Empleo verde y local

ENERGY SELF-CONSUMPTION AND RENEWABLE DISTRIBUTED GENERATION AS A SOURCE OF EMPLOYMENT

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Executive Report

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1. Introduction

In-depth analysis and development of proposals are essential steps to reactivate some sectors of the economy in the current socio-economic context. The sector of renewable energies has been one of those branches that combined the creation of business fabric and jobs, the improvement of the Spanish trade balance, energy autonomy and the reduction of environmental impacts CO_2 emissions.

ISTAS had previously conducted studies on the sector's jobs in 2008 and 2010 and the potential to create new jobs in different scenarios by 2020.

The development of renewable energies projects is currently affected by regulatory measures that threaten the viability of existing facilities and limit their subsequent development. However, given the current energy prices, the notion that new technologies have competitive advantages for household consumers and companies is gradually getting through. Consumers are becoming aware of the fact that self-supply and distributed power from renewable energy sources would reactivate this sector and create a significant number of jobs. The present study includes an in-depth analysis of the current state of affairs and job estimates in a supporting scenario. It also includes some proposals for the development of this scenario.

The current model of electricity production is based on generation in large plants, transmission to consumption areas and distribution among end consumers. It is therefore a one-way, centralized system with poor control over energy demand, and in which generating points are located away from consumers.

Given their low power and location near consumption areas, distributed generation patterns are based on a series of connected generation systems in distribution grids, users' households or electricity companies that can be directly linked to consumers, power transmission or distribution grids.

This study focuses on electricity production from renewable energy sources that are currently being installed in a distributed pattern in order to obtain factual job estimates from wind, photovoltaic, biomass and biogas generation.

The main barrier to the development of the renewable energy sector in Spain is the current regulatory framework. Renewable energy facilities have been affected by successive retroactive restrictions over the last years. In particular Royal Decree RD 413/2014 and Ministerial Decree IET/1045/2014 introduced retroactive modifications to tariffs and conditions for investment in the renewable energy industry. These measures practically destroy any trust in future support policies the government might plan for several years.

Self-supply through a net balance system is a useful measure to promote the generation of distributed power. Self-supply is based upon the principle in which consumers (both domestic and industrial) can produce their own energy by means of small installations located at points of consumption. Through this procedure consumers become owners of their production units.

Ease of installation in buildings make photovoltaic and mini-wind energy the most suitable technologies for this system.

The development of self consumption systems requires an adequate regulatory framework for the regulation of installations and the establishment of specific administrative procedures.

The system proposed in this study (annual net balance) is used in several countries where self-supply systems are regulated. With this system the surplus energy produced by an installation that is not being used at a given moment is refilled into the grid for later use. The energy grid is used for the storage of produced energy in a battery-like function.

Producers /consumers are not refunded for their energy input in the grid. Compensation is made by discounts in their electricity bills, i.e.: users pay for their energy consumption and the energy they refilled into the grid is discounted from their bills. Balance is made on an annual basis.

Net balance is the leading measure to promote self-supply, although other regulatory, administrative, economic, financial and fiscal measures are suggested with the intent of promoting solar and wind power distributed generation. Biomass and biogas technologies are also included in this set of proposals.

2. Energy and job scenarios

2.1. Energy scenarios by generation technology

- **Photovoltaic**

The ultimate goal is to reach 11,261 MW of photovoltaic power in 10 years. 44% of that power is related to residential (or mostly residential) buildings and 56% to industrial facilities:

- Domestic installations: 5,005 MW, 1,251,250 installations in buildings and houses
- Industrial installations: 6,256 MW

The scenario is based on a self-supply system with annual net balance. Another necessary measure to reach the conceived goal is to extend the scope of the mandatory requirement to install photovoltaic power for minimum photovoltaic contribution established by provision *HE5* of the *Technical Building Code*[1].

These and other additional measures described in the following chapter of this report are aimed at achieving the ambitious, yet realistic goal of reaching a 15% penetration of photovoltaic energy in buildings within a 10-year period (for buildings registered in the 2011 census).

These domestic installations will have an average power of 4 KWp. The average power for industry, service and production facilities will be of 50 KWp.

- **Low and medium wind power**

The scenario for low and medium wind power calls for the installation of 595 MW in 10 years.

The proposal includes 50% ground installation and 50% of installations in buildings.

The plan includes three basic sections:

1. 200 MW of medium wind power from turbines between 60 and 100 KW. This type of installation. This type of installations is designed for two industrial uses and for municipalities. The most adequate locations for these sites are open spaces in periurban settings exposed to wind

2. 100 MW of 5-10 KW mini-wind power installations. They can be located in open spaces, periurban and urban areas. This section is usually designed to supply telecommunications systems, electric cars chargers or street lights

3. Mini-wind power section with 3% penetration in existing buildings which represents an equivalent power of 295 MW. Such turbines are designed to benefit from turbulent air currents generated in buildings and urban spaces.

- **Biomass**

[1] The Spanish Technical Building Code (TBC) is the normative framework that establishes the safety and habitability requirements of buildings set out in the Building Act (LOE). More at http://www.codigotecnico.org/ingles/introduction/

The scenario for this technology includes the installation of new plants that will only use currently available biomass. In terms of power making additional use of 20% of available resources implies achieving a total accumulated power of 1000 MW.

This is perfectly viable alternative in terms of resources thanks to the optimal use of herbaceous and woody biomass.

Three types of plants are considered for this option:

Type 1. Small plants of approx. 5MW (lower power plants are less efficient)
Type 2. Medium-sized plants close to 15 MW – although in less proportion
Type 3. Co-generation with biomass associated to the industrial sector

In terms of resources the plants will use forestry resources and agricultural stomp (cereal straw, palm olive, etc.).

- **Biogas**

The scenario for this technology is based only on new installations that use agro-industrial biogas. Biogas from sewage sludge and landfills is not considered for this scenario.

In this case the ultimate goal is to use 50% of available waste for biogas generation. Available resources are understood as those registered by the Ministry of Environment in the Renewable Energy Plan 2011-2020.

In terms of power, using 50% of available resources represents 360.3 MW.

This scenario considers two types of installations:

Type 1: Small plants with an average power of 500 KW
Type 2: Large plants (15-20 MW). In this case, the priority issue is that currently available manure treatment plants[2] with associated co-generation will use biogas as fuel.

The following table summarizes the energy scenarios showing the annual power that would be installed for each technology and the total installed power within a ten-year period (*accumulated power*).

Table 1: Summary of energy scenarios

[2] Upon the conclusion of this report the Association for the Reduction of Environmental Effects of Slurries (ADAP) forecasted the closing of all facilities for the treatment of slurries in the pig industry if the new regulation on renewable energy, cogeneration and waste treatment was not revised

	POWER (MW)	
TECHNOLOGY	ANNUAL*	ACCUMULATED
BIOGAS	36	360
BIOMASS	102	1,018
PHOTOVOLTAIC	1,922	11,261
WIND	59	595
TOTAL	**2,119**	**13,234**

* NOTE: Annual power is referenced in the tenth year since no constant rate of installation is considered for photovoltaic energy

2.2. Job scenarios

Job creation estimates for these scenarios include only new jobs (to be added to the existing ones).

The following table summarizes potential job creation estimates:

Table 2: Summary of generated jobs by technology

	JOBS				
TECHNOLOGY	MANUFACTURE AND INSTALLATION	OPERATION AND MAINTENANCE	TOTAL DIRECT JOBS	TOTAL INDIRECT JOBS	TOTAL
BIOGAS	721	6,485	7,205	7,385	14,590
BIOMASS	23,350	12,375	35,725	31,438	67,163
PHOTOVOLTAICA	22,224	9,491	31,715	14,272	45,987
MINIWIND	3,526	941	4,466	3,573	8,040
TOTAL	**49,820**	**29,291**	**79,111**	**56,668**	**135,779**

Jobs in the **installation** category are defined as the necessary jobs to carry out manufacture, assembly, civil works and installation tasks. This category also includes jobs associated with management tasks (purchase and sales), as well as research, development and technology innovation associated to manufacture in the renewable energy sector.

Jobs in the **operation and maintenance category** include tasks related to the operation of plants, management, sales and associated products, fuel supply and logistics (in the case of biomass and biogas), as well as maintenance and service tasks.

- **Assessments on jobs**

The role of the Spanish industry in the **manufacture phase** of this sector is arguably significant. The sector has the necessary technical and professional capacity to cover the examined scenarios with its

own technology. Several Spanish companies currently manufacture equipment and components for the analyzed technologies.

The sector has also involved in notable R+D+i efforts. In the case of mini-wind power almost all turbine manufacturers have their own designs and patents and develop new products on a regular basis. The case study shows that both innovation and research activities in technology centers are essential for the development of low-power mini-wind projects.

In the generation of distributed power the weight of **operation and maintenance activities** varies across technologies. In the case of **biomass,** jobs in operation and maintenance tasks have a significant weight since these activities are essential for the adequate functioning of the facilities. In **biogas** plants, operation and maintenance tasks reduce significantly since this technology includes elementary applications that do not require additional maintenance and they are designed for households and domestic environments, in which case, maintenance is carried out by external companies. This is a rather positive aspect in terms of cost reduction although no significant jobs are created. The extension of these energy models will help corroborate if maintenance tasks continue to have little influence in sectors like photovoltaic and mini-wind power.

The Spanish Technical Building Code establishes mandatory preventive maintenance for solar photovoltaic and wind technology to be carried out by qualified personnel. Minimum requirements include a six-monthly review, but further research on the impact of maintenance tasks on jobs will be necessary as these preventive programmes develop.

Recent studies by ISTAS, notably the 2010 "*Study on jobs associated to the promotion of renewable energy industries in Spain*", show that employee qualification in the sector of renewable energy is generally high and that jobs in the sector show high levels of stability and quality.

Studies and interviews carried out to collect information corroborate that job quality indicators continue to be high in generated distribution, although due to the crisis in this sector a substantial job loss and reduced job security are observed.

Professional qualifications may help maintain levels of technical qualification in this sector.

The number of jobs in the **collection and preparation of sub-product (raw material)** grows significantly in **biomass technology.** Previous research by ISTAS did not consider this phase that is closely related to the agriculture and forestry sector (as well as transport and logistics operations) due to the fact that jobs were scattered and difficult to quantify. This phase shows intensive job activity across all regions of the country. During the **collection of raw material** the number of jobs may double compared to those in operation and maintenance tasks.

2.3. Environmental and socio-economic benefits in the different scenarios

- **A more sustainable energy model**

Penetration of renewable energy into the energy mix avoids fossil and nuclear fuel imports, therefore reducing energy dependence. It also maintains the sustainability of prices and improves the security of energy supply.

An energy model based on renewable sources reduces typical environmental impacts associated with the energy sector, and has especial reducing effects on nuclear wastes, GHG emissions and other polluting discharges resulting from fossil fuel uses.

Energy production from renewable sources proposed in this programme would avoid 9.65 million tones of CO_2 equivalent.

Table 3: Avoided CO_2 equivalent emissions of energy production

	Production (GWh)	Avoided emissions Kt CO_2/year
BIOGAS	**2,882**	**980**
BIOMASS	**7,126**	**2,423**
PHOTOVOLTAIC	**16,078**	**5,467**
WIND	**2,314**	**787**
TOTAL	**28,401**	**9,656**

Source: Own research

Aside from emissions avoided by energy production, in the case of biogas production avoided emissions of methane and nitrous oxide due to uncontrolled discharges of manure and slurries are also a factor to be considered. The reduction of GHG emissions due to the digestion of manure and slurry would be of 4.76 million tones of CO_2 equivalent.

Table 4: GHE avoided with the use of biogas

	AMOUNT OF BY-PRODUCT NECESSARY FOR BIOGAS GENERATION (m^3 or Tm)	BIOGAS PRODUCTION (m^3)	AVOIDED GHE EMISSIONS (TCO_2 EQUIVALENT)
SLURRY	22,980,256	514,903,362	3,729,696
MANURE	14,124,423	248,617,059	1,031,083
TOTAL	**37,104,679**	**763,520,421**	**4,760,778**

Source: Own research

The use of biomass will help reverse other environmental effects as waste management and fire prevention. For instance, the use of biogas from biomethanation of slurries allows a controlled

management and treatment of livestock wastes. The use of residual biomass in a framework of sustainable forestry management might also prevent many forest fires in Spain.

Furthermore, distributed generation and self-supply systems require less power infrastructures. Such infrastructures eventually represent a significant occupation of territorial space which results in increased social discomfort. Small investment required for this system would save costs and lower energy prices.

- **Energy-saving and energy-efficiency**

Distributed generation and self-supply systems reduce power loss during transport and distribution - currently around 10% - since generation points are located near consumption areas.

On a national scale such systems allow a flexible management of energy demands. Self-suppliers will no longer be passive consumers. They will become instead owners of their electricity consumption and will take action to balance production and consumption.

Distributed generation and micro-generation systems allow the use of residual heat generated during energy production.

- **Democratization of the energy system**

Technologies based on renewable energy sources allow small-scale distributed generation patterns with a large number of new participants/ energy producers that include individuals, communities, small producers' and consumers' cooperative societies, SMEs, etc. New participants in energy generation will reduce the power and pressure of the energy oligopoly on public authorities and allow more transparency, participation and democratic control of the energy generation process.

- **Creation of green jobs and local jobs**

Generation of distributed power and self-supply based on renewable energy sources create more jobs than conventional systems based on fossil fuel and nuclear energy, and even more than large renewable energy facilities. Furthermore, jobs associated with distributed power and self-supply are more distributed across the territory than those created by traditional models and generally contribute to the territorial attachment of population.

3. Proposed measures to achieve the envisaged goals

3.1. Cross-cutting proposals

Net annual balance

An adequate regulatory framework on net annual balance would encourage self supply and stimulate the market, rendering profitable some projects that are currently on standstill due to their high installation costs.

This system will make **shared self-supply** possible, which means that one installation may generate electricity for several users located in one single building and under one single registration. Each building would have one installation shared by several users, increasing the system's economic and technical performance.

Another significant factor to consider is that **no fixed power limit** must be established. The limit would be set by the fact that **installed power** (as generating point) must always be **less than or equal to contracted power**, in order to adjust production to consumption.

Simplified administative procedures

Changing the existing regulatory framework to allow the development of distributed generation systems is an essential step. Regulatory changes must be directed towards the simplification of administrative procedures for access and connection of low-power installations.

Tax incentives

Reducing the fiscal burden through tax benefits, reduced VAT, etc. will stimulate distributed generation. Procedures aimed at promoting integrated renewable energies, such as local tax reductions are particularly significant, for instance a 50% property tax reduction applicable to properties with renewable energy installations.

Dissemination and training

Information, training and educational programmes must play an active role in overcoming the barriers for the implementation of distributed generation and self-supply systems and the optimization of opportunities. The pace of social changes is a key factor in the process.

Authorities

Increased of public investment (direct demand) is another desirable measure, especially in terms of public (local, regional and national) involvement in energy policies. Such measures would increase the effective demand of the sector. The effects in terms of budget policies would also be positive, and combined with adequate energy saving policies, would eventually reduce the costs of energy in administration facilities and subsequently public expenditure.

Business cooperation

Promoting business cooperation (through consortia, technical institutes, joint ventures, long-term agreements, etc.), will help overcome the barriers for small and medium-sized companies in this sector.

Business alliances grant a better access to material, financial and human resources. They also improve strategic guidance (synergies, new markets, diversification and internationalization) and improve production efficiency (economies of scale, know-how, shared risks)

Such cooperation can develop between companies from the same sector (horizontal) or from different industries (vertical). Business cooperation in certain regions would invigorate locally-generated development capacities.

3.2. Specific proposals by type of technology

- **Photovoltaic**

The main measures to be implemented in order to reach the envisaged goals include the regulation of self-supply systems through net annual balance and the increase of minimum mandatory photovoltaic energy contribution for buildings.

It was already mentioned in this report that recent changes introduced in the Technical Building Code provisions reduce the minimum required photovoltaic energy contribution for buildings compared with the 2006 regulation.

Secondary measures include the differentiation of small and large consumers in the energy sector, installing bi-directional active energy measurement meters and soft loans guaranteed by public funds.

- **Low and medium wind power**

For the development of this technology as a complementary element to the net annual balance, it becomes necessary to implement incentives to investments through direct government/regional funds that might ensure technical and economic viability of minor installations and their commercial take-off.

The integration of these technologies in urban environments (an important aspect in the analyzed scenario) requires the development of municipal ordinances with simple tools to characterize and calculate wind power resources in cities.

Backup measures include simplifying the certification process for wind turbines and implementing professional specific certificates/accreditations for installers of low-power wind turbines.

- **Biomass**

Biomass requires a premium system for energy production due to the costs of fuel. In this technology the number hours entitled to payment should not be restricted. The quality eligible for premium would be set for reasonable level of profit depending on the year in which the plan will start. Premium will gradually reduce as the costs of technology decrease (due to the maturity curve). Premium for energy production must be established by subgroups.

Specific measures will be required to grant biomass supply. Supply difficulties and costs of fuel are the main barriers for the development of this technology. A set of measures is proposed to help the forestry sector, promote contracts to ensure biomass supply and support the development of logistics companies.

The promotion of biomass must be integrated in rural, industrial, and agricultural development policies, as well as in territorial management measures. Coordination between different administrations is a priority issue in this process.

- **Biogas**

Biogas also requires a production bonus system which proved highly efficient in the early development of renewable technologies. In this technology the number hours entitled to payment should not be restricted. The quality eligible for premium would be set for reasonable level of profit depending on the year in which the plan will start. Premiums will gradually reduce as the costs of technology decrease (due to the maturity curve).

Supporting small generation plants calls for more sections than the existing in the former premium system in Spain included in the Royal Decree RD 661/2007. New proposals recommend one specific section for plants below 500 KW.

An investment programme, though not essential for the achievement of described goals, could promote a faster development and reduce production premiums. This measure would balance the financial burden of this technology which would be shared by the electricity sector (via production premiums) and by other sources like the Ministry of Agriculture / Environment or by Regional Governments that must also collaborate in these efforts given their significance in the solution of environmental problems (pollution of soils, aquifers, methane emissions, etc.).

Backup measures must aim at promoting the application of digestates in agriculture as fertilizers or organic composts, and implementing public investment programmes for agro-industrial biogas facilities that recognize avoided GHG emissions.

Results and conclusions

Study results

Results indicate that potential jobs associated with the development of the proposed 10-year scenario would reach a total figure of 135,779, of which 79,111 would be direct jobs and 56,668 indirect ones.

Manufacture and installation tasks will provide 49,820 direct jobs, whereas operation and maintenance would provide 29,291 jobs by the end of the proposed programme.

Biomass technology will be the top job creator with 35,725 direct jobs, followed closely by photovoltaic energy (31,715 jobs). Biogas would provide 7,205 and mini-wind 4,446 jobs.

The implementation of this plan would produce 28,401 GWh by the tenth year, equivalent to the average energy consumption of 8.14 million Spanish households.

This plan would also represent significant environmental benefits with the saving of 5.68 million tons of oil-equivalent in primary energy production and a 14.41 million tons reduction of CO_2 emissions.

Upcoming research

For methodology reasons this study focuses on a distributed generation model for electricity production from renewable sources. It represents a theoretical model for analysis by technology and type of scenario, however, in practical terms a distributed generation model should be largely based on the use of thermal energy. It is therefore recommendable to conduct similar studies focused on this type of application.

Conclusions

Energy transition in electricty production. The proposal for the promotion of distributed generation described in this report is integrated in the framework of transition to a sustainable energy model. The transition in the electricity sector must be aimed at replacing conventional energy sources by clean energy production.

Stable political and regulatory framework. Energy supply from renewable sources increased during the last decade thanks to an adequate regulatory framework that ensured its stability and development. The successful development of renewable energy sources for electricity was undoubtedly the result of government policies implemented since the 1990's. At present there is an urgent need to recover the government's energy policy on renewable energies and establish a roadmap for a distributed generation model based on renewable sources and energy efficiency.

Political will to develop a financially viable programme. The proposal to promote a distributed generation model for the next 10 years included in this report is technically and financially viable. It simply requires political will to address this challenge.

Energy scenarios are mostly focused on solar photovoltaic energy (85% of total power) for being the most profitable technology.

A more conservative scenario was chosen for biomass in this study considering the available potential resources due to the environmental/financial costs, and primary interests in the development of thermal biomass projects. Biomass facilities still require production premiums to achieve profitability and it would prove ineffective to overload the system with unnecessary costs when other, more efficient and profitable sources are available.

New job sources as a solution to the economic crisis. Spain has sufficient capability to develop a national manufacturing, installing and operating facilities to cover national energy needs. Supporting distributed generation and self-supply systems represents an opportunity to reactivate the country's economy and create quality jobs.

Promoting distributed generation systems will boost the renewable energy sector and auxiliary industries. Industries that will benefit from the driving force of these policies include:

- construction
- buildings' energy refurbishing
- energy supply services
- smart electricity networks
- information and communication technologies
- home automation systems
- electric cars industries
- training and awareness projects
- sustainable agriculture, livestock and forestry projects

Integration of renewable energies in urban areas. The proposal described in this report confers particular significance to the integration of renewable energies in buildings and urban areas. This

application is still underdeveloped in Spain and should be promoted given its low environmental impact and its advantages in terms of energy saving and efficiency.

Opportunities in local and rural areas. Distributed generation and self-supply systems are based on proximity patterns that reinforce local economy and encourage the settlement of local population. The development of technologies like biomass and biogas is a significant factor for the integration of renewable energies in agricultural and livestock sectors and could be a key element in the social and economic improvement of rural areas.

Sustainability of employment. Supporting distributed generation and self-supply systems will not only have positive effects in terms of job creation, it will also render existing employment more sustainable in the agriculture, livestock and industrial sectors. Harvesting seasons will increase in agriculture and the introduction of renewable energies would reduce energy costs in industry.

Renewable energies may imply a business area for companies in similar sectors, e.g.: synergy effects between mini-wind power facilities and the railway sector, electric appliances' assembly facilities and auxiliary industries in car manufacturing.

Research, development and innovation. Considerable R+D+i efforts have been undertaken in the sector of renewable energies. The Spanish renewable energy industry's head-start is mostly based on the work of public research centers and leading companies that have increased their technical capability in particular areas like wind power, solar photovoltaic and solar thermoelectric technologies since the 1980s. In the 1990s, the Ministry of Industry, through the Institute for Energy Diversification (IDEA), promoted a series of test facilities, mostly wind farms, financed by government-sponsored companies and other support schemes. Regarding distributed generation, R+D efforts in large wind farms had a clear influence on medium and low power applications. Most wind turbine manufacturers have developed their own designs/patents and continually develop new products.

Environmental sustainability. The proposal implies significant benefits, in terms of avoided polluting emissions and other environmental problems, especially in the cases of biomass and biogas.

Risk of offshoring. It becomes necessary to implement a new regulatory framework to promote distributed generation for the future development of the renewable energy sector. There is a serious risk of disappearance of the industrial network associated with renewable energies in Spain. Most workload and activity is currently focused on foreign demands and the development strategy of the industry depends largely on the internationalization of the sector. If future development relies only on foreign demand and no domestic projects are recovered or started, Spain will lose all professional and industrial expertise accumulated over years.

The development of a distributed generation model as the one described in this report represents a genuine opportunity for the sector of renewable energies in Spain. Such model would ensure economically and environmentally sustainable growth.