International Energy Agency

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Energy Policies of IEA Countries

Spain

2015 Review

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea
Luxembourg
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

The European Commission also participates in the work of the IEA.

International Energy Agency

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TABLE OF CONTENTS

List of figures, tables and boxes

LIST OF FIGURES

LIST OF TABLES

LIST OF BOXES

1. EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS

EXECUTIVE SUMMARY

Spain enjoyed an economic boom from the late 1990s to 2008, after which the economy entered into a recession, which lasted until late 2013. The economy is growing again, but total primary energy supply (TPES), total final consumption of energy (TFC), electricity demand, and energy-related carbon dioxide (CO_2) emissions all remain significantly lower than before the recession.

Spain maintains many of its strengths in the energy sector, notably regarding security of supply, but at the same time, the economic situation has brought new challenges that have prompted government action. This has been particularly true for the electricity sector.

An important aspect of Spain's energy policy is the growing role of the European Union (EU) as the source of policy goals and related obligations. Since 2009, the progressive liberalisation and cross-border integration of the electricity and natural gas markets has continued, notably by means of the 2009 third Internal Energy Market Package. Also, Spain and other EU member countries are taking broad-ranging measures to meet the EU targets for 2020 on greenhouse gas (GHG) mitigation, renewable energy, and energy efficiency.

SECURITY OF SUPPLY

Spain´s dependence on energy imports has decreased from around 80% of its energy supply back in 2009 to around 70% in 2014. This success can be attributed in part to the rapid increase in renewable energy supply. Oil supplies are well diversified by country of origin, and Spain holds slightly more oil stocks than required under its International Energy Agency (IEA) membership obligation. Moreover, in 2010, Spain raised the minimum stock requirement to 92 days from 90 days.

Spain has one-third of the total liquefied natural gas (LNG) regasification capacity in the European Union, and diversification of import sources has been successful. Gas is imported from more than ten countries, and the largest importing companies may source only half of their annual total from any given country. Obligatory emergency gas stocks stand at 20 days, further increasing security of supply. Welcoming Spain's efforts to enhance security of energy supply both in oil and gas sectors, the International Energy Agency (IEA) encourages Spain to assess its shale gas potential.

In the electricity sector, Spain has built a large, well-diversified power generation fleet and a very reliable power system. It has succeeded in integrating a large share of wind and solar power while limiting renewable curtailment. As the country has relatively low cross-border capacity, variations in power generation have to be dealt with largely within the Iberian system. This situation has recently improved, however, and more interconnections with France are being planned (see "Market integration and cross-border connections" below).

Security of energy supply has been improved as a result of both laws and regulations, but also because of significant capacity increases over the past 15 years and declining demand for primary energy and electricity during the recession. The resulting large excess capacity for power generation and LNG terminals, however, has put the financial stability of both electricity and gas systems under stress.

FINANCIAL STABILITY IN ELECTRICITY AND NATURAL GAS SYSTEMS

After taking office in December 2011, the new government saw stabilising the public sector finances as an urgent priority. Public debt had soared from less than 40% of gross domestic product (GDP) in 2007 to around 80% of GDP in 2011 and was growing at an unsustainable rate. The government had also inherited a massive imbalance between the regulated costs and revenues of the electricity system. This imbalance, the so-called tariff deficit, was perceived as a financial liability for the state; solving it became one of the government's main focus areas in energy policy.

The tariff deficit, which had been accumulating since 2001, began to spiral out of control after 2005. From 2005 to 2013, the costs in the electricity system grew by 221% while revenues increased by only 100%. Subsidies for renewable electricity are the single largest cost element. By 2012, the accumulated debt in the system had reached more than EUR 20 billion and was set to expand by billions every year unless action was taken. In 2012, the government temporarily eliminated subsidies for new installations. It also reduced remuneration for transmission and distribution network activities, increased access tariffs, and introduced a 7% tax on electricity generation (22% for hydropower). Nevertheless, the deficit grew to EUR 26 billion by the end of 2012.

In July 2013, the government introduced a broader electricity market reform package. The reform reduced the remuneration and compensation for the activities in the electricity system by several billion euros per year. It also introduced the principle of "no new cost without a revenue increase". Importantly, the reform introduced a new way of calculating compensation for renewable energy, waste, and co-generation (combined production of heat and power). With some exceptions, by mid-2015 the comprehensive reform had been implemented. The reform has reached its aim: the sector's costs and revenues are back in balance, and the accumulated deficit, which peaked at the end of 2013 at EUR 29 billion or 3% of GDP, should gradually disappear over the next 15 years.

Electricity market reform has been complex but necessary. The electricity system's future financial sustainability depends both on macroeconomic developments and on a sustained commitment to the reform by the country´s politicians. To overcome any perceived risks for investing in electricity infrastructure in Spain, the government should closely follow the principles of transparency, predictability, and certainty when revising the parameters for defining reasonable return. More generally, to avoid any political interference in the future, the principle of "no new cost without a revenue increase" should be strictly enforced.

As a consequence of the high level of costs in the electricity system, end-user prices in Spain are among the highest in IEA member countries. The government could reform end-user prices by eliminating any cost components that are unrelated to the supply of electricity to final users, recovering them via more appropriate mechanisms. Spain should revisit its renewable energy goals: the burden could be shared more evenly across sectors, which primarily implies a stronger focus on limiting oil use in the transport sector.

Triggered by the recession, a tariff deficit also emerged in the natural gas system, as falling gas demand reduced revenues from infrastructure (pipelines, underground storage and LNG regasification plants) use. By the end of 2013, a tariff deficit of EUR 400 million had accumulated. While this amount was little more than 1% of the accumulated tariff deficit in the electricity sector, it was expected to double in 2014. In July 2014, the government introduced a new mechanism to gradually eliminate the accumulated tariff deficit. Accordingly, all new system costs must be matched by cost cuts or revenue increases elsewhere. Also, the access tariffs will be automatically increased, if the annual tariff deficit rises over a predetermined threshold.

The IEA welcomes the government's actions, which have eliminated the annual deficit from 2014 on. The accumulated tariff deficit has thus stopped from growing and will gradually be eliminated. The government must maintain a strong long-term commitment to balancing the costs and revenues in the natural gas system.

MARKET INTEGRATION AND CROSS-BORDER INTERCONNECTIONS

Creating single markets in electricity and natural gas has long been a priority for the European Union. For obvious reasons, physical cross-border capacity in electricity is essential not only for market integration but also for renewable energy integration and security of supply. Spain's electricity interconnection capacity remains very low at around 4% of installed capacity in 2014. Until very recently, efforts to increase interconnection capacity with France have had few results. In a welcome development, the 1.4 gigawatts (GW) Santa Llogaia–Baixas interconnection was inaugurated in February 2015 – the first new interconnection in almost three decades.

New momentum for additional interconnections is evident: the October 2014 European Council agreed on a target of a 10% share of interconnection capacity in total installed generation capacity in every member country by 2020. Furthermore, this target is to be raised to 15% by 2030. European Union funds are available for priority projects, and the political leaders of France, Portugal and Spain are committed to this objective. After so many years of limited results, it is highly encouraging to see the recent positive developments and the strong political support for further developing interconnections between the Iberian Peninsula and France. The planning and construction of new interconnections should be vigorously pursued and EU funding sources used to the full.

Beyond physical interconnections, cross-border market integration with the rest of Europe has significantly improved over the past few years. Since May 2014, the Iberian market area is coupled with other European market areas, allowing for an optimal utilisation of interconnections. Integrating the intraday and balancing markets closely with the rest of Europe would ensure a more efficient use of existing interconnections.

Regarding natural gas, Spain's underutilised LNG capacity can help increase flexibility, diversity, and security in the EU internal market. For that to happen, more interconnection capacity is needed between the Iberian Peninsula and the rest of Europe. The IEA therefore welcomes the recent decisions to expand this interconnection capacity, in particular through the MidCat project. The IEA also recognises the importance of political and financial support for the project from the EU level and welcomes the recent work to develop and launch a gas hub. An organised gas hub would benefit Spain by providing a more transparent price reference for gas.

PLANNING FOR A LOW-CARBON FUTURE

For understandable reasons, the government´s immediate focus since 2011 has been on restoring financial stability in the electricity and natural gas systems. Now that these extensive reforms have been successfully implemented, the government should focus on providing guidance on long-term energy policy. The government should prepare an integrated long-term energy strategy, with a particular focus on energy demand and energy efficiency. This should be done with the long-term GHG reduction objective in mind. In this context, Spain should keep all options open for low-carbon power generation. It should also increase efforts to limit peak electricity demand through energy efficiency measures.

Spain´s current measures to reduce energy-related CO_2 emissions focus on energy efficiency and renewable energy. Spain is set to meet the 2016 target for 9% final energy savings in the non-emissions trading scheme (ETS) sector from the early 2000s levels. In 2013, it had already reached savings of 10.1%, and the government expects an increase to 15.5% in 2016. Nonetheless, current policies and measures are not enough to meet the target of reducing GHG emissions by 10% from 2005 to 2020 in the non-ETS sector. This is evident from the scenarios laid out in Roadmap 2020, which was adopted in October 2014.

Transport is the largest GHG emitter in the non-ETS sector and, therefore, is the natural focus area of Roadmap 2020. Measures focus on modal shift, fleet renewal, and more efficient ways of driving. In the buildings sector, renovations of dwellings are expected to account for 66% of all emission cuts. In industry, energy efficiency and fuel switching are the focus. The Roadmap, however, does not consider what kind of incentives would be needed to trigger the required investments and in what proportion they would be divided between the public and private sectors. Raising tax rates in a revenue-neutral way, notably, fuel taxation where tax rates are relatively low by international comparison, can encourage more efficient oil use thus delivering environmental and energy security benefits.

Ambitious policies on energy efficiency bring benefits beyond emissions reductions: they save money, reduce import dependence, and improve air quality. An important new funding source is the National Energy Efficiency Fund, set up in July 2014. The IEA also encourages Spain to ensure that any spending on energy efficiency and renewable energy contributes to the overall cost-effectiveness of energy policy. From the financial and environmental perspective, the IEA applauds Spain's decision to significantly cut subsidies for hard coal production since 2011.

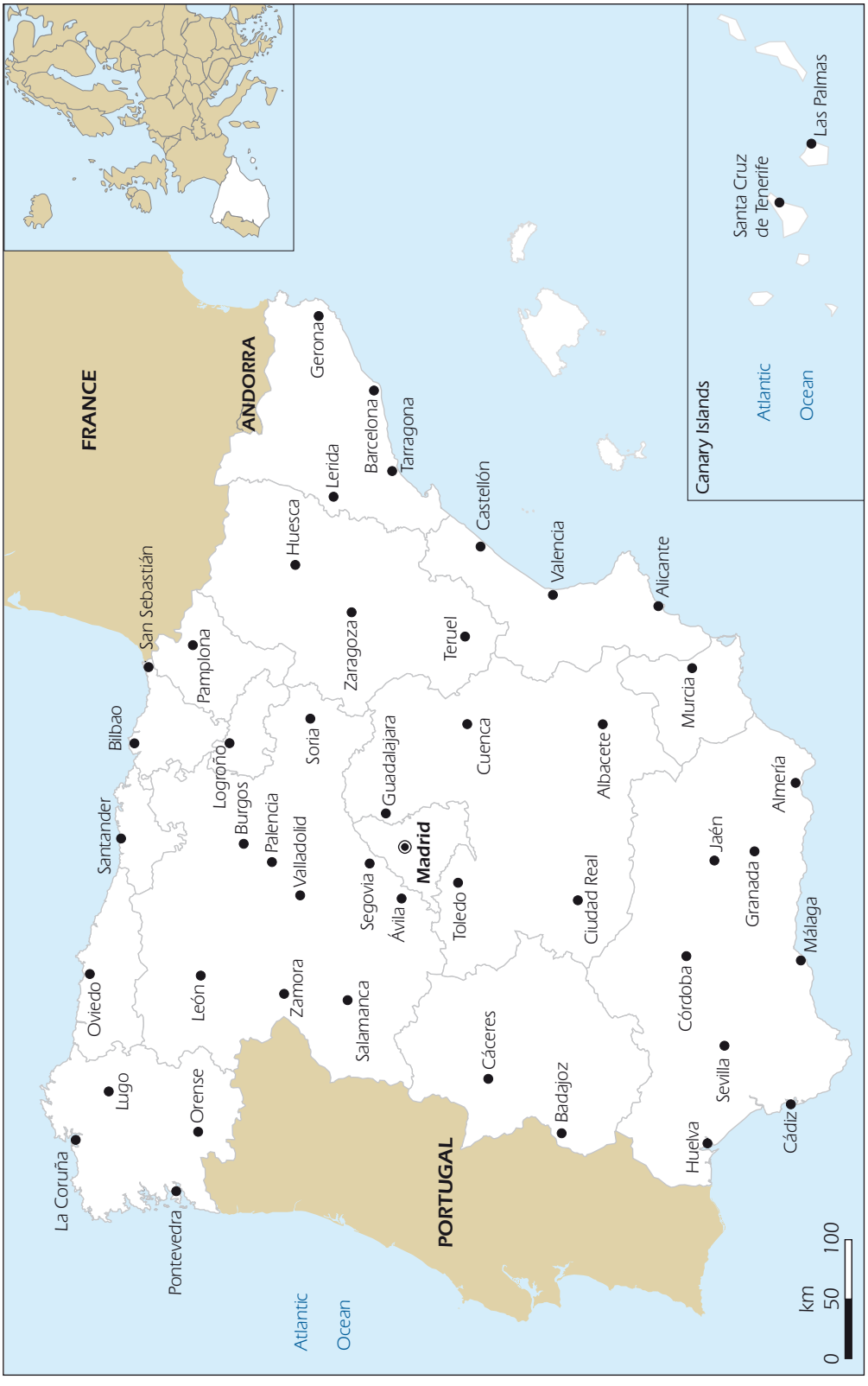
KEY RECOMMENDATIONS

The government of Spain should:

- ☐ *Develop, in light of the EU 2030 targets, a long-term energy strategy covering all sectors, including energy demand, in close consultation with all stakeholders.*
- ☐ *Maintain a strong long-term commitment both to balancing the costs and revenues in the electricity and natural gas systems and to the principles of transparency, predictability, and certainty when regularly revising the parameters for remuneration in these systems.*
- ☐ *Reform energy taxation and introduce revenue-neutral fiscal incentives to encourage GHG reductions and energy efficiency improvements.*

PART I
POLICY ANALYSIS

Figure 2.1 Map of Spain



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

2. GENERAL ENERGY POLICY

Key data (2014 estimated)

TPES: 113.9 Mtoe (oil 41.2%, natural gas 20.8%, nuclear 13.1%, coal 10.3%, biofuels and waste 5.5%, wind 3.9%, hydro 3%, solar 2.5%, electricity net imports -0.3%), -18.1% since 2004

TPES per capita: 2.5 toe (IEA average: 4.4 toe)

TPES per GDP: 0.09 toe/USD 1 000 PPP (IEA average: 0.13 toe/USD 1 000 PPP)

Energy production: 34.2 Mtoe (nuclear 43.7%, biofuels and waste 19.2%, wind 13.1%, hydro 9.8%, solar 8.4%, coal 4.7%, oil 0.9%, natural gas 0.1%, geothermal 0.1%), +5.1% since 2004

Electricity generation: 273.9 TWh (nuclear 20.9%, wind 19.1%, natural gas 17.2%, coal 16.3%, hydro 14.3%, oil 5.2%, solar 5%, biofuels and waste 2%), -1% since 2004

Electricity generation per capita: 5.9 MWh (IEA average*: 9.9 MWh)

* IEA average includes electricity and heat generation; there is no heat generation in Spain.

COUNTRY OVERVIEW

The Kingdom of Spain has a population of around 47 million and an area of 505 000 square kilometres (km^2). It covers most of the Iberian Peninsula and includes also the Canary Islands, Balearic Islands and the cities of Ceuta and Melilla in North Africa. Owing to its size and geography, the country's climate can vary substantially by region.

Exceptionally for a developed country, Spain's population has grown by around 17% since 2000, almost entirely because of immigration. The economy has grown roughly at the same pace. From 2000 to 2008, Spain's economy grew by almost 30%, much faster than the Organisation for Economic Co-operation and Development (OECD) average of less than 20%. The driver was a debt-fuelled construction boom which came to an abrupt end in 2008, as in many other countries

In 2009, gross domestic product (GDP) decreased by 3.8% and only turned to full-year growth in 2014. Rescue loans to the Spanish banks from the euro-zone and an economic recovery programme helped stabilise the economy. Spain took a wide range of measures to consolidate its fiscal position, stimulate economic growth, and diversify its economy beyond construction and tourism. Improved economy has recently also helped reduce unemployment, although it is still high, at 23% in March 2015, according to Eurostat.

Services account for around 72% of GDP; manufacturing and construction for around 25%; and agriculture for nearly 2.6%. All shares are close to the OECD average. Tourism is particularly important, and Spain's tourism industry is the second-largest in the world in terms of revenue and the fourth-largest in terms of arrivals (58 million in 2012). Retailing and banking are also prominent. The country's industry was for a decade dominated

by construction, accounting for some 16% of GDP in 2007, at the height of the housing boom. Other large subsectors are vehicle manufacturing, energy industries and food-processing.

Since 1978, Spain has been a constitutional monarchy, and the king has a limited role in day-to-day politics. The centre-right government led by Prime Minister Mariano Rajoy took office for a four-year term in the third quarter of 2011, after seven years of Socialist Party rule.

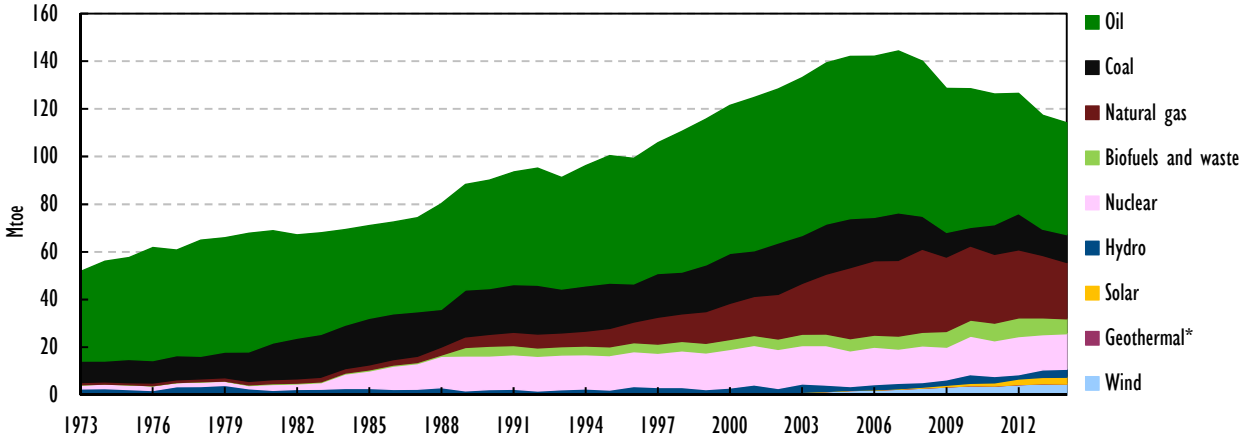
A fairly decentralised country, Spain is divided into 17 autonomous regions, each with its own parliament. In the energy sector, the autonomous regions are responsible for e.g. authorising power plants and energy networks. Spain joined the European Union in 1986 and adopted the euro as its currency in 2002.

SUPPLY AND DEMAND

SUPPLY

Spain's total primary energy supply (TPES)[1] was 113.9 million tonnes of oil-equivalent (Mtoe) in 2014. This was 18.1% lower than a decade earlier. Energy supply peaked at 143.8 Mtoe in 2007 after decades of steady growth. From 2007 to 2014, TPES declined by 20.8% (Figure 2.2).

Figure 2.2 TPES, 1973-2014



Note: data for 2014 are estimated.

* Negligible.

Source: IEA (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

Fossil fuels accounted for 72.2% of TPES in 2014, including oil (41.2%), natural gas (20.8%) and coal (10.3%). Renewable energy sources accounted for 14.9% of TPES and nuclear power for 13.1%. Electricity net imports amounted to 0.3% of TPES (counted as a negative value). The fossil fuel share has contracted from 81.8% of TPES in 2004, while renewable

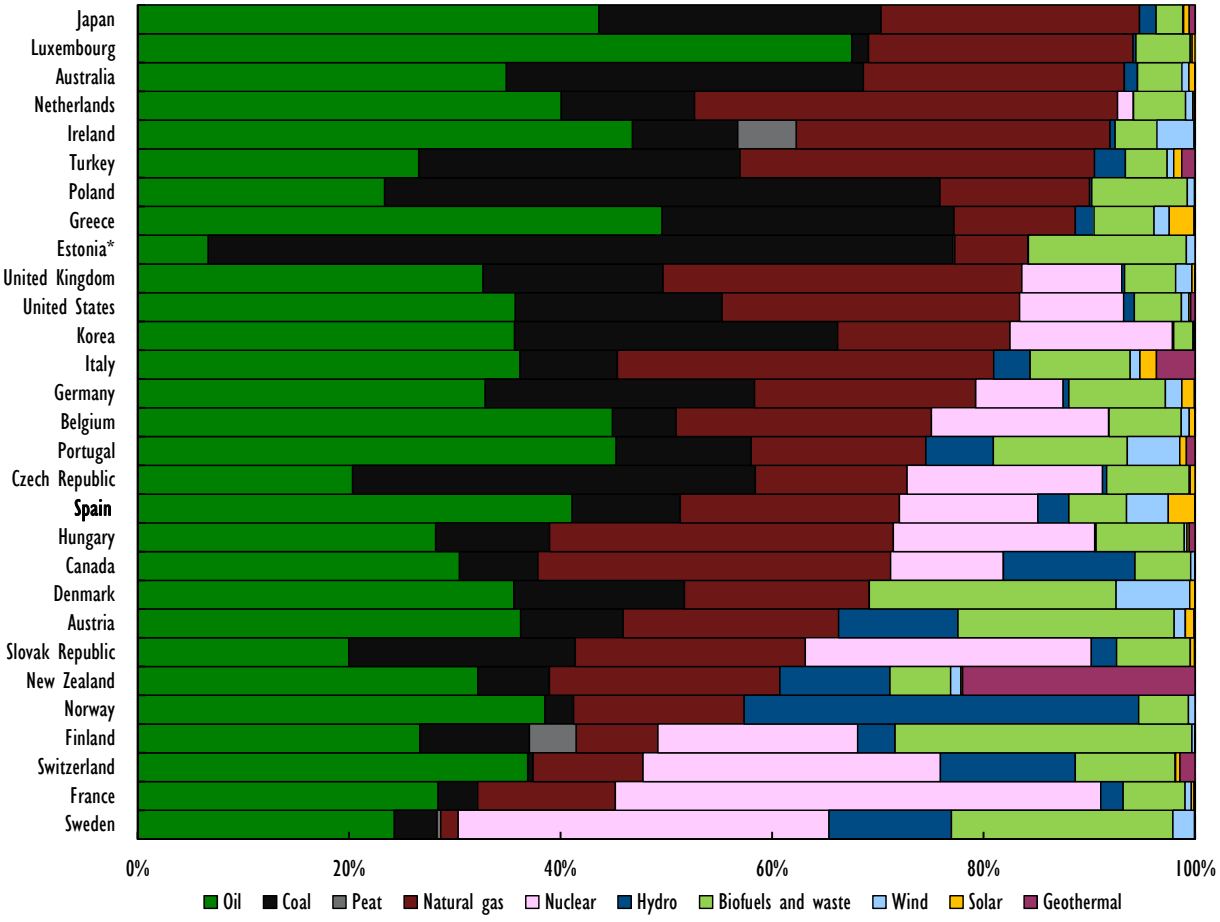
1. TPES is made up of production + imports - exports - international marine bunkers - international aviation bunkers ± stock changes. This equals the total supply of energy that is consumed domestically, either in transformation (for example refining) or in final use.

energy has increased its share in TPES from 7%. The nuclear power share in TPES has increased slightly from 12.1% in 2004.

Spain relies on energy imports as domestic production accounts for around 30% of TPES. The country mainly imports fossil fuels. In 2014, it imported 81.6 Mtoe of crude oil and oil products, and exported 22.2 Mtoe. Net imports of oil and oil products have declined by 23.1% from 2004, as domestic demand for oil has fallen and exports demand is growing. Natural gas imports amounted to 31.6 Mtoe in 2014, of which 7.1 Mtoe was re-exported and net imports were then 24.5 Mtoe. Net imports peaked at 35.2 Mtoe in 2008. Coal imports totalled 9.5 Mtoe and exports 0.8 Mtoe. Coal net imports were 39% lower in 2014 than in 2004.

Spain's fossil fuels share in TPES was twelfth-lowest among International Energy Agency (IEA) member countries in 2014, similar to Hungary's and the Czech Republic's (Figure 2.3). The share of solar in TPES is the highest while wind share is third-highest behind Denmark and Portugal.

Figure 2.3 Breakdown of TPES in IEA member countries, 2014



Note: data are estimated.

* Estonia's coal represents oil shale.

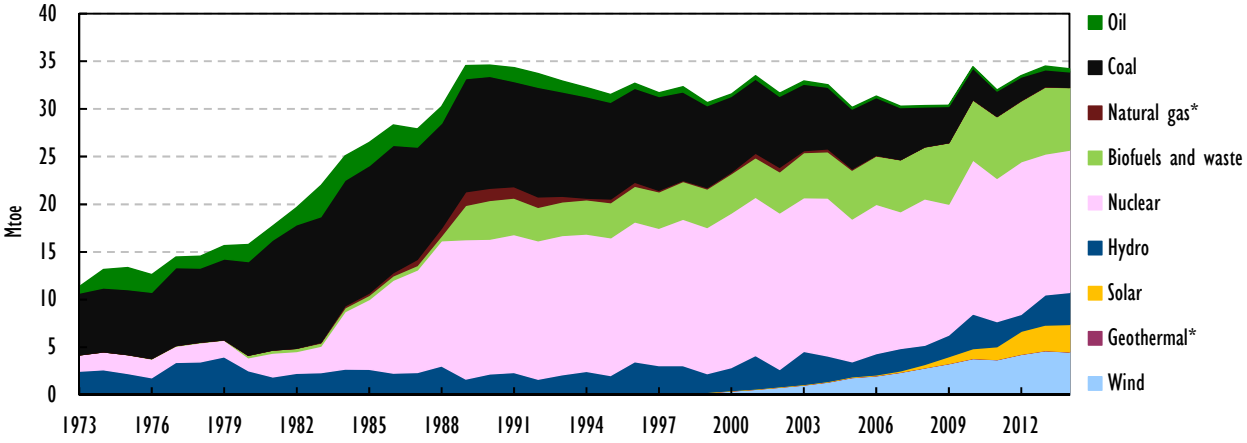
Source: IEA (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

Spain produced 34.2 Mtoe of energy in 2014, half of which comes from renewable sources, making total production volatile year-on-year (Figure 2.4). Production has

averaged 32.2 Mtoe over the ten years to 2014. Total production was 12.6% higher in 2014 than in 2009, because of a surge in solar and wind power over the five years.

Spain's energy production consists principally of nuclear power (43.7%) and renewable energy, including biofuels and waste (19.2%), wind (13.1%), hydro (9.8%), solar (8.4%) and geothermal (0.1%). Fossil fuel production is largely coal (4.7%) with modest production of oil (0.9%) and natural gas (0.1%).

Figure 2.4 Energy production by source, 1973-2014



Note: data are estimated for 2014.

* Negligible.

Source: IEA (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

The ten-year trend in Spain's energy production shows a contraction in fossil fuels and growth in renewables. From 2004 to 2014, coal production declined by 74.9% and natural gas by 93.3%. Oil production grew by 19.6%, but at marginal volumes, as with natural gas.

Renewable energy production increased by 93.8% from 2004 to 2014. This was mainly a result of incentive-induced growth in solar and wind power. Solar power was 49 times higher in 2014 than ten years earlier while wind power was 233% higher. Geothermal and biofuels and waste also increased by 265% and 35.5%, respectively.

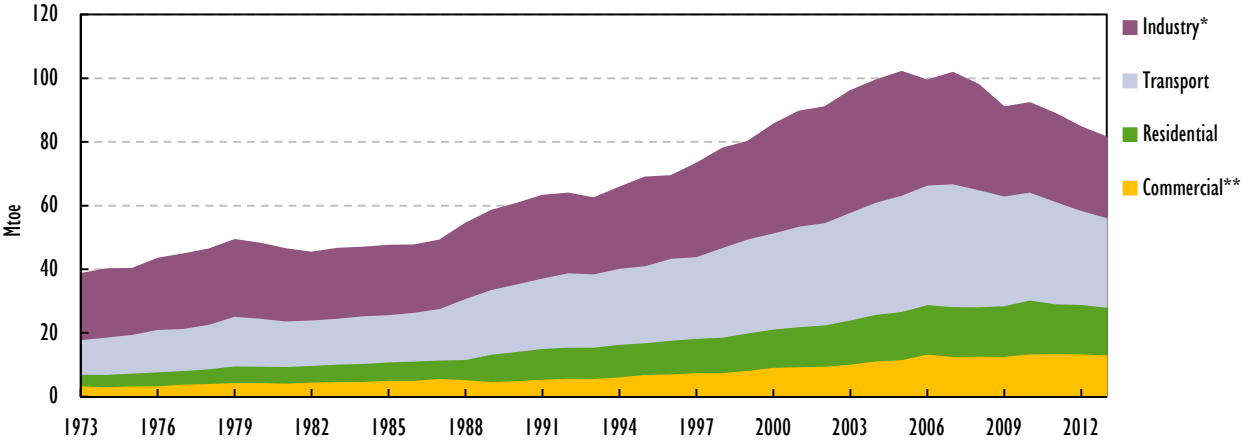
Nuclear power production has been declining from a peak of 16.6 Mtoe in 2001 and was 9.9% lower in 2014 than in 2004. Hydropower is volatile year-on-year depending on weather conditions and water availability.

DEMAND

Spain's total final consumption (TFC)[2] amounted to 81.5 Mtoe in 2013 (the latest year for which data are available). TFC represents around 70% of TPES, with the remainder used in power generation and other energy industries. TFC has declined by 15.2% from 2003 to 2013, peaking at 102.1 Mtoe in 2005 (Figure 2.5). According to the Ministry of Industry, Energy and Tourism, TFC continued to decline in 2014, owing to a weak economy and improved energy efficiency.

2. TFC is the final consumption by end-users, i.e. in the form of electricity, heat, gas, oil products, etc. TFC excludes fuels used in electricity and heat generation and other energy industries (transformations) such as refining.

Figure 2.5 TFC by sector, 1973-2013



* *Industry* includes non-energy use.

** *Commercial* includes commercial and public services, agriculture, fishing and forestry.

Source: IEA (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

Transport and industry are the largest consuming sectors with 34.6% and 30.9% of TFC in 2013, respectively. The residential sector represented 18.4% while the commercial and other services sector (including agriculture) had the smallest share of 16.2%.

Demand in transport and industry contracted over the decade to 2013 while households and the commercial sector consumption grew. The industry sector cut consumption by 34% over the ten years, with its share in TFC falling from 39.7% in 2003. Transport demand was 16.8% lower in 2013, with its share down from 35.4% in 2003. The commercial sector's consumption increased by 28.6% during 2003-13, from a share in TFC of 10.6% in 2003. Demand in the residential sector grew by 8.1% in total, up from 14.2% of TFC in 2003.

In the 2014-2020 National Energy Efficiency Action Plan, the government estimates total final energy consumption in 2020 to be 80.1 Mtoe. From 2014 to 2020, consumption of electricity and renewable energy is estimated to increase and that of oil products to fall.

INSTITUTIONS

Spain's **Ministry of Industry, Energy and Tourism** leads energy policy formulation. Within the ministry, the responsible body is the **State Secretariat for Energy** whose main responsibilities include:

- Issuing regulations concerning energy and mining matters.
- Legislation on the tariff structure, prices of energy products, and levies and tolls.
- Legislation to save energy, promote renewable energy and support new energy and mining technologies.
- Legislation and, if needed, adoption of measures to ensure energy supply.

The ministry is supported by several bodies in the energy sector, including the following:

- The **Institute for Energy Diversification and Saving (IDAE)** does activities to increase public knowledge and awareness, provides technical advice, finances projects of

technology innovation with potential for replication. It led in developing the 2004-2012 *Energy Saving and Efficiency Strategy (E4)* and the several subsequent National Energy Efficiency Action Plans.

- The **Strategic Reserves Corporation (CORES)** is the stockholding agency in charge of maintaining stocks of oil products and monitoring industry obligations to hold stocks of oil products, liquefied petroleum gas and natural gas. CORES also verifies the operators' obligation to diversify their natural gas supplies.
- The **Institute for Restructuring and Alternative Development of the Coal Mining Regions (IRMC)** is responsible for specific actions for the coal mining sector, in accordance with the EU legal framework.

In addition, Spain has the following regulators in the energy sector:

- The **National Commission of Markets and Competition (CNMC)** is an independent organisation that ensures fair competition and regulates markets and all productive sectors of the Spanish economy in order to protect consumers. The CNMC was created in 2013 by merging the functions and powers of the Spanish competition authority and sectoral regulators for electronic communications, audio-visual, electricity and natural gas (previously the National Energy Commission, CNE), postal, airports and railways. The aim was to avoid an overlap of competences, to take advantage of the experience and knowledge acquired in the various regulated sectors and to provide an integrated view of the regulatory activity. The CNMC is the **national regulatory authority (NRA)** for the gas and electricity sectors.
- The CNMC is financed from electricity and natural gas tariffs and a levy on the wholesale of oil. It co-ordinates the work of the competition authorities of the autonomous regions. It is completely autonomous and fully independent from the government, the autonomous regions and the market players.
- In accordance with EU rules on the electricity and natural gas sectors, the CNMC has the power to approve the methodology used for calculating the network access tariffs. The government, in turn, sets the tariffs for network access on the basis of the CNMC methodology. It also approves the CNMC methodology for calculating the charges of the electricity system and sets the level of these charges. System charges are used to cover system costs (including the remuneration for renewable generation).
- The **Nuclear Safety Council (CSN)** is the competent body in matters of nuclear safety and radiation protection. It is directly accountable to the Spanish Parliament, and formally independent from the Administration.

Other relevant ministries and bodies in the energy sector which co-ordinate policies with the Ministry of Industry, Energy and Tourism include:

- The **Ministry of Agriculture, Food and Environment** is responsible for several energy–related policies, such as air pollution and climate change.
- The **Ministry of Economy and Competitiveness** is in charge of Spain's research and development (R&D) policy. It co-ordinates the implementation of the national energy R&D policy with the Ministry of Industry, Energy and Tourism and the Ministry of Public Works and Transport.
- The **Ministry of Public Works and Transport** covers the development of transport infrastructure and is in charge of managing transport demand.

- The **autonomous regions** have legal competences related to energy, primarily in authorising power plants of less than 50 megawatts (MW), that is most renewable energy facilities, and distribution networks of electricity and natural gas. They are also strongly involved in designing and implementing climate change, energy efficiency and renewable energy policies at the regional level.

KEY POLICIES

Spain's energy policy strives to support sustainable development and ensure energy supply that allows for economic growth and competitiveness, while reducing the impact of energy production, transformation and end use on the environment.

Spain's main energy policy goals are derived from the EU directives. For example, EU law sets requirements for electricity and natural gas markets, and for energy efficiency in appliances and buildings. European Union targets for 2020 on GHG reduction, renewable energy and energy efficiency are shaping Spain's energy policy.

Under the target to reduce GHG emissions in the Union by 20% below 1990 levels to 2020, Spain will have to cut emissions from the sectors outside the European Union Emissions Trading Scheme (EU-ETS) by at least 10% below 2005 levels and by 21% in sources within the ETS. Spain is close to meeting the EU target to increase the share of renewable energy in gross final energy consumption from 12.1% in 2005 to 20% in 2020. In addition to this overall target, Spain and other EU member states have a separate binding target for renewable energy to cover 10% of transport fuel demand in 2020. The country will also have to increase energy efficiency to contribute to the EU target of reducing energy demand by 20% below the business-as-usual level by 2020. In October 2014, the Union has also adopted GHG and renewable energy targets for 2030 but these targets have not yet been allocated among the member states.

MARKET REFORM

Spain underwent an electricity market reform from early 2012 to 2015, with the aim of ensuring the sustainability of the system, balancing costs and revenues and protecting electricity consumers. The reform was developed to give predictability and transparency to the Spanish electricity system, to put an end to a burgeoning tariff deficit that had become a financial liability for the government and to bring the electricity system back to financial stability. The natural gas market reform in 2014 did the same for that sector in which the tariff deficit was much smaller than in the electricity system.

Since the last in-depth review in 2009, also the Electricity Directive (Directive 2009/72/EC) was approved. The new Electricity Law approved in December 2013 revised the Spanish legal framework in accordance with the new European regulations and directives (the Third Package), but taking account of the Spanish situation regarding the integration of renewable energy sources and the low level of interconnections with other EU member states.

One of the main changes was the empowerment of the NRA by incorporating new competences and functions with the aim of strengthening its role. In particular, the NRA is entitled *i)* to approve the methodologies to calculate transmission and distribution tariffs, provision of balancing services and access to cross-border infrastructures, *ii)* to impose penalties; and *iii)* to issue binding decisions for the relevant companies. Consumer protection was increased as well by establishing new measures.

SECURITY OF SUPPLY

Spain depends on imports for some 70% of its energy supply, and securing these supplies is crucial for the country. Oil supplies are well diversified by country of origin and Spain holds slightly more oil stocks than required under the IEA obligations. Moreover, the country raised the minimum oil stock requirement from 90 to 92 days in 2010. The regulation also sets stock requirements for LNG (minimum 20 consumption days) and liquefied petroleum gas (LPG).

Spain is now the world's third-largest LNG user, after Japan and the Republic of Korea (hereafter, "South Korea"). It receives gas from more than ten countries and has limited the maximum share of any given country to 50% in the total imports of major importing companies.

Security of electricity supply is closely linked to variations in intermittent renewable power, mainly wind. As Spain has relatively low cross-border capacity, variations in wind power generation have to be dealt with. Spain has successfully focused on developing a well-integrated system to balance these variations. Hydro and natural gas provide backup for wind power. Regarding nuclear power, the government considers all energy sources are needed for a balanced energy mix. As nuclear power helps both to secure energy supply and to limit greenhouse gas emissions, it cannot be disregarded, as long as the power plants are operated in compliance with the safety and security rules imposed by the Nuclear Safety Council.

NATIONAL INFRASTRUCTURE INVESTMENT PLAN

Investments in electricity and natural gas infrastructure are obligatory and follow a national infrastructure investment plan. The plan concerns the regulated section of the electricity and natural gas market, and therefore includes transmission networks, LNG facilities and oil and gas storage facilities.

The plan is prepared by the government in consultation with industry, transmission system operators (TSOs) and regulators, and is based on energy consumption and intensity projections. The plan also supports the government's quantitative goals for energy saving, efficiency and renewable energy. The plan for 2008-16 was definitively suspended in 2012, because the economic crisis had rendered the projections and assumptions outdated. A new Electricity Plan for 2015-20 is in preparation and would include updated projections for the planning period. It will enter into force by the end of 2015.

CLIMATE CHANGE MITIGATION

Under the EU effort-sharing agreement, GHG emissions from the sectors not covered by the EU-ETS must be cut by 10% below the 2005 levels by 2020. Energy use produces the most emissions in these sectors. For the ETS sector in the Union as a whole, the reduction target is 21% below the 2005 levels by 2020. Since 2013, emission allowances are no longer allocated by the national governments, but at the EU level.

Domestic efforts to limit CO_2 emissions have focused on promoting energy efficiency and renewable energy sources through various measures. The current measures are listed in the 2014-2020 National Energy Efficiency Action Plan and the National Renewable Energy Action Plan. Although the country could use international carbon credits to help meet the 2020 non-ETS target, the government aims at meeting the target by domestic measures alone and has prepared a Roadmap 2020 for this purpose in October 2014.

ASSESSMENT

Spain enjoyed an economic boom from the late 1990s to 2008, after which the economy entered a recession until late 2013. In 2014, GDP remained around 5% below its level in 2008, and TPES, TFC and electricity use also remained below their 2008 levels. Spain maintains many of its strengths in the energy sector, notably regarding security of supply but, at the same time, the economic situation has brought new challenges that have called for government action, in particular in the electricity sector.

SECURITY OF SUPPLY

As a positive development, Spain´s dependence on energy imports has decreased from around 80% of its energy supply in 2008 to around 70% in 2014. Securing these supplies remains crucial. Oil supplies are well diversified by country of origin and Spain holds slightly more oil stocks than required under the IEA obligation. Moreover, the minimum stock requirement was raised from 90 to 92 days at the beginning of 2010.

Diversification of natural gas sources through LNG has been particularly successful, with gas being imported from more than ten countries. The maximum share of any given country was also limited to 50% of total imports by the largest importing companies. Obligatory emergency gas stocks stand at 20 days. As gas will continue to have a strong role in the Spanish energy system, the IEA encourages the government to assess Spain's shale gas potential.

Security of electricity supply is based on ample and well-diversified sources for power generation, a large generating capacity and a very reliable power system. Spain has succeeded in integrating a large share of wind and solar power while limiting renewable curtailment and maintaining a high level of security of electricity supply.

As another positive development, the long-awaited new cross-border line between Spain and France was inaugurated in February 2015. More interconnections for electricity and natural gas will be built in the coming years, facilitated by the European Council support in October 2014 and the availability of EU funding for the projects. The IEA welcomes this new momentum and urges the government to strongly pursue the development of electricity and natural gas interconnections with neighbouring countries.

ECONOMIC SUSTAINABILITY

Security of supply benefits from remarkable energy infrastructure, but this has come at a price. Easy access to credit in the boom years led to over-investment in many types of infrastructure, including in the energy sector. Today, Spain has a large excess capacity in power generation and LNG terminals, for example. For several reasons, the financial sustainability of the energy sector, in particular, electricity has become a major issue.

The current government, in office since December 2011, has been forced to adopt broad and necessary economic reforms. In the energy sector, the electricity market reform was a high priority. The immediate focus of this complex and multifaceted reform was to bring the electricity system back to financial stability. The electricity market reform included adopting a large number of laws and rules between early 2012 and mid-2015. The government is to be applauded for being brave enough to tackle the accumulated debt in the electricity system (peaking at around EUR 29 billion in 2013), as previously its growth had gone unchecked.

The electricity market reform seeks to ensure a reasonable return (*rentabilidad razonable*) for all subsidised technologies. The reasonable return is calculated, not for each specific facility, but for a standard installation. That means that a company which is more efficient than the standard would obtain a higher reasonable return than the standard. On the other hand, new installations need to undergo a competitive bidding process to be granted with the specific remuneration. This mechanism is established in order to guarantee that only the most efficient installations will be supported. The rate of return will be revised every six years. Transparency and public consultation have proved important factors in successfully bringing changes to renewable energy remuneration regimes. These principles should also be applied during revision processes.

Electricity prices for end-users increased substantially during the recession, i.e. at the same time as demand decreased. This price increase was the result of previous government policies which are either paid for through taxes on electricity generation or through network access tariffs. High end-user prices are best explained by the increasing costs of government policies, less so by wholesale prices or transmission and distribution costs. An important percentage of the household price of electricity is tax (value-added tax [VAT] and a special tax on electricity consumption) and other costs, such as support for renewable energy generation or compensation for electricity generation costs in the Canary and Balearic islands.

Energy market competition is a topic related to economic sustainability. In the past years, Spain has taken various steps to increase competition in the oil, natural gas and electricity wholesale and retail markets. The IEA encourages the government to continue efforts to increase competition in energy markets.

NEED FOR A LONG-TERM FOCUS

Long-term planning is an essential tool for a successful energy policy. For understandable reasons, the government´s immediate focus since 2011 has been on bringing electricity and natural gas systems back to financial stability. These extensive reforms have now been adopted. In October 2014, the European Union adopted targets to 2030. The government should now prepare an integrated long-term energy strategy, with a particular focus on energy demand and energy efficiency. For its energy scenarios, the government should also collect more disaggregated end-use data.

The government is now preparing new infrastructure planning for 2015-20. The plans for 2008-16 were based on projections for economic growth and related energy consumption that were far too optimistic. As infrastructure planning remains an essential part of Spain's energy policy, it would be useful to thoroughly analyse what could have been done and should be done better. The questions could include how to improve the accuracy of the modelling and the assumptions underlying energy infrastructure planning, and how the planning should be monitored and, if needed, revised.

RESPONDING TO EU-WIDE CHALLENGES

Apart from its domestic energy challenges, Spain shares many challenges with other EU countries. For example, increasing energy costs is an issue across Europe and governments need to find ways of bringing down the cost of decarbonisation and also of stimulating energy savings.

Another major challenge in many EU member states relates to the inherent tension between market liberalisation and decarbonisation. Market liberalisation is for price

signals to provide incentives for investment, while decarbonisation is promoted through market intervention in favour of some low-carbon technologies. A better market design compatible with both remains to be defined. Addressing decarbonisation and reconciling market design with climate policy targets, for example, are issues for the whole of the European Union, and serious work remains to be done to find more sustainable financial solutions.

RECOMMENDATIONS

The government of Spain should:

- ☐ *Continue efforts to increase competition in the energy markets.*
- ☐ *Strongly pursue the development of electricity and natural gas interconnections with neighbouring countries.*
- ☐ *Analyse how to improve the accuracy of the modelling and assumptions underlying energy infrastructure planning.*

Reference

IEA (International Energy Agency) (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

3. CLIMATE CHANGE

Key data (2013)

GHG emissions without LULUCF* (2012): 340.8 $MtCO_2$-eq, +20.1% since 1990

GHG emissions with LULUFC* (2012): 307.3 $MtCO_2$-eq, +18% since 1990

2008-12 target: +15% from 1990

CO_2 emissions from fuel combustion: 239.7 $MtCO_2$, +16.8% since 1990

CO_2 emissions by fuel: oil 56.4%, natural gas 25.1%, coal 18.2%, other 0.3%

CO_2 emissions by sector: transport 34.1%, electricity generation 28.4%, manufacturing and construction 16.6%, other energy industries 7.9%, residential 6.6%, commercial and other services 6.5%

* Source: UNFCCC (2014).

GREENHOUSE GAS EMISSIONS

Spain is a party to the Kyoto Protocol. The related EU Burden-Sharing Agreement (2002/358/EC) limited its greenhouse gas (GHG) emissions to an average of 15% above their 1990 level from 2008 to 2012. Spain's total emissions of the six GHGs have increased strongly since 1990, driven by economic and population growth. Emissions of nitrous oxide (N_2O) have remained fairly stable, whereas other emissions have increased substantially.

According to the United Nations Framework Convention on Climate Change (UNFCCC), the average of 2008-12 total GHG emissions without land use, land use change and forestry (LULUCF) was 358.4 million tonnes of carbon dioxide-equivalent ($MtCO_2$-eq), or 26.3% more than the 283.8 $MtCO_2$-eq in 1990. With LULUCF, the average of 2008-12 GHG emissions was 324.8 $MtCO_2$-eq, or 24.7% more than the 260.4 $MtCO_2$-eq in 1990. To meet its +15% Kyoto obligation, Spain purchases international carbon credits to bridge the gap between its emissions and the target.

ENERGY-RELATED CO_2 EMISSIONS

EMISSION TYPES

According to the UNFCCC, carbon dioxide (CO_2) accounted for 81.2% of total GHG emissions in 2012, followed by methane (CH_4) for 9.5% and by nitrous oxide (N_2O) for 7%. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) collectively accounted for 2.3% of the total.

UNFCCC data show that Spain's energy sector accounted for 77.9% of total GHG emissions, followed by agriculture (11.1%), industrial processes (6.9%) and the waste sector (3.8%).

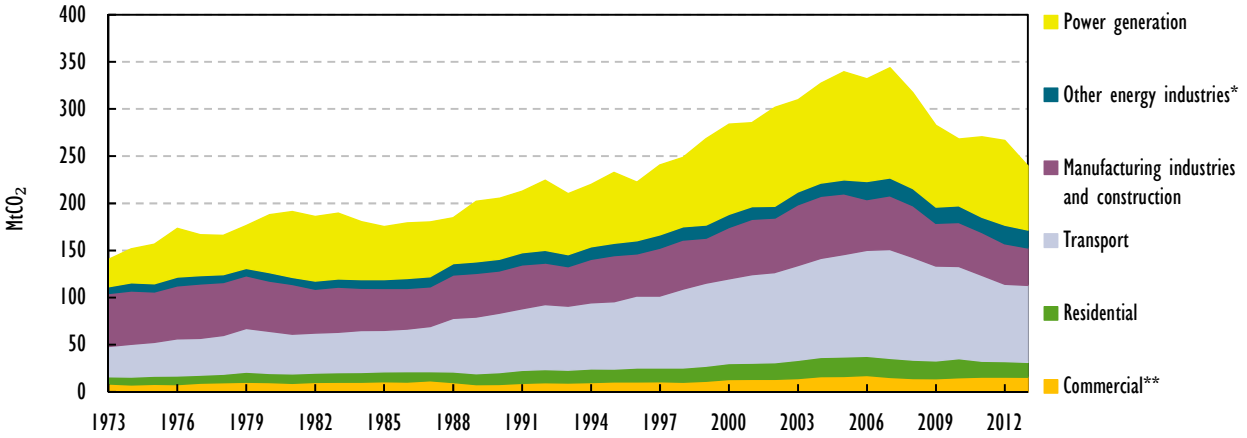
SOURCES OF CO_2 EMISSIONS

Energy-related CO_2 emissions are estimated at 239.7 million tonnes (Mt) in 2013 which is 16.8% higher than in 1990. Emissions peaked at 343.7 Mt in 2007 before declining by a total of 30.3% in the six years to 2013. The decline was driven by a sharp fall in energy demand, brought on by the economic crisis, but also by decarbonisation in the power sector.

The largest CO_2 emitting sectors in Spain are transport (34.1% of the total in 2013) and power generation (28.4%). Industry accounted for 16.6%, followed by other energy industries (including refining) for 7.9%, households for 6.6% and the commercial sector for 6.5%.

From 2007 to 2013, the sharpest fall in emissions came from the power generation sector – a decline of 41.7% in total. Emissions declined also in manufacturing (-30.4%), as well as in transport (-29.3%) and the residential sector (-21.8%). In contrast, emissions grew in other energy industries (by 0.5%) and in the commercial sector (0.7%).

Figure 3.1 CO_2 emissions by sector, 1973-2013

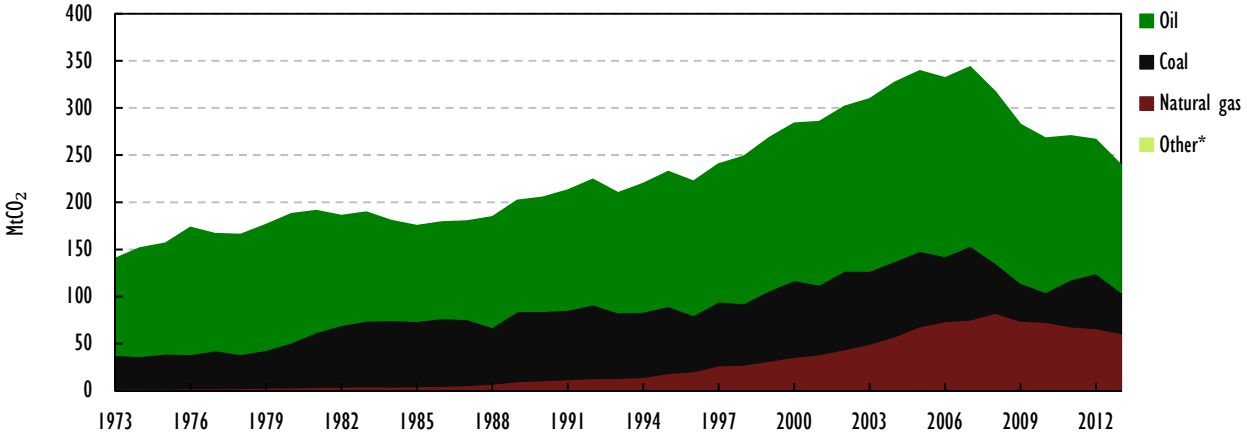


* *Other energy industries* includes other transformations and energy own-use.

** *Commercial* includes commercial and public services, agriculture/forestry and fishing.

Source: IEA (2015, forthcoming), *CO_2 Emissions from Fuel Combustion*, OECD/IEA, Paris.

Figure 3.2 CO_2 emissions by fuel, 1973-2013



* *Other* includes industrial waste and non-renewable municipal waste (negligible).

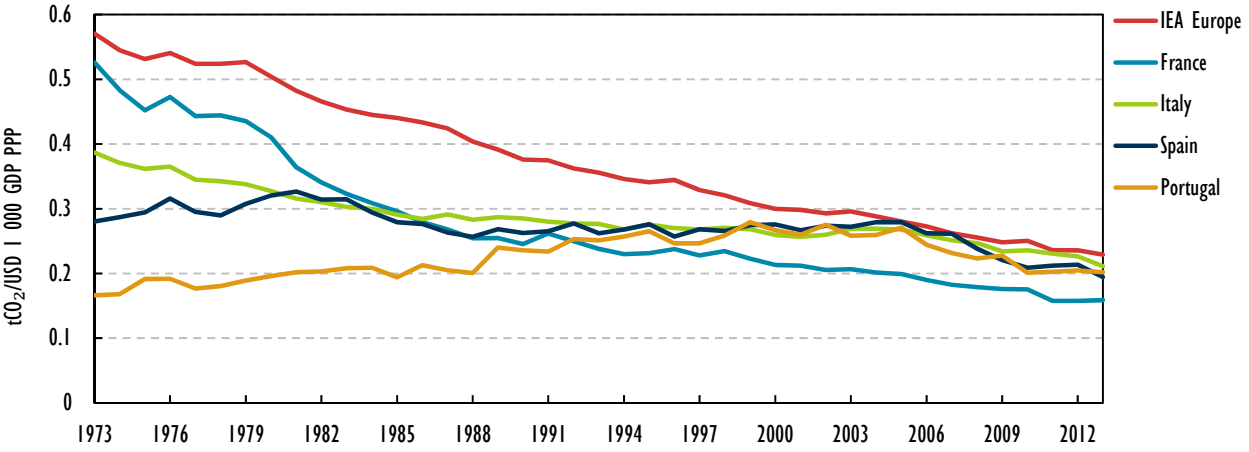
Source: IEA (2015, forthcoming), *CO_2 Emissions from Fuel Combustion*, OECD/IEA, Paris.

Oil and oil products produced 56.4% of energy-related emissions in Spain in 2013, while 25.1% of emissions came from natural gas and 18.2% from coal. Emissions from industrial and non-renewable municipal waste were 0.3% of total energy-related emissions. Compared to 1990, emissions from coal have declined by 40.5%, while emissions from other fuels have increased. Emissions from natural gas increased more than fivefold from 1990 to 2013. Emissions from oil increased by 11.8% over the same period.

CARBON INTENSITY

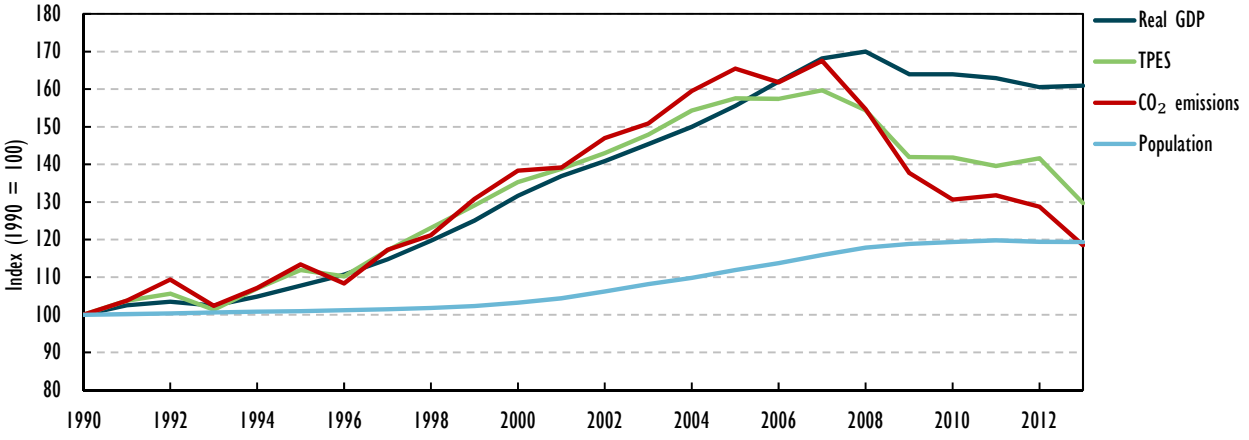
Spain's carbon intensity, measured as CO_2 emissions by real gross domestic product adjusted for purchasing power parity (GDP PPP), amounted to 0.19 tonnes of CO_2 per USD 1 000 PPP (tCO_2/USD 1 000 PPP) in 2013. Spain's carbon intensity is lower than the IEA average of 0.3 tCO_2/USD 1 000 PPP and lower than the IEA Europe average of 0.23 tCO_2/USD 1 000 PPP.

Figure 3.3 Energy-related CO_2 emissions per unit of GDP in Spain and in other selected IEA member countries, 1973-2013



Source: IEA (2015, forthcoming), *CO_2 Emissions from Fuel Combustion*, OECD/IEA, Paris.

Figure 3.4 CO_2 emissions and main drivers in Spain, 1990-2013



Sources: IEA (2015, forthcoming), *CO_2 Emissions from Fuel Combustion*, OECD/IEA, Paris.

Spain's carbon intensity was 25.9% lower in 2013 than in 1990, although in 2007 intensity was the same as in 1990. Much of the decline occurred since 2007 when the country started decoupling GHG emissions from energy supply and from GDP. Spain has reduced emissions intensity particularly by reducing emissions from power generation and industry. In power generation, a major factor has been the strong increase of renewable energy to 39% of the total in 2013, up from 22% in 2003.

INSTITUTIONS

The **Ministry of Agriculture, Food and Environment** is responsible for several energy–related policies, including climate policy. Within the ministry, the **Secretariat of State for Climate Change** is responsible for formulating and co-ordinating climate change policy. Within the Secretariat of State, this work is delegated to the **Spanish Climate Change Office**.

Climate policy, including strategies and road maps, is formulated in co-ordination with a large number of stakeholders. Among government ministries, co-ordination is done by the **Climate Change Interministerial Commission**. It is chaired by the Minister of Agriculture, Food and Environment and it has high-level officials as representatives of most ministries.

Co-ordination between the central government and the regional authorities is the task of the **Co-ordination Commission of Climate Change Policies**. It is chaired by the Secretary of State for Environment and has representatives of all autonomous communities.

The **National Climate Council**, chaired by the Minister of Agriculture, Food and Environment, is tasked with developing, monitoring and evaluating the Spanish climate change strategy. The **Social Dialogue Round Tables** are stakeholder bodies that include representatives of trade unions, industry associations and ministries responsible for environmental, industry and employment policies.

POLICIES AND MEASURES

TARGETS

Spain's GHG targets are derived from the European Union's 2020 targets. As a result of the effort-sharing of the Union's GHG target of -20% from 2005 to 2020, Spain will have to reduce emissions from the sectors outside the Emissions Trading Scheme (ETS) by 10% below their 2005 levels by 2020. For this, it can use international flexibility mechanisms to cover an amount equalling 4% of the non-ETS sector emissions in 2005. The ETS sector in the European Union as a whole will have to cut emissions by 21% from 2005 to 2020. For the first Kyoto commitment period (2008-12), Spain's target was +15% from the base year (1995 for F-gases, 1990 for the other gases).

Beyond 2020, the European Union is pledging a -40% GHG target from 1990 to 2030, as agreed by the European Council in October 2014. From 2005 levels, emissions reductions below 2005 levels would be 43% in the EU-ETS sector and 30% in the non-ETS sector. The level of effort to be made by each member state to achieve this EU target has not yet been decided. Importantly, however, the plan is to meet the target with EU measures alone, without contribution from international credits. This would arguably increase compliance costs from today's levels. By 2050, Spain and other developed countries are aiming to reduce GHG emissions by 80% to 95% below their level in 1990.

EUROPEAN UNION EMISSIONS TRADING SCHEME (EU-ETS)

The EU-ETS is a mandatory cap-and-trade system covering CO_2 emissions from energy-intensive industry. It was launched in 2005 and its first commitment period ran until the end of 2007. The second phase covered the period 2008-12. Installations under the EU-ETS can meet their obligations either by reducing emissions on their own, or by purchasing allowances from other installations covered by the scheme, or by purchasing credits under the Kyoto Protocol's flexible mechanisms (joint implementation or the clean development mechanism).

From 2005 to 2012, emission allowances were allocated to the facilities on the basis of a national allocation plan (NAP). The NAP was prepared by the central government following criteria set out in the ETS Directive (2003/87/EC, later amended by 2009/29/EC) and approved by the European Commission. More than 95% of the allowances in the European Union were allocated to the companies free of charge. Over-allocation of allowances as well as a decline in economic activity led to a large surplus of allowances, a steep decline in their prices and a need to reform the ETS scheme.

The third phase of the EU-ETS will run from 2013 to 2020. It is significantly different from previous phases. National allocation plans are no longer required and a single EU-wide ETS cap is introduced. The cap is reduced by 1.74% per year from 2010 onwards, resulting in a total reduction of 21% by 2020 below the 2005 levels. More than 40% of allowances will be auctioned and electricity generation will no longer receive free allowances. For the sectors where allowances will still be given away for free, such as manufacturing industry and heat sectors, harmonised allocation rules apply, based on EU-wide benchmarks of emissions performance. A separate cap applies to the aviation sector. From 2021 to 2030, the number of allowances will be reduced by 2.2% per year, and a market stability reserve of allowances is expected to be introduced from 2019.

In Spain, the ETS sector comprises around 1 100 facilities and accounts for 40% to 45% of national GHG emissions. Comparison of the volume of allowances allocated and the actual emissions from 2005 to 2012 implies that the ETS has had little impact on the sector's emissions. In the 2005-07 commitment period, the ETS sector was allocated an annual average of 182 Mt of allowances, while the actual emissions were 185 Mt. In the 2008-12 commitment period, the average allocation was 152 Mt per year, while the actual emissions were only 138 Mt per year.

By subsector, power generation has constantly received fewer allowances than it has needed (i.e. it has actually had to take action under the ETS), while manufacturing industry (coke ovens, iron and steel, cement, glass, lime, ceramics, and pulp and paper) has been grossly over-allocated, even before the collapse of the demand for construction materials during the years of economic crisis. Spain's case is by no means an exception. Over-allocation from the first and second commitment periods has been a persistent problem with the ETS. The reform of the system at the EU level is under way.

In the 2013-20 phase, Spain will gain revenue from auctioning allowances. These revenues were determined by law for the 2013 and 2014 state budgets. Currently, it provides for 90% of revenues (up to EUR 450 million) to be used for supporting the cost of electricity generation from renewable sources, with the remaining 10% (up to EUR 50 million) for other measures to address climate change (OECD, 2015).

DOMESTIC MEASURES OUTSIDE THE EU-ETS

Spain´s current measures to reduce energy-related CO_2 emissions focus on energy efficiency and renewable energy. They are detailed in Chapters 4 and 9. Examples of new

programmes implemented since 2012 include the Climate Project Programme (FES CO_2), in which the government acquires verified CO_2-equivalent emissions reductions from projects in Spain. Another example is the carbon footprinting programme that will allow companies and organisations to voluntarily offset their emissions.

A specific measure in the transport sector is the vehicle registration tax which is based on CO_2 emissions since 2008. Current rates range from 4.75% for vehicles emitting between 121 grammes (g) and 159 gCO_2/km to 14.75% for vehicles emitting 200 gCO_2/km and more. The tax has helped reduce the CO_2 intensity in the majority of new cars to less than 120 g/km. However, the annual vehicle circulation fee remains based on engine capacity.

The current policies and measures are, however, not enough to meet the -10% target from 2005 to 2020 in the non-ETS sector. This is evident from the scenarios laid out in the Roadmap 2020 (*Hoja de ruta de los sectores difusos a 2020*), adopted in October 2014.

From 2013 to 2020, Spain and other member states will have to follow an annual emission allocation set out in Decision 2013/634/EU. Spain's allocated GHG emissions from the non-ETS sectors were 221 MtCO_2-eq in 2013 to be reduced to 209 MtCO_2-eq in 2020 in a linear manner, as set out in the Effort-Sharing Decision (406/2009/EC). The Roadmap projects that under current policies and measures, emissions in the non-ETS sectors would grow from 216 MtCO_2-eq in 2013 to 228 MtCO_2-eq in 2020. This would lead to cumulative excess emissions of 54.5 MtCO_2-eq. To avoid that outcome, the Roadmap presents 43 additional measures across all sectors that should be sufficient for full compliance with the emission allocation to 2020. The Roadmap considers domestic measures alone, but Spain will also have the option of using international carbon credits to cover 4% of the non-ETS sector emissions in 2005, or 40% of the 2020 target.

Transport accounts for around 40% of GHG emissions in the non-ETS sector and is the natural focus area of Roadmap 2020. Buildings and industry account for around 11% each. In agriculture and the waste sector, emissions are typically unrelated to energy use.

In the transport sector, the measures focus on modal shift, fleet renewal and more efficient ways of driving. In the buildings sector, renovations of dwellings are expected to account for 66% of all emission cuts. In industry, the focus is on energy efficiency and fuel switching. The new measures analysed in Roadmap 2020 build on the current ones. These are detailed in Chapters 4 and 9 of this report.

Roadmap 2020 optimises the mix of measures on the basis of marginal abatement cost, rate of return, investments and cost savings per tCO_2 and employment per tCO_2. Most of the measures would have a positive net economic impact, while renovations of buildings would create the most employment, around 700 000 man-years. Renovation of buildings would also require the most investment, in total almost EUR 16 billion from 2013 to 2020. The transport sector would require EUR 8.6 billion and industry EUR 1.9 billion over the same period.

In total, the Roadmap requires investments of EUR 27 billion to 2020, but foresees these measures will generate savings of EUR 21 billion to 2020 and EUR 62 billion to 2030. Implementing the Roadmap would save 41 terawatt hours (TWh) (3.5 Mtoe) of energy in 2020 and generate additional demand for 17 TWh (1.4 Mtoe) of renewable energy in 2020. The measures are also projected to avoid emitting 122 MtCO_2 from 2020 to 2030, which will help Spain meet its future GHG targets. Importantly, however, the Roadmap does not consider what kind of incentives would be needed to trigger the required investments and in what proportion they would be divided between the public and private sectors.

INTERNATIONAL MEASURES

Spain experienced a significant gap between emissions reductions from domestic measures and the required total reductions for the first Kyoto commitment period (2008-12). The government therefore decided to use the Kyoto flexible mechanisms (emission allowance trading/clean development mechanism/joint implementation) for bridging the gap. Under its 2008-12 compliance path, Spain needed to limit average annual emissions to +37% from the base-year levels and may cover up to 20% of base-year emissions with international carbon credits.

The government has signed bilateral agreements with host countries (particularly in Latin America), is participating in bilateral projects and in buying emission credits. Also, it is participating in the following multilateral funds with more than EUR 400 million:

- World Bank (more than EUR 275 million): Spanish Carbon Fund; Community Development Carbon Fund; Bio-Carbon Fund; Carbon Partnership Facility.
- Corporación Andina de Fomento (EUR 47 million): Ibero-American Carbon Initiative (IIC).
- European Bank for Reconstruction and Development/European Investment Bank (EUR 80 million): Multilateral Credit Carbon Fund; Green Fund.
- Asian Development Bank (EUR 23 million): Asia-Pacific Carbon Fund.

Spain will continue to use international mechanisms to meet its 2020 target. Beyond 2020, however, international mechanisms will no longer be used in the Union.

ASSESSMENT

Spain met its Kyoto target for 2008-12 with a combination of domestic measures and international carbon credits. For 2020, Spain will have to cut emissions from the sectors outside the EU-ETS by at least 10% below 2005 levels, while the EU-wide cap for ETS sector is -21% from 2005.

The road to 2020 seems clear. The ETS sector – the source of around 40% of Spain's GHG emissions – will by definition take care of itself. For the non-ETS sector, Roadmap 2020 was adopted in October 2014. As current measures are deemed insufficient to meet the sector's 2020 target, the Roadmap includes additional domestic measures for transport, buildings, less energy-intensive parts of the manufacturing sector, agriculture, the waste sector and the use of F-gases. As in the period 2008-12, Spain also has the option of using international credits to meet the target.

In the non-ETS sector, Spain should pursue ambitious emissions reductions, as the economy is returning to growth. Furthermore, ambitious policies on energy efficiency typically bring benefits beyond emissions reductions: they save money, reduce import dependence and improve air quality.

To implement the Roadmap, incentives are now needed. Currently, a mixture of subsidies, taxes and regulations is used to mitigate emissions in the ETS and non-ETS sectors. The government should ensure full co-ordination between these schemes in order to ensure that it is achieving emissions abatement at least cost and re-allocate funding accordingly.

The government should consider reforming fuel taxation, given the large share of transport in total emissions. The tax reform could be carried out in a revenue-neutral manner. In particular, the government should narrow the tax gap between diesel and petrol. The tax on

diesel used in transport should be increased to at least the same level as that for petrol in EUR/CO_2 terms to take into account diesel's higher carbon content and its significant contribution to local air pollution, particularly from older vehicles. The government should also reform the vehicle circulation tax and base it on emissions rather than engine size.

Reforming taxes on fuel used in the non-ETS sector should also include tackling the several partial or total tax exemptions in the sector. These exemptions lower end-use prices, reduce incentives to use energy efficiently, and result in revenue losses. For example, several categories of users in agriculture, mining, aviation, navigation and railway transport are exempted from fuel tax.

Beyond 2020, Spain and the other EU member states decided in October 2014 on a -40% target for the European Union from 1990 to 2030. The level of effort to be made by each member state to achieve the non-ETS part of the target has not yet been decided. At this stage, the target should be met with EU measures alone. Spain should base any decisions on domestic burden-sharing on detailed analysis and prioritise cost-effectiveness and technical feasibility. The Roadmap 2020 provides a sound basis for this post-2020 work.

RECOMMENDATIONS

The government of Spain should:

- ☐ *Develop incentives for triggering the implementation of the policies and measures in the Roadmap 2020; and make cost-effectiveness a key criterion for prioritising these incentives.*
- ☐ *Consider introducing a revenue-neutral tax reform as a main measure to encourage energy saving and GHG reductions under the Roadmap 2020.*

References

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4. ENERGY EFFICIENCY

Key data (2014 estimated)

Energy supply per capita: 2.5 toe (IEA average: 4.4 toe), -24.4% since 2004

Energy intensity: 0.09 toe/USD 1 000 PPP (IEA average: 0.13 toe/USD 1 000 PPP), -23.1% since 2004

TFC (2013): 81.5 Mtoe (oil 49.0%, electricity 24.5%, natural gas 18.7%, biofuels and waste 6.2%, coal 1.3%, solar 0.3%), -15.2% since 2003

Consumption by sector (2013): transport (34.6%), industry (30.9%), residential (18.4%), commercial and other services (16.2%)

FINAL ENERGY USE

FINAL CONSUMPTION BY SECTOR

Spain's total final consumption (TFC) was 81.5 million tonnes of oil-equivalent (Mtoe) in 2013. Energy demand fell by 20.2% from a peak of 102.1 Mtoe in 2005 to 2013. The decline was driven by the economic crisis and plunging energy consumption in industry and transport. Prior to 2005, demand grew steadily for nearly two decades. The government expects energy demand to stay rather stable for the rest of the decade and amount to 80.1 Mtoe in 2020, as indicated in the 2014-2020 National Energy Efficiency Action Plan.

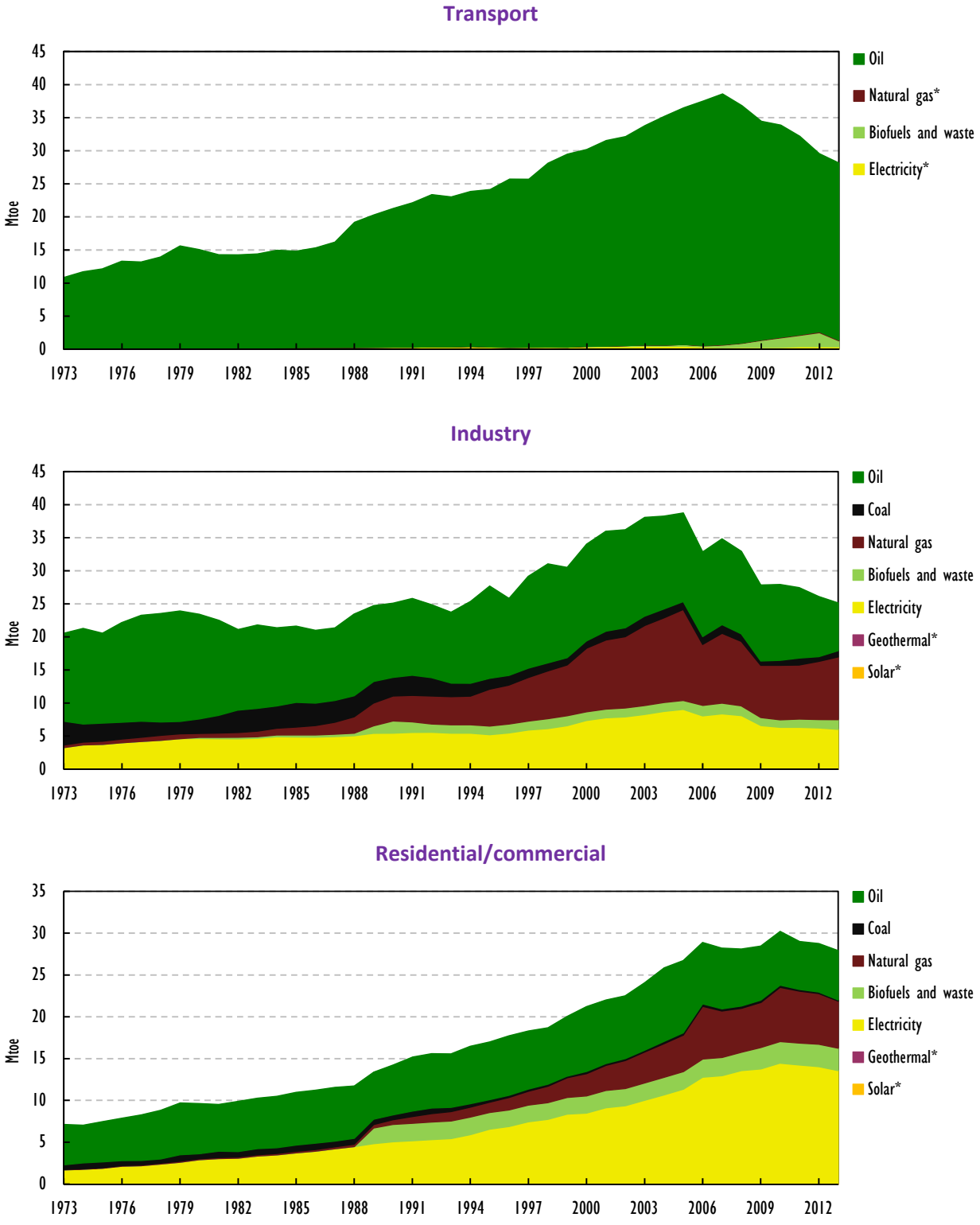
Transport is the largest consuming sector in Spain, with final consumption of 28.1 Mtoe in 2013 or 34.6% of TFC. Demand from the transport sector peaked at 38.6 Mtoe in 2007 before falling by 27.1% in the following six years. Transport's share of TFC also fell from 37.9% in 2007. Spain has the fifth-largest share of transport in TFC among International Energy Agency (IEA) member countries.

Industry represents 30.9% of TFC or 25.1 Mtoe in 2013. It was the largest consuming sector up to 2005, when it peaked at 38.8 Mtoe (38.0% of TFC). From 2005 to 2013, industry consumption contracted by 35.1% which led to a significant fall in the sector's share of TFC. With the current industry share of 30.9%, Spain ranks 17th-highest among IEA member countries.

Despite the economic crisis, energy consumption increased in the **commercial sector,** including public services and agriculture. Demand from this sector grew by 12.7% from 2005 to 2013, with the share of TFC increasing from 11.4% to 16.2% (IEA median).

Residential consumption declined by a marginal 0.8% over the same period, which is significantly lower than the decline in TFC. This led to an increase of this sector in the share of TFC from 14.8% in 2005 to 18.3% in 2013, ranking Spain as tenth-lowest in the IEA member countries.

Figure 4.1 TFC by sector and by source, 1973-2013



* Negligible.

Source: IEA (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

Oil is the main fuel in the transport sector although the use of biofuels and waste has surged over the past decade. Biofuels and waste accounted for 3.2% of energy consumed by transport in 2013, up from 0.4% in 2002 albeit falling from 7.2% in 2012. Oil represented 95.1% in 2013 while electricity and natural gas together accounted for 1.7%.

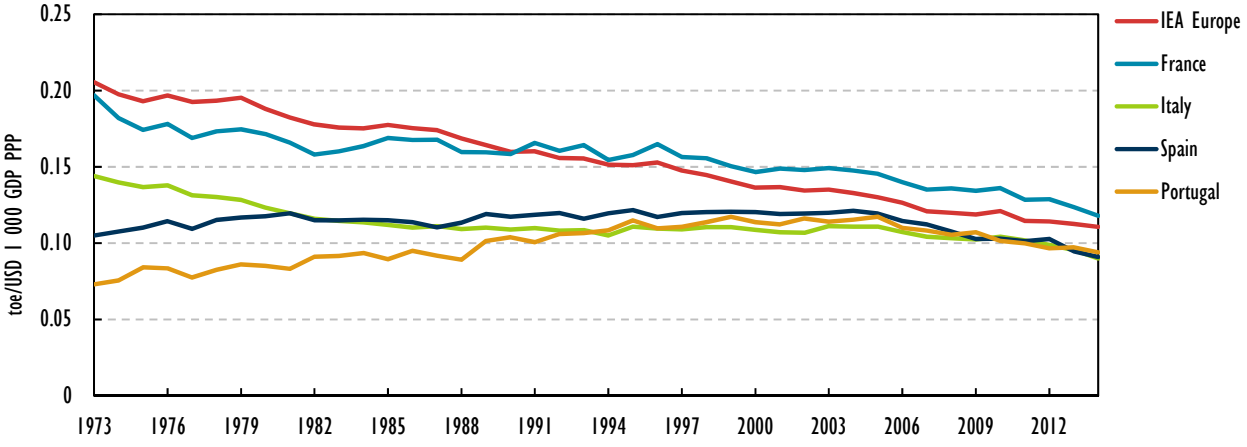
Industry relies on natural gas, oil and electricity for most of its energy needs. Natural gas accounted for 37.8% of industry demand in 2013, oil for 28.7% and electricity for 23.9%. The remainder was sourced from biofuels and waste, and coal. Over the past decade, industry demand moved away from oil towards gas. The share of oil in TFC fell from 39.2% in 2003, while the share of gas increased from 31.8%.

The residential and commercial sectors together consume mostly electricity (48.1% of total sectoral demand in 2013), followed by oil (21%) and gas (20%). Over the past decade, demand has shifted from oil towards electricity and gas. Biofuels and waste accounted for 9.5% of TFC in 2013, slightly higher than in 2003.

ENERGY INTENSITY

Energy intensity, measured as the ratio of total primary energy supply (TPES) per unit of real gross domestic product adjusted for purchasing power parity (GDP PPP) was 0.09 tonnes of oil-equivalent per USD 1 000 PPP (toe/USD 1 000) in 2014. The ratio is lower than both the IEA average of 0.13 toe/USD 1 000 PPP and the IEA Europe average of 0.11 toe/USD 1 000 PPP. Spain's energy intensity is ranked fourth-lowest among IEA member countries, after Ireland, Switzerland and the United Kingdom. Spain's energy intensity in 2014 was 23.1% lower than ten years earlier, while the average IEA intensity declined by 17.8% over the same period.

Figure 4.2 Energy intensity in Spain and in other selected IEA member countries, 1973-2014

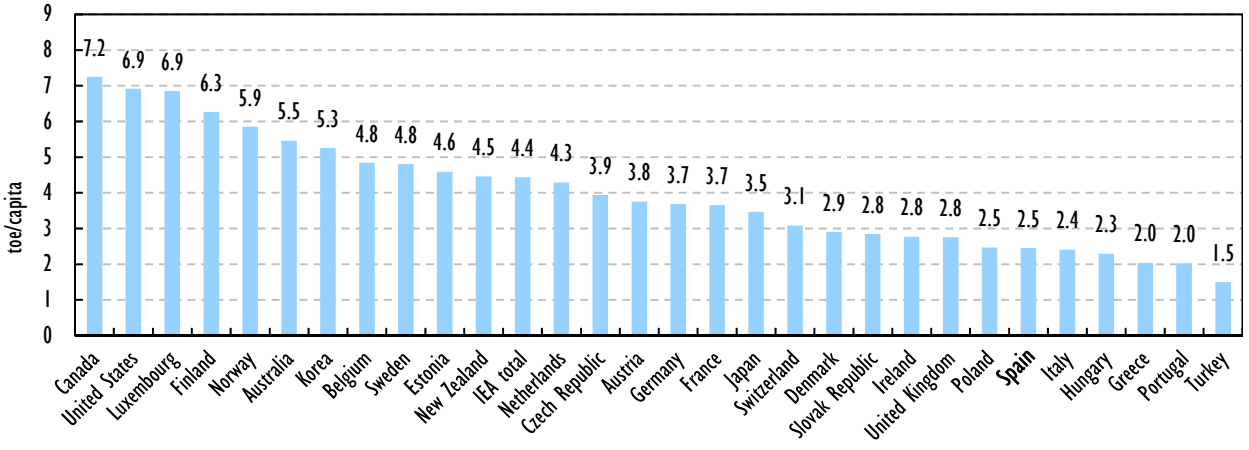


Note: data are estimated for 2014.

Source: IEA (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

A further common indicator for international comparisons is energy consumption per capita (see Figure 4.3). Spain's rate of 2.5 tonnes of oil-equivalent (toe) per capita per year is sixth-lowest among IEA member countries.

Figure 4.3 TPES per capita in IEA member countries, 2014



Note: data are estimated.

Source: IEA (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

INSTITUTIONS

The **Ministry of Industry, Energy and Tourism** (**Minetur**) is responsible for drafting and implementing government policy on energy, specifically through the State Secretariat for Energy, which also has the mandate to propose policies and measures for energy saving and efficiency.

The key government body for implementing energy efficiency policies is **the Institute for Diversification and Saving of Energy (IDAE)**. It is attached to the ministry, formally as a public business body. IDAE manages energy efficiency programmes and projects to help Spain meet its 2020 energy efficiency target (see below). The programmes often involve grants and subsidies and are funded from the central government budget, from the recently established **National Energy Efficiency** Fund and from the **European Union (EU) Regional Development Fund**. IDAE also collects data on energy efficiency developments in Spain.

As energy efficiency policies and measures are often implemented at the regional and municipal levels, Minetur and IDAE typically develop these policies and measures in co-ordination with the autonomous communities. For example, the regional governments are responsible for enforcement of the regulations on energy labelling and energy efficiency standards of appliances.

POLICIES AND MEASURES

Spain's various policies and measures to improve energy efficiency and save energy originate from both the European Union and national governments. European Union regulations are directly applicable in all member states, while EU directives leave the member states room to decide how to implement them.

EU DIRECTIVES AND REGULATIONS

Spain's energy efficiency policies are aligned with several EU regulations and directives. Since 2006, European policies have been designed to help reach indicative (non-binding) EU targets for energy efficiency for 2016 and for 2020. The 2016 target is to reduce final energy

use in the sectors outside the EU-ETS by 9% from the early 2000s. The 2020 target, agreed upon in 2007, is to reduce primary energy use in the Union by 20% from baseline projections.

The 2016 target was embedded in the Directive on Energy End-Use Efficiency and Energy Services (2006/32/EC). The directive encourages energy efficiency through the development of a market for energy services and the delivery of energy efficiency programmes and measures to end-users. It requires member states to create national energy efficiency action plans for meeting the target. The directive also sets the framework for measures such as financing, metering, billing, promotion of energy services, and obligations for the public sector. In addition, it requires member states to oblige energy distributors or retailers to offer either competitively priced energy services, audits or other measures to improve energy efficiency.

The Energy Efficiency Directive 2012/27/EC (EED) was developed and adopted out of concern that the European Union was unlikely to reach the 20% energy efficiency target for 2020. The EED replaces the previous directive (2006/32/EC) and strengthens many of its elements. The EED comprises a series of binding measures and requires each member state to:

- Set an indicative national energy savings target for the period 1 January 2014 to 31 December 2020 in line with the EU-wide 20% by 2020 target.
- Oblige energy providers to achieve cumulative end-use energy savings by 2020 equivalent to 1.5% of annual energy sales over the seven years from 2014 to 2020. Member states may pursue alternative ways to achieve equivalent energy savings.
- Carry out a comprehensive assessment of national heating and cooling systems to identify and implement the cost-effective potential for deploying highly efficient co-generation, efficient district heating and cooling, and other efficient heating and cooling solutions by the end of 2015.
- Assess the energy efficiency potential of its gas and electricity infrastructure in particular regarding transmission, distribution, load management and interoperability, and identify measures and investments for the introduction of cost-effective energy-efficient improvements in the network infrastructure by 30 June 2015.
- Ensure that the metering and billing of actual energy consumption in all sectors occur at a frequency that enables end-users to take informed decisions about their energy consumption; and that meters are installed for all energy sources at end-users' premises, if technically possible and economically feasible.
- Develop public procurement rules ensuring that central governments purchase only high-efficiency products.
- Facilitate the development of national financing facilities for energy efficiency measures.

In addition to the horizontal EED, several sectoral EU regulations and directives to increase energy efficiency are in force.

The Directive on the Energy Performance of Buildings (EPBD, 2002/91/EC, recast as 2010/31/EU) sets requirements for energy efficiency in building codes, including minimum energy performance requirements and energy certificates. The 2010 recast requires all new public buildings to be at least "near-zero energy" by the end of 2020, and all new buildings to reach this target by the end of 2020.

The recast Directive Establishing a Framework for Setting Ecodesign Requirements for Energy-related Products (Ecodesign, 2009/125/EC) aims to improve energy efficiency

throughout a product's life cycle. It applies to products that use energy and to products that have an impact on energy use, such as building components. Product-specific standards are set by EU regulations based on the directive.

Requirements for energy labelling of household appliances are based on several directives adopted since 1992. The recast of the Energy Labelling Directive (2010/30/EU) expands the mandatory labelling requirement to cover commercial and industrial appliances and also energy-related appliances; product-specific labelling standards are set up under this directive.

Current EU transport policies aim to reduce CO_2 emissions from new passenger cars, which in practice will lead to efficiency improvements in the car fleet. Under Regulation 443/2009, car manufacturers and importers are obliged to limit CO_2 emissions from new passenger cars to a weight-based fleet-wide average of 130 grammes of CO_2 per kilometre (gCO_2/km) by 2015 and to 95 gCO_2/km by 2020. In terms of fuel consumption, the 2015 target roughly corresponds to 5.6 litres per 100 km (L/100 km) of petrol or 4.9 L/100 km of diesel. The 2020 target equates to around 4.1 L/100 km of petrol or 3.6 L/100 km of diesel. A similar regulation for new vans was introduced in 2011 (Regulation 510/2011), with a limit of 175 gCO_2/km by 2017 and 147 gCO_2/km by 2020.

NATIONAL POLICIES AND MEASURES

Policies and measures for meeting the 2020 target are listed in the 2014-2020 National Energy Efficiency Action Plan (NEEAP). It was preceded by the NEEAP for 2011-2020. Major policies and measures are outlined in the sectoral sections below.

The 2020 target

Spain is set to meet the 2016 target for 9% final energy savings. In 2013, it had already reached savings of 10.1% and the government expects an increase to 15.5% in 2016.

The EED obliges all energy distributors or energy retail sales companies to save 1.5% of their energy sales to final customers in a cumulative manner over the seven-year period from 2014 to 2020 (i.e. 1.5% in 2014, 3.0% in 2015, 10.5% in 2020). The savings are counted from the average of the years 2010-12.

For 2014-20, Spain's total savings target is 15 979 thousand tonnes of oil-equivalent (ktoe). The 2014-2020 NEEAP includes a distribution of this target by sector. Measures in industry are to deliver 54.6% of the savings, in transport 25.3%, in buildings and equipment 15.3%. The remaining 4.8% of savings should be from measures in the public sector, agriculture and fishing, and through communication measures. The NEEAP foresees final energy consumption in Spain to amount to 80.1 Mtoe in 2020, practically unchanged from 2013.

This target is planned to be met through the use of three mechanisms: an energy efficiency obligation system (to meet 40% of the total volume target in 2020), projects financed from EU and other funds (31%), and alternative measures according to Article 7(9) of the Energy Efficiency Directive (29%). The three mechanisms are explained in more detail below.

Energy efficiency obligation scheme

Under the EED, distributors of gas and electricity and retailers of transport fuels are obliged to reduce their sales by 1.5% per year from 2014 to 2020. For this purpose, the EU member states must set up an energy efficiency obligation system. In Spain, the obliged companies can either implement energy efficiency projects themselves or pay to the National Energy

Efficiency Fund which will finance energy efficiency projects. The obligation scheme and the National Energy Efficiency Fund were introduced under Law 18/2014 of 15 October.

Minetur sets the savings obligation annually for each of the obligated parties. For 2015, the total savings obligation is 262 ktoe (3 047 gigawatt hours [GWh]). The largest obligations were set for Repsol, Endesa, Gas Natural Fenosa and Iberdrola. In practice, this savings obligation is converted into a financial contribution to the National Energy Efficiency Fund at the rate of EUR 789 728 per ktoe, or EUR 207 million in total for 2015. The Fund will finance a broad scope of projects with the general aim of saving energy.

EU-funded projects

The European Union's structural and investment funds offer financing for projects that help meet the EU 2020 goals for smart, sustainable and inclusive growth. This includes a broad range of low-carbon projects. The funds include the Regional Development Fund, the European Social Fund, the European Agricultural Fund for Rural Development and the European Maritime & Fisheries Fund. The European Commission and the national authorities must, however, agree on programmes setting out the priorities for each country, region or policy area concerned, before any financing can be considered. This work is yet to be completed in Spain.

Alternative measures

The current alternative measures listed in Table 4.1 are estimated to deliver energy savings of 3 634 ktoe from 2014 to 2020 (Ministry of Industry, Energy and Tourism, 2015).

Table 4.1 Alternative measures for meeting the obligation to 2020 under the EED, Art 7

Measure	Accumulated final energy savings 2014-20, ktoe
Law 15/2012 on fiscal measures for energy sustainability	**1 935**
Programmes implemented by IDAE	
Efficient Vehicle Incentives Programmes (PIVE, calls 3-6)	807
Electric Mobility Project (MOVELE)	4
Aid Programme for the Energy Renovation of Existing Buildings in the Residential Sector (PAREER Programme)	14
JESSICA-F.I.D.A.E Fund (Energy Saving and Diversification Investment Fund)	130
Communication campaigns	26
Other programmes	
Plan to improve environmental performance in the hotel sector (PIMA SOL)	6
Efficient Vehicle Programme (PIMA Aire)	48
Efficient Driving Programme in New Drivers' Driving Licence	82
Programmes implemented by the autonomous communities	**583**
Total	**3 634**

Source: Ministry of Industry, Energy and Tourism (2015), *Informe Anual 2015 de Seguimiento de los Avances hacia los objetivos nacionales de eficiencia energética para 2020*, Madrid.

Law 15/2012 introduces a 7% tax on electricity generation (22% for hydropower), a tax on nuclear fuel, taxes on coal and oil use for power generation, and a tax on natural gas use.

The JESSICA-F.I.D.A.E Fund (Energy Saving and Diversification Investment Fund) is budgeted with nearly EUR 123 million for financing urban sustainable development projects to improve energy efficiency, use renewable energy and projects to be developed by energy service companies (ESCOs) or other private enterprises.

The measures on transport and buildings are explained in more detail in the respective subsections below.

ESCOs

Since the approval of the 2008–2012 Energy Saving and Efficiency Action Plan, all lines of support for energy efficiency have included ESCOs as a potential beneficiary. In March 2014, 968 companies were registered as energy service providers. They are essentially engineering and installation and assembly companies, and their number has grown continuously this decade. Some of them are associated with buildings heating system maintenance companies (this activity is regulated through the Regulation on Building Heating Installations (RITE), as well as with subsidiaries of building companies and electricity suppliers.

ESCOs have found a market in public sector projects. The government has stimulated such projects, while in the private sector ESCOs have not been often used. In the area of public procurement, ESCOs are heavily involved in the management of municipal lighting systems in towns and cities of more than 50 000 inhabitants.

Under Law 2/2011 on Sustainable Economy, public administrations are obliged to adopt a plan for optimising the energy consumption of their offices and facilities through energy service agreements which help to reduce energy consumption. This reduction remunerates the procuring company in the form of lower energy bills and ultimately helps reach budgetary sustainability in public finances.

More recently, Law 8/2013 on urban renovation, regeneration and renovation proposes the participation of ESCOs in building energy renovation incentive programmes, taking on financing commitments from the operations through savings that are amortised over time, for the implementation of energy saving and efficiency measures. The government also sees a role for ESCOs in helping carry out projects under the energy efficiency obligation scheme.

BUILDINGS

Spain had around 10 million occupied buildings in 2012, out of which 9.6 million were used by households and 0.4 million by the service sector. Households accounted for around 60% of all final energy use in buildings and the service sector for around 40%.

Three legal instruments set the framework for energy efficiency in buildings. They are the Technical Building Code (TBC), the Regulation on Thermal Building Regulations (TBR) and Royal Decree 235/2013 on the Energy Certification of Buildings. The Energy Performance of Buildings Directive (EPBD 2010/31/EU) was transposed into Spanish law in 2013 through revisions to these legal instruments.

The EPBD requires all member states to follow a similar framework for setting building energy code requirements based on the integrated performance of the whole building and all energy uses. These minimum energy requirements for new buildings are described in the TBC and they vary across the country by climate zone. The TBC includes requirements for

energy efficiency and the use of renewable energy, such as maximum U-values[1] for building components; minimum efficiency performance standards for thermal installations and lighting; contribution of minimum natural lighting; as well as a minimum level of solar contribution to power and domestic hot water supply.

The EPBD also requires member states to introduce mandatory energy performance certificates (EPCs) that provide clear information on buildings' energy performance to prospective tenants and buyers. EPCs must include reference values that allow consumers to compare and assess energy performance. They must also be accompanied by recommendations for cost-effective improvement options to raise the energy performance and rating of the building. The 2010 revision of the EPBD strengthens the role of EPCs by requiring that they be published at the time of advertising a building's sale or rental, rather than only at the time of signing a purchase agreement or rental contract.

Under the Energy Efficiency Directive (2012/27/EC), Spain is also required to establish strategies for the renovation of its building stock. It is also required to improve the energy performance of 3% every year of the total floor area of heated and/or cooled buildings owned and occupied by the central government.

To meet the 2020 energy efficiency targets, Spain has introduced several economic support programmes, including the following.

The state plan for the promotion of rental housing, building restoration and urban regeneration and renovation, 2013–2016 (Royal Decree 233/2013) of the Ministry of Development aims at promoting the energy renovation of residential buildings. Under the plan, subsidies are granted for improving the thermal envelope of buildings to reduce energy demand for heating and cooling. The plan also subsidises the installation of heating, cooling, domestic water heating and ventilation systems and common building facilities, such as lifts and lighting. To qualify for subsidies, the building's total annual energy demand for heating and cooling must be reduced by at least 30% below the levels recorded before taking the measures, as demonstrated by the energy certificate.

The PAREER Aid Programme for the Energy Renovation of Existing Residential Buildings (housing and hotel use) was approved by IDAE in September 2013. It promotes Integrated measures for energy saving, energy efficiency and renewable energy use. PAREER awards grants and soft loans, depending on the focus of measures (thermal envelope, heating and lighting). It had an initial budget of EUR 125 million. In April 2015, the programme was expanded to cover all kinds of existing buildings. Its budget was increased by EUR 75 million and now totals EUR 200 million under the name PAREER CRECE. The period for application runs until the end of 2016.

The PIMA SOL environmental stimulus plan finances energy renovation of hotels. It is promoted by the Ministry of Agriculture, Food and Environment. The JESSICA-F.I.D.A.E fund (see the previous paragraphs under "Alternative measures") offers financing for the renovation of non-residential buildings.

TRANSPORT

Among the different modes of transport, road transport accounts for 80% of final energy consumption in the sector, air transport for 14%, railways for 3% and marine transport for

1. The U-value represents the rate of heat loss, i.e. how much energy passes through one square metre of a material by a difference of one degree of temperature. It is measured in watt (W) per degree Kelvin (K) per m^2.

3%. The sector is characterised by a high level of vehicle use, an ageing automobile stock and a low percentage of freight transport by railway. The sector depends on oil for 94% of its energy needs. This implies a strong need for more efficiency to reduce the sector's environmental impact.

Promoting energy saving and efficiency in the transport sector focuses on three areas: modal change; fleet renewal and new technologies; efficient use of transport means.

Regarding modal change, the 2009 Spanish Sustainable Mobility Strategy (EEMS) and the 2011 Law on Sustainable Economy set the framework for promoting sustainable mobility plans. Such plans have been implemented by practically all Spanish municipalities with more than 50 000 inhabitants. The plans aim at increasing the share of more efficient modes and to reduce the use of private, low-occupancy vehicles.

Regarding fleet renewal and new technologies, the main instrument is the Efficient Vehicle Incentives Programme (PIVE). PIVE aims at substituting and modernising road transport fleets of vehicles for both passengers and freight in order to take advantage of both the higher energy efficiency of new vehicles (energy label A or B) and alternative technologies and fuels. Under the programme, owners of cars older than ten years and light vans older than seven years have been eligible for a EUR 2 000 subsidy when purchasing an efficient new vehicle, with the old one being scrapped. Half of the subsidy is provided by the Ministry of Industry, Energy and Tourism through IDAE, and the other half by the manufacturer or importer.

In total, the government has allocated EUR 715 million to six calls for PIVE since 2012. The programme is expected to replace around 711 000 vehicles, save 248 million litres of fuel per year which, in turn, will avoid 509 thousand tonnes of carbon dioxide ($ktCO_2$) emissions per year. According to NEEAP 2014-2020, the new vehicles promoted under the PIVE programme reduce fuel consumption and CO_2 emissions by an average of 30% compared to the scrapped vehicles, from 166 gCO_2/km to 116 gCO_2/km. In the first half of 2015, two more calls were launched: PIVE 7, with a budget of EUR 175 million, aims at replacing 175 000 inefficient cars and vans. PIVE 8, in turn, offers a subsidy of EUR 1 500 per vehicle and, with a budget of EUR 225 million, aims at replacing 300 000 inefficient cars and vans.

In addition to the PIVE programme, the government plans to encourage the renovation of the commercial vehicle fleet through the PIMA Aire programmes. These aim to renew more than 50 000 commercial vehicles and to promote the introduction of electric motorcycles.

In 2014, a new programme to encourage the purchase of electric vehicles (MOVELE 2014) was introduced. Its budget of EUR 10 million will subsidise the purchase of around 2 000 electric, plug-in hybrid or will extend the range of electric vehicles. In early 2014, Spain had around 9 000 registered electric vehicles. It also had around 11 000 liquefied petroleum gas (LPG) vehicles, mainly taxis, ambulances and distribution vehicles, and 18 000 natural gas vehicles, mainly buses, waste collection trucks, minibuses, freight trucks and vans.

Regarding the efficient use of transport means, the measures focus on fleet management (for accurate route and load management) through audits, deploying computer systems and ongoing training in efficient driving techniques for both professional and non-professional drivers.

Since January 2014, training in efficient driving techniques is included in the Spanish driver licensing system for passenger and industrial vehicles. This measure is expected to generate significant energy savings, as around 450 000 new driver's licences are granted

every year. Also, in recent years more than 85 000 professional drivers have been trained in efficient driving techniques, in collaboration with the central government, regional authorities and vehicle manufacturers and road haulage associations.

APPLIANCES AND EQUIPMENT

Requirements for minimum energy efficiency standards and energy labelling of appliances are based on EU law, in particular Directive 2009/125/EC and related product-specific regulations, and Directive 2010/30/EU on energy labelling.

The first Energy Labelling Directive was transposed into Spanish law in 1994. It rated the energy efficiency of a range of household appliances on a scale from A to G, with A being the most efficient. The current Energy Labelling Directive (2010/30/EC) defines ratings of A+, A++ and A+++ for some appliances, such as household refrigerators and washing machines, as their energy efficiency has improved significantly since the early 1990s.

The first minimum efficiency performance standards (MEPS) were applied to household refrigerators under Directive 96/57/EC from September 1996. The successor to that directive is the Ecodesign Directive (2009/125/EC), first adopted in 2005 and recast in 2009 to make provision for MEPS for both energy-using and energy-related products (e.g. windows).

Under the directive, the European Union introduces product-specific regulations that apply directly in all EU member states. To date, MEPS have been developed for around 20 product groups. In addition to household appliances, the Ecodesign Directive is also applied to industrial equipment. The first four regulations under the directive were on industrial products (motors, circulators, fans and water pumps).

Spain has subsidised the replacement of old household appliances with new energy-efficient ones (labelled “A” or higher) under Plan Renove which was launched in 2006. The extensive programme has managed to help raise general awareness of energy efficiency and introduce higher-efficiency appliances into the Spanish market.

IDAE is managing a programme of interest-free loans for improving the efficiency of street lighting in municipalities. The programme has a budget of EUR 36 million for the application period from May 2015 to May 2016.

INDUSTRY

According to the 2014-2020 NEEAP, the largest energy users in Spanish industry are chemicals (19.9% of total final energy use in industry), metallurgy (19.5%), non-metallic minerals (18.1%), food, drink and tobacco (10.0%) and pulp and paper (8.9%). These five branches accounted for 76.4% of the energy consumption in the sector in 2012. Energy-intensive industries are regulated under the EU-ETS which in principle should encourage energy efficiency improvements, but the low CO_2 allowance prices in recent years have dampened that effect.

The 2012 Energy Efficiency Directive requires large enterprises to carry out an energy audit at least every four years, with the first one to be completed by December 2015. These audits should take into account relevant European or international standards, such as EN ISO 50001 (Energy Management Systems), or EN 16247-1 (Energy Audits). Under the EED, member states should also encourage the development of training programmes for energy auditors. The EED also encourages member states to offer incentives for small and medium-sized enterprises (SMEs) to undergo energy audits.

IDAE is encouraging energy efficiency improvements in industry through grants. For this purpose, it is running a programme for SMEs and large industrial enterprises. The initial budget is EUR 49 million and the period of application from May 2015 to May 2016. The programme aims, in particular, to promote the adoption of the best available technologies in equipment and processes, and the implementation of energy management systems.

COMBINED HEAT AND POWER

According to IDAE, at the end of 2012 Spain had an installed co-generation capacity of 6 676 MW, which generated 35 720 GWh of electricity (around 12% of the total in Spain) and 179 580 terajoules (TJ) of heat. Around 90% of this combined heat and power (CHP) capacity is in industry. The 2012-13 electricity market reform affected the CHP sector very negatively. CHP electricity generation at high-efficiency plants had qualified for feed-in tariff/premiums, but these were abolished in the 2013 electricity market reform and replaced by a reasonable return calculated on the basis of capacity. From the beginning of 2013, taxes were introduced on natural gas (the source for 90% of CHP) and electricity output under Law 15/2012. As result of these reforms, the sector is generating 14% less power than before the reform, accounting for 11% of the total in Spain.

A 2006 study analysed the potential of high-efficiency co-generation in Spain for 2010 to 2015 to 2020. The study included several scenarios and for 2020, it projected an installed capacity ranging from 9.5 GW to 12.3 GW. Spain's mild climate, however, limits the demand for heat outside industry. The government is yet to carry out a comprehensive assessment of the potential for the application of high-efficiency co-generation and efficient district heating and cooling systems, as required under the EED by the end of 2015.

ASSESSMENT

Since the last IEA in-depth review of Spain in 2009, energy demand in the country has been declining year after year. From its peak in 2005 to 2013, TFC declined by one-fifth. This is mostly because of developments in the country's economy, but the various energy efficiency measures are also having an impact.

Energy efficiency helps strengthen energy security, decrease dependence on foreign resources, enhance the sustainability of the energy system, foster innovation on energy service products and create local added value and jobs. As shown by the large volume of new programmes, the government is committed to energy efficiency.

Spain's energy intensity, both in terms of TPES/GDP and TFC/GDP has decreased markedly over the same 2005-13 period. This would appear a very welcome development. As the economy has finally returned to growth since 2013, it now remains to be seen whether the decoupling is of a structural nature and whether it will continue during the economic upturn. The IEA encourages the government to introduce a coherent and well-balanced policy mix in the area of energy efficiency to help ensure energy demand and GHG emissions remain decoupled from economic growth also during the recovery.

ENERGY EFFICIENCY OBLIGATION SCHEME AND ESCOS

A clear trend over the past years has been the growing harmonisation of energy efficiency policy at the EU level. The 2020 target and several regulations and directives set the framework for a large part of energy efficiency policies and measures also in Spain.

In a welcome development, Spain is set to meet the 2016 target of 9% final energy savings in the non-ETS sector from the early 2000s levels. In 2013, it had already reached savings of 10.1% and the government expects a further increase to 15.5% in 2016.

The 2012 Energy Efficiency Directive establishes a common framework to increase energy efficiency within the European Union through a broad range of measures. Under the directive, Spain is obliged to set up an energy efficiency obligation scheme to ensure that energy distributors and/or energy sales companies reach a cumulative energy saving target by the end of 2020. The law establishing the energy efficiency obligation scheme was adopted in October 2014. The scheme includes transport, from which the directive provides a possibility of exemption.

In order to meet their energy savings obligations, the obliged companies pay to the National Energy Efficiency Fund, set up in July 2014. The fund focuses on carrying out energy efficiency measures in the buildings sector, in transport and in industry. This initiative marks a major change in Spanish energy policy and it could provide a major boost for energy efficiency in the service sector, create jobs in the building sector, and save energy expenses for end-users. The positive impacts could extend beyond 2020.

ESCOs can pinpoint cost-effective energy-efficient improvements in specific companies. ESCOs often operate on the basis of "no cure, no pay" and can usually provide bankable projects. However, contracting ESCOs among the energy-consuming companies is not widespread, and financial institutions are not very familiar with ESCOs in Spain. The government should facilitate raising awareness of ESCOs to help municipalities and private and public companies benefit from the opportunities these companies can offer in realising cost-effective energy efficiency potentials.

TRANSPORT

The transport sector is the largest energy-user. From 1990 to 2012, its share in TFC has remained relatively stable at around 40%. The sector depends on oil for around 94% of its energy needs. This picture is similar in other developed countries. Biofuels use for transport remains small, although is set to increase towards 2020. Electricity is used for rail transport, but for road transport it remains expensive as a large-scale solution. Developments in battery technology are thus needed. Natural gas is almost totally absent in the transport sector.

Road transport heavily dominates both passenger and freight transport. The government was wise to focus its efforts on replacing inefficient vehicles with more efficient ones. Spain's vehicle stock has become relatively old and the PIVE programme is an efficient tool for renewing the fleet. The PIVE programme's budget of more than EUR 1.1 billion since 2012 is impressive. The programme delivers multiple benefits, as it reduces CO_2 emissions, air pollution and oil demand and supports employment in Spain's significant car industry.

Another major measure that is to be applauded is the inclusion of training in efficient driving techniques in the Spanish driver licensing system. The government has also launched programmes to promote the renewal of commercial vehicles and the purchase of electric vehicles.

The IEA also welcomes the government's plans to increase the use of natural gas vehicles, continue to promote railroad transport for passengers and freight, and optimise existing train connections to maritime ports.

An area where the government could consider bolder action is transport fuel taxation. Tax rates are relatively low and raising them would encourage more efficient oil use and thus deliver environmental and energy security benefits. Any tax reform can be designed to be revenue-neutral, and exemptions for professional drivers and long-distance commuters could be designed to make the reform more acceptable.

BUILDINGS

Energy efficiency standards for new buildings have been improved over the past years. This has been driven by EU legislation, but Spain and other member countries can also go beyond the minimum required by the Union.

The government has introduced several programmes for energy efficiency improvements in existing buildings. This is the right focus and can bring multiple benefits. As the demand for new buildings will likely remain low for several years, more can be achieved in the existing buildings. Intensified refurbishment efforts also help restore employment in the building sector.

Energy demand in buildings can be reduced also through policies to set minimum performance standards on appliances, especially in households. In Spain, this is based on EU regulations. Energy efficiency can be supported also by promoting the uptake of efficient appliances. This will also help level peak electricity loads in the power sector and the IEA acknowledges Spain's success in this area. These measures should be an ambitious way to ensure that high-efficiency boilers are at least the minimum requirement for heating equipment. Spain has been promoting solar heating solutions, and should also recommend heat pumps for water heating and/or space heating or cooling. In the long term, mandatory measures and building codes should be extended to all existing buildings in order to achieve significant improvements by 2050, in Spain and also in other countries.

MARKET SURVEILLANCE OF ENERGY-RELATED PRODUCTS

According to IEA studies, energy labelling and energy efficiency standards of appliances are among the most cost-effective measures to save energy. The energy efficiency gains, which the Ecodesign Directive and the Energy Labelling Directive can deliver for energy-related products, are substantial. European industrial organisations and consumer organisations have called for an improvement of member states' market surveillance. In Spain, enforcing these regulations is the competence of the regional governments, but their budgets are often constrained and capacity is limited. Sufficient resources need to be ensured also in Spain for enforcing the regulations and inspecting products to reap the full energy efficiency benefits from these regulations. This will also help Spain continue its successful tradition of encouraging the replacement of old inefficient appliance with new efficient ones.

RECOMMENDATIONS

The government of Spain should:

General

- ☐ *Introduce a coherent and well-balanced policy mix in the area of energy efficiency to help ensure energy demand and GHG emissions remain decoupled from economic growth when the economy begins to recover.*

- *Remove barriers to enable municipalities and private and public companies to fully take advantage of the services which ESCOs offer.*

Transport

- *Increase energy efficiency in all modes of transport through a coherent and well-balanced set of tax measures, economic incentives, energy efficiency performance standards and information campaigns.*
- *Continue, and intensify, the promotion of public transport, electrification and gasification of road vehicles, but also encourage walking and cycling.*
- *Increase consumer awareness about the environmental and societal costs of all modes of mobility.*

Buildings

- *Continue to support energy renovations of buildings and consider gradually increasing the funding for this purpose.*
- *Support financing mechanisms that increase private sector activity in buildings efficiency improvements.*

Products

- *Strengthen the market surveillance regime of energy-related products to ensure it can detect non-compliant products, protect consumers and ensure a level playing field among manufacturers and dealers.*

References

IEA (International Energy Agency) (2015, forthcoming), *Energy Balance of OECD Countries*, OECD/IEA, Paris.

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Ministry of Industry, Energy and Tourism (2015), *Informe Anual 2015 de Seguimiento de los Avances hacia los objetivos nacionales de eficiencia energética para 2020*, Madrid.

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PART II
SECTOR ANALYSIS

5. OIL

Key data (2014 estimated)

Crude oil production: 305 kt (negligible)

Crude oil, NGL and feedstock imports: 64.2 Mt, +7.9% since 2004

Oil products net exports: 2.7 Mt (imports 16.7 Mt, exports 19.3 Mt)

Share of oil: 41.2% of TPES and 5.2% of electricity generation

Supply by sector (2013): 47.8 Mt (transport 56%, industry 15.1%, other energy 10.8%, commercial and services 6.6%, power generation 5.8%, residential 5.8%)

SUPPLY AND DEMAND

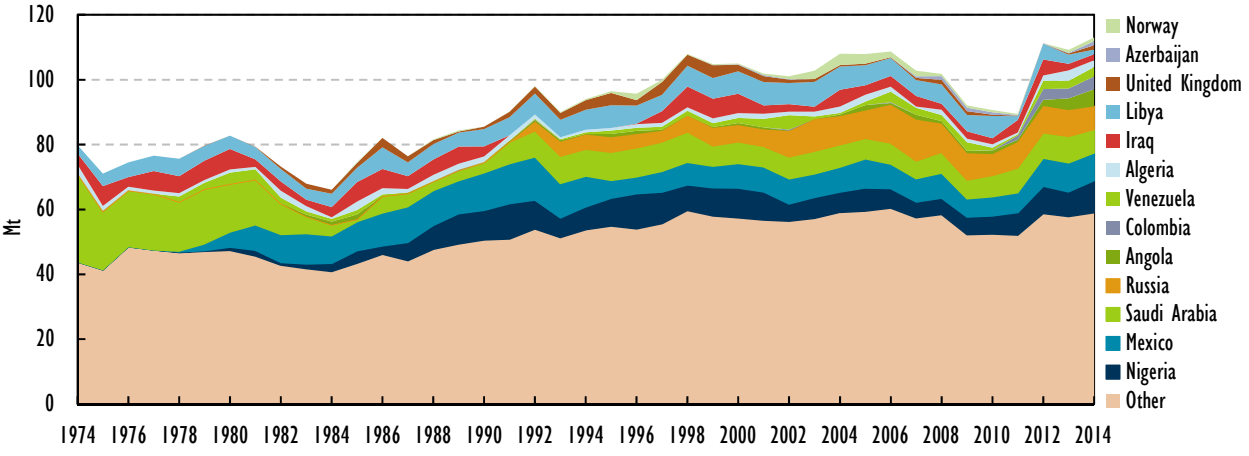
SUPPLY

Oil is the largest energy source in Spain, accounting for 41.2% of total primary energy supply (TPES) in 2014 or 46.9 million tonnes of oil-equivalent (Mtoe). Oil supply peaked at 68.1 Mtoe in 2005 and, after plateauing for three years, declined steeply from 2008, as a result of the deep recession. Overall, it fell by 30.6% in the nine years to 2014. Prior to 2005, supply had been growing at a steady rate since the mid-1980s.

Crude oil

Spain relies on imported crude oil as indigenous production is negligible (only 305 kilotonnes [kt] in 2014, less than 1% of crude oil supply). Spain imported 59 million tonnes (Mt) of crude oil during 2014, sourced from a large number of countries. Most imports came from Nigeria (16.8% of the total), Mexico (14.5%), Saudi Arabia (12.3%), Russia (12%) and Angola (8.9%) (Figure 5.1).

Figure 5.1 Crude oil imports by source, 1974-2014



Note: data for 2014 are estimated.

Source: IEA (2015a, forthcoming), *Oil Information*, OECD/IEA, Paris.

Crude oil imports were volatile during the decade from 2004 to 2014, with a period of decline from 2006 to 2011 followed by a surge in 2012 (reflecting increased competitiveness and output of its refineries), a slight contraction in 2013 and a 2% increase in 2014. From 2004 to 2014, imports from Angola increased by 905% and from Nigeria by 58.7%, while imports from Mexico grew by 10.9% and from Saudi Arabia by 5.5%. Russian imports declined by 20% over the same period.

Spain also imports natural gas liquids (NGL) and refinery feedstocks. Total imports, including crude oil, amounted to 64.2 Mt in 2014.

Oil products

Imported crude oil, NGL and feedstocks are refined domestically. Spain is a net exporter of oil products and produced 60.8 Mt of oil products in 2014, which is 2.2% more than in 2004. Refinery output followed the same pattern as crude oil imports, declining from 2006 to 2011 and a surge in 2012. Unlike crude oil imports, however, refinery output has fallen for two consecutive years since 2012. Gas and diesel oil account for 45.1% of domestically produced oil products, followed by kerosene (other than jet fuel) at 14.3% and gasoline at 12%.

Around a third of Spanish oil products was exported in 2014 (19.3 Mt). Exports have surged over the past decade, increasing by 143% from 2004 to 2014. This reflects the decline in domestic demand and the increased competitiveness of Spanish refineries following recent modernisation (see below under Infrastructure, refineries). Exports are mainly destined to France (12.5%), Morocco (10.3%), the United States (8.9%) and Italy (8%).

Spain imported 16.7 Mt in 2014, 16% more than in 2013, after five consecutive years of declining imports. In 2014, imports were 34.5% lower than in 2004. The top five countries importing oil products in 2014 were the United States (12.6% of the total), Algeria (8.8%), the Netherlands (8.5%), Saudi Arabia (6.9%) and Italy (6.5%).

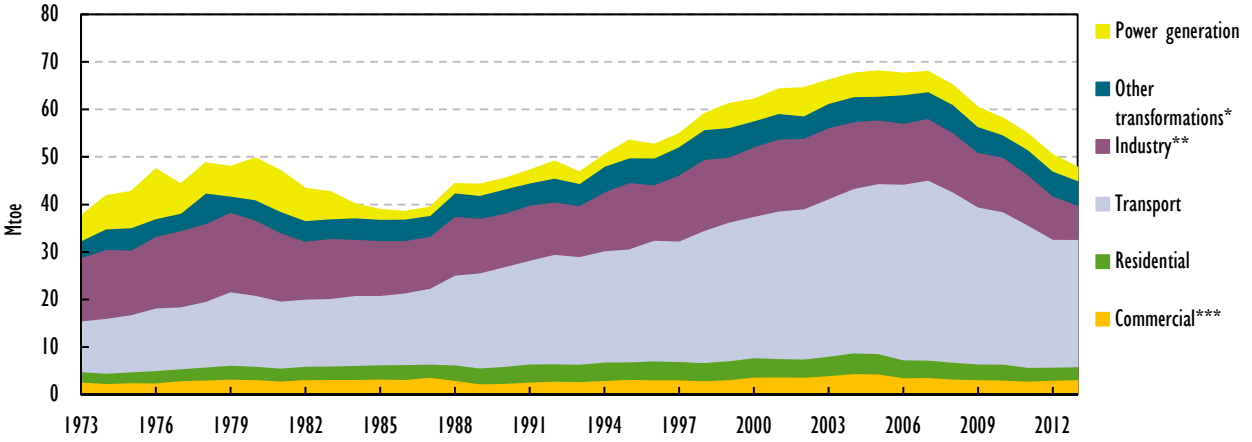
DEMAND

Transport is by far the largest oil-consuming sector, accounting for 56% of total demand in 2013 (the latest year for which data are available) (see Figure 5.2). Industry accounted for 15.1% and energy sector own-use for 10.8%. Commercial services (including agriculture) consumed 6.6% of the total, while power generation and the residential sector accounted for 5.8% each.

Demand for oil in transport has fallen by 19.4% over the past ten years, peaking in 2007 and falling on average by 3.5% per year from 2007 to 2013. Conversely, demand from refineries and energy own-use has increased by a marginal 0.5% from 2007 to 2013. Before 2007, demand was growing steadily in transport and refineries, but declining slowly in other sectors.

Oil consumption in industry declined steeply from 2007 to 2013, by 44.4%. Power generation reduced oil consumption by 33.8%, commercial and public services by 12.1% and households by 25.1%.

Figure 5.2 Oil supply by sector, 1973-2013



Notes: TPES by consuming sector.

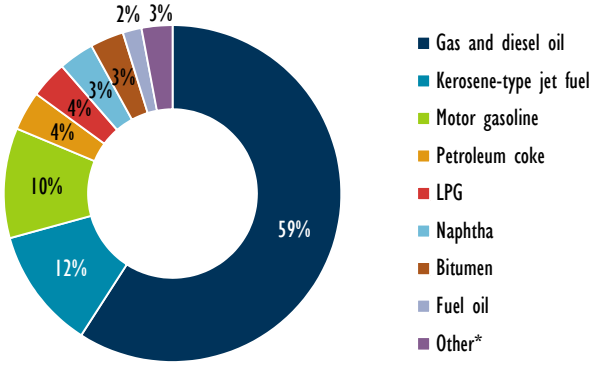
* *Other transformations* includes refineries and energy own-use.

** *Industry* includes non-energy use.

*** *Commercial* includes commercial and public services, agriculture/fishing and forestry.

Source: IEA (2015b, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

Figure 5.3 Oil consumption by product, 2013



* *Other* includes lubricants, white spirit, paraffin waxes, aviation gasoline and gasoline-type jet fuel.

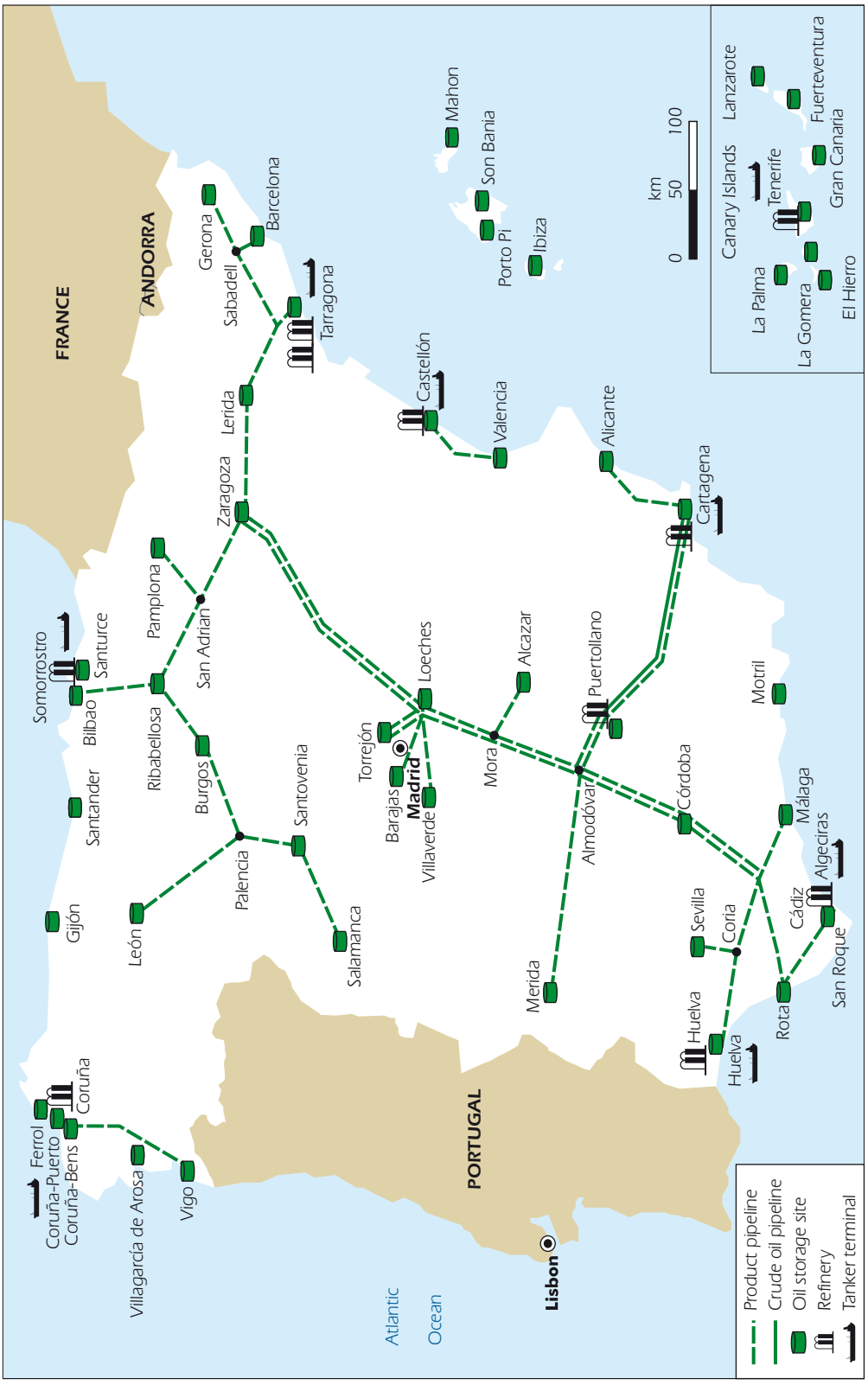
Source: IEA (2015a, forthcoming), *Oil Information*, OECD/IEA, Paris.

INFRASTRUCTURE

REFINING

Spain has a large and relatively complex refining industry, with nine refineries and total nameplate capacity of 76.530 kilotonnes (kt), or around 1.5 million barrels per day (mb/d), distributed among three companies: Repsol (52% of total capacity), CEPSA (38%) and BP (10%). Average utilisation rates in 2012 stood at 84%. Eight of the nine refineries are located on the coast, including in the Canary Islands. Only Repsol's Puertollano refinery is located inland, and is supplied via a 358 km-long pipeline linked to the port and refinery of Cartagena (see Figure 5.4).

Figure 5.4 Map of the Spanish oil infrastructure, 2014



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Recent refining investments aim to redress the supply shortfall of middle distillate products, notably diesel and jet fuel, as well as to reinforce international competitiveness. BP completed a coker unit at its Castellon refinery in early 2009. CEPSA has upgraded the two refineries at Algeciras and particularly Huelva. Repsol has invested over EUR 3 billion in Cartagena and has built a delayed coker unit at its Bilbao refinery.

PORTS AND PIPELINES

Spain enjoys a flexible and efficient oil system, thanks to its wide geographic and interconnecting coverage, including an extensive network of pipelines and storage capacity connected to refineries. It has an efficient and flexible system, where transport and storage services are integrated, making products available in any of its storage facilities.

The CLH (*Compañía Logística de Hidrocarburos*) oil pipeline network is over 4 000 km long. It links the main eight peninsular refineries and the main import ports with 39 storage plants of the company which serve the mainland, and with 28 storage plants which supply the main airports. The network has a central dispatching unit at Torrejón, close to Madrid, which supports, manages and supervises the automatic systems in all the installations, and from which it is possible to operate directly over any of their systems and resolve any possible incidents.

In addition to the CLH pipeline network, Spain's oil pipeline system includes two parallel pipelines owned by Repsol that transport crude oil and products between the Cartagena and Puertollano refineries. The oil pipeline network is an integrated network, owned 100% by CLH (except for Repsol's pipelines mentioned above) but third-party access (TPA) is guaranteed to both logistic and storage facilities by means of a negotiated procedure which has non-discriminatory, transparent and objective technical and economic conditions; in addition, the prices charged must be made public.

STORAGE

The Spanish logistic system is a competitive market with growing storage capacity and many players. Storage services are offered by 41 companies at 138 sites (including airports); some of the companies are subsidiaries of oil producers. Most of the storage sites, including the largest ones, are connected to Spain's CLH pipeline network.

Storage capacity at terminals and airports in 2014 was 14.98 million cubic metres (mcm), or 94.2 million barrels (mb). Moreover, 15.89 mcm, or 99.94 mb of additional storage capacity are available at refinery sites for crude oil and refined products. The coastal refineries are the main sites for crude imports and storage. These refineries also import a substantial share of refined products through the nearby ports. The remaining volumes of refined products are imported directly to storage facilities, located mainly in Barcelona and Bilbao.

CLH is the main storage capacity holder, with a storage capacity of 7.9 mcm distributed in 39 storage facilities and 28 airport facilities. The breakdown by product is as follows:

- unleaded petrol: 1.1 mcm
- diesel: 5.3 mcm
- aviation kerosene: 1.2 mcm
- fuel and intermediate fuel oils: 0.3 mcm.

RETAIL MARKET STRUCTURE

The Spanish oil retail market is fully open to competition. Imports, exports, trade and prices are free. The government intervenes only to protect competition and to avoid abuse of dominant position. At the end of 2013, Spain had 10 617 filling stations, up from 9 446 at the end of 2008, according to AOP, the Spanish oil industry association. The retail network has been rather concentrated in the hands of integrated oil companies, such as Repsol, CEPSA, BP and GALP, but their share of filling stations has declined from 70% in 2008 to 61% at the end of 2013.

Competition in the retail oil market has been reinforced by Law 11/2013 of 26 July implementing measures to support entrepreneurs and to foster growth and job creation. The law introduced several measures, including regulating clauses in exclusive contracts between retailers and major operators, simplifying administrative procedures to set up new filling stations and, from the summer 2016, capping the market share of operators at 30% of total points-of-sale in any autonomous region.

EMERGENCY RESPONSE POLICY

DECISION-MAKING STRUCTURE

The Spanish national emergency strategy organisation (NESO) is part of a comprehensive structure of emergency organisations in Spain. The National Security Strategy, adopted on 31 May 2013, defines the structure of the National Security System. It is aimed at acting decisively and with a comprehensive integrated view on all problems that could put at risk the security of supply. This National Security System consists of the following bodies:

- The National Security Council which is the highest decision-making body within the national security system.
- The Department of Homeland Security is the permanent advisory and technical body in national security issues under the Prime Minister. This department monitories risks, threats and crises, issues early warnings when necessary and provides adequate support and co-ordination in the event of a crisis situation. It acts as a link between the National Security Council and the other relevant bodies, such as the Ministry of Industry, Energy and Tourism.
- Specialised Committees that are created at the initiative of the National Security Council in order to gain expertise from other bodies or entities, in close relationship with the crisis at issue.

In the case of an oil supply disruption, the Directorate for Energy Policy and Mining as well as the Strategic Reserves Corporation (CORES) would play a major role by providing specific technical support for the implementation of specific measures and, at the same time, by co-ordinating their actions with oil operators. Such support could be provided as part of specialised committees, at the initiative of the Department of Homeland Security and/or as a result of the administrative procedures established by the law, all subject to the nature and circumstances of each crisis. Preventive actions are developed through scenario planning at the sectoral level.

STOCKS

Stockholding structure

Law 34/1998 on the Hydrocarbons Sector establishes the government's power to oblige all operators to hold emergency stocks equal to a maximum of 120 days of sales or consumption, and several measures that the government can implement during a supply disruption to reduce oil demand.

Royal Decree 1716/2004 regulates the stockholding obligation of minimum security stocks, the diversification of natural gas supplies, and the stockholding agency CORES is to be in charge of creating and maintaining the strategic stocks, and to monitor compliance with the minimum emergency stock obligation. The royal decree specifies the obligation for operators to hold a minimum of 92 days of stocks as emergency stocks, and stipulates that the government can regulate the use of emergency stocks during a supply disruption.

More recently, Royal Decree of Law 15/2013, dated 13 December, on the restructuring of the public entity known as Operator of the Railway Network (ADIF) and on implementing other urgent economic measures,, aligned Law 34/1998 to the terminology and general framework of EU Directive 2009/119/EC of 14 September 2009 that imposes an obligation on member states to maintain minimum stocks of crude oil or petroleum products, namely by designating CORES as the national central stockholding agency.

In December 2014, Spain's oil stocks equalled 116 days of net imports. (61 held by industry and 55 by CORES). Since March 2005, the country has consistently met its stockholding obligations as a member of the IEA.

At the end of 2014, Spanish public stocks were made up of 54% middle distillates, 35% crude oil, 8% motor gasoline and 3% residual fuel oil.

Location and availability

In order to maximise flexibility in the event of a domestic oil supply disruption, CORES gives some consideration to geographical criteria in deciding where to keep stocks.

Monitoring and non-compliance

Stockholding compliance is controlled annually by CORES, and any breach by a company can be penalised by the Ministry of Industry, Energy and Tourism. Spanish law distinguishes between three levels of infringement and stipulates that penalties can range up to EUR 30 million (and a one-year activity ban) for very serious violations.

Stock drawdown and timeframe

In the event of an IEA collective action, the decision to release either industry or CORES stocks is taken by the government in accordance with various criteria. In the past, industry's stocks releases have been chosen over those of CORES because of cost efficiency and flexibility. The procedure of putting industry's stocks on the market usually consists of a reduction of the obligation. This method has been applied in the last co-ordinated actions.

The government also has the option of releasing public stocks. In the event of a CORES stock release, it would make additional barrels of oil available to operators, as a proportion of their share on the Spanish market. The purchase of stocks by companies is carried out through a tender open to all Spanish operators. CORES has vast experience in

carrying out this type of operation, as the same procedure has been followed each time that CORES has acquired or sold products.

CORES maintains its strategic reserves of oil mainly within the logistic operators' facilities (either segregated or commingled, depending on storage agreements), and at its own facilities in Puertollano and Cartagena. All crude stocks (both industry and public) are located in refineries.

Financing and fees

CORES finances its activities by collecting a monthly fee from the operators, distributors and consumers obliged to maintain emergency stocks. CORES calculates the fee annually on the basis of a budget, which is then approved (or modified) and published by order of the Ministry of Industry, Energy and Tourism. CORES is not state-funded and stock purchases are financed through loans and bonds.

OTHER MEASURES

Demand restraint

The transport sector makes up the biggest share of oil consumption in Spain, representing 56% of the total in 2013. Thus, the likely, most effective demand restraint measures would be targeted on the use of transport fuels.

Article 49 of Law 34/1998 of 7 October and Article 39 of Royal Decree 1716/2004 of 23 July establish that, in situations of supply shortage, the Council of Ministers has the legal ability to take numerous measures to restrain demand, such as carpooling, driving bans according to odd/even licence plates, speed limits, public transport fare reduction or an increase in public transport services. The legal prescription of these measures gives the government both power and flexibility in the case of a supply disruption.

Certain demand restraint measures were put in place in March 2011 as a result of the Libyan crisis, such as speed reductions, but there has been no calculation of volumetric savings.

Fuel switching

In the event of an emergency, some diesel-fuelled power stations can switch to heavy fuel oil. However, since less than 1% of electricity consumed in Spain is produced by oil-fired power plants, the impact of an eventual oil crisis in power supply on consumers would be negligible.

Other

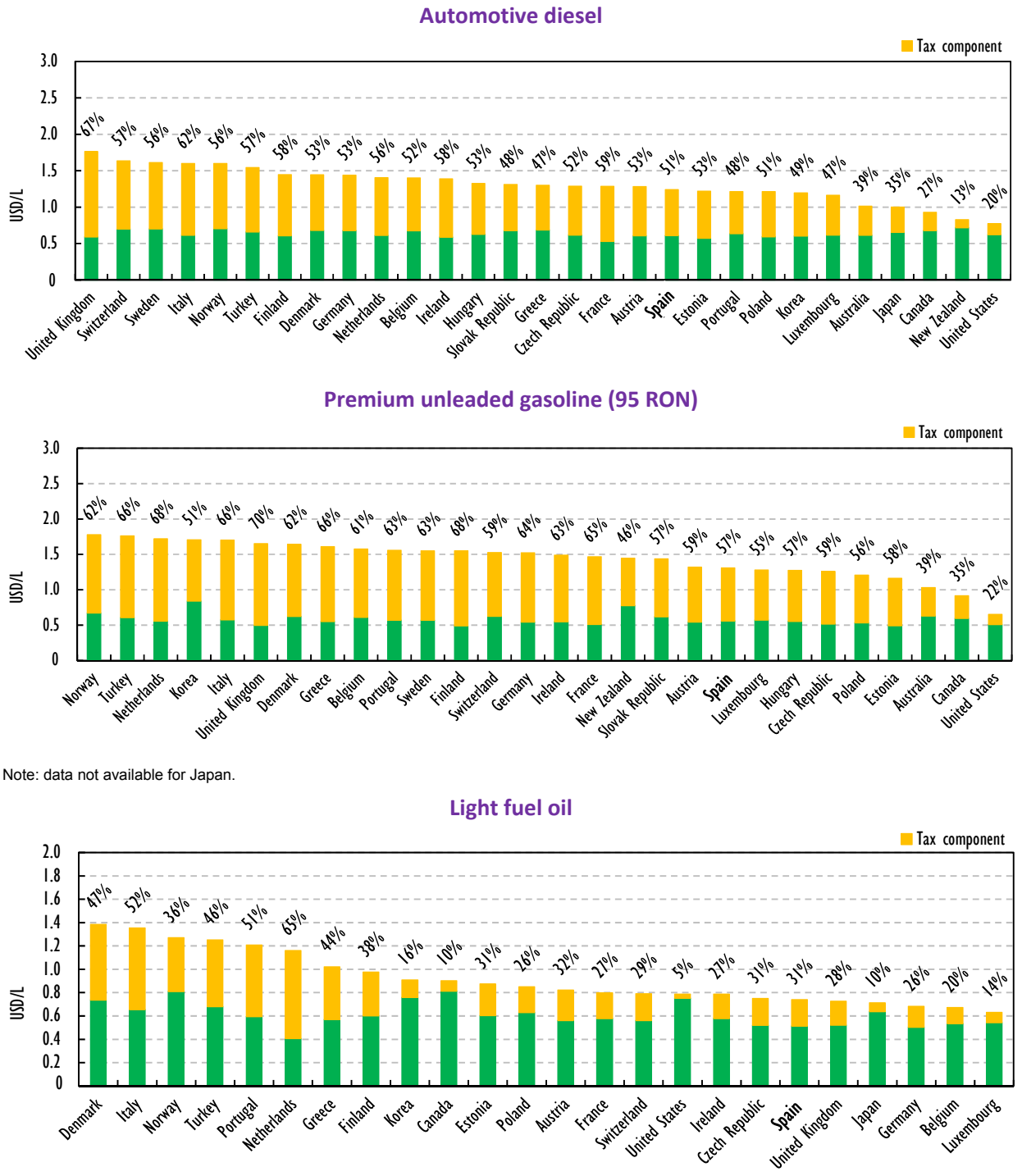
As a result of previous incidents at the national level, such as the Puertollano refinery accident in 2005, relocating emergency reserves has proved to be a useful and effective way to deal with regional supply disruptions. The CLH infrastructure has a major role in enhancing flexibility so that CORES and the Ministry of Industry, Energy and Tourism can put in place measures to relocate emergency reserves quickly. As a result, demand can be met with the existing resources.

PRICES AND TAXES

Transport fuel prices remain below the IEA median, mainly because of relatively low taxation, especially compared to other IEA European countries (see Figure 5.5). Taxation

includes two components: a value-added tax and an excise tax (*impuesto sobre hidrocarburos*). The excise tax rate is the sum of a state and a regional rate.

Figure 5.5 Fuel prices in IEA member countries, first quarter 2015



Note: data not available for Japan.

Note: data not available for Australia, Hungary, New Zealand, the Slovak Republic and Sweden.

Source: IEA (2015c, forthcoming), *Energy Prices and Taxes*, OECD/IEA, Paris.

In 2009, taxation was increased to help limit the government's budget deficit. The state excise tax for automotive gasoline was increased from EUR 0.396 per litre in 2008 to EUR 0.465 per litre. State excise tax for diesel was increased from EUR 0.302 per litre to EUR 0.331 per litre.

The regional rate is set by the regional authorities and is in force since 2007. It varies according to the autonomous community, from zero in some regions to EUR 0.048 per litre in others for both gasoline and diesel.

In addition to excise taxes, oil products are levied a 21% value-added tax (VAT), but it is fully refunded for industry, electricity generation and truckers. Freight transport in Spain is traditionally by road, and low taxes have maintained the sector relatively competitive. VAT has been increased sharply in recent years, from 16%, the level maintained since 1995, to 18% in July 2010 and again to 21% in September 2012.

ASSESSMENT

Oil remains the largest energy source in Spain. It covered 41% of TPES in 2013 which was the seventh-highest share among IEA member countries. Oil´s share in TFC was 49% in 2013.

The Spanish oil market is highly liberalised and includes a large, modern and competitive refining sector. The oil sector has a unique and highly efficient pipeline and storage system. Several positive examples of the government's efforts to increase competition further are evident, including recent legal changes in regulating the wholesale market, oversight on third-party access to pipeline and storage infrastructure, reduction of the administrative burden to simplify the entrance of new market actors, as well as the introduction of restrictions for dominant actors to expand their service station network.

Before the economic crisis, Spain's economy grew rapidly, accompanied by a correspondingly rapid growth in energy demand. The crisis broke this trend, resulting in a decoupling of GDP and energy demand. However, according to official projections, this decoupling will continue in the event the forecast economic growth materialises, indicating a less energy-intensive future economy. Such a development would be highly advantageous, contributing to industrial competitiveness and to meeting environmental and energy policy objectives alike. However, the necessary policy initiatives to initiate and promote such positive decoupling process remain to be taken.

While transport remains the largest end-use sector, 44% of oil demand in 2013 was accounted for by other purposes, including power generation on the Balearic and Canary islands. Compared to other European countries, Spain continues to have a relatively low tax level on transport fuels, although taxes have been increased since 2008. The "dieselisation" of the Spanish vehicle fleet began in 1999 and is today strongly driven by the difference in tax rates.

While Spain started with an ambitious policy to substitute oil in the transport sector, subsequent policy revisions have reduced the share of renewable transport fuels by half. Today, Spain's overall blending obligation is 4.1% and the policy is to increase this share to 10% by 2020, as required under Directive 2009/28/EC. The pace of increasing the share is not determined yet.

As detailed in Chapter 4 on Energy Efficiency, the government has launched several programmes to promote energy saving and efficiency in the transport sector. The programmes

will limit oil demand and help Spain meet its 2020 targets for energy efficiency and greenhouse gas reductions. The programmes provide financial support for modal shift actions and more efficient means of transport, and include company transportation schemes, efficient freight and passenger management, and efficient driving training for industrial and commercial vehicles. The IEA welcomes these efforts to limit oil dependence. As the programme duration is limited, the IEA also encourages the government to continue to introduce new measures, when needed, in particular on tax instruments, car efficiency and modal shift.

Spain has a flexible and efficient organisation for emergency stockholding and a solid tradition of compliance with its stockholding obligations.

RECOMMENDATIONS

The government of Spain should:

- ☐ *Continue to introduce incentives to reduce oil dependence and promote a decoupling of economic growth and oil demand, focusing in particular on tax instruments, car efficiency and modal shift.*
- ☐ *Increase efforts to substitute oil with renewable energy, notably in the transport sector.*
- ☐ *Continue to ensure compliance with the stockholding obligation.*

References

IEA (International Energy Agency) (2015a, forthcoming), *Oil Information*, OECD/IEA, Paris.

IEA (2015b, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

IEA (2015c, forthcoming), *Energy Prices and Taxes*, OECD/IEA, Paris.

IEA (2014), *Energy Supply Security 2014*, OECD/IEA, Paris.

6. COAL

Key data (2014 estimated)

Production: 2.7 Mt of hard coal and 1.2 Mt of sub-bituminous coal

Net imports: 15.1 Mt, -38.3% since 2004

Share of coal: 10.3% of TPES and 16.3% of electricity generation

Inland consumption (2013): power generation 85.1%, industry 8.5%, coke ovens and other transformations 5.2%, residential 0.9%, commercial and agriculture 0.4%

SUPPLY AND DEMAND

SUPPLY

Total supply of coal was 11.7 million tonnes of oil-equivalent (Mtoe) in 2014, or 10.3% of total primary energy supply (TPES). This is 44.3% lower than in 2004. Coal supply depends mostly on electricity demand, and on coal's competitiveness against other energy sources in electricity generation. But it is also affected by policies on subsidies, air pollution control and greenhouse gas (GHG) mitigation. Over the past decade, coal supply has ranged from 21 Mtoe in 2004 to 7.8 Mtoe in 2010.

Coal supply consists of domestic and imported coal. In 2014, imports accounted for 74.2% of the total. According to the Ministry of Industry, Energy and Tourism, steam coal imports in 2013 amounted to 10.5 million tonnes (Mt) and were sourced from 14 countries, mainly from Indonesia (32% of the total), Colombia (24%) and Russia (20%). Coking coal imports amounted to 2.5 Mt and came mainly from the United States (51%) and Australia (40%).

Domestic coal production amounted to 1.6 Mtoe in 2014, comprising 2.7 Mt of hard coal and 1.2 Mt of sub-bituminous coal (see Table 6.1). All domestic coal is used for power generation. In 2013, Spain held an estimated 868 Mt of hard coal reserves and 3 363 Mt of hard coal resources as well as 319 Mt of brown coal reserves (brown coal resources are not specified) (BGR, 2014).

Table 6.1 Domestic coal production by type of coal, 2009-14

Mt	2009	2010	2011	2012	2013	2014*
Hard coal	6.95	5.99	4.26	3.91	2.54	2,67
Sub-bituminous	2.49	2.44	2.36	2.28	1.83	1,24
Total	**9.45**	**8.43**	**6.62**	**6.19**	**4.37**	**3.91**

* Provisional.

Source: Ministry of Industry, Energy and Tourism.

Production of hard coal peaked in 1985 at 16.1 Mt while the production of sub-bituminous coal peaked in 1983 at 24.5 Mt. Coal production has been declining since the mid-1980s, owing to diminishing competitiveness against imported coal. From 2004 to 2014, hard coal production declined by 70% and sub-bituminous coal production by 89.4%. The declining trend is set to continue as subsidies for hard coal production are being phased out by 2018.

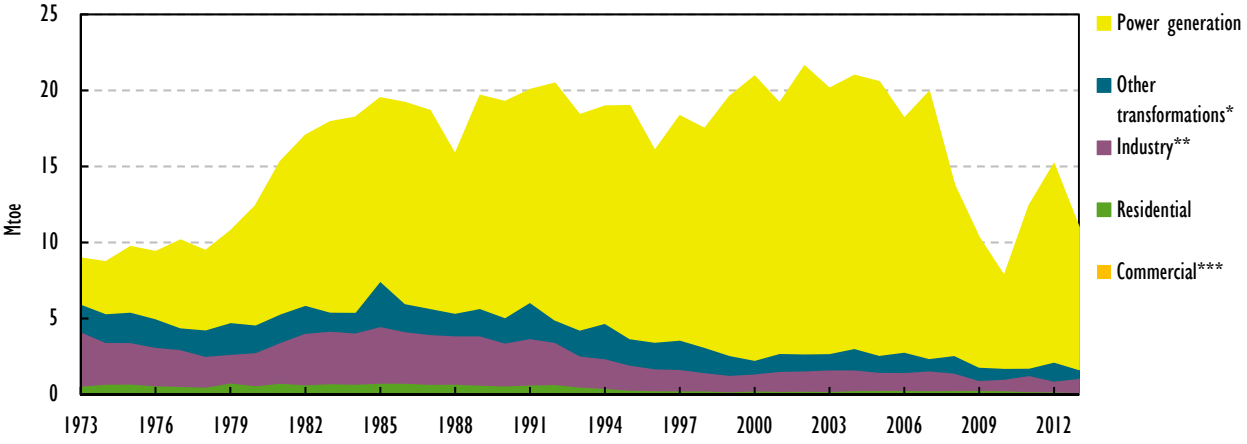
DEMAND

Around 85% of coal is used for generating electricity, and a good 9% for industrial processes, mostly to produce iron and steel, but also cement. Around 5% is used in energy own-use or for autonomous power generation. Residential heating accounts for around 1% of coal use (see Figure 6.1).

Over the past decade, demand for coal in power generation fluctuated strongly. Coal is often used to supplement hydropower, and so its use for power generation increases in dry years and decreases in rainy years. In recent years, however, coal use has been more affected by competition with natural gas and wind power, pollution control requirements, and carbon dioxide (CO_2) allowance prices under the European Union Emissions Trading Scheme (EU-ETS). Power generation's share in coal demand has declined from 88.1% in 2007 to 77.8% in 2010.

In 2014, coal provided 44.7 terawatt hours (TWh) of electricity, or 16.3% of total generation. Around 5% of total electricity generation in Spain is produced from domestic coal. For comparison, in 2010, coal only accounted for 8.8% of total generation, providing 26.3 TWh.

Figure 6.1 Coal supply by sector, 1973-2013



Note: TPES by consuming sector.

* *Other transformations* includes coke ovens, other refining and energy own-use.

** *Industry* includes non-energy use.

*** *Commercial* includes commercial and public services, agriculture/forestry and fishing (negligible).

Source: IEA (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

INDUSTRY STRUCTURE

Spain's coal mining industry has been consolidating and its production declining for a couple of decades and these trends are set to continue. From 1990 to 2014, the number

of coal mining companies fell from 234 to 13, the number of workers from 45 200 to 3 126 and coal production from 19.2 Mt to 3.9 Mt.

Existing coal mining companies are very small. In 2013, only seven companies produced more than 100 kilotonnes (kt) (see Table 6.2) and only one company had more than 500 miners.

Table 6.2 Coal producers by capacity, 2014

Annual production capacity, kt	Number of companies	Total annual production, kt	Share in total production
< 25	3	31	0.8 %
25-100	3	215	5.5%
> 100	7	3 657	93.7%
Total	**13**	**3 904**	**100%**

Source: Ministry of Industry, Energy and Tourism.

POLICIES AND MEASURES

The production and use of domestic hard coal has long been an area of active government intervention in Spain. Hard coal production has been subsidised to make it competitive against imported coal and incentives. In addition, from 2011 to the end of 2014, some power generators were also obliged to use domestic coal as set out in Royal Decree 134/2010.

SUBSIDIES

Subsidies for producing hard coal and restructuring the coal industry are subject to EU rules and approval by the European Commission (EC). The Commission has permitted Spain to grant operating aid and inherited liabilities aid under these rules, laid out in Council Regulation 1407/2002 on state aid to the coal industry (until 2010) and in the Decision 2010/787/EU which will phase out gradually the remaining subsidies by the end of 2018. Until then, state aid may be granted for production in uncompetitive mines to help with their closure. Competitive hard coal production is set to continue.

As a prerequisite for receiving state aid, Spain and other EU member states have been required to submit to the Commission a national plan for gradually reducing coal mining and restructuring the economies of the mining regions. The plan should include production targets, staffing and aid levels, supply guarantees and economic restructuring policies for the coal mining regions.

The main coal policy document in Spain in recent years has been the National Coal Plan 2006-2012 (*Plan del Carbón,* or *Plan nacional de reserva estratégica de carbón 2006-2012 y nuevo modelo de desarrollo integral y sostenible de las comarcas mineras*). It follows the 1998-2005 plan. The government has submitted the Coal Closure Plan 2013-2018 to the Commission for its approval, as required under Decision 2010/787/EU.

In the 2006-2012 Plan, demand for coal was guaranteed by volume quotas for power plants set by the government. Power producers contract directly with mining companies for the volume and price of coal under their quota. Each power plant sets out the technical and

quality characteristics for the coal it purchases. Coal prices may vary for the same power plant depending on the supplier and also vary between power generating companies.

From 2006 to 2012, operating aid was to be reduced by 1.25% per year for underground mines and by 3.25% per year for opencast mines. Excluding aid from SEPI (*Sociedad Estatal de Participaciones Industriales*), the entity that manages state ownership in companies, to the operator of the stockpile HUNOSA, the 2006-2012 Plan considered that operating aid would decrease from EUR 345 million in 2007 to EUR 324 million in 2012. However, following the 2011 general election, the new government drastically reduced operating aid to coal mines from EUR 301.5 million in 2011 to EUR 38.4 million in 2013 and then further to EUR 33 million in 2014 (see Table 6.3) in order to meet the requirements of Decision 2010/787/EU, which will gradually phase out the remaining subsidies for hard coal by the end of 2018.

Table 6.3 Operating aid to coal mining companies, 2009-14

	2009	2010	2011	2012	2013	2014
Private companies (EUR million)	244.15	239.37	229.07	30.85	32.17	28.53
HUNOSA	78.62	75.47	72.45	27.44	6.26	4.46
Total	322.76	314.84	301.52	58.29	38.43	32,99
Aid per tonne (EUR)	*34.17*	*37.35*	*45.54*	*9.42*	*8.80*	*10.40*
Aid per employee (EUR)	*61 466*	*68 533*	*76 103*	*17 074*	*11 669*	*10.553*

Source: Ministry of Industry, Energy and Tourism.

Aid to former workers and for mine closures remains a consideration in the scope of Decision 2010/787/EU. The government is also spending on research and development (R&D) to develop clean coal technology, including carbon capture and storage (see Chapter 11).

OBLIGATION TO USE DOMESTIC COAL

The National Coal Plan 2006-2012 did not foresee Spain's recession, which led to an imbalance between supply and demand for domestic coal. On the one hand, demand for electricity declined, and on the other, domestic coal lost competitiveness as a source of electricity due to hydro availability, increases in renewable electricity with priority dispatch, competition against natural gas, and imported coal. At the same time, subsidised production of domestic coal continued more or less unchanged. As a result, domestic coal began to pile up at the mines. In 2009, the government set up the temporary strategic coal stockpile (*Almacenamiento Estratégico Temporal del Carbón*), which acquired the subsidised coal from local coal mines. HUNOSA was designated as the operator of the stockpile.

As an intended solution to the oversupply of domestic coal relative to the demand for it, the government introduced in 2010, under Royal Decree 134/2010, an obligation for ten power plants to use domestic coal. This obligation was implemented by giving priority to the dispatch of these ten indigenous coal-fired power plants over other power plants (preferential dispatch mechanism). The owners of the ten power plants running on indigenous coal were compensated to help them cover their generating costs. This compensation (at most EUR 400 million a year) is considered a regulated cost of the

electricity system and is covered under capacity payments. The plan was approved by the European Commission, as it complied with the state aid rules and internal electricity market legislation. The obligation was valid from 2010 to the end of 2014. Plans for any possible incentives for the use of domestic coal after 2014 had not been approved by the time of writing (May 2015).

AIR POLLUTION CONTROL

Operation of coal-fired power plants depends crucially on pollution control regimes. In Spain, these are largely determined by United Nations Economic Commission for Europe (UNECE) protocols and EU directives, notably the National Emission Ceilings Directive (2001/81/EC), the Large Combustion Plants Directive (LCPD, 2001/80/EC) and the Directive 2010/75/EU on Industrial Emissions (see Box 6.1). Under the first directive, Spain had to limit its total sulphur dioxide (SO_2) emissions to 746 kt by 2010. According to the Ministry of Agriculture, Food and Environment, Spain's emissions of SO_2 from large combustion plants were 404 kt in 2010, or 342 kt below the limit.

Box 6.1 The Directives on Large Combustion Plants and Industrial Emissions

EU air pollution legislation is affecting the current and future prospects of coal-fired power generation.

The **Large Combustion Plant Directive (LCPD, 2001/80/EC)** is aimed at reducing acidification, ground level ozone and particulates by controlling the emissions of sulphur dioxide, oxides of nitrogen and dust from large combustion plants. All combustion plants built after 1987 must comply with the LCPD emission limits. Those power stations in operation before 1987 have three options for complying: 1) by installing emission abatement equipment, e.g. flue-gas desulphurisation; 2) by operating within a "National Plan" setting a national annual mass of emissions calculated by applying the ELV approach to existing plants, on the basis of those plants' average actual operating hours, fuel used and thermal input, over the five years to 2000; or 3) by opting out of the Directive. An existing plant that chooses to opt out is restricted to 20 000 total hours of operation after 2007 and must close by the end of 2015.

The LCPD is expected to lead to retiring 8 gigawatts (GW) of coal-fired power capacity in the United Kingdom. In other EU countries, reductions are expected to be much lower, totalling around 10 GW. All in all, the shutdowns would affect around 2% of EU total generating capacity.

In 2011, the **Industrial Emissions Directive (IED, 2010/75/EU)** came into force, updating and merging seven pieces of existing legislation, including the LCPD. For power plants, the update tightens ELVs for sulphur dioxide (from 400 milligrammes per normal cubic metre (mg/Nm^3) to 200 mg/Nm^3). Operators will have to install selective catalytic reduction from 2016 to meet the nitrogen oxides (NO_x) ELV. Peaking plants (<1 500 annual operating hours) can run indefinitely, a Transitional National Plan to mid-2020 allows trading in most pollutant categories to reduce emissions equivalent to the Directive's ELVs, and a derogation allows operators to run their plants for just 17 500 hours after 1 January 2016 before closure, which must be before the end of 2023.

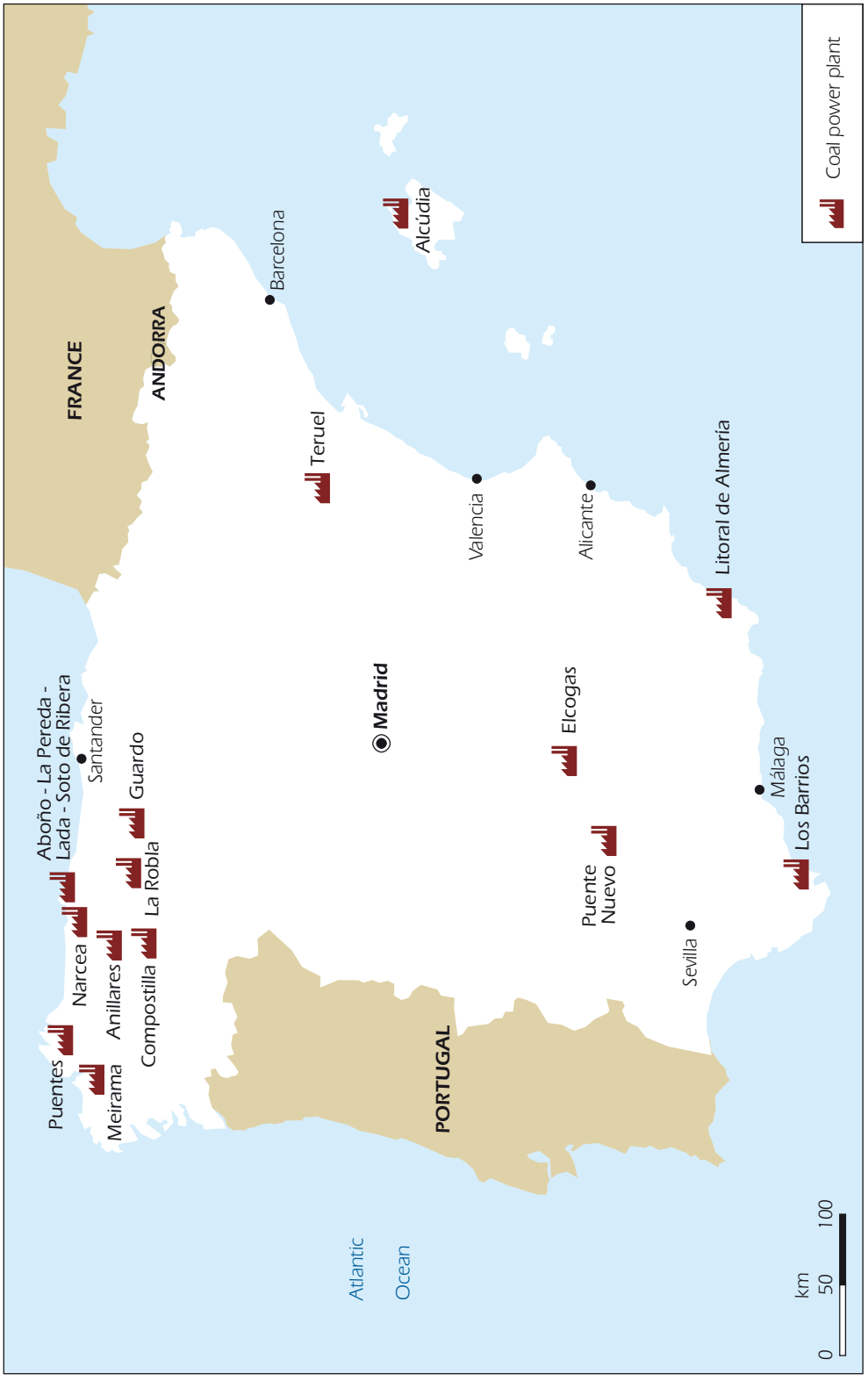
Table 6.4 Coal-fired power plants in Spain, 2014

Plant name	Location	Owner	Capacity, MW_e	Units, MW_e (commissioned)	Fuel	LCPD	Notes
Aboño	Candás, Asturias	Hidroelectrica del Cantábrico	903	1 x 360 (1974) 1 x 543 (1985) 1 x 800 (planned)	Bituminous coal	Plan Plan	FGD (2006)
Alcúdia	Puerto de Alcúdia, Mallorca	Gas y Electricidad S.A. (GESA)	510	2 x 125 (1982) 2 x 130 (1997)	Imported coal	Plan ELV	½ FGD (1998) FGD (1997)
Anillares	Páramo del Sil, León, Castilla y León	Gas Natural - Fenosa / Endesa	350	1 x 350 (1982)	Bituminous coal	Plan	
Compostilla	Ponferrada, León, Castilla y León	Endesa	1 030	1 x 330 (1972) 2 x 350 (1981/84)	Anthracite / Bituminous coal	Plan Plan	FGD (1996) FGD (2009)
Elcogas	Puertollano, Ciudad Real, Castilla-La Mancha	Elcogas	335	1 x 335 (1996)	Coal / petcoke	ELV	IGCC
Guardo	Velilla del Rio Carrión, Palencia, Castilla y León	Iberdrola	515	1 x 165 (1964) 1 x 350 (1984)	Bituminous coal	Plan Plan	FGD (2009)
Lada IV	Langreo (Asturias)	Iberdrola	350	1 x 350 (1981)	Bituminous coal	Plan	FGD
La Pereda	Mieres, Asturias	Hulleras del Norte	50	1 x 50 (1994)	Waste coal	ELV	CFBC
La Robla	La Robla, León, Castilla y León	Gas Natural - Fenosa	620	1 x 270 (1971) 1 x 350 (1984)	Anthracite / Bituminous coal	Plan Plan	FGD (2008) FGD (2008)
Litoral de Almería	Carboneras, Almeria, Andalucía	Endesa	1 100	2 x 550 (1984/87)	Imported coal	Plan	½ FGD (1997)
Los Barrios	Algeciras, Cádiz, Andalucía	E.ON	550	1 x 550 (1985)	Imported coal	Plan	FGD (2008)
Meirama	Cerceda, La Coruña, Galicia	Gas Natural - Fenosa	550	1 x 550 (1980)	Imported coal	Plan	
Narcea	Tineo, Oviedo, Asturias	Gas Natural - Fenosa	569	1 x 65 (1965) 1 x 154 (1969) 1 x 350 (1984)	Anthracite / Bituminous coal	Plan Plan Plan	FGD (2008)
Puente Nuevo	Puente Nuevo, Córdoba, Andalucía	E.ON	324	1 x 324 (1980)	Bituminous coal	Plan	FGD (2008)
Puentes	As Pontes, La Coruña, Galicia	Endesa	1 400	4 x 350 (1976-79)	Imported coal	Plan	
Soto de Ribera	Ribera Arriba, Oviedo, Asturias	Hidroelectrica del Cantábrico	350	1 x 350 (1984)	Bituminous coal	Plan	FGD (2008)
Teruel	Andorra, Teruel, Aragón	Endesa	1 050	3 x 350 (1979-80)	Bituminous coal / lignite	Plan	FGD (1996 & 2000)

Notes: Abbreviations: CFBC – circulating fluidised bed combustion; FGD – flue-gas desulphurisation; IGCC – integrated gasification combined-cycle; MW_e - megawatt electrical.

Sources: The National Plan for Reducing Emissions from Large Combustion Plants (PNRE-GIC); Ministry of Industry, Energy and Tourism; UNESA.

Figure 6.2 Map of coal-fired power plants in Spain, 2014



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: Ministry of Industry, Energy and Tourism.

Until 31 December 2015, under the LCPD, emissions to air of SO_2, NO_x and particles from installations with a thermal input capacity above 50 megawatts (MW) are regulated. New plants (licensed after 1 July 1987) had to comply with the directive's emission limit values (ELVs) immediately, while existing plants were given until 1 January 2008 to be allowed to operate under a national plan to achieve equivalent pollution reductions. Plants which are operated 20 000 hours or less between 1 January 2008 and 31 December 2015 may opt out. Spain was granted certain special derogations that permit less stringent ELVs or desulphurisation rates for particular plants.

Since the 2009 International Energy Agency (IEA) in-depth review, some power plants opted out and closed. These are: *Escatrón*, *Escucha*, *Cercs*, *Lada III*, *Puertollano* and two generation units in the *Soto de Ribera* power plant. Spain has 17 operating coal-fired power plants, with status under the EU Large Combustion Plants Directive (see Table 6.4 and Figure 6.2).

Coal-fired power generation emits more CO_2 per kilowatt hour (kWh) than other power plants, such as the combined-cycle gas turbines (CCGTs). One way to address this high carbon intensity is to increase plant efficiency. Air pollution legislation in the European Union is an indirect driver for increasing the efficiency ratio, as it requires upgrade and the closure of old, polluting and inefficient coal-fired power plants by the end of 2015.

ASSESSMENT

Around 85% of coal in Spain is used for power generation. In 2013 coal accounted for 9% of TPES, and around 15% of electricity supply in the country. Some two-thirds of this coal was imported and the remaining one-third was produced in Spain. In this decade, coal-fired power generation has ranged from 22 terawatt hours (TWh) to 55 TWh per year, varying mainly according to hydropower availability.

For regional and social policy reasons, the coal mining sector has long received subsidies. In the 2009 in-depth review, the IEA recommended the government continue to reduce these subsidies and set a date for their complete elimination. The IEA is pleased to note that this recommendation has been fully met.

The EU state aid rules introduced in 2010 dictate that subsidies for coal production in the Union must be eliminated by the end of 2018. Soon after taking office in 2011, the current government cut these subsidies by around 90% from more than EUR 300 million in 2011 to EUR 33 million in 2014. This has led to a dramatic decline in coal production in Spain.

As all domestically produced coal is used for power generation, coal production is part of electricity security of supply. However, in the short term the decline in domestic coal production has not threatened Spain's robust electricity security, as coal is abundantly available on the global market and electricity can be generated from many other energy sources.

In addition to subsidising domestic coal production, the government has also intervened to oblige coal-fired power plants to use this domestic coal, as most power plants would otherwise burn higher-quality imported coal. The regime was introduced by the previous government in 2011, but it expired at the end of 2014. This will reduce the annual costs in the electricity system by a maximum of EUR 400 million, as generators will no longer need to be compensated for using domestic coal. The IEA welcomes the decision to abandon this obligation.

From 2015 on, domestically produced coal will need to compete against imported coal in power generation. Although some mines located inland next to power plants are likely to survive, coal production in Spain can be expected to decline further. Coal used to generate power should also decline with the entry into force of the Large Combustion Plant Directive. Investments are needed to reduce pollutants from existing coal plants and this may not be economic. The date of closure of these plants will impact both coal and electricity markets.

The IEA encourages the government to continue efforts to eliminate the remaining subsidies for coal production by the end of 2018, as required under Decision 2010/787/EU. The government should also ensure stable regulatory conditions for the use of domestic coal in electricity generation.

RECOMMENDATIONS

The government of Spain should:

- ☐ *Continue efforts to eliminate the remaining subsidies for coal production by the end of 2018, as required under the Decision 2010/787/EU.*
- ☐ *Ensure stable regulatory conditions for the use of domestic coal in electricity generation.*

References

BGR (Federal Institute for Geosciences and Natural Resources on behalf of the German Mineral Resources Agency) (2014), "Reserves, Resources and Availability of Energy Resources", *Energy Study*, BGR, Hannover, December.

IEA (International Energy Agency) (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

7. NATURAL GAS

Key data (2014 estimated)

Natural gas production: 24 mcm (negligible)

Net imports: 28.2 bcm, no change since 2004

Share of natural gas: 20.8% of TPES and 17.2% of electricity generation

Consumption by sector (2013): 29.9 bcm (industry 36.5%, power generation 33.6%, residential 12.3%, commercial and public services 9.4%, other energy 7.7%, transport 0.5%)

SUPPLY AND DEMAND

SUPPLY

Natural gas accounted for 20.8% of total primary energy supply (TPES) and 17.2% of electricity generation in 2014. Natural gas supply amounted to 23.7 million tonnes of oil-equivalent (Mtoe) or around 27 billion cubic metres (bcm) in 2014. This is 32.2% lower than in 2008 and 6% lower than in 2004. Gas supply peaked at 34.9 Mtoe in 2008, before the recession, and has been declining since.

IMPORTS AND EXPORTS

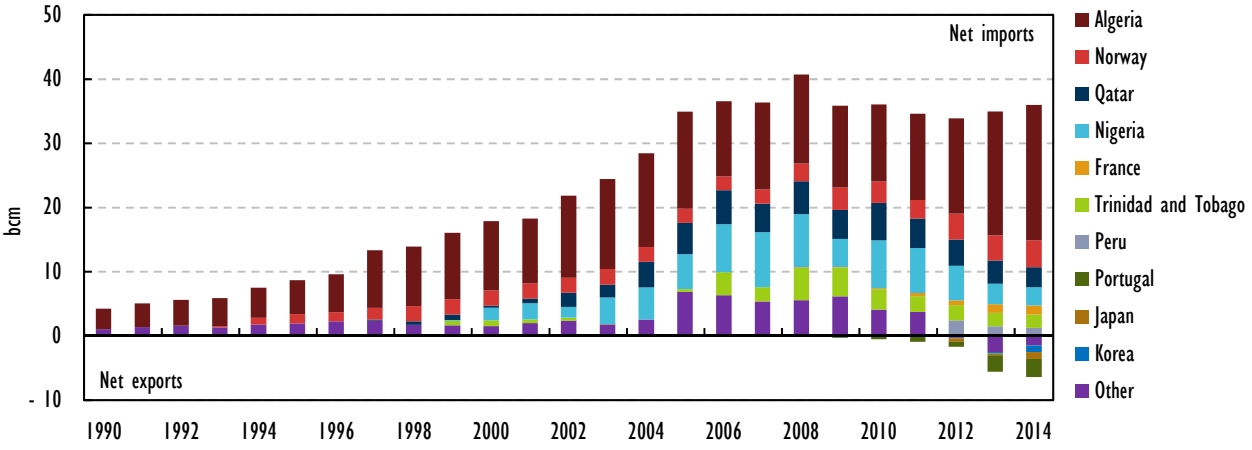
Spain relies on natural gas imports as production is negligible, some 24 million cubic metres (mcm) in 2014. In 2014, imports were 36.4 (bcm), originating mostly from Algeria (57.9% of the total), Norway (11.5%), Qatar (8.6%), Nigeria (7.8%), Trinidad and Tobago (5.7%) and France (4%). In total, Spain received gas from 11 countries.

Spain imports pipeline gas and liquefied natural gas (LNG), with pipeline gas accounting for 53% of total imports in 2014, according to the stockholding agency CORES. The share of LNG in total imports has fallen from 60% in 2012, owing to a steep decline in gas demand, high LNG prices and also the opening of the second import pipeline for Algerian gas. The traditionally high share of LNG (more than 50% of the annual total from 2000 to 2012) helps Spain to diversify its gas imports by country. Diversification is also a legal obligation. Under Royal Decree 1766/2007, in case the sum of all supplies of natural gas for national consumption from a given country exceed 50% of total imports, direct suppliers and consumers holding supplies for more than 7% of national annual consumption must limit their supplies from the country to less than 50% of the total. As a result, Spain has the most diversified import structure in Europe.

Spain also exports some of the imported gas, with re-exports amounting to 8.2 bcm in 2014, up from 5.8 bcm in 2013. Re-exports are a new phenomenon in Spain and reflect the decline in domestic demand and an increase in LNG demand and LNG prices in East Asia and Latin America. Spanish companies typically buy LNG under long-term contracts. The International

Energy Agency (IEA) expects that in 2015, Spain's LNG re-exports will halt, as the premium of fuel in Asia has fallen and European and Asian prices are converging again.

Figure 7.1 Spain's natural gas net trade by country, 1990-2014



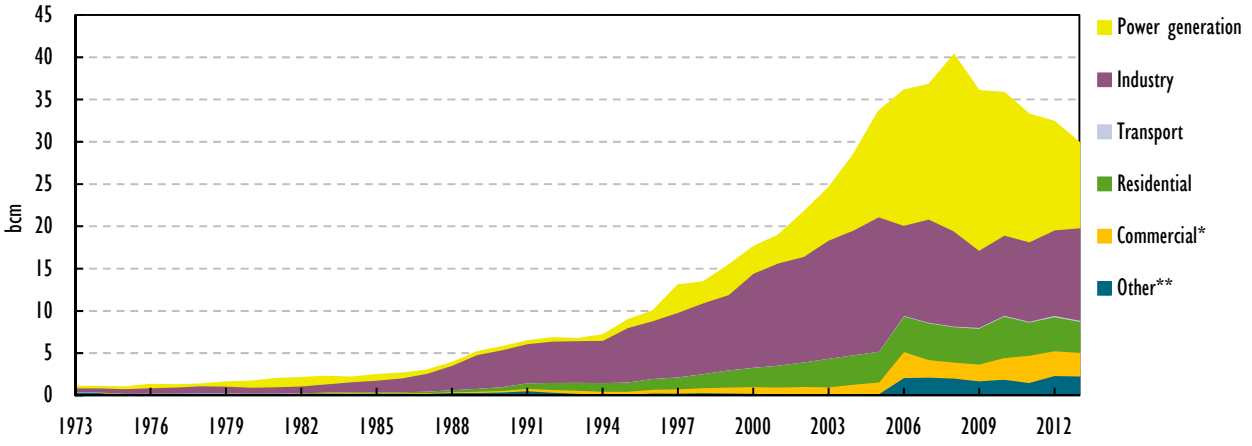
Note: data for 2014 are estimated.

Source: IEA (2015a, forthcoming), *Natural Gas Information*, OECD/IEA, Paris.

DEMAND

Natural gas demand amounted to 26.1 Mtoe (29.9 bcm) in 2013 (the latest year for which data are available). Natural gas consumption rose by 22.1% from 2003 to 2013 and peaked in 2008. From the peak to 2013, gas demand has contracted by 25.3% (Figure 7.2). According to Sedigas, the gas industry association, from 2013 and 2014, demand declined by 9.6%.

Figure 7.2 Natural gas demand by sector, 1973-2013



Notes: TPES by consuming sector.

* *Commercial* includes commercial and public services, agriculture/fishing and forestry.

** Other transformations includes LNG plants, other refining and energy own-use.

Source: IEA (2015a, forthcoming), *Natural Gas Information*, OECD/IEA, Paris.

Industry was the main consumer of natural gas in 2013. It accounted for 36.5% of total demand, up from 25.4% in 2009. Industry's natural gas demand increased by 20.2% from the low in 2009.

Power generation accounted for 33.6% of total consumption in 2013. Demand from this sector grew fast for more than a decade before peaking at 20.8 bcm in 2008 (at 52% of total natural gas demand). Since then, demand has halved to 10.1 bcm in 2013. Demand has fallen on the one hand with the general decline in electricity demand, on the other hand with increases in power generation from imported coal and from sources that by law benefit from priority dispatch, i.e. wind, solar and also domestic coal. In 2013 and 2014, Spain's natural gas power plants were in use on average only 11% of the time.

Households consumed 12.3% of natural gas in 2013, followed by commercial and other services (9.4%), refining and energy own-use (7.7%), and transport (0.5%). From 2003, gas demand in commercial services (including agriculture) more than doubled while demand from LNG processing and refining (including energy own-use) boomed from less than 1% of total demand. Households consumed 8.6% more gas in 2013 than in 2003, while the transport sector has doubled its consumption from initial negligible levels in 2006.

REGULATORY FRAMEWORK

The legal basis for the functioning of Spain's natural gas system is provided by EU regulations and national laws implementing European Union (EU) directives. Since 2008, as in the electricity sector, the European Union has increased harmonisation in the natural gas sector with the aim of creating a single market by 2015.

Natural gas market integration has focused on two areas: first, integrating national and regional gas markets and co-ordinating system operations via commonly agreed network codes and, secondly, constructing cross-border interconnections and co-ordinating network infrastructure planning via the European Network of Transmission System Operators for Gas (ENTSO-G) ten-year network development plans and regional plans. Spain's natural gas market design and interconnection developments are explained in the following sections of this chapter.

The relevant EU directives and regulations for natural gas are:

- Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC ("Gas Directive")
- Regulation (EC) No 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005 ("Gas Regulation")
- Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators ("ACER Regulation")
- Regulation (EU) No 1227/2011 of the European Parliament and of the Council on wholesale energy market integrity and transparency ("REMIT Regulation").

The cornerstone of the 2009 Gas Directive is effective separation of network activities from supply, generation or production activities, so-called unbundling. The directive also strengthened the independence of national regulatory authorities from the governments

and promotes their co-operation at EU level through ACER. It also increased the independence of the transmission system operators (TSOs) and their co-operation at EU level, through ENTSO-G.

The Gas Directive was transposed into national legislation by the Royal Decree-Law 13/2012 in March 2012. The Royal Decree-Law transposes the unbundling provisions as follows:

- The unbundling model adopted for the main TSO (Enagás Transporte, with more than 95% of transport pipelines) is "ownership unbundling". REGANOSA also has been certified as TSO by the National Commission of Markets and Competition (CNMC), the regulator. Enagás Transporte was floated on the Madrid stock exchange in June 2002. No shareholder is allowed to have more than 3% of voting rights, or 1% if the shareholder is active in the natural gas sector.
- Small gas TSOs in Spain can opt between the ownership unbundling model or the Independent System Operator (ISO) model.
- CNMC will be in charge of the certification procedure as foreseen by the directives, taking the utmost account of the European Commission´s opinion.

For distribution companies, legal and functional unbundling from supplier and production companies applies.

The Royal Decree-Law 13/2012 also empowered the regulator *Comisión Nacional de Energía* (CNE) since June 2013 integrated into the newly established *Comisión Nacional de los Mercados y la Competencia, CNMC*) as the national regulatory authority with the new competences laid out in the EU directives and regulations for natural gas mentioned above. These include the methodology applied in third-party access tariffs, TSO accreditation, the methodology regarding the provision of balancing services, the compliance monitoring of network security and reliability rules, and access conditions to storage, including underground storage, LNG storage tanks, line packs, and other ancillary services and the assessment of TSOs' investment plans.

CROSS-BORDER MARKET INTEGRATION

The 2009 EU legislation (the Third Package) also moved regulation of gas transmission pipelines on cross-border issues into an EU framework which builds on the independence and the EU-wide co-operation of the TSOs and the national regulatory authorities (NRAs).

Regional gas market integration has been developed under the South Gas Regional Initiative (SGRI) in co-operation between the regulators and TSOs from France, Portugal and Spain. Capacity allocation mechanisms and congestion management procedures have been developed according to the European network codes (see below). SGRI has also made progress and continues to work on issues such as incremental and new capacity, interoperability and data exchange, balancing, congestion management and developing a gas hub in the market of these three countries. These are also included in the SGRI 2015-16 work programme.

As individual EU national gas markets have different network operation rules, the Third Package includes also a procedure to agree on harmonised technical rules through the adoption of EU-wide framework guidelines (FG) and network codes (NCs). The codes are applicable to interconnection points between entry-exit zones, either cross-border or within a country. The areas in which the FG and NCs are to be adopted are listed by Article 8(6) of Regulation (EC) No 715/2009. These 12 areas are:

- network security and reliability rules
- network connection rules
- third-party access rules
- data exchange and settlement rules
- interoperability rules
- operational procedures in an emergency
- capacity allocation and congestion management rules
- trading rules related to technical and operational provision of network access services and system balancing
- transparency rules
- balancing rules, including network-related rules on nominations procedure, rules for imbalance charges and rules for operational balancing between TSOs' systems
- rules regarding harmonised transmission tariff structures
- energy efficiency regarding gas networks.

CURTAILING THE TARIFF DEFICIT

Regulated third-party access to all basic gas infrastructures (pipelines, LNG facilities and underground storage) is founded on cost-based access tariffs. Entry-exit single-zone tariffs apply in the whole gas system. According to the Third Package rules, the methodology and tariffs are set by the CNMC and the Ministry of Industry, Energy and Tourism (Minetur) and are expected to cover the costs of remunerating infrastructure owners.

The large investments made in the gas sector in recent years and the decrease in demand owing to the recession had started to create an imbalance between revenues and costs, albeit a much lower one than the imbalance in the electricity sector. The Royal Decree-Law 13/2012 introduced measures to prevent these imbalances, including *i)* a moratorium on new regasification plants; *ii)* a moratorium on administrative authorisations for new gas transport pipelines and metering stations; and *iii)* modifications to the remuneration of underground storage areas.

In 2013, gas demand continued its steep decline, and access tariff revenues fell short of regulated costs by EUR 326 million. From 2008 to 2013, the gas system's costs had increased by one-quarter, while the system's revenues had declined by one-quarter. According to Minetur, the accumulated tariff deficit reached EUR 400 million at the end of 2013 and, without measures, would have reached EUR 800 million by the end of 2014.

To stop the tariff deficit from growing and to gradually eliminate it altogether, in July 2014 the government passed the Royal Decree Law (RDL) 8/2014 that applies to the gas system's regulated costs and revenues. The Royal Decree Law was later confirmed by Law 18/2014 of 15 October.

According to Law 18/2014, the natural gas system's revenues must cover the system's costs. Revenues can only be used to cover these costs and if the costs increase, the revenues must be increased correspondingly. RDL 8/2014 also specifies the costs that will be financed by the system's revenues. The main cost element is the remuneration

of transport, regasification, storage and distribution. The revenues will also be used to pay down the accumulated tariff deficit over 15 years from 2015 on.

Law 18/2014 establishes separate methodologies for remunerating distribution, on the one hand, and regasification, transport and storage, on the other. Distribution companies are remunerated on the basis of the remuneration for the previous year, and the growth of its customer and sales base.

Remuneration of transport, regasification and storage has two components. The fixed component covers operating and maintenance costs, depreciation and a financial return on the net asset value of the company equalling the average rate of the ten-year government bond over the previous 24 months, plus 50 basis points. The variable component allows the owners of facilities to cover the risk of demand fluctuations. The parameters for calculating the remuneration are valid for six years, but can be revised after three years under exceptional circumstances.

The TPA tariffs will be automatically increased in the following year, if the annual tariff deficit reaches more than 10% or if the combined annual tariff deficit and the remaining annuities of paying down the accumulated tariff deficit exceed 15%. The tariff increase will correspond to the volume by which those thresholds were exceeded.

INFRASTRUCTURE

Spain had 81 000 kilometres (km) of natural gas pipelines in 2013. Other major elements of gas infrastructure are the six operational LNG terminals and four underground storage facilities (see Figure 7.3). The gas grid serves 76% of the population and reaches 1 700 municipalities, 6 000 industrial facilities and 7.55 million customers in total.

The gas transmission infrastructure is developed under the regulated system allowing for full cost recovery by the developer. The government is using an infrastructure planning approach to assess the need for new transmission lines, LNG facilities and underground storage. Companies building the required infrastructure will be guaranteed a return on their investment, but will have to make it available for use by third parties.

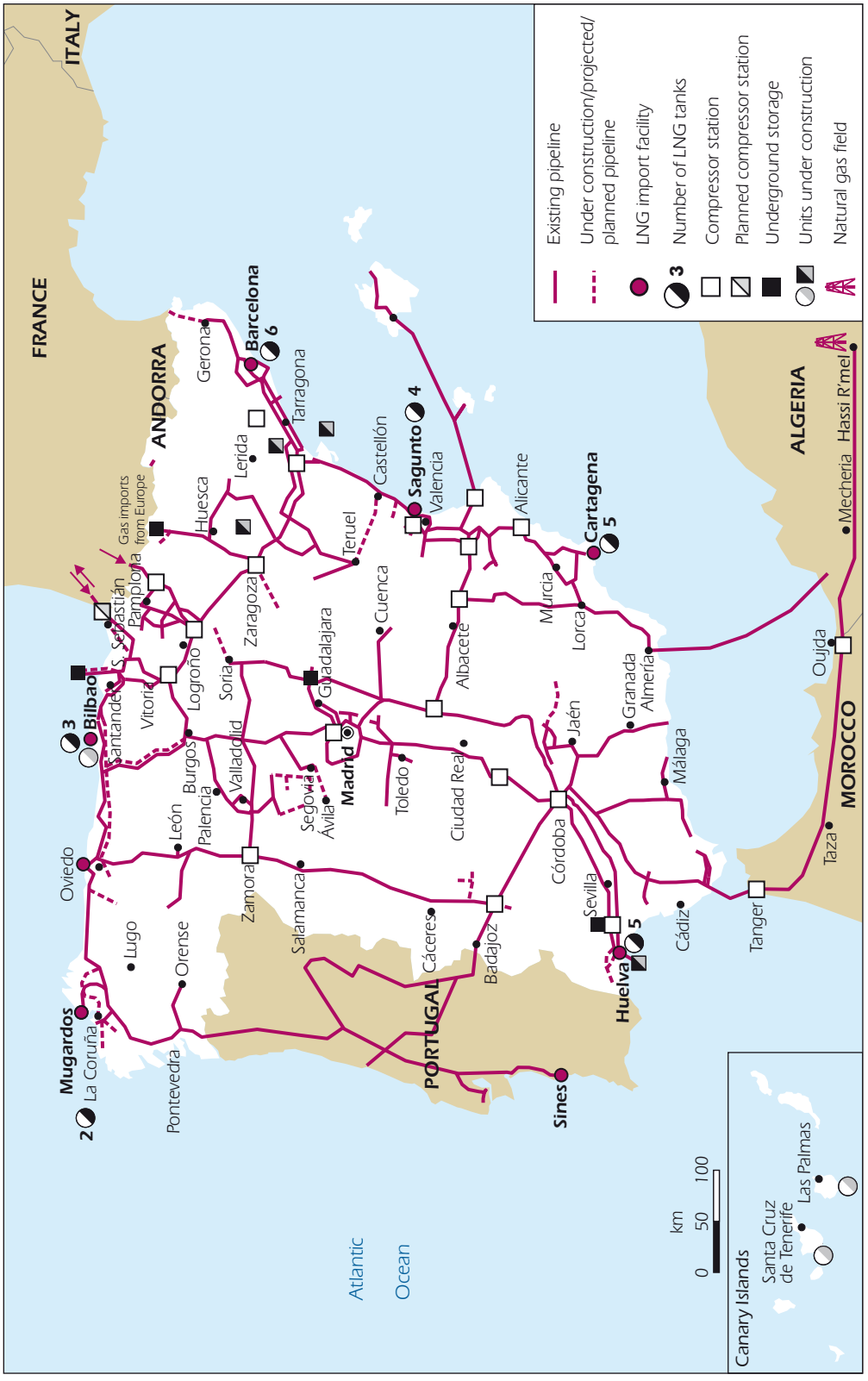
Because of the unforeseen decline in gas demand since 2008, the government revised the 2008-2016 National Infrastructure Investment Plan in 2012. The Royal Decree-Law 13/2012 cancelled or postponed projects for new regasification plants and pipelines not deemed economically profitable for the system, excluding international commitments and those pipelines mainly used for the local supply of natural gas. A new National Infrastructure Investment Plan to 2020 is yet to be approved

INTERCONNECTIONS

The Spanish gas grid is connected with Algeria, Morocco, Portugal and France (see Figure 7.3 and Table 7.1). Algerian gas is imported via Morocco over the 12 bcm/year Maghreb pipeline and, since 2010, directly from Beni Saf to Almería over the 8 bcm/year Medgaz pipeline. Both import pipelines have several billion cubic metres of annual spare capacity.

The interconnections with France and Portugal are bi-directional. The two interconnections with Portugal, at Tuy and Badajoz, have spare capacity, whereas the capacity of the two interconnections with France, at Larrau and Biriatou, faces congestion.

Figure 7.3 Map of the Spanish natural gas infrastructure, 2014



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

The development of gas interconnection capacity between France and Spain has been a priority for integrating the Iberian Peninsula with the rest of Europe. Capacity has been increased recently, on the basis of long-term commitments taken by shippers through the "open seasons" of 2013 and 2015. Capacity at the Biriatou-Irun interconnection is set to increase further to 1.9 bcm/year in both directions by early 2016.

The MidCat project will link France and Spain east of the Pyrenees. It would increase the annual capacity from Spain to France to around 14 bcm and from France to Spain to around 13 bcm. It would also require strengthening the gas network in France at the cost of around EUR 600 million. In 2013, MidCat was included in the European Union's energy infrastructure projects of common interest (PCI). It is also considered a key security of supply in the 2014 European Energy Security Strategy Communication. It will therefore be eligible for EU funding, including from the sizable structural funds.

Spain and France confirmed in December 2014 their commitment to increasing natural gas interconnection capacity, in particular through the MidCat project. The development of MidCat was agreed upon by the Prime Ministers of France, Portugal and Spain and the President of the European Commission at a summit on 4 March 2015.

Table 7.1 Spain's cross-border natural gas interconnections, 2014

From	Capacity, bcm	To	Capacity, bcm
Portugal – Badajoz	2.1	Portugal – Badajoz	4.0
Portugal – Tuy	0.75	Portugal – Tuy	1.2
France – Larrau	5.1	France – Larrau	5.1
France – Biriatou/Irun	0.3	France – Biriatou/Irun	0.3
Algeria	12.0		
Morocco	8.0		
Total to Spain	**28.25**	**Total from Spain**	**10.6**

Source: Enagás Transporte.

In recent years, wholesale prices for natural gas were higher in Spain than in France, reflecting the increase in international prices of LNG which was mainly driven by a raise of Asian demand after the Fukushima accident. More interconnection capacity with France would lead to closer a price convergence that would benefit Spain and Portugal under current price trends.

Capacity allocation and congestion management of interconnections are based on EU rules. The first co-ordinated auction of yearly products in all virtual interconnection points within the SGRI, with France, Portugal and Spain) took place in March 2014. SGRI's objective for 2015 is to introduce day-ahead and daily products. These auctions are considered crucial for completing the EU internal market for natural gas.

UNDERGROUND STORAGE

Spain has four operating underground gas storages (UGS) sites. They have a combined working gas capacity of 4.1 bcm, a total injection capacity of 22.7 mcm/d and a withdrawal capacity of 31.5 mcm/d (see Table 7.2). Out of the four sites, three are depleted gas fields: Gaviota (offshore, Basque country), Serrablo (Huesca) and Marismas (Huelva). Yela

(Guadalajara), in turn, is a saline aquifer. Marismas is owned by a subsidiary of Gas Natural Fenosa, and the other three by Enagás Transporte.

Table 7.2 Underground gas storage in Spain, 2014

UGS site	Working gas capacity, bcm	Injection capacity, mcm/d	Withdrawal capacity, mcm/d
Gaviota	1.547	4.5	5.7
Serrablo	0.82	3.8	6.7
Yela	1.05	10	15
Marismas	0.686	4.1	4.1
Total	**4.103**	**22.4**	**31.5**

Source: Gas Infrastructure Europe, on the basis of data from Enagás Transporte.

The total working volume of Spain's underground gas storage has increased strongly since 2008, when only Gaviota and Serrablo were operational. This and the decline in gas demand has helped increase the share of gas storage working capacity in total gas demand from 6% in 2008 to around 14% in 2013, a share lower than the EU average of around 20%. Spain uses storage at its LNG terminals to complement UGS**.**

The plan to further increase UGS capacity at Gaviota was abandoned because of the decline in gas demand. The 1.9 bcm Castor offshore UGS project was commissioned in April 2012, and, subsequently, cushion gas injection started in May 2013. However, in view of the induced seismicity, further studies were commissioned in this regard. In the meantime, operations were suspended until conclusions arising from these studies become available. Then, a formal decision must be adopted by the Ministerial Board, in accordance with the Royal Decree-Law 13/2014 of October 2014.

The Royal Decree-Law 13/2014 introduced a general and specific legal framework (in economic and safety terms) for this project, in accordance with the Hydrocarbons Law. It also established the provisions for the current transitory period until the studies are finished and the final decision is adopted.

Enagás GTS manages the total available UGS capacity as a single facility in order to optimise network operations and to minimise gas flows from storage to consumers. It allocates UGS capacity in the following order: first, capacity is allocated to the supplying companies according to three ratios: *i)* final firm sales in the previous year (up to 20 days of firm demand in order to comply with the strategic reserves obligation imposed by law), *ii)* total sales (firm and interruptible) in the previous year (ten days) and *iii)* sales to potential customers under the last-resort tariff (30 days). The remaining capacity is allocated through an auction mechanism.

LNG FACILITIES

Spain has six operating regasification plants. At the end of 2014, they had a total LNG storage capacity of 3.3 mcm (equivalent to 2.0 bcm of gas storage), with a maximum emission rate of 7.1 mcm per hour, or 62 bcm per year (see Table 7.3). Since 2008, when the previous IEA in-depth review of Spain's energy policies was launched, all LNG terminals except for Mugardos have been expanded and the total regasification capacity has increased by 8%, despite the decline in gas demand.

Table 7.3 LNG regasification terminals in Spain, 2014

LNG terminal (owner)	LNG storage m^3 (n)	Emission capacity (mcm (n)/h)	Tanks
Barcelona (Enagás Transporte)	760 000	1,95	6
Huelva (Enagás Transporte)	619 500	1.35	5
Cartagena (Enagás Transporte)	587 000	1.35	5
Bilbao (BBG)	450 000	1.0	3
Sagunto (Sagunto)	600 000	1.0	4
Mugardos (Reganosa)	300 000	0.413	2
Total	**3 316 500**	**7.063**	**25**

Notes: m^3 = cubic metres; n = under normal temperature and pressure.

Source: Enagás.

Spain's LNG capacity continues to grow, as three LNG terminals are planned to be commissioned in the near term. El Musel in Asturias (300 000 m^3 of storage and of 800 000 m^3 of emission capacity per hour) was mothballed in 2012 and is ready to go into operation once gas demand recovers sufficiently. On the Canary Islands, Granadilla on Tenerife and Arinaga on Gran Canaria are being developed. Both will have 150 000 m^3 of storage and 150 000 m^3 of emission capacity per hour, but as of June 2015, their construction had not yet begun. All three projects are owned by Enagás Transporte.

The utilisation rate of Spain's LNG regasification capacity averaged 20.6% in 2013, slightly less than the EU average of 23.5%. These low utilisation rates reflect the declining demand for natural gas in Europe and increasing demand (and higher prices) for LNG in Asia and South America. LNG re-exports from Spain in 2013 amounted to 5.8 bcm and to 8.2 bcm in 2014.

Spain has the largest LNG regasification capacity in the European Union, accounting for around one-third of the EU total of 183 bcm in 2013. Because of rather low interconnection capacity, Spain's ample spare LNG capacity is of limited use outside the Iberian Peninsula, regardless of gas market conditions.

MARKET STRUCTURE

The Spanish natural gas sector is privately owned and operated; this includes production, transmission, distribution and retail. Gas Natural Fenosa is the leading shipper in Spain. Enagás Transporte owns and operates most of Spain's high- and medium-pressure grid, as well as three of the country's six LNG regasification terminals.

WHOLESALE MARKET

Most of the gas traded in the Spanish market is negotiated in bilateral over-the-counter (OTC) transactions, over an electronic trading platform developed by Enagás Transporte, called "MS-ATR". In addition to OTC trading, the gas wholesale market comprises auctions at different horizons for regulated activities (for the last-resort supply, and working and cushion gas). These auctions are run by OMIE, the electricity market operator.

Natural gas is traded in Spain across eight balancing points: the six LNG terminals; the virtual balancing point (so-called AOC) and the virtual storage point comprising the four Spanish underground storage sites in operation (Serrablo, Gaviota, Marismas and Yela).

Liquidity lies mostly on the LNG terminals, which accounted for 65.5% of all OTC trade in 2013. The Barcelona LNG terminal was the main trading point with 17.7% of gas trade. The AOC accounted for 33.7% of OTC trade and less than 1% was traded at the underground storage sites. The trading volume in the Spanish OTC market in 2013 was 1.2 times natural gas demand. Liquidity has increased towards the end of 2014, according to CNMC, and reached more than three times physical volume in September-November 2014 (CNMC, 2015a).

The largest buyers in the OTC market in 2013 were Unión Fenosa with 20.9% and Gas Natural 14.9%. They both are part of the Gas Natural Fenosa Group. In total, around 40 traders are active on the OTC market.

Creating a gas hub in Spain is expected to increase the transparency of wholesale prices. This, in turn, could bring about efficiency and lower prices. In 2014 the Ministry of Industry, Energy and Tourism set up a working group to analyse the regulatory measures needed to launch a gas hub in 2015. This work involves all major stakeholders, including CNMC and Enagás Transporte, and is done in parallel with the SGRI. The Hydrocarbons Law, which includes the foundation of a gas hub, was approved by the Parliament in May 2015. As of June 2015, the ministry is developing a regulation on market rules for the operation of the gas hub.

DISTRIBUTION

The companies that carry out distribution activities are Gas Natural SDG S.A. Group, EDP Group, REDEXIS Group, Madrileña Red de Gas S.A., Gas Directo S.A., Distribución y Comercialización de Gas Extremadura S.A., Tolosa Gas, S.A. and Gasificadora Regional Canaria S.A.

RETAIL MARKET

At the end of 2014, Spain had 7.55 million gas consumers, around 99% of which were households (CNMC, 2015b). The number of consumers has increased constantly in the last years, by 10.6% since 2008.

The retail market is moderately concentrated, with a Herfindahl-Hirschman Index (HHI) of 2 250 in 2012. The three largest companies still supply around 70% of natural gas, but the number or new entrants is increasing. In 2014, Gas Natural Fenosa supplied 46.6% of all natural gas in the retail market. Endesa had a market share of 16.3%, Union Fenosa Gas 9.0%, CEPSA 6.7%, Iberdrola 4.9% and EDP 3.6%. Apart from CEPSA, these companies are also the largest ones in the electricity retail sector. The remaining 12.9% of sales were divided among three dozen companies. At the end of 2014, 106 companies were registered as retailers in the Spanish gas market, of which 42 were active.

In terms of number of customers at the end of 2014, Gas Natural Fenosa had 58.3% of the total. Endesa had 16.0%, EDP 11.1%, Iberdrola 10.9%, GALP 3.2% and E.ON 0.43%. The remaining 0.1% of customers (around 7 000) were supplied by several other retailers (CNMC, 2015b).

The rates of customers switching supplier vary, dropping from around 18-19% per year from 2011-12 to around 12-13% in 2013-14. Typically, around 70-80% of switching occurs within the free market section, while the rest are moves from the last-resort supplier to the free market (see below under "Prices and taxes").

EMERGENCY RESPONSE POLICY

The Spanish natural gas system is based on the System Technical Management Rules, with a procedure to cope with exceptional situations that may affect the operation of the system. The system operator (Enagás GTS) is responsible for putting this procedure into practice, declaring the level of emergency and co-ordinating the actions of the system users, namely traders, infrastructure owners and others. It must also keep the Ministry of Industry, Energy and Tourism, as well as CNMC, properly informed at all times, and must act in co-ordination with the electricity system operator on gas supply for electricity generation. An operation group, composed of representatives of the main gas users, supports the system operator in taking decisions.

CORES is responsible for controlling the minimum stockholding obligations that correspond to operators in the natural gas and liquefied petroleum gas (LPG) sectors, as well as for verifying the operators' obligation to diversify their natural gas supplies.

The 2015 Hydrocarbons Law obliges shippers and self-supplied consumers to maintain at all times natural gas stocks equalling 20 days of firm sales or consumption during the preceding calendar year (firm sales are supplies that cannot be interrupted, for either commercial or technical reasons). The stocks must be kept in underground storage. The government assumes control of the strategic stocks in emergency situations.

EMERGENCY RESPONSE MEASURES

Spain's gas emergency response measures are guided by EU Regulation 994/2010. Several stakeholders are given specific responsibilities in the event of a gas crisis, notably with regard to making gas stocks available to the market.

Enagás GTS, as the technical system manager, would declare one of three levels of exceptionality of the emergency situation, and would co-ordinate the actions of system users. The Ministry of Industry, Energy and Tourism would establish conditions and terms for the use of gas stocks by Enagás GTS. CORES is responsible for monitoring the gas stocks, and would be responsible for ensuring that the obliged entities fulfil their responsibilities with regard to stock releases.

The Spanish system is designed to be highly flexible (mainly through LNG diversification), and thus fuel switching is not regarded as a priority tool to face disruptions. Nevertheless, combined-cycle power plants can work with an alternative fuel (mainly diesel) for short periods of time.

ADDITIONAL MEASURES

Every year, the Winter Action Plan lays out additional requirements for shippers from 1 November to 31 March. The Winter Action Plan is approved on a yearly basis by the Directorate-General for Energy Policy and Mining at the Ministry of Industry, Energy and Tourism. The plan includes minimum stock levels, a method to predict the increase of demand in case of a cold spell and a cold spell definition.

Spain's gas network is based on the N−1 standard, an obligation under EU Regulation 994/2010. In the event of a disruption of the single largest infrastructure (N−1), the remaining infrastructure must be capable of meeting total gas demand in the country.

PRICES AND TAXES

WHOLESALE PRICES

In the absence of an organised gas hub to provide a single liquid transparent reference price for gas in Spain, the CNMC has developed a gas import index price, on the basis of customs declarations from shippers, reflecting the cost of short- and long-term contracts supplying the Spanish gas market.

This index shows that gas import prices more than doubled from a low of EUR 14.03 per megawatt hour (MWh) in July 2009 to EUR 28.59 per MWh in July 2012. The move was closely linked to an increase in oil price, as gas import prices are traditionally linked to it. In July 2012, the gas index price declined to EUR 26.39 per MWh in December 2013. According to the most recent information by CNMC (2015a), the index price was EUR 26.38 per MWh in November 2014. For comparison, the November price was 18% higher than the UK NBP price and 135% higher than the US Henry Hub price.

RETAIL PRICES

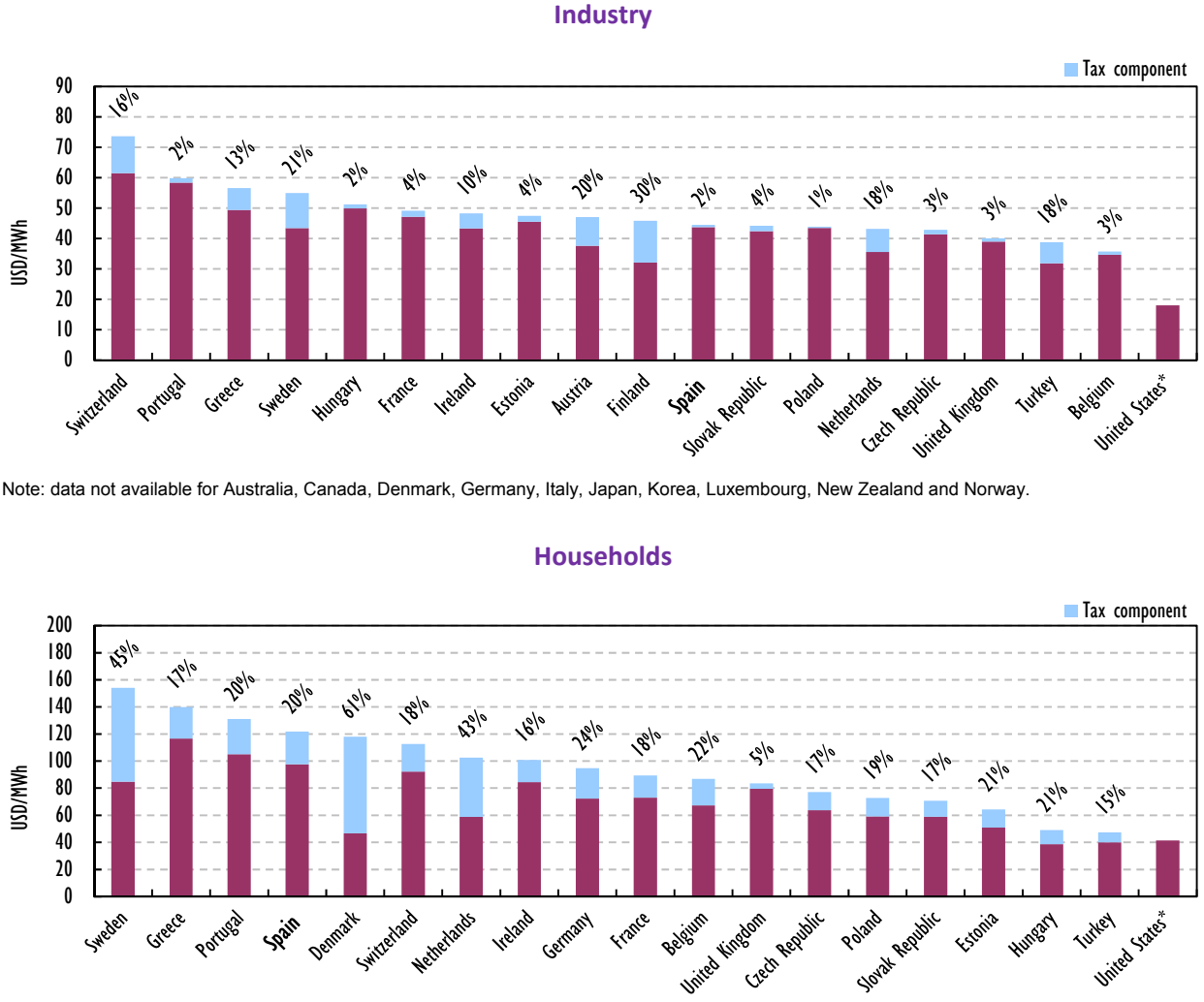
Natural gas prices for end-users peaked in 4Q 2008 and declined by 19% to 3Q 2009. Since then, prices increased every quarter to 2014, in total by 49%, according to the Eurostat consumer price index for natural gas in Spain. In 4Q 2014, the cost of natural gas for households was EUR 98 per MWh and for industry EUR 33 per MWh (IEA, 2015b). Among the IEA member countries, Spanish households pay rather high prices, while prices for industry are around the median (see Figures 7.4 and 7.5).

Taxes on natural gas have been increased in recent years. Retail prices for households include a value-added tax which has been 16% since 1995, but was raised to 18% in July 2010 and to 21% in September 2012. Retail prices also include an excise tax. It was introduced by Law 15/2012 of 27 December 2012 on fiscal measures for energy sustainability and applies from the beginning of 2013. For industry, the excise tax is EUR 0.15 per gigajoule (GJ), equalling EUR 0.54 per MWh). For households, it is EUR 0.65 per GJ, equalling EUR 2.34 per MWh.

LAST-RESORT TARIFF

Since July 2008, regulated tariffs for end-users (last-resort tariff) apply to residential customers consuming less than 50 MWh per year and connected to a network at a pressure under 4 bar. Consumers under the last-resort tariff are supplied by five main retailers which have been designated as suppliers of last resort (Gas Natural Fenosa, Endesa, GALP, EDP and Iberdrola).

Figure 7.4 Gas prices in IEA member countries, 2014



Note: data not available for Australia, Canada, Denmark, Germany, Italy, Japan, Korea, Luxembourg, New Zealand and Norway.

Note: data not available for Australia, Austria, Canada, Finland, Italy, Japan, Korea, Luxembourg, New Zealand and Norway.

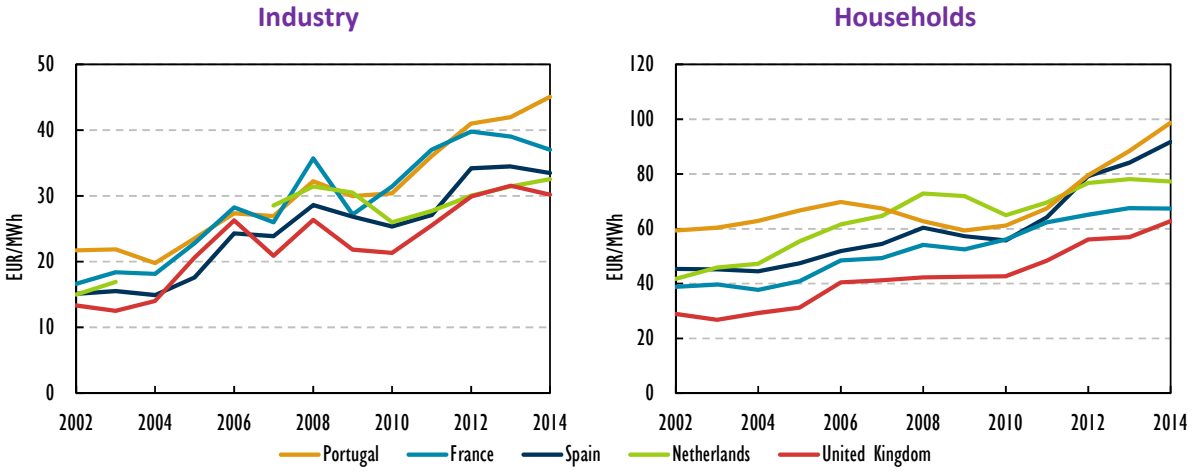
* Tax information not available.

Source: IEA (2015b, forthcoming), *Energy Prices and Taxes*, OECD/IEA, Paris.

The government sets the tariff with reference to international quotes (Henry Hub and NBP) and periodic gas auctions: two auctions have to be held each year for the "base load gas" product and one for the "winter gas" product. Ministerial Order ITC/863/2009, approved on 2 April 2009, regulates the auction procedures. The price is reviewed quarterly against Henry Hub, UK NBP and Brent crude oil prices.

At the end of 2014, 5.6 million customers (74.6% of the total) were supplied under the free market price, while 1.9 million consumers (25.4% of the total) were supplied under the last-resort tariff. In volume terms, only 3% to 4% of gas demand was supplied under the last-resort tariff.

Figure 7.5 Gas prices in Spain and selected IEA member countries, 2002-14



Note: data are not available for the Netherlands industry price from 2004 to 2006.

Source: IEA (2015b, forthcoming), *Energy Prices and Taxes*, OECD/IEA, Paris.

ASSESSMENT

The last IEA in-depth review of Spain coincided with the end of the long boom in natural gas demand in Spain. From 2008 to 2013, gas demand declined by one-quarter. The recession was a major factor in the decline, and so were developments in electricity generation, the largest gas user. As renewables and domestic coal were favoured by law and as international coal prices decreased, natural gas lost ground as a source of electricity. In 2013-14, Spain's combined-cycle gas turbines (CCGTs) only ran 11% of the time. The unforeseen trend change in gas demand has affected the natural gas sector in many ways.

In order to meet fast-growing demand, significant import capacity was built. The infrastructure planning did not foresee the end of the demand boom and by how much demand would fall after 2008. Spain now has six LNG terminals in operation, totalling 62 bcm of annual capacity, and 28 bcm of pipeline interconnections. In addition, another 7 bcm of LNG capacity is mothballed until demand picks up. Total import capacity is more than three times annual demand, and the LNG terminals are functioning at around 20% of their capacity.

From a positive angle, this overcapacity provides Spain with very robust gas infrastructure to ensure security of supply. Spain has also invested in underground storage capacity and raised its emergency stockholding obligations. It enjoys a high level of security of supply and has the most diversified gas import structure in Europe.

Spain has one-third of the total LNG regasification capacity in the European Union. This underutilised capacity can help increase flexibility, diversity and security in the EU internal market. For that to happen, more interconnection capacity is needed between the Iberian Peninsula and the rest of Europe.

The IEA therefore welcomes the recent decision to expand interconnection capacity between the Iberian Peninsula and France, in particular through the MidCat project. The IEA also recognises the importance of the Union's political and financial support for the project.

In the past few years, over-investment in gas infrastructure began to manifest itself in a tariff deficit resembling the one in the electricity sector. The mechanism was similar: the revenues

from network access tariffs were not high enough to cover the regulated costs of the gas system. These costs are mainly remuneration for transmission, distribution, storage and LNG regasification.

In 2012, the government cut system costs by halting the licensing of new infrastructure (with some exceptions including the infrastructure required to comply with international commitments) and by suspending the commissioning of the El Musel LNG terminal. However, this was not enough to balance the gas system's costs and revenues, as demand for gas was declining faster than expected. Falling gas demand, in turn, reduced the access tariff revenues from infrastructure use. By the end of 2013, a tariff deficit totalling EUR 400 million had accumulated. This was still just a bit more than 1% of the tariff deficit in the electricity sector, but the accumulated deficit was expected to double in 2014.

To solve the tariff deficit problem definitely, in July 2014 the government adopted new principles and methodologies for determining the regulated costs and revenues of the gas system. In the new system, revenues will be high enough to cover all costs and gradually eliminate the accumulated tariff deficit. All new costs must be matched by cost cuts or revenue (TPA tariff) increases. Also, the TPA tariffs will be automatically increased if the annual tariff deficit rises over a certain threshold.

The IEA congratulates the government for its action to stop the tariff deficit from growing and to gradually eliminate it. As in the electricity system, the government should now maintain a strong long-term commitment to balancing the costs and revenues also in the natural gas system. The IEA also advises the government to introduce a robust planning methodology for the development of new gas infrastructure to replace the short-term measure of halting the licensing of new infrastructure.

Wholesale gas trade in Spain is carried out bilaterally in an OTC market. Existing price indices include an index of border prices developed by the regulator (which is currently close to hub prices in northern Europe), as well as estimates of OTC transaction prices (which are higher). Spain would benefit from an organised gas hub to provide a more transparent price reference for gas. In a welcome development, the government set up a working group in 2012 to enable the creation of an organised market by 2015. The IEA urges the government to facilitate the setting-up of the gas hub without delay and welcomes the adoption of the revised Hydrocarbons Law in May 2015 in this regard.

Spain's retail gas market is fully liberalised. A large majority of consumers have opted for market offers and the annual supplier-switching rates are relatively high, ranging from 11% to 19% this decade. However, one-quarter of gas consumers are supplied under last-resort tariffs set by the government on the basis of auctions organised three times a year. Virtually all household consumers are eligible for the last-resort tariff. Although gas supplied under last-resort tariffs only accounts for 3-4% of total gas demand in Spain, the IEA encourages the government to phase out the last-resort tariff and consider more targeted options for household and vulnerable customers.

RECOMMENDATIONS

The government of Spain should:

- ☐ *Maintain a strong long-term commitment to balancing the costs and revenues in the natural gas system, in accordance with the new legal framework approved in 2014.*

- *Introduce a robust planning methodology for the development of new gas infrastructure to replace the short-term measure of halting the licensing of new infrastructure.*
- *Support the smooth launch and functioning of an organised gas hub in 2015, in accordance with the Hydrocarbons Law.*
- *Consider more targeted options for domestic and vulnerable end-users.*

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8. ELECTRICITY

Key data (2014 estimated)

Total electricity generation: 273.9 TWh, -1% since 2004

Electricity generation mix: nuclear 20.9%, wind 19.1%, natural gas 17.2%, coal 16.3%, hydro 14.3%, oil 5.2%, solar 5%, biofuels and waste 2%

Installed capacity*: 108.2 GW

Peak demand (2013): 40 GW

Electricity consumption (2013): 237.1 TWh (commercial services and agriculture 35.9%, residential 30.6%, industry 29.5%, energy sector 2.1%, transport 1.8%)

* Source: REE (2014).

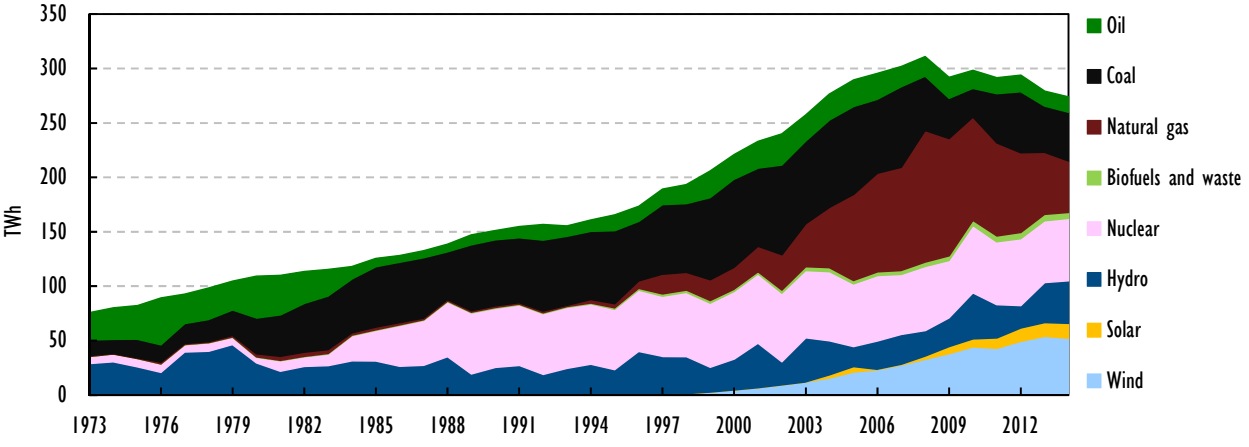
SUPPLY AND DEMAND

GENERATION

Electricity generation peaked at 311 terawatt hours (TWh) in 2008, after years of booming. Since then, generation has been on a downward trend with mild annual fluctuations. Electricity generation totalled 273.9 TWh in 2014, which is 1.9% lower than in 2013 and 11.9% lower than in 2008. Output in 2014 was 1% lower than ten years earlier in 2004.

Electricity is generated from diverse, well-balanced sources. In 2014, nuclear power was the main source, with a share of 20.9%. Wind power provided 19.1% and natural gas 17.2%. The remainder consists of coal (16.3%), hydropower (14.3%), oil (5.2%), solar (5%) and biofuels and waste (2%) (see Figure 8.1).

Figure 8.1 Electricity generation by source, 1973-2014



Note: data are estimated for 2014.

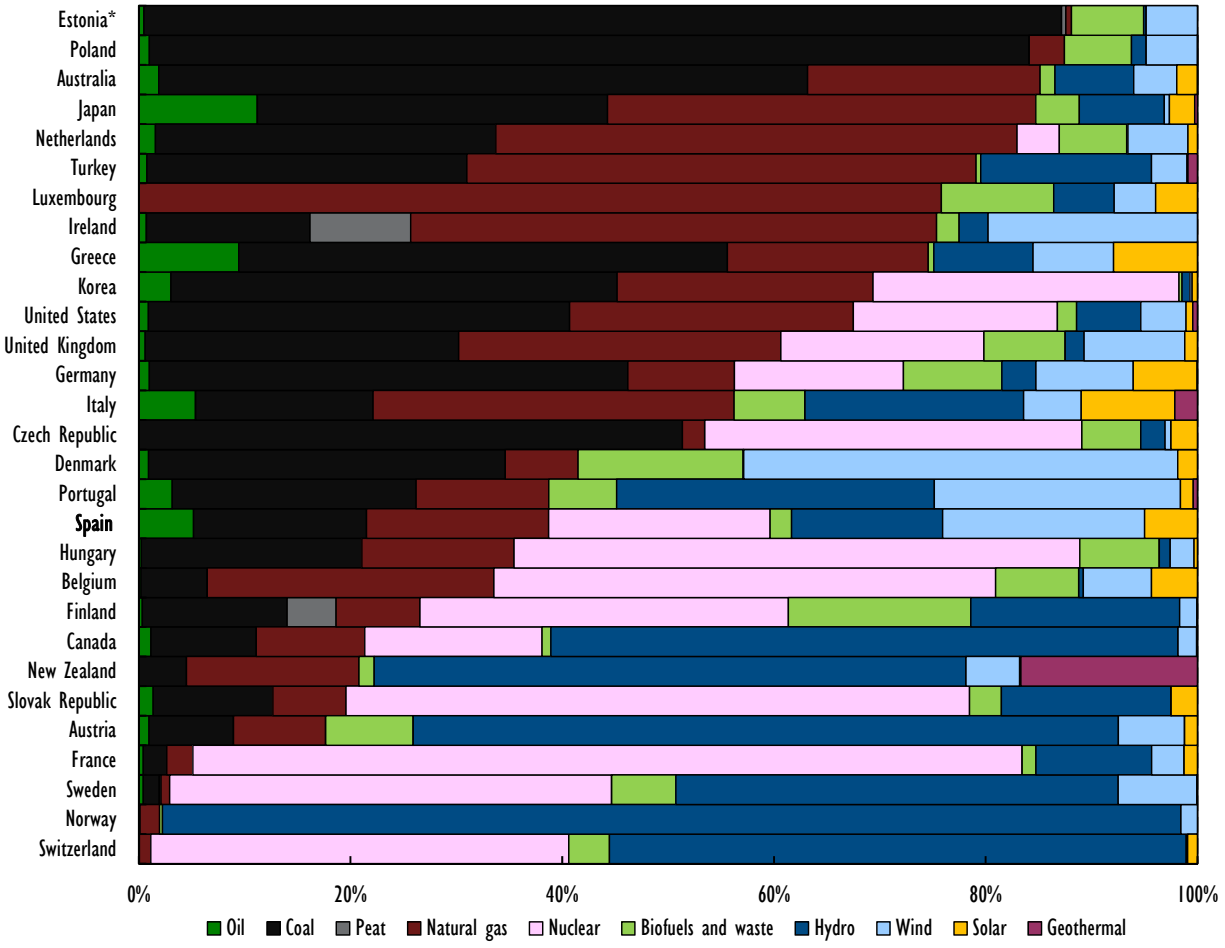
Source: IEA (2015a, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

Wind and solar power generation have boomed over the past decade while coal-fired and oil-fired generation have nearly halved. Nuclear power and hydropower fluctuate frequently, averaging 20% and 11% of total generation over the past decade, respectively. Natural gas-fired generation peaked at 38.8% of the total in 2008 and has been declining fast since.

According to government projections, electricity generation will expand by 12% to 312.5 TWh by 2020. Wind and solar power will continue to grow albeit at a much slower pace, while the use of coal and oil will continue to decline. The most significant increase will be in the use of natural gas which is expected to re-surge by the end of the decade, increasing by 48% to become the main fuel in electricity generation with a share of 27% of the total.

In comparison to other IEA member countries, Spain's share of fossil fuels in electricity generation was twelfth-lowest in 2014 (Figure 8.2) and the shares of both wind and solar power fourth-highest. Spain is ranked behind Denmark, Portugal and Ireland with regard to the share of wind in electricity generation and behind Italy, Greece and Germany with regard to the share of solar.

Figure 8.2 Electricity generation by source in IEA member countries, 2014



Note: data are estimated.

* Estonia's coal represents oil shale.

Source: IEA (2015a, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

GENERATING CAPACITY

Total installed capacity amounted to 108 gigawatts (GW) at the end of 2014, a decline of 0.1% from 2013 (see Table 8.1). 95% of capacity is in the peninsular system (mainland Spain) and 5% in the extra-peninsular system (the Balearic and Canary Islands, Ceuta and Melilla). From 2001 to 2008, the year of a peak in electricity generation, total capacity increased by 87%, led by increases in combined-cycle gas turbines (CCGTs) and wind power. This was one of the largest increases among the IEA member countries.

Table 8.1 Installed generating capacity at the end of 2014

Technology	Peninsular system, MW	Extra-peninsular system, MW	National total, MW
Hydro	19 891	8	19 899
Nuclear	7 886*		7 886
Coal	10 972	510	11 482
Oil	520	2 979	3 498
Natural gas (CCGT)	25 343	1 854	27 197
Wind	22 845	184	23 029
Solar PV	4 428	244	4 672
Solar thermal electricity	2 300		2 300
Renewable thermal	1 011	5	1 016
Co-generation and other	7 075	121	7 196
Total	**102 271**	**5 905**	**108 176**

* Includes the 455 MW Santa Maria de Garoña NPP which was shut down in July 2013, but for which an application for licence renewal has been submitted.

Source: REE (2014) *The Spanish Energy System. Preliminary Report 2014*. Madrid.

From the peak in 2008 to 2014, electricity generation declined by 13%, but generating capacity increased by another 14%, or 13.2 GW, largely thanks to subsidies. Wind power capacity increased by 7.3 GW, CCGTs by 4.2 GW, hydro by 3.2 GW and other renewables, mainly solar, and co-generation by 2.6 GW. Nuclear was practically flat (+0.2 GW), while oil-fired capacity decreased by 3.7 GW and coal-fired capacity by 0.4 GW.[1]

The heavy investment in gas-fired capacity as backup for wind power in the last decade is partly explained by the low cross-border transmission capacity that, even at the end of 2014, was only around 4% of generating capacity on mainland Spain (see Table 8.1).

Another factor was the limited availability of hydropower for backup. It may face difficulties in the coming decades as climate change may raise temperatures and increase droughts. After 2008, however, the decline in the use of CCGTs has been steep. The load factor of CCGTs was around 11% in 2013 and 2014. Demand for gas-fired power has fallen on the one hand because of the general decline in electricity demand, and on the other hand because

1. Capacity data are from 31 December of each year. This is particularly worth noting in the case of solar PV which increased by 2.7 GW in the course of 2008.

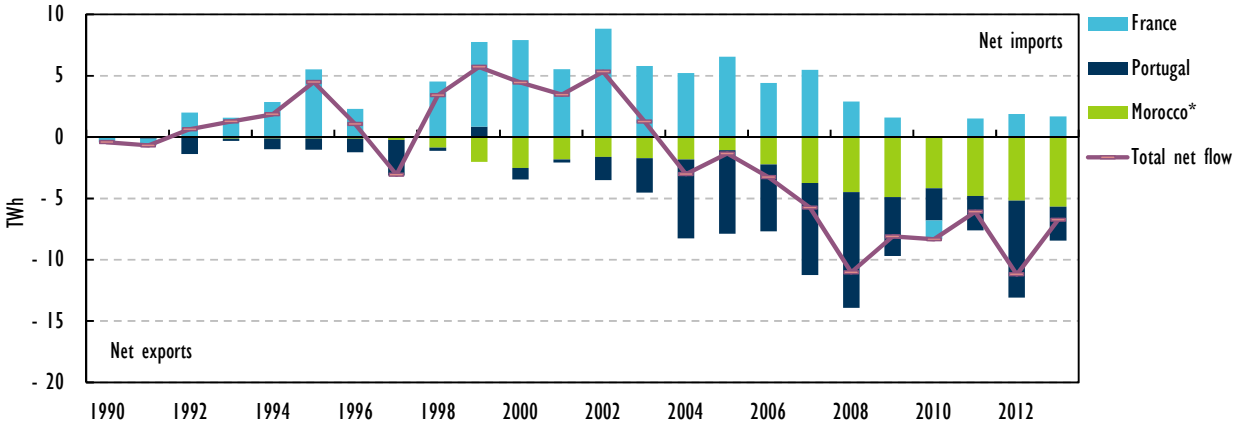
of increases in power generated from cheap imported coal and from sources that by law benefit from priority dispatch, i.e. wind, solar and also domestic coal.

IMPORTS AND EXPORTS

In 2014, Spain's cross-border electricity trade amounted to 28 TWh, corresponding to around 11% of electricity demand in the country. With exports of 15.7 TWh and imports of 12.3 TWh, Spain was a net exporter of 3.4 TWh.

The country has been a net exporter since 2004, previous to which the volume of trade was lower and net trade was more volatile. Since 2004, net exports have doubled, mainly owing to increasing exports to Portugal, which was made possible through growing interconnection capacity. Spain is a net exporter to Portugal and Morocco and a net importer from France since 2011. In 2013, net imports from France were 1.7 TWh. The volume of Spain's cross-border electricity trade by country varies from year to year, mainly because of weather conditions (see Figure 8.3).

Figure 8.3 Net electricity imports to and exports from Spain, by country, 1990-2013



* Includes exports to Andorra that are around 3% of total exports.

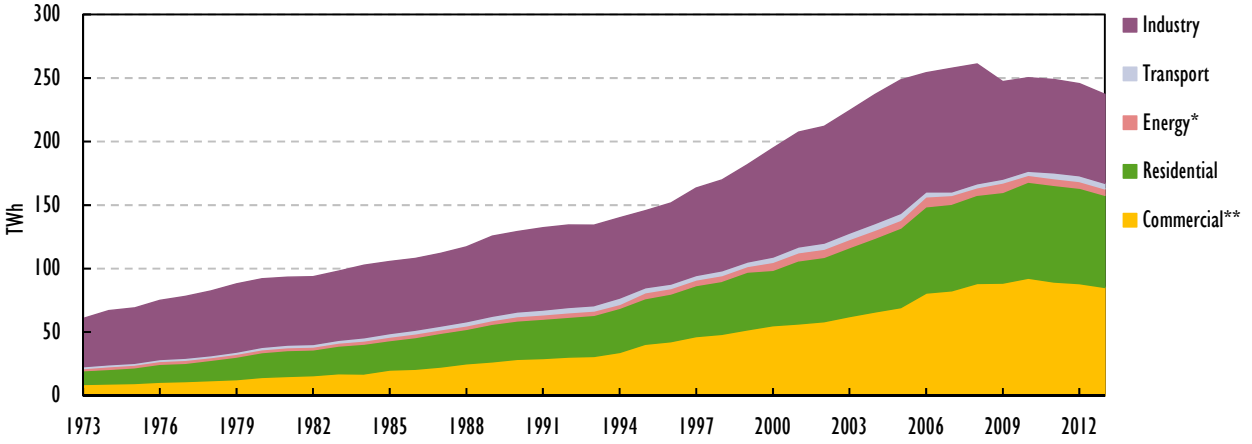
Source: IEA (2015b, forthcoming), *Electricity Information*, OECD/IEA, Paris.

DEMAND

Spain's electricity consumption amounted to 237.1 TWh in 2013. Demand peaked at 261 TWh in 2008, after decades of steady growth, declined by 5.3% in 2009 owing to the recession, recovered slightly in 2010 and has continued to fall since (see Figure 8.4). In 2013, consumption was 5.7% higher than in 2003, but 9.1% lower than the peak of 2008.

The commercial and public services sector (including agriculture) and the residential sector are the largest consumers. The commercial sector accounted for 35.9% of demand in 2013, up by 36.8% compared to 2003. The residential sector consumed 30.6%, increasing by 33.7% over the same period. Industry's demand accounted for 29.5% of the total in 2013 (27.3% lower than in 2003), collapsing by 18.5% in 2009 and experiencing a steady decline since then. The energy sector, including coal mining, oil and gas extraction and refining, consumed 2.1% while transport consumed 1.9% of electricity; demand from both sectors has been volatile since the mid-2000s.

Figure 8.4 Electricity consumption by sector, 1973-2013



* *Energy* includes coal mining, oil and gas extraction, and refining.

** *Commercial* includes commercial and public services, agriculture, fishing and forestry.

Source: IEA (2015b, forthcoming), *Electricity Information*, OECD/IEA, Paris.

Electricity demand has traditionally peaked in winter, but the difference between winter and summer peaks has narrowed in recent years, largely because of increasing use of electric cooling. In the peninsular system, which has 102 GW of installed capacity, the maximum instantaneous power in 2014 occurred at 20:18 on 4 February, at 39 948 megawatts (MW). This was 3.3% below the peak in 2013 and 14.3% below the record peak of 45 450 MW reached on 17 December 2007. The maximum hourly demand in 2014 was also recorded on 4 February (between 20:00 and 21:00) at 38 666 MWh, or 13.8% below the all-time high recorded in 2007 (REE, 2014).

INSTITUTIONS AND REGULATORY FRAMEWORK

INSTITUTIONS

The **Ministry of Industry, Energy and Tourism (Minetur)** has the lead responsibility for formulating and implementing energy policy. This includes approving the electricity network access tariffs, regulated components of electricity prices and level of access tariffs. The ministry, after due consultations with the autonomous communities, is responsible for establishing the National Electricity Network Development Plan. The plan is also evaluated by the **National Commission of Markets and Competition (CNMC)** and approved by the Congress. The national plan draws up the transmission network investments for six years.

Integrated in Minetur, the Directorate General for Energy Policy and Mines is the national competent authority responsible for facilitating and co-ordinating permit granting for European Union (EU) projects of common interest, including important interconnection projects.

The **autonomous communities** have certain regulatory powers on electricity. Most importantly, they authorise new power plants below 50 MW, which includes most renewable electricity projects. They also authorise 220 kilovolts (kV) transmission grids and all distribution grids.

The National Commission of Markets and Competition (CNMC), under the **Ministry of Economy and Competitiveness**, is the regulator for several sectors, including energy.

In particular, the CNMC sets out the methodology for calculating the network access tariffs according to transmission and distribution costs, and Minetur approves the tariffs obtained by using that methodology. The CNMC also supervises the access to cross-border interconnections. At the EU level, the CNMC co-operates with other regulators through the **Council of European Energy Regulators (CEER)** and the **Agency for the Cooperation of Energy Regulators (ACER)** on developing network codes and implementing the internal electricity market.

LEGAL BASIS

The liberalisation of the Spanish electricity market started in the 1990s, in the framework of the EU energy market liberalisation. The Electricity Sector Act 54/1997 set the legal basis for the electricity sector for 16 years and was amended to transpose EU directives 2003/54/EC and 2009/72/EC concerning the common rules for the internal market for electricity. This Act includes the legal unbundling of networks from competitive generation and supply activities, third-party access (TPA) to the network, the creation of National Regulatory Authority for Energy (NRA) and the gradual liberalisation of the retail market. Act 54/1997 was replaced by Electricity Sector Act 24/2013 in December 2013, as part of the 2013 electricity market reform (see below).

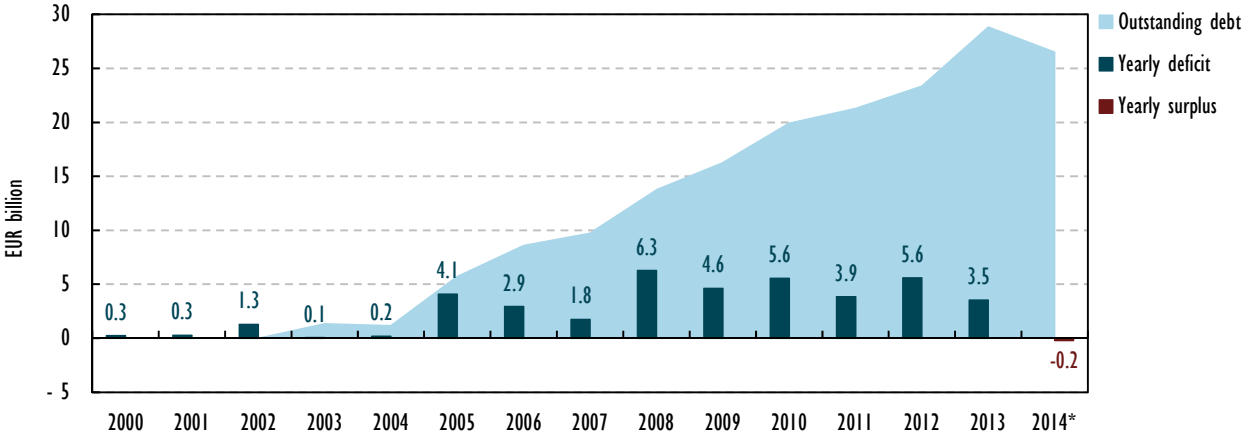
In recent years, the EU dimension in the regulatory framework of the electricity sector has grown in importance. The development of an integrated Internal Electricity Market has become a political priority. This market integration has focused on two areas: first, integrating national and regional electricity markets and co-ordinating system operations via commonly agreed mechanisms based on the European regulations and guidelines and, secondly, constructing cross-border interconnections and co-ordinating network infrastructure planning via the European Network of Transmission System Operators for Electricity's (ENTSO-E) ten-year network development plans and regional plans. Spain's electricity market design and interconnection developments are explained in the following sections.

TACKLING THE TARIFF DEFICIT

Despite the work on developing an internal EU electricity market, the government's main focus in the electricity sector since 2011 was to solve the massive tariff deficit accumulated since 2001. By 2012, the deficit had reached more than EUR 20 billion (2% of gross domestic product [GDP]) and was set to grow by billions every year unless action was taken.

Since 2001, the revenues in Spain's electricity system have been too low to cover all the costs paid out from the system (see Figure 8.5). The result was a tariff deficit that grew year after year. At the present time, the revenues come both from network access tariffs paid by generators and end-consumers (represented by suppliers) and from the state budget. The costs of the electricity system include remuneration for transmission and distribution network activities, but also many different subsidies, including for generating electricity from renewable energy and waste, and at CHP plants, generating electricity in the extra-peninsular system and using domestic coal for power generation. The costs also include annuities on paying back the debt created by the accumulation of annual tariff deficits (see Figure 8.6).

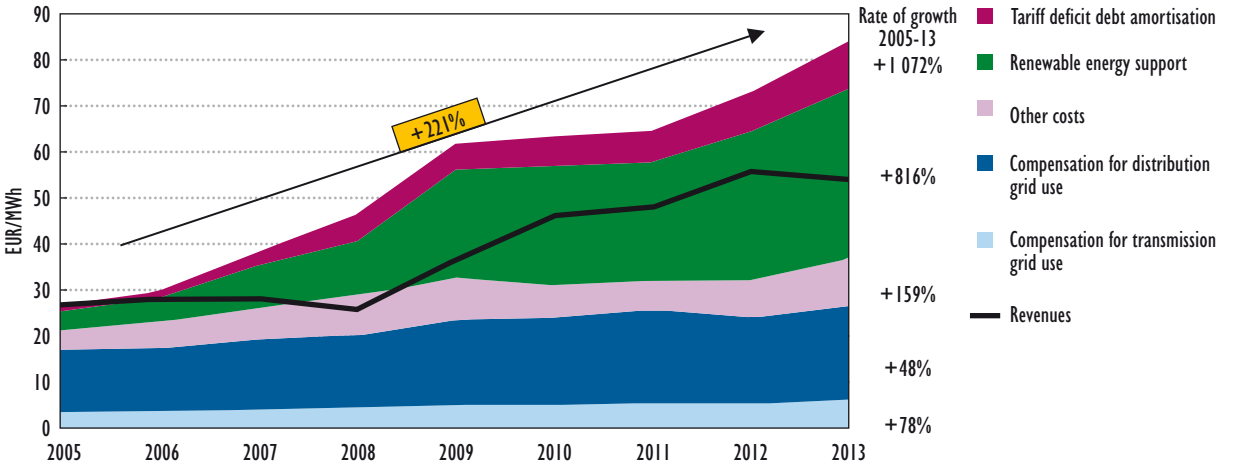
Figure 8.5 Tariff deficit accumulated in Spain, 2000-14



* Estimated.

Source: Ministry of Industry, Energy and Tourism.

Figure 8.6 Costs and revenues in the Spanish electricity system, 2005-13



Source: Ministry of Industry, Energy and Tourism.

The electricity system costs started to grow significantly faster than revenues around 2005. End-user electricity tariffs were fixed at a certain level, but fuel prices for electricity generation increased rapidly for natural gas and coal, leaving utilities having to supply electricity below cost.

Spain entered a multi-year recession in 2008 from which it returned to full-year growth only in 2014. The long recession invalidated the projections for electricity demand on which the expected annual access tariff revenue relied. Electricity demand turned out to be much lower than assumed and so were the tariff revenues for each year.

At the same time, costs were increasing rapidly. From 2005 to 2013, revenues in the electricity system doubled, but the regulated costs more than tripled (up by 221%). All cost components – apart from remuneration for transmission and distribution network use – grew much faster than the revenues (see Figure 8.6). In particular, Spain's relatively early and large-scale deployment of wind and especially solar power proved more expensive than anticipated. A case in point is the EUR 450 per MWh subsidy for solar PV

for 25 years granted in 2008 under a law that did not include a cap on total subsidies or on installed capacity, just a deadline for applications. Spain had opted for wind and solar power deployment partly as a way to meet the EU renewable energy targets, but partly also to promote domestic renewable energy technology providers. Subsidies to renewable energy, combined production of heat and power (CHP) and waste increased from EUR 1.2 billion (bn) in 2005 to EUR 8.6 bn in 2012, according to the Ministry of Industry, Energy and Tourism.

Initially, the deficit was financed by the five main utilities according to a mechanism that implied that they should be paid back from the electricity system's future revenues. Since 2003, the utilities were allowed to sell the debt of the electricity system to third parties. Since 2005, as the deficit started to grow faster, it also became more difficult to finance. The problem worsened with the recession, and the financial situation of the utilities deteriorated.

To ease the burden on the utilities, the government established in April 2009 the Electricity Deficit Amortisation Fund (FADE) to borrow from the market to pay the utilities. FADE in turn would pay back the lenders from the revenue received from future access tariffs. Most importantly, it was 100% guaranteed by the State. FADE, however, only stabilised the funding issue, but did not stop the tariff deficit from accumulating.

After the 2011 elections, the new government saw stabilising the public sector finances as an urgent priority. Public debt had soared from less than 40% of GDP in 2007 to around 80% in 2011 and was growing at an unsustainable rate. The electricity tariff deficit, which has an impact on public debt because of the state guarantee to FADE, had reached more than 2% of GDP. The government addressed the tariff deficit by new legislation in 2012 and 2013.

The new government initially tried to control the tariff deficit by drafting a tax law and five Royal Decree-Laws[2] that were adopted between early 2012 and early 2013. These measures cut subsidies for existing renewable power capacity and eliminated them for future installations. At the same time, they increased access tariffs and introduced a 7% tax on electricity generation (22% for hydropower) and reduced remuneration for transmission and distribution network activities. All in all, the measures were calculated to reduce the annual tariff deficit by EUR 6 billion, but they were still not enough to bring the electricity system's costs and revenues to balance.

The accumulated tariff deficit had increased from less than EUR 2 billion in 2005 to around EUR 26 billion at the end of 2012. In spite of all the measures taken, it was set to increase by another EUR 3 billion in 2013 and EUR 4.5 billion in 2014. The government concluded that more measures were needed to cut costs and increase revenue, and introduced a more fundamental electricity market reform in July 2013.

2013 ELECTRICITY MARKET REFORM

The July 2013 package of draft measures to reform the electricity market included a draft electricity market law, a draft royal decree-law, seven draft royal decrees and five draft ministerial orders. The new regulatory framework was set to change the remuneration and compensation for renewables, co-generation and waste technologies, transmission

2. A royal decree-law is a legal instrument that can be adopted faster than an ordinary law, because Parliament has no role in drafting it, only in adopting it. Its use, however, is normally limited to emergencies.

and distribution activities, self-consumption, the non-peninsular system and fossil-fired generation. It was also set to change the remuneration for interruptible demand, the methodology to calculate the retail electricity prices for household consumers and last-resort tariffs for vulnerable consumers.

The reform had the following objectives:

1. Ensuring the sustainability of the electricity system

- *Sufficiency*: electricity system's revenues are to be sufficient to fully cover the system's costs, while allowing for a reasonable return on past investments.
- *Financial stability*: every regulatory measure increasing costs or reducing revenues in the electricity system is to include additional measures to ensure the system´s economic and financial stability. For this purpose, the government will issue every year a forecast of the costs and revenues of the system for the following six years.

2. Balancing the costs and revenues in the electricity system

A new mechanism is introduced for remunerating network use and supporting electricity generation from renewable energy, CHP and waste.

- *Transmission and distribution*: investors are guaranteed a return on investment of 200 basis points above the ten-year government bond. The maximum investment in transmission will be known for the next six years.
- *Renewable energy, CHP and waste*: operators are guaranteed a reasonable return of 300 basis points above the ten-year government bond. This return is calculated on the asset base of a standardised facility over its lifetime. The standardised costs vary according to the technology and year of entry into operation, among other factors. They are revised every six years, except for the initial investment value and the regulatory lifetime. The subsidy is calculated so that the standard facility obtains a reasonable return, considering its investment costs, wholesale market income and operational costs during the regulatory lifetime. The subsidy is thus based on installed capacity, rather than electricity generated, as in the past. Because the return is calculated over the lifetime of a facility, the income obtained in the past by existing facilities is taken into account to determine the value of future support. Therefore, standard facilities that will reach the guaranteed return, considering the support received in the past and the expected market income until the end of their regulatory lifetime, will face a cut in future support.

The new Electricity Law (Act 24/2013) differentiates between access tariffs aimed at recovering transmission and distribution costs, and charges for recovering the rest of the regulated costs, such as support for renewable energy, CHP and waste.

3. Reducing the cost of electricity generation

- Capacity payments (mainly for CCGTs) are reduced.
- Mothballing CCGTs under strict criteria ensuring security of supply.
- Demand-side participation (accepting interrupted power supply): compensation for instant interruptibility services is reduced and providers for this service are selected through auctions.

4. Informing and protecting electricity consumers

- The regulated end-user last-resort tariffs that were set *ex ante* by auctioning were replaced (Law 24/2013 and Royal Decree 216/2014) by an *ex post* market-based voluntary price to small consumers (VPSC or PVPC in Spanish, see below under Retail market and prices). Last-resort tariffs are at present only for certain groups of consumers: those vulnerable (a subgroup within consumers eligible for PVPC) and consumers temporarily without a supplier.
- The rate of the last-resort tariff for vulnerable consumers (*bono social*) is linked to the new *ex post* tariff and eligibility for it will be reduced.
- Supplier switching is facilitated.
- An arbitration mechanism for the resolution of consumer disputes is strengthened.

The electricity law was adopted in December 2013 as Electricity Sector Act 24/2013. As of March 2015, the only measures pending final adoption from the July 2013 package were the Royal Decrees on capacity payments and mothballing, retail electricity supply and self-consumption.

Looking back, the accumulating tariff deficit was in no way unavoidable. Spain is one of several EU countries that have experienced a tariff deficit in the electricity sector in recent years. As in these countries, end-user prices have been regulated, the government has not allowed the regulator to set the tariffs at a level that would ensure system cost recovery, and the electricity system costs have included a high and rising volume of subsidies for renewable energy (European Commission, 2014).

In Spain, the previous governments had several options for avoiding the tariff deficit. The simple option would have been to increase access tariffs enough to balance the system. It was also possible to place a smaller burden on the electricity sector for reaching the country´s EU renewable energy targets and correspondingly setting higher targets for transport fuels and heat. Another, more general option would have been to introduce a carbon tax across all fuels to limit greenhouse gas (GHG) emissions and to finance any subsidies needed from the general government budget rather than from the electricity system (Robinson, 2013).

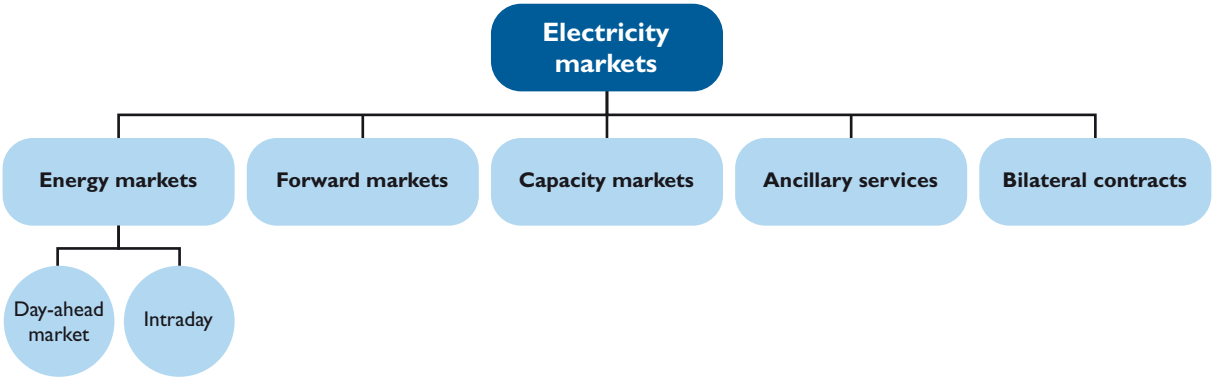
Spain’s electricity market reform is set to gradually decrease the accumulated tariff deficit and eventually, in 15 years, to eliminate it. Fitch Ratings, a credit rating agency, expected Spain's accumulated tariff deficit to fall from EUR 28.4 billion in 2013 to EUR 26.8 billion at the end of 2014. The reductions are driven by reduced subsidies for renewable energy, CHP and waste (from EUR 9.1 billion to EUR 7.5 billion) and increasing regulated revenue. According to the CNMC, unit costs in the electricity system declined from EUR 81.4 per MWh supplied to end-users in 2013 to EUR 77.5 per MWh in 2014, or a drop of 4.8%. The electricity system's future financial sustainability depends both on macroeconomic developments and on a sustained commitment to the reform by the country´s policy makers.

WHOLESALE MARKET STRUCTURE AND DESIGN

The Spanish wholesale market comprises an organised market (the spot market managed by OMIE, the electricity market operator) and a non-organised market for bilateral trade. The organised market includes a day-ahead market followed by six intraday auctions. In addition,

the market design includes capacity payments and ancillary services. The day-ahead spot market is coupled with Portugal since July 2007 and with the North-West Europe region since May 2014.

Figure 8.7 Overview of electricity markets in Spain



The Spanish wholesale market is part of the Iberian power market (*Mercado Ibérico de Electricidad* – MIBEL) created in 2007. OMIE in Spain manages the spot market (daily and intraday markets) while OMIP in Portugal manages the futures market. Both are part of the *Operador del Mercado Ibérico* (OMI, Iberian market operator) business group which is 50/50 owned by the Spanish (OMEL) and Portuguese (OMIP SGPS) wholesale market operators from the pre-MIBEL times.

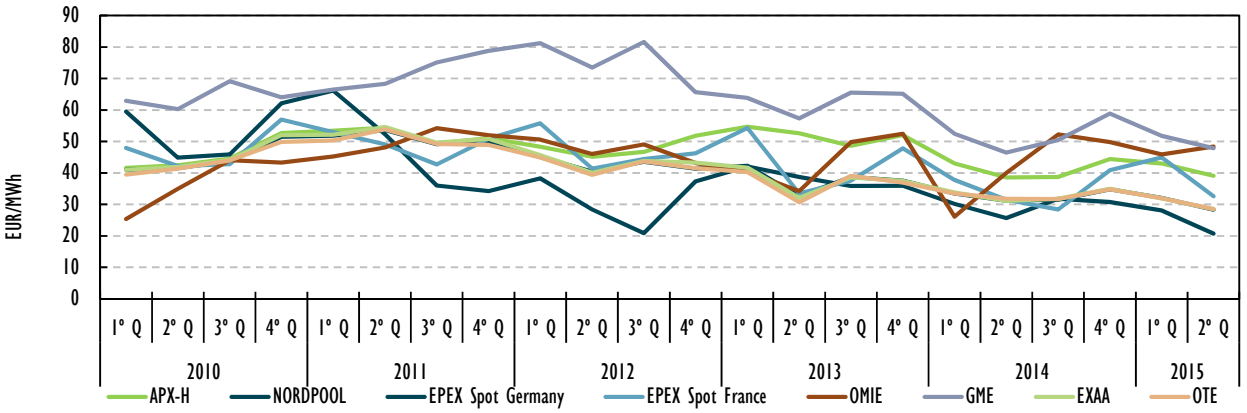
The two system operators, *Red Eléctrica de España* (REE) and *Red Eléctrica Nacional* (REN), are responsible for technical management, including system security and ancillary services. MIBEL has a single price for 90% to 95% of the time, but when interconnections are congested, the market is split into Spanish and Portuguese price areas. The wholesale market is fairly competitive, with the five main players each having a 15% to 24% market share.

In addition to the organised markets, physical bilateral contracts are possible between qualified consumers and producers on the spot market. This non-organised part of the market represents 26% of the energy sold in the daily programme, increasing very rapidly since 2007.

The OMIP forward market had a volume of 419 TWh in 2013. The exchange offers several derivative products (swaps, futures and options), and has seven brokers and three clearing houses active. In general, the forward price is higher than the average spot price. In 2013, the annual average price for futures contracts (EUR 49.2 per MWh) was EUR 5 per MWh higher than the average spot price (EUR 44.2 per MWh) according to CNMC. This relatively large difference is explained by the high volatility of spot prices which, in turn, is mostly a result of a large share of wind and solar power in the generation mix.

This day-ahead spot price falls in the range of other European markets. In 2013, coal set the price 69% of the time and gas 9% of the time. Other technologies, including hydro, set the price around 22% of the time.

Figure 8.8 EUROPEX quarterly electricity prices, January 2010 to June 2015



Source: OMIE.

Looking at hourly prices, however, wholesale prices can be very low. In 2013, the price was zero for 5.5% of total hours and less than EUR 10 per MWh for 9.7% of the hours. These low prices are the result of high wind and solar power generation, combined with the inflexibility of nuclear and CHP plants. Adding more wind and solar power into the electricity system while demand is expected to decline risks increasing the frequency of zero or low prices.

MARKET CONCENTRATION

The largest companies in terms of installed capacity in Spain are Iberdrola, Endesa and Gas Natural Fenosa. They hold around 75% of installed capacity, excluding wind and solar capacity. Hidroeléctrica del Cantábrico (EDP) and E.ON both have 5% to 6% of installed capacity. The National Commission of Markets and Competition (CNMC) concludes that market concentration in electricity generation is moderate, below that of other European countries. The last major merger in the sector was that of Gas Natural with Union Fenosa in 2009.

Defining the relevant market for calculating concentration, however, is somewhat complex. Electricity is increasingly generated by distributed renewable energy sources, the ownership of which is relatively fragmented. In particular, solar power has been developed by small players from outside the energy sector, attracted by generous renewable support tariffs.

The CNMC calculates that if all technologies are considered, the Herfindahl-Hirschman index (HHI) for generation was around 1 000 in 2013, implying a competitive marketplace. However, if only price-setting technologies (hydro, coal and natural gas) are considered, HHI rises to 2 300, implying a highly concentrated marketplace. Spain is also well connected with Portugal, but poorly connected with France, limiting competition across the border.

DAY-AHEAD MARKET COUPLING

MIBEL has been coupled with the North-Western Europe (NWE) region since 13 May 2014. Market coupling was designed to ensure full use of net transfer capacity after the day-ahead market. After the introduction of market coupling, capacity use increased from 70% to almost 100%. Furthermore, capacity use against the price spread (in the wrong direction)

which occurred 9% of the time before, disappeared. Market coupling has thus reached its objective and ensures efficient use of existing net transfer capacity.

During hours of high renewable generation, prices tend to be lower in Spain than in France. Conversely, wholesale prices in the Central-Western Europe (CWE) region can be lower than the cost of fossil fuel-fired generation in Spain. Electricity trade across the border can ensure the least cost dispatch, as far as sufficient cross-border interconnection capacity is available.

The cross-border network capacity, however, is not sufficient to ensure the convergence of prices on both sides of the Spanish-French border. From 13 May to 30 September 2014, prices were the same for less than 1.5% of the time. Yet, the price difference remained low over the period, less than EUR 1 per MWh. Thanks to improved use of cross-border capacity, the value of cross-border trade dropped.

INTRADAY MARKET

The intraday market consists of six sessions which can be attended by all those who have participated in the daily market or executed a bilateral contract. Intraday trades have to comply with the limitations set by the system operator to avoid constraints. The prices on the day-ahead market and the intraday market are close. The latter enjoys high liquidity compared with neighbouring countries, which ensures the robustness of price signals.

Despite good performance, existing intraday arrangements in Spain are not compatible with CWE and in particular France, which limit cross-border trade of balancing services. Unlike Spain, France has opted for a continuous intraday trade promoted at European level, instead of six sessions. There is a need to develop cross-border trade of balancing power in order to reduce the cost of renewables integration.

BALANCING MARKET

Balancing is a market-based activity comprising secondary reserve (regulation of both energy and capacity), tertiary reserve (energy), load generation deviation management and constraints management. The cost recovery of the balancing services is designed so as to provide appropriate incentives for market participants to balance their scheduled generation and loads. This has led to the introduction of a dual imbalance charge. The cost of the balancing market amounts to around EUR 5.6 per MWh.

Cross-border trade in balancing power was commenced in June 2014 under the Balit (balancing inter-TSO) platform. The Balit platform enables bilateral exchange between TSOs (Portugal-Spain or Spain-Portugal). This bilateral TSO-TSO approach was chosen in other European countries as well. Further harmonisation efforts across Europe are being envisaged in the framework of the electricity network codes.

CAPACITY PAYMENTS

Many conventional power plants receive availability capacity payments as part of the wholesale market design. Availability capacity payments in 2014 amounted to EUR 180 million, corresponding to EUR 0.7 per MWh of electricity consumed. The payment is available for gas-fired generators on generation adequacy grounds.

Apart from that, certain technologies (CCGT and hydro) receive other capacity payments linked to the long-term investment. In 2014, the annual amount for those capacity payments was around EUR 260 million.

However, at the same time, the country has significant overcapacity in power generation. The need for the system of capacity payments is currently under discussion in Spain and in May 2015 the Royal Decree on capacity mechanisms and mothballing remains to be adopted. The industry argues that a capacity mechanism is needed to keep enough power plants available in order to ensure security of supply.

TRANSMISSION AND DISTRIBUTION

TRANSMISSION

The Spanish high-voltage transmission network is owned and operated by REE, the transmission system operator (TSO). In 2013, the transmission network had a total length of 40 000 km, of which 20 641 km at 400 kV and included 5 216 substations with a transformer capacity of 80 695 megavolt-amperes (MVA). These numbers include both peninsular and extra-peninsular networks in the islands.

REE was certified in 2012 by CNMC as an ownership-unbundled TSO. It is a publicly listed company, and to guarantee its independence, ownership in it is limited by law. The state must own at least 10% of the shares, while other entities may hold no more than 5% of the share capital or use no more than 3% of voting rights. For electricity companies, the limit is 1% of voting rights. The state, via the *Sociedad Estatal de Participaciones Industriales* (SEPI) owns 20% of the shares, while the other 80% is well diversified, the largest owners being several investment funds with a stake of around 3%. By law, REE cannot own any shares in companies involved in the generation or supply of electricity or gas.

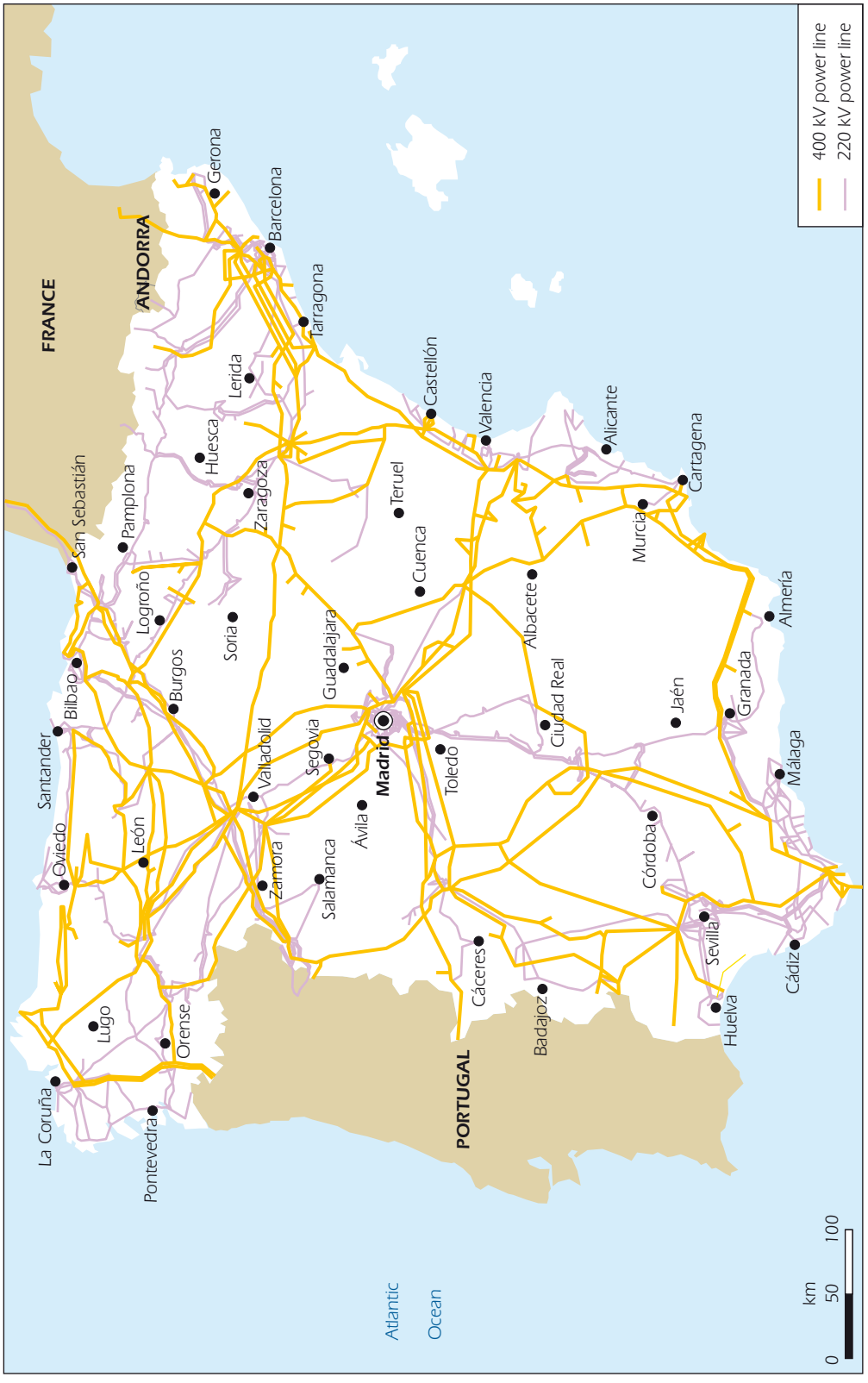
Transmission network development is the responsibility of the Ministry of Industry, Energy and Tourism and of the autonomous regions. It is performed in close co-operation with stakeholders and supported by REE as the technical adviser. In recent years, transmission grid developments have been strongly influenced by the need to mesh the grid following the rapid increase in demand from the 1990s to late 2000s and the integration of intermittent renewable energy sources. Transmission investments peaked in 2010. The new National Infrastructure Investment Plan foresees investments of EUR 550 to 600 million per year over the period 2013-17, of which EUR 425 to 450 million for the mainland. The new investment plan focuses on increasing security of supply and reducing system costs.

DISTRIBUTION

Distribution companies are responsible for operating, maintaining and developing the distribution network which is used by retailers (supply companies representing end-users) for delivering electricity to end-users. Spain has five major distribution companies, all subsidiaries of the companies involved also in power generation and supply: Endesa, Iberdrola, Gas Natural Fenosa, E.ON and HC Energia-EDP.

In addition, more than 300 small companies operate in the distribution sector. The large distribution companies that have more than 100 000 customers must be legally unbundled from generation and retail supply activities, while smaller companies only need to be functionally unbundled.

Figure 8.9 Map of Spain's electricity network, 2014



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

NETWORK ACCESS TARIFFS AND REMUNERATION

The TSO and the distribution companies are remunerated from the revenue that generators and retailers pay in access tariffs to the electricity system. Since 1 January 2014, the remuneration rate on these network assets equals the average rate of the 10-year Spanish government bond over the preceding three months plus 200 basis points (2%). The CNMC proposes the remuneration for each company to the Ministry of Industry, Energy and Tourism which may modify the proposals before approving them.

In 2014, the remuneration for transmission network use equalled EUR 6.7 per MWh supplied to end-users. For distribution network use, the remuneration was EUR 21 per MWh supplied to end-users, according to CNMC.

Network access tariff paid by generators for using the transmission and distribution grids is EUR 0.5 per MWh. This tariff is uniform across the entire Spanish territory, including the extra-peninsular system. Network access tariffs paid by consumers (passed on to them by retailers) vary according to voltage, power and periods of time. On average, they were EUR 60 per MWh in the 12 month period from October 2013 to September 2014, the latest for which the breakdown is available.

The government sets the network access tariffs on the basis of a non-binding opinion by CNMC. This commission is also responsible for the methodology for calculating network access tariffs. As a general rule, access tariffs are revised once a year. In 2013, however, they were exceptionally revised twice as part of efforts to ensure the financial stability of the electricity system.

CROSS-BORDER INTERCONNECTIONS

CAPACITY

Spain is interconnected with Portugal, Morocco and France. The total interconnection capacity is 5.7 GW (as of March 2015), for a peak demand of 39.9 GW in 2014 and an installed capacity of 102.3 GW in the Spanish peninsular system, including 30 GW of wind and solar power.

According to ENTSO-E, Spain's interconnection capacity as a share of generating capacity was one of the lowest in the Union in 2014, only Poland and the islands states of Malta and Cyprus[3] had a lower share.

New interconnections are set to increase the commercial net transfer capacity (NTC) to 6.4 GW by 2017 and at least to 8.6 GW by 2020. This equals an increase in the share of interconnection capacity in total installed capacity (of 2014) from 4.2% to 8%, which falls short of the 10% share the EU countries are targeting for 2020 and the 15% share for 2030.

3. 1. Footnote by Turkey: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of United Nations, Turkey shall preserve its position concerning the "Cyprus issue".
2. Footnote by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Considering the Iberian Peninsula as a whole, the installed capacity is 120 GW of which interconnection with France represented only 1.2% in 2013, 2.4% in 2015 and 4.1% in 2020, assuming that the new western undersea interconnection cable is built by 2020 (see below).

Table 8.2 Net transfer capacities between Spain and its neighbouring countries, MW

Border with	2014	2017	2020
France	1 400	2 800	8 000*
Portugal	2 700	3 000	3 000
Morocco	600	600	600
Total	**4 700**	**6 400**	**11 600****

Note: Net transfer capacity = total transfer capacity *minus* transmission reliability margin. The table refers to capacities to and from Spain.

* Includes the Biscay/Gascoigne Bay project and the two additional projects through the Pyrenees: Navarra or País Vasco (Spain) - Cantegrit (France), and Aragón (Spain) - Marsillon (France). Considering only the Biscay/Gascoigne Bay project, it would be 5.000 MW.

** Includes the Biscay/Gascoigne Bay project and the two additional projects through the Pyrenees: Navarra or País Vasco (Spain) - Cantegrit (France), and Aragón (Spain) - Marsillon (France). Considering only the Biscay/Gascoigne Bay project, it would be 8.600 MW.

Source: REE.

The degree of interconnection differs at the different borders:

Spain exports power to Morocco through the 600 MW NTC undersea high-voltage direct current (HVDC) cable crossing the Gibraltar Strait. In 2013, the interconnection was used at full capacity, leading to exports of 5.4 TWh. There are no plans for more interconnection capacity with Morocco, however.

Spain is relatively well interconnected with Portugal. Since 2014, the commercial capacity is 2 700 MW, after the recent interconnection in the south from Andalusia, equalling 10% of the installed capacity in Portugal. Another 300 MW will be added before 2017 (in the north from Galicia), increasing the commercial capacity to 3 000 MW.

Interconnection with France has long been a bottleneck for electricity exchanges between the Iberian Peninsula and the countries north of the Pyrenees. The NTC of 1.4 GW will be doubled in summer 2015 when the 1.4 GW Santa Llogaia-Baixas interconnection will enter in commercial operation. The interconnection was inaugurated on 20 February 2015 by the Prime Ministers of Spain and France. The project, however, took 25 years to finish and cost more than initially expected, mainly because building the line over the Pyrenees raised strong local opposition on the French side. The project needed facilitation by the European Commission and had to be built completely underground (see Box 8.1).

On 4 March 2015, the Energy Interconnection Links Summit took place, where the Madrid Declaration was signed by Mariano Rajoy, Prime Minister of Spain, Pedro Passos Coelho, Prime Minister of Portugal, François Hollande, President of France, and Jean-Claude Juncker, President of the European Commission (EC). The President of the EIB, Werner Hoyer, and the EU Commissioner for Energy and Climate Action, Miguel Arias Cañete, also attended the Summit.

The Madrid Declaration underlines the critical importance to attain a fully functioning and interconnected internal energy market, which constitutes a fundamental dimension in building the European Energy Union. For the EU member states below the minimum level of physical market integration, such as Portugal and Spain, it is essential to build the necessary energy infrastructure to achieve an efficient internal energy market, in particular cross-border interconnections of the electricity and gas networks.

Box 8.1 The Santa Llogaia-Baixas interconnection

The Santa Llogaia–Baixas line is the first interconnector between Spain and France since 1982, when the Arkale–Argia line was inaugurated. Discussions to build a new cross-border line started in 1987, initially focusing on building another overhead line. Assuming a typical cost of EUR 1 million per km for a 400 kV line, a 70 km line would cost between EUR 70 and 100 million, considering the need to cross the Pyrenees.

Several plans for the new cross-border line were abandoned because of local opposition in the 1990s. In 2001, Spain and France agreed to increase the interconnection capacity from 1.4 GW to 2.8 GW and further to 4 GW. The French National Commission of Public Debate (CNDP) organised a consultation that raised strong public opposition. Once again, France abandoned the plans in 2003.

In 2008, the Prime Ministers of the two countries found a new agreement on the project, mediated by Mario Monti, former EU Competition Commissioner and facilitated by promises of EU funding. The project consists of an underground line that requires the HVDC technology but limits the impact on the landscape and the impact of electromagnetic fields on health. A strong political push from the highest level was needed to move the project forward.

The interconnector is a 64.5 km direct current (DC) line (31 km in Spain, 33.5 km in France), alongside a high-speed railway and a motorway. It is a double circuit line (2 x 1 000 MW) at 320 kV. The HVDC technology used, called (voltage source converter), requires converting power from alternative current to direct current at converter substations built at each end of the line (Santa Llogaia and Baixas). The line includes an 8.5 km tunnel (7.5 km on the French side and 1 km on the Spanish side, with an inner diameter of 3.5 m) in the Pyrenees, close to the high-speed railway tunnels. It is the longest and the highest-voltage power line worldwide using the VSC technology.

The total cost of the line is EUR 700 million, around ten times the cost of an overhead line. The project benefited from an EU subsidy of EUR 225 million from the European Energy Programme for Recovery (EEPR). It also received a loan of EUR 350 million from the European Investment Bank (EIB). Each country paid half of the project costs. The regulators approved the investment on the basis of a cost-benefit analysis. The Santa Llogaia-Baixas line, the first new interconnection between the two countries in 33 years, was inaugurated on 20 February 2015.

Financial support for fulfilling this obligation is available at the European level, notably through the Connection Europe Facility, the Structural Funds, and the European Fund for Strategic Investment which has been recently presented by the EC and the EIB.

At the Summit, several new interconnections between Spain and France were considered. The Western Interconnection project, currently at the feasibility stage, would connect the two countries through an undersea cable in the Bay of Biscay. The main technical challenge for the 370 km HVDC cable is the crossing of the Capbreton submarine canyon. The Western Interconnection would increase interconnection capacity from 2.8 GW to 5 GW for a cost of almost EUR two billion. It is included in the list of European energy infrastructure Projects of Common Interest (PCI).

The TSOs of France, Portugal and Spain have also prepared a “Common strategy paper for the development of interconnections of the Iberian Peninsula with the internal electricity market and beyond”, including two more projects to help increase the interconnection

capacity between Spain and France: one between País Vasco or Navarra (Spain) and Cantegrit (France) and another one between Aragón (Spain) and Marsillon (France).

On this basis, and following the "Common strategy paper", the TSOs have further assessed the projects that will be addressed in parallel in order to raise the cross-border capacity between Spain and France to 8 GW in 2020. The three projects are detailed as follows:

The Biscay Bay project is already included in the list of PCI intended to connect the Biscay-Gascoigne Bay in Spain to the Aquitaine area in France, with current costs estimated at EUR 1.9 billion. This project is now under technical studies, which benefit from the maximum support of 50% of all eligible costs under the Connecting Europe Facility and amount to EUR 3.25 million. This project could help rebalance the flow of electricity between east and west of the French-Spanish border.

Two additional projects through the Pyrenees should bring the interconnection level between France and Spain to around 8 000 MW. A first project will connect Navarra or País Vasco (Spain) to Cantegrit (France), and the other one Aragón (Spain) to Marsillon (France). Both projects are estimated to cost EUR 0.9 billion to 1.2 billion. The best available environment-friendly and cost-effective technologies will be used to increase local public acceptance.

All three projects were endorsed by France, Portugal, Spain and the European Commission on 4 March 2015 and are set to benefit from EU funding and EIB loans. The three countries and the EC also agreed to create a high-level group for South-West Europe on interconnections. The group will be set up by the European Commission to facilitate an agreement on the detailed routes of the interconnectors before the end of 2015 to expedite the construction of the lines by 2020. On this basis and in line with the studies carried out by the TSOs, the group will report to the President of France, the Prime Ministers of Spain and Portugal and the President of the European Commission. The aim is to ensure the most rapid early launch, possibly in 2016, of the administrative process for the permit granting, according to the trans-European energy infrastructure regulation (TEN-E, 347/2013).

The new cross-border lines would require network reinforcements both in Spain and in France for accommodating stronger power flows. This is especially true for south-west France where the transmission network is relatively weak.

The TSOs calculate that constructing the three projects would raise the interconnection capacity between Spain and France to around 8 GW. Together with the 3 GW of interconnections with Portugal, Spain would thus have 11 GW of interconnection capacity with other EU member states, and it would thus meet the EU 10% interconnection capacity target.

As previously agreed by the European Council, Spain, France, and Portugal recall that the European Commission will also report regularly to the European Council with the objective of reaching a 15% target by 2030 as proposed by the European Commission.

CAPACITY ALLOCATION AND CONGESTION MANAGEMENT

In May 2014, the Iberian Peninsula was coupled with the NWE market area and interconnection capacity between Spain and France is therefore allocated by implicit auctions, i.e. automatically as part of electricity trade through the power exchanges. The wholesale systems in Spain and Portugal had been coupled already last decade when MIBEL was formed.

The objective of price-coupling is to ensure efficient use of existing cross-border capacity one day ahead of physical delivery. This market integration will also increase wholesale price convergence. Since price-coupling in May 2014 with Spain and Portugal, the NWE price-coupled area has been further extended to Italy and Slovenia in February 2015. It is now called the multi-regional coupling and it covers around 85% of electricity demand in the European Union.

Before price-coupling with NWE, electricity prices between France and Spain differed most of the time, reflecting congestion at the border and inefficient use of available capacity by traders. In 2012, the average spot price differential between the two countries ranged from EUR 5.4 to EUR 5.9 per MWh.

Congestion at the Spanish-French border is set to decrease. In February 2015, interconnection capacity with France doubled from 1.4 GW to 2.8 GW. Similarly, the capacity at the interconnection with Portugal will increase by 300 MW in 2015. Declining congestion will also reduce the congestion rents that the TSOs have gained from auctioning scarce cross-border capacity. These revenues amounted to EUR 110 million in 2013, up from around EUR 80 million in 2012 and EUR 60 million in 2011. Under EU Regulation 714/2009, this revenue from allocating cross-border capacity must be used to fund investments aiming to reinforce cross-border capacity.

After the day-ahead market, the interconnections could also be used for cross-border intraday trade and for cross-border trade of balancing energy. Regional integration of intraday and balancing markets would help accommodate the rising volumes of wind and solar power which have priority in dispatch and the output of which cannot be predicted accurately long in advance.

Yet, intraday trade between Spain and France, although possible, remains limited. As for balancing markets, there is no trade at all. On the one hand, importing balancing energy is not allowed in Spain. On the other hand, the designs of balancing markets in Spain and France are incompatible.

INTERCONNECTIONS AND ENERGY POLICY

The future value of interconnections will depend on long-term energy policies in Spain and in the rest of Europe. The Iberian Peninsula has ample wind and solar resources, but it is located far from the large consumption centres in CWE. Wind and solar generation profiles can be complementary as different regions have different wind patterns, and statistical aggregation of wind and solar over large geographical areas can reduce forecasting errors. Market integration over large geographical areas and expansions in transmission capacity will enable intermittent renewable energy to help reduce CO_2 emissions at least cost.

Cross-border interconnections are a priority of EU energy policy. The conclusions of the European Council of October 2014 include the commitment to reach a 10% share of electricity interconnection capacity in installed generating capacity by 2020. For this, special efforts are needed to connect the Baltic states, Portugal and Spain, Malta, Cyprus[1]

1. 1. Footnote by Turkey: The information in this document with reference to “Cyprus” relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of United Nations, Turkey shall preserve its position concerning the “Cyprus issue”.

2. Footnote by all the European Union Member States of the OECD and the European Union:The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

and Greece with other countries. The European Council also decided to increase to 15% the interconnection target by 2030.

More interconnections between France and Spain are needed in order to integrate variable renewables in an efficient manner. The 27% target for renewable energy by 2030 is binding at the EU level and translates into around at least 40% of renewable energy in the electricity mix.

Completing the planned interconnection projects will enable larger electricity trade between Spain and France. Spain will be able to export excess renewable energy, in particular wind power and hydropower which usually peak during storms. In contrast, on sunny days, when wind power generation tends to be low, wholesale electricity prices would be lower in France where the bulk of electricity is generated at nuclear power plants. Exports would flow from France to Spain.

The cost of grid integration of more wind and solar power is a key decision factor in renewables deployment policies after 2020. Cross-border interconnections help limit integration costs in Spain. According to the Spanish government, without interconnections, the additional cost of renewable energy objectives for Spain would reach several billion euros per year, including grid reinforcement costs, ancillary services, backup costs, curtailment costs and impact of increased price volatility on the market.

Although a detailed discussion of quantitative analysis of the benefits and costs of increased interconnections goes far beyond the scope of this report, three main types of benefits can be identified:

- Additional interconnections would allow the system to integrate more renewable energy. Without them, increasing renewable energy output would challenge the operating security of the electricity system and require curtailing part of the renewable energy output. Increasing exports to France would help avoid curtailments.
- Additional interconnections would reduce the overall cost of conventional generating capacity needed to complement the variability of wind and solar power. Several studies indicate that the contribution of interconnections to adequacy fall in the range of 60% to 90% of interconnection capacity. If regulations allow, Spain could import more electricity to meet its demand when there is less wind and sun, rather than maintaining expensive gas-fired capacity. Conversely, if the current situation of structural excess capacity persists, new interconnections can help increase electricity exports.
- Additional interconnections would reduce the volatility of wholesale electricity prices in Spain. Being part of a larger electricity market helps reduce price volatility which, in principle, reduces the cost of hedging for consumers The new interconnection between Santa Llogaia (Spain) and Baixas (France) is projected to reduce the volatility and the electricity tariff by around 2%, saving more than EUR 250 million in the first six months after its commissioning, according to Minetur. The price differential between Spain and France would be reduced by EUR 1 per MWh in annual average in the second half of 2015, from EUR 7 to EUR 6 per MWh.

The Iberian Peninsula remains in several ways isolated. This is true for cross-border transmission capacity and, less so, for market rules that differ from the rules in the CWE region. More cross-border capacity is needed for accommodating renewables efficiently. Overhead lines would be a relatively inexpensive solution to this, but overcoming local opposition to them calls for using more expensive underground or undersea lines. From a

European energy policy perspective, developing interconnections with Spain needs to be supported if the policy targets for 2030 are to be met.

RETAIL MARKET AND PRICES

RETAIL MARKET STRUCTURE

Spain's retail electricity market consists of a free market price segment and a segment that can also opt for the electricity price called voluntary price for the small consumer, VPSC (PVCP in Spanish), only available for customers with a connection of less than 10 kW. Spain's electricity system had 27.6 million customers in September 2014, the latest month for which data are available (CNMC, 2015b). Of these, 13.9 million were on the regulated end-user tariff and 13.7 million on free market prices.

In December 2013, a total of 162 retailers were active in the free market segment. The three largest retailers (Endesa, Iberdrola and Gas Natural Fenosa) supplied 67% of all electricity, down from 72% in December 2012, but a still significant concentration.

The VPSC (PVPC in Spanish) segment had only five suppliers in 2013, designated by law: Endesa, Iberdrola, Gas Natural Fenosa, Hidroeléctrica del Cantábrico (EDP) and E.ON. All but E.ON are also among the main operators in the natural gas sector. Since 2014, three more reference suppliers for this segment have been nominated according to Royal Decree 216/2014, which regulates the methodology for the calculation of the VPSC (PVPC in Spanish).

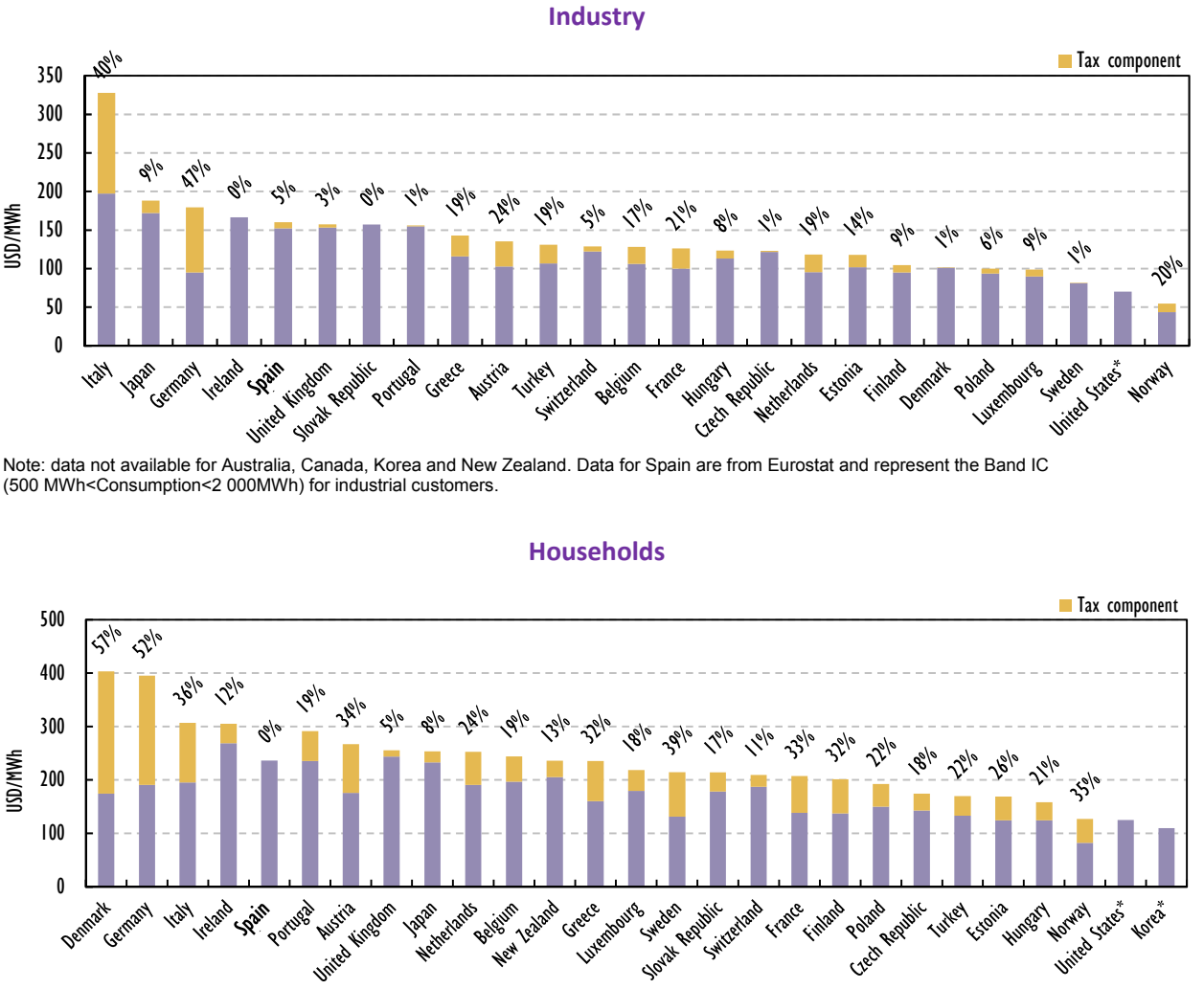
The largest overall retail market share in 2013 was held by Endesa which had 40% of customers and supplied 37% of the electricity volume. Concerning the free market, Endesa is still the first supplier in terms of energy supplied with a share of 34%, though Iberdrola was the largest by number of customers (48% of the total).

Retailers not belonging to the five main operators are, however, gradually increasing their market share from 16% in December 2011 to 21% in December 2013. They mainly serve industrial customers, with a market share in December 2013 of 30%. On the other hand, new entrants only had a 3% share in the residential market in December 2013. Endesa, Iberdrola and Gas Natural Fenosa supplied 90% of the total electricity to the domestic segment. The rate of customers switching supplier has increased steadily over the past years, from 5.2% of customers in 2009 to 13.0% in 2013.

RETAIL PRICES

Electricity prices in Spain are relatively high by IEA standards. They have also increased significantly over the past decade (see Figures 8.10 and 8.11). According to Eurostat, the annual average electricity price for medium-sized Spanish households increased every year over the past decade, from EUR 0.1079 per kWh in 2004 to EUR 0.2252 per kWh in 2014, or by 109%. Specifically, prices increased by 65% from 2008 to 2014. The average price for medium-sized industry increased even faster from 2004 to 2014, from EUR 0.0538 to EUR 0.1185 per kWh, or by 120%. From 2008 to 2014, the increase was 30%.

Figure 8.10 Electricity prices in IEA member countries, 2014



Note: data not available for Australia, Canada, Korea and New Zealand. Data for Spain are from Eurostat and represent the Band IC (500 MWh<Consumption<2 000MWh) for industrial customers.

Note: data not available for Australia and Canada. Data for Spain are from Eurostat and represent the Band DC (2 500 kWh<Consumption<5 000 kWh) for domestic customers.

* Tax information not available.

Source: IEA (2015c, forthcoming), *Energy Prices and Taxes*, OECD/IEA, Paris.

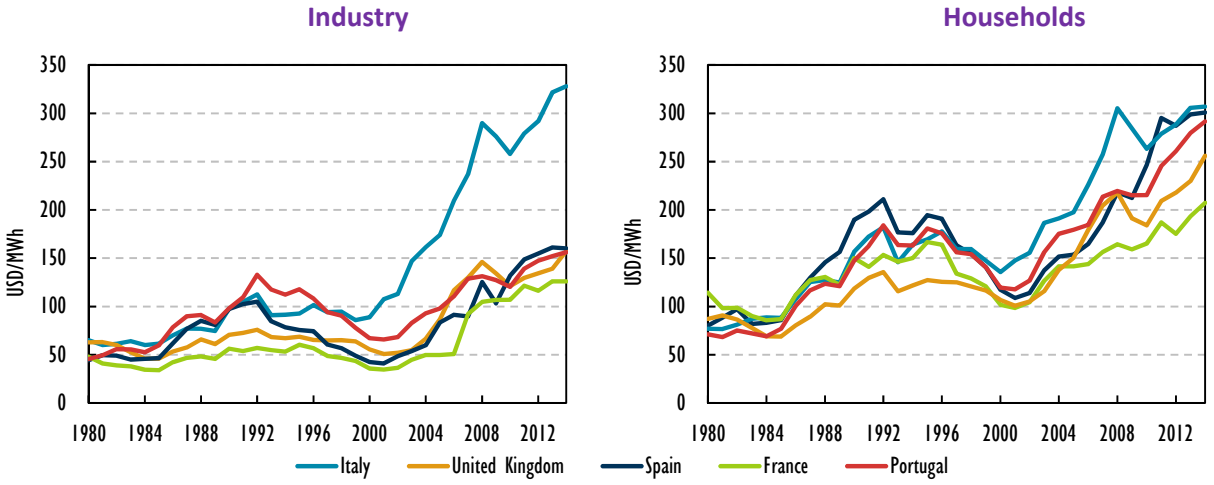
In contrast, wholesale prices in the Spanish market decreased from EUR 65.89 per MWh in 2008 to EUR 42.13 per MWh in 2014, or by 36%. Retail prices have therefore not risen because of energy costs, but because of taxes and network access tariffs. The access tariff has been used both to remunerate transmission and distribution network activities, and to pay for several kinds of subsidies, including on renewable energy, CHP, electricity supply in the extra-peninsular system, and interruptibility services. These subsidies increased fast from 2005 to 2013 and led to the burgeoning tariff deficit, as explained above (see Figure 8.5).

In the 12-month period from October 2013 to September 2014, the latest for which the breakdown is available, energy costs accounted for 45% of the average electricity user's retail price. Access tariff was higher, accounting for 50%, while the remaining 5% was for capacity payments.

According to Eurelectric, energy and network use components of household electricity prices in Spain were below the EU average in the second half of 2012. The Ministry of Industry, Energy and Tourism estimates that in 2012, regulated costs included in end-user electricity prices were on average 40% higher in Spain than in comparable countries.

The value-added tax on electricity applies to households. It had been 16% since 1995, but was raised to 18% in July 2010 and to 21% in September 2012.

Figure 8.11 Electricity prices in Spain and in other selected IEA member countries, 1980-2014



Note: data for Spain from 2011 are from Eurostat and represent the Band IC (500 MWh<Consumption<2 000MWh) for industrial customers and the Band DC (2 500 kWh<Consumption<5 000 kWh) for domestic customers.

Source: IEA (2015c, forthcoming), *Energy Prices and Taxes*, OECD/IEA, Paris.

END-USER ELECTRICITY PRICES

Out of the 27.6 million customers in Spain's electricity system in September 2014, the latest month for which data are available, 25.5 million were eligible for the VPSC (or PVPC in Spanish), i.e. had a connection of less than 10 kW. However, only 13.9 million were on the tariff, while the remaining 11.6 million eligible customers preferred the free market price. Since the introduction of energy cost-covering last-resort tariffs in July 2009, the share of customers eligible for those tariffs but serviced under free market prices increased from 0% to around 45% in September 2014. Customers under PVPC (the ancient last-resort tariff until the approval of Law 24/2013) accounted for 11% of total electricity consumers in September 2014, according to CNMC.

In December 2013, the government decided to change the methodology for calculating the electricity price for consumers with a connection of less than 10 kW. Until 2013, the energy component of the last-resort tariff was determined by quarterly auctions (so-called CESUR auctions). The result of the auction for Q1 2014 was 26% higher than the previous auction. The Ministry of Industry, Energy and Tourism, following an opinion of the regulator CNMC, decided to annul the auction. After that, a new methodology for the calculation of the energy cost component of the electricity price for consumers of less than 10 kW was adopted (Royal Decree 216/2014). The new method links retail prices to hourly wholesale spot prices. The reform essentially removes government interference with electricity prices.

The new electricity pricing system entered into force on 1 April 2014 and comprises different tariffs. The VPSC (PVPC in Spanish) has two options:

- a real-time price based on hourly spot prices is calculated *ex post* using smart meter data or standard load profiles. This price replaces the auctioning system;
- a fixed annual price must also be offered as an alternative by companies.

A subgroup of the PVPC group of consumers is the last-resort tariff (*bono social*) which is intended to address energy poverty. It is therefore lower than the PVPC electricity price. It is available to customers with a 3 kW connection or smaller in their primary residence, but also to retired people, families with numerous children and the unemployed. In the period October 2013 to September 2014, 2.5 million customers were on this tariff and their electricity consumption amounted to 4.0 TWh, or 1.5% of total consumption in Spain.

SELF-CONSUMPTION

Distributed generation from rooftop solar PV has expanded rapidly in Spain. The installed PV capacity was 4.6 GW in 2013, of which around 0.6 GW is behind-the-meter rooftop solar PV.

Solar PV deployment can be very fast. In 2008 alone, 2.7 GW was installed thanks to generous subsidies. If retail electricity tariffs continue to increase and the cost of solar PV to decrease (solar panel prices declined by around 80% from 2008 to 2014), the expansion of rooftop solar PV can be expected to continue.

Regulating self-generation or behind-the-meter generation is a new issue to which a perfect solution is yet to be found. Rooftop solar PV offers potential for increasing energy independence, improving local electricity security and avoiding network losses. At the same time, it challenges the business models of traditional utilities and, in particular, the network operators. This is because network costs are mainly fixed costs that do not depend on the energy consumed, while self-generation reduces the billing base on which the network costs are recovered.

To address this issue, the government in 2013 rebalanced the regulated tariffs towards fixed charges. The annual fixed component cost increased from EUR 22 per kW to EUR 42 per kW, or by 92%. For a 4 kW connection, this is an increase of EUR 80 per year, whatever the energy consumed.

In addition, the new Electricity Sector Act 24/2013 aims to ensure that consumers with distributed generation contribute to the costs of the electricity system under the same conditions as other customers. The related Royal Decree on self-consumption has been drafted, sent to CNMC and submitted to public consultation. The draft implies that a household would need to have two meters, one for the electricity consumed at the connection point to the network and one for the electricity generated

In 2008, the government approved the substitution plan for all Spanish residential meters by smart meters by 2018. The absence of a meter for distributed generation would be illicit and heavily fined. Depending on the level of penalties and the cost of network access, the new regulatory framework will dramatically change the economics of old and new rooftop solar PV. The key challenge here is to find the right balance and price system (different components of retail prices and network charges) to ensure efficient development of distributed generation.

ELECTRICITY SECURITY

From a security perspective, Spain's electricity system is very strong. Energy sources for electricity are well diversified and balanced between hydro, nuclear, coal, natural gas and intermittent renewables. Total installed capacity is very high and reserve margins are expected to remain high until 2020. The networks are new and well-developed, ensuring a high quality of power supply.

Spain generates around 25% of its electricity from wind and solar power and demonstrates that electricity from these variable sources can be integrated while ensuring a high level of security of supply. For instance, wind power's share on 25 January 2014 peaked at 68.5% of generation during one hour without any consequence for system operation security. Essential in this regard is the Renewable Energy Control Centre (CECRE), created by REE, to maintain the reliability and stability of the electricity system. It is an operational unit within the REE Power Control Centre, used to monitor and control electricity generated from wind or other renewable energy sources, and to securely integrate them into the power system. The control system has proved to work well, as strong fluctuations in wind generation have been accommodated in the electricity system without major blackouts.

Future security of supply may become challenged, however, because many conventional power plants are ageing or uneconomic, and expected to close down in the coming years. The market and regulatory frameworks should ensure a high level of electricity security over time.

GENERATION ADEQUACY

According to the CNMC, no capacity constraints are expected in Spain in the medium term. The reserve margin above peak demand is expected to remain over 16% until 2017/18, even in scenarios of high-demand growth. The reserve margins are higher in summer (see Table 8.3).

Table 8.3 Expected reserve margin in winter in Spain

Reserve margin, winter	2014/15	2015/16	2016/17	2017/18
Low -demand scenario	30%	33%	29%	26%
High-demand scenario	19%	22%	19%	16%

Sources: CNMC, REE.

These adequacy forecasts assume specific availability factors for different technologies. In particular, wind, solar and biomass capacity is contributing 12% of its nameplate capacity in winter (3.7 GW out of 30 GW installed capacity). The available capacity of CCGTs is assumed to be constant over the period at 22 GW out of 27 GW of installed capacity.

This capacity does not take into account the likelihood of mothballing some CCGTs which is expected in the coming years. In 2013 and 2014, the load factor of CCGTs was around 11%. On account of this situation, in July 2013 Iberdrola asked for the closure of the third unit (800 MW) of the Arcos de la Frontera power plant (Andalusia). These assets are losing money and will be mothballed. The authorisation procedure for the closure of generation facilities is regulated under Royal Decree 1955/2000. Mothballing (temporary closure) is

envisaged in Law 24/2013, but in May 2015 the regulation implementing the law was still to be adopted.

NETWORK ADEQUACY

As the Spanish electricity network is very strong, the quality and reliability of the transmission service is excellent. For instance, the mean interruption time (TIM) was 0.28 minutes in 2012 on the mainland, the lowest since 1992. The corresponding unserved energy in the transmission network was only 133 MWh. Reliability of the transmission network is monitored by CNMC.

Usually, most of the interruptions come from the failure of distribution lines but no information is available on this. Given that the Spanish network is relatively new and that many distribution lines run underground, reliability of the distribution network does not seem to be a major issue.

Regarding cross-border interconnections, increasing interconnections with France is perceived to help further improve security of supply in Spain. Existing lines already capture benefits in terms of security of supply, including synchronous frequency and sharing of primary reserves with other countries. The new Santa Llogaia-Baixas interconnection further strengthens security of supply. However, to reach the interconnection target of 10% set by the European Council, Spain also needs the aforementioned planned interconnection projects between Spain and France to become a reality.

ASSESSMENT

The Spanish electricity system is one of the most diversified by energy source among the IEA member countries, with a very high degree of security of supply and a relatively low CO_2 intensity. Remarkably, the system has succeeded very well in integrating high volumes of variable wind and solar power despite the relative lack of interconnection capacity.

Since the 2009 IEA in-depth review, Spain has managed to further develop its electricity system to absorb an increasing share of variable renewable energy sources (wind and solar). In line with the IEA recommendations, the country is also moving towards a more fully market-based and independently regulated electricity system. As in all countries, however, work remains.

TARIFF DEFICIT

The main focus of the current government, in office since December 2011, has been to reintroduce financial stability to the electricity system. For a number of years, and for several reasons, the system's costs were allowed to increase faster than revenues. This led to an accumulated tariff deficit equalling 3% of GDP at the end of 2013. After more than a decade of ineffective or no action at all by its predecessors, the current government had to act as part of measures to balance the country's public finances. Reigning in a deficit of that size was never going to be easy in a system where so many benefited from subsidies that had to be cut.

Legislative action to reform the electricity system started in 2012 and culminated in the broad July 2013 reform package. With some exceptions, the complex reform has now (as of spring 2015) been implemented. The electricity sector's costs and revenues are back in balance, and the deficit should gradually disappear over the next 15 years.

Tough decisions in a context of a severe economic crisis were absolutely necessary in order to ensure the financial sustainability of the electricity system. The consequences of these measures were harsh for many stakeholders in the power industry and among consumers. In practice, the new measures consisted of changes in feed-in tariffs of the existing installations in order to guarantee a reasonable return, which in certain cases implied smaller-than-expected returns on investment.

By reducing subsidies and increasing taxes and charges, the government is discouraging new investment in generating capacity. This does not hurt Spain's energy policy goals in the short term, for the country has a large overcapacity, but the changes affecting existing installations have increased the perceived regulatory risk for future investments.

Uncertainty related to the key concept of reasonable return remains. As the rate of return is revised every six years, it may be subject to potentially large revisions, because interest rates are now historically very low. More generally, to avoid political interference with the system's costs in the future, the principle of "no new cost without a revenue increase" should be strictly enforced. Also, calculating the access tariffs and monitoring the balance of costs and revenues should be assigned to the independent regulator, CNMC.

A useful lesson that can be drawn from all that has happened in the Spanish electricity sector in past years is that if something appears too good to be true (such as the EUR 450 per MWh feed-in tariff for solar PV for 25 years, as promised in 2008[2]), it probably will not last. Business is risky, and higher subsidies come with a higher political risk. A lesson for future governments, both in Spain and in other countries, is to be realistic and make only promises that can be kept.

As a reflection of the high level of costs in Spain's electricity system, end-user prices in Spain are one of the highest among the IEA member countries. The electricity bill contains a number of components unrelated to the supply of electricity to final users. To the extent that these charges are independent of the supply of electricity, they should be eliminated and recovered via more appropriate mechanisms.

A broader question for Spain to consider in the context of electricity system costs is whether the cost of renewable electricity deployment should be borne only by electricity consumers. The subsidies are the single largest cost component in the electricity system and are thus reflected in end-user prices. Fossil fuel consumption could be taxed more, and the tax revenue could be used for covering subsidies for cleaner energy. Another question is how much renewable electricity Spain wants to generate to meet its future renewable energy goals. The burden could be shared more evenly across sectors, which primarily implies a stronger focus on limiting oil use in the transport sector.

MARKET STRUCTURE AND REGULATION

An area of the electricity market reform where the government has yet to introduce new rules is capacity mechanism and mothballing of CCGTs. Declining electricity demand, changes in relative prices of fuels, and policy decisions rendered Spain's 27 GW CCGT fleet idle around 90% of the time in 2013 and 2014. It makes economic sense to mothball part of this capacity, while it also makes sense to leave some of it immediately available on the ground of security of supply. In the longer term, CCGT capacity will be needed for backing

2. By comparison, the weekly average wholesale price at Spain's OMEL electricity exchange ranged from EUR 26 to EU 76 per MWh in 2007-08.

up more renewables and coping with the potential closure of coal plants because of ageing and stricter air quality requirements.

The current capacity payment system, however, is relatively expensive and not targeted at the power plants needed to ensure generation adequacy in a least cost manner. Instead, the capacity needed could be ensured by tender. Another option for study is to designate an independent entity for acquiring reserve capacity plants to be used only to avoid physical shortages of electricity.

Another area where regulatory clarity is needed without delay is self-consumption of distributed generation. Self-generation, mainly from increasingly competitive solar PV, reduces the revenues for covering regulated costs in the electricity system, including the cost of renewables, since it reduces the number of kW and kWh that distributors can bill. Unless further reforms are undertaken, this could create a new spiralling deficit. The government should clarify the regulatory regime for the appropriate development of self-consumption and distributed generation while guaranteeing cost-reflective network charging.

Although the electricity market reform has at least temporarily increased the perception of regulatory uncertainty for investors in renewable electricity, Spain will likely need more of these investments towards 2030 as the European Union strives to meet its EU-wide target of a 27% share of renewable energy. To facilitate further integration of renewable energy, the government should work towards increasing efficient flexibility sources in the system. These include nuclear and combined heat and power generation (CHP) flexibility, demand response, and cross-border interconnections.

Nuclear and CHP plants amount to 15 GW of installed capacity and generate base load power or power according to industry needs. Experience in other IEA countries shows that they can contribute to system flexibility by integrating wind and solar power, if needed.

Similarly, demand response is currently limited to interruptible contracts for large industry. Demand response is a promising source of flexibility that can help balance services, ancillary services and increase consumption in periods of low electricity prices as are already experienced in Spain during 15% of the hours.

Since 2008, CNMC, which regulates the electricity sector has seen its mandate reinforced in several areas, including on defining a methodology for determining network tariffs for both transmission and distribution. The final authority for setting tariffs remains, however, with the Ministry of Industry, Energy and Tourism. This might impact the level of confidence in markets and investments. The IEA encourages the government to grant the regulator more powers and greater independence, including exclusive authority to determine network tariffs for both transmission and distribution and to monitor all regulated costs and revenues (including renewables), in a transparent manner in order to prevent future deficits.

MARKET INTEGRATION AND CROSS-BORDER INTERCONNECTIONS

Market integration with the rest of the European market has significantly improved over the past few years. Since May 2014, the Iberian Market is coupled with the other European market areas, allowing for an optimal utilisation of interconnections. However, substantial challenges remain with regard to intraday and balancing markets. Better integrating the day-ahead and balancing markets with the rest of Europe would ensure better use of existing interconnections.

Cross-border interconnection is essential for market integration, renewable energy integration, and security of supply. Spain's interconnection capacity remains very low, at around 4% of installed capacity in 2014. Efforts to increase the interconnection capacity with France have brought frustratingly few results over the past decades until very recently. In a welcome development, the 1.4 GW Santa Llogaia–Baixas interconnection was inaugurated in February 2015 – the first new interconnection in almost three decades.

The situation is becoming better, however, and new momentum for additional interconnections is evident after the government took the matter to the EU level in 2014. As part of completing the internal market for electricity, securing electricity supply, and facilitating the grid integration of renewable energy, the October 2014 European Council agreed on a target of a 10% share of interconnection capacity in total installed generation capacity in every member country by 2020. Furthermore, this target should be raised to 15% by 2030. European Union funds are available for priority projects, and the political leaders of France, Portugal and Spain are committed to the political objective. After so many years of very limited results, it is highly encouraging to see the recent positive developments and the strong political support for further developing interconnections between the Iberian Peninsula and France. The planning and construction of new interconnections should be vigorously pursued and EU funding sources for them used to the full.

To facilitate interconnection projects, and transmission projects in general, timely planning of the required infrastructure is of the essence. Also, project authorisation often involves several steps with different authorities. As far as possible, project authorisation should be streamlined.

RECOMMENDATIONS

The government of Spain should:

- *Maintain a strong long-term commitment to balancing the costs and revenues in the electricity system, as laid out in the Electricity Sector Act 24/2013.*
- *End capacity payments as soon as possible and refrain from introducing other forms of payments for mothballed or closed plants not required by the system; in case of short-term concern over availability of generating capacity, select by tender the power plants required for security of supply.*
- *Work to increase efficient flexibility sources in the system in order to facilitate further integration of renewable energy, including demand response, nuclear and co-generation (CHP) flexibility, and cross-border interconnections.*
- *Improve intraday and balancing markets by moving away from the current bidding window procedures and closing intraday trade closer to real time and integrating these markets with the rest of Europe.*
- *Strongly pursue the development of key transmission infrastructure, including interconnections with neighbouring countries, especially with France, in order to foster market integration, facilitate renewable energy integration and enhance security of supply.*
- *Focus on timely planning of the required transmission infrastructure following the European-wide planning processes and using cost-benefit analysis.*

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9. RENEWABLE ENERGY

Key data (2014 estimated)

Total supply: 17 Mtoe (14.9% of TPES) and 110.5 TWh (40.4% of electricity generation). IEA average: 9.4% of TPES and 22.4% of electricity generation

Biofuels and waste: 6.2 Mtoe (5.5% of TPES) and 5.5 TWh (2% of electricity generation)

Wind: 4.5 Mtoe (3.9% of TPES) and 52.3 TWh (19.1% of electricity generation)

Hydro: 3.4 Mtoe (3% of TPES) and 39.1 TWh (14.3% of electricity generation)

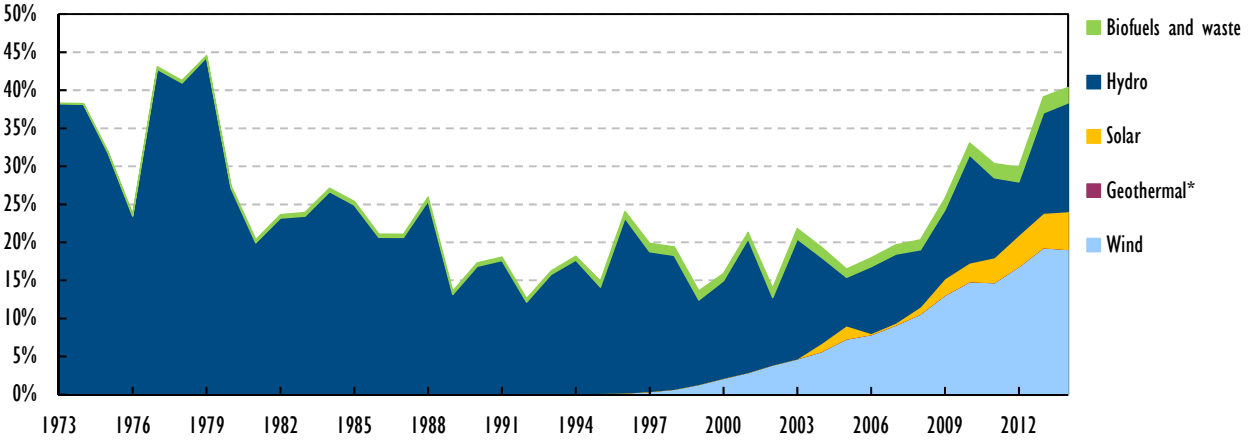
Solar: 2.9 Mtoe (2.5% of TPES) and 13.7 TWh (5% of electricity generation)

SUPPLY AND DEMAND

Renewable energy accounted for 17 million tonnes of oil-equivalent (Mtoe) or 14.9% of Spain's total primary energy supply (TPES) in 2014. It includes biofuels and waste (6.2 Mtoe or 5.5% of TPES), wind power (4.5 Mtoe or 3.9%), hydropower (3.4 Mtoe or 3%) and solar energy (2.9 Mtoe or 2.5%).

Renewable energy as a share of TPES increased from 6.4% in 2004 (8.9 Mtoe). This was mainly driven by electricity generated from wind and solar power with strong support from the government (Figure 9.1). Solar power increased at an annualised rate of 16% per year from 2004 to 2014 and wind power by 13%. Biofuels and waste grew by 4.4% per year, and hydropower by 2.3% per year, although varying strongly year-on-year, depending on climatic conditions.

Figure 9.1 Renewable energy as a percentage of TPES, 1973-2014



Note: data are estimated for 2014.

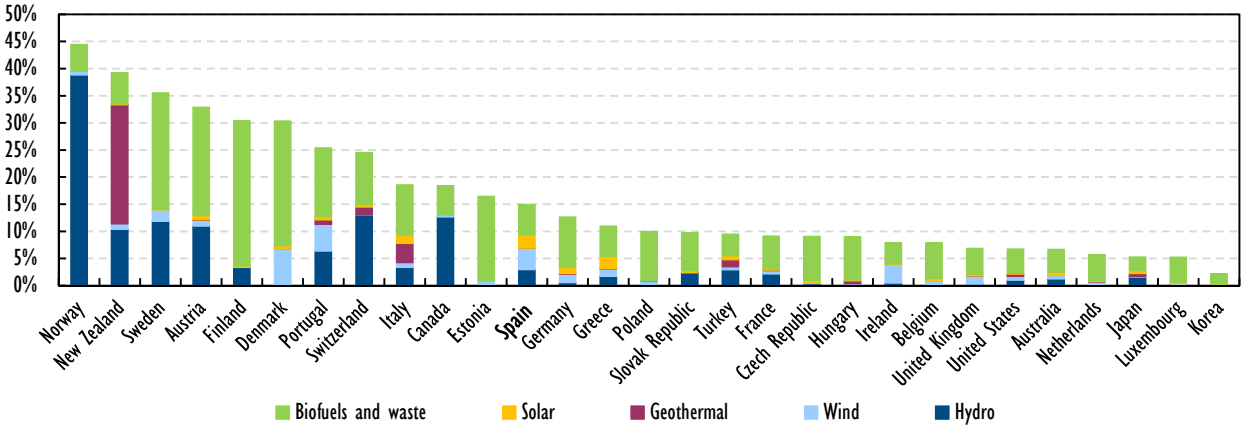
* Negligible.

Source: IEA (2015, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

Biofuels and waste are mainly consumed by the residential sector (2.5 Moe or 50% of biofuels and waste supply), industry (1.5 Mtoe or 28.9%) and transport (0.9 Mtoe or 17.8%) with the remainder used in electricity generation. Wind and hydropower are used to generate electricity, while solar energy is also used for heat in the residential sector and industry (around 9% of solar supply or 0.2 Mtoe).

Spain has the twelfth-highest share of renewables in TPES among International Energy Agency (IEA) member countries (see Figure 9.2). Its share of solar energy in TPES is the highest among IEA countries, followed by Greece.

Figure 9.2 Renewable energy as a percentage of TPES in Spain and IEA member countries, 2014

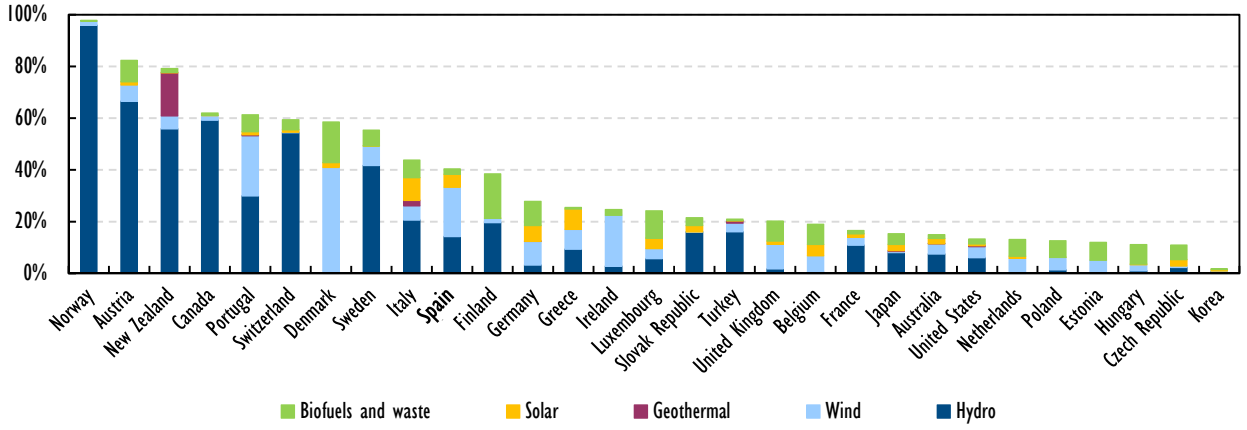


Note: data are estimated for 2014.

Source: IEA (2015a, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

Electricity from renewable sources amounted to 110.5 terawatt hours (TWh) in 2014, or 40.4% of total generation. Renewables in electricity generation include wind (52.3 TWh or 19.1% of total electricity generation), hydro (39.1 TWh or 14.3%), solar (13.7 TWh or 5%) and biofuels and waste (5.5 TWh or 2%). The share of renewables in generation has increased from 19.3% in 2004 (53.4 TWh).

Figure 9.3 Electricity generation from renewable sources as a percentage of all generation in Spain and IEA member countries, 2014



Note: data are estimated for 2014.

Source: IEA (2015a, forthcoming), *Energy Balances of OECD Countries*, OECD/IEA, Paris.

Among the IEA member countries, Spain has the tenth-highest share of renewables in electricity generation and its share of solar power is the fourth-highest, after Italy, Greece and Germany. Wind power in TPES and in electricity generation is also fourth-highest behind Denmark, Portugal and Ireland. The shares of biofuels and waste and hydropower in both TPES and electricity generation were around the median level among the 29 IEA members.

Spain's wind power capacity is the fourth-highest in the world after China, the United States and Germany, and practically equal with India, according to the Global Wind Energy Council. Spain is also among world leaders in solar power, but the absolute capacity is low.

Thanks to a very favourable promotion policy, renewable electricity generating capacity increased by 70% (20 gigawatts [GW]) from 2005 to 2012 (see Table 9.1). From 2008, the year when electricity demand in Spain peaked, to 2013, capacity increased by 11 GW, while demand declined by 23 TWh or 9%. For financial reasons that are explained below and in Chapter 9, the promotion policy was reviewed and adjusted to continue with the principle of remunerating renewable generation with a reasonable return.

Table 9.1 Renewable electricity generating capacity, 1990-2013 (MW)

Technology	1990	2000	2005	2007	2008	2009	2010	2011	2012	2013
Wind	2	2 206	9 918	14 820	16 555	19 176	20 693	21 529	22 789	22 958
Hydro	15 657	17 960	18 220	18 372	18 451	18 505	18 535	18 540	18 550	19 094
Pumped storage	2 418	2 418	2 424	2 424	2 424	2 449	2 449	2 465	2 465	2 462
Solar PV	3	12	60	739	3 389	3 488	3 921	4 352	4 646	4 766
Solar thermal	0	0	0	11	61	282	732	1 149	2 000	2 250
Municipal waste	27	94	189	189	189	189	223	224	224	224
Industrial waste	0	0	0	0	0	0	0	50	50	50
Solid biofuels	115	150	354	396	374	502	545	563	640	657
Biogases	0	50	152	165	149	177	205	209	218	220
Total capacity	**15 804**	**20 472**	**28 893**	**34 692**	**39 168**	**42 319**	**44 854**	**46 616**	**49 117**	**50 219**
Solar collectors surface (1 000 m^2)	281	403	797	1 199	1 617	2 010	2 373	2 651	2 855	3 088
Capacity of solar collectors (MW_{th})*	197	282	558	839	1 132	1 407	1 661	1 856	1 999	2 162

* Converted at 0.7 kW_{th}/m^2 of solar collector area, as estimated by the IEA Solar Heating & Cooling Programme.

Note: m^2 = square metres; MW_{th} = megawatt thermal.

Source: IEA (2015b, forthcoming), *Renewables Information*, OECD/IEA, Paris.

INSTITUTIONS

The **Ministry of Industry, Energy and Tourism (Minetur)** is responsible for national policy on renewable energy. The main government agency for developing and implementing policies for renewable energy is the **Institute for Diversification and Saving of Energy (IDAE)** which is attached to Minetur. The **National Commission of Markets and Competition (CNMC)**, the regulatory body, is responsible for several aspects of the system for remunerating renewable electricity generation. It also monitors compliance with the biofuels consumption obligation.

The **autonomous communities** authorise new power plants below 50 MW, which include most renewable electricity projects. They, and the municipalities, are involved in developing policies and implementing programmes to support renewable energy use for heat and in isolated electricity networks.

POLICIES AND MEASURES

TARGETS

Spain's renewable energy policy is aligned with the EU 2020 targets. For 2020, Spain has a binding national target for renewable energy to equal 20% of gross final consumption of energy. In addition to this overall target, Spain and other EU member states have a separate binding national target for renewable energy to cover 10% of transport fuel demand in 2020. Beyond 2020, the EU member states have agreed on a target for a 27% share of renewable energy in energy consumption in 2030. The target is binding for the EU as a whole only. The level of effort to be made by each EU member state to achieve this EU target has not yet been decided.

Spain's targets on renewable energy for 2020 and the policies and measures to meet them were initially laid out in the National Renewable Energy Action Plan 2011-2020 (NREAP) which was first published in 2010 and revised in 2011. The NREAP followed the 2005-2010 Renewable Energy Plan.

The NREAP sets a national 2020 target of 20.8% of renewable energy in gross final energy consumption. This target is lower than the 22.7% share in the initial 2010 NREAP, but still above the EU target of 20%. The downward revision was motivated by the need to reduce support costs under Spain's general economic conditions. For reasons of economic sustainability, many of the policies and measures in the 2011 NREAP have also been revised. The main policies and measures by sector are detailed below.

Spain has made clear progress towards the 2020 target. It has increased the share of renewable energy in gross final energy consumption year after year, according to Minetur, from 12.1% in 2005 to 15.6% in 2011, 16.8% in 2012, 16.3% in 2013 and around 17% in 2014. The share has increased mainly as a result of increasing renewable electricity generation, but also as a result of increasing renewable energy use for heat and transport fuels and decreasing final energy consumption.

To reach the 2020 target from the 2014 levels, the government plans to focus on increasing renewable electricity capacity. It forecasts the need for an additional 8.95 GW, mainly wind, by 2020, and plans to organise tenders for new capacity in the coming years. The government also plans to increase the obligation to use biofuels in transport.

In principle, Spain can also resort to so-called co-operation mechanisms to help meet its 2020 target. These include statistical transfers between the EU member states of a specified amount of energy from renewable sources and joint renewable energy projects with other countries.

ELECTRICITY

The central government and the autonomous regions have seen renewable energy as both bringing environmental and energy security benefits, and enhancing local economic development and employment. Renewable energy technology development, especially wind and solar, has also been a focus area of Spain's industrial policy. However, the policies

to promote renewable electricity generation in the last decade came at a high cost and with limited regard for long-term cost sustainability.

The laws and regulations guiding electricity generation from renewable sources have changed fundamentally since 2009, the time of the previous IEA in-depth review of Spain. The 2012-13 electricity market reform is explained in more detail in Chapter 8. In this section, only aspects relevant to electricity generated from renewable sources are discussed.

Until 2012, the legal and economic framework, which regulated the generation of electricity from renewable sources in Spain, was based on a system of feed-in tariffs and premiums designed to deliver generating facilities a reasonable rate of return. In July 2013, the feed-in tariffs and premiums were abolished and replaced with an economic remuneration system that allows an efficient and well-managed company to cover its investment and operation and maintenance costs in order to compete on the market under the same conditions as conventional power plants. This new economic system is intended to guarantee a reasonable return to all renewables facilities.

The reform was motivated by the need to balance the costs and revenues in the electricity system. Since 2005, costs had increased much faster than revenues. This resulted in a chronic tariff deficit which, by 2012, had accumulated to EUR 26 billion and was growing by billions per year. Renewable electricity support costs were the single largest cost component of the electricity system (see Figure 8.5).

Renewable electricity support costs were high partly because of exceeding the capacity targets set in the 2005-2010 Plan. As an example, the Plan envisaged a total public spending of around EUR 5.0 billion in premiums on electricity generation. For 2010, the budget estimate was EUR 1.8 billion. In 2012, however, the support on renewable electricity was EUR 6.2 billion, increasing to EUR 6.8 billion in 2013.

The new government that took office in 2011 set an objective of curtailing the electricity tariff deficit as part of its efforts to stabilise public spending. In January 2012, the Royal Decree-Law 1/2012 suspended support schemes for future renewable electricity plants, but not for the existing ones. Later in 2012, the government introduced a 7% tax on electricity generation (22% for hydropower).

The new remuneration system was introduced by Royal Decree-Law 9/2013 of July and later confirmed by the Electricity Sector Act 24/2013 of October. Under the new system, renewable energy operators are guaranteed a reasonable rate of return that is composed of the 10-year government bond plus a spread, which is currently set at 300 basis points (at least for the first regulatory period). This return is calculated on the asset base of a standardised facility over its lifetime. The standardised costs vary according to the technology and year of entry into operation, and are revised every six years. The remuneration is the difference between the reasonable return and the wholesale market price. The remuneration is thus based on installed capacity, rather than on electricity generated, as in the past. Because the return is calculated over the lifetime of a facility, those facilities that in the past have reached a return higher than the one guaranteed now could experience lower returns in the future.

The Electricity Sector Act 24/2013 also abolished the distinction between the special and ordinary regimes. Generators within the special regime (i.e. renewable electricity generators, excluding facilities above 50 MW) have had priority dispatch over the ordinary regime ones (conventional plants). Among special regime generators, preference was given to non-manageable renewables (i.e. wind or solar plants, as opposed to biomass or urban waste which were deemed manageable). Special regime generators had to deliver

binding day-ahead bids and programming, and were responsible for their imbalances on even terms with the ordinary regime ones.

Under Act 24/2013, renewables and co-generation will participate in the wholesale market like any other technology. Renewables maintain priority access and priority dispatch (all market conditions being equal and subject to technical requirements for the safe operation of the system). Operators also remain responsible for their imbalances.

Support costs for renewable electricity

According to the Council of European Energy Regulators (CEER), in 2012, Spain generated 68 TWh of renewable electricity that received support (see Table 9.2). This was 23% of total electricity generation, the third-highest share in a comparison of 22 European countries, after Denmark (56%) and Portugal (30%). The average for the 22 countries was 12.6%.

Table 9.2 Support for renewable electricity by technology, 2012

Technology	Electricity generated receiving support (TWh)	Renewables incentive costs (EUR million)	Cost (EUR/MWh)
Biogas	0.8	49	59
Hydropower	4.6	187	40
Solar – CSP	3.4	925	270
Solar – PV	6.7	2 614	390
Solid biomass	4.3	336	78
Wind power	48.3	2 053	42
Total (average for cost)	**68.1**	**6 164**	**90**

Source: CEER (2015), *Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, Council of European Energy Regulators, Brussels.*

Unit-specific support for renewable electricity in Spain in 2012 ranged from EUR 40.31 per MWh for hydro to EUR 349.08 per MWh for solar power (photovoltaics [PV] and concentrated solar power [CSP] combined). For wind power, the support was EUR 42.48 per MWh and for biomass EUR 75.01 per MWh. The average level of support in Spain was EUR 90.34 per MWh of renewable energy generated, sixth-highest in the comparison. In 2013, the average declined to EUR 86.62 per MWh, thanks to a drop in the support level for solar power (see Table 9.3).

Table 9.3 Support for renewable electricity by technology, 2013

Technology	Electricity generated receiving support (TWh)	Renewables incentive costs (EUR million)	Cost (EUR/MWh)
Biogas	0.9	51	57
Hydropower	7.0	303	43
Solar – CSP	4.4	1 113	251
Solar – PV	6.8	2 564	378
Solid biomass	4.6	354	76
Wind power	54.6	2 398	44
Total (average for cost)	**78.3**	**6 783**	**87**

Source: CEER (2015), *Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, Council of European Energy Regulators, Brussels.*

Support costs for renewable electricity amounted to EUR 6.2 billion, or EUR 20.72 per MWh of all electricity generated (from renewables or other) in 2012.this was also the third-highest in the CEER cross-country comparison, after Italy (EUR 32.03 per MWh) and Germany (EUR 25.86 per MWh). The average was EUR 13.68 per MWh. In 2013, the total support costs in Spain increased to EUR 6.8 billion, as more hydro, wind and solar thermal (CSP) power was generated. At the same time, total electricity generation declined, which increased the level of renewables support costs for all electricity generated to around EUR 24 per MWh. Data for a 2013 cross-country comparison were not readily available.

HEAT

The use of renewable energy (biomass) for heat in industry is already competitive and does not need government support. In the residential sector, Spain has a natural advantage in solar heating, and, under the 2005-2010 Plan, it received significant government support. Since September 2006, Spain's building code CTE (*Código Técnico de la Edificación*) requires new and refurbished buildings to meet a certain share of domestic water-heating demand with solar thermal energy. This share ranges from 30% to 70% depending on climate and other local conditions. CTE was amended by Law 8/2013 of 26 June to prioritise the use of renewable energy over fossil fuels. Spain does not, however, hold an official record of renewable used for heating and cooling facilities.

New potential for using biomass for residential heating in Spain is fairly small. There are, however, some opportunities for integrated district heating and cooling systems, and a few projects have been implemented in locations with favourable conditions. The Regulation of Thermal Installations in Buildings (RITE) includes sections on the installation of biomass systems for space and water heating in buildings. This measure aims at overcoming the long-existing regulatory barrier to the proper development of this technology. Since 2006, RITE has been updated and revised several times to promote more efficient technologies, including renewable energy ones. The latest revision was by Royal Decree 238/2013.

Projects to promote heat from renewable sources have been funded through energy service companies (ESCOs) under the programmes BIOMCASA I and II, GEOCASA, SOLCASA and GIT which focus on biomass, geothermal and solar thermal energy. The programmes combine energy saving and renewable energy promotion. They were started in 2009/10. By the end of 2014, they had invested EUR 38 million in around 70 MW of renewable energy capacity. In addition, from 2006 to 2011, EUR 119 million was spent under the Renewable Energy Plan 2005-2010 on investment aid for heat from renewable energy. The projects were managed through agreements with the autonomous regions.

Investments in renewable heat energy are also financed from the EUR 123 million Energy Saving and Diversification Investment Fund (FIDAE) (see Chapter 4).

TRANSPORT FUELS

The use of biofuels in transport is based on an obligation under the EU Renewable Energy Directive (2009/28/EC) to supply 10% of road transport energy needs from renewable sources by 2020. The previous, but non-binding, EU target was for a 5.75% share for 2010. To reach the EU target, Spain has set up an obligation for biofuels use. Before 2013, biofuels use was also encouraged by tax incentives, but they were abolished in an effort to balance the government's budget deficit.

Law 12/2007 and Ministerial Order ITC/2877/2008 set up binding targets and established a regulatory framework for the use of biofuels and other renewable sources in transport. Fuel suppliers must ensure that a specific volume share of their fuel sales to the transport sector comes from renewable energy sources in a given year. Only biofuels meeting the EU sustainability criteria qualify. Therefore, the life-cycle emissions of greenhouse gases (GHG) from biofuels must be at least 35% lower than those of the fossil fuels they replace. This savings requirement rises to 50% in 2017. Also, biofuels from sensitive or carbon-rich land are excluded. The targets should be adapted to the forthcoming directive on indirect land use change (ILUC) which will amend Directive 98/70/EC on fuel quality and Directive 2009/28/EC on renewable energy. The ILUC directive is to be adopted in mid-2015.

The biofuels obligation is met by holding tradable certificates. These are issued by CNMC which also administers the compliance system. Each company subject to the obligation has to hold a minimum amount of certificates. Fuel suppliers can reach the overall target through different ratios of bioethanol and biodiesel, provided that the minimum individual targets for both are met. The targets were reduced in February 2013 by Law 11/2013 and since then are as follows:

- minimum share of biofuels in petrol and diesel for transport use: 4.1% (previously 6.5%)
- minimum share of biofuels in petrol use: 3.9% (previously 4.1%)
- minimum share of biofuels in diesel use: 4.1% (previously 7%).

Since 2010, up to 30% of the obligation can be fulfilled by certificates earned in the previous year, if the company has previously transferred them. The company can also reach the targets by paying compensation, but only if it had reached at least 50% of its obligation.

ASSESSMENT

Renewable energy to 2020

In 2013, 15% of Spain's energy demand was met by renewable energy. This performance is mainly accounted for by a very strong contribution from renewable electricity (40% of electricity generation in 2014), a sector in which Spain has become one of the world leaders over the last 15 years. With an installed renewable electricity capacity of 50 GW and a current ability to deal with an instantaneous penetration rate of over 60%, Spain is also at the international forefront in developing the system operation tools necessary for securely integrating a high proportion of intermittent renewable generation.

Spain's near-term renewable energy goals are aligned with those of the European Union, through its obligation to meet 20% of gross final energy demand from renewable sources by 2020. The government expects that this target will be met mainly by electricity, forecasting the need for an additional 9 GW of renewable generation, mainly wind, by 2020. Given the short time remaining to 2020 in project deployment terms, the rate of progress on this objective will require very careful monitoring, as well as clarity on the scope for renewable heat and transport to help meet the 2020 target. It should be noted that this period coincides with only one cycle of Spain's six-year electricity planning process.

As regards renewable energy for transport, Spain's biofuels obligation has been reduced to 4.1% of transport fuels, far below the 10% required by 2020 under EU law. To avoid falling short of the 10% target, the government plans to increase the mandatory blending obligation. This is indeed what the government should do.

Renewable heat appears to be an area of less ambition when moving towards the 2020 target, although its use is set to increase to 2020. As Spain does not have an official record of renewable heating and cooling facilities, creating one would help to gather data to support policy measures.

Renewable electricity

Implementation of renewable electricity policy in any country involves a large number of players. Therefore, a clear understanding and assignment of roles and responsibilities is essential to ensure efficient use of resources, regulatory certainty and transparency. In Spain, there are particular complexities relating to roles and responsibilities in authorising renewable energy generation and in managing the financial flows relating to renewables subsidies. The authorisation of renewable generation is divided, in most cases, between the central (>50 MW) and regional (<50 MW) governments.

Law 3/2013 which created CNMC (the regulator) and Law 24/2013 of the Electricity Sector have brought transparency and regulatory certainty to the electricity system with regard to the distribution of competences. CNMC has the powers to set network access tariffs according to the methodology they develop. The government has the powers to set the rest of the costs in the electricity system (including the remuneration to renewable generation): this process includes a public consultation and a report by CNMC, providing a valuable forum for engagement.

One of the goals of the new regulatory mechanism for renewable generation is to give the Spanish electricity system the predictability and transparency required to attract foreign investors to return. The support system will be revised every six years. The methodology to review the spread (which is a component of the reasonable rate of return) is stated in Law 24/2013 of the Electricity Sector and Royal Decree 413/2014. The process of fixing the spread, in which the regulator CNMC is also involved, has to be passed in a law, taking into consideration the economic situation of the country, the electricity demand and the reasonable rate of return.

Spain has achieved a high level of flexibility in the operation of its electricity system. However, to ensure that the economic benefits of this flexibility are realised, system operation and market arrangements must be aligned. To this end, the revised renewable generation regime should be reviewed to identify how it could better encourage efficient generation performance and competition between technologies. In addition, as explained in Chapter 8, intraday markets should be developed and integrated with the wider European market to reduce ancillary service costs and facilitate greater participation of renewable electricity.

Timely and cost-effective development of indigenous renewable energy resources will be critical to reducing Spain's heavy reliance on imported fossil fuels. Ensuring the availability of robust, objective and dedicated energy modelling capacity will be essential to properly inform renewable energy policy development. First, currently available resources should be maximised and co-ordinated. Secondly, these resources should be augmented with a view to providing the analysis necessary to underpin a clear statement of post-2020 renewable energy goals and the ongoing review of the effectiveness and efficiency of renewable energy policy interventions. The quality of the analytical capacity will be critical to ensuring a technically feasible, and cost-effective, contribution by renewable energy to climate change goals in the period beyond 2020. Such an analytical facility would also help guide energy R&D, and improve the quality of engagement between government and stakeholders.

RECOMMENDATIONS

The government of Spain should:

- *Provide clarity to the market on how to achieve the 2020 target by identifying measures to optimise the contribution of each sector (electricity, heat and transport).*
- *Identify as a matter of urgency the cost-effective potential of the renewable heat and transport sectors to help meet the 2020 non-ETS target and improve security of supply.*
- *Continue to improve the efficiency of renewable electricity generation through promoting competition between renewable technologies and participation by the sector in the electricity market.*
- *Ensure regulatory certainty for the new investment support mechanism for renewable electricity by following, in every regulatory period, the methodology for reviewing the reasonable rate of return transparently and through a public consultation.*

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10. NUCLEAR ENERGY

Key data (2013)

Number of reactors: seven nuclear units operating at five nuclear sites

Installed capacity: 7 121 MW_{net}, 7 416 MW_{gross}

Electricity generation (2014 estimated): 57.3 TWh

Share of nuclear (2014 estimated): 13.1% of TPES and 20.9% of electricity generation

OVERVIEW

Nuclear power plays an important part in the Spanish energy supply, constituting 21% of the total electricity generation and about 13% of total primary supply (TPES). However, in the last decade the share of electricity produced by nuclear reactors has decreased in comparison to historical values as a result of the large development of renewable resources, in particular wind energy. Spain hosts seven nuclear units operating in five sites, for a cumulative net capacity of 7.1 gigawatts (GW); nuclear represents about 7% of the total generating capacity of the country. In 2014, nuclear power generated about 57 terawatt hours (TWh) of electricity, unchanged compared to 2013 but down by about 8% from 2012, because the Santa Maria de Garoña NPP ceased exploitation and most nuclear units had refuelling outages. All the Spanish nuclear power plants (NPPs) are privately owned and the majority of them are managed by economic interest groups. The major electricity generating companies in Spain are the main shareholders, in particular Iberdrola and Endesa (see Table 10.1).

Santa Maria de Garoña NPP, a boiling water reactor (BWR) of 455 megawatts (MW) that entered into operation in 1971, has been idled and defuelled by the operator at the end of 2012, though the operating licence was valid until July 2013. The decision to disconnect the plant from the grid was not related to safety concerns but solely driven by economic considerations, as its owner (Nuclenor) argued, given the financial impact of new taxes on electricity generation and nuclear spent fuel. The Santa María de Garoña plant ceased operation in July 2013. However, in May 2014 Nuclenor applied for a licence renewal up to 2031, which would make the investment required economically justifiable. In July 2014 the Spanish Nuclear Safety Council (CSN) approved a complementary technical instruction addressed to Nuclenor on documentation and additional requirements associated with the application of this renewal. Currently, the CSN is evaluating the documentation relating to this application before sending its compulsory and binding report to the Ministry of Industry, Energy and Tourism.

Two nuclear units have been shut down and are at different stages in the decommissioning process: Vandellos I and José Cabrera (Zorita), the first commercial NPP in Spain. Vandellos I, a 480 MW gas-cooled graphite-moderated reactor, was permanently shut down in October 1989, after 18 years of commercial operation, after a turbine fire made it uneconomic to repair. Level 2 of decommissioning was completed by the end of 2003, and most of the site

released. José Cabrera, a pressurised water reactor (PWR) of 160 MW, was permanently shut down in 2006, after 38 years of operation, and decommissioning activities are on-going.

Spain had an effective programme for power uprates, which allowed increases in the overall net capacity of nuclear plants by 586 MW with respect to original designs, or an average power increase of about 10%. Nuclear licensees expressed the objective of an additional 200 MW of power uprates for the next decade.

Table 10.1 Nuclear units in operation in Spain, 2013

Power plant name	Reactor type	Original design capacity (MW)	Capacity net (MW)	Capacity gross (MW)	Commercial operation	Years of operation	Owner
Almaraz, Unit I	PWR	900	1 011	1 049	1983	31	Iberdrola (52.7%) Endesa (36%) Gas Natural (11.3%)
Almaraz, Unit II	PWR	930	1 006	1 044	1984	30	Iberdrola (52.7%) Endesa (36%) Gas Natural (11.3%)
Ascó I	PWR	888	995	1 033	1984	30	Endesa
Ascó II	PWR	888	997	1 035	1986	28	Endesa (85%) Iberdrola (15%)
Cofrentes	BWR	939	1 064	1 102	1985	29	Iberdrola
Trillo	PWR	990	1 003	1 066	1988	26	Iberdrola (48%) Gas Natural (34.5%) Hidrocantábrico (15.5%) Nuclenor (2%)
Vandellós II	PWR	930	1 045	1 087	1988	26	Endesa (72%) Iberdrola (28%)
Total		**6 465**	**7 121**	**7 416**			
Santa Maria de Garoña	BWR	460 (gross)	466		1971		Nuclenor (Iberdrola 50%, Endesa 50%)

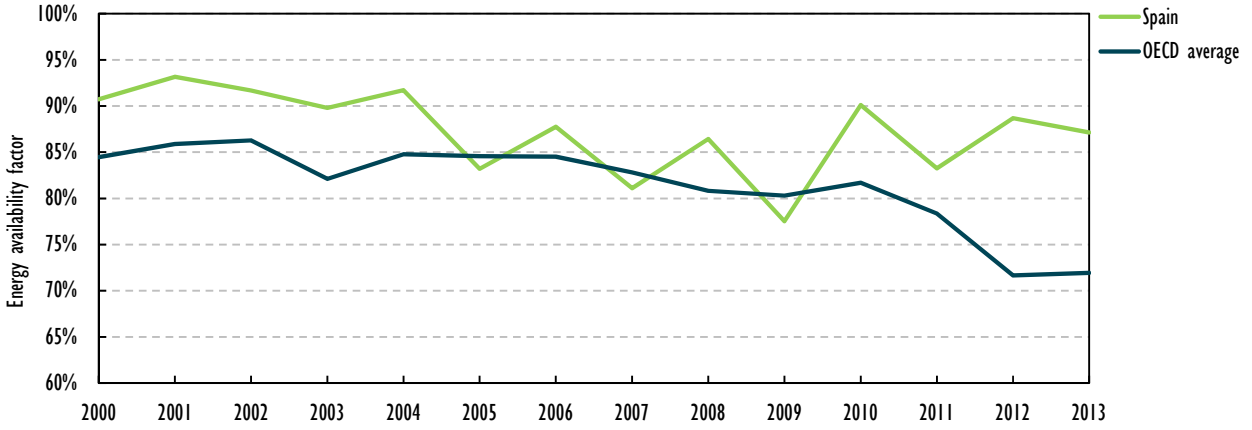
Note; PWR = pressurised water reactor; BWR = boiling water reactor.

Sources: IAEA, PRIS and Spain's country submission to the IEA.

The development of nuclear power in Spain began in the mid-1960s, with the construction of three small reactors of different designs, none of which is currently in operation. The bulk of existing nuclear capacity was started in the 1970s and came into commercial operation in the 1980s. Following a 1983 moratorium, confirmed in 1994, the plants under construction were abandoned and no new nuclear reactor has been built in Spain since. In comparison with other Organisation for Economic Co-operation and Development (OECD) countries, the lifetime of the Spanish nuclear fleet is quite homogeneous, with an average of 28.5 years of operation.

Over the past years, Spanish NPPs reached availability and load factors of about 85%. This is below the value of over 90% achieved at the beginning of 2000, but still above the average of OECD countries.

Figure 10.1 Energy availability factors of NPPs in Spain and the OECD, 2000-13



Sources: IAEA, PRIS.

NUCLEAR POLICY

The government considers that Spain requires a balanced electricity mix that takes into account all energy sources and available capacities. The government recognises the role of nuclear energy in the reduction of greenhouse gas (GHG) emissions and in the diversification of energy supply sources and thus considers that NPPs could not be disregarded as long as they comply with nuclear safety and radiological protection requirements imposed by the Nuclear Safety Council. This is a major change since the last in-depth review, as the previous government's policy was to progressively reduce the share of nuclear in the energy mix, while ensuring security of supply.

According to Spanish regulation, nuclear plants can remain in operation as long as they comply with the safety standards required by the Nuclear Safety Council.

INSTITUTIONS

The Ministry of Industry, Energy and Tourism (Minetur) is in charge of nuclear energy and radioactive waste management policy. The ministry is responsible for issuing the operating licences for nuclear facilities, subject to mandatory reports from the Spanish Nuclear Safety Authorities, and for submitting regulatory proposals, adopting provisions to implement current regulations and applying the disciplinary regime with regard to nuclear energy. The government is also responsible for defining the policy on management of radioactive waste and spent nuclear fuel as well as for monitoring the compliance with international commitments in the field of nuclear energy.

The Nuclear Safety Council (CSN, *Consejo de Seguridad Nuclear*) was set up in 1980 as the sole competent authority over nuclear safety and radiological protection matters. The CSN is legally and financially independent from the General Administration of the State. It has a role of control, surveillance and regulation of all nuclear facilities in Spain. It submits reports to Minetur on issuing and renewing licences for the operation of the plants and other facilities handling radioactive material. These reports are binding if negative and when they impose necessary safety requirements. The CSN may suspend the operation of facilities for safety reasons and initiate procedures to impose sanctions on operators. The CSN obtains almost all its economic resources through the collection of fees for the services provided

in compliance with its functions. It participates in international activities regarding nuclear safety under the co-ordination of the OECD Nuclear Energy Agency (NEA) and on the European Nuclear Safety Regulators Group (ENSREG).

CIEMAT (*Centro de Investigaciones Energéticas Medioambientales y Tecnológicas*) is an institution attached to the Ministry of Economy and Competitiveness in charge of research. Government-funded R&D on nuclear energy focuses on safety, plant life management and radioactive waste. CIEMAT collaborates with several institutions in Spain and participates in international R&D programmes through Euratom and in international activities with the International Atomic Energy Agency (IAEA) and OECD/NEA. CIEMAT is funded from the governmental research budget, via international collaborations and undertakes contractual research for third parties.

ENRESA (*Empresa Nacional de Residuos Radioactivos*), the Spanish national agency for spent fuel and radioactive waste management, was established in 1984 by the Parliament. It is a state-owned company, owned by CIEMAT, which holds 80% of the shares, and by the Spanish industrial holding (SEPI) for the remaining 20%. ENRESA activities include treatment, conditioning, storage and disposal of spent nuclear fuel and radioactive waste, together with the dismantling and decommissioning of nuclear installations. ENRESA is also responsible for managing the fund that finances spent fuel management and decommissioning activities, and co-ordinates R&D activities in the related fields. It is funded by the plant operators in proportion of their nuclear power output, by other producers of radioactive waste and through a special tax on electricity transport.

ENUSA Industrias Avanzadas is a state-owned company established in 1972 for the activities related to the front-end of the fuel cycle. It is owned by SEPI (60%) and CIEMAT (40%). ENUSA is in charge of the supply of enriched uranium for all the Spanish NPPs and operates a nuclear fuel manufacturing plant at Juzbado. The ENUSA's mining activities were stopped at the end of 2000 because of the low price of uranium, and because the facilities are at different stages of decommissioning.

NUCLEAR SAFETY

As described above, the CSN is the sole competent authority over nuclear safety and radiation protection matters. It has a role of control, surveillance and regulation over all nuclear facilities in Spain.

With regard to nuclear regulation, operating licences for Spanish NPPs are granted for a ten-year period by Minetur, following a binding report on nuclear and radiological safety from the CSN. Spanish NPPs are subject to a continuous oversight process by two inspectors present on site and an assessment programme based on the analysis of NPPs' performance indicators and on the information from inspectors. The CSN determines the appropriate level of response based on the indications of the assessment programme.

The application for the renewal of an operating licence must include the results of the periodic safety review (PSR) which must prove that the installation fulfils its design licence basis and complies with new standards; if necessary the licensee proposes adequate corrective measures. The CSN usually takes one year for the evaluation and the submission of its report to the ministry after establishing the limits and conditions for the licence renewal. For applications beyond the original lifetime (40 years in Spain), the licensee must include an Integrated Ageing Assessment and Management Plan with appropriate ageing

analysis to ensure that the system and equipment can be operated safely beyond 40 years. For these applications, the CSN usually takes three years to evaluate the application.

Since 2008, the Parliament reinforced the role of CSN in fostering transparency and public awareness in nuclear matters. The CSN Advisory Committee for information and public participation was established in 2007 with the objective of encouraging public participation and improving transparency in matters regarding nuclear energy. In 1998, the CSN set up a public information centre at its headquarters and, in recent years, improved the accessibility of its internet site and made information available to the public. Also, in 1999, information committees were created in the vicinity of NPPs to facilitate information exchanges between the general public and professionals from among safety authorities and plant operators.

Box 10.1 Results of EU stress tests

Following the accident at the Fukushima Daiichi nuclear power plant on 11 March 2011, the European Council requested that a comprehensive safety and risk assessment of operating reactors and spent fuel storage facilities be performed, under the co-ordination of the European Commission and the European Nuclear Safety Regulators Group. These "stress tests" focused on lessons learned from the accident in three main areas: natural external hazards (including earthquakes, tsunamis and extreme weather events); the loss of safety systems/design issues (loss of electrical power, including internal and external power supply, and loss of the ultimate heat sink); and severe accident management (means to prevent and mitigate the consequences of the loss of core and spent fuel storage cooling functions and containment integrity). A key issue was the ability to maintain cooling without either off-site electricity supply or on-site backup power.

Spain performed stress tests on the six power plants in operation as well as on the nuclear fuel manufacturing facility (Juzbado) and the José Cabrera NPP which is being dismantled but has temporary fuel storage facility on site. In addition to the scope of stress tests, the CSN launched a process to improve the resilience of plants against other man-made events that may lead to the loss of control of a large part of the installation and severely affect the safety of the plant. The CSN and the licensee established a well-defined plan for improvement measures in some of the Spanish NPPs to be implemented by the end of 2016, and before the end of 2017 for some other plants.

The peer review concluded that the Spanish Action Plan is ambitious and effective in establishing a higher level of safety for NPPs. It has identified several good practices in the Action Plan, in particular the close co-operation between the CSN and the licensee, and the request for an additional safety assessment that takes "beyond design" events into account. The importance of the periodic safety review process was also emphasised, including the inclusion of severe accident management in the review process. However, some challenges were identified in the timely implementation at the national level of regulatory requirements on safety reference levels for existing reactors.

Note: Detailed results of the EU stress tests can be accessed at: www.ensreg.eu/EU-Stress-Tests.

INCIDENTS OF NOTE

Every year the CSN informs the Parliament of all its activities and this report includes any event that has any relation with nuclear safety. Since the last in-depth review, no nuclear facility in Spain has reported to the International Atomic Energy Agency (IAEA) any event

of level 2 or above on the INES scale.[1] The latest report from a nuclear facility on INES level 2 dates from 2008, in the nuclear plant of Asco I. In its 2013 annual submission, the CSN reported 43 events, all of them classified as INES-0 events (below-scale or "deviations") that occurred at the NPPs and at other nuclear facilities (Juzbado and El Cabril). During the last five years, 10 INES-1 events were reported at the Spanish NPPs. This is an indication of the high safety level of the Spanish nuclear industry.

NUCLEAR FUEL CYCLE, RADIOACTIVE WASTE AND DECOMMISSIONING

POLICY AND LEGISLATION

The government is responsible for the policy on radioactive waste management and the dismantling and decommissioning of nuclear facilities. The sixth General Radioactive Waste Plan (GRWP), adopted in 2006, frames and guides the implementation of this policy. The seventh GRWP is currently under preparation to comply with the Euratom directive 70/2011 on spent fuel and radioactive waste; it will address the changes since 2006 and update the economic and financial forecasts. ENRESA is the national body responsible for the radioactive waste management and decommissioning.

Spain has adopted the open fuel cycle with direct disposal of nuclear spent fuel, without reprocessing. The spent fuel discharged from the reactor is currently stored in the pools of the NPPs and in dry-storage facilities waiting for the commissioning of a centralised storage facility. The Spanish strategy is to store spent fuel in a centralised storage temporary facility (CST) before its final disposal in a deep geological repository; this is considered in the proposal for the seventh GRWP submitted by ENRESA. A site for the CST has been identified at Villar de Cañas and the facility is expected to be operational by 2018.[2] As for planning and economic estimations, the deep geological repository may begin first operations in 2063. With regard to very-low (VLLW) and low- and intermediate-level radioactive waste (LILW) Spain has adopted the policy of final disposal in the centralised facility of El Cabril.

FRONT END OF THE FUEL CYCLE

Spain does not have uranium mining and milling operations. At the end of 2000, ENUSA closed its uranium mining activities in Saelices el Chico because of low uranium prices. The facilities, including the Quercus processing plant, are at different stages of decommissioning and environmental restoration. In 2013, however, Berkeley, an Australian company, acquired from ENUSA the exploitation rights for uranium in the Alameda and Villar deposits (addendum reserves). The mining licence for the Retortillo deposit has been granted by the regional government of Castilla y León in 2014, and Berkeley is seeking to finalise all permits required to begin operation at Retortillo.

1. The INES scale was introduced by the IAEA and NEA in 1990 and comprises seven levels of severity, from 1 (anomaly) to 7 (major accident), each level representing an accident approximately ten times more severe than the previous level. Level 0 indicates events with no safety significance. When originally conceived, the INES scale was constructed so that about one INES 1 event and ten INES-0 events would occur per year in a "normal" NPP. The IAEA requires reporting of events of level 2 or above on the INES scale.

2. The CTS facility will include a casks holding facility projected for the end of 2016.

Natural uranium supply comes from a variety of countries. In 2013, Russia, Niger and Canada provided 80% of the requirements. No conversion and enrichment facilities exist is Spain. ENUSA is responsible for the procurement of conversion and enrichment services, which are provided by a variety of suppliers.

ENUSA operates a nuclear fuel fabrication facility in Juzbado, in the province of Salamanca, which supplies fuel assemblies for all Spanish NPPs, with the exception of Trillo. In 2013, over 1 100 fuel assemblies for PWR, BWR and the Russian Federation designed PWR (VVER) were manufactured; 65% of the production was exported to other European countries, such as Belgium, France and Sweden.

WASTE MANAGEMENT: LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE

At the end of 2013, the inventory of Spanish VLLW and LILW definitively disposed of at El Cabril centralised facility was about 37 000 cubic metres, of which over 29 000 m^3 were LILW. The current projection from ENRESA is for a total amount of about 185 000 m^3, under the hypothesis of 40 years of NPPs operation. About 50% of this amount is expected to be VLLW. The waste would derive mainly from decommissioning activities (63%) and from NPPs operation (26%).

Since 1992, low level and intermediate-level radioactive waste are disposed in a centralised facility at El Cabril, in the province of Cordoba. Since 2008 the facility includes a complementary installation of 30 000 m^3 for the management and disposal of very low-level radioactive waste, which have lower requirements and can be managed in a more economical manner. In 2013, ENRESA started the process for the construction of a second cell of 39 000 m^3 for VLLW disposal and is currently under construction. The long-term objective is to build two additional cells to reach the site's authorised capacity of 130 000 m^3.

The fundamental objective of this near-surface disposal facility is the definitive disposal of LILW in a solid matrix and finally in cells (28 cells for LILW and 4 cells for VLLW). El Cabril facility provides an integrated management system that includes waste collection, transport, treatment and conditioning, and accurate information on the waste inventory, radiological characterisation and quality assurance.

WASTE MANAGEMENT: HIGH-LEVEL RADIOACTIVE WASTE

On December 2013, the total amount of stored spent fuel was about 4 500 tonnes of uranium (tU) and is expected to reach 6 700 tonnes of uranium under the assumption of a 40-year lifetime for all Spanish NPPs. The total volume of spent nuclear fuel is estimated to reach about 10 000 m^3. In addition, France will return to Spain a limited amount of ILW and HLW (about 16 m^3) from reprocessing fuel at Vandellos I nuclear plant. Additionally, it is still to be decided the final management of some fissionable material from the reprocessing fuel of the Santa María de Garoña NPP, which was sent to the United Kingdom before 1983, when reprocessing was still an option in Spain.

The nuclear spent fuel discharged from the reactor is currently stored in the pools of the NPPs and, because lack of capacity in the pools, in dry-storage facilities at some plant sites (individualised temporary storage facilities, ITSF). Two ITSFs are at Asco and Trillo, and a third is being commissioned at the Santa Maria de Garoña NPP. There is an additional temporary storage facility at the José Cabrera NPP required for the dismantling operations of the plant.

Since 2008, ENRESA and the government have made considerable progress in developing a centralised temporary storage facility (CST) which will host spent nuclear fuel (SNF) and high-level waste (HLW) for a period of 60 years. Following a site selection process started in 2009, on 30 December 2011 the government chose the municipality of Villar de Cañas in the province of Cuenca among the 14 candidate municipalities. In 2014, ENRESA submitted to the competent ministries the application for site and construction licences. The facility is expected to enter into operation in 2018, with a buffer storage that could be ready in late 2016.

With regard to the final disposal of SNF and HLW, ENRESA proposed deep geological disposal as the safest and most sustainable option. The current draft of the seventh GWRP establishes a tentative programme and project milestones for starting operations in 2063.

DECOMMISSIONING

Two nuclear units have been shut down and are at different stages of decommissioning: Vandellos I and José Cabrera (Zorita).

Partial dismantling was initiated at Vandellos I in 1998, nine years after the permanent shut-down of the plant, when the ownership of the plant was transferred to ENRESA. The level 2 of decommissioning was completed by the end of 2003, with the confinement of the reactor and the dismantling of all other facilities, buildings and structures onsite; most of the site has been released. In 2005, a dormancy period of 25 years was authorised in order to reduce the activity of the internal structures to 5% of the initial level; the last stage of decommissioning will be carried out by ENRESA by 2028 with the removal of the reactor shroud and all the internals, and with the complete release of the site.

José Cabrera, a PWR of 160 MW and the first commercial NPP in Spain, was permanently shut down in 2006, after 38 years of operation. ENRESA took ownership of the plant in 2010 and started decommissioning activities which are ongoing. All internals are stored in the interim storage facility at the plant's site together with spent nuclear fuel. ENRESA expects to complete the decontamination and dismantling by 2018.

Other decommissioning activities are currently ongoing at CIEMAT installations and at various uranium concentration plants: Lobo plant, Quercus plant, Elefante plant and at the Andujar uranium mill.

FUNDING

In addition to the technical duties related to decommissioning and waste management activities, ENRESA also manages a fund for covering the current and future liabilities (including long-term) arising from these activities. ENRESA estimates the total cost for radioactive waste management to be EUR 19.5 billion (in 2014 euros), from 1985 to 2083; 27% of these costs have already accrued by the end of 2013.

Spain has progressively implemented the Euratom directive on waste management funding, moving from a levy on electricity prices to a full internalisation of these costs. Since 2010, all costs for waste management are supported by waste producers (NPPs, Juzbado fuel assembly plant and other radioactive facilities), and only a minimal fraction arises from a tax on electricity transmission (0.001%). Currently each NPP pays ENRESA a fee proportional to the total gross electricity output ranging from EUR 6.6 to EUR 7.8 per MWh which is higher than in any other OECD country.

Fees from NPPs represent over 99.5% of the ENRESA revenues, for example EUR 382 million in 2013. About two-thirds of the revenues cover current expenses of ENRESA, while the emaining goes to the fund to finance future liabilities. At the end of 2013, total assets of the fund were estimated at about EUR 3.8 billion and were invested in non-speculative activities in financial markets with a target rate of return of 3% to 4%.

The fund's investments are supervised and controlled every six months by an independent committee, appointed by the Ministry of Industry, Energy and Tourism and composed of representatives from several ministries. ENRESA is responsible for ensuring that financial provisions of the fund are adequate to cover future liabilities,. ENRESA can propose to the ministry an increase of the fees in case of shortfall.

RESEARCH AND DEVELOPMENT, OTHER NUCLEAR INFRASTRUCTURE

Spain has a comprehensive nuclear energy R&D programme, with the participation of important entities such as CIEMAT, CSN, ENRESA, ENUSA and other companies of the nuclear industry. CIEMAT is active in the area of nuclear fission, in activities related to ionising radiations and in nuclear fusion, and participates in the European Fusion Programme and in the experimental projects of the Joint European Torus (JET) and the International Thermonuclear Experimental Reactor (ITER). Most of the fission research is to support the industry in the areas of nuclear safety, radioactive waste, decommissioning and dismantling, and structural material behaviour.

Besides, ENRESA has recently approved its 7th R&D Plan that covers the period 2014–18. The research areas are, *i)* waste technology, *ii)* treatment and conditioning technology, including dismantling, *iii)* confining material and systems, and *iv)* performance and safety assessment, radiological protection and modelling.

In addition, the CSN undertakes R&D activities, with the aim of filling knowledge gaps that are relevant to the nuclear regulatory activities. In this regard, the CSN issues R&D plans, covering a timeframe of four years. The current plan covers the 2012-15 period. Typically, most of the projects within this plan have been fulfilled by means of a memorandum of understanding with different R&D entities (both national and international). In some cases, direct funding aids (subventions) to entities have also been used as a tool to develop R&D activities.

Spain also participates in international activities on nuclear data research, reactor physics, transmutation and advanced fuel cycles with the IAEA, the OECD/NEA and Euratom.

In 2007, a Fission Technology Platform (CEIDEN) was set up to co-ordinate the needs and R&D efforts in the field of nuclear fission technology. CEIDEN comprises all sectors related to R&D and innovation in Spain (utilities, service and engineering companies, universities, research centres, regulators, administration, among others) and includes more than 90 companies.

ASSESSMENT

Over the past 40 years, Spain has developed a well-integrated and efficient nuclear infrastructure, with seven nuclear units under exploitation, a fuel manufacturing facility, solutions for the back-end of the fuel cycle and efficient regulatory institutions. NPPs are operated very efficiently with high load and availability factors, above the OECD average.

Currently, nuclear energy produces about 20% of total electricity, contributes effectively to reducing GHG emissions, secures energy supply, and plays an important role in the diversification of the energy mix.

Most of the Spanish nuclear capacity was put into operation in a relatively short timeframe, in the mid-1980s and will reach the end of the design lifetime in the mid-2020s. If the operators do not pursue the option of lifetime extension, a significant share of carbon-free base-load electricity production could be withdrawn from the Spanish generation mix. Such a scenario would make it more challenging to limit CO_2 emissions and would reduce the diversification and the adequacy of the Spanish generation mix. It could also result in higher costs for the whole electricity system.

A recent study (OECD, 2012) has concluded that lifetime extension of NPPs is the lowest-cost option for power generation and is economically competitive, even at high discount rates. In some OECD countries, utilities have already obtained licences to operate their NPPs beyond 40 years or are in the process of submitting an application to the safety authorities. A stable energy policy and predictable regulatory framework with regard to nuclear energy would allow the utilities to evaluate the economic viability of lifetime extension projects in a competitive market and to plan the investments and upgrades needed to meet the required safety levels. In this respect, the CSN (the nuclear safety council) has already determined the safety analyses and documentation required for applications beyond the design lifetime of 40 years.

Since the last in-depth review, Spain has made significant progress in the definition and implementation of the radioactive waste management policy. In December 2011, Villar de Cañas was selected as the site for the centralised temporary storage facility for spent fuel and high-level waste. The spent fuel currently stored in the NPP pools or in on-site individualised storage facilities will be transferred to the temporary repository for about 60 years before final disposal. Preliminary and construction authorisations have been submitted to the ministry in 2014 and the centralised temporary storage facility is expected to enter into service in 2018 for a period of 60 years.

Progress has also been made in the definition of a strategy and in clear implementation plans for the final disposal of spent fuel and high-level radioactive waste. The current proposal, as in the draft of the seventh General Radioactive Waste Plan, calls for the implementation of a deep geological repository, which is considered as the safest and most sustainable option. Under the current schedule, the facility should be completed in 2063 and ready for operations in 2068.

Spain has a well-defined scheme for establishing and managing the funds dedicated to cover future liabilities, decommissioning and radioactive waste management. Financial provisions are allocated to a special fund managed by ENRESA under the control and supervision of an independent body. Since 2010, these costs are almost entirely supported by the waste producers, through a levy on the nuclear power generation, in accordance with the OECD ''polluter pays principle''. ENRESA is responsible for ensuring that the funding is consistent with the estimates of future liabilities, but may propose to the Ministry of Industry, Energy and Tourism an adjustment of the fee on waste, should the provisions be insufficient.

Overall, the waste management policy of Spain is well defined and in an advanced stage of implementation in comparison with other OECD countries. ENRESA regularly monitors the adequacy of the financial reserves set aside for decommissioning and nuclear waste management. However, the timely completion of the centralised temporary storage

facility deserves attention, given the limited space currently available in some of the NPPs' spent fuel pools.

The government has fostered communication on nuclear energy issues with local communities, citizens and the civil society. Relevant information is provided to the general public via the internet sites of the Nuclear Safety Council, the Ministry of Industry, Energy and Tourism, and other relevant institutions. Local information committees are regularly organised in each NPP municipality hosting a nuclear plant to inform the local public on events and on the performance of the plants, on emergency planning and on other major topics related to nuclear energy. The information exchange and broad involvement of the general public and the local communities has proved to be effective in reaching public support for the siting of the centralised temporary storage facility.

RECOMMENDATIONS

The government of Spain should:

- ☐ *Provide a long-term policy framework aiming at encouraging market-based investments in nuclear lifetime extension.*
- ☐ *Develop scenarios for nuclear generation capacity in the energy mix after 2020, taking into account the impact of different shares of nuclear energy on meeting carbon emissions targets, on the cost of electricity supply and on the diversification of the energy mix.*
- ☐ *Pursue its current policy on waste management and disposal, continuously monitor the adequacy of the provisions for decommissioning and waste management, and ensure the timely construction of the centralised temporary storage facility.*
- ☐ *Continue to communicate effectively with the civil society on nuclear energy to address public concerns and to foster knowledge and understanding of nuclear issues.*

Reference

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PART III
ENERGY TECHNOLOGY

11. ENERGY TECHNOLOGY RESEARCH, DEVELOPMENT AND DEMONSTRATION

Key data (2013)

Government spending on energy R&D: EUR 72.4 million

Share of GDP: 0.09 units of GDP per USD 1 000 (IEA median*: 0.44)

R&D per capita: EUR 1.8

* Median of 22 IEA member countries for which data are available.

RD&D STRATEGY

Energy research and development (R&D) is an integral part of the Spanish Strategy for Science, Technology and Innovation 2013-2020 (SESTI). The SESTI sets out medium-term objectives and priorities for research, development and innovation to 2020, as defined in the Science Act of 2014. The SESTI was drawn up in co-operation with the key players in the Spanish science and technology system, representing central government, autonomous regions, scientists and technical experts and social partners. The SESTI merged two strategies – the Spanish Strategy for Science and Technology and the Spanish Strategy for Innovation.

The strategic goals of the SESTI are to build a cutting-edge, highly competitive and integrated R&D network, which will include, among others, co-ordinating policies and creating a favourable climate for R&D investment and creating new communication formats to raise public awareness.

The SESTI is implemented by a National Plan for Scientific Research, Development and Technological Innovation (2013-16). The national plan establishes a state R&D programme to respond to societal challenges with a major focus on environmental challenges, clean energy and transport, and climate change.

Energy is one of the eight focus areas of the SESTI. Energy research, development and demonstration (RD&D) is also closely aligned with EU-level strategic priorities of the 2008 SET Plan. In the SESTI**,** energy-related RDI activities are described under the Challenge on Secure, Sustainable and Clean Energy. They cover four areas: *a)* sustainability for actively combating climate change, reducing greenhouse gas emissions, favouring the development of technologies for geological capturing and storing of carbon dioxide (CO_2) and energy sources such as wind, solar, bioenergy, marine, geothermal, hydrogen and nuclear energy, and energy efficiency; *b)* competitiveness for improving the efficacy of the Spanish and European networks by developing the domestic energy market; *c)* supply security for improved co-ordination of the national energy supply and demand within an international context; and *d)* social and technological aspects.

RESEARCH INSTITUTIONS AND SELECTED PROGRAMMES

The **Ministry of Economy and Competitiveness** is responsible for Spain's R&D policy. This new ministry was established in 2011 with a merger of budgets and resources from the previous Ministry of Economy and the former Ministry of Science and Innovation. Responsibility for national energy R&D is divided between the Ministry of Economy and Competitiveness and the Ministry of Industry, Energy and Tourism.

Publicly funded R&D is conducted by research institutions, universities, technology centres and private enterprises. The government funds several public research institutions that focus on applied research and pilot and demonstration projects, and these institutions often receive also private-sector funding. Three of the primary institutions – CIEMAT, CENER and CIUDEN – and their selected activities are described in more detail below.

CIEMAT (CENTRE FOR ENERGY, ENVIRONMENT AND TECHNOLOGICAL RESEARCH)

CIEMAT is the major publicly funded energy research institution in Spain. It carries out R&D and demonstration projects primarily on energy, but also on environment and other technology areas. CIEMAT is governed by the Ministry of Economy and Competitiveness and collaborates closely with industry. It also has close ties with the Ministry of Industry, Energy and Tourism and the Ministry of Agriculture, Food and Environment, as well as with diverse autonomous and local administrations. CIEMAT also supports and assists ENRESA and the Nuclear Safety Council in radioactive waste treatment and increasing facility safety.

In 2013, CIEMAT had more than 1 300 staff and a budget of EUR 106 million of which EUR 44 million from external sources, namely national and international calls, other national institutions and the private sector.

CIEMAT has facilities in six locations in Spain, four of them related to energy R&D, and its energy activities include mainly renewable energy (wind, solar and biomass), energy efficiency, fuel cells and hydrogen, smart grids, and nuclear fission and fusion. The majority of its capacities are located in its central office in Madrid. CIEMAT has two recognised international singular scientific facilities (ICTS): the Solar Platform in Almeria (PSA) and the Thermonuclear Fusion Devices TJ-II in Madrid. The PSA is situated in the south-east of the country and is a world leader in concentrated solar power (CSP) research since 1977. R&D activities at PSA are focused on improving CSP technologies (parabolic troughs, central receivers, dishes, Fresnel collectors). In addition to electricity generation, areas for R&D activities include research in solar sensors and solar air conditioning and cooling, and development of solar thermal applications for industry: such as production of hot water and steam, industrial cold, desalination, and drying. CIEMAT's CEDER R&D centre in the province of Soria is dedicated to research and development of biomass which covers all stages, from obtaining the resource, waste or crop, to energy use, including pre-treatment of raw materials. This centre also carries out a programme of technical support and development of low power wind energy, <100 kilowatts (kW).

CENER (NATIONAL RENEWABLE ENERGY CENTRE)

The CENER-CIEMAT Foundation started its activity in 2002 and its Board of Trustees comprises the Ministry of Economy and Competitiveness, CIEMAT, the Ministry of Industry, Energy and Tourism, and the government of Navarra. CENER carries out applied

research and technology transfer in the following areas: wind energy; biomass; solar PV; solar thermal; grid integration; and bioclimatic architecture.

CENER has around 200 staff and an annual budget of approximately EUR 23 million, of which 60% is self-financed. It works closely with Spanish energy companies and, compared with CIEMAT, its activities are closer to the market.

CENER's main activity is on wind energy, and it operates a major wind turbine test facility. With more than EUR 50 million invested, the facility includes test laboratories for blades and power trains, an aerodynamic tunnel, a laboratory for composite materials, and an experimental wind farm (6 x 5 megawatts [MW]). Another major investment is a demonstration plant for second-generation biofuels (more than EUR 33 million invested).

CIUDEN (FUNDACIÓN CIUDAD DE LA ENERGÍA)

Spain has significant experience in researching and piloting carbon capture and storage (CCS) technologies. Several pilot-scale CO_2 projects have been implemented in post-combustion, pre-combustion and oxyfiring in the power sector as well as one project in the refining sector. Ciuden was created in 2006 by the Spanish government to lead activities in the area of CCS and in relation to promoting economic developments in regions historically associated with coal mining and use, such as El Bierzo in the province of Leon.

Ciuden was involved in the large demonstration facility planned under the EU EEPR funding scheme during 2009-13. The OXYCFB300 project at Compostilla was developed by Endesa Generación, Foster Wheeler Energy Oy, and Ciuden. It was intended to be a 345 MW (gross) oxyfuel power plant project. The project received a EUR 180 million grant, which was used for engineering and design studies as well as construction of the world's largest oxyfuel pilot plant. In the absence of a positive policy and market environment for CCS, however, the project was shelved in 2013.

In addition to carbon capture projects, Spain has performed high-level studies on potential CO_2 storage capacity in the Spanish territory. The studies have revealed significant potential, up to 13 gigatonnes (Gt) of CO_2. A small number of test injection sites have been selected for research purposes.

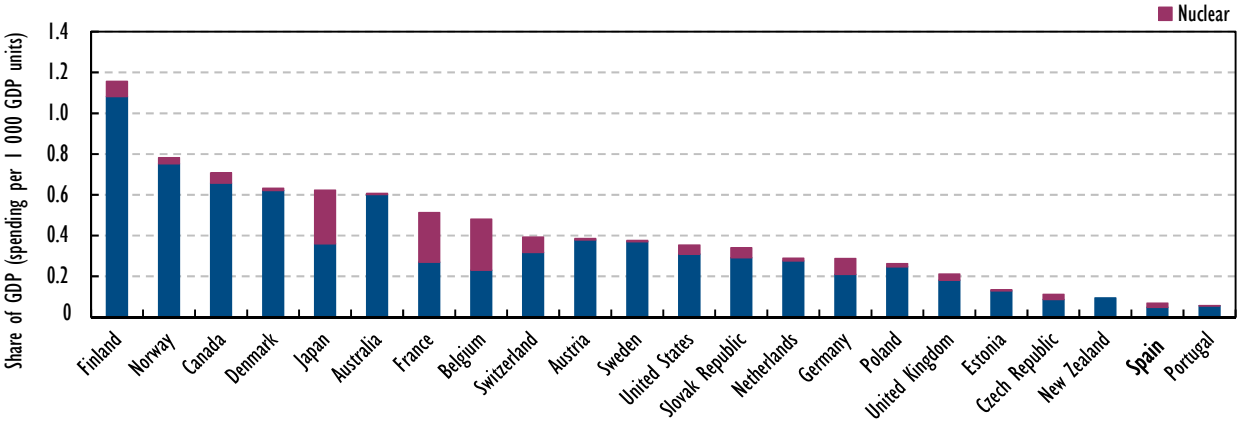
FUNDING

The overall R&D budget in Spain, both from private and public sources, has been severely reduced after the economic crisis and is now well below that of most Organisation for Economic Co-operation and Development (OECD) countries. In 2013, the SESTI has set a new, lower, target of 2% gross expenditure on R&D (GERD) per gross domestic product (GDP) for 2020, compared to the 3% target set by the Europe 2020 Strategy for Spain.

RD&D budgets have been limited for energy, too. As an example, the overall budget of CIEMAT has been reduced by about 25% below the level of 2009; about 40% of the budget is ensured by external funding. Given the current budget constraints and limited resources, prioritisation of topics and further collaboration with industry and international partners is particularly important.

Government spending on energy RD&D declined from EUR 163 million in 2012 to EUR 72 million in 2013. As a share of GDP, the 2013 level was one of the lowest among the International Energy Agency (IEA) countries (see Figure 11.1).

Figure 11.1 Government energy RD&D spending as a ratio of GDP in IEA member countries, 2013



Notes: data are not available for Greece, Hungary, Ireland, Italy, Korea, Luxembourg and Turkey.

Source: IEA (2014), "RD&D Budget", *IEA Energy Technology RD&D Statistics* (database). DOI: http://dx.doi.org/10.1787/data-00488-en, accessed on 4 May 2015.

Private R&D expenditure is particularly low, and innovation depends to a large degree on government support. Corporate R&D expenditure amounted to 0.69% of GDP in 2012, while the OECD average was 1.63%. Corporate R&D has not increased as rapidly as public support to R&D over the last decade. This dependence on government support exposes corporate R&D activities to spending cuts in the public budget, as observed during the economic crisis.

The National Plan for Scientific Research, Development and Technological Innovation (2013-16) envisages a large increase in financing from the private sector in order to bring Spain's figures closer to the European Union (EU) average. In this respect, the National Plan focuses on three areas of action. First, the development of instruments for public-private co-operation to allow a higher participation of private funding for activities carried out with universities and public R&D centres. Secondly, the adoption of measures encouraging access to bank financing and other instruments by innovative companies, especially companies with a technological base, and young innovative companies. Thirdly, the creation of an environment which is favourable to the development of venture capital, both national and international, public and private, and access by innovative companies to these funds.

A concrete example of public-private partnership is the Alliance for Energy Research and Innovation (ALINNE), established in 2011. From the private sector, ALINNE comprises Abengoa, Acciona, ACS, Endesa, Gas Natural Fenosa, GPTech, Iberdrola, REE, Repsol and Inerco, many of which have a strong international presence already. ALINNE aims at identifying technology areas on which Spain should focus its efforts on energy innovation.

Funding for early-stage R&D is allocated through competitive calls from the State in accordance with the National Plan for Science, Technology and Innovation. R&D activities closer to the markets require companies to apply for funding through the Centre for Industrial Technological Development (CDTI), a public business entity dependent on the Ministry of Economy and Competitiveness. Between 2000 and 2012, the CDTI gave more than 80% of its support in low-interest loans.

A major source of funding in energy RD&D in Spain is the European Union. In 2013, Spanish participants received almost EUR 43 million from the EU's Framework Programme 2007-2013 budget, the second-highest contribution after Italy. Spanish entities participated in 27 of the 43 programmes that received subsidies, and led five of them (Ministry of Industry, Energy and Tourism, 2014). In addition, the European Regional Development Fund granted several million

euros in subsidies to Spanish companies for energy-related RD&D projects in 2013. Over the whole 2007-2013 programme period, Spanish entities received almost EUR 220 million for non-nuclear energy RD&D. Only Germany and Italy received more (IEA, 2014).

INTERNATIONAL COLLABORATION

Spain participates in several international collaborative efforts, including 19 IEA Implementing Agreements: seven related to end-use (buildings, transport, electricity); four focusing on fossil fuels (CCS, coal); and eight examining renewable energy technologies, policies and modelling. The country also participates in the Implementing Agreements on fusion indirectly through the European Atomic Energy Community (Euratom).

Within the Union, Spain participates in several ERA-NETs (European Research Area Networks), mostly in the areas of renewable energy and energy efficiency. ERA-NETs are networks of national science and technology funding organisations in Europe. They identify common priorities and co-ordinate national activities within the European research area (ERA), and their co-operation is funded from the EU framework programme for research, technological development and demonstration activities.

CIEMAT is closely involved in the European Energy Research Alliance (EERA) as one of the 15 European research institutes that form its Executive Committee. EERA is an initiative under the SET Plan and aims to improve the co-ordination of energy technology research at a pre-commercial scale between leading European research organisations and institutes. EERA has set up 15 joint programmes to accelerate the development of new energy technologies and to integrate activities and resources, combining national and Community sources of funding. CIEMAT participates in 11 of these joint programmes: advanced materials and processes for energy application (AMPEA); bioenergy; concentrated solar power; energy storage; economic, environmental and social impacts; photovoltaic solar energy; wind energy; smart cities; smart grids; fuel cells and hydrogen; and nuclear materials.

Also within the EU framework, Spanish companies participate in several energy-focused technology platforms. The European technology platforms bring together stakeholders in industry-led efforts to define medium- to long-term research and technological development. Covering the whole economic value chain, they aim to better align EU research priorities with industry's needs.

ASSESSMENT

Energy RD&D is an integral part of the Spanish Strategy on Science, Technology and Innovation (SESTI) 2013-2020. The SESTI set out the rationale, objectives and indicators to measure the impact of the Spanish RD&I policy until 2020. It also emphasises the role of R&D in solving the major societal challenges, and aims to improve R&D

Public funding of R&D has traditionally been lower in Spain than in most developed countries. The economic crisis has exacerbated this situation. The SESTI has set a new, lower, target of 2% of R&D spending (public and private combined) per GDP for 2020, compared to the 3% target set by the Europe 2020 Strategy for Spain. A higher ambition would arguably increase the opportunities for Spain to change its economic structure and to overcome the current economic crisis.

As a partial remedy to low national funding for energy RD&D, Spanish entities have very successfully turned to EU funding. Only Germany and Italy received more funding for energy RD&D from the 2007-2013 EU Framework Programme. The IEA encourages

the government to look for opportunities to increase RD&D spending nationally and also to continue its strong participation in EU programmes.

The SESTI is thematically aligned with the Europe 2020 Strategy, and Spain is actively involved in diverse international R&D initiatives, including the EU Strategic Energy Technology Plan (SET Plan). The IEA welcomes the efforts of the government and CIEMAT in facilitating the co-operation with intergovernmental bodies and R&D centres of other countries, especially with EU's Horizon 2020 that may provide additional opportunities for Spanish energy researchers. Spain is very active in international energy R&D co-operation, including 19 in IEA Implementing Agreements. The IEA applauds this commitment.

In order to maximise the impact of R&D activities under resource constraints, it is important to align the capabilities of all participants in the innovation system (scientists, technical experts, state governments, autonomous regions, and social partners) in setting out objectives and priorities based on the assessment of their strengths and weaknesses. Close collaboration between public and private key R&D players is critical to achieving goals cost effectively. In this context, the IEA commends the establishment of the public-private partnership Alliance for Energy Research and Innovation. The Alliance aims to improve the efficiency and efficacy of the Spanish R&D system, to help consolidate existing strengths and to further internationalise Spanish companies. Previously, public-private partnerships on wind and solar energy have reinforced Spanish industry's position on these technologies.

Although the government adopted the SESTI as a general R&D strategy, there is no overarching energy-specific R&D strategy to underpin the effective achievement of energy policy objectives. In addition to supporting the supply-side energy R&D projects (solar PV, and others), a balanced focus should be given to demand-side regulation-related R&D (zero emission building, for example) and to facilitate positive interaction between R&D and energy policies.

RECOMMENDATIONS

The government of Spain should:

- ☐ *Establish an energy R&D strategy and agenda to prioritise and co-ordinate energy R&D programmes with government energy policies, so as to underpin efficient achievement of these policy objectives; include in the energy R&D strategy a stronger focus on demand-side issues, including energy efficiency.*
- ☐ *Continue to facilitate Spanish researchers' active participation in the diverse international R&D programmes.*
- ☐ *Continue to foster close co-operation between the key R&D players from both public and private sectors in setting out R&D priorities and cost-effective objectives.*

References

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PART IV
ANNEXES

ANNEX A: ORGANISATION OF THE REVIEW

REVIEW CRITERIA

The Shared Goals, which were adopted by the IEA Ministers at their 4 June 1993 meeting in Paris, provide the evaluation criteria for the in-depth reviews (IDRs) conducted by the IEA. The Shared Goals are presented in Annex C.

REVIEW TEAM AND PREPARATION OF THE REPORT

The IEA in-depth review team visited Spain from 23 to 27 June, 2014. The team met with government officials, energy suppliers, interest groups and various other organisations. This report was drafted on the basis of these meetings, the team's preliminary assessment of the country's energy policy, the government response to the IEA energy policy questionnaire and other information. The members of the team were:

IEA member countries

Mr. Aad van Bohemen, the Netherlands (team leader)

Mr. Christian Bühlmann, Switzerland

Ms. Rebecca Minch, Ireland

Mr. Peter Nielsen, Denmark

Dr. Björn Telenius, Sweden

Mr. Julien Tognola, France

European Commission

Mr. Antonio Lopez-Nicolas

OECD Nuclear Energy Agency

Dr. Marco Cometto

International Energy Agency

Mr. Kijune Kim

Dr. Manuel Baritaud

Mr. Miika Tommila

The team is grateful for the co-operation and assistance of the many people it met throughout the visit. Thanks to their kind hospitality, openness and willingness to share information, the visit was highly informative, productive and enjoyable. The team wishes to express its gratitude to Mr. Alberto Nadal, Secretary of State for Energy, and his staff at the Ministry of Industry, Energy and Tourism. In particular, the team wishes to thank Ms. Maria Lorena Prado Orcoyen, Deputy Director-General, and Mr. Luis Hilario Alonso Mijares for their professionalism displayed throughout the review.

Miika Tommila managed the review and drafted the report, with the exception of Chapter 8 on Electricity (drafted with Manuel Baritaud) and Chapter 10 on Nuclear Energy (drafted by Marco Cometto). Sonja Lekovic drafted the supply and demand sections of the report. Juho Lipponen and Tristan Stanley provided text on carbon capture and storage for Chapter 11.

The report was prepared under the guidance of Kijune Kim, Head of Country Studies Division. Helpful comments were provided by the review team members and the following IEA staff: Tyler Bryant, Carlos Fernández Alvarez, Rebecca Gaghen, Takashi Hattori, Costanza Jacazio, Caroline Lee, Cuauhtémoc Lopez-Bassols, Kieran McNamara, David Morgado, Rodrigo Pinto Scholtbach, Carrie Pottinger and Sam Thomas.

Sonja Lekovic and Bertrand Sadin prepared the figures. Mi Hee Han helped with maps and tables. Roberta Quadrelli and Zakia Adam provided support on statistics. Muriel Custodio, Astrid Dumond and Angela Gosmann managed the production process. Viviane Consoli and Therese Walsh provided editorial assistance.

ORGANISATIONS VISITED

ACOGEN, co-generation association

AEE, Spanish Wind Energy Association

AEGE, large energy consumers' association

AMI, association of maintenance and energy service companies

ANESE, association of energy service companies

AOP, oil industry association

APPA, renewable energy industry association

ASGECO, consumer association

CEOE, Spanish Confederation of Business Organisations

CIEMAT, the environmental, energy and technological research centre

CIUDEN, Spanish Energy Research Foundation

CLH, hydrocarbons logistics company

CNMC, Commission of Markets and Competition

CORES, Strategic Reserves Corporation

CSN, Nuclear Safety Council

EDP

Enagás, natural gas transmission system operator

Endesa

ENRESA, nuclear waste company

E.ON

Gas Natural Fenosa

Greenpeace

Iberdrola

IDAE, Institute for Energy Diversification and Saving of Energy

IRMC, Coal Institute

Ministry of Agriculture, Food and Environment

Ministry of Finance and Public Administration

Ministry of Industry, Energy and Tourism (Minetur)

Ministry of Public Works and Transport

OMIE, electricity market operator

Protermosolar

Red Eléctrica de España (REE), electricity transmission system operator

SEDIGAS, gas industry association

UNEF, solar PV association

UNESA, electricity industry association

WWF Spain

ANNEX B:
ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY		1973	1990	2000	2010	2012	2013	2014E
TOTAL PRODUCTION		**11.3**	**34.6**	**31.6**	**34.4**	**33.5**	**34.5**	**34.2**
Coal		6.5	11.7	8.0	3.3	2.5	1.8	1.6
Peat		-	-	-	-	-	-	-
Oil		0.7	1.2	0.2	0.1	0.1	0.4	0.3
Natural gas		0.0	1.3	0.1	0.0	0.1	0.0	0.0
Biofuels and waste[1]		0.0	4.1	4.1	6.3	6.4	7.0	6.6
Nuclear		1.7	14.1	16.2	16.2	16.0	14.8	14.9
Hydro		2.5	2.2	2.4	3.6	1.8	3.2	3.4
Wind		-	0.0	0.4	3.8	4.3	4.6	4.5
Geothermal		-	0.0	0.0	0.0	0.0	0.0	0.0
Solar/other		-	0.0	0.0	1.0	2.4	2.7	2.9
TOTAL NET IMPORTS[2]		**41.7**	**55.6**	**91.5**	**95.5**	**88.5**	**79.1**	**80.5**
Coal	Exports	0.0	0.0	0.5	1.1	1.4	0.5	0.8
	Imports	2.1	7.1	13.3	7.8	13.0	8.1	9.5
	Net imports	2.1	7.1	12.8	6.7	11.6	7.6	8.7
Oil	Exports	4.3	12.1	7.5	11.5	19.4	21.8	22.2
	Imports	45.3	61.7	79.0	81.0	79.7	78.8	81.6
	Int'l marine and aviation bunkers	-2.2	-4.7	-8.7	-11.4	-11.9	-10.7	-11.6
	Net imports	38.8	44.9	62.8	58.1	48.4	46.3	47.9
Natural Gas	Exports	-	-	-	1.0	2.4	5.1	7.1
	Imports	0.9	3.7	15.5	31.9	30.5	30.9	31.6
	Net imports	0.9	3.7	15.5	30.9	28.1	25.8	24.5
Electricity	Exports	0.2	0.3	0.7	1.2	1.6	1.4	1.4
	Imports	0.0	0.3	1.1	0.4	0.7	0.9	1.1
	Net imports	-0.2	-0.0	0.4	-0.7	-1.0	-0.6	-0.3
TOTAL STOCK CHANGES		**-1.5**	**-0.2**	**-1.2**	**-2.1**	**3.5**	**3.1**	**-0.8**
TOTAL SUPPLY (TPES)[3]		**51.6**	**90.1**	**121.9**	**127.8**	**125.5**	**116.7**	**113.9**
Coal		9.0	19.3	20.9	7.8	15.2	11.0	11.7
Peat		-	-	-	-	-	-	-
Oil		37.6	45.5	62.1	58.2	50.4	47.8	46.9
Natural gas		0.9	5.0	15.2	31.1	28.6	26.2	23.7
Biofuels and waste[1]		0.0	4.1	4.1	6.7	7.9	7.1	6.2
Nuclear		1.7	14.1	16.2	16.2	16.0	14.8	14.9
Hydro		2.5	2.2	2.4	3.6	1.8	3.2	3.4
Wind		-	0.0	0.4	3.8	4.3	4.6	4.5
Geothermal		-	0.0	0.0	0.0	0.0	0.0	0.0
Solar/other		-	0.0	0.0	1.0	2.4	2.7	2.9
Electricity trade[4]		-0.2	-0.0	0.4	-0.7	-1.0	-0.6	-0.3
Shares in TPES (%)								
Coal		*17.4*	*21.4*	*17.2*	*6.1*	*12.1*	*9.4*	*10.3*
Peat		-	-	-	-	-	-	-
Oil		*72.9*	*50.5*	*51.0*	*45.5*	*40.2*	*41.0*	*41.2*
Natural gas		*1.8*	*5.5*	*12.5*	*24.4*	*22.8*	*22.4*	*20.8*
Biofuels and waste[1]		*-*	*4.5*	*3.4*	*5.3*	*6.3*	*6.0*	*5.5*
Nuclear		*3.3*	*15.7*	*13.3*	*12.6*	*12.8*	*12.7*	*13.1*
Hydro		*4.8*	*2.4*	*2.0*	*2.8*	*1.4*	*2.7*	*3.0*
Wind		*-*	*-*	*0.3*	*3.0*	*3.4*	*4.0*	*3.9*
Geothermal		*-*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Solar/other		*-*	*0.0*	*0.0*	*0.8*	*1.9*	*2.3*	*2.5*
Electricity trade[4]		*-0.3*	*-*	*0.3*	*-0.6*	*-0.8*	*-0.5*	*-0.3*

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Unit: Mtoe

DEMAND							
FINAL CONSUMPTION	**1973**	**1990**	**2000**	**2010**	**2012**	**2013**	**2014E**
TFC	**38.5**	**60.6**	**85.5**	**92.2**	**84.7**	**81.5**	**..**
Coal	4.2	3.4	1.4	1.0	0.9	1.1	..
Peat	-	-	-	-	-	-	..
Oil	28.9	38.2	52.2	50.0	41.8	39.9	..
Natural gas	0.4	4.3	12.3	14.8	15.0	15.3	..
Biofuels and waste[1]	-	3.9	3.4	5.2	6.1	5.0	..
Geothermal	-	0.0	0.0	0.0	0.0	0.0	..
Solar/other	-	-	0.0	0.2	0.2	0.2	..
Electricity	5.1	10.8	16.2	21.1	20.7	20.0	..
Heat	-	-	-	-	-	-	..
Shares in TFC (%)							
Coal	*10.8*	*5.6*	*1.6*	*1.1*	*1.1*	*1.3*	..
Peat	-	-	-	-	-	-	..
Oil	*74.9*	*62.9*	*61.0*	*54.2*	*49.4*	*49.0*	..
Natural gas	*1.2*	*7.1*	*14.4*	*16.1*	*17.7*	*18.7*	..
Biofuels and waste[1]	-	*6.5*	*4.0*	*5.6*	*7.2*	*6.2*	..
Geothermal	-	-	-	*0.0*	*0.0*	*0.0*	..
Solar/other	-	-	*0.0*	*0.0*	*0.0*	*0.0*	..
Electricity	*13.2*	*17.8*	*19.0*	*22.8*	*24.4*	*24.5*	..
Heat	-	-	-	-	-	-	..
TOTAL INDUSTRY[5]	**20.6**	**25.1**	**34.0**	**27.9**	**26.1**	**25.1**	**..**
Coal	3.6	2.8	1.1	0.8	0.7	0.9	..
Peat	-	-	-	-	-	-	..
Oil	13.3	11.2	14.6	11.5	9.1	7.2	..
Natural gas	0.4	3.8	9.6	8.2	8.8	9.5	..
Biofuels and waste[1]	-	1.8	1.3	1.1	1.3	1.5	..
Geothermal	-	-	-	-	0.0	0.0	..
Solar/other	-	-	0.0	0.0	0.0	0.0	..
Electricity	3.3	5.4	7.4	6.3	6.2	6.0	..
Heat	-	-	-	-	-	-	..
Shares in total industry (%)							
Coal	*17.5*	*11.2*	*3.3*	*2.7*	*2.7*	*3.7*	..
Peat	-	-	-	-	-	-	..
Oil	*64.8*	*44.7*	*43.0*	*41.1*	*34.9*	*28.7*	..
Natural gas	*1.9*	*15.0*	*28.3*	*29.5*	*33.7*	*37.8*	..
Biofuels and waste[1]	-	*7.4*	*3.8*	*4.1*	*4.9*	*5.8*	..
Geothermal	-	-	-	-	-	-	..
Solar/other	-	-	-	-	-	-	..
Electricity	*15.9*	*21.7*	*21.6*	*22.6*	*23.9*	*23.9*	..
Heat	-	-	-	-	-	-	..
TRANSPORT[3]	**10.9**	**21.3**	**30.2**	**33.9**	**29.5**	**28.1**	**..**
OTHER[6]	**7.1**	**14.2**	**21.3**	**30.4**	**29.0**	**28.2**	**..**
Coal	0.6	0.6	0.3	0.3	0.2	0.1	..
Peat	-	-	-	-	-	-	..
Oil	4.8	6.0	7.8	6.4	5.8	5.9	..
Natural gas	0.1	0.6	2.7	6.5	6.1	5.6	..
Biofuels and waste[1]	-	2.1	2.1	2.6	2.7	2.7	..
Geothermal	-	0.0	0.0	0.0	0.0	0.0	..
Solar/other	-	-	0.0	0.2	0.2	0.2	..
Electricity	1.7	5.1	8.5	14.5	14.0	13.6	..
Heat	-	-	-	-	-	-	..
Shares in other (%)							
Coal	*7.8*	*4.1*	*1.2*	*0.8*	*0.6*	*0.5*	..
Peat	-	-	-	-	-	-	..
Oil	*67.8*	*41.9*	*36.5*	*21.1*	*20.0*	*21.0*	..
Natural gas	*0.8*	*3.9*	*12.5*	*21.3*	*20.9*	*20.0*	..
Biofuels and waste[1]	-	*14.6*	*9.7*	*8.5*	*9.2*	*9.5*	..
Geothermal	-	-	-	*0.0*	*0.0*	*0.0*	..
Solar/other	-	-	*0.1*	*0.6*	*0.8*	*0.8*	..
Electricity	*23.7*	*35.6*	*39.9*	*47.5*	*48.4*	*48.1*	..
Heat	-	-	-	-	-	-	..

Unit: Mtoe

DEMAND							
ENERGY TRANSFORMATION AND LOSSES	**1973**	**1990**	**2000**	**2010**	**2012**	**2013**	**2014E**
ELECTRICITY GENERATION[7]							
Input (Mtoe)	12.6	33.1	45.6	49.8	53.1	47.4	..
Output (Mtoe)	6.5	13.0	19.0	25.7	25.3	24.0	23.6
Output (TWh)	75.7	151.2	220.9	298.3	293.9	279.3	273.9
Output Shares (%)							
Coal	*18.9*	*40.1*	*36.6*	*8.8*	*19.0*	*15.2*	*16.3*
Peat	-	-	-	-	-	-	-
Oil	*33.2*	*5.7*	*10.2*	*5.6*	*5.2*	*4.9*	*5.2*
Natural gas	*1.0*	*1.0*	*9.1*	*31.8*	*24.9*	*20.4*	*17.2*
Biofuels and waste[1]	*0.1*	*0.4*	*1.0*	*1.6*	*1.9*	*2.1*	*2.0*
Nuclear	*8.7*	*35.9*	*28.2*	*20.8*	*20.9*	*20.3*	*20.9*
Hydro	*38.2*	*16.8*	*12.8*	*14.2*	*7.0*	*13.2*	*14.3*
Wind	-	-	*2.1*	*14.8*	*16.8*	*19.3*	*19.1*
Geothermal	-	-	-	-	-	-	-
Solar/other	-	-	-	*2.5*	*4.1*	*4.5*	*5.0*
TOTAL LOSSES	**13.9**	**29.4**	**36.9**	**36.4**	**41.4**	**36.5**	**-0.3**
of which:							
Electricity and heat generation[8]	6.1	20.1	26.6	24.2	27.9	23.4	..
Other transformation	4.1	3.1	2.3	1.7	2.2	1.9	-0.3
Own use and transmission/distribution losses[9]	3.7	6.2	8.0	10.5	11.3	11.2	..
Statistical Differences	**-0.9**	**0.0**	**-0.5**	**-0.9**	**-0.6**	**-1.2**	**..**
INDICATORS	**1973**	**1990**	**2000**	**2010**	**2012**	**2013**	**2014E**
GDP (billion 2005 USD)	476.06	744.04	979.53	1219.91	1187.05	1172.45	1188.74
Population (millions)	34.96	39.01	40.26	46.56	46.77	46.59	46.46
TPES/GDP (toe/1000 USD)[10]	0.11	0.12	0.12	0.10	0.11	0.10	0.10
Energy production/TPES	0.22	0.38	0.26	0.27	0.27	0.30	0.30
Per capita TPES (toe/capita)	1.48	2.31	3.03	2.74	2.68	2.51	2.45
Oil supply/GDP (toe/1000 USD)[10]	0.08	0.06	0.06	0.05	0.04	0.04	0.04
TFC/GDP (toe/1000 USD)[11]	0.08	0.08	0.09	0.08	0.07	0.07	..
Per capita TFC (toe/capita)	1.10	1.55	2.12	1.98	1.81	1.75	..
CO_2 emissions from fuel combustion ($MtCO_2$)[11]	139.3	202.6	278.5	262.0	260.3	235.5	..
CO_2 emissions from bunkers ($MtCO_2$)[11]	6.9	14.9	27.3	35.9	37.6	33.8	..
GROWTH RATES (% per year)	**73-13**	**73-90**	**90-00**	**00-10**	**10-12**	**12-13**	**13-14**
TPES	2.1	3.3	3.1	0.5	-0.9	-7.0	-2.4
Coal	0.5	4.6	0.8	-9.4	39.4	-27.5	6.1
Peat	-	-	-	-	-	-	-
Oil	0.6	1.1	3.2	-0.7	-6.9	-5.1	-1.9
Natural gas	8.7	10.3	11.8	7.4	-4.2	-8.4	-9.5
Biofuels and waste[1]	17.1	40.2	0.2	5.0	8.1	-10.2	-11.9
Nuclear	5.5	13.2	1.4	-0.0	-0.4	-7.7	1.0
Hydro	0.6	-0.7	1.0	4.1	-30.3	79.0	6.3
Wind	-	-	79.1	25.1	5.7	9.0	-3.0
Geothermal	-	-	3.9	11.5	4.9	2.8	8.8
Solar/other	-	-	51.9	41.3	52.5	11.2	7.3
TFC	1.9	2.7	3.5	0.8	-4.2	-3.8	..
Electricity consumption	3.5	4.6	4.1	2.7	-0.9	-3.4	..
Energy production	2.8	6.8	-0.9	0.9	-1.4	3.0	-0.8
Net oil imports	0.4	0.9	3.4	-0.8	-8.7	-4.4	3.4
GDP	2.3	2.7	2.8	2.2	-1.4	-1.2	1.4
TPES/GDP	-0.2	0.7	0.3	-1.7	0.5	-5.8	-3.8
TFC/GDP	-0.4	0.0	0.7	-1.4	-2.9	-2.5	..

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Footnotes to energy balances and key statistical data

1. Biofuels and waste comprises solid biofuels, liquid biofuels, biogases, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
2. In addition to coal, oil, natural gas and electricity, total net imports also include biofuels and waste.
3. Excludes international marine bunkers and international aviation bunkers.
4. Total supply of electricity represents net trade. A negative number in the share of TPES indicates that exports are greater than imports.
5. Industry includes non-energy use.
6. Other includes residential, commercial and public services, agriculture/forestry, fishing and other non-specified.
7. Inputs to electricity generation include inputs to electricity and CHP plants. Output refers only to electricity generation.
8. Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 33% for nuclear and solar thermal, and 100% for hydro, wind and solar photovoltaic.
9. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
10. Toe per thousand US dollars at 2005 prices and exchange rates.
11. "CO_2 emissions from fuel combustion" have been estimated using the IPCC Tier I Sectoral Approach from the *2006 IPCC Guidelines*. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2013 and applying this factor to forecast energy supply. Projected emissions for coal are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

ANNEX C: INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The member countries* of the International Energy Agency (IEA) seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants. In order to secure their objectives, member countries therefore aim to create a policy framework consistent with the following goals:

1. Diversity, efficiency and flexibility within the energy sector are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. The environmentally sustainable provision and use of energy are central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should respect the Polluter Pays Principle where practicable.

4. More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA member countries wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. Continued **research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. Co-operation among all energy market participants helps to improve information and understanding, and encourages the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at the meeting of 4 June 1993 Paris, France.)

* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

ANNEX D: GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations and acronyms are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention, this glossary provides a quick and central reference for the abbreviations used.

ACER	Agency for the Cooperation of Energy Regulators
ALINNE	Alliance for Energy Research and Innovation
AMPEA	advanced materials and processes for energy application
BWR	boiling water reactor
CCGT	combined-cycle gas turbines
CCS	carbon capture and storage
CDTI	Centre for Industrial Technological Development
CECRE	Renewable Energy Control Centre
CEER	Council of European Energy Regulators
CFBC	circulating fluidised bed combustion
CH_4	methane
CHP	combined heat and power
CIEMAT	Centro de Investigaciones Energéticas Medioambientales y Tecnológicas
CLH	Compañía Logística de Hidrocarburos
CNE	Comisión Nacional de Energía
CNMC	Competition and Markets Commission
CNDP	National Commission of Public Debate
CORES	Strategic Reserves Corporation
CO_2	carbon dioxide
CSN	Nuclear Safety Council
CSP	concentrated solar power
CST	centralised storage temporary
CTE	Código Técnico de la Edificación
DC	direct current
EC	European Commission
EED	Energy Efficiency Directive
EEMS	Spanish Sustainable Mobility Strategy
EEPR	European Energy Programme for Recovery
EERA	European Energy Research Alliance
EIB	European Investment Bank
ELV	emission limit value
ENSREG	European Nuclear Safety Regulators Group
ENTSO-G	European Network of Transmission System Operators for Gas
EPBD	Energy Performance of Buildings Directive

EPC	energy performance certificates
ERA	European research area
ERA-NETs	European Research Area Networks
ESCO	energy service companies
ETS	Emissions Trading Scheme
EU	European Union
EU-ETS	European Union Emissions Trading Scheme
FADE	Electricity Deficit Amortisation Fund
FG	framework guidelines
FGD	flue-gas desulphurisation
FIDAE	Energy Saving and Diversification Investment Fund
GDP	gross domestic product
GERD	gross expenditure on research and development
GHG	greenhouse gas
GRWP	general radioactive waste plan
HFC	hydofluorocarbon
HHI	Herfindahl-Hirschman Index
HLW	high-level waste
HVDC	high-voltage direct current
IAEA	International Atomic Energy Agency
ICTS	international singular scientific facility
IDAE	Institute for Diversification and Saving of Energy
IEA	International Energy Agency
IGCC	integrated gasification combined-cycle
IIC	Iberoamerican Initiative for Carbon
ILUC	indirect land use change
IRMC	Institute for Restructuring and Alternative Development of the Coal Mining Regions
ISO	Independent System Operator
ITER	International Thermonuclear Experimental Reactor
JET	Joint European Tours
LCPD	Large Combustion Plants Directive
LILW	low- and intermediate-level radioactive waste
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LULUCF	land use change and forestry
MEC	Ministry of Economy and Competitiveness
MEPS	minimum efficiency performance standards
MINETUR	Ministry of Industry, Energy and Tourism
N_2O	nitrous oxide
NAP	national allocation plan

NC	network codes
NEA	Nuclear Energy Agency
NEEAP	National Energy Efficiency Action Plan
NESO	National emergency strategy organisation
NGL	natural gas liquids
NO_x	nitrogen oxides
NPP	nuclear power plant
NRA	National Regulatory Authority
NTC	net transfer capacity
OECD	Organisation for Economic Co-operation and Development
OMI	Operador del Mercado Ibérico
OTC	over-the-counter
PCI	Projects of Common Interest
PFC	perfluorocarbon
PIVE	Efficient Vehicle Incentives Programme
PSA	Solar Platform in Almeria
PSR	periodic safety review
PWR	pressurised water reactor
R&D	research and development
RDL	Royal Decree Law
REE	Red Eléctrica de España
REN	Red Eléctrica Nacional
RITE	Regulation on Building Heating Installations
SEPI	Sociedad Estatal de Participaciones Industriales
SESTI	Spanish Strategy on Science, Technology and Innovation
SF_6	sulphur hexafluoride
SGRI	South Gas Regional Initiative
SME	small and medium-sized enterprises
SNF	spent nuclear fuel
SO_2	sulphur dioxide
TBC	technical building code
TBR	thermal building regulations
TFC	total final consumption
TIM	mean interruption time
TPA	third-party access
TPES	total primary energy supply
TSO	transmission system operator
tU	uranium
UGS	underground gas storage
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VAT	value-added tax

VPSC	voluntary price to small consumers
VSC	voltage source converter

Units of measure

bcm	billion cubic metres
gCO_2/per kilometre	grammes of carbon dioxide per kilometre
GW	gigawatt
K	kelvin
km^2	square kilometre
$ktCO_2$	thousand tonnes of carbon dioxide
kt	kilotonne
ktoe	thousand tonnes of oil-equivalent
kW	kilowatt
kWh	kilowatt hour
L/km	litres per kilometre
m^2	square metre
mb/d	million barrels per day
mcm	million cubic metres
$MtCO_2$-eq	million tonnes of carbon dioxide-equivalent
Mtoe	million tonnes of oil-equivalent
MVA	megavolt-amperes
MW	megawatt
MWh	megawatts per hour
MWth	megawatt thermal
Nm^3	normal cubic metre
PPP	purchasing power parity
tCO_2	tonnes of carbon dioxide
TJ	terajoule
toe	tonnes of oil-equivalent
TWh	terawatt hour
W	watt


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Energy Policies of IEA Countries

Spain

Since the last IEA review in 2009, Spain's dependence on energy imports has decreased markedly, in part thanks to a rapid increase in renewable energy supply. Spain's security of supply has further been improved with diversified import sources and enhanced storage capacity for both oil and gas.

In the electricity sector, Spain has built a large, diverse and reliable power generation fleet. After several years of efforts, the government has now also managed to solve the massive imbalance between the electricity system's regulated costs and revenues. The broad and deep electricity market reform has fundamentally changed the remuneration scheme for renewable energy. Spain must now maintain its strong and long-term commitment to a financially sustainable electricity system. To improve investor confidence, it should also closely follow the principles of transparency, predictability and certainty when revising policies and regulations.

New momentum for establishing additional cross-border connections in electricity and gas will eventually enable Spain to use its large power and liquefied natural gas capacity to increase flexibility, diversity and security in the European Union internal market. The government should now focus on longer-term issues including energy demand and greenhouse gas emissions. A critical question is how to encourage the transition to a low-carbon energy system.

This review analyses the energy policy challenges Spain faces and provides sectoral recommendations for further policy improvements. It is intended to help guide the country towards a more secure and sustainable energy future.

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