
# Macroeconomic study on the impact of Wind Energy in Spain

**Created by:**

Deloitte.

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## 1. The study[1]

It is no easy task to identify a business activity that has progressed so much in the last 15 years as the wind industry in Spain. The industry has achieved a highly prominent position in economic terms as a result of the billings of the companies operating in it, of its contribution to the creation of value (contribution to GDP growth) and jobs, and of the vitalising effect that this business has on other economic sectors.

Today, wind energy plays a fundamental role in the Spanish electricity industry: in 2007, based on information published by Red Eléctrica de España, wind energy accounted for 9.1% of the total electricity output and was the fourth ranked technology in the production mix. In the first nine months of 2008 this figure rose to 11%.

The significant level of technological and economic development of Spanish companies in the industry has enabled them to achieve a major volume of exports of goods and services, and even to create subsidiaries in the leading markets. Furthermore, attracted by the buoyancy of the industry, leading companies from other countries (such as the United States of America and China) have set up in Spain to carry on business and production activities, which is contributing to economic growth and is boosting technological progress.

Moreover, the wind energy industry is making a major contribution to sustainable development in Spain, since its characteristics are in tune with the principal substance of Spain's energy and environmental policy, namely the reduction of greenhouse gas and other polluting gas emissions, increased use of renewable energies and reduced energy dependence through lower fossil-fuel imports.

## 2. Importance of the industry on the world stage

The importance of the wind energy industry at world level is demonstrated by the rapid increase in installed capacity, which exceeded 94,000 MW in 2007, and by the average annual growth of almost 30% in the last ten years. Should this trend continue, forecasts predict that the installed capacity at world level will reach 170,000 MW by 2010.

[1] Deloitte worked with the Spanish Wind Energy Association on the publication of a "Macroeconomic study on the impact of Wind Energy in Spain"-November 2008.

**The industry has achieved a very prominent position in Spain.** With a generating capacity of 15,145 MW, at the end of 2007 Spain was the third leading country in terms of installed capacity, behind only Germany and the US, which have installed capacities of over 22,000 MW and 16,000 MW, respectively.

**Also worthy of particular mention is the significant role played by wind power generation in Spain.** In 2007 27,026 GWh of power were produced using this technology, accounting for 9.1% of the total output of the system, ranking Spain second in the world, surpassed only by Denmark, where more than 20% of total output is produced using wind energy.

**The Spanish wind energy industry as a whole represents a point of reference for the industry throughout the world, since it has a significant business fabric in all phases of the value chain of the industry and is clearly orientated towards a global market.** This network of companies is made up of wind farm promoters and wind turbines manufacturers, but also includes a whole host of component manufacturers and service providers that have emerged as a result of the rapid growth of the industry. In addition, many of these companies have a significant presence in the leading markets outside Spain and leading industry players from other companies have decided to establish a presence in Spain.

## 3. Macroeconomic impact of the industry

The contribution of Wind Energy to GDP (value creation) has grown rapidly in recent years. **In the period from 2003 to 2007 it increased from EUR 1,022 million to EUR 1,933 million (amounts in nominal prices, i.e. unadjusted for price changes).**

| | Nominal GDP Growth of the Spanish Wind Energy Industry | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2003 | Δ | 2004 | Δ | 2005 | Δ | 2006 | Δ | 2007 |
| **Cost of production** | | | | | | | | | |
| Final consumption | | | 446.423.484 | 33% | 595.493.120 | 1% | 604.306.567 | -21% | 476.633.617 |
| Gross capital formation | | | 542.073.314 | -17% | 447.876.089 | -13% | 391.687.437 | 30% | 508.494.602 |
| Net exports | | | 228.207.360 | 76% | 400.766.275 | 83% | 732.316.511 | 29% | 947.922.567 |
| Exports of goods and services | | | 952.711.479 | 30% | 1.234.414.145 | 57% | 1.937.478.064 | 32% | 2.553.450.778 |
| Imports of goods and services | | | 724.504.119 | 15% | 833.647.870 | 45% | 1.205.161.553 | 33% | 1.605.528.211 |
| **GDP at factor cost** | | | **1.216.704.157** | **19%** | **1.444.135.484** | **20%** | **1.728.310.515** | **12%** | **1.933.050.786** |
| **Gross value added** | | | | | | | | | |
| Income generated in production (Billings) | 4.289.079.634 | 32% | 5.642.240.937 | 16% | 6.536.362.307 | 30% | 8.466.023.204 | 19% | 10.059.942.652 |
| Expenses incurred in production | 3.266.933.884 | 35% | 4.425.536.779 | 15% | 5.092.226.823 | 32% | 6.737.712.689 | 21% | 8.126.891.866 |
| **GDP at factor cost** | **1.022.145.751** | **19%** | **1.216.704.157** | **19%** | **1.444.135.484** | **20%** | **1.728.310.515** | **12%** | **1.933.050.786** |
| **Return on factors** | | | | | | | | | |
| Compensation of employees | 510.947.825 | 9% | 556.606.785 | 16% | 644.619.158 | 14% | 735.045.549 | 22% | 900.261.562 |
| Consumption of fixed capital | 172.412.670 | 18% | 203.547.661 | 12% | 228.111.612 | 9% | 249.117.103 | 3% | 256.013.941 |
| Operating surplus | 338.785.256 | 35% | 456.549.712 | 25% | 571.404.714 | 30% | 744.147.863 | 4% | 776.775.283 |
| **GDP at factor cost** | **1.022.145.751** | **19%** | **1.216.704.157** | **19%** | **1.444.135.484** | **20%** | **1.728.310.515** | **12%** | **1.933.050.786** |
| **NDP at factor cost** | **849.733.081** | **19%** | **1.013.156.497** | **20%** | **1.216.023.872** | **22%** | **1.479.193.412** | **13%** | **1.677.036.845** |

**Figure 1. Nominal GDP and NDP (Net Domestic Product) growth of the Spanish Wind Energy Industry in the period from 2003 to 2007.**
**Source: Spanish Mercantile Registry and Deloitte.**

**The GDP of the Wind Energy Industry grew in real terms (at factor cost) by 62.7% in the period from 2003 to 2007;** giving average annual growth of 15.7% in those years.

- ✓ The increase in the contribution to GDP was above 8.5% in all those years
- ✓ The growth was above 10% in all the years except 2007

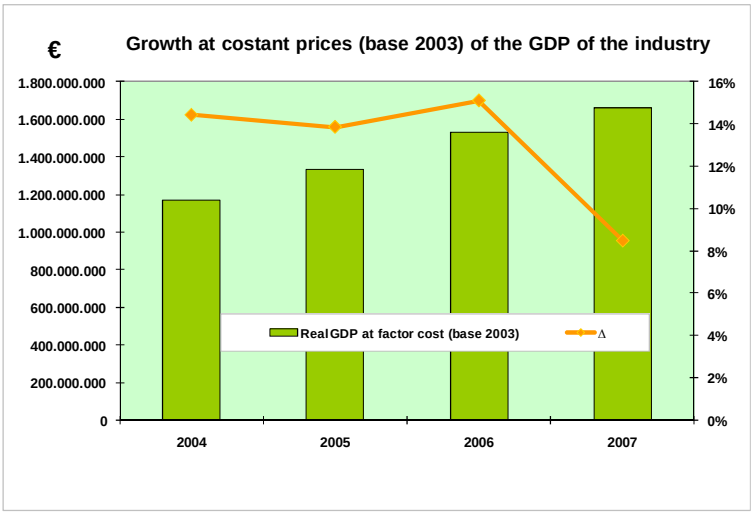



**Figure 2. Growth at current prices (base 2003) of the GDP of the Spanish Wind Energy Industry in the period from 2003 to 2007. Source: Spanish Mercantile Registry and Deloitte.**

It should be highlighted that unlike other industries, such as construction, wind energy growth has brought about the creation of a significant industrial fabric, technological base and a source of know-how, which has made it possible for Spanish companies to establish a significant international presence, in view of the foreseeable maturation of the Spanish market.

Growth in 2007 was lower because the revenue of wind energy developers grew less than in preceding years. Although the installed capacity in Spain increased very significantly, the price in the electricity market dropped considerably.

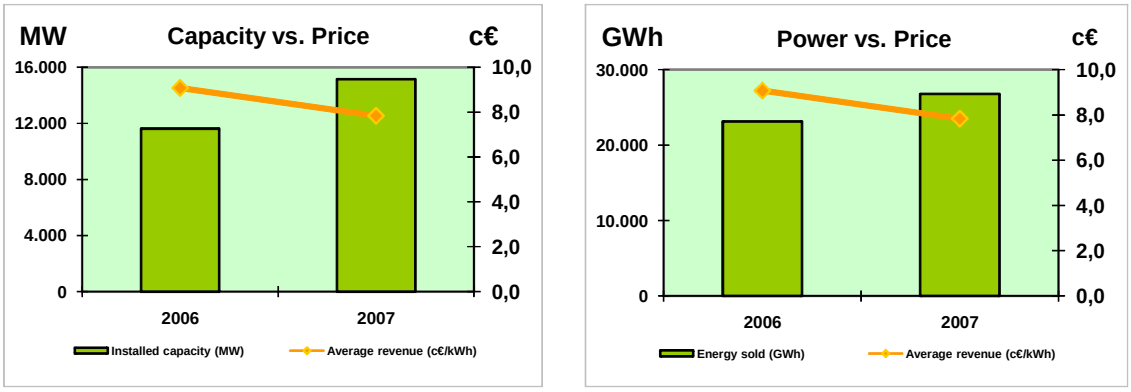



**Figure 3. Increase in installed capacity and output of the Spanish Wind Energy Industry and power prices for 2006-2007. Source: CNE, OMEL, REE and AEE.**

**The relative importance of the industry in the Spanish economy has risen significantly**. In 2003 it accounted for 0.14% of Spanish GDP, while in 2007 it represented 0.21%, an increase of 44% in the period, as compared with year-on-year GDP growth of 3% for the Spanish economy as a whole. A comparison with other sectors of the Spanish economy shows that the relative importance of the Wind Energy Industry was greater than that of, among others, the leather and footwear (0.16%) and fishing (0.18%) industries.

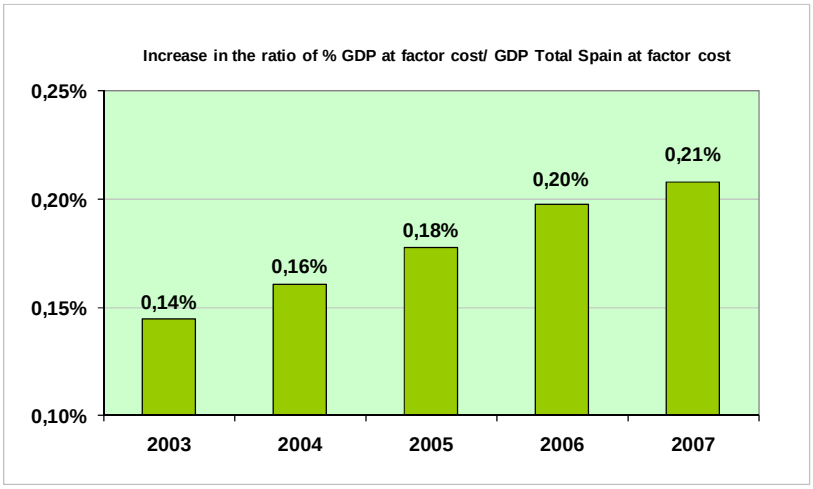



**Figure 4. Increase in the relative importance of the Wind Energy Industry with respect to the total GDP of the Spanish economy. Source: International Monetary Fund and Deloitte.**

Also, **the relative importance increased with respect to the GDP of the Energy Industry** from 5.35% in 2003 to 6.95% in 2007.

It should be noted that in contrast to other means of generation, both under the ordinary regime and those using other renewable energy sources, which are highly dependent on the import of equipment and technology, most wind power is produced locally, which has a significant indirect effect on other economic sectors.

As a result of the high level of technological development of the companies in the industry and of growth in world demand, **in 2007 the industry's exports exceeded EUR 2,550 million** (EUR 2,100 million in real terms, base 2003)**.** Net exports (exports minus imports) accounted for more than 49% of the gross value added of the Industry.

In addition, the main Spanish players in the Industry have established subsidiaries in the most important markets. Another factor that demonstrates the importance of the Spanish Wind Energy Industry and its position as world leader that is not reflected in the exports figure because the related power is not produced in Spain, is the direct presence of major Spanish companies (mainly wind turbines manufacturers and wind farms promoters) in the leading markets such as China or the United States.

## Estimated direct impact on GDP of the Spanish Wind Energy Industry for 2008-2012

Forecasts point towards **the contribution to Nominal GDP of the Wind Energy Industry in Spain exceeding EUR 2,655 million in 2010 and EUR 3,230 million in 2012**.

**In real terms,** the increase in the Industry GDP at factor cost for 2008-2012 would lead to an increase in the contribution of:

- ✓ 26% for 2008-2010
- ✓ 46% for 2008-2012

**Significant economic growth is forecasted for all the activities involved in the value chain of the Industry.**

As a result of the foregoing, **the relative importance of the Wind Energy Industry in the Spanish economy will grow significantly, and will account for 0.27% of GDP in 2012.** The increase in the contribution of the Industry with respect to the real GDP of the Spanish economy is expected to exceed 83.5% in 2003-2012.

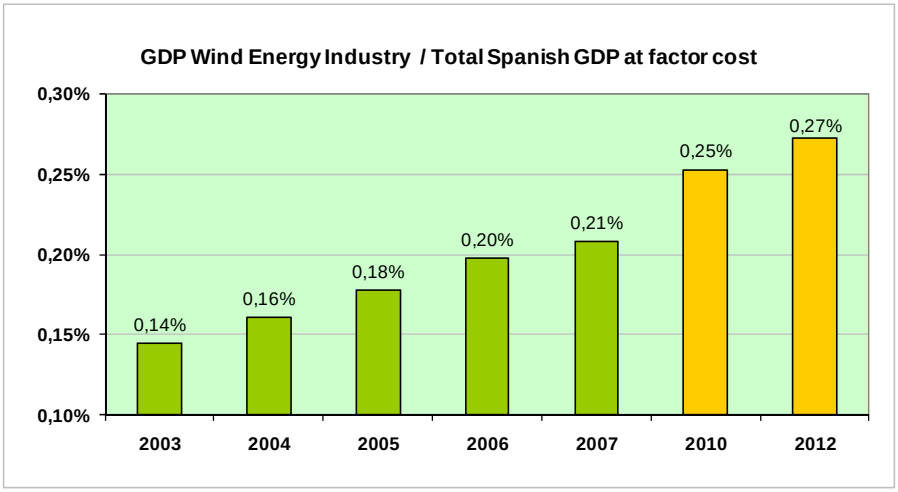



**Figure 5. Projected increase in the relative importance of the Wind Energy Industry with respect to total Spanish GDP. Source: International Monetary Fund and Deloitte.**

## Indirect impact on GDP of the Spanish Wind Energy Industry

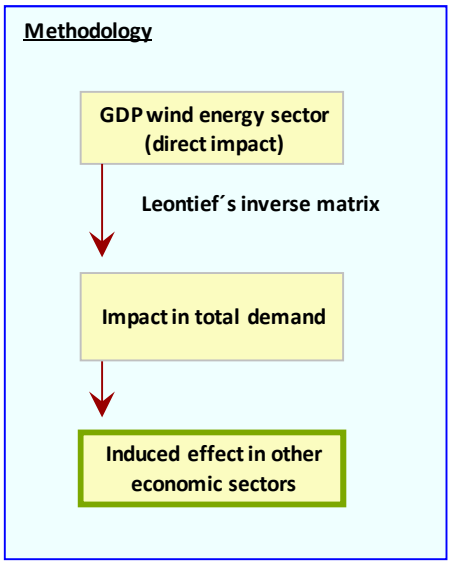
**The various subsectors in the Wind Energy Industry need products and services from other activities. Therefore, the Industry has an additional knock-on economic impact on other sectors of the economy that can be assessed using input-output tables.**

The input-output tables show all the production and distribution operations that take place between the various sectors of the economy. Based on the matrix of technical coefficients and the Leontief inverse matrix the indirect effects of a line of business on the other sectors of the economy can be quantified.

At present the Wind Energy Industry is not shown separately in the tables in the Spanish National Accounts and, therefore, it is necessary to assess the interrelations with the other sectors of the economy. To this end, the Industry players drew up and completed a questionnaire on the structure of the procurements of the various subsectors in the Industry.

Accordingly, based on the most recent tables published by the Spanish National Institute of Statistics and on the information obtained from the questionnaires (mentioned above), a new model of tables was built showing a breakdown of the figures for the subsectors identified with Wind Energy Industry.

The method applied is as follows:



This analysis shows that the three sectors on which the Wind Energy Industry has the greatest indirect effect are: metalworking, the manufacture of metal products and the manufacture of electrical machinery and materials.

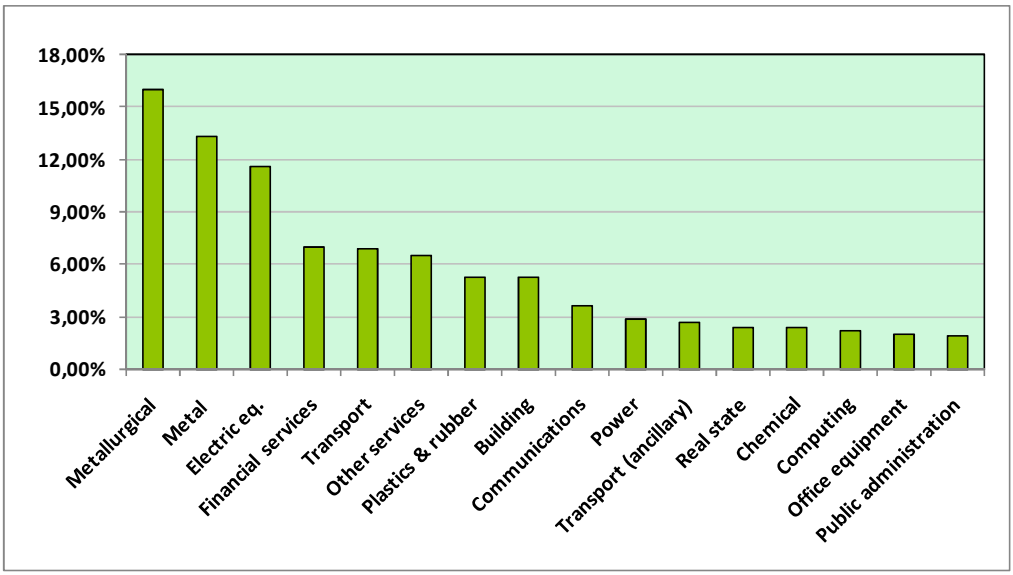



**Figure 6. Industries on which the activity of the Wind Energy Industry have the greatest effect.**
**Source: Deloitte.**

Based on the methodology applied, in 2007 the Wind Power Industry generated in terms of GDP (nominal figures for 2007):

- ✓ Directly: EUR 1,933 million (EUR 1,633 million in real terms, base 2003).
- ✓ Indirectly (knock-on effect) on the rest of the economy: EUR 1,337 million (EUR 1,150 million in real terms, base 2003).

**Meaning that the joint impact (direct + indirect) exceeded EUR 3,270 million.** For every increase of EUR 1 in the GDP of the Wind Energy Industry, the GDP of the other economic activities increases by EUR 0.69 due to the knock-on effect.

**The Wind Energy Industry contributed 0.35% of Spanish GDP in 2007.** The indirect impact would therefore be 0.14%.

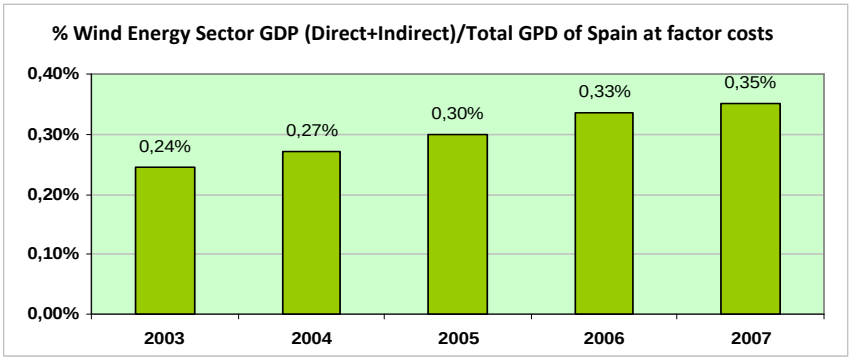



**Figure 7. Total relative impact of the Wind Energy Industry on Spanish GDP.**
**Source: Spanish National Institute of Statistics and Deloitte.**

Based on the projected growth of the Wind Energy Industry and of Spanish GDP, in 2012 the GDP of the Wind Energy Industry, considering both the direct and indirect effects, will exceed EUR 5,000 million in nominal terms and will represent 0.45% of total Spanish GDP.

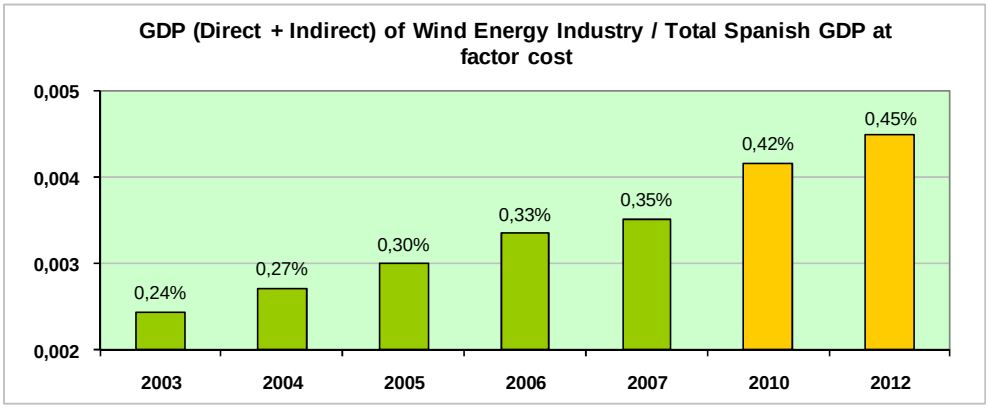



**Figure 8. Total relative impact of the Wind Energy Industry with respect to Spanish GDP (2010 and 2012). Source: Spanish National Institute of Statistics and Deloitte.**

## Impact of the Wind Energy Industry on the Balance of Trade, Incentives and Externalities arising from the activity

This document contains an economic assessment of the benefits of wind energy that justify the incentives to make capital-intensive projects viable. In 2006 these incentives totalled EUR 757.1 million in real terms (base 2003). However this year the Wind Energy Sector generated externalities and taxes and security payments for EUR 1,241 million.

**It should be noted that this income supplement for the producers in the Wind Energy Industry was established according to certain expenses not taken into account by market mechanisms, i.e. externalities: more environmentally-friendly projects, reduction of energy dependence, sustainability, etc.**

**Additionally, it is relevant to include in the comparative analysis the Wind Energy Sector Tax and Social Security payments.**

| € Real (Base 2003) | 2004 | 2005 | 2006 |
|---|---|---|---|
| Incentives | 432.807.401 | 561.302.805 | 757.164.062 |
| GHG reduction economic impact | 0 | 235.873.860 | 147.879.065 |
| Energy dependency reduction | 288.979.119 | 466.518.501 | 787.948.476 |
| Tax balance | 95.245.065 | 149.120.156 | 167.702.052 |
| Social Security payments | 113.061.000 | 125.610.000 | 137.761.000 |

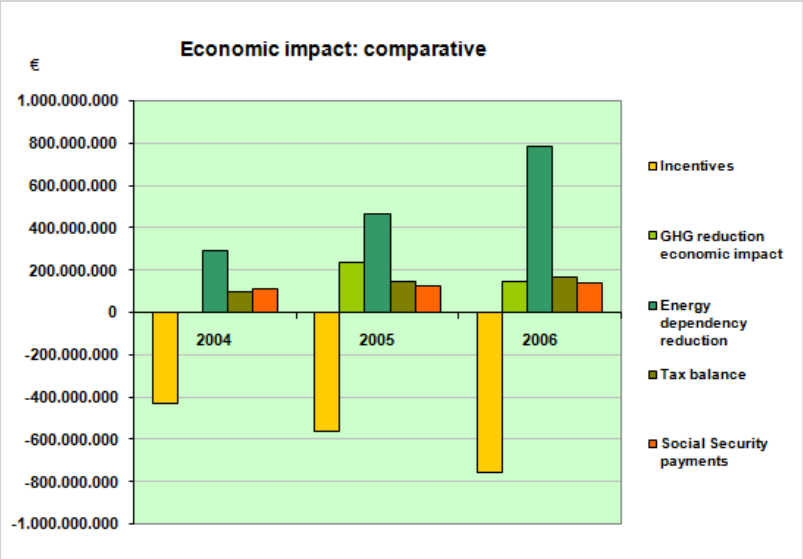



**Figure 9. Comparative analysis between incentives received by Wind Energy Sector, and Tax and Social Security Payments + Externalities.**

## Jobs created by the Wind Energy Industry

Companies' financial statements deposited at the Mercantile Registry generally disclose the number of persons employed (permanent and temporary) by them. Based on this information and on interviews conducted with the Industry players, the number of persons employed directly by the Industry in 2003-2007 was quantified, and the employment/GDP elasticity was estimated for the Wind Energy Industry.

20,781 persons were employed directly by the Industry in 2007. Employment grew by an annual average of 4.81% in 2003-2007. **The subsectors employing the largest number of persons in the Industry were the component manufacturing and services subsectors**, which in 2007 employed 32% and 30%, respectively, of the total, which stands to reason, since these are more labour-intensive activities.

Based on the information indicated above and on the Industry's GDP figures, the employment/Industry GDP elasticity was calculated at 0.42.

In addition, the Wind Energy Industry will be important in the coming years in terms of job creation, since it employed directly more than 21,000 persons in 2008 and will employ more than 30,000 in 2012. This is without doubt very important with a view to the growth of the world Wind Energy Industry and the aforementioned solid position of the Spanish Industry.

Also, the estimated number of jobs created as a result of the knock-on effect of the Wind Energy Industry in 2007 was 16,949. Taking into account the direct and indirect effects, a total of 37,730 persons were employed as a result of the activities of the Wind Energy Industry in 2007.

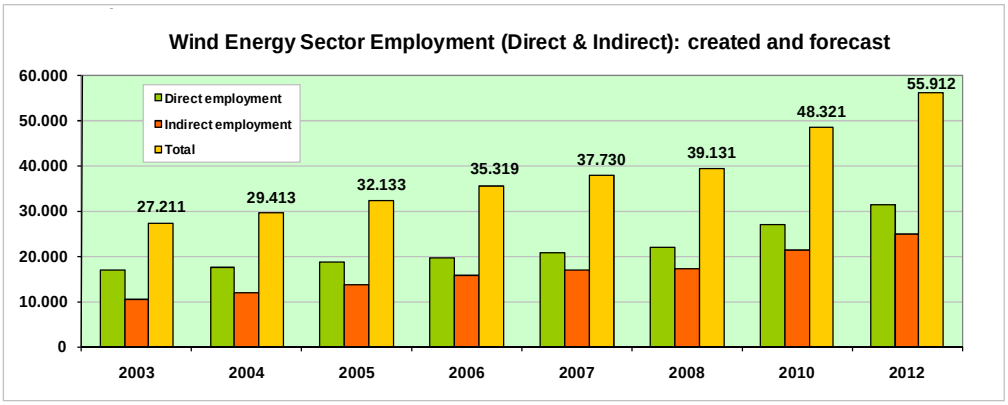



**Figure 10. Wind Energy Sector Employment (Direct & Indirect): created (from 2003 to 2007) and forecast (2010 & 2012). Source: Spanish Mercantile Registry and Deloitte.**

# 4. Environmental impact of the Industry and reduction of energy dependence

## Environmental impact

Although greenhouse gas emissions have risen considerably since 1990, the Wind Energy Industry has contributed to limiting the increase. **Wind power production avoided the emission of around 18 million tonnes of greenhouse gases in 2007, 3.5% of total Spanish emissions.**

Per the estimates for the period, **the emissions avoided will be much higher in 2010 and 2012, at more than 24.66 and 30.23 million tonnes, respectively.**

Furthermore, per the calculations made, in 2007 emissions of 11,132 tonnes of NOx and 33,817 tonnes of $SO_2$ were avoided.

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Figure 11. GHG emissions avoided as a result of the development of wind power.
Source: Red Eléctrica de España, Ministry of Industry, Tourism and Trade-General Secretariat of Energy, Ministry of the Environment and Deloitte.

## Reduction of energy dependence

Also, in 2007 the level of primary energy self-sufficiency in Spain was 18.6% (source: Spanish Secretariat-General of Energy) and, therefore, due to Spain's high energy dependence on imports, wind powered production makes a significant contribution to avoiding fossil-fuel imports.

**In 2007 imports of around 5.5 million tonnes of oil equivalent were avoided and, based on fuel prices for that year[2], the saving relating to those imports amounted to more than EUR 850 million.** For 2010 and 2012 the imports replaced will exceed 8.0 and 9.9 million tonnes of oil equivalent, respectively.

| GWh | 2003 | 2004 | 2005 | 2006 | 2007 | 2010 | 2012 |
|---|---|---|---|---|---|---|---|
| **Technology replaced** | | | | | | | |
| Coal | 8.888 | 10.642 | 11.575 | 10.541 | 12.805 | 14.988 | 17.652 |
| Fuel-oil/Gas | 988 | 1.073 | 1.498 | 2.194 | 1.840 | 2.361 | 2.906 |
| Combined cycle | 1.844 | 4.038 | 7.305 | 10.189 | 12.381 | 23.259 | 30.180 |

| toe | 2003 | 2004 | 2005 | 2006 | 2007 | 2010 | 2012 |
|---|---|---|---|---|---|---|---|
| **Imports avoided** | | | | | | | |
| Coal | 2.043.116 | 2.501.864 | 2.751.395 | 2.505.569 | 3.043.819 | 3.601.873 | 4.242.105 |
| Fuel-oil/Gas | 170.246 | 184.941 | 258.177 | 378.303 | 317.270 | 407.100 | 501.023 |
| Combined cycle | 317.946 | 696.176 | 1.259.301 | 1.756.569 | 2.134.407 | 4.009.817 | 5.203.090 |
| **Total** | **2.531.307** | **3.382.981** | **4.268.872** | **4.640.441** | **5.495.496** | **8.018.791** | **9.946.218** |

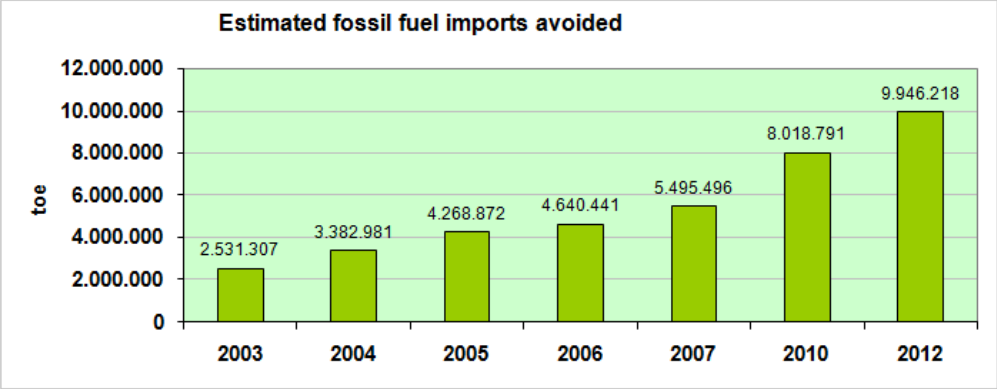


**Figure 12. Fossil fuel imports avoided as a result of the development of wind power in Spain.**
**Source: Red Eléctrica de España, Ministry of Industry, Tourism and Trade-General Secretariat of Energy and Deloitte.**

[2] Source: Bloomberg – Average price in Europe of Natural Gas (Zeebrugge), Coal (McCloskey) and Oil (Brent).

## 5. Conclusions

**In recent years a very strong pioneering economic sector has developed, that generated value to society directly of EUR 1,933 million and indirectly to the rest of the economy of an additional EUR 1,337 in 2007. In the coming years its important role will become even more accentuated as a result of the significant growth in installed wind capacity and the leading position in the world held by Spanish players in the Industry.**

In addition, **Spain is a net exporter of the equipment, services and technology associated with this Industry,** and the development of the Industry has attracted foreign investment to Spain.

This sound economic position has been **accompanies by job creation** and a very significant contribution to the **achievement of the energy and environmental policy targets set.**

The Wind Energy Industry is undoubtedly one of the most significant industries when it comes to the reduction of greenhouse and other polluting gas emissions, the increased penetration of renewable energies and the reduction of fossil fuel imports. It should be borne in mind that this favourable environmental impact brings with it economic benefits in the shape of reduced $CO_2$ emission right needs, lower costs arising from poor air quality and pollution, reduced outflows of economic benefits abroad arising from fuel imports, etc.

The main conclusion is that the policy of providing public support to this means of renewable power production has been very efficient in economic and technological terms.

It is therefore essential that the following issues be afforded great importance in the near future in the decisions taken by Industry players and regulators:

- ✓ The significant growth experienced by the Spanish Wind Energy Industry means that it must be taken into account due to its impact on economic activity levels.

  **The contribution of the Industry to Spanish GDP amounted to EUR 1,933 million in 2007 (EUR 1,663 million in at 2003 constant prices), accounting for more than 0.21% of Spanish GDP in that year.**

  The projected increases in future installed capacity (80.9% at world level in 2010, and 33.1% and 98.3% in Spain in 2010 and 2015) guarantee the sustainability of the Spanish Wind Energy Industry for the coming years.

  **Per the analysis conducted, the Industry's contribution to Spanish GDP in 2012 will exceed EUR 3,230 million, representing 0.27% of total Spanish GDP.**

- ✓ **The importance of the Industry is also demonstrated by its capacity to generate wealth in other sectors of the economy.** Based on the study performed, as a result of a knock-on effect, the Wind Energy Industry contributed indirectly EUR 1,337 million to GDP through other sectors of the economy in 2007.

  The multiplier effect of the Industry's economic activity is higher than that of other industries because all the activities in the value chain (development, construction, manufacturing and services), are carried on in Spain, mostly by Spanish players. Moreover, foreign players in the Wind Energy Industry have set up in Spain to carry on production activities here, meaning that a significant proportion of the acquisitions of inputs required for their business processes is made in Spain.

The sectors of the economy most affected by the operations of the Wind Energy Industry are: metalworking, the manufacture of metal products, the manufacture of electrical machinery and materials, the financial services industry and land transport.

- ✓ In view of the high degree of technical and economic development achieved by the players in the Spanish Wind Energy Industry, **in 2007 the Industry generated exports of over EUR 2,500 million.** In addition, Spanish companies have set up subsidiaries in the principal markets, in which they are perceived as being operators and manufacturers of reference.

- ✓ The growth of the Wind Energy Industry has contributed significantly to the technological development of Spain (scientific development).

  **The Industry contributed EUR 170 million to R&D&i in 2007.** As a result of the increase in installed capacity and of the technological challenges facing the Industry (improve output predictability, adapt equipment to withstand voltage dips, etc.), this figure will increase significantly in the coming years.

- ✓ In 2007 **the Wind Energy Industry employed directly 20,781 persons**, and the contribution per employee to GDP was more than EUR 80,000.

  Since important labour-intensive industrial activities are carried on in Spain, the sensitivity of job creation of increases in economic activity is higher then in other important sectors of the economy (e.g. the energy industry).

  The increased activity in the coming years should mean that **in 2012 30,000 persons will be employed directly** by companies in the Industry in Spain.

  The importance of the Industry is also patent in terms of the indirect jobs that it creates. Based on the study performed, in 2007 **it was estimated that 16,949 jobs had been created indirectly by the Wind Energy Industry.**

- ✓ Wind power contributed very significantly **to reducing the emissions arising from the use of fossil-fuels in 2007 (around 18 million tonnes of $CO_2$ eq.),** as well as a very large volume of NOx and $SO_2$ (11,132 and 33,817 tonnes, respectively).

- ✓ Wind power has replaced a significant volume of power produced using imported fossil fuels (and will replace even more in the future).

  The lower volume of imports reduces Spain's energy dependence on other countries. **In 2007 the wind power produced avoided the import of around 5.5 tonnes of oil equivalent**, which in economic terms reduced outflows of economic benefits abroad by more than EUR 850 million.

- ✓ Wind power is in tune with the energy and environmental policy targets set at European Union level for 2020: achieve a greenhouse gas emission reduction of 20% and penetration of renewable energies of 20%.