Sustainable Development and Renewable Energy in the MENA Region: Analytical Framework

Dr.Hanan Hamed M. Sileem
Lecturer at Economics Department,
Sadat Academy for Management Sciences,
hanan@sadatacademy.edu.eg

Abstract
Development of the renewable energy industry has become a priority over recent years for the MENA region for many reasons, most importantly to mitigate climate change while achieving sustainable development. Empirical Literature has indicated that there are in place several approaches for mitigation and adaptation measures; however the selection for the appropriate methodology for developing economies differ from those economies in a higher level of development. The current paper focuses on analyzing the most relevant and cost effective renewable energy projects to the MENA region using SWOT analysis approach. In addition, there are less expensive methods for mitigation that help economies to lower climate change cost. The paper highlights the opportunities and threats for Recycling in MENA region, with a special focus on Egypt. Finally, it is clear from the analysis that what determines and guides the switch for renewables is the available natural resources as well as the available awareness in the country towards sustainable development and environment.
Keywords: Renewable energy, SWOT analysis, recycling, sustainable Development

Introduction

Climate change is an eminent issue for both developed and developing economies. The current international climate agreements have put in motion several environmental legislations to combat fossil fuel, e.g. Kyoto Protocol. In particular, the protocol placed a clean development mechanism (CDM) that enables funds for friendly environment projects to promote sustainable development in developing economies. The possibility of financing clean projects and allowing their potential impacts on sustainable development includes several opportunities.

Of all Kyoto flexible mechanisms, the CDM stands out as the most important mechanism to the current research. First, it is the only mechanism that allows developing economies to participate in the climate arrangements and negotiations. Second, CDM targets promoting sustainable development in developing economies, who cannot afford addressing their climate commitments with their fragile institutions at that time through; (i) transfer and production of clean technology using more financial resources; (ii) stimulating domestic health benefits by having cleaner air and water; (iii) promoting environmental awareness (iv) generating employment in new small and medium enterprises; (v) enhancing energy efficiency (directly and indirectly); (vii) upgrading public and private sector capacity (Olsen, 2007).

However, Energy Efficiency technologies namely co-generation; combustion control; waste heat recovery; fuel switching and Renewable energy are identified as priority clean technologies for CDM in developing economies (Moomaw et al, 2011). Over the first commitment period 2008-2012, CDM potentials to reduce GHG emissions particularly in fast growing developing economies were expected to range between 150 and 250 million ton of CO_2e (equivalent) per year mainly through energy efficiency, renewable energy and fuel switching (Tellier, 2006). In particular, China alone was expected to reduce around 30-40 % of this figure (UNEP Risoe Center, 2015).

Nevertheless, the real contribution of CDM on sustainable development through energy efficiency and fuel switching remain unsatisfactory. On one hand, HFC gas destruction projects amounted to the largest GHG reductions. On the other hand, renewable energy is the largest in number, around 71% of the CDM projects are renewables because their GHG reductions are accompanied by direct financial saving (UNEP Risoe Center, 2015). Although these projects generate less overall reductions than gas capture because of the relative lower climate impact associated with other GHG in comparison to CO_2.

In general, Energy diversity helps to maintain a sustainable supply of fuels for electricity generation that protects consumers from possible fluctuations in price or quantity supplied (Matek & Gawell, 2015). However, the overall sustainable development benefits of renewable projects are arguably much higher particularly in fast growing economies such as China (UNEP, 2010). Moreover, CDM have potentials to reduce GHG emissions particularly if these benefits are associated with other indirect benefits that occur through promoting rural development, energy access and capacity building (Tellier, 2006).

The sustainable development benefits involve a change in usual lifestyles that is reflected on re-shaping the standard form of living and doing business and developing industry. A good example is the restructuring of the agriculture sector in China. China has witnessed great progress in the reduction of GHG emissions in agriculture and the countryside in recent years. In 1200 counties across the country, scientific application of fertilizers and renewable energy technologies are being vigorously developed, such as the use of marsh gas, solar energy and stoves that save on firewood and coal.

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By the end of last decade, there were over 26.5 million households in China using marsh gas, saving annually around 16 million tons of standard coal, with reduction in 44 million tons of CO_2 emissions.

Furthermore, China has constructed 26,600 breeding farm marsh gas projects, and installed 42.86 million sq m of solar-powered heaters in the countryside, 14.68 million sq m of solar energy houses, 1.12 million solar energy stoves and more than 200,000 small wind-driven generators. China has installed firewood- and coal-saving stoves in 151 million households and energy-saving stoves in 34.71 million households (China National Statistical Bureau, 2011). To date, China has in place renewable energy technologies that mount to 1676 energy projects spread across the Chinese provinces; classified into156 biomass, 1352 wind, 2 geothermal, 4 mixed renewable, 162 solar energy projects. According to UNEP, China is a leading economy in utilizing renewable energy forms. So, it is possible to develop while diversifying energy sources with more renewables and less fossil fuel (UNEP Risoe Center, 2015).

Renewable energy forms

There are many forms of renewable energy. Most of the sources of renewable energies often depend on sunlight. For instance, Wind and hydroelectric power are the direct result of differential heating of the Earth's surface which leads to air moving with forming precipitation as the air is lifted. In addition, solar energy generated due to direct transfer of sunlight using panels or collectors. Wind, solar and hydropower are used to generate electricity. Moreover, Biomass energy is the stored sunlight contained in plants.

However, there are some forms of energy that does not perquisite sunlight. For example, geothermal energy, which is a result of radioactive decay in earth's crust combined with the original heat surrounding Earth; finally, tidal energy, which is a conversion of gravitational energy. Geothermal and biomass energy can be controlled to contribute to both heat and electricity generation. Solar thermal energy is generally used for water and space-heating (Sustainable Energy Authority of Ireland, 2013). For instance, Table (1) provides a sample of expected energy supply in terms of generating electricity for many renewables compared to nuclear and fossil fuel sources (Moomaw et al., 2015)

Table 1: Global Total Primary Energy Supply In 2008 Using Different Primary Energy values in Exajoules (EJ)

Energy source	EJ	%
Fossil fuel	418.15	81.41
Nuclear	29.82	5.81
Renewable:	65.61	12.78
Bioenergy	50.33	9.80
Solar	0.51	0.10
Geothermal	2.44	0.48
Hydro	11.55	2.25
Ocean	0.00	0.00
Wind	0.79	0.15
Other	0.03	0.01
Total	513.61	100

Source: Moomaw et al. (2011)

The GHGs emissions for the energy sector are associated with liquid fossil fuels such as gasoline, diesel, kerosene, heavy fuel oil and aviation fuel as well as solid fuels such as firewood, charcoal and coal. An additional source of emissions is diesel-generating power plants serving isolated areas. Switching to cleaner and renewable energy sources such as wind power and run-of-river hydro-power. Replacement of diesel generator power supply with mini-hydro is also applicable (UNEP, 2010).

However, Biomass is particularly useful for the heat sector, e.g. biomass-based district heating, wood chip boilers, but can also be used to generate electricity as indicated in Table (1). Biomass is defined as the biodegradable proportion of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, including fisheries and aquaculture, and the biodegradable fraction of industrial and municipal waste. Energy from biomass, including organic waste, is referred to as bioenergy. When plant material is burned for energy purposes, carbon dioxide is released. However, because new plant growth absorbs the amount of released CO_2 on combustion, bioenergy is considered to be ‘carbon neutral’.

Liquid biofuels are compressed gaseous fuels and used for a transport fuel; it is produced from biomass, e.g. biomethane. Biomethane is a biofuel which can be injected into the natural gas grid to complement or substitute natural gas. Biomethane is derived from biogas produced through anaerobic digestion (e.g. in a reactor or at a landfill). Prior to injection into the natural gas grid or to use as vehicle fuel, biogas must undergo an upgrading process, where all contaminants, e.g. CO_2 are removed and the percentage of methane is increased from the usual 50-75% to more than 95%. Research on the production of biomethane from various biomass sources such as grasses, crop residues, and municipal solid waste is still ongoing. A number of conversion techniques used to produce biodiesel, bioethanol and biomethane. Bioliquid sources include vegetable oils (rapeseed, soya and palm), animal fats and used cooking oils. The liquids may be used to produce heating, cooling and electrical energy. Liquid biofuels can be incorporated as blends with petrol/ diesel fuels or used on their own as a replacement fuel (Sustainable Energy Authority of Ireland, 2013).

Many theoretical and empirical literatures have anticipated the expected reduction of carbon emissions from renewable energy (Moomaw et al., 2011). Every source of these renewables has a low environmental cost with the exception of hydroelectric form; however, every energy form is significantly more expensive than fossil fuel; in addition, none of these forms is sufficiently available to immediately replace the fossil fuel. That is why many developing economies needed international funding mechanism such as CDM to get involved in clean projects. Table (2) shows current number of CDM projects in less developed economies.

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Table 2: CDM Projects In Major Regions in the World in 2010 and 2015				
Region	**Number of projects in 2010**	**Percentage in 2010**	**Number of projects in 2015**	**Percentage in 2015**
Asia and Pacific	4373	79.1%	6987	81.9%
Latin America	889	16.1%	1108	13%
Africa	143	2.6%	240	2.8%
Middle East	63	1.1%	108	1.3
Europe and Central Asia	61	1.1%	86	1%
Less Developed economies	5525	100%	8529	100%

Source: UNEP Risoe Center (2015).

MENA Region Experience

The MENA region is dominated by the Sahara and Arabian deserts, yet it has important solar resources, which provide an excellent basis to build a renewable energy market. Table (3) provides the renewable projects placed and financed by CDM in MENA region in 2015.

Table 3: Renewable projects in the MENA Economies in 2015					
Country	**Biomass energy**	**Solar**	**Hydro**	**Wind**	**Total renewable energy projects**
Iran, Islamic Republic	0	0	2	1	3
Kuwait	0	0	0	0	0
Morocco	3	2	0	7	12
Qatar	0	0	0	0	0
Syrian Arab Republic	0	0	0	0	0
UAE	0	0	0	0	0
Bahrain	0	0	0	0	0
Lebanon	0	1	0	0	1
Saudi Arabia	0	1	0	0	1
Libya	0	1	0	0	1
Tunisia	1	1	0	2	4
Iraq	0	0	0	0	0
Yemen	0	0	0	0	0
Djibouti	0	0	0	0	0
Oman	0	0	0	0	0
Jordan	0	0	0	0	0
Egypt	2	0	0	4	6

Source: UNEP Risoe center, (2015).

As indicated in Table (3), Morocco and Egypt are leading the region in renewable projects, yet there are still opportunities, weakness, threats and strength points in their renewable energy policies. For instance, in the Egyptian case, Hydropower has played a role in electricity generation in Egypt for decades due to the Aswan Dam which produces 15,300 GWh a year, almost 5-10% of Egypt's annual energy needs. As 85 percent of Egypt's hydroelectricity potential has already been developed, there are still opportunities for tidal and solar energy due to its location, geography and climate. Egypt has an average level of solar radiation between 2,000 to 3,200kWh per sq m a year, providing a promising opportunity for using this form of renewable energy. To date, however, setting up solar projects has been slow due to high capital costs. In 2010, Egypt's only major solar power project was placed in Kuraymat. The factory is mixed renewable energy source; it has a 140MW solar thermal combined with cycle power plant of which 20MW is from solar energy (Ministry of Environment and Protection of Nature, 2015).

Since the establishment of Egypt's New & Renewable Energy Authority (NREA) in 1986, to act as a dedicated focal point for developing and promoting renewable energy technologies on a commercial scale; a number of governmental organizations have been set up to help promote and develop policies to encourage the growth of the renewable energy industry.

Egypt has a competitive and comparative advantage for potential implementing the energy efficiency in different sectors due to its cheap labor, and tax exemptions for investment projects and having potential areas for proposed CDM projects in fuel-switching and agricultural sectors which can include improved combustion processes, solid waste management and waste digestion. These factors are reflected in favored low Marginal Abatement Costs (MAC) to attract more clean investments (Koths & Sterk, 2006).

Egypt also has huge renewable energy sources, e.g. wind energy. Currently, the Red Sea region hosts four projects generating wind energy in Suez (UNEP Risoe Center, 2015). In addition, in the Zafarana area, there is a wind farm generating 360 MW; it is the largest wind farm in the continent (Amereller, 2015). Waste digestion might be another promising area for clean technology investment in Egypt that is expected to result in annual GHG reductions around 2 Million Tons.

However, total benefit from clean environment is not yet achieved in Egypt due to several economic and financial barriers; for instance, the lack of enforcement of legislation; the insecurity in doing business; lack of funding; as well as lack of transparency in the carbon market prices. In addition, there is lack of reliable information on biomass due to a shortage in local expertise, and manufacturing companies dedicated to bioenergy systems existing in Egypt. Furthermore, pricing policies do not take into account the high environmental costs of traditional energy sources compared to Renewables. Finally, there is a need to increase awareness among various institutions and communities to ensure the involvement of people in adopting clean technique (El-Dorghamy, 2007).

Egypt's current energy strategy regulated by resolution in February 2008 targets a 20% increase in the share of renewable energy of Egypt's energy mix by 2020. This target is expected to depend on financing more wind power projects to increase the share of wind power in total electricity generation to reach 12 percent. This expected to generate a wind power capacity of about 7200MW by 2020 (Ministry of Environment and Protection of Nature, 2015). In December 2014, Egypt has enacted a new Renewable Energy Law (Law 203/2014) which is a major step towards establishing a comprehensive legal framework for renewable energy projects (Amereller, 2015).

SWOT Analysis for Renewable Energy Sources

A strategic evaluation for the possibilities embodied in renewables can briefly be described through a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis approach, which is presented in Table (4). The SWOT analysis is a strategic management approach to analyze situations into four components, namely Strengths, Weakness Opportunities, and Threats. This analysis provides an overall assessment of the internal and external environments surrounding the subject of the analysis. The SWOT matrix is only presenting an example of a game of cooperation where host countries and all relevant parties win, i.e. respecting the environmental integrity of local and international communities in order to avoid dangerous, possibly irreversible and self-reinforcing climate changes. Thus, the analysis underlines the strengths and opportunities that can be used to overcome the weaknesses and eliminate the threats facing the MENA economies.

Table 4: SWOT analysis For Renewable resources in MENA region

Strengths	**Weaknesses**
• Large market size • Open investments policies • Promote Low carbon industries • Expected CO_2 reductions (empirically suggested and examined). • Promoting small and medium sized business. • Solar energy potentials • Wind and tidal energy potentials	• Low absorptive capacity of technological transfer • Low spending on R & D • High levels of corruption • Lack of transparency • Lax enforcement of environmental laws • Weak institutions • Lack of accurate pollution measuring systems in the cities • Lack of awareness
• Available natural resources • Access to financial resources (CDM of Kyoto Protocol) • A growing International interest • Partnerships and civil initiatives. • Increasing social responsibility consumption. • Taking advantage of bulk municipal solid waste • Low cost actions, e.g. preventing wasted food; every tone of food waste prevented has the potential to save 4.2 tones of CO_2*	• Local resistance for adopting more clean technology projects (particularly where fossil fuel is abundant, oil exporting economies • Expensive cost of processing methods for some renewables. • High levels of risk; some processes can trigger further accumulation in GHG emissions, e.g.: 1. Emissions of fossil-derived carbon dioxide from the combustion of plastics and some textiles in incinerators; 2. Emissions of nitrous oxide during incineration of wastes; 3. Emissions of fossil-derived carbon dioxide from operations of collection, transportation and processing wastes.
Opportunities	**Threats**

* The CO_2 impact would be equal to taking one in four cars off the road. Source: Developed by the Author

Promising Opportunities for Renewable Energy in the MENA region

There are some areas that have potentials on promoting rural sustainable development in MENA region in the industry sector that include:

- Replacing coal or diesel in boilers with biomass residues; lining steel pipes with rubber and sealing leakages to reduce steam losses; and installing pre-heat exchange units particularly for cement production.
- Use of electricity instead of diesel in load-haul-dump machinery; installation of conveyor belts for transporting ore instead of using trucks; using electric loaders; use of electric acid plant heaters instead of kerosene, etc.

In addition, the most common GHG emissions associated with the agricultural sector are CO_2, methane and nitrous oxide, produced from burning of savannas, field burning of agricultural residues, rice cultivation, animal waste, enteric fermentation and the use of fertilizers on agricultural soils. Opportunities for renewables projects in the agricultural sector can include:

- Use of coffee, floriculture, forest and other residues as feedstock in ovens and furnaces, or as feedstock in bio-digesters.
- Use biogases for energy generation from animal waste, and agricultural residues.
- Land-use mitigation by reducing fertilizer use or allowing zero tillage.
- Use of animal and human waste management for methane flaring.

Furthermore, possible renewable opportunities in transport can include; establishing an efficient public transport system, e.g. a bus transport project. For instance, (i) public bus and tram in Switzerland are both operated by electricity; (ii) The introduction of low-emission vehicles, particularly in a commercial context; (iii) Switching to fuels with lower emission factors, possibly including bio-fuels.

One of the most promising areas is Waste management; it involves sources of domestic and commercial/industrial solid waste, waste water and sludge. Commercial and industrial waste water include liquid waste from manufacturing factories, establishments such as hotels and restaurants, and residential premises. The growth of the urban population and the growth in economic activity in most sectors have resulted in an accumulation of domestic and commercial solid waste as well as commercial and industrial waste in urban areas. Anaerobic decomposition of organic waste at disposal sites is a major source of methane. Opportunities in waste management can include the following:

- **Establishing engineered landfills of untreated commercial and industrial waste** where methane emissions could be recovered, captured or controlled for electricity production for domestic or industrial use, or simply flared. This method actually promotes the production of methane. The gas can be flared on the spot to generate heat and electricity or processed to natural gas-like fuels.

  The disadvantages of landfill dumping include the need to large areas; furthermore it can contaminate soil and water, and emit climate-relevant methane, carbon dioxide and odors. In order to minimize the environmental damage, modern landfills are equipped with a waterproof ground layer and the means to capture the liquid that drips out of the waste as well as monitor its quality. Moreover, aeration is provided in an attempt to minimize methane.
- **Composting.** Avoiding methane from organic wastewater and solids by composting. Good quality garden and food wastes are segregated at source and composted, producing a reduced and stabilized residue of compost of sufficient quality to be marketed as a soil conditioner or growing medium in agriculture.
- **Anaerobic Digestion.** Like composting, this option produces a compost residue from source-segregated wastes for use in agriculture. The waste is digested in sealed vessels under air-less (anaerobic) conditions, during which a methane-rich biogas is produced. The biogas is collected and used as a fuel for electricity generation.
- **Incineration.** Options assessed include mass-burn incineration of bulk solid waste with and without energy recovery (i.e. electricity only or combined heat and power), refuse-derived fuel combustion and gasification. However, mechanical-biological treatment, refuse-derived fuel, recycling and organic composting can release around 150,000 t CO_2 eq. per year; while, incineration, which will set free around 480,000 t CO_2 eq. every year, three times more than refuse-derived fuel (Sustainable Energy Authority of Ireland, 2013)
- **Recycling.** Paper, glass, metals, plastics, textiles and waste electrical and electronic equipment are recovered from the waste stream and reprocessed to make secondary materials. For many materials the process of turning them back into useful raw materials is straightforward: metals are shredded into pieces or remelted almost indefinitely without any loss in quality; and glass is crushed into cullet; while paper is reduced to pulp and can be recycled up to six times. Plastics, which are made from fossil fuels, are somewhat different, although they have many useful properties; they are flexible, lightweight and can be shaped into any form (The Economist, 2007).

A number of recycling processes leads to negative fluctuations in GHG emissions. This means it avoids releasing emissions that would have been produced by other processes – for example (i) energy recovered from incineration avoids the use of fossil fuels elsewhere in the energy system; (ii) recycling avoids the emissions associated with producing materials recovered from the waste from primary resources; (3) use of compost avoids emissions associated with the use of any peat.

Policy Recommendations and conclusion

I) Personal actions and voluntarily initiatives pillar would involve

- **Voluntarily initiatives**. For example, planting one million tree initiative in USA. A growing number of non- profit websites are set to help organizations in developing their response strategies to the global warming (Dow & Downing, 2006). Another example for international initiatives is putting lights off worldwide on Earth Day; on that day people also close machines and electricity for an hour. This helps in promoting awareness about environment.
- **Promoting individuals involvement**. This means people get more involved into emission reduction and decrease their resistance to change to clean technology. For instance, people all over the world start to leave their cars and take public transportation to lower their daily emissions by their cars. People can donate or exchange old books, clothes, computers and excess building materials.

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- **Adopting and encouraging actions to reduce emissions in work place**; for instance, train employees on recycling practices prior to implementing recycling programs for separation of different types of wastes, i.e. trashes for plastic waste, other for paper and others for food leftovers to allow easy management for solid waste to reduce methane emissions. In addition, the reuse of office furniture and supplies**,** e.g. envelopes, file folders, and paper; as well as encouraging employees to reuse office materials rather than purchase new ones.
- **Education campaign on waste management** that includes an extensive internal web site, quarterly newsletters, daily bulletins, promotional signs and helpful reference labels within the campus of an institution**.** In Switzerland**,** they incorporate the information about the carbon emissions for each activity in the curriculum of 6-10 years old students.
- **Using solar power** might cost less than extending a power line to the grid for People living in remote locations without connections to the utility grid. This offers a power connection by the solar system to the electricity grid; its bill can be credited for any excess power may be produced.
- **Creating a Database for state incentives for Renewables and efficiency** that provides information about what each state, city, or utility offers as form of rebates, tax credits, or other financial incentives in each area to promote for the awareness and implementation of renewables at municipal level.

II) Promoting Social responsible production pillar.

Many producers are responding to the desires and demands of socially and environmentally responsible consumers. Theoretically, the domain of socially responsible consumption has improved over the years, as have socially responsible corporate programs in the marketplace; many people are (1) purchasing based on firms' corporate social responsibility (CSR) performance; (2) recycling; and (3) avoiding or reducing the use of products based on their environmental impact (Webb et al., 2008).

III) Promoting good governance pillar

The best way to reduce global warming is cutting down anthropogenic GHGs emissions associated with economic growth and increasing world population however, stopping the use of fossil fuels quickly, is not possible in a short term. On the one hand, replacing fossil fuel with CO_2-free renewable energies will be expensive and difficult and needs more time. On the other hand, effective solutions are developed world-wide to combat global warming including for example:

- **Exporting recyclable material to other developing nations**, especially China. The country has triggered over the last decade large amounts of raw materials; e.g. scrap metals, waste paper and plastics, all of which can be cheaper than virgin materials. In most cases, these waste materials are recycled into consumer goods or packaging and returned to Europe and America via container ships. With its hunger for resources and the available cheap labor, China has become the largest importer of recyclable materials in the world (The Economist, 2007).
- **Construction an efficient collection system of wastes,** e.g. setting up storage centers where recyclable and reusable materials collected by the street sweepers are stored prior to selling to junk dealers.
- **Geo-engineering** schemes propose solar radiation management technologies that modify or reflect incoming shortwave solar radiation back to space. Geo-engineering involves releasing sulfur in the atmosphere to reflect sunlight before it reaches the planet. Reflective films lay over deserts; white plastic islands over the ocean. Research on climate engineering may well be the best investment. Thermal panels covert the sun radiations into heat. Photovoltaic panels convert the sun radiations into electricity (Ming et al., 2014).
- **Nuclear power station** can involve launching an international project to develop safe nuclear power. Building nuclear power plant has zero GHG emissions. The advantage of using nuclear power includes replacing fossil fuel and reducing dependence on oil and gas imports. These power stations are less expensive to operate. However, this option has high health risk in the case of nuclear leaks or explosions (Downie et al., 2009).

In conclusion, the best effective policy to reduce GHG emissions is to spread public awareness about the potential gain from participating in less polluting activities and adopting new habits at work and in home. The situation is more complex for less developing economies, as they lack many features that could assist in sustaining their development on the long run. Local developers, stakeholders, and relevant parties should be more dedicated to promote for clean projects and management of solid waste as part of their social responsibility role. To sum up, economics is the study of human behavior; thus, sustaining development and changing to healthier environment depend on changing life styles and habits rather than availability of more finance.

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