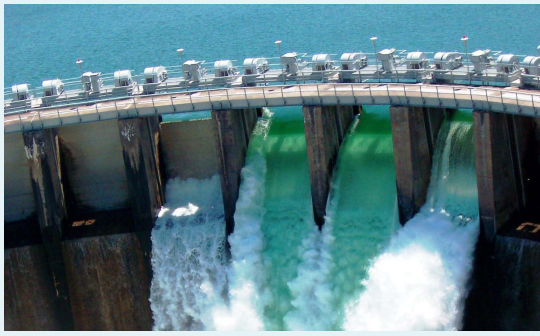
Blue Plan Papers 6

INFRASTRUCTURES AND SUSTAINABLE ENERGY DEVELOPMENT IN THE MEDITERRANEAN: OUTLOOK 2025

El Habib El Andaloussi



PLAN BLEU
UNEP/MAP Regional Activity Centre

February 2010

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Contents

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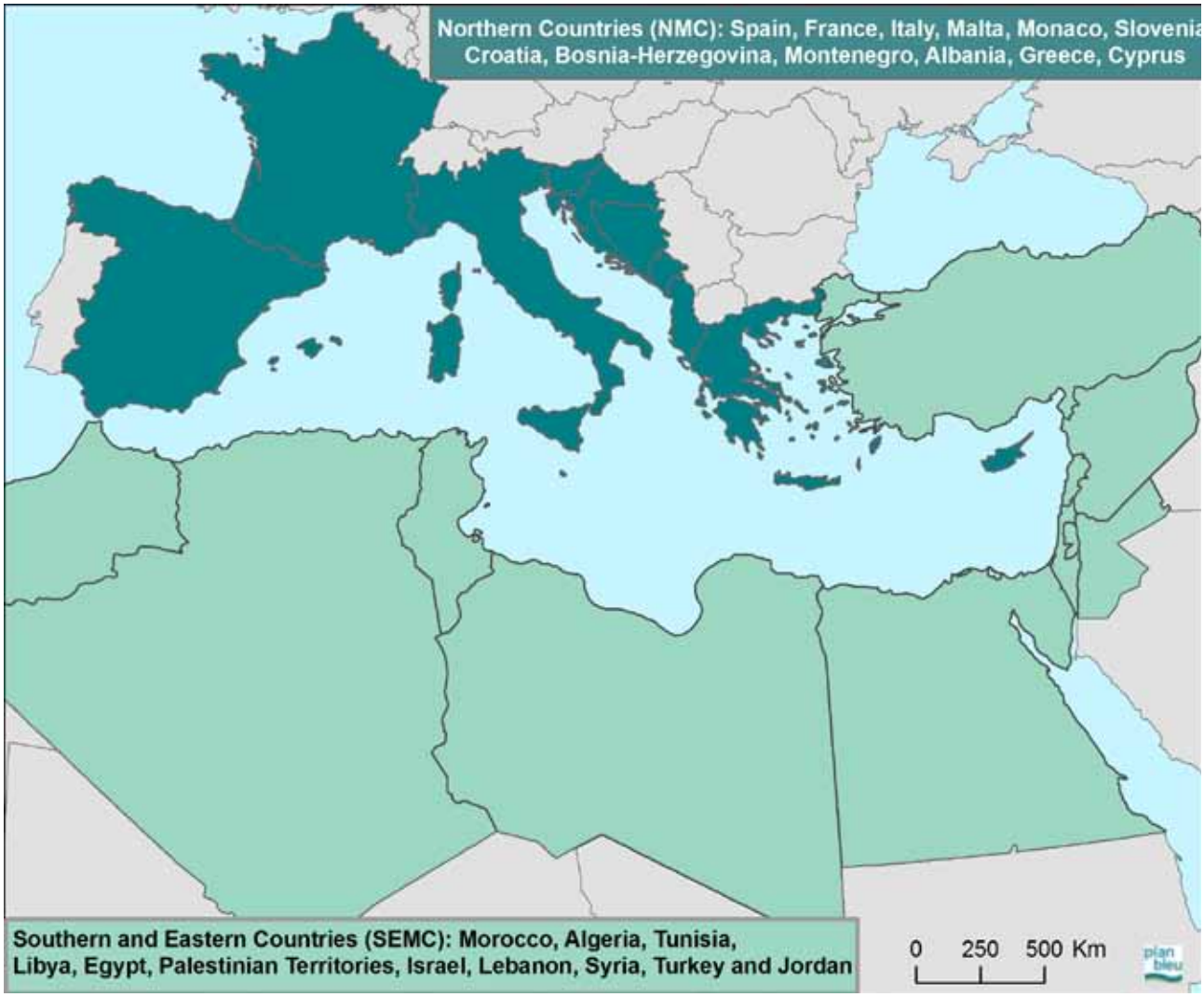
Introduction

Context

The combined effect of demographic pressure and economic growth, the energy system of the Mediterranean region is facing severe constraint, whether of supply, transportation, distribution or consumption. The demand is now covered by more than 80 %, of fossil fuels. In the Southern and Eastern Mediterranean Countries (SEMCs), hydrocarbons account for not less than 94 % of the total energy consumption.

In the Mediterranean, as in all regions of the world, issues of economic development, energy, environment and climate are inherently interrelated. The increase in consumption and in needs requires an increase in energy production that requires structuring investments for the long term, investments that are capital-intensive and that have a long lifetime. To energy supply units, it is necessary to add investments related to transport, storage and distribution, coal harbours, natural gas transportation infrastructures, electricity interconnection and electricity exchange likely to optimize the operation of power plant installed capacities. According to the choices and decisions taken, the generated impacts can be quite different, and this, in terms of cost, carbon balance and GHG emissions, ecological footprint and socio-economic development.

It thus emerges as essential to conduct a reflection on the development of the infrastructures that will help boost exchanges, above all those of power and gas interconnections, from a sustainable development perspective. The purpose is to identify those elements likely to contribute to the achievement of the stated objectives in the ‘’Mediterranean Strategy for Sustainable Development (MSSD)’’.



MSSD objectives

The MSSD has set itself four objectives:

- Contribute to economic development by enhancing Mediterranean assets,
- Reduce social disparities by implementing the Millennium Development Goals (MDGs), and strengthen cultural identities,
- Change unsustainable production and consumption patterns and ensure the sustainable management of natural resources,
- Improve governance at the local, national and regional levels.

The MSSD also aims at fostering energy saving policies and promoting the use of renewable energies. Desirable targets would consist in reducing in the range of 1 to 2% per year of the intensity of energy consumption per GDP unit, a better mobilization of renewable energies to meet 7% of the total energy demand by 2015 and halving the portion of the populations in developing countries not having access to electricity.

Approach adopted

Infrastructures are only a means for the production or transportation of energy. The reflection should belong within a comprehensive approach whose objective is to meet demand and matching sustainable development targets; i.e.: sustainable management of energy resources under economically acceptable conditions and reduction of climate change contributions and impacts via the use of appropriate production and transportation patterns.

This study purports to consider not only the transport and storage infrastructures, but also the energy production facilities intended to meet both domestic demand and exportation needs. Particular focus shall be placed on gas, electricity and renewable energies, knowing that the first two energy sources—reporting significant growth in the Mediterranean—require fixed and dedicated transport and distribution infrastructures, with oil, coal and LNG being exchanged and flowed via conventional transport means (land, rail, sea).

Objective and content

The objective of this study is to conduct an inventory of the entire energy sources and infrastructure options—be they underway or envisioned—which would allow an analysis of the extent of their compatibility with the objectives of sustainable development, in particular those set in the MSSD: i.e., with regard to the reduction of the CO_2 emissions, cost-effectiveness, universal access to electricity, promotion of renewable energies, as well as consideration of environmental impacts and vulnerability to natural and non natural risks.

The study comprises three sections: Energy infrastructures and exchanges, trend or business as usual scenario (BaU) by horizon 2025, and Plan Bleu alternative scenario.

The first section, dedicated to a diagnostic review of the energy situation in the Mediterranean, comprises 3 sub-sections: analysis of the current energy and electricity demand, status of the resources and supply sources of Mediterranean countries, and inventory of the energy infrastructures and exchanges.

The second section puts forward the hypotheses underlying, and the results obtaining from, a trend scenario, comprising the projections of up to 2025 of primary energy consumption, the energy dependence resulting thereby, the electricity sector and the CO2 emissions due to increasing energy consumption, as well as the preliminary lessons learnt.

The third section puts forward an alternative scenario entitled “From Fossil Energy to Green Energy”, which contrasts with the previous scenario by the sobriety of energy consumption, based on a more significant tapping of the energy saving potential, as well as on a more sustained integration of renewable energies. This section includes three sub-sections: selected hypotheses, compared results of the two scenarios and the advantages of the alternative scenario.

Status of the energy sector in the Mediterranean Basin

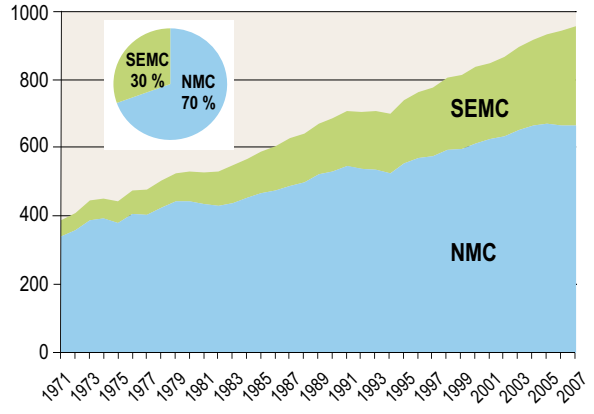
Energy demand

Primary energy: Rapidly increasing demand, espacially in the SEMCs

With a total of 955 million tons of oil equivalent (Mtoe), the Mediterranean region accounted for 8% of the world primary energy consumption in 2007. Between 1971 and 2007, this volume passed from 410 to 955 Mtoe, based on an annual average growth rate of 2.5%. Consumption per capita stood at 2100 Koe. It is 13% higher than the world average, and had increased, on average, at the rate of 1.3% per year between 1971 and 2007.

These figures conceal the consumption disparity between the Northern and Southern rims of the Mediterranean basin. Although the share of the Southern and Eastern Mediterranean Countries (SEMCs) in global consumption has been steadily on the increase since the early 1970s, it accounted for hardly 30% of this consumption in 1970. Indeed, the energy consumption of the SEMCs passed from 48 Mtoe in 1971 to 291 Mtoe in 2007, that is, an average rate of 5.2%, while that of the Northern Mediterranean Countries (NMCs) stood at around 1.9% (340 to 665 Mtoe).

Figure 1 Primary energy consumption in the Mediterranean in 2007, by area (in Mtoe)

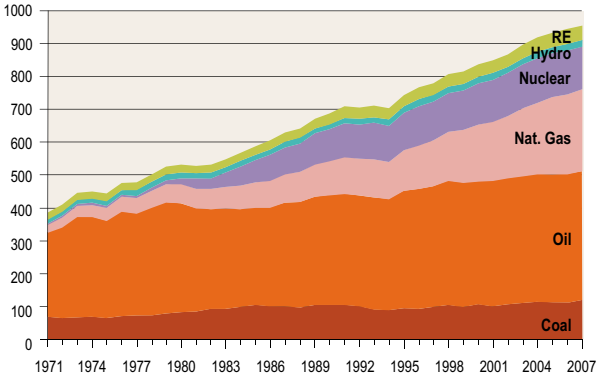


Source: IEA, Energy Balances, Edition 2009

Annual per capita energy consumption increases more rapidly in the South and the East (3.0%) than in the North (1.4%), but it remains 3 times lower in the SEMCs (1.1 toe) than in the NMCs (3.3 toe).

When breaking down the evolution of primary energy consumption by source of energy between 1971 and 2007, the obtaining trend reveals an increase of natural gas penetration in the fuels mix and a relative stability of coal and oil.

Figure 2 Evolution of primary energy consumption in the Mediterranean by source (Mtoe)



Sources : IEA, Energy Balances, Edition 2009

This trend is confirmed by a comparison of the structure of energy consumption by source of 1971 and 2007.

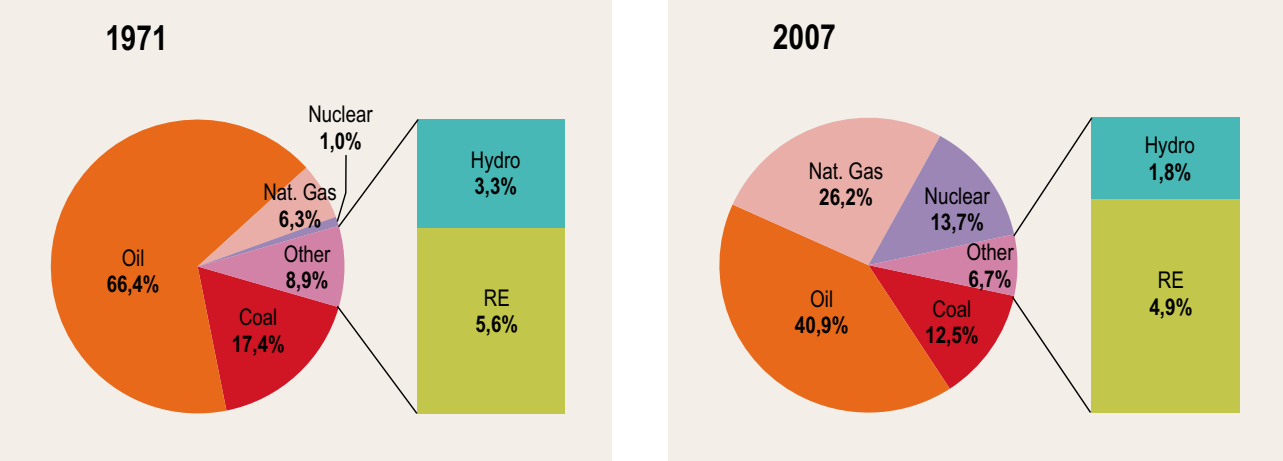
Oil has always been the dominant fuel in the energy mix of the Mediterranean countries. Its consumption increased from 257 Mtoe in 1971 to 391 in 2007, that is, an annual increase by 1.2%. Its share, however, decreased from 66% in 1971 to 41% in 2007.

Natural gas: Over the past decades, the average annual increase in the natural gas demand stood at around 6.7% per year, passing from 24 to 251 Mtoe (that is, around 300 billion m^3). One of the explanatory factors is the high growth of power generation, as resulting from the many gas-powered electricity generation projects.

The share of natural gas in the energy balance passed from 6% in 1971 to 26% in 2007. Currently, it holds a significant position in the energy balance of almost all Mediterranean countries, except for Cyprus, Malta, Palestine and Lebanon. Natural gas consumption in the SEMCs has reported the highest growth among all energy sources, with an average annual rate of 11.3% (from 2 to 101 Mtoe).

Coal consumption passed from 67 Mtoe in 1971 to approximately 119 Mtoe in 2007, that is an average annual increase by 1.6%. Estimates show that coal withstands competition, in spite of the increase in the

Figure 3 Structure of primary energy consumption in the Mediterranean, by source



Source: IEA, Energy Balances; Editions: July 2009 (OECD countries), and September 2009 (Non OECD countries)

use of natural gas. This is related to certain countries (Greece, Spain, Italy) which are at the same time large producers and large consumers, as well as to its use by Turkey, Israel and Morocco, which look upon it as a means of diversification and a guarantee of a additional source of energy.

Nuclear energy: after a period of fast growth between 1970 and 1990, nuclear energy consumption stabilized around 126 to 130 Mtoe between 2000 and 2007. Its share in the energy mix has been in the range of 13 to 14% over the last 15 years. The growth of nuclear energy in the NMCs slackened following the Italian moratorium and the Spanish decision to call off the development of this energy on its territory. Currently, nuclear energy is absent from the energy mix of the SEMCs, even though several projects have been announced.

Renewable energies: The share of renewable energies more than doubled between 1971 and 2007, passing from 35 Mtoe in 1971 to 65 Mtoe in 2007, that is, a growth rate of 1.7% on average per year. However, in 2007, they accounted for a mere 6.7% of the primary energy supply and offered a modest portion in the energy mix.

Case of power demand: A two-digit growth

The consumption of the NMCs, standing at around 1130 TWh in 2007, represented nearly three times that of the SEMCs (422 TWh). It grew fourfold for the region as a whole from 1971 to 2007. Trends confirm a markedly more steady growth in the SEMCs—in the order of 7.9% per year over the past 25 years (between 5 and 17%, according to energy sources), this being due in particular to high consumption in Turkey, Egypt, Tunisia, Algeria and Morocco—than in the NMCs (3.5%). Around three quarters of the power consumption (approximately 1552 TWh in 2007) are consumed in the NMCs. The North/South ratio, in terms of per capita electricity consumption, decreased from 8 in 1971 to 3.6 in 2007.

Around 300 TWh (that is, approximately 16% of the production) constitute the losses due to distribution networks and to the own consumption of the power generation sector. Total power production in the Mediterranean stood at around 1847 TWh in 2007, as against 420 TWh in 1971 (reporting growth rates between 5 and 17%, according to energy sources over the period 1971-2007).

The growth of power production per energy source between the two rims of the Mediterranean is summarized in the table below:

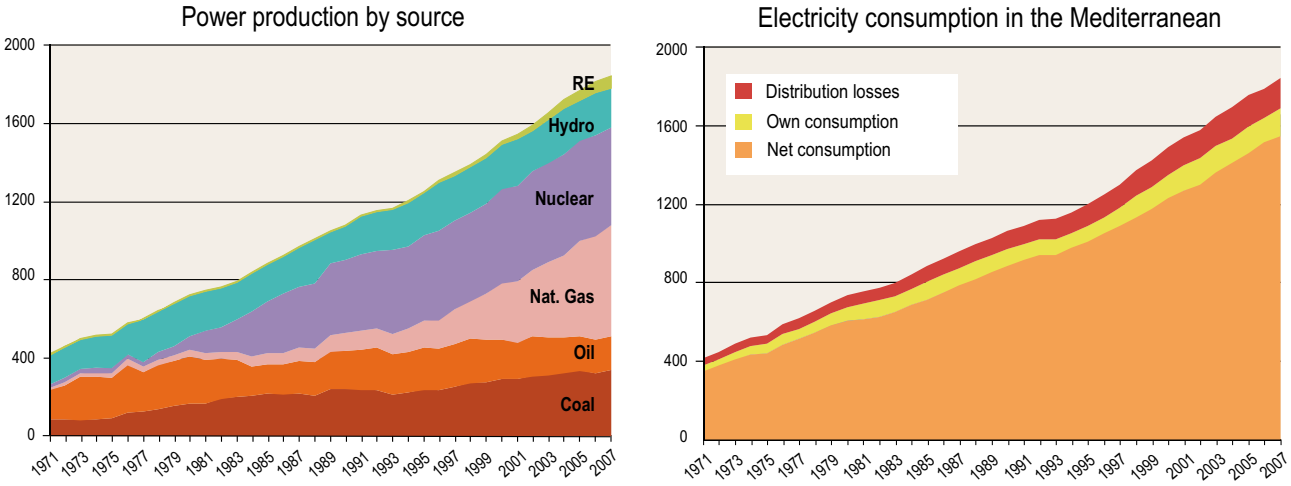
Table 1 Evolution of power production, by source (1971-2007)

	Coal	Oil	Nat. Gas	Nuclear	Hydro	RE	Total
NMC	2.9%	-1.4%	9.8%	10.2%	0.2%	7.3%	3.5%
SEMC	10.1%	4.4%	17.0%		4.8%	6.8%	7.9%
TOTAL	3.9%	0.3%	11.5%	10.2%	0.9%	7.2%	4.2%

Source: IEA, edition 2009

The spectacular growth of natural gas over the period 1971-2007 (+ 17% per year, to reach 266 TWh in 2007), in the SEMCs, is due to the low use of this fuel in the 1970s. In the NMCs, it pursues its penetration at a rapid pace of 9.8%.

Figure 4 Electricity generation and consumption in the Mediterranean



Source: IEA, Energy Balances, editions of July (OECD countries) and September 2009 (Non OECD countries)

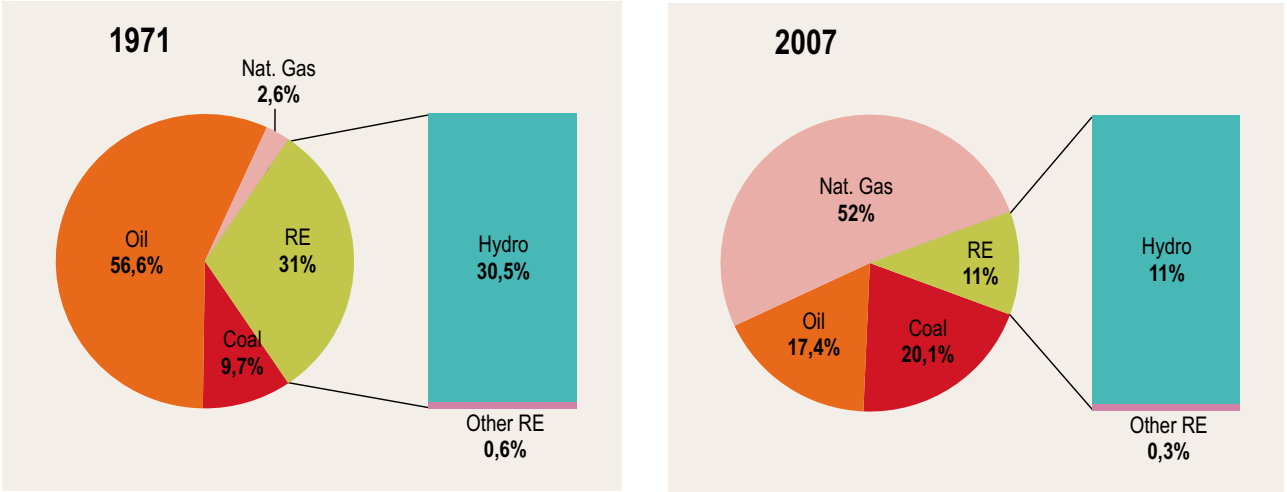
Power production based on coal has, on its part, grown significantly, at an average annual rate of 10.1%; it thus passed from 3 to 104 TWh between 1971 and 2007. Hydro-power passed from 10 to 57 TWh during the period considered. Its share in the total power production decreased, declining from 30 to 11%.

Power production based on renewable energies started back in the 1990s with projects in Morocco and in Egypt, but it stagnated in 2007, accounting for 0.3% of the total power production. Nuclear power production is likely to develop as from 2020, with the power plants projects in Egypt and Turkey.

To meet this electricity demand, the power capacity installed has reported significant growth over the past three decades. Quadrupling the total power production between 1971 and 2006 had required 224 GW of new power generation capacity in the Mediterranean basin, of which over 36% (81 GW) was constructed in the SEMCs. The power capacity installed in the North was, in 2006, of around 340 GW, as against hardly 103 GW in the SEMCs. The capacity installed in France—of 116 GW—is, alone, larger than that of the whole countries of the Southern Mediterranean.

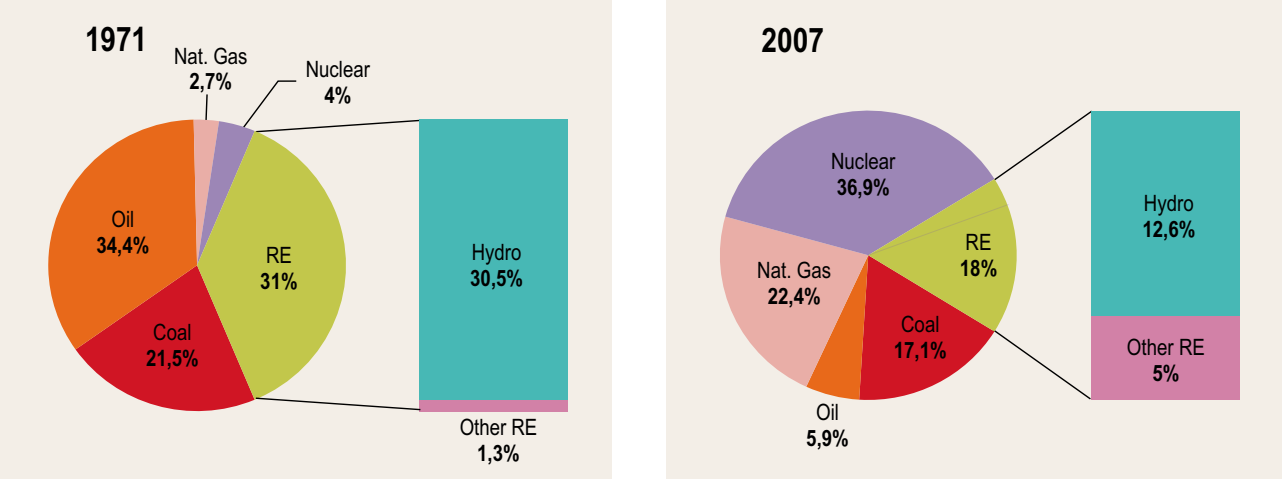
In 2006, natural gas dominated the power generation facilities (24%), followed by hydro-power stations (22%), oil (19%), nuclear power (16%), coal and renewable energies (14 and 6%). The capacity installed in the SEMCs was dominated by natural gas, oil and hydro-power (45, 20 and 19% of the total, respectively).

Figure 5 Power production in the SEMCs, by energy source



Source: IEA, Energy Balances, edition 2009

Figure 6 Power production in the NMCs, by energy source



Source: IEA, Energy Balances, edition 2009

Table 2 Power plants installed in the Mediterranean in 2006 (GW)

ST-Coal*	ST-Oil	ST-gas*	NGCC gas*	GT & Diesel*	Nuclrar	Hydro	RE	TOTAL
60.9	56.4	40.6	66.1	25.4	71.2	97.2	26.2	444
14%	13%	9%	9%	15%	16%	22%	6%	

*ST Steam Turbine; GT Gas Turbine ; NGCC Natural Gas Combine Cycle

Source: OME, National Power Utilities

The capacity installed of renewable energies (not including hydro) reported a significant increase as from 2000, with an average annual growth of over 36%, reaching 26 GW in 2007. This trend is due to the spectacular increase in the wind power capacity, which stood at 21 GW in 2007, as against 3 GW in 2000.

Final energy consumption: The residential and transport sectors on the increase

Total final consumption (TFC) represents the consumption of the final sector users: industry, transport, residential and other (commercial and tertiary, public administration, agriculture . . .).

In the Mediterranean region, the TFC trends per sector are illustrated in the figure below which shows an average growth rate of 2.2% per year between 1971 and 2007. The average annual growth by sector over the same period is of 3.3% for the transport sector, followed by the residential and other sectors (2.4% each) and the industrial sector (1.3%).

Transport continues to be the chief consumer. The structure of energy demand has reported a drastic change over the past three decades. From energy-based industry, the Mediterranean now presents a more balanced consumption, where transport and the residential sector have seen their shares increase.

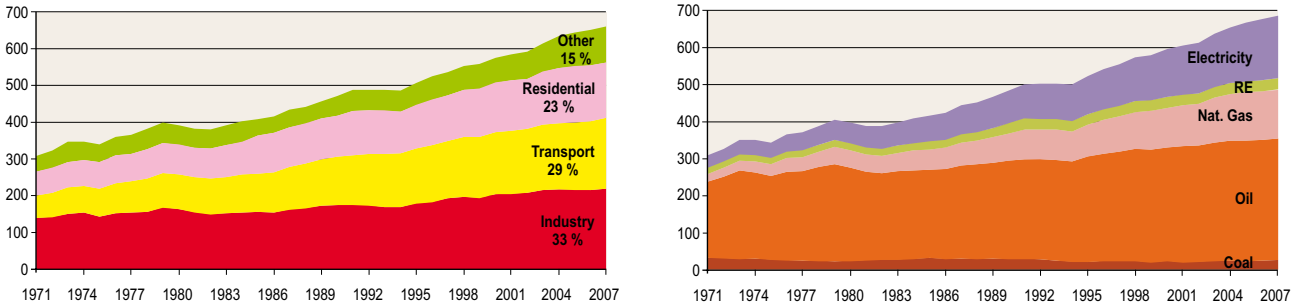
In the NMCs, the TFC by sector reported an average annual growth by 1.5% between 1971 and 2007, whose breakdown goes as follows: 2.8% for transport, 1.8% for the residential sector, 0.3% for industry and 1.8% for the other sectors. The share of the transport sector in the NMCs increased considerably over the period (passing from 19% to 31%).

In the SEMCs, the TFC, of around 202 Mtoe, presents the following breakdown: the industrial sector (37%), the household sector (27%), the transport sector (26%) and the other sub-sectors (11%). The most significant consumption increase relates to the residential sector: + 29%, between 2000 and 2007. The consumption of the industrial sector increased by 25%, while that of the transport sector increased by 23% over the same period.

In 2007, final energy consumption in the SEMCs was primarily based on oil products at 50%, followed by electricity and natural gas (19% each) and, finally, coal (7%). Oil products are mainly dedicated to the transport sector (47%), followed by the industrial sector (26%), the residential sector (17%) and, finally, the tertiary sector (11%)

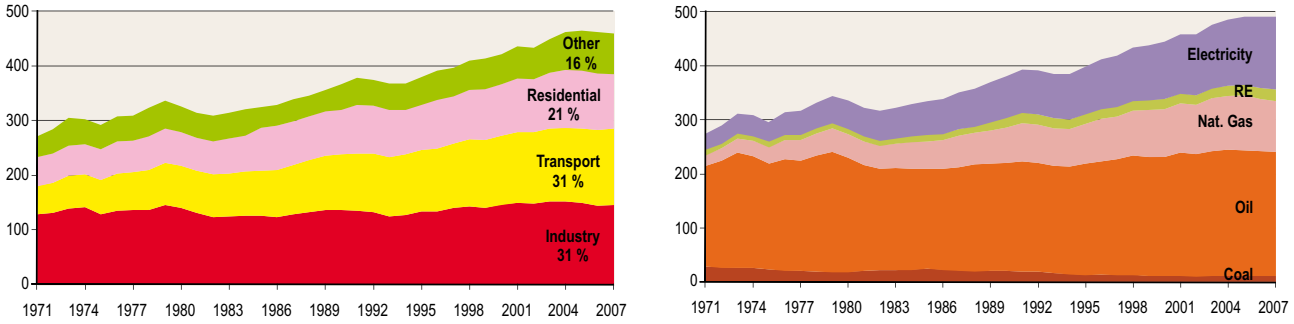
As regards electricity, the final consumption of 422 TWh in the SEMCs remains concentrated in the industrial sector, claiming 39%, followed by the

Figure 7 Total final consumption in the Mediterranean, by sector and by source (in Mtoe)



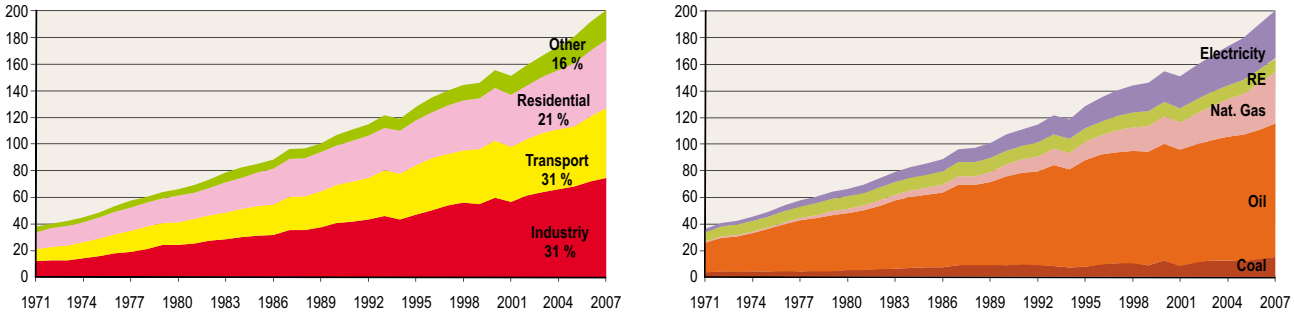
Source: IEA, Energy Balances, Edition 2009

Figure 8 Total final consumption in the NMCs, by sector and by source (in Mtoe)



Source: IEA, Energy Balances, Edition 2009

Figure 9 Total final consumption in the SEMCs, by sector and by source (in Mtoe)



Source: IEA, Energy Balances, Edition 2009

residential sector (35%), the sector labelled "other" (tertiary, agriculture) claiming 25% and transport standing at 1%. As for natural gas, it remains concentrated in the industrial sector claiming 26% and the residential sector claiming 62%, with the remainder being claimed by the other sub-sectors. Coal is consumed almost entirely in the industrial sector (80%), with the remainder being claimed by the residential sector.

The residential sector remains a high potential sector, in particular in the SEMCs. In the SEMCs, the building construction sector accounts for between 18 and 42% of the energy consumed, and there is a significant energy saving potential in this sector. Pilot projects have shown that, with an over-cost in the range of 10 to 15% with respect to the initial construction cost, they may obtain up to 60% of energy saving in this sector. Besides, the SEMCs are reporting a dynamic phase, hence both challenges and opportunities which are somewhat different from those of NMCs. The combination of a steady demographic growth, an increasing rate of urbanization and a rise in the average standards of living implies an increasing energy demand, induced in particular in the building construction sector, with a significant demand on new housing facilities. This offers the opportunity of constituting a low-energy consuming housing stock, which does represent an asset for the region and calls, above all, for an urgent implementation of measures aimed at achieving a "Sustainable Mediterranean Building". In the

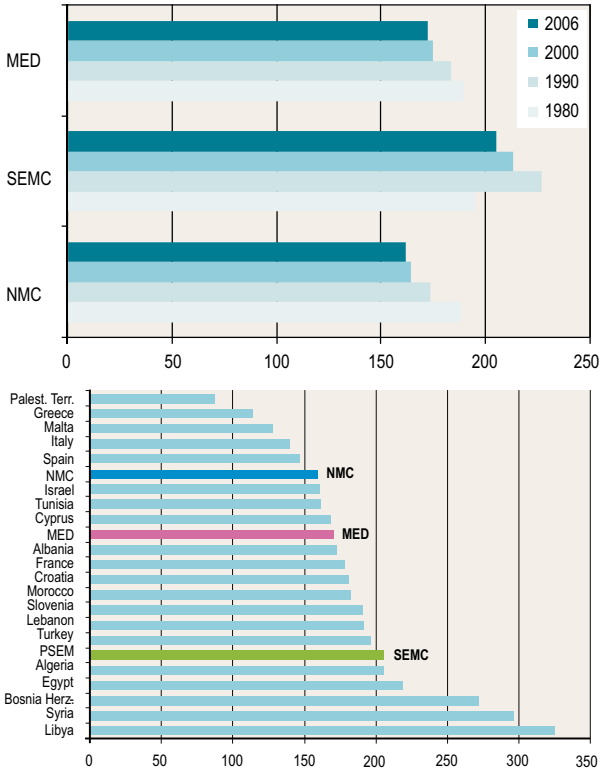
SEMCs, energy efficiency in building construction is, therefore, a strategic stake for control over energy demand. While the time lag, with respect to the other rim of the Mediterranean, is large, anticipation and reversing the scenario are still possible.

Energy efficiency and CO_2 emissions

Is energy used efficiently? There is one first indicator, total or primary energy intensity (EI), to compare between the countries and to measure the evolutions. This is the energy consumption/GDP ratio—the latter being calculated at purchasing power parity (PPP)—in order to take into account the differences in standards of living.

This indicator, which is expressed in toe per unit of GDP, characterizes the degree of "energy sparing/sobriety" of a country or of a mode of development: it measures the quantity of energy consumed for the same level of comfort or production. Energy intensity depends obviously on such factors as climate and structure of the economy. But when one compares countries with similar economic structures, the key factor is the efficiency with which energy is produced and consumed: very roughly speaking, the lower the intensity, the higher the efficiency[1].

Figure 10 Energy intensity in the Mediterranean



Sources: OME, WDI, Plan Bleu computation

1 If one takes the reverse of the EI, which represents energy productivity, the higher the latter, the better is production per energy unit (1 Mtoe).

The early energy efficiency policies were put in place in the wake of the first oil crisis of 1973. The Figure below shows the evolution of primary energy consumption over the period 1980-2006. The lower curve represents effective primary energy consumption, and the upper curve shows what this consumption would have been if the energy intensity of the whole NMCs had remained at its value of 1980. The uppermost section of the diagram (negawatts) represents the savings made in terms of primary energy consumption, as a result of the reduction in total energy intensity. In 2006, the quantity of negawatts for the NMCs stood at around 114 Mtoe, that is, 16% of the primary energy consumption, which is 1.5 times higher than the consumption of oil products in the NMCs. Accordingly, the NMCs achieved, thanks to the improvement of their EI, over the period 1980-2006, aggregate savings in the order of 1300 Mtoe, or the equivalent of about 2 years of consumption (level of 2006).

In the SEMCs as a whole, one notices a stabilization of the level of EI since 1980, marked by an annual average growth of 0.2%. On the other hand, since 1990, several SEMCs have engaged in a process of greater energy sobriety and there may be noted a slight decrease by -0.6% per year from 1990 to 2000 and a little more than -0.7% between 2000 and 2006.

Table 3 Evolution of energy intensity in the Mediterranean (1980 to 2006)

	Total energy intensity (toe per thousand Euros 2006 ppp)				Annual growth rate (%)		
	1980	1990	2000	2006	1980-1990	1990-2000	2000-2006
NMC	0.189	0.173	0.164	0.162	-0.84%	-0.55%	-0.23%
SEMC	0.196	0.227	0.214	0.205	1.50%	-0.61%	-0.68%
Med	0.180	0.183	0.175	0.172	-0.34%	-0.46%	-0.26%

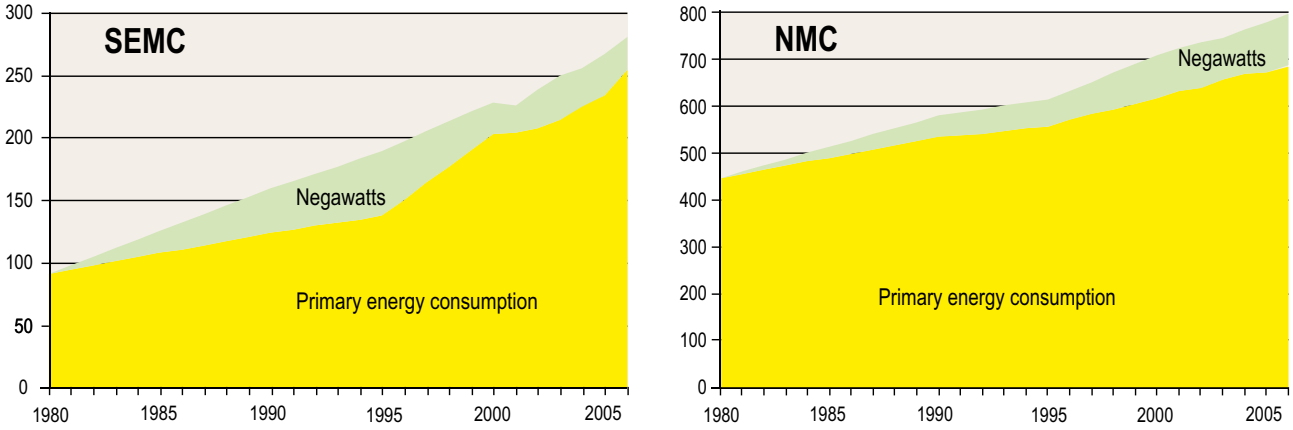
Sources: OME, IEA

The Energy efficiency gains, which could have been obtained if the SEMCs had maintained at the same EI level of 1980 over the period 1980-2006, are estimated as between 5 at 14% per year, that is, an aggregate value of 286 Mtoe over the period 1980-2006, equivalent to over a year of consumption (level of 2006).

Several regional studies, like that of OME, or national studies, like those of the Tunisian or Moroccan Solar Plans, estimate that there is a significant potential generated by control over demand by improving the energy efficiency of industry and better checking the demand for transport, heating and air-conditioning; the potential was estimated as around 300 Mtoe/year by 2025[2].

2 Updating of the estimates issued by Plan Bleu in "A Sustainable future for the Mediterranean: the Blue Plan's environment and development

Figure 11 Energy saving potential obtaining from a decrease in energy intensity



Source: Plan Bleu, State of the Environment and Development in the Mediterranean - 2009, p. 49.

One of the main consequences of this efficiency in the use of energy is **the continual increase in CO_2 emissions**.

In 2000, 72% of Mediterranean GHG emissions could be ascribed to CO_2 due to energy use, distributed as 77% in the NMCs and 64% in the SEMCs. In 2007, the NMCs emitted around two thirds of the CO_2 emissions due to the use of energy of the whole Mediterranean basin. However, the increase in CO_2 emissions is faster in the SEMCs. This growth pace is almost twice faster than the global pace. Electricity (around 40%) and heating constitute the chief contributor to the rise in emissions between 1990 and 2007 in the SEMCs. For the NMCs, the chief contributor is the transport sector (around a third (1/3)).

One can but notice the continual weight of fossil energies over the last period, with a persistence of coal in the energy mix. With 10.2% of the world power consumption and 8.2% of primary energy consumption, the Mediterranean emitted nearly 8% of the global CO_2 emissions in 2007.The comparison between the EU-27 and the Mediterranean region is interesting, as they constitute two sets with roughly the same population size. Primary energy and electricity consumption in the Mediterranean represents not more than a half of the EU-27 consumption, whereas the CO_2 emissions per toe are 6% higher in the Mediterranean compared to those of the EU-27, which clearly attests to the fact that the Mediterranean energy mix is more CO_2 emitting than the European (EU-27) mix, it being even higher when considering that of the SEMCs (+16%).

The NMCs are responsible for two thirds of the region's CO_2 emissions. The major CO_2 emitting countries are Italy, France and Spain. Taking into consideration the current trends, only France and Cyprus would be reducing their CO_2 emissions by 2025. Over time, though, this situation is set to evolve towards CO_2 emissions of an equivalent level on both sides of the Mediterranean. This change will be the result of the combined effect of the legislations on climate change in the NMCs and of economic development in the SEMCs, compounded by an intensive use of fossilfuels.

Considerable and unevenly distributed natural resources, but increasing energy dependence

Limited fossil resources, but inexhaustible renewable sources

The Mediterranean region holds 5% of the world's oil and gas reserves, which are concentrated in the South. Mediterranean countries, particularly the SEMCs, hold proven reserves of around 8 600 million tons (MT) of oil and around 9 000 billion m^3 (Gm^3) of gas. Libya, Algeria, Egypt and Syria concentrate most of the gas and oil reserves. These four countries have a well developed infrastructure for oil and gas production and for exportation of hydrocarbons, mainly to Europe.

Fossil energies (oil, gas, coal) account for 80% of the energy supply. Four producing countries—namely

outlook", 2005. Difference between the primary energy consumption of the Mediterranean countries within the framework of a trend scenario without specific efforts on energy savings, and the same consumption in case these countries make efforts, together with targeted assistance to sustain innovative approaches in matter of energy-efficient housing, etc.

Algeria, Egypt, Libya and Syria—provide 22% of the oil imports and 35% of the gas imports of the whole Mediterranean basin. At the rate of the current production, the lifespan of the oil reserves is around thirty years and that of the gas reserves is around fifty years. The coal reserves, concentrated between Greece and Turkey, total around 9 billion tons for the whole region.

Table 4 Oil and gas reserves and production in the Mediterranean (2007)

	Oil			Natural Gas		
	Reserves (MT)	Production (MT)	R/P Ratio (year)	Reserves (Gm^3)	Production (Gm^3)	R/P Ratio (year)
Algeria	1545	95	16	4580	86,5	53
Egypt	600	34,6	17	2170	55	39
Libya	5700	91,8	62	1540	15,9	97
Syria	409	19,8	21	360	5,5	65
Tunisia	90	4,2	21	97	2,7	36
Italy	99	5,2	19	120	8,4	14
other countries	128			137		
Mediterranean	8571	256	33	9004	178	51

Sources: BP Edition June 2009, CEDIGAZ, OGJ, World Oil, WEC Survey of Energy Resources & national sources

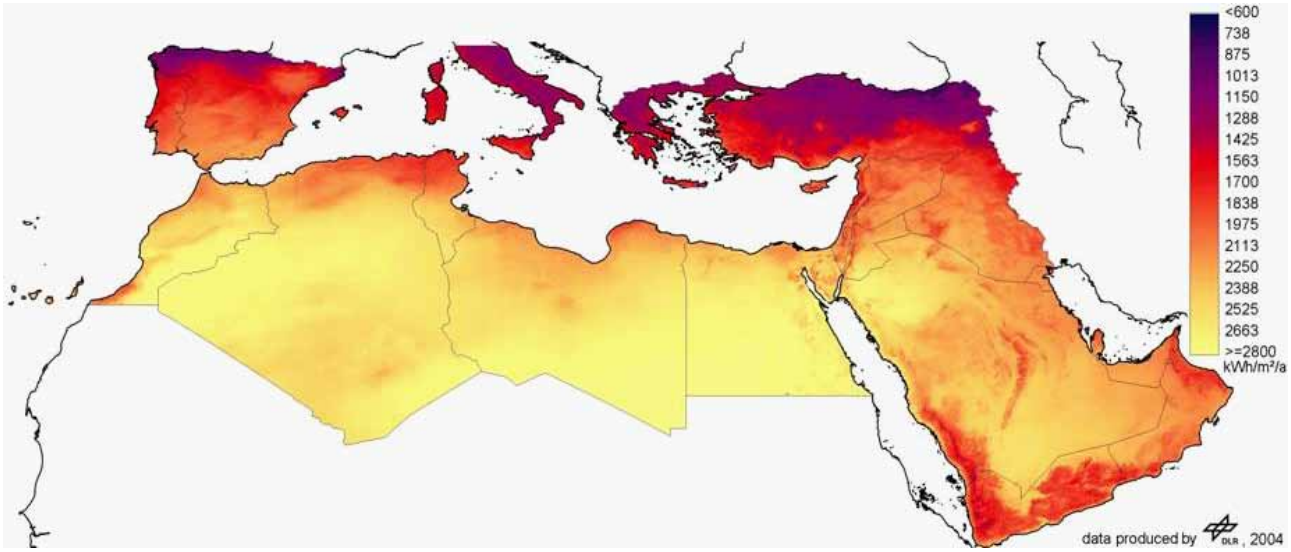
The production of hydrocarbons in the SEMCs amounts annually to 245 MT of oil, over 165 Gm^3 of natural gas and around 12 MT of LPG. The refining capacity is around 500 Mt/year (more than 11% of world capacity) for the 89 Mediterranean refineries, of which 34 in the SEMCs with a capacity of 152 Mt/year. This infrastructure allows an exportation volume of 170 MT of crude oil per year. It is also worth mentioning that Egypt and Turkey are transit countries for most of the oil exported by the countries of the Gulf and the Caspian Sea

As regards renewable energies, the Mediterranean holds a significant potential, particularly in terms of solar and wind energy. As of now, their contribution to meeting the demand is extremely low. Solar radiation is estimated as between 1300 kWh/m²/year on the coast and 3200 in the Saharan desert. The sunshine duration ranges between 2650 and 3600 h/year.

As far as wind energy is concerned, certain sites hold a potential likely to be tapped on a large-scale: Tunisia, in the northern Cap Bon zone; Egypt, on the Red Sea; and—especially—Morocco, in Gibraltar and in the southern zones of Tan Tan, Laayoune Tarfaya. This potential allows for operation over an annual duration ranging from 3500 to 4000 hours.

With 6% of the primary energy supply, renewable energy sources contribute a modest portion to the energy mix. Hydroelectric power is the most largely tapped, and it accounted for over 76% of the 'renewable' power production in 2006. The installed renewable energies capacity (excluding hydro) has been reported significant progress since 2000, with an average annual growth of over 36%, totalling 26 GW in 2007. This trend is due to the spectacular increase in the wind power capacity, totalling 21 GW in 2007, as against 3 GW in 2000.

Figure 12 Annual direct solar radiation map (for 2002)

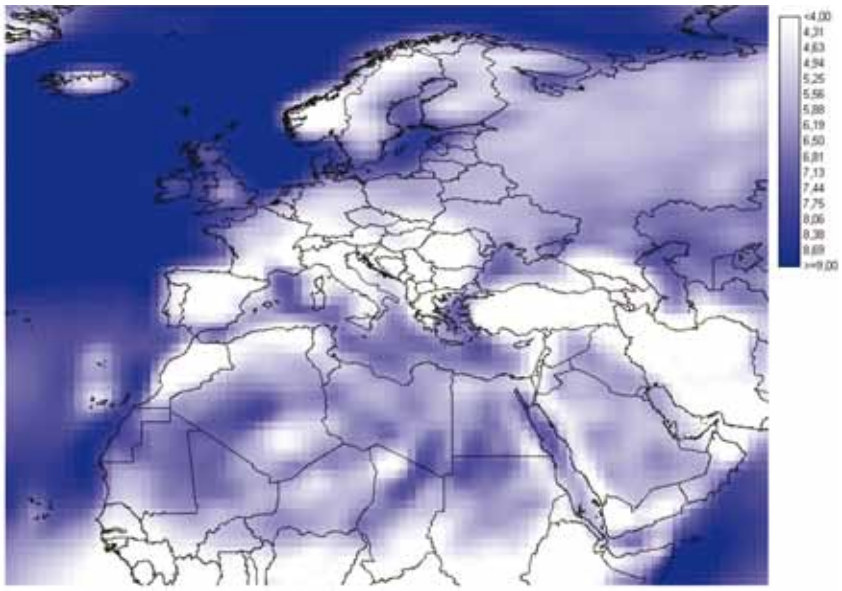


Source: DLR, (www.dlr.de)

To what extent are renewable energies integrated in the energy mix in the Mediterranean? Although reporting an increase by over 88% in volume between 1971 and 2007, renewable energies hardly account for 6.7% (biomass included) of the regional energy balance.

Prompted by incentives, policies and technological progress, renewable energies reported an exceptional growth in the power production sector, with over 9.7%[3] of average growth per year during the period 1980-2007, starting—it must be admitted—from very low values. Growth in the SEMCs stood at 9.9% (from 0.1 to 1.7 TWh), as against 9.7% per year in the NMCs, over the same period (from 5.3 to 61.9 TWh).

Figure 13 Wind resource map (in m/s for 2003)



Source: DLR, 2003 (www.dlr.de)

Table 5 Renewable energies: Power production capacities in 2007 (MW)

	Hydro	Wind	Solar	Geotherm.	Biomass	S/tot RE	Total RE
Spain	18200	15200	500		1000	16700	34900
France	25500	2300	100		1100	3500	29000
Italy	21072	2500	100	700	1200	4500	25572
Greee	3134	900				900	4034
Cyprus						2	2
Malta							
Slovenia	920					30	950
Croatia	2060					20	2080
Serbia&M	3497						3497
Bosnia-H.	2064						2064
Macedonia	503						503
Albania	500						500
NMC	77450	20900	700	700	3300	25600	103050
Turkey	13063	147		15		162	13225
Syria	1528		1			1	1529
Lebanon	276						276
NACs							
Israel						30	30
SE Med	14867	147	1	15		163	15030
Egypt	2783	217	2		36	255	3038
Libya			1			1	1
Tunisia	66	20	1		0,1	21	87
Algeria	275		2			2	277
Morocco	1729	140				140	1869
SW Med	4853	377	6		36	419	5272
SEMCs	19720	524	7	15	36	582	20302
TOTAL	97170	21424	707	715	3336	26182	123352

Source: Eurelectric, IEA, EC/DG-Tren

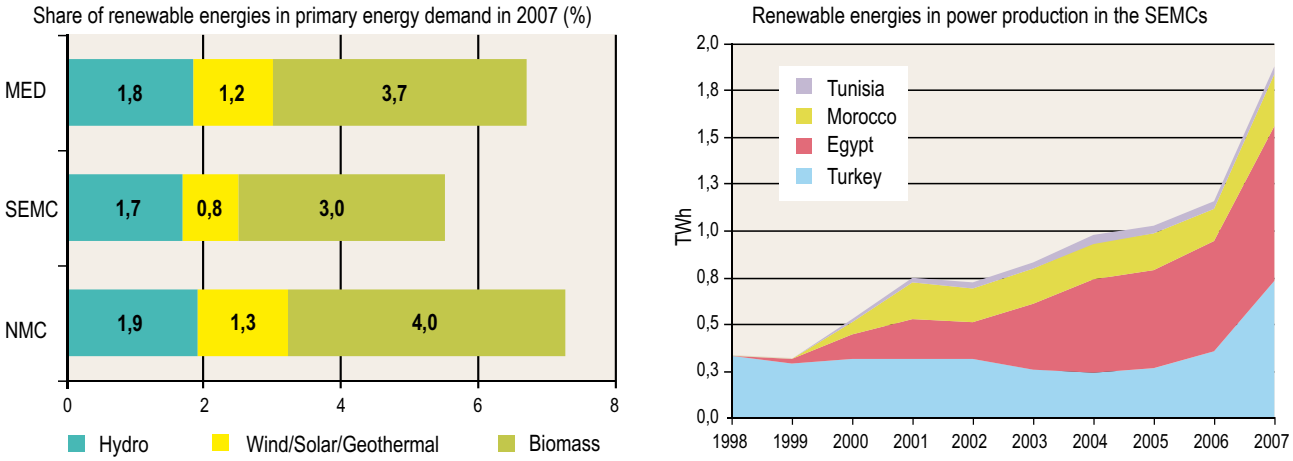
In terms of ratio to primary energy consumption, in 2007, renewable energies sources represented a mere 3.0% (6.7%, biomass included) in the Mediterranean, and 2.5% in the SEMCs (5.5%, biomass included), which remains insufficient with regard to the MSSD objective of 7% of primary energy.

There is increasing awareness; yet, projections in terms of energy efficiency and renewable energies remain limited. The adoption in November 2005 of the MSSD by the whole Mediterranean riparian countries and the European Community stands as a real mark of political will.

The renewable energy volume produced in absolute value is on the increase; however, in view of the simultaneous increase in demand, the share of RE (hydropower, wind, solar, geothermal) in primary energy supply increases very slowly (2.5% in 2007, exclusive of biomass). These hardly positive Mediterranean-wide evolutions conceal a number of encouraging experiences in Egypt, Morocco and Tunisia, for wind energy, and in Israel and Turkey, for solar water heaters.

3 The world growth stood at 8.3% per year over the same period 1980-2007 (from 36 to 502 TWh).

Figure 14 Renewable energies in the Mediterranean



Source: Plan Bleu, State of the Environment and Development in the Mediterranean - 2009, p. 48.

Egypt, whose energy sector contributes for 71% of GHG emissions, counts on the development of renewable energies to reverse this trend. For this purpose, it established an agency 'National Renewable Energies Authority (NREA)' and set out an ambitious wind power plan.

A few other SEMCs have set themselves objectives for RE penetration in their energy balance, but more particularly in their power production mix: Algeria, with 6% of RE by 2015; Libya, with 6% by 2020; Morocco, with 10% by 2012; Tunisia, with 4% of RE in the energy balance by 2011; and Turkey, with 2% of wind power, based on the installation of over 926 MW capacity by 2012.

Energy dependence

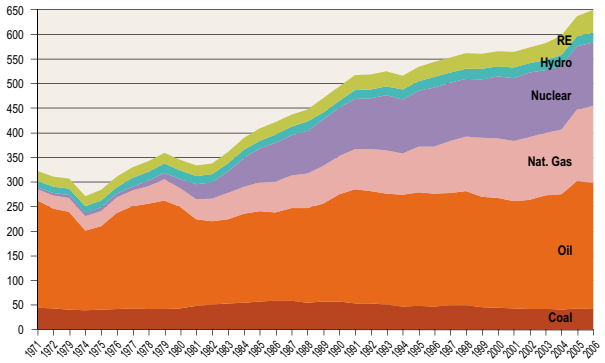
Energy dependence in the Mediterranean—all energy sources considered—stood at 35% in 2007. The Northern rim is an exclusively fossil fuel importer, while among the SEMCs, one must distinguish the exporting countries (Algeria, Egypt, Libya and Syria) from the others.

For the NMCs, energy dependence increased from 61% in 1990 to 68% in 2007. For the importing SEMCs, energy dependence increases more rapidly than for the NMCs: from 60% in 1990 to 76% in 2007. The exporting SEMCs export between 185% and 200% of their primary energy consumption (this rate stood at 223% in 1990, and at 188% in 2000).

In 2007, Mediterranean countries imported a total of 589 Mtoe of fossil fuels: 466 Mtoe by the NMCs and 123 Mtoe by the importing SEMCs (cf. Table 16). For the latter countries, the evolution of fossil energies imports thus reported an average annual growth rate of around 7.2% between 1971 and 2007. Tunisia has recently become a net importer.

In 2006, the energy exporting Mediterranean countries supplied around 22% of the Mediterranean total oil imports and 35% of the gas imports. Primary energy production in the SEMCs was 1.4 times higher than that of the NMCs in the 1990s and 1.8 times in the early 2000s. In the NMCs, the dwindling importance of coal and the oil crisis have left ground for nuclear power, hydro-power and the development of renewable energies.

Figure 15 Primary energy production (en Mtoe)

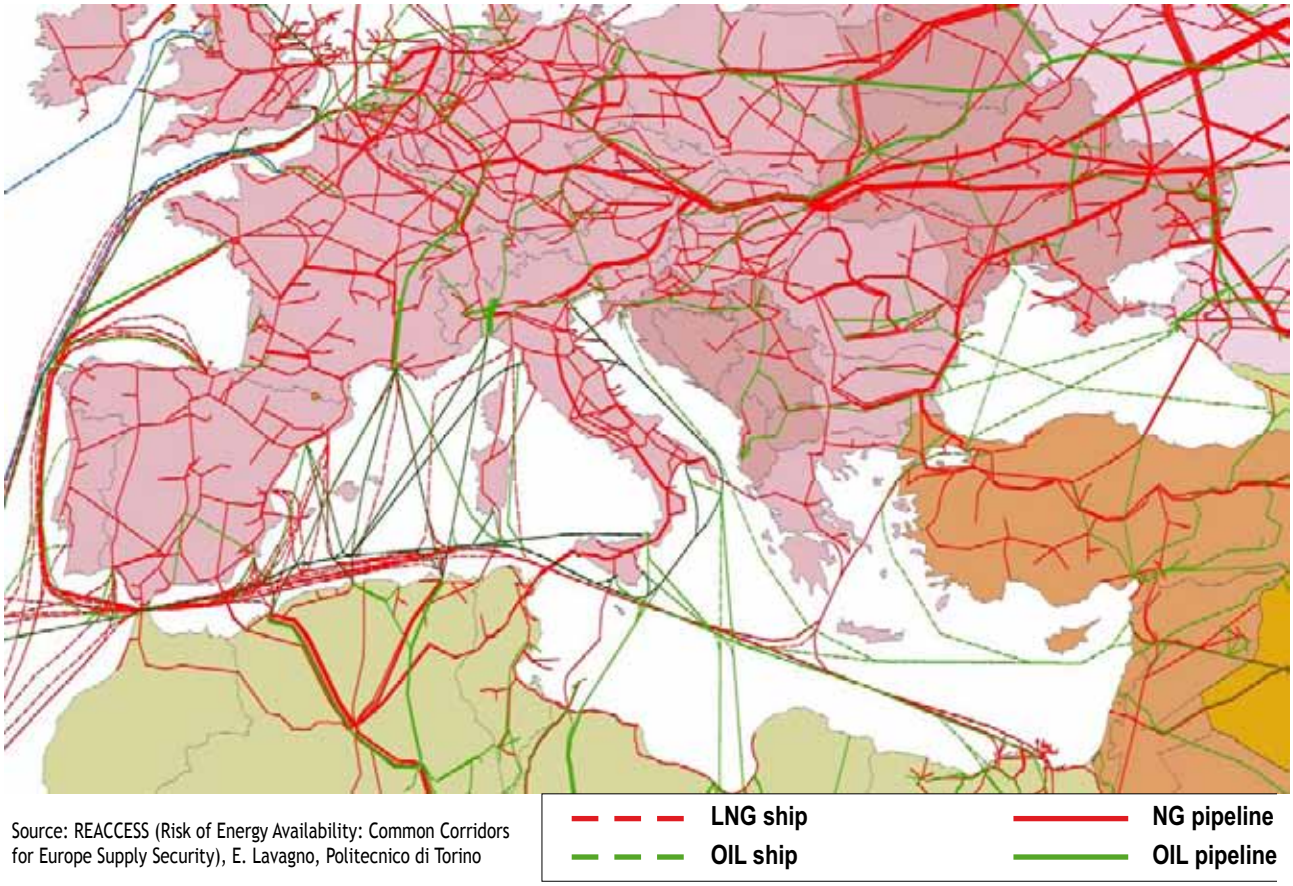


Source : IEA, Energy Balances, editions 2009

Energy infrastructures and exchanges

The development of energy trade flows rests on a significant infrastructure: oil refineries, oil loading and unloading ports, LNG plants and terminals, gaslines and oil pipelines, electrical inter-connections... These infrastructures, existing or underway, are described in an annex attached to this report.

Figure 16 Energy infrastructures in the Mediterranean (maritime routes and pipelines)



Source: REACCESS (Risk of Energy Availability: Common Corridors for Europe Supply Security), E. Lavagno, Politecnico di Torino

Gas infrastructure

The capacity of the export infrastructure for natural gas, gas pipelines and LNG is around 125 Gm^3 per year. Gas exports totalled around 85 Gm3 in 2007 (59 Gm^3 from Algeria, 16 Gm^3 from Egypt and 10 Gm^3 from Libya) and are set to exceed some hundred Gm^3 in 2012.

With 7 plants, the LNG infrastructure in the Mediterranean represents over a third of the number of LNG plants on world level, for a capacity of 45 Gm^3/year. Algeria counts 4 plants, Egypt 2 plants and Libya 1 plant. There are also 8 gas pipelines of over 80 Gm^3/year, extensible to more than 140 Gm^3/year, based on small investments :

- the gas pipeline Enrico Mattei –EMG- (ex-Transmed) between Algeria and Italy via Tunisia (27 Gm^3 extensible to 33);
- the gas pipeline Pedro Duran Farell –PDFG- (ex-GME Maghreb-Europe) between Algeria and Spain and Portugal, via Morocco (12/20 Gm^3);
- the Greenstream gas pipeline between Libya and Italy (8/16 Gm^3);
- the Arab Gas Pipeline (AGP) between Egypt and Jordan (3/10 Gm^3).
- the Blue Stream gas pipeline between Russia and Turkey (16/32 Gm^3);
- the gas pipeline east of Anatolia, between Turkey and Iran (7/10 Gm^3);
- the gas pipeline between Turkey and Azerbaijan, via the Caspian Sea (7/10 Gm^3);
- the gas pipeline connecting Turkey to Greece (1/10 Gm^3/year, extensible with interconnector ITGI to Italy).

As from 2000, a quite significant infrastructure has come into being in Mediterranean countries: 4 gas pipelines and 2 LNG plants in Egypt; LNG re-gasification terminals in Spain, in France, in Turkey and in Greece. Other projects are underway, of LNG terminals (France, Italy, Croatia …), as well as gas pipelines connecting Algeria to Spain (Medgaz), Algeria to Italy via Sardinia (Galsi) and the interconnector (ITGI) between Turkey, Greece and Italy. The latter (ITGI) is most advanced and represents the most concrete option to ensure access to the gas resources of the Caspian and, more particularly, those of Azerbaijan. It is also planned to construct a gas pipeline originating in Nigeria, via Algeria, to supply Europe.

Figure 17 Gas infrastructures in the Mediterranean

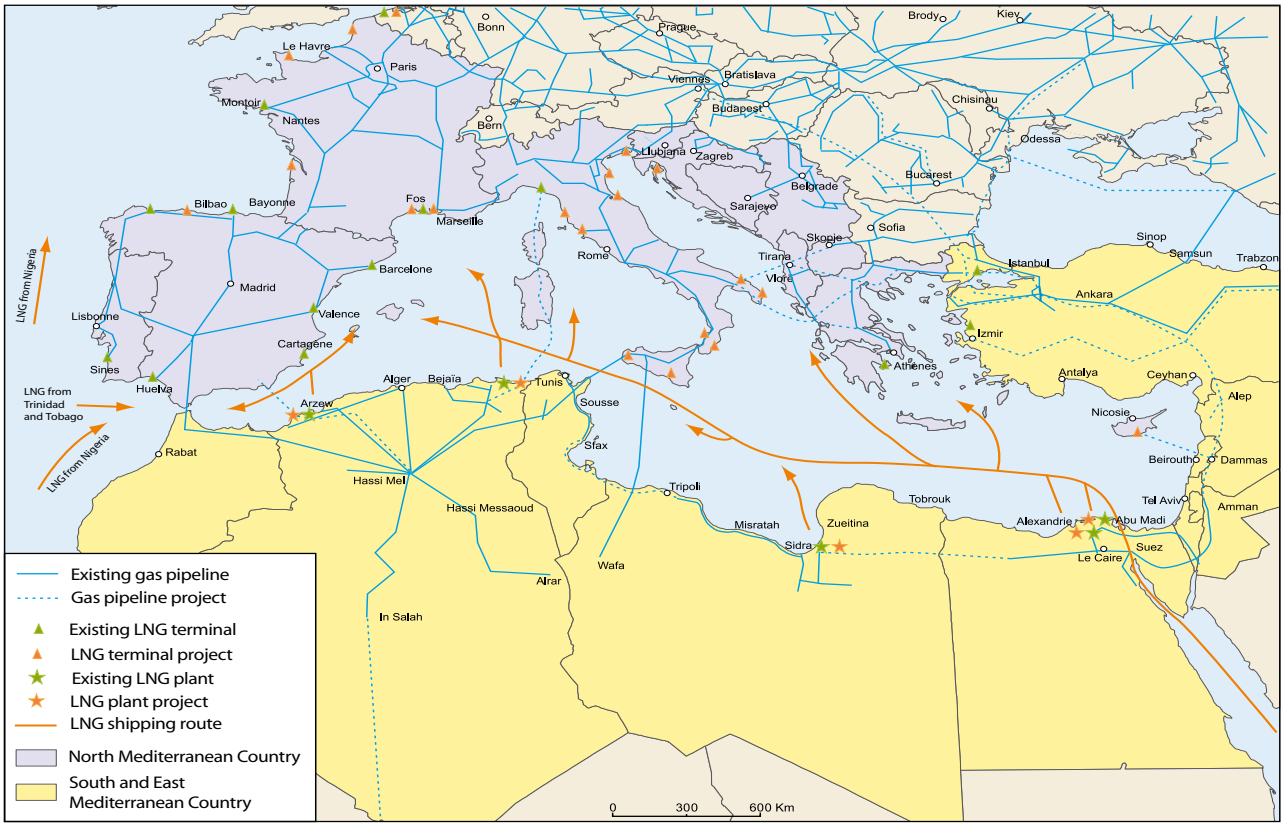
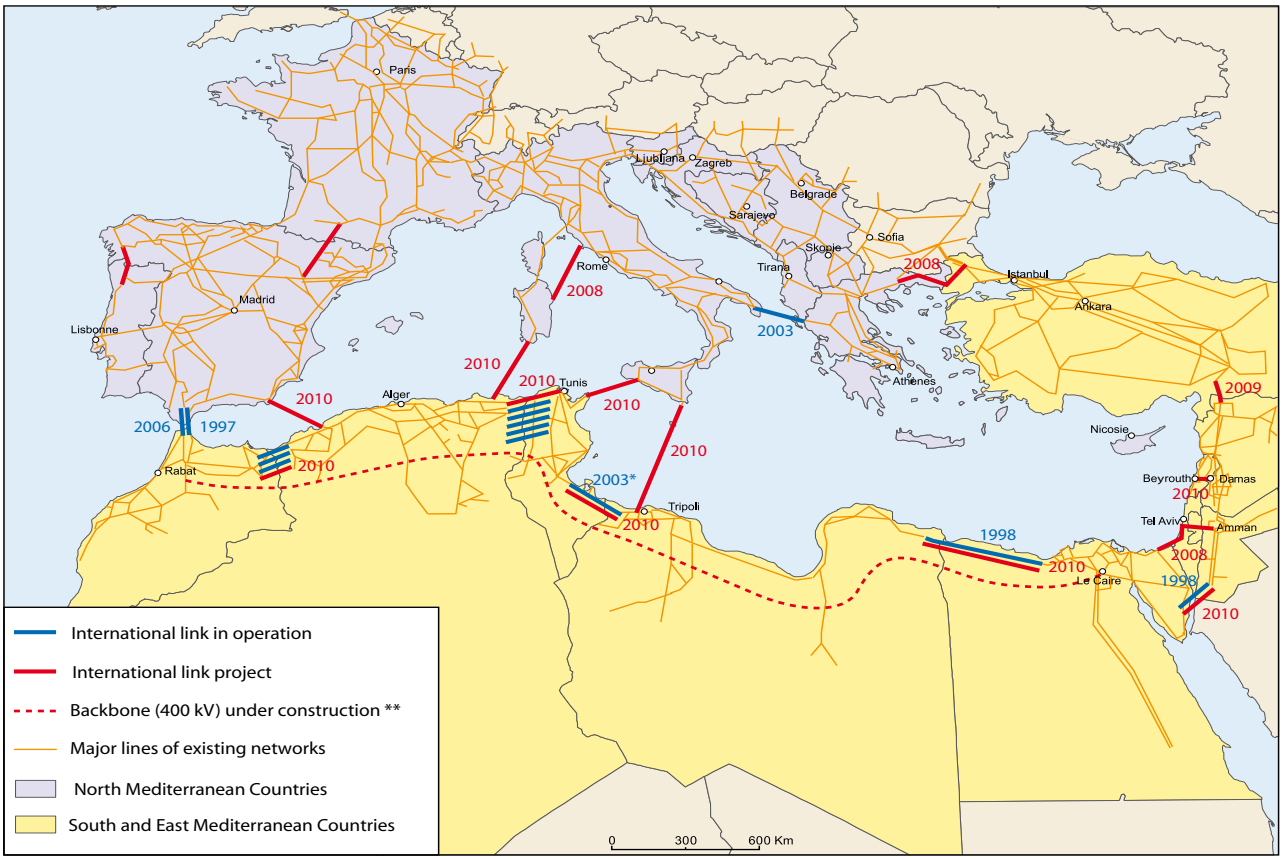


Figure 18 Electric interconnections in the Mediterranean



* Construction completed but not in operation yet. ** ELTAM project (Egypt-Libya-Tunisia-Algeria-Morocco).

Sources: Medelec and OME 2008 (Background map, Plan Bleu)

Oil infrastructure

The Mediterranean being a major transit zone, most oil flows are conducted by means of tankers, complemented by three large pipelines: the first, called BTC, conveys crude oil from the Caspian to the Mediterranean (50 Mt/year, via Turkey); the second, called SUMED, conveys oil from the Persian Gulf to the Mediterranean (120 Mt/year, via Egypt) thus easing the pressure on the Suez Canal; while the third conveys Iraqi oil to the Mediterranean (70 Mt/year, via Turkey). Russia is ready to supply the pipeline project planned by Turkey and Italy, between Samsun (Black Sea) and Ceyhan (The Mediterranean), thus easing the pressure on the Bosphorus.

Electric interconnections

Over the past few years, the SEMCs have pledged to connect their grids. Several interconnections are already in operation: in the Maghreb (Algeria-Tunisia: 4 connections; Algeria-Morocco: 3 connections); other interconnections have recently been commissioned, of which those connecting Spain to Morocco, Algeria to Morocco, Libya to Egypt, Egypt to Jordan, and Syria to Jordan and Lebanon. Several new interconnection projects in progress connect Morocco to Algeria, Algeria to Tunisia, Tunisia to Libya, Libya to Egypt, Syria to Turkey, and Turkey to Greece.

Currently, the Mediterranean is divided into 3 not-as-yet interconnected blocks (western block, eastern block and Turkey). This situation is set to change in view of the many interconnection projects in progress, initially connecting the blocks to each other, and then connecting them directly, via underwater cables, to Europe. The situation of electric exchanges—being currently low (10% of the exchanges with the SEMCs)—is set to report an upswing upon completion of the «electric loop» around the Mediterranean.

Since the commissioning of the Spain-Morocco connection in 1997 (doubled up in July 2006), the two Mediterranean shores have already been connected. The interconnection between the two shores will be further reinforced by the future tripling of the Spain-Morocco line and the underwater cable projects connecting Algeria to Spain and Italy, Tunisia to Italy, Libya to Italy, and Montenegro to Italy.

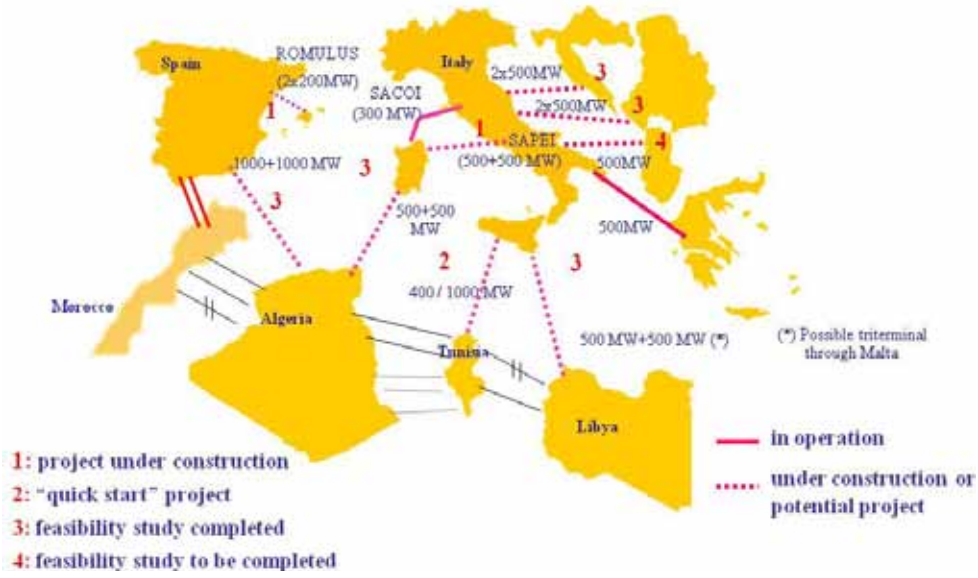
Insufficient regional energy exchanges in the South, but more significant from South to North

In 2006, total exports and imports from, or to, Mediterranean countries amounted to around 450 Mt of crude oil and petroleum products, 207 Gm^3 of natural gas and around 249 TWh of electricity. Intra-Mediterranean net exchanges amounted in 2006 to around 97 Mt of oil and oil products, 72 Gm^3 of gas and 70 TWh of electricity.

With some hundred Mt, the SEMCs cover over 25% of the crude oil needs of the Southern European countries (France, Greece, Italy, Portugal and Spain) and over 44% of the natural gas needs of France, Italy, Spain, Portugal, Greece and Slovenia.

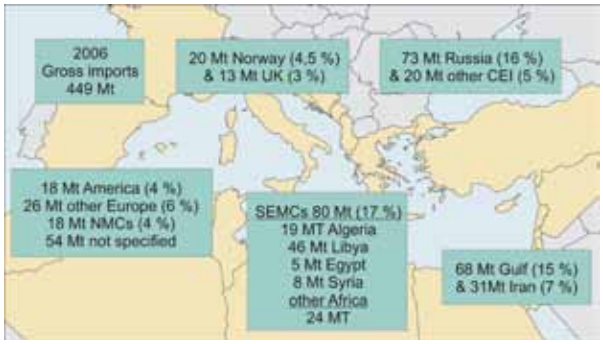
- **As regards oil**, Mediterranean countries are dependent on 26 supply countries, 4 of which are Mediterranean (Algeria, Egypt, Libya and Syria). The major sources (2006) are Russia, Saudi Arabia, Libya, Iran, Norway, Algeria, the United Kingdom and Nigeria. They import 22% from the Mediterranean region itself, followed by the CIS 21%, the Middle East 15% (of which Saudi Arabia 9%), Europe 13% (of which 5% for Norway and 3% for the UK), the Caspian Sea 11% (of which 8% for Iran) and Africa 5% (of which 3% for Nigeria).

Figure 19 Direct electric connections projects (HVDC cables)



Sources: Bruno Cova (CESI), Medelec

Figure 20 Oil supplies in the Medierranean (2006)

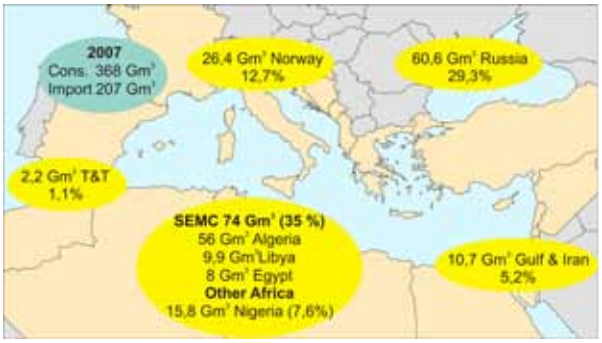


Source: Plan Bleu (based on IEA, BP data)

- As far as **natural gas** is concerned, Mediterranean countries depended on 14 exporting countries in 2007, of which 3 are Mediterranean (Algeria, Egypt, Libya). The 3 southern Mediterranean exporting countries covered, with more than 73 Gm^3 in 2007, over 35% of the gas needs for France, Italy, Spain, Greece, Slovenia and Turkey. The major sources are Russia (29%), followed by Algeria (26%), Norway (13%), Nigeria (8%), the Netherlands (7%), Iran (3%) and the Middle East (2%).

  Algeria exported 54 Gm^3 to the Mediterranean (out of a total 59 Gm^3 in 2007); Libya dedicated its exports fully to the Mediterranean (Italy and Spain). Egypt exported half of its exports, that is, 8 Gm^3, in the Mediterranean. Via Syria, Lebanon is set to receive its first gas imports before the end of 2009. In 2007, the top importing countries were Italy (around 75 Gm^3), France (47 Gm^3), Spain (35 Gm^3) and Turkey (35 Gm^3), the four of which represent alone 93% of the total imports in the Mediterranean.

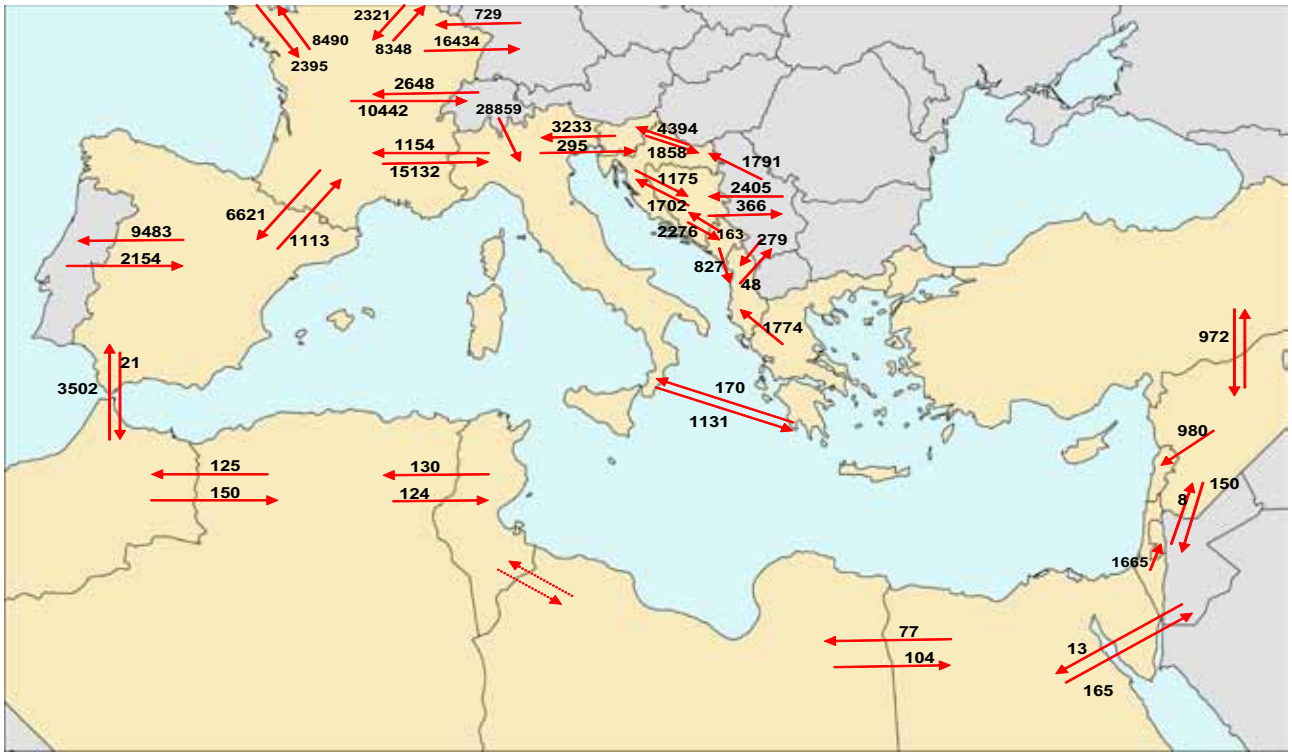
Figure 21 Gas supplies in the Mediterranean (2007)



Source: Plan Bleu (based on Cedigaz, BP data)

- **Power exchanges** remain marginal compared to total power consumption. The volume of the exchanges between Mediterranean countries and their neighbours totalled 251 TWh (120 exported and 134 imported) in 2007. Intra-Mediterranean trade is illustrated in Figure 22, clearly showing the prevalence of power exchanges in France, Spain, Italy, Portugal, Slovenia and Croatia.

Figure 22 Inter-Mediterranean power exchanges in 2007 (in GWh)



Source: Plan Bleu (données UCTE; Eurelectric; UAPTDE; Comelec; Compagnies & OME)

Thus, the Mediterranean outbound volumes amounted to the exportation of 120 TWh, of which 65 TWh from France and 14.1 TWh from Spain. Net exchanges between Mediterranean countries amounted to 73 TWh in 2007. Only a tenth of the total intra-Mediterranean exchanges, that is around 7.5 TWh, involves trade between the SEMCs, including exchanges with Europe (Morocco-Spain). These small quantities are due to the limited capacity of the existing electrical interconnections.

The largest portion of the 7.5 TWh is exchanged between Morocco and Spain, Morocco, Algeria and Tunisia, Libya, Egypt, Jordan, Syria and Lebanon.

According to the estimates of the MedRing[4] study, power exchanges are likely to total a minimum of 75 TWh by 2012. The advantages obtaining from the completion of the Mediterranean electric loop should be definitely higher than the conservative figures put forward by the MedRing study ($300 million per year) in 2003.

Deficit of comprehensive, planned and concerted vision on regional level

As outlined above, energy resources are concentrated in the southern rim of the Mediterranean basin, whereas the countries of the northern rim are major consumers, which induces South-to-North export flows, as well as gives rise to infrastructures across the Mediterranean. The question that needs to be asked, though, is the following: Do the many infrastructures—constructed or underway—converge all to the achievement of the same objective, with the constant concern for integration and optimization?

There is no denying the fact that there is a certain redundancy in the gas and power networks which seem to overlap. Such is the case of the Morocco-Spain electrical lines and gas pipeline via the Strait of Gibraltar, similarly to the other gas pipelines and cables constructed or planned throughout the Mediterranean. Each North African country projects to build a power line to Europe—Spain or Italy, according to the case—, while these electric connections follow practically the same gasline routes, which confirms the lack of coordination and concerted action on regional level, as well as a failure to identify priorities.

It seems clear enough that it is commercial terms which prevail between companies and that energy options are not based on economic and environmental criteria. Issues of a strategic nature are part and parcel of the choices and govern many investments in infrastructures.

This deficit of a comprehensive vision can lead to inconsistencies and wastages. A part of the Spanish electricity, generated with Algerian or Libyan gas, is redirected to Morocco—an energy deficit country since 2006—, with significant losses in the transmission lines. On the other hand, the gas combine cycle power plant of Tahaddart, near Tangiers close to the electric interconnection via Gibraltar, had been designed to export part of the production to Spain. Unfortunately today, the power transit is done in a North-South direction, i.e. from Spain to Morocco, which is neither logical nor economical and, in any event, not at all advantageous from a sustainable development perspective.

Financial and technological challenges

The construction of infrastructures that are so sophisticated and so significant entails considerable financial needs. Based on OME estimates, the needs in investments for the electricity sector alone of the SEMCs would be in the order of 450 billion US$ for the time frame 2025, of which 60% would be allocated to production, 25% to transport and 15% to distribution.

Information on the financing of energy projects in the Mediterranean has recently been announced by potential funding agencies: thus, EIB has evaluated as 200 billion €, over 20 years, the needs for UfM financing in the field of sustainable development. In total, the funding agencies have pledged some 23 billion €.

Besides, MEDREG (Association of Mediterranean Regulators) conducted a survey in March 2009, geared towards setting up a framework that is conducive to improving the investment climate, ensuring diversification of energy sources and boosting energy interconnection networks.

The achievement of such ambitious objectives sets—in addition to financing issues—the challenge of technological development and of capacity building in the fields of studies, construction, maintenance and operation in the countries of the South. There exists in certain SEMCs a significant industrial base which can be harnessed to the development of a North-South cooperation/ collaboration. The installations in place and the experience gathered in the countries of the South can serve as determining factors for the development of capital equipment and assets in the energy sector. These two factors are essential for the future of the region, and they call for a broader consideration and a more in-depth reflection.

4 MEDRING is the most comprehensive study conducted on electric interconnections in the Mediterranean between 2001 and 2003. It was supervised by CESI (Italy) in partnership with EDF, REE, DESMIE, SONELGAZ, STEG, EEHC, NEPCO, PEEGT, TEIAS, ONE and GECOL. The MedRing study has sought to (i) identify the economic advantages of the electric loop, (ii) highlight the operational difficulties and the constraints, and (iii) recommend solutions to overcome them.

Table 6 Investments and energy projects in the Mediterranean

Designation of Project	Site	Investment amount (Million US$)	Status
Revamping of liquefaction plants	Algeria, Libya	2200	Completed in Algeria, in progress in Libya
LNG SEGAS plant	Egypt	1300	Extension in progress
LNG IDKU plant	Egypt	1900	Extension in progress
Syria-Iraq gas pipeline		196	Projected
Nigeria-Algeria TSGP (gas pipeline)		10000 à 13000	Planned
LNG plant train Skikda	Algeria	2900	In progress
LNG train Arzew	Algeria	2770	In progress
Algeria-Italy Electric Interconnection (HVDC cable)	Algeria, Italy	205 to 578	Planned
Tunisia-Italy Electrical Interconnection (HVDC cable)	Tunisia, Italy	380-410	Planned
Refinery of Adrar	Algeria	303	Completed
Refinery project of Tiaret	Algeria		Planned
Libya-Tunisia Gas pipeline	Libya, Tunisia	250	Planned
Egypt-Libya Gas pipeline	Egypt, Libya	1400	Planned
Syria-Lebanon Gas pipeline	Syria, Lebanon		In progress
Syria-Turkey Gas pipeline	Syria, Turkey		Project
Additional capacity of around 120000 MW to be built by 2025	SEMCs	Around 100 000	Estimated as 10000 MW per year
Decommissioning - Refurbishing of around 22000 MW of old power plants	SEMCs		Estimated as 1500- 2000 MW per year
Mediterranean Solar Plan (MSP)	SEMCs	Between 38 & 46 billion € (another estimate gives a twice higher cost of 80 billion €).	Final design study, supported by UfM
Tunisian Solar Plan (TSP)	Tunisia	Estimated as 2150 million €; Financing: 163 M€ (National Fund for Energy Conservation - FNME); 380 M€: public sector, STEG (National Electricity and Gas Utility); 1582 M€: private funds, of which 685 for export projects & 24 M€: international co-operation funds	40 projects over the period 2010-2016
Montenegro – Italy (HVDC cable)	Montenegro, Italy		Planned
ELMED Project (Mediterranean Electricity). Interconnection between Tunisia and Italy via underwater cable 400 kV & Combine Cycle PP	Tunisia, Italy	Project N°31 of the Tunisian Solar Plan , and financing under the TSP	Period 2010-2016
Turkey – Israel electric interconnection (HVDC cable)	Turkey, Israel		Planned
Turkey – Greece electric interconnection (HVDC cable)	Turkey, Greece		In progress
Egypt–Syria–Jordan–Iraq–Turkey–Lebanon–Libya –Palestine electric interconnection project	Estearn Mediterranean countries		Planned
Turkey-Greece-Italy gas pipeline project	Turkey, Greece, Italy		In progress
Malta-Sicily electric interconnection	Malta, Italy		Planned
Turkey–Israel electric interconnection project (HVDC cable)	Turkey, Israel		Envisioned

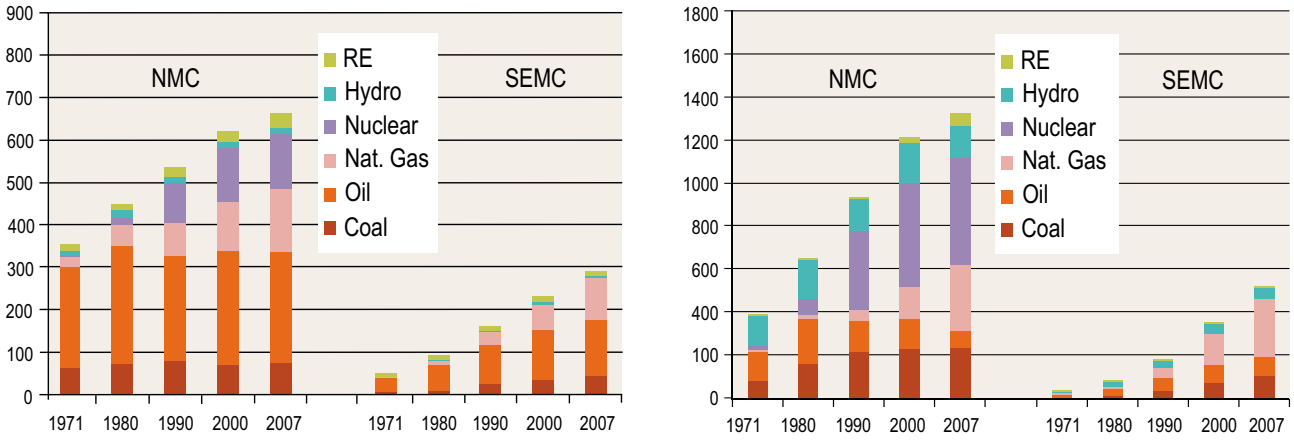
Sources: Various sources, Plan Bleu collected data

The Business as Usual scenario (BaU): Energy increase far short of the services expected

Stock-taking of the energy situation in the Mediterranean highlights significant discrepancies not only between the Northern rim and the Southern and Eastern rim, but also between the countries of either group. As regards energy consumption, the mismatch between North and South, having been of 88% - 12% in 1971, was to slightly narrow, being of 70% - 30% in 2007, though remaining rather significant.

The SEMCs face high demographic growth combined with a fairly low income, a rapid urbanization and significant socio-economic development needs. This is resulting in an increase and new demand on, energy services and related infrastructures. In all the SEMCs, demand on energy, and on electricity in particular, is more rapidly on the increase. The mature economies of the NMCs are marked by a shift towards the services sector and the saturation of energy demand for certain energy services.

Figure 23 Energy and power demand in the Mediterranean, by source (en Mtep)



Sources: IEA, Energy Balances, editions July (OECD countries) and September 2009 (Non OECD countries)

Hypothesis

The main hypothesis of the trend scenario (BaU) relate to the determining factors of the North-South divide: i.e., population and economic growth. The international prices of fossil fuels are also taken into account. Lastly, insofar as it is founded on the projection of the current trends, resting on the structural factors identified in the first part, the scenario integrates two elements: these are, on the one hand, the objectives of the countries as regards the use of renewable energies and, on the other hand, a certain wait-and-see policy in matter of development of regional cooperation, whether this relates to completing the Mediterranean ring or to the implementation of the MSP.

Demographic growth

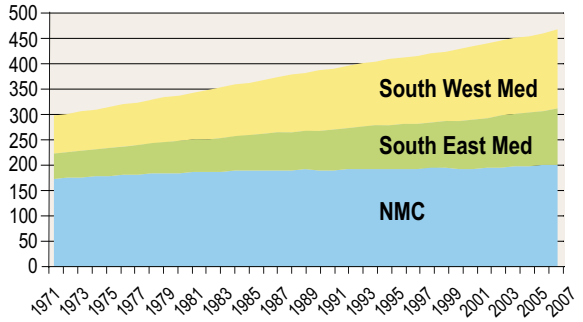
In 2007, the population of the Mediterranean totalled 466 million inhabitants. The population of the NMCs has stabilized and is set to steadily grow at an average rate of 0.2% per year up to 2025, to reach 206 million inhabitants. In the SEMCs, the annual average demographic growth rate is set to decline from 2.2% (over the period 1971-2007) to 1.2%, with the population reaching 326 million by 2025.

Economic growth

The account of gross domestic product (GDP) data, as well as economic growth forecasts, have been obtained from OME member companies and supplemented by the World Bank's "World Development Indicators 2007" (Washington, DC: The World Bank, 2007). Total economic growth in the Mediterranean reported a rate of 2.8% per year on average between 1971 and 2006. It slightly slackened over the past five years (2%). Economic growth in the SEMCs was approximately twice higher than that in the NMCs (4.3 and 2.5%, respectively) over the period 1971- 2006.

For the period of the projection, 2006-2025, the economic growth expected is of 4% per year on average. These rates would be growing fast, and would apply mainly to Turkey (4.7%), the other countries ranging between 3% and 4%. In the North, the economic growth rate would remain within 1.8% from 2006 to 2025.

Figure 24 Demography in the Mediterranean



	Population (in millions)			Growth (in %/year)	
	1971	2007	2025	1971-2007	2007-2025
NMCs	169,9	201,0	206,0	0,5%	0,1%
Turkey	36,2	73,9	87,8	2,0%	1,0%
Syria	6,6	19,9	26,1	3,1%	1,5%
Lebanon	2,5	4,1	4,3	1,4%	0,3%
Palestine		3,8	5,4		1,9%
Israel	3,1	7,2	8,3	2,4%	0,8%
SE Med	48,4	108,9	131,8	2,3%	1,1%
Egypt	36,0	75,5	95,8	2,1%	1,3%
Libya	2,1	6,2	8,4	3,1%	1,7%
Tunisia	5,2	10,2	12,7	1,9%	1,2%
Algeria	14,2	33,9	40,4	2,4%	1,0%
Morocco	15,4	30,9	37,3	1,9%	1,1%
SW Med	72,9	156,6	194,7	2,1%	1,2%
SEMCs	121,3	265,5	326,5	2,2%	1,2%
TOTAL	291	466	532	1,3%	0,7%

Sources: WDI, OME, Plan Bleu

Table 7 Economic growth in the Mediterranean

	GDP in billion dollars ($2000)				Annual growth rate (%)	
	1971	1990	2006	2025	1971-2006	2006-2025
NMCs	1457	2616	3513	4919	2,5 %	1,8%
SEMCs	173	378	756	1577	4,3 %	4,0%
TOTAL	1629	2995	4269	6497	2,8 %	2,2%

Sources: WDI Indicators, OME/Questionnaires & Plan Bleu

In per capita terms, the gap between the North and the South of the Mediterranean is set to narrow, over the period from 2006 to 2025, with an average economic growth of 1.6 % for the North and 2.7%, for the South. In spite of a more steady total economic growth in the SEMCs, the GDP per capita gap between the two zones remains significant, being in the range of 1 to 6.7 in 2006. According to several forecasts, this average disparity is set to decrease slightly by 2025 (around 1 to 4.9).

Table 8 PIB per capita

	GDP per capita (in $2000)				Annual growth rate (%)	
	1971	1990	2006	2025	1971-2006	2006-2025
NMCs	8 557	13 894	17 730	23 907	2,1%	1,6%
SEMCs	1 425	1 933	2 891	4 832	2,0%	2,7%
TOTAL	5 591	7 798	9 289	12 207	1,5%	1,4%

Sources: OME, Plan Bleu

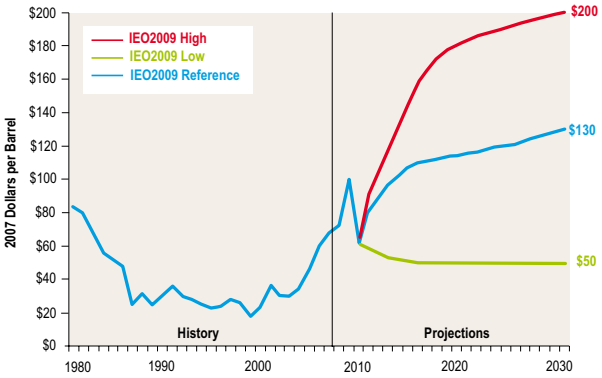
Energy price

The energy price is collected by OME via questionnaires where energy forecasts are supplied by each Mediterranean country. Average oil prices belong in the international prices posted by the various scenarios issued by the EIA (Energy Information Administration of the US Department of Energy), the International Energy Agency (IEA), the Organization of Petroleum Exporting Countries (OPEC), or the European Union.

Generally, each source uses a different benchmark crude. The real world price for crude oil, for EIA, is defined as the price of low-sulphur crude oil delivered in Oklahoma. The IEA uses the OECD crude oil import price, OPEC uses its own basket price, and the European Union relies on Brent. Although all these sources use different price assumptions, their forecasts follow a similar trend.

In its Annual Energy Outlook 2009, the EIA assumes that crude oil prices (expressed in dollars of 2007) are likely—according to the baseline scenario—to increase gradually, starting from $61 in 2009, as demand continues to grow and as higher-cost supplies brought to market to reach, in 2030, a price ranging between $130 (baseline scenario) and $200 (high scenario).

Figure 25 Crude oil forecast prices



Source: IEA International Energy Outlook Presentation, 2009

For OPEC (Outlook 2008), the world price of crude oil is assumed to remain within a range of $70 to $90 per barrel, in nominal terms, by 2030.

The International Energy Agency assumes, in its recent World Energy Outlook (Paris, IEA, WEO 2009), that the oil price by barrel, of $97 in 2008 and of around $61 in 2009, would rise to around $190 by 2030 (in nominal terms). According to the IEA, this assumption is the result of a significant adjustment upwards and accounts for the recent rapid rise of the prices of physical deliveries in the short term of forward contracts, as well as of a revaluation of the prospects concerning the cost for oil supplies in view of demand forecasts.

The longer term evolution of the baseline scenario of the EIA assumes an average price of the oil barrel of around $100 by 2030 (baseline scenario corresponding to the trend scenario).

Table 9 Objectives of the Mediterranean countries (as per country)

Pays	Capacités installées Production	Dispositif juridique en vigueur ou envisagé	Stratégie de développement	Objectifs en matière d'énergie solaire	Objectifs en matière d'énergie éolienne
Algérie	3MW en électrification rurale (<0,05% capacité installée) et 250 MW en hydro-électricité (3,7%)	Tarifs de rachat avec une prime de 200 à 300% par rapport au coût de production de référence	6% de la production électrique en 2015 (yc cogénération) et 11% à horizon 2020-2025	3 centrales hybrides gaz-CSP de 400 MW chacune (110 MW en solaire au total) Quelques MW en PV	nd
Égypte	15 TWh/an d'hydro-électricité (12% de la production totale) 370 MW de parcs éoliens (<1%))	Aucun à ce jour Loi sur l'électricité en préparation avec mise en place d'un fonds ENR et ouverture au secteur privé	20% de la production électrique en 2020	Une centrale hybride gaz-CSP de 140 MW	7 200 MW en 2020
Israël	95% des ménages équipés en chauffe-eau solaire Quelques MW en PV	Appels d'offres pour les centrales Tarifs de rachat pour les petites installations Incitations fiscales	5% de la production électrique en 2015 (700 à 800 MW), et 10% en 2020	2 centrales CSP de 125 MW chacune, une centrale PV de 15 MW 500 MW supplémentaires à terme	nd
Jordanie	17 MW (0,8% de la production totale d'électricité)	Appels d'offres pour les centrales > 5MW Loi sur l'électricité en préparation avec mise en place d'un fonds ENR et ouverture au secteur privé	10% de la consommation électrique totale en 2020	600 MW en 2020 30% des ménages équipés en chauffe-eau solaire en 2030	600 MW en 2020
Liban	Production hydro-électrique et solaire marginale (< 1% du total)	Aucun à ce stade	Pas de stratégie nationale	Développement des chauffe-eau solaires	nd
Maroc	4% de la consommation d'énergie (yc hydro-électricité) 130 MW en éolien	Appels d'offres en concession pour les centrales Prime pour le rachat de l'électricité excédentaire pour EnergiPro Projet de loi sur les ENR en préparation	10% de la consommation d'énergie (ou 20% de la production électrique totale) en 2012	500 MW en 2015 (yc microcentrales)	1 500 MW en 2012, dont 1 000 MW en autoproduction (EnergiPro)
Mauritanie	Électrification rurale essentiellement	Aucun à ce jour Projet de loi en préparation sur des tarifs spécifiques ENR Appels d'offres envisagés pour les grandes centrales	Pas de stratégie nationale	nd	Identifié comme un secteur à potentiel
Syrie	3,7% de la consommation d'énergie (hydro-électricité)	Incitations financières pour l'installation de chauffe-eau solaires Réglementation en préparation	3% de la consommation d'énergie en 2011 18% en 2020 (non affiché)	2 centrales CSP pour 220 MW une centrale PV pour 20 MW	400 MW pour 4 centrales
Territoires palestiniens	70% des ménages équipés en chauffe-eau solaire	Aucun à ce stade	20% de la consommation d'énergie en 2012	Identifié comme un secteur à potentiel	
Tunisie	1% de la consommation d'électricité (hydro-électrique, éolien et PV) 55 MW d'éolien	Politique active d'efficacité énergétique Aides à l'investissement pour les projets domestiques et industriels Loi de février 2009 sur les tarifs de rachat et l'ouverture au secteur privé pour l'autoproduction	4% de la consommation énergétique ou 10% de la consommation d'électricité en 2011	Projet de 20 MW en CSP	170 MW de grandes centrales 70 MW pour le petit éolien
Turquie	37 TWh/an d'hydro-électricité (19% de la production totale) 430 MW d'éolien	Tarifs de rachat et certificats verts (yc sur l'hydro-électricité) Législation proche des normes européennes	25% de la consommation d'électricité en 2020 avec un triplement de la capacité hydro-électrique (non officiel)	Identifié comme un secteur à potentiel	20 000 MW en 2020 (non officiel)

Sources: OME, DGIPE

Public policy options

Most of the countries have adopted **a gas policy**, particularly in power production. Three countries (Algeria, Egypt and Tunisia) currently report a rate of 80% of natural-gas based power generation. Major programmes of switching fuels in thermal power plants to natural gas have been implemented over the past few years in Egypt, Syria and Libya. With the recent entry of countries (Israel, Morocco, Jordan and, soon, Lebanon), the whole Mediterranean countries have become gas consuming countries. Between 1971 and 2006, natural gas consumption had multiplied by more than 10 times, passing from 6 to 26% of the total energy balance. As resource, natural gas is abundant and available; it represents the most economical option for many applications, while this is the least polluting fossil fuel. It has a very significant growth potential and its use, in the trend scenario, will continue to grow. However, the region's potential and the inception of a true awareness in the countries are fostering—as we have already seen—a development of **renewable energies**. The trend scenario, in this regard, rests on the country-surveys and on the targets of the Mediterranean countries, such as they are set out in the public policies. Besides, in the NMCs, the implementation of the "Energy-Climate Package 20/20/20» by the European Commission is likely to be conducive to a faster development of renewable energies.

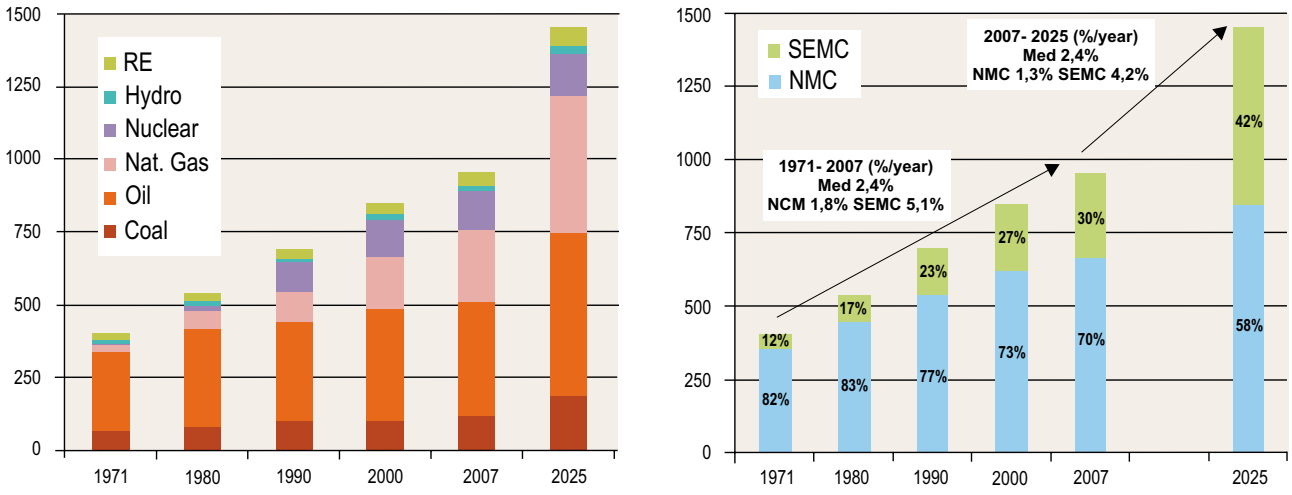
As regards **regional cooperation**, the trend scenario assumes a continuation of the current behaviours of Mediterranean States, marked by a difficulty to conceive collectively of the region's energy future, which difficulty is likely to delay the implementation of the Mediterranean Solar Plan, as well as of closing the electric ring via completion of the interconnections. This wait-and-see attitude also impacts the technical choices, such as preferring, for instance, to export natural gas, via gas pipeline or LNG tanker, rather than electricity, and this, in spite of technological advances (DC cables...).

Projections by 2025

The projections of the trend scenario at horizon 2025 take into account the energy policies of the SEMCs; they derive from the countries' national forecasts. The SEMCs are divided into two groups: importing SEMCs, and exporting SEMCs. The policies followed by the first group integrate many energy challenges, such as the high dependence on fossil energies, with importation of more than 90% of the needs.

The policies conducted by the second group (Algeria, Egypt, Libya and Syria) are geared towards a strategy of increase of fossil energies exports. The economies of these energy exporting countries are quite dependent on the incomes from their hydrocarbon exports (over 95%); the medium-term prospects for their sector include, overall, a boost of oil and gas production, a significant increase in crude oil, gas and LNG exports, and a scale-up of basic petrochemical industry with the launch of several partnership projects.

Figure 26 Evolution of primary energy demand (in Mtoe)



Sources: IEA (1971 to 2007), OME & Plan Bleu computation

Primary energy consumption

The total primary energy demand of the whole Mediterranean countries is set to increase by 2.4% per year on average, to thus pass from 955 Mtoe, currently, to 1457 Mtoe, by 2025. The largest portion of the increase in primary energy demand is likely to originate from the SEMCs which would claim over 42% by 2025, as against 30% currently.

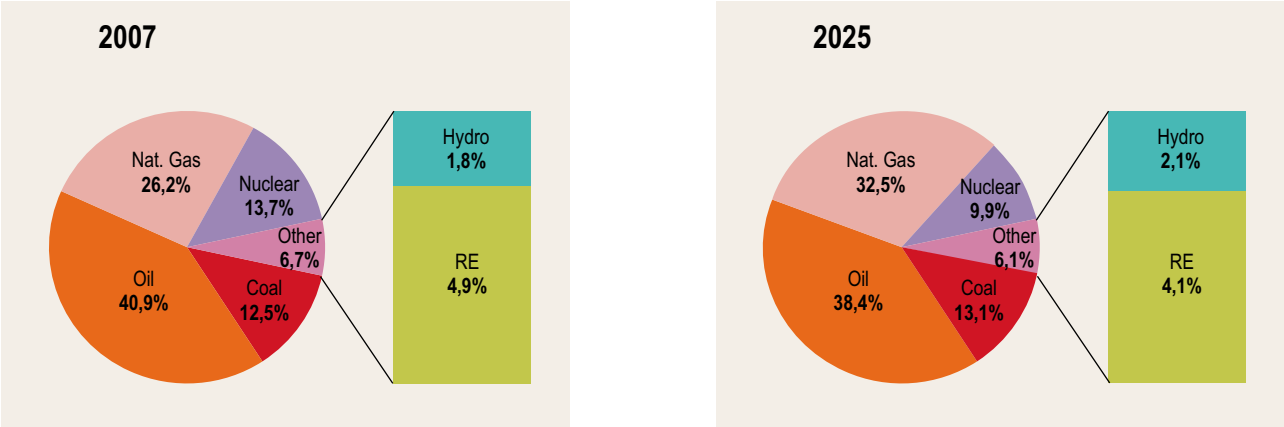
By 2025, primary energy consumption per capita in the SEMCs is set to represent a half of that of the NMCs (as against 20% in 1971).

Table 10 Primary energy consumption in the Mediterranean (Horizon 2025)

	Primary energy consumption (Mtoe)				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	354	535	665	848	1,8%	1,3%
SEMCs	48	159	291	609	5,1%	4,2%
TOTAL	402	694	955	1457	2,4%	2,4%

Sources: IEA, OME, Plan Bleu

Figure 27 Structure of energy consumption in the Mediterranean, by source (2007 & 2025)



Sources: IEA, OME, Plan Bleu

- The share of **coal** is set to reach 190 Mtoe by 2025, with an average annual increase rate of 2.6%, due mainly to projects of coal power stations in Turkey and Morocco. **Coal** consumption in the SEMCs is likely to increase by 43 to 115 Mtoe between 2007 and 2025. In the NMCs, it is set to decrease slightly or stabilize at 75 Mtoe between 2007 and 2025, though the European Union commitments to reduce its carbon dioxide emissions (-20% by 2020 under the Energy-Climate Package) could entail a more substantial reduction.

Table 11 Coal consumption in the Mediterranean (Horizon 2025)

	Coal consumption (en Mtoe)				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	61,9	79,3	76	75	0,6%	-0,1%
SEMCs	5,2	21,9	43	115	6,0%	5,6%
TOTAL	67	101	119	190	1,6%	2,6%

Sources: IEA, OME, Plan Bleu

- **Oil** consumption is set to reach 558 Mtoe, according to an average annual growth of 2.0% per year until 2025, and its share would stabilize at around 38%. Oil would thus maintain its dominant position and would concentrate in the sectors of use marked by the absence of a true alternative, typically in fuel cars and lubricants. The relative regression of petroleum products is primarily due to the competition reported by natural gas in households and the tertiary sector, particularly in the field of electricity.

  The growth of oil consumption is likely to be higher in the SEMCs (3.0%) than in the NMCs (1.4%), the difference being mainly induced by a rapidly increasing demand in the transport sector. Thus, oil consumption in the SEMCs is set to increase from 130 Mtoe in 2007 to 222 Mtoe in 2025, whereas that of the NMCs would pass from 261 Mtoe to 336 Mtoe for the same period.

  It is worth emphasizing that an additional refining capacity of 100 Mt is set to be added in the Mediterranean region by 2025, and this, in order to

address the increase in demand on oil products, in middle distillates (diesel). Gasoline surpluses in the Mediterranean are set to exceed 30 Mt in the decade to come, but the usual import destinations, particularly the USA, will not, perhaps, be able to absorb this entire surplus.

Lastly, the transport sector is set to remain the largest consumer in the region by 2025. Oil—now prevalent in this sector—will maintain its share in the energy demand.

Table 12 Oil consumption in the Mediterranean (Horizon 2025)

	Oil consumption (in Mtoe)				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	239,6	248,6	260,6	336	0,2%	1,4%
SEMCs	32,3	93,1	130,5	222	4,0%	3,0%
TOTAL	272	342	391	558	1,0%	2,0%

Sources: IEA, OME, Plan Bleu

- In 2025, **natural gas** would reach 32%, that is, 472 Mtoe (550 billion cubic metres or Gm^3), with an average increase rate of 3.6% per year. In the NMCs, the average annual growth rate—of 5.5% between 1971 and 2007—would stand at 2.7% up to 2025 (243 Mtoe). Power production will continue to be the largest gas consuming sector in the region. Its share in the total natural gas demand would rise to 48% by 2025.

  Natural gas will also report an increase in penetration in the residential and tertiary markets in the SEMCs, prompted by population growth in cities and by an increase in urbanization in coastal zones. The high level of natural gas consumption should be easily met by the availability of gas reserves (9000 Gm^3 in the Mediterranean, representing nearly 5% of world gas reserves), but there will be a need for huge investments in infrastructure in order to connect production regions to the consumption centres and for the exploration of the new areas, particularly off-shore zones, which are either not explored or under-explored.

  Algeria, Egypt and Libya are and remain net gas exporters in the Mediterranean. Their exports will increase, passing from 85 Gm^3 in 2007 to 210 Gm^3 in 2025. Algeria will continue to be the major gas exporter. The other countries of the region will depend even more on imports. The import and export infrastructures ranging from gas pipelines, LNG plants and reception terminals, will develop considerably in the region.

Table 13 Natural gas consumption in the Mediterranean (Horizon 2025)

	Natural gas consumption (in Mtoe)				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	22	76,3	149	243	5,5%	2,7%
SEMCs	2,3	29,8	101	229	11,1%	4,6%
TOTAL	24	106	251	472	6,7%	3,6%

Sources: IEA, OME, Plan Bleu

- As far as **nuclear power** is concerned, Turkey and Egypt have recently called for an action plan for a nuclear power station. Their national energy forecasts include that nuclear energy production would account for 4 to 7% of the total power production by 2020. Additionally, Tunisia, is planning a study for the introduction of nuclear energy in its energy mix (2000 MW after 2025). In view of all this, nuclear power could account for 2% of the demand on primary energy in the SEMCs as from 2025.

Table 14 Nuclear energy production (Horizon 2025)

	Nuclear production (in Mtoe)				Annual growth rate (%)	
	1971	1990	2006	2025	1971-2006	2006-2025
NMCs	4	97,2	130,4	130	10,2%	0,0%
SEMCs	-	-	-	14		
TOTAL	4	97	130	144	10,2%	0,6%

Sources: IEA, OME, Plan Bleu

- Development of **renewable energies**: In the SEMCs, the quantity of renewable energy (including hydro-power) is set to reach 29 Mtoe by 2025. For the NMCs, it would pass from 48 Mtoe to 60 Mtoe by 2025.

Table 15 Consumption of renewable energies (Horizon 2025)

	Consumption of renewable energies (incl. hydro) (in Mtoe)				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	26,4	34,5	48	60	1,7%	1,2%
SEMCs	8,4	13,9	16	29	1,8%	3,4%
TOTAL	35	48	64	89	1,7%	1,8%

Sources: IEA, OME, Plan Bleu

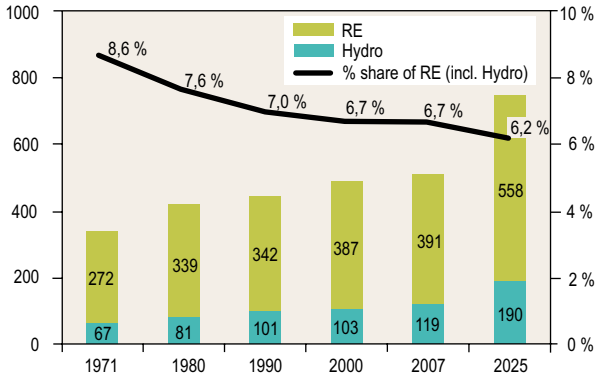
In absolute values, the share of renewable energies is set to increase (+ 40%) by 2025. The power production capacity based on renewable energies would be of 14 000 MW for a power generation

of 42 TWh. However, in spite of this high growth, the share of renewable energies in the energy mix would remain rather constant, standing at 6%, as a result of the high increase in total demand.

- On sector level, **transport** is set to remain the region's largest consumer in 2025. Industry will account for the highest increase in total final consumption, mainly as a result of progress in the SEMCs.

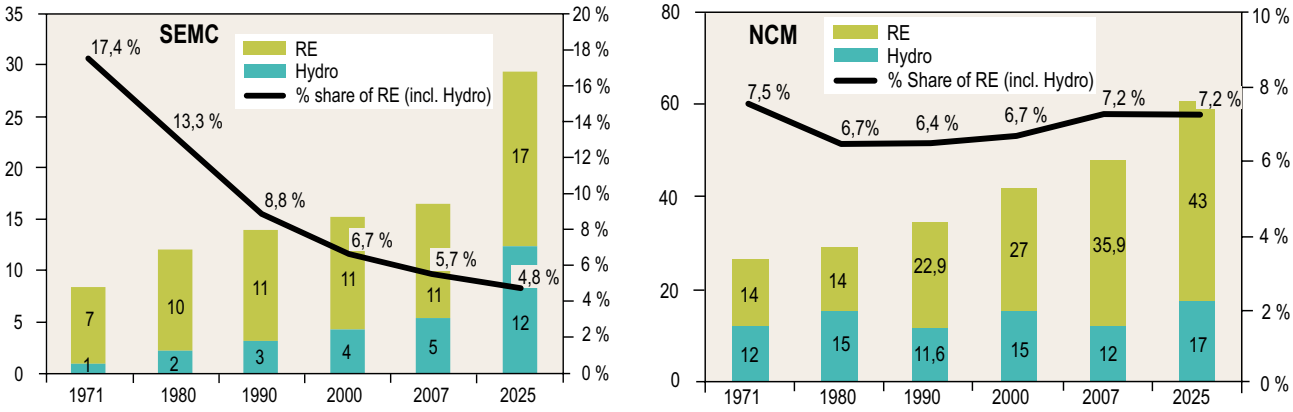
The structure of final energy demand has changed drastically during the past three decades, passing from a prevalence of industry to a new balance where the transport sector and residential demand have reported increasing shares. In the decades to come, the residential sector will further increase its share to reach a quarter of the total final consumption.

Figure 28 RE & Hydro-power sources in the Mediterranean (Mtoe & %)



Source: OME

Figure 29 RE & Hydro-power sources in the SEMCs and NMCs (Mtoe & %)



Source: OME

Energy dependence

In 2025, the Mediterranean region would import 39% of its oil and 28% of its gas needs. Dependence vis-à-vis fossil energies will remain around 35%.

For the NMCs, energy dependence would increase from 68% in 2006 to more than 72% by 2025. For the importing SEMCs, it would pass from 76% to 88%, while for the exporting SEMCs, exports would decline to 160% of their primary energy consumption.

The net quantities imported in the Mediterranean at Horizon 2025 are given in the table 16.

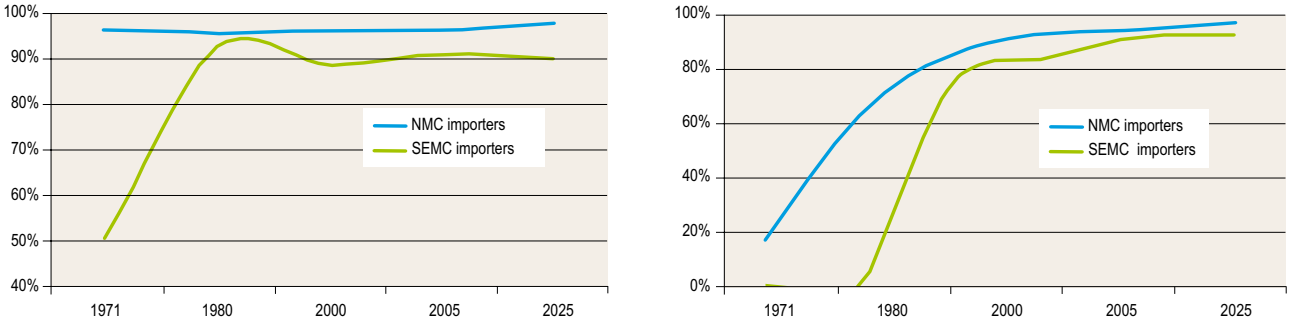
Primary energy production in the SEMCs—being 1.8 times that of the NMCs back in the early 2000s—would increase by 2025 to reach 3 times the production of the NMCs. Primary energy production in the producing/exporting countries would report a quite accelerated growth (2.8% per year between 2006 and 2025, as against 1.8 between 1971 and 2006).

Table 16 Net quantities imported in the Mediterranean (in Mtoe)

	1971	1990	2000	2007	% /year 1971-2007	2025	% /year 2007-2025
Importing Northern countries	257	325	397	466	1,7%	614	1,5%
Importing Southern countries	10	47	85	123	7,2%	311	5,3%
TOTAL Importers	267	372	482	589	2,2%	925	2,5%
Exporting Southern countries	-188	-176	-206	-229	0,5%	-410	3,3%

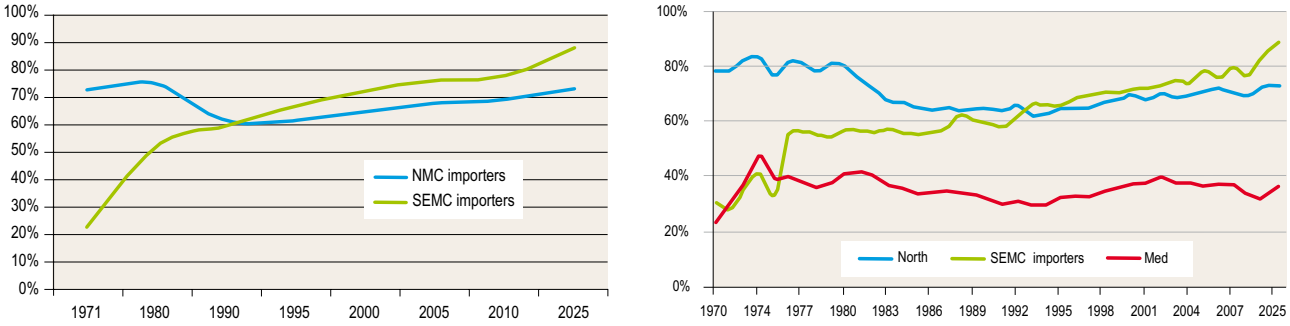
Sources: IEA for the review, OME for the scenario

Figure 30 Oil and gas dependence of the Mediterranean importing countries



Source: OME

Figure 31 Total energy dependence of the Mediterranean importing countries



Sources: OME, Plan Bleu

Table 17 Evolution of energy dependence (in %)

	1971	1980	1990	2000	2006	2007	2025
Spain	76%	77%	62%	77%	82%	79,5%	78%
France	71%	73%	51%	51%	51%	50%	58%
Italy	83%	90%	83%	87%	87%	85%	89%
Greece	77%	91%	72%	80%	82%	77%	76%
Cyprus	99%	99%	100%	99%	102%	96%	97%
Malta	100%	100%	100%	100%	100%	100%	99%
Slovenia			48%	53%	52%	53%	54%
Croatia			43%	53%	54%	57%	81%
Bosnia & H.			35%	28%	26%	29%	51%
Serbia			31%	15%	38%	38%	43%
Albania	-42%	-12%	8%	46%	52%	65%	60%
PNMs	78%	79%	64%	69%	71%	70%	72%
Turkey	29%	46%	51%	65%	73%	74%	78%
Syria	-96%	-79%	-91%	-92%	-42%	-23%	64%
Lebanon	92%	93%	94%	97%	97%	97%	98%
Palestine					100%	100%	100%
Israel	7%	98%	96%	97%	92%	92%	92%
Egypt	-109%	-119%	-72%	-24%	-29%	-20%	7%
Libya	-8189%	-1242%	-534%	-341%	-458%	-468%	-551%
Tunisia	-140%	-85%	-11%	13%	23%	15%	72%
Algeria	-1046%	-457%	-348%	-425%	-410%	-346%	-373%
Morocco	89%	81%	88%	94%	95%	95%	93%
SEMCs	-370%	-153%	-81%	-50%	-46%	-39%	-16%
MED	23%	41%	31%	37%	37%	37%	35%
NMCs importers	73%	75%	61%	64%	68%	70%	72%
SEMCs importers	30%	57%	59%	71%	76%	79%	88%
SEMCs Exp	-1184%	-425%	-223%	-188%	-187%	-161%	-161%

Sources: IEA, OME

Table 18 Primary energy production and net imports (en Mtoe)

	Production of Total Primary Energy						Annual Growth Rate (%)	
	1971	1980	1990	2000	2006	2025	1971-2006	2006-2025
Spain	10	16	35	32	31	42	3,2%	1,6%
France	48	53	112	132	133	131	3,0%	-0,1%
Italy	20	20	25	28	25	27	0,7%	0,4%
Greece	2	4	9	10	10	11	4,7%	0,2%
Cyprus	0	0	0	0	0	0	4,6%	4,8%
Malta	-	-	-	-	-	0		
Slovenia	-	-	3	3	4	4		0,1%
Croatia	-	-	5	4	3	3		-0,9%
Bosnia & H.	-	-	5	3	3	3		0,2%
Serbia & M.	-	-	13	11	12	11		0,0%
Albania	2	3	2	1	1	1	-2,0%	0,3%
North Med	97	114	210	224	223	233	2,4%	0,2%
Turkey	14	17	26	26	25	59	1,7%	4,7%
Syria	5	10	22	34	27	14	4,8%	-3,4%
Lebanon	0	0	0	0	0	0	0,4%	0,9%
Palestine								
Israel	6	0	0	1	3	3	-2,1%	-0,4%
SE Med	25	27	49	60	55	76	2,2%	1,7%
Egypt	16	33	55	56	82	110	4,7%	1,6%
Libya	138	97	73	75	104	200	-0,8%	3,5%
Tunisia	5	7	6	7	7	5	0,9%	-1,2%
Algeria	42	67	104	150	173	316	4,1%	3,2%
Morocco	1	1	1	1	1	2	0,1%	5,0%
SW Med	201	205	239	289	366	633	1,7%	2,9%
SEMCs	226	232	288	349	421	709	1,8%	2,8%
TOTAL	323	346	498	573	643	942	2,0%	2,0%
NCs Imp	97	114	210	224	223	233	2,4%	0,2%
SEMCs Imp	25	25	33	34	35	69	0,9%	3,6%
Total Imp.	122	140	243	258	258	302	2,2%	0,8%
SEMCs Exp	-201	-207	-255	-315	-386	-640	1,9%	2,7%

	Total Net Imports						Annual Growth Rate (%)	
	1971	1980	1990	2000	2006	2025	1971-2006	2006-2025
Spain	32,7	52,8	56,5	93,0	112,8	145,8	3,6%	1,36%
France	115	141	115	126	141	181	0,6%	1,3%
Italy	95	112	123	145	165	217	1,6%	1,4%
Greece	7	12	13	18	25	35	3,7%	1,7%
Cyprus	1	1	2	2	4	4	5,3%	0,0%
Malta	0	0	1	1	1	2		1,5%
Slovenia	-	-	3	3	4	4		1,0%
Croatia	-	-	4	4	5	12		4,1%
Bosnia & H.	-	-	2	1	2	3		3,5%
Serbia & M.	-	-	6	2	6	9		1,8%
Albania	-1	- 0	0	1	1	2		2,1%
North Med	257	334	325	397	468	614	1,7%	1,4%
Turkey	6	14	27	51	70	205	7,4%	5,9%
Syria	-3	-4	-11	-16	-8	26	3,4%	
Lebanon	2	2	2	5	6	11	3,3%	3,3%
Palestine	-	-	-	-	1	2		5,3%
Israel	0	8	12	19	18	32	11,5%	3,0%
SE Med	5	21	30	59	86	276	8,3%	6,3%
Egypt	-9	-18	-23	-11	-18	9	2,2%	
Libya	-136	-89	-62	-58	-86	-169	-1,3%	3,7%
Tunisia	-36	-3	-2	1	2	14		10,8%
Algeria	-38	-55	-81	-121	-139	-249	3,8%	3,1%
Morocco	2	4	6	9	12	20	5,5%	2,9%
SW Med	-184	-162	-160	-179	-229	-376	0,6%	2,6%
SEMCs	-178	-141	-129	-121	-143	-100	-0,6%	-1,9%
TOTAL	79	193	196	276	325	515	4,1%	2,5%
North Med	257	334	325	397	468	614	1,7%	1,4%
SEMCs Imp	10	29	47	85	108	311	7,1%	5,7%
Tot Imports	267	363	372	482	576	925	2,2%	2,5%
SEMCs Exp	-188	-170	-176	-206	-251	-410	0,8%	2,6%

Sources: IEA, OME

Total energy production in the SEMCs is likely to reach around 710 Mtoe, as against 420 Mtoe in 2006, of which mainly natural gas (+ 100%) and oil (+20%). The rise in production would originate in a limited number of exporting countries in the SEMCs (Algeria, Egypt, Libya and Syria). The production of natural gas in the Mediterranean, after having doubled up a first time over the past twenty years (from 76 Gm^3 in 1987 to 185 Gm^3 in 2007), would further double up by 2025, passing to 360 Gm^3 in 2025.

The electricity sector

According to the forecasts of power utilities, the total power production in the Mediterranean basin is set to reach around 3000 TWh by 2025, with an average annual growth rate of 2.7% between 2007 and 2025. In the NMCs, total power production would pass from 1328 to 1790 TWh (average annual growth by 1.7%). In the meantime, the production of the SEMCs would more than double up, passing from 519 to 1212 TWh.

The NMCs/ SEMCs per capita power consumption ratio would decrease from 3.6 in 2007 to 2.3 in 2025.

Table 19 Power consumption per capita (in kWh/cap)

	1971	1990	2000	2007	2025
NMCs	2035	4368	5582	6182	8700
SEMCs	253	787	1251	1728	3713
TOTAL	1301	2567	3209	3674	5641

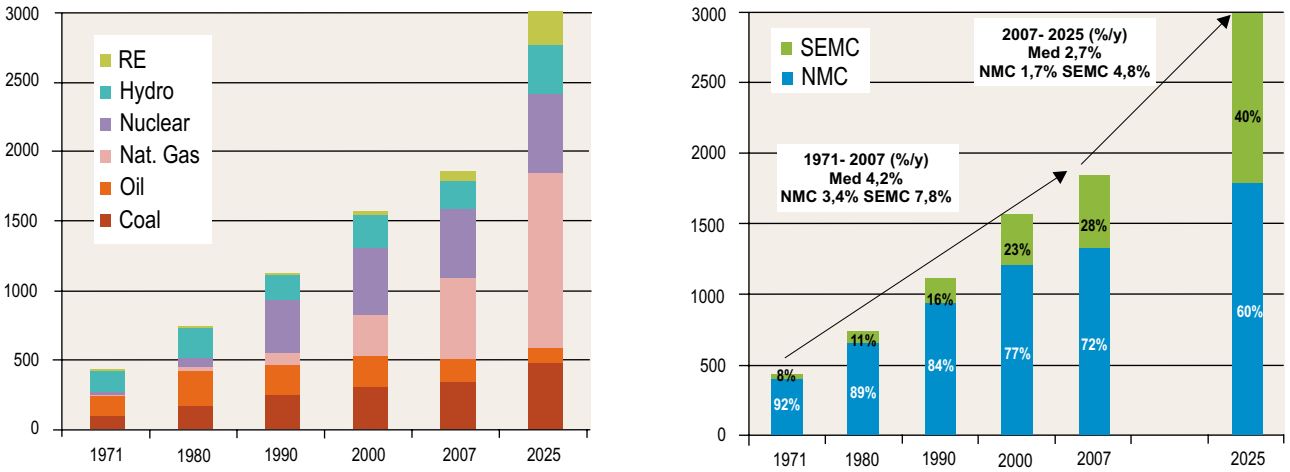
Source: OME

Table 20 Power production in the Mediterranean (Horizon 2025)

	Power production (in TWh)				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	385	899	1 328	1790	3,5 %	1,7%
SEMCs	34	176	519	1212	7,9 %	4,8%
TOTAL	419	1075	1 847	3002	4,2 %	2,7%

Sources: IEA, OME, Plan Bleu

Figure 32 Evolution of power production in the Mediterranean (in TWh)



Sources: IEA (1971 to 2007), OME & Plan Bleu computation

- Power production by source in the SEMCs

For the Mediterranean as a whole, the major increase is expected with regard to natural gas-powered production, whose share would pass from 31% to 42%, followed by renewable energies, from 14.5% to around 20%. The other sources—coal, nuclear power and oil—are on the decrease, passing from 18.3% to 15.6%, 27.1% to 19.1%, and 9.2% to 3.6%, respectively.

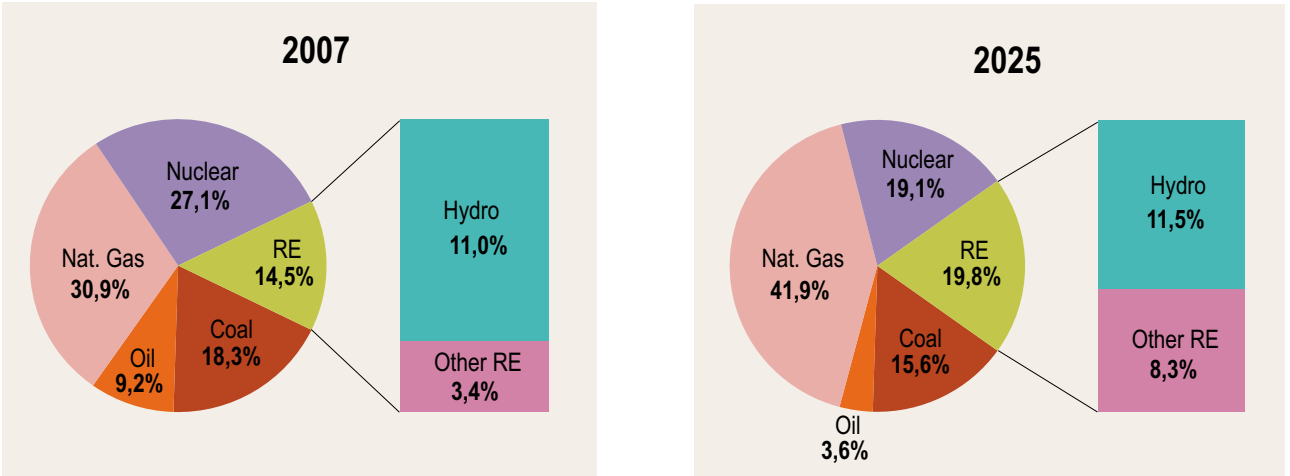
As regards the South, the SEMCs reported—concerning **natural gas**-powered electricity production—a value of 267 TWh in 2007 and would reach around 682 TWh by 2025. This natural gas-based power production stood at 3% in 1971, around 51% in 2007, and is set to reach 56% by 2025.

The share of **oil**-powered electricity production is set to decrease to 40 TWh by 2025 (3.6%). As for coal-powered electricity production, it would reach 252 TWh by 2025 (16%).

Hydro-power would reach around 142 TWh by 2025. Its share in the total power production decreased, passing from 30 to 18%, to stabilize around this same portion by 2025 (16%). While the SEMCs have used most of their hydro-power potential, Turkey will be the only country to report growth in this sector.

Power production based on **renewable energies**—having stood at 1.7 TWh in 2007 (0.3% of the total power production)—would pass to 42 TWh by 2025 (3.4%).

Figure 33 Structure of power production in the Mediterranean, by source (2007 & 2025)



Sources: IEA, OME, Plan Bleu

Though currently non-existent, **nuclear power** production would pick up under the impetus of the power stations projects in Egypt and Turkey as from 2020.

Table 21 Production of coal-powered electricity in the Mediterranean, Horizon 2025 (in TWh)

	Coal-based power production				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	82,8	200,8	233	217	2,9%	-0,4%
SEMCs	3,3	32,9	104	252	10,1%	5,0%
TOTAL	86	234	337	469	3,9%	1,8%

Sources: IEA, OME, Plan Bleu

Table 22 Production of oil-powered electricity in the Mediterranean, Horizon 2025 (in TWh)

	Oil-based power production				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	132,4	137	80	69	-1,4%	-0,8%
SEMCs	19,3	56,8	90	40	4,4%	-4,4%
TOTAL	152	194	170	109	0,3%	-2,5%

Sources: IEA, OME, Plan Bleu

Table 23 Production of gas-powered electricity in the Mediterranean, Horizon 2025 (in TWh)

	Natural gas-based power production				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	10,5	47,5	305	576	9,8%	3,6%
SEMCs	0,9	48,1	266	682	17,1%	5,4%
TOTAL	11,4	96	571	1258	11,5%	4,5%

Sources: IEA, OME, Plan Bleu

Table 24 Production of hydro-power in the Mediterranean, Horizon 2025 (in TWh)

	Production of hydro-power				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	138,7	134,7	147	204	0,2%	1,8%
SEMCs	10,4	37,7	57	142	4,8%	5,2%
TOTAL	149	172	204	345	0,9%	3,0%

Sources: IEA, OME, Plan Bleu

Table 25 Power production based on renewable energies (RE) in the Mediterranean, Horizon 2025 (in TWh)

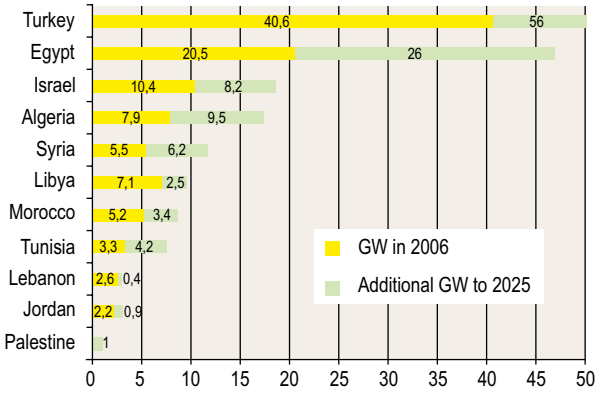
	RE-based power production				Annual growth rate (%)	
	1971	1990	2007	2025	1971-2007	2007-2025
NMCs	5	6,2	62	206,6	7,2 %	6,9 %
SEMCs	0,2	0,1	1,7	41,5	6,2 %	19,3 %
TOTAL	5,1	6,3	64	248	7,3 %	7,9 %

Sources : AIE, OME, Plan Bleu

- Installed power capacity

Power demand is set to increase by 65% by 2025. The SEMCs—which are due to report a stronger growth than the NMCs—would require an increased production. Economic and social growth in the SEMCs would stimulate power consumption in this region: from 1730 kWh per inhabitant and per year in 2006 to 3720 kWh in 2025. To meet demand in 2025, the countries would need to install new power stations and refurbish old ones. By 2025, power production will have shifted to natural gas (56%) in the SEMCs, and to nuclear power (29%) in the NMCs.

Figure 34 Power production capacity installed in the SEMCs



Sources: OME, Plan Bleu

More than two thirds of the additional installations of new power generation capacity would be undertaken in the SEMCs. Total power production is estimated as 3000 TWh for 2025. In 2025, total power production would be thermal, for the major part, with natural gas accounting for 42% of the fuels burned for power generation. In spite of a significant rise, renewable energies (exclusive of hydro-power) would account for a mere 8.3%.

Between 2006 and 2025, an additional capacity of around 200 GW of power stations would need to be installed. The overwhelming majority would be power stations based on natural gas (60% of the increase, that is, 118 GW), on RE (21% of the increase, that is, 42 GW) and on hydro-power (11% of the increase, that is, 21 GW). It should be noted that the share of the capacity based on oil would be declining throughout the region.

Table 26 Installed power capacity in the Mediterranean by 2025 (GW)

ST-Coal*	ST-Oil	ST-Gas*	NGCC*	GT & Diesel*	Nuclear	Hydro	RE	Total
88	43	78	147	18	79	119	68	639
14%	7%	12%	23%	3%	12%	19%	11%	100%

*ST Steam Turbiner ; GT Gas Turbine ; NGCC Natural Gas Combine Cycle
Sources: OME, Plan Bleu

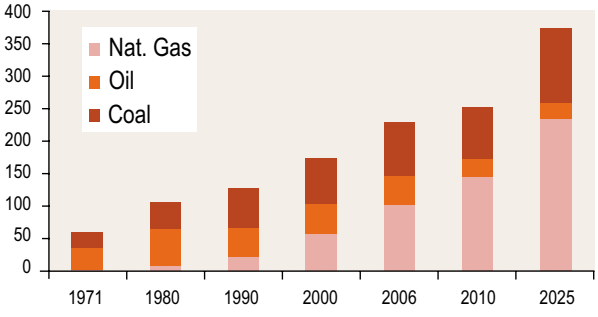
The total installed capacity in the SEMCs was of 105 GW in 2006, dominated by natural gas, oil and hydro-power (45, 20 and 19% of the total, respectively). The capacity would pass to 224 GW by 2025 (120 GW), with gas accounting for 53% of the total installed capacity i (64 GW), followed by hydro-power and coal. Nuclear power could figure in the energy mix as from 2020 thanks to the Egyptian and Turkish projects (Tunisia after 2025).

- **Fossil fuels for power production** stood at 229 Mtoe in 2006, which accounts for 23% of the total primary energy demand. In 2025, fossil fuels dedicated to power production would reach 375 Mtoe (around 25% of the total primary energy demand), with gas, coal and oil representing shares of 63%, 30% and of 7%, respectively.

  For the SEMCs, fossil fuels for thermal power production amounted to 93 Mtoe in 2006 (which accounts for 33% of the total primary energy demand), with gas, coal and oil representing shares of 55%, 23% and 22%, respectively. By 2025, the fossil fuels dedicated to power production would reach 200 Mtoe (around 32% of primary energy), of which 65% for gas, and 35 and 8%, for coal and oil, respectively

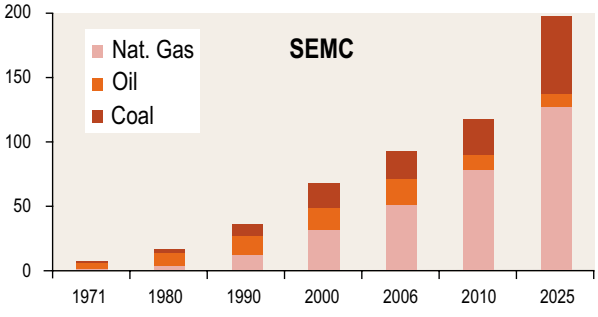
  The following table gives the quantities (Mtoe) of fossil fuels as inputs to power stations in the Mediterranean.

Figure 35 Input fuels to power stations (in Mtoe)



Source: OME

Figure 36 Input fuels to power stations in the SEMCs (in Mtoe)



Source: OME

Table 27 Input fuels to power stations (Mtoe)

	2006			2025		
	NMCs	SEMCs	MED	NMCs	SEMCs	MED
Nat. Gas	48	51	99	101	125	226
Oil	23	20	43	15	9	24
Coal	56	22	78	49	60	110
TOTAL	127	93	220	166	194	360

Source: OME estimates

It may be concluded that the share of fossil fuels in power production is set to remain fairly stable up to 2025 (25% of TPES) for the region as a whole and for the SEMCs. The oil consumption involved in power production would decrease while that of natural gas would increase.

As regards the efficiency of fossil fuels in power production, for the three fuels (coal, oil and gas), the trend is towards an improvement, with a reduction of the specific consumption over the period concerned. The most notable improvement relates to natural gas, thanks to substantial progress in combine cycle power plants (50% of efficiency, as against some 25% for a gas turbine).

Lessons learnt

The development of the energy infrastructures described in the first part and the energy needs issuing from the baseline scenario would lead in future to significant oil, gas and electricity exchanges.

- Energy export flows take a South-North direction. Obviously enough, South-South infrastructures are necessary, not only to ensure northward transit but also to help meet the needs of the South and

to strengthen cooperation. It must be admitted, however, that—for the time being—one cannot really speak of an integration of the Mediterranean region: electric connections exist between the countries of the South, but the exchanges are low, as attested by the figures. The exports potentials originating from Mediterranean countries (chiefly from the SEMCs) with regard to oil, gas and electricity by 2025, all destinations considered, are of over 200 bcm for gas (+133%, compared to the current situation), of 240 MT for oil (+36%) and of 300 TWh for electricity (+20%).

Table 28 Intra-Mediterranean exchanges (Electricity, Oil & Gas)

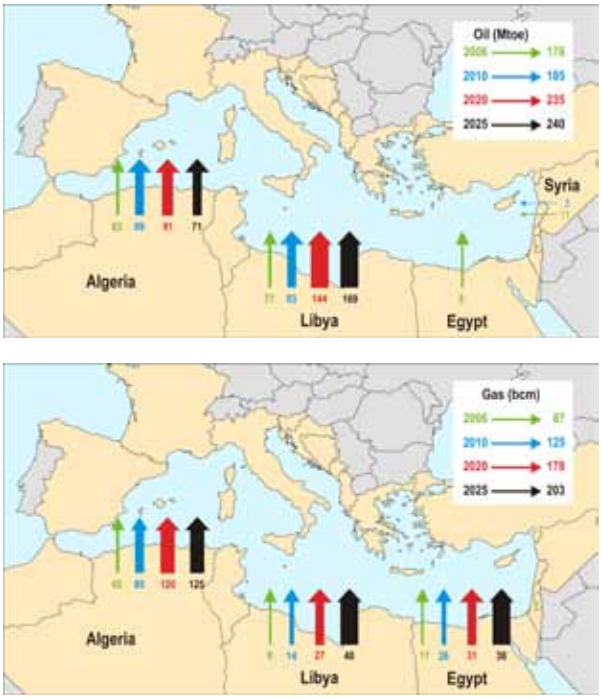
	Intra-Mediterranean exchanges			Total potential exports (all destinations considered)		
	Oil (Mt)	Gas (bcm)	Elec. (TWh)	Oil (Mt)	Gas (bcm)	Elec. (TWh)
2006	96	72	70	176	87	250
2025	110	100	90	240	203	300
Increase 2025/2006	15%	39%	29%	36%	133%	20%

Sources: IEA, Cedigaz, Eurelectric, OME, Plan Bleu estimates

- The five Southern Mediterranean energy producing countries cover more than 25% of the crude oil needs of Southern European countries (France, Greece, Italy, Portugal and Spain), and more than 44% of the natural gas needs of France, Italy, Spain, Portugal, Greece and Slovenia. As for intra-Mediterranean electric exchanges, they account for 29% of the total exchanges with all the countries neighbouring Mediterranean ones.
- For the time frame 2025, a growth of energy exchanges is expected to reach around 240 Mtoe, as against 180 Mtoe in 2007. While oil exchanges would stabilize at the current level of 100 Mtoe, those of natural gas would pass from 72 to more than 100 bcm and those of electricity would pass from 73 TWh to nearly a hundred TWh.
- Intra-Mediterranean oil exchanges would increase slightly (+15%), compared to the current level, while electricity exchanges would rise significantly (+30% of expected growth) over the fifteen coming years. The most significant evolution, however, would relate to gas exchanges (+40%). Indeed, natural gas imports would be increasingly significant, passing from 207 Gm^3 currently (of which 72 Gm^3 originating from Mediterranean countries) to around 300 Gm^3 by 2025 (of which 100 Gm^3 originating from Mediterranean countries).

  The development of energy exchanges in the Mediterranean region, together with the socio-economic development of the SEMCs, makes it necessary to implement many energy infrastructures projects.

Figure 37 Potential hydrocarbon exports in the SEMCs

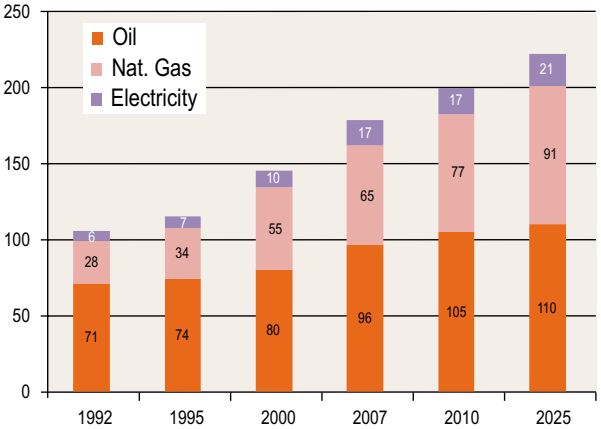


Sources: IEA, BP, OME, national sources and author's estimates

- Total primary energy demand for the whole Mediterranean countries would be on the rise, and is set to increase by 2.4% per year on average, thus passing to 1457 Mtoe by 2025, as against 955 Mtoe in 2007. By 2025, the Mediterranean share of global energy demand would remain relatively stable, around 9%.

  The largest portion of the increase in energy demand would come from the SEMCs, which are likely to claim over 42% of the primary energy demand, as against 30% currently.

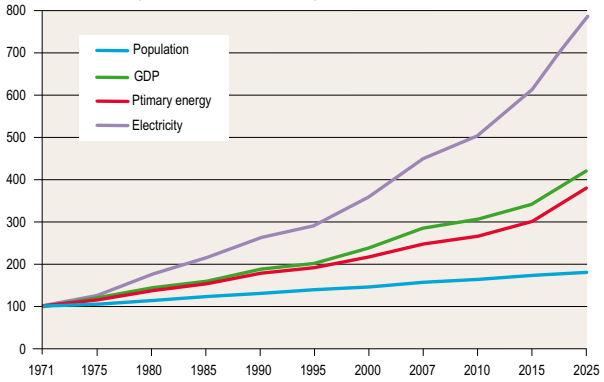
Figure 38 Intra-Mediterranean energy trade, Horizon 2025 (in Mtoe)



Sources : AIE, Cedigaz, Eurelectric, OME, estimations Plan Bleu

- The growth of the electricity consumption in the Mediterranean (as illustrated via the evolution of the indices of the Figure below) is much more accelerated than growths of other parameters as economic, energy consumption or demographic growth. This is in particular the case in the SEMCs, where power demand and primary energy consumption would grow more rapidly than the economic and demographic parameters.

Figure 39 Mediterranean: Evolution of the parameters (1970 = index 100)

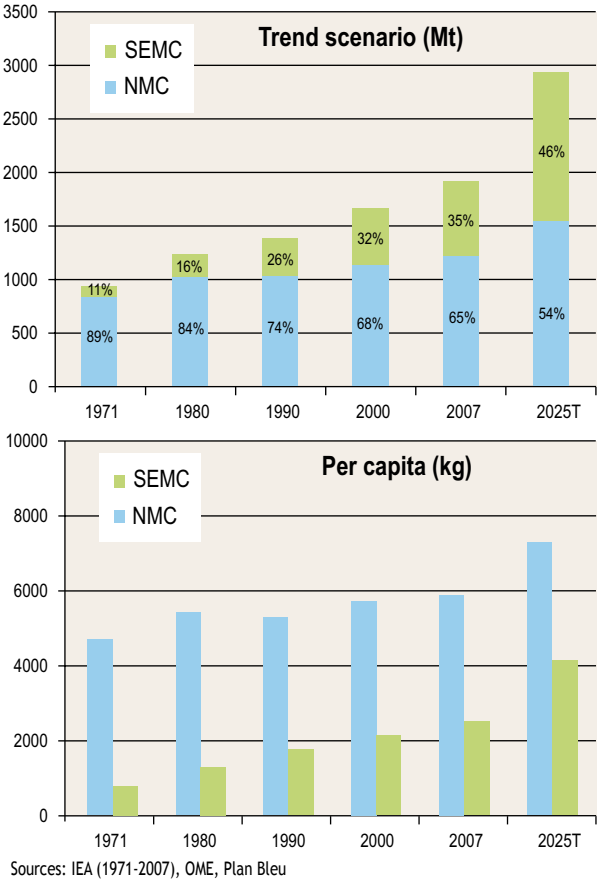


Sources: OME, Plan Bleu

- Fossil energies would still account for around 84% of the primary energy demand in the Mediterranean by 2025. Oil would remain the dominant source of energy with 38% in 2025. In spite of the development of gas for power production, the oil demand would continue to increase, as well as the demand on fuels in the transport sector. The gas demand would report a high increase, from 251 Mtoe in 2007 to 472 Mtoe in 2025, that is, an annual growth rate of 3.6% per year, and would account for 33% of the energy mix in the Mediterranean. The demand for coal would continue to present an accelerated growth by 2.6% per year on average, thus reaching 13% of the energy mix by 2025. Renewable energies would progress slightly with an average annual growth of 1.8% per year. By 2025, they would still account for a modest 6.2% of the primary energy demand. The insufficient tapping of the renewable energies potential foretells, in this baseline scenario, an **energy future in the Mediterranean that remains almost totally based on fossil energies**.
- This prevalence of fossil energies generates significant impacts. For the NMCs, the CO_2 emissions due to energy consumption are set to reach 1741 $MTCO_2$ by 2025, with a growth rate of 1.1% per year. By 2025, in order to maintain the level of CO_2 emissions in the NMCs equivalent to that of 2007 (1370 $MTCO_2$), the quantity to be avoided should be of 370 $MTCO_2$, that is, the equivalent of the CO_2 emissions of Spain in 2007. The additional increase would be more significant in the SEMCs; the CO_2 emissions due to energy consumption in the SEMCs are set to double up by 2025 (1550 $MTCO_2$), at a growth rate of 4.1% per year.

  For the NMCs, the per capita CO_2 emissions (of 6100 kg in 1990 and 6800 kg in 2007) should pass to 8440 kg by 2025. For the SEMCs, the CO_2 emissions from energy sector passed from 2020 kg in 1990 to 2895 kg in 2007; they would total 4760 kg by 2025.

Figure 40 CO_2 emissions (1971-2025)



Sources: IEA (1971-2007), OME, Plan Bleu

Nevertheless, this situation is not a sealed fate and there are several options that help ease the various constraints. The most significant options consist in tapping the high energy efficiency potential, boosting clean and efficient technologies, as well as promoting renewable energy sources. The reinforcement of the electrical interconnections and the future completion of the ''Mediterranean ring'' would allow a more accelerated growth of power exchanges and would help towards a tapping of the renewable energies potential in the SEMCs.

It is these measures that have been represented and quantified in **the alternative scenario developed in the third part of this report**.

Alternative Scenario: From fossil energy to green energy

The Mediterranean region as a whole will have to face, for the decades to come, with significant energy and climate challenges. Energy demand will increase quite significantly, while the prices of fossil fuels will probably follow an upward trend. It is assumed in this scenario that, to take up these challenges, the Mediterranean countries will step up their efforts to set out adequate public policies in the fields of energy efficiency and energy saving, of renewable energies and reduction of GHG emissions, with the general objective of uncoupling economic growth from energy demand.

The fact that the countries of the Northern rim (EU countries) have already set themselves ambitious objectives following approval of the EU Energy-Climate Package constitutes, for the SEMCs, a driving force in matter of international policy for climate protection.

Hypothesis

The hypothesis selected for the construction of this alternative scenario of sustainable development have been established 'according to expert opinion', following the organization of a regional workshop. They are based on more sustained economic growths, higher than those selected within the trend scenario (BaU scenario), being of 1 point for the SEMCs and of around +0.3 for the NMCs. With regard to the SEMCs, average growth is of 5% per year, as against 4% in the BaU scenario, while that of the NMCs is of 2.1% in the alternative scenario, as against 1.8% in the BaU scenario.

The average price of the oil barrel selected is that of the high hypothesis of the IEA baseline scenario, that is, around $150, as against $100 in the trend scenario.

Other elements are integrated in the construction of the alternative scenario.

Progress of national policies

- Development of renewable energies: The hypothesis selected for the alternative scenario is that of a faster development of renewable energies targeting 10% of the primary energy balance and 40% of the power production, instead of 6% of the primary energy balance and 19% of the power production in the BaU scenario. This hypothesis is not unfeasible, as certain Southern Mediterranean countries have adopted ambitious measures which are already bearing fruit. In Tunisia, this has been obtained by decreasing energy intensity by 2.8% per year, by a penetration of renewable energies—passing from 0.5% in 2005 to 1% in 2007, by an energy saving of around 800 ktoe and by an emissions reduction estimated as 2.4 $MTCO_2$. New measures have been taken to raise to 3% per year the reduction of energy intensity and to 4% the share of renewable energies in the energy balance by 2011.

Besides, the potential is considerable: solar radiation is estimated as between 1300 kWh/m²/year on the coast and 3200 in the Saharan desert. Sunshine duration ranges between 2650 and 3400 h/year. As for wind energy, several sites have a potential where the mean wind velocity largely exceeds 7 m/s (being of up to 11 m/s for certain sites) and is likely to be tapped on a large scale. Egypt thus has one of the highest mean wind velocities in the world, with 11 m/s, which makes it possible to operate there a wind farm

Table 29 Demographic and economic growth in the Mediterranean

	Population (% per year)		Economic growth (% per year)		
	1971-2006	2006-2025	1971-2006	2006-2025 (Trend Sc.)	2006-2025 (Alternative Sc.)
NMCs	0,4%	0,2%	2,5%	1,8%	2,1%
SE Med	2,3%	1,1%	4,2%	4,4%	5,4%
SW Med	2,2%	1,2%	4,5%	3,2%	4,2%
SEMCs	2 ,2%	1,2%	4,3%	4,0%	5,0%
TOTAL	1,3%	0,8%	2,8%	2,2%	2 ,7%

Sources: WDI, OME estimates & questionnaires, Plan Bleu

during 3900 h/year, as against 1900 h in Spain and Greece. Certain countries could install more significant capacities of renewable sources, such as Egypt (7000 MW); Morocco (1700 MW with a potential that may reach 6000 MW); Turkey (1500 MW out of 20000 MW); Algeria (855 MW); Syria (500 MW); Libya (339 MW); Tunisia (280 MW out of 1800 MW); Israel (200 MW); and Palestine (110 MW).

- Reduction of the wastages and of pollution: The extraction and exploitation of the potential discovered lead to wastages and generate considerable atmospheric emissions, particularly the natural gas flaring from fields production, totalling more than 147 billion m^3 in 2007 on global level (5% of the production) by producing countries. Efforts have been made by certain countries, of which Algeria, in particular. While the associated gas volumes have almost tripled over the past 30 years, the 'flared gas/ produced gas ratio' passed from 80% in 1970 to 13% in 2002, and to less than 7% in 2007. Complete elimination of flaring is scheduled for 2012 (according to Sonatrach), while significant progress could still be made by Egypt and Libya, which will benefit from support of the initiative managed by the GGFR (Global Gas Flaring Reduction) Partnership of the World Bank.
- Improvement of electricity transmission and distribution networks (HV, MV and LV) by reduction of on-line losses and by continuity of service: Power conveyance to over 71 million clients in the whole of the SEMCs, via transmission and distribution power lines, involves losses on these networks. These transport and distribution losses have reported a slight improvement, passing—on the whole—from 16% in 2000 to 13% in 2007 of the gross power quantities available. The alternative scenario assumes a reduction of the losses and an improvement of the transmission and distribution grid systems to reach levels less than 10% (around 8% for the NMCs currently).
- The same applies to improvement of the productivity in power generation: Specific consumption in power generation and the quantities of input fuels burnt in power plants have been constantly on the increase due to low efficiency of the power stations of the SEMCs, which is around 34%. By way of comparison, the efficiency of the new natural gas combine cycle power stations, installed already in some SEMCs, reach 50% of output.

Rapid development of regional cooperation

This scenario integrates the initiatives launched by the UfM (Union for the Mediterranean), both with regard to convergence of the national energy policies of the SEMCs and to putting in place a large-scale energy plan (Mediterranean Solar Plan), whose major objective is the development of a sustainable energy future in the Mediterranean region.

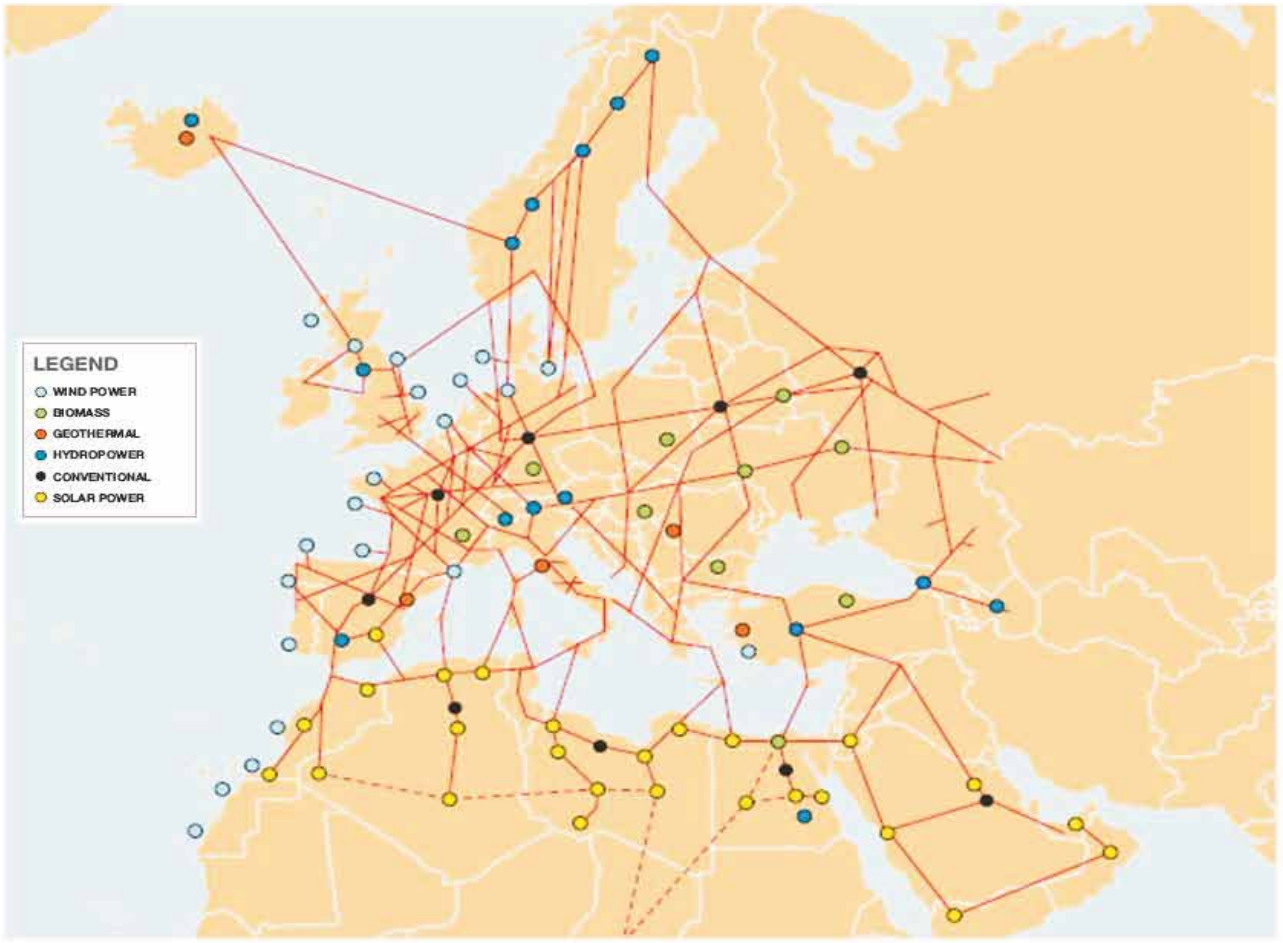
The Mediterranean Solar Plan (MSP) belongs in the regional projects listed in the partnership between the Mediterranean riparian countries and the European Union. The chief objectives of the MSP are the installation, by 2020, of 20 000 MW additional capacity of low carbon power production, particularly solar, in the South and East of the Mediterranean and the development of interconnection lines allowing the exportation of part of this green electricity to the European Union. Such installations would make it possible to optimize the potential of renewable energies of the SEMCs, based on efficient and clean technologies.

The Solar Plan aims at gearing investments firstly towards a reduction of consumption, and then to a consumption that is the closest possible to production sites, thus reinforcing in a «clean» way the energy systems of the SEMCs.

The European Directive 2009/28 relating to renewable energies, approved by the European Parliament on December 17, 2008[5], envisages the taking into account of joint projects between Member States and third countries under the objectives set by each Member State. This Directive makes it possible for Member States to associate their national assistance modes with those of other Community States, as well as to conduct "physical" importation of green electricity from third countries, which may be reckoned in the national objective of the energy package. Its article 9 (see copy of the text in Annex) allows the taking into account of electricity produced within the MSP framework by the countries of the Southern rim and exported to the countries of the Northern rim. However, "virtual" imports (investments in renewable energies in third countries) cannot be reckoned under the objectives laid down by the Directive. Statistical transfer (exchange of renewable credits between surplus and deficit countries) is limited to Member States. Within the framework of our alternative scenario, it is assumed that all these issues should

5 Legislative resolution of the European Parliament, dated December 17, 2008, further to the draft Directive of the European Parliament and the Council related to the promotion of the use of energy produced based on renewable sources (COM(2008)0019 – C6-0046/2008 – 2008/0016(COD))

Figure 41 Sketch for a supergrid with EU-MENA HVDC connection



Sources: TREC, Concept Desertec EU-MENA (www.desertec.org)

evolve towards a situation where exportation of this green electricity from one SEMC to a European country could be carried out in a virtual way. It is not necessary to convey a green kWh from an exporting country to an importing country.

According to a study on the MSP and the conditions of its success, issued in May 2009, by the IGF (Inspection Générale des Finances) and the CGIET (Conseil Général de l'industrie, de l'Energie et des Technologies), the implementation of the MSP will require significant funds, in the range of 38 to 46 billion €. Other experts, entrusted with a study by the European Commission, estimate the cost as 80 billion €.

Technological advances

Electricity transmission over very long distances is quite costly both in terms of investment and of on-line losses. However, technologies of direct current transmission have developed quite significantly. It is nowadays possible to supply large quantities of electricity over long distances via High Voltage Direct Current (HVDC). Improvements of this technology are expected in the medium term, both with regard to cost and to performance. Alternative Current technology (AC technology) is adapted for interconnection lines of less than 50 km. HVDC cables have become less expensive and more efficient for distances beyond 60 km.

Around the Mediterranean, there are several projects for which direct current cables and back-to-back stations would have a role to play. Back-to-back stations will, probably, be the solution to recommend with a view to addressing the technical problems currently arising with regard to putting on stream the Libya-Tunisia interconnection (construction completed in 2003, but not in operation yet awaiting 'go-ahead' by the Union for the coordination of Transmission of Electricity (UCTE[6]).

6 The UCTE (Union for the Coordination of Transmission of Electricity) aims, above all, at the development of technical coordination between the transmission system operators with a view to promoting secure operation of interconnected european networks, mainly via the adoption of common rules....The UCTE currently undertakes to extend its network to neighbouring

HVDC technology is increasingly gaining ground in matter of stabilization of major grids, all the more so when it comes to increasing incorporation of fluctuating resources (such as the wind resource). The long-distance HVDC option contributes significantly to boosting compensatory effects between local and remote energy sources.

The European Commission has announced the updating of the MedRing study. In the short term, the objective is to implement permanent power continuity between the various systems, which are currently independent around the Mediterranean. In the medium-to-long term, it would be necessary to complete the implementation of projects of green power exportation lines based on HVDC lines (Horizon 2020/2025).

Compared results of the two scenarios (BaU and alternative)

The table 30 presents a comparison between the main results, by country, of both BaU and alternative scenarios, namely those related to energy demand, power demand and CO_2 emissions levels. These results are analyzed in the report in a more detailed way, while highlighting all the challenges and advantages related to this sustainable scenario.

Energy consumption would be reduced by 20% for the whole Mediterranean region by 2025, while elctricity consumption would report a reduction by 23%. The energy consumption reductions vary according to the countries from -1% to -28%, those of electricity consumption from -1% to -45%, while CO_2 emissions would be reduced by 25%. Over a half of the reductions—whether in terms of energy or of CO_2 emissions—takes place in the SEMCs; the share of the SEMCs is even more significant (around 2/3) when it comes to the reduction in electricity consumption.

In absolute values, the total reductions are of 287 Mtoe of energy consumption for the whole Mediterranean (of which 149 Mtoe for the SEMCs); a total reduction of 690 TWh of the power consumption for the whole Mediterranean (of which 432 TWh for the SEMCs); and a total reduction of 808 $MTCO_2$ for the whole Mediterranean (of which 418 $MTCO_2$ for the SEMCs).

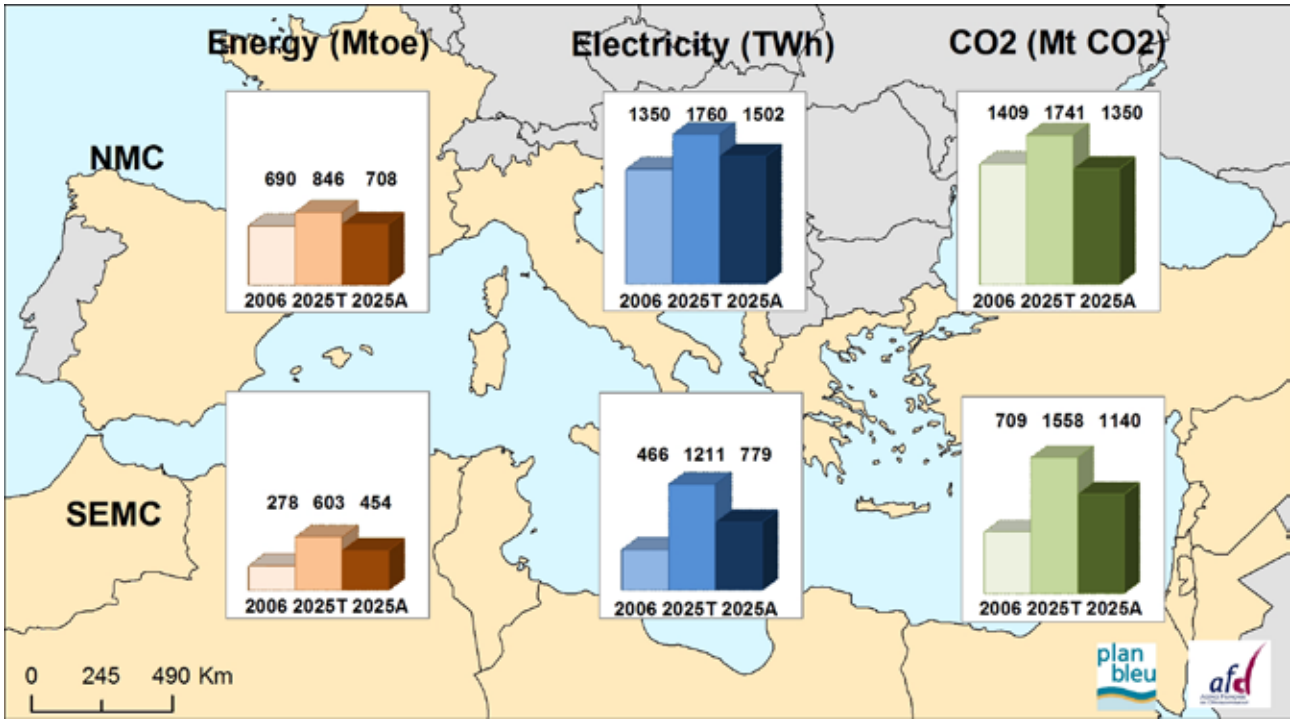
Table 30 Synthesis of the main results by country

	ENERGY 2025 (Mtoe)			CO_2 emissions 2025 (Mt CO_2)			ELECTRICITE 2025 (TWh)		
	2007	Trend	Alternative	2007	Trend	Alternative	2007	Trend	Alternative
Spain	144	188	154	329	405	341	300	399	352
France	264	314	280	400	489	389	564	687	649
Italy	178	242	183	463	576	393	308	452	322
Greece	32	45	40	99	125	104	63	106	78
Malta	1	2	1	3	4	4	2	5	3
Cyprus	2	4	4	10	10	10	5	6	5
Slonenia	7	7	7	14	14	14	15	16	15
Croatia	9	15	12	20	35	27	12	26	16
Bosnia H.	6	7	4	15	19	10	12	15	14
Serbia & M.	16	20	20	51	58	54	37	41	40
Albania	2	3	3	5	6	5	3	8	8
Turkey	100	261	189	246	715	506	192	537	363
Syria	20	39	30	47	97	73	39	70	50
Lebanon	4	11	9	15	27	21	10	19	12
Israel	22	34	26	63	100	73	54	92	52
Palestine	1	2	2	2	6	5	0,2	8	7
Egypt	67	118	91	151	278	209	125	248	153
Libya	18	31	23	48	75	55	26	50	27
Tunisia	9	18	15	20	45	32	15	43	26
Algeria	37	67	52	82	159	122	37	96	53
Morocco	14	28	17	35	57	43	23	55	36
NMCs	662	846	708	1409	1741	1350	1321	1760	1502
SEMCs	292	603	454	709	1558	1140	519	1211	779
Med.	953	1449	1162	2118	3299	2490	1840	2971	2281

Source: Plan Bleu

countries in order to promote their interconnection, in addition to those with Mediterranean countries.

Figure 42 Graphic representation of the results of the Trend (T) and Alternative (A) scenarios



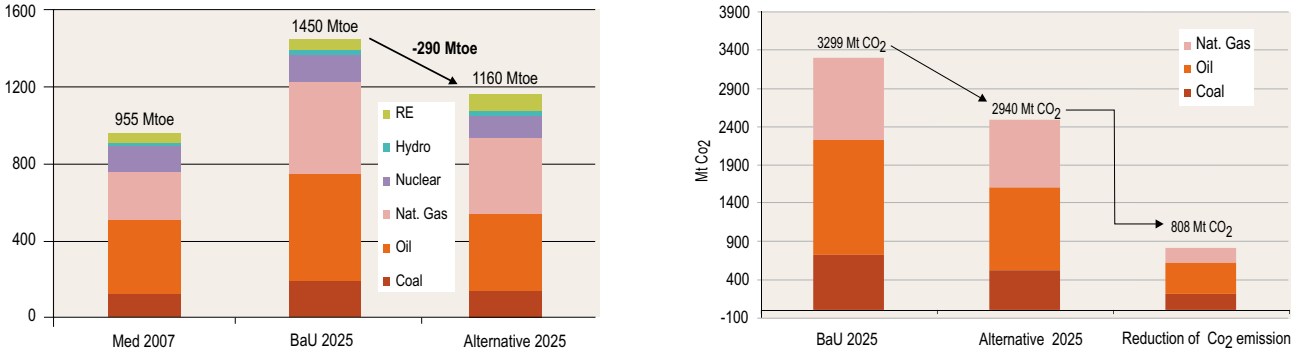
Sources: Plan Bleu, AFD

Indeed, by 2025, primary energy demand would be brought down to around 1160 Mtoe in the alternative scenario, as against 1450 Mtoe in the BaU scenario. Power demand would be of only 2281 TWh in the alternative scenario, compared to 2970 TWh in the trend scenario.

The breakdown of these reductions reveals that all fossil sources would report a drop in their respective consumption sectors, particularly coal, oil and natural gas in the power generation sector, but also oil in all its uses (residential, transport and industry) and natural gas in the industrial and residential sectors.

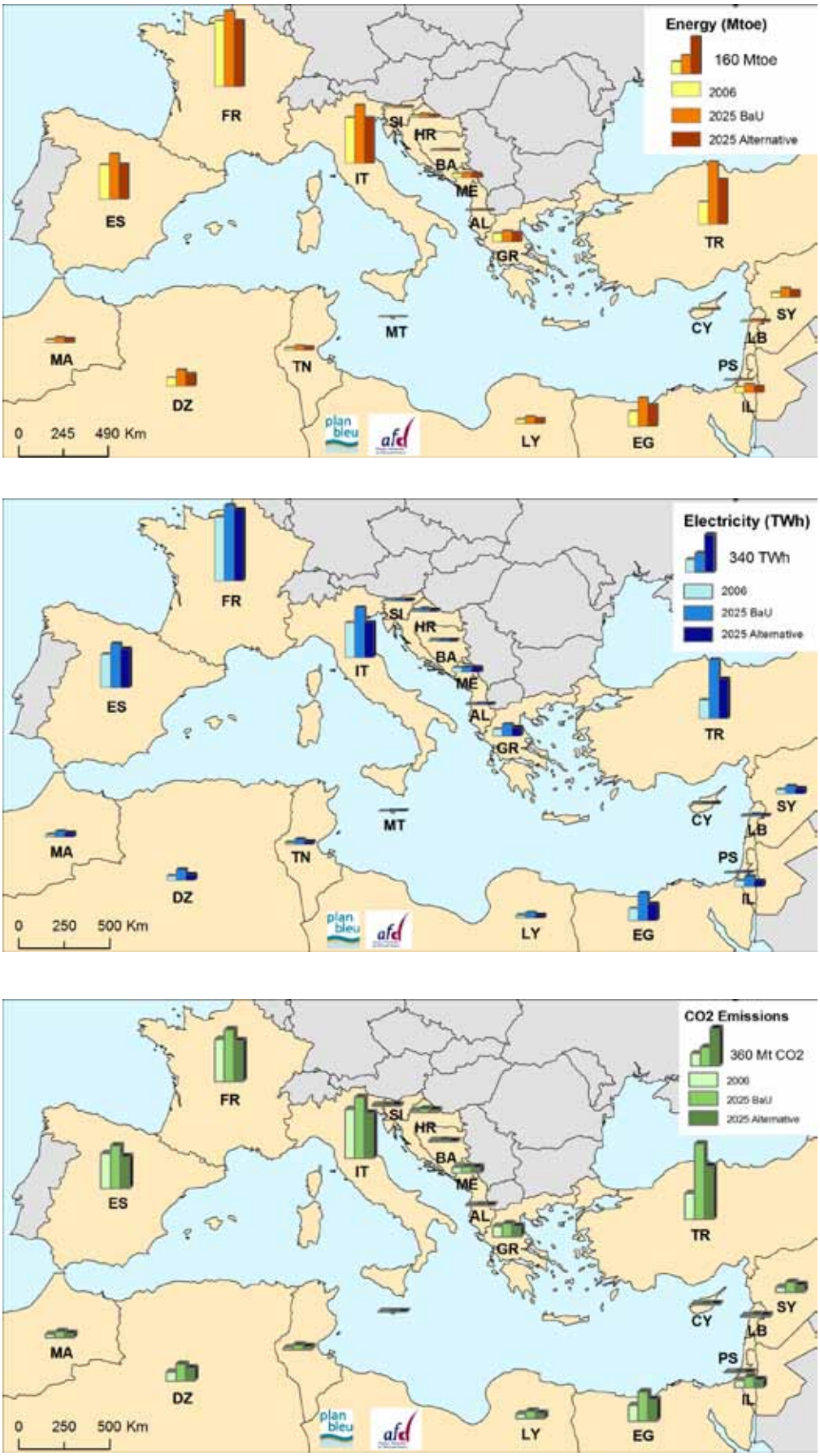
In the alternative scenario, oil's share reaches of 35% (instead of 38%, baseline scenario) which, when applied to a reduced overall demand, will be equivalent to the stabilization at 2007 levels, while the BaU scenario estimates a 43% increase between 2007 and 2025 (+167 Mtoe). Concerning natural gas, this is equivalent to savings of more than 100 billion m^3 on the gas demand, almost a third of the current demand, limiting by as much the imports of hydrocarbons, their transport and the related environmental risks. As for coal, a saving of around 54 Mtoe would be achieved, even though its share would remain unchanged at around 12%.

Figure 43 Energy demand and CO_2 emissions in the two scenarios



Sources: Plan Bleu, OME

Figure 44 Comparison of the results (Energy, Electricity and CO_2 emissions) of the 2 scenarios



Sources: Plan Bleu, AFD

Table 31 Primary energy consumption in the two scenarios, by source (in Mtoe)

	Coal	Oil	Gaz	Nuclear	Hydro	RE	Total	%Coal	%Gas	%Oil	%RE+Hydro
Med 2007	119	391	251	130	18	47	955	12%	26%	41%	6,8%
Trend 2025	190	558	474	140	30	55	1449	13%	33%	39%	6%
Alternative 2025	135	404	392	115	30	83	1162	12%	34%	36%	10%
Energy savings	54	154	82	25	0	-27	287				

Sources : Plan Bleu, OME

Table 32 Power production in the two scenarios, by source (in TWh)

	Coal	Oil	Gas	Nuclear	Hydro	RE	Total	%Gas	%Oil	%RE+Hydro
Med 2007	337	170	571	501	204	64	1847	31%	9%	15%
Trend 2025	469	109	1258	573	345	217	2971	42%	4%	19%
Alternative 2025	221	38	669	468	345	541	2281	29%	2%	39%
Energy savings	248	72	589	105	0	-324	690			

Sources : Plan Bleu, OME

In the SEMCs, the alternative scenario assumes the deployment of a full power production capacity based on renewable energies (exclusive of hydro-power) in the order of 35000 MW for a production of 100 TWh (exclusive of hydro-power).

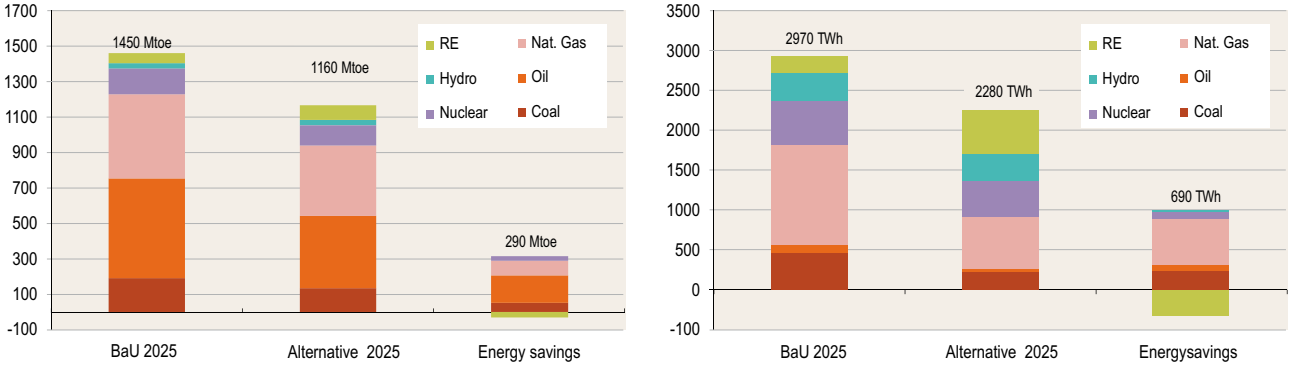
The total energy saving achievable based on this alternative scenario could reach around 290 Mtoe/year by 2025 for the all countries, that is the equivalent of around 2/3 of the foreseeable increase in energy demand between 2007 and 2025. Around 52% of this potential relates to the SEMCs, and 48% to the NMCs. The following figure compares the structure of energy supply of the two scenarios by 2025.

The fall in energy demand in this scenario, implies a 10 point drop of the index of dependency throughout the Mediterranean countries, compared to the BaU scenario by 2025. Finally, the index of dependency of 59% actually would pass to 55% in the alternative scenario by 2025, against 64% in the BaU scenario.

It would also help achieve quite substantial financial savings. Assuming a linear tapping of the savings potential over the 20 years to come, the aggregate quantity of primary energy savings would be around 3600 Mtoe for the Mediterranean countries as a whole, that is, the equivalent of more than 850 billion dollars (at the average price of 280 $/toe, corresponding to the price of $40 per barrel). By way of comparison, the cost of the Mediterranean Solar Plan project—which aims at the erecting of 20 000 MW of renewable energy—is estimated as between 38 and 46 billion €. Admittedly, this value is quite approximate and one must subtract from it the costs of implementation of energy demand side-management policies, but such costs are, generally, considerably less significant. The fact remains that, by lowering the cost of energy services, this scenario reveals a huge economic growth potential.

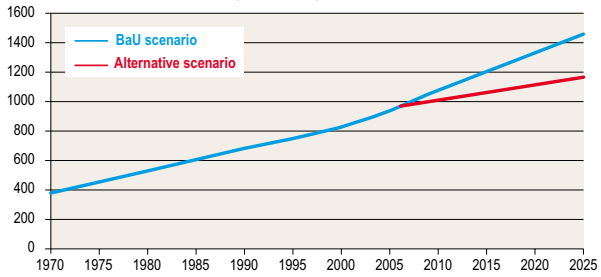
In the case of this alternative scenario with a more proactive energy policy, the promotion of efficient technologies, energy saving measures and a deeper penetration of renewable energies, energy intensity could decrease, for the Mediterranean region, to -1.8% on average per year (corresponding to -1.9% for the NMCs and -2.5% for the SEMCs).

Figure 45 Electricity and energy savings



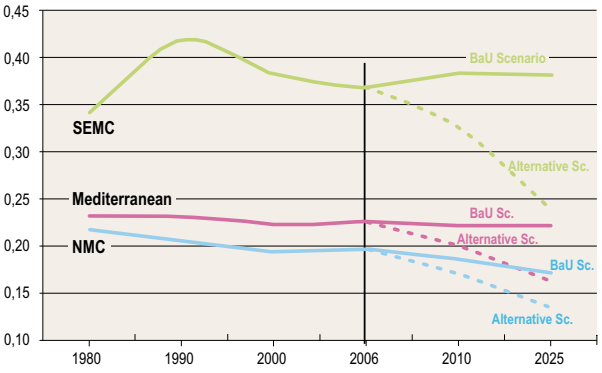
Sources: Plan Bleu, OME

Figure 46 Energy consumption according to the two scenarios (in Mtoe)



Sources: IEA, OME, Plan Bleu

Figure 47 Energy intensity in the Mediterranean (toe/1000 GDP $2000)



Sources: IEA, OME, Plan Bleu

Benefits of the alternative scenario

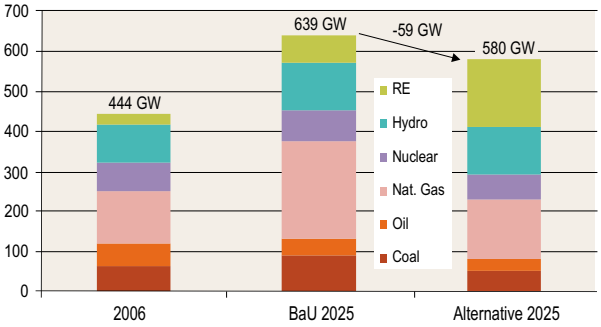
- The impact in terms of employment is difficult to evaluate. Plan Bleu is due to initiate in 2010 a study on "Energy, Sustainable Development in the Mediterranean and Impact on Employment", similar to that already conducted in relation to EU countries by 2030[7]. However, some countries among the SEMCs, of which Tunisia and Morocco, have attempted to estimate the impacts on employment of moving to more ambitious objectives of renewable energies in their national energy balance.
- The environmental impacts of such a scenario would be significantly mitigated. GHG emissions in 2025 would be reduced by 25% with respect to the baseline scenario, both in the North (-22%) and in the South (-27%), that is, 808 MT of CO_2 emissions avoided by 2025, corresponding to 38% of the current emissions. The contribution of Mediterranean countries to global CO_2 emissions in 2025 would be less than 7% (instead of 9%, according to the BaU scenario) and would bring the 4 EU-Med countries closer to fulfilling their commitments under the Kyoto Protocol. This would also contribute to an improvement of air quality in the cities.
- Many energy supply infrastructures could be avoided (or deferred) and their related environmental impacts and risks reduced by as much. Thus, in this optimistic, but not utopian, scenario, it has been reckoned that, by 2025, the following could be avoided:

1. **Construction of 117 power stations of 500 MW each, that is, around 59 GW in total**, which difference is due to the decrease in power demand generated by energy efficiency measures. Another part of the power stations which would not be built could be replaced by the construction of several additional renewable power stations (wind, PV and biomass) of a capacity of 102 GW; these would add up to the capacity installed in renewable energies, estimated in the BaU scenario. The total RE capacity installed would reach 170 GW (exclusive of hydro) and account for 29% of the total capacity (as against 6% in 2006 and 11% in 2025 in the BaU scenario). Corresponding power production based on renewable energies (wind, photovoltaic and biomass would be at more than 36%, as against 19% in the BaU scenario. In this scenario which assumes energy policies with a deep penetration of renewable sources in the power generation sector, **the share of the SEMCs would reach 35 GW, as against 14 GW in the BaU scenario, corresponding to over 13.4% of the renewable power production (wind, photovoltaic and biomass), as against 3.4% in the BaU scenario**. The share of the NMCs would reach 135 GW, as against 54 GW in the BaU scenario, corresponding to more than 30% of the renewable power production (as against 10% in the BaU scenario.
2. **Avoidance of congestion** of traffic/navigation in the Mediterranean sea, with all attendant risks of accidents and marine pollution, by an appreciable reduction of the number of ships (tankers, methane carriers and coal carriers) whether in rotation or transit in the Mediterranean (Cf. part in the second report dedicated to maritime transport).
3. **Avoidance of the construction of several pipelines** and/or tankers of a total capacity of 154 Mt/year, gas pipelines and/or methane

7 " Impact on Employment of Climate Change and of CO_2 Emissions Reduction Measures in the UE for the Time Frame 2030"', a prospective approach to the impacts on employment from a sectoral and territorial point of view.

carriers of a total capacity of approximately a hundred billion m^3/year, and coal carriers equivalent to over 54 MT of imported coal avoided. This would contribute to checking the accentuation of CO_2 emissions levels and of pollution in the Mediterranean.

Figure 48 Capacity installed for power production in the two scenarios (in GW)



Sources: OME, Plan Bleu

These orders of magnitude have no predictive value. They simply illustrate quantitatively the potential benefits of alternative strategies that simultaneously reduce countries' vulnerability to geopolitical risks, and socio-economic and environmental pressures.

Renewable energies minimize the risks of increased energy dependence and the impact on global warming and without presenting new technological risks. In the Mediterranean, their huge potential is untapped, when it could considerably (and at lower cost in many cases) improve the livelihood of millions of people, particularly in rural areas. For certain countries (Morocco, Tunisia), renewable sources are already put to service in matter of rural electrification.

In view of the great inertia of energy systems and the irreversibility of certain infrastructures, today's choices are decisive. In order to take up this challenge and to accelerate the energy transition to more sustainable supply modes, the room for manoeuvre already exists and has already been explored by certain Mediterranean countries. The more advanced countries in this transition are investing in the future and will be winners, in the medium term, on the threefold economic, social and environmental level, while benefiting from technological progress.

Conclusions and lessons learnt

The resulting figures from both the BaU and alternative scenarios, set the tone of the challenges and efforts that lie ahead for a more sustainable energy future in the Mediterranean. According to the alternative scenario, the potential for energy savings is significant: more than half of the additional energy demand and CO_2 emissions expected between 2007 and 2025 could be avoided.

However, in spite of a certain progress and of the setting of ambitious targets by many SEMCs, which take the cue from the measures fixed in the EU "Climate-Energy Package[8]" in 2007, the merit of sustainable energy strategies is not perceived as yet. The actions are not up to the challenges and are hampered by obstacles of a more institutional and cultural than technical nature.

The transition to a larger share of renewable energies, to better energy efficiency, could be accelerated by more active, more aggressive public policies, promoting a subtle combination between control over demand and diversified, less polluting and less costly energy supply. Such strategies require not only perseverance and will, but also optimisation of knowledge. Apart from the national policies, Mediterranean cooperation, thus, has a major role to play.

In the absence of recommendations, it is possible to offer an overview of the principles and the technical, institutional, national and regional elements likely to sustain the effectiveness of public energy policies.

On regional level

All Mediterranean countries are not on the same level of awareness and action. Without a fully comprehended complementarity between the more advanced and less advanced countries, the technological and institutional gap could widen in the energy field, too, and efforts could get scattered.

This complementarity requires, above all, a reinforcement of power interconnections and a completion of the Mediterranean loop, thus facilitating a more significant growth of electric exchanges and the tapping of the renewable energies potential in the SEMCs, and this, via the erecting of the Mediterranean Solar Plan project, for example.

The development of energy exchanges in the region, as well as the socio-economic development of the SEMCs, will make necessary and possible the implementation of many energy infrastructures projects. Though we cannot go as far as to lay the foundations for a "regional governance"', it remains possible to put forward a certain number of strategic principles which could be jointly adopted by Mediterranean countries:

- Improve coordination between the various programmes and initiatives, such as the Mediterranean Renewable Energy Programme (MEDREP), the Rome Mediterranean Energy Platform (REMEP), and the Euro-Mediterranean Energy Policy. The Union for the Mediterranean (UfM) through the Mediterranean Solar Plan associated to the 4 Immediate Action Plans (IAP), could be the platform for cooperation in the field of renewable energies and energy efficiency untapping synergies and mutually beneficial opportunities towards more sustainable development paths in the region.
- This platform could be entrusted with the task of designing and ensuring the adoption of a long term master plan for energy highways across the Mediterranean. This master plan would comprise all current energy transport corridors, as well as the future routes under consideration, based on a choice between the various options and taking into consideration the objectives of sustainable development. This plan should emerge from a concerted consideration, then be accepted on regional level and become binding to all partners in the region. Project funding and technological means would be allocated in accordance with this plan.
- As a general rule, gas sale/purchase contracts do not take into account sustainable development objectives, other than the legal obligations. Companies are bound only by the technical feasibility conditions of projects, as well as by the economic and commercial clauses. None of the partners is naturally willing to take responsibility for over-costs, even with regard to environment protection. This regional cooperation platform

8 The Energy-Climate Package aims at reducing GHG emissions by 20% by 2020, increasing energy efficiency by 20% and raising to 20% the share of renewable energies. It also aims at promoting the use of bio-fuels, whose share would reach 10%. The package further proposes the establishment of a legal framework for technologies of carbon sequestration and storage. In particular, plans will have to be designed according to three large energy consuming sectors: electricity, heating and air-conditioning, and transport. Emissions reduction would be increased to 30% by 2020 if a new world agreement were entered on climate change in Copenhagen in December 2009.

could be assigned the objective of seeing to a better mainstreaming of the environmental and social stakes in the commercial contracts on bases likely to avoid any distortion of competition.

- Three principles of mainstreaming environmental and social stakes can be put forward:
  - With regard to electricity, the most reasonable option is to consume electricity in the vicinity of its production site in order to minimize transport, the environmental footprint arising from the infrastructures, and on-line losses. As this is not always possible, there is a balance that needs to be found between the "centralized" portion of the energy system and the "decentralized" portion,
  - It is necessary to choose the least CO_2 emitting fossil energy transport solution; for so doing, it is advisable to systematically establish an energy balance and a carbon balance, as well as an economic and financial balance with regard to infrastructures,
  - It is advisable to adopt the following approach as regards infrastructure projects: (i) saturate the existing installations and infrastructures, (ii) then, undertake their extension, and (ii) finally, consider new sites and layouts,
- The last element of a regional scale would consist in boosting Mediterranean cooperation in matter of implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and the post-Kyoto flexibility mechanisms, and direct to the region the investments targeted at the reduction of GHG emissions.

On national level

To remove the barriers and obstacles to the development of renewable energies and energy efficiency, a set of actions and measures could be mainstreamed in the national policies:

- Set, in the national and local strategies, quantitative, more ambitious objectives of REU and RE, reduce by 2 to 3% per year the energy intensity per unit of GDP and target at least 10% of the total demand for energy sourcing from RE,
- Urge the economic actors, local authorities and consumers to adopt sustainable behaviours in matter of energy saving, based on a pricing policy, targeted subsidies, tax incentives and public awareness campaigns sustained by NGOs and the media, for example; promote economic mechanisms, such as renewable energies certificates,
- Put in place appropriate control systems requiring owners and/or operators of the infrastructures to issue in a periodic way detailed balances and transparent reports on their technical and commercial performance, as well as on the mainstreaming of environmental impacts,
- Develop training activities, as is the case in certain SEMCs with the recent establishment of IMER (Institut Méditerranée des Energies Renouvelables) in Tunisia, and the project of establishment of a RE school in Algeria,
- "Lead by example", by enhancing the mainstreaming of RE and the reinforcement of EE in administrations, public entities and regional authorities (local government):
  - generalization of low consumption lamps (LCLs),
  - generalization of solar systems for the production of domestic hot water (solar water heaters) in hospitals, boarding schools, university campus, school institutions, social centres and prison institutions,
  - mainstreaming EE in construction standards, and RE in the residential, industrial and agricultural sectors: RE based power production, pumping by small wind-generators…

Methodology

The geographic coverage encompasses 22 Mediterranean countries.

The data sources are obtained from the International Energy Agency (IEA publications, for OECD countries in July 2009 and for non OECD countries in September 2009), as well as from recent statistics derived from the Medstat project (for the years 2003 to 2007) in whose development Plan Bleu has participated.

The retrospective examination of the energy balances of Mediterranean countries broken down as by energy source, sector and sub-sector, made it possible to have a clear distribution of the energy supply and sector consumption. This distribution is analyzed by country, based on the evolution of the energy balance of each country:

- energy supply (production/ importation/ exportation)
- energy processing (refineries/ power plants/ liquefaction)
- own consumption and network distribution losses
- final consumption by energy source, sector and sub-sector (industries, transport, residential/tertiary).

As regards projections, the calculations are made via an econometric model developed on Excel spreadsheet which takes into account the exogenous variables based on GDP, population and international prices. The projections in the BaU scenario integrate the energy projects existing and in progress, and the objectives of penetration of renewable energies (supply) and of energy savings (demand) set out by the countries. These data have been collected by the Mediterranean Energy Observatory (OME), and via surveys conducted by MedReg (Association of Mediterranean Regulators) and provided in the annexes to this report. The formulation of primary energy demand is given by the following relation: CENER = k x (Pop) x $(GDP)^e$, where CENER = primary energy consumption; and e = income-elasticity (=CENER growth rate/ GDP growth rate).

As regards the alternative scenario, the hypothesis for the NMCs are aligned on the reduction objectives corresponding to those of the "Energy-Climate Package" of the EU 20/20/20. The objectives of the SEMCs ranging, according to the countries, from 5% to 13% of renewable energies in the primary energy balance, and from 15% to 40% of renewable electricity, lead them to an integration of RE projects beyond those listed in the Mediterranean Solar Plan (35000 MW in the SEMCs, instead of the 20 000 MW of the MSP), energy savings of 25% thanks to a high penetration of efficient technologies in the final sectors, particularly in high energy consuming industries, in the residential (building, electric household appliances, awareness raising targeted at behavioural change…), in transport (cleaner vehicles, and shift to public transport), in the power generation sector, as well as in improvement of distribution networks (minimising losses). For instance, the saving potential in a few industries in Egypt, compared to the international standard, is given in the table below:

	Specific energy consumpt. in Egypt *kg fuel oil/ton product*	**Specific energy consumpt. on international level** *kg fuel oil/ton product*	**Saving potential** *%*
Steel	950	100-350	25
Cement	200	100-120	50
Plastic	350	180-600	25
Rubber	1000	305-610	25
Amoniac/fertiliser	1654	740-850	25
Paper	1000	480	40
Glass	620	120-190	45
Aluminium	4460	3375	32

Source: Med-ENEC Project, Egypt report 2006

Calculations of CO_2 emissions: the equation of Kaya makes it possible to relate GHG emissions and the other parameters: economy, energy intensity, population...

$$(CO_2 = CO_2/TOE \times TOE/GDP \times GDP/POP \times POP)$$

For the sake of simplification, we have used, for the estimates of CO_2 emissions due to energy consumption, the following simplified equation :

$$(CO_2 = CO_2/TOE \times TOE)$$

The carbon dioxide contents of each fuel used for the estimates of CO_2 emissions due to energy consumption, are mean values coming from IEA publication.

Fuels	Coal	Oil	Natural Gas
tCO_2/toe	3.80	2.70	2.26

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Statistical data: sources IEA Edition 2009 (OECD countries July 2009 non-OECD countries September 2009), Medstat, OME and annual reports of the national energy companies.

Annexes

Annexes listed below are available on the Plan Bleu website to the following address www.planbleu.org:

Annex 1: Energy infrastructures in the Mediterranean

Annex 2: Detailed data by country

- Annex 2a: Data and statistics, by country
- Annex 2b: Scenarios results, detailed data by country

Annex 3: Abstract from the European Directive on Renewable Energies

Annex 4: List of energy projects in Mediterranean countries

Annex 5: Progress status of HVDC cables

Annex 6: Energy accounting and renewable energies

Annex 7: RE and EE objectives in Mediterranean countries

Annex 8: Cost estimate of the Mediterranean Solar Plan (MSP).

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