The Impact of Green Energy on Employment: A Preliminary Analysis

Sofia Gkatsou
Maria Kounenou
Panagiota Papanagiotou
Dimitra Seremeti
Dimitrios Georgakellos
University of Piraeus
Department of Business Administration
Karaoli and Dimitriou 80
185 34 Piraeus, Greece

Abstract

The purpose of the present work is to investigate the effects of the development of renewable energy sources on the creation of new labour. Specifically, up to now there has been an ongoing debate about how the development of green energy affects the creation of new jobs as well as the loss of existing ones on the power generation field. This is because the creation of green jobs automatically means that the fossil fuel based electricity generation has to decrease its potential, since there is the new legislation of the European Union that obliges the member states to progress towards green energy creation. Thus, this study attempts to forecast the positive and negative impacts of green energy on employment through the case of Greece for the period of 2012-2050.

Keywords: Green Energy, Employment, Externalities, Life Cycle Assessment, Greece.

1. Introduction

Nowadays, there have been numerous studies concerning the creation of new employment by the renewable energy sources (RES), or also known as "green energy".Green energy is all the sorts of energy that is an outcome of the exploitation of the natural resources of the environment such as the sun power, the wind power, the sea power, biomass and geothermal energy. So far, the most popular way in the energy production field has been the exploitation of coal and lignite. Greece is a country which is very rich in lignite, and this has made it the number one resource of electricity production. The new legislation established by European Union obliges the member states to reach an ambitious 20% of their electrical energy production by using renewable energy sources and an also ambitious 10% for the covering of cooling and heating charges. Inevitably, this covering of 20% of electrical charge needs by renewable energy sources is going to have a clear impact on the diminution of the coal and lignite based production of electrical charges, which would eventually lead to the loss of a number of jobs at the coal mines and at the power plants.

On the other hand, the development of renewable energy charges is going to have an impact on the diminution of carbon dioxide emissions that leads to the greenhouse effect on the first place and in time it is going to create new employment, since this renewable energy trend will lead to the creation of new companies that would either produce products such as wind turbines, photovoltaic panels etc. or provide services. Another field that is going to be favoured is the technical industries that are going to hire engineers and other personnel for the system design, the installation and maintenance. Thirdly, companies that are going to supply spare parts of these systems will be also kept quite busy.

The main purpose of this paper is to study the pros and cons of the job creation through the use of renewable energy sources and to conclude whether the green energy ultimately produces as many jobs as we want to believe. A reference also is made to the situation prevailing at this moment in Greece on the usage of green energy and employment, as well as an attempt to forecast the positive and negative impacts of green energy on employment in this country for the period of 2012-2050.

2. Literature Review

2.1 How can jobs in renewable energy be characterized?

"Green jobs" can be defined as jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources. Green goods and services fall into one or more of five groups: energy from renewable sources, energy efficiency, pollution reduction and removal, natural resources conservation, and environmental compliance, training, and public awareness.Yi (2013), in addition, defined green jobs as "any activity that generates electricity using renewable or nuclear fuels, agriculture jobs supplying corn or soy for transporting fuel, manufacturing jobs producing goods used in renewable power generation, equipment dealers and wholesalers specializing in renewable energy or energy-efficiency products, construction and installation of energy and pollution management systems, government administration of environmental programs, and supporting jobs in the engineering, legal, research and consulting fields" (Global Insight, 2008). Therefore, this dataset covers a wide range of job categories related to direct employment as well as indirect and induced jobs.
By the term direct employment, specialists mean the jobs that are created in the "design, manufacturing, delivery, construction/installation, project management and operation and maintenance (O&M) of the difference components of the technology, or power plant, under consideration" (Wei et al., 2010). Direct jobs are relatively easy to measure and understand. It must be noted, however, that countries may estimate direct employment according to a narrower or broader definition of the renewable energy industry, making cross-country comparison of estimates difficult. On the other hand, the term of indirect employment includes all those jobs involved in supplying the renewable energy industry. These are jobs in the industrial input sectors in the production and the operation and maintenance of renewable energy technologies. Finally, induced jobs are created when wealth generated by the renewable energy industry, directly or indirectly, is spent elsewhere in the economy, thus stimulating demand in industries that may be entirely unrelated. These classifications are helpful for formulating testable hypotheses and collecting data to test them.

2.2 Green economic development and green jobs

Green economic development has three basic characteristics. Firstly, it is economic development driven by specific sectors of economy, namely clean energy industries. Secondly, it encompasses the goal to create jobs. Thirdly, it is driven by strategic actions of relevant policy actors, and thus government policies play a significant role.The logical link between renewable energy development and economic development is based on the jobs created and maintained by the renewable energy industry. We can expect that the growth of renewable energy capacity is accompanied by green jobs employed for site construction, installation, operation and maintenance.
Duero and Kopp (2012) underline the need for the European Union to establish a framework under which the eco-industry is going to be developed, under today's conditions, with the RES market being still volatile and the alternative energy sources not having yet reached price parity for their products. The two surveyors also highlight the need for initiatives from the private sector to finance renewable energy projects. Also, new investment forms, sustainable financial products and transparency are the key factors that will lead to positive net present value projects. Finally, the two authors claim that the state should stand by these initiatives by offering incentives to investors (low taxation, small financing) that would result into many new megawatts (MW) installed and extra tax benefits. With such conditions, the banking sector could also be a partner in such projects by offering low interest rates on green loans, which, with time, would lead to increased gains.

According to the American Enterprise Institute (http://www.aei.org), some useful data about green jobs' creation are the following-ones:

1. Green Jobs Are Supporting Two of the Nation's Hardest Hit Industries: At the peak of the recession in 2009, construction and manufacturing sectors reported unemployment rates of 19% and 12.1% respectively. Collapse in these industries put massive numbers of hardworking Americans out of work, and bolstering them should be high priority for economic recovery. It came on surface that green building accounted for 25% of all new construction ventures in 2010, including energy efficiency retrofits which create jobs at 3 times the rate of oil and gas investments. Likewise, we know that 50% of parts for wind turbines are American-made, along with 90% of energy efficiency materials like HVAC systems, siding, and refrigerators.
2. Green Jobs Out-Number Fossil Fuel Jobs 4 to 1: CAP analysis of 2010 BLS Figures found 575,000 jobs in the oil and gas sector, including extraction, refining, and other support activities – even with oil and gas production reaching an 8-year high under the Obama Administration.

Adding mining and related activities to the mix brings 2010 fossil fuel jobs to 783,000, nearly 4 times smaller than the total Green Goods and Services category. According the analysis by the Brookings Institution, green jobs outpaced the job growth in the greater economy by a factor of 2 to 1 during the peak of the recession (2008-2010), and pay an average of $7,000 more than other jobs across the greater economy.

3. Green Jobs are Diverse: While construction and manufacturing account for the majority of all private-sector jobs in the GGS category, there are also other diverse sectors that include professional scientific services, recycling and waste reduction, administration, and mass transportation activities. In contrast, more than one-third of all 2010 jobs in the oil and gas sector were in support services, including gas station attendants. According to projection from the American Petroleum Institute (API), nearly half of all oil jobs will be in gas stations by 2030.
4. Green jobs are Regional Economic Drivers: In every geographic region, green jobs represented an increasing percentage of total employment growth. In the South, Alabama and Missouri saw 44,288 and 65,205 jobs added in 2010- representing 2.4% and 2.5% of total employment. On the west coast, California and Oregon added 338,445 and 54,953 jobs- representing 2.3% and 3.4% of total employment. The Midwest saw phenomenal growth, with 22,192 green jobs constituting 3.7% of their total employment – and a whopping 126,855 jobs in Ohio making up 2.6% of total growth. On the east coast New York added 248,526 green jobs, accounting for 3% of new employment. There were 26,941 green jobs added in Washington, DC, which was 3.9% of total employment. No matter what corner of this country you travel to, green jobs are putting Americans back to work.
5. Green jobs are the Future: The truly exciting trend is that these jobs are being created across all economic sectors and a diverse set of employment categories. These are concrete changes that we can see in our own communities.Green jobs are transforming the economy to be more efficient, less polluting, and more competitive in new technologies and global industries like clean energy. America has always been on the cutting edge of innovation and we are already seeing our investments in the clean economy paying dividends. The right policies and bold political will are needed to continue this solid growth.

In the U.S., what is happening is that state and local governments are actively promoting renewable energy and energy efficiency in order to call for economic development opportunities and create green jobs. What is coming out from the analysis is that both state and local clean energy policies have positive and statistically significant impacts on green jobs at the metropolitan level. In addition to environmental motivations for these policies, an important sanity for adopting these policies is to induce economic development through the creation of green jobs. In many cases, the rationales for supporting the clean energy industry are based on economic development instead of climate protection (Rabe, 2004). Green economic development is an emerging economic development framework that integrates the traditionally contentious relationship between economic development and environmental protection. Most of the green economic development activities rely on research, development and deployment of renewable energy and energy efficiency technologies. Chapple et al. (2011) defined green economy as “economic activity that reduces energy consumption and/or improves environmental quality”.

Moreover, Carley et al. (2011)have approached green economic development from the perspective of “energy-based economic development”, by defining it as a process by which various policy actors in a given region work to promote clean energy, “in ways that contribute to job creation, job retention and regional wealth creation” (Carley et al., 2011).

3. Impacts of RES in Employment

The renewable energy industry, compared with fossil fuel technologies, which are typically mechanized and capital intensive, is more labour-intensive. This means that, on average, more jobs are created for each unit of electricity generated from renewable sources than from fossil fuels.Renewable energy already supports thousands of jobs in the United States. For example, in 2011, the wind energy industry directly employed 75,000 full-time-equivalent employees in a variety of capacities, including manufacturing, project development, construction and turbine installation, operations and maintenance, transportation and logistics, and financial, legal, and consulting services (AWEA, 2012). More than 500 factories in the United States manufacture parts for wind turbines, and the amount of domestically manufactured equipment used in wind turbines has grown dramatically in recent years: from 35 percent in 2006 to 70 percent in 2011 (AWEA, 2012; Wiser and Bolinger, 2012).

Other renewable energy technologies employ even more workers. In 2011, the solar industry employed approximately 100,000 people on a part-time or full-time basis, including jobs in solar installation, manufacturing, and sales (The Solar Foundation, 2011); the hydroelectric power industry employed approximately 250,000 people in 2009 (Frantzis, 2010) and in 2010 the geothermal industry employed 5,200 people (Jennejohn, 2010). Increasing renewable energy has the potential to create still more jobs. In 2009, the Union of Concerned Scientists conducted an analysis of the economic benefits of a 25 percent renewable energy standard by 2025; it found that such a policy would create more than three times as many jobs as producing an equivalent amount of electricity from fossil fuels—resulting in a benefit of 202,000 new jobs in 2025 (UCS, 2009).

In addition to the jobs directly created in the renewable energy industry, growth in renewable energy industry creates positive economic "ripple" effects. For example, industries in the renewable energy supply chain will benefit, and unrelated local businesses will benefit from increased household and business incomes (Environmental Protection Agency. 2011). Moreno and Lopez (2008) have performed a study about the effect of RES on employment at the Asturias area in Spain. The results of the study point out the employment decrease in the energy sector, as a result of the decreasing exploitation of coal mines on the short run, without taking into account facts as the displacement from fossil to renewable energy, the creation of new infrastructure of renewable energy such as high tension cables and gas plants as well as energy storage techniques.

The second conclusion that comes out from this study is that the main sector of jobs per unit of installed power comes from thermal, photovoltaic and wind energy sources development. The two surveyors forecast that the development of these three sectors will make up for the lost jobs during the years prior to the study. The jobs that will be created, is forecasted that will mostly come from the construction and installation rather than from system maintenance. This automatically means that the market of renewable energy sources is going to be in great need of engineers and technicians who are highly experienced in the construction and installation of renewable energy. Unfortunately, the major Polytechnic schools in the country as long as the technical schools of the country have not designed courses that would provide with the qualified knowledge that would lead to the optimum results. This is why a skill requirements analysis is desirable by the project managers. This analysis is divided in two levels, one level being the technical and engineering requirements and the second focuses on the installation of thermal and photovoltaic panels.

Asturias, according to the surveyors has to face this new reality on both the supply (impetus of renewable energy, new transmission lines and power generation technologies) as well as the demand side (energy storage and energy efficiency). In this context, Asturias, in order to prevail, should give incentives to its people to invest on renewable energy and the private sector should make sure to educate and train its personnel so that they are able to fulfil their tasks with efficiency.On a study concerning the jobs created by the wind energy in the whole of the European Union, Blanco and Rodrigues (2009) concluded that in the European Union there are more than 104,000 people occupied in the renewable energy sources, which represents a raise of 226% compared to 2003. Another very important conclusion of the Blanco-Rodrigues study is that employment on wind energy is now much more widespread compared to the past. The countries of the southern of Europe have shown a dynamic progress on the creating of new wind-energy orientated jobs, with France, Italy, Portugal and Ireland showing great competitiveness with respect to traditional wind energy forces such as Spain, Denmark and the Germany. The liberalization of the energy market in Eastern Europe, alongside with the cheap labour cost has also given a great potential to local energy market managers to take a piece of the market cake.

Blanco and Rodrigues (2009) also found a clear, but not parallel connection between the power installed and the number of jobs created. Although there is a number of jobs such as development, operation and maintenance (O&M) and specialized services that are usually provided on a local level, the development of large unit is dependent upon factors such as the size of the market, the possible connection to one of the three traditional market leaders (Denmark, Germany or Spain), the country's legislation, the quality of education and the cost of the working force. Therefore the index of installed power over number of jobs created is limited by the international nature of the wind power jobs as well as by the import-export relations.

Also, the general downfall of the renewable energy source job creation does not seem to influence much the creation of new employment; on the contrary, there has been a notable displacement of working force of traditional electrical power production towards wind power production.

Finally, the lack of specialized personnel influences negatively the covering of the most specialized positions such as O&M, system design and aerodynamics computation and fluid engineering. The two surveyors ended up at the conclusion that the standardization of qualifications is mandatory, as well as the design of courses that are specialized enough to cover the needs of the renewable energy sources engineering. To sum up, wind energy is an attractive employment field that is emerging in Europe, since it covers so many different activities. Like it was mentioned above, a respectable number of jobs is covered usually by local professionals and thus, if the proper conditions allow it. On the other hand these locals should be educated enough, so as to be competitive enough and to cover the needs of the wind-turbine fields. Figure 1 shows the "direct employment" by the type of Company. The RES systems and components manufacturers retain almost the 57% of the wind energy sector. These results are consistent with what has been found by other studies (Lehr et al., 2008).

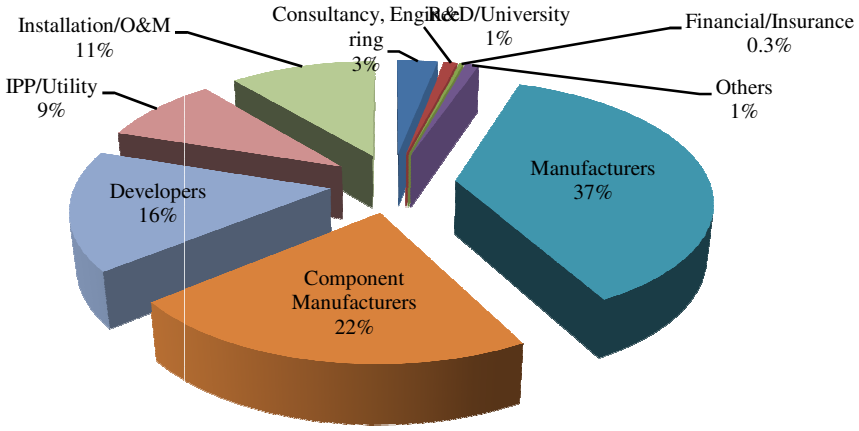

Figure 1. Direct employment by type of company (Blanco and Rodrigues, 2009)

Equivalent results were extracted by a survey performed by Wei et al. (2010). The outcomes of this study was that renewable energy sources produce much more positions per power installed compared to the fossil fuel energy production while the type of employment varies depending on the different technologies, while the time and location of the employment usually varies within the same country. Another very useful outcome of this study is that energy efficiency investments are both the most easily implemented and bring the highest payoff in induced jobs. The more energy efficient an investment is, the higher the probability that the needs in fossil fuels and renewable energy is going to be diminished. Thus, aggressive efficiency investments should be backed up by limiting the barriers on energy markets, more ample awareness on green energy matters, empowering green energy education and non- stop financing. Wei (2010) also highlights the variety of jobs created on both local and international level with system engineering, installation and maintenance taking place at a local level and manufacturing taking place at an international level.

On the other hand, there is Lesser's (2010) opinion, who deals with the subject on its pure economic view. Judging from the experience of Spain and Germany, two countries that have massively invested on green energy and have paid a high price for the creation of green jobs, Lesser (2010) even questions the positive effects of green energy on the melioration of the ambient conditions and claims that every green job created leads to the loss of two jobs on the fossil fuel energy production.

Lesser (2010) claims that even though a specific amount of energy needs less people to be produced through the renewable energy sources, this is bad for the economy because on the short run, there is a loss of jobs in the energy sector and even less people will be occupied at the coal mines and the power plants. The surveyor neglects the fact that this lower cost energy production is going to have an impact on the electricity price. To add to that, Lesser talks about an 'artificial price suppression' for decisions that were taken by different states' boards of energy directories in order to determine the price of the electric unit which is less than the price of electricity produced by fossil fuels. To his favour, he mentions that under the present situation of recession, since initiatives for private act are less by the day, it is harder for new technical industries to rise which would employ engineers for the design and technicians for the installation of the system in order to install more power and create more jobs.

Cai et al. (2011), taking into consideration a period of five years of time, claimed that one cannot be certain if renewable energy sources create more jobs than the ones that they take away. During a five-year study performed in China, Cai et al. (2011) figured out that during the first three years of the change from fossil fuel and natural gas to renewable energy, the project didn't create as many jobs as the ones lost by the reduction of use of coal mines and fossil fuels. So, especially for developing countries like China, the answer to our question is never a simple yes or no. The results show that from 2006 to 2009, mitigation of traditional power techniques has resulted into a loss of 44,000 jobs. However from 2009 onwards, as the renewable energy sources that lead to indirect employment emerged, the results of the study showed that 472,000 indirect jobs were created. These results can work as a framework for individuals in China as well as developing countries in general to promote and invest in photovoltaic, wind turbines and biomass. Cai et al. (2011) calculated that for every 1% of augmentation of photovoltaic installed in China, there is a 0.68% raise in job creation, which makes photovoltaic the best employing manner in power production, while for example nuclear power production costs the total employment of the country a loss of 0.01%. On the other hand, China faces huge barriers to the exploitation of its solar power since it has to import 50% of its polysilicon crystal. Moreover, the backwards power grid of the country, according to the surveyors is a problem. If huge amounts of energy are produced by PV panels, this may jeopardise the system stability and security. Finally, the surveyors highlighted the need for a more organised educational system that would produce experts on the renewable energy sources.

Lehr et al. (2008) discuss the future of RES in Germany, forecasting a raise in the cost of installation of renewable generators. Another forecast made by Lehr et al. (2008) is that the renewable energy market will be a mature one by 2020 and in case the fossil fuel prices go up, this is going to have an effect on the velocity of maturity, since the demand will be growing and maturity will come earlier. Lehr et al. (2008) also point out the obvious link between the world markets and production. In the manufacture sector, according to Lehr et al. (2008), Germany holds the 16% of world markets and as it can be easily understood future world manufacturing markets of generators will grow much more easily than in Germany. The surveyor also underlines that the German manufacturers should focus on the R&D of more sophisticated and effective products; launch them to the international market and focus on exports. This survey is another indication of the job creation potential in a country which has from scratch realised the importance of the RES and has developed a leading industry in the manufacturing of RES products, creating also side jobs in exports.

Sastresa et al. (2009) have presented to us an evaluation of the socio-economic impact of the installation of RES on local communities, through the creation of jobs. This assessment method has borrowed some contributions of a similar analysis, to reduce the ratio of uncertainty on jobs, which is a critical measurement in such an analysis. Sastresa et al. (2009)have used primary information sources in order to present the effect of RES usage on new job development. The society under examination is the province of Aragon in Spain. In order to perform the analysis the surveyors selected two measurements, namely the installed power over the jobs created and a quality factor which is dependent upon the location of the power installed, the timeline of the job (temporary, permanent) and the professional specialization. Also, a number of variables were taken into consideration, namely, the territorial situation of the area, the existing technology, the structure of the business that offers the RES services, the supply of training to the employees and the structure of the professionals within the business.

By using an outside-to in analysis, the surveyors classified the activities of the RES power installation (R&D, system manufacture, construction and installation, O&M, updating and/or dismantling), they defined the indicators to be in use (MW/jobs and the quality factor), they gathered the data (selection of the territory, compilation from secondary sources, creation of a database, fieldwork, detailed analysis, estimation and evaluation of employment indices). Taking all the above into account, the surveyors end up to the conclusion that the primary sources of information are the most significant for the calculation of the total impact of the use of RES sources on employment, while the territorial development and the quality of the job are the key drivers for the sector competitiveness. An idea that comes up repeatedly and is commonly accepted is that the exploitation of renewable energy for electricity production generates more jobs than plants supplied with conventional energy; for every MW installed it is estimated that renewable energy sources generate between 1.7 and 14.7 times more jobs than natural gas generated plants and up to 4 times more jobs than those supplied with coals.

The results also have shown that the ratios applied to one territory are not necessarily applicable to a similar analysis on a different area.

The most important information according to Sastresa et al. (2009) is to know the exact value of the contribution ratios of RES to the reduction of unemployment, once the indicators and the selected variables are defined.

According to Wiser (2000), for green development to evolve successfully, there must be a just legislative framework which would offer opportunities to people who want to take the initiative to invest on green power. Wiser (2000) study reveals that there are only very few cases throughout the globe where legislation really facilitates the procedures for green development. After a long literature review, Wiser(2000) has concluded that the design of the legal framework under which electricity industry is going to operate is a complicated task which requires a number of trade-offs between completing and conflicting goals. According to Wiser, tariffs should be held on such a level so that both producers and consumer are satisfied. The surveyor also recognizes that over-production is going to suppress rates for the benefit of the consumer and thus in an ideally independent market, the investment is going to seem pointless, thus a borderline rate should exist that is going to please both producers and consumers. Another incentive that is going to lead to the creation of jobs would be if the government of a state or country could keep taxation low for the companies that are dealing with energy solutions, so that extra taxation is not going to have an effect on the rates and thus the consumer. Also, Wiser (2000) highlights the need for the protection of small and medium size producers with respect to large producers, in order for local economies to emerge and develop.

Merkandya (2011), reports that a major issue for Britain's renewable energy industry was the fact that the country imported most of its onshore wind power. Also, the country's investing environment seems quite hostile to locals and foreigners. Due to public opposition, lengthy bureaucratic processes and uncertainty over the policies to be followed, both locals and foreigners find it quite hard to invest in the British RES sector, a fact that is setting barriers to the creation of new employment. Another very important barrier for the evolution of this industry is the fact that there are not enough skilled personnel to back up its procedures. The fact of the matter is that even though the wind energy jobs are quite good, they demand highly trained personnel and they provide very short training availability, which is making things even worse.

According to the surveyor, a motivation for the development of the green technology has been, apart from the fact that it is an obligation, the fact that green development is going to create new jobs, i.e. the direct effect of this development is clearly the creation of jobs connected to the RES, e.g. wind farm engineer-system designer. The indirect effect according to the researcher is the boosting of all the economies that surround, i.e. new jobs that deal with the supply of steel are going to be created. The development of the manufacturing industry is going to have its impact on trade since there are going to be new jobs created that deal with the import and export of renewable sources. Since the country will export more goods, trading business is expected to have a high performance. Finally, the new jobs created are going to have a positive effect on the budget of the country since more and more people are going to be able to respond to their tax obligations.

Rivers (2013) utilized an analytic equilibrium model to distinguish the relationship between renewable energy policies and the unemployment rate. The results of the simple model propose that the adoption of renewable energy policies by subsidies, alongside with the taxation on fossil fuel consumption is going to have a negative impact on the unemployment rate. A more complicated version of the model that takes into account as a primary factor suggest that when there is little possibility of substitution between capital and labour, when international capital funds are not available and when the implementation of renewable energy solutions is high, the promotion of renewable energy sources could diminish the unemployment rates. Rivers is once more called to give an answer to the question if renewable energy creates job opportunities or it results to the loss of jobs. According to him, the only thing that alters is the nature of the jobs offered, since the results of his study have shown that green alteration has little impact on unemployment. Rivers (2013) also notes how many results vary from one society to another, taking into account the socioeconomic conditions of each country. The results of mobilization from fossil fuel to RES is much easier in countries where the citizens are able to take on the cost of investing in such projects because the conditions favour such an action (low or no taxation on profit, loans by banks with a small interest) and where competition between installing companies make such an investment look attractive. For developing countries where the citizens cannot take upon the cost of installation, the government has not set a number of ground rules under which producers are going to perform, international capital is not available, governmental policies favour multi-national companies and large scale producers, the displacement from one form of producing to the other seems vain.

In EU's final report about the impact of renewable energy policy on economic growth (Employ-RES, 2009) it is stated that the current high economic benefits of the RES sector can be increased in future if support policies are improved to stimulate innovative technologies appropriately. It finds that renewable energy sector is already a very important one in terms of employment and value added. New industries with strong lead market potential have been created, which contribute about 0.6% to total GDP and employment in Europe. This development is likely to accelerate if current policies are improved in order to reach the agreed target of 20% renewable energies in Europe by 2020.

Finally, a theory and visual aspect of some economists (http://american-journal.org, journal of economics) for green jobs creation is that governments do not "create" jobs; the willingness of entrepreneurs to invest their capital and the combination of consumer demand for goods and services. All the government what they can do is subsidize some industries while jacking up costs for others. In the green case, it is diminishing jobs in the conventional energy sector, and most likely in other industrial sectors, through taxes and subsidies to new green companies. Economic growth does not come from political mandates; it comes from increases in productivity and most of the studies ignore the millions of jobs that will destroyed by the restrictions imposed by governments on disfavoured products and technologies. The subsidized jobs "created" are, by definition, less efficient uses of capital than market-created jobs. That means they are less economically productive than the jobs they displace and contribute less to economic growth. Finally, the good produced by government-favoured jobs is inherently a non-economic good that has to be maintained indefinitely, often without an economic revenue model, as in the case of roads, rail systems, mass transit, and probably windmills, solar-power installations, and other green technologies.

4. The situation in Greece

Greece has slowly progressed towards green economy, in order to visualize the opportunities for new jobs. Although Greece has not yet made the essential shift towards the direction of the desired economy of low emission, it is no coincidence that Greece is substantially below the objectives for the promotion of renewable energy sources. Today, less than 10% of electricity comes from RES, as soon as 2020 this percentage should figure 20%. In addition, the national commitment to 2020 includes RES by 18% in final energy consumption, or about 35% share in electricity generation.

Greece has slowly progressed towards green economy, in order to visualize the opportunities for new jobs. In this section, the effect of green energy on employment, for the years 2012-2050, in Greece has been examined. The calculation has been based on the future electricity generating mix of this country for the same period, as it has been estimated by Rentizelas and Georgakellos (2014). According to them, "the analysis has been performed using a linear programming model for the yearly decisions of which electricity generation source should be used to minimise the electricity generation cost. The external cost has been calculated using the Life Cycle Assessment (LCA) methodology. More specifically, the life cycle inventory concept has been used in order to quantify the atmospheric emissions associated with each power generation technology under examination while the calculation of the external cost was based on the 'impact pathway' methodology which has been developed in the series of ExternE projects, and is further improved within NEEDS and other related ongoing projects. All energy systems are described on a 'cradle to grave' basis, i.e. the construction and operation in each stage (e.g. transportation, electricity generation) were examined. The necessity of the LCA incorporation in the model stems from the fact that it is the basic unambiguous scientific tool for the assessment of the environmental performance of the options under examination: since there is a number of power generation technologies (e.g. those based on Renewable Energy Sources - RES) with almost zero environmental externalities during the electricity generation phase but with rather considerable ones during the other stages of their life-cycle, using this methodology, decreases the uncertainty of the analysis and improves the reliability of the results and, thus, of the decision making" (Rentizelas and Georgakellos, 2014). The analysis performed concerns five RES technologies (geothermal, hydro, wind, solar-PV and biomass power plants) and four different scenarios:

- Case I: LCA externalities included - High CO_2 price
- Case II: LCA externalities included - Low CO_2 price
- Case III: LCA externalities not included - High CO_2 price
- Case IV: LCA externalities not included - Low CO_2 price

On the other hand, the estimated direct employment effects related to the operation of RES technologies in Greece (per TWh of electricity generated) are 363.2 man-years for biomass-fired power plants, 146.2 man-years for solar-PV power plants, 136.9 man-years for wind power plants, 95.6 man-years for hydro power plants and 74.0 man-years for geothermal power plants (Tourkolias and Mirasgedis, 2011). Based on these estimations and considering the future electricity generating mix mentioned above, the effect on employment of these five RES technologies, for the years 2012-2050 in Greece, are calculated and presented for the four selected scenarios in Figures 2 to 5. Evidently, Figures 2 to 5 present the positive effects of green energy on employment.

However, there is also the opposite effect as well. Specifically, while public investment in renewable energy has job creation as one of its explicit goals, the resources (in the form of green subsidies) used to create "green jobs" must be obtained from elsewhere in the economy. Therefore, this type of policy absorbs or destroys capital from the rest of the economy. In other words, the money spent by the government as subsidies to create "green jobs", cannot be consumed or invested by private parties elsewhere in the economy and thus the jobs that would depend on such investment will never be created. In order to know how many net jobs are destroyed by a green job program for each one that it is intended to create, the following approach has been proposed (Álvarez et al., 2009): "the average annual productivity that the green job subsidy would have contributed to the economy, is being compared with the average productivity in the private sector that allows them to keep their job, the latter being ultimately the measure which justifies the creation or preservation of that job". This is being calculated by the following equation (Álvarez et al., 2009):

$$\text{Jobs destroyed elsewhere in the economy for every ''green'' job subsidized} = \frac{\text{Annual subsidy to RES per worker}}{\text{Average productivity per worker}}$$

From the above equation and considering that the average subsidies and support to RES electricity production is 0.89 US$/MWh for biomass-fired power plants, 24.34 US$/MWh for solar-PV power plants, 23.37 US$/MWh for wind power plants, 0.67 US$/MWh for hydro power plants and 0.92 US$/MWh for geothermal power plants (Morriss et al., 2009), while, according to the OECD (2012 data), the average productivity per worker in Greece was 0.07 million US$ (data extracted on 16 November 2013 from OECD.stat), the number of jobs destroyed elsewhere in the economy for every 'green' job subsidized can be calculated. This calculation is being realized using the results presented in Figures 2 to 5, which have been based on the future electricity generating mix mentioned above, in order to estimate the annual subsidy to RES per worker.

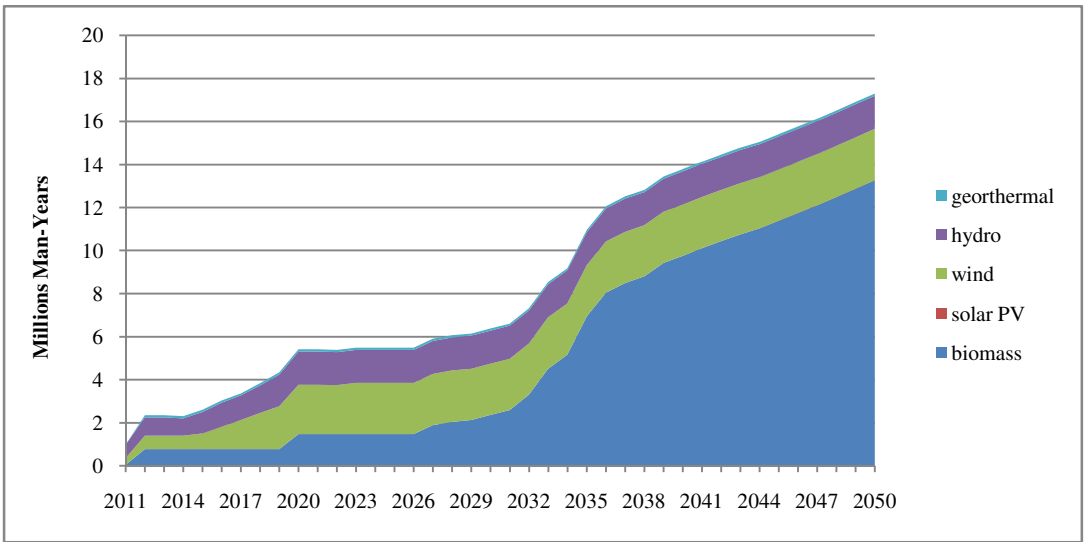

Figure 2. Annual direct labour requirement per TWh of electricity generated (Case I)

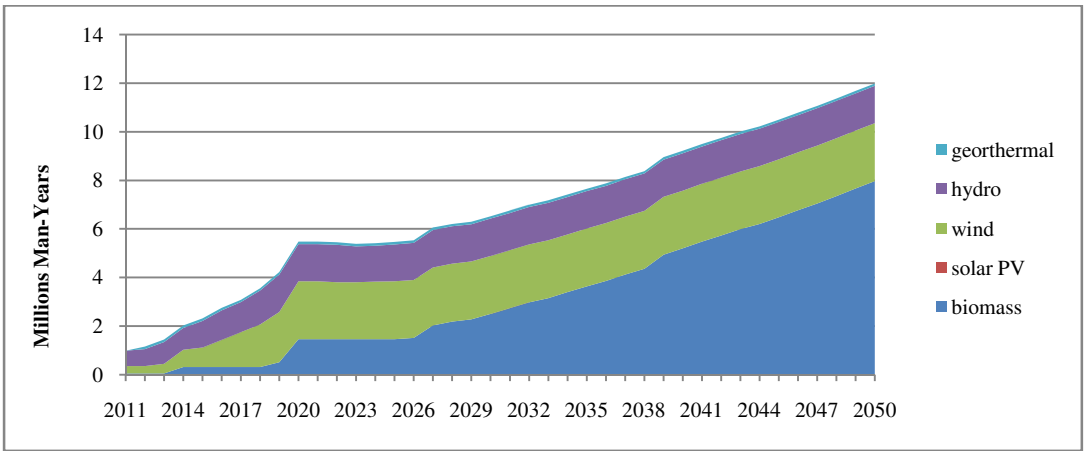

Figure 3: Annual direct labour requirement per TWh of electricity generated (Case II)

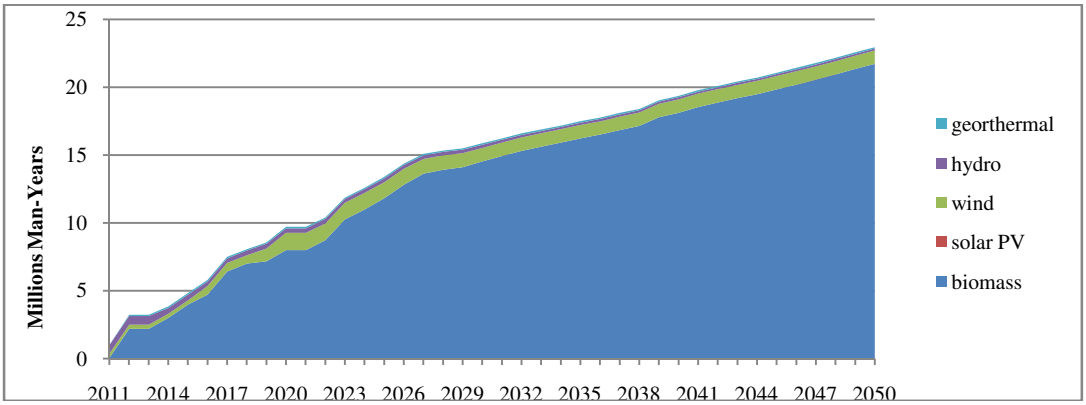

Figure 4: Annual direct labour requirement per TWh of electricity generated (Case III)

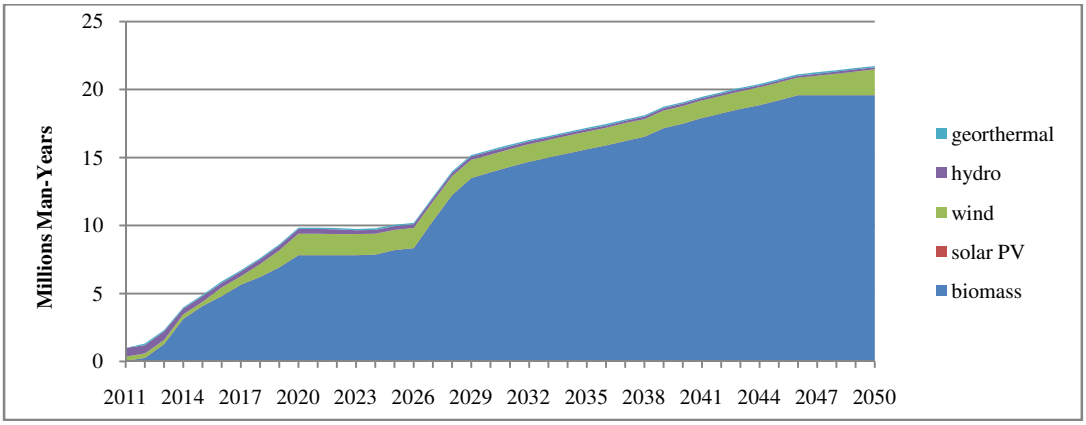

Figure 5: Annual direct labour requirement per TWh of electricity generated (Case IV)

Therefore, the number of jobs destroyed elsewhere in the economy for every 'green' job subsidized in Greece is given in Figure 6, for the years 2012-2050 and for the four selected scenarios. As it can be seen in this Figure, the results are the same for the four selected scenarios (case I to IV) and for the periods 2011 to 2026 (about 5 jobs destroyed for every 'green' job subsidized) and 2027 to 2050 (about 2.5 jobs destroyed for every 'green' job subsidized). Furthermore, the results are analysed per RES technology. Thus, the most job 'destroyable' technologies are undoubtedly the wind electricity generation technologies together with the solar-PV electricity generation ones. However, this is rather anticipated since the subsidies for both of them are quite significant.

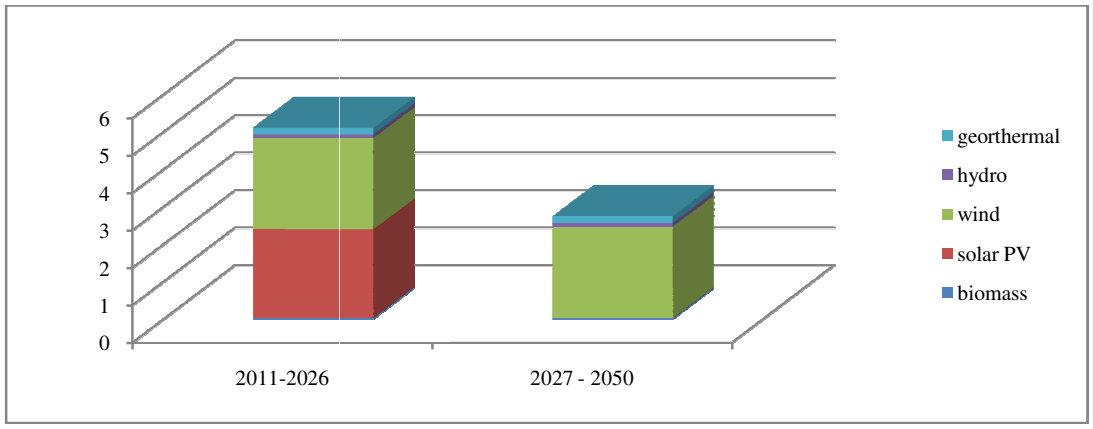

Figure 6: Jobs destroyed elsewhere in the economy per every subsidized green job (Cases I-IV)

If the conditions are favourable, the moving from one side of power production to the other is going to affect a number of employment groups and it will facilitate the living conditions of the inhabitants. Unemployment rates will fall, if a country's potential is enough to cover its needs, it can also export electrical power to neighbour countries and also the local industries are going to produce eco-friendly products, with a lower production cost. Let us finally not forget that eco-friendly policies are not only welcome, but also well promoted.

5. Discussion and Concluding Remarks

To conclude this paper, onecould summarize that in order for the renewable energy sources to produce employment, favourable conditions must be present. The renewable energy sources have positive effects, not only due to their contribution to the power production without the emission of carbon dioxide pollutants, as a positive externality, but it might be contributed to the diminishing of unemployment in general, as some studies indicates. But unfortunately, a lot of attention must be given to the fact that while green energy creates jobs, on the other hand it is responsible for the loss of many others.Figure 7 shows the future expectation on job employment by green energy. More precisely, it shows the employment in EU-27 from 2010 to 2020 will be 8% decrease in the jobs creations, while between 2020 and 2030 there will be another 10% decrease. On the other hand, some of the G-20 countries will have an increase in Green Jobs in the decade 2010-2020. Moreover, Figure 8illustrates a future scenario from today analysis about the situation in green employment.

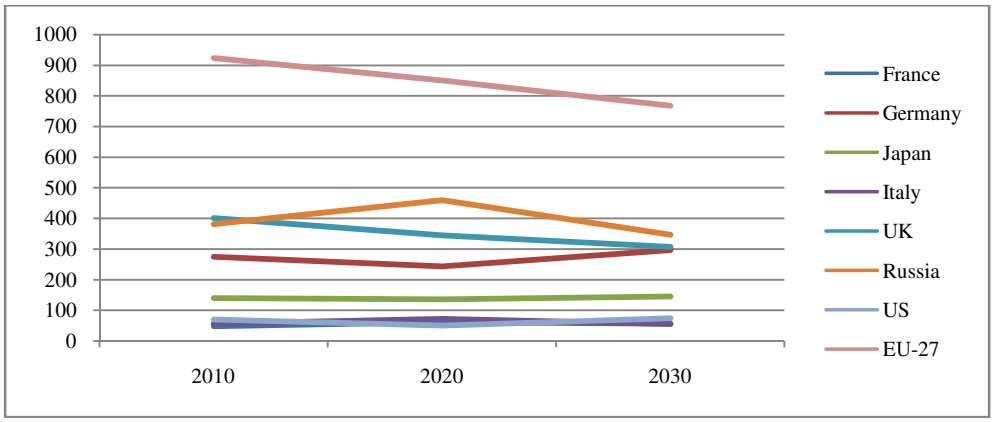

Figure 7: Annual jobs creationby green energy (own elaboration based on Greenpeace data)

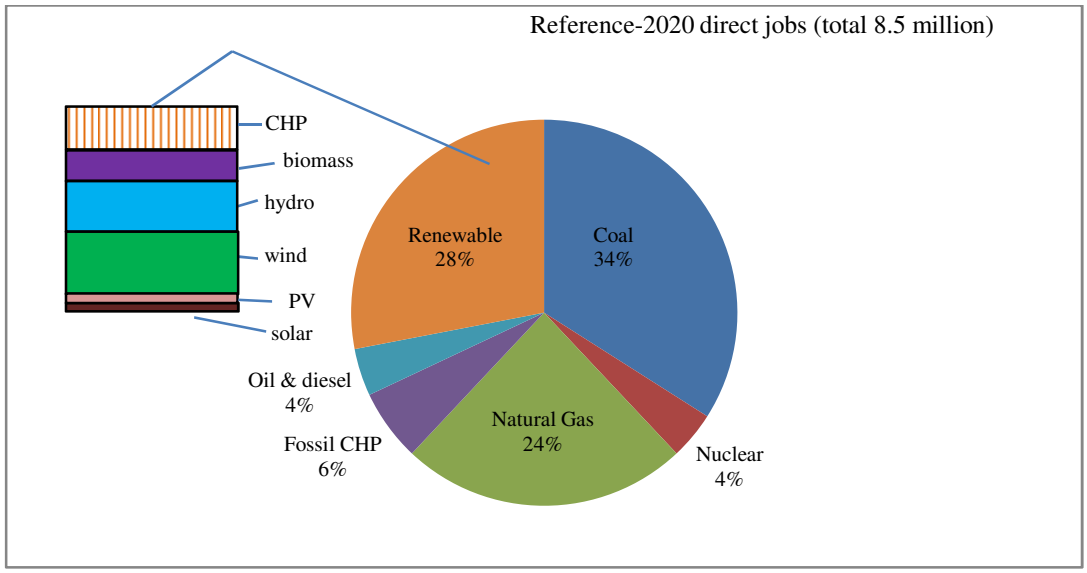

Figure 8: A future scenario from today's analysis versus to an optimisticone (own elaboration based on aei.org data)

Furthermore, in this study the effect of Green Energy implication on employment, for the year 2012-2050, in Greece has been examined by utilizing the "Life Cycle Assessment". In order to calculate how many net jobs are destroyed by a "green job program" for each one that is intended to create, the Alvarez's equation has been used. However, consideration should be taken while public investment in RES creates "green jobs";these subsidies must be found from some other economical sources, removing by this way capital from the rest of economy.The results for the four selected cases I to IV show that the number of lost jobs, in other sectors of the economy for every "green job" subsidized in Greece, is about 5 jobs for the period 2011 to 2026 and about 2.5 jobs from 2027 to 2050.

When the results analysed per RES technology, has been observed the most "jobs destroyable" technologies are the wind and the solar electricity, as both are the most subsidized ones.Finally, it should be kept in mind that job growth will not be endless. It will eventually reach a highpoint and from there onwards the situation will remain stagnant. In order for Green Development in countries to be evolved successfully, there must be a solid legislative framework and a low taxation which would offer opportunities to people and companies who want to take the initiative to invest on Green Power. But some questions arise: Will the employment continue to grow or there will be decline? To what extent conversional energy will be substituted by renewable energy sources? Which is progress when all the existed RES projects approach the final target? The coming year's data will give us more details for further study and research to develop more solid future forecasts.

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