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The energy sector in Mediterranean and MENA countries

Abstract: This paper describes the energy sector in the Mediterranean and MENA (Middle East and North Africa) countries. It first analyses the production of energy by fossil and renewable sources and discusses the increasing demand in the area and its consequences. It describes the policy frameworks to promote renewable energy as well as fossil-fuel subsidies, which are still abundant in the MENA area. It presents some avenues for integration across the Mediterranean and finally it discusses the implications of the Arab spring on energy production in the next future.

Keywords: energy, Mediterranean countries, MENA countries, subsidies

JEL codes: Q42; Q43; Q48

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1. Introduction

The Middle East and North Africa (MENA) region has about 57% of the world's proven oil reserves and 41% of proven natural gas resources and the upstream potential of many countries in the region is still underexplored. The area is also endowed with large solar resources. However, the political upheaval that took hold place in several Arab countries in 2011 has raised some concerns on the stability of this area. Important political changes are taking place and some observers fear that this might affect energy policies and production. Neighbouring countries, especially those in the northern shore of the Mediterranean, which are dependent on energy imports, are looking for opportunities to reinforce the links with the southern shore. Indeed, the Mediterranean is characterized by a gap between countries rich in natural resources in the South and countries dependent on such resources, mainly in the North. The commercial bundle is strong: in 2010 the MENA region accounted for 32% of EU natural gas imports, slightly more than the 28% recorded in 2000 (Darbouche and Fattouh, 2011).

As for energy policies, EU countries have high requirements in terms of energy efficiency and renewable energy production, while non-EU countries in the northern shore are moving in the same direction. However in many MENA countries the situation is completely different: fuel prices are distorted by subsidies and thus energy intensity is artificially higher. Moreover, the efficiency of supply is poor.

The aim of this contribution is to describe the energy sector in the area. First, we present some descriptive statistics on energy production in the two sides of the Mediterranean and MENA countries. Section 3 discusses the energy policies implemented, both to stimulate renewable energy production and to subsidize fossil-fuels consumption. Section 4 discusses the avenues for cooperation across the Mediterranean, while section 5 discusses the estimated consequences of the Arab spring on energy production in the area. Finally, Section 6 concludes.

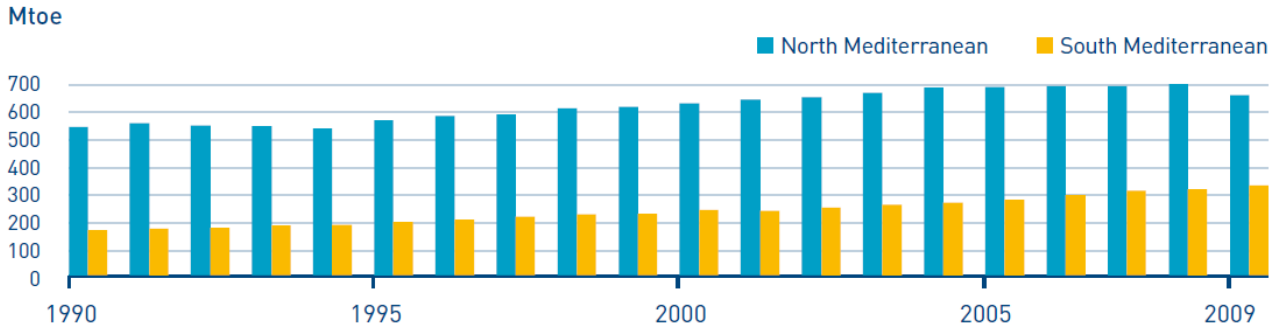
2. Energy production and consumption

Energy demand is mainly driven by economic and population growth. The economy has grown at a yearly 2.2% in the 1990-2009 period in the area. Notice however that great disparities in living standards occur between the two shores: the northern shore accounts for three-quarters of the Mediterranean's GDP. As for population, there are around 492 million inhabitants in the region and more than half are concentrated in four countries: Egypt, Turkey, France and Italy. The population has grown at 1.1% annual rate in the last 40 years and estimates suggest it will be 582 million by

2030. This growth is expected to take place mainly in the southern shore of the Mediterranean (OME, 2011).

Total primary energy production in the Mediterranean has increased on average by 1.3% per year since 1990 reaching 636 Mtoe (million tonnes of oil equivalent) in 2009. However, the energy demand has increased more rapidly (2.5% per year over the last twenty years) reaching 988 Mtoe in 2009. The primary energy demand is reported in Figure 1, which distinguishes North and South Mediterranean: this is split unevenly, with the northern shore demanding around two thirds. Primary energy demand has been increasing in both areas over time: the recent crisis has however reduced primary energy demand in absolute terms in the northern shore for the first time in 2009.

Figure 1: Primary energy demand in the Mediterranean, 1990 – 2009



source: OME (2011)

As for the power generation capacity installed in the Mediterranean, this amounts to 496 gigawatts in 2009 (OME, 2011): natural gas is the main source (33%) followed by hydropower (18%), nuclear (14%), coal (13%), oil (12%) and non-hydro renewables (10%). Energy production is not sufficient to satisfy energy demand in the area, thus the region imports it from outside. All North Mediterranean countries are net fossil fuel importers, while the situation in the South is more varied. There are producing countries such as Algeria, Libya and Egypt which are large exporters, as well as countries such as Morocco which are net fossil fuels importers from neighbouring countries. Fossil fuels dominate the energy mix in the region (oil is 41%, natural gas 28%, coal 12% for a total of 81%), followed by nuclear (12%), and renewables (hydro is 2% and other renewables are 6%). Several factors, such as population growth, rapid urbanization and economic growth, are putting pressure on existing infrastructure. This in turn implies a relatively high demand for new investments. Over the next 30 years, the total investment needed in the energy sector in MENA are estimated to be more than USD 30 billion a year, which is about 3% of the region's total projected GDP (World Bank, 2010).

2.1 Fossil fuels

The production of fossil fuels across the Mediterranean has steadily increased from 1990 to reach 436 Mtoe in 2009 (the average yearly growth rate is 1.2%). In 2011, the proven oil reserves in the Mediterranean area were around 67 billion barrels, mostly (94%) located in Libya, Algeria and Egypt. As for oil production estimated in the Mediterranean, this amounted to 5 million barrels per day in 2010. Oil has been the dominant fuel in Mediterranean energy mix since the 1970s. Its demand increased over time at an average 1.3% per year (1990-2009 period), nonetheless its share in the energy mix decreased from 50% in 1990 to 41% in 2009, mainly because of an increase in the use of natural gas in electricity generation. Looking at world's production data for 2010 (reported in the first column of Table 1), we find that the largest producers of oil are the Russian Federation, followed by Saudi Arabia and the USA. However, Saudi Arabia is the largest exporter, as of 2009. Interestingly, some Mediterranean countries as Italy, France and Spain are among the largest importers.

Table 1: The largest producers, net exporters and net importers of crude oil

Producers	**Mt**	**% of world total**	**Net exporters**	**Mt**	**Net importers**	**Mt**
Russian Federation	502	12.6%	Saudi Arabia	313	USA	510
Saudi Arabia	471	11.9%	Russian Federation	247	China	199
USA	336	8.5%	Iran	124	Japan	179
Iran	227	5.7%	Nigeria	114	India	159
China	200	5.0%	United Arab Emirates	100	Korea	115
Canada	159	4.0%	Iraq	94	Germany	98
Venezuela	149	3.8%	Angola	89	Italy	80
Mexico	144	3.6%	Norway	87	France	72
Nigeria	130	3.3%	Venezuela	85	Netherlands	57
United Arab Emirates	129	3.2%	Kuwait	68	Spain	56
Rest of the world	1526	38.4%	Others	574	Others	477
World	*3973*	*100.0%*	*Total*	*1895*	*Total*	*2002*

Data relative to crude oil, NGL, feedstocks, additives and other hydrocarbons. Data for production for 2010, data for exports and imports for 2009. Source: IEA (2011a)

The Mediterranean region has also large natural gas reserves: more than 8.9 trillion cubic metres (tcm) are located in Algeria, Lybia and Egypt. In the 1970s, natural gas was poorly used but it is nowadays widely used: its demand increased an annual average growth rate of 5% (from 108 Mtoe in 1990 to 274 Mtoe in 2009), reaching a significant share of the fuel mix in the region (28%).

As for the larger MENA region, the endowment is consistent, but its global share in terms of exports remains below its potential. Indeed, the overall gas production of the MENA region represented in 2010 only the 20% (669 bcm) of the world total gas production. Table 2 reports some statistics on world's gas production: Iran, Qatar and Saudi Arabia are among the top 10 producers in 2010. Iran is the second largest gas reserve holder in the world. However, since the Islamic revolution in 1979, gas production has mainly been devoted to meet the domestic demand. The country is the third-largest gas consumer in the world: the sustained economic growth of the last decade has increased energy demand at 6.8% annual average. Qatar has the third largest gas reserves in the world, but, contrary to Iran, is strongly developing exports: the country has invested in the liquefied natural gas (LNG) technology and has become in the last decade by far the world's largest supplier of gas through this channel.

Indeed, we find Qatar as well as Algeria among top exporters. While Qatar invested in LNG, Algeria exports mainly through pipelines. In 2010 Algeria exported natural gas mainly to Italy (28 billion cubic metres), Spain (12 bcm), France (6 bcm) and Turkey (4 bcm). Around 70% of the commercial gas production (80 bcm, in 2010) is exported while 30% is consumed domestically. Again we observe among the largest net importers some EU countries.

Table 2: The largest producers, net exporters and net importers of natural gas

Producers	**bcm**	**% of world total**	**Net exporters**	**bcm**	**Net importers**	**Bcm**
Russian Federation	637	19.4%	Russian Federation	169	Japan	99
USA	613	18.7%	Norway	101	Germany	83
Canada	160	4.9%	Qatar	97	Italy	75
Iran	145	4.4%	Canada	72	USA	74
Qatar	121	3.7%	Algeria	55	France	46
Norway	107	3.3%	Indonesia	42	Korea	43
China	97	3.0%	Netherlands	34	Turkey	37
Netherlands	89	2.7%	Malaysia	25	United Kingdom	37
Indonesia	88	2.7%	Turkmenistan	24	Ukraine	37
Saudi Arabia	82	2.5%	Nigeria	24	Spain	36
Rest of the World	1143	34.8%	Others	165	Others	253
World	*3282*	*100.0%*	*Total*	*808*	*Total*	*820*

Net exports and net imports include pipeline gas and LNG. Data for production for 2010, data for exports and imports for 2009. Source: IEA (2011a)

In spite of the large proven gas reserves, some MENA countries are facing gas shortages. This is due to the sustained economic growth of the area, which increases electricity demand and thus local consumption: today around 70% of the gas produced in the region is consumed locally; which explains why the MENA region plays a relatively modest role in international gas trade (Glachant et al., 2012). All MENA countries endowed with fossil fuels have been following a similar path in recent years: an increasing domestic demand, amplified by artificially low prices (an issue discussed in detail in Section 3), which puts a strain on exports. In the last years there has been a shift from oil to natural gas, in order to free oil for exports. The lack of infrastructures prevents however further increases in production. As will be discussed in Section 5, the recent turmoil might imply delays in investment in infrastructures.

For example, Libya's proven natural gas reserves are estimated at 1.5 tcm (trillion cubic meters) and recent discoveries are expected to raise these figures. Natural gas production has grown substantially in the country in the last few years, reaching a level of 15.8 bcm in 2010 and it now accounts for 45% of the country's generated electricity. However, past projects to increase the production in order free up oil for exports are likely to be delayed. Another country whose infrastructure has been severely damaged is Iraq. With proven natural gas reserves estimated at 3.2 tcm in 2010, the country's production has decreased substantially over the last decade because the conflicts have seriously impaired Iraqi infrastructure. Indeed, over 40% of the production in 2008 was flared due to a lack of sufficient infrastructure to utilize it for consumption and export.

The Mediterranean has around 18 billion tonnes of coal reserves, which are almost entirely found in five countries: Serbia, Bosnia and Herzegovina, Greece, Turkey and Spain. Coal production in the region is around 44 million toe (tonnes of oil equivalent) and 40% is produced in Turkey alone. Coal's share in total primary energy production in Mediterranean countries has been declining since the 1990s and is now 7% of energy production. It has been replaced by natural gas, especially in power generation. There are however different patterns across the Mediterranean: coal demand has declined strongly in the North over the past 20 years while increasing in the South. As a consequence, total coal demand in the region is rather stable at around 108 million toe (close to 1990 values), and it accounts for 11% of the energy mix.

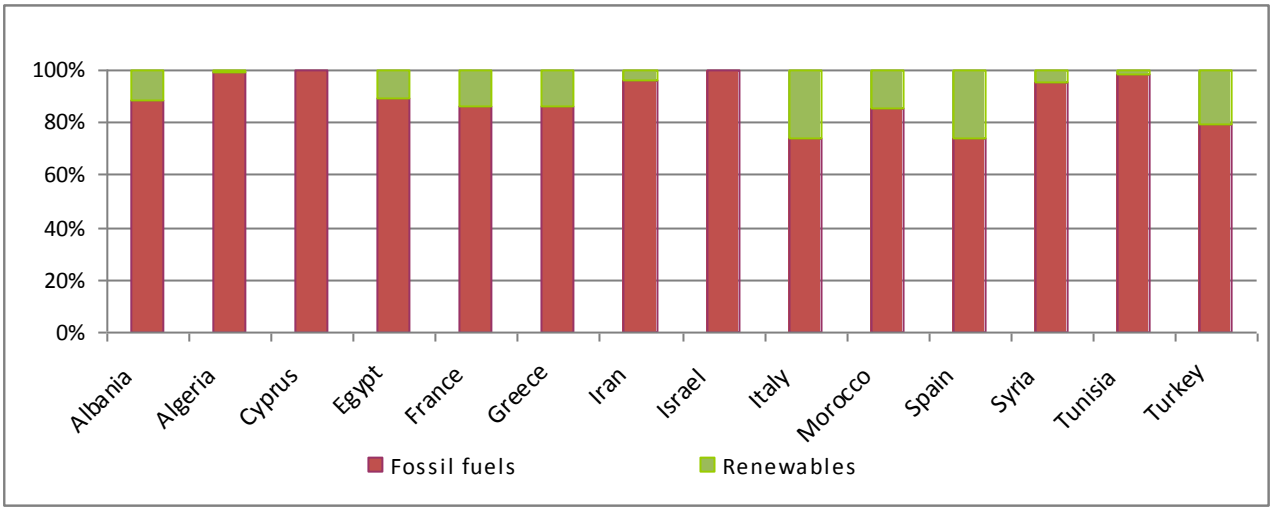
Nuclear energy production has expanded from 1973, following the nuclear development programme in France. Power generation from nuclear plants has been rather stable in the last 20 years and accounted for 24% of generation in 2009. France is the largest producer in the area with an installed capacity of 62,763 megawatts. There are no nuclear power stations in the MENA area but some countries, such as Turkey and Egypt, have announced plans. Indeed, nuclear power generating costs are less volatile than those of hydrocarbons and nuclear power is seen as an option that could help

alleviate energy security issues as well as CO2 emissions. However, the Arab spring in 2011, jointly with the Fukushima Daiichi nuclear power accident in Japan in the same year, are likely to delay these plans.

2.2 Renewable sources

The Mediterranean has a large renewable energy potential. Nonetheless, renewables account nowadays for a limited share of the region's primary energy supply (8% in 2009) and production (12%). The most exploited renewable sources have historically been biomasses and hydropower. Additionally, geothermal energy has been quite developed in few countries (i.e. Italy). More recently, wind and solar, both for electricity and heat production, are increasing their share in the energy mix: non-hydro renewables more than doubled their installed capacity in the period 2005 to 2009, mainly with wind turbines. The electricity production from renewables (primarily from hydropower) has reached 18% of electricity supply, almost 340 terawatt-hours in 2009. Figure 3 reports the breakdown of electricity production in 2009 between fossil fuels and renewable sources: fossil fuels are still largely predominant everywhere.

Figure 3: Electricity production in 2009



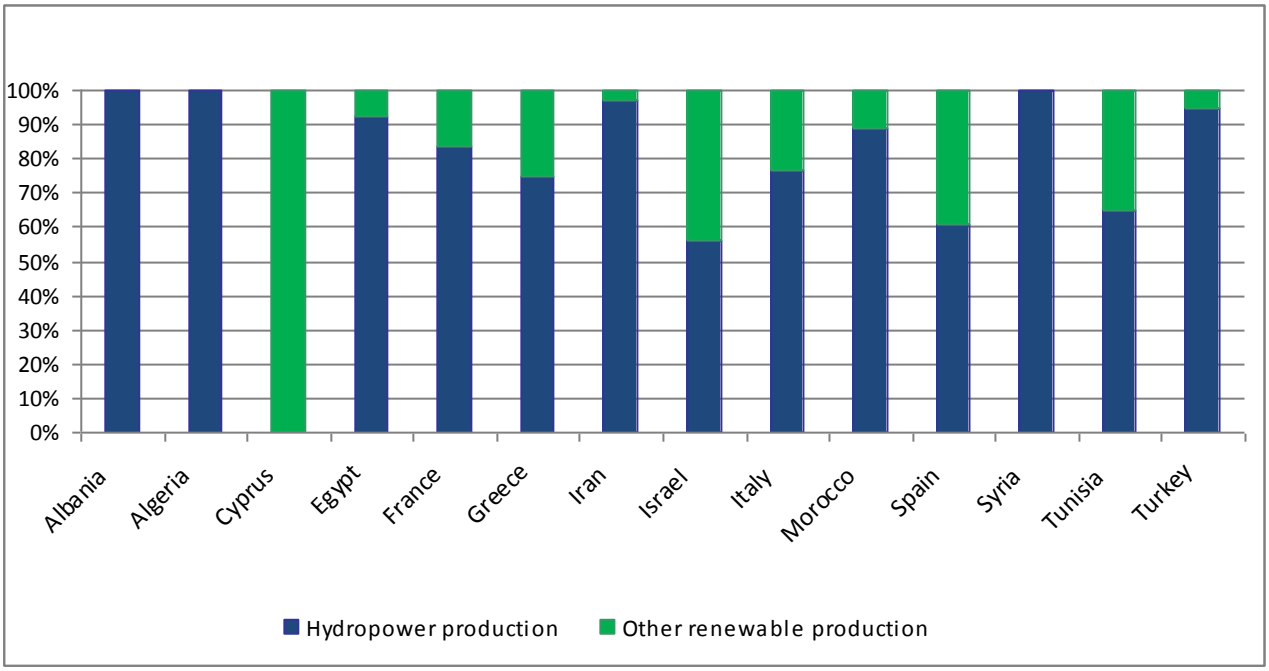
Source: Own elaboration from EIA (2012)

EU countries are investing in these sources, notably Italy and Spain. There are few other countries that produce significant levels of renewable energy: Turkey produces around 10 Mtoe, followed by Morocco and Egypt while in the other countries there is barely any production.

Two trends describe the development of renewables in the area. Although renewable generation is growing at a sustained pace (CAGR 1.95% for the period 2000-2009), total power generation is growing more rapidly (CAGR 6.3% over the same time period): non-renewable generation

increased by 248 TWh since 2000 (almost doubling), while renewables grew by only 3 TWh. Second, among renewables non-hydro are growing more rapidly than hydropower. The breakdown between hydropower and other renewable sources is reported in Figure 4.

Figure 4: Renewable electricity production in 2009



Source: Own elaboration from EIA (2012)

The larges source of hydropower in the MENA area is the Aswan Dam in Egypt, inaugurated in 1971. It has a capacity of 2100 MW and produces about 13-14 TWh per year. Non-hydro renewables grew at an average rate of 25.2% since 2000, however from negligible levels. As for non-hydro renewable sources, their growth is concentrated in Egypt, Morocco, Tunisia and Israel. As of 2009, the other countries in the region did not report any non-hydro generation.

Egypt has seen a strong deployment of non-hydro renewables, i.e. wind, especially along the Red Sea coast, in the past years. Albeit being an exporter of fossil fuels the issue of resource depletion is becoming more important: domestic demand for energy is increasing and blackouts are more frequent especially in the summer period. Egypt has developed its wind resources with the support of international institutions, notably the World Bank, with the aim of facing the resources problem.

Israel shows surprisingly little production of renewable electricity. The abundant solar resources have been adopted on a large scale since the 1970s for heat. A mass development is however missing and a possible explanation is the small internal market which does not allow to realise economies of scale. However, as solar photovoltaic (PV) is becoming a less expensive technology

and concentrated solar power (CSP) is being commercialised in Spain and the United States, an increase of solar energy production might take place in the future.

Morocco and Tunisia have made some efforts to develop renewable energy, notably wind and hydro power over the past years. As for the other countries, no efforts to develop solar and wind resources have been made so far and renewable energy production is almost absent. This attitude is slowly changing (see more in Section 3), but an increase in renewables would require international support, as in the case of Egypt. The EU can play a key role in this respect, as will be discussed in Section 4.

As already mentioned, increasing income per capita is likely to imply a problem of resource depletion in the future. Thus, countries are slowly taking steps towards renewables. For example, the United Arab Emirates now hosts the International Renewable Energy Agency (IRENA), and their state-owned power company is working on a city project of Masdar with 90,000 residents which is intended to be completely supplied by renewables.

Per-capita consumption in the residential sector in the south Mediterranean is currently low by regional and international comparisons, being less than half that of the northern shore. This reflects relatively poor living conditions for large parts of the population. Many countries in MENA have close to 100% access to electricity, but an estimated 28 million people still lack access to electricity, especially in rural areas, and about 8 million people rely on traditional biomass for their energy needs (World Bank, 2010). This gap in consumption is expected to shrink and economic development is expected to increase cooling demand considerably. The penetration rates of cooling installations are already rising to high rates in Israel, United Arab Emirates and Saudi Arabia. Indeed, the climate of the countries in the area could lead to very high penetration rates: estimates for Egypt are for a possible 95% penetration rate, compared to the actual 10% share. However, demand for cooling is high were renewable heat is available, *i.e.* when it is hot outside. Thus synergies might emerge.

3. Energy policies

3.1 Policies for renewable energy

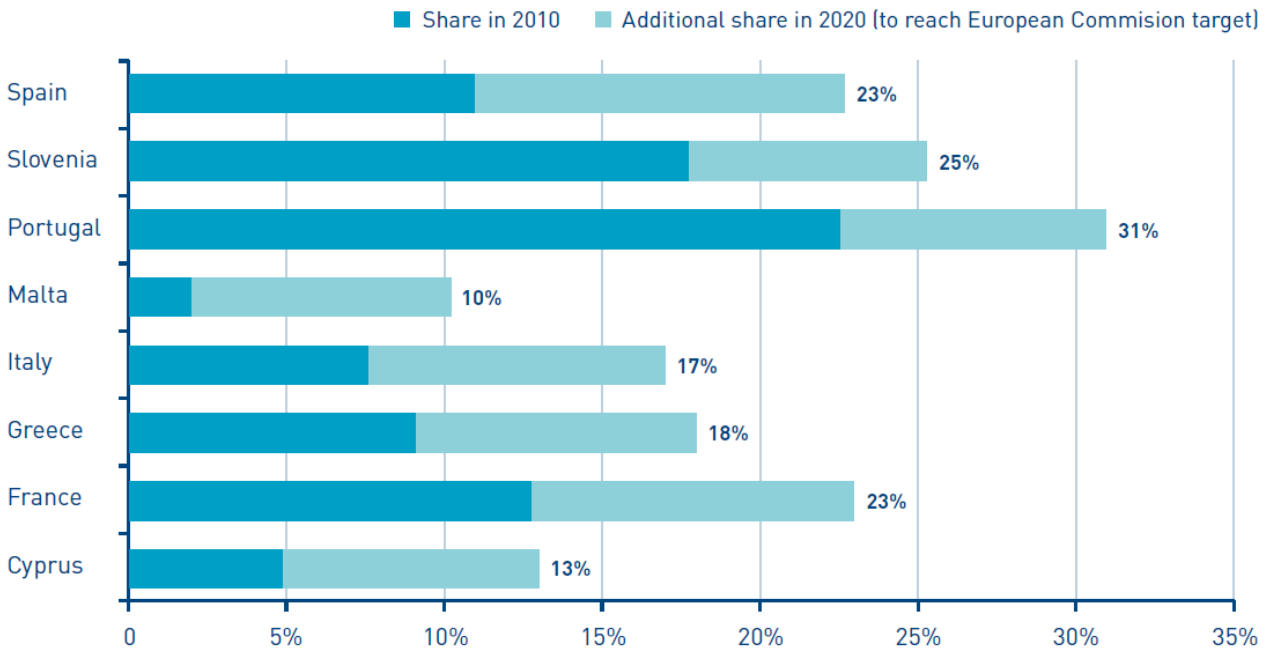
Energy subsidies are increasingly introduced to promote the use of renewable energy sources as the market alone fails to capture all the costs of producing and using fossil fuels. Support to renewables is necessary to offset these external costs. In order to reach this result governments have used mainly two types of instruments: the Feed-in Tariff (FiT) and the Green Certificate (GC). The first is a tariff that pays the value of energy plus an incentive for the costs of production while the second is a mechanism that sets targets of renewables production, giving the chance to the

producers to purchase it through a GC from other suppliers. These policies are generally integrated with tax incentives, investment subsidies and special loan programs. Even in countries relying mainly on GCs, FiTs are becoming increasingly popular to support small-scale generation as for example in Italy.

The eight EU members in the Mediterranean follow common policies under the umbrella of the Union directives and regulations. The directive on promotion of the use of energy from renewable sources (EU, 2009) imposes to all member countries binding targets for the share of renewable energy in gross final consumption. The overall EU target is 20% of gross final energy consumption (today is 8.5%) and 20% of energy savings. As for renewable energy in transports, by 2000, a number of EU countries have introduced biofuels targets. These measures are driven by environmental and energy security concerns, as well as the aim to promote economic growth and job creation in the agricultural sector. The increase in biofuels has been supported by a 2003 European Directive that requires 5.75% of the transport's energy demand to come from biofuels by 2010. The 2009 directive imposes a 10% target for 2020.

However, the overall target for renewable energy production is divided among member states according to the current level of penetration. Data reported in Figure 5 show that considerable progress is needed to achieve these targets. Renewables need to double in almost all EU Mediterranean countries and a drastic change is needed in Malta, where renewables need to increase from 2% to over 10% of final energy consumption.

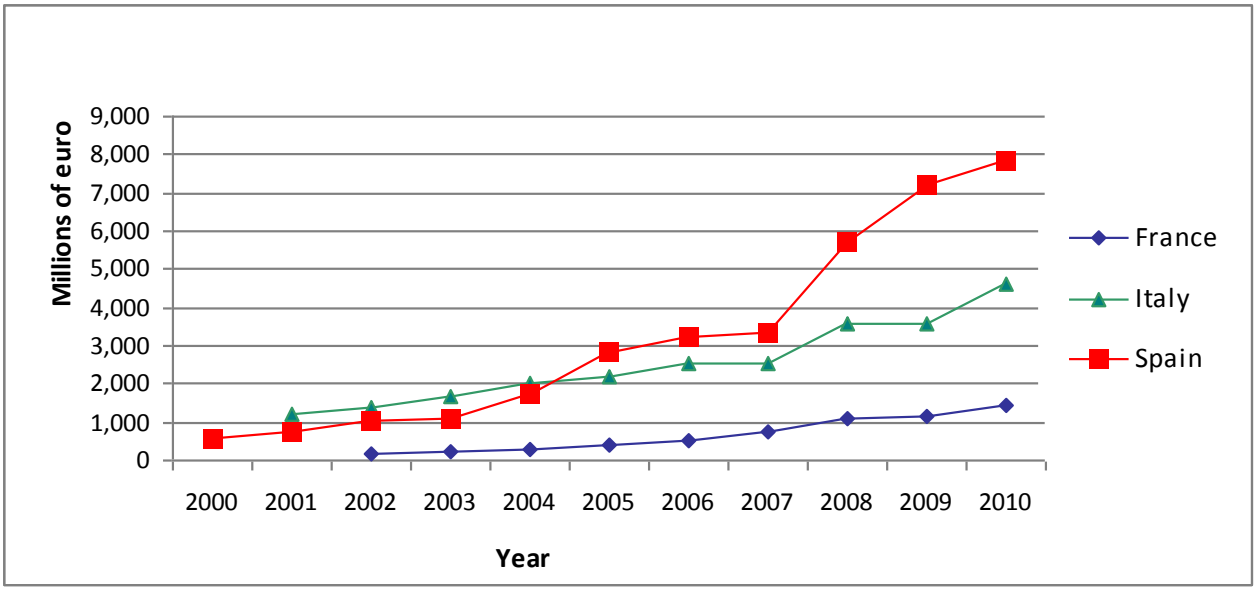
Figure 5: Renewables' share in final energy in EU countries



Source: OME (2011)

In order to obtain these targets, GC and FiT are in action in most EU countries. Data on the actual estimated amount of subsidies for renewable electricity production granted in three large EU Mediterranean are reported in Figure 6.

Figure 6: Total subsidies for renewable electricity production (2000-2010)



Source: own elaboration based on country's reports

Also the target of 20% energy savings by 2020 is likely to be missed. Indeed, in spite of significant progress, the actual measures are likely to achieve only a 10% saving.

The emphasis on biofuels in the EU is expected to continue. The plans require 21.250 Mtoe/y of biodiesel and 7.121 Mtoe/y of bioethanol by 2020. Trade will be necessary: estimates suggest imports of 26% of biodiesel and 25% of the bioethanol to meet the national plans (Muller et al., 2011).

The non-EU countries in the northern shore of the Mediterranean are implementing the *acquis communautaire* in order to conform to the EU requirements and expand their market opportunities.

In comparison to policies for renewable electricity or biofuels for transport, policies to encourage the development of renewable energy in heating have been neglected. However, an analysis by IEA (2008) has shown that the effectiveness of these policies is limited. Nowadays, the most widely adopted financial mechanism to support renewable heat are direct subsidies for the purchase of a renewable heating system. They are generally more effective in the prototype and demonstration phase, but persist when the technology is mature. This might be due to the perceived lack of alternative policies available: the heat market is different from the electricity market in the sense

that allocating the additional costs of renewable heating technology among all heating fuel consumers according to the “polluter-pays” principle appears to be more complicated.

MENA countries instead do not have stringent obligations. Indeed, in this area the impetus for the development of renewables comes mainly from international cooperation and multilateral initiatives (see more in section 4). The MENA region is lagging behind in implementing reforms in the electricity sector and lacks private sector investment. There is thus much scope for improving the efficiency of energy supply and energy conservation, as well as the development of renewable energy resources. MENA has begun to exploit its renewable energy potential on a large scale with the support of international institutions such as the World Bank, which counted in 2010 seventeen investment projects under its supervision for about 2.1 billion USD. Additionally it launched the Clean Technology Fund, which has allocated a total of 1.2 billion USD for MENA, of which 750 million USD to design and implement a MENA Concentrated Solar Power (CSP) plan, 275 million USD to develop wind energy in Egypt and 200 million USD to develop wind energy in Morocco.

The World Bank is also carrying out analytical and advisory energy work in most countries of the region, on issues such as developing an energy/electricity sector master plans and reforms (Djibouti, Lebanon, Morocco and Syria) or energy efficiency (Jordan, Tunisia and Yemen), developing a financial and institutional framework for energy or specific frameworks for wind power (Egypt and Morocco). Many of these activities above are also carried in close partnership with donors in the region.

All North African countries and Israel have introduced financial support mechanisms for renewable electricity, contrary to Saudi Arabia and United Arab Emirates. Nonetheless, in practice, the financial incentives have not been implemented and thus they have not encouraged a renewable electricity market to date. Indeed, most of the non-hydro renewable development has been driven by international funding from international donors or Clean Development Mechanisms (CDM) revenues (UNEP Risoe, 2010).

In the last few years a number of large projects started, aimed at increasing the integration of the electricity market among the shores of the Mediterranean. These include the Mediterranean Solar Plan (MSP) and the Desertec industrial initiative and will be discussed in depth in the next section. These investments will help MENA countries to increase renewable energy production. The projects to strengthen network interconnections among the MENA countries and between the two shores of the Mediterranean will also facilitate the integration of markets.

Algeria established dedicated renewable energy actors in the past twenty years. Albeit the large resources of these institutions, opposition from entrenched interests from the oil and gas sectors

undermines their effectiveness. A FiT has been introduced in 2004, however, there is no effective implementation.

Egypt has founded the National Renewable Energy Authority (NREA) in 1986 but no actual financial support mechanism for renewable electricity generation, apart from guaranteed grid access, priority dispatch and some reduction in import duties for technology equipment. International development cooperation has supported renewable generation and is currently shifting to financing an extension of the grid as an infrastructure upgrade is crucial for a large-scale deployment of wind resources: the best are located along the Red Sea coast, quite far from the bulk of the demand, along the Nile and in the capital.

Israel has introduced a FiT in 2009 to meet its targets of 5% renewable electricity generation by 2014 and 10% by 2020, but the mechanism has only marginally been implemented. Large solar demonstration projects, co-financed with the European Investment Bank, have started in the Negev Desert. These are part of a development plan to build 10 large CSP plants in the Negev between 2010 and 2020.

In Morocco the 2007 energy efficiency and renewable energy law includes provisions for an incentive mechanism, however no support scheme for renewable energy is actually implemented. Since 2009, the government has accelerated its renewable energy promotion efforts in order to attract foreign capitals. Again, these efforts are also driven by increasing energy security concerns: the country's electricity imports (primarily from Spain) have quadrupled from 2005 to 2007. In 2009 a new renewable energy law established a renewable energy and energy efficiency fund with the aim of helping leverage public-private partnerships for the development of five large-scale projects within the 2 GW solar programme to 2020, which has been announced in 2009.

In Tunisia the National Fund for Energy Conservation (FNME) provides financial support for renewable electricity installations. The Tunisian Solar Plan (PST) was launched in 2009 with a budget of 2.2 billion USD and encompasses 40 projects to be implemented between 2010 and 2016 under public-private partnership arrangements. National public sector financing to leverage private investment will amount to 25%, while the rest is expected to be covered from multilateral development cooperation, bilateral cooperation and CDM revenues.

Saudi Arabia does not have an official target nor policy instruments, but announcements from the government suggest a possible target of 7-10% peak electricity generation from renewables by 2020, which would be equivalent to around 5 GW capacity, mostly from solar. The aim is to dedicate some of this production for export.

Finally, United Arab Emirates aim at establishing Abu Dhabi as a global R&D and manufacturing hub for renewable energy technologies, especially solar. The government in 2006 started the

already mentioned Masdar City project, which aims to be the world's largest carbon-neutral urban development. However, this demonstration project may not be sufficient to achieve the 7% target, which implies an estimated installed capacity of at least 2 GW of renewable energy.

3.2 Fossil-fuel subsidies

Subsidies to the consumption of fossil-fuels lower prices to consumers and are now rare in most OECD countries, but still present in many other regions, including MENA. Subsidies to production instead are measures that seek to expand domestic supply and are still widely adopted in both OECD and non-OECD countries, although many subsidies in this category have been reduced.

Both kinds of subsidies encourage excessive production or consumption, naturally leading to an inefficient allocation of resources and market distortions. However, subsidies to production are difficult to quantify as they are often offered through indirect mechanisms, for example tax concessions. While they are absent in the northern shore of the Mediterranean, fossil-fuel consumption subsidies are widely adopted in the MENA region.

Subsidies that artificially lower energy prices have a number of shortcomings. They encourage unnecessary consumption, which leads to faster depletion of energy resources and discourage rationalisation and efficiency improvements in energy intensive industries. There is a strong empirical link between low energy prices and excessive consumption. Extremely high rates of electricity consumption in MENA can be shown to derive from cheap electricity tariffs. The resulting subsidy, in certain cases, has over-burdened government resources at the expense of social and economic expenditures (Khatib, 2010). Additionally, these subsidies can encourage fuel adulteration and the substitution of subsidised fuels for more expensive fuels (Shenoy, 2010). For example, subsidised kerosene for households might be diverted for unauthorised use as diesel fuel, due to the wide price differentials. There is an incentive to sell subsidised products in neighbouring countries with higher prices, thus heading to fuel smuggling. These subsidies undermine the competitiveness of renewable sources. Additionally, they impose a significant fiscal burden on countries' budgets. Moreover, they have negative effects for producers as they quicken the depletion of resources and can thereby reduce export earnings in the long run. Finally, once introduced, they are difficult to reform or eliminate.

Historically, the rationale for the introduction of energy subsidies has been manifold. A first justification is the need to alleviate energy poverty: these subsidies might improve the living conditions of low income population by making cleaner and more efficient fuels affordable: for example, liquefied petroleum gas (LPG) in place of traditional biomass. Secondly, in energy-producing countries, they are seen as a means as a way to share the value of national resources.

Finally they are used to stimulate regional employment and economic development. Nowadays there is a general consensus on the necessity to cut these subsidies as they have often proven to be an unsuccessful or inefficient mean of achieving these goals.

Fossil-fuel consumption subsidies worldwide amounted to 409 billion USD in 2010. The annual level fluctuates widely following changes in international energy prices, domestic pricing policy, exchange rates and demand.

In a period of high prices, they impose unsustainable costs on the budgets of those countries that import energy at world prices and sell it domestically at lower, regulated prices. As a consequence, many such countries seized the opportunity offered by the fall in prices after the second half of 2008 to reduce subsidies without impacting much on inflation.

A related motivation for phasing out these subsidies is that in the absence of offsetting compensation payments to companies they reduce companies' revenues and thus limit their investments in infrastructure. This problem is particularly relevant in the electricity sector (leading to blackouts or low levels of electricity access), but is also present in the oil, natural gas and coal sectors.

Energy subsidies are often intended to redistribute income to the poor, however the greatest beneficiaries are the individuals that consume more energy, *i.e.* owners of motor vehicles and electrical appliances. The IMF has estimated that 80% of the total benefits from oil subsidies in 2009 accrued to the richest 40% of households (Coady *et al*., 2010). Nonetheless, removing these subsidies needs a careful implementation as the adverse impact on poor households can be disproportionally large.

Over time, these subsidies may even reduce the exports that earn essential revenues to the governments. Furthermore, a number of major oil exporters, including Iran, rely on imports of refined petroleum products, as low domestic prices undermine investment in refining capacity. This problem is particularly acute if governments do not reimburse refiners for their losses. Without new measures to phase out subsidies the increase in domestic oil demand to 2020 in Middle East countries is projected to absorb 24% of the growth in crude oil production (IEA, 2010).

The largest subsidies in absolute terms are granted by those countries with the largest resource endowments. Iran was the largest subsidiser in the world in 2010 with 81 billion USD followed by Saudi Arabia, at 44 billion USD and Russia, with 39 billion USD.

Subsidies accounted for around 20% of GDP in Iran and 10% in Saudi Arabia in 2009 (IEA, 2010). This under-pricing has strained the Iranian economy, forced reliance on refined product imports and led to widespread energy inefficiency. To reduce the fiscal burden, Iran enacted a subsidy reform law in 2010 which would increase prices to market-based levels over the period from 2010 to 2015

and use the savings to replace price subsidies with targeted assistance to low-income groups. Current plans call for oil-product prices to rise to at least 90% of the average Persian Gulf export price and for natural gas prices to be raised to 75% of the export price. Saudi Arabia instead plans minor electricity tariff increases for industrial and commercial users.

Of course, these reforms are likely to be postponed in countries that have faced recent political turmoil (i.e. in Egypt, world's sixth largest subsidized with around USD 20 billion). In September 2009, G-20 leaders committed to phase out and rationalise inefficient fossil-fuel subsidies. Many countries are now pursuing these reforms, which would have a dramatic effect on supply and demand in global energy markets. A universal phase-out of all fossil-fuel consumption subsidies by 2020 would cut global primary energy demand by 5%. Such amount corresponds to the current consumption of Japan, Korea and New Zealand (IEA, 2010).

4. Cooperation in the Mediterranean

The high dependency on foreign gas in the EU causes serious concerns for the security of supply: for example, in January 2009 18 European countries reported major cut-offs of their gas supplies from Russia, as a consequence of a Russian dispute with Ukraine. There is a thus large potential for the MENA region to help the EU in its efforts to diversify among suppliers.

Cooperation across the Mediterranean is meant to span from fossil fuels to renewables. Efforts towards energy efficiency and renewable energy could represent the key elements of an EU foreign energy policy towards the region. An approach based on these two priorities would provide the double dividend of accompanying sustainable economic development in the MENA countries and, at the same time, free gas for exports. Indeed, it is efficient that North Africa's solar potential is first devoted to satisfy the increasing domestic electricity demand, thus liberating additional gas exports to Europe. Transporting gas is cheaper than transporting electricity and it is more accepted by public opinion (pipelines are not visible, contrary to overhead power lines).

The two shores of the Mediterranean Sea have historically been linked by hydrocarbons trade, which contributed to build long-term partnerships for decades. Now there is an increasing focus on regional co-operation in the electricity sector, particularly for renewables-based generation. Additionally, large schemes to develop electricity inter-connections are under consideration. The European Union policy aims at strengthening energy sector integration and stimulating investments in efficient and low-carbon energy technologies in the south Mediterranean. It is also considering the integration of the southern shore of the Mediterranean in the European Union internal energy market by establishing an EU-Southern Mediterranean Energy Community. The "Mediterranean

Ring" aims to connect several electricity corridors, according to the technical standards and the need of synchronisation. There is complementarity across the Mediterranean in terms of seasonal electricity demand and this provides mutual benefits in terms of energy supply.

Energy has been a dominant issue in European Union initiatives, starting with the EuroMed Partnership initiated in 1995 with the Barcelona Declaration, the European Neighbourhood Policy in 2003 and the Union for the Mediterranean in 2008, as well as many multilateral or bilateral agreements. The European Union's Energy 2020 Strategy (COM(2010) 639) states that strengthening the external dimension of the European Union energy policy is a key priority. This has been reinforced with the EC's Partnership for Democracy and Shared Prosperity with the Southern Mediterranean, (COM (2011) 200) issued in 2011. In March 2011, the EC proposed a group to focus primarily on the development of renewable energy. In the medium term this is expected to lead to extending the Energy Community Treaty to neighbours or establishing a complementary European Union-Southern Mediterranean Energy Community. Among the EU priorities are greater integration of energy markets by completing the Mediterranean electricity and gas rings.

A New Response to a Changing Neighbourhood, a joint communication from the EC and the High Representative of the Union for Foreign Affairs and Security Policy in May 2011 states that the EU is to step up energy cooperation with European Neighbourhood Policy partners with the aim of further market integration and increased energy security based on converging regulatory frameworks.

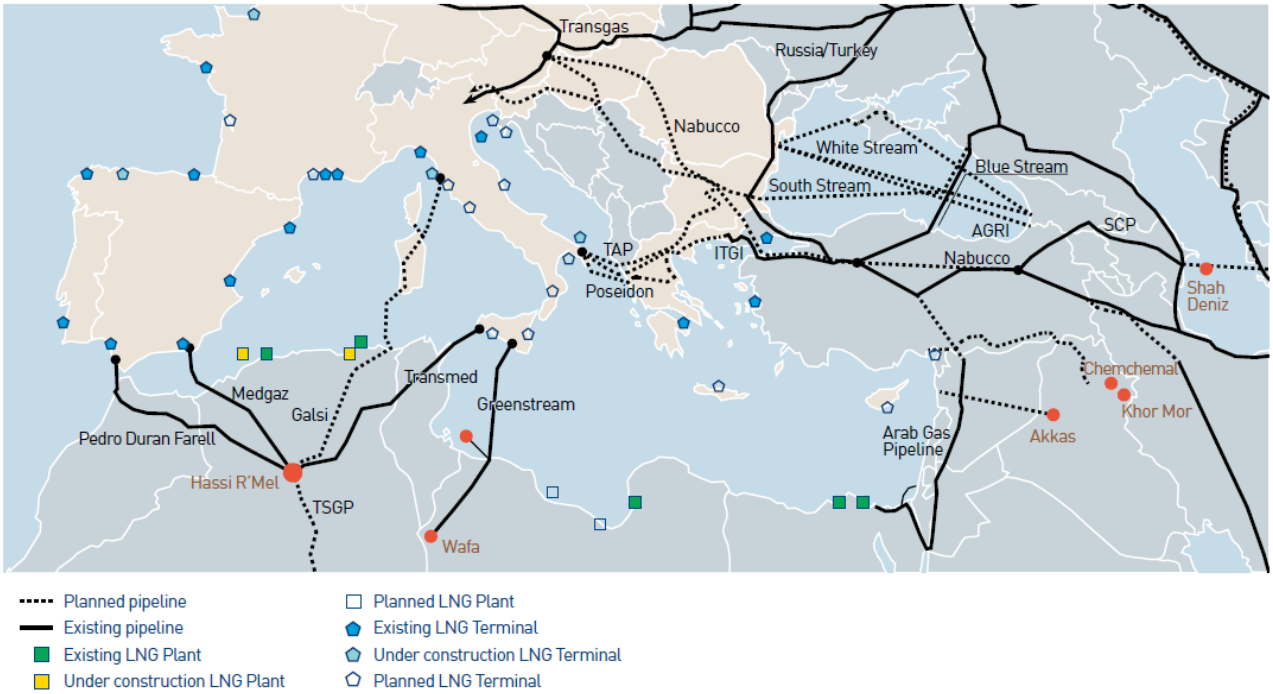
4.1 Fossil fuels

As for fossil fuels, the infrastructure in the Mediterranean is quite developed. Algeria has a well-established pipeline transport system linking its gas fields to Italy, Spain and Portugal. Moreover, the new deepwater Medgaz pipeline, commissioned in March 2011, allows Algeria to serve the Spanish market without transit through other countries. The Galsi pipeline from El Kala to Sardinia, if and when completed, will provide direct access to the Italian market. Libya has only one direct pipeline to export gas to Sicily in Italy (Greenstream). Also, the Arab gas pipeline connects Egypt with Jordan, Syria and possibly Europe through Turkey. Another pipeline allows Egypt to transport gas to Israel. In addition, the Greece-Turkey inter-connector pipeline allows Europe to receive Caspian gas through Turkey. There are several other pipeline projects that aim to bring Caspian gas to Europe through Turkey, which are reported in Figure 7.[1] Besides pipelines, there are several

[1] A detailed North Africa pipelines map can be found also here:
http://www.theodora.com/pipelines/north_africa_pipelines_map.jpg

existing and planned liquefied natural gas plants in the south Mediterranean that allow gas exports to Europe and other markets.

Figure 7: natural gas pipelines in the Mediterranean

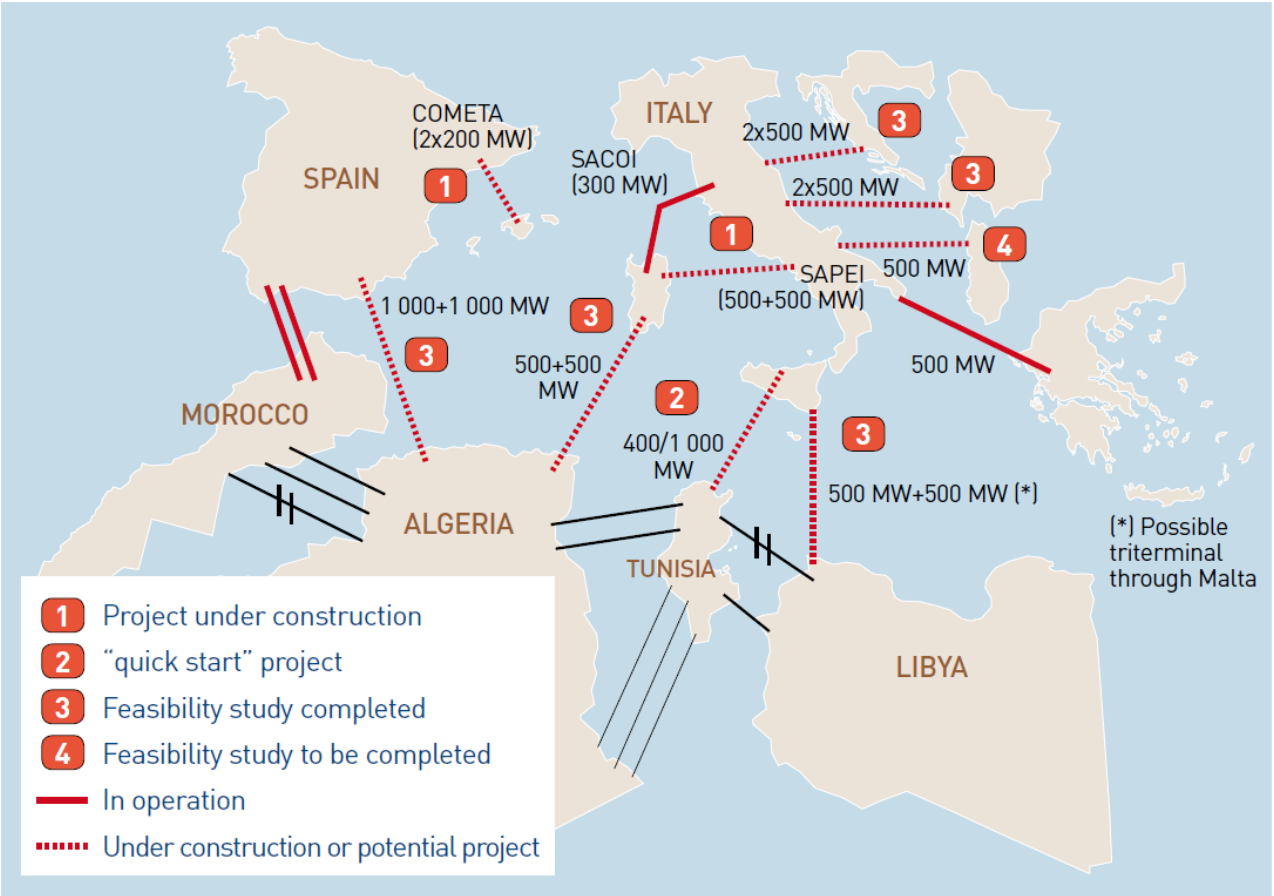


source: OME (2011)

4.2 Electricity and renewable energy

A prerequisite for cooperation in this field is an improvement of the existing grid. South-North HVDC (high voltage direct current) links across the Mediterranean basin allow to buffer electricity price rises in Europe. More interconnections will help to promote an electricity market in the MENA region and facilitate integration over time of the south into the European electricity market. This contributes to increase security of supply for the North Mediterranean, particularly for Italy, as these inter-connections could avoid the heavily congested corridors across the Alps. Currently there are four main routes under consideration for HVDC South-North interconnection projects: Tunisia-Sicily; Algeria-Sardinia; Algeria-Spain and a more unlikely Libya-Sicily route. Only the first is progressing and is planned to be operative in 2016.

Figure 8: HVDC transmission links in the Mediterranean



Source: OME (2011)

To take additional power, an Italian grid upgrade in Calabria and Sicily would be necessary to reduce congestion and allow additional flows from North Africa.

The selection of submarine routes for the south-north corridors is complex: it is necessary a technical analysis to identify the optimal sending and receiving ends of the new corridors, as well as their size and the required reinforcements in the terrestrial transmission grids. An environmental study is necessary to provide an analysis of the morphology of the Mediterranean Sea depth to assess the most viable submarine inter-connection alternatives. Finally, economic analyses are necessary to assess the profitability of the new corridors (the expected cost is around 1 billion EUR per corridor). The analyses shall investigate the impact of the electricity imported from the south on prices in the European integrated electricity market.

In the South Mediterranean countries, more cross-border electricity trade can be a catalyst for growth, as the sector's liberalisation would attract foreign capitals. However, an obstacle is the level of subsidies for electricity in many countries in the South: domestic tariffs are too low to offer profitability for producers.

All southern and eastern Mediterranean countries have embarked during the last years – with the support of the European Union – on an energy pathway focusing on an increased development of renewable energy and of energy efficiency. The EU should try to accompany the creation of the broader economic and political frameworks that, after the recent Arab uprisings, new governments will develop. In this way it will also be able to have an impact on the energy cooperation, therefore contributing to ensure European energy security.

Concerning the development of renewable energy in the southern shore of the Mediterranean, several projects have been promoted over the last two years. We will discuss them in detail. These large-scale renewable energy projects are strictly related to the development of gas markets as an increase in renewables production is meant to free gas for export.

Mediterranean Solar Plan

The Mediterranean Solar Plan (MSP) was launched in 2008 and is a key project of the Union for the Mediterranean (UfM), a multilateral partnership that encompasses 43 countries from EU and the Mediterranean basin. It is aimed at increasing solar and other renewable energy sources for power generation, improve energy efficiency, develop electricity grid inter-connections and encourage the transfer of know-how and technology to emerging economies. The objective is to achieve the development of 20 GW of new renewable energy installed capacity in the MENA countries by 2020 along with the necessary electricity transmission capacity and interconnections between the two shores of the Mediterranean. This will require total investment of around 60 billion EUR. Additionally, it aims at obtaining significant energy savings by 2020.

This plan needs to address a number of issues such as new interconnections across the Mediterranean, investment in new grids and reinforcement of existing interconnections.

By contributing to the development of solar and other renewables generation capacity and green electricity trade between the Mediterranean countries and the EU, the MSP intends to address the challenges of internal energy demand in the participating countries. During the first Joint Committee of National Experts in July 2011 the European Investment Bank (EIB) presented proposals for the creation of new financial instruments to support the MSP process.

The European Commission is accompanying this initiative through capacity building projects such as “Paving the Way for the Mediterranean Solar Plan”, aimed at contributing to the establishment of harmonized legislative and regulatory frameworks for renewable energy, improving knowledge transfer and enhancing capacity building across all the southern Mediterranean partner countries. Indicative budget is around EUR 5 million for the period 2011-2013. The Medgrid initiative, launched in 2010 under the umbrella of the MSP, aims to create a network of energy enterprises to

realise a large network of underwater electric interconnections in the Mediterranean. The estimated budget is 8 billion EUR.

Transmission grids in the south are weak or already saturated: they were designed to serve systems based on fossil fuel generation along coastal lines or hydropower on the Nile. However, new large renewables generation projects are largely based in areas far from existing grids and thus transmission systems will have to be expanded and reinforced. Also the current structure of the European Union transmission grid need to be improved as it does not allow the injection of several GW from the South, because of congestion.

Desertec industrial initiative

Desertec industrial initiative (Dii) was launched in July 2009, by 12 companies, manly from Germany, with the aim to deliver the framework for large-scale use of desert solar and wind energy resources to replace fossil fuels and nuclear energy, while also promoting development in North Africa. It involves the construction of concentrating solar power systems over 17000 sq. kms of the Sahara desert in order to generate 50 GW of installed CSP capacity by 2050, which would be distributed to Europe and North Africa through a high voltage super grid.

The objective is to meet local demand first and allow these countries to also export energy to Europe. Several individual projects are to be created in co-operation with local subjects (governments, companies), aiming to produce and transfer power generated from renewable resources. In this process, Desertec tries to be a facilitator, catalyst and coordinator.

Among the Dii's main goals are the drafting of business plans and starting industrial preparations for building a large number of networked solar power plants distributed throughout the MENA region. Again a reinforcement and expansion of the electricity grids locally and in connection to the European grids is one of the prerequisites. Dii expects a super-grid development across the continents, connecting the major renewable sources with demand areas. The target is to produce and export power sufficient to meet around 15% of Europe's electricity requirements and a substantial portion of the energy needs of the producer countries by 2050.

This initiative has the support of the European Commission, through the project "Paving the Way for the Mediterranean Solar Plan" and through the financial support of the European Investment Bank's Facility for Euro-Mediterranean Investment and Partnership (FEMIP) and the Neighbourhood Investment Facility (NIF).

5. The Arab spring

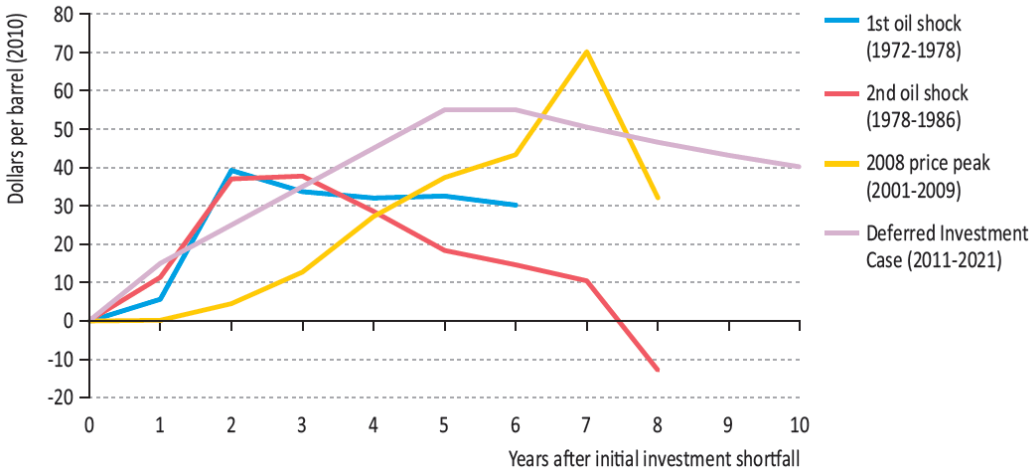
The recent Arab uprisings may have an important impact on the MENA energy markets prospects. The domestic social tensions suggest that reforms, including fossil-fuels subsidies reforms, will be delayed, leading to an increase in domestic energy consumption and thus to a constraint of gas exports in the near future.

The IEA (2011b) projects that MENA will contribute more than 90% to the required growth in oil production expected for 2035. For such an increase, upstream investment in MENA needs to average 100 billion USD per year from 2011 to 2020 and 115 billion USD per year from 2021 to 2035 (in year-2010 dollars). However, the recent uprising might delay some of these investments. Indeed, governments might choose to develop production capacity more slowly: they might prefer to hold back resources for future generations or to support the oil price in the short term. Moreover they could give priority to spending on other public programmes rather than upstream development. Legal changes, renegotiation of existing agreements, increased political instability are all factors that could possibly contribute to a delay in investment.

IEA has produced a scenario which incorporates this hindrance and assumes that upstream oil (and gas) investment will be reduced by one-third in all MENA countries, compared with a business as usual scenario without delays over the period 2011 to 2015. The shortfall in investment will affect oil and gas markets directly and have indirect effects on the other energy markets. In this scenario oil and gas production capacity falls progressively short of that projected in the scenario without delays. The shortfall in oil production in MENA reaches over 6 mb/d in 2020: this is large enough to have a significant impact on global oil markets and increase oil and gas prices.

The upward part of the price trajectory in this scenario is similar to that occurred in the last decade, resulting in a spike in 2008, which was also the result, at least in part, of insufficient investment. The downward slope is comparable to the decline after the second oil shock in 1979-80, which saw the same kind of market reaction with a demand decrease through increased efficiency, fuel switching and increased investment in exploration and production in other regions. This is reported in Figure 8.

Figure 8: Change in crude oil price assuming a delay in investment in MENA



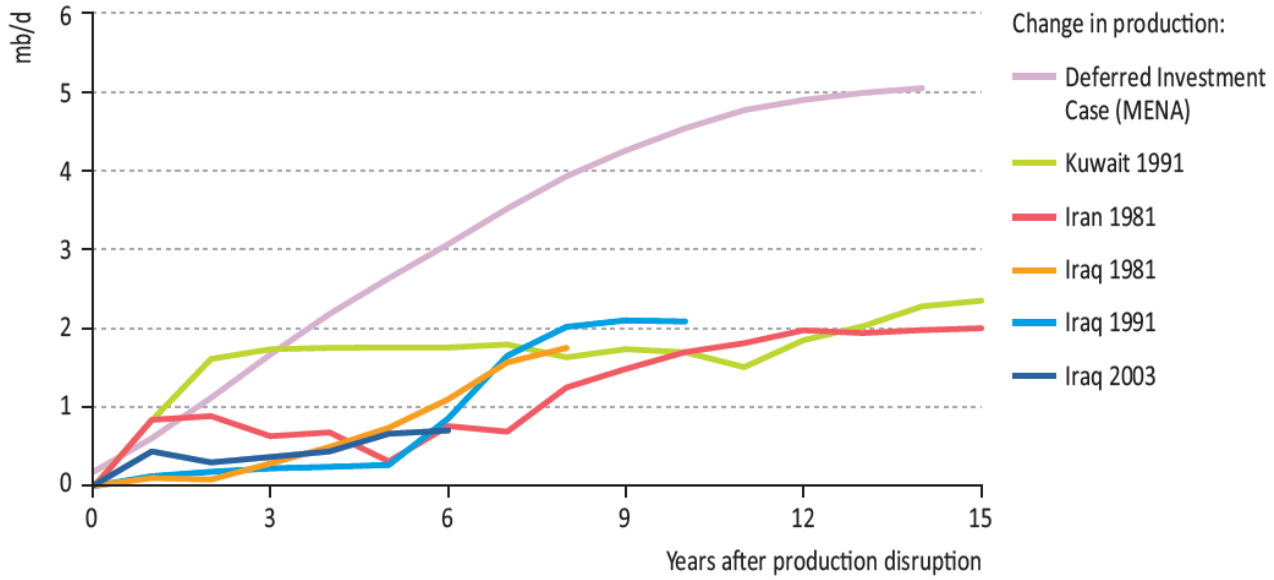
source: IEA (2011b)

Gas and coal prices are expected to react to the increase in oil price and the reduction in investment in gas supply capacity in MENA, though to a different extent across regions. In the period of high oil prices, gas and coal prices are expected to decouple from oil prices. Notice that the loss of gas supply, as a proportion of global supply, is significantly less than that of oil supply.

With sharply higher prices, global oil demand is assumed to remain rather constant in the medium term. However, sustained high prices at the level expected make the production of biofuels competitive (IEA, 2010).

MENA investment is assumed to recover gradually after 2015 but, due to the decline in production from existing fields, total MENA production continues to fall until 2020. After 2020, MENA production starts to increase again, reaching its 2010 level by 2023. The recovery of production in the MENA region after 2015 is comparable to that observed after past supply disruptions, as shown in Figure 9.

Fig: 9 Oil production recovery assuming a delay in investment in MENA



source: IEA (2011b)

6. Conclusions

The MENA region has large fossil fuels resources and is thus crucial in global oil and, to a lesser extent, gas markets. Moreover, its geography gives to the area a huge endowment of solar resources, which are still largely undeveloped. On the other side of the Mediterranean, the EU includes some of the largest energy importers in the world and is thus extremely sensitive to the issue of security of supply.

We discuss the policies implemented in recent years: while EU countries have stringent requirements as concerns renewable energy production and energy savings, the MENA countries lack such policies and additionally face the problem of fossil-fuel consumption subsidies, which are costly and extremely difficult to phase out. We also present a number of joint projects across the Mediterranean. These span from new pipelines for gas to an improvement of the HVDC links across the sea. Much attention is devoted to renewable energy production in the southern shore of the Mediterranean (such as the Mediterranean Solar Plan and the Desertec industrial initiative), as this would yield the double dividend of an increase renewable energy production to satisfy the increasing local demand in a sustainable way and freeing natural gas for export in the northern shore.

The recent political turmoil that took place in few Arab countries is adding uncertainty to this scenario. This could be an opportunity for EU countries to strengthen cooperation with new

governments in the fields of energy supply and transmission, both from fossil fuels and from renewable sources. The most likely effect, however, is a delay in the investment in infrastructure. This will probably imply a loss of production, which is expected to be initially small, but to become larger in the longer term. As a consequence, crude oil price is expected to increase.

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