



Analysis of renewable energies in European Union



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ABSTRACT

The paper's main research objective is to analyse the renewable energy sector in the European Union member states. The first step of the research was to generate clusters of countries based on the share of renewables in total energy produced and the countries' energy dependence. In order to generate the clusters, we applied the k-means clustering method based on the data obtained from Eurostat. By using the Statistical Package for the Social Sciences, three clusters of countries have been generated. In the next step the EU states were ranked based on the following criteria: share of renewable energy sources, share of renewable electricity, share of renewable heating and cooling and share of renewable energy in transport. Then the main characteristics of the renewable energy policy in each member state have been highlighted.

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1. Introduction

The need for energy is growing, conventional sources being limited and fast depleting [1]. Unknown quantities of coal, gas and oil reserves are buried deep in the ground or under the ocean. Therefore, identification of new sources is becoming increasingly difficult and expensive and the exploitation is very dangerous either due to accidents when drilling under the ocean floor, or to the need to burn large amounts of natural gas for refining when it comes to oil sands [2–4]. Besides, using nuclear fuels involves

many risks that threaten humans health and safety, as well as the environment [5]. Human errors and colossal mechanical failures could generate huge costs and devastating effects on human health killing thousands of people in a short period of time and tens of thousands in the long term due to the radiation generated [6], as well as large areas of radioactively contaminated land [3]. Moreover, global warming and energy crises have direct consequences on the quality of human life [7].

Under these conditions, renewable energy sources are an option worthy of serious consideration for governments [8] because they could be easily identified and explored without causing major accidents or dangerous situations [9] affecting life on earth and as technology and infrastructure will be improved, the energy produced will be very cheap [10].

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Despite debates aroused by costs installation in many countries [11], renewables are considered a key element in the European energy policy [12] because they could cover a large proportion of the European Union's energy needs. Moreover, they help Europe to maintain and defend its leadership position in terms of innovation at global level [13] by developing new technologies and generating employment opportunities.

The significant energy potential and the high availabilities of use at national and local levels [14] convert renewable energy into an important option creating many benefits for the states. Renewables give European Union member states the possibility of developing a competitive, reliable and sustainable energy sector, contributing to solving the most pressing energy issues and challenges facing the community:

- reduce the countries dependence on imports of energy, especially dependence on fossil fuels such as oil, coal and natural gas

The growing demand for energy increases fossil fuels imports from countries rich in natural gas and oil, which involve economic costs. Political and economic problems and challenges of supplier countries are a source of uncertainty and risk in energy supply [15] and the increasing dependence on foreign energy sources could lead to rivalry by deciding who gets control over global energy resources that could escalate to a military confrontation [16].

European Union countries are dependent on imports of fossil fuels [13], especially oil and gas, about half of energy consumption coming from imports [17]. The dependence of these countries on imported energy resources results in a low-power security. However, increasing security in energy supply involves not only reducing imports and growing domestic production, which according to the European Commission would mean a too simplistic approach to problem solving, but requires the identification of rigorous and complex solutions. Such an approach would include, among others, the diversification of energy and alternative energy, the development of technologies in the field and a new energy demand management [18].

- increase security in the energy supply

Security of energy supply is a vital ingredient for any nation's survival, and insufficient energy sources contribute to the increased vulnerability of national economies [19] to fluctuations in energy products prices in the international markets. EU energy vulnerability generated by high import dependence [20] may cause serious problems in security of energy supply in the absence of measures to deal with this challenge. Additionally, the oil markets are very volatile [21], with large price differences from one period to another.

Based on these issues and on the fact that the energy situation varies from country to country and from region to region, we could consider renewable energy as an important way to fight these problems, with the possibility of becoming a major player in the energy market [22] and making a substantial contribution of increasing energy supply security [23] in the European Union countries. Moreover, security of energy supply is one of the most important factors in strengthening the Union's stability [24] and the bad experiences in international energy markets and unexpected oil crises have turned it into an important issue on the EU political agenda [25]. In addition to energy security and independence, renewable energy involves lower imports, reducing funds for imports of conventional energy [26].

- meet targets for reducing carbon emissions and ensure protection of the environment

World leaders have pledged to gradually reduce emissions of greenhouse gases, especially carbon dioxide by 2050 in order to reduce the magnitude of climate change impact. In this context, EU heads of states have established to reduce greenhouse gases emissions 80–95% below 1990 levels by 2050. Another European Union's commitment set for 2020 refers to reducing greenhouse gas emissions 20% below 1990 levels, which is one of the main objectives of Europe 2020 Strategy. In addition, EU 15 member states are signatories to the Kyoto Protocol in order to reduce their collective emissions 8% below 1990 levels, and most countries having joined the EU on May 2004 are on track to achieve the objectives of Kyoto Protocol [27].

The main cause of carbon dioxide released into the atmosphere are the fossil fuels [28,29] used to produce both electricity and heat, which leads to an enhanced greenhouse effect known as global warming. Among greenhouse gases that contribute to global warming, nearly three-fourths of the emissions are represented by carbon dioxide [30]. Over the last century the use of fossil fuels has generated the highest levels of carbon dioxide emissions [31], hitting a record that has never been done before. Without strong and policy action in the area, atmospheric carbon dioxide concentrations would double over the next 50 years leading to amplified global warming which will be between 1.8 and 6.3 degrees Fahrenheit. The immediate effects would consist in melting glaciers and rising sea and ocean levels as well as flooding thousands of miles of coastlines [32,33]. The rise in global temperature could also lead to extreme weather events such as droughts, floods and heat waves [34] as well as a number of other effects including increases in heat-related deaths, loss of plant and animal species [35] and the spread of pests and diseases.

In fact, according to specialists, carbon dioxide effects will also be felt the next millennium due to carbon dioxide accumulation in the atmosphere and oceans, which are characterized by a gradual warming up process compared to earth [36].

In this context, renewable energy proves to be a strategic investment, more friendly to people and environment than conventional energy which causes health problems such as casual respiratory diseases as well as fatal diseases like cancer [37,38] and many environmental problems and challenges facing humanity today such as greenhouse gas emissions, air pollution, water and soil contamination [39]. Therefore, renewable energy technologies, still under development, could be used to produce electricity and heat, and the amount of carbon dioxide released into the atmosphere would be small or almost nonexistent [40].

Renewable energy has also some impacts on the environment, but they are much lower [41]. On one hand, biomass plants may release carbon dioxide emissions [42,43] and on the other hand wind energy could change the landscape and cause death or injury of some birds [44] due to installation of specific devices. The construction of hydropower plants could also damage wildlife, altering ecosystem processes [45,46]. Compared to fossil fuels burning, the effects of installing renewable energy technologies are small and localized; however they must be carefully examined in order to be attenuated where it is possible.

Aside these issues and challenges whose resolution is considered a priority task because they are seen as necessary conditions for an economic sustainable development, the benefits of renewables for countries and regions are enormous.

In a time of uncertainty and economic crisis the renewable energy industry records a significant increase providing jobs [47] and helping countries and regions to improve their economic competitiveness [48] through long-term stabilization of energy prices [49] and the reduction of expensive additional controls generated by pollution-intensive industries [50]. Therefore, renewable energy offers opportunities for economic development, especially as they are available everywhere and have sufficient

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