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Greece & Turkey; Assessment and Comparison of Their Renewable Energy Performance

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ABSTRACT: This paper is a comparative review of the renewable energy performance of Turkey and Greece. Both neighboring countries sharing the same energy hub with a large potential for renewable energy production. Albeit having strikingly similar energy objectives and hindrances, they are currently challenged by different contexts. Turkey, although not a European Union member, it spends efforts to tacitly comply with European Union legislation and sets ambitious renewable energy targets. Greece on the other hand is afflicted by an economic crisis that threatens to retard its renewable energy developments unless Greece uses renewable energy sources as a means to escape the crisis. This paper is useful for potential renewable energy investors in the area of Greece and Turkey.

Keywords: Greece; renewable energy sources; Turkey
JEL Classifications: O13; O57; Q28

1. Introduction

The Republic of Turkey was founded in 1923 and has a land surface of 783,562km^2 and a coastline of 7,200 km (About.com.Geography, 2010). Turkey lies in the south-western part of Asia with 3% of its ground belonging to the European continent. Turkey is bordered with Greece and Bulgaria from the west, with Georgia, Armenia and Azerbaijan and Iran from the east and with Iraq and Syria from the south. The Black Sea is at its north. In 1923 Turkish population was 12m, while in 2009 has soared to 73.7m. Hence, there is an increased annual energy demand of about 8% accompanied by increased pollution concerns. Turkey has a young population which justifies the growing energy demand per person and a fast growing urbanization (Koyun, 2007). Turkey holds a significant geopolitical position and it is an energy transit country from the Caspian Sea, Middle East and Middle Asian markets. About one third of Turkish population is employed in agriculture, which is also a sector that demands a lot of energy (through irrigation, greenhouse and barn heating or cooling and food drying).

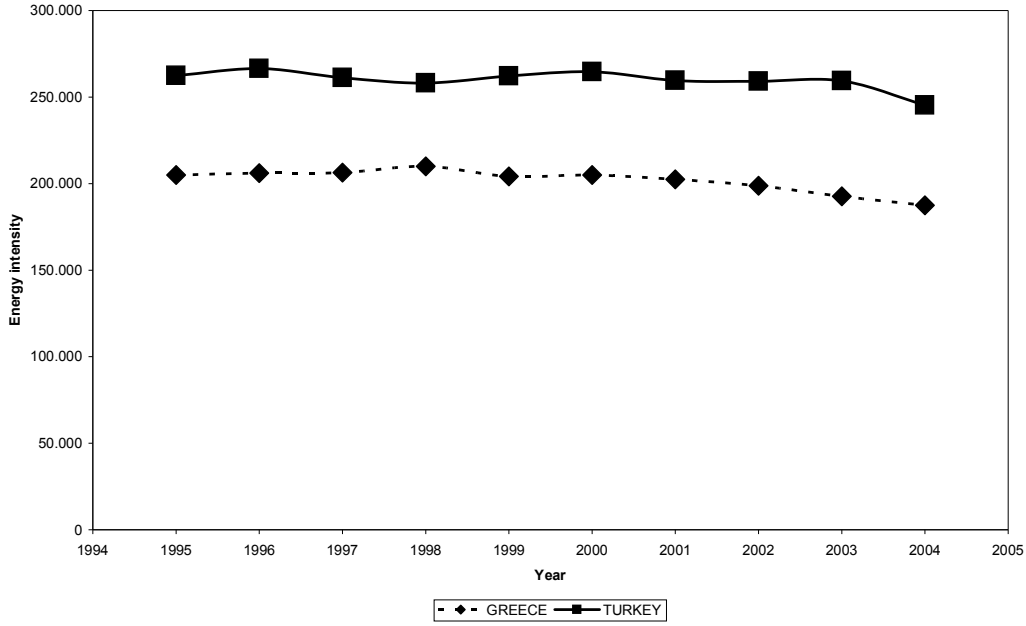
Greece has land borders with Albania, FYROM and Bulgaria from the north and Turkey from the east. The Ionian Sea lies in its west and the Mediterranean Sea to its south. Greece covers a total area of 131,990km^2 and has a very long coastline (13,676 km) and about 1400 islands (About. com. Geography, 2010). Greece has a predominantly service economy which accounts for 70% of its gross national product (GDP). Most of Greek mainland and Aegean islands were under Ottoman control until the 19th century. Greece gained its independence from Ottomans in 1822 and the Greek state was officially recognized in 1830. Greek population is 11.3m and is shrinking with a decrease of 1.6% since 2001 (census 2011).

Greece is a European Union (EU) member while Turkey has been granted an EU candidate status since 1999. Greece and Turkey signed the European Energy Charter Treaty in 1991 which aims to build up multilateral governance for the energy sector with equal rules for trade, investment and production in the energy sector. Greece also ratified Kyoto Protocol against global warming through

reduction of CO_2 emissions in 2002, followed by Turkey in 2009. Turkey and Greece can form a promising geopolitical energy coalition (Menegaki, 2011).

Figure 1 illustrates a slightly downward slope of energy intensity curves for both countries. This means that the average annual rate of growth in GNP is higher than the average annual rate of growth for primary energy consumption. The reduction of total energy intensity has been influenced both by improvements in energy efficiency and structural changes within the economy. The latter included a shift from industry towards services, which are typically less energy intensive (Greek Ministry of Development, 2009). Regulatory and incentive measures for the use of natural gas and financial support to industry investments in energy efficiency programmes have contributed to the energy intensity decrease. Economic growth has required less additional energy consumption since 2000. Thus, there has been a relative decoupling of economic growth from energy use. The average Greek citizen uses 2.8 tonnes of oil equivalent per year (Dimitropoulou *et al*., 2009). Economic crisis will provide only a temporary relief because of declined demand and reduced supply.

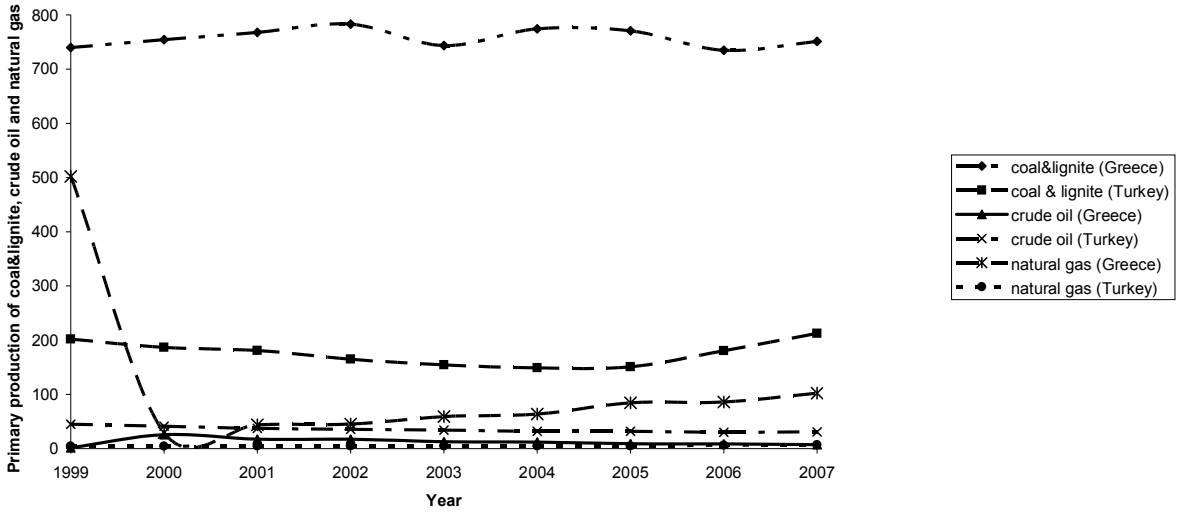
Figure 1. Energy intensity in Greece and Turkey (data code tsien020, Eurostat)



As regards Turkey, Erdal et al. (2008) report results that reject the neutrality hypothesis of energy to growth, and they claim that there is another 25-30% energy saving potential in Turkey. Energy efficiency law was enacted in 2007 to provide an impulse to energy efficiency in industry, electrical power plants, transmission and distribution systems, building, and transport sectors (Keskin, 2008). Turkish energy policy has been highly supply-oriented in order to meet the fast growing demand, while energy efficiency has received little attention. An energy efficiency strategy was developed in 2007, also addressing some other vital issues like privatization.

Turkish primary energy production consists of lignite: 52%, wood: 12%, hydro: 10%, hard coal: 4% and petroleum: 8%. The primary energy consumption consisted of crude oil: 29%, natural gas: 32%, lignite: 15%, hard coal: 14%, hydro: 3% and other: 8%. A 70% of Turkish energy demand is covered by imported energy and a 59% is used for electricity production (Yilmaz, 2011; Nalan et al, 2009). Turkey spends about 65-70% of the income earned from exports in order to finance its energy imports. It has large hard coal reserves which are used in steel manufacturing, cement production, heating and electricity. Domestically produced coal accounts for 24% of the total energy consumption of the country (Bayrakci and Kocar, 2012). However, the country also needs to import hard coal because of production difficulties in this sector and insufficient investments in Turkey. The country had to turn to its internal source of energy after 1960s due to the petroleum crisis (Yilmaz, 2011). Figure 2 illustrates primary energy production of coal and lignite, crude oil and natural gas for both Greece and Turkey.

Figure 2. Production of coal and lignite, crude oil and natural gas for Turkey and Greece (data codes: ten00077, ten00078, ten00079, Eurostat).



Lignite is the basic significant electricity source in Greece which ranks third in the EU for lignite production and sixth worldwide. Based on Public Power Corporation (PPC) estimations, the remaining reserves will last for the next 44 years. The calorific value of Greek lignite is low (900-1100kcal/kg). Since 1998, Greece has supported the supply and use of natural gas, which has a diversified origin source: Russian gas imported through Bulgaria and Caspian region while Middle East gas is imported through Turkey. Greece imports practically all the oil and gas it needs, since its primary production is extremely low. Greece is compliant with the IEA-90 day stockholding obligation (for emergency reserves) since 2004. Greek energy production is based as follows: lignite (50%), oil (13%), gas (21%), RES (4%), imports-exports (7%), autonomous producers (5%) (Ageridis, 2009). Figure 3 shows the energy dependence of the two countries from 1998. The Greek one is almost stable and the Turkish one has an increasing tendency.

Turkey aims to create energy autarky, efficiency and security by satisfying demand with its own resources and the acceleration of renewable energy sources (RES) penetration through a mix of public, private and foreign capital, while at the same time protecting the environment. Security will be guaranteed with diversifying energy resources, even making preparations for nuclear energy. Turkey has made significant steps in energy market privatization but needs to further decrease regulation. The upgrade of its transmission and distribution grid will improve reliability. Last, Turkey aims to use its geopolitical location to establish itself as a transit country for international oil and gas trade.

According to the Greek National Action Plan for RES, which covers years 2010-2020, the country will have achieved RES penetration by 2020 as follows: 40% electricity, 20% heat and 10% transport. Major players in the field will be wind and photovoltaic. Hydro is already large (Chaviaropoulos, 2010). As part of EU the energy policy pursued by Greece must conform to sustainability, competitiveness and security. The adoption of the Third Energy Package and Climate Change Package (for further opening up of the gas and electricity markets in EU, in 2009) is the EU attempt to create a comperehensive European legal regime covering the carbon and RES sectors.

Turkish energy policy objectives are the same with the Greek ones (security, diversification, environmental protection). Greece additionally and sententiously states that it wants to improve its productivity and competitiveness through clean energy technology investments, securing regional development (Ageridis, 2009).

Figure 3. Energy dependence of Turkey and Greece (data code tsigs360, Eurostat).

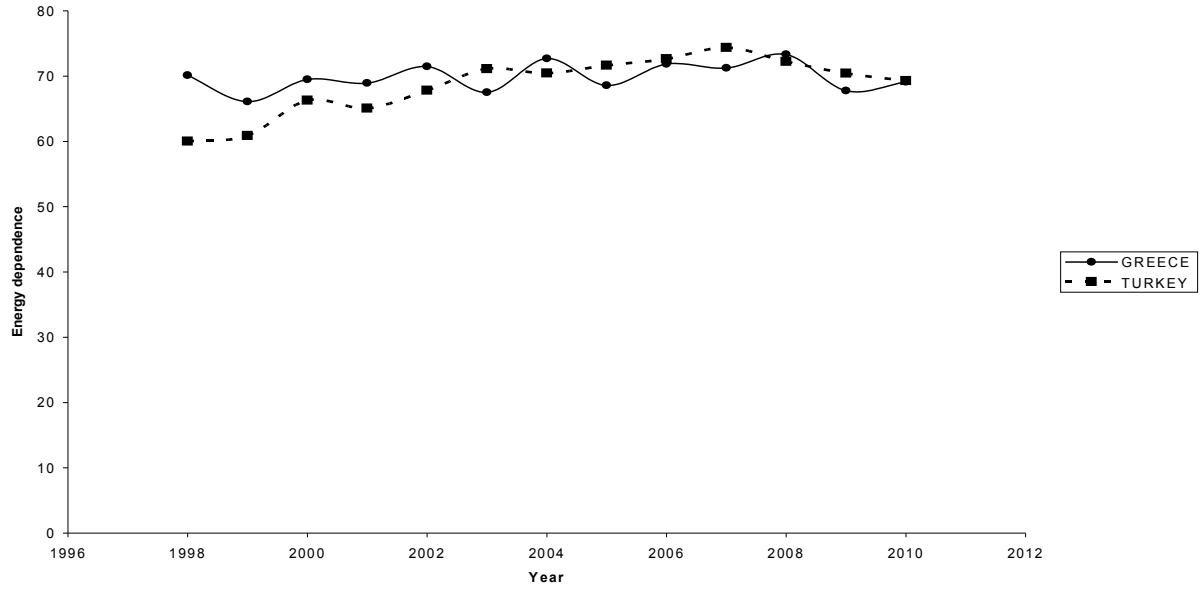


Figure 4. Market share of largest generator in the electricity market (data code tsier060, Eurostat).

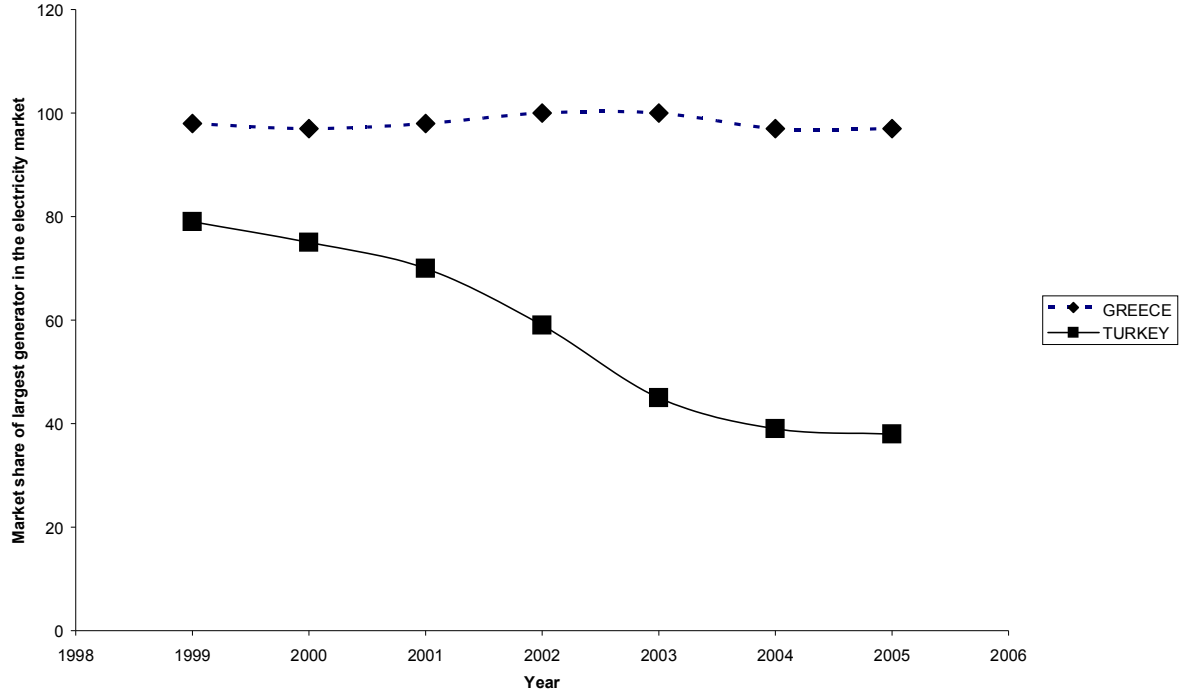


Figure 4 is eloquent of the degree of regulation still existent in both countries. The Turkish Electricity Authority (TEK) used to be a state owned vertically integrated company responsible for the generation and distribution of electricity throughout the country until 1971. In 1984, the private sector was also introduced in the field with Law No 3096. In 1990, Law 3613/1990, provided support to maintain stability of electricity energy prices through the establishment of the Electrical Energy Fund (Hepbasli and Ozgener, 2004a,b).

In 1993, in view of market liberalization and privatization, TEK was separated into TEAS (generation, transmission and wholesale) and TEDAS (distribution). Then, with the enactment of the Electricity Market Law in 2001, which led to the establishment of the Energy Market Regulatory Authority (EMRA) to issue all the necessary secondary legislation, TEAS was split into separate

generation, distribution and trade companies while transmission remains with the public sector: Turkish Electricity Generation Company (EUAS), Turkish Electricity Transmission Company (TEIAS), and Turkish Electricity Trading and Contracting Company (TETAS).

Before the 2001 reforms, EUAS operated 91% of Turkish power supply. However, EUAS sold off most of its power plants and other holdings under the government privatization plan. In 2003, 27 state-owned coal and hydropower plants were transferred to a government holding company in preparation for privatization, accounting for 28% of the Turkish power generating market. The Turkish government originally set a goal of 2006 for the total privatization of EUAS, although this has proceeded more slowly. To date, the privatization process is weak due to lack of investor interest and political uncertainty. In 2004, Turkish authorities withdrew a bill that would have weakened the country's power sector liberalization program after receiving heavy criticism from the World Bank, EU, and others (U.S. Energy information administration, 2010).

Turkey has made progress in its preparations for the internal energy market through the adoption of two major framework laws for the electricity and gas sectors concerning mostly restructuring and the players in the sectors. Those two laws (2002 Electricity Market Law, 2008 cost-based pricing mechanism) should, however, be aligned to a greater extent with the two key Community Directives concerning the internal energy market. In 2002, the Energy Market Regulatory Authority (EMRA) began to issue licences for various activities in the electricity sector and to approve tariffs of the companies. The independence and administrative capacity of this authority needs to be strengthened, including in terms of the number of qualified staff it employs (EU, 2010).

Despite the good legislative and regulatory framework, not much competition has developed. There is a lack of consumer choice caused by the small number of market players; new entrants have difficulties competing with the state-owned part of the sector. Furthermore, the current generation overcapacity and lack of cost-reflective prices, especially in the state-owned hydro power plants, have made new investment unattractive. In addition, the Build-Own-Operate (BOO) and Build-Operate-Transfer (BOT) schemes have a relatively high market share (with high guaranteed price) and only 29% of the market has been made eligible to choose suppliers. The Electricity Strategy contains the key elements for tackling these issues, including the privatisation of EUAS and handling the stranded cost issues caused by the BOO and BOT schemes (Energy Charter Secretariat, 2007)**.**

Turkey prefers using the hydro as a means to balance the price increases in other segments of generation range and this clearly is viewed unfair by the gas-fired generation plant owners from the private sector. The Turkish government also seems to be concerned on the supply security under the new regime and this is also a reason for keeping state-owned energy companies.

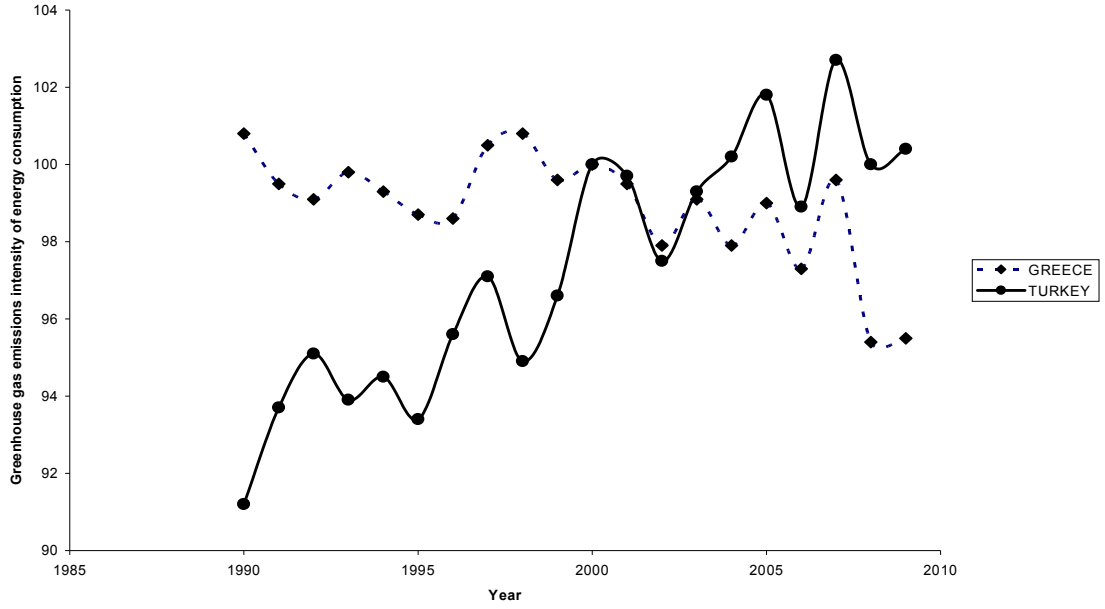
Turkey appears as having made more steps in market liberalization but it is diversification of public providers, not private penetration. Turkey owns the highest infrastructure in the sector as well as total primary energy production. Primary energy production per capita is low in Turkey. Turkey also has high energy dependence on imports from other countries and has a large supply of RES with hydro energy coming first. Electricity share produced by RES is also high.

On the other hand, Greece started liberalization of its electricity sector in 1999 with the enactment of Law 2773/1999 aiming at compliance with the provisions of Directive 96/92/EC, but still the former state monopoly PPC continues to hold a dominant position. The provisions of directive 2003/54/EC have also mobilized private investment and competition in the sector. However, the peculiar scheme remains; the networks have remained monopolistic and regulated, whereas free market rules have been applied for electricity generation and supply to eligible customers (Iliadou, 2009). PPC remains a vertically integrated private company. It owns and operates 98% of power generating units and is the exclusive owner of transmission system and distribution network. It has five business divisions: mines, generation, transmission, distribution and supply. Power tariffs remain below EU averages. PPC currently operates around 96% of all generation, although competition is developing quickly and recently there has been entry of several European power companies to the market, often in partnership with a Greek firm. PPC holds a 49% stake in transmission services (U.S. Energy Information Administration, 2010).

Although Turkey has made important progress in switching to cleaner fuels, such as natural gas, energy related environmental problems are rapidly growing in this country (Figure 5). In 2003, it is estimated that 36% of CO_2 emissions occurred due to energy, 34% due to industry, 15 % due to transportation and 14% due to other sectors such as housing, agriculture and forestry. By 2020 these

percentages will have been 40%, 35%, 14% and 11% correspondingly. Turkey should continue to lower the usage of coal, both domestic and imported. The government should end the subsidies for its domestic coal industry and not grant exemptions to environmental regulations. The International Energy Agency in its 2005 review of Turkey suggested replacing the subsidies by restructuring programs to address social impacts.

Figure 5. Greenhouse gas emissions intensity in Greece and Turkey (data code tsdcc220, Eurostat).



On the other hand, Greece, due to the fact that it is an EU member, it is obliged to embrace and share European visions on the topic of environmental protection. Strategic energy objective of EU is to decrease greenhouse gases by 20% until 2020, compared to emission levels of 1990. Due to the above, the EU proposes joint achievement of three related objectives until 2020: i) improve energy efficiency by 20%, ii) increase RES share of energy mix by 20%, iii) increase biofuels contribution to transportation by 10%.

The rest of this paper is organized as follows: Part 2 provides a summary of RES legislation and policies, Part 3 juxtaposes the performance of the two countries in the various RES sectors, part 4 summarizes the barriers faced and the perspectives and part 5 is a discussion with concluding remarks.

2. Renewable Energy Sources Legislation and Policies in Turkey and Greece

Our information on RES legislation and policies has been mainly obtained from the International Energy Agency (IEA). Contrary to the early, abundant and much verbose Greek relevant legislation and policies on RES, Turkish legislation albeit sparse, provides the country with the necessary tools for a promising development of RES. Next, parts 2.1 and 2.2 provide brief surveys of the relevant legislation and policies in Turkey and Greece.

2.1. Turkey

Turkish laws and policies on RES, which are provided in IEA, are few (Table 1) and have been issued much more recently than the corresponding Greek ones (Table 2). Both Tables 1 and 2 consist of three columns. The first contains the name and issue date of the law, the second contains the specific policy aspect the law or policy handles and the type of the RES it applies to.

Particularly, the IEA reports six items of laws and policies with the earliest issued in 2001, while for Greece it reports fifteen items with the earliest dating back in 1985. Of course Greece consistent with its EU membership is obliged to follow the development and timing pattern dictated by EU directives. This is not an obligation for Turkey which nevertheless is a candidate for EU membership.

Law No 4628/2001 exempts from licensing obligations electricity generation facilities from RES with maximum capacity equal to 500kW (Kucukali and Baris, 2011).

Table 1. Turkish laws and policies pertaining to renewable energy sources.

Law-Policy/year of issuing	Aspect	Type of RES
Renewable Energy Law No.6094/2010	Incentives/Subsidies	All
Strategic Plan 2010 for 2010-2014	Education, Incentives/Subsidies, R&D	All
Energy Efficiency Law-No.5627/2007	Incentives/Subsidies, Policy Processes, R&D, Regulatory Instruments, Voluntary Agreement	All
Law on Geothermal Resources and Natural Mineral Waters-Law No 5686/2007	Regulatory instruments	Geothermal
Law on Utilization of Renewable Energy Resources for the purpose of generating electrical energy-No 5346/2005	Incentives/ Subsidies, Regulatory Instruments	All
Electricity market licensing regulation, No 4628/2001	Incentives/Subsidies, Regulatory instruments	All

Source: Adapted from International Energy Agency.

The Energy Efficiency Law No 5627/2007 sets the rules for energy management in industry and has amended Law No 5346/2005 on the utilization of RES with the purpose of generating electrical energy. Electricity produced from RES used to receive a fixed purchase price of €0.05 and €0.055/kWh for ten years, for plants installed until end of 2011. The purchase price has now been amended according to Law 6094/2010. Also, Law No 5627/2007 exempts RES plants with installed capacity of maximum 500kW, cogeneration plants with at least 80% efficiency and micro cogeneration plants with 50kW installed capacity. Furthermore, Law 5686/2007 sets the rules and principles for exploring, producing and protecting geothermal and natural mineral water resources.

The "Strategic Plan 2010" covers the whole area of RES for the years 2010-2014. It encompasses elements about the education of the Turkish population on RES issues, a plan for incentives and subsidies as well as a strategy about research and development in the field. The Strategic Plan 2010 is the first plan in announcing the target of 30% of the total electricity generated from RES by 2030. The plan aims to diversify the energy supply of Turkey, make greater use of domestic resources, increase energy market efficiency and protect the environment. It also seeks to increase licensed projects, support small hydro sector and increase electricity connection for wind power plants and attract investments for geothermal plants. The plan gives a lot of importance to hydroelectricity and wind energy together with the promotion of energy efficiency.

The electricity market licensing regulation in Law No 4628/2001, pertains that legal entities applying for licenses for construction of RES are required to pay only 1% of the total license fee. Also they are exempted from paying the annual license fee for the first eight years. The Turkish electricity transmission company (TEIAS) or other distribution companies are required to give priority to systems based on RES. Therefore the real beginning for RES policy in Turkey is considered to have been signaled with the modification of the license regulation in the electricity market (Havva, 2006).

Law 6094/2010 increased the Turkish feed-in-tariffs and included bonus payments for hardware components made in Turkey to support the national manufacturing sectors. An older Law No 5346/2005 guaranteed tariffs of €0.05-0.055 /kWh without taking into consideration the type and capacity of the plant (Kukukali and Baris, 2011).

2.2. Greece

Legislation and policies on RES in Greece are more abundant and appear almost two decades earlier than in Turkey (Table 2). We present and comment on them at a chronological order from the oldest to most recent.

Law 1559/1985 (today superseded) mainly regulated alternative forms of energy and special matters concerning the production of electricity from conventional fuels. It allowed third parties to produce electrical power from RES up to the satisfaction of their own needs while any surplus could only be sold to the PPC, not to third parties. The capacity of grid-connected RES power plants of

independent producers could exceed three times the total installed capacity of their energy needs when the resource was wind, solar or hydro. Therefore, while private initiative was foreseen therein, it was simultaneously restrained.

Table 2. Greek laws and policies pertaining to renewable energy sources

Law-Policy/Year of issue	Aspect	RES Type
Law 4001/2011	Policy processes and public investment	All
Feed-in tariffs included in Law 3851/2010 for the transposition of 2009/28/EC Directive.	Incentives, subsidies	All
National Operational Programme for Competitiveness, 2010	Incentives, subsidies, R&D	Geothermal, Hydro, Solar, Thermal, Wind
Renewable Energy Law 3851, 2010	Financial, Incentives, subsidies, Policy processes and public investment	All
Feed-in-tariff for solar PV, 2009 amended in 2010	Incentives, subsidies	Solar, Photovoltaic
Generation of electricity using renewable energy sources, 2006, amended in 2009	Incentives, subsidies, regulatory instruments	All
Law 3468/2006 on Production of electricity from RES, High efficiency cogeneration of heat and power and other devices.	Regulatory instruments, Financial	All
Law 3423/2005 Introduction of biofuels and other renewable fuels in the Greek market, 2005	Financial	Bioenergy
Development incentives for renewable energy sources, 2004	Incentives, Subsidies	All
Common Ministerial Decision 1726/2003	Regulatory instruments	All
Law 2941/2001	Regulatory instruments	All
Feed-in-Tariffs, Law 2773 1999 on Liberalisation of RES development	Incentives, Subsidies	All
Pilot Projects Regarding Renewable Energies, 1999	R&D	All
Law 2244/1994 superceded	Incentives, subsidies, regulatory instruments	All
Operational Programme for Energy (OPE): Fiscal Incentives for Renewables and Energy Conservation, 1994	Incentives, subsidies	All
Incentives for Investment in Combined Heat and Power, 1990	Incentives, subsidies, regulatory instruments	Heating and Cooling (Domestic/ Industrial Process)
Founding Decree of the centre for Renewable Energy Sources (CRES), 1987	Regulatory Instruments	All
Law 1559/85:Regulation of alternative forms of energy and specific issues of power production, 1985, superseded	Regulatory Instruments	All

Source: Adapted from International Energy Agency.

The founding decree of the Centre for RES (CRES) was provided in article 25 of Law 1514/1985 but came into force in 1987. It is responsible for the promotion of scientific and technological research and it operates as the national coordinating centre for promoting RES applications and energy efficiency.

Development Laws 2601/1998 and 1982/1990 as well as the Operational Programme for Energy (1994-1999) and the Operational Programme for Competitiveness (2000-2006) set the incentives for investment in combined heat and power. Eligible investors were required to demonstrate fuel efficiency of at least 60% for the industrial sector and 65% for the service sectors. Law 2773/1999 replaced the provisions of Law 2244/1994 on the buy-back tariffs for electricity produced by combined heat and power.

From that time on, any private investor can produce electricity subject to the issuing of a generation license by the Regulatory Authority for Energy (RAE). Also, it states that the transmission system operator (TSO) is obliged to grant priority access in load dispatching to RES electricity producing installations (Vassilakos et al., 2003). The Operational Programme for Energy comprised fiscal incentives for renewable energy conservation. It provided capital cost grants for the promotion of RES and energy conservation. The operational programme for competitiveness provides grants to private investments in RES, pursues the rational use of energy and small scale cogeneration.

Law 2244/1994 has been superseded. It is regarded as the cornerstone of the Greek national policy for RES development. Although it was the main regulatory tool for the production of electricity by independent producers, the paradox is that the PPC remains the exclusive electricity buyer and retailer in Greece. For the Greek interconnected system, the law established a fixed sale rate for renewable energy at a level equal to 90% of the medium-voltage general use tariff and made it obligatory for the PPC to buy that energy. The final rate in 2006 corresponded to 0.07287 €/kWh. In the islands not connected to the mainland interconnected system, the pricing was based on 90% of the low voltage, household rate and corresponded in the 2006 to 0.08458 €/kWh. Other provisions of the law included the removal of restrictions for the exploitation of small water falls, the simplification of bureaucracy and the improvement of the pricing system.

Law 2773/1999 about feed-in-tariffs is also superseded. In the interconnected network, the PPC paid the generator a price which was composed of energy and a capacity charge. The energy charge was 90% of the energy part of the medium-voltage domestic end-use tariff and the capacity charge was 50% of the capacity part of the same tariff. In the non-interconnected islands PPC pays only for energy, not capacity. In 2001 the average tariff was €0.0616/ kWh in the interconnected system and €0.0731/kWh on the islands. The Regulatory Authority for Energy is the Greek national regulatory authority and was established based on the provisions of this law which was issued when Directive 96/92/EC was transposed into the Greek law. It has a very restricted role compared to international practice though.

Law 2941/2001 defined the terms under which it is allowed to install RES stations in forests and forestry lands and the characterization of RES projects as projects of public utility status which gives them the same rights and privileges in land expropriation procedures as those of public works (Vassilakos et al, 2003).

The Common Ministerial Decision 1726/2003 set stricter deadlines for every step of the licensing procedure for RES installations. If the answer is not given in the specified time period, then it is considered to be positive.

Law 3468/2006 aims to reduce bureaucratic licensing procedures for RES. Also the law gives attention to hybrid systems for the storage of RES produced electricity, mainly in the non-interconnected islands (EREC, 2009).

Law 3299/2004 is a development law that replaced the development law of 1998 and was also amended in 2006. It foresaw financing of 20-40% (in specific regions this could reach up to 55%) of the initial investment of RES installations (depending on the part of the country it was made), or alternatively 100% tax exemption for the cost of the new installation. In particular, the Greek territory is divided into three zones where the capital grants are 20, 30 and 40% of the investment cost depending on the zone. The grant is increased up to 10% for medium-scale enterprises and up to 20% for small ones. In particular, for investments in power generation using solar and wind energy, the grant percentage along with the above markup amounts to 40%.

Law 3423/2005 is the implementation of the EU biofuels directive in the national law. Biofuels are not subject to the fossil fuel tax which is 0.245 € /litre.

Law 3468/2006 transposes EU Directive 2001/77/EC regarding the promotion of electricity produced from RES in the internal electricity market, also promoting high efficiency cogeneration of electricity and heat plants.

Renewable energy Law 3851/2010 includes a complete set of feed-in-tariffs set up for electricity generated from various RES. The feed in tariff for solar photovoltaics applied to residential users and small companies for small rooftop PV systems up to 10kWp (kilo watt peak), though a residence has to cover part of its hot water needs by some other renewable source (e.g. solar thermal) to be eligible for the feed-in-tariff.

The Renewable Energy Law 3851/2010 sets higher targets that should reach 20% of total national energy consumption and 40% of total electricity consumption by 2020. Moreover, 20% of energy used in heating and cooling and 10% of energy used in transportation have to be produced from RES. The new legislation foresees the creation of a special Renewable Energy Investment Service that will act as an interface between public institutions and investors, review the main challenges to RES deployment and manage the support funding allocation process. Existing remuneration of individual residents in areas where RES plants are in operation, have been amended and replaced by a credit on electricity bills. The licensing process has been eased with the issuance of licenses under the Ministry of Environment, Energy and Climate Change. The whole licensing process can not last over a 30-month period. Priority is given to RES on desalination plants on islands. Still, RES projects are not granted grid priority access as grid connection will be established on a first-come first served basis until the network is saturated. Furthermore, the installation of off-shore wind farms is allowed. This law is the transposition of 2009/28/EC Directive and has not been implemented by Greece yet.

Law 4001/2011 transposes into national legislation the 3rd Internal Energy Market directives. It stipulates the unbundling of the system operators and enhances the role of the independent regulator regarding security of supply, licensing, monitoring of the market and consumer protection (OECD/IEA, 2011). The 3rd energy package comes at a time that the second electricity directive has not been fully and properly implemented which means that fundamental structural changes will be required if the goals of the 3rd energy package are to be achieved.

3. Renewable Energy Performance of Turkey and Greece

This section provides a comparison of the RES situation in both countries by illustrating the strengths and weaknesses of both countries in this field. We present and compare performance on solar, biomass, geothermal, hydro power and wind energy. Different data ranges in the figures are due to data non-availability in Eurostat, either for Greece or Turkey. Therefore, to enable comparisons, we had to keep only the years for which data for both countries were available. Also, to make data comparable we have normalized them with respect to the population size of each country.

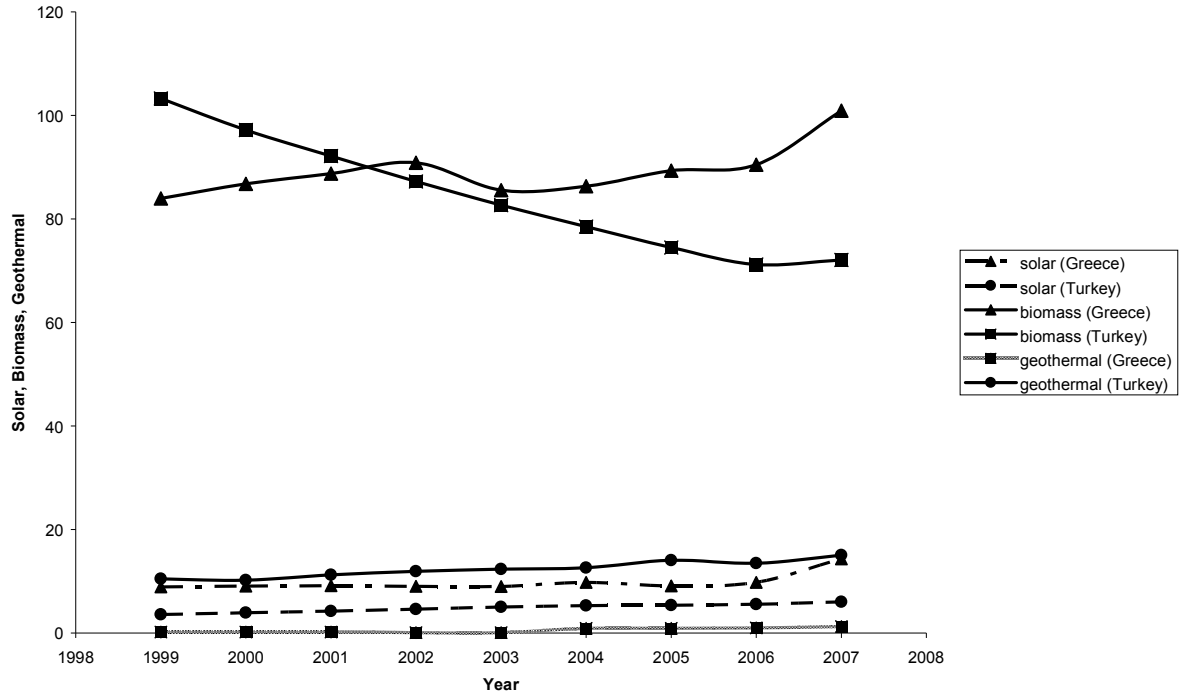
Solar

Based on Figure 6, Greece slightly overcomes Turkey in the field of solar and biomass energy production. Also, Greece enjoys the precedence in geothermal energy. Turkey had reduced the amount of its produced RES because of the imported natural gas (Yilmaz, 2011). However, nowadays after Law 5346/2010, Turkey, in its Turkish strategic plan (2010-2014) plans to reverse this and increase the share of RES in electricity generation at 30% by 2023, while reducing the share of gas below 30%. Regarding electricity generation from RES, this stems from hydro at 79%, wind 19%, and biogas 2%.

Turkey lies in a sunny belt between 36on and 42on latitudes. The yearly average solar radiation is 3.6 kWh/m^2 day and average sunshine duration is 2604h, corresponding to around 305 days of the year (Nalan et al., 2009). Solar energy in Turkey is mainly utilized for domestic hot water production (Republic of Turkey, 2010). Also, Turkey is currently studying the feasibility of PV cells local manufacturing.

The application of active solar systems in Greece started in mid 70s. The oil crisis in conjunction with the rising electricity prices at that period, contributed significantly to the development of solar market. Until 1987 the market was rising because of financial motives and an advertising campaign by the state. All systems were mainly produced by Greek manufacturers (Eurostat, 2012).

Figure 6. Solar, biomass and geothermal energy in Turkey and Greece (data code: ten00082 from Eurostat)



Greece has 300 sunny days a year (Vassilakos et al., 2003). Greece rates among the first EU countries using solar energy for water heating with a total surface of installed solar collectors to 3,140,000m^2 with the majority installed in the residential sector. From solar systems, 99% of them are small scale systems for domestic hot water, 0.75% are large scale systems for hot water in the tertiary sector (hotels, hospitals and swimming pools) and 0.17 % are large systems for hot water, air-conditioning and space heating in industry (European Commission, 2001). Greece plans to develop solar systems for combined space and water heating in the residential sector as well as in the industrial sector (Hellenic Republic, 2006). These photovoltaic applications are fewer due to their high capital cost. The total installed capacity in 2000 was 332kWp (Vassilakos et al., 2003).

Biomass

Biomass is an important source of renewable energy in Turkey with a potential of 31,000Mtoe/year of biomass energy and includes fuelwood, agricultural residues, animal wastes etc. (Bayrakci and Kocar, 2012). Biomass can be converted to liquid or gaseous fuels or burned to produce electricity. According to Kaygusuz and Sari (2003), animal wastes mixed with straw to increase their calorific value, is the principal fuel of many villages in rural mountainous regions of Turkey. Research about anaerobic digestion for methane production, has been upheld in the country. Also the risk of energy forests disappearing is imminent since co improvement studies were being undertaken by the Turkish government at least until 2003. The vivid agriculture sector in Turkey offers various opportunities for agricultural residues to create a strong energy base for electricity production. Last significant biogas opportunities have been tested to be viable from an economic point of view and can replace stoves in rural Turkey.

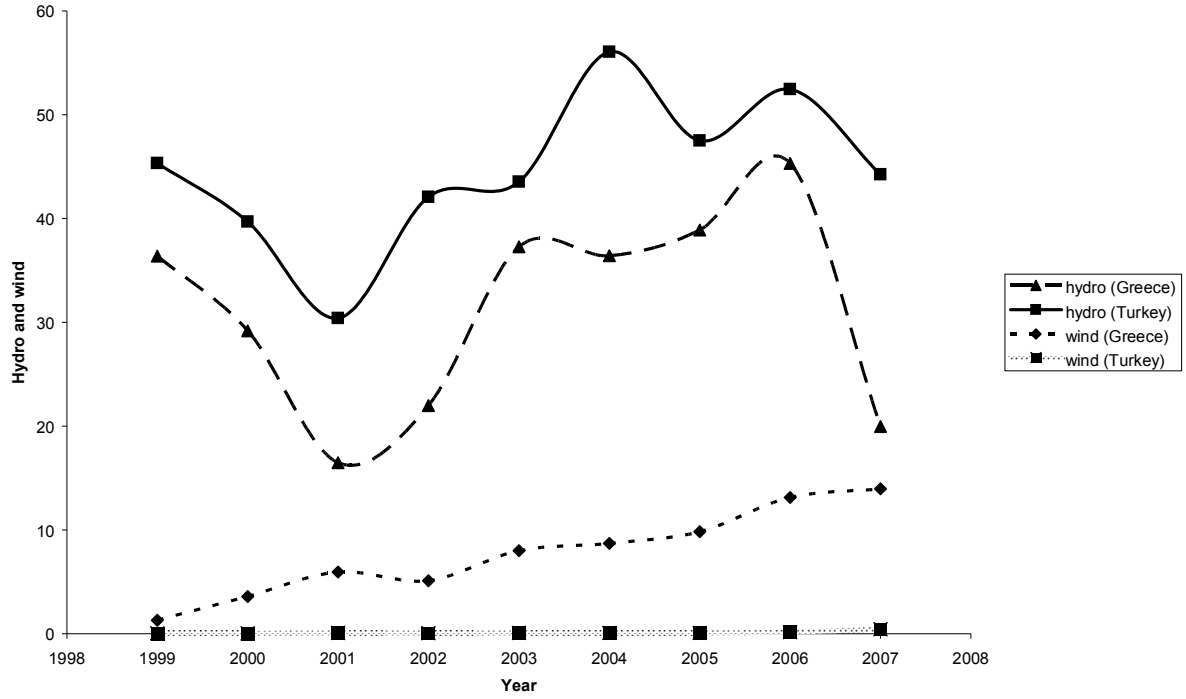
Greece exploits biomass for steam production in industry as well as in power generation. A total capacity of 57MW was in place in 2006 with an expected increase by 10% in 2015 (Hellenic Republic, 2006). The Greek biomass annual potential from agriculture and forest residues is estimated to 10Mt. Until 2000 biomass encompasses mostly wood directly used in the domestic sector (Vassilakos et al., 2003). Furthermore biogas from municipal waste landfills started being considered round 2000. Also, domestic use of wood (for cooking and heating) accounted for 75% of the produced biomass at that time. The first biogas plants with installed capacity of 24MWe (mega watt electric), exploiting biomass from forests and agricultural residues to produce electricity had contributed with an additional combined capacity of 350MW by 2006 (Hellenic Republic, 2006).

Geothermal

Thermal plants became part of electricity production in Turkey by 1950s (Yilmaz, 2011). The first geothermal application for heating was in a hotel in Gonen-Balikkesir in 1964. Turkey is located in the Mediterranean sector of Alpine-Himalayan Tectonic belt (Hepbasli and Ozgener, 2004) and is ranked fifth for the potential of geothermal resources and seventh in the utilization of those resources in the world with two thirds of the country's geothermal resources being located in the Aegean region (Republic of Turkey, 2010). However, only 3% of the total geothermal potential of this country is utilized. When Turkey uses all its potential, it can meet 14% of its total needed energy demand (Havva, 2006). Kaygusuz and Sarı (2003) report that there may exist 4500MW of geothermal energy usable for electrical power generation in high enthalpy zones which is the equivalent for heating capacity for 50,000 households. Turkey has a two-fold objective for its geothermal energy: One is for electricity generation and the other is for direct uses, because 95% of its fields are of low-medium enthalpy. Up to 2003, there were 26 geothermal district heating systems in Turkey and one heat pump system at experimental level (Kaygusuz and Sarı, 2003). A geothermal law was issued only in 2007, meaning that there was no legislative framework for all these years.

The exploitable geothermal potential in Greece is estimated to be 200-300MW and aims mainly to reinforce the electricity balance of islands (Hellenic Republic, 2006). The use of geothermal energy for heating purposes (in greenhouses) has increased after the introduction of the relevant law which simplified the exploitation of geothermal fields.

Figure 7. Hydro power and wind energy in Turkey and Greece (code ten00082 from Eurostat).



Hydro power

According to Figure 7, Turkey is overcoming Greece in hydro power production and Greece overcomes Turkey in wind energy production. Turkey has a share of 16% of the total hydro capacity in Europe. Development of small hydro power plants began in Turkey in 1902 (Havva, 2006). Law No 5346/2005 shifts interest from small hydro power to big hydro power plants by defining that hydro plants with a reservoir area less than 15km^2 to be considered within the definition of RES (Kucukali and Baris, 2011).

Installed capacity of Greek small hydro units (defined at 15MW capacity) had reached the amount 69MW in 2003. Large hydro units, belonging to PPC, reached installed capacity of 3,010MW in 2003. It is estimated that hydro units in Greece will amount to 3732 MW in 2015 and there is additional potential for further development (Hellenic Republic, 2006). Electricity production from hydro plants varies from year to year, mainly due to operational characteristics such as lower rainfall,

less hours of operation for some plants and use of water for irrigation purposes, (Vassilakos et al., 2003).

Hydro power has traditionally been important in Greece as compared to the markets for wind energy and solar thermal systems which have grown only in recent years (EU, 2008). Greece produces 1.29% of European hydroelectricity. Hydroelectricity remains a small factor in terms of the Greek energy consumption, but it is important regionally. Studies show that Greece can produce hydroelectricity up to 21 billion kWh. So far only 25% of this energy is used with 12 big and 8 small hydroelectric stations totalling 2514 MW. There are 6 hydroelectric stations under construction with a total power of 763 MW. However, the full potential of these large power stations is already being largely exploited, or they are confronting environmental problems that limit further expansion. Even though water is clean energy, the construction of major dams often requires the flooding of natural sites, disrupting biotopes and resulting in other negative environmental impacts. However, small hydroelectricity power stations have so far been relatively unexploited, and they have a number of potential advantages over larger stations. They do not require the construction of large-scale and expensive infrastructure, they are well suited to the needs of rural areas, and potentially, they have a much lower impact on the environment. For this reason the Greek authorities decided to launch projects for small-scale hydroelectric power stations as part of the European Union supported programme for developing RES. The private sector, which was given financial incentives to implement the projects, contributed 55% of the total cost (EU, 2006). Hydroelectricity is 5% while the rest of RES account only for 1% of total energy production (U.S. Energy Information Administration, 2006).

Wind

Turkey albeit with a significant wind energy potential (of 7.2km/s on elevation of 1132m), has performed meager progress in the field. Nevertheless, it is reported as one of the countries with the best wind maps among European countries with a technical potential of 88GW. The first wind power plant was commissioned in 2001 in Izmir. Areas by the sea such as the Mediterranean, Aegean and Black sea seashores are appropriate for wind farms. Currently there are 16 projects in the Aegean region and 9 projects in Marmara region (Balat, 2008). Turkey also provides motives for manufacturing RES parts and associated technology within its territory On the other hand, Greece has over 1,000 islands with sea wind and an average wind speed exceeding 7.5m/s (Vassilakos et al., 2003). It is estimated that the installed capacity of wind plants will reach 1670MW in 2015.

Furthermore, there is significant increase of wind power in Greece due to the installation of wind parks by private investors. The best sites for the installation of wind turbines are located in Evia, Laconia, Thrace, the Aegean islands and Crete, meaning that in Greece the potential of wind energy is more dispersed than it is in Turkey. However, the problem in Greece is that areas of high wind potential are isolated from the existing grid infrastructure. Electricity generation from wind consisted of wind energy by 19% (Hellenic Republic, 2006). Wind parks have increased because their cost is subsidized at 30-50% of their construction cost. It is estimated that the installed capacity of the wind parks in Greece will reach 1,670MW in 2015.

4. Barriers and Perspectives for Greece and Turkey

RES in most countries became a topic for discussion after the first oil crisis in the 70s. Undoubtedly, RES investments cause a considerable increase in the cost of capital. However, without them, the fuel cost and the CO_2 payments are increased. Even with a relatively low CO_2 price (20euro/tn), the increase in capital stock will be lower than the cost incurred from fuel and CO_2 payments (Hellenic Wind Energy Association, 2012). The real beginning for renewable energy policy in Turkey was the definition of renewable energy sources in the decree of the Modification of the License Regulation in the Electricity Market in 2003. Before then, there was no national renewable energy policy and few government incentives existed to promote market deployment of renewable energy.

Both countries face similar barriers for the establishment of RES. Oikonomou et al. (2009) explain how the typical five major type barriers for RES occur in Greece: a) technological (limitations in the grid infrastructure which cannot absorb the electrical energy produced by RES in areas with increased potential and lack of data e.g. land registry, property and use as well as management of protected areas), b) environmental (inability to measure environmental and socio-economic impacts), c) social/public opinion, d) economic (absence of units responsible for the creation, operation and

manufacturing for RES equipment) and e) regulatory (increased bureaucracy to get a licence), administrative and legislative (lack of policy regarding industrial relations and the collaboration between companies and local authorities to promote RES development). Michalena and Angeon (2009) recognize the role of institutional thickness (local atmosphere of acquiescence based on tradition and developed human bonds) which also plays a role in the promotion of RES in societies. The growth of the RES sector in Greece is guaranteed by legally binding targets that require a RES share of 29% of total produced energy by 2020, from a current share of nearly 10%, which includes small hydroelectric dams. More financial incentives, such as tax breaks, direct subsidies and an attractive feed-in tariff system will reduce the cost of promoting RES.

Many of the RES barriers are common for many other countries, such as bureaucracy or institutional barriers. Turkey in particular, faces lack of financial resources and proper lending facilities, particularly for small-scale projects (Kaya, 2006) and the lack of detailed RES assessments and data banks (Koyun, 2007). It is a contradiction to EU legislation that no detailed environmental impact assessment is required for RES projects in Turkey (Kucukali and Baris, 2011). Turkey needs foreign environmental expertise to handle environmental projects and promote its energy efficiency which is lower compared to Europe (Republic of Turkey, 2010).

Nalan et al. (2009) also report as a barrier the high capital cost of the technologies. The tax system tends to penalize capital intensive RES investments. Moreover, the fact that external and social costs have not been taken into account in the pricing of fossil fuels, makes penetration of RES more difficult. They further claim that lack of large scale RES product manufacturing is a serious hindrance because of import tariffs. The impact of visibility effects is also high in Turkey since there are no integrated PV systems.

Although total RES production has increased since 1990, total share of RES in primary energy supply has declined. The fixed feed-in tariffs and purchase obligation for distribution companies under the new Renewable Energy Law will stimulate investments. In fact, the recent price increases in gas fired plants provoked renewable (hydro) investments of the private sector to allow for a better fuel mix economically. There is a large potential for use of heat from RES (geothermal, solar thermal and biomass), and a projected regulation on co-generation plants is expected to increase heat trading. Large-scale hydropower plants, on the other hand, will continue to be dominated by state enterprises as is the case in Greece too.

The geography of Greece consisting of a very large number of islands represents a challenge for the power production and system supply of the country. Largest opportunities come from wind and solar energy, biomass for district heating and electricity installations as well as small hydro. PV in Greece focus on isolated systems in remote areas for electrification and agricultural use. Natural gas penetration has been growing since 1997.

Grid availability is an important issue in Greece since the areas of high wind potential are isolated and far from the existing grid infrastructure. PPC dominates more than 75% of the wholesale market and more than 90% of the retail market in 2010. It also remains the owner of transmission and distribution assets and has 49% stake in the operator of the transmission system and wholesale market (OECD/IEA, 2011).

The lack of prospect and long term planning in Greece is also reflected in the structure of the educational system. The target for 20.1% for electricity generation in Greece had estimated that 70,000 employees would be needed for this sector. However, the tertiary educational system has introduced topics related to RES that are quite general and without any specific focus (Koutsogianni et al, 2011).

Crisis leads to a number of changes (mergers, takeovers, disinvestments) and most investors are on a stand-by mode, because they want to see whether sector problems will be assessed in a transparent and effective manner. Due to crisis, industrial energy demand has fallen, the same but less has domestic demand (Ekaterinari, 2009).

With Greece being part of EU it is obliged to follow EU Directives. Sometimes national initiatives to privatize the energy industry do not act in the same direction with environmental policies at the EU. For instance the introduction of competition may result in lower prices, while to achieve a level of environmental protection, these prices must be increasing to cause limited demand increases (Vassilakos et al., 2003). The 2020 RES target in Greece, the Emissions Trading System (EU-ETS) and the EU air quality standards are pushing Greece to decarbonize its lignite-dominated electricity

sector. Reform of the electricity, natural gas and coal sectors is a condition for the assistance from EU countries and the IMF (OECD/IEA, 2011).

5. Discussion and Concluding Remarks

This paper has focused mainly on data from Eurostat to make comparisons on the energy profiles and RES development between Turkey and Greece. Unfortunately we were unable to use several interesting energy variables provided by Eurostat because of data non-availability, mostly by Turkey. This might mean that there is a problem of energy data accountability in this country. Furthermore, the length of data period used in the graphs is also contingent on data availability by both countries. The paper also uses various measurements available in different pieces of literature and therefore we cannot be sure of the underlying methods used. Overall, this is a review paper that sketches RES tendencies and development similarities and differences in the two neighboring countries, which will be of interest to potential investors and policy makers both from Greece and Turkey and worldwide.

Apparently Turkey has been late to develop a legal framework and the relevant energy policies for RES, but it has been very quick in catching up with Greece and Europe and it has set up objectives extending up to 2023. While Greece which has started its legislation and policies much earlier, it extends its objectives only up to 2020. Moreover, contrary to Greece, Turkey has followed an unbundling regime, i.e. separation of the operation at transmission level from the business of producing or supplying.

Turkey aspires to a more diversified energy base and a much quicker strategy to eliminate its energy dependence from imports. For instance, it plans to have a nuclear power plant with a capacity of 1800MW at the black sea port of Sinop (Capik et al. 2012) and has important oil and gas transit pipeline projects that are either completed or under way which will improve the security of supply in it as well as in Europe, and make it an important transit country and an energy hub.

Having normalized RES production in both countries with respect to the population size we observe that Greece overcomes Turkey in the solar, biomass, geothermal and wind energy production, while Turkey overcomes Greece in hydropower production. Although both Turkey and Greece have a long tradition in hydro power, Turkey produces 16% of EU production while Greece only 1.29%. Therefore, in absolute figures Turkey has a much larger hydro energy production than Greece. Turkey nowadays moves from small to larger hydro projects which can have major environmental impacts. This tendency is the opposite in Greece.

Because Greece has a much smaller geographical territory than Turkey, and not so deep mainland as Turkey has, RES are evenly distributed in all its grounds. Most Turkish RES potential (e.g. in wind and geothermal) are in the Aegean region. Therefore interesting co-operations can develop in these two countries with imports and exports in energy and grid infrastructures. Also, while Turkey has a five day longer sunshine than Greece, the speed of wind in the Greek Aegean islands is stronger by 300m/s.

While Greece possesses more sophisticated environmental assessment and societal acceptance tools for RES, the economic crisis that has broken out since 2008 has decreased investments and hiders industrialization. Turkey is not affected by this crisis and eventually will have the opportunity not only to catch up with Greece but to overcome it as well in the RES sector, unless Greece seizes the opportunity to use RES as a means to escape the crisis. Also, Greece is neighboring with more European countries and can develop a peripheral energy plan with other Balkan countries.

Both countries possess critical geographical positions. Greece is the entrance of Europe from the east and Turkey is the exit of Asia from the west. Turkey is a much larger country with higher inequalities in income and education outreach and a larger population. Also a higher percentage of Turkish population is employed in agriculture. The island geography of Greece presents challenges that Turkey does not have to face.

Both countries are energy importers and rely much on lignite and hydro. Surprisingly Turkish energy market is more deregulated, although RES legislation was applied much earlier in Greece than in Turkey. Greece imports gas through Turkish pipelines and Turkey imports electricity from Greece. Greece is more adherent to EU legislation, since it is an official EU member and hence has access to various funding mechanisms which are unavailable to Turkey. Also, Greece being an EU member is more restricted by environmental and emission levels targets. Both Greece and Turkey have similar energy objectives but Turkey additionally and sententiously favors inland production of RES parts.

Feed-in-tariffs in Turkey are flat while Greece has already adopted a more graded and sophisticated technology specific feed-in-tariff system.

Greece is afflicted by a huge economic crisis having started in 2008 whose outcome is doubtful, as doubtful is future RES development in this environment. Turkey on the other hand, has survived an economic crisis in 2001 and has proceeded in RES development and planning in a very dynamic way.

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