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The outlook for renewable energy in Navarre: An economic profile

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Abstract

This paper describes the outlook and development of renewable energy in Navarre (Spain), which has become one of the leading regions in renewables over the last 10 years. This paper focuses its attention on the key features of the energy policy in Navarre, where there has emerged a dynamic enterprise sector. This sector has enormously increased its employment rates in the region. The success of renewable energy in Navarre is the result of the joint impact of decisive institutional support, industrial initiatives and consensus among social agents with regard to renewables. Tax incentives and local investment programs designed to break down the reluctance of local authorities and a campaign to obtain public support have, moreover, proven more efficient than the prior feed-in tariffs scheme, designed to develop the renewable energy sector and create international companies within it. The paper culminates in a detailed prognosis based on the SRN2003 survey of employment and installed power, which covers the majority of the firms operating in the Navarre renewables sector. Findings, however, suggest that the future of the sector in Navarre could be held back by the shortage of trained workers. This article might serve as a pertinent example for the deployment of renewables at regional level worldwide.
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Keywords: Renewable energy; Employment prognosis; Navarre

1. Introduction

The development of renewable energy involves an economic effort and strong political commitment, the justification for which is dependent upon the views of the public and social agents. The motivation for making the effort lies mainly in the environmental issues surrounding energy production and climatic change. Nevertheless, there is increasing concern for sustainability in modern societies. One of the main advantages of renewable energy is its potential to provide decentralised employment. This means that jobs are spread throughout the territory in which alternative energy is deployed, resulting in a balance between energy development and industrial progress.

1.1. Navarre in Spain and in Europe

Navarre is one of Spain's 17 regions (autonomous communities) situated in the North of the Iberian peninsula. It has a surface area of 10,391 km^2 and a wide range of climate and landscape. While occupying a strategic position in the communications network between Spain and France, the region also benefits in its trade relationships with other regions from belonging to the Atlantic Axis (European regions on the Atlantic shore) (Fig. 1).

In 2003, Navarre had a total population of 578,210. Her population density is just 55.65 inhabitants/km^2, clearly below the Spanish average of 80 inhabitants/km^2. Navarre is, in addition, one of Spain's smallest regions, in terms, not only of its surface area (2% of the total Spanish surface), but also of its demographic and economic statistics (1.35% share in population, 1.6% share in gross domestic product (GDP) and a 2.5%

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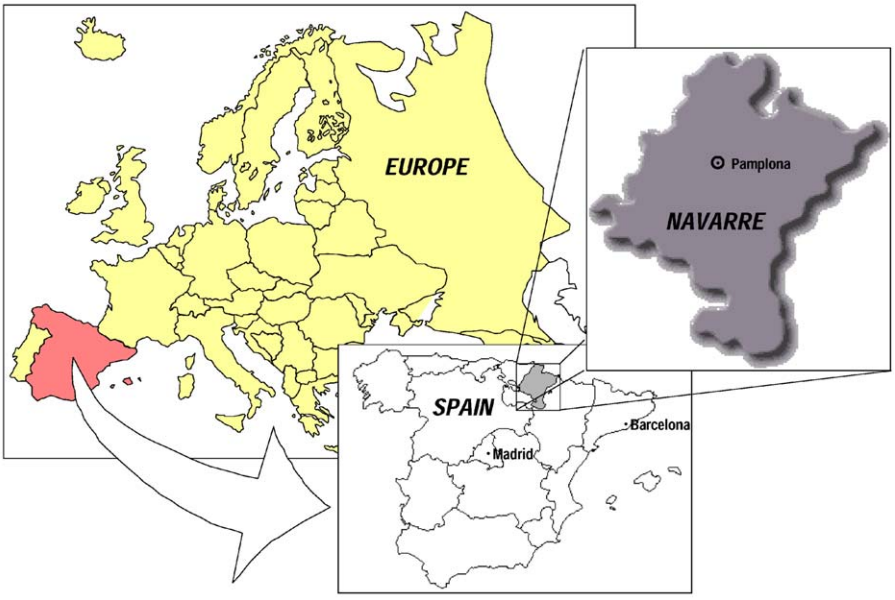

Fig. 1. Location of the Autonomous Community of Navarre in Spain.

Table 1
Navarre data in relation to Spain and in European Union-15, year 2002

Variables	Navarre	Spain	European Union-15
Surface (km^2)	10,391	504,790	3,191,120
Population (in thousands)	556	41,117	371,090
Unemployment rate	6.20	13	7.60
Employment distribution by sectors			
Agriculture	7.20	6.80	1.70
Industry and construction	37.20	30.80	30.30
Services	55.60	62.40	68
GDP per capita	107	84	100

Source: Own design based on information from the Eurostat, the Spanish Institute of Statistics (INE) and the Spanish Ministry of Economy.

share in industrial GDP) (see Table 1) (Cámara Navarra de Comercio e Industria, 2002).

Comparatively speaking, Navarre ranks high within the Spanish economy in per capita income, labour productivity and employment rate. According to the Eurostat 2002 report, Navarre is the second region in Spain and the fifty-first (out of 266) in Europe-25, in GDP per capita terms.

1.2. Purposes and objectives

Over the last 10 years, Navarre has become one of the leading European regions in renewables. This claim is borne up by the fact that 60% of total electricity consumption in the region is sourced from renewables. Taking this specialisation into account, the Spanish Government chose Navarre as the location for two important national renewable energy centres: the R + D + I Centre and the Training Centre. Meanwhile, the region is steadily emerging as a touchstone for European standards; witness the Navarrese participation in the Wind Energy Potential I project (WEP I) within the European ECOS-Ouverture Initiative. Similarly, Navarre earned the best regional policy in Europe award, at the European Conference for Renewable Energy, held in Berlin in January 2004.

Thus, this paper examines progress in the area of renewable energy in this Spanish region, focusing on the driving factors behind its development and the role played by the regional energy policy in the achievement of the proposed goals.

Following on from this introduction, the remainder of this paper is organised as follows. Section 2 provides an outlook for renewables. Section 3 describes the methodology adopted in our study. The expansion of renewable energy in Navarre is described in Section 4, where attention is focused on the driving factors, and regional and national renewable energy policies are compared. The characteristics of the renewables sector in Navarre beyond 2001 are presented in Section 5. A prognosis for the period 2004–2008, especially in terms of employment, is provided in Section 6. The paper finishes with some conclusions and indications of limitations that may arise in the near future.

This study is largely based on the RN2002 report (Pintor et al., 2003), produced by the authors at the request of the Government of Navarre, with a view to obtaining a reliable prognosis of human resource trends

in companies within the renewables sector, beyond the year 2004.

2. The outlook for renewables in Spain

The development of renewables requires not only a major economic effort, but also the skill to deal with the environmental issues that arise in connection with the search for new energy sources. Nevertheless, there is nowadays a significant level of concern for sustainable management in the energy arena. In addition, renewable energy has tremendous potential for decentralised job creation. That is, jobs will be spread throughout the territory in which renewables are deployed, thus reconciling industrial development with the diversification of energy sources (OECD, 1998; Thothathri, 1999; European Commission, 1996, 2000; Menéndez, 2001).

The promotion of electricity production from renewable sources ranks high among the objectives of EU energy policies (European Commission, 1997, 2001), which set the target to produce to source at least 12% of the EU's *primary energy* from renewables by the year 2010. Thus, in 2000, the European Commission's Department of Energy and Transport proposed a 22% increase in the generation of electricity from renewables by 2010. The goal is different for each member state, however. In light of the country's recent progress in the development of renewables the target for Spain, e.g., is 29.4%. The set goals rely, moreover, on large-scale hydraulic energy, which is not usually considered renewable. In Europe, hydropower, regardless of size, was defined as renewable energy under the Council of the European Union (CEU) Directive (CEU, 2001). Nevertheless, the EU Council of Ministers also added a section that effectively left the door open for subsequent reconsideration of which kinds of hydropower should be classed as renewable energy (Rowlands, 2005). Meanwhile, individual member states, such as Spain, would be allowed to continue distinguishing "good" hydroelectric power from "bad" on whatever basis they preferred. Thus, Spain has set its boundary between these two kinds of energy at 10 MW.

Some current references to aid understanding of the development of renewables in the European Union are the book by Reiche (2002), the paper by Reiche and Bechberger (2004) and the article by Meyer (2003).

There is a long history of research involving energy models (Hogan, 2002). Among these generic studies of energy problems and models, Arocena et al. (2002) address the Spanish case. The key paper on sustainability in Spain is Hernández et al. (2004), which discusses the links between renewables and global warming.

Energy demand in Spain is rising at a much higher rate than GDP, which increased by about 19.5% (in constant euros) in the period 1993–1999, while energy demand increased by 27.5% according to the Comisión Nacional de la Energía (CNE, 2002). This imbalance threatens the fulfilment of the renewable energy development goals defined earlier.

The subsidisation of renewables is an essential factor for their development. Spanish legislation favours a *special regime* to deal with their expansion (Spanish Act 54/97 and Royal Decrees RD 2366/94 and RD 2818/98). Thus, the Spanish energy model hinges on the following factors:

(a) The 2002–2011 plan for electricity and gas networks to allow access to all enterprises by 2003, on the basis of free-market competition.
(b) Spain's Renewable Energy Development Plan 2000–2010 (PPRE, Ministerio de Industria y Energía, 1999), aimed at supplying 12% of the energy demand from renewables.
(c) Deregulation of the renewables sector, separating energy transportation and distribution (regulated activities), on the one hand, and energy generation and marketing (non-regulated activities), on the other hand.
(d) Energy Conservation and Efficiency Strategies aimed at achieving a level of GDP more in harmony with energy consumption, with the emphasis on the use of green energy.
(e) It must be stressed that, because of their powers for autonomous decision-making, each Spanish region is largely able to design its own specific energy policy.

In the European ranking with regard to renewables, meanwhile, Spain's position is average. The contribution of renewables to the energy supply in Spain is just 7%, which is well behind the 20% of Sweden, Austria and Finland, but ahead of the under 1% achieved by the United Kingdom, Belgium, Holland and Luxembourg (Reiche, 2002; Reiche and Bechberger, 2004). Some significant data concerning the growth of renewables in Spain are displayed in Table 2.

3. Methodology

3.1. Delimiting the renewables sector

Since we needed detailed data in order to analyse the situation of the renewables sector in Navarre, our principal problem was how to define its limits. Within this activity not only do we find industrial enterprises such as the producers of wind turbines, we must also consider the role of wind plant promoters and companies providing servicing. Neither the Statistical Classification of Economic Activities in the European

Table 2
Primary consumption of renewable energy in Spain (GWh)

	1998	1999	2000	2001	2010
Wind	1438	2610	4837	7227	21,483
Hydro (>10 MW)	30,392	21,506	24,975	36,088	31,053
Mini-hydro (<10 MW)	5603	4547	4420	4814	6890
Solar-thermal	302	324.8	359.6	406	3,898
Solar-PV	11.6	11.6	23.2	23.2	220.4
Thermoelectrics	0	0	0	0	2,088
Biomass	41,389	41,621	41,957	42,502	109,794
Biogas	1032	1125	1264	1322	1740
Biofuels	0	0	592	592	5800
Solid urban waste	2865	3202	3236	3236	7923
Geothermal	46.4	58	92.8	92.8	34.8
Total	83,091	75,017	81,745	96,303	193,012

Note: Current action and prognosis for the PPRE. For the distinction between hydro and mini-hydro, see Sections 1–2 in this paper.
Source: Spanish Institute for Energy Conservation and Diversification (IDAE).

Community (NACE-93 Rev. 1.1.) nor in the Spanish Classification of Economic Activities (CNAE-93, Rev. 1), updated in January 2003, provide any information about the renewables sector.

A survey among the firms in the renewables sector was therefore required to obtain the necessary information. Our first task was to delimit the sector. Using both classifications, we identified the activities relating to the renewables sector. These were selected from the following codes of the NACE-93 Rev.1 and ISIC Rev.3: 28 (manufacture of metal products), 29 (manufacture of machinery and equipment), 31 (manufacture of electrical machinery and apparatus), 36 (manufacturing n.e.c.), 40 (electricity, gas, steam and hot water supply), 73 (research and development) and 74 (other business activities).

Next, we conducted a search of Navarrese firms with deep involvement in the renewable energy sector. For this we used the *Catalogue of Industry in Navarre*[1] (Government of Navarre, 2003), the DICODI[2] database, DICODI database (INE, 2002) and the *Directory of Companies compiled by the Spanish Institute for Energy Conservation and Diversification* (IDAE, 2003). This process provided a total of 54 companies involved in this kind of activity.

[1]The Navarre Catalogue of Industry contains a listing of Navarrese companies with more than five workers, classed according to the geographical and other criteria of the Spanish CNAE-93 classification (see http://www.cfnavarra.es/industria/catalogo/resul.asp, latest update 20 January 2005).

[2]This database contains institutional and economic data on over 50,000 Spanish companies, listed according to the Spanish CNAE-93 classification.

3.2. Choice of variables

We made the following selection of variables to analyse the characteristics of the renewables sector:

- Employment, because of the close relationship between renewable energies and employment reported in the literature reviewed (OECD, 1998; Thothathri, 1999; European Commission, 1996, 2000; see also Menéndez 2001; Ministerio de Medio Ambiente (MMA), 2000).
- Turnover, because, along with employment, it is the most important variable in the analysis of firm size and the evolution and competitive potential of the sector.
- Investment, because it is the key to analysing the future of any economic sector.

3.3. Data collection. The SRN2003 survey

As our data collection method, we chose either postal surveys or personal interviews with the manager or CEO of each company selected from the renewable energy sector. The complexity of the study and the need for close contact with the firm manager to obtain reliable data led us to opt for personal interviewing. The low rate of response associated with postal surveys and the time restrictions involved in a telephone survey were additional reasons for this choice.

When it comes to forecasting the situation for the period 2004–2008, the prognosis for a specific sector in a given geographic location can be reached by a variety of different methods. Traditionally, it has proved useful to depict several scenarios using estimations based on a set

of macroeconomic variables (Brown et al., 2001). Some reports, grounded basically on the knowledge of a group of experts in the area of interest, use the Delphi method (Sharma et al., 2003). Other papers report on a market survey of final consumers in the sector under analysis (Manologlou et al., 2004). Finally, alternative market research methods can be used to evaluate the estimations and predictions of producers in the sector (Bird et al., 2002).

In light of the above, the special characteristics of the renewables sector and its geographical characteristics will have a strong influence on the choice of methodology used to obtain information. Therefore, the use of experts to help predict the future of the whole range of renewable energy types is extremely complex, and the resulting estimations may be unreliable. We eventually decided to include the characteristics and the prognosis for the period 2004–2008 in the same questionnaire or survey.

Thus, the survey is divided into four blocks or sections: (i) institutional data and geographical spread of the company; (ii) markets and customers; (iii) current turnover, investment, installed power and employment data; (iv) prognosis and predictions for the future of renewables.

The survey resulted in a high rate of response, with valid replies being returned by 70% of the companies selected in advance, i.e., 90% of the sector's business activity. Notwithstanding the high response rate, and taking into account the reduced size of the sample, the sampling error is around 8% at the 95% confidence level.

The statistical information was processed with the DYANE-2 market research package, and the SPSS 12 statistical analysis package.

4. Renewable energy expansion in Navarre

4.1. The renewable energy boom in Navarre

From 1950 to 2003 Navarre was characterised as being heavily energy-dependent on other regions or countries. Navarre has no source of primary energy, such as oil, gas or coal. Navarre's only indigenous energy resources are hydroelectric power stations and the biomass. Table 3 summarises Navarre's situation in terms of energy sources from 1984 to 1993.

In 1985, the Government of Navarre, aware of these poor figures, passed a law that embodied the regions' first energy plan (Government of Navarre, 1995). It sought, among other things, to:

(a) Diversify energy sources.
(b) Reduce energy dependency, by exploiting the region's abundant renewable energy sources.
(c) Develop new infrastructure to enable the use of new energy sources.
(d) Enhance the conservation and efficient management of energy.

Table 3
Final energy consumption in Navarre (1984–1993)

Energy sources	1984 (GWh)	1984 (%)	1993 (GWh)	1993 (%)
Coal	895	8.9	680.5	5.6
Petroleum and derivatives	5875	58.3	6100	50.3
Gas	55.2	0.5	1633	13.5
Biomass	1317	13.1	1273	10.5
Electricity	1933	19.2	2438	20.1
Total	10,077	100	12,124	100

Source: Faulin et al. (2003).

These objectives had a strong influence in the renewable energy policy, which will be analysed in detail in Section 4.2. In 1995, the Navarrese authorities approved their First Regional Energy Plan 1995–2000 (FEPN), which emphasised the importance of wind energy in the deployment of renewables in Navarre. Thus, Navarre became one of Spain's leading regions in the development of a renewable energy promotion plan, setting itself very ambitious aims for the end of 2010.

Navarre's First Regional Energy Plan (FEPN) was implemented with great success between 1998 and 2002, predominantly in the areas of wind and solar-PV energy, with a moderate increase in other types. The growth pattern is summarised in Fig. 2.

Navarre's progress in wind energy far surpasses that of other Spanish regions. Thus, it ranks slightly ahead of Italy (788 MW), which takes fourth place in Europe for wind power production. Furthermore, Navarre owns 2.5% of the installed power in the world and the 20% of the installed power in Spain (IDAE, 2003). When it comes to solar-PV energy, Navarre owns the largest plant in Spain, with 50% of the installed power.

4.2. Driving factors behind the renewable energy boom in Navarre: regional vs. national policy

We will now attempt to explain the success of Navarre's 1995–2000 Renewable Energy Promotion Plan, and describe how the specific characteristics of this region contributed towards it. Success was, perhaps, mainly due to a combination of circumstances involving the collaboration of social agents and the local and regional authorities in Navarre. This co-operation was essential, as evidenced by the difficulties experienced by Holland (Agterbosch et al., 2004) or the United Kingdom in exploiting the biomass (Upreti, 2004).

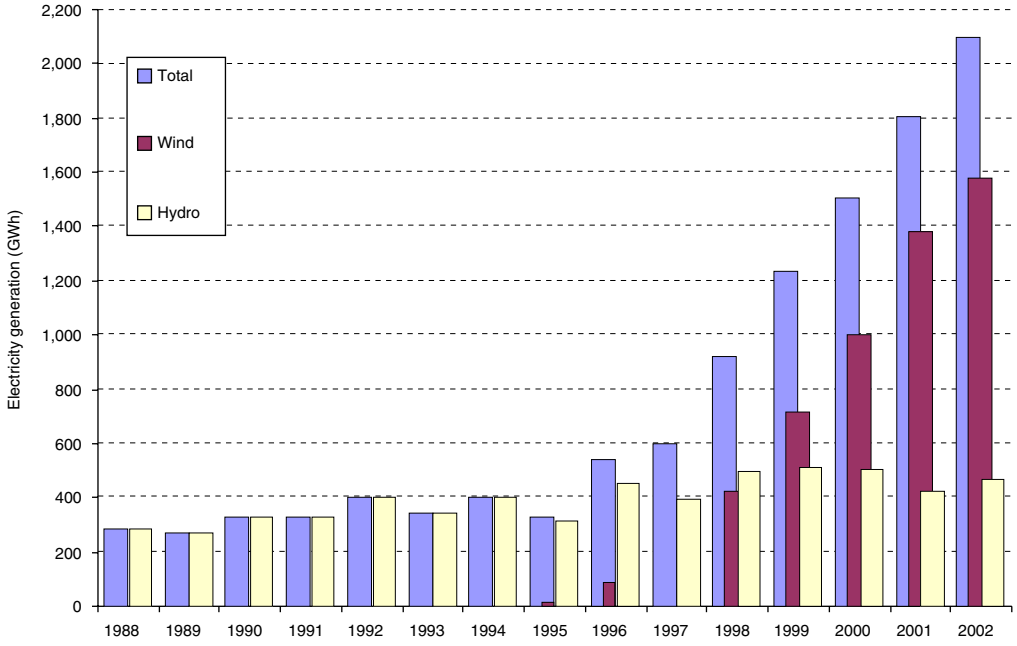

Fig. 2. Evolution in electricity generation from renewables in Navarre. *Source*: Government of Navarre, Department of Industry and Technology, Trade and Labour.

The support of renewables in Spain has been implemented using feed-in tariffs, which made the generation of renewable energy profitable. There are two tariff options for green electricity. One is an annual guaranteed fixed tariff which remains the same throughout the year (for wind energy from 6.62 € cents/kWh in 1999 to 6.28 € cents/kWh in 2002 or 6.48 € cents/kWh in 2004). The other is an average pool price plus a production incentive or premium of 50% of the average pool price, approved under the Spanish Royal Decree RD436/2004 (for wind energy from 6.67 € cents/kWh in 1999 to 7.46 in 2002 or 6.67 in October 2004). Tariffs are adjusted annually in accordance with the variation in average electricity prices, but always within a price corridor of between 80% and 90% of the pretax consumer price for electricity, as stipulated for the electricity sector under a 1977 law. In addition, Spanish Royal Decree RD2818/1998 requires premiums to be reviewed every 4 years, thus generating additional uncertainty.

Nonetheless, this policy is common to all Spanish regions, and cannot, therefore, be used to explain the Navarrese success nor the current situation in some European countries (Reiche and Bechberger, 2004; Meyer, 2003). Other explanatory factors are the pooled use of strategies based on supply support (supply push) and demand (demand-pull) policies, along with social policies. These policies explain the growth of renewables in Navarre, especially in the case of wind energy. Moreover, the successful development of wind energy was the catalyst that provided the stimulus for exploiting other renewable sources. Thus, we can summarise the determining factors underlying the development of this sector in Navarre in the following terms:

(a) Specific characteristics of Navarre.
  (i) Navarre presented a major deficit in energy generation capacity.
  (ii) Major wind and solar potential was discovered in Navarre.
  (iii) Navarre is a small region, and the energy policies of the regional government are highly efficient, thanks to their precise knowledge of local conditions.

(b) Appropriate regional policy.
  (i) The Government of Navarre was quicker to back renewable energy sources than other Spanish regions, and set itself more ambitious goals. This policy was the outcome of the awareness of lack of natural resources for energy generation.
  (ii) A long-standing policy to back renewables. The local authorities followed their initial policy with a firm decision to rely on renewables to solve Navarre's energy problem. Yue et al. (2001) reported that the main hindrance to the growth of wind energy was lack of government aid.
  (iii) The Government of Navarre helped companies by granting direct subsidies in the periods: 1994–1999 (20% of gross investment) and 2000–2004 (30% of gross investment). This

financial aid helped all kinds of industrial companies in Navarre, including those belonging to the renewables sector.

(iv) A specific regional policy to support the construction of installations for renewable energies (wind parks, solar parks or biomass factories). This policy involved €400 million worth of investment, on the part of the Government of Navarre (Department of Industry and Technology, 2004), for the promoters of such installations. Measures were also implemented to support the communities affected. In many cases, they were to take the form of investment in areas surrounding wind parks, and included payment for the use of the land on which the parks are built. These support measures involved payments from the promoters of wind parks to local communities in the period 1995–2004. Such investment was crucial in breaking down reluctance at that level (Reiche and Bechberger, 2004)

(c) Entrepreneurship abilities.

(i) The presence of a group of Navarrese investors with a strong entrepreneurial spirit who, foreseeing the success of the renewable energies, were prepared to invest in them. This group of investors included Esteban Morrás, awarded with the Poul La Cour prize in November 2004, and one of the key figures in the development of wind energy in Europe. He was also one of the driving forces behind the creation of the EHN company, the first Navarrese firm to venture into renewables.

(ii) The birth of EHN, founded in 1989 as a mixed firm with both public and private capital, has proven historical. EHN's main activity from 1993 was the production of aero-generators and the installation of wind parks. The support of the Government of Navarre, as EHN's principal stockholder, along with the management of its CEO, Esteban Morrás, ensured the success of this policy.

(iii) After the success of EHN, other companies, such as Gamesa Eólica, Ecotecnia, or Mtorres, raised Navarrese renewables to international status. These companies succeeded in developing their own technology, producing excellent aero-generators, and, eventually, ranking among the top 10 companies in the international market.

(iv) The support of Iberdrola, the electricity company that maintained a monopoly over the Navarre energy market in the early nineties. In other European countries, such as Denmark or Germany, the opposition of electricity companies delayed the development of renewables (Farstad and Ward, 1984).

(d) Social conscience.

(i) For a proper understanding of the success of the Navarre's energy policy, due recognition must be given to the support shown by the Navarrese public. This came about, chiefly, as a result of their awareness of the scarcity of energy resources in Navarre, about which they were well informed, thanks to a specific campaign run by the Government of Navarre.

(ii) A specially designed survey was held in Navarre to poll public opinion on the subject of Navarre's energy problems and the issue of renewables. The outcome of the survey was favourable to wind energy and other renewables. It also revealed the importance of building wind parks on clearly visible sites, to increase public support for that kind of energy. This set of policies, implemented in the period 1994–2000, met with success. The approval of people residing in vicinity of wind parks was crucial for the success of the Navarre Government policy (Wolsink, 2000; Ek, 2005).

The aforementioned factors boosted renewables in Navarre, pioneer among the Spanish regions in the development of wind energy. Thus, per capita output of this kind of energy was 11.82 kWh in Navarre against 0.15 kWh in Spain as a whole (Department of Industry and Technology, 2004)

5. The development of the renewable energy enterprise sector in Navarre beyond 2001

5.1. The upsurge of a new enterprise sector

A new enterprise sector has been created in Navarre, under the aegis of renewable energy, as a consequence of official support. Using the SRN2003 survey (Pintor et al., 2003), databases were built for the Navarre renewables sector, which comprises 54 companies, engaged either in industrial activities or services. These figures might appear modest, but should be viewed in relation to the roughly 400 or 500 renewables companies in Spain as a whole, according to figures supplied by the Spanish Ministry for the Environment (MMA 2001). Nevertheless, one of the most important findings made by the SRN2003 survey and reported in Faulin et al. (2003) relates to the growth of the sector from 1994 to 2002:

(a) The first couple of years 1994–1995 were characterised by inactivity due to the non-existence of plans to promote new energy sources.

(b) During the second stage, 1995–2000, Navarre made

major strides forward with the creation of new renewables companies, thanks to the FEPN.

(c) The third stage, 2001–2002, was marked by a decrease in the creation rate of new companies and a reduction in turnover (see Figs. 3 and 4). The employment rate, however, rose steadily during the second and third stages (see Fig. 5).

Thus, in 2002, firms engaged in activities relating to renewables provided around 1800 jobs, which is 0.9% of the working population of Navarre, and 2.5% of the active population in industrial activities (INE, 2001). The degree of specialisation of the Navarre economy in renewables becomes patent when these employment figures are viewed in relation to the 3,522 jobs (0.03% of Spain's active population) in renewables at national level (MMA, 2000).

5.2. Characteristics of the renewable energy enterprise sector in Navarre

5.2.1. A young workforce

As the previous sections have described, enterprise development in renewable energy is a recent

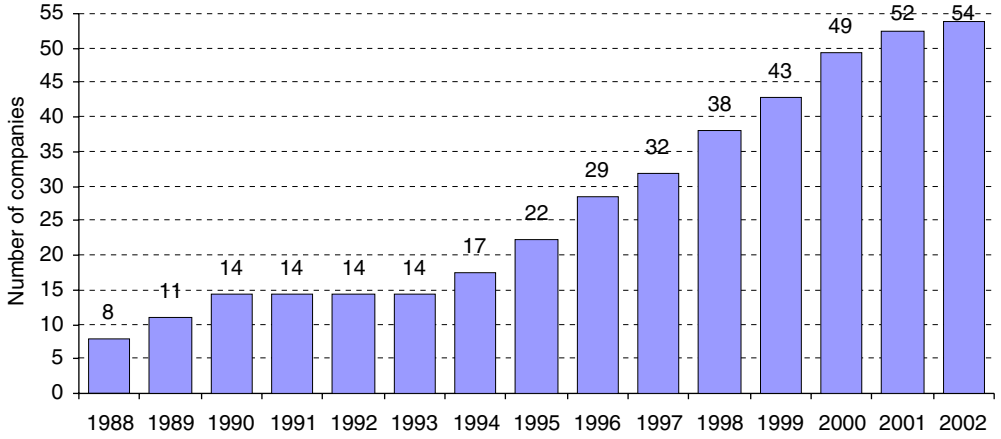

Fig. 3. Pattern of growth in the number of renewable energy companies in Navarre (1988–2002).

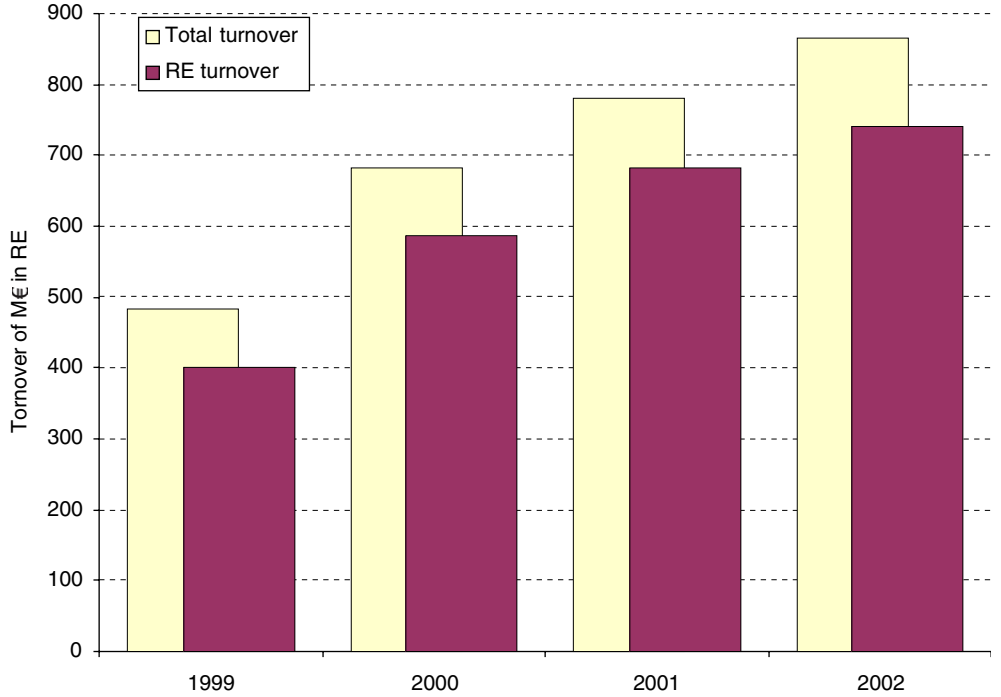

Fig. 4. Renewable energy companies in Navarre: turnover in M€ (1999–2002).

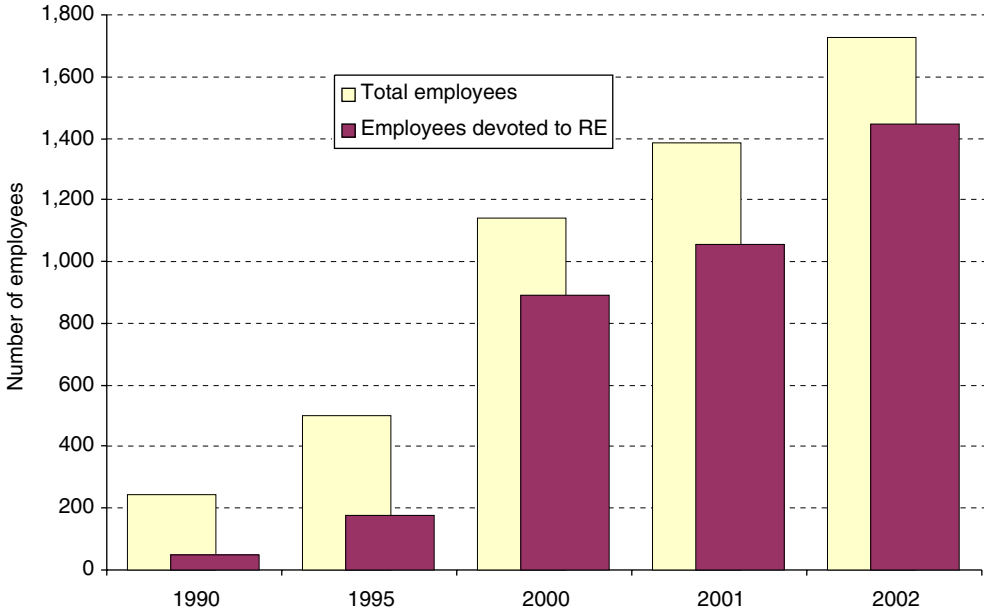

Fig. 5. Pattern of growth in numbers employed in Navarre's renewable energy sector (1990–2002).

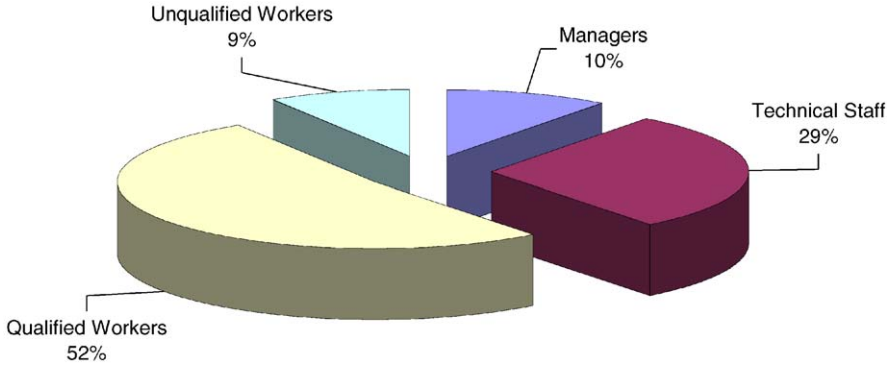

Fig. 6. Distribution of workers by skills level in the Navarre renewables sector.

phenomenon. The employees and workers hired by the companies in this sector are comparatively young, 46% of them being under the age of 30, and 86% under 40.

Nevertheless, the most outstanding feature of the employment situation is the specialisation of the workforce and their level of training. Unskilled workers total barely 9% of the workforce, vs. 39% of the national workforce in companies engaged in environmental activities (Fundación Entorno, Empresa y Medio Ambiente, 2001). Thus, 42% of the companies in the renewables sector are unable to cover vacancies because of the lack of skilled workers, especially for jobs requiring technical skills. Fig. 6 shows some further details in this respect.

5.2.2. Productive specialisation and energy type

Production of capital goods, energy production and equipment installation services are among the productive activities associated with renewables in Navarre. Companies producing this kind of goods tend to be large and have an excellent level of technology. The Navarrese wind energy market, e.g., produced in 2000 almost 14% of the aero-generators assembled in the world. The manufacturer was Gamesa Eólica (one of Spain's leading renewables firms), EHN (owner of one-third of the wind parks in Spain), MTorres and Ecotecnia. This productive specialisation is illustrated in Table 4.

There are two main types of renewable energy in Navarre: wind and solar-PV. Together they are being developed by 94% of the companies dedicated to

renewables. If we are to focus on the role of wind energy in the sector as a whole, we will find that it accounts for 81% of the employment and 95% of turnover. This distribution can be observed in Figs. 7 and 8.

Table 4
Productive specialisation in renewables in Navarre

Activities	% Companies	% Workers	% Turnover
Production of capital goods	35	36	31
Energy production	28	19	28
Equipment installation	17	26	25
Audits, analysis and services management	11	4	4
Maintenance	4	4	4
Infrastructures construction	4	7	4
Research and development	2	4	4

Source: RN2002.

6. Prognosis for renewables in Navarre: impact of the energy policy

6.1. Prognosis for renewable energy up to the year 2008

The SRN2003 survey offers an analysis of the most promising types of renewable energy in three different scenarios: Navarre, Spain, and the international market from 2004 to 2008. In this survey, company managers predicted the top three emerging renewables for each scenario. Figs. 9–11 summarise their predictions.

The predictions for Spain are quite similar to those for the worldwide forecast, and augur a great future for wind energy, solar-PV energy and solar-thermal energy, in that order. These predictions coincide with those reported in other international studies (Jackson and Oliver, 2000; Filgueiras and Silva, 2003). Other important predictions found by RN2002 are major growth in biogas and solar-thermal energy, predictions being higher for Spain than for other countries (see Figs. 10 and 11). There appears, moreover, to be greater faith in the renewables sector in Navarre than in the rest of

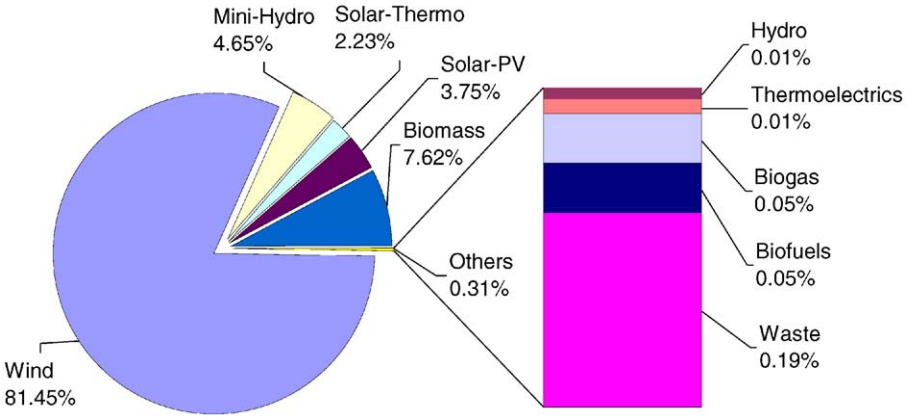

Fig. 7. Workers (%) in renewable energy in Navarre.

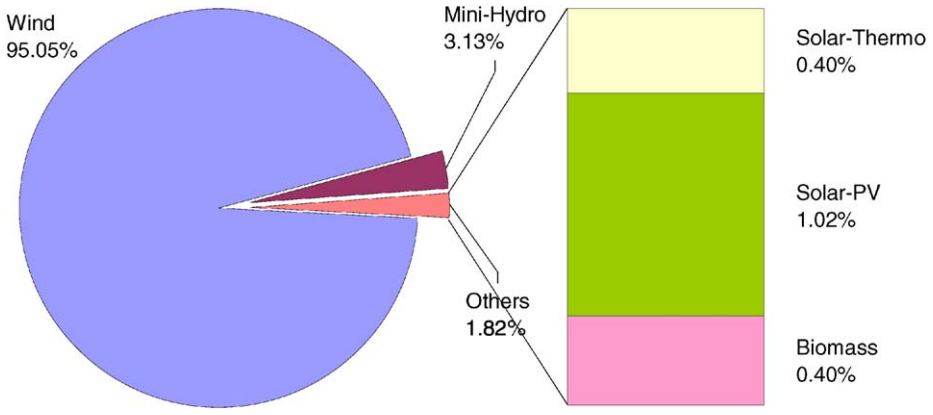

Fig. 8. Turnover (%) per renewable energy type in Navarre.

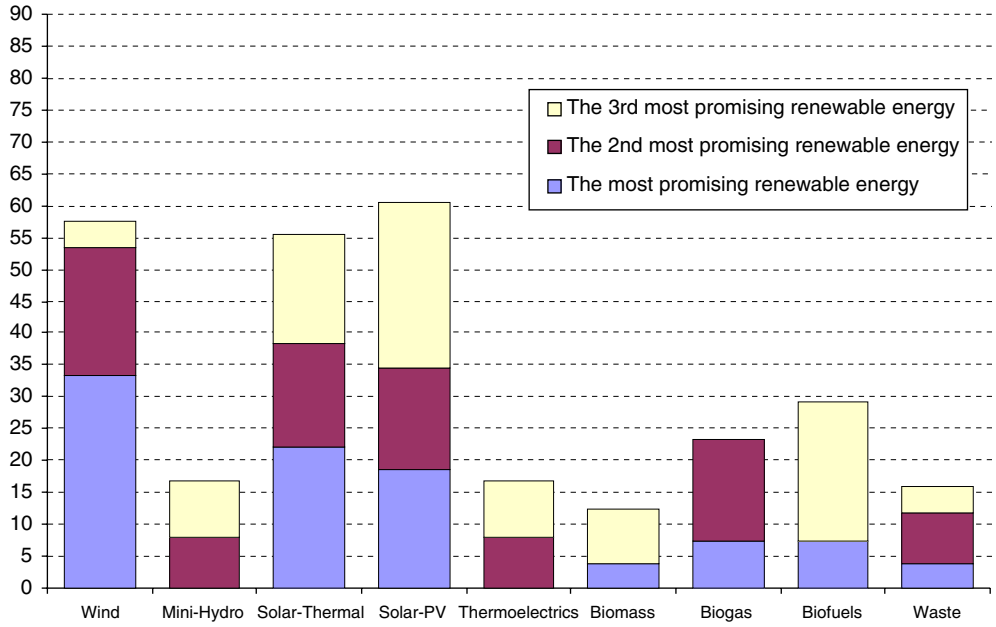

Fig. 9. Percentages for the most promising renewables in Navarre (2004–2008).

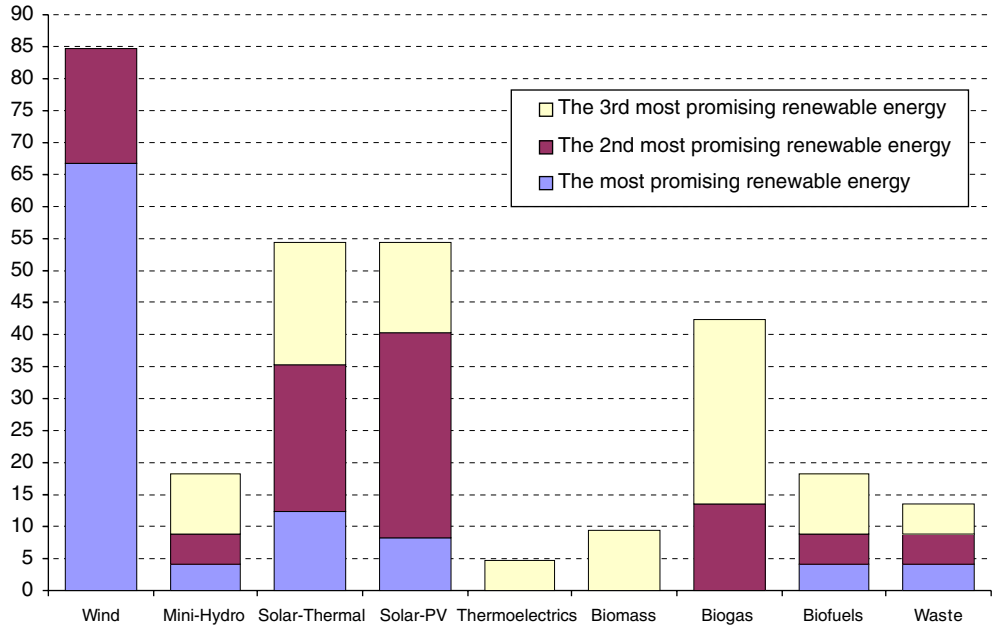

Fig. 10. Percentages for the most promising renewables in Spain (2004–2008).

Spain or other countries. Wind energy takes the lead in Figs. 9–11, with similar patterns emerging for both solar-thermal energy and bio-combustibles.

6.2. *The prospects for employment and the future development of renewable energy in Navarre*

Having offered a general prognosis by energy type, we will now present a further prediction in economic terms for the future of renewables in Navarre for the period 2004–2008. We will cover three main areas: turnover, investment and employment. These data were taken from SRN2003 and summarised in Table 5, which describes the expected increase in the sector for the period 2004–2008.

Detailed analysis of the data reveals that investment will increase enormously over the next few years. That could be due to the fact that the renewables sector is

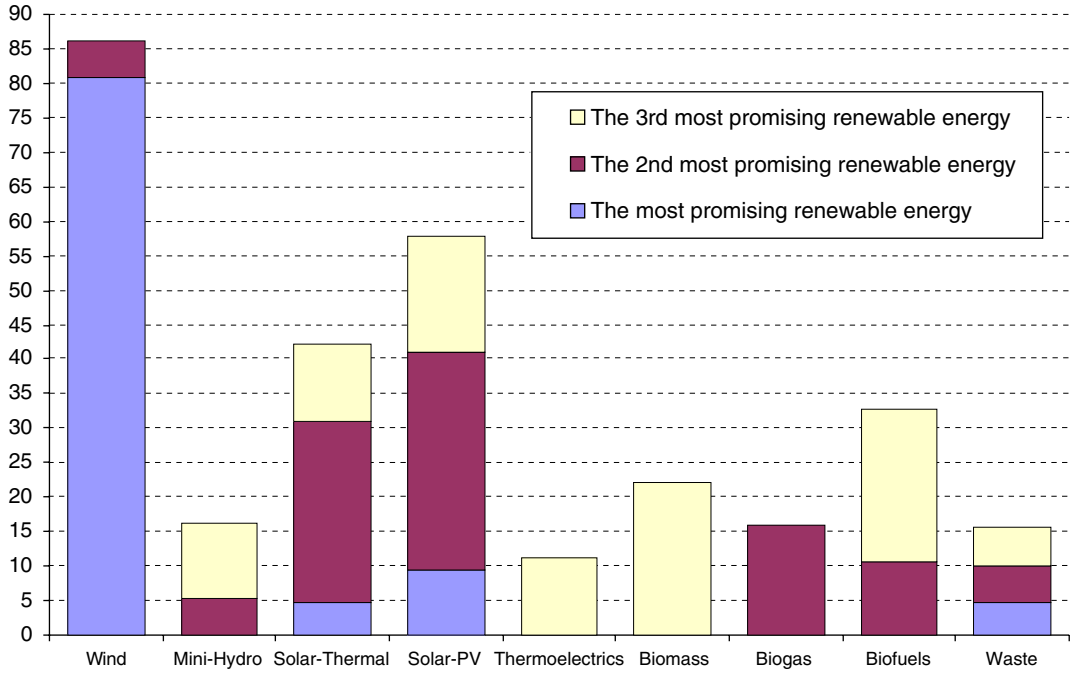

Fig. 11. Percentages for the world's most promising renewables (2004–2008).

Table 5
Predicted increase in turnover, investment and employment by firm size 2004–2008

	Turnover increase (%/year)	Investment increase (%/year)	Employment increase (%/year)
Large company (250 or more employees)	13	13	7
Medium company (50–249 employees)	5	17	23
Small company (10–49 employees)	19	14	13
Micro company (1–9 employees)	28	36	13
Total in RE sector	19	31	17

Source: RN2002.

Table 6
Employment predictions for the year 2008 in Navarre

	Number of jobs in 2004	Employment increase in %/year in the period 2004–2008	Number of jobs in 2008
Wind	1176	13	1688
Mini-hydro	67	10	88
Solar-thermal	32	33	76
Solar-PV	54	33	127
Biomass	110	20	189
Others	4.5	16	7
Total in the RE sector	1446	17	2167

Source: RN2002.

technology-intensive. Though increases in employment will be less spectacular, some small companies are much more dynamic than others.

Bearing in mind the positive relationship between renewable energy and employment (OECD, 1998; Thothathri, 1999; Menéndez, 2001; MMA, 2000; European Commission, 1996, 2000), our study has made this variable its chief focus, given the influence of this relationship in inter-regional and intra-regional imbalances. Taking into account the number of workers in the renewables sector, the RN2002 predictions indicate an employment increase per type of energy, as illustrated by the data displayed in Table 6. Among these data, we highlight a considerable percentage increase in solar energy (solar-thermal and solar-PV), and a more moderate increase in wind energy and mini-hydraulics.

Keeping in mind the final outcomes generated by SRN2003, we have performed a sensitivity analysis using the projections estimated in several Spanish and EU projects. We have followed the methodology described by Junginger et al. (2004) in the Netherlands. Other important studies that can be cited are TERES II and IREEG, both financed under the European Union

Table 7
Description of the comparative studies using sensitivity analysis

Study	Acronym	Short description
European RE studies	TERES II	Project developed within the ALTENER program, in order to update TERES I. TERES II describes the expansion of renewable energy in Europe with predictions up to the year 2020. It shows employment estimations, country by country, using the SAFIRE model.
Impact of RE on employment and economic growth	IREEG	Study carried out as part of the ALTENER program, in order to analyse the effects of employment on the development of renewable energy industries for each country in the European Union. It makes use of the SAFIRE model with corrections by experts, and extends its own Input–Output tables (renewables enhanced Input–Output tables–RIOT). Their outcomes have established the grounds for the MITRE model.
Estimation of environmental employment in Spain	MMA	Study developed by the Spanish Ministry for the Environment (MMA) following the rules and goals of the European Union. It estimates employment data in the renewable energy sector. It employs some specific ratios linking employment with installed power in the European Union.
Impact of RE on employment and economic activity in Navarre	RN2002	Study conducted by the authors for the Government of Navarre. It explores links between employment and economic activity in the renewable energy sector in Navarre.

Source: Prepared by the authors using data supplied by the European Commission (1996, 2000) and MMA (2000).

ALTENER program, and both based on the Safire[3] model.

Among the Spanish reports published within the European Union guidelines regarding renewables, we make special mention of the study conducted by the Spanish Ministry for the Environment (MMA, 2001). Their ratios have been applied in several Spanish regions, such as Andalusia (Junta de Andalucía, 2002). There are further reports on several different economic sectors, such as the studies conducted by the European Wind Energy Association (EWEA, 2004). The main characteristics of the above studies are profiled in Table 7.

[3]The Strategic Assessment Framework for Rational Use of Energy (Safire) model is an established model, which analyses the first-order impacts of different modes of energy consumption, the introduction and spread of energy technologies and energy policies. Similarly, some assumptions on a number of economics indicators (market penetration, employment creation, value added, etc.) are described.

Our first step towards obtaining an accurate description of the situation will be to test the robustness of the European models, by making accurate predictions for renewables in Spain, using real data for the year 2000. Table 8 presents the results of this robustness test, and highlights the fact that the IREEG study is more robust than the TERES II report. The IREEG report could therefore provide the installed power and energy produced variables for Spain, which could then be used to make an adequate forecast for Navarre, after applying a suitable correction factor.

The correction factor or coefficient of equivalence, developed by the authors, is the average of the difference in installed power between Navarre and Spain in 2001, and is used to adjust the PPRE figures for Navarre. Mathematically speaking the coefficient is as follows:

$$\beta = \frac{\frac{\text{installed power Navarre 2001}}{\text{installed power Spain 2001}} + \frac{\text{installed power Navarre 2010}}{\text{installed power Spain 2010}}}{2}.$$

Thus, a series of comparisons were made between the Government of Navarre predictions and the coefficient of equivalence forecast for the period 2000–2010. The results, which are summarised in Table 9, highlight the difficulty of obtaining predictions for small regions through the application of generic models.

On the basis of the above data and studies conducted by the Government of Navarre, along with those of IREEG and MMA, we have obtained precise employment projections for 2008 in Navarre. These projections have been contrasted with the RN2002 findings. Fig. 12 shows the main features of this comparison, especially the underestimation of the IREEG and MMA theoretical studies in relation to the RN2002 findings.

7. Conclusions

The advantages of renewable energy over traditional energy sources, such as fossil fuels, are well known and evident. The European Union has therefore promoted renewable energy in Europe, setting the following goal for 2010: 22% of electrical consumption and 12% of primary energy consumption should be supplied by renewables. Interest in and concern for renewable energy has increased in most European countries.

Furthermore, manufacturing opportunities at local level have provided a strong motivation for regional governments to promote the production and use of renewable energies. New manufacturing is being effective in reviving sluggish local economies through the creation of direct and indirect jobs.

Navarre was one of the first Spanish regions to invest in renewable energy; the wind industry being its primary focus. Hence, the main objective in the drive to reduce the energy shortage in Navarre is being met, since lack of energy sources and foreign dependency are less patent

Table 8
Energy production (GWh) in Spain in 2000

	Policies proposed by TERES II				IREEG report	Real produced energy	IREEG estimations vs. real data (%)
	Policy 1	Policy 2	Policy 3	Policy 4			
Wind	174	198	198	640	2942	4850	61
Hydro	21,818	21,818	21,818	21,818	21,818	25,039	87
Mini-hydro	3338	3070	3756	3070	4361	4431	98
Solar-thermal	570	5536	3756	11,363	454	407	110
Solar-PV	395	326	395	395	35	23	129
Biomass	43,205	44,880	40,903	55,487	46,857	42,054	111
Biogas	2117	1814	2117	2361	721	1745	41
Biofuels	244	558	454	1384	174	593	29
Waste	10,758	6571	7618	8222	802	7943	10
Total	82,701	84,980	85,015	105,356	78,130	81,957	95

Note: Real data and predictions.
Source: Prepared by the authors from data supplied by the European Commission (1996, 2000).

Table 9
Comparison between IREEG results and government of Navarre predictions

Installed power (MW)	Power in Navarre 2005		Power in Navarre 2010	
	Gov. of Navarre	IREEG	Gov. of Navarre	IREEG
Wind	936	354	1536	516
Hydro	30	584	106	584
Mini-hydro	160	128	175	189
Solar-thermal	3	28	7	39
Solar-PV	4	32	7	32
Biomass	25	652	75	653
Urban solid waste	2	13	4	14

Source: Prepared by the authors from data supplied by the European Commission (1996, 2000) and Government of Navarre.

nowadays. With the introduction of tax incentives to drive the growth of wind power—provided that the equipment was produced locally—manufacturing took off and, within the space of a few years, the region was generating almost 50% of its energy needs from wind sources. According to present targets, Navarre's wind capacity should reach 1334 MW by 2006, making it self-sufficient in electricity consumption from renewable energy.

Among the positive aspects of the renewable energy support policies in Navarre, we might mention the following:

(1) The success of renewable energy in Navarre is the result of the joint impact of decisive institutional support and consensus among social agents with regard to renewables. Similarly, the implementation of policies to reduce local reluctance and the introduction of tax incentives for investors have proven more efficient than the feed-in tariffs scheme for helping to create international companies in this sector.
(2) The growth and success of renewable energy in Europe are based on each country specialising in one specific type of energy. Thus, Navarre is no exception. Wind energy is the paradigm of Navarre's success in the field of renewables.
(3) Navarre has built around renewables a dynamic enterprise sector, with high technological standards. This sector is focused on the production, utilisation and maintenance of capital goods in order to generate energy. Expectations for these companies are tremendous.
(4) Renewables have had a positive influence on employment in Navarre. This has helped greatly in achieving balance in the spread of jobs across different areas of Navarre, a fact that is confirmed by national and international studies.
(5) Last but not least, the estimations of employment data in the renewable energy sector, which were based on surveys in the enterprise sector, are more precise than if they had been based on physical magnitudes or registered activities data. We are led to this conclusion by the results of the RN2002 and

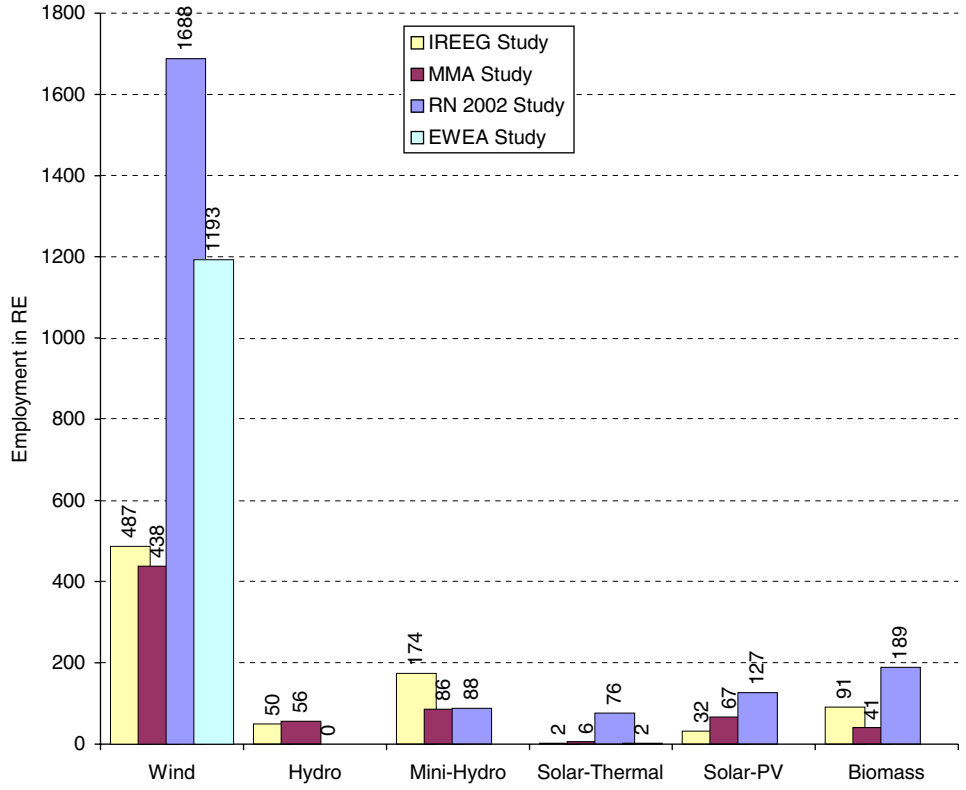

Fig. 12. Employment in renewable energy in Navarre in 2008.

the way they compare with those of the TERES II project or the IREEG report.

There are, however, other less positive aspects to the renewable energy support policies that may limit the future success of the renewable energy policies:

(1) The main limitation standing in the way of the progress in renewable energy in Navarrese companies is the shortage of qualified workers, particularly graduates specialised in renewables. Future policies should therefore include measures to adapt and increase the training of future workers to meet the new needs of firms.
(2) Future renewable policies will focus on certain kinds of renewable energies, to the detriment of the most fully developed renewable energy in Navarre, which is wind energy. This future situation could produce unnecessary uncertainty among firms in the renewables sector, and have dramatic effects on employment and investment. Moreover, all kinds of renewable energies do not meet with the same degree of public support, as revealed by the recent manifestations of public resistance to the installation of biofuel and biogas factories in the region.

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