Pathways of renewable generation in the MENA region: opportunities for scaling up green finance

Isabella Alloisio, FEEM, ICCG, CMCC

Francesco Pietro Colelli, ICCG

Pathways of renewable generation in the MENA region: opportunities for scaling up green finance

Isabella Alloisio, FEEM, ICCG, CMCC

Francesco Pietro Colelli, ICCG

Abstract

Solar systems, among other renewable sources, have the highest potential to contribute to the MENA region's future generation needs. This reflection provides an insight into the most recent cost analysis as well as the different trade-offs available to the region's economies for scaling up such potential: MENA countries are highly heterogeneous in terms of both energy dependence and carbon intensity of electricity generation. Export-dependent economies need to choose between using cheap fossil fuels for domestic consumption or preserving such resources for export. Oil importers see domestic renewable generation as a way to reduce the pressures on fiscal budgets and to increase their energy security. Expectations of an oil price trend stably around USD 50-60/bbl are fueling the needed fiscal reform *momentum* throughout the whole region, with important direct impacts on the profitability of renewables. Particular attention will also be given to the development of financial mechanisms that can lower the cost of renewable energy systems, and notably to the role of Gulf Sovereign Wealth Funds potentials for providing suitable long-term and affordable financing.

Introduction

In the MENA region, a qualitative leap in the development of new generation capacity will be needed to meet growing domestic consumption. Electricity demand in MENA countries has increased at an average pace of 6% annually during the past decade and is **expected to increase by 84% by 2020, as** compared to the 2010 demand levels[1]. Such trends are spurred by different factors, from **population growth, economic development, rising living standards and heavy energy consumption subsidies**. Meeting the expected increase in energy demand across the region will require significant scaling up of both traditional and renewable generation capacity. Some estimates forecast that around **135 GW of additional generating capacity** will be needed **by 2020**, **requiring infrastructure investment costs, for electricity alone, of about USD 450 billion**[2]. Quadrupling generation capacity **by 2050** would require infrastructure investments of **USD 676 billion** under a business-as-usual scenario, and **between USD 839 billion and USD 1,220 billion** if increasing the importance of solar and nuclear capacity in complementing gas generation, with solar power alone totaling up to 546 billion in 2050[3].

The need to move away from a business-as usual power market is evident from the carbon intensity of electricity generation, which currently constitutes the largest source of CO2 emissions in the region. The **electricity sector was responsible for 42% of total carbon emissions in 2011**, **accounting for 943 million tons of CO2 per year** (MtCO2/year) over a total of 2,228 MtCO2/year[4]. Differences exist within the countries' carbon emissions intensities in the electricity sector, due to the choice of both fuel and technology mixes: on a per capita basis, the **most intense emitters are Bahrain and Kuwait** surpassing 1,400Kg CO2/capita, and **Saudi Arabia** around 7,000Kg CO2/capita, because of its main reliance on oil for electricity generation. Conversely, in Egypt and Algeria - countries where gas accounts for 76% and 90% of electricity generation respectively – the figures total 800-900 KgCO2/capita[5]. For instance, if all electricity generated in the region in 2009 had had the same level of Egypt's carbon emissions intensity (466kg CO2/kWh), it would have produced approximately 30% less carbon emissions from the power sector, and thus have reduced its total carbon emissions by approximately 11%[6].

Therefore, **electricity generation offers significant opportunities to reduce the region's emissions**. Decarbonizing electricity production with less carbon intensive alternatives, if carefully planned, will also contribute to the region's social development, spur growth, creating industrial opportunities and green jobs, as well as preserve the environment and its scarce water resources. This reflection does not tackle the important issue of strained assets, which will be covered by a later one.

Renewable energy potentials and costs: solar power primacy in the MENA region

The endowment of renewable resources in the MENA region makes the needed transition to a renewable-based power system economically feasible and, therefore, very attractive. Wind resource is optimal, as wind speed exceeds 6.9 m/s (IRENA, 2015a). The region also has the best and most **abundant solar endowments** in the world: **Global Horizontal Irradiance** (GHI), a benchmark for photovoltaic, ranges between 1,920 (Lebanon) and 2,450 (Egypt) kWh/m2/year (compared to the European average of 1,200). **Direct Normal Radiation** (DNR), a benchmark for CSP, ranges between 2,050 and 2,800 kWh/m2/year.

CSP is a key technology for the region, since thanks to thermal storage and hybridization possibilities it provides flexible electrical production capacity to utilities and grid operators, allowing a more effective management of variable energy from other renewable sources such as photovoltaic and wind power. Yet, CSP's significant investment costs and viability gap make it highly reliant on public support: the weighted average LCOE of CSP varies between USD 0.20 – 0.25/kWh, but projects

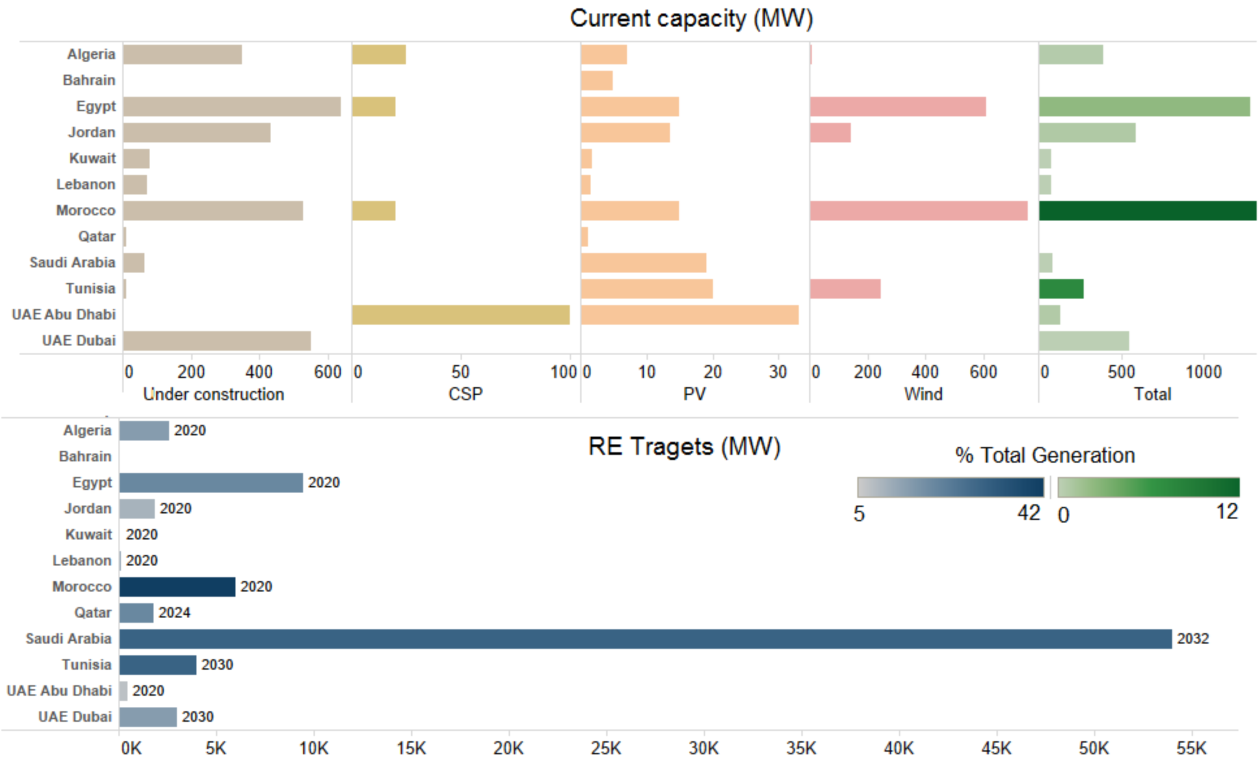
[1] IRENA (2014a).
[2] Ibid.
[3] World Energy Council, (2013).
[4] World Bank (2015).
[5] Ibid., and IEA (2014a).
[6] Khoury (2012).

have been built with LCOEs of USD 0.17/kWh[7] and power purchase agreements (PPA) have been signed at even lower values, where low-cost financing was available[8].

Utility-scale solar PV projects are among the most competitive renewable sources in the region. In 2014 the cost of PV modules was 80% lower than in 2000[9], resulting in a decrease of 53% of LCOE from 2009 to 2014. Significant technological developments have also made PV modules more durable and resistant to such extreme conditions as high temperatures and dust and sand deposition – problems affecting the MENA region. The IEA hi-Ren Scenario for 2050 estimates that additional **CO2 emission reductions due to PV might total 120 million tons in the Middle East**[10], thanks to total **PV capacity reaching 94 GW in 2030** and **268 GW in 2050**[11].

Figure 1 shows the total capacity under construction, the installed capacity per technology, and the future targets adopted by each country of the MENA region as of February 2015.

Figure 1: Renewable Energy Capacity in the MENA region[12]



[7] IRENA (2014b).
[8] As for instance for the Ouarzazate Noor I plant in Morocco, Carafa (2015).
[9] REN21 (2015).
[10] IEA data (2014c) refers to the Middle East and not to the MENA region.
[11] IEA (2014c). The scenario assumes minimum LCOE for newly built utility-scale PV plants to reach USD 71/kWh in 2025, while 2015 regional bids have already established a lower trend: USD 5.98-5.84/kWh for two projects in Dubai (totaling 300 MW) and of USD 6.13-7.67 for four 50 MW PV projects in Jordan, down from an average of USD 10.69 for similar projects in 2014.
[12] RECREE (2015).

Additional costs of renewable power systems

A favorable picture also concerns additional costs of renewables' LCOE: as for back-up capacity costs, the MENA region benefits from a good fit of solar power generation with demand patterns, given the **coincidence of peak demand and peak insolation during summer months[13]**. Grid infrastructure development poses important challenges, since utility-scale solar projects may be located in deserts or other dry inland areas far from cities or existing transmission hubs. Such developments are hence much needed in the area since **a strong and well-connected power grid ensures meeting the growing demand**, guarantees availability for generators, and allows an efficient use of flexible resources in the system[14].

One significant issue concerns expanding grid interconnections that allow for **South-South and North-South axis export of energy** among Mediterranean countries. Morocco, Tunisia and Jordan have in fact included in their legislations possibilities for exporting RE-sourced electricity[15]. Enabling this opportunity will have a direct impact on the profitability of renewable energy generation, since those countries could benefit from high European electricity prices. South-South and North-South cooperation in this regard will furthermore make it possible to better integrate renewables into the energy mix and deal with intermittency in a larger and more reliable grid.

Planning the future energy mix: what are the true costs in a low price environment?

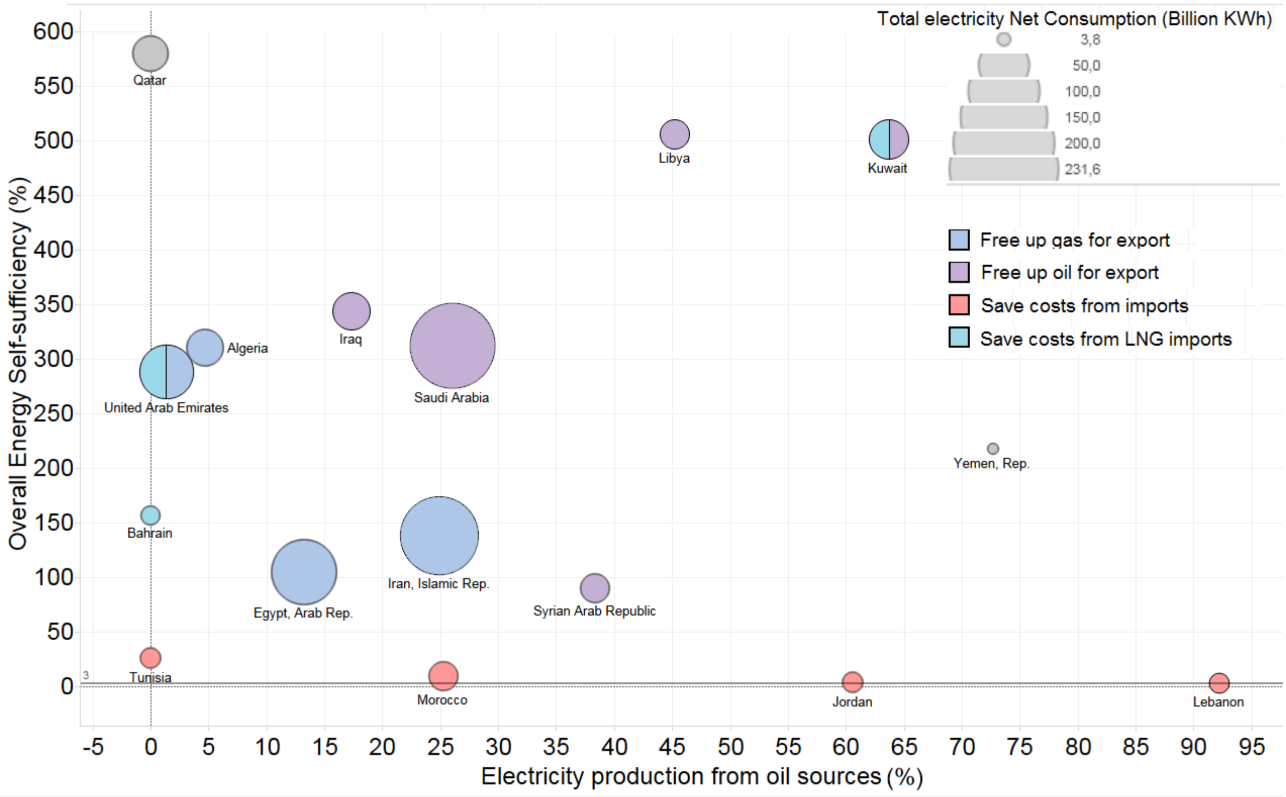
This section will focus on the profitability of those sources that can be complementary to gas in the future energy mix. Currently, **as much as 23% of electricity comes from oil in the Arab states**[16] - the world average is 5%[17] - making renewable energy generation a key opportunity for replacing oil-fired power generation. Sharp differences exist in the countries, as figure 2 shows. The figure also emphasizes the countries' energy dependence and generation market size[18].

A set of early studies[19] evaluates the economic feasibility of installing a 100 MW PV plant to replace oil-fired power generation, finding an oil price threshold value of around USD 80/bbl. Yet, rapid PV cost developments outlined before and a new for oil price trend have sharply changed the assumptions underlying such models. In fact, those studies[20] integrating lower PV generating cost figures find that **solar energy in the MENA region is cheaper than building a new conventional oil-fired plant at an oil price above USD 20-30/bbl**. USD 45/bbl are needed to compete with a half-depreciated oil-fired power plant, and more than USD 60/bbl to replace a fully depreciated one. Furthermore, Deutsche Bank reports that at USD 50/bbl, fuel cost alone to produce electricity are over USD 0.09/kWh, and every USD 10 change in oil prices affects the cost by roughly 0.02/kWh.[21]

These figures reaffirm, therefore, that solar **PV systems seem fully competitive in the current low oil price environment** – a trend that originated between July 2014 and April 2015 and that is expected to persist[22].

[13] Mills (2012)
[14] For instance, the GCC Interconnection Authority (GCCIA) intends to construct a 400 kV backbone grid that will become the basis for a future trade power market and increase the balancing area by integrating the members' systems. IRENA (2015b)
[15] RECREE (2015)
[16] Arab World aggregate, composed of members of the League of Arab States. World Bank, (2015)
[17] World Bank (2015)
[18] Data sources: Overall energy self-sufficiency in 2012 from Energy Atlas (IEA, 2015a) ; Electricity production from oil sources is the average between 2010 and 2012 from WDI (World Bank, 2015); 2012 total electricity net consumption from (EIA, 2015)
[19] BNEF (2011), Mills (2012), Ramadhan M. (2013)
[20] Energy Intelligence, (2015)
[21] Deutsche Bank (2015a)
[22] IEA(2015)

Figure 2: Renewables' generation incentives



These considerations mainly depict **an incentive for oil importers to switch to renewables** (red label in figure 2). A *momentum* has in fact begun in Jordan, Morocco, and the UAE's Northern Emirates[23] (see Figure 1). Action is instead urged in countries such as Lebanon, especially if we consider the share of oil-fueled power generation. As for those **oil exporters** that burn a large amount of oil (purple label in figure 2), a direct cost comparison often does not capture the cost competition outlined. **Saudi Arabia** for instance consumes oil valued at its extraction costs at USD 5/bbl, making oil by far the cheapest source.

A true cost comparison should instead be based on the **opportunity cost of domestic consumption,** represented by the fuel's export price. Such revenues were sizable in the past: Saudi Arabia used an average of 0.7 million bbl/d of crude oil for power generation during the summer months from 2009 to 2013, while production fluctuated between USD 9-10 million bbl/day. As a result, emissions from fuel combustion reached 458 MtCO2 in 2014, up to 200% from 1990, with oil combustion accounting for 70% of the amount.

Similarly, **Kuwaiti** crude consumption averaged roughly 0.08 million bbl/d in those years, while production ranged between 2-3 million bbl/day. A further incentive that is extremely relevant for Kuwait concerns the **stability of the supply of electricity**: during summer months, since the country often experiences **electricity shortages** due to both a lack of gas availability and sudden shutdowns of oil refineries, causing frequent blackouts and brownouts[24].

Finally, key markets are countries where the demand for **natural gas** is rapidly outpacing cheap supply and that are, or will soon become, LNG importers (**Dubai, Kuwait and Bahrain**). The availability of LNG from Qatar through the Dolphin pipeline was originally as cheap as 2/MBtu. These prices have already risen sharply: LNG now averages USD 7/MBtu in Asia and the Middle

[23] In Figure1 distinguishes for the UAE between Abu Dhabi and the Northern emirates, the latter classified under 'Save costs from LNG exports'.
[24] IEA (2014b).

East[25], but prices have reached peaks of USD 14.4/MBtu for the Northern Emirates[26]. This means that these countries will be better off investing in renewable energy for power generation.

Reform of energy consumption subsidies in the MENA region

A first effect of low hydrocarbon prices is that the former revenues of oil exporters has declined, limiting the pressure for phasing out domestic fossil fuel consumption. At the same time, current prices have sharply lowered their overall export rents, which might incentivize an increase in the volume of exports to compensate for such losses. In **Algeria**, for instance, freeing up domestic resources for export is particularly important because the public budget, relying for 60% on the hydrocarbons sector, has been badly hit by both reduced prices and a sharp decrease in total export volumes.

Under oil price forecasts made in early 2015, estimations report the fall in anticipated oil export earnings of energy exporters to be USD 287 billion (21% of GDP) in the Gulf Cooperation Council (GCC), and USD 90 billion (11% of GDP) in non-GCC countries[27]. Clearly, the impact will be different within the region according to the accumulated financial buffers available, with the UAE and Saudi having substantial reserves compared to their counterparts.

Budget constraints driven by low oil prices provide **strong incentives for fiscal reform**. Most importantly, the **phase out of energy subsidies** (both for electricity and fossil fuels) has recently become an imperative for both oil importers and exporters. The IMF[28]estimates that fiscal gains from removing energy subsidies in the MENA are below USD 500 billion, **representing more than 10% of the region's GDP**. Such a reform would result in a 50% reduction in premature deaths from air pollutio – with 40% of this reduction due only to the scrapping of petroleum subsidies - and **generate a 36% reduction in CO2 emissions** (of which 22% from petroleum and 30% from the phase out of natural gas subsidies). **The net gains in economic welfare[29]** would reach **4.7% of regional GDP**.

Net importers put forward the most ambitious subsidy reform programs: **Tunisia** aims to phase out subsidies in all sectors within seven years, starting from 2014, while **Jordan** plans substantial subsidy decreases in the industrial and commercial sector by 2017. Successful reform has also been undertaken in **Egypt,** where the government committed itself to a complete phase out of subsidies for electricity by 2019 and for all fossil fuels by 2024[30]. Nevertheless, action is mostly needed in GCC countries: in the UEA, Saudi Arabia, Dubai, Qatar, Bahrain and Oman where, despite some reform steps, the average price of electricity still remains well below its actual production cost.

[25] IEA (2015).
[26] IRENA, (2015c).
[27] IMF (2015a).
[28] IMF (2015b)
[29] The benefits from reduced environmental damage and higher revenue minus the losses from consumers facing higher energy prices.
[30] RECREE (2015).

Table 1: Fiscal incentives for energy subsidy reform[31]

	(1) **Break-even Oil Price** (USD)	**(2) External Losses** (%GDP)	**(3) Retail Price levels** (USD cents)		*(4)* **Implied subsidy**[32]
			Power	***Fuel***	
UAE Abu D.	73-80	12%	1.4/kWh-5.8/kWh	47/litre	48%
UAE Dubai			**6/kWh -10/kWh**		
Saudi Arabia	87-104	20%	1.35/kWh -7/kWh	14/litre	83%
Kuwait	49-78	**35%**	**0.3/kWh – 4/KWh**	23/litre	**96%**
Qatar	60-76	25%	2/kWh -4/kWh	27/litre	89%
Algeria	**119-130**	10%	4.2/kWh - 5.1/kWh	n/a	74%

A report by the Deutsche Bank[33] found that in Saudi Arabia and the UAE **PV systems would have already reached grid parity if actual costs were at their undistorted level** (USD 0.07- 0.08 kWh). Such cuts are also necessary to help these countries face higher demand by rationalizing energy consumption and establishing a basis for much needed **energy efficiency and demand side measures**, such as air-conditioning standards (e.g., 70% of peak electricity demand in the summer in Saudi Arabia is from air conditioning).

Challenges to reform include estimating and assessing true amount of subsidies, assessing social and economic impacts of phase out and, most importantly, assuring public acceptability[34]. Yet, governments should harness the opportunity offered by the current situation, since cutting subsidies at a time of low global energy prices **would be better received by consumers in the short term,** making subsidy reform easier to implement.

Lowering financing costs for low carbon development

The previous discussion showed that despite recent developments the competitiveness of renewables vis-à-vis fossil-fuel-based technologies is still very heterogeneous and dependent on the establishment in the near future of new policies and regulatory frameworks that could prevent a lock-in of carbon intense generation. Further costs decreases, especially coming from better policies and lower financial risks, will be key factors for helping renewable energy catch on in these markets.

Lowering financing costs through investment de-risking constitutes a key opportunity for gaining further cost advantages, since **green investments are disadvantaged because of high interest rate conditions compared to brown investments.** In fact, the costs of capital intensive renewable energy technologies are remarkably more sensitive to the increase in financing costs than fossil fuels, which are dominated by fuel cost. Recent analyses[35] show that **LCOEs for green energy technologies have a higher interest rate elasticity than those for brown energy technologies**, so that a decrease in interest rates will translate into a stronger decrease in green technology costs than in brown technology costs.

[31] (1): Fiscal break-even price IMF (2014), Deutsche Bank (2015b); (2): IMF (2015a) (3): (PwC, 2015a) (4): RECREE (2015).
[32] Average between implied subsidy in commercial, residential and industrial electricity prices, constructed from a price-gap approach using Palestine as benchmark.
[33] Deutsche Bank (2015a)
[34] Earlier this year, for instance, Kuwait tried to revise a flat fee lower than USD 0.01/kWh for residential and industrial users, but had to cancel the move due to public dissent.
[35] Monnin (2015)

Figure 3: LCOE sensisitivy to financing costs[36]

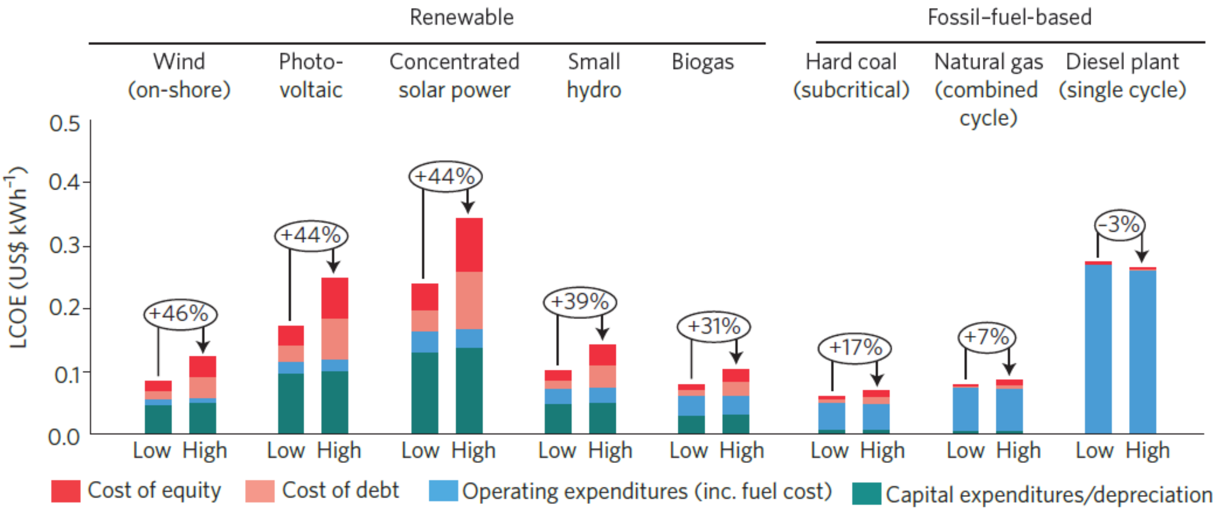


Figure 3 shows the sensitivity of the LCOE of different technologies under a low financing cost scenario (cost of debt 5% and cost of equity 10%), and a high financing cost scenario (cost of debt 10%, cost of equity 18%). The sensitivity might even be underestimated since the study assumes that differences affect only capital costs, while higher risks typical of developing countries will likely also affect other parameters, such as the equity/debt structure or the loan tenor[37]. Furthermore, this condition is exacerbated in developing countries where finance for infrastructure projects is restrained because of factors such as higher inflation, competing needs for capital, government policy stability and less developed financial systems and – especially for hydrocarbon export dependent economies - exposure to commodity prices.

The role of Sovereign Wealth Funds for RE investment in the MENA region

Investments from **institutional investors can provide multiple opportunities for lowering such financing costs.** These actors can effectively tackle long-term finance undersupply given the longer term liabilities of their assets and investment horizon (15-20 years), their larger amounts of capital to invest and their lower expectation of returns (15% IRR)[38]. Nevertheless, direct asset allocations of institutions investors to green investments have been low. As for **pension funds**, green investments only represent 3% of their investment in infrastructure projects, which in turn only covers 1% of their total portfolio[39]. These actors, in fact, face both liquidity and diversification constraints and usually require sizeable investments.

Among institutional investments, SWFs, defined as state-owned investment vehicles, have emerged in the international financial landscape as dynamic actors for long-term investments, as they have important advantages compared to others. SWFs allocate a higher share of their assets to illiquid investments – 10%, while pension fund shares averages 9% and life insurers as little as 4%. They are not bound by short-term obligations, i.e. do not have a defined liability profile as pension funds and insurance companies do. Finally, they usually have a higher tolerance propensity to risks and losses, very suitable to investments in renewable energy infrastructure[40].

Such characteristics are as yet not shared heterogeneously among SWFs, as multiple funds with different objectives but similar funding sources often coexist within a country. Types and objectives can be roughly divided into three categories. First, **stabilization funds,** aimed at insulating the

[36] Schmidt (2014).
[37] Ibid.
[38] Alloisio, Carraro (2015).
[39] Kaminker (2013).
[40] Alloisio, Carraro (2015).

budget and economy from volatile commodity prices by controlling inflation and stabilizing exchange rates through the accumulation of foreign exchange reserves. These actors will likely invest in liquid assets carrying a low risk as bonds. Second, **savings funds,** established to transfer wealth across generations. Third, **development funds**, which allocate resources to priority socioeconomic projects. These result as the **most relevant for supporting green financing,** as they have to fund liabilities that are long-term oriented and multi-generational in nature[41].

Opportunities for SWFs financial de-risking:

- Provide **affordable long-term capital** and complement available private credit.
- Provide **risk insurance or guarantees** in a way similar to some MDBs, such as the World Bank Group's Multilateral Investment Guarantee Agency (MIGA) - i.e. by guaranteeing for risk of breach of a Power Purchase Agreement.
- Complement commercial banks in funding the initial stage of the project cycle, providing **project development grants or loans** and backing public commitment to take "first-loss" equity position, in order to ease reaching financial closure[42].
- Gather support of fixed income investors by **supporting a green bond market**, in a way similar to World Bank's Green Bond initiative, which since 2008 has raised the equivalent of $6.4 billion in Green Bonds. In the case of GCC's SWFs, there could be the potential for fueling the development of a green Sukuk market[43].
- Large **domestic stabilization funds** can channel part of their reserves to help the government assume the **currency risk** of a project on behalf of the project developer, as for instance when a feed-in tariff (FiT) scheme is indexed to a foreign currency[44].
- If the SWF specializes in RE projects, as for instance UAE's Masdar, its engagement will serve as project validation, **improving investors' confidence** and further lowering financing costs.

Regional investments coming from the Gulf's SWFs[45] can be of particular importance, since taken all together they manage assets for a total value of over USD 2,000 billion[46]. Yet, investments in the energy sector of the Gulf's SWFs have often focused on lower risk investment in transmission projects or mature generation technologies[47]. The most active, UAE's Masdar, manages two clean tech funds totaling USD 540 million and has committed more than US USD 1.7 billion to renewable energy developments worldwide, and its renewable energy portfolio accounts for almost 68% of the Gulf's RE capacity and close to 10% of the world's installed CSP capacity[48].

---

[41] Kaminker (2013)

[42] Like development funds. In the Maan region, Jordan, the Kuwait Fund for Arab Economic Development Activities (KFAED) provided a grant of USD 120 million for a 66MW wind power, while the Abu Dhabi Fund for Development (ADFD) provided USD 150 million for a solar project.
In 2015 IRENA and the ADFD have collaborated to offer concessional loans worth USD 350 million to promote renewable energy projects in developing countries.

[43] Sukuk are tradable Islamic finance instruments representing an ownership in underlying assets or earnings from those assets. The growing Sukuk market is well-suited to channel capital to fund renewable energy and climate change projects (PwC, 2015b)

[44] As an example, in the Ouarzazate Noor 1 CSP project Morocco denominated the PPA in dollars and euros, with Moroccan Agency for Solar Energy (MASEN) taking the currency risk. Nelson D., 2014

[45] Other funds established in the region with the specific aim of providing financing to low carbon projects are the smaller Algerian National Fund for Renewable Energy and Cogeneration (FNER), financing newly introduced feed-in tariffs schemes by using 1% of oil royalties, and the Moroccan Energy Development Fund (EDF) with a total capital of USD 1 billion.

[46] SWF Institute (2015)

[47] The Abu Dhabi Investment Authority (AIDA), the largest SWF, has for instance a long-term and relatively high risk profile, but its investments in the energy sector are small-stake in utilities such as gas and electricity transmission and distribution in developed countries.

[48] Masdar (2015).

Compared to current investments (only three invested in RE projects, as table 2 shows) **SWFs have a greater unexploited potential**. In order to increase SWFs support for low carbon technologies, a pivotal role should be played by national governments which aim at removing barriers in the investment environment (policy de-risking). In this regard, the development of Private-Public Partnerships (PPPs) can increase the attractiveness of investments for SWFs by enabling them to assume only the project risk. In 2010, for instance, the InfraMed infrastructure fund was established to attract private capital of the Gulf's SWFs towards energy infrastructure projects in the MENA region[49]. Furthermore, a reliable and stable regulatory framework could be fostered by EU-sponsored institutions such as MEDREG and Med-TSO.

Table 2: Current RE investments by Gulf SWFs[50]

Kuwait Investment Authority 592 billion	
Aim:	No declared strategy towards developmental or sustainability goals, but active if the viability and long-term returns are proved.
Investment strategy:	Longest-running, active and heterogeneous fund: relatively high risk profile in equity and fixed income assets mainly overseas.
RE Investments:	USD 149 million for a 65 MW wind farm in Jordan (2013).
Quatar Investment Authority 256 billion	
Aim:	Sustainable investment, since the objective is the diversification of the economy away from hydrocarbons.
Investment strategy:	Flexible investor.
Re Investments:	9.6% shareholding in Iberdrola (USD 2.8 billion)[51]. 2.2% shareholding in Energies DePortugal.
Abu Dhabi Mubadala Development Company 66 billion	
Aim:	Economic diversification and build-up of social and industrial infrastructure.
Investment strategy:	Long-term, capital-intensive investments, facing higher risk than AIDA.
Re Investments[52]:	60% of equity on a 100MW CSP plant, Shams 1 (USD 600 billion) 11MW Masdar City project (US$18-22 billion). 31% equity share in the Jordanian 117 MW Tafila Wind Project (USD 290 billion).

[49] Alloisio, Carraro (2015).
[50] SWF Institute (2015), Mao (2012).
[51] The acquisition went beyond simple financial interest since the deal comprised the establishment of headquarters in Qatar to evaluate new RE business opportunities.
[52] Masdar also provides capital as well as consulting services for 'Special Projects', risky projects due to remoteness and technical complexity such as micro-grid connected and off-grid PV Plants in the UAE, Mauritania and Afghanistan.

Conclusions

Significant opportunities exist in the MENA region to reduce CO2 emissions from the **decarbonization of the power generation sector**. This can be achieved first of all by improving the balance between fossil fuels in the current energy mix. With gas taking over dirtier fuels the region could achieve as high as 30% less carbon emissions[53]. Most importantly, the region will have to **deploy its huge renewable energy resources**, as estimates find that additional CO2 emission reductions could **total up to 120 million tons only thanks to solar PV** capacity scale-up by 2050[54].

This reflection provided an outline of the key drivers affecting generation cost considerations as well as broader economic incentives. For energy exporters, low hydrocarbon prices are reducing the opportunity cost of an already very cheap oil-based domestic consumption. Nevertheless, **sharp cost decrease of renewable technologies** such as photovoltaics and the **urgent need for energy subsidies reform,** will likely have a bigger impact on the profitability of renewable energies in the near future.

At the same time, policy and financial de-risking of utility scale projects, achieved for instance by establishing Public Private Partnerships, will be necessary to increase the much needed private investments. In this regard, important lessons can be drawn from the experiences of energy-importing countries such as Jordan and Morocco. Providing a de-risked framework is a necessary condition for **enabling the Gulf's Sovereign Wealth Funds (SWFs) to step in**. In fact, concerning project investment, the only cases in which two SWFs (Masdar from UAE and the KIA from Kuwait) took equity positions in large-scale projects date back to 2013 and were limited to one country (Jordan). Furthermore, concerning the provision of non-commercial funding, lessons can be learned and partnerships established with Development Finance Institutions (DFIs), particularly active in the region[55]. Finally, providing the **opportunity for investing in pooled instruments such as green bonds** will be an effective way to catalyze investments from those funds facing liquidity and size constraints.

[53] Khoury, (2012).
[54] IEA, (2014c).
[55] In late 2014 the International Financial Corporation (IFC), a member of the World Bank Group, for instance finalized a $207.5 million debt package to fund the construction of seven solar photovoltaic plants in Jordan, which became the largest private sector-led solar initiative in the MENA region.

References

Alloisio I., Carraro C. (2015). Public Private Partnerships for Energy Infrastructure: A Focus on the MENA Region, in *Public Private Partnerships for Infrastructure and Business Development.* Ed. Caselli *et al*., New York, Palgrave Macmillan.

BNEF, B. N. (2011). *Sun sets on oil for Gulf power generation.* Retrieved from: http://about.bnef.com/press-releases/sun-sets-on-oil-for-gulf-power-generation/

Carafa L., F. G. (2015). Electricity transition in the Middle East and North Africa. *Journal of Cleaner Production*.

Deutsche Bank. (2015a). *Markets Research on Solar Photovoltaic.* Retrieved from: https://www.db.com/cr/en/docs/solar_report_full_length.pdf

Deutsche Bank. (2015b). *GCC in times of cheap oil.* Retrieved from: http://wn.com/deutsche_bank_ag

EIA (2014). *Saudi Arabia uses largest amount of crude oil for power generation since 2010.* Retrieved from: http://www.eia.gov/todayinenergy/detail.cfm?id=18111

Energy Intelligence (2015). *Rivalry Grows Between Renewables, Cheap Fossil Fuels.* Retrieved from: http://www.energyintel.com/pages/login.aspx?fid=art&DocId=875800

IEA (2015). *Oil Market report.* Retrieved from: https://www.iea.org/media/omrreports/fullissues/2015-10-13.pdf

IEA (2014a). *Emissions From Fuel Combustion Highlights.* Retrieved from: https://www.iea.org/publications

IEA (2014b). *Kuwait Country Profile.* Retrieved from: http://www.eia.gov/beta/international/analysis.cfm?iso=KWT

IEA (2014c). *Technology Roadmap Solar Photovoltaic Energy.* Retrieved from: https://www.iea.org/publications

IEA (2015). *Key Natural Gas Trends.* Retrieved from: http://www.iea.org/publications/freepublications/publication/KeyNaturalGasTrends.pdf

IMF (2014). *Regional Economic Outlook Update Middle East and Central Asia: Statistical Appendix.* Retrieved from:

IMF (2015a). *Learning to Live With Cheaper Oil Amid Weaker Demand.* Retrieved from: http://www.imf.org/external/pubs/ft/reo/2015/mcd/eng/mreo0115.htm

IMF (2015b). *How Large Are Global Energy Subsidies?* Retrieved from: https://www.imf.org/external/pubs/cat/longres.aspx?sk=42940.0

IRENA. (2014a). The Pan Arab Renewable Energy Strategy for 2030. Retrieved from: http://www.irena.org/DocumentDownloads/Publications/IRENA_Pan-Arab_Strategy_June%202014.pdf

IRENA. (2014b). *Renewable Power Generating Costs.* Retrieved from: http://www.irena.org/documentdownloads/publications/irena_re_power_costs_2014_report.pdf

IRENA. (2015a). *Global Energy Atlas*. Retrieved from: http://irena.masdar.ac.ae/

IRENA. (2015b). *The Age of Renewable Power.* Retrieved from: http://www.irena.org/DocumentDownloads/Publications/IRENA_PST_Age_of_Renewable_Power_2015.pdf

IRENA. (2015c). *Renewable Energies Prospects: United Arab Emirates.* Retrieved from: http://www.irena.org/remap/irena_remap_uae_report_2015.pdf

Kaminker, C. e. (2013). *Institutional Investors and Green Infrastructure Investments.* OECD Working Papers on Finance, Insurance and Private Pensions. No35.

Khoury, E. (2012). *Carbon Footprint of Electricity in the Middle East*. Retrieved from: http://www.carboun.com/energy/carbon-footprint-of-electricity-in-the-middle-east/

Masdar. (2015). *Clean Technology Investments*. Retrieved from: http://www.masdar.ae/en/investment/about-masdar-capital

Mills. (2012). *Sunrise in the Desert. Solar Becomes Commercially Viable in the MENA.*

Retrieved from: https://www.pwc.com/m1/en/publications/solar-in-the-desert-in-collaboration-with-emirates-solar-industry-association.pdf

Monnin, P. (2015). *The Impact of Interest Rates on Electricity Production Costs.* Retrieved from: http://www.cepweb.org/wp-content/uploads/CEP_DN_Interest_Rates_Energy_Prices.pdf

Nelson D., S. G. (2014). *Finance Mechanisms for Lowering the Cost of Renewable Energy in Rapidly Developing Countries.* CPI Series .

PwC. (2015a). *Developing renewable energy projects: A guide to achieving success in the Middle East.* Retrieved from: https://www.pwc.com/m1/en/publications/documents/eversheds-pwc-developing-renewable-energy-projects.pdf

Ramadhan M., H. A. (2013). The Prospect of Solar Energy in the Development of Power Stations in the State of Kuwait. *Journal of renewable Energy*.

RECREE, R. C. (2015). *Arab Future Energy Index.* Retrieved from: http://www.rcreee.org/projects/arab-future-energy-index%E2%84%A2-afex

REN21. (2015). *Renewables Global Status Report.* Retrieved from: http://www.ren21.net/status-of-renewables/global-status-report/

Schmidt, T. (2014). *Low-carbon investment risks and de-risking.* Nature Climate Change. Retrieved from: http://www.readcube.com/articles/10.1038%2Fnclimate2112

SWF Institute. (2015). *Sovereign Wealth Fund Rankings*. Retrieved from: http://www.swfinstitute.org/sovereign-wealth-fund-rankings/

World Bank. (2015). World Development Indicators. Retrieved from: http://data.worldbank.org/data-catalog/world-development-indicators

World Energy Council. (2013). World Energy Scenarios: Composing energy futures to 2050.

Retrieved from: https://www.worldenergy.org/publications/2013/world-energy-scenarios-composing-energy-futures-to-2050/.