

# 05

SUSTAINABLE  
ENERGY

CONNECTED TO  
PROVIDING A SECURE  
AND EFFICIENT ELECTRICITY  
**SUPPLY OF  
THE HIGHEST QUALITY**

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## CORNERSTONES FOR ACHIEVING SUSTAINABLE ENERGY



### INTEGRATION OF RENEWABLE ENERGIES

The safe integration of renewable energies to reduce air pollutant emissions, and to reduce Spain's dependence on foreign energy.

**42.8%**  
of the electricity demand covered by renewable energies



### SUSTAINABLE DEVELOPMENT OF THE TRANSMISSION GRID

Construction of new facilities in order to increase transmission capacity, strengthen grid meshing, facilitate the evacuation of renewable energies and enable connections between electricity systems.

**600 km** of new line in the grid  
**98.2%** availability of the peninsular grid



### ENERGY EFFICIENCY

Development of various initiatives aimed at achieving a more efficient management of the electricity system in the fields of energy storage and smart grids, as well as fostering consumer involvement as an active part of the electricity system.

**'PRICE' Project**  
**'PERFILA' Project**



### TECHNOLOGICAL INNOVATION

Incorporation of new innovative technologies that improve the stability and efficiency of the system, and facilitate the integration of renewable energies.

**66** technological innovation projects  
**8.3** million euros in investment



### INTERNATIONAL INTERCONNECTIONS

Strengthening interconnections in order to improve the guarantee and security of supply, enabling a greater integration of renewables and facilitating the creation of a single European electricity market.

**France:**  
**Santa Llogaia-Baixas line (2015)**

**Portugal:** Puebla de Guzmán-Tavira line (2014)

SUSTAINABLE ENERGY, A SECURE AND EFFICIENT ELECTRICITY SUPPLY OF THE HIGHEST QUALITY

## QUALITY AND SECURITY OF THE ELECTRICITY SUPPLY

RED ELÉCTRICA, as transmission agent and operator of the Spanish electricity system, is responsible for contributing to making the objectives of the energy policy viable in regard to providing a secure, efficient and sustainable electricity supply.

Therefore, the Company is working on the development of a transmission grid that is better meshed, more robust and better interconnected through the strengthening of international interconnections and also those between the islands. It is also fo-

cus on initiatives aimed at energy efficiency and on the incorporation of innovative technologies to improve system efficiency. All this is geared towards the achievement of the new energy targets set by the European Council for 2030:

### DEVELOPMENT OF THE TRANSMISSION GRID

#### Electricity infrastructure planning [EU10]

THE MINISTRY of Industry, Energy and Tourism (MINETUR) is responsible for designing Spain's energy policy. To this end, it proposes, in collaboration with the Autonomous Communities, a medium and long term energy

planning. The policy details the new electricity infrastructures that must be undertaken nationwide, under the principles of transparency and with minimal cost for the electricity system as a whole. These infrastructures are

essential both to improve the quality and security of supply and to provide greater efficiency and competitiveness of the electricity markets.

The current planning is contained within the

'Electricity and Gas Sector 2008-2016 Planning' document, approved by the Council of Ministers in 2008 and updated in the 2010 and 2012 annual programmes, and in the agreement of the Council of Ministers in June 2014.

However, there is a set of actions contained in this plan whose administrative authorisation is paralysed although, as an exception, the administrative process was unblocked for certain actions contained in the resolutions of the Council

of Ministers in December 2012, February 2014 and June 2014. In this process, Red Eléctrica is responsible for drawing up proposals for the planning of the transmission grid. ▶

**40%**  
reduction in CO<sub>2</sub>  
emissions  
compared to  
1990 levels ▼

**27%**  
▲ improvement  
in energy  
efficiency

**27%**  
demand coverage  
by renewable  
energies ▼

◀ Thus, since 2010, various proposals stemming mainly from the need to adjust to the prevailing economic situation and the new electricity sector legislation have been submitted to the MINETUR.

After submitting the final draft of the initial proposal in July 2014, the MINETUR sent the actions proposed therein to the Autonomous Communities so that they could present any argument they deemed necessary. These arguments were

sent to Red Eléctrica on 12 November, with further arguments being received at a later date (1 December 2014 and 12 January 2015). From that date, Red Eléctrica has two months to send the MINETUR the Grid De-

velopment Proposal that takes into account the arguments submitted by the Autonomous Communities. The infrastructure planning, once approved by the Government, covers terms of six years and is binding for Red Eléctrica.

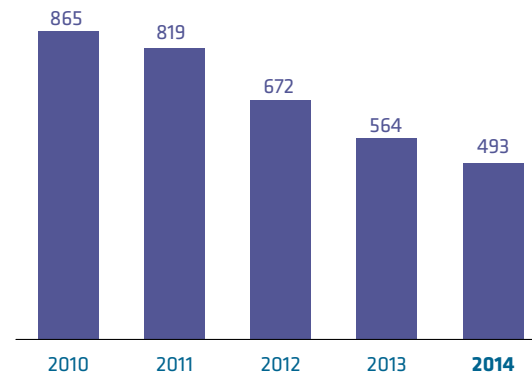
THE DEVELOPMENT OF INTERNATIONAL INTERCONNECTIONS represents the most significant actions of the latest electricity infrastructure planning proposal

### Transmission grid construction [EU4]

IN 2014, investment in the transmission grid responded basically to the need to increase grid capacity and meshing, support electricity distribution in several areas of the country, and also to move forward with the execution of projects of a unique nature such as international interconnections and submarine interconnections

between the islands. In 2014, a total of 600 km of new line and 95 new substation bays were brought into service, and transformer capacity was also increased by 3,250 MVA, representing a total investment in the transmission grid of 493 million euros.

INVESTMENT IN THE TRANSMISSION GRID  
(Millions of Euros)



### PRIORITY OBJECTIVE IN THE DEVELOPMENT OF THE TRANSMISSION GRID

- >> Ensure the quality and security of supply.
- >> Improve the efficiency of the system.
- >> Improve transmission grid meshing.
- >> Support the electricity distribution network.
- >> Strengthen international interconnections.
- >> Facilitate the powering of the high speed train routes.
- >> Favour the evacuation of renewable energies.

## MAIN TRANSMISSION GRID AXES IN 2014

### ASTURIAS-GALICIA LINK

**Status:** under construction  
**Total investment:**  
218.9 million euros  
**Investment in process:**  
32.5 million euros  
**Construction:** 2008-2019

#### General objective

Guarantee the security and quality of supply throughout the whole northern axis, creating a 400 kV transmission infrastructure, through the incorporation of 361 km of line, 46 substation bays and 3 transformers. A large part of the axis was commissioned before 2011. The Boimente-Pesoz line is currently under construction.

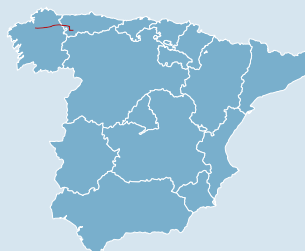
#### Specific objectives

Connect northern Galicia with the west of Asturias to meet the consumption forecasts for this area and facilitate the evacuation of new generation. The aim is to close the Cantabrian axis linking it up with the Soto-Penagos line, so that areas with surplus energy such as Galicia

and Asturias can evacuate their energy to regions with a lack of supply. Another of its future objectives is to enable the powering of the high speed train in the Cantabrian region.

#### Key socio-environmental measures

- >> Performing specific environmental studies for the design of accesses. Restoration of the aforementioned accesses at the end of works via the introduction of topsoil, seeding and planting of trees native to the area.
- >> Performing a comprehensive inventory of the actions regarding the pruning and felling of flora and continuous monitoring to avoid any unnecessary effects.
- >> Hanging electricity lines by helicopter to avoid affecting the land and flora (more than 20% of line hung using this method).
- >> Hoisting via the use of a boom crane in steep areas



and those with native flora.

- >> Over-elevation of towers to reduce the opening up of safety corridors.
- >> Intensive archaeological monitoring. Protection and cataloguing of items found: Celtic hillfort remains, Roman mining channels, lime kilns and civil war trenches.
- >> Amicable agreements reached with landowners in 96% of the cases.

#### SUMMARY 2014

- >> Attainment of the administrative permits for the Boimente-Pesoz line and commencement of its construction.

#### FORECAST FOR 2015

- >> Construction of the Boimente-Pesoz line.

### BESCANÓ-LA FARGA-SANTA LLOGAIA AXIS

**Status:** under construction  
**Total investment:**  
92 million euros  
**Investment in process:**  
1.3 million euros  
**Construction:** 2013-2017

#### General objective

Give continuity to the inter-connection with France and improve the electricity supply to Gerona.

#### Specific objectives

Strengthen the meshing of the 400 kV grid in Catalonia and support the powering of the high speed train in the Barcelona-French border section. The axis consists of 164 km of line, 25 substation bays and 2 transformers.

#### Key socio-environmental measures

- >> Design of the lines, in parallel to the existing 220 kV and 132 kV lines and the subsequent dismantling of sections of the indicated existing lines.
- >> Restoration of the safety corridors used by the sections of the lines being dismantled.
- >> Marking with bird-flight diverter devices on a high percentage of the line.
- >> Biological stoppage of works.
- >> Amicable agreements reached with landowners in 96% of the cases.



#### SUMMARY 2014

- >> Commissioning of the Bescanó-La Farga-Santa Llogaia line and of the Santa Llogaia substation.

#### FORECAST FOR 2015

- >> Commencement of the construction of the La Farga substation and the incoming/outgoing line.

## ALMARAZ-GUILLENA AXIS

**Status:** in service

**Total investment:**  
201 million euros

**Construction:** 2012-2014

### General objective

Ensure the quality of supply for the forecasted demand in the Autonomous Communities of Extremadura and Andalusia via the connection of the central and southern areas of the Spanish peninsula through an 400 kV axis, consisting of 703 km of line, 37 substation bays and 2 transformers.

### Specific objectives

The axis will link up the Almaraz, San Serván, Brovales and Guillena substations, linking from north to south an area with a generation deficit, and will serve as support for the expansion of the interconnection with Portugal, as well as support for the distribution in the area allowing the evacuation of new renewable generation.

### Key socio-environmental measures

Given the characteristics of

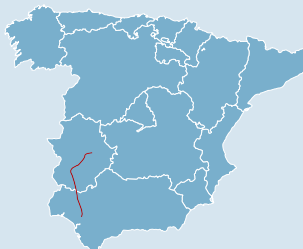
the area where the work was undertaken, the principal challenge was the design of the route and the siting of towers so as to have the minimal effect on the protected natural areas, pasture lands and other areas rich in biodiversity, especially bird life, for which the following actions were carried out:

>> Drafting of specific reports regarding the effects on Red Natura and the establishment of specific measures for the protection of priority habitats.

>> Over-elevation of towers to avoid the need for opening up of safety corridors.

>> Assembly and hoisting with boom cranes in all sensitive areas.

>> Installation of bird-flight diverter devices (spirals and blades) in SPAs and on lines crossing major water courses (more than 85% of the axis).



>> Biological stoppages of works on 78 towers during various periods from 1 January to 23 August.

>> Establishment of numerous accompanying measures of various characteristics aimed at improving habitats.

>> Amicable agreements reached with landowners in 90% of the cases.

### SUMMARY 2014

>> Commissioning of the Brovales-Guillena and Mérida-San Serván lines, as well as the Almaraz substation.

### FORECAST FOR 2015

>> The axis is fully operational and no further work is foreseen.

## SAN MARTÍN AXIS

**Status:** under construction

**Total investment:**  
31.1 million euros

**Investment in process:** 2.4 million euros

**Construction:** 2011-2016

### General objective

Facilitate the evacuation of the production of the Es Murterar thermal power station and strengthen supply to the northwest of Majorca.

### Specific objectives

The axis, which consists of 20 substation bays, 12 km of line and 2 transformers will facilitate the evacuation of the production of the Es Murterar thermal power station.

### Key socio-environmental measures

>> Landscaped integration of the San Martín substation, through the design of the GIS building and by the incorporation of vegetation on the land on the southwest side.

>> Stoppage of works for the Alcudia-San Martín line between the months of April and September in urban areas to avoid the impact on tourism.

>> The line was buried underground throughout its entire length.



### SUMMARY 2014

>> Bringing into service of the San Martín substation, I/O San Martín and the Alcudia substation.

### FORECAST FOR 2015

>> Commissioning of the San Martín - Alcudia 2 line and continuing with the work of building the Murterar - San Martín line with the final section of line being brought into service in 2016.

## ARAGÓN-LEVANTE LINE

**Status:** under construction

**Total investment:** 156.4 million euros

**Investment in process:** 15.6 million euros

**Construction:** 2010-2018

### General objective

Strengthening of the transmission grid meshing to allow wind power energy from Aragon to be evacuated to Castellón, through a 414 km network of line, 31 substation bays and one transformer. This connection is part of a new Basque Country-Navarra-Aragon-Levante axis for the evacuation of wind power, avoiding the saturation of the existing Valladolid/Palencia-Madrid and Aragon/Cataluña-Levante corridors.

### Specific objectives

The axis links the substations of Aragon, Fuendetodos, Muniesa, Mezquita and Morella, allowing wind power evacuation to Castellón from new generation in the region of Maestrazgo.

### Key socio-environmental measures

- >> Biological stoppage between March and June to avoid the breeding season of the Dupont's lark.
- >> Biological stoppage between January and June due to the nesting of Golden eagles.
- >> Intensive archaeological supervision in the Community of Valencia and monitoring in Aragon.



### SUMMARY 2014

- >> Obtaining administrative authorisations for the Mezquita-Morella line and commencement of the Morella substation enlargement.

### FORECAST FOR 2015

- >> Commencement of construction of the Mezquita-Morella line and the commissioning of the Morella substation.

## OTHER IMPORTANT GRID DEVELOPMENTS IN 2014

Among the facilities brought into service in 2014, in addition to those lines identified in the main axes, also noteworthy are the Vilanova-Valldigna-Gandia line (31.3 km) and the Costa de la Luz-Onuba line (25.7 km), amongst others, as well as various 400 kV and 220 kV substations.

## PENINSULAR AND NON-PENINSULAR TRANSMISSION GRIDS [EU4, G4-9]

	2010	2011	2012	2013	2014
Km of 400 kV line	18,792	19,671	20,109	20,639	21,094
Km of 220 kV line	17,565	18,410	18,779	19,077	19,221
Km of 150-132-110 kV line	257	272	272	272	272
Km of <110 kV line	2,010	2,011	2,014	2,014	2,014
<b>Total km of line</b>		<b>40,364</b>	<b>41,174</b>	<b>42,002</b>	<b>42,601</b>
400 kV Substation bays	1,189	1,253	1,319	1,374	1,394
220 kV Substation bays	2,662	2,813	2,936	3,026	3,077
150-132-110 kV Substation bays	47	52	52	52	52
<110 kV Substation bays	725	743	743	745	769
<b>Total substation bays</b>	<b>4,623</b>	<b>4,861</b>	<b>5,050</b>	<b>5,197</b>	<b>5,292</b>
<b>Transformer capacity (MVA)</b>	<b>70,219</b>	<b>72,869</b>	<b>78,629</b>	<b>81,289</b>	<b>84,539</b>

## DATA AS AT 31 DECEMBER 2014

2014	Peninsula	Balearic Islands	Canary Islands	Total
Overhead lines (km)	39,068	1,061	1,023	41,151
Submarine cable (km)	265	306	30	601
Underground cable (km)	463	150	237	850
<b>Total</b>	<b>39,795</b>	<b>1,517</b>	<b>1,289</b>	<b>42,601</b>

## GRID DEVELOPMENT ON THE ISLANDS

### Balearic Islands' electricity system

**THE MOST SIGNIFICANT MILESTONE** in the Balearic Islands' system is the commencement of the Majorca-Ibiza interconnection: a link that enhances the electricity integration process between the Balearic Islands and the Spanish Peninsula, key to ensuring the reliability of supply in the archipelago. The main objective of this interconnection is to end

the current electrical isolation of Ibiza, in addition to saving costs for the system and promoting competition in electricity generation on the islands.

The electricity interconnection, with a total length of 126 km, consists of an alternating current double link in high voltage 100 MVA per line and a voltage of 132 kV. The route of the

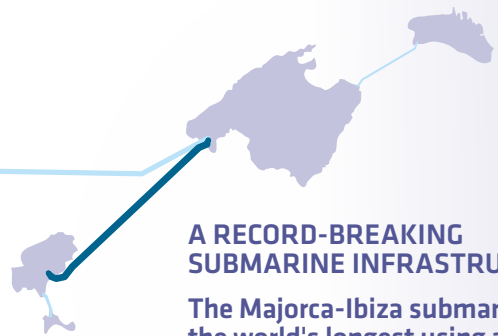
line consists of a land section on each island which runs underground (3 km in Majorca and 5 km in Ibiza) and a submarine section of 118 km, with a maximum depth of 800 m. In 2014, work began on the laying of the submarine cables and it is forecasted that the double link will be brought into service in 2015.

Although this is the main project, there are other interconnection projects between islands that will connect Majorca-Menorca and Ibiza-Formentera.



### MAIN MEASURES FOR THE SOCIO-ENVIRONMENTAL PROTECTION OF FLORA, FAUNA AND NATURAL HERITAGE

- >> Measures to protect endangered species such as the Spur-thighed tortoise or noble pen shell.
- >> Action protocol in the case of sighting whales.
- >> Minimising effects on Posidonia and beaches through the use of micro-tunnelling to house cables.
- >> Stoppage of works during the high season for tourism.
- >> Study of cultural heritage, noting the absence of archaeological remains.



### A RECORD-BREAKING SUBMARINE INFRASTRUCTURE

The Majorca-Ibiza submarine double link is the world's longest using alternating current and the deepest of its type running along the seabed at depths of up to 800 metres.



**More information** regarding the interconnection between the Spanish Peninsula and the Balearic Islands in the 'Unique projects' sub-section of the 'Activities' section of the corporate website.



## Canary Islands' electricity system

RED ELÉCTRICA will invest approximately 800 million euros in the Canary Islands' system in the coming years. This investment will drive the progressive change of the current energy model in the Canary Islands, to move towards a model based on the integration of renewable energy and the development of interconnections between the islands. The new infrastructure will allow the evacuation of

energy from future wind farms and improve the efficiency and security of the Islands' electricity systems, as well as strengthen the meshing of the transmission grid to ensure the security of supply. The aim is, ultimately, to implement a more sustainable, efficient and safe system, with significant investment in which Red Eléctrica will commit to and for which it has adequate technical, human and financial capacity.

Additionally, Red Eléctrica and Endesa have reached an agreement on the transfer of the concession for the Chira-Soria hydroelectric pumping station in Gran Canaria. The total investment in the facility is of approximately 300 million euros. The project, which is in the administrative permitting phase, encompasses the construction of a reversible pumping station, which will not be used as a genera-

tion facility, but as a tool for the system operator for ensuring the stability and security of the electricity supply. It will be one of the major projects of Red Eléctrica over the coming years, as it will provide an essential infrastructure for the integration of renewables on the island and will contribute to a new energy model in the Canary Islands.



### STRENGTHENING AND IMPROVING THE CANARY ISLANDS' TRANSMISSION GRID

#### Priority objectives

- >> Drive the change in the energy model on the Canary Islands:
  - > Facilitate the evacuation and integration of renewable energies.
  - > Construct a reversible hydroelectric pumping station.
  - > Ensure a more sustainable and efficient electricity supply.
- >> Move towards more secure and robust electricity systems:
  - > Improve grid meshing.
  - > Resolve structural weaknesses in the grid.
  - > Increase the quality standards of existing infrastructure.
  - > Develop interconnections between the islands.



**More information** regarding the 'Canary Islands' Electricity System' in the 'Activities' section of the corporate website.

INCREASED  
EFFICIENCY, security  
and sustainability  
of the electricity  
systems on the  
Canary Islands



## GRID MAINTENANCE

RED ELÉCTRICA's mission is to guarantee that the facilities of the transmission grid are always in optimum condition in terms of availability and reliability by establishing adequate maintenance, renovation and improvement policies. This is accomplished through the establishment of an annual programme that sets out all the activities and resources necessary to

ensure energy efficiency and the continuity of the electricity supply. This programme is established in line with the Company's strategic plan.

In line with Red Eléctrica's responsible management model, the following maintenance activities carried out in 2014 are noteworthy:

### IMPROVING THE QUALITY OF FACILITIES

- >> Review of maintenance processes for the safe, efficient and effective operation of the transmission grid.
- >> Implementation of a new system for the monitoring and evaluation of the performance of contractors.
- >> Strengthening the Peninsula-Balearic Islands interconnection through additional optical fibre and telecommunication systems.
- >> In addition to scheduled maintenance, work has continued regarding the environmentally friendly weatherproofing of facilities and the reconditioning of various transformer units.

### TECHNOLOGICAL INNOVATION ACTIONS

- >> Installation of remote devices for the control of fires near to the electricity lines and a device to dissuade birds from nesting via the use of ultrasound.
- >> Use of drones for the inspection of overhead lines, contributing to the minimisation of socio-economic impacts.
- >> Installation of a new type of fibre optic communications cable, housed within one of the conductors (OPPC type), on the island of Tenerife.
- >> Study on the potential development of a sustainable hybrid transformer

### ACTIONS FOR THE OPTIMISATION AND EFFICIENCY OF RESOURCES

- >> Use of a fleet management system, resulting in an increased availability of own resources increased availability of own resources, as well as saving fuel.
- >> Establishing links between fibre optic cable and telecommunications equipment between different substations and converter stations for the interconnection with France.

### MAR PROJECT (IMPROVEMENT OF GRID ASSETS)

Within the maintenance activity, Red Eléctrica is undertaking a significant programme for the integration of the assets acquired from the utility companies, especially in the island systems, raising them to the quality standards established by the Company. The programme, being carried out in the period 2011-2018, is contributing to a significant improvement in the levels of quality of service in the two archipelagos.

RED ELÉCTRICA'S MISSION IS TO GUARANTEE that the facilities of the transmission grid are always in optimum condition in terms of availability and reliability

## Service quality [EU28, EU29]

**THE SERVICE QUALITY INDICATORS** highlight for yet another year the highest level of security and quality of supply provided by Red Eléctrica's facilities, being well within the benchmark established in the current legislation which establishes average

interruption time at 15 minutes/year.

In 2014, there was a significant improvement in the values regarding Energy Not Supplied (ENS) and Average Interruption Time (AIT) compared to the previous year. The greater part of the energy not supplied is due to supply

interruptions in insufficiently meshed nodes, whose particular topology, on occasions, involves maintaining connections in antenna configuration associated to a single line. This type of incidents represented 84% of the total ENS registered in the peninsular system.

### QUALITY OF SERVICE INDICATORS

	2010	2011	2012	2013	2014*
<b>Peninsular grid</b>					
Grid availability (%)	97.93	97.72	97.78	98.20	98.20
Energy Not Supplied (ENS) (MWh)	1,552	259	113	1,126	199
Average Interruption Time (AIT) (minutes)	3.135	0.535	0.238	2.403	0.429

\* The 2014 values are pending external audit.

## CONTINGENCY MANAGEMENT

**RED ELÉCTRICA** develops protocols and methodologies to efficiently manage the contingencies that may occur in the Company. These protocols are set out in a series of policy documents governing actions in the case of operational emergencies. Their application in crisis situations are complemented through mobile response units/equipment capable of responding immediately in any area of the country, aimed at guaranteeing the quality and continuity of supply.

These measures are complemented with action plans, called Service Restoration Plans, which detail the precise actions to be taken to restore the electricity supply, under safe conditions, when the electricity system faces contingencies. As an additional measure, other documents

**THE COMPANY HAS CONTINGENCY PLANS IN PLACE** to ensure the quality and continuity of supply in any area of the country

## ACCESS AND CONNECTION TO THE TRANSMISSION GRID

complete the coverage of operational contingencies, covering the full spectrum of contingencies such as those affecting the environment and/or people. These other rules include actions when faced with situations caused by pandemics, evacuation of buildings and facilities of the Company and the protection plans of buildings, facilities and substations of the Company. Red Eléc-

trica also has a dedicated training centre called the Red Eléctrica Corporate School (ECRE), where staff from the electricity control centres is trained by means of system restoration and service recovery simulations.

RED ELÉCTRICA  
CORPORATE  
SCHOOL  
(ECRE), trains  
electricity control  
centre staff by  
means of system  
restoration and  
service recovery  
simulations

**DURING 2014**, Red Eléctrica continued to manage the procedures for access and connection to the transmission grid. The economic situation, expectations of growth in demand, the regulatory situation and the existing capacity in the complete set of generation facilities, as well as the delay in the approval of a new planning horizon of the transmission grid, have led to a slowdown in the trend regarding new requests for access to the transmission grid.

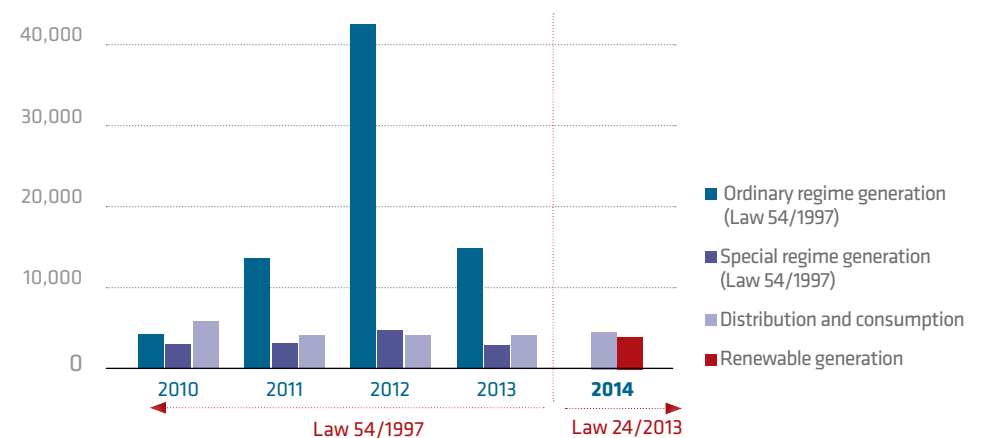
In particular, the suspension of the planning of electricity and gas sectors 2008-2016 (according to Royal Decree Law 13/2012) and the need for policy development for

access and the failure to grant connection permits regarding transmission grid developments not approved by planning have meant the decline of the total quota of requests for

access to the transmission grid. The graph shows the evolution in recent years of access requests received, foreseen to be provided connection to the transmission grid.

### REQUESTS RECEIVED FOR TRANSMISSION GRID ACCESS

Requests received in MW or MVA



## TRANSMISSION GRID LOSSES [EU12]

THE TRANSMISSION of electricity inevitably entails a loss of energy in the grid. This means that in order to satisfy a given final consumption, it is necessary to have a higher level of generation. Therefore, losses in the transmission grid are the difference between the energy generated and the energy demanded for distribution.

There are several factors that generate losses: the Joule\* effect, the corona effect and the own consumption of electricity substations required for their proper operation. Of these, the most important is undoubtedly the Joule effect associated with the

flow of current through the conductors.

Losses in the electricity transmission grid depend on the distance between generation points and consumption points (primarily), the generation mix, the size of the transmission grid, voltage levels, international exchanges and the behaviour of the demand (amount of energy demanded and shape of the demand curve).

Red Eléctrica works to improve the aspects that depend on their management and that can influence the reduction of

these losses. Among them are the following actions:

- >> Development and meshing of the transmission grid
- >> Increase the number of conductors per line

(Both measures aim to generate, in a parallel way, so that electricity flows with the same intensity, which causes reduced resistance thus reduced losses).

- >> Using technologies and systems with the best performances (conductors with less resist-

ance, efficient equipment etc.).

- >> Maintenance of facilities to ensure they are in the best condition for their correct functioning.

However, these improvements have a greatly reduced impact in the evolution of losses, as other aspects, not controlled by Red Eléctrica have the greatest influence.

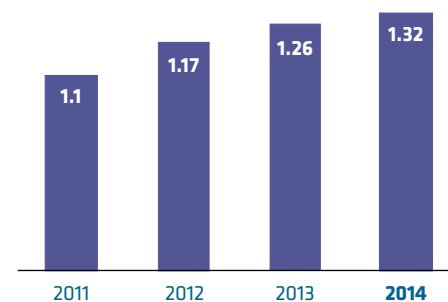
Losses increase mainly with the increase in distances between generation and consumption points. The structure of electricity generation depends on the rules of the electricity market,

regulated by an independent body. The role of Red Eléctrica, as electricity system operator, shall conform to specific and mandatory operational procedures. According to these procedures, it is not possible to operate the electricity system taking into account the criteria for reducing losses, so the Company's capacity to act in relation to reducing losses is limited.

Moreover, it is noteworthy that in the case of the Spanish electricity system, increased losses are closely related to the amount of renewable energies in the generation mix. Normally, increases in hydroelectricity and wind power are related to an increase in transmission distances (this type of generation is usually quite a distance away from consumption points).

RED ELÉCTRICA WORKS TO IMPROVE the aspects that depend on their management and that may influence the reduction of energy losses in the grid

PERCENTAGE OF LOSSES IN THE TRANSMISSION GRID WITH RESPECT TO ANNUAL DEMAND



\* Joule effect: the effect whereby, when an electrical current flows through a conductor, part of the kinetic energy of electrons is transformed into heat which thereby raises the temperature of the conductor. Joule effect losses are proportional to the intensity flowing through the conductor and the resistance thereof, the greater the length of the line the greater this resistance is. In view of this, it can be understood that the losses are mainly related to the distance between points of generation and consumption.

## INTERNATIONAL INTERCONNECTIONS

### FOR THE EFFICIENT

operation of the electricity system it is essential to strengthen international interconnections. Having an increased electricity exchange capacity with neighbouring countries provides greater security of supply and a better use of renewable energy. In the case of Spain, the need for investment in the strengthening of interconnections is very important because it has

a limited level of interconnection with Europe, well below the 10% of its installed capacity target established at the European Summit in Barcelona in 2002.

In this regard, in October 2014, the European Council set a new target: to raise interconnection capacity up to 15% by 2030. This milestone was agreed to along with the other three targets related to the energy strategy that shall be achieved in the same time scale. In the

case of Spain, it is clear that in order to achieve these targets it must have a greater electricity interconnection between the Iberian Peninsula and Europe.

Therefore, interconnection projects will be, in the coming years, the most significant actions of Red Eléctrica regarding infrastructure development.



**More information**  
in the 'Unique projects' subsection  
in the 'Activities' section of the corporate website.

### BENEFITS OF INTERNATIONAL INTERCONNECTIONS

#### Technical

- >> Allow the security of supply of the interconnected countries to increase, increasing grid reliability in border areas.
- >> Improve the quality of supply, with greater frequency stability and quality.
- >> Reduce losses, especially in electrically complementary borders.
- >> Facilitate the integration of non-manageable renewable energy.
- >> Contribute to a greater diversity of energy sources.
- >> Reduce the required power reserves in each country, which means less need for investment in generation and transmission.
- >> Represent an essential element for building the Internal Electricity Market and for increasing competition.

#### Environmental

- >> Reduce CO2 emissions.
- >> Contribute to meeting the environmental targets of the European Union.
- >> Represent a reduced effect on the region resulting from lower requirements for investment in generation and connection networks.

#### Economic

- >> Increase the geostrategic importance of the region and the countries through which the interconnection passes.
- >> Attract investments arising from reduced energy costs, leading to the creation of employment.
- >> Promote competition amongst companies.
- >> Reduce economic distortions arising from the heterogeneity of prices in Europe.

## INTERCONNECTION WITH FRANCE

IN 2014, the construction of the interconnection axis with France through the Eastern Pyrenees was completed; an interconnection whose inauguration and commissioning is foreseen for 2015. This infrastructure doubles the current electricity exchange capacity between Spain and France from 1,400 MW to 2,800 MW. However, this is still insufficient to reach the minimum level of interconnection of 10% of installed capacity recommended by the European Union.

The Spain-France interconnection is of great importance due to its influence on the quality and security of the Spanish electricity system and the integration of renewable energy.

### GENERAL PROJECT DATA

- >> Construction of a high voltage direct current line that overcomes the physical barrier posed by the Pyrenees and is buried throughout its entire length of 65 kilometres.
- >> A tunnel (8.5 km in length and 3.5 metres in diameter) houses the cables in the stretch that crosses the Pyrenees.
- >> A total investment of €700 million, co-financed with our neighbouring country through the company INELFE (owned 50% by REE and 50% by RTE). The project has received a grant of 225 million euros from the European Union.
- >> A converter station has been built at each end of the line, Santa Llogaia (Spain) and Baixas (France), in order to transform alternating current into direct current and vice versa.

The circumstances surrounding the project have made it a considerable engineering feat that has been carried out with minimal environmental impact and maximum integration into the landscape.



**More information** regarding the interconnection with France in the 'Unique projects' subsection of the 'Activities' section of the corporate website.

## INTERCONNECTION WITH PORTUGAL

IN 2014, the Puebla de Guzmán-Portuguese border electricity line was brought into service with the aim of increasing the interconnection capacity between Spain and Portugal and enhancing the security level of the operation of both electricity systems. The interconnection involved the meshing of the 400 kV grid of the Spanish

and Portuguese systems between the substations of Puebla de Guzmán (Spain) and Tavira (Portugal). This infrastructure, which has represented an investment of 9.5 million euros, has seen the expansion of one substation bay in the Puebla de Guzmán substation and the construction of a 25 km line.

At the same time, the administrative permitting process for the new northern interconnection (Galicia-Porto) will continue with an investment of 12.5 million euros and it is forecast to be brought into service for 2017. With these interconnections the objective of reaching a commercial exchange capacity of 3,000 MW with the neighbouring country is maintained.

### Future international interconnections

**THE NEED** to increase interconnection capacity is, for the European Commission, one of the four electricity priorities for achieving energy targets that will allow access to a sustainable, competitive and secure energy. Therefore, to improve the interconnection of the Spanish Peninsula with the European system several Projects considered to be of

Common Interest (PCI) are included:

- >> A phase shifter in the Arkale-Argia 220 kV line
- >> A submarine interconnection through the Bay of Biscay.
- >> A new interconnection project with Portugal in the region of Galicia, between Fontefría and Vilafria.

The classification as PCI is relevant because it measures Community contribution covering various areas, most notably the obligation for Member States to grant the PCIs the status of maximum priority at a national level and potentially receive community economic and financial support.

## INTEGRATION OF RENEWABLES

**IN LINE** with previous years, the main objective of the operation of the electricity system throughout 2014 has been to ensure the integration of the maximum amount of renewable energy into the system, whilst ensuring the security and quality of the electricity supply. To this end, the role of CECRE (Control Centre of Renewable Energies), a pioneering control centre

and worldwide benchmark reference regarding the monitoring and control of renewable energies, has been essential. In 2014, the work carried out by CECRE has made it possible to register new all-time highs in daily and monthly wind power production, reaching 352,087 MWh on 25 March 2014 and 6,626 GWh in January 2014 respectively.

In 2014, energy production coming from renewable sources in the peninsular electricity system represented 43% of the total generation. For yet another year, the important role played by wind power production stood out, whose contribution to the annual energy production reached 20%, ranking second, just behind that of nuclear

energy, as the technology that contributed most to demand coverage.

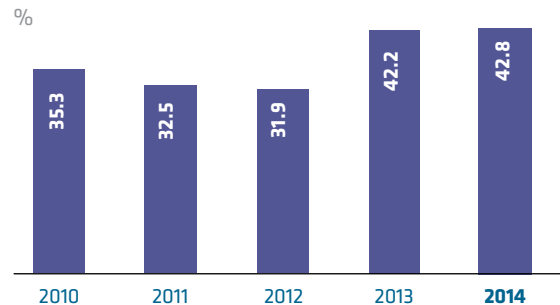
Similarly, in the months of January, February and November wind generation technology was the great-

est contributor to the total energy production of the peninsular electricity system, reaching 29.2%, 27.8% and 25.8%, respectively.

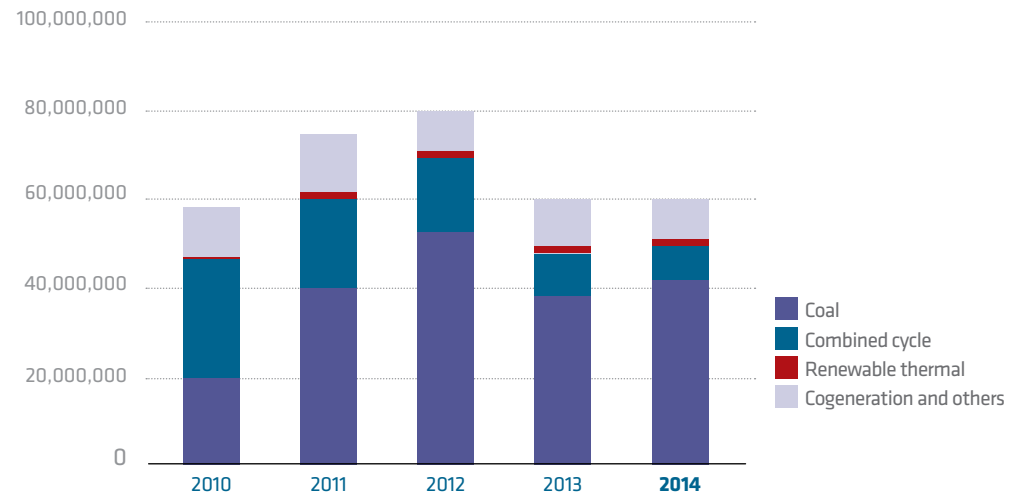
In 2014, the Cross-border Energy Balance Mecha-

nism came into operation, a process that allows the exchange of surplus energy between neighbouring electricity systems using the unused interconnection capacity. ▶

### EVOLUTION OF THE CONTRIBUTION OF RENEWABLE ENERGIES IN THE COVERAGE OF DEMAND



### CO<sub>2</sub> EMISSIONS ASSOCIATED WITH ELECTRICITY GENERATION ON THE PENINSULA (t CO<sub>2</sub>)





◀ With this mechanism competition in generation resources is promoted, optimising the use of international interconnections and promoting the integration of renewable energies. Also, this fact is another step in the progress towards the internal electricity market.

Regarding the Balearic Islands' electricity system, in 2014 work continued with the realisation of the positive effects of the operation of the link that joins the island of Majorca with the peninsular electricity system. This infrastructure represents an improvement in the quality and security of the electricity supply on the islands of Majorca

and Menorca, avoiding frequency deviations outside of established limits and outages caused by loss of generation. Furthermore, the energy transferred from the Spanish Peninsula covered 27% of the demand on the Balearic Islands, at times reaching peaks of 35% of the hourly consumption. This resulted in a saving of 23% on the

cost of coverage of the Balearic Islands' system and avoided the emission into the atmosphere of about 340,000 tons of CO<sub>2</sub>.

In the Canary Islands' electricity system, generation from renewable sources - wind and photovoltaic - represented 8% of the total generation in 2014, at times reaching levels of 32% in Tenerife and 35% in Palma throughout the year, values especially challenging in small isolated electricity systems. In mid-2014, the hydro-wind power station in Gorona del Viento located on the island of El Hierro was brought into service and which consists of two reservoirs, higher and lower elevation, a wind farm and a pump-turbine system that underwent testing in the second half of the year.

## ENERGY EFFICIENCY

RED ELÉCTRICA continues to work actively on the promotion, development and dissemination of demand-side management measures as one of the necessary tools for both the current and future electricity system.

In this regard, demand-side management initiatives seek to contribute to the guarantee and security of supply by promoting the integration of renewable energy, reducing green-

house gas emissions and promoting the sustainable use of energy in order to reach a greater efficiency for the electricity system as a whole. Amongst the initiatives developed, noteworthy are, on the one hand, those measures designed to achieve a more balanced consumption profile and, on the other, those that aim to provide a greater flexibility in the operation of the system.

### PARTICIPATION OF RENEWABLES IN THE COVERAGE OF THE ELECTRICITY DEMAND 2014

%

10.2 Cogeneration and others

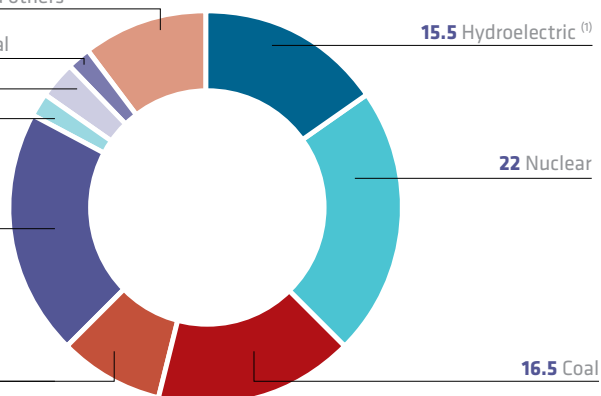
1.9 Renewable thermal

3.1 Solar photovoltaic

2 Solar thermoelectric

20.3 Wind

8.5 Combined cycle



<sup>(1)</sup> Excludes pumped storage generation

## Active citizen

### THE ELECTRICITY SYSTEM

is in a transition phase towards a new more dynamic energy model in which the role of the citizen, as a key part of system operation, is becoming increasingly noteworthy. For this reason, Red Eléctrica promotes the implication of consumers by disseminating recommendations on best practices regarding efficient consumption. In this regard, in 2014 the 'Operation System for Dummies' book was drafted and disseminated to meet this commitment to disclose the operation of this activity managed by the Company.

Also in 2014 hourly energy pricing schedules were made public through the web that are applied in

RED ELÉCTRICA promotes the involvement of the consumer as a key player in the new energy model.

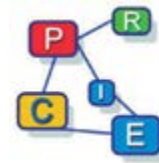
the electricity bill of those consumers with contracted power not exceeding 10 kW and which are covered by the Voluntary Price for the Small Consumer (*Precio Voluntario para el Pequeño Consumidor [PVPC]*).

The progressive electrification process of our society, resulting from the ever-increasing impor-

tance of electricity in our lives, requires this kind of initiatives that enable citizens to easily understand the functioning of the electricity system, helping them to change their habits leading to a more efficient and responsible use of energy.

## INICIATIVAS PARA UNA GESTIÓN EFICIENTE DEL SISTEMA ELÉCTRICO

### 'PRICE' PROJECT



The 'PRICE' deployment project (Joint Smart Grid Project in the Corredor del Henares area of the Community of Madrid) has received the European Electricity Grid Initiative Core Label that recognises the alignment of the same with the criteria and objectives defined in the European Electricity Grid Initiative.

In 2014, the demonstration phase of this project started, a project carried out in the field of residential demand, and that has allowed Red Eléctrica to gain knowledge and technology for the implementation of demand-side management tools and new mechanisms aimed at providing citizens with information regarding the status of the electricity system.

### PROFILING SERVICE



Red Eléctrica leads this project that seeks to introduce improvements in the current profiling service through a panel of approximately 20,000 consumers, who already have smart meters installed,

The project seeks to improve the current profiling service and

have more knowledge available about both household hourly consumption and that of an important part of small businesses and services. With this in mind, Red Eléctrica is spearheading this project, that includes the involvement of the major distribution companies, and that is based on the analysis of the hourly information

coming from a panel of around 20,000 consumers.

The information that has been collected since January 2014 from the members of the panel has been used in the proposal for initial profiles for 2015 developed by Red Eléctrica.

## INTERRUPTIBILITY SERVICE

ORDER IET/2013, of 31 October 2013, included as part of the demand-side management service the challenge of a new mechanism for allocating the interruptibility resource based on an auction procedure.

Red Eléctrica, in its role as administrator of the auction, made a major effort in 2014 for the transparent and effective implementation of this new mechanism, especially in the tasks of communication with the stakeholders involved through briefings and a

plenary session with all the applicants requesting the service.

In order to allocate the service, an auction system with face-to-face bidding is used. It is a competitive and efficient mechanism, similar to that used in other known markets, such as the wholesale fish markets or the Dutch flower auctions. Specifically, it has been large industries of the country that have competed for the allocation of the interruptible resource in auctions held between 17 and 21 November in

**DURING 2014 the first auction for the Interruptibility service was successfully held**

Madrid, and on 22 and 23 December in Zaragoza and have resulted in the allocation of 3,020 MW of interruptible resource for the system during 2015.



**More information** regarding the interruptibility service in the 'Operating System' subsection of the 'Activities' section of the corporate website.

## TECHNOLOGICAL INNOVATION

IN 2014 work was carried out on the development of 66 technological innovation projects aimed at increasing system efficiency and facilitating the integration of renewable energies.

Some of these projects, which are encompassed within the Technological Innovation and Development Plan designed by the Company for the 2012-2016 horizon, have been promoted in collaboration with different universities and public administrations.

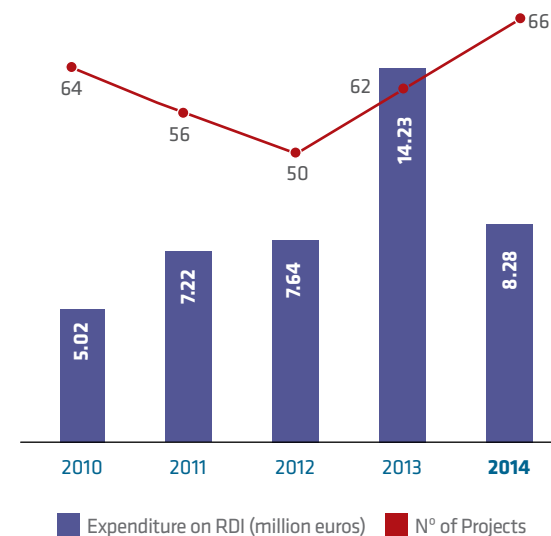
A total of 8.3 million euros was earmarked for carrying out these projects. This figure, despite being significantly lower than the previous year (14.2 million euros), due to the commissioning of major equipment on which work had been carried out during the previous years, consolidates a growing

trend in the Company's commitment to innovation and technological development that has been taking place since 2010. In this regard, in order to maintain this commitment to incorporating new innovative technologies that increase the efficiency and sustainability of the system, Red Eléctrica plans to

invest around 9.2 million euros in 2015.

A total of 288 employees worked on the 66 RDI projects that were active in 2014. Of the 288 employees, 46 were women (16%). 39,100 work hours were dedicated by our own staff, the equivalent of 23.1 full-time personnel.

### EXPENDITURE ON RDI



## INNOVATION: NATIONWIDE PROJECTS

IN 2014, two projects represented a major milestone in Red Eléctrica's commitment to incorporating innovative technologies to improve key aspects such as energy efficiency, the integration of renewable energies and the stability of the electricity system.

On the one hand, the installation and commissioning of a flywheel to stabilise the frequency of the electricity system of Lanzarote-Fuerteventura, installed in Mácher (Lanzarote).

On the other hand, the installation of a battery for large-scale energy storage (ALMACENA Project) located in Carmona (Seville), which has allowed two functionalities to be tested aimed at promoting the integration

of renewable energies and improving operation services (load curve modulation and frequency-power regulation).

THE 'ALMACENA' PROJECT (STORAGE) PROMOTES the integration of renewables and improves operational services, providing greater stability to the system

### Other national projects completed in 2014

**REGARDING** the projects included in national programmes for the promotion of innovation, work continued on the IN- NPACTO programme: ESP-

Líder (SSSC device for the redirection of current flows in Torres del Segre) and the PRICE project (intelligent demand-side management).

>> Implementation of new functionalities of the SAIR system (Automatic Grid Inspection System).

>> Improved tools for calculating demand coverage.

>> Software for the simulation of voltages induced in the sheaths of underground cables.

>> Methodology for the controlled powering of transformers.

>> Study of the possible impact of geomagnetic solar storms on the Spanish electricity system and RTE. The project has received a grant of 225 million euros from the European Union.

## INNOVATION: EUROPEAN PROJECTS

**INTERNATIONALLY**, noteworthy are the efforts to develop the Implementation Plan 2015-2017, a document containing the technological measures to be carried out over the next three years under the RDI plan of ENTSO-E; as well as the collaboration on a joint roadmap for energy technology under the SET Plan of the

European Union 'Towards an integrated Roadmap: Research & innovation challenges and needs of the EU Energy system'. Also a new edition of the Monitoring report of ENTSOE was prepared, focusing on analysing the use made by TSO's of the results of the European RDI projects concluded in recent years.

Furthermore, in 2014 the European project GRID+ concluded (which has supported the European Electricity Grid Initiative for the coordinated design a joint RDI roadmap between TSO's and DSO's).



### 'BEST PATHS' PROJECT

This European project, launched in 2014, aims to overcome the various technical barriers that the current pan-European power network could encounter in order to safely, efficiently and reliably integrate massive amounts of energy from renewable sources such as solar or offshore wind power, satisfying the demand in a competitive manner and

reducing the levels of CO2 produced. Red Eléctrica co-ordinates this project, which embraces five large-scale demonstrations, with a total budget of 62.8 million euros (with EU funding in the amount of 35.5 million euros).

The Best Paths project has the participation of 39 partners from universities, technological centres, the industrial sector, electricity utilities and European TSO's.



**More information**  
in the 'Red21' section  
of the corporate  
website.

## INNOVATION: PROJECTS OF ENVIRONMENTAL INTEREST

**IN 2014** of note was the RDI project 'Birds and Power Lines: Mapping of bird flight paths' with which Red Eléctrica won the European Environment Award 2014, in the special category 'Business and Biodiversity'.

The project allows sensitivity maps to be drafted which identify areas with the greatest potential risk of birds colliding with

power lines, which in turn facilitates more efficient and sustainable decisions during the stages of planning and development of new power lines, in addition to prioritising corrective actions on existing lines.

Also, work has continued on a project aimed at developing and validating an experimental technique for the recovery of underwater Posidonia oceanica meadows, an aquatic plant native of the Mediterranean-

an Sea which enjoys a high level of protection, that involves the collection and cultivation of Posidonia oceanica seeds grown under laboratory-controlled conditions or fragments obtained directly from natural seagrass meadows.

This will mitigate the effects of works for the laying of submarine electricity cables programmed in the Balearic Islands.

**RED ELÉCTRICA WAS THE WINNER** of the European Environment Award 2014 in the special category 'Business and Biodiversity'



**More information**  
in the 'Environment' sub-section of the 'Sustainability' section of the corporate website.