

PROSPECTS OF RENEWABLE ENERGY PRODUCTION IN THE MEDITERRANEAN REGION

Stratigea, A.

National Technical University of Athens

Biska, A.

National Technical University of Athens
and

Giaoutzi, M

National Technical University of Athens

Abstract

The focus of the present paper is on the renewable energy developments in the Mediterranean Region. In the first part is presented the EU policy framework for renewable energy and the targets set for 2020, both at the EU and the member state level. In the second part, are explored the patterns of renewable energy developments in the Mediterranean basin, against the 2020 targets. In the final part, conclusions are drawn on the prospects of the Mediterranean countries for reaching the renewable energy targets for 2020.

Keywords: renewable energy, policy, Mediterranean countries, RE targets for 2020

Introduction

The rapid exhaustion of conventional energy reserves together with the environmental impacts emerging from the combustion of fossil fuels (natural gas, diesel, coal etc.) threaten the sustainability of the whole planet, from an economic (e.g. economic stability due to high and volatile oil prices) but also an environmental point of view (greenhouse effects, global climate change, global warming, resource depletion, etc.).

In coping with the above issues, EU has undertaken certain initiatives, placing emphasis, among others, on the promotion of renewable energy share in the energy mix. EU in general and each member state in particular are committed to reach certain targets, relating to the share of renewable energy (RE) for the year 2020.

In the present paper the focus is on the renewable energy developments of the EU member states in the Mediterranean basin. More specifically, in the *first part* is presented the EU policy framework supporting the increase of RE share in the energy mix, together with the targets set for 2020 both at the EU but also at the member state level. In the *second part* are presented the patterns of renewable energy developments in the EU Mediterranean countries but also the policy impacts towards reaching the mandatory EU targets in 2020. Finally, in the *last part*, some conclusions are drawn as to the emerging prospects of the Mediterranean countries in this respect.

Conceptual Definitions

At this stage, it is worth clarifying certain concepts, used in the renewable energy context, that may promote communication among disciplines involved in the policy making process. More specifically, the following definitions are provided (Directive 2009/28/EC):

- *Energy from renewable sources*: energy produced from renewable non-fossil sources, namely wind, solar, aero thermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.
- *Gross final energy consumption*: the energy commodities delivered for energy purposes to industry, transport, households, services (including public services), agriculture, forestry

and fisheries, including also the energy sector (electricity and heat consumption by the energy sector for electricity and heat production purposes) and the losses of electricity and heat during the distribution and transmission phase.

- *Gross inland (energy) consumption (GIC)*: the total quantity of energy needed to satisfy the inland consumption of a geographical entity (total energy demand). It is calculated by adding *primary production*, plus recovered products, plus net imports, plus stock changes, minus exports, minus bunkers (i.e. quantities supplied to sea-going ships). Gross inland energy consumption incorporates:
 - ✓ consumption by the energy sector itself;
 - ✓ gross final energy consumption by the end users;
 - ✓ distribution and transformation losses;
 - ✓ ‘statistical differences’ not already captured in the figures on primary energy consumption and final energy consumption.
- *Primary energy production*: refers to the extraction of energy from natural sources. The precise definition depends on the type of energy source involved. In case of renewable energy sources it holds:
 - ✓ Hydropower, wind and solar photovoltaic energy: quantity of electricity generated by hydro, wind and solar RES. Production is calculated on the basis of the gross electricity generated and a conversion factor of 3600 kJ/kWh.
 - ✓ Geothermal energy: refers to the quantity of heat extracted from geothermal fluids. Production is calculated on the basis of the difference between the enthalpy of the fluid produced in the production borehole and that of the fluid disposed of via the re-injection borehole.
 - ✓ Biomass / wastes: corresponds to the heat content (NCV) produced by the combustion of municipal solid wastes (MSW), wood and other solid wastes. In case of anaerobic digestion of wet wastes, the production refers to the heat content (NCV) of the biogases produced. In case of biofuels, the production refers to the heat content (NCV) of the fuel.
 - ✓ Biofuels: liquid or gaseous fuel for transport produced from biomass.
 - ✓ Bioliqids: liquid fuel for energy purposes other than transport, including electricity as well as heating and cooling, produced from biomass.
- *Tone of oil equivalent (toe)*: conventional standardized unit for measuring energy, defined on the basis of a tone of oil with a net calorific value of 41 868 kilojoules/kg.

Policy Framework for the Promotion of Renewable Energy in the EU

The impacts of human activities on climate change have raised the issues of environmental responsibility of states and the need for their active participation in the efforts to mitigate quantity of greenhouse gases, as being the key contributor to global climate change (Meyer and Koefold, 2003).

In this respect, two important initiatives have been undertaken, namely the United Nations Framework Convention on Climate Change and the Kyoto Protocol (1997). The later has been widely debated as ‘*a controversial initiative*’ (Strachan et al, 2006:2), setting, to the states signing the protocol, quantitative targets for six greenhouse gases, in respect to the pollution levels of 1990, with CO₂ being the most important among them. EU is considered to play a protagonist role in the global mitigation efforts along the lines of the Kyoto Protocol, undertaking the task to reduce greenhouse gases by 8%, during the period 2008-12, with base the 1990 levels.

At the same time, the *energy consumption patterns* in Europe are expected to raise in the future (EC, 2004). This entails a relative increase in energy imports (expected to reach 70% in 2020 – COM (2000)769], as Europe is largely dependent on outward resources in order to meet this demand. These increasing consumption patterns, apart from the environmental impacts and

their preventing role to the EU efforts to fulfil its international commitments, also put at stake the energy security and cost-competitiveness of energy production in Europe.

In order to meet the Kyoto commitments but also pursue the key objectives set for a secure, competitive and environmentally friendly energy production system at the EU level [COM (1995)682], EU has stimulated renewable energy production, by exploiting the abundance of renewable energy resources appearing in its territory (biomass, wave, tidal, solar and wind resources).

Towards this end, EU policy efforts are supporting technology programmes (e.g. ALTENER Program); set political targets (e.g. 12% RE in 2010); and enact sector-specific legislation (e.g. Directives for electricity, biofuels etc.). The *key steps* of the EU energy policy for promoting the key objectives set for a secure, competitive and environmentally friendly energy production system are presented in the following sections.

EU Renewable Energy Targets for 2010

The dependence of the EU states, on energy imports, is rapidly increasing and brings forward a number of issues, relating to the: geopolitical risks and security of supply; implications for balance of trade; economic instability; environmental consequences, etc. In order to deal with the above issues, is acknowledged by the countries the need to further exploit their renewable energy potential and increase its share to the Union's overall gross inland energy consumption. This will further enhance development perspectives of the European regions and their potential to combat the greenhouse effects [COM (1997)599].

The dependence of the EU energy system on external resources is, among others, also stressed in the Green Paper on 'European Strategy for the Security of Energy Supply' [COM (2000)769]. This affects, in a varying degree, the member states, according to the level of reliance, of their energy systems, on external energy resources.

In the Green Paper is also stressed the burden of both transport costs and transit requirements placed by the distance of the EU markets from the external energy suppliers, upon which it is based. This implies additional costs and involves certain environmental risks. As a result, by increasing the share of RE in the EU energy production systems the above problems may be reduced, while the proportion of RE in the energy balance will largely depend on their connectivity to the grid network and their competitiveness in the emerging decentralized production pattern [COM (2000) 769]. The key priorities, set in this respect, refer to both the control of energy demand and the management of supply, where renewable forms of energy are of first priority.

In 1997, with the adoption of the White Paper on the 'Energy for the Future: Renewable Sources for Energy, the EU strategy on renewable energy has been formulated. The aim of this strategy has been twofold: first to cope with the growing dependence on fossil fuel imports from politically unstable regions outside the EU; and second to de-carbonise the energy sector, for improving environmental performance [COM(1997)599]. Towards this end, emphasis is placed on both the strengthening of the share of renewable energy in the EU energy production systems, but also on the role of national efforts and respective strategies of the member states, pursuing renewable energy objectives in alignment with the EU objectives.

The formulation of indicative targets is of importance as a guideline but also as a policy tool, for both the EU and the member states, providing a '*clear political signal and impetus to action*' [COM (1997) 599: p. 10]. In this respect, it was set the target of doubling the share of RE in the total EU gross final energy consumption from 6% in 1997 to 12% in 2010, and in particular with the 22,1% *indicative share of electricity* produced from renewable energy sources in the total Community electricity consumption by 2010 (Directive 2001/77/EC) (see Table 1).

In Table 2 below are shown the targets set as well as the average annual growth rate of energy production from RES, needed for the EU-15, in order to meet the targets set by the Directive 2001/77. Each member state should propose its contribution to the overall EU target

by 2010; and define the related state strategy and national action plans that encourage the increase of RE share, based on the availability and potential of local RE sources.

Table 1: Energy production from RES in EU-15
Source: COM (2001)69 final

Index (%) \ Year	1995	1996	1997	1998	Target 2010
Primary production of RES	10.0	10.0	10.8	11.3	-
Share of electricity of RES origin	13.8	13.5	14	14.2	22.1
Gross inland consumption of RES	5.3	5.4	5.8	5.9	12.0

Table 2: Targets for the promotion of RE-electricity set in the Directive 2001/77/EC
Source: EREC, 2008

Type of Energy \ Year	1997 (Eurostat) TWh	2001 (Eurostat) TWh	AGR* (1997-2001) %	Directive Targets 2010 TWh	AGR* needed (2001-10) %
Total renewable energy (RE)	338.3	408.5	4.8	675	5.7
Total consumption of electricity	2426	2671	2.4	3068	1.6
Share of RE %	13.9	15.3	-	22.1	-

*AGR: Annual Growth Rate

National targets of the Member states for the share of RE in the overall electricity consumption are shown in Table 3 below for the EU-15.

Sectoral targets set for each specific RE sector are also presented in Table 4 below. As can be seen, it is clear that wind energy is far beyond the target, while the other types of energy (hydro, geothermal and photovoltaic) are in line with the expectations of the White Paper (EREC, 2008).

Table 3: Reference values for member states for fixing national indicative targets as to the share of RE to the gross electricity consumption¹ in 2010 (EU-15)

Source: Directive 2001/77 (p. 39)

Renewable Energy		RES-E ² 1997*	RES-E** 1997 %	RES-E** 2010 %
Member State (EU-15)				
1	Belgium	0.86	1.1	6.0
2	Denmark	3.21	8.7	29.0
3	Germany	24.91	4.5	12.5
4	Greece	3.94	8.6	20.1
5	Spain	37.15	19.9	29.4
6	France	66.00	15.0	21.0
7	Ireland	0.84	3.6	13.2
8	Italy	46.46	16.0	25.0
9	Luxemburg	0.14	2.1	5.7
10	Netherlands	3.45	3.5	9.0
11	Austria	39.05	70.0	78.1
12	Portugal	14.30	38.5	39.0
13	Finland	19.03	24.7	31.5
14	Sweden	72.03	49.1	60.0
15	United Kingdom	7.04	1.7	10.0
EU		338.41	13.9 %	22.1 %

*National production of RES-E in 1997.

** Share of RES-E in 1997 and 2010 are calculated by dividing national production of RES-E by the gross national electricity consumption.

Table 4: Renewable energy sector-specific targets for 2010

Source: EREC, 2008

Year	1995 (Eurostat)	2001 (Eurostat)	AGR* (1995-2001) %	Targets 2010 White Paper ³	AGR* needed (2001-10) %
Type of RE					
Wind	2.5 GW	17.2 GW	37.9	40 GW	9.8
Hydro	87.1 GW	91.7 GW	0.9	100 GW	1.0
Photovoltaic	0.04 GWp	0.26 GWp	36.6	3 GWp	31.2
Biomass	44.8 Mtoe	56.5 Mtoe	3.6	135 Mtoe	10.3
Geothermal	2.72 Mtoe	3.43 Mtoe	3.9	5.2 Mtoe	4.7
Solar thermal	6.5 Mio ⁴ m ²	11.4 Mio m ²	9.8	100 Mio m ²	27.2

*AGR: Annual Growth Rate

Emphasis is placed also by the EU on strengthening the presence of *liquid biofuels*, by increasing their share in the EU transport fuel market. The aim of this action is twofold:

¹ Gross (national) electricity consumption or consumption of electricity: refers to the national electricity production, including auto-production, plus imports minus exports (Directive 2001/77).

² 'RES-E' is the share of renewables in gross electricity consumption.

³ Presents estimates of a particular RES development scenario towards achieving the indicative target of 12% share of renewables in 2010 in EU [COM (1997) 599 – White Paper "Energy for the Future: Renewable Sources of Energy"].

⁴ 'Mio m²' stands for million square meters.

- First to deal with the unpredictability of oil prices in the short/medium term and the finite oil reserves by reducing dependence of the EU countries on imported energy, and increasing the share of biofuels' production in Europe [COM(1997)599]; and
- Second, to deal with the reduction of environmental impacts from conventional transport fuels, taking also into account the increasing demand for transport and the respective emission patterns, in the EU. The intensified use of biofuels for transport refers also to the policy efforts required for complying with the Kyoto Protocol. In this respect, the *Biofuels Directive*(2003) has set the "reference values" of 2% market share for biofuels in petrol and diesel consumption in 2005 and 5.75% share in 2010 (Table 5 below) (Biofuels' Directive 2003/30/EC). All member states have the same target.

Table 5: Targets for biofuels' share in 2010

Source: EREC, 2008

Year \ Type of energy	1997 (Eurostat) Mtoe	2001 (Eurostat) Mtoe	AGR* (1997-2001) %	Directive Targets 2010 Mtoe	AGR* needed (2001-10) %
Biofuels	0.27	0.68	20.2	17	5.7
Gasoline & oil demand	237.7	256.5	1.5	295.8**	1.6
Share of biofuels (%)	0.1	0.26	-	5.75	-

*AGR: Annual Growth Rate

** Trends to 2030 - EC

The progress towards reaching the 2010 *target of 12% share of RE* in the total EU gross final energy consumption shows that the target will not be met, despite the fact that renewable energy from various sources has increased by 55% in absolute terms [COM (2011)31]. This is mainly due to the following reasons [COM (2006) 848, COM (2011) 31]:

- Low cost-competitiveness of RE as compared to fossil fuels, due to limited internalization of external costs in market prices of fossil fuels;
- Unclear and discouraging procedures for planning, building and operating systems, mainly due to the inspected complexity, novelty and decentralized nature in RES;
- Opaque and discriminating rules for getting access to the grid but also limited information at almost all levels;
- Limited effectiveness of national efforts (policies) to contribute to the overall EU target;
- 'Loose' legislative framework and absence of legally binding targets at the EU level;
- Absence of legal framework as to the energy saving (energy efficiency) that has resulted to a certain increase of the overall EU energy consumption;
- Weak legal framework for the use of renewables in the transport sector;
- Complete absence of legal framework for the heating and cooling sectors;
- Vulnerability of national policies to changing political priorities, etc.

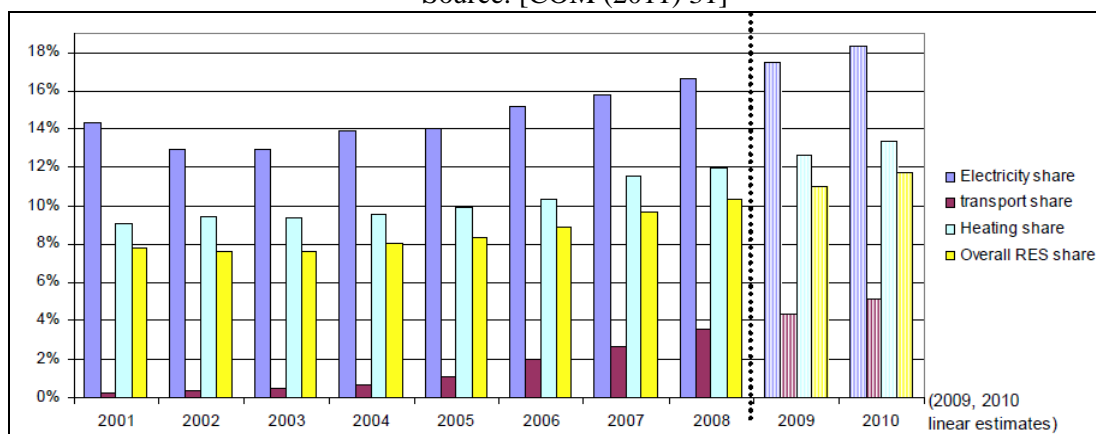
Nevertheless, the progress achieved during 2001-2008 indicates a small divergence from the 2010 targets (see Fig. 1 below).

The 2010 - *target of 22.1% share of RE* in the gross electricity consumption, is also not expected to be met, apart from a few member states, namely Denmark, Germany, Hungary, Ireland, Lithuania, Poland and Portugal [COM(2011)31]. Nevertheless, commitment of member states to national targets has led to partial achievements that contribute to the overall EU target. More specifically a 19% of RE share in the EU overall electricity consumption will probably be achieved by 2010, which is not far away from the EU target set (see Fig. 1 below).

The contribution of wind energy in electricity production exhibits considerable progress. The same holds for the contribution of biomass, which exhibits a considerable growth from 7% in the past years to 13% in 2003 and 23% in 2005 (EREC, 2008).

Fig. 1: Sectoral and overall growth of RE in the EU

Source: [COM (2011) 31]



As to the biofuels' share, only 1% is reached in 2005, representing half of the target set for this year (2% share) [COM (2006)848]. In respect to the 2010 target (5.75% share), it is very unlikely to be achieved, based on the present policy framework and the efforts of the member states (see Fig. 1 above). According to the EC Communication of 2011 [COM (2011) 31], from all EU member states, Austria, Finland, Germany, Malta, Netherlands, Poland, Romania, Spain and Sweden are the only ones expected to achieve their targets for renewable energy in transport in 2010.

EU Renewable Energy Target for 2020

Until 2008, the development of RES in the EU was driven by a loose legislative framework, setting indicative, non-binding targets that aimed at introducing a new spirit in energy production, in order to meet the objectives and global commitments of the EU. The basis of this framework was the "Renewable Electricity Directive" in 2001 and the "Biofuels' Directive" in 2003. Based on the national targets, EU would have been able to reach, by 2010, a share of renewable energy of 12% in the total EU final gross energy consumption; of 22.1% in electricity generation and finally a share of renewable energy of 5.75% in replacing petrol and diesel in transport.

In 2006, EU sets out a *long term vision* for the EU energy future beyond 2010, based on further exploitation of renewable energy in its territory. In this vision, expressed through the EU Renewable Energy Road Map [COM (2006) 848], it is proposed the establishment of:

- A *mandatory, legally binding target* of reaching a *share of 20% of renewable energy* in total final gross energy consumption in EU for the year 2020. Fulfillment of this mandatory target was expected to affect positively greenhouse gas emissions; increase security of the EU energy system by decreasing dependence on imported energy; motivate private investments in the RE sector, but also support regional development at a European level. For reaching this target it is required that all member states undertake action for the increase of their contribution to the EU overall target, by promoting renewable energy in the electricity, transport, heating and cooling sectors in their territories.
- A *mandatory, legally binding target* of *10% share of biofuels* in the overall consumption of petrol and diesel in transport in 2020. This can be seen as a minimum target, taking into account the availability of sustainably produced feed stocks, car engines and biofuels production technologies [COM (2006) 848].

The above targets seem to be rather realistic as it is exhibited, by renewable energy projections to 2020, for the member states (Fig. 2 below). In almost half of the Member States (Austria, Bulgaria, Czech Republic, Denmark, Germany, Greece, Spain, France, Lithuania, Malta, Netherlands, Slovenia and Sweden) targets seem to be exceeded, while a certain surplus

is also calculated. Italy and Luxembourg seem to lag behind, with the remaining demand to be covered by “imports”. These are in the form of ‘statistical transfers’ from Member States with surplus or other third countries [COM (2011)31]. If all these production projections are met, the overall share of renewable energy in the EU will exceed the 20% target in 2020 [COM (2011)31].

Fig. 2: Development of renewable energy in electricity in EU up to 2020 (projections)
Source: COM(2011)31

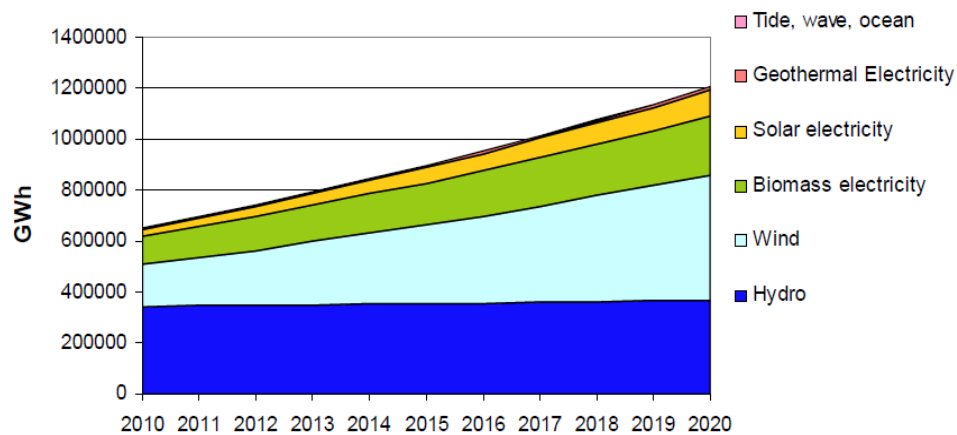
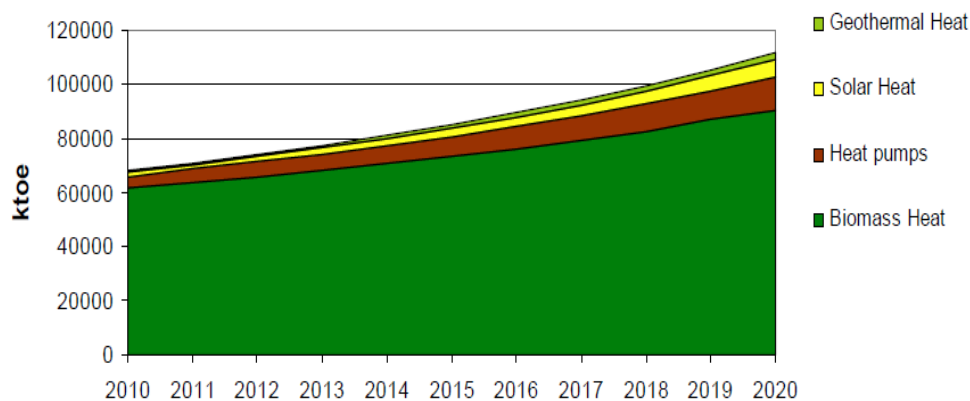


Fig. 3: Development of renewable energy in heating and cooling in EU up to 2020 (projections)
Source: COM (2011) 31



Moreover, projections to 2020 of renewable energy in heating and cooling in the EU show that biomass technology exhibits 50% contribution in energy production up to 2020 (Fig. 3) (half for heating, one third for transport and the rest for electricity) [COM(2011)31].

The failure of many member states to reach the EU 2010 targets and the experience gained so far, has motivated the shift of the focus of the EU energy policy framework beyond 2010. Based on the vision expressed through the EU Renewable Energy Road Map [COM (2006) 848], the Renewable Energy Directive of 2009 (Directive 2009/28/EC) has been enacted. In this Directive it was set the EU energy policy framework towards 2020. The key issue in this Directive, is the shift from ‘indicative targets for the electricity and transport sectors’ to ‘legally binding, mandatory EU 2020 targets’, as it was proposed by the EU Energy Road Map, supported by a comprehensive legislative framework incorporating ‘electricity, transport, heating and cooling sectors’.

In the new EU Directive for renewable energy, member states are enforced to develop specific National Renewable Energy Action Plans (NREAPs) and take responsibility for

contributing to the overall EU mandatory renewable energy targets in 2020, based on their specific potential and starting point of RE production.

In the NREAPs, each member state shall set out national targets for the share of renewable energy in transport, electricity, heating and cooling in 2020. Moreover, they are committed to reform their energy planning regimes; further develop the electricity grids in order to accommodate renewable energy produced; and support innovative actions in order to further facilitate the development of the renewable energy sector [COM(2011)31]. Also, they have to ensure that the share of renewable energy, calculated in accordance with the 2009/28 Directive instructions, is at least equal to the national overall target set in 2020 (Directive 2009/28/EC).

The new Renewable Energy Directive, put in force in 2009, represents a strong and stable regulatory framework for the development of renewable energy in Europe. It lays down legally binding rather than indicative national targets, such that the EU achieves a *20% share of renewable energy* in gross final energy consumption and *10% share of biofuels* in transport by 2020 (Directive 2009/28/EC). Moreover, it lays down rules relating to ‘statistical transfers’ between member States, joint projects between Member States and with third countries, guarantees of origin, administrative procedures, information and training, access to the electricity grid for energy from renewable sources, etc., while it establishes sustainability criteria for biofuels and bioliquids (Directive 2009/28/EC). Finally, it introduces the enforcement of National Renewable Energy Action Plans, presenting the legal requirements of member states in support of renewable energy production, which constitute the cornerstones for a more promising RE future of the EU, reaching the ambitious targets set for 2020.

Patterns of Renewable Energy Developments in the Mediterranean Basin

The present paper elaborates on the patterns of renewable energy development in the EU member states of the Mediterranean basin. The scope of the study is to identify trends by exploring past developments in the sector as well as planned renewable energy development patterns, reflecting the efforts of member states in the period 2010-20 to reach the 2020 mandatory RE targets. The countries considered are Greece, Spain, France, Italy, Cyprus, Malta and Slovenia (see Fig. 4 below).

Fig. 4: The Mediterranean basin study region (Cyprus, France, Greece, Italy, Malta, Slovenia and Spain)

Source: <http://www.res-legal.de/index.php?id=1&L=1>



Based on their NREAPs, the following mandatory national targets per sector for 2020 are set (Table 6):

Table 6: National targets for 2020 based on the NREAPs of the member states
Source: Member States' NREAPs

Country	Electricity		Heating & Cooling		Transport		Share of RE Overall targets in gross final energy consumption in 2020 (%)
	2005 ⁵ share (%)	2020 NREAP (%)	2005 share (%)	2020 NREAP (%)	2005 share (%)	2020 NREAP (%)	
Cyprus	0,0	16,0	9,1	23,5	0,0	4,9	13,0
France	13,5	27,0	13,6	33,0	1,2	10,5	23,0
Greece	8,03	39,8	12,76	19,7	0,02	10,1	18,0
Italy	16,29	26,39	2,80	17,09	0,87	10,14	17,0
Malta	0,0	13,8	0,0	6,2	0,0	10,7	10,0
Slovenia	28,5	39,3	20,0	30,8	0,3	10,5	25,0
Spain	18,4	40,0	8,8	18,9	1,1	13,6	20,0

The variables used in this context are the following: gross final energy consumption; share of renewables in gross final energy consumption; primary renewable energy production; share of renewables in the electricity production; and the share of renewables in the transport sector. The main data *sources* used are:

- EUROSTAT: data on the past developments of the above variables, in the Mediterranean countries, for the period 1990-2009; and
- The National Renewable Energy Action Plans (NREAPs) for the study region, for the period 2010-20 (projections based on the 'additional energy efficiency' scenario⁶).

Sectoral analysis includes the study of past and planned (NREAPs) developments in the EU Mediterranean countries on the following energy-related topics:

- Gross final energy consumption for exploring developments of consumption patterns;
- Share of renewables in the gross final energy consumption (overall EU target for 2020: 20%).
- Primary renewable energy production in the Mediterranean;
- Share of renewables in the electricity production;
- Share of renewables in the transport sector that explores the contribution of renewable energy in biofuels' production in the study region (EU target for 2020: 10%).

Gross Final Energy Consumption in the Mediterranean

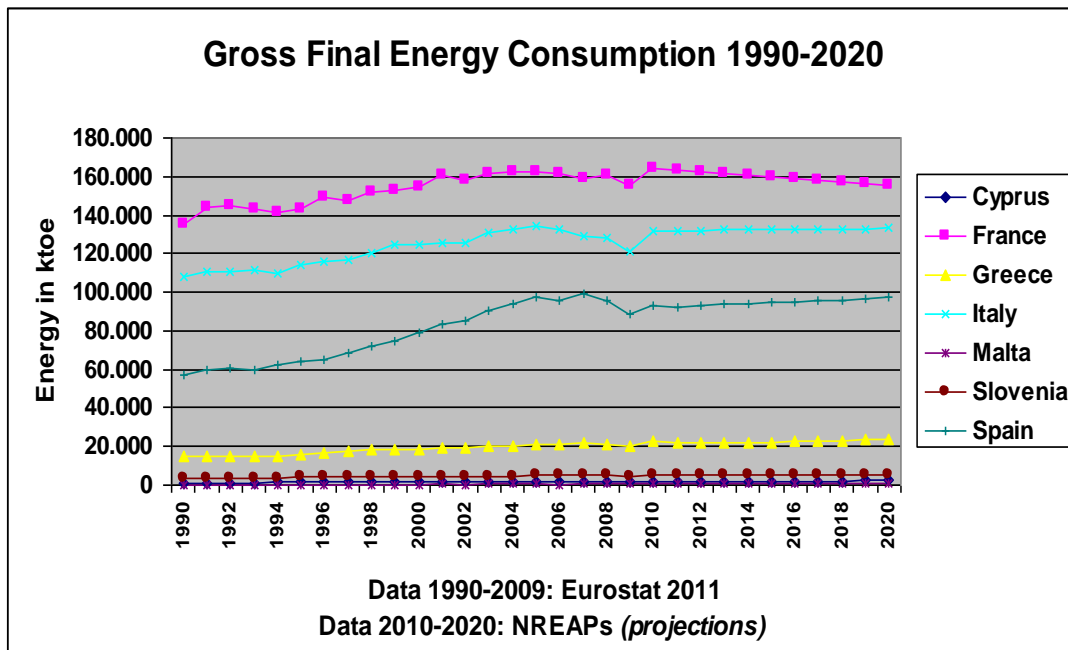
EUROSTAT data shows that the gross final energy consumption in the study region exhibits a diverse pattern of development over the period 1990-2009 (Fig. 5). Most of the countries present both upward and downward trends. France, Italy and Spain exhibit higher fluctuations from 1990 to 2009, while for the period 2010-20, a certain stabilization or even decrease in energy consumption pattern is planned (e.g. France). Greece and Cyprus, with a few exceptions, exhibit a steadily increasing trajectory in energy consumption, although this tends to stabilize in the period 2010-20, as predicted in their NREAPs. Malta is also exhibiting several ups and downs in the period 1990-2009, while in the decade 2010-20 an increasing pattern of energy consumption is planned in its NREAP.

⁵ Year 2005: renewable energy base year for scenario building towards meeting the mandatory targets in 2020.

⁶ 'Additional energy efficiency' scenario: scenario based on the projection of various energy-related issues, common for all EU member states, in order to estimate the development of the renewable energy sector in 2020 in the EU member states, taking into account all additional energy efficiency measures to be adopted from 2009 onwards.

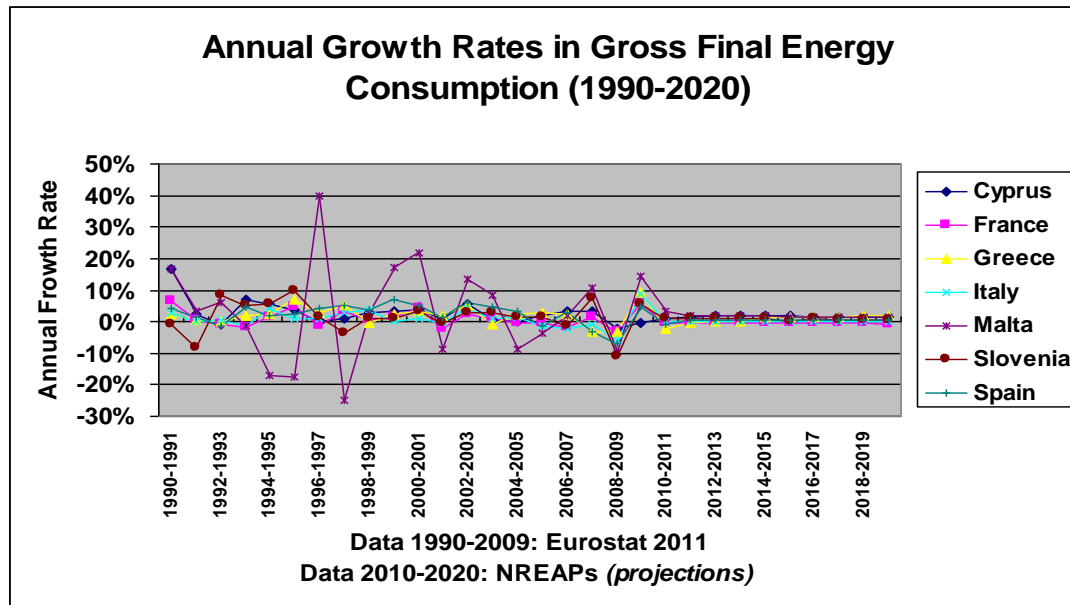
In general, all NREAPs of the Mediterranean countries are heading to stabilized energy consumption patterns for the years 2010-2020, based on policy interventions for rational use and saving of energy (see Fig. 5).

Fig. 5: Gross final energy consumption 1990-2020
 Source: EUROSTAT and NREAPs data, own elaboration



As to the annual increase rates in gross energy consumption, most countries exhibit certain stability, with converging among countries ups and downs, apart from Malta, which exhibits irregular patterns of average annual rates in gross final energy consumption, with considerable peaks (Fig. 6). More specifically, during 1990-2009, Malta, Cyprus, Spain and Greece exhibit the highest average annual rates in gross final energy consumption (3.21%, 2.95%, 2.56%, and 2.21% respectively), followed by Slovenia, Italy and France (1.54%, 1.06% and 1.01% respectively).

Fig. 6: Annual growth rates in gross final energy consumption (1990-2020)
 Source: EUROSTAT and NREAPs data, own elaboration

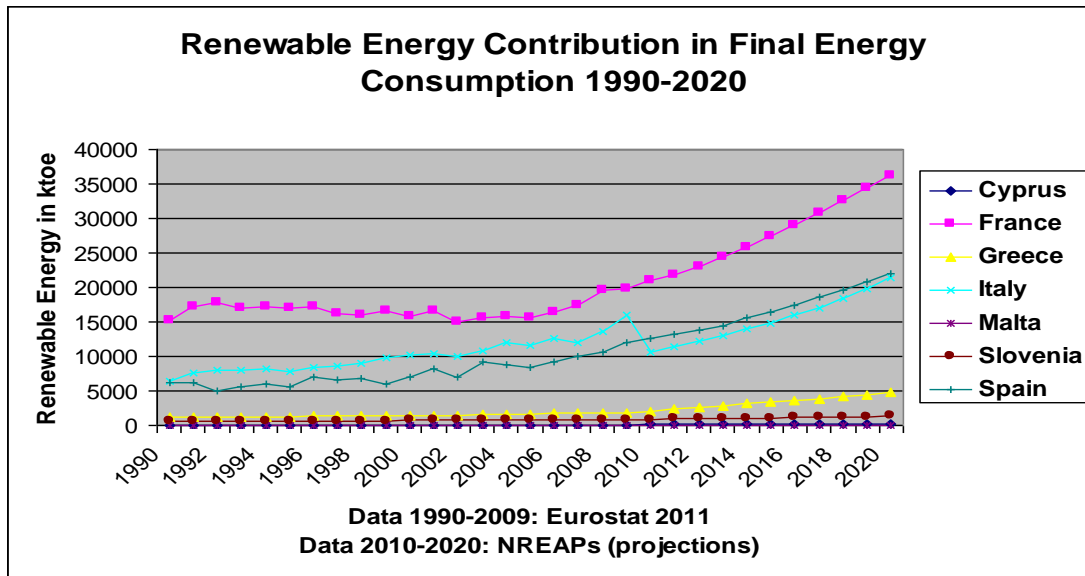


During 2010-20, average annual growth rates in gross final energy consumption exhibit a steadily decreasing trajectory in all Mediterranean countries, reflecting their efforts for rational use of energy and energy saving. Only France exhibits steadily decreasing negative average annual growth rates, implying a year by year decrease of the final energy consumption in the period 2010-20. In the rest of the Mediterranean countries, it is noticed a decrease in the average gross annual rates in final gross energy consumption, which nevertheless remain positive. This implies that final gross energy consumption in these countries is still increasing in this period, but at lower pace, based on lowering energy consumption policies.

Share of Renewables in Gross Final Energy Consumption in the Mediterranean

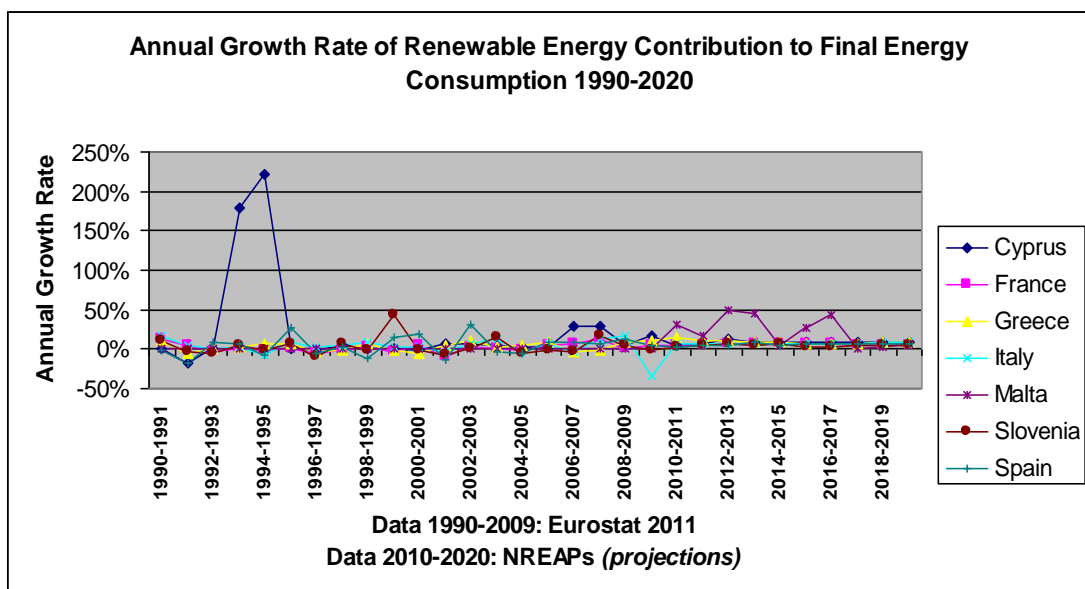
The share of renewable energy in the final energy consumption in the EU Mediterranean countries, based on the EUROSTAT and RERISK Project data, seems to follow an increasing pace during 1990-2009, with countries exhibiting diversified efforts in this respect (Fig. 7). The only country with zero share of RE in this period is Malta (0% share of renewables). Cyprus has made a quite remarkable progress, Italy, Spain, Slovenia and Greece have also considerably raised their share of RE in the final energy consumption, while France follows.

Fig. 7: Renewable energy contribution in final energy consumption
 Source: EUROSTAT and NREAPs data, own elaboration



The annual growth rates of the share of renewable energy in the final gross energy consumption, for the period 1990-2009, are exhibiting a rather unstable trajectory in the Mediterranean countries, with sharp peaks (ups and downs) during the whole period (see Fig. 8). Exception from the above is Malta, where the share of RE is zero (no renewables in Malta’s final gross energy consumption).

Fig. 8: Annual growth of renewable energy contribution to final energy consumption
 Source: EUROSTAT and NREAPs data, own elaboration



When average annual growth rates are considered, Cyprus is at the top, exhibiting an average annual growth rate of 24.34%, which reflects the remarkable efforts undertaken by Cyprus at this period. Spain, Greece, Slovenia and Italy follow, at a distance, with average annual growth rates of 4.40%, 3.27%, 3.18% and 3.15% respectively. Last comes France, with average annual growth rate of RE at 1.75%, that reflects the starting point (share of RE in gross

final consumption at the beginning of the period) as compared to the rest of the Mediterranean countries.

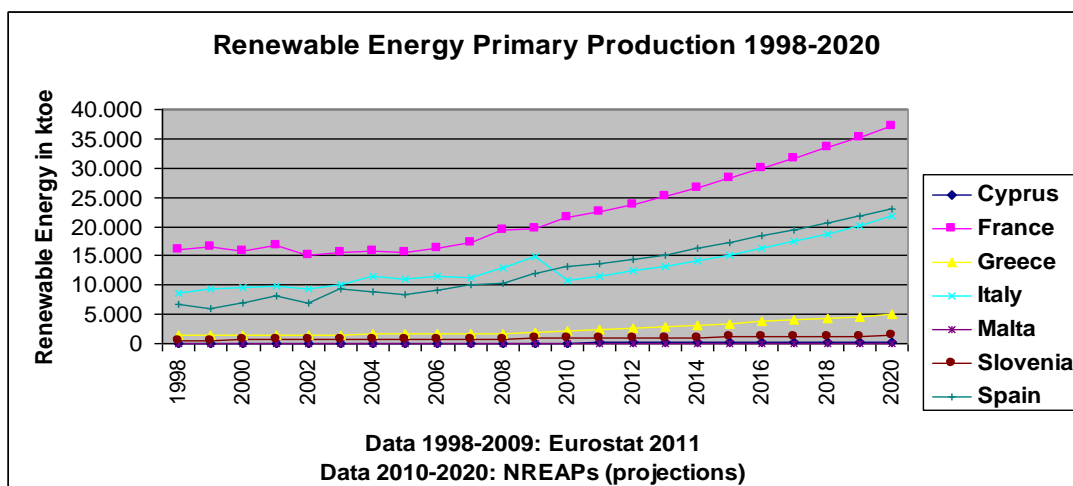
The planned renewable energy contribution to the final gross energy consumption for the period 2010-20, indicates that more dedicated efforts are requested from the Mediterranean countries. More specifically, Malta should follow a very quick pace with average annual growth of RE in final energy production of 22.77%, which is the largest among the Mediterranean countries. It follows Greece and Cyprus (9.06% and 8.75% respectively), while last come Italy, Spain, France and Slovenia (7.31%, 5.69%, 5.62% and 4.40%).

The above annual growth rates for the period 2010-20, compared with those of the period 1990-2009, clearly show rather ambitious efforts needed, by each Mediterranean country, for reaching the EU overall RE target by 2020. This implies that for reaching the national mandatory targets set, countries should follow strictly their national renewable energy action plans, as in most of the countries there is a 'long way' between the target values in 2020 and the 'starting point' in 2009.

Primary Renewable Energy Production in the Mediterranean

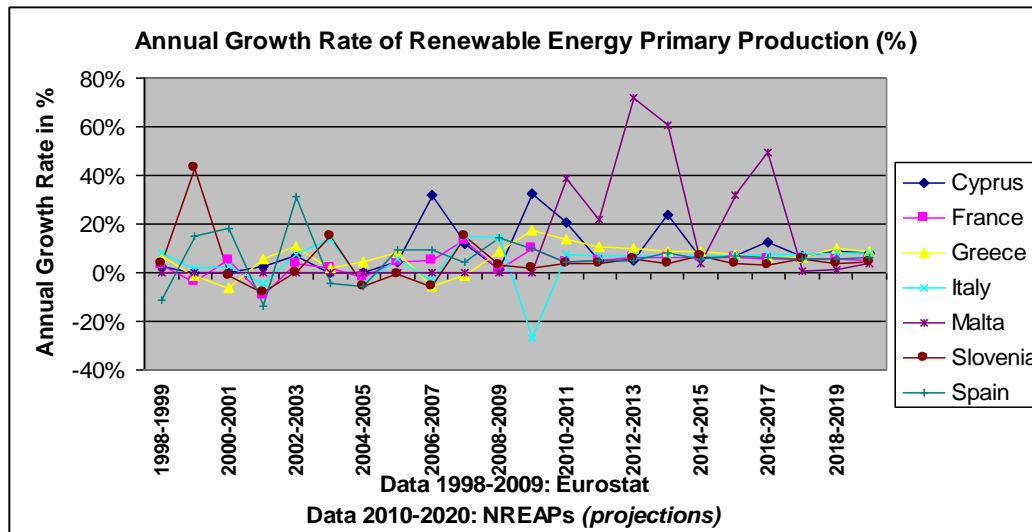
EUROSTAT data for the period 1998-2009 exhibit Spain, Italy and Slovenia to have reached increasing trajectories of primary renewable energy production, with certain upward peaks, which place them in ranking high in the study region (see Fig. 9 and 10). France and Greece follow, exhibiting a steadily increasing pace in RE primary production for 1998-2009, while Cyprus exhibits a rather fast pace, mostly after its accession in the EU. Finally, Malta keeps the lowest place, for the period 1998-2009, with zero RE primary production in its territory, although a member of the EU since 2004.

Fig. 9: Primary renewable energy production 1998-2020
Source: EUROSTAT and NREAPs data, own elaboration



During the period 2010-20, Greece and Cyprus, as shown in their NREAPs, have to follow a faster pace when compared to the rest of Mediterranean countries, as they are far from the national 2020 target. France and Spain are closer to their national 2020 targets, implying a larger potential for reaching them. Italy and Slovenia are in an even better position, in this respect, while Malta (the only country of the Mediterranean basin with zero contribution of renewable primary energy production for the period 1998-2009) has to devote extra efforts in the period 2010-20, in order to meet its national targets.

Fig. 10: Annual growth of renewable energy primary production
Source: EUROSTAT and NREAPs data, own elaboration



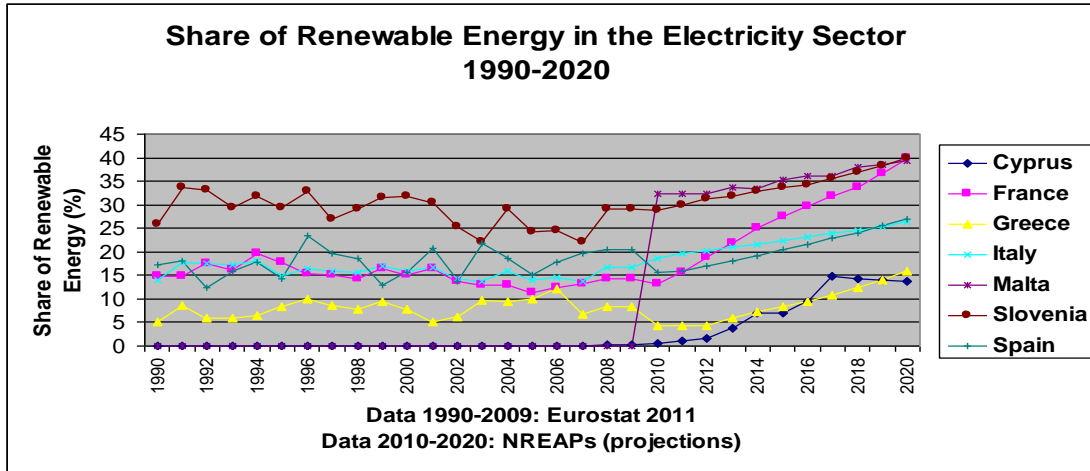
For the period 2010-20 (see NREAPs of the EU Mediterranean countries), it is evident that all countries have to devote considerable efforts for reaching their 2020 national targets.

Malta is at the bottom with zero RE primary production. Cyprus and Greece, despite satisfactory average annual growth rates during 1998-2009 (7.76% and 4.17% respectively), need to enhance their efforts (average annual growth rates 10.42% and 9.06%) for reaching national targets in 2020. On the other hand, Spain, Italy, France and Slovenia, based on their fast pace in the period 1998-2009 (6.39%, 2.50%, 2.66% and 5.06% respectively), need to follow a relatively low average annual growth rate for the period 2010-20 (5.8%, 7.3%, 5.6% and 4.4% respectively), when compared to the rest of the Mediterranean countries, in order to reach their national 2020 targets.

Share of Renewables in Electricity Production in the Mediterranean

The share of renewable energy in electricity production shows a large variation among Mediterranean countries during the period 1990-2009 (Fig. 11). Slovenia and Spain keep the first and second places respectively, although Spain exhibits a slightly decreasing average annual growth rate (-0.08%). Moreover, they also exhibit the largest fluctuations, compared to the rest of the Mediterranean countries. France and Italy show rather stable patterns with comparable values. France shows a slightly decreasing average annual growth rate for the period 1990-2009, unlike Italy, which exhibits an increasing average annual growth rate. Greece also exhibits a high fluctuation for the period 1990-2009, ending up to a slightly decreasing average annual growth rate of the share of renewables in electricity. Finally, Cyprus and Malta show zero shares of renewables in electricity for the period 1990-2006 and 1990-2009 respectively, with Cyprus making the first steps in the field by 2007, while Malta in 2010.

Fig. 11: Share of renewable energy in the electricity sector 1990-2020
 Source: EUROSTAT and NREAPs data, own elaboration

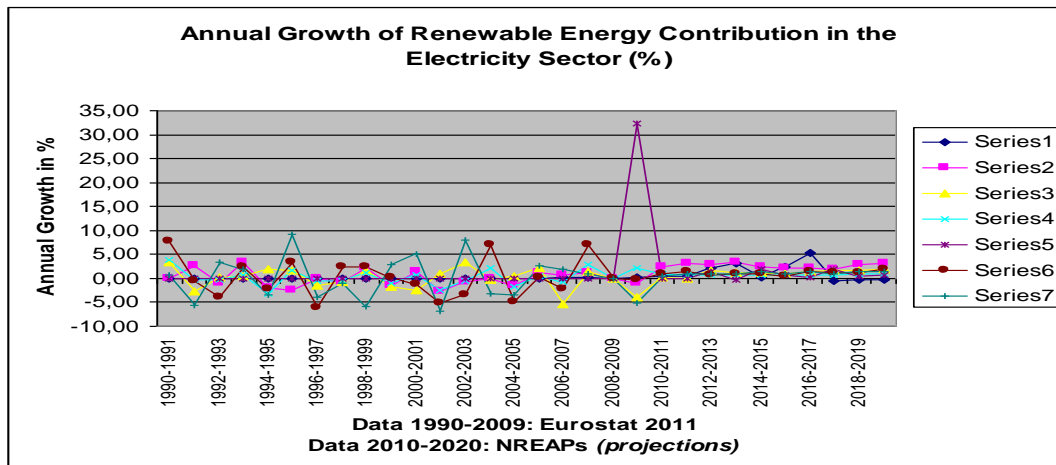


Based on the average annual growth rates of the share of renewables in electricity production, during 1990-2009 (Fig. 12), it can be seen a very little progress, in the Mediterranean, with some of the countries exhibiting negative average annual growth rates (France -0.08%, Greece -0.03 and Spain -0.08%), while others positive rates (Cyprus 0.03%). The highest positive average annual growth rate is exhibited by Italy (0.24%).

For the period 2010-20, Mediterranean countries, based on the mandatory targets for renewable energy set by the EU, need to undertake focused efforts, strengthening their efforts towards the end year 2020.

In addition, based on the national sectoral targets for 2020, France is exhibiting the highest average annual growth rate (2.65%), followed by Cyprus, Greece, Spain and Slovenia (1.32%, 1.17%, 1.15% and 1.12% respectively), while at the bottom rank Italy and Malta (0.77% and 0.69%).

Fig. 12: Annual growth of renewable energy contribution in the electricity sector
 Source: EUROSTAT and NREAPs data, own elaboration



Share of Renewables in the Transport Sector in the Mediterranean⁷

The share of renewable energy in the transport sector in the Mediterranean countries in 2005, presents *two groups* of countries. The first group comprises countries with some progress in the field, namely France (1.2% share in transport), Spain (1.1%), Italy (0.9%) and Slovenia (0.3%); and the second group, comprising countries that embark from the zero level (Cyprus, Malta and Greece). This to a certain extent may explain their difficulty to meet the 2010 biofuels' target of 5.75%.

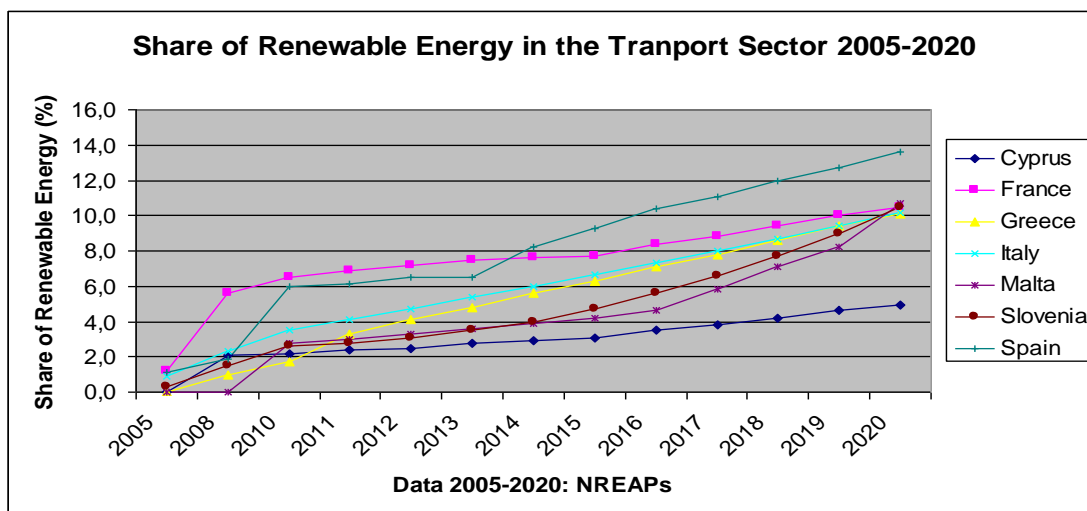
The biofuels' target has been estimated as likely to be reached only by two countries in the Mediterranean basin, namely France (6.5%) and Spain (6.0%) (Fig. 13), while the rest appear to be lagging behind in respect to the 2010.

Nevertheless, the pattern of the share of biofuels in the transport sector has followed an upward trajectory to 2010 (Fig. 13). Based on the average annual growth rates in the period 2005-08, France and Spain are keeping their pace (average annual growth rate 1.06% and 0.98% respectively), followed by Malta and Italy (0.56% and 0.53%), Slovenia and Cyprus (0.46% and 0.44%) and finally Greece (0.34%).

For the period 2010-20, efforts are steadily increasing, according to the NREAPs of the Mediterranean countries. In this respect, Malta, Slovenia, Greece and Spain appears that need to undertake the most dedicated effort in order to reach sectoral targets (average annual rate of 0.8% for all four countries), together with Italy (0.7%), while France and Cyprus may keep a slower pace, based on the progress already achieved (rates 0.4% and 0.3% respectively).

Fig. 13: Share of renewable energy in the transport sector 2005-2020

Source: EUROSTAT and NREAPs data, own elaboration

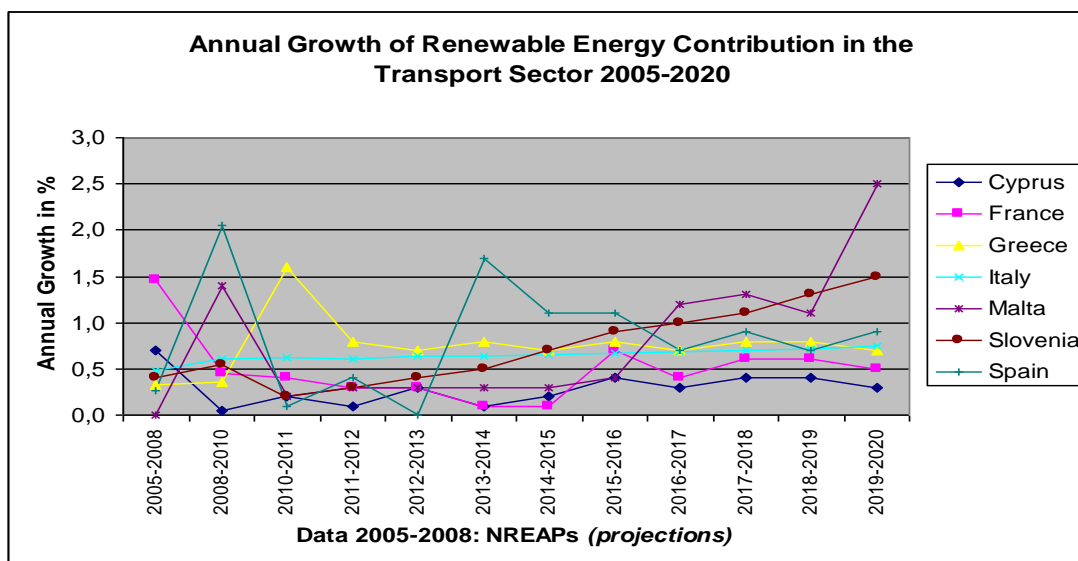


The annual growth rates of the Mediterranean countries on the share of RE in the transport sector, for the period 2010-20, have as follows: France, Malta and Spain exhibit rather irregular patterns of annual growth rates, with France placing special emphasis at the take off of the period. The most regular annual growth pattern is exhibited by Italy, Greece and Cyprus, respectively. Finally, Slovenia shows steadily increasing annual growth rates, having strengthened its efforts during the last few years.

⁷ The data used at this stage is emanating from the NREAPs of the Mediterranean countries, as EUROSTAT data exists only for two of the seven Mediterranean countries (France and Spain) for the years 2005-2008.

Fig. 14: Annual growth of renewable energy in the transport sector 2005-2020

Source: EUROSTAT and NREAPs data, own elaboration



The comparison of the annual growth rates for 2005-08 and 2010-20 respectively shows that Greece (0.336% and 0.8%), Slovenia (0.46% and 0.8%), Malta (0.56% and 0.8%) and Italy (0.526% and 0.7%) should strengthen their efforts in order to reach the 2020 national targets. Spain (0.98% and 0.8%) and Cyprus (0.44% and 0.3%), on the other hand, are in a better position, as they can continue with almost the same pace, while France (1.06% and 0.4%) may lower pace in order to reach the national target.

Conclusions

The Mediterranean countries are enjoying an abundance of resources to be used potentially as renewable energy sources. The experience of renewable energy development patterns in the period 1990-2009 clearly shows the diversifying efforts dedicated by the different Mediterranean countries. Moreover, the study of the pattern of RE development in the period 1990-2009 shows several ups and downs in most of the countries, advocating the fact that not fully concrete or literally followed RE development plans were in place, which, taking also into account the non-binding nature of 2010 targets, has driven a more 'loose' trajectory of RE developments in the Mediterranean countries. More specifically, the following patterns of RE development are shown:

- The share of renewables in gross final energy consumption has made a considerable progress in most countries (Italy, Spain, Slovenia and Greece, followed by France), while Malta has zero progress, although member of the EU since 2004.
- As to the primary renewable energy production, Spain, Italy and Slovenia rate first in their efforts, followed by France and Greece, while last comes Malta, with zero primary RE production.
- Slovenia and Spain rate first as to the share of renewables in electricity production. Second rate France and Italy, exhibiting rather stable patterns, while Greece follows. Cyprus and Malta have zero share of RE in electricity production, with Cyprus taking the first steps in 2006 and Malta in 2010.
- Finally, as to the share of renewables in the transport sector (time period 2005-08), France and Spain are rating first, being the only countries of the Mediterranean reaching the 2010 EU biofuels' target (5.75%), while Italy and Slovenia follow. Finally, Greece, Cyprus and Malta start from scratch and are far away from the EU target in 2010.

In decade 2010-20, the Mediterranean countries need to undertake a more substantial effort, based on the national 2020 mandatory targets they have to meet. This effort of course is differing from country to country, based on a number of factors, such as the starting point, RE potential, etc. More specifically:

- As to the RE contribution to final gross energy consumption, Malta has to undertake the most substantial effort, followed by Greece and Cyprus, while at the bottom lie Italy, Spain, France and Slovenia.
- In the primary RE production sector the situation is similar, with Malta rating first as to the effort needed for reaching 2020 targets.
- All countries need to undertake focused efforts in order to reach 2020 targets in respect to the share of RE in the electricity production.
- Finally, as to the biofuels' share in transport, Malta, Slovenia, Greece, Spain and Italy need to place more effort to reach the mandatory targets, in respect to Cyprus and France that have already made considerable progress in the previous period and thus can lower their level of effort.

Based on the previously presented analysis of past (1990-2009, EUROSTAT) and projected RE data (2010-20, NREAPs) for the Mediterranean countries, it is evident that most of them should strengthen their efforts in order to fulfill commitments undertaken towards meeting the EU 2020 targets. This can be further justified by the *gap* existing between the pattern of RE in 2010 and the targeted RE pattern in 2020; and the average annual growth rates followed in 1990-2009 in respect to the average annual growth rates needed in 2010-20 for the renewable energy sectors examined in this study.

In this respect, there is a need to undertake more dedicated efforts and strictly follow the implementation and monitoring of the NREAPs, as most of the Mediterranean countries have a 'long way' to cover towards RE mandatory targets in 2020.

References

1. COM (1995) 682, An Energy Policy for the European Union, Commission of the European Communities, Brussels (13.12.1995).
2. COM (1997) 599, Energy for the future: Renewable energy sources of energy, White Paper for a Community Strategy and Action Plan, Communication from the Commission, European Commission (26.11.1997).
3. COM (2000) 769, Towards a European Strategy for the Security of Energy Supply - Green Paper, Commission of the European Communities, 29.11.2000.
4. COM (2001) 69, Implementation of the Community Strategy and Action Plan on Renewable Energy Sources (1998-2000), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 16.2.2001.
5. COM (2006) 848, Renewable Energy Road Map - Renewable energies in the 21st century: building a more sustainable future, Communication from the Commission to the Council and the European Parliament, Brussels, 10.1.2007.
6. COM (2011) 31, Renewable Energy: Progressing towards the 2020 Target, Communication from the Commission to the European Parliament and the Council, Brussels, 31.1.2011.
7. Directive 2001/77/EC, Promotion of electricity produced from Renewable Energy Sources in the Internal Electricity Market, European Parliament and the Council, 27.9.2001.
8. Directive 2003/30/EC, Promotion of the use of biofuels or other renewable fuels for transport, European Parliament and the Council, 8.5.2003 (OJ L 123, 17.5.2003).
9. Directive 2009/28/EC, Official Journal of the European Communities, Directive of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
10. EC (2004), Local energy action: EU good practices, European Commission, Directorate General for Energy and Transport, ISBN 92-894-8218-4, Belgium.

11. EREC (2008), Renewable energy target for Europe – 20% by 2020, European Renewable Energy Council, November.
12. ESPON RERISK (2010), RERISK Final Report, The ESPON 2013 Programme ReRisk: Regions at Risk of Energy Poverty, Applied Research Project 2013/1/5, European Union.
13. EUROSTAT (2011), Environment and Energy / Energy / Main Indicators – Energy Statistics.
14. Meyer, N.I. and Koefold, A.L. (2003), Danish energy reform: policy implications for renewables, *Energy Policy* 31(7): 597-607.
15. Stracham, P.A., D. Lal and F. Von Malmberg (2006), The evolving UK wind energy industry: Critical policy and management aspects of the emerging research agenda, *European Environment* 16, Wiley & Sons Ltd and ERP Environment, 1-18.
16. National Renewable Energy Action Plan of *Spain* 2011-2020, 30 June 2010, Ministerio de Industria, Turismo y Comercio, Spain.
17. National Action Plan for the Promotion of Renewable Energies of France, 2009-2020, in accordance with Article 4 of European Union Directive 2009/28/EC, Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer.
18. National Action Plan for the Promotion of Renewable Energies of Greece, 2010-20, Ministry of Environment, Energy and Climate Change, July 2010.
19. Italian National Renewable Energy Action Plan (in line with the provisions of Directive 2009/28/EC and Commission Decision of 30 June 2009), Italian Ministry for Economic Development, 30 June 2010.
20. Malta's National Renewable Energy Action Plan as required by Article 4(2) of Directive 2009/28/EC, 6 July 2010.
21. National renewable energy action plan, 2010-2020 (NREAP), Slovenia, Ljubljana, July 2010.