



Renewable energy sources: Using PROMETHEE II for ranking websites to support market opportunities



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ABSTRACT

Environmental sustainability has become a major goal of public policies throughout the world, as environmental resources are continually eliminated. Climate change mitigation involves decarbonizing electricity generation as the most important energy system-wide change, with a vital role for energy efficiency. The utilization and development of Renewable Energy Sources (RES) constitutes the most critical measure to safeguard energy security, strengthen environmental protection, and tackle climate change. RES are favored as a means of reducing the use of fossil fuels. The market of RES is continuously developing and promoted through the Internet. Renewable energy is, by definition, sustainable and clean. Moreover, the market of RES offers the opportunity to tackle the increasing depletion of fossil resources and the associated environmental impacts. The paper aims to present RES and study the energy policy in EU and Greece. Furthermore, the status of the renewable energy market in Greece and especially in the Prefecture of Thessaloniki is presented. The Internet research retrieved 30 enterprises that promote renewable energy in the Prefecture of Thessaloniki, which were analyzed according to 18 characteristics representing internet adoption. The multicriteria method used for total ranking is PROMETHEE II. According to PROMETHEE II findings, the 'superior' websites can be used to form a conceptual content model while designing an enhanced website for a RES enterprise. The results show that these enterprises in the Prefecture of Thessaloniki must adjust to the new 'information era' and aim to become more effective and efficient while creating their autonomous website. Furthermore, most enterprises with their own websites in this sector are generally still in the initial adoption phase and they should further mature in the next phases of e-commerce adoption.

1. Introduction

Throughout the world, environmental sustainability has become an important goal in public policies as environmental resources are continually eliminated, thus governments enable management strategies in order to efficiently control their use (Andreopoulou et al., 2011). According to the International Atomic Energy Agency (2009), the concept of sustainable development encompasses three interdependent and mutually reinforcing pillars: social development, economic development and environmental protection, all linked by effective government institutions (Verbruggen et al., 2014). Sustainable Development stands for meeting the needs of present generations without jeopardizing the ability of future generations to meet their own needs – in other words, a better quality of life for everyone, now and for the generations to come (Andreopoulou, 2012). The economic growth in most developed

countries is based mainly on the exploitation of energy, the sources of which are unevenly distributed around the world, a fact which at times has resulted in regional conflicts (Zafeiriou et al., 2011).

There has been a recent surge of concern regarding the increasing emissions of air pollutants and global climate change on the one hand and increasing energy consumption and the security of energy supplies on the other (Batley et al., 2001; Fuss et al., 2009; Longo et al., 2008; Stigka et al., 2014). This concern goes hand in hand with the occurrence of environmental problems resulting in the disruption of the balance of ecosystems (Economou, 2010). Addressing climate change implies decarbonizing electricity generation as the most important energy system-wide change, with a critical role for energy efficiency (International Energy Agency, 2012; Verbruggen et al., 2014). The utilization and development of renewable energy has become an important measure to safeguard energy security, strengthen

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environmental protection, and tackle climate change all over the world (Ming et al., 2014). RES are favoured as a means of reducing the use of fossil fuels (Li et al., 2009; Stigka et al., 2014).

The superiority of RES is founded on their following traits: (a) they are inexhaustible either because of their great reserves or because they can be regenerated by nature or humans, (b) their use contributes to the limitation of humans' energy dependence on exhaustible resources such as oil, and (c) they contribute to the security of the country's energy supply and they preserve the natural environment (Manolas, 2007; Zafeiriou et al., 2011). Furthermore, although conventional fuels cost less compared to more environmentally friendly energy sources, their cost does not reflect true social externalities.

The recent switch from conventional to renewable energy sources (RES i.e. wind, solar, hydro-electricity, biomass), and their gradually extensive use is a common feature of the energy policy adopted by the developed world (Katinas and Markevicius, 2006; Midilli et al., 2006; Jehlickova and Morris, 2007; Manolas, 2007; Zafeiriou et al., 2011). The main objectives of the energy policy implemented in European Union are the following: (a) safety in the energy supply; (b) competitive prices and low cost in energy generation; and (c) energy consumption in an environmental friendly manner. All the objectives regarding the increase of RES as a share of total energy consumption by its members are quite ambitious and are expected to be realized by issuing a number of directives (Zafeiriou et al., 2011).

Higher penetration of RES in the electricity generation will be achieved through the implementation of coordinated fiscal, regulatory, physical planning and technical measures that are targeted to exploit the economic potential for development of large RES plants, to complete the necessary grid infrastructure works, to work towards the establishment of a distributed power generation structure in the planning of new power plants and to facilitate the gradual decommissioning of the old inefficient thermal power plants (Ministry of Environment Energy and Climate Change, 2010). In many European countries, incentives and financial motives are provided in order for the use of renewable energy resources to be enhanced. Examples of these motives are special pricing for bio-electric energy, subsidies and non-interest loans for special environmental capitals, as well as tax motives for investments (Vamvuka, 2009; Zafeiriou et al., 2011).

In the present paper we class as renewable, the following forms of energy: solar energy, wind energy, hydraulic energy in hydroelectric plants, biomass, biofuels and geothermal heat pumps. We discuss these sources below.

The generation of electricity from sunlight directly (photovoltaic) and indirectly (concentrating solar power) over the last decade has been growing exponentially worldwide (Intergovernmental Panel on Climate Change, 2011; Hernandez et al., 2014). In general, solar energy technologies fall into two broad categories: photovoltaic (PV) and concentrating solar power (CSP). Photovoltaic cells convert sunlight into electric current, whereas CSP uses reflective surfaces to focus sunlight into a beam to heat a working fluid in a receiver (Hernandez et al., 2014).

Wind energy is popularly perceived as one of the cleanest sources of energy (Premalatha et al., 2014). Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electrical power, windmills for mechanical power, wind pumps for water pumping or drainage, or sails to propel ships (Khare et al., 2013). Though wind energy is a pollution-free and inexhaustible source, it has some problems. For instance, Wind energy is a fluctuating resource which can diverge quickly.

Hydropower and the potential for its exploitation by constructing hydropower plants also have a very significant place (Panic et al., 2013). Hydropower can be used to balance short-term variability in electricity demand, especially for systems with electricity inputs from various energy sources which can result in load imbalances within the grid (Spanhoff, 2014). Electricity generation capacity and availability by large dams with high water storage capacity is very different from

small run-of-river hydropower schemes (Lenzen, 2010; Spanhoff, 2014). Hydropower has traditionally been important in Greece, and the markets for wind energy and active solar thermal systems have grown in recent years (European Renewable Energy Council, 2009).

Geothermal resources are either in the form of subsurface thermal collectives (hot dry rock) or surface hydrothermal hot springs (Lashin and Al Arifi, 2014). Geothermal resources that have been utilised, or are prospective for development, range from shallow ground to hot water and rock several kilometres below the Earth's surface (Energy and Geoscience Institute, 2001; Bahadori et al., 2013).

Biomass energy comes from arable food and feed crops. Using forest biomass, namely residues from logging activities, primary and secondary mill residues, urban wood wastes, and energy crops (Solomon and Luzadis, 2008) in district energy systems provides the opportunity to produce heat and/or power with limited environmental impacts by utilizing renewable source of energy and increasing conversion efficiency simultaneously (Rosen et al., 2005; Akhtari et al., 2014).

In today's globalized markets new business practices have emerged, trying intensively to find new investment opportunities, to enhance competitiveness and business efficiency. The enterprises aim at their participation in the internet society since the benefits are high and electronic systems are ready to serve customers all over the world 24 h per day and 7 days a week (Andreopoulou et al., 2014a, 2014b; Koliouka and Andreopoulou, 2013). Small-Medium Sized Enterprises, however are not adopting e-commerce with the same speed as their larger counterparts due to various adoption barriers (Kartiwi and MacGregor, 2008; Vlachvei et al., 2013). Nowadays, the enterprises promoting RES need to stand the test of time in the digital era by creating their autonomous website. The most effective websites will reflect best practices across several key characteristics and this gap in the literature is fulfilled by our research. The optimum websites are identified aiming to benchmark further internet adoption in RES enterprises.

The paper aims to study the energy policy in European Union and Greece and present the current status of the renewable energy market in Greece and especially in the Prefecture of Thessaloniki. Specifically, the RES enterprises' websites promoting renewable energy derived from the Internet are studied and the multicriteria method of PROMETHEE II is applied for the total ranking in order to identify the 'superior' ones, which can be used as models to form a conceptual content model while designing an enhanced website for a RES enterprise.

In Section 1, we have introduced RES and their different types, such as solar energy, wind energy, hydraulic energy in hydroelectric plants, biomass, biofuels and geothermal energy. In Section 2, we present the material that was used and the multicriteria method that we applied to commit this study. The results of the case study in combination with the Energy context in European Union and Greece are presented in Section 3. The final section, Section 4 contains discussions and necessary recommendations for entrepreneurs and website developers, according to the content of the websites aiming to adjust to the new 'information era' and market trends.

2. Methodology

The conceptual framework of European Union and Greece was studied through bibliographical research. The energy context is presented based on official documents of national and international institutes, research centers and government departments.

Websites that promote Renewable Energy Sources were retrieved from the Internet using various key words and combinations such as "renewable energy market", "renewable energy in Thessaloniki", "renewable energy technologies", etc. As a first step, a qualitative analysis was performed on the collected websites to examine the type of common features found in them. There were various features/criteria (g1, g2, ..., gn) introduced in the retrieved websites used to describe variables. These criteria are presented in Table 1. More specifically, the

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