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Overview of challenges, prospects, environmental impacts and policies for renewable energy and sustainable development in Greece

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ABSTRACT

The aim of the study was to present the current status of the electrical energy market, energy legislation, green house gas emissions, energy consumption trends and future prospects of sustainable development in Greece. The study described current issues relevant to the renewable energy sources (RES) such as the climatic factors that affect the penetration of RES into the Greek energy mix, the current regulation status, the barriers and evaluation of their contribution in the energy balance. The study also investigated the increasing power demand, emissions and energy trends in the residential sector in Greece. The paper evaluated the current status of the building stock, RES and the future energy related prospects of the Aegean Sea islands. The islands were categorized based on energy production cost, heating degree days, building characteristics and natural resources to identify islands with higher and lower renewable energy potentials. The study revealed that the islands with the higher potential energy savings in the residential sector are Lesbos, Lemnos, Samothrace, Chios, Andros, Patmos, Kea and Kimolos while at the same time, Rhodes, Naxos, Amorgos, Syros, Ios and Kythnos are those islands that present the lower potential. The study will help to propose action plans and implementation strategies in terms of residential renewable energy applications in non-grid interconnected islands in Greece.

Contents

Abbreviations: BP, British Petroleum; CHP, combined heat and power; CIA, Central Intelligence Agency; CRES, Center of Renewable Energy Sources; FIT, feed-in tariff; GDP, gross domestic product; GHG, green house gas; HDD, heating degree days; PPC, public power company; PV, photovoltaic; RES, renewable energy sources; SWHS, solar water heating system; TPES, total primary energy supply; VAT, value added tax.

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1. Introduction

Fossil fuels dominate in the global energy production market contributing 80% of the primary energy demands. Recent data indicate that annual global electricity production counts for 20.68 trillion kW h while at the same time the consumption stands for 19.01 trillion kW h [1]. At the end of 2009, the renewable energy contributed 19% to the global final energy consumption (biomass 13%, hydro 3.2%, and other sources 2.6%). This resulted in the production of about 18% of the total global electricity supply by renewable sources or in other words, with the total global power generating capacity estimated to be 4800 GW in 2009, the renewable part stood for 1230 GW [2].

The financial crisis decelerated global growth and along with it the investment interest in sustainable energy sector. Nevertheless, prospects of a new dynamic sustainable development could arise by addressing the challenges and seizing the opportunities as they arise in the new era's volatile environment. With the energy markets increasingly manipulated by gigantic multinational energy companies and with the hydrocarbons reserves accumulating in a few hands, a stable energy supply which is the basic prerequisite for recovery from the recession becomes an easy target which must be shielded from pricing and geopolitical games. A leading role in this effort can be played by the further introduction of renewable energy sources into the energy mix. Furthermore, it has to be noted that a passage to more decentralized, sustainable energy sources and adequate supplies of energy could lead to significant reduction of poverty.

The aim of the study was to review the past and current status of energy consumption, energy trends, green house gas (GHG) emissions, energy policy strategies, legislation, current renewable energy status and potential and barriers relevant to implementation of renewable energy technologies in Greece with further attention to Aegean Sea islands. The study also investigated the current general framework, regulations and feed-in tariffs (FIT) of the country and reviewed the energy production cost, heating degree days, building characteristics and natural resources to identify islands with higher and lower renewable energy potentials.

2. Overview in the Greek region

Table 1 summarizes some important indicators of Greece. The total population of Aegean Sea islands is 508,807 based on 2001 data, with urban and rural shares of 53.4% and 46.6%, respectively.

Table 1
Indicators of Greece [3,4].

Indicator	Value
Population (millions)	11.24
Energy production (Mtoe)	9.86
Net imports (Mtoe)	25.16
TPES (Mtoe)	30.42
Electricity consumption (TWh)	64.31
Carbon dioxide emissions (Mt of CO_2)	97.81
TPES/population (toe/capita)	2.71

2.1. Climate

Greece is located between latitudes 34° and 48° in the Northern Hemisphere, experiencing typical Mediterranean climate with relatively warm and dry summers, mild and rainy winters and generally long sunshine periods throughout the year. In Greece the climatic condition varies mainly due to the topographic configuration and extended alternation between the land and sea. The cold and rainy season lasts from mid-October to end of March and the hot and dry season from April to October. The average minimum temperature ranges from 5 to 10 °C in coastal areas and from 0 to 5 °C in inland areas. The winter is milder in the Aegean and Ionian sea regions than in northern and eastern Greece. The warmest period is within July and early August when the mean maximum temperature ranges from 29 °C to 35 °C [5,6].

2.2. Energy status and GHG emissions

2.2.1. Electrical energy

Electricity can be generated using fossil fuels and renewable energy resources. The mix of energy generation technologies depends on factors such as available local energy resource, international circumstances, local energy policy and geological, geophysical, geographical and climatic features.

In EU-27, the production of electricity from new RES (other than hydropower) was estimated to be 198 TWh in 2007. With the hydro production remaining relatively constant, a significant growth in new RES was observed in the past three decades. Wind power is the main cause of this growth, growing from almost zero in 1990 to 100 TWh of production in 2007. In terms of fossil fuel fired power production, coal and lignite were used for the production of more than half of the generation with 930 TWh in 2007 whereas 6% was produced by oil fired units and a significant 42% by gas-fired units [7].

The installed energy generating capacity in Greece during the period between 1990 and 2007 is shown in Fig. 1. Vastly available lignite is the main energy resource in Greece. The oil based power generation plants also contribute significantly in Greece. It can be seen from Fig. 1 that there is a fixed share of installed hydropower units, a gradual increase in natural gas power generation plants and a small but continuous increase of installed wind power plants signifying a new era for the penetration of renewable resources in Greece.

Fig. 2 shows the electricity production in Greece for the period between 1990 and 2007. The total power generation has gradually increased over the period and the annual percentage share of lignite and oil power sources has declined (see Fig. 2). The annual share of power production from natural gas, wind and other renewable resources has steadily increased over this period.

Table 2 presents a comparison between EU-27 and Greece in terms of energy production and usages. The size of the Greek energy market represents a share of less than 2% of the EU market. Table 2 indicates that a significant effort is required by the Greek