



INTERNATIONAL ENERGY AGENCY

# Energy Policies of IEA Countries



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# PORTUGAL

## 2009 Review

# Energy Policies of IEA Countries



## PORTUGAL 2009 Review

Portugal has made considerable efforts to strengthen its energy policy since the last IEA in-depth review in 2004. A large number of IEA recommendations have been successfully implemented, including greater diversification of the energy mix and increased energy policy co-ordination. A new National Energy Strategy, published in October 2005, identified three principal means for meeting Portugal's policy goals: the promotion of renewable energy, increased energy efficiency and competition in energy markets.

Over a short period of time, Portugal has become a leader in terms of renewable energy development. Well-designed incentive mechanisms and the adoption of ambitious targets ensure hydro, wind and other technologies will continue to grow. The National Action Plan for Energy Efficiency was enacted in 2008, and Portugal aims to implement energy efficiency measures equivalent to 9.8% of total final energy consumption by 2015. This plan complements a well-developed and co-ordinated climate change policy. Further steps have been taken towards the liberalisation of energy markets, including the innovative creation of a single operator for the transport of natural gas and electricity, natural gas storage and operation of the Sines LNG terminal.

Still, a number of challenges remain. Energy markets are not as competitive as policy makers may have wished, and energy research and development policy co-ordination needs to be strengthened.

This review provides sectoral critiques of existing policy and recommendations for further improvements. It is intended to serve as an indispensable guide for Portuguese policy makers as they travel along the path to a more sustainable energy future.

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INTERNATIONAL ENERGY AGENCY

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**PORTUGAL**

**2009 Review**

# INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-eight of the thirty OECD member countries. The basic aims of the IEA are:

- To maintain and improve systems for coping with oil supply disruptions.
- To promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations.
- To operate a permanent information system on international oil markets.
- To provide data on other aspects of international energy markets.
  - To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use.
    - To promote international collaboration on energy technology.
      - To assist in the integration of environmental and energy policies, including relating to climate change.



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The OECD is a unique forum where the governments of thirty democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

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# EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS

## EXECUTIVE SUMMARY

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Portugal has continued to develop and strengthen its energy policy over the period since the last in-depth review in 2004. The list of Portuguese policy achievements is extensive and a large number of policy developments and accompanying actions have been implemented. Many have been based on recommendations contained in the previous review and are designed to have long-term practical impact on the character and nature of the Portuguese energy system. The most important of these has been the publication of a new National Energy Strategy in October 2005, which replaced the previous 2003 strategy. The new strategy sets out a series of measures to achieve the government's principal objectives of securing energy supply, protecting the environment and maintaining economic competitiveness. The key policies to attain these goals have been identified as competition in energy markets, the promotion of renewable energy and increased energy efficiency.

Many steps have been taken towards the liberalisation of energy markets. These have included the creation of two large competing players in the natural gas and electricity sectors, and the development of a single operator for the transportation of both natural gas and electricity. Portugal has taken an innovative approach to the unbundling of the gas and electricity transportation assets and placed them, along with natural gas storage and the Sines LNG terminal, in one regulated entity, Redes Energéticas Nacionais (REN). The Portuguese example has the potential to serve as a model for other IEA members. Another important step has been the implementation of the Iberian Electricity Market (MIBEL) in 2007. Similar arrangements are presently being developed in the natural gas market (MIBGAS).

Further steps have been taken to enhance security of energy supply. Portugal remains in compliance with the IEA oil stockholding obligations, fossil fuel import sources have been diversified, and production from indigenous energy sources has been increased. An LNG terminal at Sines is operational and natural gas storage capacity has grown. Capacity in both the electricity and natural gas networks has been expanded and interconnections with neighbouring Spain strengthened.

Significant growth in renewable energy capacity over the past four years will play a large part in aiding Portugal in meeting its GHG obligations. Furthermore, the government recently set a new more demanding target such that power generation from renewable sources is to supply 45% of gross

electricity consumption by 2010, an increase on the previous target of 39%. Other new and ambitious targets for renewable energies include a wind power capacity target of 5 100 MW and 5 575 MW of installed hydropower capacity by 2010. Progressive policies have also been adopted for biofuels and micro-generation.

The establishment of the Climate Change Commission by means of the CECAC as a co-ordinating body for climate change policy is a hugely progressive step that has strengthened Portugal's efforts to meet its climate change obligations. The national emission inventories, the second National Allocation Plan 2008-2012 (NAP II) and the Portuguese Carbon Fund build on this progress. Clear roles have been assigned to policy stakeholders. CECAC has taken lead responsibility for the co-ordination of activities, the development of policies and measures, and management of the Portuguese Carbon Fund.

The government has also developed a robust set of policies and measures with the aim of reducing energy consumption, particularly in buildings, industry and transport sectors. A buildings' energy certification system became mandatory in July 2007, higher construction standards have been imposed, and motor vehicle taxes have become a function of GHG emissions. A National Action Plan for Energy Efficiency (PNAEE) was enacted in 2008 and it targets an increase in energy efficiency equivalent to 9.8% of total final energy consumption by 2015. The plan is made up of a broad range of programmes and measures and pays particular attention to transport and industry, the largest consumers of energy.

Each of these developments demonstrates a visible commitment to energy policy reform and improvement. They reflect a broad attempt to engage with, and build upon, the IEA 2004 recommendations and the continued implementation of EU energy policy and targets. Nonetheless a number of policy challenges remain.

## **CONTINUED STRUCTURAL REFORM OF THE ELECTRICITY SECTOR**

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While there has been a large degree of progress in the electricity sector, some structural weaknesses remain. Further gaps need to be bridged before the market becomes fully competitive and the benefits of competition are passed to final consumers. There is considerable scope for higher levels of competition, at both wholesale and retail levels, to develop in the near future. Government policy in this sector must continue its focus on the design and implementation of effective mechanisms to encourage competition. The awarding of permits to new market entrants for incremental generation capacity is a welcome step forward but further measures must be taken.

## CONTINUED GROWTH OF RENEWABLE ENERGIES

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Portugal is now among the leading IEA member countries in terms of both hydro and wind power penetration and is at the forefront of ocean power development. Historically, Portugal was highly dependent on imported fossil fuels. Renewable energy policy, therefore, is an important instrument for achieving broader policy goals of energy security, sustainability and competitiveness. Care must be taken to ensure that targets are realistic, affordable and regularly monitored and updated as necessary. Environmental assessments of new projects should continue to be subject to the broadest possible public analysis and a greater examination on how the costs of renewable energy are distributed through existing cost recovery mechanisms is needed.

## ENERGY TECHNOLOGY, RESEARCH AND DEVELOPMENT

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Public funding for energy research and development, as a percentage of GDP, remains the lowest among IEA member countries. A formal national energy research and development strategy has not been developed, and co-ordination among relevant ministries and stakeholders in the sector leaves room for further improvement. The sector needs clearer leadership and closer co-operation between the different ministries, relevant research laboratories and the private sector. Policy makers need to explore all possible means to respond to these challenges and the possible advantages provided by effective energy research and development policy must be fully considered. We encourage the government to vest leadership and responsibility for the sector within one ministry in order to facilitate the development of a more coherent, appropriately funded, energy research and development strategy. This strategy should be consistent with broader industrial and educational policy.

## KEY RECOMMENDATIONS

*The government of Portugal should:*

- ▶ *Build on past successes and take further steps to increase competition levels in the electricity and natural gas markets and examine means by which they can encourage new entry in wholesale and retail markets.*
- ▶ *Continue to pursue support schemes for renewable energy while ensuring that the cost-effectiveness of the overall strategy is optimised and the costs of the policy are distributed equitably among consumers.*

- ▶ *Invest in developing a formal energy research and development strategy, consistent with energy policy and broader economic goals, with leadership and responsibility for delivery provided by the appropriate ministry in collaboration with other ministries, third-level institutions, the private sector and state agencies.*

**PART I**  
**POLICY ANALYSIS**

Figure 1  
Map of Portugal



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

## COUNTRY OVERVIEW

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Portugal is geographically situated on the west coast of continental Europe, in the Iberian peninsula. It borders Spain to the north and east, and the Atlantic Ocean to the west and south. In addition to the continental territory, Portugal includes the two autonomous regions of the Atlantic Ocean, the islands of the Azores located to the west and Madeira to the south-west. On the continental territory, the river Tagus divides the more mountainous north from the plains of the south.

The Portuguese Republic is a parliamentary republic, based on the constitution of 1976, most recently amended in 2004. The national legislature is the unicameral National Assembly (parliament) of 230 members, who are elected by universal suffrage for a term of four years. The Assembly of the Republic has responsibilities at political, legislative and fiscal levels. The Prime Minister, who presides over Cabinet meetings, is nominated by the President, the supreme representative of the Portuguese Republic. At present, the President is Mr. Aníbal Cavaco Silva and the Prime Minister, Mr. José Sócrates.

Portugal covers a total area of 92 142 square kilometres and is home to 10.62 million people. In the past Portugal benefited from a fortuitous location, being situated in a geo-strategic position between Europe, America and Africa. The Portuguese climate is marked by mild winters and balmy warm summers. The wettest months are November and December and the driest periods typically occur between April and September.

## THE ECONOMY

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Over the past two decades, boosted by EU membership, Portugal has undertaken a wide range of reforms to liberalise the economy and open it to foreign trade and investment. These reforms paid off in terms of GDP growth and Portugal managed a significant catch up towards the living standards of more developed OECD economies until the early 2000s.

Thereafter, growth stalled, unemployment increased, the convergence process suffered a reversal, and it was not until 2005 that economic growth picked up again, thanks in part to a renewed effort at macroeconomic and structural reforms. A forceful fiscal consolidation brought the deficit down from more

than 6% of GDP in 2005 to 2.6% both in 2007 and in 2008, and inflation moderated to about 2.4% in 2007 and 2.8% in 2008, 0.5 percentage points below the euro average.

Economic activity decelerated sharply in 2008 and growth came to a halt, reflecting the decline in investment and exports. In line with the recent intensification of the global financial crisis and expectations of a sharp decline in Portugal's export markets, activity is expected to contract until the second half of 2009, before recovering slowly towards the end of the year.

## **ENERGY SUPPLY AND DEMAND**

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A significant increase in final energy consumption has resulted in high import dependence for Portugal, given that domestic production is limited to renewable energy sources. Oil dominates primary energy supply. Natural gas was first introduced in 1997 and is gaining an increasing share in energy supply and electricity generation. Electricity generation depends to a large extent on hydro energy, which exhibits significant annual variation; hard coal also plays a significant role in the electricity mix. Industry and transport are the major energy-consuming sectors. Energy and CO<sub>2</sub> intensity are above the EU average, although energy consumption and CO<sub>2</sub> per capita are below the EU average. Much debate on energy focuses on the future energy mix in the light of relatively high dependence on imports, particularly oil as illustrated in Figure 2, and climate change.

### **SUPPLY**

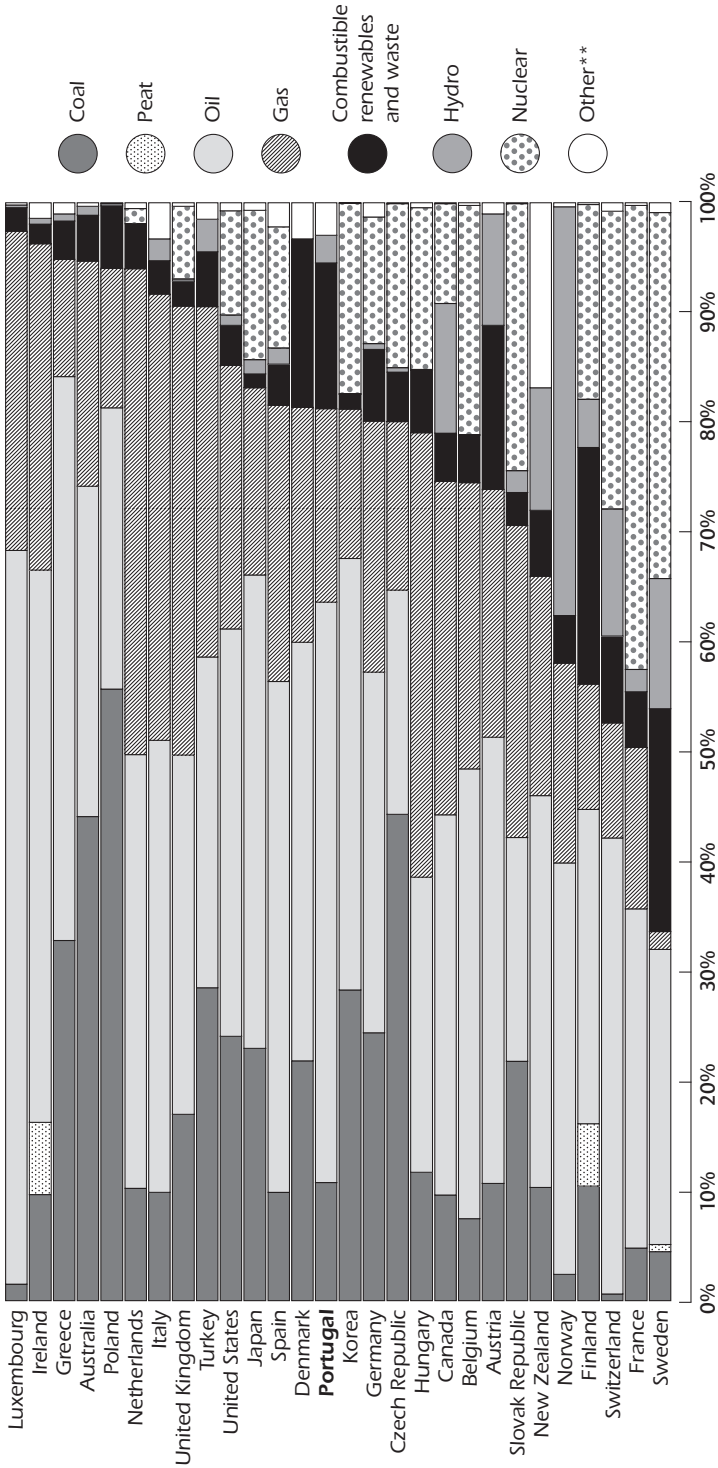
Primary energy supply in Portugal has increased significantly between 1990 and 2008 (by 45% or 2.5% per annum). In 1997, natural gas was first introduced in primary energy supply and by 2008 the share of gas in total energy supply had reached 17.59% (remaining below the EU-27 average). Fossil fuels, mainly oil and coal, represented 52.89% and 10.75% of TPES in 2008. Domestic energy production is based entirely on renewable energy sources, mainly hydro, wind and biomass and its share - including waste - of total energy supply in 2008 was 18.77%, significantly higher than the EU-27 average.

Import dependence of Portugal in terms of energy (81.23% by 2008) is much higher than the EU-27 average. Most of the imported energy is oil but also includes significant amounts of gas and solid fuel. Crude oil is imported from African countries (Algeria, Nigeria and Libya) and Brazil. Nigeria and Algeria are also main suppliers of natural gas. Solid fuels (hard coal) mainly originate from Colombia and South Africa.



Figure 2

Total Primary Energy Supply in IEA Member Countries, 2008\*



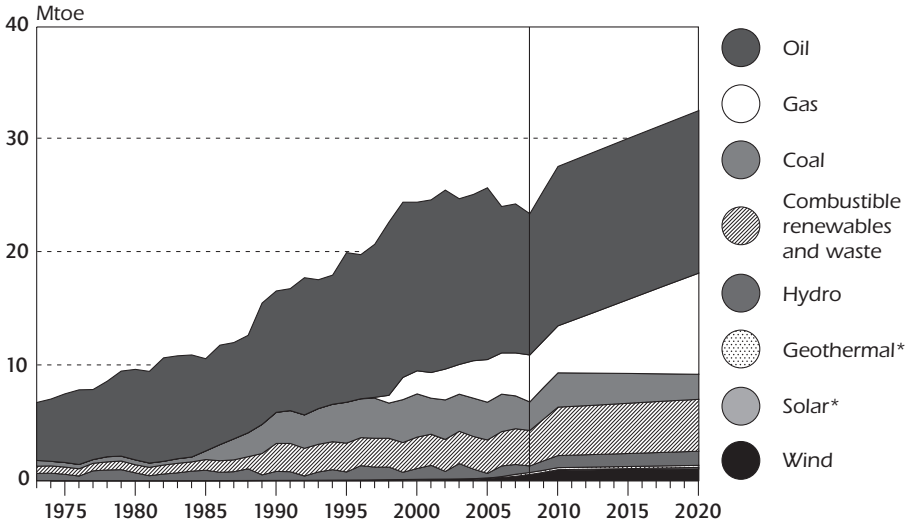
\* estimates

\*\* includes geothermal, solar, wind, and ambient heat production.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

Figure 3

Total Primary Energy Supply, 1973 to 2020

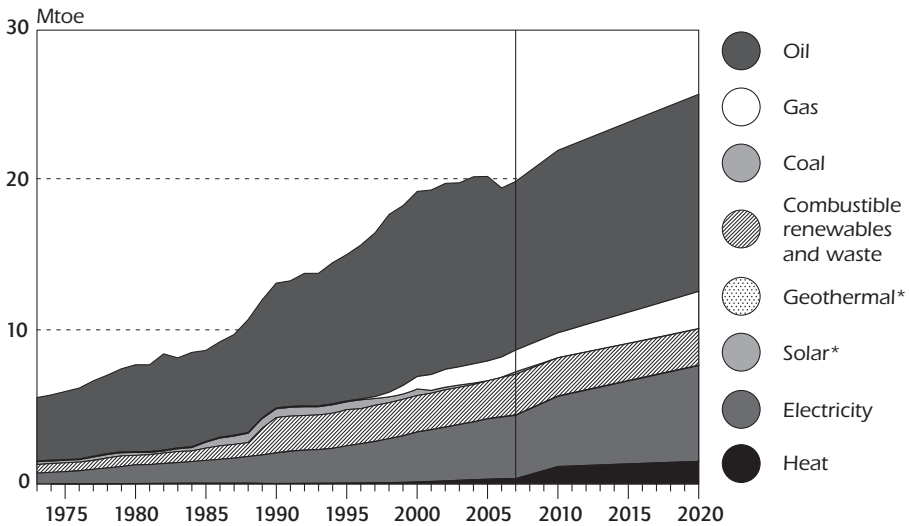


\* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008 and country submission.

Figure 4

Total Final Consumption by Source, 1973 to 2020



\* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008 and country submission.

## DEMAND

Energy demand in Portugal has increased considerably since 1990 (56% increase in the period 1990-2008) but has been relatively static over the past six years. The increase since 1990 has been mainly due to increases in the consumption of the transport, services and commercial sectors. Transport and industry are the most important energy-consuming sectors (both are above EU average shares), with a 71% aggregate share in total final energy consumption in 2008. In the same year: 55.4% of consumed energy came from oil, while 21% from electricity and 12.86% from renewable energy sources (including waste).

## KEY ENERGY POLICIES

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In October 2005, the government approved a new National Energy Strategy, which replaced the 2003 strategy. The new strategy set out a series of measures to achieve the government's main objectives of securing energy supply, protecting the environment and maintaining economic competitiveness. The key policies to achieve these goals were identified as market liberalisation, the promotion of renewable energy and increased energy efficiency and innovation.

The strategy was prepared with the firm intention of reducing the country's dependence on imported energy sources, particularly fossil fuels, and decreasing CO<sub>2</sub> emissions. In addition, the government sought to create the conditions to increase competitive pressures within the natural gas and electricity sectors. In terms of actions, the following were identified as key to the success of the strategy:

- The liberalisation of the natural gas and electricity markets and the creation of two large competing players in both sectors;
- The development of a single transmission operator for the transportation of both natural gas and electricity;
- Strong efforts to promote and support renewable energy sources: and
- The implementation of a plan to increase energy efficiency.

Since September 2006, all electricity consumers have been free to choose their supplier (although regulated tariffs remain as an option). The generation market has largely been liberalised with the ending of the majority of legacy Power Purchase Agreements and the licensing of the construction of four new gas-fired power stations for approximately 3 320 MW of capacity. Spain and Portugal launched the all-Iberian electricity market (MIBEL) in January 2004, with the goal to improving security of supply and economic efficiency.

A single market operator was created in 2006, and a common price for electricity for both countries applies if interconnection capacity allows. MIBEL enables any consumer in the Iberian zone to acquire electricity from any generator or retailer operating in either Portugal or Spain. 2008 saw new measures introduced to harmonise regulation in the two countries and further congestion management mechanisms are being developed in the Spain-Portugal interconnections.

Regarding the natural gas market, Portugal received a derogation in relation to the implementation of Directive 2003/55/CE. Nonetheless, market liberalisation has been advanced by two years for household consumers and by one year for industrial consumers. Energias de Portugal (EDP), the previous electricity incumbent, entered the natural gas market in 2004 and is now the country's second largest player behind Galp. At the same time, Galp, the integrated oil and natural gas group, entered the electricity market where in 2008 it sold 1 548 GWh of power.

A further important step towards the evolution of competition was the creation of a single transmission system operator for the gas and electricity networks and the vesting of the transportation assets in the new entity, REN – Redes Energéticas Nacionais. In September 2006, REN (previously the electricity transmission grid operator) acquired the gas transmission infrastructure formerly operated by the Galp-owned Transgás, and latterly the Sines LNG terminal and existing gas storage facilities.

In 2007, the government defined three major targets for renewable energy by 2010: a 45% share of renewable electricity in gross electricity consumption; a 10% share of biofuels in the total road transport fuel consumption; and the replacement of 5% to 10% of coal consumption by biomass or residues in two power plants at Sines and Pego. The country is making good progress in relation to the development of new renewable electricity capacity and between 2004 and 2008, capacity increased by more than 2 400 MW<sup>1</sup>, a large proportion of which is wind. Policies to encourage the development of biofuels have been implemented, including partial exemptions from excise duty and total exemptions for biofuels produced in certain small and pilot projects, the imposition of a quota for biofuels in transport fuels, and the establishment of voluntary agreements for public passenger transport fleets. By the end of 2007 biomass contributed 1 510 GWh to electricity output at a time when coal-fired electricity production was declining.

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1. DGEG.

In May 2008, the government published the National Energy Efficiency Action Plan (PNAEE), also designated Portugal Efficiency 2015. The Plan comprises a set of measures targeted at an increase in energy efficiency, equivalent to 9.8% of total final energy consumption by 2015, giving compliance to the European Union's Energy Services Directive. The Action Plan focuses on demand side management, and interacts with the National Climate Change Programme (PNAC) and the National Allocation Plan for Emission Allowances (PNALE). It addresses four specific sectors: transport, residential and services, industry, and the public sector; and established goals in three cross-cutting areas: consumer behaviour, taxation, and incentives and financing.

The main policy instruments adopted by Portugal to fulfil its climate change obligations to the EU Burden-Sharing Agreement under the Kyoto Protocol are the National Climate Change Programme (PNAC 2006 and New 2007 Measures), the ETS – National Allocation Plan 2008-2012 (PNALE II) and the Portuguese Carbon Fund. Portugal's strategy for meeting its legally binding target under the Kyoto Protocol relies heavily on supply side measures, *e.g.* changing the energy generation mix and making it more environment-friendly, but also on the demand side through National Action Plan for Energy Efficiency. Portugal has been focusing on reducing CO<sub>2</sub> emissions and its reliance on external sources of energy by promoting investments in renewable energy sources, energy efficiency measures and clean technologies.

## SECURITY OF SUPPLY

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The Directorate-General for Energy and Geology (DGEG) is in charge of monitoring security of supply, in co-operation with REN, the natural gas and electricity transmission system operator. In the case of natural gas, REN is required to monitor compliance of market participants in terms of their obligation to maintain mandatory gas reserves. These reserves must amount to the equivalent of 15 days' consumption in the case of non-interruptible gas-fired power plants; and the equivalent of 20 days' consumption for non-interruptible customers in the remaining market. The average daily consumption figures are calculated on the basis of a twelve-month moving average. These obligations are monitored by REN and reported to DGEG on a monthly basis. Mandatory gas reserves can only be mobilised with the permission of the Minister for Economy and Innovation.

In the electricity sector, Portugal has an adequate security margin except in long periods of drought. Four 400 kV lines ensure interconnection with Spain. The remaining interconnections are composed of 220 kV lines. The overall available interconnection capacity varies between 1 100 and 1 600 MW for imports from Spain and varies between 1 200 and 1 600 MW for exports. Three further 400 kV interconnections are planned in order to increase grid integration.

# ENERGY INSTITUTIONS

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## Directorate-General for Energy and Geology (DGEG)

The Directorate-General for Energy and Geology rests within the Ministry of Economy and Innovation (MEI). The directorate is responsible for the development and implementation of sustainable and secure policies related to energy and geological resources. In particular, DGEG promotes and participates in the development of the legal and regulatory frameworks related to energy production, transportation, distribution and consumption. The DGEG also provides support to government decision-making in crisis and/or emergency situations in co-operation with the Commission for Energy Emergency Planning (CPEE).

## Regional Directorates for Economy (DREs)

The Regional Directorates for Economy are the part of the state administration, which act on behalf of the Ministry of Economy and Innovation (MEI) at regional level. The DREs represent MEI to the local authorities and are responsible for the implementation of MEI policies at that level.

## Energy Services Regulatory Authority (ERSE)

The Energy Services Regulatory Authority (ERSE) is the sectoral regulator for natural gas and electricity. It is a financially autonomous public corporate body, its purpose being the regulation of the natural gas and electricity sectors. ERSE is independent in the exercise of its functions. The ERSE mission includes, *inter alia*, protecting the rights and interests of consumers in relation to energy prices, quality of service, access to information and security of supply.

## Portuguese Competition Authority

The Competition Authority was created by Decree-Law 10/2003 of 18 January. It succeeds the Competition Council and the Directorate-General of Competition and Trade, as an independent and financially autonomous institution. The Authority has regulatory powers on competition over all sectors of the economy, including the regulated energy sectors, the latter in co-ordination with the relevant sector regulators.

## Entity for the Management of Oil Products Strategic Stocks (EGREP)

The national stockholding agency EGREP was established in 2004, based on Decree-Law 10/2001 of 23 January on Petroleum Reserves, and was later amended in 2001. EGREP is a wholly government-owned organisation, which has its own board of directors, a supervisory board and an independent auditor.

### **Commission for Energy Emergency Planning (CPEE)**

The CPEE is the agency specifically focused on energy supply security and rests within the national civil emergency structure (CNPCE – Civil Emergencies Planning Board, under the authority of the Minister of Defence). CPEE staffing and functioning is DGEG's responsibility, and the Director-General of DGEG serves as chairman. The CPEE is composed of delegates from the Ministry of Defence, the autonomous regions, DGEG, including representatives of the energy sector.

### **National Energy Networks (REN)**

Created in 2007, REN is responsible for the planning, construction, operation and maintenance of the National Electrical Energy Transmission Grid (RNT), for the global technical management of the National Electrical System (SEN) and management and trading of the remaining legacy power purchase agreements. REN is also responsible for the planning, construction, operation and maintenance of the National Natural Gas Transportation Grid (RNTGN); the technical management of the National Natural Gas System (SNGN); the reception, storage and regasification of the liquefied natural gas (LNG) at the Sines LNG facility; and the operation, maintenance, construction and management of the underground storage of natural gas.

### **National Laboratory on Energy and Geology (LNEG)**

At the time of the review, INETI (the National Institute for Engineering, Technology and Innovation) was being reorganised to create two separate laboratories within one institution – LNEG (the National Laboratory on Energy and Geology) – in order to restructure its research and technological activities. LNEG will be the largest public sector research and development institution in Portugal, primarily focused on energy and geology, and also on the provision of services to the private sector. LNEG carries out research, testing and technological development programmes.

### **Technological and Nuclear Institute (ITN)**

The Technological and Nuclear Institute (ITN) is a research institute with state laboratory status whose main activity is the peaceful application of nuclear technologies and ensuring the state meets its obligations with respect to radiological protection and nuclear safety.

## **ENERGY MARKET REFORM**

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### **NATURAL GAS**

As an emerging natural gas market Portugal benefited from a derogation until 2010 in relation to the implementation of Directive 2003/55/EC concerning common rules for the internal market in natural gas. Nonetheless,

the restructuring of the natural gas sector began in 2006 with the approval of Decree-Law 30/2006 of 15 February, which defined the general principles for the organisation and operation of the National Natural Gas System. The law transposed Directive 2003/55/EC into national law and led to the reorganisation of the entire sector.

Decree-Law 140/2006 of 26 July established the legal regimes applicable to the activities of natural gas transmission, underground storage, reception, storage and regasification at liquefied natural gas (LNG) terminals and natural gas distribution, including the legal basis for transmission and distribution concessions, and the definition of the procedures applicable to the award of such concessions. This bill also established the time frame for market opening, advancing the required EU deadlines for liberalisation and defining the legal regime governing supply and the organisation of the respective markets.

This process continued in 2007 with the opening of the market to standard regime electricity generators in line with the previously established timetable. In 2007, the separation in accounting terms (for all companies) and legal terms (for companies with more than 100 000 consumers) of the activities of distribution and supply was also achieved. Full market opening is expected by January 2010.

## ELECTRICITY

The legislative framework for the Portuguese electricity sector was revised in 2006, abolishing the pre-existing dual regime, where a public service sector, regulated by ERSE and supplied by plants under exclusive power purchase agreements (PPAs) with the transmission system operator (TSO), coexisted with a fully liberalised segment. Distribution was legally unbundled from supply, with the creation of the so-called "last-resort supplier". The last-resort supplier is obliged to accept any customer at tariffs that are regulated by ERSE.

With the termination of the pre-existing power purchase agreements in July 2007, all electricity generated by standard regime power plants in Portugal began to be traded in the MIBEL spot and forward energy markets. The incumbents' PPA early termination was compensated by means of the Costs for the Preservation of Contractual Equilibrium (CMEC), a stranded costs recovery mechanism designed by the government and framed in legislation published in 2004. The CMEC is an adjustable financial compensation scheme aimed at guaranteeing that plants that terminated their PPAs are able to recoup the same level of profits from the market as they would have obtained under the former PPA.

Since 2007, the first full year of complete liberalisation of the electricity sector, all customers have been free to choose their supplier and the government



has engaged in a number of programmes to encourage competition in the generation sector, including virtual power producer (VPP) auctions and competitions for new capacity.

## **ENERGY TAXES AND SUBSIDIES**

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Energy taxes in Portugal generally exceed the minimum levels required by EU legislation. The value-added tax (VAT) rate increased from 17% to 19% in 2002, and again to 21% in July 2005. VAT has been reduced to 20% from July 2008 for automotive fuels and LPG. An intermediate rate of 12% on diesel fuel for heating, coloured and marked diesel, and fuel oil with low sulphur content, remains in place. A reduced VAT rate of 5% continues to be applied to household consumption of natural gas and electricity.

## **ENERGY PRICES**

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Retail sale prices of unleaded gasoline and diesel fuels were liberalised in January 2004 and the maximum price regime was abolished. At present there are no price controls. Excise duties are fixed by the government. DGEG monitors fuel prices, making them public on an ongoing basis through a specific website showing the daily updated prices, of around 2 500 auto-fuel supply stations, while also providing information to the Competition Authority.

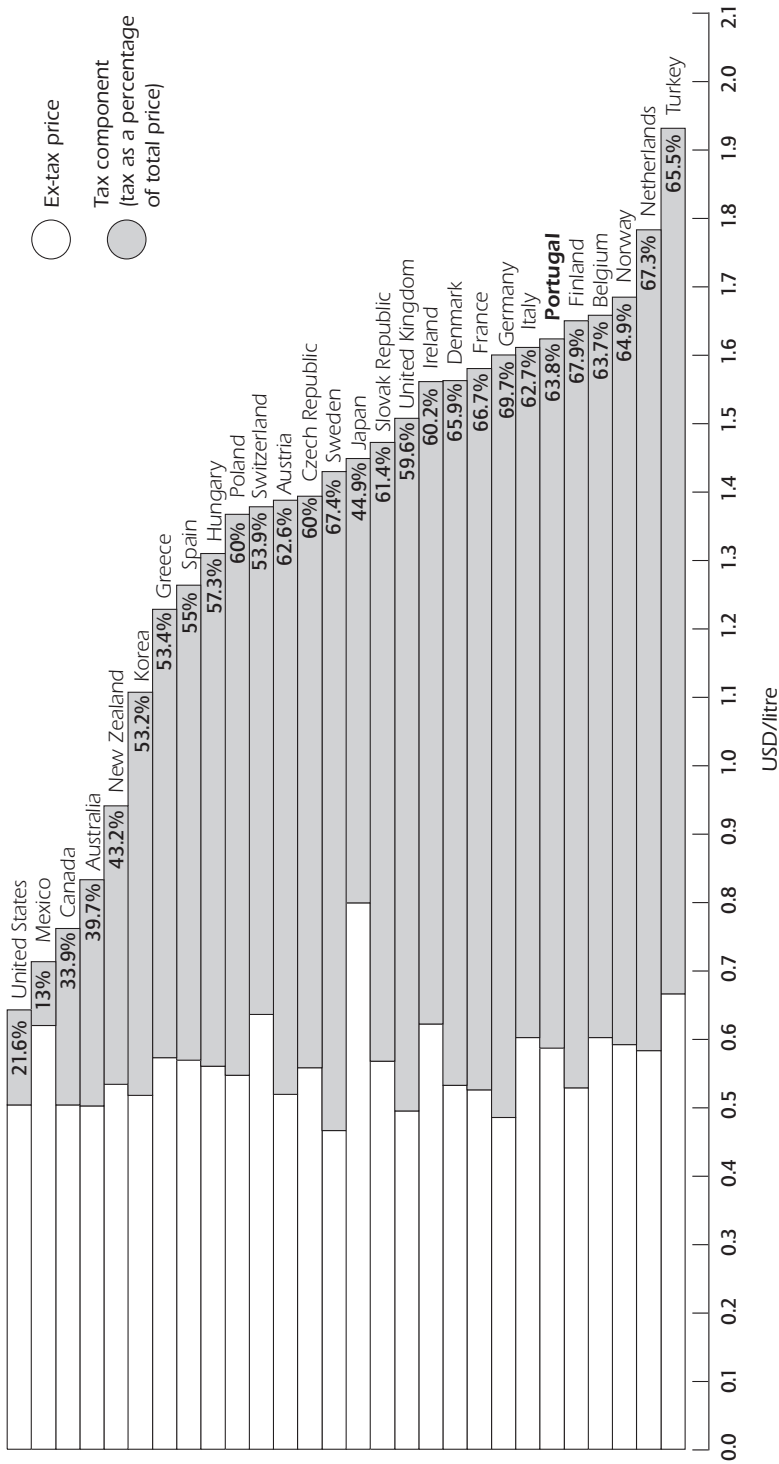
## **CRITIQUE**

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There have been many positive policy developments in Portugal over the period since the last review. An impressive number of policy outputs and accompanying actions, designed to have lasting practical impact on the character and nature of the Portuguese energy system, have been implemented and for this the administration must be complimented. These outputs have included the development and enactment of new laws, the publication of significant policy documents and the establishment of many policy goals and targets. Significant examples include the National Energy Strategy, published in 2005, the enactment of liberalisation and unbundling legislative reforms in the electricity and gas sectors and the preparation and implementation of the PNAEE, PNAC and the second National Allocation Plan (NAP II). Each of these demonstrates a visible commitment to energy policy reform and improvement, which reflects a broad attempt to engage with, and build upon, the IEA previous 2004 recommendations and the continued implementation of European Union's energy policy and targets.

The requirement for greater policy co-ordination highlighted in our previous review has been addressed in an impressive manner with regard to climate

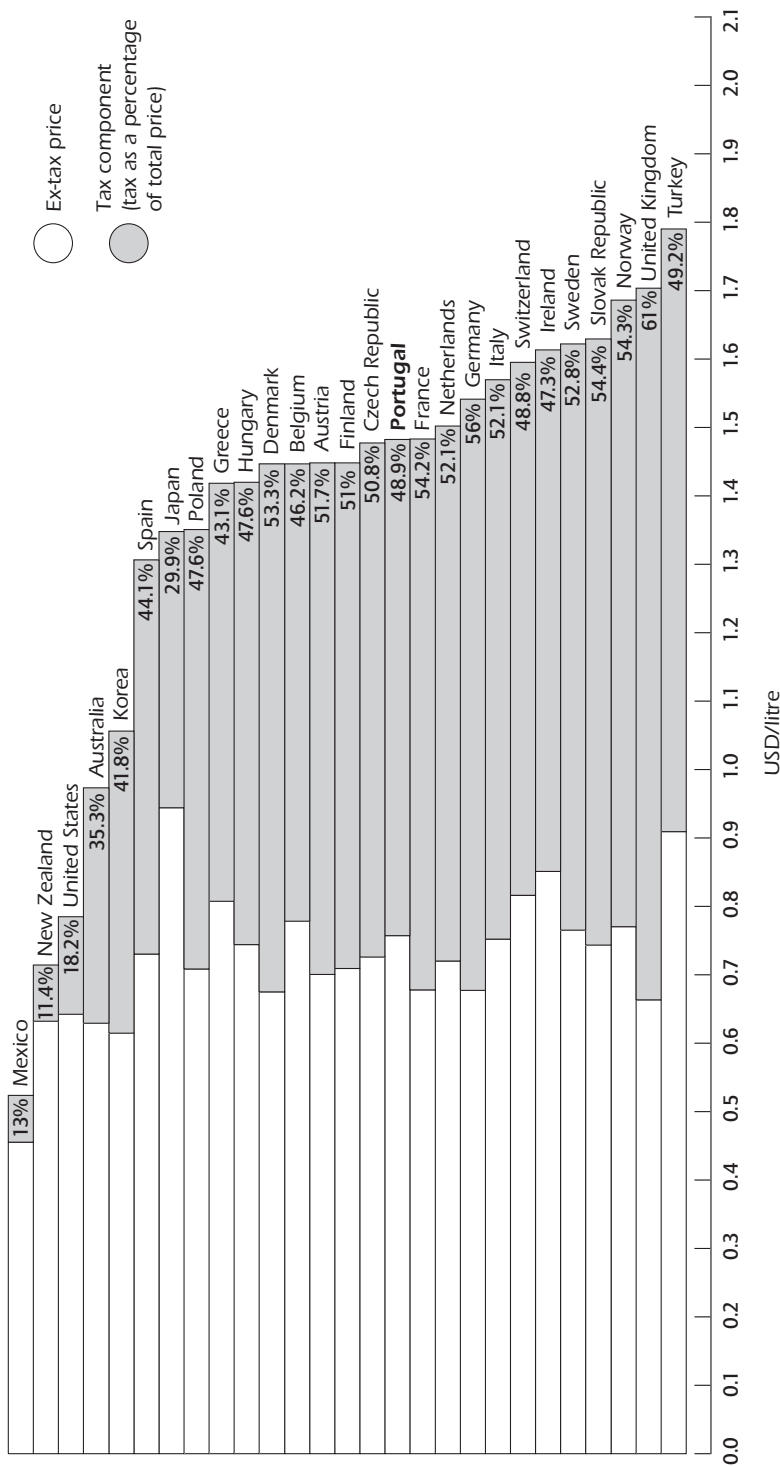
Figure 5  
**OECD Unleaded Gasoline Prices and Taxes, Fourth Quarter 2008**



Note: data not available for Luxembourg.  
 Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2009.

Figure 6

### OECD Automotive Diesel Prices and Taxes, Fourth Quarter 2008



Note: data not available for Canada and Luxembourg.  
 Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2009.

change, as evidenced by the establishment of CECAC, the Climate Change Commission and the stakeholder forum; for this the administration must be also be commended. PNAC, together with other recent actions, drew a road-map towards meeting Portugal's Kyoto targets including a wide range of measures that can provide visible guidance for all stakeholders.

Portugal has clearly articulated and generally understood long-term policies and strategies to enhance and expand the contribution of renewable energy to total primary energy supply (TPES) by 2020. This includes an ambitious 31% target for the share of renewable energy in final energy consumption by 2020. A greater role for renewable generation in the electricity generation mix has the potential to deliver significant benefits for Portugal in terms of increased energy diversity, a reduced reliance on imported fossil fuels and an improved emissions performance by the electricity system. Despite these ambitious policies, it is not fully clear that their costs, both financial and economic, as well as their impact on final consumer energy prices are well understood and appreciated. Furthermore, such an understanding is critical to a common agreement about how the costs of this policy should be distributed.

Apart from contributing to a more sustainable low-carbon energy system, ambitious plans to implement new clean energy technologies offer Portugal potential opportunities for new economic activity and employment creation. In this regard, the government must be praised for the strategic creation of linked research and development and industrial clusters in key technology development activities such as wind, solar and wave. Nonetheless, there remains a concern that the country lacks a clear policy with regard to energy technology, research and development. The framing of ambitious renewable targets has not been matched by public investment in research and development and the new technologies that can deliver these targets.

The legislative changes that enabled the fundamental restructuring and reorganisation, liberalisation and new entry in the electricity and gas markets represent a significant advance on the last review. In addition, vertical ownership unbundling for transportation and supply activities, previously imposed in the electricity market, has been replicated in the natural gas market. From this process a new entity has emerged, REN, in the form of a common independent transmission system operator for both markets. The establishment of REN as the operator of gas and electricity transportation grids, of the underground gas storage and of the Sines LNG terminal, and the vesting of the electricity and natural gas transmission assets in the company, mark a significant step on the way to competitive electricity and natural gas supply markets and represent a model that other economies could replicate.

Further structural gaps remain to be addressed before the electricity and gas markets become fully competitive and the benefits of liberalisation can be passed to consumers. The emphasis in policy delivery must move to the establishment of new market structures particularly in the electricity market.

Despite this progress, the outcome in terms of entry into the competitive electricity market could be improved and steps must be taken to deliver the benefits of real competition to consumers in the short to medium term.

## RECOMMENDATIONS

*The government of Portugal should:*

- ▶ *Assess and examine the full range of its energy policies, targets and measures, continually assessing whether they form a coherent and consistent whole over the medium to long term.*
- ▶ *Invest in developing a clear energy R&D strategy – led by a single ministry in collaboration with relevant stakeholders.*
- ▶ *Take further steps to encourage new entry to the natural gas and electricity markets including fully cost-reflective retail tariffs and strengthening the ability of the regulator to respond more quickly to changes in market conditions.*
- ▶ *Ensure sufficient resources to implement the complex energy policy agenda, including monitoring and evaluation of policies and programmes.*
- ▶ *Consider increasing public awareness and understanding of energy realities, including market reform, energy security and the costs of energy sustainability decisions and policies.*



## OVERVIEW

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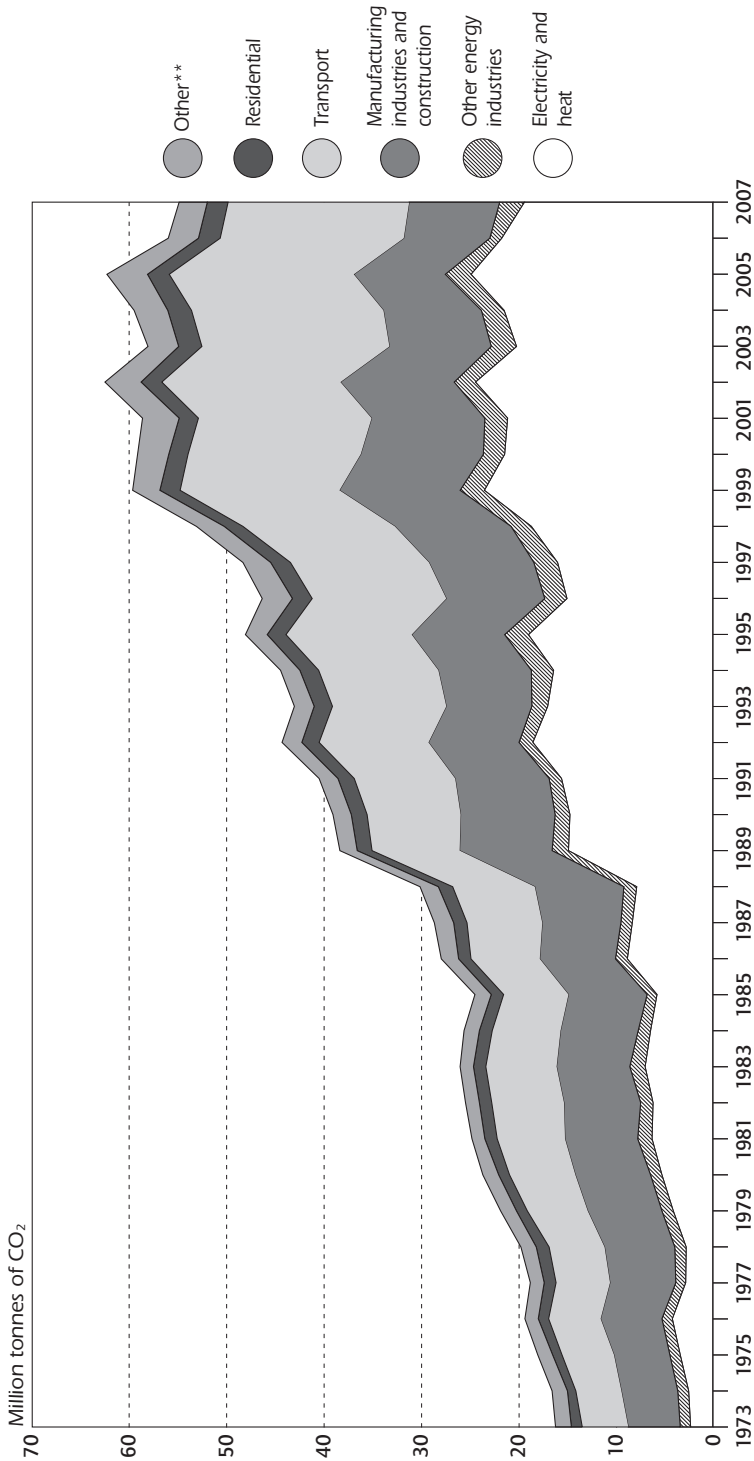
Portugal's commitment to the EU Burden-Sharing Agreement under the Kyoto Protocol is to limit the increase of its greenhouse gas (GHG) emissions to 27% between 1990 and the first commitment period of 2008-2012. The Portuguese "Assigned Amount" under its Kyoto target for 2008-2012 period is 382 million tonnes of CO<sub>2</sub> equivalent, meaning 76.39 Mt CO<sub>2</sub>eq per year. The most recent communication to the United Nations Framework Convention on Climate Change (UNFCCC) noted that between 1990 and 2006, total emissions per capita and per unit of gross domestic product (GDP) increased by 32.7% and 1%, respectively. Although per-capita carbon emissions are among the lowest in the European Union, the carbon intensity of Portugal's economy is not as low as it should be. There is, therefore, an opportunity for gains in efficiency and sustainability.

The main instruments to fulfil Portugal obligations to achieve its climate change objectives are the National Climate Change Programme (PNAC 2006 and New 2007 Measures), the ETS - National Allocation Plan 2008-2012 (PNALE II) and the Portuguese Carbon Fund. Portugal's strategy for meeting its legally binding target under the Kyoto Protocol relies heavily on supply-side measures, *e.g.* changing the energy generation mix and making it more environment-friendly. Portugal has been focusing on reducing CO<sub>2</sub> emissions and its reliance on external sources of energy supply by promoting investments in renewable energy sources, energy efficiency measures and clean technologies.

Factors that drive the increase in emissions are, among others, economic growth and higher energy demand, increasing road transport volume and distance driven supported by strong development of road infrastructure and rapid growth in private car ownership. Climatic variables, such as precipitation, which vary from year to year, have also a significant effect on hydropower generation and result in substantial inter-annual variations in emissions.

CO<sub>2</sub> represents 77% of total GHG emissions. The majority of emissions are generated by energy-related activities, which are responsible for almost 90% of total CO<sub>2</sub> emissions. On average, during the period from 1990 to 2007, 84% of primary energy consumed was produced from fossil fuels (coal, oil and natural gas) whereas renewable energy represented the remaining part, *i.e.* 16% on average. This situation is changing with the progressive increase in renewable energy sources such as wind.

**Figure 7**  
**CO<sub>2</sub> Emissions by Sector\*, 1973 to 2007**



\* estimates using the IPCC Sectoral Approach.

\*\* includes emissions from commercial and public services, agriculture/forestry and fishing.

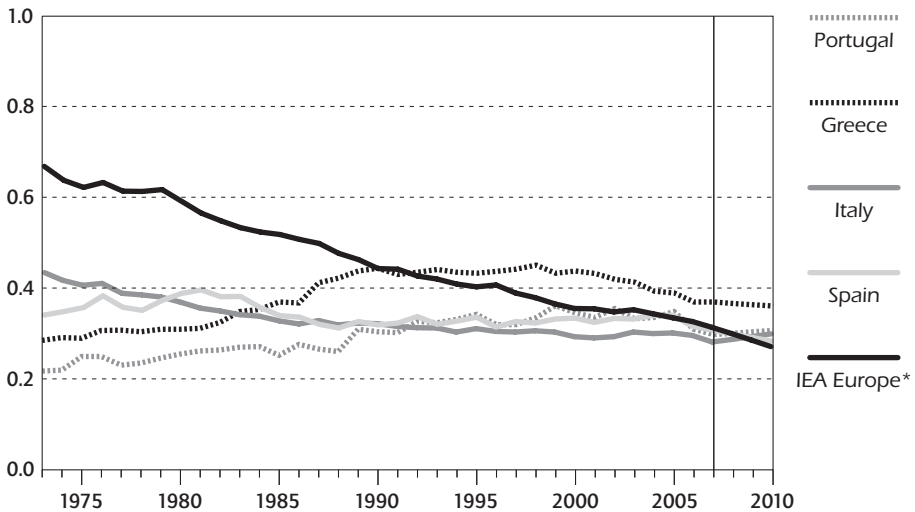
Source: CO<sub>2</sub> Emissions from Fuel Combustion, IEA/OECD Paris, 2008.



Figure 8

### Energy-Related CO<sub>2</sub> Emissions per GDP in Portugal and in Other Selected IEA Member Countries, 1973 to 2010

(tonnes of CO<sub>2</sub> emissions per thousand USD GDP using 2000 prices and purchasing power parities)



\* excluding Luxembourg and Norway throughout the series, as forecast data are not available for these countries.

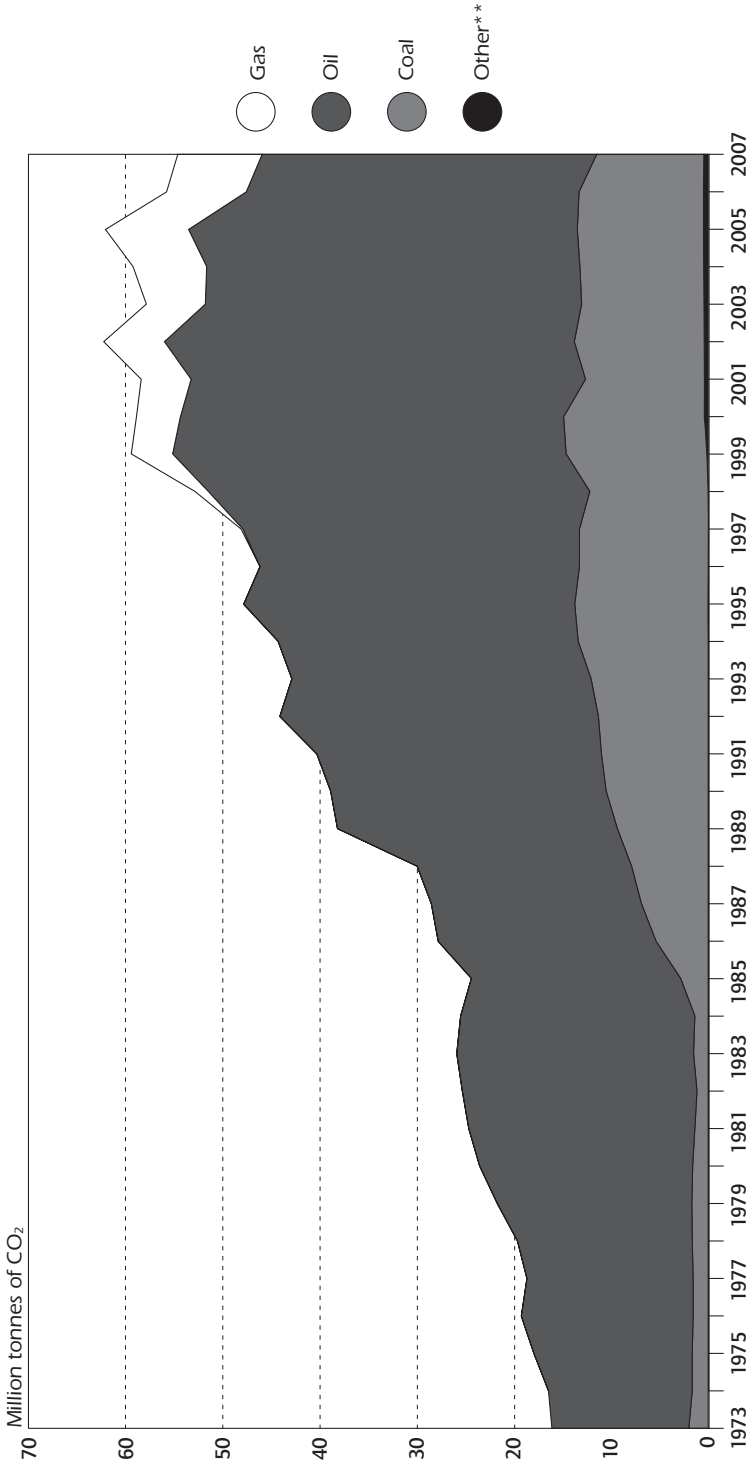
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008; *National Accounts of OECD Countries*, OECD Paris, 2008 and country submissions.

Energy use in Portugal produces relatively low CO<sub>2</sub> emissions per unit of GDP and per capita. This rate has been relatively static over the past decade at a time of rapidly increasing GDP. In 2006, Portugal emitted 0.31 kg of CO<sub>2</sub> per USD of GDP (in 2000 prices and purchasing power parities), lower than each of the previous four years. This represents an increase of just 2.2% since 1990, equal to the OECD average, and places Portugal in the middle among OECD European countries. Portugal's CO<sub>2</sub> emissions per capita were 5.32 tonnes, which places it among the best performers in OECD Europe, behind Turkey and equal with Sweden.

## CO<sub>2</sub> EMISSIONS FROM FUEL COMBUSTION

Between 1990 and 2007, total CO<sub>2</sub> emissions from fuel combustion increased by 41%, from 39.28 Mt to 55.19 Mt. This growth is not linear, however, and CO<sub>2</sub> emissions have been in decline since they peaked in 2003. In 2006, fuel combustion accounted for 87% of all CO<sub>2</sub> emissions in Portugal. In 2007, the bulk of all CO<sub>2</sub> emissions came from two sectors, road transport and

Figure 9  
CO<sub>2</sub> Emissions by Fuel\*, 1973 to 2007



\* estimated using the IPCC Sectoral Approach.  
 \*\* includes industrial waste and non-renewable municipal waste (negligible).  
 Source: CO<sub>2</sub> Emissions from Fuel Combustion, IEA/OECD Paris, 2008.

electricity production, which between them account for 38.19 Mt or 69% of emissions. Manufacturing and construction are also significant contributors producing 9.35 Mt or 16.96% of emissions.

Road transport has seen the largest increase in emissions in the period since 1990, 93.39%, or 56.62% of all emissions increases, reflecting the growing prosperity of Portuguese consumers and the high levels of state investment in road infrastructure in the intervening period. Electricity production has also seen a significant increase in emissions over the same period, 31.51%, although this has been tempered somewhat in recent years by the growth in renewables and gas-fired power. On a fuel basis, coal and oil were the largest emitters in 2007, 11.16 Mt and 34.76 Mt respectively, or 83% combined, followed by natural gas, 8.82 Mt or 15.98%.

## **POLICIES AND MEASURES**

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### **INSTITUTIONS**

The Climate Change Committee (CAC), an inter-ministerial body, was created in 1998 in order to integrate climate change issues within broader government policy. The CAC prepared the National Strategy on Climate Change and its implementation document, the National Climate Change Programme (PNAC), in 2001. The PNAC, which was updated in 2004, 2006 and in 2008, is the main strategic instrument guiding Portugal towards meeting its targets under the Kyoto Protocol and the EU Burden-Sharing Agreement. The PNAC entrusts the Ministry for Environment, Spatial Planning and Regional Development (MAOTDR) with the responsibility of leading and co-ordinating the development of programmes and actions to limit GHG emissions at governmental level.

In 2006, government established an executive arm to the Climate Change Commission, CECAC, which was also appointed Designated National Authority (DNA) for the Kyoto Protocol flexibility mechanisms. The CECAC is responsible for overall climate policy co-ordination, PNAC monitoring, Portuguese Carbon Fund management, and international negotiations (UNFCCC and EU). The Portuguese Environmental Agency (APA) assumes the role of co-focal point to the UNFCCC, is the competent authority in the European Union Emissions Trading Scheme (EU-ETS) and the responsible entity for the National System for the Estimation of Emissions by Sources and Removals by Sinks of Air Pollutants (SNIERPA).

### **POLICY OVERVIEW**

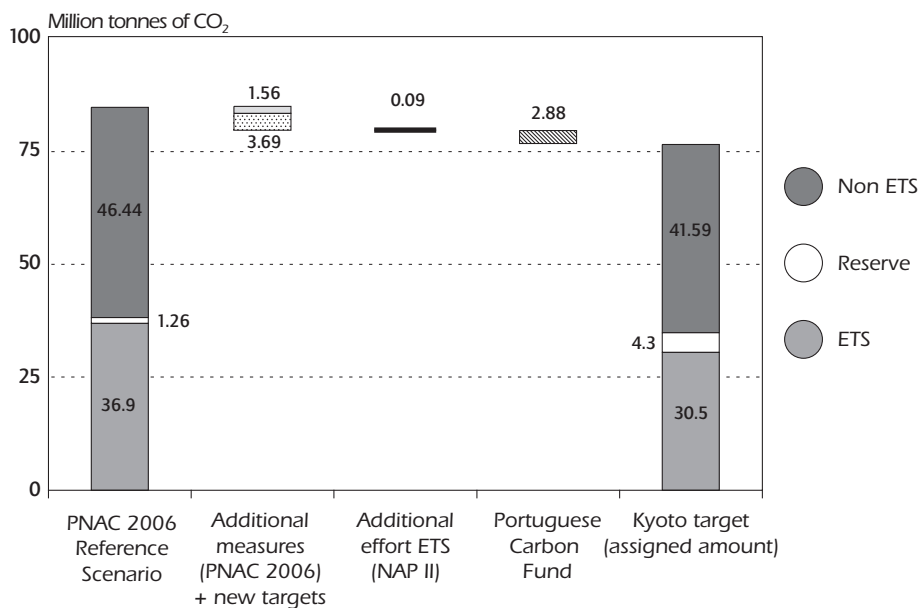
In the second half of 2005, a review of the PNAC was initiated. The outcome of this process was PNAC 2006, which was approved by Council of Ministers Resolution 104/2006 of 23 August. The new policy document recommends

that the energy sector should contribute a reduction effort of about 1.35 Mt CO<sub>2</sub>eq per year (2008-2012), through the implementation of additional measures, mainly in the fields of the energy efficiency and in the promotion of renewable energy use. PNAC 2006 evaluated Portugal's path towards meeting its first commitment period target under the Kyoto Protocol, taking into account the updating of macroeconomic information and activity variables of the various sectors, as well as the assessment of the policies implemented and the measures in force.

Taking into consideration the implementation of the PNAC 2006 and the new energy goals launched by the government in 2007, the total national amount of emissions for this period is 79.36 Mt CO<sub>2</sub>eq per year; hence the deficit will be 2.97 Mt CO<sub>2</sub>eq per year. With an emissions reduction effort of 0.09 Mt CO<sub>2</sub>eq/year coming from NAP II from the ETS, the remaining deficit (2.88 Mt CO<sub>2</sub>eq per year) will be addressed by the Portuguese Carbon Fund (see Figure 10). This deficit is currently under review as a result of the global economic crisis, which is estimated to contribute to further unquantified emissions reductions up to 2012.

Figure 10

### Portugal's Kyoto Challenge



Source: PNAC 2006.

Following Directive 2004/101/CE, a maximum percentage of the allocation of emission allowances to the installations can come from the flexible mechanisms of the Kyoto Protocol (Joint Implementation and Clean Development Mechanism), corresponding to 10% of the amount of emission allowances assigned in the NAP II, for each installation.

## EU EMISSIONS TRADING SCHEME

The EU-ETS limits the amount of CO<sub>2</sub> emissions from installations in six energy-intensive industries: power and heat; iron and steel; cement and lime; glass and ceramic construction materials; pulp and paper; and oil refining.

Each installation is allocated emission allowances and must hold allowances to cover its total CO<sub>2</sub> emissions. If its emissions are higher than expected, it can purchase more allowances on the allowance market to avoid a penalty. If, in turn, it needs fewer allowances than it holds, it can sell them. Allocation in the first two phases of the EU-ETS is based on a National Allocation Plan that is prepared by the national government and approved by the EU Commission. Allocation criteria are laid out in Annex III to the EU Emissions Trading Directive (2003/87/EC).

The EU-ETS was launched in 2005 and its first commitment period ran until the end of 2007. For 2008-2012, the second commitment period for which 44% of national emissions are covered, Portugal can allocate 34.81 Mt of CO<sub>2</sub> allowances per year of which 30.5 Mt CO<sub>2</sub>/year corresponds to incumbent's installations and 4.3 Mt CO<sub>2</sub>/year to new entrants reserve (see Table 1). The total annual allocation in 2008-2012 is 8.8% lower than in the first commitment period. All allowances are allocated for free.

In the ETS sector, Portugal had in 2005, 2006 and 2007 some 244, 253 and 258 installations respectively. During that period, five installations accounted for 51% of the country's CO<sub>2</sub> emissions. The ceramics industry accounted for almost half of all installations, or 114, 115 and 119 in each year, but only 3.15% of total allocated emission allowances. Combustion installations numbering 77, 84 and 87 in those three years (including energy, co-generation and other combustion installations), accounted for 65% of total allocated emission allowances.

In comparison with the EU as a whole, the EU-ETS sets a reasonable burden on process industries in Portugal, as opposed to electricity and heat generation. In 2005, process industries' share of the emissions in the trading sector was 40% in the EU as a whole, but 35% in Portugal.

Table 1

## GHG Allocations on a Sectoral Basis

(ktoe CO<sub>2</sub> per year)

<i>Sector/ subsector</i>	<i>Real emissions 2005</i>	<i>Real emissions 2006</i>	<i>Real emissions 2007</i>	<i>PNALE I</i>	<i>PNALE II</i>
<b>Energy supply</b>	<b>26 997</b>	<b>23 763</b>	<b>21 493</b>	<b>26 685</b>	<b>19 670</b>
Energy	21 912	18 667	16 418	20 969	14 002
Refineries	3 009	3 018	2 938	3 266	3 048
Co-generation	2 076	2 078	2 137	2 450	2 620
<b>Industry</b>	<b>9 428</b>	<b>9 320</b>	<b>9 736</b>	<b>10 171</b>	<b>10 840</b>
Cement & lime	6 983	6 862	7 108	7 136	7 208
Cement	6 610	6 505	6 713	6 765	6 744
Lime	373	357	396	371	464
Ceramics	866	825	883	1 160	568
Glass	640	656	696	681	767
Pulp & paper	315	312	315	363	372
Ferrous metals	220	273	235	309	335
Other – combustion plants	404	428	498	522	1 590
<b>Existing installations</b>	<b>36 426</b>	<b>33 084</b>	<b>31 229</b>	<b>36 910</b>	<b>30 510</b>
<b>Reserve for new entrants</b>	<b>390</b>	<b>1 162</b>	<b>1 348</b>	<b>1 250</b>	<b>4 300</b>
<b>TOTAL</b>				<b>38 160</b>	<b>34 810</b>

Source: APA.

As from 2013, new rules for EU-ETS will apply. An EU-wide cap was adopted, which gradually falls to a GHG emissions level of -21% by 2020 compared to 2005.<sup>2</sup> Allocation rules will be harmonised, with a focus on auctioning. For example, all allowances for the power sector will have to be auctioned, even though transitional free allocation for modernisation of electricity generation is possible in eligible countries, whereas manufacturing industry can still receive part of its allowances subject to carbon leakage allowances for free, based on stringent EU-wide benchmarks. Flexible mechanisms can be used to cover at least 11% of the 2008-2012 allocation or up to a maximum of 50% of the needed emissions reductions between 2005 verified emissions and the average phase II cap. By the time of writing (May 2009), the maximum share for flexible mechanisms and many other details remained to be confirmed by the EU member states and the EU Parliament.

2. The annual reduction factor also applies to beyond 2020, unless changed by other policy decisions.

## DOMESTIC MEASURES OUTSIDE THE EU-ETS SECTOR

The European climate and energy package aims at reducing the EU's greenhouse gas emissions to 20% below 1990 levels by 2020, or even by 30% if other developed countries commit to comparable reductions under a new global climate change agreement. The package also implements the EU target of more than doubling the share of energy it obtains from renewable sources such as wind, solar and biomass to 20% by 2020. In addition, the measures agreed will contribute towards meeting the EU's goal of increasing energy efficiency by 20% by 2020.

This new legislation, which was adopted by the Council on 6 April 2009, requires Portugal to meet the following requirements:

- To adhere to the new provisions of the EU Emissions Trading Scheme, *i.e.* to implement the EU-27 target for power generation and covered industries.
- To limit the increase in its GHG emissions by up to 1% in 2020 in the sectors not covered by the Emissions Trading Scheme (mainly transport, building, waste management and agriculture) compared to 2005.
- To increase the share of renewable energy in final energy consumption to 31% by 2020 (from 20.5% in 2005), including a specific 10% biofuels target in the transport sector.
- To be in line with an improvement of energy efficiency at EU level by 20% by 2020.

After 2012, the ETS sector in the EU as a whole will have to cut emissions by 21% from 2005 to 2020. As a result of the effort-sharing of the EU GHG target of -20% from 2005 to 2020, Portugal will have to limit emissions from the non-ETS sectors to +1% from their 2005 levels by 2020.

Portugal has proposed a number of important domestic measures to attain its targets. These include increasing renewable energy sources (RES) penetration to deliver 45% of gross national electricity consumption by 2010. This will be done by increasing installed wind power capacity to 5 100 MW and increasing hydroelectric capacity by 575 MW as well as increasing electricity generated from co-generation systems with a 2 000 MW target of installed capacity by 2010. Gas-fired electricity generation capacity is expected to reach 5 360 MW in 2010 to offset the closure of higher-emitting fuel plants, while 5% to 10% substitution of biomass or waste at Sines and Pego power plants is expected.

The government also proposed to reduce power losses in the transmission and distribution networks, increase the energy efficiency of buildings and reduce electricity consumption by about 1 000 GWh by 2010.

In addition, the government has committed to a number of actions in the transport sector. Road transportation represents 87% of transport-related emissions (the EU-15 average is 83%) and fuel consumption associated to private vehicles in circulation accounts for over half of such emissions. During the past 15 years, the number of cars in circulation increased by 135%. On this basis, there is an obvious need to increase the demand for public transport and restrict the circulation of private vehicles.

In this regard, measures adopted include the development of higher-efficiency vehicles (to reach a target of 120 g CO<sub>2</sub> per kilometre by 2010); the expansion of the Lisbon "Metro" light rail network; the promotion of modal transfer in key transit corridors; the penetration of natural gas in public transport (buses and taxis); and the greater use of biofuels (10% goal to be reached by 2010).

Climate policy is undergoing review during 2009/10 with the aim of preparing a post-2012 National Climate Change Programme which will ensure the country fulfils its EU and international commitments and ultimately moves into a low-carbon economy.

## INTERNATIONAL MEASURES

Portugal intends to make use of the flexible mechanisms under articles 6, 12 and 17 of the Kyoto Protocol. Following the analysis of the National Climate Change Programme 2006, the new 2007 targets and the NAP 2008-2012, in accordance with Council Ministers Resolution 1/2008, the final Kyoto deficit to be offset by the Portuguese Carbon Fund is estimated at 2.88 Mt CO<sub>2</sub>eq/year. However, taking into account a conservative estimate of Portugal's emissions until 2012, the deficit could be somewhat higher, and the Portuguese Carbon Fund's current planned investment target addresses this 2.88 Mt CO<sub>2</sub>eq/year deficit.

In order to meet this estimated shortfall, the Portuguese Carbon Fund is tasked with acquiring credits under the Kyoto Protocol's flexible mechanisms.<sup>3</sup> A multiannual budget of EUR 348 million has been created for this purpose to be managed by the Portuguese Carbon Fund.

## CRITIQUE

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There have been many positive developments regarding the climate change policy since the last in-depth review and for these the government must be complimented. Developments such as the national emission inventories, the second National Allocation Plan 2008-2012 (NAP II), the Portuguese

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3. Established by Decree-Law 71/2006, of 24 March.



Carbon Fund and the establishment of the Climate Change Commission are progressive steps. Clear roles have been assigned to policy stakeholders with the Climate Change Commission, by means of the CECAC, taking lead responsibility for the co-ordination of activities, the development of policies and measures and management of the Portuguese Carbon Fund.

Permanent emissions reductions involve a behavioural change in energy use across the economy. In this context, the Forum for climate change stakeholders, which has only recently been established in 2008 with its first meeting on the EU 2020 package, is a very positive development. It should assist in starting the process of developing public understanding of the long-term implications of the large emissions reductions required for 2020 and beyond.

To date, Portugal has been focusing on reducing CO<sub>2</sub> emissions and its reliance on external sources of energy supply by promoting investments in renewable sources and in new energy saving and clean technologies. Portugal's commitment to the EU Burden-Sharing Agreement under the Kyoto Protocol is to limit the increase of its GHG emissions to 27% between 1990 and the first commitment period of 2008-2012. The Portuguese Assigned Amount under its Kyoto target for 2008-2012 period is 382 Mt CO<sub>2</sub>eq, meaning 76.39 Mt CO<sub>2</sub> per year. Like many European countries, Portugal faces a significant challenge to meet its targets with current emissions in excess of its Kyoto target of +27% compared to 1990 emissions. This emissions growth mainly due to the growing trend in transport emissions, as a result of greater affluence, and delays in the roll-out of transport infrastructure designed to achieve emissions savings. This challenge is even more significant if considered in the context of the new climate targets at the EU level.

Portugal's strategy for meeting its legally binding target under the Kyoto Protocol relies heavily on supply-side measures, *e.g.* changing the electricity generation mix and making it more environment-friendly. The main drivers set out in the National Energy Strategy and in the National Climate Change Programme (PNAC 2006), updated in 2007, include an increased reliance on renewable sources and upgrading and replacing of current fuel/gas-oil plants with new, more efficient technologies generating lower CO<sub>2</sub> emissions.

The significant growth in renewable energy over the period since the last review will play a large part in meeting Portugal's obligations. The government is to be commended for recently revising its targets so as to increase the level of renewable power generation such that it is able to provide 45% supply of gross electricity consumption by 2010, compared to 39.48% in 2008.

Initiatives on electric vehicles have commenced notably with recent government collaboration with industry to make electric vehicles widely available in Portugal from 2011. Tax incentives and public procurement, as well as local

small-scale projects, are also being applied to support deployment. The high profile prioritisation of this approach to climate change policy is worthwhile and successful roll-out will have a positive impact by diverting emissions from the non-ETS sector.

Considered together, there is as a comprehensive list of actions, measures and targets across the energy, transport, waste, and agriculture and forestry sectors, with the remainder of emissions reductions to be accounted by carbon purchases of 2.8 Mt CO<sub>2</sub>/year. There is a process in place for twice-yearly reviews of progress against all measures by CECAC, which has recently launched an innovative emissions monitoring and forecasting website. It was made clear that, as part of this process, measures that fail to meet expected milestones and implementation would be flagged and early corrective action taken where necessary. New or replacement measures might also be considered if necessary.

While a clear path towards compliance has been laid, through the Burden-Sharing Agreement, elements of this path are in doubt. For example, a 2.1 Mt CO<sub>2</sub> emissions reduction is expected from transport-related measures by 2010. Much of this is to come from transport infrastructure improvements in both public and private transport, with biofuels alone assumed to deliver 1.243 Mt CO<sub>2</sub>/year from 2010 if the 5.75% target is to be achieved. Many of these infrastructural projects, however, are behind schedule, thus delaying and putting the delivery of expected emissions savings from this sector in doubt, at least within the time frame of the National Climate Change Programme (PNAC).

The trend in emissions in recent years, as well as the requirement to find measures to deliver even greater levels of emissions reductions on baseline levels by 2020, and solely in the non-ETS sector as part of the proposed EU 2020 target of 1% above 2005, bring costs. The likely presence of costs underlines the importance of the recommendation in the last review to address cost-effectiveness in selecting appropriate measures.

## RECOMMENDATIONS

*The government of Portugal should:*

- ▮ *Continue to support the reduction of energy-related GHG emissions to meet the expected Portuguese non-ETS target under the EU Burden-Sharing Agreement for emissions. This could be further reinforced by using targeted policy interventions to reap the energy efficiency potential of end-use consumers.*

- ▶ *Build on the success of CECAC and as a matter of priority examine the cost-effectiveness of climate change measures. This should include examining the scope for additional fiscal and taxation tools to provide further necessary incentives.*
- ▶ *Follow through on its publicised commitments to the widespread deployment of electric vehicles with a tangible roll-out plan, involving all stakeholders (such as local authorities, researchers and manufacturers).*



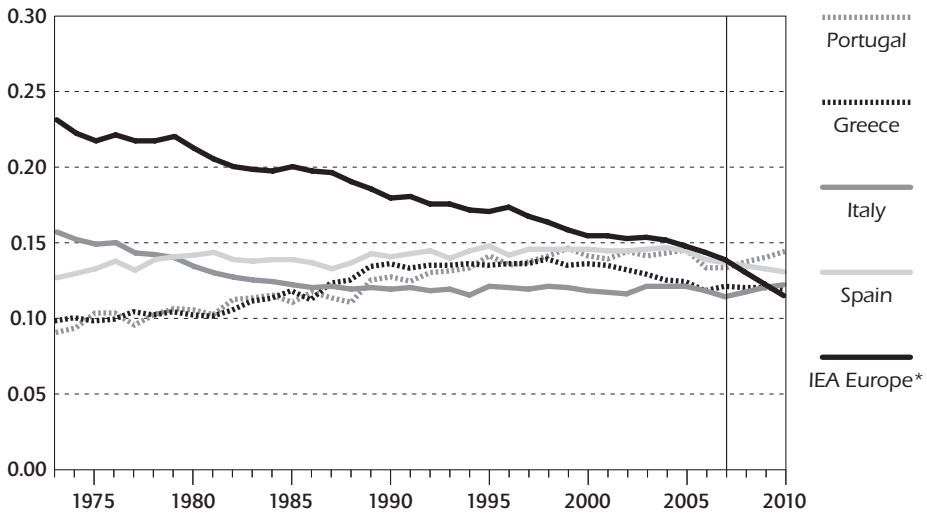
## OVERVIEW

Portugal is at the lower end of IEA member countries in terms of energy intensity. In 2007, for each unit of gross domestic product (GDP in 2000 USD and purchasing power parities<sup>4</sup>), the country needed to consume 0.11 toe of primary energy. This compares favourably to the OECD Europe average of 0.145 toe of primary energy in the same year.

Figure 11

### Energy Intensity in Portugal and in Other Selected IEA Member Countries, 1973 to 2010

(toe per thousand USD at 2000 prices and purchasing power parities)



\* excluding Luxembourg and Norway throughout the series, as forecast data are not available for these countries.

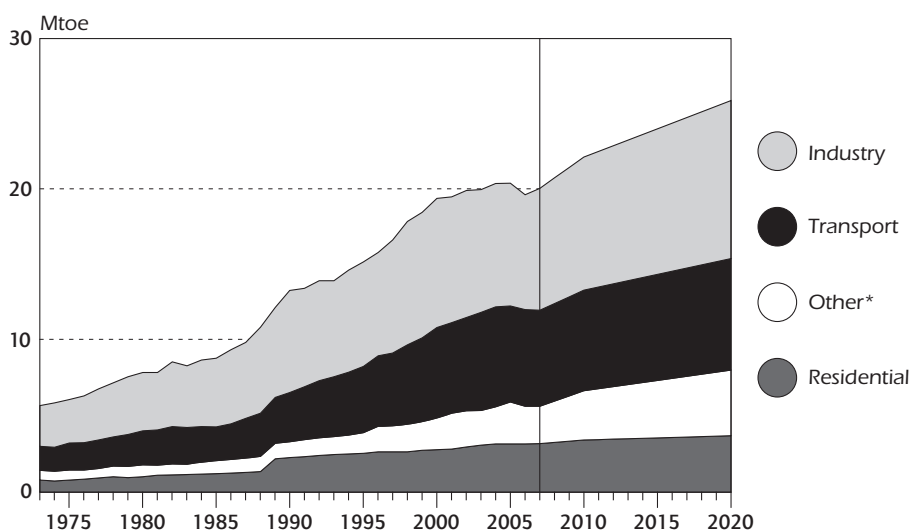
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008; *National Accounts of OECD Countries*, OECD Paris, 2008 and country submissions.

4. International price comparisons based on exchange rates may not reflect the purchasing power of different currencies over time. An alternative means of doing so is provided by purchasing power parities expressed in 2000 United States dollars. The measures used here were developed by the Economic and Statistics Division of the OECD and Eurostat to enable international price comparisons to be made for GDP and its components.

Intensity has increased slightly since 1990, which is generally the opposite of what has been the case elsewhere in Europe over the same period. Portugal's total final consumption (TFC) of energy was 20.79 Mtoe in 2008, which represents an increase of 3.3% above the 2007 level of 20.10 Mtoe. In 2008, the industrial sector was the largest consumer of energy, 8.31 Mtoe or 39.95%, followed by the transport sector (largely road transport), 6.46 Mtoe or 31.08%, and other sectors (including residential) with 6.02 Mtoe or 28.97%.

Figure 12

Total Final Consumption by Sector, 1973 to 2020



\* includes commercial, public services, agriculture, forestry, fishing and other non-specified sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008 and country submission.

## INSTITUTIONAL ARRANGEMENTS

Directorate-General for Energy and Geology (DGEG) retains a number of competencies concerning energy efficiency, including the promotion and development of standards, regulations and technical specifications aimed at increasing energy efficiency and the provision of an adequate framework for the development of regional energy agencies. The DGEG also enforces energy management legislation and works to foster energy efficiency and the diversification of primary energy sources.

The Agency for Energy (ADENE) is also responsible for a number of activities in the energy efficiency sector and corresponding areas and is also the interface with other sectoral policies. ADENE's main tasks are regulated by Decree-Law 314/2001, which updates a previous Decree-Law 223/2000. Recent ADENE activities include a wide variety of projects within the framework of several community programmes in co-operation with other agencies and international organisations. ADENE is involved in the *Energy Efficiency in Buildings* and *Solar Water for Portugal* programmes as well as activities related to demand-side management and renewable energy in partnership with the energy market. ADENE co-ordinates the training of qualified experts and is responsible for the Energy Certification module in all training courses related to the Directive on Energy Performance of Buildings. The Portuguese Environmental Agency (APA) is responsible for monitoring energy efficiency and interior air quality under the System for Energy Certification in Buildings.

## **POLICIES AND MEASURES**

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### **OVERVIEW**

Increased energy efficiency is a goal of Portuguese energy policy and it will play an important role in meeting the country's climate change obligations. The government has developed a robust set of measures with the aim of reducing energy consumption, particularly in buildings, industry and transport. An Energy Certification System for Buildings became mandatory in July 2007, higher construction standards have been imposed and vehicle taxes have become a function of GHG emissions.

A National Action Plan for Energy Efficiency (PNAEE) was enacted in 2008 by means of the Council of Ministers Resolution 80/2008 and comprises a set of measures aimed at an increase in energy efficiency, equivalent to 9.8% of total final energy consumption by 2015. The plan is made up of a broad range of programmes and measures considered crucial for Portugal to achieve, and surpass, the 9% target set under Directive 2006/32/EC on End-Use Efficiency and Energy Services. The PNAEE aims to bring greater coherence to energy efficiency policies, address all sectors and aggregate the various measures previously in place. It also introduces a wide range of new measures on twelve specific programmes. The measures in the Action Plan target energy efficiency improvements in all sectors, with more than two-thirds of the projected energy savings coming from the transport (38%) and industry combined (30%). Full implementation of the plan could save a total of 1.79 Mtoe of TFC or the equivalent of 4.77 GWh of electricity consumption over the 2008 to 2015 period.

The PNAEE focuses on demand-side management and is consistent with the National Climate Change Programme (PNAC 2006) and the National Allocation Plan for Emission Allowances (PNALE). The PNAEE encompasses four broad sectors: transport, residential and services, industry, and the public sector. It also establishes goals in three cross-cutting areas: consumer behaviour, taxation, incentives and financing (Table 2).

**Table 2**

**The National Action Plan for Energy Efficiency**

<i>Technologies</i>	<i>Transport</i>		<i>Residential and services</i>		<i>Industry</i>	<i>Public sector</i>		
	1	Vehicle renewal	4	Home and office renewal	7	Industry efficiency system	8	State energy efficiency
	2	Urban mobility	5	Building efficiency system				
	3	Transport efficiency system	6	Renewables just in time and solar programme				
<i>Behavioural</i>	<i>Behaviours</i>							
	9	Plus programme	10	Operation E				
<i>Taxes</i>								
			11	Green taxes				
<i>Incentives and Financing</i>								
			12	Energy Efficiency Fund				

Source: DGEG.

One important measure in the PNAEE is the “efficiency cheque” that promotes the reduction of electricity consumption by providing an incentive for domestic consumers to reduce their consumption by providing bonuses to those who consume less. The efficiency cheque provides a payment for two years, worth 10% or 20% of annual electricity costs to consumers with verified energy reductions of 10% or 20% in the previous two years.



## Portugal Efficiency 2015

### Transport sector targets and measures

*Private motor car renewal.* Target : to reduce the percentage of vehicles aged more than ten years from the current 37% of total fleet to 35% in 2010 and to 30% in 2015; also to reduce the average CO<sub>2</sub> emission of new cars sold from 143 g/km to 120 g/km in 2010 and 110 g/km in 2015.

Measures: Tax incentive for the abatement of vehicles when buying low-emission new ones and a new motor vehicle tax calculation formula that incorporates a CO<sub>2</sub> emissions factor.

*Tyre pressure control and fuel efficiency.* Target: to reduce from 30% to 15% by 2015 the percentage of vehicles running with incorrect tyre pressure and to increase from 10% to 20% in 2015 the volume of efficient fuels sold.

Measures: Information campaigns and fuel certification.

*More efficient vehicles.* Target: to ensure that 20% of the 2015 vehicle fleet will be equipped with monitoring equipment (on-board computer, GPS, cruise control, automatic verification of tyre pressure).

Measures: Voluntary agreements with car importers.

### Urban mobility

*Increase urban mobility and spatial planning in district capitals.* Target: 5% modal shift by 2015.

Measures: To put in place metropolitan transport authorities in Lisbon and Oporto, establish the Mondego light rail system and develop regional and urban mobility plans.

Develop urban mobility plans for corporate centres and industrial parks with over 500 workers.

*Improve public transport efficiency.* Target: 10% of low-emission vehicles in fleet by 2015; 5% of mini-bus on public vehicle fleets by 2010 and 15% by 2015.

Measures: Incentives to replace vehicles and mini-buses in the public transport fleets.

Establish a GPS-based innovative platform for traffic route management. Target: 5% of GPS equipment with traffic optimisation.

Measures: Create a traffic optimisation system in large cities using GPS platforms.

## **Transport efficiency system**

*Create a national logistical system.* Target: decrease road transport from 80% to 75% by 2015 and increase inter-modality in goods transport.

Measures: Construction of a national logistical platform network.

*Implementation of the Motorways of the Sea network.* Target: shift 15% of international goods currently transported by road to maritime transport by 2010 and 20% by 2015.

Measures: Transfer of goods transportation from road to maritime mode.

To increase passenger rail transport with absolute targets set in passenger-km.

*Establish an energy-efficient goods transport system.* Targets: decrease energy intensity of goods transport.

Measures: Voluntary agreements with industry.

*Energy efficiency in the government-owned vehicle fleet.*

*10% decrease in fuel consumption by 2015.*

Measures: Phasing out vehicles with CO<sub>2</sub> emissions above a certain level and guaranteeing a 20% quota of low-emission vehicles. Despacho 7382/2009 sets quotas for the maximum emissions of CO<sub>2</sub> of these vehicles from 2009 to 2012.

## **Residential and services sectors targets and measures**

Sustainable urban rehabilitation programme: one in every 15 households meet an optimal energy class (greater or equal to B-);

Programme to replace one million large electric appliances (white goods): provision of a EUR 50 bonus for the replacement of an existing low-efficiency good with an A+ appliance and EUR 100 for an A++ appliance; old appliances must be handed over for recycling;

Phase-out of incandescent light bulbs: large-scale substitution of incandescent light bulbs with compact fluorescent light bulbs (CFLs);

Simplified permitting of energy-efficient construction projects;

Stimulating small-scale electricity production: turn 75 000 homes into electricity producers (installed capacity of 165 MW) by 2015;

One in every 15 buildings equipped with solar hot water heaters.

## **Industry targets and measures**

Agreements with manufacturing industry to reduce energy consumption by 8%;

Creation and implementation of a Management System of Intensive Energy Consumption, extended to medium-sized enterprises (with

consumption over 500 toe), with fiscal incentives provided for energy management measures.

### **Public sector targets and measures**

Energy certification of all state buildings to be completed;

20% of state buildings to fall within energy performance class greater than or equal to B;

20% of the state vehicle fleet to produce CO<sub>2</sub> emissions less than 110g/km;

Phase-out of inefficient street lighting;

20% of traffic lights to use efficient light-emitting diodes (LEDs).

### **Information and communication measures**

The launch of an "Energy Plus Bonus" programme to reward excellence in energy efficiency in companies, buildings, schools and others;

The "Energy Efficiency Plus" programme will include an energy efficiency "seal of approval" to identify best practices for homes, public buildings, enterprises, schools and equipment;

The development of information and communication campaigns to increase awareness and knowledge of energy efficiency and actions that can be taken, including training schemes, with a budget of up to EUR 2 million per year.

### **Fiscal measures**

Creation of a new taxation regime for vehicles and industrial fuels;

Creation of an accelerated depreciation regime for investments in energy-efficient equipment and vehicles in the industry and service sectors;

Providing fiscal incentives for micro-electricity production and progressively aligning the tax system with that of the energy certificates for buildings (for example fiscal benefits for class A/A+ level homes).

### **Financial measures and incentives**

Encouraging reduced electricity consumption by providing an incentive for major consumers to reduce consumption by providing bonuses to those who consume less, and establishing an Energy Efficiency Fund;

The "efficiency cheque", provided for two years, worth 10% or 20% of annual electricity costs, to consumers with verified energy reductions of, respectively, 10% or 20% following investments in energy efficiency;

A reduction of 2.5% in the electricity tariff to those with lower energy consumption, and creating pricing schemes in favour of energy efficiency;

The creation of a subsidised low-interest personal line of credit, worth EUR 250 million per year, for investments in energy efficiency measures, with an emphasis on urban renewal. Interest rate reduction of 4% provided for credit, up to 8% without guarantees;

Stimulate Energy Service Companies (ESCOs), by providing incentives for their establishment (QREN), calls for tender for public-sector audits, and establishing regulations for an "efficiency contract".

Source: DGEG.

## EU TARGETS AND DIRECTIVES

Within Europe, energy efficiency policy is increasingly guided by EU directives and non-binding goals, which leave considerable scope for Portugal to decide how to implement them. The most important directives are described below.

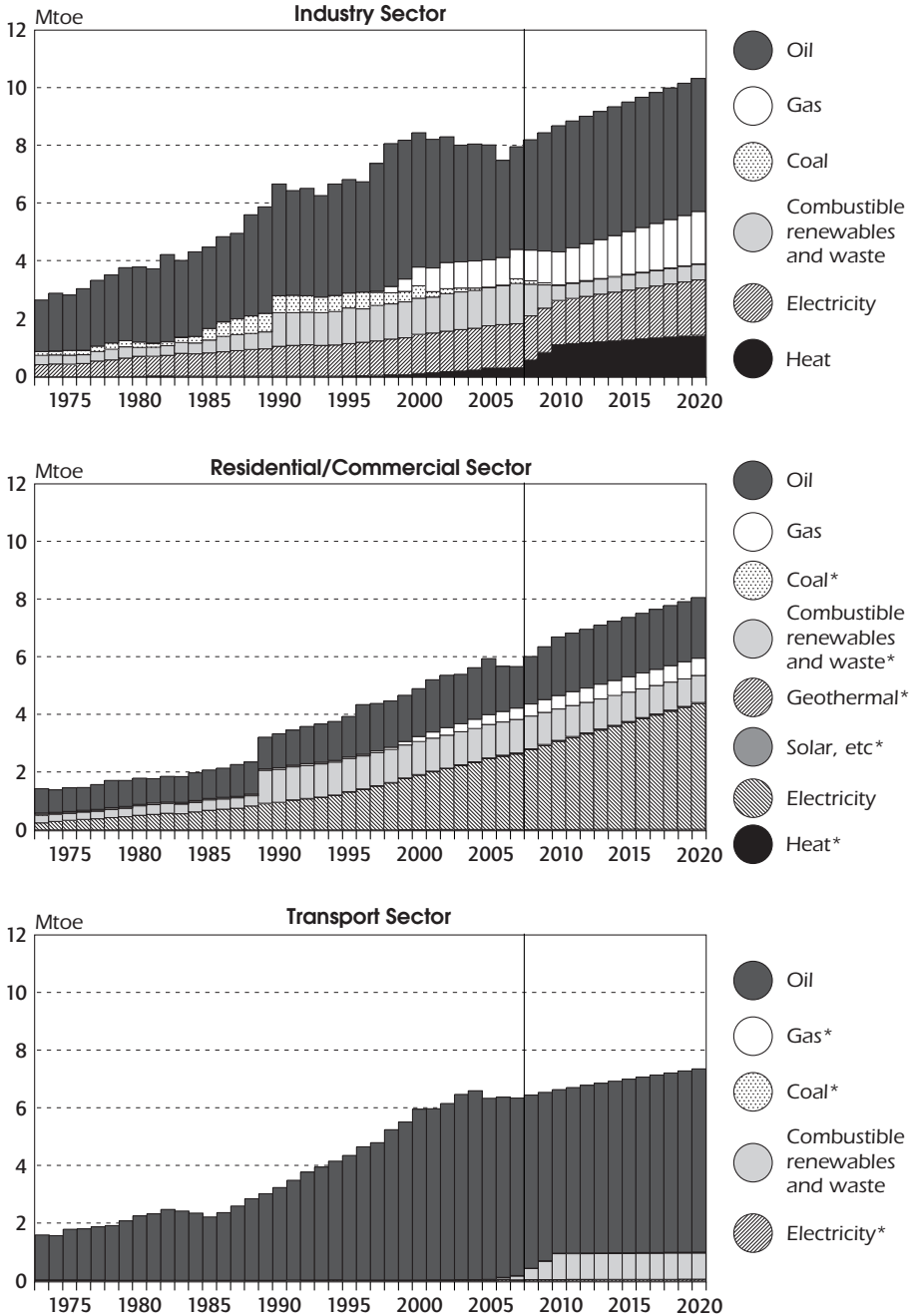
The *Directive on Energy End-Use Efficiency and Energy Services* (2006/32/EC) contains an indicative national energy savings target of 9% up to 2016, to be reached by way of energy services and other energy efficiency improvement measures in the sectors that are not part of the EU-ETS. The reduction is calculated against the annual average TFC in the non-ETS sectors over the most recent five-year period previous to 2008 for which official data are available.

The *Directive on the Energy Performance of Buildings* (EPBD, 2002/91/EC) setting requirements for a more energy-efficient building code was transposed into Portuguese law in April 2006 by means of three legal instruments. In Portugal, implementation of the directive is the overall responsibility of the Ministry of the Economy together with the Ministry of Environment.

Requirements for energy labelling of household appliances, in turn, are based on several directives adopted over the past fifteen years. They also include compulsory minimum efficiency requirements. Over the longer term, the *Directive Establishing a Framework for Setting Ecodesign Requirements for Energy-Using Products* (2005/32/EC) will improve the energy efficiency of all new products outside the transport sector. The directive was transposed into Portuguese national law by Decree-Law 26/2009 of 27 January. Furthermore, the EU-ETS has an indirect, but strong, effect on energy efficiency in heavy industry and the heat and power sector.

Figure 13

Total Final Consumption by Sector and by Source, 1973 to 2020



\* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008 and country submission.

## SECTORAL POLICIES

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### BUILDINGS

Energy use in residential and commercial buildings is responsible for about 24.5% of Portugal's total final energy consumption in 2007. In its Sustainable Urban Rehabilitation programme, the government aims to have one in every 15 households meet an optimal energy class (*i.e.* greater or equal to B-) and an equal proportion of buildings equipped with solar hot water heaters.

#### Energy Performance of Buildings

An energy certification system for buildings became mandatory in July 2007 and all buildings are required to have an energy consumption certificate, stating energy consumption and proposed measures towards reduction, where necessary.

Portugal has also taken a number of steps to transpose the EU Directive on the Energy Performance of Buildings (EPBD) into national law. This includes the publication of the following decrees:

Decree 78/2006: System for Energy and Indoor Air Quality Certification of Buildings (SCE);

Decree 79/2006: Revises the Regulations for HVAC systems, including requirements for regular inspection of boilers and air-conditioners (under the former RSECE);

Decree 80/2006: Revises the Thermal Regulations for Buildings (RCCTE).

A key component of the SCE is the Energy Certificate. This document assigns an energy performance label to residential and service buildings and lists measures for improving the energy performance of these properties, thus increasing energy savings by 20% to 40% and reducing subsequent CO<sub>2</sub> emissions. The energy label allows the residential or service units to be classified on an efficiency scale ranging from A+ (high energy efficiency) to G (poor efficiency). This is similar to the scale used for domestic equipment and appliances and allows for easy reading and interpretation by the consumer.

Since July 2007, all new residential and service buildings with a floor area of more than 1 000 square metres required an Energy Certificate. From July 2008, this requirement extended to all new buildings, which must obtain at least a B classification. All buildings require certification from 1 January 2009.

SCE operates in conjunction with two sets of regulations applied to construction: the Regulations on the Characteristics of the Thermal Performance of Buildings (RCCTE) and the Regulations on Heating, Ventilation and Air-Conditioning (HVAC) Systems in Buildings (RSECE).

The SCE also involves a management support system based on a website which provides information on the certification process and an advertising campaign «Let's save energy to save Portugal». It also includes information about training courses, a list of qualified experts, lists of valid certificates (viewed on-line through a search by address function). More than 50 000 certificates have been issued to date and at least 75% of the new house stock are at present A or B class.

Portugal implemented new Regulations on Heating, Ventilation and Air Conditioning (HVAC) Systems in Buildings in 2006, revising the national RSECE building code of 1998. The revision complemented the Portuguese implementation of EU Directive 2002/91/CE on the Energy Performance of Buildings.

The 2006 revisions establish strict standards for:

- HVAC energy use: enumerating energy consumption limits in utilities of large buildings;
- Indoor air quality: assuring a reference indoor quality and limiting the concentration of pollutants inside the buildings;
- HVAC units design; limiting the installed power on HVAC systems and establishing a number of energy efficiency requirements on the design of new HVAC systems;
- Maintenance: mandating the performance of energy audits, every six years, of large non-residential buildings and periodic inspections to boilers and air-conditioning systems. Energy units and equipment must have preventive maintenance plans;
- Compliance with the RSECE is mandatory whenever a permit is requested for a new building or the renovation of an existing building.

The Regulations on Thermal Behaviour of Buildings (RCCTE, Decree-Law 80/2006 revising Decree-Law 40/90) update a previous law and established stricter conditions for building design as a means to ensure that:

- Heating, cooling or ventilation requirements, as well as indoor air quality and hot water consumption needs, are satisfied without excessive energy consumption.
- Pathological effects are minimised within buildings. For example limiting the occurrence of condensation and its potential negative impact on the durability of a building and its indoor air quality.

The updated RCCTE imposes minimum energy consumption requirements, determined according to the season, for heating, cooling and hot water

purposes. It makes mandatory the use of solar thermal heating for hot water in all new buildings when suitable.

RCCTE is mandatory whenever a permit is requested for a new building or the refurbishment of an existing building. It applies to all new residential buildings and to all service buildings with a useful area less than 1 000 m<sup>2</sup>, which do not have centralised air-conditioning systems. It is also applicable to large renovations, if refurbishment costs exceed 25% of the building's total value.

## APPLIANCES

Mandatory energy labelling of domestic appliances is based on the EU directives and concerns lamps, ovens, refrigerators, freezers, washing machines, tumble-dryers and dishwashers. Appliances are classified from A to G, where class A is for the most energy-efficient appliances. In 2004, two new classes were introduced: compared to class A, electricity use in class A+ is 25% lower and in class A++ 40% lower. The government is supporting a programme to replace one million large electric appliances (white goods), by providing a EUR 50 bonus for the replacement of an existing low-efficiency good with an A+ appliance and EUR 100 for an A++ appliance. Old appliances must be handed over for recycling.

In addition, a tax on low energy efficiency light bulbs was enacted by Decree-Law 108/2007 of 12 April and came into force in March 2008. This tax aims at compensating the environmental costs related to the inefficient use of energy and fostering the use of more efficient and economical lighting. It is applied to manufacturers and retailers. The applicable taxes are:

- Incandescent light bulbs: EUR 0.41 per unit;
- High-pressure mercury vapour lamp: EUR 6.77 per unit.

Revenues generated by the tax on inefficient incandescent light bulbs are used to provide support for PNAEE energy efficiency measures.

## INDUSTRY AND SERVICES

A number of measures have been implemented targeting reduced consumption of energy in the industrial and service sectors.

### **Regulation for Energy Consumption Management, RGCE**

Energy efficiency has also been promoted in the industrial sector, through the application of the Regulation for Energy Consumption Management (RGCE), introduced in the early 1980s. This regulation has been applied to



energy-intensive companies (those with annual energy consumption of over 1 000 toe) and establishes targets for the progressive reduction of specific energy consumption.

The RGCE is based upon an energy audit, which is carried out with the objective of reducing specific energy consumption, and which forms the basis of a five-year energy rationalisation plan. RGCE also obliges the enterprises to monitor their Energy Plan, in order to assure the successful implementation of energy efficiency measures, namely, energy management systems, installation of compressors with variable speed drives (VSD), condenser batteries for reactive energy compensation, replacement of electrical motors with high-efficiency equipment and replacement of traditional lighting systems with lighting control electronic systems.

Table 3

### Application of the RGCE in the Industrial Sector

	2006	2007	2008
Energy audits and corresponding energy rationalisation plans	76	106	70
Energy consumption in installations (toe per year)	597 584	1 435 509	746031
Energy savings (toe per year)	10 796	24 847	8101
Annual energy savings (%)	1.8	1.7	1.1

Source: DGEG.

### Management System of Intensive Energy Consumption, SGCIE

The SGCIE, Management System of Intensive Energy Consumption (Decree-Law 71/2008 of 15 April) is integrated into the PNAEE, revises RGCE and aims at the promotion of energy efficiency and the monitoring of energy consumption in energy-intensive installations (CIE) consuming more than 500 toe per year.

This regulation defines energy-intensive installations, broadening the scope of application of the previous regulation (RGCE) to a higher number of enterprises and installations, thus increasing the potential of energy efficiency measures.

SGCIE imposes binding energy audits over a six-year period, focused on energy use, in installations with an energy consumption above 1 000 toe per year.

An eight-year period is applied to energy audits in installations with an energy consumption of between 500 and 1 000 toe per year.

Operators of relevant installations are obliged to conduct energy audits and develop Energy Consumption Rationalisation Plans (PREn), establishing targets for energy and carbon intensity and specific energy consumption. Upon approval of the Directorate-General for Energy and Geology (DGEG is the competent authority that supervises and inspects SGCIE operation), the PREn become an Agreement for Rationalisation of Energy Consumption (ARCE).

The ARCE gives to facilities' operators excise duties exemption (ISP) on oil and energy products (coal, oil coke, fuel oil and oil gases) and the possibility to apply for incentives on energy audit costs and on investments in energy management and monitoring equipment.

Facilities considered under the National Allocation Plan for Emission Allowances (PNALE) or facilities with annual energy consumption lower than 500 toe are not covered by the SGCIE, but both may participate on a voluntary basis.

## TRANSPORT

The transport sector is responsible for around one-third of final energy consumption. In 2008, the Portuguese transport sector consumed 31% of energy, largely in the road transportation sector. Between 1990 and 2007 CO<sub>2</sub> emissions from the transport sector increased by 93%, more than any other sector.

Table 4

### Breakdown of Passenger Travel by Mode, 2007

	<i>Passenger car</i>	<i>Bus and coach</i>	<i>Rail</i>	<i>Tram and metro</i>
Share, %	82.3	12.1	4.4	1.2
Annual energy savings (%)	1.8	1.7	1.1	

Source: *EU Energy and Transport in Figures – Statistical Pocketbook 2009*.

Private cars remain the dominant form of passenger travel in Portugal. Traffic volume by passenger cars grew by 170% between 1990 and 2007, while tram and metro use almost doubled, bus and coach use remained static and railway use for passenger transport declined.

There are 2.7 million more passenger cars in Portugal now than in 1990, and the country's passenger car density has risen from 171 to 412 per 1 000 inhabitants in 2007, as compared to the EU-27 average of 464. Over the same period, the country's stock of goods vehicles doubled, from 781 000 to 1.33 million. Between 1990 and 2007 the length of motorways in Portugal has increased from 316 km to 2 545 km, while the length of the rail network has fallen from 3 064 to 2 838 km.

In 2007, international haulage accounted for 60% of all haulage by heavy-duty vehicles registered in Portugal. Freight volumes, as in many smaller European economies, are closely linked to developments in the overall economy, are likely to peak at least in the short term. The government has targeted energy savings equal to 3.8% of TFC to come from the transport sector by 2015.

Given that the transport sector is the largest consumer of energy, the government has introduced a large number of measures across all modes in an effort to improve efficiency levels. The following is a summary of the targets and measures adopted.

Motor vehicle tax has been amended such that the tax calculation formula incorporates a CO<sub>2</sub> emissions factor, thereby creating a fiscal incentive in favour of more energy-efficient vehicles. The government hopes to reduce the average CO<sub>2</sub> emissions of new cars sold from 143 g/km to 120 g/km in 2010 and 110 g/km in 2015. The government also plans to reduce the percentage of vehicles older than ten years from the current 37% of total fleet to 35% in 2010 and 30% in 2015. This will be done by means of a tax rebate when replacing an older vehicle.

The government is also developing a series of voluntary agreements with vehicle importers to ensure that 20% of the vehicle fleet will be equipped with monitoring equipment (on-board computer, GPS, cruise control, automatic verification of tyres) by 2015.

The energy efficiency of the government-owned vehicle fleet is also targeted – the goal is to decrease fuel consumption by 10% in 2015. This is to be done by phasing out vehicles with CO<sub>2</sub> emissions above a certain level and guaranteeing a 20% quota of state vehicles with CO<sub>2</sub> emissions lower than 110 g/km.

Driving behaviour will also be targeted by means of an eco-driving campaign aimed at the general public and the inclusion of eco-driving as a subject for driver training programmes. In addition, Portugal is one of the first three countries to develop and implement a national project to distribute electric vehicles. Following an agreement with Renault and Nissan, Portugal plans to make one-fifth of its public fleet vehicle purchases zero-emissions standard from 2011. This target demands the purchase of 1 500 electric vehicles in 2011. Furthermore, in June 2009, similar sized agreements were reached

with 21 Portuguese municipalities and companies. Renault-Nissan will start deliveries to Portugal of its electric cars in early 2011, making Portugal the first European country to be supplied with electric vehicles from the two-company alliance. In 2012, Nissan and Renault will mass-market electric vehicles globally.

The state will provide an income tax benefit for private buyers of about EUR 800 per vehicle and also introduce tax incentives for companies that convert to electric-powered vehicles. These benefits will start in late 2010 and will last at least five years. Additional measures, such as reduced parking rates, preferential access and financing subsidies are being studied. Recharging facilities will also be installed at a large number of gasoline stations.

A number of actions are being put in place to increase urban mobility; spatial planning measures in district capitals aim at a 5% modal shift by 2015. This will include the establishment of Lisbon and Oporto metropolitan transport authorities, establishing the Mondego light rail system in Coimbra and developing regional and urban mobility plans.

## **OTHER ENERGY EFFICIENCY MEASURES**

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In addition to governmental measures, the independent energy regulator (ERSE – Energy Services Regulatory Authority) developed a competitive mechanism for promoting efficiency in electricity consumption – the Consumption Efficiency Promotion Plan (PPEC). This Plan supports entrepreneurial actions taken by suppliers, grid operators, associations and bodies protecting consumers' interests. The annual budget was EUR 10 million for each of the years 2007-2008 and EUR 11.5 million for years 2009-2010.

The government evaluates and ranks proposed actions according to a cost-benefit analysis. The benefits are assessed on the one hand by the cost reduction on the electrical sector supply side and on the other hand by the environmental benefits in terms of GHG reductions, mainly CO<sub>2</sub>. These measures are financed by use of system tariffs.

Under the Incentives Programme for the Modernisation of the Economy (PRIME) that was in force until the end of 2006, the government supported projects to improve energy efficiency and co-generation, in various sectors of economic activity, excluding the residential sector. Between 2004 and 2006, 72 projects benefited from financial incentives totalling EUR 7.786 million. The annual energy savings were 44 320 toe and 42.9 MW of power generating capacity was installed.

## CRITIQUE

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There have been a range of commendable developments in energy efficiency policy in the period since the last review; the most notable of these is the Portugal Efficiency 2015 target in which the government set a 9.8% savings target for 2015. The government has deliberately assumed a more strenuous 2015 target, above that set out in the EU Energy Services Directive. Furthermore, the government has also worked to ensure that the programme is integrated with other relevant programmes such as the National Climate Change Programme (PNAC) and the National Allocation Plan for Emission Allowances (PNALE).

The broad strategy for achieving the target is outlined in the National Action Plan for Energy Efficiency, which was finalised in 2008. The Plan describes twelve programmes for the transport, residential, services, industry and public service sectors, but it is relatively early to assess their impact and performance. Several studies addressing monitoring and target assessment are being carried out, most notably within the framework of the Intelligent Energy Europe Programme. Progress in some of these sectors will be supported by complementary regulations or European law, while in other sectors there will be significant reliance on voluntary participation or large changes in consumer behaviour.

Portugal has made good progress implementing the Directive on the Energy Performance of Buildings into domestic law. Certification of new buildings started in July 2007 and a substantial number of certificates have already been issued by qualified experts. Among other measures introduced in the buildings sector has been a tax on less efficient light bulbs, revised building codes, having one in every 15 buildings equipped with solar hot water heaters and a simplified permitting process for energy-efficient construction projects. In the domestic sector, a number of schemes have been developed to promote awareness of energy efficiency among the general public. More recently an initiative has been put in place in order to freely distribute 4.5 million of CFL efficient light bulbs among the less wealthy segments of the population as well as students in public primary and secondary schools. This initiative, if successful, means that Portugal will have met approximately 20% of the PNAEE target set for 2015 in this specific area in a short period of time.

In the industrial sector, the Management System of Intensive Energy Consumption (SGCIE) involves a programme of audits, agreements and tax rebates. The latter initially targeted large users but has now recently been applied to medium energy users, a welcome expansion of the programme. The SGCIE imposes binding energy audits, with a six-year periodicity, focused on energy use, layout and conservation of the installations with energy consumption above 500 toe per year. The government should also consider developing programmes to bring about similar increases in efficiency among

smaller commercial consumers. The introduction of higher taxes on industrial fuels is also a positive step towards reducing energy consumption.

In the transport sector, the restructuring of the motor vehicle taxation system to reflect carbon emissions is a laudable step. There is also tax relief for scrapping older heavy carbon-emitting cars. Early results are positive for both petrol and diesel vehicles. This indicates that drivers and car purchasers are receptive to fiscal stimuli. Further analysis of these impacts may suggest additional similar measures in the transport sector, as part of the green taxes component of the PNAEE.

Nonetheless, the largest single component in the PNAEE expected 9.8% reduction by 2015 comes from the transport sector (3.8%, over a third). Given the trends in transport, the growth of the sector over the past fifteen years and the emissions projections highlighted elsewhere, this target seems optimistic without additional measures and targeting interventions. Faster delivery of transport infrastructure projects and further incentives to change private transport behaviour are needed. In the case of the former, a Contingency Plan for PNAC is being prepared at the moment and this is a welcome development. Measures that will reinforce the modal shift from individual transport to collective transport and promote eco-driving are part of the proposal. Furthermore, given the large volume of goods moved by road, greater efforts need to be made to reinforce a modal shift from road to rail and maritime transport for freight carriage. In this regard, the government target of a shift of 15% of international goods currently transported by road to maritime mode by 2010 and 20% by 2015 is a positive step.

To improve energy efficiency, the IEA also urges the government to continue its work in making the national and EU policies fully consistent with the energy efficiency policy recommendations the IEA presented to the Summit Meeting of the Group of Eight (G8) in Japan in July 2008. The IEA Energy Ministers endorsed the initial 16 measures in 2007. Since then, nine new recommendations have been added (see Box 2).

## RECOMMENDATIONS

*The government of Portugal should:*

- ▮ *Build on progress to date and continue to vigorously pursue its energy efficiency strategy, in particular, by*
  - *Evaluating the impact of various current tax incentives as regards the cost-effectiveness of energy savings achieved with a view towards investigating the potential for additional measures.*

- *Identify new areas to be targeted for specific actions following evaluation of the impact of measures already implemented and plan additional ones if necessary, as foreseen in PNAEE.*
- *Ensure regular progress reporting and contingency planning on the implementation and energy savings impact of all measures in the Action Plan.*
- *Continue to develop statistics on sector-specific energy consumption and energy efficiency indicators in order to develop and evaluate energy efficiency policies and measures.*
- *Follow through on its commitment to the widespread deployment of electric vehicles with a tangible roll-out plan, involving all stakeholders, such as local authorities, potential infrastructure providers and manufacturers.*

### ***Business/industry sector***

- ▮ *In the medium term, extend energy efficiency measures to the small- and medium-sized business sectors.*

### ***Residential sector***

- ▮ *Investigate the potential for rapid targeting of the older energy-inefficient housing stock with measures to increase energy efficiency.*

### ***Transport sector***

- ▮ *Control the reasons for possible delays in transport projects, with a view towards taking corrective action and developing new mechanisms for monitoring future projects.*
- ▮ *Examine the possibility of developing additional measures targeted on reducing the use of motor vehicles in urban areas.*

## **Box 2**

### **IEA G8 Energy Efficiency Recommendations**

At the Group of Eight\* (G8) Summit in 2005 in Gleneagles, Scotland, the G8 countries asked the IEA to assist in developing and implementing energy efficiency policies. Responding to this request, the IEA subsequently prepared a set of energy efficiency policy recommendations covering 25 fields of action across seven priority areas: cross-sectoral activity, buildings, appliances, lighting, transport, industry and power utilities. These 25 recommendations were presented to the Summit of the G8 in Hokkaido, Japan in July 2008. The fields of action are outlined below.

1. The IEA recommends action on *energy efficiency across sectors*. In particular, the IEA calls for action on:

- Measures for increasing investment in energy efficiency.
  - National energy efficiency strategies and goals.
  - Compliance, monitoring, enforcement and evaluation of energy efficiency measures.
  - Energy efficiency indicators.
  - Monitoring and reporting progress with the IEA energy efficiency recommendations themselves.
2. *Buildings* account for about 40% of energy used in most countries. To save a significant portion of this energy, the IEA recommends action on:
- Building codes for new buildings.
  - Passive energy houses and zero-energy buildings.
  - Policy packages to promote energy efficiency in existing buildings.
  - Building certification schemes.
  - Energy efficiency improvements in glazed areas.
3. *Appliances and equipment* represent one of the fastest growing energy loads in most countries. The IEA recommends action on:
- Mandatory energy performance requirements or labels.
  - Low-power modes, including stand-by power, for electronic and networked equipment.
  - Televisions and set-top boxes.
  - Energy performance test standards and measurement protocols.
4. Saving energy by adopting efficient *lighting* technology is very cost-effective. The IEA recommends action on:
- Best-practice lighting and the phase-out of incandescent bulbs.
  - Ensuring least-cost lighting in non-residential buildings and the phase-out of inefficient fuel-based lighting.
5. About 60% of world oil is consumed in the *transport* sector. To achieve significant savings in this sector, the IEA recommends action on:
- Fuel-efficient tyres.



- Mandatory fuel efficiency standards for light-duty vehicles.
  - Fuel economy of heavy-duty vehicles.
  - Eco-driving.
6. In order to improve energy efficiency in *industry*, action is needed on:
- Collection of high-quality energy efficiency data for industry.
  - Energy performance of electric motors.
  - Assistance in developing energy management capability.
  - Policy packages to promote energy efficiency in small and medium-sized enterprises.
7. *Energy utilities* can play an important role in promoting energy efficiency. Action is needed to promote:
- Utility end-use energy efficiency schemes.

Implementation of IEA energy efficiency recommendations can lead to huge cost-effective energy and CO<sub>2</sub> savings. The IEA estimates that, if implemented globally without delay, the proposed actions could save around 8.2 Gt CO<sub>2</sub>/yr by 2030. This is equivalent to one-fifth of global energy-related CO<sub>2</sub> emissions in 2030 under the IEA Reference Scenario, in which no new policies are adopted or implemented. Taken together, these measures set out an ambitious road-map for improving energy efficiency on a global scale.

\* The Group of Eight is an international forum for the governments of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States.



**PART II**

**SECTOR ANALYSIS**



## **OVERVIEW**

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Oil has been the dominant primary energy source in Portugal over the past four decades; nonetheless its share in total primary energy supply (TPES) has decreased from 75.5% in 1973 to 64.2% in 2001 and to 52.9% in 2008. In 2008, coal accounted for 10.8% of TPES, a portion that has had remained relatively stable over the past decade. The Portuguese government expects oil to remain the country's largest source of energy, but its share of TPES is forecast to gradually decrease to 50.5% in 2010 and to 43.9% in 2020. The portion of coal in TPES is forecast to decrease steadily to 10.9% in 2010 and 6.7% in 2020.

## **OIL DEMAND AND TRADE**

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### **OIL DEMAND**

Portugal has no proven reserves of oil or natural gas of any significance. At present, there is no indigenous oil and gas production, though some oil exploration activities are conducted. Oil demand in Portugal has been relatively stable in the last decade, and total oil demand averaged 301 thousand barrels per day in 2007. The Portuguese government forecasts that total oil consumption will be approximately 301 kb/d (or 15 million tonnes per year) by 2010 and 313 kb/d (approximately 15.5 Mt/yr) by 2020.

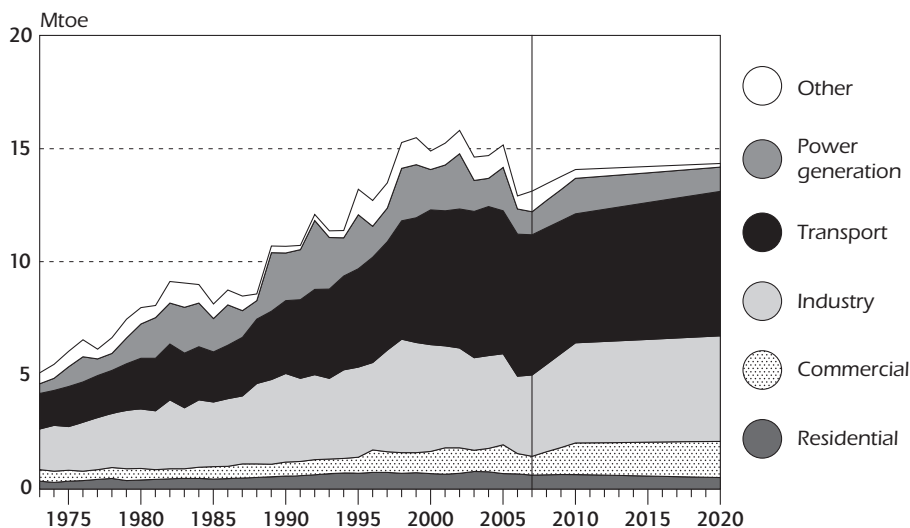
Oil demand in the transport sector has increased significantly by approximately 40%, from 101 kb/d (about 5 Mt/y) in 1996 to around 141 kb/d (approximately 7 Mt/yr) in 2007. Increased demand from the transport sector has been led by sharp growth in demand for diesel, which increased by 91.7% during the same period. Conversely, motor gasoline demand decreased by 18.4% over the same period.

### **OIL IMPORTS/EXPORTS**

In 2007, Portugal imported 249 kb/d of crude oil and 72 kb/d of refined products. While about 64% of crude oil was supplied by seven OPEC member countries, 70% of refined products were imported from OECD European countries such as Spain (37%), the United Kingdom (13%) and the Netherlands (10%). In the same year, Portugal exported 25 kb/d of gasoline, mainly to the United States, and 13.7 kb/d of residual fuels largely to OECD Europe. Total net oil imports in 2007 averaged 296 kb/d, which represented 98.3% of total demand.

Figure 14

### Oil Supply by Sector\*, 1973 to 2020



\* total primary energy supply by consuming sector. Other includes other transformation and energy sector consumption. Industry includes non-energy use. Commercial includes commercial, public services, agriculture/forestry, fishing and other final consumption.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008 and country submission.

The Portuguese government foresees that total net imports will reach around 330 kb/d (16.4 million tonnes per year) in 2010 and 343 kb/d (17 Mt/y) in 2020. This forecast implies that Portugal's minimum stock level required to cover 90 days of net imports would be 29.8 million barrels (mb) in 2010 and 30.9 mb in 2020.

## OIL SUPPLY INFRASTRUCTURE

### REFINING SECTOR

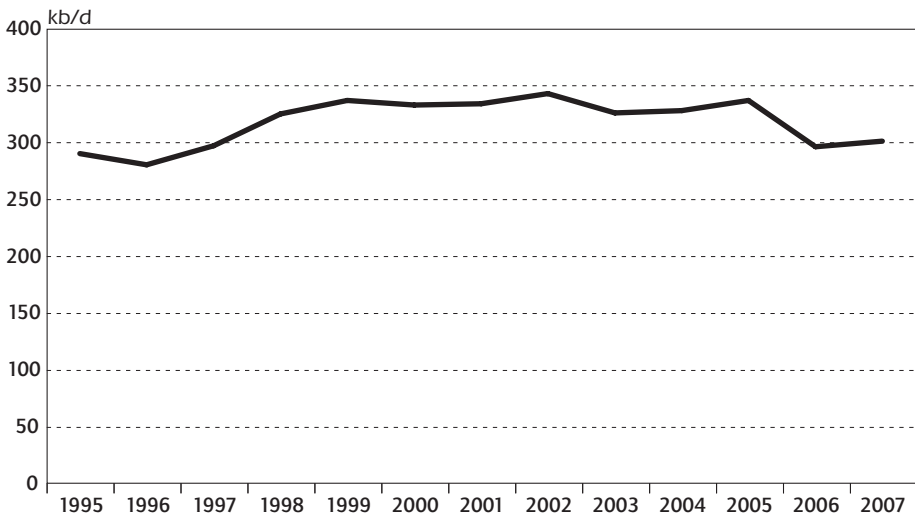
There are two oil refineries in Portugal, both of which are owned by Petrogal (a Galp Energia company), with a combined crude oil refining capacity of 304 kb/d (15.2 Mt/year). The larger refinery, located at Sines on the coast of southern Portugal, has a refining capacity of 215 kb/d (10.8 Mt/year), accounting for 71% of the country's total capacity. The Porto refinery, smaller but relatively more complex<sup>5</sup>, is located on the north-western coast of the country and has a distillation capacity of around 89 kb/d (4.4 Mt/y).

5. Using the Nelson Index, Sines refinery complexity level is 5.3 and Porto refinery complexity level is 6.9 (Source: Galp annual report 2007).

In 2007, the two refineries processed a total of roughly 275 kb/d (13.6 Mt) of crude oil, which meant that the overall capacity utilisation rate was roughly 80%. In the same year, diesel oil, gasoline and heavy fuel oil were estimated to account for some 34%, 19% and 18% respectively of the refineries' total product yield. Although the two refineries may operate independently, they exchange semi-finished products for the purpose of optimising their capacity utilisation.

Figure 15

### Oil Demand in Portugal, 1995 to 2007



Source: *Oil Information*, IEA/OECD Paris, 2008.

Currently Portugal has a diesel deficit of approximately 20 kb/d (1 Mt/year), which is expected to increase if no further measures are taken. In order to rectify this imbalance, in 2007 Galp Energia announced a reconfiguration project in the two refineries to increase diesel production to match demand by converting the heavier fractions of crude oil (vacuum gasoil or VGO) by a catalytic reaction in a hydrogenating atmosphere (hydro-cracking). This process produces high-quality diesel and jet fuel with improved environmental performance.

Changes in the refining scheme will take place to recover more vacuum gasoil from a mild thermal cracking (visbreaking) of the vacuum residue in both Sines and Porto refineries. The total investment is estimated to be in the order of EUR 1.3 billion and start-up is expected in early 2011. Not only will completion of this project allow the processing of a greater choice of crude oils in both refineries, but it will also increase diesel production by 51.5 kb/d (2.6 Mt/y). As a result, Portugal will become a significant net exporter of diesel.

## STORAGE CAPACITY

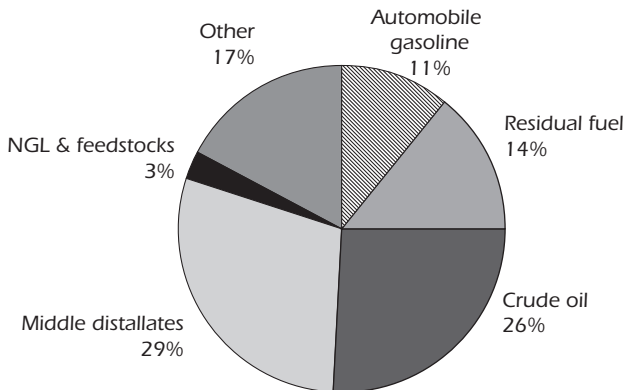
Portugal's total storage capacity, including both crude oil and products storage, was around 41 mb (6.4 million cubic metres) at the end of 2007. This capacity includes operational industry stocks, mandatory and agency-owned emergency reserves, and military installations in civil use, both in the mainland and in Azores and Madeira autonomous regions. Almost 77% of total storage capacity (31 mb) was owned by Galp Energia at the end of 2007 and approximately 73% was located at the two Petrogal (Galp Energia) refineries: Sines refinery (18 mb or 44.4%) and Porto refinery (11.5 mb or 28.4%). Storage capacity of crude oil, diesel and gasoline accounted for 29%, 22% and 6% respectively of total capacity.

Other relevant storage facilities in 2007 belonged to: the logistical company CLC (Companhia Logística de Combustíveis) with some 2.2 mb, representing 5.6% of the total storage capacity in Portugal; Repsol (2.4%), Tanquisado (1.4%), Sigás (1.2%), Esso (1.0%), Cepsa (0.9%), BP (0.7%) and other small operators, as well as NATO tanks in civilian use (3.2%).

Portugal envisages that its storage capacity will increase by 11% (4.3 mb) over the 2007 level by 2012. The capacity expansions are expected at Aveiro and in the two refineries. The increase in storage capacity will be for refined products, mainly for diesel (64% of the total increase) and gasoline (19%).

The NATO storage facility in Monte de Caparica (POL NATO) is currently unused, but will be rented by EGREP for the strategic storage of gasoil in 2009. POL NATO, which has a total capacity of 1.1 mb (175 000 m<sup>3</sup>), is not suitable for commercial operations because of lack of a tanker-truck filling facility.

Figure 16  
**Total Industry Stocks**  
(at end-September 2008)



Source: EGREP.



## PORTS

Portugal does not have any cross-border pipelines for transportation of crude oil and oil products. This has meant that all imports of crude oil pass through the two major ports on the Atlantic Ocean. The oil terminal at Sines port, which is operational year-round, has the capacity to unload around 64 kb/hour and supports very large crude carriers. Because of weather-related difficult conditions in winter, the oil terminal at Leixões Port does not function to receive oil tankers during 50 to 80 days per year. To solve this problem, Petrogal installed a single point mooring (SPM) terminal (a buoy) at sea. The buoy is located approximately three kilometres offshore from Leixões port and is connected to the shore (Petrogal refinery) by an underwater pipeline. In 2007, because of this SPM, Leixões port operated throughout the year. The SPM has an unloading capacity of 50 kb/hour. Tank farms from other companies are connected to ocean terminals at Leixões, Aveiro, Lisboa, Setúbal, Madeira and Azores, which enhance flexibility of response in emergencies.

## PIPELINES

For distribution of oil products to the central part of the country, CLC operates a 147 km-long pipeline linking the Sines refinery with a tank farm at Aveiras (some 45 km north of Lisbon). The CLC pipeline is a multi-product pipeline, with a capacity of 80 kb/d. The utilisation rate of the CLC pipeline averaged around 66 kb/d in 2007. This pipeline and the terminal tank farm are owned and operated by a consortium among Petrogal (65%), BP (20%) and Repsol (15%). There is also a 4 km jet fuel pipeline running from the Porto refinery to the Sá Carneiro international airport (serving northern Portugal). This jet fuel pipeline, with a capacity of 13 kb/d, is operated by Petrogal.

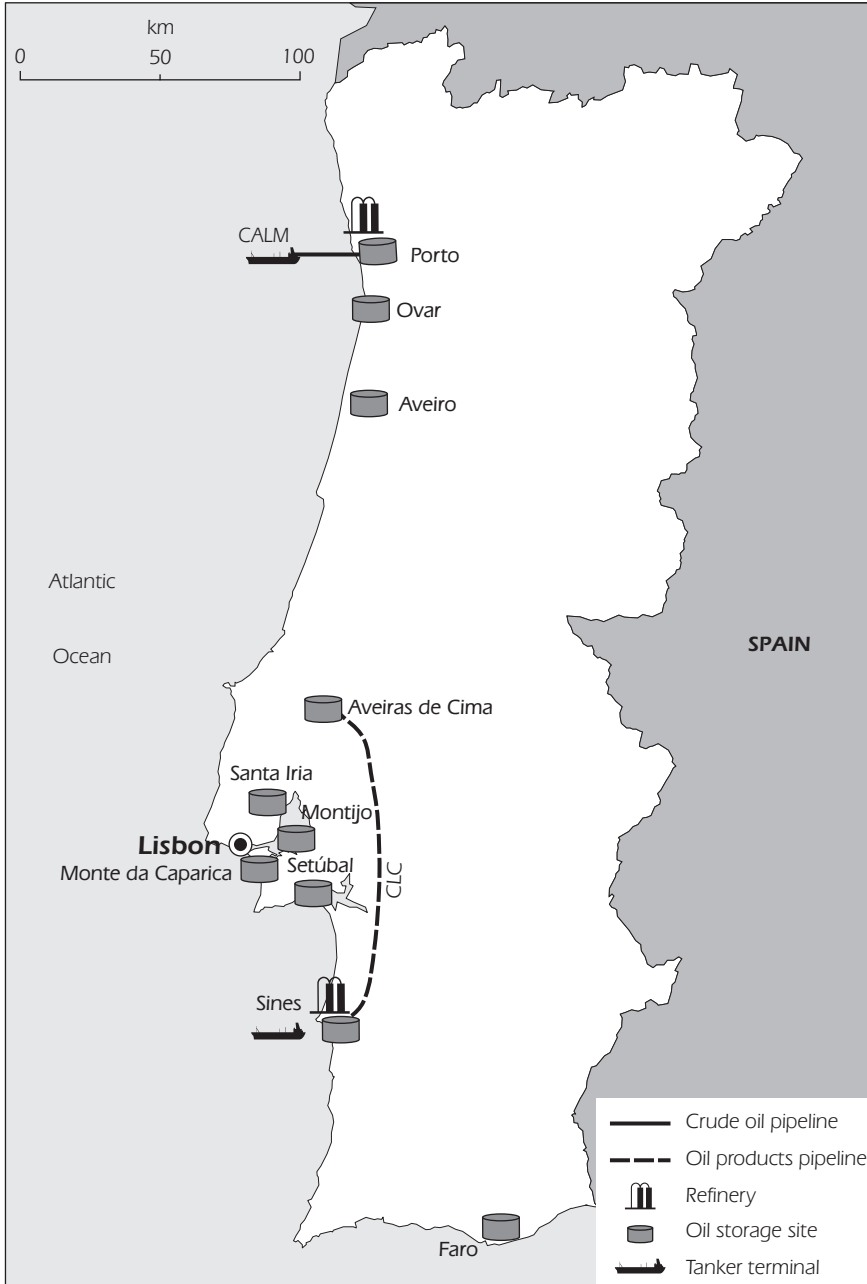
The economic viability of a pipeline connection with Spain has not been evaluated by the administration, neither has the expansion of the Companhia Logística de Combustíveis (CLC) pipeline into a national transportation system.

## DOWNSTREAM MARKET

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There are a small number of companies operating at the wholesale level in the Portuguese market, with over 90% of wholesale business on the mainland in the hands of four oil companies and with roughly 70% of trade controlled by the three main oil companies (in 2008 Galp acquired Esso and Agip networks in Iberia). Vertical integration of the main operators (oil companies) spans the value chain, from transport and bulk distribution to retail, also including, in the case of Galp, mainland refinery operations.

Figure 17  
Oil Infrastructure, 2008

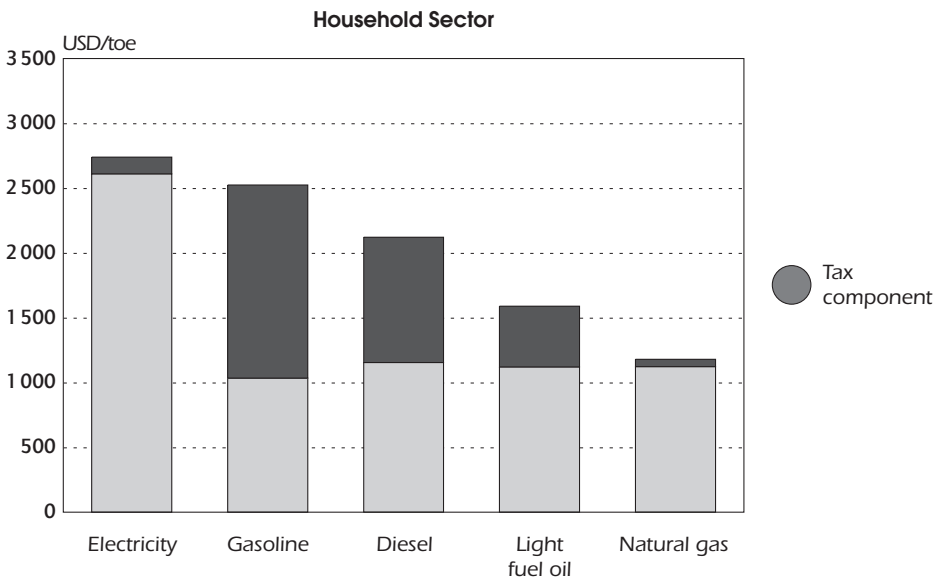
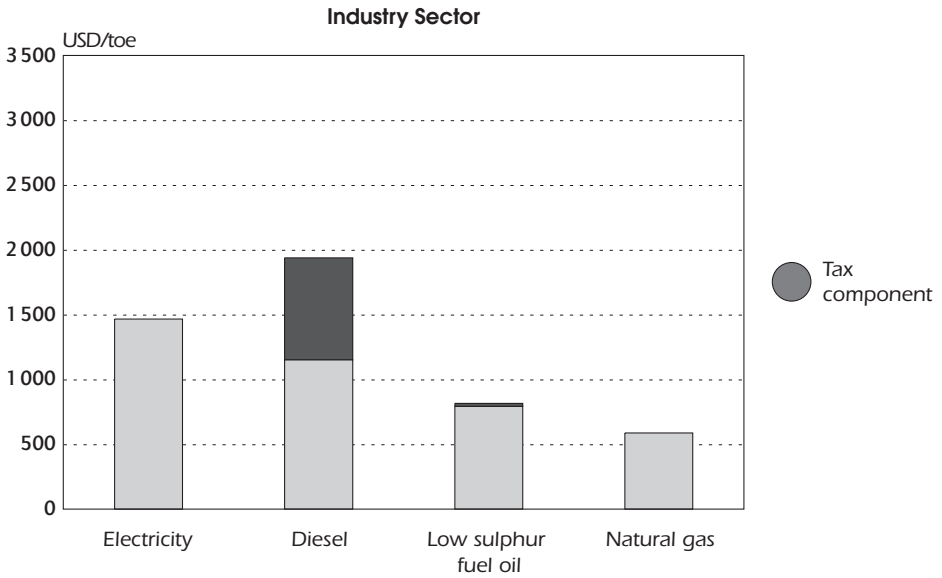


The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

CALM = Catenary Anchor Leg Mooring buoy technology.

Source: Country submission.

Figure 18  
Fuel Prices, 2008



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2009.

The retail gasoline market in mainland Portugal is highly concentrated, with the three main operators, Galp, Repsol and BP, together accounting for over 70% of outlets. There are other operators in the market, mainly the major supermarket/hypermarket chains. Their retail prices in 2008 were on average around 9 eurocents per litre lower than the major oil companies.<sup>6</sup>

In terms of price regulation for fuel on the mainland, the last phase of retail price liberalisation was concluded in January 2004. Since then, there has been no ceiling on retail prices either for unleaded 95-octane petrol or for diesel for road users. Prices for other fuels (98-octane and additive petrol, diesel and new generation petrol) had already been liberalised.

The entry of large supermarket chains into the liquid fuel retail market has brought clear benefits for the consumer in terms of price cuts, in some cases in the framework of agreements with oil companies. Also to facilitate competition, licensing procedures for petrol stations have been simplified, introducing a less time-consuming licensing process (Decree-Law 195/2008, of 6 October).

## **EMERGENCY RESPONSE POLICY AND EMERGENCY ORGANISATION**

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### **EMERGENCY RESPONSE POLICY**

Security of supply, jointly with sustainability and competition, is a cornerstone of Portuguese energy policy as now established by the Resolution of the Council of Ministers n<sup>o</sup> 169/2005 (RCM). This policy set out a number of goals and measures for strengthening overall energy security, including security of supply of oil and gas.

The use of stocks held by the stockholding agency EGREP and by industry is central to Portugal's oil emergency response policy. Portugal would consider the release of public stocks, or lowering stockholding obligations on industry, or a combination of both, as response measures in an IEA collective action. The administration regards the concentration of storage infrastructure and the vulnerabilities associated with the transport system as the biggest domestic risks to oil products supply security, as evidenced in the domestic crisis in June 2008 that originated from a truckers strike.

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6. Report by the Competition Authority on the Fuel Market in Portugal, Portugal Competition Authority, June 2008.

## EMERGENCY ORGANISATION

The stockholding agency EGREP was established in 2004, following Decree-Law 10/2001 on Petroleum Reserves, which was later amended in 2001 and 2004. EGREP is a wholly state-owned organisation, which has its own board of directors, a supervisory board and an independent auditor. EGREP is required to run a balanced budget and its costs are charged to the industry on a per-tonne basis, by means of a levy on every tonne of products brought to the domestic market. Its annual budgets and activity plans, including stock levels and financing requirements, are subject to government approval. Stockpiling is financed with long-term (20 years) bonds. EGREP has been given a credit rating of AA/stable by a Portuguese rating company.

The legal structure of the National Emergency Sharing Organisation (NESO) has not changed since the publication of Decree-Law 224/2002. The Directorate-General of Energy and Geology (DGEG) in the Ministry of Economy and Innovation and the Commission for Energy Emergency Planning (CPEE) are the two core bodies of the Portuguese NESO structure. The CPEE is an organisation which specifically focuses on energy supply security and has a place in the national civil emergency structure (CNPCE - Civil Emergencies Planning Board, under authority delegated to the Minister of Defence). CNPCE is the umbrella organisation for civil emergency and is intended to promote the preparation and to co-ordinate emergency response at national level in relation to all strategic resources. CPEE staffing and functioning is a DGEG responsibility, and the Director-General of DGEG serves as chairman of the CPEE. The CPEE is composed of delegates from the Ministry of Defence, Azores and Madeira autonomous regions, DGEG, as well as of members of industry, which includes the energy-related sub-sectors of oil, natural gas and electricity. Since the last review, the stockholding agency EGREP has become a member of the CPEE.

In case of an energy emergency, the CPEE may be activated by itself as the supporting body of NESO, under the minister responsible for energy even if the CNPCE is not activated.

The minister responsible for energy (Minister of Economy and Innovation) has the authority to decide whether the country will accept the IEA initial assessment, and which response measures to take in order to participate in an IEA collective action.

Decree-Law 114/2001 defines the process for the government declaration of an energy crisis situation and lists allowed emergency measures. It also defines responsibilities for crisis management. The CNPCE regularly conducts emergency response exercises at national level which are used as opportunities to test the Portuguese NESO and train its staff.

## EMERGENCY OIL RESERVES

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### STOCKHOLDING REGIME AND LEGAL INSTRUMENTS

Decree-Law 10/2001 is the legal basis for the stockholding regime. The Portuguese government meets its stockholding obligation towards the IEA, and the EU, by holding agency stocks and placing a minimum stockholding obligation on industry. Oil industry operators are required to hold two-thirds of the EU obligation (*i.e.* 60 days of consumption of gasoline, distillates and fuel oil), while the stockholding agency, EGREP, is obliged to hold the remaining one-third and to cover the difference between total EU and IEA stock obligations. The industry and EGREP are also required to hold reserves of 20 and 10 days of liquefied petroleum gas (LPG), respectively. At least one-third of the individual stock obligations of companies and EGREP must be held as final products.

According to Decree-Law 10/2001, the Minister of Economy and Innovation can authorise a given entity to enter into an agreement with EGREP so that the latter will ensure its total stock obligation, provided that the applicant's request is for a limited and specified duration and that the applicant's inability to maintain the required stocks by itself is justified by reasons beyond its control. Currently, there is no threshold concerning volumes of stocks delegated to EGREP by such entities. However, EGREP is consulted beforehand as to the feasibility of each request. Fulfilling the entire obligation via EGREP has been used by small operators entering the market so that the need to have storage capacity does not create a barrier to entry or competition. During the time under such agreements between EGREP and small operators, which is, in principle, limited to two years at maximum, the latter must find a solution for their storage needs. At the end of 2008, the authorisations in force concerned 10 746 m<sup>3</sup> (around 91 kb) of gasoline, 24 096 m<sup>3</sup> (around 180 kb) of distillates and 553 tonnes (around 6.5 kb) of LPG, which were held by EGREP on behalf of three entities.

Decree-Law 71/2004 allows Portugal to hold compulsory stocks in other EU countries, but until now this facility has only been awarded to EGREP. Portugal has signed bilateral stockholding agreements with Germany and Spain. A bilateral agreement with the Netherlands has also been approved and is awaiting formal signature. As EGREP is reducing stocks held outside Portugal, room is being given to allow oil companies to keep stocks under bilateral agreements.

### LOCATION, QUALITY OF CRUDE, PRODUCT TYPES

EGREP holds its compulsory stocks in both Portugal and abroad. Total public stocks of EGREP at the end of September 2008 were about 8 million barrels. Agency stocks in Portugal, with a total volume of 5.1 million barrels, are

mainly located in the Sines refinery, and other Petrogal facilities. EGREP will be utilising a NATO facility which will be rented in the second half of 2009 to store gasoil. Nearly 60% of public stocks held domestically are crude, with a basket of 9 grades (Antan, Arabian heavy, CPC, Iranian light, Kirkurk, Marlim, Oso Condensate, Saharan Blend and Ural).

Agency stocks in Portugal are commingled with industry commercial stocks. Under the above-mentioned bilateral stockholding agreements, EGREP holds 2.9 million barrels of crude oil in a salt cavern in Germany and 403 000 barrels of diesel in Spain. EGREP signed a 10-year storage contract with the cavern operator in 2004. The cavern compound is linked to the NWO (North-West Pipeline) and to the port of Wilhelmshaven, and to a number of refiners. The contract with a Spanish storage operator is perceived as temporary; these diesel stocks are intended to be transferred to the POL NATO facility in Portugal (which EGREP is renting), starting in the 2<sup>nd</sup> quarter of 2009.

As of end-September 2008, there were 19.9 million barrels of industry stocks in Portugal, of which around 70% were held in refined products. Compulsory stocks held by industry are allowed by law to be commingled with commercial stocks. An international inspection company is commissioned to verify EGREP emergency oil reserves in storage facilities twice a year.

## TICKETS

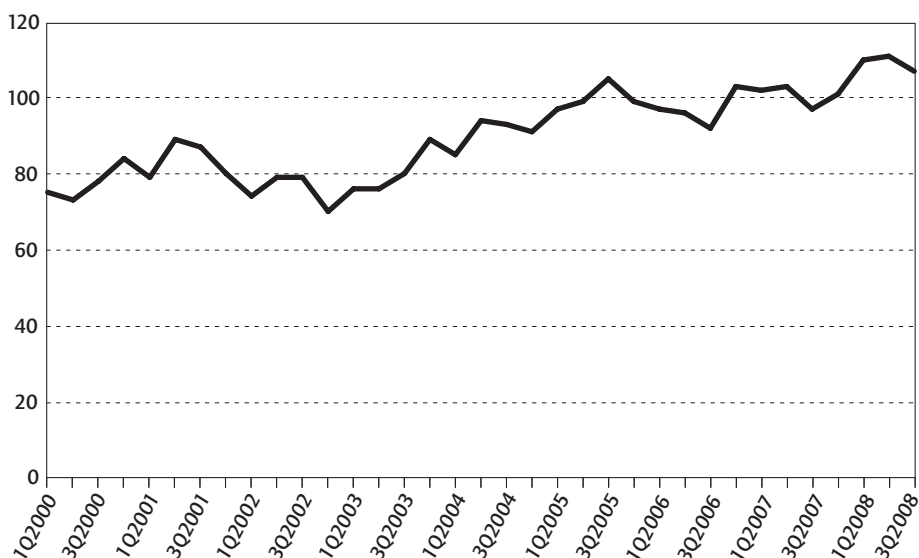
From 2005 to early 2008, EGREP signed several ticket agreements with Dutch refiners on gasoline, distillate and fuel oil stocks, under the *ad hoc* format that is common in this market, with the full endorsement of both the Portuguese and Dutch authorities. Currently, EGREP does not enter into ticket contracts, because the administration has regarded such ticket agreements as a temporary measure to meet the IEA 90-day obligation. At present, a domestic ticket market does not exist in Portugal. However, as tickets are considered a standardised form of delegated stocks, in principle, tickets can be allowed even in the domestic market.

## DAYS' COVER

Portugal has been compliant with the IEA's 90-day obligation since the second quarter of 2004 by holding additional compulsory stocks in other EU countries, as described above because of lack of storage capacity. Portugal's total stock levels gradually increased over the past four years and reached approximately 28.3 million barrels (equivalent to approximately 109 days of net imports) at the end of September 2008. At the same time, total public stocks held in the national territory and abroad stood at 5.1 million barrels (18 days of net imports) and 3.3 million barrels (12 days of net imports), respectively, while total industry stocks stood at 19.9 million barrels (79 days

of net imports). Although there was a temporary drop of stock levels in the first three quarters of 2006, Portugal's reserves in terms of days of net imports have been mostly above 100 days since the fourth quarter of 2006.

Figure 19  
Days of Net Imports



Source: IEA.

## STOCK DRAW/DOWN

The Minister of Economy and Innovation has the authority to release EGREP emergency stocks or to allow the reduction of stocks held by industry. There is a clear procedure for the drawdown and sale of agency stocks that are stored in Portuguese facilities. Industry operators shall have a right of first refusal over stocks held by EGREP, in proportion to their share in the financing of such stocks (*i.e.* according to their respective market shares). Each operator's share shall be determined on the basis of the four preceding quarters. The following steps would be taken for sales of agency stocks held domestically:

- After government notifies the volumes to be released, EGREP invites operators to express their interest in receiving stocks from the strategic reserves;
- Operators make their decisions known in writing within 72 hours;



- Galp is notified by EGREP of the volumes of products to be delivered to each operator;
- Galp starts making volumes available in five days for products and 15 days for crude oil after receipt of EGREP notification;
- Delivery points to be agreed between Galp and recipients. According to the storage contracts signed between EGREP and Galp, the latter shall use its best endeavour to deliver at the locations where the operators are usually supplied;
- Release price to be determined as the average of previous week's Platt's quotations, so as to avoid arbitrage between EGREP and national refiner.

In the case of drawdown of the crude oil stocks which EGREP possesses in Germany, a different strategy will be taken according to the emergency situation. Sale by tender to the global market, in response to the IEA emergency programme, is one option. Swapping or processing of stored crude oil at nearby refineries is another option. Repatriation of crude oil is regarded as the last option. The drawdown rate of crude oil from underground storage in Germany is estimated at around 60 kb/day.

Decree-Law 114/2001 stipulates that lowering the legal level of industry compulsory stocks requires an order from the Minister of Economy and Innovation, which would be followed by DGEG notification to oil companies. In case consumers continue to express complaints about lack of oil products to the market after the minister orders to reduce industry stockholding obligations, oil companies may be requested to demonstrate that they are not hoarding products.

## FINANCING

EGREP is financed by levies charged to operators with compulsory stock obligations. The fees are to be paid according to the volumes operators sell in the domestic market.

## OIL DEMAND RESTRAINT

Decree-Law 114/2001 sets out demand restraint measures in a supply crisis scenario. Persuasive measures such as media awareness campaigns, publication of leaflets and explanatory guides, display of posters in public locations and direct action by state or public administration agents are designed to persuade operators and consumers to voluntarily reduce energy use. The decree-law also envisages the following compulsory measures if further reduction of energy demand is needed:

- Restrictions on the use of private motor vehicles by banning driving and motor sport events, penalising the sub-optimal occupancy of private vehicles, reducing maximum speed limits, etc;
- Restrictions on empty journeys or under-utilised public and commercial transport routes;
- Restrictions on the use of energy-consuming equipment such as limiting operating times and lighting levels, heating and cooling in public or private buildings and locations open to the public;
- Imposition of operating rules for energy-consuming equipment to increase the efficiency of energy use; and
- Enforcement of fuel switching.

Furthermore, the decree-law stipulates measures designed to indirectly promote energy saving, including the introduction of flexible working hours, limitation of television broadcasting times and performance events, and increasing energy tariffs and charges.

No studies have been conducted on the expected effectiveness of demand restraint measures but the administration believes that supply-side restraint can be a very effective measure if demand does not react to measures imposed during a crisis.

## OTHER OIL EMERGENCY RESPONSE MEASURES

Considering that Portugal has no indigenous oil production, surge production of oil is not considered as an emergency response measure. Despite fuel switching being clearly stated as an available emergency response measure in Decree-Law 114/2001, no specific policy has been developed. Fuel switching capacity for oil consumers is very limited in the short term.

## COAL

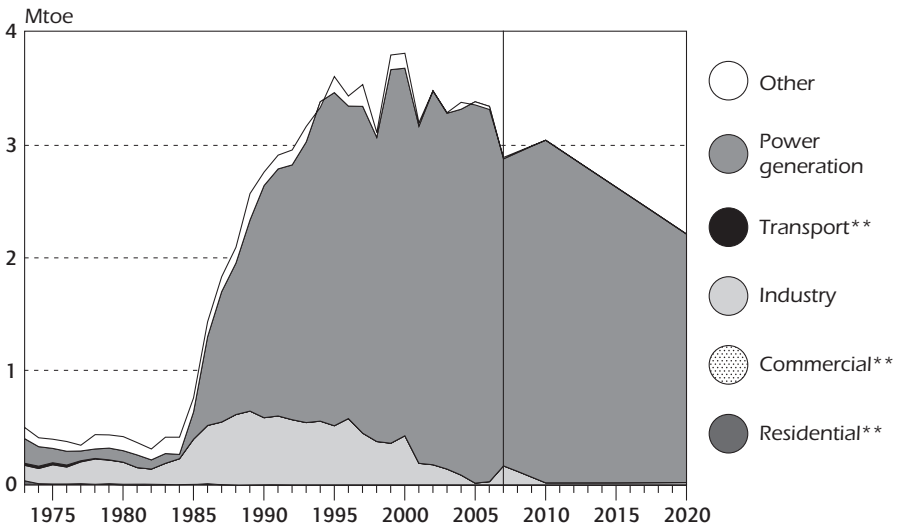
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### OVERVIEW

Portugal has not produced coal since its last mine was closed in 1994. It imports coal for electricity generation especially in periods of decreased hydropower. Coal represented 10.8% of Portugal's TPES in 2008, a sharp fall from the levels of the previous year. Coal consumption decreased by 12.1% mainly owing to lower coal-fired electricity production while the clinker and cement industry increased its coal use in the same period.

A 17.4% decrease in total imports was recorded in 2007 compared to 2006 (3.31 Mtoe). In 2007, the total amount of imported coal was approximately 4.78 Mt, which includes all coal types. Portugal's main coal suppliers are Colombia and South Africa, with shares of 50.3% and 32.4% of total imports, respectively (2007 data). Other suppliers in decreasing order of importance are the United States, Indonesia, Norway, Russia, Ukraine, Spain and Latvia.

Figure 20  
Coal Supply by Sector\*, 1973 to 2020



\* total primary energy supply by consuming sector. Other includes other transformation and energy sector consumption. Industry includes non-energy use. Commercial includes commercial, public services, agriculture/forestry, fishing and other final consumption.

\*\* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008 and country submission.

There are two coal-fired power plants operating in Portugal. These are located in Sines (1 250 MW) and Pego (620 MW). Sines power plant, in particular, is a provider of baseload power generation. Both plants operate according to the Rankine cycle with efficiencies in the range of 32% to 35%. Sines power plant has typical emissions of 890 g CO<sub>2</sub> per kWh. A revamping of Sines and Pego power plants initiated to desulphurise the flue gases is reaching its conclusion.

## CO<sub>2</sub> CAPTURE AND STORAGE (CCS)

Portugal has made a preliminary CO<sub>2</sub> storage assessment. The country aims to have 800 MW of clean coal power generation at Sines by 2020. To meet this

ambition, a study was established under the aegis of the Directorate-General for Energy and Geology (DGEG) in partnership with utility EDP and the research body INETI. Several options for project implementation are being assessed including the characterisation and qualification of deep saline aquifers for storage, separation techniques including the use of membranes and adsorbents, implementation of integrated gasification combined cycle (IGCC) with pre-combustion, and oxy-combustion in post carbon capture (PCC) or circulating fluidised bed combustion (CFBC).

INETI/LNEG is investigating the onshore structures in the Mesocenozoic Lusitanian basin. The collaboration included a preliminary study to determine possible sites for CO<sub>2</sub> storage in Portugal (see Figure 21).

An action plan is being developed to ensure that the target defined by the Portuguese government will be met. It will include a comprehensive research and development programme and a CCS pilot plant integrating oxy-combustion in a circulating fluidised bed with CO<sub>2</sub> recovery and underground disposal. This project will involve Energias de Portugal (EDP) and the National Laboratory on Energy and Geology (LNEG). DGEG will be responsible for legislation in relation to CO<sub>2</sub> capture and storage and for disseminating information to promote public acceptance.

## CRITIQUE

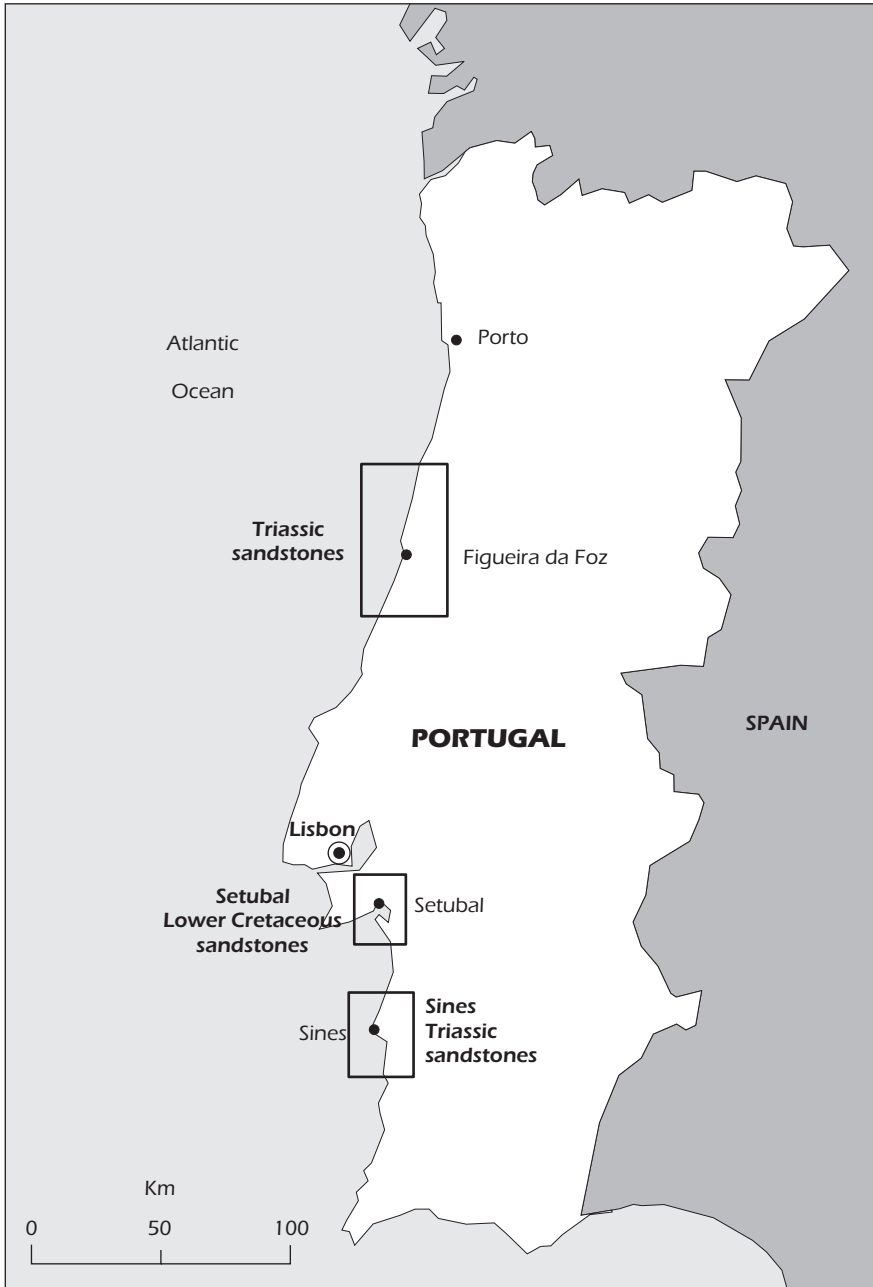
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Oil continues to be the dominant primary energy source in Portugal, and the share of oil in the country's total primary energy supply (TPES) stood at 54% in 2007. It is expected that oil will remain the country's largest source of energy in the longer term, but its share of TPES is forecast to gradually decrease to 52% in 2010 and to 44% in 2020. Total oil demand in Portugal has remained relatively stable in the last decade, while oil demand in the transport sector has significantly increased over the same period, driven to a large extent by sharp demand growth for diesel. Import sources of crude oil and oil products are well diversified.

Portugal has been making efforts to upgrade refining capacity at its two refineries in order to eliminate the current diesel deficit and meet expected growth in demand. Self-sufficiency in diesel will be achieved by the planned investment, which will significantly reduce dependence on imported oil products. Storage capacity in Portugal is not sufficient to cover the IEA 90-day obligation, because of imbalanced storage capacity for oil products, which caused some proportion of agency stocks to be held abroad. It is commendable that the country has plans to expand storage capacity to reduce the imbalance and to hold emergency stocks domestically to a greater extent.

Figure 21

Potential CO<sub>2</sub> Storage Sites



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Source: INETI, 2007.

The wholly government-owned stockholding agency, EGREP, was established in 2004, with its legislation, organisation and financing well in place. The Portuguese Administration meets its stockholding obligation to the IEA and the EU by holding agency stocks and placing a minimum stockholding obligation on industry. Oil industry operators shall hold two-thirds of the EU obligation, while the stockholding agency EGREP is obliged to hold the remaining one-third of the EU obligation and cover the difference between total EU and IEA stock obligations. Small operators may delegate their obligation to EGREP under certain conditions. The country has been consistently compliant with the IEA 90-day obligation since the second quarter of 2004 by allowing EGREP to hold emergency stocks abroad under bilateral agreements. The Administration has a policy to move away from ticket holding under bilateral agreements as a measure to meet the IEA obligation.

The use of stocks held by EGREP and by industry is central to Portugal's emergency response policy. Portugal would likely consider the release of public stocks or lowering stockholding obligations on industry, or a combination of both, as response measures to contribute to an IEA collective action. Portugal has a well-defined stock release procedure for public stocks stored in the country. The Administration regards the concentration of the storage infrastructure in certain areas and the vulnerabilities related to the transport system as the biggest domestic risks in oil products supply security.

In the retail market, the change in law of 2004, which facilitated the entry into the market of retailers other than oil companies, has made a positive difference. The entry of new operators and large supermarket chains into the previously concentrated liquid fuel retail market has brought clear benefits for the consumer in terms of price cuts. For this the authorities should be commended. The retail market now is becoming somewhat more concentrated, as some major brands have left the Portuguese/Iberian market, namely, Shell, Esso and Agip.

During the 2006 to 2007 period coal consumption decreased, mainly because of lower use in the electricity production sector. Corresponding to the growth of electricity demand, DGE has licensed eight new combined cycle gas-fired (CCGT) plants which are planned to come on stream between 2009 and 2012. As a result, coal demand will be further decreased.

Long-term coal power generation contracts lock Portugal into significant long-term emissions in the electricity sector. Portugal should consider how to counter the climate change impact of its long-term coal generation contracts in a cost-effective manner, whether by replacing coal-fired plants and/or reducing their emissions using CCS.

## RECOMMENDATIONS

*The government of Portugal should:*

### ▶ *Oil*

- *Continue to promote existing plans for expansion of storage capacity and upgrading refining capacity.*
- *Continue to identify and assess critical components of the energy infrastructure and to prepare contingency plans to cope with possible risks.*

### ▶ *Coal*

- *Develop a long-term position in relation to coal-fired generation within the framework of broader energy and climate change policy.*
- *Strengthen its efforts with regard to research into potential CCS capacity and continue to maintain a leadership role in the process.*





## OVERVIEW

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Natural gas supply to Portugal began in 1997. Since then, natural gas demand has steadily increased and by 2008 reached 4.76 billion cubic metres (bcm). In 2008, natural gas provided Portugal with 17% of its total primary energy supply (TPES) by fuel. The country has no natural gas resources and all gas is imported. Pipeline imports from Algeria, transited via Spain, were the source of 2 036 bcm of gas in 2008, while liquefied natural gas (LNG) from Nigeria supplied the remaining 2 728 bcm. Portugal imports LNG via the Sines terminal, which is owned and operated by REN Atlântico. A large proportion of natural gas is consumed by electricity generators and consumption in the residential and commercial sectors is limited. The Portuguese natural gas market, as an emerging market, received a derogation under Directive 2003/55/CE; therefore, the market liberalisation process commenced in 2006.

## SUPPLY AND DEMAND

The electricity sector is the largest consumer of natural gas, accounting for 56.7% (2.3 bcm) of consumption in 2007. Industry consumed 31.7% (1.3 bcm) of total volume in the same year while the commercial and residential sectors consumed 11.2 % (0.46 bcm). Most of the remaining small volume was consumed in oil refineries or in the gas transportation system.

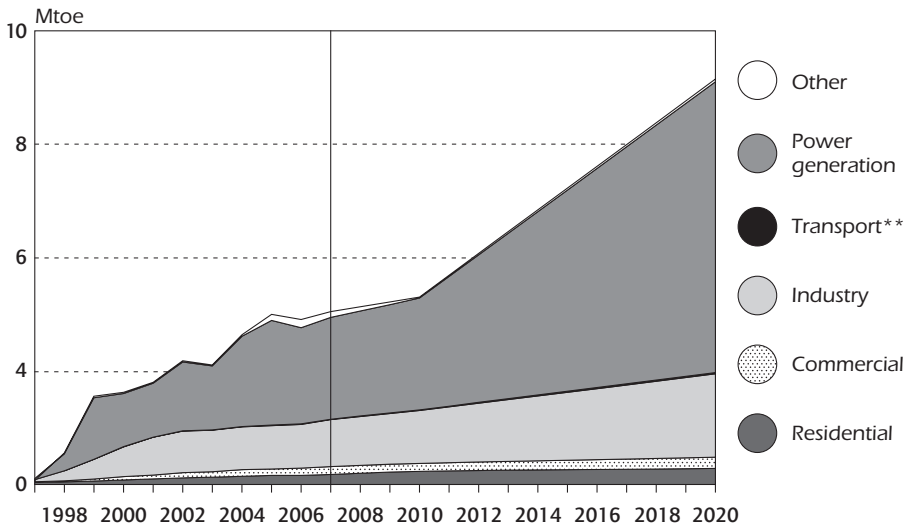
Natural gas demand is expected to continue to grow in the near future with the planned installation of a number of new gas-fired CCGT units with an estimated combined capacity of 3 200 MW and the further development of the Iberian electricity and natural gas market initiatives (MIBEL, MIBGAS). The government forecasts that Portuguese natural gas demand will reach 4.3 bcm (4.134 Mtoe) in 2010 and 9.4 bcm (8.934 Mtoe) in 2020. Gas is also expected to make inroads into the industrial, commercial, and domestic sectors as the network is expanded.

## IMPORTS

LNG is imported into Portugal's sole terminal at Sines, which receives supplies from Nigeria and some spot volumes from other sources. Portugal is currently over-contracted for LNG, but possesses some flexibility to swap or trade excess in the spot market. Increasing capacity at Sines will open up further transit opportunities in the Iberian peninsula for Nigerian and other LNG sources.

Figure 22

Natural Gas Supply by Sector\*, 1997 to 2020



\* total primary energy supply by consuming sector. Other includes other transformation and energy sector consumption. Industry includes non-energy use. Commercial includes commercial, public services, agriculture/forestry, fishing and other final consumption.

\*\* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008 and country submission.

Galp Energia currently has four long-term contracts for natural gas supply, which taken together amount to nearly 6 bcm per year. Transgás (renamed Galp Gás Natural in February 2007) and Sonatrach signed the first supply contract in late 1993. In addition to this contract, three additional long-term contracts for the acquisition of LNG were signed with Nigeria. The contract with Algeria’s Sonatrach is for the supply of natural gas delivered via pipeline. The quantities of natural gas related to this contract are 1.6 bcm in 1998, 1.9 bcm in 1999, 2.1 bcm in 2000 and 2.5 bcm in each year between 2001 and 2020 (the final year of the contract).

Additionally, the quantities defined in the three contracts signed with Nigeria are 0.42 bcm, 1 bcm and 2 bcm, commencing in 2000, 2003 and 2006 respectively. These contracts last for a period of 20 years, with a six-year make-up period, and deliveries are taken at Sines or in any Iberian terminal along the south and east coasts should the necessity arise.

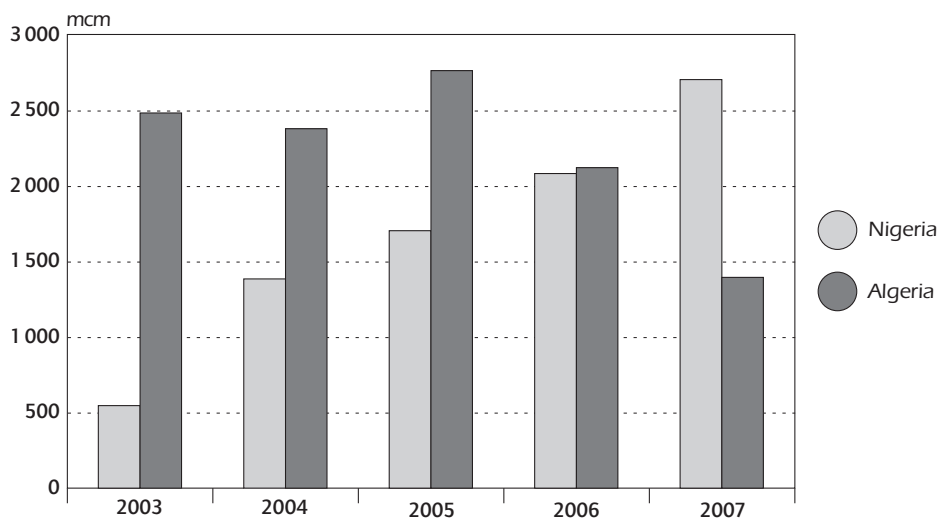
The present levels of gas demand in Portugal, circa 4 bcm, mean that the quantities involved in the long-term take-or-pay contracts with Sonatrach and Nigeria LNG exceed domestic consumption levels. Galp Energia estimates that the Portuguese natural gas market will reach 7.2 bcm in 2012, meaning there

is likely to be a capacity shortfall when current contracting arrangements are taken into consideration.

Ambitious to secure additional sources of supply, Galp Energia is currently reviewing a range of further supply opportunities, including the Delta Caribe LNG project in Venezuela and Angola LNG II. In relation to the Venezuelan project, Galp Energia has signed an agreement for a 15% stake of two LNG liquefaction facilities with a total liquefaction capacity of 13 bcm per year. Galp Energia will have the possibility of acquiring up to 2 bcm of LNG per year from the facilities. The final investment decision for this project is expected to be taken by the end of 2010 and first volumes of LNG are planned to be imported in 2014.

Figure 23

### Natural Gas Imports by Source, 2003 to 2007



Source: IEA.

## TRADE AND TRANSIT

Natural gas transported through the Portuguese transmission network is mainly for domestic consumption. The only transit at the moment relates to the capacity shared between the Portuguese and the Spanish gas network operators, REN Gasodutos and Enagás, for interconnecting the Spanish system between Badajoz in the Estremadura region and Tuy in the north of Spain. However, the transmission network was designed to provide transit to the north-west of Spain (Galicia), with capacity of 0.36 bcm per year reserved for this specific purpose.

In 2005 and 2006, the gas volumes transiting Portugal to the north-west of Spain were about 0.4 bcm, representing 8.1% and 8.5% of the natural gas

volumes entering the Portuguese transmission network. In 2007, transits were reduced to 0.2 billion cubic metres, following the start of the Mugardos LNG facility in Galicia, and were just 39 million cubic metres in 2008.

As market opening is very recent, there is still no trading activity nor an organised platform or hub within which to trade gas. Nevertheless, because of its geographic location, Portugal could benefit from the creation of an Iberian hub where Portuguese market agents could buy/sell gas from/to other Iberian players, boosting competition in the market.

## **INDUSTRY STRUCTURE**

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The Portuguese gas market is dominated by two utilities: vertically integrated previous incumbent Galp Energia, which handles gas importation and distribution (GDP, Gas de Portugal), and retail supply through regional utilities; and Energias de Portugal EDP, which is also present in the natural gas sector throughout the Iberian peninsula, by means of EDP Gás, a distribution company in Portugal, and through Naturgas, which operates in the Spanish market. In both Spain and Portugal, EDP Gas is also involved in commercial activities both in the regulated and liberalised natural gas markets.

In 2004, the EU rejected on competition grounds, a veto backed by the European Court, the previous Portuguese government's plans to merge EDP with GDP (Galp Energia's natural gas business). Since then, government policy has been to promote competition between EDP and Galp such that each invests in the alternative market, with Galp acquiring power generation assets and EDP expanding into the gas market.

In 2005, the Portuguese government established a national strategy for the energy sector mandating the unbundling (legal separation) of LNG regasification, natural gas transportation and a large part of the natural gas storage assets from the incumbent Galp. These assets, all related to the regulated activities, were sold to REN, the electricity transmission grid operator. The vesting of these assets in REN occurred in September 2006.

In October 2006, the government floated 23% of its 30% stake in Galp Energia on the Euronext Lisbon market following an agreement made in late 2005 with Galp's largest shareholder, Italy's Eni, which in turn agreed not to increase its stake for five years. At present, Galp is owned by Eni (33.34%), Amorim Energia (33.34%), the Portuguese state (7.00%), Caixa Geral de Depósitos (1%) and a free float (25.32%). EDP is 20%-owned by the Portuguese government, while Spain's Iberdrola (9.3%), Algeria's Sonatrach (2.23%), local banks and private investors also own shares in the company. EDP acquired part of Portgás, a natural gas distributor, at the end of 2004 and currently owns 72% of the business of this company, now known as EDP Gás. Several other foreign operators also participate in the Portuguese gas

sector through shareholdings in regional gas companies. GDF Suez, Spain's Enagas and other minority stakeholders also hold shares of Portuguese utilities.

Most large industrial gas sales, including power generators, are handled directly by the Galp Group through Transgás or Galp Gas Natural, which also supplies Portugal's regional distributors, under the existing long-term take-or-pay supply gas contract signed prior to the approval of the Decree-Law 140/2006, of 26 July.

Portugal's main gas-storage facility is the 0.12 bcm Carriço underground storage unit in central Portugal, which has 1 bcm of potential capacity. In May 2006, Carriço's storage facility in western Portugal reached a capacity of 120 million cubic metres working volume, boosting flexibility for gas balancing.

## NATURAL GAS TRANSMISSION

Natural gas transmission activities are carried out under an exclusive concession granted by the Portuguese State (40 years) to the system operator REN Gasodutos. Previously, Transgás, a Galp group company, operated the natural gas transmission network. The granting by the government of the National Natural Gas Transmission Network (RNTGN) concession to REN Gasodutos followed the decision to separate natural gas supply from transmission activities. The terms of the concession contract were established by the Council of Ministers Resolution 105/2006 of 3 August and REN Gasodutos was awarded the concession in September 2006.

RNTGN consists of a main trunk line and branch lines totalling 1 248 km, and is divided into seven sections. It has two interconnections with Spain, one at Campo Maior and another at Valença do Minho, also connects with the LNG import terminal at Sines and the underground natural gas storage facility in Carriço. Transmission system entry capacity is also expected to increase at the cross-border Valença de Minho–Tuy pipeline and the construction of a new cross-border interconnection with the Spanish natural gas grid between Mangualde in the centre of Portugal and Zamora, in Castilla-León, Spain. In addition, eight industrial branch lines supplying natural gas to industrial units and new gas-fired CCGT power stations are planned over the next three years.

Natural gas enters the network at two points: Campo Maior, located on the eastern border with Spain and the Sines LNG terminal, located to the south of Lisbon. According to the Ministry of Economy and Innovation, the normal operation capacity of the two main entry points is approximately 10 bcm per year, of which 4.1 bcm per year at Campo Maior and 5.9 bcm per year at the Sines LNG terminal. In addition, the Valença de Minho entry point, which is located on the northern border, occasionally receives natural gas from Spain and has a capacity of about 0.75 bcm per year. At the Sines terminal, LNG is

offloaded and pumped into temporary storage tanks, where it remains until a regasification order is issued by the owner of the gas.

In order to accommodate the expanded send-out capacity of the Sines LNG terminal, Portugal expects to install a compressor station in the grid (near Carregado) in 2012.

The RNTGN main dispatching centre is located in Bucelas (Loures) and there is also an unmanned emergency dispatching centre in Pombal, which is located in a different seismic zone to the main dispatching centre. There are also four operations and maintenance centres located at Sandim (Vila Nova de Gaia), Pombal, Portalegre and Bucelas (Loures).

The Access to Grids, Infrastructure and Interconnections Codes establish the conditions and obligations governing the right of access to all infrastructure of the RNTGN, which must be complied with by the regulated companies operating in the natural gas sector and by eligible customers. The Code also establishes the conditions under which the operator may refuse the access to grids, interconnections and storage facilities.

Table 5

### Portuguese Natural Gas Transmission Network

	<i>Location</i>	<i>Start-up</i>	<i>Diameter [mm]</i>
Lote 1	Setúbal - Leiria	February 1997	700
Lote 2	Leiria - Sto Tirso- Braga	February 1997	700/508
Lote 3	Campo-Maior - Leiria	February 1997	700
Lote 4	Braga - Tuy	December 1997	508
Lote 5	Portalegre - Guarda	October - 1999	305
Lote 6	Coimbra- Viseu	September - 1999	508
Lote 7	Setúbal - Sines	November - 2003	813

Source: REN Gasodutos.

## DISTRIBUTION

The distribution network is composed of medium- and low-pressure pipelines and serves the residential sector, commercial and small and medium-sized industry sectors. Natural gas distribution is carried out on a public service concession basis.

Natural gas distribution in Portugal is organised into six local distribution companies (LDCs) under 40-year concessions awarded by the State (from January 2008) and five autonomous network operators (AGUs) administered

under 20-year licensing agreements. The six concession holders are Beiragás, Lisboaagás, Lusitaniagás, Portgás, Setgás and Tagusgás, and five AGUs: Dianagás, Dourogás, Duriensegás, Medigás and Paxgás. While the concession areas are connected to the transmission network, the autonomous grids are in some cases (in less densely populated areas) supplied by natural gas tankers. The legal basis for the natural gas distribution concessions was established in Decree-Law 140/2006 of 26 July and contracts with the concession holders were signed in April 2008.

Each LDC has a long-term exclusive concession for its local operating area. The concession agreements were put in place to develop natural gas distribution throughout the major Portuguese urban areas linked to the high-pressure network. AGUs were built in the areas where it was not economically viable to construct the high-pressure network. They are supplied from the Sines LNG terminal by means of tankers and use local distribution networks to provide natural gas to residential, commercial and small industrial customers. The AGUs have licences similar to the concession agreements but with a 20-year period. Prices and tariffs for each are determined by ERSE, the sectoral regulator. Since July 2007, regional distribution concessionaires and the licensees for local distribution with more than 100 000 customers that have been required to supply gas through legally unbundled companies are Portgás, Lisboaagás, Setgás and Lusitaniagás.

Table 6  
Natural Gas Distribution in Portugal, 2007

<i>Distributor</i>	<i>Consumption (Ncm)</i>	<i>Market share</i>	<i>No. of customers</i>
Lisboaagás	222 345	30.08%	462 398
Portgás	214 798	29.06%	169 132
Lusitaniagás	160 047	21.65%	154 674
Setgás	60 851	8.23%	125 394
Beiragás	29 928	4.04%	29 809
Tagusgás	26 667	3.61%	18 766
Duriensegás	11 067	1.50%	14 905
Medigás	5 976	0.81%	7 300
Dianagás	4 973	0.67%	2 767
Dourogás	2 528	0.34%	4 905
Paxgás	0	0.00%	0

Source: DGEG.

Lisboagás, 100%-owned by Galp, is Portugal's largest regional distributor and serves the capital, Lisbon and surrounding municipalities. Portgas, the second-largest distributor, supplies 29 municipalities in the Oporto, Braga, and Viana do Castelo districts and is owned by EDP (72.00%), GDF Suez (25.34%) and several municipalities covered by the concession. Setgás operates on the Setubal peninsula and is owned by Galp (45.0%), Eni (21.9%), and Enagás (33.1%). Other regional gas distributors include Lusitaniagás (82%-owned by Galp), Beiragás (59%-owned by Galp), and Tagusgás (41%- owned by Galp).

Table 6 lists the natural gas consumption levels and the respective shares by catchment area of the different distribution system operators, as at 31 December 2007.

## STORAGE

Portugal utilises both underground storage facilities in Carriço and LNG tanks in Sines terminal for the storing of natural gas. There are two operators active in the underground gas storage sector – REN Armazenagem and Transgás Armazenagem. The activity is operated on a public-service concession basis and the terms of both concession contracts were laid down in Council of Ministers' Resolutions 107/2006 and 108/2006, both of August 2006. Each facility is regulated and subjected to a third-party access (TPA) regime.

Under the restructuring of the national natural gas system in 2006, part of the underground storage assets remained in the hands of Transgás Armazenagem, while the rest were transferred to a new underground storage operator, REN Armazenagem, which is part of the REN group. The new entity was awarded a public-service concession from the State for the underground storage of natural gas in salt caverns and the extraction, treatment and delivery of the gas to the national gas transmission network as well as the construction, operation, maintenance and expansion of the facilities and infrastructure related to the storage of natural gas. REN Armazenagem is wholly owned by REN and its only customer until now has been Galp Gás Natural.

Transgás Armazenagem, part of the Galp group, has been operating a storage business since its incorporation in 2004, in the context of a concession granted to the previous incumbent Transgás, which included the transmission and import of natural gas into Portugal. Its only customer is the parent company. Transgás Armazenagem owns and operates one storage facility (one cavern) in Carriço, municipality of Pombal, with a storage capacity of 35 mcm, with a further 40 mcm under construction, to start operations by mid-2011. In addition, Transgás Armazenagem has subsoil usage rights to build up



to four additional caverns within an expansion area in Carriço. However, Transgás Armazenagem will be required to sell additional caverns to REN Armazenagem, on terms to be agreed by both parties, if REN Armazenagem's expansion capacity is exhausted, in which case such caverns will be considered by the Minister of Energy to be necessary for the reinforcement of security reserves capacity.

REN Armazenagem operates storage facilities in two salt caverns in Carriço, with a total storage capacity of 89.3 mcm. The current withdrawal capacity of the facilities is 7.2 mcm per day. A third cavern is under construction, with a storage capacity of 53.7 mcm. This cavern will enter into operation in beginning of September 2009. The construction of four additional underground caverns with a total working gas capacity of 200 mcm is planned in the Carriço facility over the period from 2009 to 2014.

The Sines LNG terminal, which has been operated by REN Atlântico since January 2004, has two tanks with combined storage capacity of 240 000 cm of LNG (approximately 148 mcm of natural gas). Expansion of capacity at the terminal is under way, which is designed to increase the plant's drawdown capacity up to 32.4 mcm per day of natural gas, from the existing nominal 16.2 mcm per day and peak 21.6 mcm per day capacities. Commissioning of the new facilities is scheduled for the first half of 2012.

Portugal's combined storage capacity of existing underground facilities in Carriço in 2007 (124.3 mcm) and the Sines LNG terminal (148 mcm) roughly equated to 24.5 days of average natural gas demand in 2007 and 16 days of peak demand in the same year.

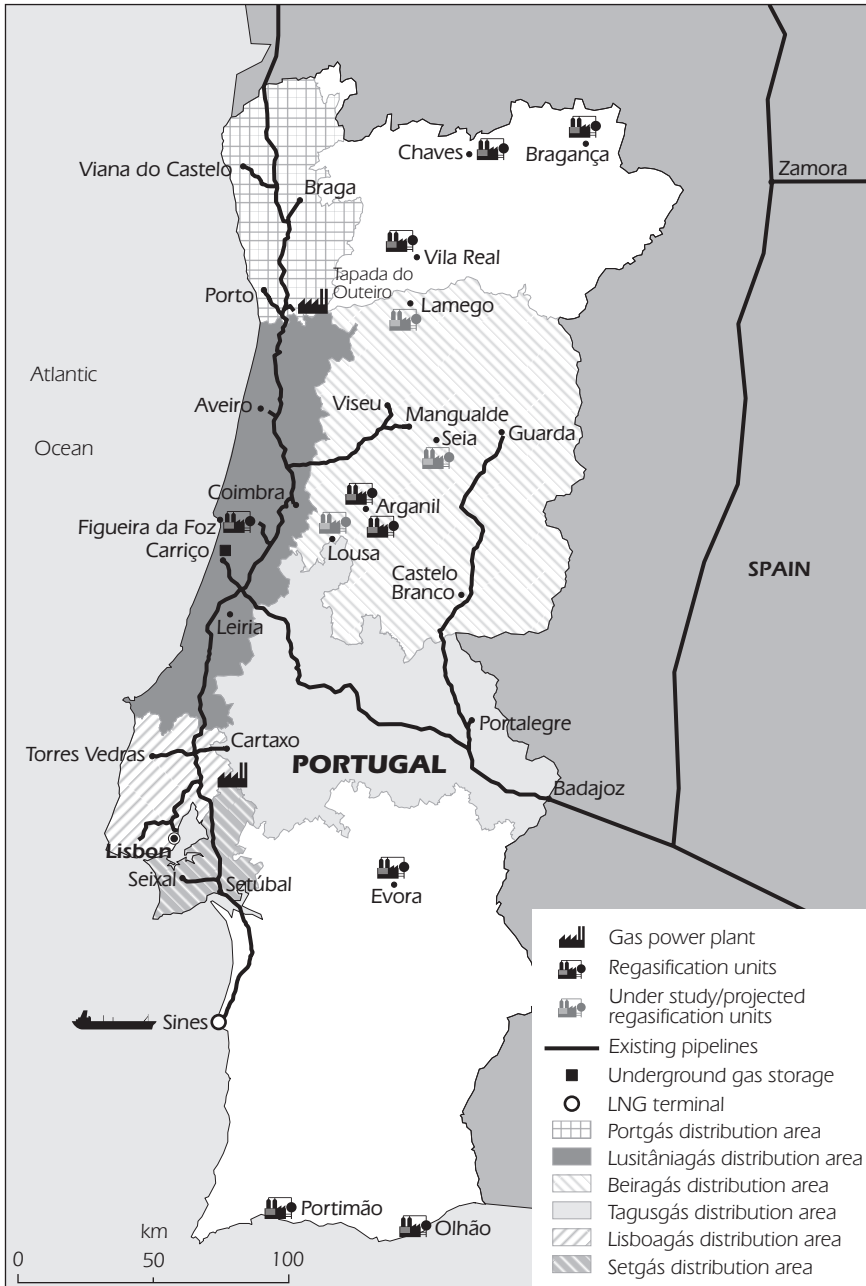
## LNG

REN took possession of the LNG terminal in Sines in September 2006, by acquiring the total share capital of Transgás Atlântico - Sociedade Portuguesa de Gás Natural Liquefeito. The terminal is held by REN Atlântico, through which REN operates the LNG reception, storage and regasification concession, subject to the public-service regime. REN Atlântico, under the terms of the concession, performs the activities of loading and dispatching tank truck and marine tankers and also the construction, operation, maintenance and expansion of such infrastructures.

The Sines LNG terminal entered the first phase of its commercial operation in January 2004. The LNG terminal consists of a jetty with a docking capacity for LNG tanks between 40 000 cubic metres and 165 000 cm with an average discharge time of 20 hours (for 145 000 cm LNG tankers), two storage tanks each having a capacity of 120 000 cm and five open rack vaporisers for regasification. The LNG terminal has a guaranteed (nominal)

Figure 24

### Natural Gas Infrastructure



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Source: *Natural Gas Information*, IEA/OECD Paris, 2008.

send-out capacity of 675 000 cm per hour (5.9 bcm per year), with a peak (interruptible) capacity of 900 000 cm per hour, and is able to load up to 3 000 trucks per year (or the equivalent of 0.08 bcm per year).

The Sines LNG terminal expansion project under way is dictated by forecast growth in gas demand and by transmission system capacity requirements in order to meet peak energy flows, while also strengthening security of supply. The nominal capacity of the third tank to be constructed will be 150 000 cm. Two new LNG vaporisers with characteristics and capacities similar to the existing ones will also be installed.

At present, Galp Energia is the sole user of the Sines LNG terminal, but the infrastructure is open to the market under a regulated third-party access regime (since 2007). Other users are expected to utilise capacity in the short to medium term, encouraged by Portugal's market opening schedule, to be completed by January 2010.

## **MARKET REFORM**

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The natural gas market in Portugal has developed later than elsewhere in Europe, following a derogation period delaying the transposition of the 2003/55/CE Directive into national legislation. The process of restructuring the natural gas sector began in 2006 with the approval of Decree-Law 30/2006 of 15 February, which defined the general principles for the organisation and operation of the National Natural Gas System. The law also transposed Directive 2003/55/EC into national law and mandated the unbundling (legal separation) of the LNG regasification facility at Sines, the natural gas transportation grid and part of the natural gas storage assets, from the previous incumbent Transgás and the sale of these to Rede Eléctrica Nacional (REN), the Portuguese electricity transmission grid operator.

Decree-Law 140/2006, of 26 July, established the legal regimes applicable to the activities of natural gas transmission, underground storage, reception, storage and regasification at LNG terminals and natural gas distribution, including the legal basis for concessions and the definition of the procedures applicable to the respective awarding. This bill also established the time frame for market opening, advancing the deadlines determined for liberalisation and defining the legal regime governing supply and the organisation of the respective markets.

This process continued in 2007 with the opening of the market to the standard regime electricity generators in line with the calendar for the liberalisation of the natural gas market defined at the Council of Ministers of 22 June 2006. In 2007, the separation in accounting terms (for all companies) and legal terms (for companies with more than 100 000 consumers) between the activities of distribution and supply was also achieved.

The deadlines established for opening the natural gas market are:

- Producers of electricity in standard generation (excludes co-generators), from January 2007;
- Customers whose annual consumption is equal to or higher than 1 million cubic metres, from January 2008;
- Customers whose consumption is equal to or higher than 10 thousand cubic metres, January 2009;
- All other customers, from January 2010.

The commencement of retail market liberalisation in the natural gas sector was January 2008. Customers with annual natural gas consumption greater than one million cubic metres were deemed eligible in January 2008 and a third-party access regime was fully implemented in July 2008. Eligible customers have the option to be supplied by a retailer or by a last-resort supplier under regulated tariffs. In 2007, end-user prices continued to be approved by the Ministry of Economy and Innovation, on the basis of proposals submitted by the concession and licence holders. In the first half of 2008, the responsibility for this approval was transferred to ERSE.

High levels of activity have been observed in the newly liberalised market. Over 32% of the market by volume has moved to the competitive market. Of this 32%, Galp has secured a 29.8% market share, EDP Gás a 2.3% share and Gas Natural a share of 0.05%. From July 2009 the liberalised market will benefit from an additional release of 300 mcm of natural gas or 12% of the market following an auction held in February 2009.

## OTHER REFORMS

In order to enhance the liquidity of the liberalised gas market, ERSE imposed an obligation on GDP to auction 300 mcm per year, for a three-year period, starting in July 2009. The first auction took place in February 2009 and all gas was sold. The auction volumes corresponded to the opening of the market to 15% of industrial consumption. Similar auctions will take place in 2010 and 2011.

Changes are being proposed to reduce fixed costs for the utilisation of the Sines LNG terminal in order to increase competition by reducing entry barriers for new suppliers. A regulated swap mechanism has also been proposed, where the incumbent supplier will take the bulk of gas from a single shipment received by a competitor and hand it back in a programme phased over time. At retail level, flexibility is to be introduced by the setting of new tariffs, facilitating seasonal consumption without increasing the current high fixed cost.

## MIBGAS

In addition to the opening of the natural gas retail market, another significant initiative in the natural gas sector is the creation of the Iberian Gas Market or MIBGAS, which will mirror recent changes to the Iberian electricity market. In this regard, the two respective regulators, ERSE and the Comisión Nacional de Energía (CNE), prepared a document, Regulatory Harmonisation Plan, for the energy sector in Portugal and Spain, which was submitted to the two governments in early 2008. The document defines the principles for the operation of the MIBGAS and a road-map for its development.

The new market should improve security of supply, operational co-ordination and the reinforcement of interconnection capacity between Spain and Portugal; increase levels of competition; harmonise and simplify to the greatest possible extent the regulatory rules; and foster greater efficiency as well as market transparency.

## RETAIL MARKET

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Decree-Law 140/2006 of 26 July established that distribution companies with more than 100 000 customers must separate their distribution and supply businesses and operate the activity of supply by means of independent companies offering a last-resort supply service.

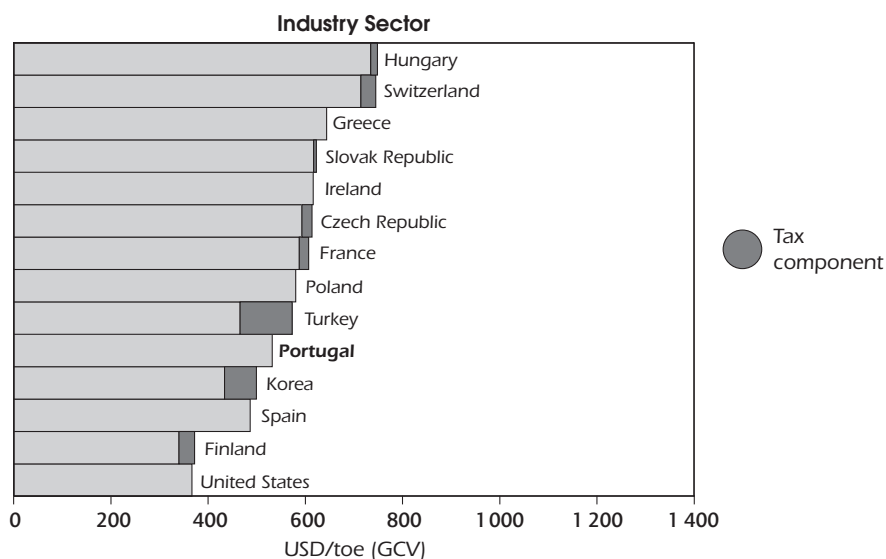
The last-resort supplier remains subject to public-service obligations in the areas served by the public natural gas system. Operators must also obtain a licence to engage in this activity. The activity is legally unbundled from the other activities and is subject to regulation. Decree-Law 140/2006 established that Transgás, SA should be awarded a last-resort supply licence for all customers with an annual natural gas consumption of 2 mcm or more, excluding standard regime electricity generators, until 2028. For smaller amounts of natural gas, licences have been awarded to the existing distribution operators lasting as long as either the existing concession contracts or the existing distribution licences.

## NATURAL GAS PRICES: POLICY

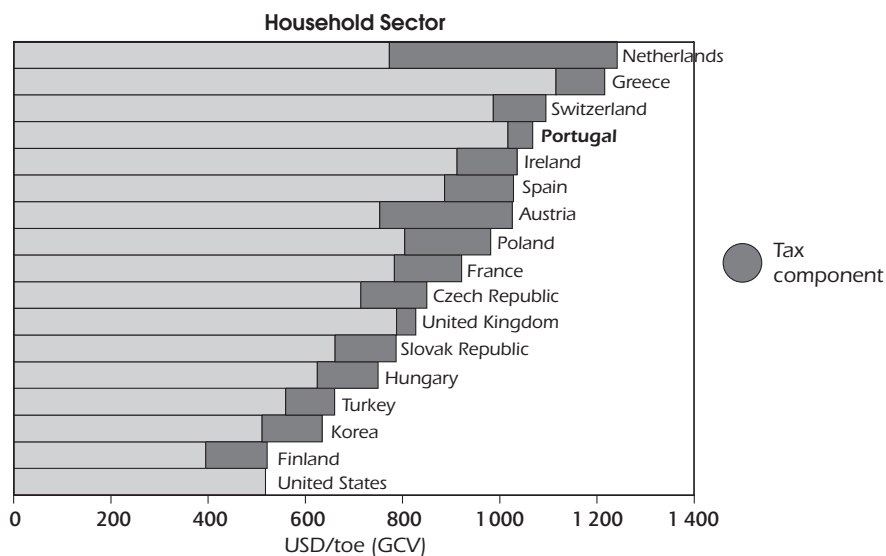
Since July 2008, the ERSE, the sectoral regulator determines and approves the end-user tariffs for last-resort suppliers and also access tariffs to the distribution network. Tariffs are determined in a manner that allows the full recover of all efficiently incurred costs. End-user regulated tariffs result from the sum of regulated tariffs determined for each activity of the natural gas value chain (wholesale energy price, retail, distribution and transmission networks and system management). Third-party access tariffs are non-discriminatory and are applied to all customers.

Figure 25

## Gas Prices in IEA Member Countries, 2008



Note: Tax information not available for the United States. Data not available for Australia, Austria, Belgium, Canada, Denmark, Germany, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Sweden and the United Kingdom.

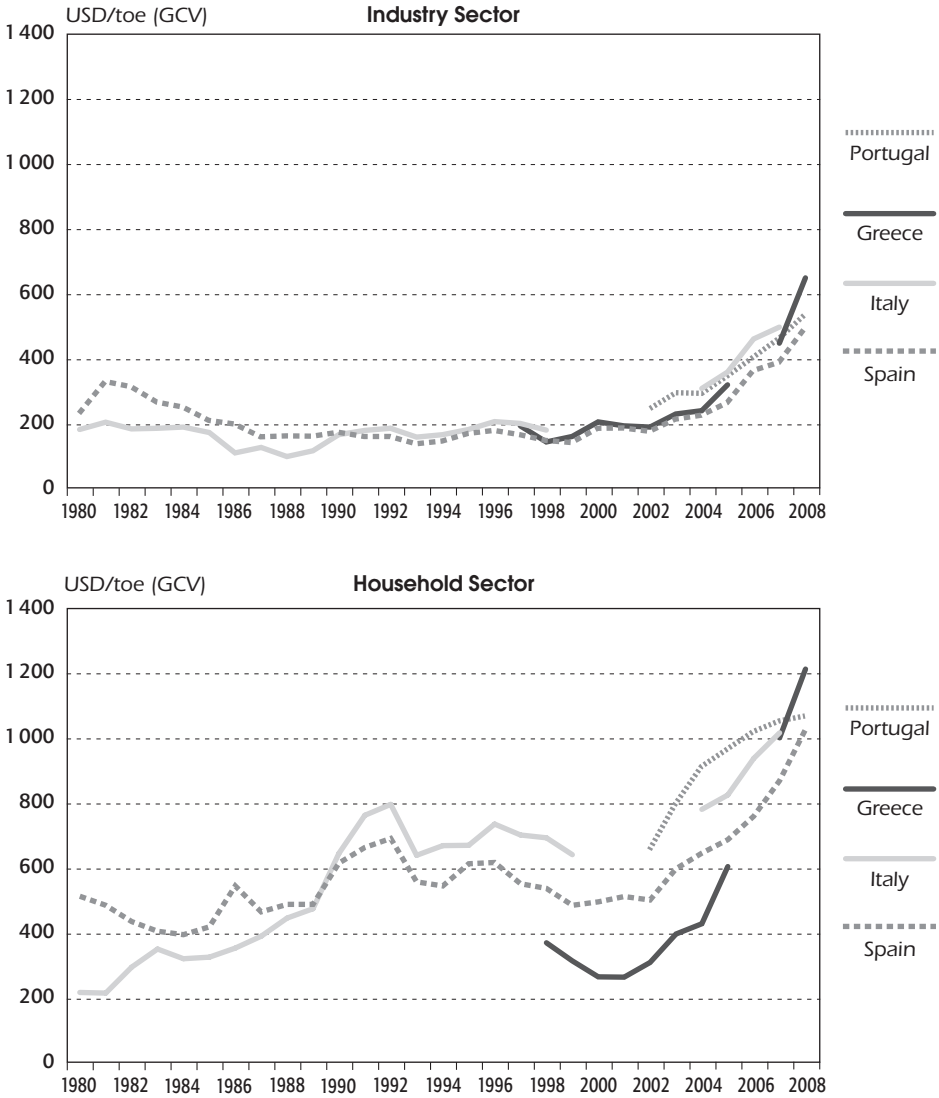


Note: Tax information not available for the United States. Data not available for Australia, Belgium, Canada, Denmark, Germany, Italy, Japan, Luxembourg, New Zealand, Norway and Sweden.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2009.

Figure 26

Gas Prices in Portugal and in Other Selected IEA Member Countries, 1980 to 2008



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2009.

For non-domestic customers, the end-user tariffs are adjusted quarterly in accordance with the evolution of wholesale gas prices. For domestic customers, the end-user tariffs are adjusted annually. There is no price capping for natural gas prices.

## NATURAL GAS SECURITY

In accordance with the terms of Decree-Law 140/2006, mandatory security reserves must be provided by those parties that import the gas. Such importers are mandated to hold gas reserves of 15 days consumption of non-interruptible gas-fired power plants (electricity producers in ordinary regime) and 20 days consumption of non-interruptible customers in the remaining market. The average daily consumption figures in each case are calculated on the basis of a daily average of the last 12-month period. At present, the government does not anticipate holding government-owned gas stocks.

The gas inventories that may be counted for the purpose of mandatory security reserves are the combined existing stocks of each supplier in underground storage, LNG storage and at LNG carriers with fixed port destination in Portugal with an estimated time of arrival of up to nine days. Currently, the available underground storage capacity is not enough to meet the compulsory gas inventory requirements, which means LNG storage is utilised for this purpose.

The Global Technical System Manager (GTSM), REN, which is responsible for the management of the Portuguese natural gas system, is assigned to monitor the compliance of the market players in terms of their obligation to maintain mandatory security gas reserves under the terms mentioned above. These obligations are monitored and reported to the DGEG on a monthly and quarterly basis. At present, the volume of mandatory security reserves is not made public.

The mandatory gas reserves in Portugal are mostly commingled with commercial stocks. The average stock level of mandatory gas reserves in 2008 was estimated to be around 234 mcm, which is equivalent to a volume of 21 days of imports in 2007. But as indicated above, some of this volume was in ships on their way from Nigeria to Portugal. The volume of commercial stocks stored underground and at the LNG terminal is roughly estimated to be between zero and 104 mcm, which is equivalent to a volume of 9 days of imports in 2007.

Decree-law 140/2006 stipulates that in emergency situations, the Minister of Economy and Innovation may define priority rules, taking into consideration the supply of household consumers, health services, safety services and other consumers highly dependent on gas. Release of compulsory gas stocks is to be decided by the minister responsible for energy under the conditions established by Decree-Law 30/2006 and Decree-Law 140/2006. No automatic triggers exist under the current relevant laws.

Taking into account that the natural gas infrastructure in Portugal is very recent and that the transmission capacity is much higher than the present



needs, no congestions have occurred thus far. As a consequence, the concept of interruptible supply has not been seriously considered in the regulatory framework in force. The regulator has established competitive bidding as the rule to solve congestion and this will eventually lead to demand-side management for client portfolio management from the shippers, if and when congestion arises in the gas system. However, interruptible supply is foreseen for future CCGT power plants with dual-fire capability. No specific mechanism or rules are established to implement interruptible contracts.

Fuel-switching capacity for gas users is limited in Portugal. In the case of electricity generation, a CCGT group at Turbogás power station has dual firing capacity and can switch between gas and diesel. The CCGT is not required to hold a volume of diesel stocks. There is no legal requirement for increasing fuel switching capability.

## CRITIQUE

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The introduction of natural gas in Portugal has been very successful in terms of penetrating the energy market through the extension of pipeline networks, the construction of an LNG terminal and a number of underground storage facilities. In a short period, natural gas has developed to become a significant contributor to Portugal's energy mix. This has led to the reduction in Portugal's dependence on imported oil and diversified Portugal's energy supply. Natural gas use is to a large extent substituting for more CO<sub>2</sub>-intensive energy sources and thereby contributing to lower CO<sub>2</sub> emissions.

Since the last in-depth review in 2004, Portugal has made significant progress with regard to the development of the natural gas market and its institutional framework and regulatory institutions.

Legislative changes, vertical ownership unbundling and establishment of the independent transmission system operator are all good examples of this.

Infrastructure development has been stimulated by active support from the government. Instrumental in this have been investment subsidies and European funds. The government support to finance expansions of the system is now less necessary and the attention should be focused on providing a good investment climate through stable policy and regulatory frameworks.

As an emerging gas market, Portugal received derogation from EU Directive 2003/55/CE. Nonetheless, the schedule for market opening is more ambitious than the directive requires and Portugal has achieved the targets set thus far for market opening.

Portugal has established a strong, well-resourced, independent regulator for the electricity and natural gas sectors. An important task for the regulator

is to set the regulated gas price for the last-resort supplier and determine tariffs for third-party use of infrastructure. It is important that the regulator's independence and authority are maintained and that the regulator retains the necessary means to conduct its duties.

Market concentration represents a significant challenge to government and regulators, and competition in both wholesale and retail markets must therefore be stimulated. The proposed auctioning process is another important step in this respect but will only work if the auctions form a part of a more coherent long-term competition strategy. Decisions on the regulated retail price must therefore be cost-reflective and responsive to changes in the wholesale market. As in the electricity market, consumers of gas need a clear timetable towards the ending of tariff regulation. To switch from regulated gas prices to a free price formation will mark an important further step towards the growing maturity of the Portuguese gas market.

The welcome establishment of an Iberian gas market – MIBGAS – is an important step to develop the gas market to the benefit of consumers in Portugal and Spain. This will increase the necessity for a consistent approach to natural gas policies between Portugal and Spain, and it will stimulate further policy developments for the benefit of Iberian markets.

IEA is pleased to see that the Portuguese government has already made efforts to streamline the licensing procedures for new energy infrastructure. The government's Simplex programme, aimed at simplifying administrative procedures, implemented measures in 2007 to reduce the duration of licensing procedures for natural gas (and electricity) infrastructure. This initiative is welcome. This kind of effort could be enhanced also by further co-operation with the related local authorities.

Although Portugal has to date built up capacity to meet projections of growing consumption of natural gas, capacity should continue to be expanded in line with forecast long-term increases of natural gas consumption. The time horizon of the current official infrastructure plan is appropriate to ensure that additional capacity can be placed in service in a timely manner.

Taking the growing importance of natural gas within the Portuguese fuel mix – particularly in the power sector – into account, the level of security of natural gas supply should be closely monitored. In this respect, it is commendable that Portugal has already taken a significant number of proactive measures, most significantly the construction of LNG import facilities, as well as planned capacity expansions to the transmission network (including greater cross-border connections, additional compression and new ring main infrastructure). A new LNG storage tank at Sines is also under construction (commissioning is scheduled for mid-2012). In this regard, the diversification of both pipeline gas and LNG supplies is important. Two suppliers provide all of Portugal's natural gas demand and the country may be vulnerable in the case of a prolonged disruption in supply from either source. Portugal is solely reliant on Nigeria for

LNG imports and consideration must be given to broaden sources of supply. Greater participation in global LNG markets would strengthen security. There is still some room for further diversifying the supply source even though this matter depends on the nature of commercial contracts. Given the current limited storage capacity, contingency plans for gas supply disruption should be developed and tested so that they can effectively be utilised should an unexpected emergency occur.

## RECOMMENDATIONS

*The government of Portugal should:*

- ▶ *Continue its efforts to reduce concentration in the retail and wholesale markets, including improving the regulatory framework towards more competition.*
- ▶ *Monitor closely the development of the natural gas market and continue to encourage investment in critical storage and pipeline infrastructure, including more flexible additional interconnections with Spain.*
- ▶ *Continue to work with the government of Spain and the relevant stakeholders to develop the Iberian natural gas market.*
- ▶ *Make sure that there is sufficient transportation and storage capacity in the long term from the perspective of the security of natural gas supply and security of electricity supply as the electricity system absorbs more gas.*
- ▶ *Further encourage the natural gas importer(s) to diversify supply sources.*
- ▶ *Further develop its gas emergency response policy and mechanisms, and also assess the possible impacts which gas supply disruptions might have on the domestic oil market and on domestic electricity supply.*



## OVERVIEW

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Over a relatively short period of time the electricity supply industry in Portugal has changed from a vertically integrated monopoly structure to a dual market structure (where regulated and free markets operate in parallel). Transmission has been ownership unbundled, while distribution system operators (DSO) are legally unbundled; the retail market is open to full competition; and a regional market, MIBEL (Iberian Electricity Market), has been implemented.

## SUPPLY AND DEMAND

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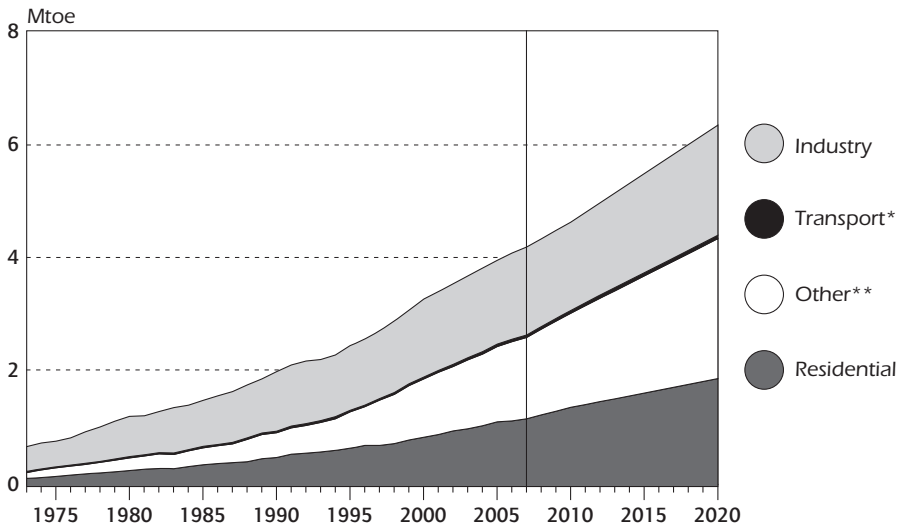
Electricity demand in Portugal has grown considerably in the past ten years, at an average annual growth rate of 4.4 %. Over the same period, GDP grew at a moderate 2% per year. In 2007, gross production of electricity was 47.2 TWh, a decrease of 3.6% or 1.8 GWh on the previous year. Prior to that, electricity demand had been rising at a higher rate than GDP growth for the past number of years (averaging 3.2 % per year in the period 2003 to 2005 compared with a GDP growth rate slightly above 0.54% per year in the same period). In the period 2005 to 2007, demand growth slowed to around 2.0 %. Residential and small business customers represent more than half of total consumption and the industrial sector almost 34%.

In 2007, the breakdown of electricity consumption by end-use sector was industry 38 %; residential 28%; commercial and services 31 %; transport 1 %; and agriculture, forestry and fishing 2%. As the economy has developed over the past decade, electricity consumption has increased particularly rapidly in households and the services and commercial sector, by 37.8 % and 38.3 % respectively since 2000. Annual use per capita, at around 4.7 MWh in 2007, is almost half of the OECD average, which is explained by the low space heating demand in a mild climate coupled with a small industrial base. Annual peak demand has grown by 10 % over the period from 2004 to 2007, from 8 250 MW to 9 110 MW.

In Portugal, the electricity consumption is sensitive to prevailing weather conditions, most obviously in winter. Peak demand tends to happen in December or January and recently a record of 9 110 MW (Portuguese mainland) was noted on 18 December 2007. Consumption levels also tend to be high in July owing to very hot weather and the increasing use of cooling appliances in businesses and households.

Figure 27

## Final Consumption of Electricity by Sector, 1973 to 2020



\* negligible.

\*\* includes commercial, public services, agriculture, forestry, fishing and other non-specified sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008 and country submission.

## INDUSTRY STRUCTURE

The legislative framework for the Portuguese electricity sector was revised in 2006, abolishing the pre-existing dual regime, where a public service sector, regulated by ERSE, and provided with power by power plants under exclusive power purchase agreements (PPA) with the transmission system operator (TSO), coexisted with a fully liberalised segment. Distribution was then legally unbundled from supply, and a last-resort supplier was created. The last-resort supplier is obliged to accept any customer who so desires.

The previous incumbent, Energias de Portugal (EDP), remains the country's largest electricity generator. At present, two independent thermal power producers (IPPs) also operate in Portugal, Tejo Energia and Turbogás, although EDP is a minor shareholder in Tejo Energia. Spanish generators including Endesa, Gas Natural, and Iberdrola recently participated in a competitive bidding process for permits to build new generating capacity in Portugal, as did EDP, Tejo Energia and Galp Energia, the local oil company. All but Gas Natural received a licence to build. For competition purposes, licensing

limits are in place, capping any one market participant's capacity at 40% of Portuguese MIBEL capacity or 50% maximum in portfolio for each primary source. Furthermore, a grid connection for 800 MW of capacity at Sines has been reserved for clean coal technology.

Renewable sources currently account for 48.8% of total capacity in Portugal, largely hydroelectric plants, which represent 34% of total installed capacity.

Electricity transmission activity is carried out by REN Rede Eléctrica by means of an exclusive 50-year concession granted by the Portuguese State in June 2007. Additionally, REN is the primary operator for the remaining legacy PPAs in Portugal. Electricity distribution is operated via the national distribution grid, consisting of a medium- and high-voltage network, and through the low-voltage distribution grids. Again, the national distribution grid is operated by means of an exclusive concession granted by the State. At present, the exclusive concession at high and medium voltage has been awarded to EDP Distribuição. The low-voltage distribution grids continue to be operated under concession agreements awarded by municipalities, primarily to EDP Distribuição.

Portugal is interconnected with Spain and electricity largely flows into Portugal, with more than 12 500 GWh of electricity imported in 2007. REN is currently planning to build two new interconnections with Spain, which are expected to be operational between 2010 and 2014, and these are expected to increase interconnection capacity from 1 800 MW to 3 000 MW.

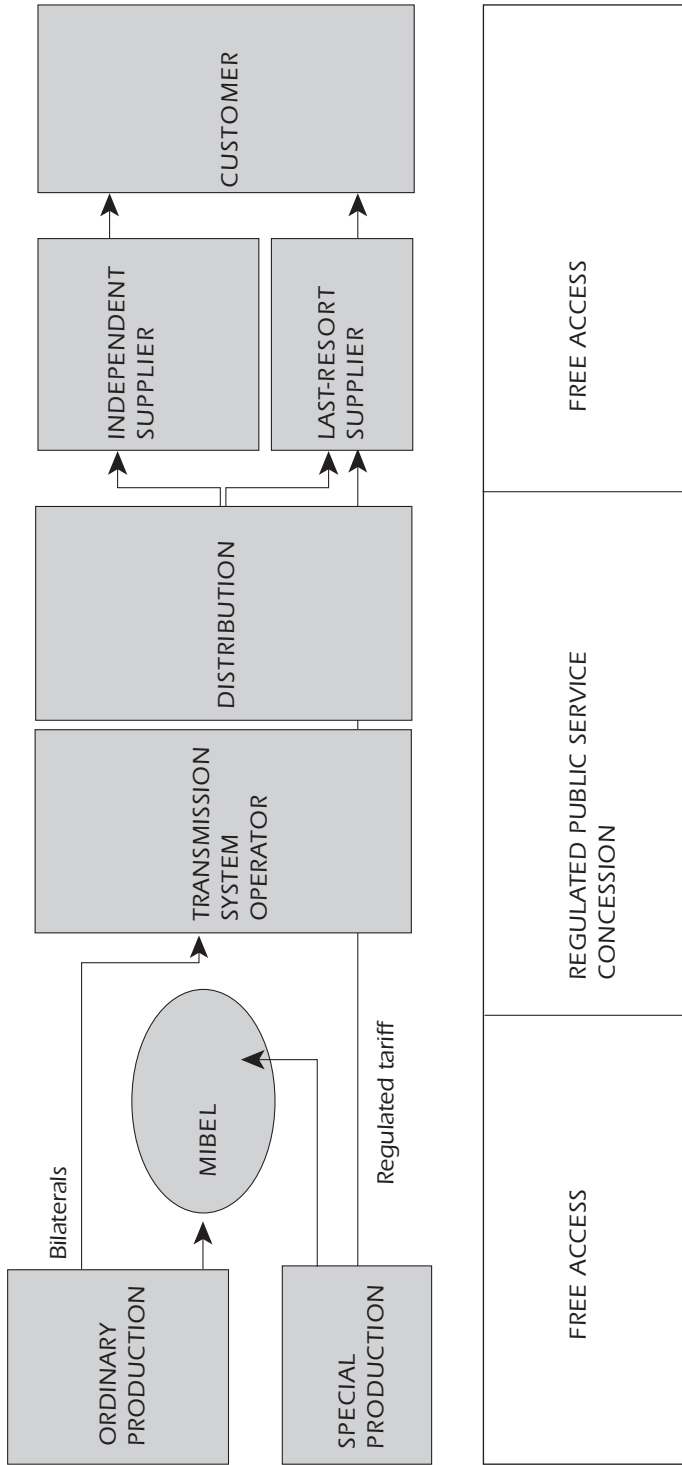
The supply of electricity is fully open to competition, subject to obtaining the necessary licences and approvals. Suppliers may freely buy and sell electricity, and have third-party access to the transmission and distribution networks upon payment of network access charges determined by ERSE, the sectoral regulator. Under the New Electricity Framework, consumers are free to choose their supplier, although a form of regulated tariff remains the preferred option for most retail customers, and customers may switch supplier without incurring any additional charges. A new entity, regulated by ERSE, is to be created to oversee the customer switching operations; at present switching is handled by EDP Distribuição under procedures regulated by ERSE.

EDP Serviço Universal, which acts as a last-resort supplier, is currently the main supplier in Portugal. Other supply companies active in the market are EDP Comercial (6% market share in 2007), Endesa (3%), Iberdrola (less than 1%) and Unión Fenosa (less than 1%). In total, there are 23 supply companies active in the Portuguese retail market, but most of those have negligible market share.

The last-resort supplier is responsible for the purchase of all electricity generated by special regime generators, an obligation which until January

Figure 28

Organisation of the Electricity Market



Source: DGEC.



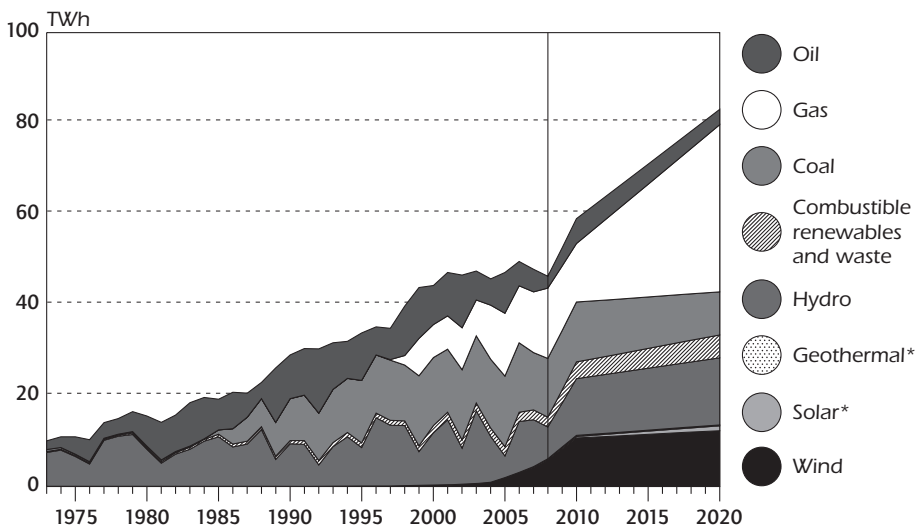
2007 was carried out by REN Rede Eléctrica, and for the supply of electricity to customers who purchase electricity under regulated tariffs and is subject to universal service obligations. The government has committed to phasing out regulated tariffs in the medium term.

## ELECTRICITY GENERATION

Electricity generation in Portugal is to a large extent exposed to competitive pressures, subject to obtaining the necessary licences and approvals from the administrative authorities. Generation of electricity is divided into two regulatory regimes: ordinary regime generation, which refers to the generation of electricity through traditional non-renewable thermal sources and large hydroelectric plants; and special regime generation, which refers to the use of alternative indigenous and renewable sources of energy for electricity generation and co-generation. Special regime generation is subject to different licensing requirements and benefits from special feed-in tariffs. Under the New Electricity Framework, the last-resort supplier (currently EDP Serviço Universal) is obliged to purchase all electricity generated under the special regime.

Figure 29

### Electricity Generation by Source, 1973 to 2020



\* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008 and country submission.

## GENERATING CAPACITY

Portugal, including Azores and Madeira, maintained slightly over 15 000 MW of installed capacity at the end of 2007. Currently, hydropower is the dominant technology with 5 020 MW (34%) of installed capacity followed by oil and natural gas, which account for 5 635 MW of capacity, or 2 852 MW (19%) and 2 783 MW (18.5%) respectively. Wind, which has grown rapidly over the past five years, provides 2 200 MW (14.65%) of capacity and coal, although static in growth terms, still retains a significant share of the generation portfolio, 1 776 MW or 11.82% of capacity. The remainder comes from other renewable sources, mainly geothermal, waste, and solar.

Despite the wide diversity of energy sources, ownership of generation in Portugal was, until recently, highly concentrated. At present, the principal thermal electricity generators are EDP Produção, subsidiary of EDP, Tejo Energia (2 x 300 MW coal-fired units, 50% owned by International Power Portugal, 38.9% by Endesa and 11.1% by EDP) and Turbogás (3 x 330 MW gas-fired CCGT, 100 % owned by International Power Portugal). In the first year of activity of the Iberian Electricity Market (or MIBEL), EDP enjoyed a market share of around 55%, Tejo Energia and Turbogás together had 20%, and the remaining 25% was supplied by the special regime producers, *i.e.* those that do not compete in the liberalised wholesale market.

## NEW CAPACITY

Between 2008 and 2015 four combined cycle gas turbines (CCGT) are planned, adding a further 3 320 MW of capacity to the electricity system. Ten new hydro-generation units will also be commissioned by the end of 2015, adding a further 1 100 MW of new installed capacity. A number of repowering projects are also planned, including Venda Nova III (436 MW) and Salamonde II (85 MW).

The decommissioning of 1 877 MW of thermal capacity is also planned before 2014. Two units at the Carregado power plant will be decommissioned in 2009 (236 MW), another two units in 2010 (236 MW) and the remaining two in 2011 (236 MW). Plants at Setúbal (948 MW by 2012) and Barreiro (56 MW by 2009) and the remaining gas turbines at Tunes (165 MW by 2010), will also be removed from service.

## TRANSMISSION

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An exclusive 50-year concession for electricity transmission was awarded to REN by the Portuguese government in June 2007. REN is responsible for the technical management of the system, ensuring continuity and security of

supply, and the integrated and efficient operation of the national electricity system. The terms of the concession granted to REN include the planning, construction, operation and maintenance of the transmission network. REN also undertakes research and development relating to electricity transmission in Portugal.

## THE NATIONAL TRANSMISSION NETWORK

The Portuguese transmission network (RNT) is owned and operated by REN. At the end of 2007, it comprised 7 426 km of lines, of which 1 588 km were at 400 kV, 3 177 km at 220 kV and 2 661 km at 150 kV. This represents a 6% increase in network capacity when compared to 2006. The network includes 53 substations with an installed transformer capacity of 23 097 MVA.

The high-voltage network is based on 400 kV lines running in a north-south direction along the coast, from generation at Sines in the south to the Alto Lindoso generation plant in the north by the interconnection to Spain. This is supplemented by 220 kV lines, principally between Lisbon and Porto, and diagonally from Coimbra to Miranda do Douro, along Douro river, and in the centre of the country. In addition, 400 kV lines run east-west from Sines to the interconnection with Spain near Brovales (Alqueva – Brovales) and from Rio Maior to the interconnection with Spain near Cedillo (Pego – Cedillo). A series of 150 kV lines provide further support to the network.

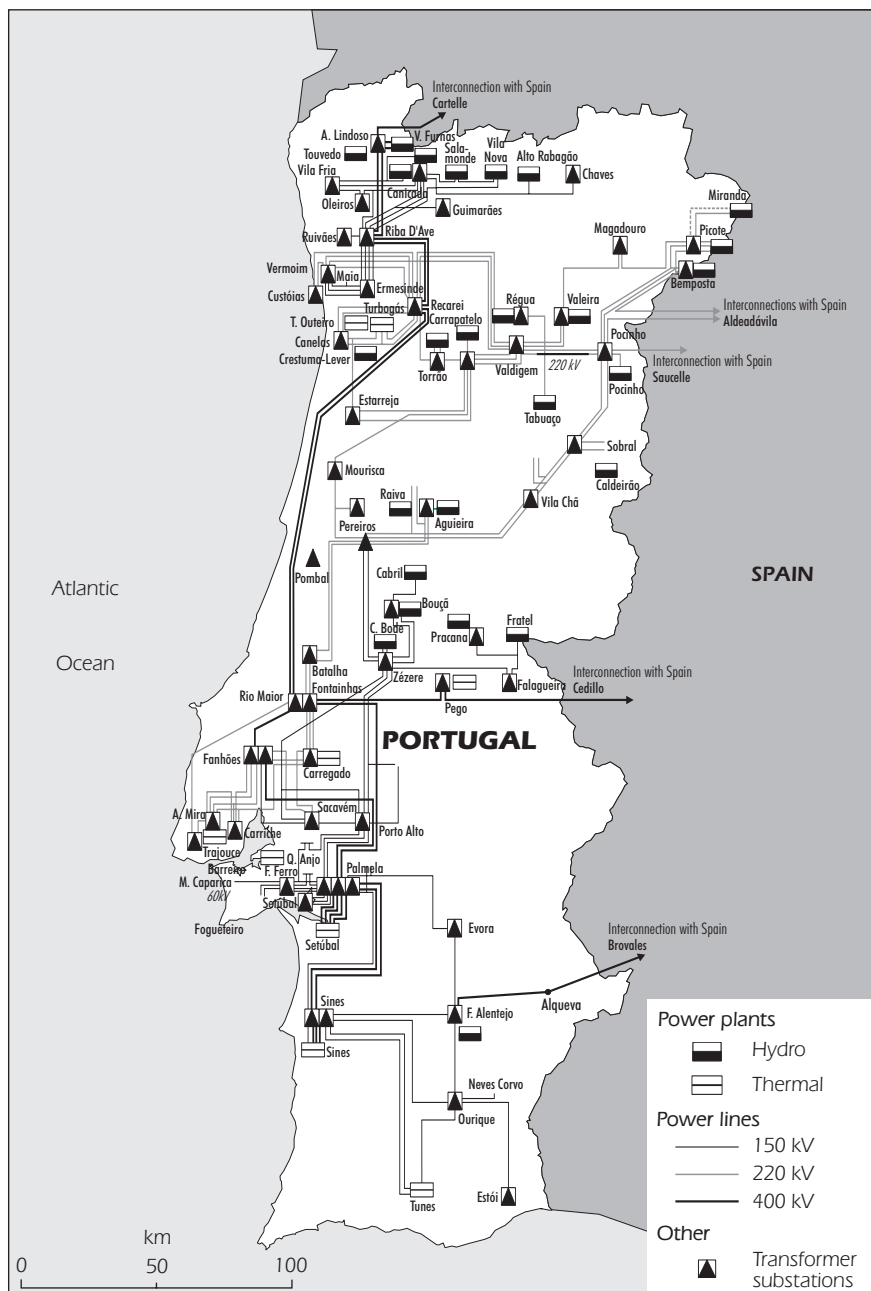
Recent network developments include the Bodiosa-Paraimo 400 kV line, the Batalha-Pego and Sines-Portimão lines (both 150 kV), the Castelo Branco-Ferro 1 and 2 and Fanhões-Trajouce (both at 220 kV), all of which entered into operation during the 2005-2007 period. This new capacity will improve overall network stability, accommodate the new renewable generation capacity and guarantee the ability to meet forecast future demand. New substations at Penela, Castelo Branco, Trafaria (Almada) and Alqueva, and a switching station at Pedralva (Braga) also came into operation in the same period.

The major components of the RNT have an average estimated technical life of between 35 and 40 years from the date of initial construction, with the exception of the power lines, which have an average estimated technical life of approximately 50 years. The RNT was constructed during the 1950s, but has been subject to regular repairs and renovations, including the renovation and replacement of older transmission lines.

The government is responsible for approving the network investment plans, for both the transmission and distribution networks. These plans result from a proposal by the respective network operator after previous public consultation and the regulator's non-binding advice. The energy regulator must then approve the investment proposals set out in these plans before their costs can be recovered from customers via the transmission tariffs.

Figure 30

### Electricity Transmission Network, 2008



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Sources: REN and IEA.

Customers use the network on the basis of regulated third-party access and pay a postage stamp tariff with full cost recovery from consumers (generators do not pay transmission costs). Network tariffs are evaluated taking into consideration the capital and operating costs, which are then charged to the consumers using the infrastructure.

The government must approve all connections for power plants – including renewable generation – following a public tender process in which all interested parties may participate. For special regime production (PRE), the licensing is a matter of approval by Directorate-General for Energy and Geology (DGEG).

## CROSS-BORDER TRANSMISSION LINES

The Portuguese electric system is linked to Spain by four 400 kV interconnector lines: a double line in the north of Portugal, at Alto-Lindoso/Cartelle, and two single 400 kV lines in the centre and south of the country, at Falagueira/Cedillo and Alqueva/Brovaes. The remaining interconnections are composed of 220 kV lines all of them in the north-east of Portugal, Bemposta/Aldeadávila, Pocinho/Aldeadávila and Pocinho/Saucelle. At present, the available capacity varies between 1 100 MW and 1 600 MW for imports from Spain, and between 1 200 MW and 1 600 MW for exports. Network congestion within Portugal is rare. In recent years, however, interconnector flows from Spain to Portugal have tended to be congested. In order to reduce the rates of congestion, an investment programme has commenced to increase the number and capacities of interconnections with the Spanish transmission network. Further developments are planned, including the construction of a new 400 kV line and the construction of two new 400 kV interconnections, one in the north-west and the other in the south.

## SECURITY OF SUPPLY

Monitoring and guaranteeing supply in the electricity sector is the responsibility of the government, via DGEG, in co-operation with REN, the transmission system operator.

Decree-Law 23/2009 of 20 January completed the transposition of Directive 2005/89/EC on security of electricity supply and infrastructure investment. The transmission network and electricity distribution development plans established in the law are also an integral part of security of supply. ERSE issues its opinion on the investments earmarked in these plans. In recent years there has been considerable investment in terms of special regime generation (in the last five years, its share in meeting demand rose from 8% to 20%). This trend is expected to continue for the next few years, along with the increase in installed capacity in terms of combined cycle and hydroelectric power stations.

The capacity margin, which is defined as the difference between the installed generating capacity and the peak in annual demand, was 35% in 2006 and 2007, while in 2005 it was 33% and in 2004, 30%. Energy sources for power generation have become more diverse in recent years. Network reinforcement works have continued in recent years, allowing for increased flows and the expansion of intermittent renewable generation. Projects to increase international transmission capacity are also under way, including an interconnection between the Algarve and Andalusia in Spain.

## **DISTRIBUTION**

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Distribution activity is legally unbundled from generation, transmission and supply activities. EDP Distribuição is the medium-voltage distribution operator under a 35-year concession granted by the government, subject to regulation. Distribution in lower-voltage level is performed (by EDP and a number of smaller operators) under concessions granted by the relevant municipality for a concession period of 20 years. EDP Distribuição, 100%-owned by EDP, is also subject to additional requirements to ensure its independence in accordance with article 15 of European Directive 2003/54/EC.

## **DISTRIBUTED GENERATION**

At the end of 2007, special regime production (wind, small hydro, CHP, etc.) represented 26% of the installed capacity on continental Portugal and 24% of electricity delivered to the grid. The main contributors are wind generators (4007 GWh in 2007) and CHP (5729 GWh in 2007). In Portugal there is a feed-in tariff and the last-resort supplier has the obligation to buy all special regime generated energy. There has been a significant investment in the grid (transmission and distribution) in order to ease the integration of special regime generation.

## **CHP DEVELOPMENT**

Combined heat and power (CHP) is treated under special regime generation. Treated similarly to renewables, there is a feed-in tariff scheme and the last-resort supplier has the obligation to buy all generated energy.

In recent years, installed CHP capacity has increased slightly and at the end of 2007 there was 1 400 MW of installed capacity, largely in the industrial sector (chemicals 36%, pulp and paper 28%, textile 15%). Co-generated electricity amounted to 5.7 TWh of output in 2007 or 12 % of total power generation. Fuel oil remains the main energy source for co-generation. Gas-

fired CHP represents 27% of capacity and biomass 24%. A small number of CHP facilities have fuel-switching capability (12 MW of capacity can switch from fuel oil to natural gas).

CHP generators benefit from a regulated feed-in tariff, determined by government, based on the avoided costs to the electrical system due to CHP generation. The tariffs are a function of operating costs, availability, transmission losses and investment costs. An environmental factor is added according to the thermal efficiency of the plant. The fuel is indexed to an international petroleum price.

Although no direct subsidies are applied, electricity produced by CHP was remunerated, in 2007, at an average feed-in tariff of EUR 95.3 per MWh. Taking into consideration the new co-generation plants already approved or under construction, Cogen Portugal expects that an additional 250 MW of capacity will be commissioned by 2010, taking installed CHP capacity to 1 650 MW.

The lack of network capacity to accommodate new generation and the lack of suitable heat consumers are barriers to further growth in industrial co-generation. The potential of the commercial sector is limited but there are some opportunities for cooling. The new National Action Plan for Energy Efficiency (PNAEE) and the implementation of the European Directive on the Energy Performance of Buildings may help to promote CHP. If some large investment projects (PIN), now under discussion are accepted and approved, the co-generation capacity may reach 2 000 MW before 2020. With this in mind, the government plans to publish a new legal framework for co-generation in 2009.

## TRANSMISSION AND DISTRIBUTION IN THE AUTONOMOUS REGIONS OF THE AZORES AND MADEIRA

In the autonomous region of the Azores, Electricidade dos Açores (EDA) is both the transmission and the distribution system operator. This company holds the concession of electricity transmission and distribution in each of the nine islands that compose the Azores archipelago. This concession was awarded by the regional government of the Azores.

In the autonomous region of Madeira, Empresa de Electricidade da Madeira (EEM) is both the transmission and the distribution system operator. This company holds the concession of electricity transmission and distribution in the islands of Madeira and Porto Santo. This concession was awarded by the regional government of Madeira.

## REGULATORY FRAMEWORK AND MARKET DESIGN

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The legislative framework for the Portuguese electricity sector was revised in 2006, abolishing the pre-existing dual regime, where a public-service sector, regulated by ERSE and supplied by plants under exclusive power purchase agreements (PPAs) with the TSO, coexisted with a fully liberalised market. Other important developments include the opening of the electricity market and strong progress in MIBEL implementation, the introduction of competition-oriented measures such as the VPP (virtual power plant) auctions and market-oriented capacity allocation mechanisms for the interconnectors.

The Energy Services Regulatory Authority (ERSE) is the sectoral regulator for natural gas and electricity. It is an independent public body and appears to be adequately staffed and financially resourced. ERSE is independent in the exercise of its functions, within the framework of the law. The ERSE mission includes, *inter alia*, protecting the rights and interests of consumers in relation to prices, quality of service, information access and security of supply. In the framework of the internal energy market, ERSE promotes efficient competitiveness, ensures a level playing field to the regulated enterprises, fosters energy efficiency and reduces environmental impact. Furthermore, ERSE tries to settle disputes, fostering voluntary settlement.

## MARKET REFORM

Between 2004 and 2008, several reforms were implemented in the wholesale electricity market, namely the implementation of the futures market platform (OMIP) in the Iberian electricity market (MIBEL) as well as the adoption, in July 2007, of the Spanish spot market as the day-ahead market for Portuguese market players.

The launch of the MIBEL daily market, managed by OMEL, was one of the most important developments in the Portuguese wholesale market in the recent past. The previous incumbent's power purchase agreements (PPAs) were terminated early in 2007 in order to facilitate liquidity in the MIBEL spot market. The early termination of the PPAs was compensated with the Costs for the Preservation of Contractual Equilibrium (CMEC) mechanism; a stranded cost recovery mechanism designed by the government and supported by legislation published at the end of 2004. CMEC is an adjustable financial compensation scheme aimed at guaranteeing that plants that terminated their PPAs will be able to recoup the same level of profits in the market they would have obtained under the former PPA. Two electricity generators (Turbogás and Tejo Energia) chose to maintain their PPAs with the TSO. The TSO created an entity, REN Trading, to trade the energy of these two power producers in the MIBEL market.



Several VPP auctions were run in Portugal, their main purpose being to facilitate the entrance of new players in the liberalised electricity supply market. Capacities available in the auctions ranged from 140 MW to 300 MW, covering power plants managed by REN, the TSO, and by the incumbent EDP. During 2007 and the first half of 2008, four VPP auctions took place, managed by OMIP and OMIClear.

The sector has seen further progress since the liberalisation of the retail market in 2007, including the definition of rules for the change of supplier process, the strengthening of regulatory harmonisation plans for the south-west European electricity market, more efficient management of interconnections (introduction of the Mechanism for Joint Management of Portugal-Spain Interconnections and increased harmonisation between the Iberian market and France) as well as consolidation of supervision of retail and wholesale markets. By early 2009, competition in the retail sector recovered some of the ground lost in the previous year with 14% of electricity consumption moving away from the regulated market, reducing the incumbents' market share by volume from 93% on 1 January 2009 to 64% by the end of the first quarter.

## MIBEL

The all-Iberian electricity market (MIBEL) became operational on 3 July 2006, with the goal of improving security of supply and economic efficiency. A single market operator was created, and a common price for electricity for both countries applies when interconnection capacity allows it.

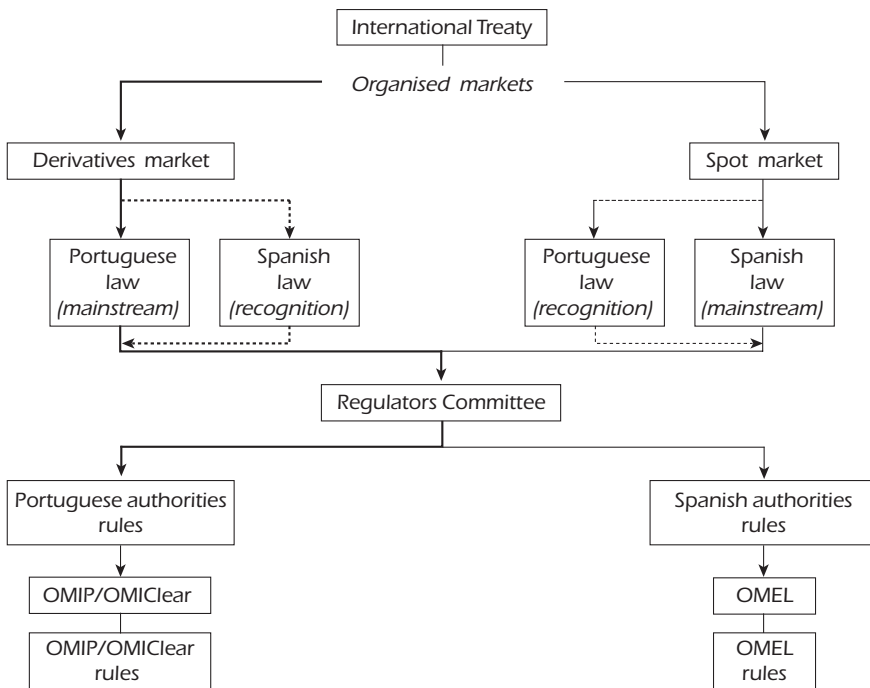
The MIBEL development process commenced in July 1998 with the signing of a Memorandum of Understanding between the Portuguese Minister of Economy and the Spanish Minister of Industry and Energy for co-operation in the electricity sector. In January 2004, an agreement creating the Iberian Electricity Market was signed in Lisbon, accelerating the creation of a single market for both countries. This agreement established the commencement of operations in 2004, and allocated the daily and intra-day market management to OMEL, located in Spain, and the management of the futures market to OMIP, located in Portugal. In addition, it stipulated a 10% share exchange between OMEL and OMIP, which was also accomplished in 2004. MIBEL enables any consumer in the Iberian zone to competitively acquire electricity from any generator or retailer that is licensed in either Portugal or Spain.

In 2008, new measures were introduced to harmonise regulation in the two countries. The objective of these changes was to enable players to operate directly in the markets irrespective of which country awarded them their permit, thereby avoiding the duplication of administrative procedures. Several agreements within the Iberian Electricity Market have also been signed and

announced by both governments, including tasks to be accomplished by the TSOs and the regulators towards the harmonisation of grid planning, transmission system operation procedures, independent metering services and data collection provision, and third-party access tariffs calculation methodology. Some convergence is also expected with respect to the road-map for regulated end-user tariffs removal. From 1 January 2010, only low-voltage customers will have access to a regulated last-resort tariff and from 1 January 2011, only low-voltage customers with a power demand below 50 kVA will be able to avail of the last-resort tariff.

Figure 31

OMIP Legal Framework



Source: OMIP, OMIClear.

Management of day-ahead and intra-day markets is the responsibility of the Operador del Mercado Ibérico de la Energía-Polo Español (OMEL), which is also responsible for settlement and communication of payment obligations and collection rights deriving from the energy contracted in the day-ahead and intra-day electricity production markets. OMIP is the operator of the Portuguese division of the Iberian Electricity Market (MIBEL – Mercado Ibérico

de Electricidade), and is responsible for the management of trading on the derivatives market, the underlying asset of which is electricity. OMIP holds a 100% stake in OMIClear, it has the role of clearing house and central counterparty in all the operations executed on the market managed by OMIP.

Apart from organised markets, players can trade electricity under bilateral agreements, with price and other conditions being negotiated as part of the agreement. The bilateral trade in electricity is similar to over-the-counter trading in any other commodities. In Portugal, after the scheduling of market programmes (spot market and bilateral market), the balancing market is operated by the TSO, with bids for energy and price being presented to the TSO by market players. This market is operated on a separate basis from the Spanish balancing market, although the regulators from Portugal and Spain have asked for a joint proposal from the TSOs in order to deepen the co-ordination mechanisms in this regard.

## CONGESTION MANAGEMENT

In cases of congestion, the management rules adopted in the MIBEL combine a market-splitting mechanism with foreseen explicit auctions. When congestion occurs the markets are split in two price zones (Portugal and Spain). Interconnection usage rights obtained in explicit auctions contain a use-it-or-lose-it provision. Therefore, rights that are not used are sold in the market and used in the market-splitting mechanism. In this case, the owner receives the price difference obtained through the market-splitting mechanism. Although foreseen, no explicit auction has taken place so far.

The mechanism adopted is similar to the one used in NordPool for congestion management when this occurs in the interconnections between Norway, Sweden, Finland and Denmark, albeit allowing for physical bilateral contracting through the interconnection. This combination of the market-splitting procedure, on the Portuguese border, and of market-coupling, on the French border, delivers a mechanism consistent with the EU internal energy market.

## CROSS-BORDER TRADE

Portugal is integrated in the Iberian Electricity Market and since July 2006 the OMIP futures market, located in Lisbon, is operating in the peninsula, with the participation of Portuguese and Spanish generators and suppliers (both regulated and in the liberalised market), as well as trading companies from several countries in Europe and from the United States. The market is showing typical youthful characteristics, such as low initial liquidity, although it has consistently increased during its two-and-a-half years of operation. Since 1 July 2007, Portuguese companies are participating in the daily day-ahead spot market (OMEL, located in Madrid).

OMIP futures use only the Spanish spot price as the reference price during the delivery period. Therefore, OMIP futures do not provide price coverage for the Portuguese price or for the price difference between the two markets. Unlike in Spain, the Portuguese special regime generators (renewables and co-generation) do not participate directly in the market. The Portuguese last-resort supplier buys all the electricity generated under the special regime.

In December 2007, 81% of Portugal mainland's consumption was traded in the spot market and less than 1% was traded under bilateral contracts. The remaining energy consumption refers to regulated supplier acquisitions to special regime generators (renewables and CHP), which is mandatory by law. It is worth noting that VPP (virtual power plant) capacity is mainly used by contractors to offer energy in the spot market, although it could be allocated to bilateral contracts. The same occurs with the CESUR (bilateral contracts with regulated suppliers allocated through an auction), which is settled in the spot market.

However, certain issues still persist that could, at least partially, obstruct the attainment of the expected advantages. Differing tax systems, independent technical management on the electrical systems at both sides of the border, the existence of costs to preserve contractual equilibrium in Portugal (CMEC) and the way in which interconnection capacity is handled, are only some of the matters which, regardless of the market mechanisms, may give rise to conditions that impair MIBEL's operation as a single market.

## **REDE ELÉCTRICA NACIONAL, SA**

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Rede Eléctrica Nacional, SA (REN) was established in 1994 as a business unit within the EDP Group and, in November 2000, it was legally and ownership-unbundled from the EDP Group following the company's privatisation and the implementation of Directive 96/92/EC.

Following the Council of Ministers Resolution 169/2005 of 24 September, the government decided to concentrate all concession holders of natural gas transportation and electricity transmission infrastructures into REN. In September 2006, REN purchased the corresponding natural gas assets owned by Galp Energia. The result of this process of consolidation was the concentration of each of the following regulated natural gas activities in the new entity: the transportation of natural gas through the high-pressure networks, the storage of natural gas and the reception, storage and regasification of LNG.

To operate the former two activities, REN first acquired the assets from Galp and the established REN Gasodutos and REN Armazenagem, who in turn took over the relevant state concessions. REN also acquired the assets of the LNG operator, REN Atlântico, and the new entity was renamed REN Atlântico. In addition to holding 100% of the share capital of each of the aforementioned

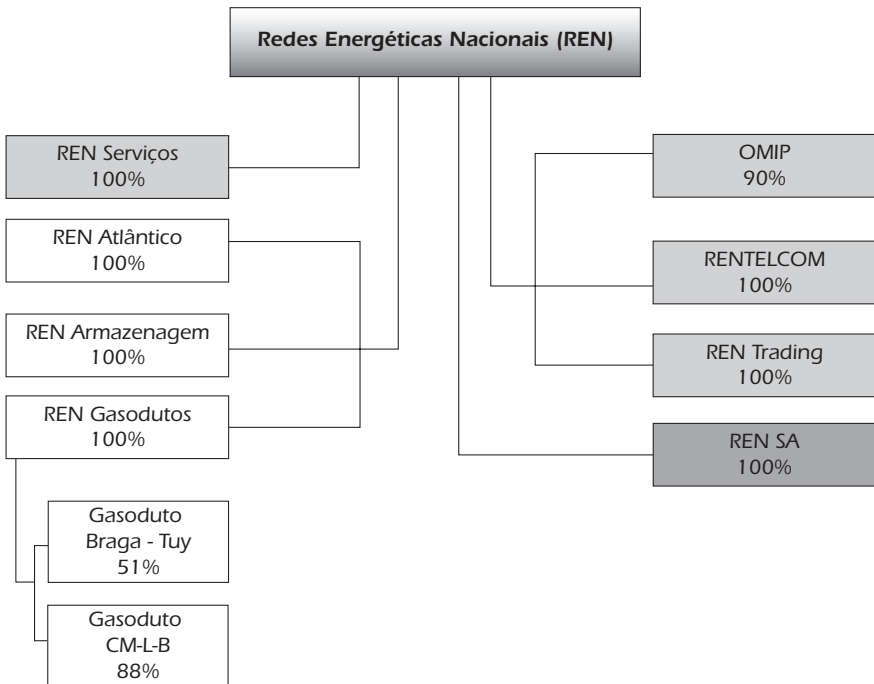
entities, REN also holds a 90% shareholding in OMIP, the operator of the MIBEL futures market, located in Lisbon.

The company was further reformed in 2007 when the government converted it into a holding company, REN – Redes Energéticas Nacionais, SGPS, SA and the high-voltage electricity transmission lines were transferred to a newly created company, Rede Eléctrica Nacional. Later in the same year two further companies were established: REN Serviços and REN Trading. The most significant of these, REN Trading, was created with the objective of managing the power purchase agreements that were not terminated under the new market arrangements, those with Tejo Energia and Turbogás. The company's main objective is to maximise revenues on the sale of energy in the market and to minimise costs of operating the plants.

Since early 2007, the ownership of REN has undergone a series of changes following the implementation of Decree-Law 228/2006 of 22 November. Previously, 70% of shares were held by state bodies or public companies and the remaining 30% by EDP. Following the establishment of Redes Energéticas Nacionais, the company was 49.9% privatised and the EDP shareholding reduced to 5%.

Figure 32

### REN Group Structure



Source: REN.

## RETAIL MARKET

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Supply is a free activity, only subject to a licence. Supply of last resort is a regulated activity and also subject to additional requirements to assure independence. EDP Serviço Universal, 100%-owned by EDP Distribuição, holds the licence for supply of last resort. Switching procedures are defined by the regulatory entity (ERSE) and the average time length for a switch to be completed has been about 2 days.

Full market liberalisation has been in place since September 2006 and by early 2007, three Spanish suppliers were active in the Portuguese retail market, selling mostly to commercial customers. However, despite this progress the share of power supplied via the liberalised market fell, when compared with 2006, and this decrease was particularly pronounced from the beginning of the second half of the year. By the end of 2008, EDP enjoyed an 82% market share while a small number of independent retailers shared 18% between them.

There are a number of reasons for this but the essence of the problem is that the reference price for energy upon which the last-resort retail tariff is based provides the incumbent supplier with a hedge against movements in the wholesale market price that is unavailable to competitors. In addition, regulated tariffs in 2007 included a subsidy equivalent to the deficit resulting from the tariffs having increased less than the normal price increase rate, in accordance with a government decision (Decree-Law 237-B/2006 of 18 December).

Another factor that led to independent suppliers being less competitive than the last-resort supplier relates to the termination of the legacy PPAs and the beginning of the CMEC. This annulled and overlaid the effect of the increase in the access tariffs resulting from the compensation for the CMECs, which are paid by all consumers. Given the high costs of the PPAs, compared with the energy price implicit in calculating the CMECs – EUR 50 per MWh – considered in determining the tariffs, their termination entailed, in the short term, a reduction of the costs to be recovered through the electricity tariffs for the last-resort supplier's customers. Thus, the situation for the last-resort supplier's customers was improved by the termination of the PPAs and the beginning of the CMECs, while the opposite was true for the liberalised market customers.

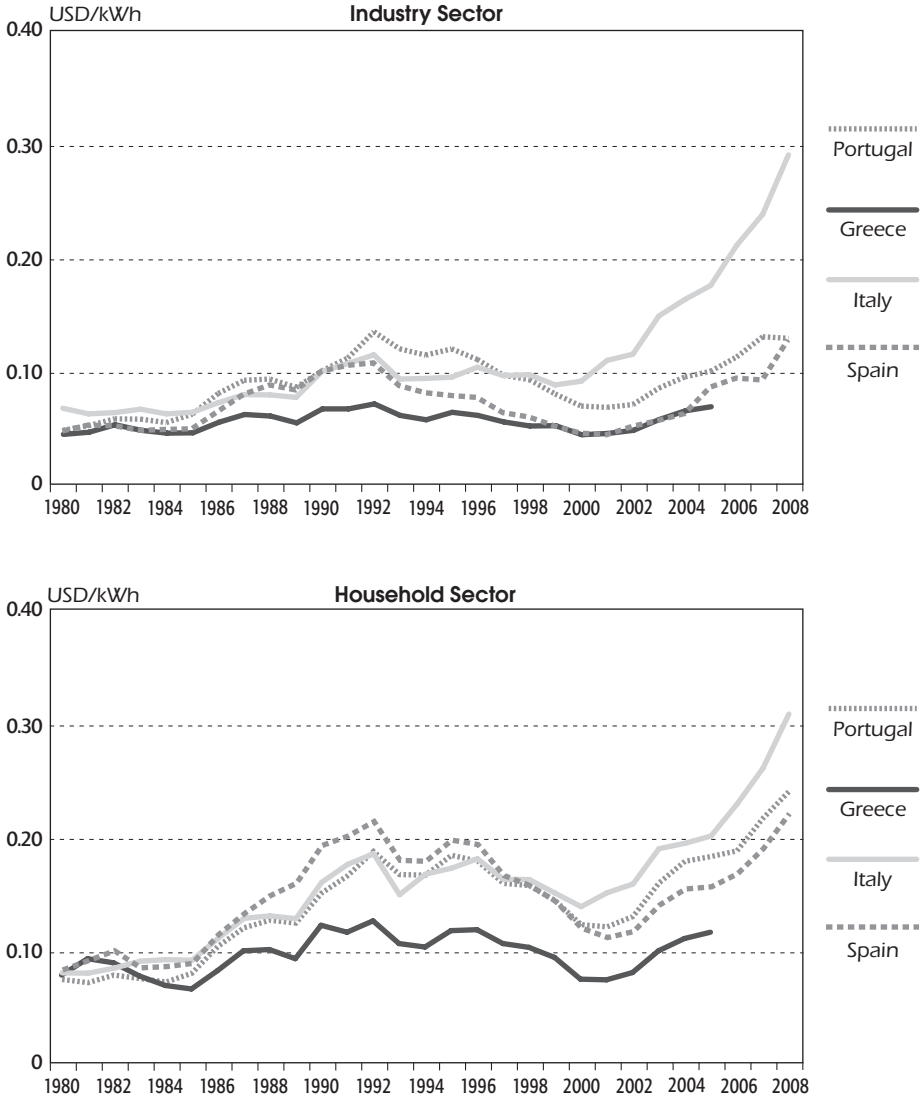
## PRICES AND TAXES

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Energy taxes in Portugal generally exceed the minimum levels required by EU legislation. A reduced VAT rate of 5% continues to be applied to household consumption of natural gas, electricity, and heating oil, as well as to diesel for agricultural purposes.

Figure 33

Electricity Prices in Portugal and in Other Selected IEA Member Countries, 1980 to 2008

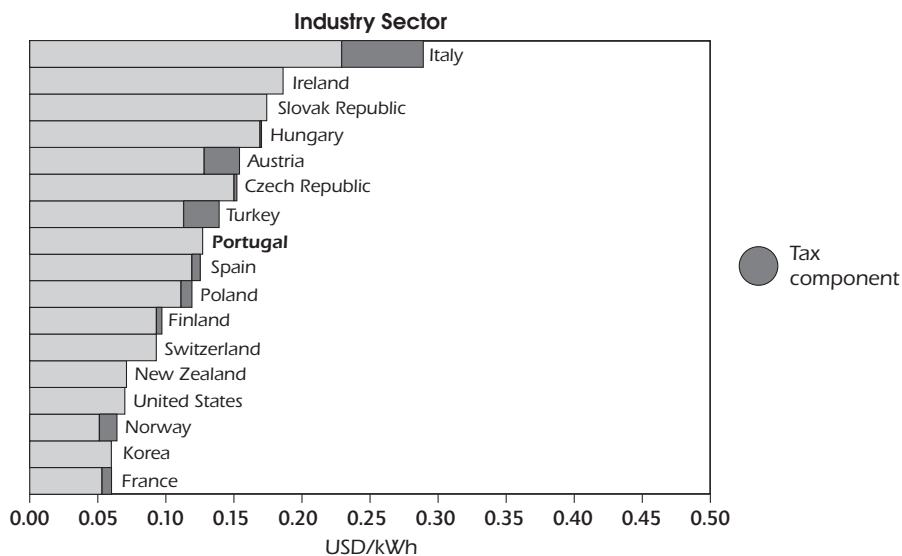


Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2008.

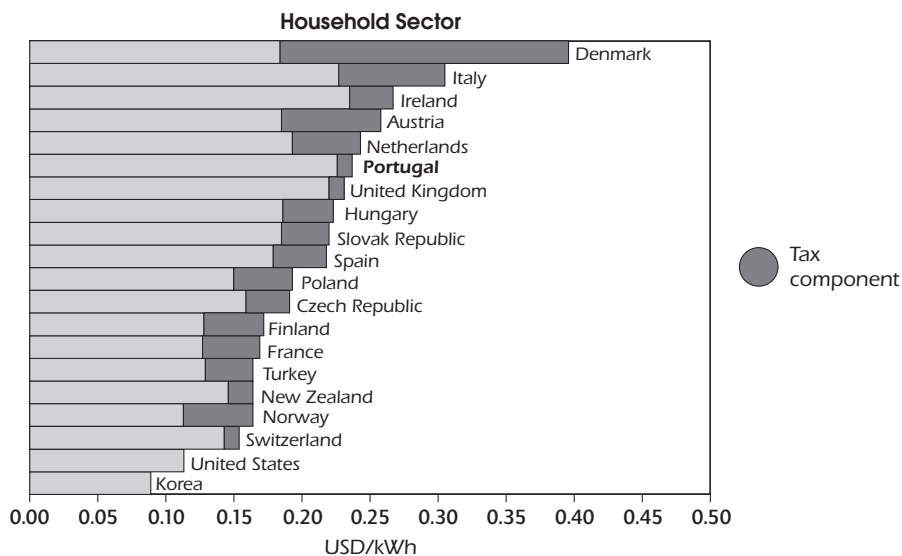
According to an analysis of electricity end-user prices published by Eurostat, for the first semester of 2008, prices paid by domestic consumers in Portugal (including taxes) are largely in line with average prices within the European Union (EU-27). The average end-user price in Portugal is 1.1% below the

Figure 34

## Electricity Prices in IEA Member Countries, 2008



Note: Tax information not available for Korea and the United States. Data not available for Australia, Belgium, Canada, Denmark, Germany, Greece, Japan, Luxembourg, the Netherlands, Sweden and the United Kingdom.



Note: Tax information not available for Korea and the United States. Data not available for Australia, Belgium, Canada, Germany, Greece, Japan, Luxembourg and Sweden.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2009.



average price in the European Union while the most representative consumer group (DC class<sup>7</sup>) pays 4.7% above the equivalent average European Union price.

Performing the same analysis for the industrial customers leads to the same conclusions. The average price paid by the industrial customers (excluding VAT) is less than 2.5% below the EU-27. The most representative customer class, IE, paid less than 1.9% of the average price in the European Union.<sup>8</sup>

## CRITIQUE

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In the period since the previous review, the Portuguese electricity sector has further evolved following the implementation of a number of structural changes. The IEA recommendations in the 2004 review have been largely implemented.

One of the most significant changes has been the establishment of the fully unbundled REN as the electricity transmission system operator (TSO) on mainland Portugal. Distribution activities have also been unbundled, but to a lesser extent, with the granting of a concession to the previous incumbent, EDP, via EDP-Distribuição Energia, which is responsible for the operation of the medium- and low-voltage networks. Distribution at lower-voltage levels is generally performed by EDP-Distribuição Energia but also by a number of smaller operators under concessions granted by the relevant municipalities. Both of these changes represent good progress over a short period of time and for these achievements the government should be commended.

The Iberian Electricity Market (MIBEL) became operational in July 2006 (when trading in the OMIP [Iberian Market Operator - Portuguese Pole] had been initiated earlier). The introduction of a regional market represents a hugely progressive step. MIBEL is the second-largest integrated regional market in Europe comprising 30 million consumers and its development opens up many new opportunities for the Portuguese electricity market. It increases the attractiveness of investing in generation, both conventional and non-conventional, in Portugal; strengthens security of supply; increases competition in the domestic market; and will eventually allow Portuguese market participants wider access to other European markets.

Since 2004, interconnection capacity between the two countries has increased with the construction of a major interconnector (Alqueva-Brovaes). Imports to Portugal now represent some 18% of the country's peak demand. Further developments are expected in the near future, with the Portuguese and

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7. Eurostat standard consumer (DC); annual consumption of 3 500 kWh among which 1 300 kWh overnight (standard dwelling of 90 m<sup>2</sup>).

8. Eurostat electricity industry (IE); annual consumption of 2 000 MWh, maximum demand of 500 kW and annual load of 4 000 hours.

Spanish governments committed to achieving 3 000 MW of interconnection capacity by 2013/14 or the capability to meet around 35% to 40% of forecast Portuguese peak demand. Portugal's position as a net importer of electricity from Spain may also change in the near to medium term as the Portuguese electricity system becomes more flexible, as capacity and interconnection export capacity expand, and as generators take advantage of access to the wider Iberian market.

Concerning electricity generation, a large number of positive changes are currently under way. These include the development of further hydropower projects, such as the upgrading of seven existing dams and the construction of ten new large-scale facilities, thus exploiting some of the remaining potential for large-scale hydro projects and increasing total hydro capacity by 2 830 MW. These additions will strengthen both the diversity of the generation mix and Portugal's progress towards meeting its climate change goals. A further eight gas-fired CCGTs (in four groups representing a total installed power capacity of about 3 200 MW) progressively starting in 2009 have been authorised. Wind targets, balanced by new hydro developments, have also been established with 8 500 MW of capacity planned by 2020 and an intermediate target of 5 100 MW by 2012. The construction of new generating capacity is beneficial in terms of security of supply but also to stimulate increased competition in the wholesale market.

Nonetheless, there remain concerns about levels of competition in both the wholesale and retail markets for electricity. Despite the introduction of MIBEL and the increase in interconnector capacity, congestion levels are still high and price differences between Spain and Portugal remain. The previous incumbent, EDP, retains control of the marginal price-setting plant in the Portuguese system (circa 75% and 100% of price-setting hydro plant). While this is a concern in the medium term, the government has determined that this level of capacity will fall to 50% by 2010. The process to license eight groups of new gas-fired CCGTs is also welcome but the government must ensure that these plants are built in line with the proposed timelines.

The present situation at retail level, however, is the one that causes a greater level of concern. The maintenance of regulated tariffs and the vesting of the provision of the last-resort supplier in EDP Serviço Universal have undermined to a large extent the possibility of a competitive retail market emerging. A large tariff deficit has been accumulated as the level of generation purchase costs in recent years has outstripped the revenues that the last-resort supplier has been allowed to recover from end-users. While the government has taken steps to reduce this deficit, namely reducing the number of customers eligible for this tariff in future, further changes need to be implemented to prevent a reoccurrence.

Competition at retail level is very much determined by the existence of a universally available regulated last-resort tariff that remains at a level below market costs. Generation costs in the imputed tariff are understood to be

below the wholesale price of generation at which competing suppliers must purchase supply. The impact of this was most notable in 2007 and 2008 when retail competition collapsed and a number of retailers left the market.

While competition levels increased in the first half of 2009, the government must continue its process of reform. It must maintain a clear commitment to end tariff regulation in the near term and allow the regulator to determine tariffs on the basis of market costs in a transparent and open manner and allow it the ability to adjust tariffs on a regular basis, including within-year adjustment. The government must also maintain the present reasonable level of consultation and debate with the public and industry stakeholders with regard to the retail market.

## RECOMMENDATIONS

*The government of Portugal should:*

- *Take further steps to increase competition levels in the wholesale market for electricity.*
- *Maintain its commitment to its previous timetable regarding the elimination of regulated retail tariffs and extend the schedule to include domestic consumers.*
- *Review the supplier of last resort mechanism and facilitate the withdrawal of the service from all but the most needy and vulnerable customers.*
- *Maintain the independence of the energy regulator and ensure it has the powers to quickly respond to changes in market conditions such that retail tariffs remain in line with wholesale prices to the greatest extent possible.*



## RENEWABLE ENERGY SUPPLY

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Renewable energy supply measures are a cornerstone of recent Portuguese energy policy. As a nation that is potentially reliant on imported fossil fuels, Portugal has made remarkable progress in harnessing and taking advantage of its indigenous sources of renewable energy. In 2008, renewable energy sources provided 18.15%, or 4.42 Mtoe, of the country's total primary energy supply.

In 2007, Portugal produced 45.35 GWh of electricity, of which 14.94 GWh (33%) came from renewable energy sources (RES), placing Portugal among the highest RES-E levels in IEA Europe. Of this total, 64% or 6.83 GWh was hydro, 5.73 GWh was wind and a further 2.38 GWh came from other renewables, mainly biomass. The total installed electrical power based on RES had reached 7 523 MW at the end of June 2007, mainly wind and hydro.<sup>9</sup> Wind capacity, in particular, has grown significantly over the period since the last review, owing in part to the availability of a new feed-in tariff scheme.

## POLICIES

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Portugal is strongly committed to the development of renewable energy sources pursuant to its National Energy Strategy. Improving energy efficiency, reducing CO<sub>2</sub> emissions and increasing the use of renewable energy sources are among the core objectives of this strategy. Promotion of the market deployment of renewable energy technologies can thus be regarded as a major policy objective, contributing to increasing security of supply, through the diversification of energy sources, while reducing the environmental impact associated with the energy system.

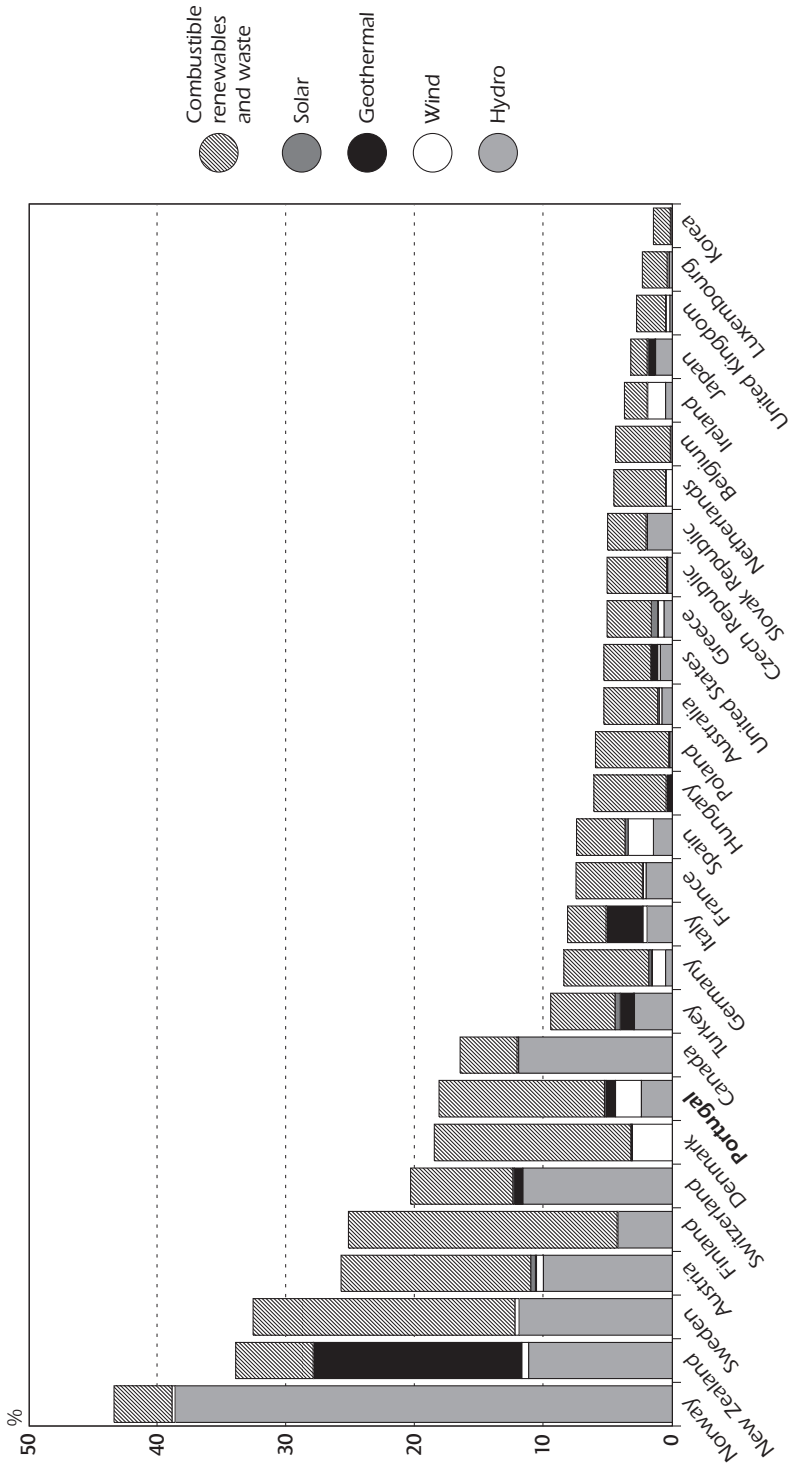
In this regard, an ambitious target for energy from renewable sources has been implemented (Cabinet Resolution 169/2005), updating previous goals. The government aims to increase the level of renewable power generation to meet 45% of final electricity consumption by 2010, an increase on the previous target of 39%. In addition, the government plans to increase its biofuels penetration target from 5.75% to 10% of the total road transport fuel placed in the market over the same time period. The policy is explicit with regard to targets for each relevant renewable technology (see Box 3).

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9. Source: DGEG.

Figure 35

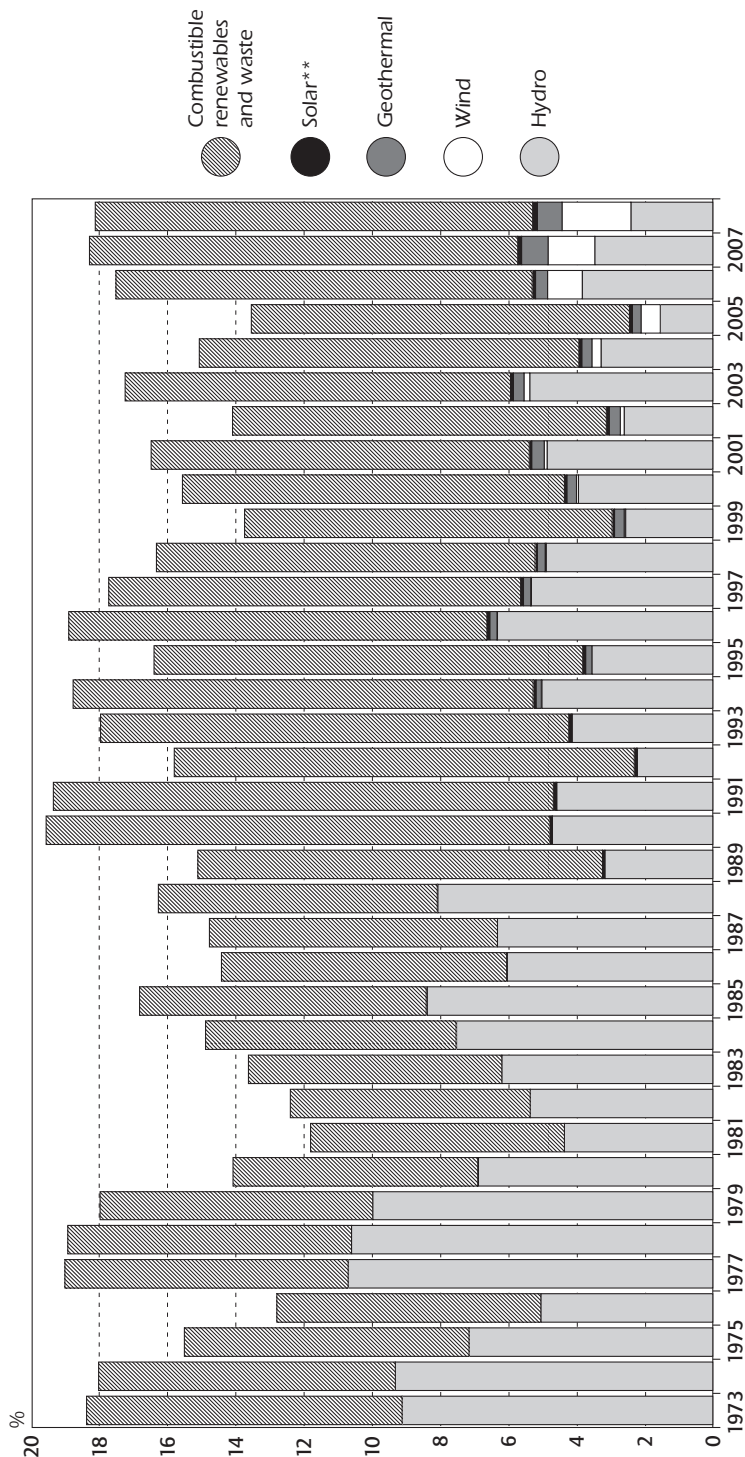
Renewable Energy as a Percentage of Total Primary Energy Supply in IEA Member Countries, 2008\*



\* estimates.  
Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2008.

Figure 36

Renewable Energy as a Percentage of Total Primary Energy Supply, 1973 to 2008\*



\* 2008 = estimates.

\*\* negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

## Renewables Targets

*Wind power:* Increase installed capacity by 1 950 MW by 2012 (to meet a new capacity target of 5 100 MW, 600 MW of which will be achieved via plant upgrades). The government will also promote the creation of new technological and investment clusters linked to wind power.

*Hydropower:* The policy anticipates making capacity upgrade investments in existing hydropower plants, in order to reach the target of 5 575 MW of installed hydropower capacity by 2010 (575 MW more than expected in previous energy policies).

*Biomass:* A 100 MW (67%) increase in installed capacity by 2010, to reach 250 MW, increased co-ordination across regional forest resources and the implementation of additional fire risk mitigation policies.

*Solar:* Construction of the world's largest photovoltaic plant at Moura and maintaining a link to micro-generation policies and goals.

*Ocean and wave energy:* Creation of a pilot area with a total exploitation potential of up to 250 MW for new emerging industrial and pre-commercial wave technology prototypes, representing an increase of installed capacity of 200 MW.

*Biofuels:* A 10% penetration of biofuels in road transport (meeting the European Union goal 10 years in advance) and the promotion of domestic agricultural initiatives by means of tax exemptions for road transport fuels that incorporate biofuels.

*Biogas:* Define goals and an action plan for a previously neglected sector, establishing a 100 MW target of installed capacity for anaerobic waste treatment units.

*Micro-generation:* Promote a programme for installing 50 000 systems by 2010. Water heating systems based on solar energy are mandatory to benefit from favourable feed-in tariffs.

Source: DGEG.

In 2005, a public tender for 1 800 MW of wind capacity was launched. The first phase of the tender was concluded in October 2006. Following the tender process, permits for 1 000 MW of installed capacity were awarded including an additional 200 MW in capacity upgrades. In the second phase of the tender process, concluded in September 2007, permits for an additional 400 MW of capacity were granted. The third phase of the tender concluded in 2008 with the award of an additional 200 MW in capacity upgrades. A national fund of EUR 76 million



was created to support innovation in renewables and energy efficiency. Following completion of the tender procedures, an industrial cluster linked to wind power was developed, with a budget of EUR 1 750 million, involving the creation of approximately 1 700 direct jobs and 4 500 indirect jobs.

A tender for the allocation of 15 thermal forestry biomass power stations with a total installed capacity of 100 MW was launched in 2006. A small number of these proposed thermal forestry biomass power stations are undergoing licensing procedures at present.

## **ELECTRICITY GENERATION FROM RENEWABLES**

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Historically, renewable power generation in Portugal was largely represented by large hydro generation capacity, a highly unpredictable source that tends to depend upon local climatic conditions. In recent years, however, Portugal has invested significantly in alternative forms of renewable energy sources while investment in hydropower has to some extent faltered. Between 2000 and 2007, wind power capacity in Portugal expanded exponentially from 87 MW to 2 126 MW, with another 739 MW under construction and 3 200 MW under authorisation. Other growing sources include biomass, photovoltaic and ocean power.

Support mechanisms for renewable energy are generally based on feed-in tariff systems, small levels of investment subsidies and tax benefits. In addition, there is a market-oriented support mechanism based on green certificates and guarantees of origin (RECS, Renewable Energy Certificate System). In 2007, REN (the electricity TSO), the body designated to issue certificates in Portugal, issued approximately 87 000 of such certificates. This corresponded to 87 GWh of hydroelectric generation, mostly from large hydropower plants. The Green Certificate mechanism does not yet apply to any existing renewable generation other than hydropower.

The principal instrument for promoting renewable electricity is a feed-in tariff mechanism. The feed-in tariff is differentiated by technology, guaranteed for a fixed time frame (typically 15 years) and applicable until a certain capacity target is attained – the special regime production law (PRE) law. Decree-Law 225/2007 introduced new tariffs for emerging technologies, such as wave energy for electricity production.

The government established ambitious goals for renewable electricity (RES-E) to be reached by 2010, increasing the targets agreed under the 2001/77/CE Directive from 39% of the gross electricity consumption to 45%. This target will be reached mainly through wind power investment (5 100 MW by 2012, 2 201 MW in 2007) and hydropower plants (5 575 MW by 2010, 4 880 MW by 2007), while photovoltaics provide a small contribution (about 200 MW by 2010).

## SUPPORT MECHANISMS

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### FEED-IN TARIFFS

The payment scheme for producers participating in the special regime is determined by a relatively complex formula first introduced in 1999 (Decree-Law 168/99). The formula has been modified a number of times, most recently by Decree-Law 225/2007.

In 2005, Decree-Law 33-A/2005 updated the values applied in the price evaluation formula for electricity produced from renewable sources. The new values were to ensure an adequate level of remuneration over a time period deemed sufficient to allow investors to earn an adequate rate of return, taking into account the different technologies. Previous feed-in tariffs were maintained either for existing facilities or those already under a licensing process, with a guaranteed remuneration for a period of 15 years at the most.

A tender was launched for new wind power sites in 2005, successfully resulting in a price for wind generation that was lower than the previous equivalent tariff. Decree-Law 33-A/2005 also modified the previous legislation on payment schemes for the special regime to some extent; it established a limit up to which producers may receive the feed-in tariff. The limit is based on produced energy as well as capping the length of new contracts at 15 years. Beyond that limit, producers in the special regime will earn the market price for their output and the price for the Green Certificates associated with the guarantees of origin. If those certificates are not functioning by the time the 15-year limit is reached, then the producers may receive the feed-in tariff, for an additional five-year period.

Decree-Law 225/2007 of 31 March either limits the feed-in tariffs to a maximum time period of 15 years (for most technologies) or at least to a certain amount of produced energy per installed electrical power. Above one of these thresholds, the specific producer will be remunerated according to electricity market values.

To date, the tender procedure for wind power has produced no impacts in the costs of wind generation. All existing sites are being paid the old tariff. Most likely, this tender procedure will only have an impact on costs with the commissioning of the awarded wind generation capacities, due to start in 2009. Considering the government's target of 5 100 MW installed wind generation capacity, 60% of wind generation will benefit from the old wind feed-in tariff (about EUR 97 per MWh) and the remaining 40% will receive the feed-in tariff as defined in the tender procedure (or less than EUR 75 per MWh).

## THE FEED-IN TARIFF FORMULA

The formula defining the payment includes a fixed term – a function of the installed capacity – a variable term which is a function of the output, and a term to compensate for the environmental impact that is avoided by producers under the special regime and which depends on the energy source used.

Feed-in tariffs are also updated every month taking into account the rate of change in the consumer price index (inflation). Producers included in the special regime also receive payment for, or must purchase, reactive power although the monies involved are small (typically up to 2.5% of the monthly invoice).

Table 7 provides a summary of the feed-in tariffs for renewable energy generation.

Table 7

### Feed-in Tariffs for Renewable Energy Generation, from 31 May 2007

<i>Technology</i>	<i>Indicative tariff (€/MWh)</i>	<i>Z. coeff.</i>	<i>Note</i>
Wind	74	4.6	Up to 33 GWh/MW or 15 years
Small hydro (<10 MW)	75	4.5	Up to 52 GWh/MW or 20 years; exceptional cases up to 25 years
Photovoltaic (> 5 kW)	310	35	Up to 21 GWh/MW or 15 years
Photovoltaic (<= 5 kW)	450	52	
Forestry biomass	109	8.2	Up to 25 years
Animal biomass	104	7.5	
Biogas (anaerobic from MSW and water treatment of waste water from animal breeding and agro-industry)	117	9.2	Up to 15 years
Landfill gas	102	7.5	Up to 15 years
Municipal solid waste (MSW)	54	1	Up to 15 years
Wave (tech. Demonstration - <= 4 MW)	260	28.4	
Pre-commercial Wave (<= 20 MW)	191	16-22	
Commercial Wave (1st 100 MW)	131	8-16	Up to 15 years
Commercial Wave (2nd 150 MW)	101	9-16	
Commercial wave	76	4.6	

All RES-E producers receive a monthly payment that is determined in accordance with the following formula established in the legislation:

$$VRD_m = \{KMHO_m \times [PF(VRD)_m + PV(VRD)_m] + PA(VRD)_m \times Z\} \times (IPC_{m-1} / IPC_{ref}) \times [1 / (1 - LEV)]$$

Each element of the formula represents different factors that influence the avoided costs due to electricity generation from RES-E.

- $VRD_m$ : The remuneration applicable to the renewable power output in the month  $m$
- $KMHO_m$ : Different tariff levels for electricity generated during day and night
- $PF(VRD)_m$ : A fixed contribution on the plant capacity that reflects the avoided investment for conventional power plants that would have to be built
- $PV(VRD)_m$ : A variable contribution per kWh of electricity generated that corresponds to the power generation costs of the conventional power plants
- $PA(VRD)_m$ : An environmental component corresponding to the CO<sub>2</sub> emissions avoided costs due to RES-E generation, multiplied by a technology-specific coefficient
- $IPC_{m-1} / IPC_{ref}$ : Adjustment to inflation
- $1 / (1 - LEV)$ : A factor that represents avoided grid losses

The environmental component is multiplied by a coefficient  $Z$ , which varies according to the RES-E technology. Following the introduction of this coefficient in 2001 (Decree-Law 339-C/2001), the support system for RES-E has changed from being based on the avoided costs due to RES-E generation only to a mechanism that takes into account different electricity generation costs by RES-E technology.

## HYDRO AND WIND POWER

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Wind and hydro resources are considered the most valuable energy resources in Portugal, those that will make the most significant contribution to national and European renewables targets, both for 2010 and 2020. The government has set an ambitious target of 5 100 MW of wind capacity by 2012 (Decree-Law 169/2005). If this target is met, Portugal will have the highest levels of wind energy penetration in the world. At the end of 2007, wind penetration levels stood at 8.5%.

The forecast high levels of wind energy penetration will require careful design and management of the Portuguese electricity system, within the context of the country's peripheral location. In this regard, the Portuguese studies

indicate that additional pumped storage capacity will contribute to national renewable energy goals, but will also enable easier integration of incremental wind power.

In Portugal in 2007 there was 4 871 MW of hydropower capacity. To meet its 2020 targets, another 2 055 MW of capacity is needed to reach 7 000 MW. At least 5 575 MW of hydropower capacity is required by 2010. In September 2007, a National Programme (PNBEPH) identified ten new potential hydroelectric power plants.

According to PNBEPH, the ten sites identified offer potential capacity of approximately 1 100 MW and an estimated yearly gross electricity output of 1 630 GWh. Seven of them, or 807 MW of capacity, will be reversible. A number of these plants are already under construction phase: Picote II (231 MW); Bemposta (Douro River, 409 MW); Ribeiradio (Vouga River, 70 MW); Baixo Sabor (Sabor River, reversible, 170 MW), and Alqueva II (Guadiana River, 260 MW).

In 2007, the amount of new wind capacity installed in Portugal was slightly lower than in previous years. According to DGEG, 427 MW of capacity, corresponding to a growth rate of 25%, was installed and commissioned during 2007. By the end of 2007, 2 108 MW of wind capacity was installed in mainland Portugal, and 18 MW was installed in the autonomous regions of Madeira and Azores.

## **WIND POWER DEVELOPMENT IN PORTUGAL**

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Between 2000 and 2007, wind power capacity in Portugal expanded exponentially from 87 MW to 2126 MW. A key factor behind the growth of the wind power sector in Portugal is the political desire to create a strong wind power sector coupled with an attractive feed-in tariff mechanism.

Portugal follows a centralised approach for the development of wind power. The fact that there is both a single transmission company and a single distribution company responsible for allocating the connection capacity – in the transmission and distribution grids – eases the ability of the country to add capacity. Also, the network operator may expropriate land in order to build power lines, substations, and power production installations as long as they are considered of public usefulness. Most wind is connected to the 60 kV network.

Similar to hydro, the wind resource is larger in the interior and in the northern part of the country while the consuming areas are generally on the west coast. That means that the transmission grid has to be developed in order to transport the electric power from the producing nodes to the consuming ones through the country even if most wind farms are connected to the distribution grid.

Another important factor contributing to the development of the wind power sector in Portugal is the fact that developers have to pay 2.5% of the revenues from electricity production to the municipality within which the wind farms are located. This has tended to facilitate the installation of wind farms since they imply a steady flow of additional income to the municipality.

Lack of investment and technical requirements are not generally regarded as barriers for the development of the wind power sector although some parties have raised their concerns regarding the lower feed-in tariff levels, as less favourable sites start to be developed. Local opposition to visual impact and environmental issues have become barriers to the future development of the wind power sector and present a tangible obstacle to the government's targets. To date, local opposition has been limited but it is growing.

The recently published Decree-Law 225/2007 for electricity production based on renewable sources introduced some changes in order to speed up the process of the environmental impact evaluation. The decree clarifies some procedures and gives time delays for them; however there is no time limit for DGE (the authority where the process starts) to send the environmental study to the Environmental Agency (APA).

According to the Portuguese Association for Renewable Energies, APREN, project developers see administrative procedures as the main barrier to the development of the renewable energy sector. Time horizons associated with the different procedures and established by law are not always fulfilled.

## OCEAN ENERGY

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Portugal is a leading player in the development of ocean energy. In late 2008, the world's first commercial wave farm was installed by Enersis, 5 km off the Atlantic coastline of northern Portugal (close to a substation at Aguçadoura) with an installed capacity of 2.25 MW (three  $\times$  750 kW).

A special tariff was established for wave energy in 2007 (Decree-Law 225/2007): EUR 260 per MWh for the first 20 MW (decreasing for additional installed capacity). Later legislation published by the Portuguese government (Decree-Law 5/2008) established a pilot zone off central Portugal and REN was appointed as manager (Decree-Law 238/2008).

The designed pilot zone provides for the installation of demonstration, pre-commercial and commercial wave energy devices for a total of 250 MW of rated capacity, comprised of 170 MW (connected to the transmission grid) and 80 MW (connected to the distribution network). The zone is located approximately 120 km north of Lisbon, off São Pedro de Moel, and covers nearly 320 square kilometres of sea at water depths between 30 and 90 metres. The decree also includes regulation, framing, licensing

and concession arrangements. The legislation's primary aim is to facilitate licensing, given that the exploitation of wave energy harnessing locations requires a state authorisation.

## OTHER SOURCES

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### PHOTOVOLTAIC

From 2002 to 2004, the DGEG allocated about 128 MW of photovoltaic (PV) capacity (corresponding to 104 MW at the grid connection) under the independent power producer (IPP) framework. Since then, the allocation of grid connections for PV installations (first step of the licensing process) has been frozen, owing to the large number of connection requests received in 2005 (more than 3 000), which largely exceeded the national PV target of 150 MW.

Progress has been made since and some of the further installations were connected in 2007, adding more than 14.5 MW of installed capacity in 2007, an increase of more than 400% over previous levels (3.4 MW) of PV capacity.

The world largest centralised PV plant (46.4 MW) is to be developed in east Alentejo, in the Moura municipality. The planned facility is being promoted by the local municipality and Acciona Energía, the Spanish utility. This huge project involves the construction of a PV module manufacturing facility, located in the same area. Both the factory and the plants started construction in 2007. The PV plant installation, which comprises 268 000 PV modules provided by the Chinese Yingly Group, is to be mounted on single-axis tracking systems.

### MICRO GENERATION

Micro-Generation Law (Decree-Law 363/2007 of 2 November commonly known as "Renewables on Demand" law) regulates the micro-production of electricity from renewable energy sources. It provides for a simplified licensing regime for local grid-connected, low-voltage, small/residential renewable energy producers and is oriented towards electricity consumers. Any entity that has a contract for purchasing electricity can be a producer of electricity from renewable energy sources, covering solar, wind, hydro, co-generation, biomass, and fuel cells using hydrogen from renewable energy micro-production. Licensing is conducted on-line via the internet, using the System of Registration of Micro-producers (SRM), an electronic platform through which producers register their installations.

The law defines two regimes:

- The general regime is applicable to any type of micro-generation (or co-generation) source. The maximum interconnection power by application is limited to 5.75 kW (25 A single-phase). The feed-in tariff equals the regulated tariff (true net metering).

- The special regime applies exclusively to renewable sources – solar PV, wind, hydro, biomass and fuel cells (provided hydrogen is produced from RES) – but the maximum interconnection power by application is limited to 3.68 kW (16 A single-phase). A reference feed-in tariff, generally established for RES-E micro-generation technologies, is initially set at EUR 0.65 per kWh and is decreased by 5% after 10 MW of overall capacity is added.

Under the special regime, PV systems benefit from 100% of the reference feed-in tariff, wind benefits from 70%, hydro and biomass from 30%. The feed-in tariff is guaranteed for five to six years (five years plus the months left in the installation year) after which, during the ten following years, the applicable feed-in tariff will be the one actually in force, revised on a yearly basis.

This new framework requires all the produced energy to be sold to the electricity supplier. Under the special regime, with the exception of biomass, the installation of a solar water heating system (a minimum of 2 square metres) is mandatory. The authorisation procedure is also simplified, mostly based on an on-line registry platform. It is expected that system licensing can occur in no more than three to four months.

The government predicts that about 165 MW of micro-generation capacity (more than 50 000 installations) will be installed by 2010, assuming a 20% yearly growth rate. Besides these schemes, other indirect market development mechanisms for renewables include reduction of the VAT rate from 20% to 12% on RES equipment, a customs duties exemption and income tax reductions (of up to EUR 777 for renewable equipment).

The installation of solar thermal equipment in new buildings is mandatory since 2006. Apart from this, a new public investment programme is planned, oriented towards social housing, public swimming pools and sports facilities.

## BIOMASS

In 2007, some 4% or 391 MW of renewable electricity capacity was biomass-fired, largely solid biomass. In the same year, 15 invitations to tender were launched for the allocation of electricity production capacity totalling 100 MW, an increase of 67% in installed capacity in the electricity distribution network for 15 forest biomass thermoelectric power plants. As a result of these invitations to tender, it is expected that almost one million tonnes per year of forest waste will be used.

Of the 15 invitations to tender, two were abandoned. A decision has already been taken on the network connection points for four power plants and it



is expected that the process of allocating network connection points for the others will be completed by the end of the year. In addition, the government proposes to implement 5% to 10% replacement of coal by biomass or waste-resultant fuel in Sines and Pego power plants from 2010.

## **RENEWABLE FUELS FOR TRANSPORT**

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In March 2006, Decree-Laws 62/2006 and 66/2006 were passed, transposing EU Directive 2003/30/EC on the Promotion of the Use of Biofuels or Other Renewable Fuels for Transport into Portuguese law. Decree-Law 62/2006 established indicative consumption targets on the use of renewable sources as a percentage of petrol and diesel. These were 2% in 2006, 3% in 2007, and 5.75% in 2008 and through to 2010.

Decree-Law 66/2006 allowed for approved biofuels producers to benefit from reductions or exemptions from petroleum taxes of EUR 280 to 300 per 1 000 litres of fuel produced for consumption in the road transport sector. For small producers – those producing less than 3 000 tonnes per year – petroleum taxes are completely waived.

Voluntary agreements on the use of biofuels in public passenger and goods transport fleets, with over 10% incorporation of biofuels into fossil fuels, were also established. The law provided for the possibility of imposing a quota for biofuels in transport fuels, in cases where their incorporation in the preceding year was less than the figure laid down for biofuels.

With Portaria 1391-A/2006, the government set the maximum ceiling on which the tax exemption can apply at 100 000 tonnes per producer. Each producer will be allocated a quota for the tax-exempt production based upon factors such as the source of the raw materials and location of the production.

In September 2008, the Council of Ministers approved a rule extending the existing tax exemptions for small biofuels producers to municipalities. The rule will allow municipalities and companies to produce biofuels, with the final product to be used exclusively for the producers' own transport fleets or in the fleets of non-profit entities.

A tax incentive scheme has been created for biofuels through an exemption on excise tax (ISP) on these products. The government hopes that this measure will foster the development of agricultural energy products as well as the construction of industrial units for the trans-esterification of vegetable oils (estimated investment of EUR 100 million). Portugal has five biodiesel industrial production plants in operation and produced 164 million litres of fuel in 2008. There are also nine smaller producers who between them produced 4.16 million litres in 2008.

## SOLAR HEATING AND COOLING

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The National Solar Heating and Cooling Programme is part of the National Energy Strategy. Solar energy for heating and cooling, and in particular the production of hot water, is mandatory within the framework of the regulation on energy performance (RCCTE) for new and renovated buildings.

The Solar Hot Water for Portugal Programme (AQSpP) is a programme developed in the beginning of this decade to increase the penetration of the solar market and aimed to achieve one million square metres of solar thermal collectors installed in year 2010. The target has been moved to the year 2015 because of inertia of the market at the time of the programme's implementation.

## CRITIQUE

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Over the period since the last review, Portugal has seen major developments in the renewable energy sector delivering multiple benefits for the country. Portugal is now among the leading IEA member countries in terms of both hydro and wind power penetration and is at the forefront of wave power development. It is highly dependent on imported fossil fuels, which in 2007 formed 82.5% of TPES. Therefore, in renewable energy policies Portugal has an important instrument with which to impact upon all three of its principal energy policy goals of energy security, sustainability and competitiveness.

It is within this context that Portugal has set very ambitious renewable energy targets, both in the electricity generation sector and in motor fuel use. In 2010, 45% of gross electricity consumption is to come from renewable energy (compared to 42% in 2007) and 10% of the fuel used in road transport is to come from motor biofuels (from circa 2.54% in 2007). Renewable energies are also a major contributor to achieving its CO<sub>2</sub> emissions target for 2012 of 27% above 1990. Portugal should therefore be commended for its ambitious targets for the planned large-scale deployment of renewable energy technologies in the electricity and transport sectors.

Many positive changes within the sector itself have been made in the four years since the last in-depth review. The feed-in tariff system has been revised, imposing among other things, a limit of 15 years in the duration of the support mechanism and a decrease in the tariff level in the case of certain technologies (*e.g.* 20% reduction for wind energy). A different approach to licensing has also been initiated, where competitive tendering has been introduced, making it possible to reduce system costs by decreasing compensation levels below the feed-in tariff rates, thus promoting cost-efficiency. A plan for expanding hydroelectricity capacity facilitates the growing balancing needs of increased levels of wind power capacity. A programme for the simplified licensing and reward of domestic micro-generation has also been implemented, allowing

households to generate electricity and benefit from favourable feed-in tariffs at times of export.

The government Simplex Programme, aimed at simplifying administrative procedures, implemented measures in 2007 to reduce the time duration of licensing procedures for electricity generating facilities. Despite this positive change, there is still room for some improvement most notably in the processes of obtaining permits from municipalities for the construction and operation of new generation infrastructure, environmental permits and in the manner in which negotiations must be conducted with land owners impacted by the construction of power lines.

There is no explicit target for the proportion of renewable energies in domestic heating and cooling use (there is a target for solar thermal). However, the Solar Hot Water for Portugal Programme has been introduced to promote domestic water heating by solar energy and includes mandatory installation of solar panels in new buildings. The target for this measure is that solar thermal collectors installed by 2010 should reach one million square metres, a welcome target. To ensure that this target is achieved, public loans to install 300 000 square metres of new solar panels in the domestic sector during 2009 were recently approved.

Public acceptance for renewable energy policy will be a more important issue as electricity prices rise (in part because of RES measures) and as more renewable plants are being planned and built. Transparency and stakeholder dialogue in the handling of renewable electricity's rapid expansion is therefore important for future growth and continued public acceptance. This applies to, for example, environmental assessments of new projects that should be subject to the broadest possible public analysis. Inviting consumer organisations and others to discussions on the level and distribution of the costs of feed-in tariffs imposed on customers through existing cost-recovery mechanisms should be considered.

The structure of current regulated retail tariffs also poses concerns. The government should consider the introduction of a mechanism to oblige all suppliers to source a portion of their output from renewable sources rather than the current mechanism where EDP Serviço Universal must purchase all renewable energy for sale to end-users. While such a policy is in place with regard to hydropower, it should be extended to other renewable energy sources without undermining the basic premise of the feed-in tariff scheme. In addition, the full costs of the accelerated pace of renewables growth must be passed on to electricity consumers in an equitable manner.

Portugal has also made good progress in meeting its biofuels obligations. Despite this, there remains a concern that Portugal may not achieve its ambitious targets, partly owing to the significant price increase of the agricultural commodities needed to produce biofuels. Conversely, there are

concerns that installed production capacity exceeds demand. In addition, the recent decline in the price of crude oil could have an impact on the financial viability of some biofuels producers. The sourcing of raw materials for biofuels production may also be challenging and producers may become reliant on imports. Therefore, the availability and pricing of inputs are likely to play an important role in meeting government targets.

## RECOMMENDATIONS

*The government of Portugal should:*

- ▶ *Vigorously pursue support schemes for renewable energy while ensuring that the cost-effectiveness of the overall strategy is optimised.*
- ▶ *Promote stakeholder dialogue in relation to the handling of renewable energy development to increase future public acceptance and attractiveness of investments.*
- ▶ *Complement the policy framework with a robust research and development policy for renewable energy technology with clear priorities and sufficient funding to reach the ambitious target of large-scale deployment of renewable energy within the coming decade. The policy framework should be complemented by a robust R&D policy on renewable energy technology with clear priorities and sufficient funding.*
- ▶ *Make greater efforts to co-ordinate with the transport sector to achieve the 10% biofuels target by 2010. This should also include regular monitoring of performance against targets in the context of prevailing global commodity prices including oil.*

**PART III**

**ENERGY TECHNOLOGY**



# ENERGY TECHNOLOGY, RESEARCH AND DEVELOPMENT

## GENERAL ENERGY RESEARCH AND DEVELOPMENT POLICY

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A clear national energy policy is the most important precondition for Portugal to formulate an effective and target-oriented public energy research and development (R&D) strategy. Several Portuguese energy policy goals involve development and deployment of new, not yet developed technologies. For example, government has announced the ambition for renewable energies to reach:

- 45% of electricity consumption by 2010;
- 10% biofuels contribution for road transportation;
- 5 to 10% of biomass and/or wastes to replace coal in Sines and Pego power stations.

The Ministry of Economy and Innovation has responsibility for energy policy and energy R&D. While the new Policy on Energy (Resolution 169) refers to the need to reinforce energy R&D, the ministry is lacking an energy R&D strategy setting out clear and quantified priorities categorised by short-, medium- and long-term objectives. The R&D programme of the ministry (PIDDAC) has a total budget of EUR six million for the five-year period 2007-2011 and invested less than EUR one million in Portuguese energy R&D in 2007/08. The present R&D programme focuses on:

- Energy efficiency
- Endogenous energy resources
- Energy and environment
- New energy systems

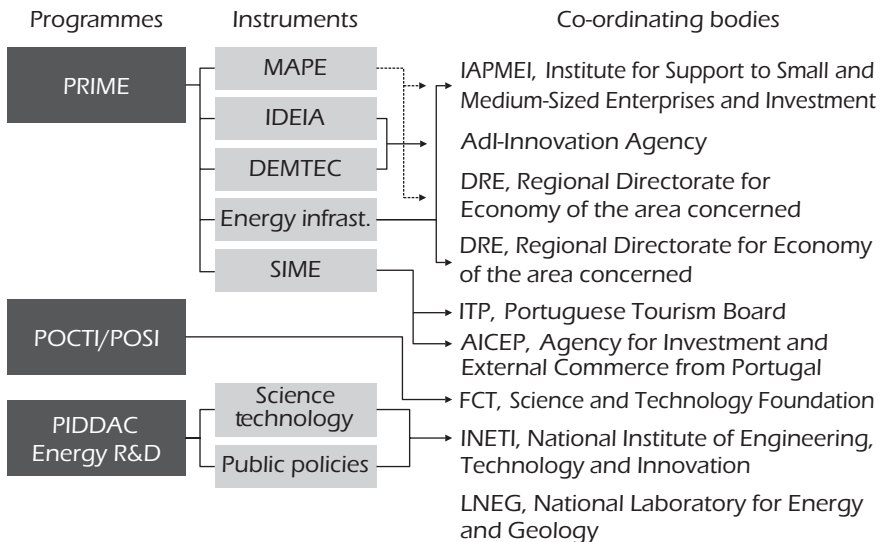
The Ministry of Science and Higher Education, responsible for national science education and policy and universities, does not regard energy R&D as a priority but has initiated a programme with the Massachusetts Institute of Technology (MIT) which includes energy (see Box 4).

## R&D FUNDING

Figure 37 gives an overview of programmes, instruments and co-ordinating bodies related to Portuguese R&D. The main funding mechanisms for energy R&D are co-ordinated by means of the Science Foundation FCT (for science) and the National Institute for Engineering, Technology and Innovation/ National Laboratory on Energy and Geology, INETI/LNEG (for applied R&D).

Figure 37

### R&D Programmes, Instruments and Bodies



Source: IEA.

## THE SCIENCE FOUNDATION FCT

The mission of the Science and Technology Foundation (FCT) includes exploiting available opportunities in all scientific and technological (S&T) domains with a view to reaching international state-of-the-art levels; and the diffusion of new knowledge to improve education, public health, environmental sustainability and the quality of life and well-being of the population.

FCT provides support through a variety of different means, namely, open calls for the financing of research organisations, research teams or individual researchers on the basis of the merit of their proposals. It also offers support through co-operative agreements and other partnerships with universities and other public and private organisations.



## EU AND INTERNATIONAL FUNDING

The structure of national schemes is largely dependent on the corresponding European framework and the promise of financial support from European funds. For each funding period, Portugal has to elaborate, in accordance with the European Commission, so-called Operational Programmes. Within these, individual measures are defined. Therefore, many Portuguese R&D institutions leverage national resources with co-funding from EU R&D programmes. (One such example of a research programme is INETI research on combustion with co-funding from national and international companies.)

## THE NATIONAL R&D BUDGET

Portugal's public energy R&D budget is small when compared to other IEA countries, not only in absolute terms but also as a percentage of GDP as illustrated in Figure 38. The Portuguese energy R&D budget per thousand units of GDP was 0.026 in 2002, the lowest among IEA members. There is a commitment among EU member states – named after the declaration signed in the Portuguese capital Lisbon – to raise their annual overall R&D expenditure to 3% of GDP.

Table 8

### Portuguese Government Energy R&D Budget\* (EUR 1 000)

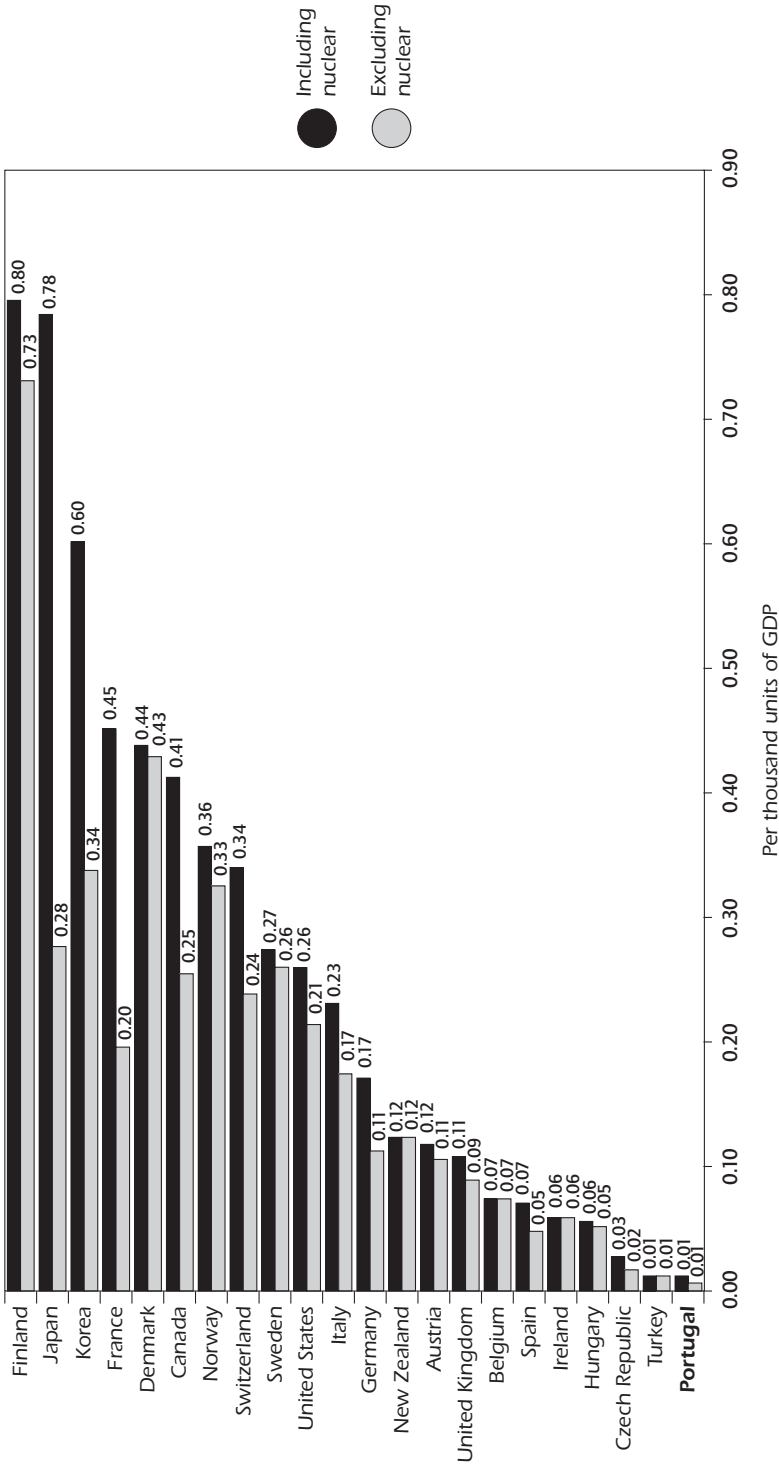
Area	1995	2000	2002	2003	2004	2005	2006	2007E	2008E
Energy conservation	665	204	100	91	1 113	626	5	38	48
Fossil fuels	138	322	640	259	619	380	22	80	40
Renewable energy	446	763	1 252	254	1 237	515	360	757	1 088
Nuclear fission	87	0	0	0	0	0	0	0	0
Nuclear fusion	0	0	0	2 000	0	650	893	1 006	944
Power&Storage	11	15	8	0	0	61	10	67	33
Other	15	173	0	20	0	87	0	41	5
<b>Total</b>	<b>1 362</b>	<b>1 477</b>	<b>2 000</b>	<b>2 624</b>	<b>2 969</b>	<b>2 319</b>	<b>1 290</b>	<b>1 989</b>	<b>2 158</b>

E: estimates.

\* The numbers presented do not include personnel expenditure.

Sources: *OECD Economic Outlook*, OECD Paris, 2008 and country submission.

Figure 38  
Government R&D Budgets in IEA Member Countries, 2007



Data not available for Australia, Greece, Luxembourg, the Netherlands, Poland and the Slovak Republic.  
 Sources: *OECD Economic Outlook*, OECD Paris, 2008 and country submissions.

Funding under the Portuguese government energy R&D budget has fluctuated significantly as can be seen in Table 8. In 2006, most funding went to renewable energy and nuclear fusion, whereas funding for energy conservation was reduced considerably. There is, however, much uncertainty in the exact breakdown as statistics are not systematically collected. Funding from EU research programmes plays a significant role in Portugal and should be added to the public research figures.

Fluctuations in R&D funding for individual technologies in recent years have made strategic and coherent efforts in pushing new technology along the innovation chain to commercialisation difficult. Governments will always have to modify investments according to changing policy priorities. A high level of fluctuations, combined with a lack of predictability and the size of the Portuguese investment in R&D make it difficult for R&D actors to plan and perform high-quality research. The fluctuation is illustrated in Figure 39. For example, fission research funding has been eliminated, while fusion research funding has increased significantly in recent years (it constituted the largest part of the national budget in 2006). Expectations are that R&D funding for energy efficiency will increase in the near term.

While energy R&D investment levels have declined over past decades, total Portuguese investment in innovation and development, while small, has increased steadily.

## **PRIORITY SETTING AND EVALUATION**

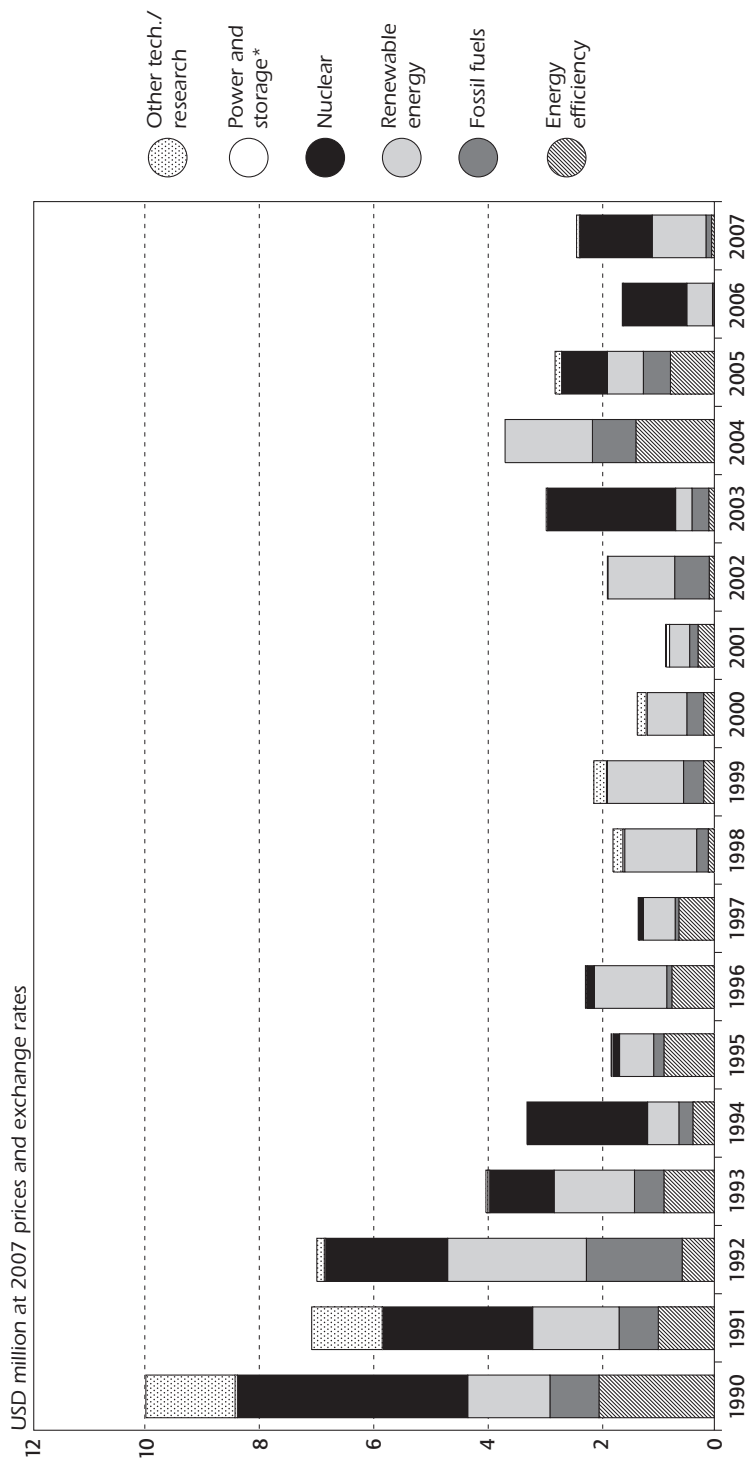
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R&D priority setting is a process to help governments optimise national investments in R&D. Several tools can be applied depending on energy policy goals, energy technologies and stakeholders. Priority setting involves the development of a consistent framework to compare the various technologies over a range of time frames and policy scenarios, with respect to their expected benefits and costs.

A systematic process for priority setting for energy R&D programmes also involves engaging and communicating with stakeholders and the wider public. To the extent that procedures for prioritising and selecting are well described and transparent, a structured approach (methodology) to priority setting can increase acceptance for the outcome of the process by generating legitimacy in a process that involves conflicting interests.

Priority setting is a continuous process. As Portuguese policies and strategic goals for technology development evolve, there is a recurring need for the Portuguese government to review the R&D priorities and related investment portfolios. It is similarly necessary to continuously review and assess R&D programmes with respect to their potential roles and contributions to specific goals.

Figure 39  
**Government R&D Spending on Energy, 1990 to 2007**

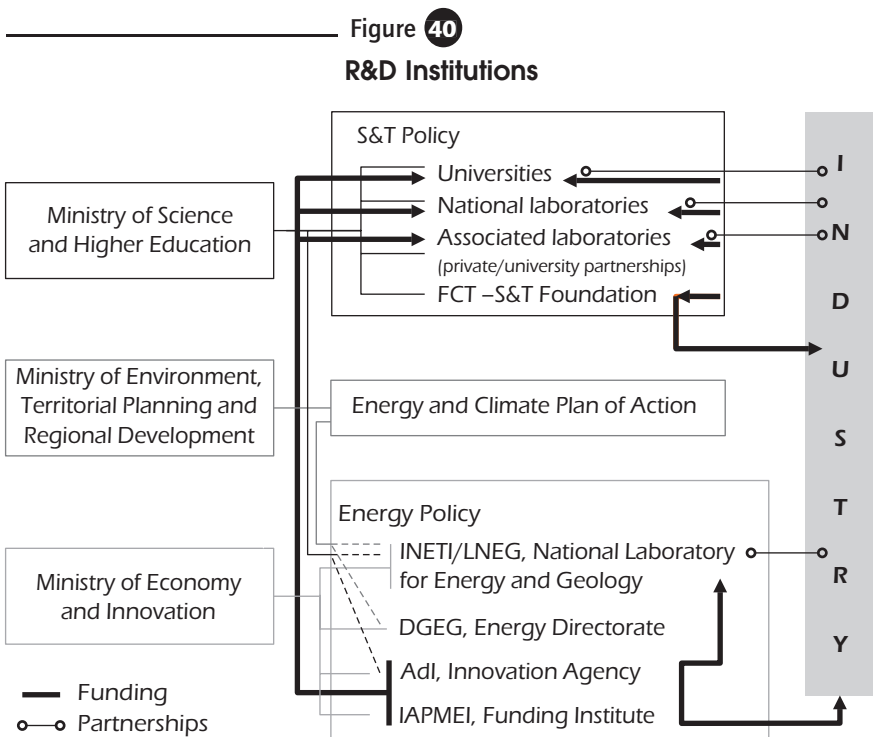


\* negligible.  
 Source: Country submission.

It is not clear if the government is taking an active, strategic role in energy R&D priority setting. The Ministry of Economy and Innovation recognises that there is a lack of coherent activity in the area of monitoring and evaluation. Projects with EU financing are monitored in accordance with EU guidelines. The different ministries involved also conduct some evaluation. However, it is recognised that the evaluation results are not applied systematically in planning new activities.

## RESEARCH INFRASTRUCTURE

Portuguese R&D institutions are active in almost all energy technologies, including nuclear fission and fusion. An overview is given in Figure 40.



Source: DGEG.

The public R&D institutions working on energy are:

- two state laboratories;
- national Institute for Engineering Technology and Innovation (INETI);
- technology and Nuclear Energy Institute (ITN, focus on safety aspects);

- one associated laboratory;
- institute of Plasmas and Nuclear Fusion;
- approximately 40 university research units.

## **INETI/LNEG**

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INETI is a national institute under the auspices of the Ministry of Economy and Innovation. It was established in 1978 (LNETI), and underwent major changes in 1993 (INETI-Industry) and 2002 (INETI-Innovation). At present, INETI is undergoing a further major change; after separation of several scientific areas to other laboratories and universities, INETI is now beginning to focus on two major themes, energy and geology. It will be organised as two separate laboratories within one institution – the National Laboratory on Energy and Geology (LNEG). LNEG’s main emphasis is on energy and geology. Its final structure is expected to be approved some time in 2009.

Most INETI funding comes from the central government budget and from EU programmes and at present INETI receives more than 85% of the non-nuclear energy research budget.<sup>10</sup> For the past five years, however, INETI/LNEG has been improving co-operation with the industrial sector. Consequently, some funding has come from the private sector through joint projects, for example funding for wind power projects. There are also examples of co-operation with the private sector in technology deployment in waste-fuelled fluidised bed installations and renewable energy technology. Recently, interest has emerged in energy efficiency in buildings, biogas and fuel cells. INETI has addressed a wide portfolio of energy R&D activities since the last review, including;

- energy efficiency (buildings and energy conversion processes);
- thermal solar applications, solar photovoltaic, passive solar;
- wind and ocean;
- bioenergy (biomass and waste, biogas, biodiesel and bioethanol);
- hydrogen and fuel cells;
- clean coal technologies;
- carbon capture and storage;
- geothermal technologies;
- network analysis.

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10. Source: INETI/LNEG.

The energy research activities in the new LNEG will be much the same as the previous activities, but will be organised under the following four categories:

- energy efficiency (buildings, industry, transportation);
- energy and environment (emissions control, CCS, co-combustion, wastes conversion);
- endogenous energy resources and renewable energies (solar, wind, wave, biomass and biofuels); and
- new energy vectors: hydrogen (production, storage and use), fuel cells, grids and networks.

The estimated 2008 LNEG budget was EUR 25.4 million of which EUR 16 million was for energy-related work. A total of 470 staff work in technical and scientific units, including staff working on geology; they are employed directly by the laboratory.

## **INDUSTRIAL ENERGY R&D**

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The costs spent on R&D by private companies in the energy sector are:

- 2005: 0.1% (at current prices) corresponding to approximately EUR 471 300;
- 2007: 3.7% (at current prices) corresponding to EUR 37.65 million.

## **INTERNATIONAL COLLABORATION**

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Given its own limited R&D budget, Portugal places emphasis on the importance of international collaboration. EU programmes are an important source of financing and Portugal actively participates in them. Furthermore, Portugal participates in eight Implementing Agreements (IEA Framework for International Technology Co-operation):

- Buildings and Community Systems (ECBCS);
- Energy Technology Data Exchange (ETDE);
- Fluidised Bed Conversion;
- Industrial Energy-Related Technologies and Systems;
- Ocean Energy Systems;
- Photovoltaic Power Systems;
- Solar Heating and Cooling;
- Wind Energy Systems.

INETI represents Portugal in the IEA Committee on Energy Research and Technology (CERT), in the Fossil Fuels Working Party (FFWP), Renewable Energy Working Party (REWEP) and the End Use Working Party (EUWP).

Massachusetts Institute of Technology (MIT) and the government of Portugal have formed a partnership to address critical energy issues and to strengthen transatlantic co-operation in energy research (see Box 4 for further details).

Box **4**

## Massachusetts Institute of Technology- Portugal Program

The MIT-Portugal Program is a large-scale international collaboration involving MIT and government, academia, and industry in Portugal to develop education and research programmes related to engineering systems. The high-level partnership represents a strategic commitment by the Portuguese government to science, technology, and higher education that leverages MIT's experience in these important areas in order to strengthen the country's knowledge base through an investment in human capital and institution building. The programme has targeted four areas as key areas for economic development and societal impact – several of them related to energy research:

- bio-engineering systems;
- engineering design and advanced manufacturing;
- sustainable energy systems; and
- transportation systems.

The programme is supported by a national initiative involving seven Portuguese universities and 14 research centres that have targeted the four key areas for economic development and societal impact. In addition to these four areas, an anchor programme includes projects to address fundamental research in engineering systems as well as flagship projects that integrate research across several of the focus areas.

A primary goal of the MIT-Portugal Program is to educate a new generation of leaders in the emerging field of engineering systems. This field integrates engineering, management sciences, economics, and policy in order to better understand, design, and implement the highly



complex, technology-based systems upon which society is increasingly dependent. Priority has been given to developing new world-class education programmes in Portuguese universities for top engineering students from Portugal and around the world. Three types of degree courses are available: PhD, Advanced Study/Masters, and short courses geared towards professionals in the four focus areas that all have a foundation in engineering systems.

A second main objective of the MIT-Portugal Program is to encourage faculty at different Portuguese institutions to collaborate on focus area research initiatives and to invigorate research and development within the industrial sector.

### **Sustainable Energy Systems sub-area**

The Sustainable Energy Systems focus area's prime objective is to engage industry and government in innovative research and educational programmes to develop standard approaches, methods, and policies for improving the long-term performance of the nation's energy sector while addressing climate change and energy security concerns.

The educational programme includes a one-year course of advanced studies (DFA) for working professionals and a multiple-year SES Doctor of Philosophy (PhD) course. The advanced studies and doctoral courses both focus on core areas in energy systems within a multidisciplinary engineering systems framework, including engineering and economics, at the level of energy systems analysis and design. Students who successfully complete the DFA may proceed to the PhD course as long as they fulfil the requirements and are approved by the SES Educational Committee.

The research and educational programmes involve numerous departments and laboratories at MIT, in collaboration with several Portuguese universities, including the Technical University of Lisbon (Instituto Superior Técnico, IST, and the Instituto Superior de Economia e Gestão, ISEG), the University of Porto (Faculdade de Engenharia, FEUP), the University of Lisbon (Faculdade de Ciências, FCUL), and the University of Coimbra (Faculdade de Economia, FEUC e Faculdade de Ciências e Tecnologia, FCTUC).

### **Industry and basic science research collaboration**

The research will intersect directly with the programme's education components and aims to create lasting connections between academia and industry in Portugal. Becoming a MIT-Portugal Industrial Affiliate gives companies the opportunity to have access to experts, innovative technology and research opportunities. At an institutional level, industry will benefit through:

- access to the best university research programmes at both MIT and at top Portuguese universities in the fields of engineering, technology, and business development;
- opportunities to participate in joint or sponsored research with institutions that have an open and fresh perspective on possible solutions to corporations' technological and business issues; and
- opportunities to strengthen their relationships with educational institutions that have extensive experience and a deep understanding of knowledge and technology transfer, from leading universities to corporations.

Many of the leading Portuguese energy companies and institutions have joined the MIT Program as Affiliates of the Sustainable Energy Systems.

Source: DGEG.

## **CASE STUDY: SUPPORTING INDUSTRIAL CLUSTERS, THE CASE OF WIND<sup>11</sup>**

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In 2005, Portugal undertook a significant review of its national energy policy. The new National Energy Strategy established renewable energy sources (RES) as an essential pillar of the future Portuguese energy matrix. The Strategy set out an integrated policy for the promotion of low-carbon energy sources, relying on the strong support of two major complementary components – wind and hydropower. A diversified policy for biomass and new energy technologies such as wave energy, solar power and biofuels, was also adopted.

The Portuguese government decided to launch two large-scale public tenders to award new interconnection capacity for future wind farms. This tender gave points to candidates offering discounts on the feed-in tariff, but also aimed to leverage technological progress and industrial policy. Indeed, one of the key needs was the creation of a wind energy, R&D and industrial cluster. This would maximise the overall value-added from the wind investment and create new economic growth and jobs, particularly in less developed areas of the country. This policy made it possible to negotiate additional proposals and commitments assumed by promoters, giving rise to private initiatives in R&D, know-how transfer and development of domestic products.

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11. Source: Europe's New Energy ERA. Manuel Pinho. Available from [http://www.min-economia.pt/document/ERA\\_BOOK\\_LORES\\_2502.pdf](http://www.min-economia.pt/document/ERA_BOOK_LORES_2502.pdf).

The first tender was concluded in October 2006. In this bid, 1 000 MW of installed capacity were awarded, with an additional 200 MW in capacity upgrades. The budget for this process was EUR 1 750 million and it led to the creation of approximately 1 700 direct jobs and 4 500 indirect jobs. In the second tender, concluded in September 2007, an additional 400 MW was granted followed by a further 200 MW of capacity upgrades in 2008. Following the tenders, industrial clusters linked to wind power in Portugal were created.

It is hoped that these clusters will create cutting-edge industrial units and capabilities in wind power technology, such as rotor blades, nacelles, towers, generators, and other electrical and electronic equipment. In addition, the winning first-phase tender has already contributed EUR 35 million towards the establishment of a national R&D fund. Envisaging the promotion of advanced R&D technology centres, this fund is to be applied to innovation and research in the field of renewable energies.

The tendering process represented more than a mere boost to the continuing development of wind energy: it introduced a new paradigm in the sector. Until then, the high growth rates in installed capacity were fuelled almost exclusively by imports of technology and equipment, as more than 80% of the components of a typical wind farm had to be imported. From now on, it is hoped the country will become a net exporter of wind turbines, in addition to producing most components to be installed in Portugal.

Finally, looking ahead it is important to underline the role of these tenders in preparing the country for the future of electricity. The tenders introduce a series of innovations which will actively help prepare the grid of tomorrow, such as advanced wind forecasting models, and the widespread integration of wind and hydro for energy storage purposes. Also the creation of integrated dispatch centres will be able to manage the production of a series of wind farms in real time, according to demand and to the needs of the grid. All this, combined with the technology transfer agreements signed with leading wind R&D companies, and with the new R&D fund and networks, has the potential to turn Portugal into a key player of renewable energy research and into a state-of-the-art laboratory for the energy model of the future.

## CRITIQUE

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The government of Portugal should be commended for its ambitious plan to implement new and clean energy technologies into the future Portuguese energy system. Apart from contributing to a more sustainable energy system, this change offers opportunities for new economic activity and employment creation. The government should also be strongly commended for its creation of strategic R&D and industrial clusters in key technology development activities such as wind, solar and wave. This approach can help bridge the "valley of death" for demonstrated technologies, leverage scarce R&D resources and have an industrial perspective on research in publicly funded laboratories.

At the same time, the Portuguese research community – universities, national and associated research laboratories – should be praised for continuously delivering research results and new researchers to support the further development of the Portuguese energy sector. Increasing collaboration with industry and through international frameworks has been commendable. This offers a promising energy research capacity that new government initiatives can build upon.

INETI has recently been restructured and named the National Laboratory on Energy and Geology Laboratory. This could indicate a renewed focus on energy technology research, development and demonstration. Until now, it has transferred research activities not related to energy and geology to other universities. The rebranding needs to be backed up with new resources and clear priorities. The new National Laboratory offers the opportunity for new leadership. INETI is working in a co-ordinated way with the government entities, research institutions and industry towards the deployment of a coherent research and knowledge transfer with impact on energy efficiency foreseeing results in economic growth and social welfare.

Notwithstanding these positive steps, challenges remain. These relate to developing large amounts of incremental wind, solar, wave and other new technologies for the Portuguese energy networks, and also to meeting the target of 10% use of biofuels for car transportation by 2010. Energy R&D policy is a means which Portugal can utilise to help respond to these challenges.

It is not clear whether the ministry in charge of energy policy has an energy R&D strategy or programme to help achieve its energy policy goals. The ministry may not have the manpower and commitment to be able to take strategic leadership in this area. Historically, this had been left to the research-performing institutions, resulting in a lack of ownership at government level, and a lack of commitment to explore opportunities for using R&D policy as an active tool to achieve national energy goals.

Development of an energy R&D strategy with clearly defined objectives, research areas and milestones should rest with the Ministry of Economy and Innovation in collaboration with relevant stakeholders – in particular the Ministry of Science, Technology and Higher Education, the energy industry and national energy research institutions. The Ministry of Economy and Innovation puts a great deal of expectation in the development of an adequate R&D strategy and the creation of a network of knowledge where INETI/LNEG will play an important role of national catalyser of energy R&D. The ministry created a Fund for Wind Industrial Investments to apply in innovative energy projects in the hedge of knowledge transfer.

Furthermore, public funding for energy R&D has not increased and remains the lowest of IEA member countries as measured against GDP. Co-ordination among relevant ministries and stakeholders in the sector could be improved.

Although the Ministry of Science and Higher Education, which is responsible for national R&D policy, does not regard energy R&D as a key priority, much energy-related R&D is carried out at universities and associated laboratories.

INETI has performed a commendable job in identifying activities which support government energy policy. With relatively small budgets it has maintained research capacity and a diverse research portfolio to respond to changing policy priorities. Despite this, it remains a concern that national R&D strategy development and priority setting is carried out by the same institute that performs most publicly funded energy R&D.

Energy issues are becoming increasingly linked with other policy fields such as environment and transport. Similarly, R&D in these sectors is becoming more multidisciplinary and there are many links to basic sciences. Therefore, close co-operation between the different ministries and the research laboratories under them is necessary. At present, there are some overlaps in the activities of the different laboratories and universities.

It is positive that INETI is actively seeking possibilities to co-operate with universities and the private sector and to participate in international research programmes. Portugal can greatly benefit from such co-operation given the low level of public funding. For the same reason, it is positive that Portugal actively co-operates internationally within the EU and IEA frameworks. At INETI, and many universities, international collaboration on energy research offers an effective way of getting access to additional funding, leveraging resources and tapping in to research expertise in other countries.

## RECOMMENDATIONS

*The government of Portugal should:*

- ▶ *Develop an integrated and coherent energy research and development strategy, aligned with industrial policy, with leadership provided by the Ministry of Economy and Innovation in collaboration with other ministries, high-level institutions, the private sector and other state agencies.*
- ▶ *Invest more in national energy R&D in an order of magnitude that could bring Portugal closer to average levels among IEA member countries.*
- ▶ *Build on its achievements in recent years by strengthening the co-ordination among the different ministries engaged in energy R&D.*
- ▶ *Continue to establish and strengthen industrial clusters in key technology areas as a means to improve public-private partnership in developing new clean energy technologies and assist the country in meeting its renewable energy targets.*



# **PART IV**

## **ANNEXES**





## ORGANISATION OF THE REVIEW

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### 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 conducted by the IEA. The *Shared Goals* are presented in Annex C.

### REVIEW TEAM

The in-depth review team visited Lisbon from 23 to 28 November 2008. 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 government response to the IEA energy policy questionnaire and other information. The team is grateful for the co-operation and hospitality of the many people it met during the visit. Thanks to their openness and candour, the visit was highly productive and enjoyable. In particular, the team wishes to express its gratitude to Director-General José Perdigoto and Deputy Director-General Bento de Morais Sarmiento, Ms. Isabel Soares and Ms. Luísa Silvério of the Directorate-General for Energy and Geology for their personal engagement in briefing the team on current Portuguese energy policy issues.

The team members were:

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Kieran McNamara managed the review and drafted the report with the exception of Chapter 9 on Energy Technology, Research and Development, which was drafted by Jeppe Bjerg and Chapter 5 on Oil and Coal, for which Aad van Bohemen and Akihiro Tonai provided support. Monica Petit and Bertrand Sadin prepared the figures. Karen Treanton and Erdinç Pinar provided support on statistics. Viviane Consoli provided editorial assistance and Marilyn Ferris helped in the final stages of preparation.

## ORGANISATIONS VISITED

The team held discussions with the following energy and environment stakeholders:

- Ministry of Economy and Innovation, Directorate-General for Energy and Geology
- ADENE, the National Energy Agency
- CHP Association (COGEN)
- Consumer Associations (DECO)
- EDP Comercial
- EDP Distribuição
- EDP Gás
- EDP Gás Distribuição
- EDP Gás Serviço Universal
- EDP Produção
- EDP Serviço Universal
- Enernova
- Enersis
- Environmental NGOs (QUERCUS)
- ERSE, the energy regulator
- Galp Gás
- Gamesa
- Gás Natural Comercializadora

- GDP Distribuição
- Generg
- Iberdrola
- INESC Porto
- INETI
- Instituto Superior Técnico - Universidade Técnica de Lisboa
- Lisboagás
- Ministry for Environment, Territorial Planning and Regional Development (MAOTDR)
- Ministry of Finance and Public Administration
- Ministry of Public Works, Transport and Communications
- Ministry of Science, Technology and Higher Education
- Oil Distributers and Retailers (APETRO)
- Oil Refining (Galp Energia, Petrogal)
- OMIP, the operator of the Iberian Electricity Market
- Portuguese Competition Authority
- The regional energy agencies (OEINERGE and ENERGAIA)
- REN – Rede Eléctrica Nacional
- REN Armazenagem
- REN Atlântico
- REN Gasodutos
- The Renewables Association (APREN)
- Tejo Energia
- Transgás, SA
- Turbogás



## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

<b>SUPPLY</b>		1973	1990	2005	2006	2007	2010	2020
<b>TOTAL PRODUCTION</b>		1.4	3.4	3.6	4.3	4.6	6.5	7.2
Coal		0.1	0.1	-	-	-	-	-
Peat		-	-	-	-	-	-	-
Oil		-	-	-	-	-	-	-
Gas		-	-	-	-	-	-	-
Comb. Renewables & Waste <sup>1</sup>		0.6	2.5	2.9	3.0	3.2	4.3	4.6
Nuclear		-	-	-	-	-	-	-
Hydro		0.6	0.8	0.4	0.9	0.9	1.1	1.2
Wind		-	-	0.2	0.3	0.3	0.9	1.0
Geothermal		-	0.0	0.1	0.1	0.2	0.2	0.2
Solar		-	0.0	0.0	0.0	0.0	0.1	0.1
<b>TOTAL NET IMPORTS</b>		5.4	13.8	23.2	20.3	20.3	21.6	25.6
Coal		0.0	0.0	-	0.0	0.0	..	..
Exports		0.3	3.0	3.2	3.5	2.9	2.9	2.1
Imports		0.3	3.0	3.2	3.5	2.9	2.9	2.1
Oil		0.2	2.5	2.4	3.4	2.5	4.4	5.3
Exports		6.4	14.4	19.2	17.4	17.1	20.7	22.3
Imports		1.1	1.1	1.3	1.4	1.5	2.2	2.5
Int'l Marine and Aviation Bunkers		5.1	10.8	15.5	12.6	13.0	14.2	14.5
Gas		-	-	-	-	-	-	-
Exports		-	-	3.9	3.7	3.8	4.3	9.1
Imports		-	-	3.9	3.7	3.8	4.3	9.1
Electricity		0.0	0.1	0.2	0.3	0.2	0.0	-
Exports		0.0	0.1	0.8	0.7	0.8	0.2	-
Imports		-0.0	0.0	0.6	0.5	0.6	0.2	-
<b>TOTAL STOCK CHANGES</b>		0.1	-0.5	-0.4	0.1	0.2	-0.1	-0.1
<b>TOTAL SUPPLY (TPES)<sup>2</sup></b>		6.9	16.7	26.4	24.7	25.1	27.9	32.7
Coal		0.5	2.8	3.3	3.3	2.9	3.0	2.2
Peat		-	-	-	-	-	-	-
Oil		5.1	10.7	15.2	12.9	13.1	14.1	14.4
Gas		-	-	3.8	3.6	3.8	4.1	8.9
Comb. Renewables & Waste <sup>1</sup>		0.6	2.5	2.9	3.0	3.2	4.3	4.6
Nuclear		-	-	-	-	-	-	-
Hydro		0.6	0.8	0.4	0.9	0.9	1.1	1.2
Wind		-	-	0.2	0.3	0.3	0.9	1.0
Geothermal		-	0.0	0.1	0.1	0.2	0.2	0.2
Solar		-	0.0	0.0	0.0	0.0	0.1	0.1
Electricity Trade <sup>3</sup>		-0.0	0.0	0.6	0.5	0.6	0.2	-
<b>Shares (%)</b>								
Coal		7.4	16.5	12.7	13.4	11.5	10.9	6.8
Peat		-	-	-	-	-	-	-
Oil		74.3	63.9	57.4	52.4	52.4	50.5	43.9
Gas		-	-	14.2	14.8	15.2	14.8	27.3
Comb. Renewables & Waste		9.3	14.8	11.1	12.2	12.6	15.3	14.0
Nuclear		-	-	-	-	-	-	-
Hydro		9.1	4.7	1.5	3.8	3.5	3.8	3.8
Wind		-	-	0.6	1.0	1.4	3.2	3.2
Geothermal		-	-	0.2	0.4	0.8	0.7	0.6
Solar		-	0.1	0.1	0.1	0.1	0.3	0.4
Electricity Trade		-	-	2.2	1.9	2.6	0.6	-

0 is negligible, - is nil. .. is not available.

Forecasts for 2030 are not available.

<b>DEMAND</b>							
<b>FINAL CONSUMPTION BY SECTOR</b>							
	1973	1990	2005	2006	2007	2010	2020
<b>TFC</b>	<b>5.7</b>	<b>13.3</b>	<b>20.4</b>	<b>19.7</b>	<b>20.1</b>	<b>22.2</b>	<b>25.9</b>
Coal	0.2	0.6	0.0	0.0	0.2	0.0	0.0
Peat	-	-	-	-	-	-	-
Oil	4.2	8.3	12.3	11.2	11.2	12.1	13.1
Gas	0.1	0.1	1.3	1.3	1.4	1.6	2.5
Comb. Renewables & Waste <sup>1</sup>	0.6	2.3	2.5	2.6	2.7	2.5	2.4
Geothermal	-	-	0.0	0.0	0.0	-	-
Solar	-	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.7	2.0	4.0	4.1	4.2	4.7	6.4
Heat	-	0.0	0.3	0.3	0.3	1.2	1.5
<b>Shares (%)</b>							
Coal	3.3	4.4	0.1	0.1	0.8	0.1	0.1
Peat	-	-	-	-	-	-	-
Oil	73.4	62.3	60.1	57.2	55.8	54.8	50.7
Gas	0.8	0.4	6.4	6.8	7.2	7.4	9.5
Comb. Renewables & Waste	10.1	17.4	12.3	13.2	13.4	11.4	9.3
Geothermal	-	-	-	0.1	-	-	-
Solar	-	0.1	0.1	0.1	0.1	0.2	0.2
Electricity	12.3	15.2	19.5	20.9	21.0	21.0	24.6
Heat	-	0.2	1.6	1.7	1.7	5.2	5.8
<b>TOTAL INDUSTRY<sup>4</sup></b>	<b>2.7</b>	<b>6.8</b>	<b>8.1</b>	<b>7.6</b>	<b>8.1</b>	<b>8.8</b>	<b>10.5</b>
Coal	0.1	0.6	0.0	0.0	0.2	0.0	0.0
Peat	-	-	-	-	-	-	-
Oil	1.8	3.9	4.0	3.4	3.6	4.4	4.7
Gas	0.0	-	1.0	1.0	1.0	1.2	1.8
Comb. Renewables & Waste <sup>1</sup>	0.3	1.2	1.3	1.4	1.4	0.5	0.5
Geothermal	-	-	-	-	-	-	-
Solar	-	-	-	-	-	-	-
Electricity	0.4	1.1	1.5	1.5	1.5	1.5	1.9
Heat	-	0.0	0.3	0.3	0.3	1.1	1.5
<b>Shares (%)</b>							
Coal	5.1	8.8	0.2	0.4	2.1	0.2	0.2
Peat	-	-	-	-	-	-	-
Oil	66.7	57.8	49.5	44.8	44.5	50.2	44.5
Gas	0.1	-	11.8	12.7	12.8	13.2	17.5
Comb. Renewables & Waste	11.8	17.4	16.5	17.9	17.4	6.0	5.2
Geothermal	-	-	-	-	-	-	-
Solar	-	-	-	-	-	-	-
Electricity	16.3	15.6	18.2	20.0	19.2	17.6	18.5
Heat	-	0.4	3.9	4.2	4.0	12.9	14.0
<b>TRANSPORT<sup>2</sup></b>	<b>1.6</b>	<b>3.2</b>	<b>6.4</b>	<b>6.4</b>	<b>6.4</b>	<b>6.7</b>	<b>7.4</b>
<b>TOTAL OTHER SECTORS<sup>5</sup></b>	<b>1.4</b>	<b>3.3</b>	<b>6.0</b>	<b>5.7</b>	<b>5.7</b>	<b>6.7</b>	<b>8.1</b>
Coal	0.0	0.0	-	-	-	-	-
Peat	-	-	-	-	-	-	-
Oil	0.9	1.2	2.0	1.6	1.4	2.0	2.1
Gas	0.1	0.1	0.3	0.4	0.4	0.5	0.6
Comb. Renewables & Waste <sup>1</sup>	0.3	1.2	1.2	1.2	1.2	1.1	0.9
Geothermal	-	-	0.0	0.0	0.0	-	-
Solar	-	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.2	0.9	2.5	2.5	2.6	3.1	4.4
Heat	-	-	0.0	0.0	0.0	0.0	0.0
<b>Shares (%)</b>							
Coal	2.4	-	-	-	-	-	-
Peat	-	-	-	-	-	-	-
Oil	59.2	35.4	32.8	27.6	25.5	30.3	26.0
Gas	3.2	1.6	5.7	6.4	6.9	7.0	7.5
Comb. Renewables & Waste	18.1	34.4	19.5	20.4	20.5	16.3	11.7
Geothermal	-	-	-	0.2	0.2	-	-
Solar	-	0.3	0.4	0.4	0.5	0.6	0.5
Electricity	17.0	28.3	41.4	44.8	46.2	45.5	54.0
Heat	-	-	0.2	0.2	0.3	0.3	0.3

<b>DEMAND</b>							
<b>ENERGY TRANSFORMATION AND LOSSES</b>							
	1973	1990	2005	2006	2007	2010	2020
<b>ELECTRICITY GENERATION<sup>6</sup></b>							
INPUT (Mtoe)	1.3	5.1	8.6	8.2	7.8	11.0	14.4
OUTPUT (Mtoe)	0.8	2.4	4.0	4.2	4.0	5.0	7.0
(TWh gross)	9.8	28.4	46.2	48.6	46.9	57.8	81.4
<b>Output Shares (%)</b>							
Coal	3.9	32.1	33.0	30.8	26.4	22.4	11.4
Peat	-	-	-	-	-	-	-
Oil	19.2	33.1	19.0	10.8	10.4	9.3	4.1
Gas	-	-	29.5	25.4	28.0	21.9	44.3
Comb. Renewables & Waste	2.0	2.4	4.3	4.1	4.6	6.2	6.1
Nuclear	-	-	-	-	-	-	-
Hydro	74.8	32.3	10.2	22.6	21.5	21.2	17.8
Wind	-	-	3.8	6.0	8.6	18.0	14.8
Geothermal	-	-	0.2	0.2	0.4	0.4	0.3
Solar	-	-	-	-	0.1	0.6	1.3
<b>TOTAL LOSSES</b>	<b>1.3</b>	<b>2.9</b>	<b>6.0</b>	<b>4.9</b>	<b>4.8</b>	<b>6.1</b>	<b>7.3</b>
<i>of which:</i>							
Electricity and Heat Generation <sup>7</sup>	0.5	2.6	4.3	3.7	3.5	4.5	5.6
Other Transformation	0.3	-0.7	0.1	0.1	0.0	0.7	0.7
Own Use and Losses <sup>8</sup>	0.5	1.0	1.5	1.1	1.4	0.8	1.0
<b>Statistical Differences</b>	<b>-0.1</b>	<b>0.5</b>	<b>0.0</b>	<b>0.1</b>	<b>0.1</b>	<b>-0.3</b>	<b>-0.6</b>
<b>INDICATORS</b>							
	1973	1990	2005	2006	2010	2020	2030
GDP (billion 2000 USD)	49.60	84.75	117.66	119.27	121.57	125.51	144.35
Population (millions)	8.72	10.00	10.55	10.58	10.61	10.21	10.49
TPES/GDP <sup>9</sup>	0.14	0.20	0.23	0.21	0.21	0.22	0.23
Energy Production/TPES	0.20	0.20	0.14	0.18	0.18	0.23	0.22
Per Capita TPES <sup>10</sup>	0.79	1.68	2.51	2.33	2.36	2.74	3.12
Oil Supply/GDP <sup>9</sup>	0.10	0.13	0.13	0.11	0.11	0.11	0.10
TFC/GDP <sup>9</sup>	0.12	0.16	0.17	0.17	0.17	0.18	0.18
Per Capita TFC <sup>10</sup>	0.66	1.34	1.94	1.86	1.90	2.17	2.47
Energy-related CO <sub>2</sub> Emissions (MtCO <sub>2</sub> ) <sup>11</sup>	16.3	39.3	62.7	56.3	55.2	58.7	68.0
CO <sub>2</sub> Emissions from Bunkers (MtCO <sub>2</sub> )	3.4	3.4	4.0	4.3	4.7	6.8	7.8
<b>GROWTH RATES (% per year)</b>							
	73-79	79-90	90-05	05-06	06-07	07-10	10-20
TPES	5.7	5.1	3.1	-6.7	1.6	3.7	1.6
Coal	-2.4	18.2	1.3	-1.2	-12.8	1.7	-3.1
Peat	-	-	-	-	-	-	-
Oil	6.5	3.3	2.4	-14.8	1.7	2.4	0.2
Gas	-	-	-	-3.0	4.6	2.8	8.0
Comb. Renewables & Waste	3.2	11.2	1.1	2.8	4.6	10.7	0.7
Nuclear	-	-	-	-	-	-	-
Hydro	7.3	-1.8	-4.3	132.4	-8.2	6.7	1.7
Wind	-	-	-	65.8	37.7	37.1	1.5
Geothermal	-	-	22.9	33.3	119.3	-1.6	-
Solar	-	-	5.0	4.3	16.7	35.7	6.3
TFC	4.9	5.2	2.9	-3.7	2.2	3.3	1.6
Electricity Consumption	8.5	5.3	4.6	3.1	2.6	3.3	3.2
Energy Production	4.4	5.9	0.4	20.7	6.7	12.0	1.0
Net Oil Imports	8.6	2.4	2.4	-18.7	2.6	3.0	0.2
GDP	2.9	3.4	2.2	1.4	1.9	1.1	1.4
Growth in the TPES/GDP Ratio	2.8	1.7	0.9	-8.0	-0.5	2.5	0.2
Growth in the TFC/GDP Ratio	1.9	1.7	0.7	-5.2	-	2.4	0.1

Please note: Rounding may cause totals to differ from the sum of the elements.

## FOOTNOTES TO ENERGY BALANCES AND KEY STATISTICAL DATA

1. Combustible renewables and waste comprises solid biomass, liquid biomass, biogas, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
2. Excludes international marine bunkers and international aviation bunkers.
3. Total supply of electricity represents net trade. A negative number in the share of TPES indicates that exports are greater than imports.
4. Industry includes non-energy use.
5. Other Sectors includes residential, commercial, public services, agriculture, forestry, fishing and other non-specified sectors.
6. Inputs to electricity generation include inputs to electricity and CHP plants. Output refers only to electricity generation.
7. 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 10% for geothermal and 100% for hydro, wind and photovoltaic.
8. 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.
9. Toe per thousand US dollars at 2000 prices and exchange rates.
10. Toe per person.
11. "Energy-related CO<sub>2</sub> emissions" have been estimated using the IPCC Tier I Sectoral Approach from the *Revised 1996 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 2007 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.



## 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

\* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, 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.

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 their 4 June 1993 meeting in Paris.)

## GLOSSARY AND LIST OF ABBREVIATIONS

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In this report, abbreviations are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention and abbreviated subsequently, this glossary provides a quick and central reference for many of the abbreviations used.

bcm	billion cubic metres
CCS	carbon dioxide capture and storage
CDM	clean development mechanism
CHP	combined heat and power
cm	cubic metres
CO <sub>2</sub>	carbon dioxide
DGEG	Directorate-General for Energy and Geology
DSO	distribution system operator
EDP	EDP – Energias de Portugal
ERSE	Entidade Reguladora dos Serviços Energéticos
ERU	emissions reduction unit
EU	European Union
EU-ETS	EU Emissions Trading Scheme
EUR	euro (currency)
GDP	Gas de Portugal
GDP	gross domestic product
G8	Group of Eight (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United states)
GHG	greenhouse gas
GW	gigawatt, or 1 Watt by 10 <sup>9</sup>
HFC	hydrofluorocarbon
IEA	International Energy Agency
INETI	Instituto Nacional de Engenharia, Tecnologia e Inovação

Jl	joint implementation
kb/d	thousand barrels per day
kWh	kilowatt-hour, or 1 watt by 1 hour by 10 <sup>3</sup>
LNG	liquefied natural gas
m <sub>2</sub>	square metre
mb	million barrels
mcm	million cubic metres
Mt	million tonnes
Mt CO <sub>2</sub> -eq	million tonnes of CO <sub>2</sub> -equivalent
Mtoe	million tonnes of oil equivalent see toe
MW	megawatt, or 1 watt by 10 <sup>6</sup>
MWh	megawatt-hour, or 1 watt by 1 hour by 10 <sup>6</sup>
NAP	National Allocation Plan
NESO	National Emergency Sharing Organisation
NO <sub>2</sub>	nitrogen dioxide
OECD	Organisation for Economic Cooperation and Development
PFCs	perfluorocarbons
PPP	purchasing power parity : the rate of currency conversion that equalises the purchasing power of different currencies, <i>i.e.</i> estimates the differences in price levels between different countries
PV	photovoltaic
R&D	Research and development
REN	Redes Energéticas Nacionais
RES	renewable energy sources
SMEs	small and medium-sized enterprises
t	tonne
TFC	total final energy consumption
toe	tonne of oil equivalent, defined as 107 kcal
TPA	third-party access
TPES	total primary energy supply
TSO	transmission system operator
UNFCCC	United Nations Framework Convention on Climate Change

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