentation and validation of an innovative system for charging of electric vehicles (EV), through the use of clean energy from regenerative braking of trains, high speed and the metro network.

The main aim of this innovative project is to install a network see recharging points connected to the railway network, called *Ferrolineras,* that offer to the market a new technological solution for this type of electric recharge processes. In addition, the project includes the installation of a photovoltaic system as extra supply source of energy, which will serve as a power booster if necessary by the end user. A pilot study in two different locations, the laboratory of energy of ADIF and the new Metro of Málaga will be developed to test the feasibility of the proposed innovation. Object of the project is also lay the foundations of your market and put in exploitation.

In specific terms, the objectives pursued with the development of this project are as follows:

- Demonstrate the feasibility of a new technology not previously scrutinised for any entity making an effect tractor on the promotion of sustainable energy.
- Help balance future electrical load expected that it will exist on the network of transport and distribution of electrical energy, to make possible the use of own electrical infrastructure of the railway, which permit the collection of important technological synergies.
- Contribute to sustainability through the use of clean electrical power that the rail system produces in the processes of trains braking. For DC systems, this energy dissipates into heat if there are no reversible substations in the network.
- the development of one of the largest electric vehicle recharging infrastructures; contributing to the demand for electric vehicles by the population
- To promote the development of one of the largest electric vehicle recharging infrastructures; contributing to the demand for electric vehicles by the population

2. The specific objectives

The specific objectives of the project are:

- Develop the constituent elements of the *Ferrolinera* as new electric vehicles charging system:
  - Structure.
  - Trickle charge system I fast charge.
  - Storage of the energy generated in braking of trains.
  - Remote management platform.
  - The user management system.
- Develop photovoltaic support to the *Ferrolinera* system.
- Install and test the above items. The trials will be conducted in real railways.
- Validation and generation of technical specifications.

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- Analyze the manufacture and subsequent marketing of the product for all rail environments, including the export of the same to other countries.

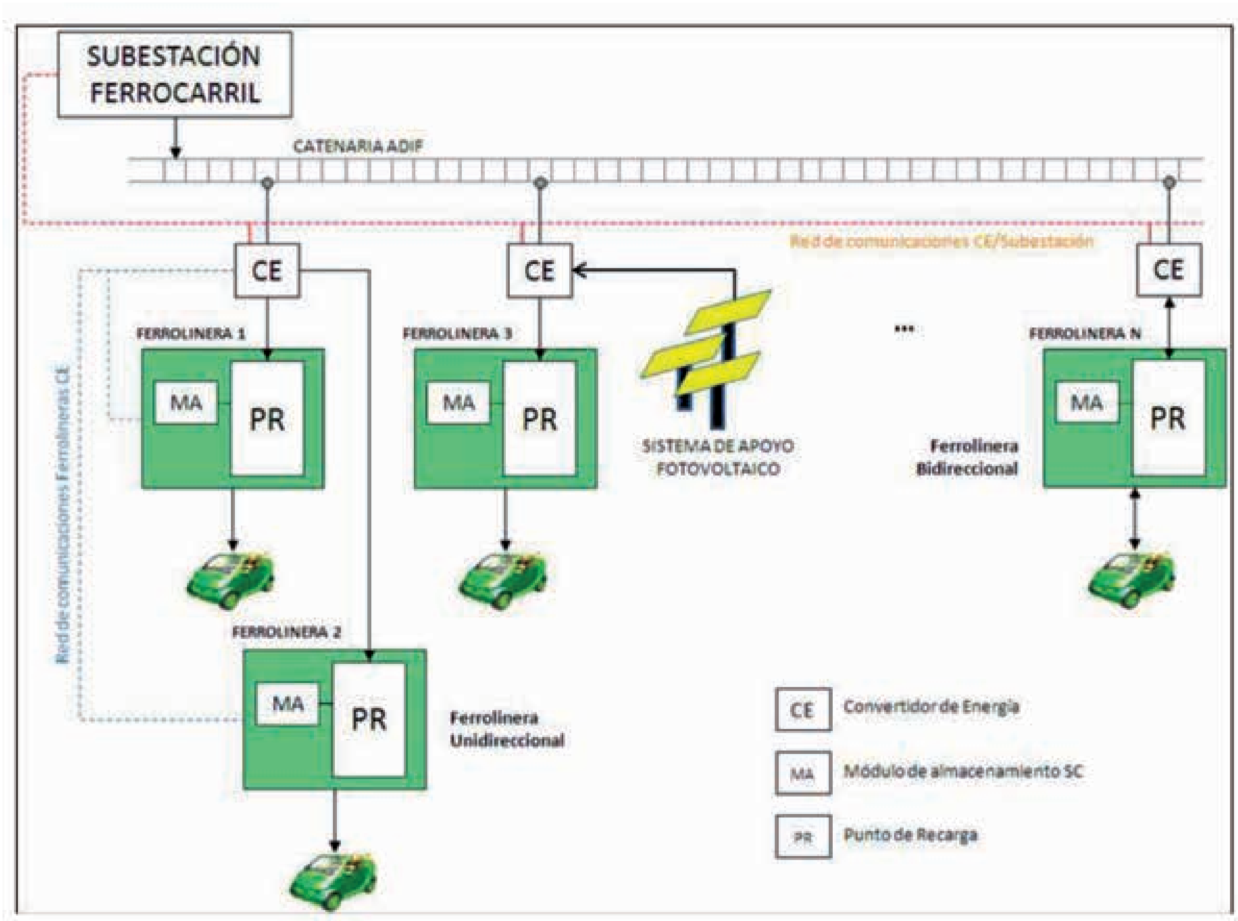


Figure 1: Overview of the project Ferrolinera 3.0.

2.1 The system

This schema considered different Ferrolineras distributed in the system. And reflects realistically what is the system, being a general explanation as follows:

- There is a railway catenary, which is powered by an electric traction substation.
- Every true kilometre there is a point of connection to the catenary. This point feeds a power converter (converter DCAC for a catenary DC or even a transformer for singlephase alternating current).
- The inverter is connected to the Ferrolinera of ADIF, having a storage module MA which focuses the energy from the electric braking of trains. As you will see later, this module will be developed with supercapacitors I Technology batteries.
- PR is the point of charging that is next to the storage system, the Ferrolinera

- There may be a support system photovoltaic that feeds the Ferrolinera through your appropriate CE.
- There are also bi-directional Ferrolineras, i.e., that batteries of the vehicle to which feed can in turn contribute to the power of the electric rail system if there was demand for this.
- There is a communications network that connects all EC computers with the management team of the substation, in a manner that emit instructions of operation to each CE based on the curve of the substation load. Although it is not indicated in the above scheme, this system is also connected to the corresponding planning and traffic control system (Note: as you will be indicated later, this communications network is not in the scope of the present technological project).
- In addition, for those EC feeding several Ferrolineras also exists an internal communications network that regulates the operation of each one of them according to the EC control setpoint (Note: as you will be indicated later, this network of communications Yes is in the scope of the present technological project).

2.2 Ferrolinera: electric recharging point on the railway network

The concept of *Ferrolinera* has been designed by Adif and refers to that point of recharging of electric vehicles is connected to an electric rail network.

The unique characteristics of the electric rail system are represented, mainly, by the very randomness of electrical loads, while dealing with movable loads (trains). It based this type of charging differentiate independently with respect to other concepts. It should be noted that in ADIF there are fed to 3,000 V DC (3,000 V DC) traction and traction networks fed to 25,000 V AC single phase (25,000 V AC). 3,000 V DC networks are used in the conventional network while the 25,000 V AC mains is used on high-speed lines.

The main problem of power electric vehicles en masse from a railway catenary is the modification of the electrical substation load curve (SE) corresponding. As is to be expected, if there are additional electrical loads represented by trains, the nominal power of the substation may be reduced, there may be significant technical limitations to supply more trains. This fact does not matter because in any case it would not be permissible to feed electric vehicles at the expense of limiting the power to trains.

Figure 2 represents in schematic way the existing in one substation any load curve (blue). This type of load curves is characterized by its irregular profile due to the characteristic of the burden the train (load variable in space and time).

In the event a series of Ferrolineras is connected to the catenary, a constant overhead (PA) is generated to substation (red). If Pmax is the maximum power that the substation can provide, there is that from the moment of connecting these new burdens might be considered overrides specific on Pmax. To all intents and purposes, these overrides are represented by tips to the substation is not able to satisfy, which would cause that promptly not you could feed the trains (or the burden represented by the Ferrolineras) according to the demanded power. As you can see in the figure, the overhead is represented by PB.

It should be noted that ADIF has registered the Ferrolinera mark under application M2965746-6 of the Spanish Office of Patents and Trademarks.

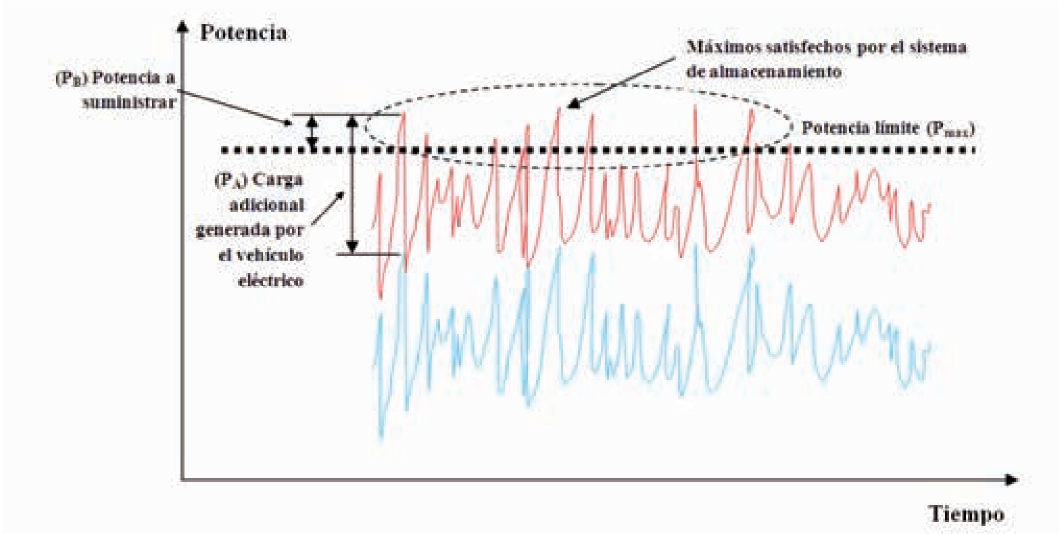


Figure 2: Explanatory scheme

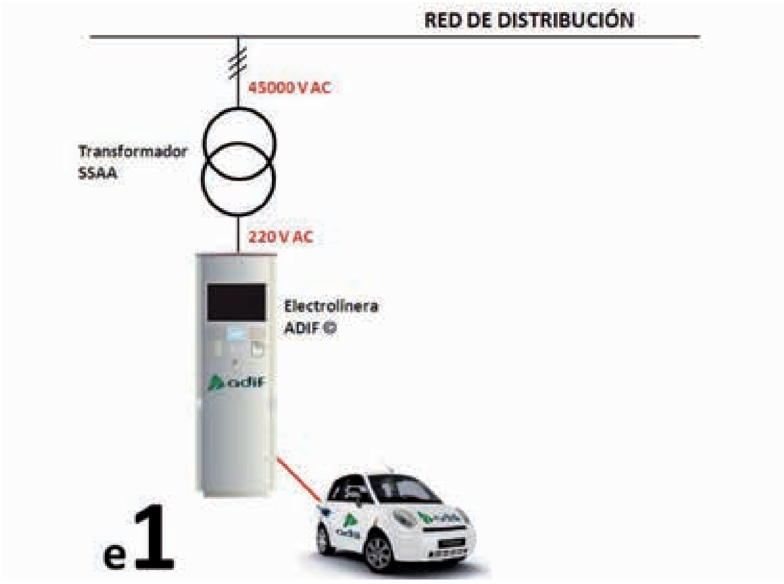
2.3 Background: Ferrolinera 1.0 and 2.0

The Ferrolinera 1.0 project, now completed, must encompass as a first pilot project to analyze possible problems that may occur in this type of cargo operations. It has been tested in the laboratory of energy of ADIF, four scenarios of an electric vehicle charging. This has been used a commercial charger, although different own electronic equipment enabling connection to the electric rail system has been developed.

The Ferrolinera 2.0 project, currently under development, is based on the above results and aims to continue working with a commercial but already plugged charger out of the controlled environment, such as the laboratory of energy of ADIF. Precisely, the objective is to install a Ferrolinera connected to the electric rail system (catenary) on the AVE station Maria Zambrano (Málaga).

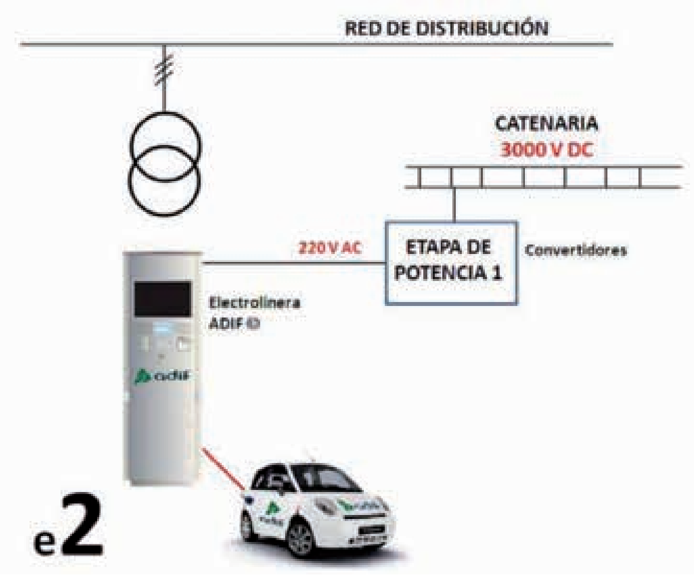
2.3.1 Project 1.0 Ferrolinera: stage 1

Consider the power of the Ferrolinera from a reducing transformer of a distribution line voltage. Does not require additional specific equipment.



2.3.2 Project 1.0 Ferrolinera: stage 2

This scenario considers the power of the Ferrolinera from the network of 3000 V DC traction. A power electronic converter is required to be connected to the network and thus adapt the voltage levels to the Ferrolinera.



2.3.3 Project 1.0 Ferrolinera: stage 3

The possibility of feeding the Ferrolinera from a team of storage of the energy generated in braking of trains is incorporated. I.e., the charging system would have the possibility of power from two sources (dual charge):

1. Directly from the network of 3,000 V DC (stage 2) traction
2. From a storage system

The introduction of a system that stores electrical energy (in this case, one that is generated when trains hinder recovery and is not consumed by other existing in the corresponding electrical canton trains) would compensate the needs generated by the Ferrolineras. In this way, the storage system would provide the PB power Ferrolineras module. I.e., the power of the Ferrolinera only from the traction network may cause a limitation to the power supply of the trains, especially in periods of high traffic density.

The incorporation of a storage system would allow that in these cases the Ferrolinera feed from such a system, there is no technical limitation to the power of trains while the system has enough energy (in any case, the periods of maximum points should not be very long at the time).

It should be noted that used in the previous functionality control system has been recently patented by ADIF under application number 201130502 of the Spanish Patent and Trademark Office.

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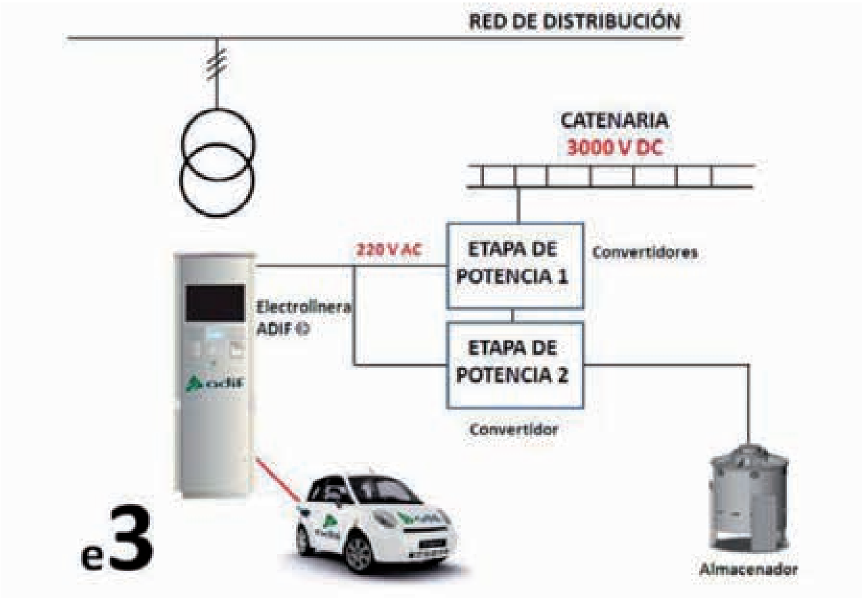
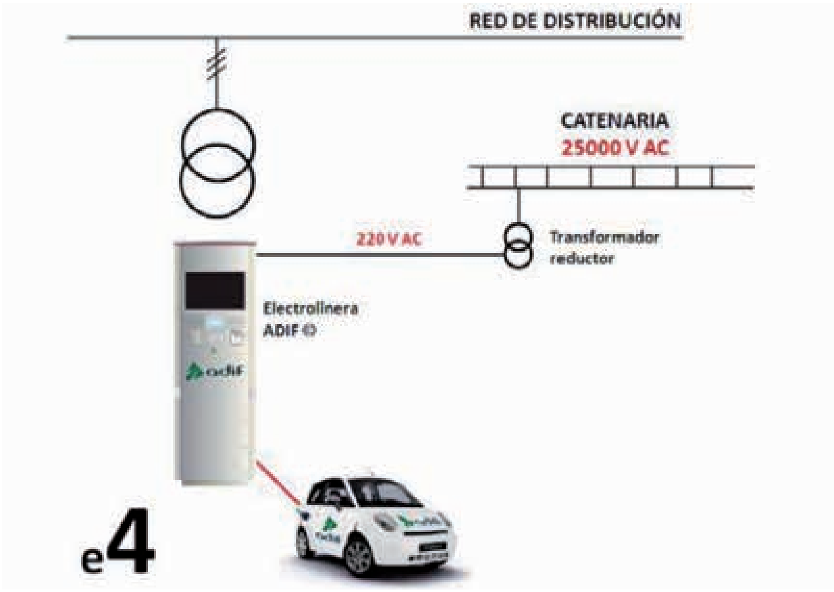


2.3.4 Project 1.0 Ferrolinera: stage 4

This scenario considers the power of the Ferrolinera from the 25,000 V AC traction network and requires a reducing transformer, a surge protector and a filter harmonics, connected to the network, to adapt the voltage levels to the Ferrolinera.



The description and the scope of the project are represented in Figure 7. It will be developed and installed more than one Ferrolinera, so that they can interconnect among them through the management system proposed, also developed in this project. The entire system will be tested and tested in the laboratory of energy of ADIF, exist a remote monitoring from the Railway Technologies Centre in Malaga; it is there where the management of the project will be developed. While the bulk of the project will be tested in the laboratory of energy, has been seen practicing other two Ferrolineras in the electrical system of Metro de Malaga (network to 750 V DC).

The connection will be made to the system of direct current as that introduces a major technological component in the project. The project will develop the following elements and main concepts:

- Ferrolinera standard and quick
- Interface and communications between Ferrolineras connected to a single computer energy converter
- Ferrolinera (supercapacitors) distributed storage system
- Interface and communications of e-maintenance and management of the system
- Computer power converter
- Use of photovoltaic solar energy infrastructure
- Network quality control system

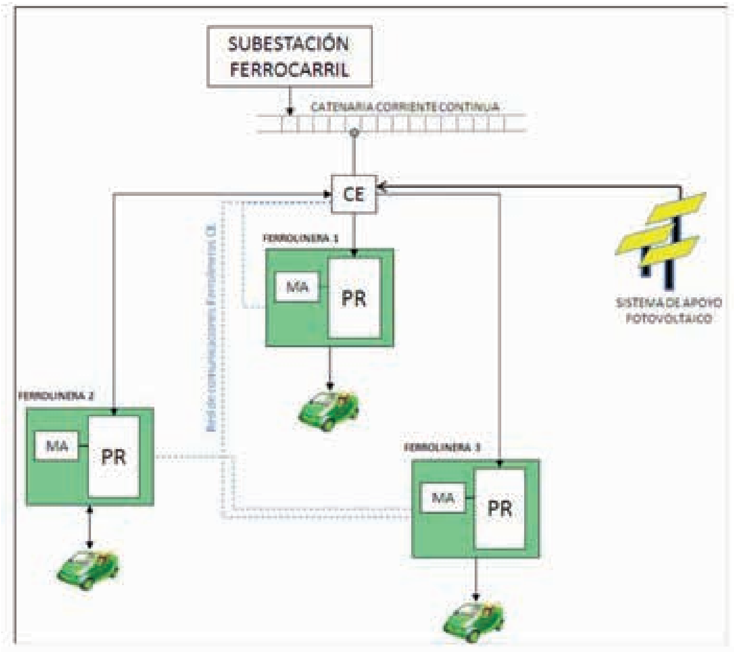


Figure 7: Project scope

Within the scope of the project covers various activities of research, development and innovation of the technology necessary to continue optimizing the use of electricity from the power of ADIF network itself, as well as the use of clean energy regenerated by the train during braking. A third source of energy from a photovoltaic system is added to the project.

It uses storage distributed in the own recharging stations and not concentrated on an electrical substation of traction (this approach best reulta from an energy point of view).

In addition, the power electronics equipment necessary to carry out the energy transfer between the catenary, distributed storage system, and integrated renewable energy sources, as well as to ensure the quality of the generated power cruising will be developed. This technology looks for an increase in the energy efficiency of the system, not only causing their own functionality, but which also derives from the individual optimization in the design of each of the teams that comprise.

This will be complemented by the development of TIC's kind technologies which carry out the communication of all these systems existing in the installation, allowing monitor, manage and control the information resident in the system: energy flows, State of the storage condition of the points of recharge, existence of faults in the system, signs of alarm, charging the user network quality, etc.

2.4 State of the art of the technologies involved

Five are the object of study and development technological lines:

- Systems of energy storage technology
    - Technology of supercapacitors
    - Battery technology
- The recharging of electric vehicles (PR-VE) point technology
- Technologies of information and communication technologies (ICT)
- Technologies for energy efficiency and network quality
- E-maintenance

2.4.1 Storage systems

Energy accumulators, as its name suggests, allow to store energy in any of its forms, so that it can be used later. In this way gets undock the demand of power generation. With respect to the electric system, these devices improve their efficiency and reliability, absorbing the energy produced from the network during the valleys of demand (low cost of generation), either from intermittent renewable energy sources in case of existence of surplus, and releasing it in the moments of greatest demand, high cost of generation or when there is no other source of energy available. The main technologies for the purpose of storage are:

- Electrochemical batteries. (Applicable in this project)
- Supercapacitors. (Applicable in this project)
- Magnetic storage (SMES) Superconductor
- Kinetic energy (flywheels) geostructural
- Storage of compressed air
- Pumped hydropower

Taking into account that the energy requirement for this project requires a storage system medium energy density and with a great capacity of response, only listed previous technologies will be explored to fund the first two.

In general, energy storage devices are used basically in four scenarios:

- Increase the efficiency of electrical systems, to reduce the need for backup generation, providing power in the daily demand peaks
- Increase the reliability of the system, to reduce the chance of outage. (Applicable in this project)

- Increase the availability of renewable sources (solar, wind, etc.). (Applicable in this project)
- Increase the efficiency and the rational use of energy in industrial processes

2.4.2 Electrochemical batteries

Devices capable of accumulating power by electrochemical processes. This energy is then returned almost in its entirety. This cycle will be repeated a number of times, given by the useful life of the device. There are various types of batteries with different characteristics (lead batteries, alkaline batteries of manganese, nickel-cadmium, nickel metal hydride, lithium ion, polymer lithium, etc). This type of battery energy density varies between 30 and 130 WhKg. It is a secondary electrical generator. Does not produce electricity, but it frees up that has been previously stored during its load. The number of uploads and downloads will be limited by its useful life.

ADVANTAGES: higher density power against other geostructural.

DISADVANTAGES: low upload speed and download allowed. (they are not devices capable of absorbing large ends of power loads or provide downloads without that do not impact negatively on its useful life). His performance is not very high, on the order of 80, due to its internal resistance, which is remarkable in the processes of loading and unloading of the device. Another unfavorable feature is the own self-discharge over time due to the leakage resistance. Some types of batteries are the so-called "memory effect", in which each refueling is limited voltage or storage capacity, due to high current, high temperatures, the ageing of the device, making impossible the use of all its energy. A no less important disadvantage is the high toxicity of heavy metals taking part in some types of batteries, which constitute a serious environmental problem. You are trying to reduce this toxicity with replacement by new less polluting substances. The main existing battery technologies are:

- Lead-acid
- NaS
- NI-CD
- Ni-Mh
- Li-ion

Batteries used in sources of energy energy storage systems renewable are stationary batteries. They are low content of antimony lead-acid batteries. They have approximately 2,000 life cycles when the depth of discharge is a 20 (i.e. that battery will be with your load 80) and some 1,200 cycles when the depth of discharge is 50. These batteries have one self-discharge less 3 and an efficiency of 75. They can withstand 80 downloads and have a life of about 15 years. They are used in installations of great powers. You can get the operating voltage required by the Association in a number of these devices. Of Li-ion, whose highest densities of power, energy and higher yields make them more attractive for these applications. In the case of lithium-ion batteries industrial, have capacities ranging from 4 Ah to 400 Ah, although their prices are well above the stationary lead-acid batteries.

The main characteristics of these devices are listed below:

- Energy density: 20-100 WhKg
- Power density: 20-200 Walter Kissling GAM

- Power range: for systems of up to 100MWh
- Power range: 1kW-30MW
- Loading and unloading times: hours
- Number of charge and discharge cycles: 1,000-3,000
- Performance: 75-99 according to technologies
- Self discharge rate: 0 - 20 per month according to technologies
- High for Li-ion and NI-CD tools Pb-acid-low prices
- As type may have toxic elements

2.4.3 Supercapacitors

The double layer supercapacitors are electrochemical capacitors with a density of unusually high energy compared to conventional capacitors, typically thousands of times greater than a high capacity electrolytic capacitor. They are storage devices of power with one capacitance greater than a farad, reaching up to thousands of farads. These devices have a maximum of up to 30 WhKg energy density.

The accumulation of energy relies on the confinement of electrostatic charges on small devices, formed by pairs of conductive plates separated by a dielectric medium. The construction and operation is similar to a conventional capacitor on a large scale. The supercapacitors are characterized by being able to be loaded and unloaded in the times on the order of seconds, which makes them especially suited to respond to needs of power tips or short duration power outages. This is because the storage of loads is purely electrostatic.

ADVANTAGES: Because of the speed of loading and unloading, can provide high chargedischarge currents, which instead damages to the batteries. They have a number of cycles of life of millions of times and require no maintenance. They can work in extreme temperature conditions. On the other hand, do not have toxic elements composition, very common in batteries.

DISADVANTAGES: limited capacity to store energy and day of today, its higher price.

The main characteristics of these devices are listed below:

- High capacities: 1-5,000 F
- Energy density: 1-10 WhKg
- Power density: kWKg 1-10
- Loading and unloading times: minutes, seconds
- Number of charge and discharge cycles: 10e6
- Limited operating voltage: 500V-1
- Electrical performance: 95-99
- Very low discharging
- Relatively high price
- Do not need maintenance
- Do not have toxic elements
- Resistance to adverse conditions of temperature

Currently the supercapacitors are classified in accordance with the materials with which they are manufactured. There are mainly four types:

- **Electrolytic double layer carbon spanner supercapacitors.** The main are used sulphuric acid and potassium or sodium hydroxide. In them the solution dissociates into positive ions of sodium or potassium, which accumulates a greater power in the presence of voltage increase of the attraction between loads.
- **Not electrolytic carbon double-layer interfaces supercapacitors.** The main are finished products such as Aerogels, soles, carbon and carbon nanotubes. The Suns are dispersions of solids in liquid found in Brownian motion indefinitely. On the other hand, a gel is a solid that has a large amount of fluid and a structure that allows that both phases combined are. Elected in water metal oxide is formed for the formation of soles for capacitors, high temperatures or with an excess of base to form the Sun. Then the Sun is gelated sent by dehydration or pH increase. Organic soles with resorcinol can also form formaldehyde. The result of the process is the formation of a very porous homogenous material that allows a high capacitance. If the Sun is combined with the carbon interface is calculated that you can achieve a capacitance of 400 farads per gram.
- **Aqueous supercapacitors of double layer with redox pseudo-capacitance oxide.** The main are lithium oxide, ruthenium dioxide, dioxide of Iridium, cobalt oxide and manganese dioxide. The supercapacitors can be manufactured according to the methodology of the previous section to develop a Sun. Another way to get it is by the deposition of metal oxide by means of a procedure of electrolysis. There have been investigations where capacitances of 400 Fg with ruthenium oxide have reached. Most profitable around 50 Fg supercapacitors has been with nickel oxide. An alternative way to generate the pore structure is the addition of lithium oxide to metal such as Platinum; This material add you acid to remove lithium and keep the porous structure of scale Nano.
- **Conductive polymer supercapacitors.** Conductive polymer as an organic substance that conducts electricity in a metal-like way, with good reversibility between State conducting and non-conducting and mechanical flexibility is defined. The main are of polypyrrol and polyaniline and polythiophene. They have a density greater than 500 Watts per kilogram energy, and even its capacitance properties are studied.

Supercapacitors research is motivated by the enormous advantages that its use represents the development of electrical circuits:

- Great period of operation
- Ability to handle high current values
- Easy to monitor load value
- High efficiency
- Wide range of voltage
- Wide range of temperature
- Long operating cycles
- Ease of maintenance

The life of a supercapacitor decreases as increases its capacitance, but currently there are devices that exceed a lifespan of twenty years with losses in the voltage supplied about a volt. Due to these properties of life and management of voltage and current, the supercapacitors have been used in various applications:

- Hybrid cars
- Energy support
- Energy storage
- Power transfer systems

2.5 Recharging points

Recharges carried out by type 2 usually do not move from the 16A single phase, for normal recharging. Raising the nominal current of the system until the 32nd for processes fast charge. Where the supply system is three-phase, and for rapid recharging systems power level rises until the 63rd. The connection between VE and the point of recharge is carried out through terminals Schuko 74, in the case of the 16A and CETAC 3262A (IEC 60809) in other cases. At any time, this type of connectors present additional threads to those assigned to the power supply and grounding.

Table 1: main features of the current post of recharge.

TECHNOLOGY	
Communications	RS-232, RS-485,Ethernet, Zigbee, PLC, GSM, GPRS
Energy management	Measurement and pricing, network quality, with-high partial and total, intelligent management of recharging
Energy efficiency	Reactive compensation and harmonic filtering
Software	Monitoring and control in real time, telemetry, management of alarms, SCADA, historic generation, multi-user management
Identification	RFID, BAR CODE, magnetic card

2.6 Information and communication technologies

The different subsystems that will be developed in the project are as follows:

Energy management:

- Power catenary-storage system
- Energy storage system-electric car (EC)
- Energy storage system-storage system (Energy for Share)
- Renewable energy system-storage systems
- Interaction quality electrical-micro smart grid (MSG)

User management:

- Charging user

- Load options-EC download (Energy for Share-Charge)
- Connection EC-RP
- Identification of the user

Supervision and Control System:

- E-maintenance
- Supervision of the smart power cruising systems

Data transmission technologies are mainly divided into three groups:

- device interconnection

Table 2: data transmission for device interconnection

Technology	Transmission medium	Transmission speed	The device maximum distance
IEEE 1394	UTP/FO	400 Mbps (V.a), 3.2 Gbps (v.b)	4.5 m - 70 m
USB	USB	12 Mbps (v.1.1), 480 Mbps (v.2)	5m
Bluetooth	Wireless	1 Mbps (v.1), 10 Mbps (v.2)	10m (v.1), 100 m(v.2)
IRDA	Wireless	9.600 bps – 4 Mbps	2 m

- LAN data networks

Table 3: data transmission for LAN networks

Technology	Transmission medium	Transmission peed	The device maximum distance
Ethernet	UTP/FO	100Mbps-1Gbps	100 m - 15 km
HomePlug	Power cord	14 Mbps	650 m^2
HomePNA	Telephone line	10 Mbps	304.8m, 929 m^2
IEEE 802.11	Wireless	54 Mbps (v.a), 11 Mbps (v.b)	33m (v.a), 100m (v.b)
HiperLAN/2	Wireless	54 Mbps	100 m
HomeRF	Wireless	10 Mbps	38 m

- control and automation networks

KEYNOTE

Table 4: control and automation networks

Technology	Transmission medium	Transmission speed	The device maximum distance
Konnex	1.TP0, 2.TP1, 3.PL100, 4.PL132, 5.Ethernet 6.Radio	9600 bps, 3. 1.2 – 2.4 Kbps, 4. 2.4 Kbps	2. 1000 m, 3. 600 m
Lonworks	1. TP, 2. Power cord, 3. Radio, 4. Coaxial, 5.FO	1. 78 Kbps, 1. 1.28 Mbps, 3. 5.4 Mbps	1. 500 m – 2700 m
X10	Power cord	60bps USA, 50bps Europe	185 m^2
BacNet	Coaxial cable, TP, FO	1Mbps-100 Mbps	Con Ethernet sobre TP: 100 m
EIB	1.TP, 2. Power cord, 3.RF, 4.Infrared	1. 9600 bps, 2.1200/2400 bps	1. 1000 m, 2. 600 m, 3.300 m
EHS	1. Power cord, 2.TP	1. 2.4 Kbps, 2. 48 Kbps	
Batibus	TP	4800 bps	200 m a 1500 m Depending on the section of the cable
Cebus	TP, Power cord, Coaxial, Infrared Radio,	10 kbps	Depending on the characteristics of the environment
DALI	Cable par		200 m
Metasys	N2Bus	9600 bps	1219 m
SCP	Par de cable	<10000 ps	
Zigbee	Wireless	20-250 Kbps	10 m – 75 m

2.7 Energy efficiency and quality of network

The set of power systems installed on micro intelligent network formed by the catenary, OURSES, quality network and loads, distributed storage system, are intended to extract, modify, store, and manage the electrical energy in the most efficient way possible, always ensuring the quality, reliability, robustness, and security of electricity supply.

To do this, each of these systems incorporates control and management advanced algorithms giving them independence and autonomy within the MSG, but at the same time they introduce them and synchronized with the rest of the electrical infrastructure that surrounds them. Looking for the efficiency and quality of whole from each of the parties in this way.

However, not only electronic systems interact with each other, the human factor within a system that hosts the project is a variable to take into account. The decisions taken by the owners of the vehicle will influence within the energy management of the micro network. Type of refills, time and simultaneity of the same in the near future transfer of power by the vehicle (vehicle to grid (V2G)), etc., are heavy weight variables in the system. That is why there must be a proper coordination between these and power systems distributed in the MSG.

On the other hand, the manager-operator system may interrupt the autonomy of the system during maintenance, alarm signals, incidents on the line, etc. These operations and decisions will have an impact in greater or lesser extent in the rest of the system so it must be prepared to deal with more efficient, safe and reliable as the new scenario occurring.

That all the subsystems mentioned above presents the coordination and synchronization is required, it is required that there is an element of management to higher level that would monitor system complete and with ability to communicate the State full system to each and every one of its parts. This system receives the name of energy management system.

The different types of converters for power that could appear in the defined system are as follows.

The electronic power converters are systems capable of converting electric energy from one type to another using different electronic devices. These systems are based on semiconductor devices to control or modify voltages and currents. They are used to adapt the nature and levels of voltages and currents between the different parts of an electrical system. Typical applications of power electronics are, among others, the conversion of power alternating (AC) into direct current (DC), DC to AC conversion, the conversion of a non-regulated in a DC voltage regulated DC voltage and the conversion of a given amplitude and frequency in another amplitude and frequency different AC power.

The following classification of converters can carry out depending on the nature of the input and the output of the converter:

- AC/DC converters
- DC/DC converters
- AC/AC converters
- DC/AC converters

AC/DC Converter: This type of converters produces a DC current from an alternating current. Generically they are called rectifiers. Depending on the level of power handling, your topology will be three-phase, high power, or single phase. Last is given to any type of power converter.

DC/AC converter: Commonly called investors and its purpose is the convert direct current into alternating current.

The two remaining cases AC/AC and DC/DC, are used to adjust the amplitude and frequency in the case of the former, the tension between two different stages of an electrical system.

Other options are presented depending on the characteristics of modulation used, number of switches, etc.:

- Matrix converters
- High frequency (HF) converters
- Bi-Level and multilevel converters

Matrix converters: Inverter three-phase crap that consists of a set of bi-directional switches that connect a three-phase load directly to the line of three-phase power.

High frequency converters: This type of converters has an extra stage in the conversion of electrical energy that is to perform the conversion in high frequency.

Multilevel converters: These converters have interesting advantages over traditional solutions for the conversion of energy from renewable sources.

An active filter is an electronic device that uses energy stored, either in a capacitor or a coil to deliver I return to store energy under a slogan that seeks to compensate for the disturbance. The slogan is known with the name of reference and his generation is given through the opening and closing of power switches (usually semiconductor). As the disturbance that can be compensated, this will depend on the strategy of control and the way that the filter is connected to the network. Depending on the desired purpose, filter connects in series to the network, correction of disturbance in the tension, in parallel, correction of power disturbances, or as a mixture of both.

2.8 E-maintenance

We define e-Maintenance as a management concept of maintenance whereby assets are controlled and managed over the Internet.

E-Maintenance as a maintenance strategy, i.e., a method of electronically using real-time data obtained from the equipment using digital technologies (mobile devices, sensors, technology, Internet, etc.) as a maintenance plan (i.e., a structured set of tasks with an interdisciplinary approach that includes the monitoring, diagnosis, prognosis) may be considered (decision and control processes), as a type of maintenance (based on CBM, proactive and predictive maintenance) or as a maintenance support (i.e., resources and services needed to carry out the maintenance).

E-Maintenance is an interdisciplinary approach that consists of monitoring, diagnosis, prognosis, and control. Control consists of the evaluation in real time of the assets and the detection of abnormal States. The diagnosis, identifies the causes of advance degradation or failure of the equipment. The Outlook analyzes the impact of the failure on the computer and the system. As a result, they can make decisions and carry out maintenance actions if necessary, with the aim of reducing the number of inspections "in situ" and eliminating unnecessary maintenance activities.

E-Maintenance integrates the principles as applied in the maintenance, by adding a Web service and principles of collaboration. Collaboration is not limited to sharing and exchanging information, but knowledge and intelligence between different units, departments, expert operators and companies in a collaborative environment for the development of better decisions of maintenance throughout the lifecycle of an asset.

The e-Maintenance Management model breaks the physical distances through the creation of intelligent networks using Internet and wireless communication technologies. Thus, a platform e-Maintenance exists when you replace the conventional hierarchical structure by an intelligent structure of (Intelligent Manufacturing Systems IMS). It consists of giving intelligence to components via electronic technology. To do this, it is necessary to have support for Exchange of information and communication networks in real time between the devices. Through a system of alarms set-based monitoring of the conditions of the equipment, it is possible to optimize the priority of peacekeeping activities. The influence of all of these capabilities is even more important when the tasks are characterized by the immediacy and the high mobility of the linked staff.

These potential improvements are summarized below:

- Remote maintenance
- Cooperative maintenance
- Maintenance on-line
- Predictive maintenance
- Troubleshooting