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Case Study on Green electricity exports from the MENA region to Europe

By Dr. Georgeta Vidican, Senior Researcher German Development Institute, Bonn, Assistant Professor Masdar Institute of Science and Technology, Abu Dhabi

(i) *Introduction*

Since the establishment of the DESERTEC Foundation in 2009[1], the possibility of producing renewable energy in the Middle East and North Africa region (MENA) and exporting it to European Union (EU) countries has received a lot of interest among scientists, industry and policymakers alike. The expected benefits from the EU-MENA energy market integration are substantial both in terms of climate change mitigation, as well as in terms of energy security and economic outcomes.

The first scientific study to explore the viability of the clean energy export concept has been the "Trans-Mediterranean Interconnection for Concentrating Solar Power" by the German Aerospace Center.[2] The results showed that solar electricity imports from concentrating solar power (CSP) produced in MENA can provide the renewable energy base load and balancing power for a sustainable European energy mix.[3] In response, industrial initiatives such as the DESERTEC Industrial Initiative (Dii)[4] and MedGrid[5] have started to develop strategic business plans for such activities. The Union for the Mediterranean (UfM) has also proposed a Mediterranean Solar Plan

[1] DESERTEC Foundation, http://www.desertec.org/organization/, Accessed on October 18, 2012.
[2] DLR, 2006. Trans-Mediterranean Interconnection for Concentrating Solar Power, German Aerospace Center (DLR), Institute for Technical Thermodynamics, Department of Systems Analysis and Technology Assessment, June 2006.
[3] The large potential for renewable energy in the MENA region implies that less than 0.2% of the land suitable for CSP plants would be enough to supply 15% of the electricity demand expected in Europe in the year 2050 (Trieb, F., et al. 2012. Solar electricity imports from the Middle Eastern Middle East and North Africa to Europe, *Energy Policy*, 42: 341-353).
[4] DESERTEC Industrial Initiative (Dii): Renewable energy bridging continents. http://www.dii-eumena.com/home.html, Accessed on October 18, 2012.
[5] MedGrid Project Vision. http://www.medgrid-psm.com/en/project/, Accessed on 10 October 2012.

(MSP), in line with the DESERTEC vision, to assist with the development of a strategic road-map for energy market integration between the two regions. Moreover, Directive 2009/28/EC (hereafter Article 9) of the European Parliament on the promotion of the use of energy from renewable sources stipulates that physical imports of clean energy from MENA can count towards the renewable energy targets of EU countries.

For MENA countries, the use of the largely available renewable energy (i.e. high solar insolation and wind resource) could materialize into various benefits such as energy security; technology transfer; income from exports of electricity as well as parts and components and services; private sector development; and job creation. Moreover, large scale deployment of renewable energy in the MENA region is likely to contribute towards reducing costs and increasing the economic viability of renewable energy relative to conventional fuels.[6] These benefits are important given that across the MENA region energy demand is increasing at a rate of 6-8% per year, and it is expected to double by 2020 and triple by 2030.[7] At the same time, unemployment rates among the educated youth are currently the highest worldwide.[8] While the socio-economic benefits of renewable energy in the region is not yet fully understood, electricity generation to cover the increasing domestic demand and for exports to Europe offers realistic prospects.

(ii) <u>*Sector Overview*</u>

In response to these opportunities and energy demand constraints, countries in the MENA region have integrated renewable energy targets into their national energy strategies. As Table 1 illustrates, these targets have already been followed by some initial projects, notably in Egypt, Morocco and Turkey.

Table 1: Renewable energy targets for selected countries in the MENA region[9]

Country	Current Medium Term Targets	Currently Installed Capacities
Algeria	14% of installed capacity by 2020 and 34.8% by 2030, with the following breakdown: 60% CSP, 23% PV and 17% wind	Negligible
Egypt	20% of total electricity generation by 2020: with 12% for wind (7,200 MW) and the remaining for hydro, solar and biomass. NREA expects solar contribution to be 120 MW (100 MW CSP and 20 MW PV)	522 MW wind, 20 MW CSP, 2,800 MW hydro, 13% of total installed capacity in 2010
Jordan	7% share of primary energy by 2015 and 10% by 2020; MEMR expects to develop by 2020 600 MW wind power, 600 MW solar power, 30-50 MW waste	17.4 MW, 0.5% of total installed capacity in 2010
Lebanon	12% of final energy consumption by 2020	273.5 MW hydro (190 MW available capacity), 12 % of total installed capacity in 2010
Morocco	42% share of installed capacity by 2020; incl. 2,000 MW for wind, 2,000 MW for solar, 12%	280 MW wind, 1,306 MW hydro, 20 MW CSP, 24% of total

[6] Dii, 2012. Desert Power 2050: Perspectives on a sustainable power system for EUMENA. Munich, Germany.
[7] International Energy Agency, 2010. World Energy Outlook 2010 – Renewables in MENA. London.
[8] Ahmed, M., Guillaume, D., Furceri, D. 2012. Youth unemployment in the MENA region: Determinants and challenges. In: *Addressing the 100 million youth unemployed - Perspectives on youth employment in the Arab world in 2012*. World Economic Forum.
[9] EIB, 2010. Study on the financing of renewable energy investment in the Southern and Eastern Mediterranean region. European Investment Bank (EIB), October 2010; UfM, 2012. MSP Working paper on political and regulatory framework issues, Union for the Mediterranean (UfM), Barcelona, July 2012.

	reduction of energy consumption by 2020 and 15% by 2030	installed capacity in 2011
Syria	6,000 MW of installed capacity by 2030 (with 50% for solar and 50% for wind)	1,500 MW hydro, 21% of total installed capacity in 2005
Tunisia	10% of total energy consumption by 2020	53 MW wind, 62 MW hydro, 3.3% of total installed capacity in 2009
Turkey	30% of total electricity generation by 2023 vs. 20% in 2009. 600 MW solar power plants through private sector by 2013 with licensing procedure already started, 20,000 MW wind energy, whole hydropower potential und 600 MW geothermal by 2023	15,433 MW hydro, 880 MW wind and geothermal. 34.5% of total installed capacity.

Morocco and Egypt, for instance, offer interesting insights into the issue of green electricity exports for four main reasons: (1) these countries have among the highest solar and wind energy resources worldwide; (2) none of these countries are resource rich but Morocco is almost entirely dependent on energy imports (more than 95% of its energy needs are imported),[10] while Egypt has only recently started to rely on imports; (3) Morocco's geographic position close to Spain facilitates the transfer of electricity to Europe; (4) Egypt's large market and industrial base could open up opportunities for local manufacturing and export of parts and components along the value chain of solar and wind technologies, while the transfer of electricity across the Mediterranean is impeded by its geographical location.[11] Hence, these countries reflect relevant similarities and differences when considering EU-MENA energy market integration.

Morocco has seen a particularly dynamic environment after the national renewable energy targets were declared in 2009, becoming the frontrunner in the MENA region for renewable energy development. In June 2011 a Memorandum of Understanding was signed between the Moroccan Agency for Solar Energy, the agency tasked with the implementation of solar energy targets (i.e. 2,000 MW by 2020), and the Dii for the development of a large solar project aimed to demonstrate the feasibility of exporting solar electricity to Europe. The 500 MW of solar energy to be developed in Ouarzazate, Morocco, 160 MW have been commissioned in 2012, is expected to include an export component in the next phases. Dii has also signed a cooperation agreement with UfM to join forces in advancing the MSP, with an emphasis on stimulating electricity exports.[12] Renewable energy plants are also being developed in Egypt, particularly in the wind sector, with a goal of developing export capabilities of renewable energy parts, components and services for the African market, and potentially green electricity exports (through the eastern Mediterranean corridor). The expected time for green electricity exports from the MENA region is currently uncertain; yet, existing studies suggest that exports could be generated not earlier than 2020.[13]

(iii) *Trade opportunities and challenges*

Trade opportunities

[10] IEA, 2012. Net energy imports. Energy Statistics Yearbook, International Energy Agency (IEA). http://www.iea.org/stats/index.asp, Accessed on October 10, 2012.

[11] Studies show that the cross-Mediterranean transfer of electricity from Egypt to Europe is made difficult by the depth of the Sea, increasing the capital costs and rendering this alternative economically unviable (DLR, 2005. Concentrating solar power for the Mediterranean region German Aerospace Center, Institute for Technical Thermodynamics, Department of Systems Analysis and Technology Assessment, April 2005). Yet, export of electricity inland, through the eastern Mediterranean countries appears feasible (Trieb et al. 2012).

[12] Dii, 2012: Renewable energy bridging continents. http://www.dii-eumena.com/home.html, Accessed on October 18, 2012.

[13] Trieb, et al. 2012.

Based on the Dii 2050 Desert Power study, the energy trade balance (taking into account the complete mix of renewable) could amount to 1,064 TWh of annual net exports from MENA to Europe, saving approximately 33 billion Euros.[14] These estimates also assume that approximately 1,100 TWh of electricity per year flows through High Voltage Direct Current (HVDC) lines between MENA and Europe.[15]

Due to its high renewable energy resource availability and relatively lower domestic market, it is estimated that Morocco has the capacity to produce almost five times the amount of power needed to satisfy its own demand, i.e. 505 TWh.[16] As a result, the potential for export of energy is sizable. In Egypt, however, the large domestic demand (due to higher population and larger economy) reduces the capacity for clean electricity exports. As per the Dii estimates, an optimal energy system in Egypt would entail that the country would import power when needed and export it when the production exceeds domestic demand.[17] However, because of the substantial manufacturing potential, Egypt could instead develop capabilities for exports of parts, components and services for both wind and solar energy technologies.[18]

Another study, focused only on CSP exports from MENA to Europe, estimates that by 2050 a total of 33 HVDC power lines to Europe would be able to transfer a total of 703 TWh/yr of solar electricity from MENA to Europe and Turkey.[19] As per the authors, the implementation of such an infrastructure could begin in 2020 and would take about 30 years for its finalization. As such, solar electricity exports could start by 2020 with units of around 3,500 MW export capacity for HVDC lines and reach a level of roughly 700 MWh per year electricity exports by 2050.[20] The cumulative investment requirement for such a project (i.e. CSP plants and transmission lines) would reach 667 billion Euros (in constant monetary value of the year 2010).[21]

As a result of these prospective developments, European countries are likely to import up to 20% of its electricity needs from North Africa at a cost that is significantly lower than if clean electricity would be provided in Europe.[22] Once carbon emission limits are in place and renewable energy costs go down, benefits from exports become more appealing.[23] Yet, more research is required to estimate economy wide benefits, in terms of job creation, private sector development, and technological catching-up for the MENA countries.

<u>Challenges</u>

The process of implementing such a complex cross regional project faces multidimensional challenges in terms of infrastructure needs, investment costs, know-how and technology development and political agreement at a regional level.

The ***infrastructure*** for electricity exports is critical, specifically the HVDC lines that need to be built as well as the lines for overland transmission. Different estimates exist with respect to the potential export

[14] Dii, 2012. Desert Power 2050, p. 10.
[15] Dii, 2012. Desert Power 2050, p. 14.
[16] Dii, 2012. Desert Power 2050, p. 84.
[17] Dii, 2012. Desert Power 2050, p. 90.
[18] Vidican, G. 2012. Building domestic capabilities in renewable energy: A case study of Egypt. Bonn: German Development Institute Press, Studies 66.
[19] Trieb et al. (2012: 353) argue that it would not make sense to export electricity surpluses from wind or photovoltaic (PV) production, as Europe has more than enough fluctuating sources of renewable energy itself.
[20] Trieb et al. (2012: 352).
[21] Trieb et al. (2012: 343).
[22] Ibid.
[23] Dii, 2012. Desert Power 2050.

corridors. For example, Dii assumes that seven sub-Mediterranean transmission corridors can be used, along with an eighth corridor between Egypt, Saudi Arabia and Turkey.[24] In addition, the development and upgrade of regional grid connections within the MENA region is crucial with regard to the export of renewable energy.[25]

The ***costs*** of implementing such large scale cross-regional project are sizable. Obtaining upfront concessional financing for green electricity exports to EU member countries remains a main challenge to generate the first large scale renewable energy plant in the MENA region. One goal should therefore be to identify innovative financial instruments to support such developments.

Perhaps the most pressing challenges relate to the ***political and institutional framework conditions*** necessary for enabling exports of green electricity from MENA to Europe. Currently, green electricity exports to EU on the basis of Article 9 seem uncertain at best. Several aspects remain to be clarified, for example: the import price of electricity, establishment of a new feed-in-tariff (FIT) for green electricity from the MENA, and the share of the electricity generated in MENA for export to Europe. Moreover, harmonization of policy regimes for renewable sources of energy across the region, along with robust national strategies for renewable energy development is critical for enabling such an unprecedented cross-regional project.

Another set of challenges relate to ***technology transfer and acquisition of know-how*** on renewable energy technology in the MENA region. Given that knowledge on renewable energy technologies is concentrated mostly in European countries, technology transfer mechanisms to support long-term sustainability of such projects are needed, in the form of joint-ventures, technology acquisitions, public-private partnerships, etc. Training programs, at professional and vocational level, will have to be put in place to support the process of capabilities building. At the same time, to avoid the aggravation of unemployment among the highly educated youth in the region, job creation is essential. But, the potential that renewable energy has in alleviating this problem is currently not well documented. For example, rough estimates from the Dii study show that by 2050 up to one million jobs are to be created (direct and indirect effects) as a result of large scale renewable energy developments in the MENA region.[26] However, induced effects (the additional labor effects on these jobs on the economy) are not considered. The Moroccan Energy Strategy presents a relatively conservative scenario, whereby 13,300 jobs in the renewable energy sector are expected to be created by 2020.[27] In Egypt, where a stronger emphasis is placed on the development of wind energy sector, the implementation of the wind energy targets is estimated to generate 75,000 jobs by 2020.[28] Hence, while assessments of gaps in the provision of skills for renewable energy sector exist[29], a thorough assessment of the job creation potential is missing in these countries. Nevertheless, for the renewable energy sector to take off in the MENA region, wide socio-economic benefits are needed, such as private sector development, employment creation, and technological catch-up.

[24] Ibid.

[25] Fritzsche, K., Zejli, D. and Taenzler, D. 2010. The relevance of global energy governance for Arab countries: The case of Morocco. *Energy Policy*, 39(8): 4497-4506.

[26] Dii, 2012. Desert Power 2050.

[27] Moroccan Ministry of Energy, Mines, Water and Environment. Moroccan Energy Strategy: Overview, May 2011.

[28] El Sewedy, 2009. Local manufacturing: Experiences from the MENA region – El Sewedy for wind energy generation (SWEG), RCREEE Conference: MENA Energized – Regional challenges to green the power sector, Sharm El Sheikh, Egypt.

[29] MEMEE, 2012. Etude pour la specification des besoins en competences dans la secteur des energies renouvelables. Ministry of Energy, Mines, Water and Environment (MEMEE), July 2011, Morocco; Vidican (2012);

(iv) Ways Forward

Considerable benefits from green electricity exports could be realized if renewable energy develops at large scale. Given that countries like Morocco rely heavily on imports of conventional energy, the potential of green electricity exports could relieve the heavy pressure on the national energy bill.

From a technical point of view, the export of green electricity from MENA to Europe appears realistic; the solar and wind energy potentials are high enough, the costs and environmental impacts are acceptable, and the technology and materials are available. While the export of green electricity to Europe is not expected to be realized before 2020, several challenges need to be overcome. As a priority, it is necessary to put in place the political and institutional framework conditions, in both MENA and EU, to allow for these large investments, and to develop a consistent regulatory framework for green energy imports from MENA, which would ultimately offer security to investors. For Morocco, the country with the highest potential for electricity exports to Europe (due to its location and existing interconnection infrastructure), these institutional aspects are essential. At the same time, availability of finance to support these large scale investments is necessary. Last but not least, measures to increase local value added in terms of jobs, private sector competitiveness, and technological upgrading, contribute not only to political stability (and hence to lowering investment risks) but also to long-term sustainable and inclusive development for countries in the MENA region.

To this end, cooperation and partnerships across different actors within and across the MENA and EU region are critical for realizing the potential benefits from clean energy exports. Such cooperation is critical for various aspects from finance, knowledge development, to policy harmonization and regulation in order to allow green energy exports. At the same time, systemic integration of strategies for renewable energy deployment, private sector development, and green exports is essential for orchestrating different development goals. The strategic road map that MSP is developing is a positive step in this direction, bringing together the relevant stakeholders and aligning its goals with cross-regional private sector initiatives such as Dii. In this process government leadership is crucial for ensuring continuity and integration of different development targets, i.e. energy security, economic development and export promotion.

Please send any comments to
Mr. Giles Chappell at:
giles.chappell@unep.org