TYPOLOGY OF EMERGING PATTERNS OF THE MEDITERRANEAN AREA IN THE ENERGY SECTOR: A TWO TIER APPROACH

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Abstract
Energy poverty is intensely debated lately, mainly at the political level, both in the developed and developing world. The concept of energy poverty refers to issues such as lack of the necessary infrastructure that prevents citizens from having access to various sources of energy.
In the Mediterranean region, there is a divergence among countries, regarding both the energy poverty patterns and the related policy framework. Apparent differences also appear between the EU countries and non-EU countries, concerning the existing infrastructure, the energy demand, the availability of natural resources and energy sources and the related policy measures.
The aim of this paper is to develop a typology of the energy poverty patterns in the Mediterranean countries and elaborate on the prospects for policy measures.
The first part provides the definition of energy poverty and the patterns appearing in the Mediterranean region. The second part presents data issues on the energy consumption and production patterns in the study region. In the third part, the available data and their sources are presented, while the fourth part presents the methodological framework and the tools used in a clustering exercise in order to identify groups of countries with similar characteristics which may be addressed by a common set of policies. The clustering process consists of two separate parts, one including all the Mediterranean countries and a second clustering separately the EU and the non-EU countries in order to identify differences among the two clusters. The fifth part presents the results of the clustering process and the visualization of the new typologies. Finally, in the sixth part, follows a set of conclusions drawn from the resulting typologies, but also the prospects for policy action in the Mediterranean region.

KEYWORDS
Energy poverty, Spatial disparities, Mediterranean energy patterns, classification, typologies

1. INTRODUCTION

The Mediterranean Sea unites countries with different demographic, socioeconomic and cultural characteristics, including both EU and non-EU countries as parts of this "entity". Mediterranean countries exhibit rather diversified patterns, as to their energy poverty and related policy framework. These are mainly due to the existing infrastructure, energy demand, availability of natural resources and energy sources as well as the related policy measures, which are considerably different between the EU and non-EU countries.
The aim of this paper is to develop a typology of the energy poverty patterns in the mediterranean countries and elaborate on the prospects for policy measures, based on energy efficiency.

2. THE MEDITERRANEAN AREA

The study region is the Mediterranean area, which consists of 21 countries, from different continents. More precisely it includes European countries, such as Spain, France, Monaco, Italy, Malta, Croatia, Slovenia, Bosnia and Herzegovina, Montenegro, Albania and Greece; Eurasian countries namely Cyprus and Turkey; Asian countries such as Syria, Lebanon and Israel, but also African countries, such as Egypt, Libya, Tunisia, Algeria and Morocco.
All the Mediterranean countries apart from Monaco, are member countries of the International Energy Agency (IEA) and seek to create conditions for their energy sectors which can make the fullest possible contribution to their sustainable economic development, the well-being of their people but also of the environment (IEA, 2011).
Seven out of the fourteen European and Eurasian countries are EU members. These are Cyprus, France, Greece, Italy, Malta, Slovenia and Spain. Relating to the energy sector, EU has set policy targets and strategies in order to promote energy efficiency in its member states.
Additionally, six out of the twenty one Mediterranean countries are OECD Members. These countries are France, Greece, Italy, Slovenia, Spain and Turkey.
The energy profiles of the Mediterranean countries vary significantly. It is noteworthy that all the EU countries apart from Malta rank at the top as far as per capita final energy consumption concerns, while France, Italy and Spain possess also the first places in the net quantities of final energy consumption.
Concerning the energy primary production, the difference noticed among the Mediterranean countries, refers mostly to both the renewable and the conventional energy sources. The EU countries have a great potential in renewable energy while many of the non-EU countries have subsoil rich in conventional energy sources (oil and natural gas).

3. ENERGY POVERTY

Energy is a basic necessity for economic and social development. Nevertheless, appropriate global strategies for meeting the energy needs, of the world's rapidly growing population, are lacking (Baker Institute Energy Forum, 2011).
According to the Population Resource Center, consumption of fossil fuels has increased steadily in recent decades, mainly due to the rising standards of living, but also to the increased demand from population growth. A growing number of energy analysts claim that the absolute amount of the yearly oil production, all over the world, is likely to reach a peak sometime in the next two decades. A small but growing number of experts also predict that the world is already at or near the "peak oil" (Population Resource Center, 2011).
Energy demand is proportional both to the population growth and the income rise. As income per capita rises, so does per capita energy use. The reason is evident. Energy (electricity to run motors, fuels for transport, and hundreds of other applications) is a vital complement to other investments for boosting productivity and stimulating economic growth. In turn, that very growth gives rise to increase of household necessities and creates comforts associated with such increased energy usage (Resources of the Future, 2011).
In 2009, world energy consumption decreased for the first time in 30 years (-1.1%) or 130 Mtoe (Megaton oil equivalent), as a result of the financial and economic crisis (GDP drop by 0.6% in 2009). In OECD, countries consumption was severely cut by 4.7% in 2009 and was almost down to its 2000 levels. Oil has remained the largest energy source (33%) despite the fact that its share has been decreasing over time. Coal has played a growing role in the world's energy consumption: in 2009, it accounted for 27% of the total (Enerdata, 2011).

3.1. Energy Poverty

Energy poverty refers to issues dealing with the lack of the necessary infrastructure that prevents citizens from having access to various sources of energy. At a household level, energy poverty takes another dimension. It reflects the inability of households to satisfy their energy needs as they cannot afford to pay for it. This situation occurs mostly in the low-income households (ESPON ReRisk, 2010).

Several agencies dealing with energy poverty issues have expressed their views on the lack of access to energy as follows:
"The access in sustainable modern energy services and products is a key aspect of human development and growth. Across the globe an estimated 3 billion people continue to lack access to sustainable and affordable modern energy. Most remain dependent on traditional fuels, often adding to stresses on natural resources and undermining the sustainability of rural livelihoods" (Energy Poverty Action[1], 2011)
"Access to energy services is a key component of alleviating poverty and an "indispensable element of sustainable human development" (Baker Institute Energy Forum[2], 2011)
"Without access to modern, commercial energy, poor countries can be trapped in a vicious circle of poverty, social instability and underdevelopment" (International Energy Agency[3], 2011)

3.2. Energy Poverty in the Mediterranean Countries

The volume of energy use differs among the world countries and regions, even at comparable levels of per capita GDP, depending on the structural characteristics of their economies, spatial features, climate, fuel and power prices, government conservation policies, and other related factors. Similarly, changes in per capita income need not signify commensurate rates of energy use; for example, shrinkage of energy-intensive manufacturing and expansion of lower energy-use service activities can contribute to de-coupling growth of GDP and energy use (Resources of the Future, 2011).
Energy poverty has a different aspect among the Mediterranean countries and although it cannot be clearly defined in each country, similar problems are noticed among countries i.e. unpaid energy bills, disease, self-disconnecting, etc (EPEE, 2011).
The reason for the differentiation among Mediterranean countries is basically due to the socioeconomic and energy data, in each country, which are much diverse. Some of these countries are oil producers, supplying the world energy market, while others have a large potential in renewable energy production. On the other hand, a great diversification appears also on their socioeconomic base, population characteristics and the GDP per capita. Issues like energy efficiency, energy use, energy resources, income per capita, differ also to a large extend.
The EU countries have great potential in renewable energy production. Apart from this potential, EU set targets for the years 2010 and 2020 through Directives concerning the renewable energy. While the 2010 targets were driven out of a loose legislative framework, the 2020 targets are mandatory for the member countries (Stratigea et al., 2011). Concerning both the renewable energy primary production and final consumption, France holds the first place among the EU countries, followed by Italy and Spain. However, it is noteworthy that Slovenia comes first at the per capita production and consumption.
Additionally, among the non-EU countries, there are some of the main oil and natural gas producers at global level. Concerning oil production, Libya and Algeria rank in the top positions, followed by Egypt and Syria. As to the natural gas production, Algeria and Egypt come first, followed by Libya and Syria. While on the other hand, Turkey ranks first in oil and natural gas consumption.

[1] Energy Poverty Action is a joint initiative of the World Business Council for Sustainable Development (WBCSD), the World Energy Council and the World Economic Forum
[2] The mission of the Energy Forum is to promote the development of informed and realistic public policy choices in the energy area by educating policymakers and the public about important trends — both regional and global — that shape the nature of global energy markets and influence the quantity and security of vital supplies needed to fuel world economic growth and prosperity.
[3] The International Energy Agency (IEA) is an autonomous organisation which works to ensure reliable, affordable and clean energy for its 28 member countries and beyond. Founded in response to the 1973/4 oil crisis, the IEA's initial role was to help countries co-ordinate a collective response to major disruptions in oil supply through the release of emergency oil stocks to the markets.

4. DATA ASPECTS

The study region consists of 19 out of the 21 Mediterranean countries. These countries can be further subdivided in EU and non-EU countries. The EU countries include Cyprus, France, Greece, Italy, Malta, Slovenia and Spain.

The non-EU countries refer to European, Eurasian, Asian and African countries. These countries are Albania, Bosnia and Herzegovina, Turkey, Syria, Lebanon, Israel, Egypt, Libya, Tunisia, Algeria and Morocco. Monaco and Montenegro, are not included in the study area because of data availability for the energy sector.

4.1. Data Sources

In order to study the energy poverty patterns in the Mediterranean area, energy data were collected from the International Energy Agency (IEA), which provides energy data on a common basis which is necessary for the clustering process.
Four main categories of energy variables were used in this respect. Primary energy production[4], energy imports, energy exports and total final energy consumption[5]. For the clustering purposes, also population data were used. All data are presented in tables 1, 2 and 3 below.
Two clustering exercises are used below using different types of data. In the first clustering process, which includes all the 19 Mediterranean countries for which data were available, the energy data refer to the agreegate data of each category. This means that each category includes all types of energy. More concretely, they include coal, crude oil, natural gas liquids, refinery feedstocks, additives, petroleum products, gases, combustible renewables and waste, electricity and heat (IEA, 2011).
In the second clustering process, EU and non-EU countries are separately studied. The energy data used for the EU countries concern the previous energy categories including only renewable energy types while the non-EU countries are studied under these categories for oil and natural gas energy types.

[4] Primary production of energy is any extraction of energy products in a useable form from natural sources. This occurs either when natural sources are exploited (for example, in coal mines, crude oil fields, hydro power plants) or in the fabrication of biofuels. Transforming energy from one form into another, such as electricity or heat generation in thermal power plants (where primary energy sources are burned), or coke production in coke ovens, is not primary production (Eurostat, 2011).

[5] Total Final Energy Consumption is the total energy consumed by end users, such as households, industry and agriculture. It is the energy which reaches the final consumer's door and excludes that which is used by the energy sector itself. Energy end user categories include private households, agriculture, industry, road transport, air transport (aviation), other transport (rail, inland navigation), services, other (Eurostat, 2011).

Table 1. Energy[6] and population[7] data in the Mediterranean countries

Country	Primary Energy Production	Energy Imports	Energy Exports	Total Final Energy Consumption	Population
Albania	1,153	1,350	223	1,820	3.14
Algeria	162,044	1,857	125,622	23,447	34.36
Bosnia& Herzegovina	4,340	2,506	872	2,961	3.77
Croatia	3,946	8,061	2,549	7,285	4.43
Cyprus	83	3,048	0	1,743	0.80
Egypt	87,487	8,375	23,900	48,300	81.53
France	136,626	175,863	36,526	165,545	64.12
Greece	9,862	32,775	7,611	21,187	11.24
Israel	3,270	23,328	3,774	13,149	7.31
Italy	26,940	185,976	30,382	133,397	59.89
Lebanon	194	5,227	0	3,561	4.14
Libya	103,743	36	85,273	8,952	6.28
Malta	1	1,856	0	362	0.41
Morocco	637	14,980	742	11,313	31.23
Slovenia	3,672	5,534	1,230	5,496	2.02
Spain	30,423	136,313	13,324	99,065	45.59
Syria	23,482	2,892	6,604	12,100	21.23
Tunisia	7,534	6,203	4,420	6,577	10.33
Turkey	28,979	79,503	6,982	74,380	71.08

Source: International Energy Agency, 2011

5. METHODOLOGICAL FRAMEWORK

The scope of this Chapter is to identify the prevailing energy poverty patterns by use of a classification approach indicating clustering of countries with similar characteristics in order to provide the appropriate policy framework for resolving energy poverty issues.

The classification of the Mediterranean countries into groups of regions with similar characteristics is a helpful tool in the study of the risk of energy poverty in the Mediterranean area. This classification may result in regional typologies that will assist policy makers to understand the picture of Mediterranean in various aspects and adjust their policy agenda accordingly.

The production of an area classification / typology is a process that consists of several steps. These steps are presented in diagram 1 below.

Several algorithms and software has been used for the clustering. K-means and hierarchical clustering are the main functions available both in commercial (such as SPSS) and open source statistical software.

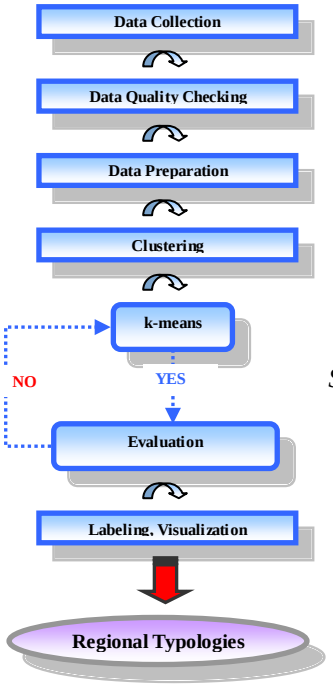
[6] Energy data are calculated in ktoe

[7] Population is calculated in millions of people

5.1. Clustering Methodology

The clustering methodology applied in this paper is a six step approach shown in the following diagram.

Diagram 1. Clustering Methodology



Source: ESPON ReRisk, 2010

5.2. Tools

The k-means procedure adopted attempts to identify relatively homogeneous groups of cases based on selected characteristics, using an algorithm that can handle large numbers of cases. The procedure tries to form groups that do differ among each other. The reason for choosing to apply a k-means cluster analysis is that it allows for the grouping of regions into categories of similar rates for a set of variables. It is a quick algorithm the results of which can be easily mapped (ESPON ReRisk, 2010).
The k-means used here is an efficient version of the algorithm presented by Hartigan and Wong (1979). The aim of the K-means algorithm is to divide M points in N dimensions into K clusters so that the within-cluster sum of squares is minimized. It is not practical to require that the solution has minimal sum of squares against all partitions, except when M, N are small and K=2. We seek instead "local" optima, solutions such that no movement of a point from one cluster to another will reduce the within-cluster sum of squares (Hartigan et al., 1979).

6. MEDITERRANEAN TYPOLOGIES

The clustering approach consists of two separate parts. The first part includes all the 19 Mediterranean countries using production and consumption energy data. The second part the clustering process includes a different approach for the EU and non-EU countries. In this part of the clustering process, the EU countries are classified in groups with similar characteristics, based on data for renewable energy production and consumption, while the non-EU countries are classified based on data about energy production and consumption regarding the conventional energy sources.
This division in this clustering approach is due to the different energy policies introduced in the EU and non- EU countries.
The clustering analysis showed that many variables had skewness and kurtosis statistics that indicate a problematic normal distribution. For these reason, the variables were divided according to each country's population. The new standardized variables were included in a new clustering

procedure without any problematic distribution.

6.1. First Clustering Results: all Mediterranean countries

The clustering procedure included the 19 Mediterranean countries for which there are available data. The clustering results showed that four main groups are defined. These groups can be identified in Map 1 below.

Source:http://europe-maps.blogspot.com

Group 1: Non-EU Countries

This group includes Albania, Bosnia and Herzegovina, Turkey, Egypt, Lebanon, Morocco, Syria and Tunisia. The primary energy production and final energy consumption per capita is very low (vary from 0,4 to 1,0 toe in both categories), energy imports remain also at very low levels, while energy exports are practically zero.

Group 2: Libya

This group includes only Libya. Energy statistics for Libya are much different from the other countries' statistics. The primary energy production and final energy consumption per capita are the highest from the rest of the countries (16,5 toe and 1,4 respectively). Libya needs almost zero energy imports while the energy exports per capita have the highest score among the Mediterranean countries. All energy production is exported, making Libya one of the main oil producers in the Mediterranean area.

Group 3: Algeria

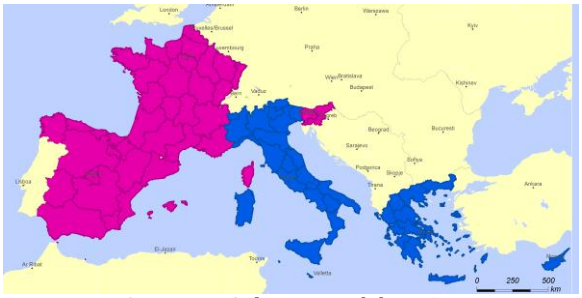
The third group includes Algeria. Energy statistics for Algeria also differ from the other countries' statistics. The primary energy production exhibits very high levels but only at one fourth compared to Libya's per capita primary production. Algeria's final energy consumption per capita is rather low compared to the average of the countries (0,5 toe) and most of the energy production is exported, placing Algeria in the second place of the oil producer countries in the Mediterranean area.

Group 4: EU Countries + 2

Countries in this group are Cyprus, France, Greece, Italy Malta, Slovenia, Spain, Croatia and Israel. In other words, this group includes all the EU countries of Mediterranean plus two more countries (Croatia and Israel). The main characteristics of this group is that while the primary energy production per capita is rather low, the needs for consumption are significantly high, a fact reflected also by the energy imports (vary from 1,8 to 4,5 toe per capita)

6.2. Second Clustering Results: EU countries vs non-EU countries

In this section, EU and non-EU countries are studied separately. Apart from the fact that EU and non-EU Mediterranean countries have different policies concerning energy, the need for a separate study also result from the previous clustering process where all EU countries consists a group on their own. While EU countries are studied concerning the renewable energy data, the non-EU countries are studied concerning the oil and natural gas energy data.



Source: IEA data, own elaboration

6.2.1 Mediterranean EU countries

The groups identified in this clustering process are presented in Map 2 and their main characteristics have as follows.

Group 1: Renewable Energy Consumers

This group of countries includes Cyprus, Greece, Italy and Malta. The per capita primary production of renewable energy is low compared to the total final consumption. As a result, the needs in renewable energy cannot be covered. A significant sum of renewable energy imports is required in order to achieve energy efficiency levels in these countries.

Group 2: Renewable Energy Producers

In the second group, three countries are identified: France, Slovenia and Spain. Unlike the first group, these three countries are the main renewable energy producers in the Mediterranean area. They cover their needs in renewable energy consumption and also export significant sum of renewable energy in other countries.

6.2.2 Mediterranean non-EU countries

In this final clustering process, four main groups are identified, presented in Map 3 below and their main characteristics have as follows.

Group 1: Algeria

The first group includes Algeria. Energy statistics for Algeria also differ from the other countries' statistics. The primary energy production exhibits very high levels but only at one fourth compared to Libya's per capita primary production. Algeria's final energy consumption per capita is rather low compared to the average of the countries (0,5 toe) and most of the energy production is exported, placing Algeria in the second place of the oil producer countries in the Mediterranean area.

Group 2: Libya

This group includes only Libya. Energy statistics for Libya are much different from the other countries' statistics. The primary energy production and final energy consumption per capita are the highest from all the rest countries (16,5 toe and 1,4 respectively). Libya needs almost zero energy imports while the energy exports per capita have also the highest score among the Mediterranean countries. All energy production is exported, making Libya one of the main oil producers in the Mediterranean area.

Group 3: Main Oil Importers

This group includes Albania, Bosnia and Herzegovina, Egypt, Morocco, Syria, Tunisia and Turkey. The per capita primary oil and oil products production are practically zero. This means that these countries cover their needs in oil consumption through imports. Energy imports in these countries place them in the first position among non-EU countries.

Group 4: Low Level Gas and High Level Oil Consumers

The countries in this group are Croatia, Israel and Lebanon. The main characteristic of this group is the low level of per capita oil and gas consumption.

7. CONCLUSIONS

Energy poverty strategies should in principle provide some form of financial assistance concerning the households' energy bills but also forms of negotiation between consumer and supplier (EPEE, 2011).
The Mediterranean countries take different approaches to address fuel poverty. While the EU countries promote the use of renewable energy sources, the non-EU countries orient themselves in reducing energy consumption.
The International Energy Agency (IEA) seeks to create conditions in which the energy sectors of their Member countries' economies can make the fullest possible contribution to sustainable economic development by giving particular emphasis to energy security and environmental protection and also by recognizing the significance of the increasing global interdependence in energy. IEA's objective is to create an international common policy framework based on energy efficiency and energy security in a cost-effective manner, flexibility to energy emergencies, environmental protection (decrease of fossil fuels and use of more environmentally accepted energy sources), improvement of energy technologies and cooperation among all energy market participants (IEA, 2011).

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