Energy

Ibrahim Abdel Gelil
Farid Chaaban
Leila Dagher

I. INTRODUCTION

Access to affordable energy services is fundamental to human development and economic growth. The abundance of hydrocarbon resources in some parts of the Arab region has played a major role in the region's socioeconomic development in multiple ways. As in other regions of the world, the Arab energy system today is heavily dependent on fossil fuel resources. For energy-rich and energy-poor Arab countries alike, how energy resources are obtained and managed play a determining factor in governments' spending, balance of payments, energy security, environmental quality, and economic growth.

Today, the decisive role of the energy sector in fueling sustainable economic growth in the region has come under close scrutiny. Because oil and gas are global commodities, Arab economies remain exposed to market price volatilities and global demand, which in the past has caused immediate disruption to cash flows and government spending, while continuing to pose serious challenges to economic diversification and sustainable socioeconomic development. For energy-poor countries, dependence on imported fossil energy sources leaves them vulnerable to disruption in oil and gas supplies. Reducing the size of the energy bill in some of these countries continues to remain a major preoccupation of government officials, due in no small part to energy's significant burden on public finances.

In Arab countries today nearly 60 million lack access to affordable energy services. Without access to energy, their opportunities for economic development and improved living standards are severely constrained. The wide disparities in access to affordable modern energy services between different countries and between urban and rural populations within the same country aggravate inequality, worsen poverty, and threaten social stability.

The environmental impacts of the fossil fuel-based Arab energy system threaten the socioeconomic development gains of the past few decades and

FIGURE 1 OIL AND GAS CONTRIBUTION TO GDP IN SELECTED ARAB COUNTRIES (2008)

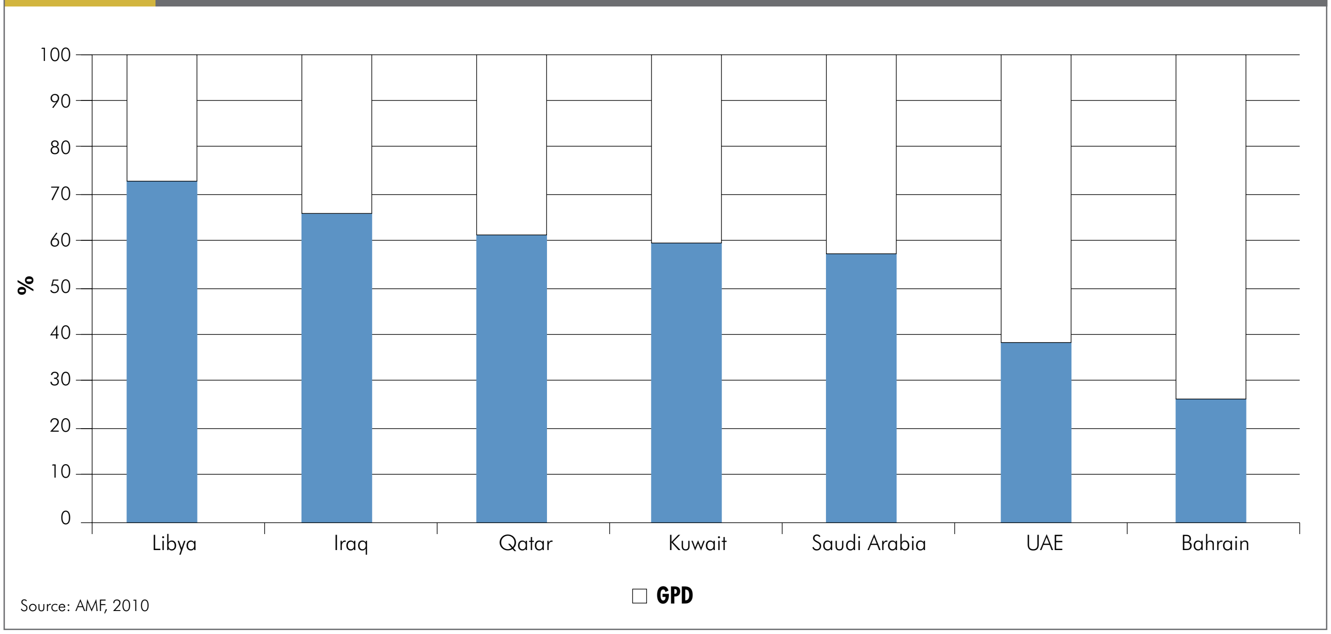
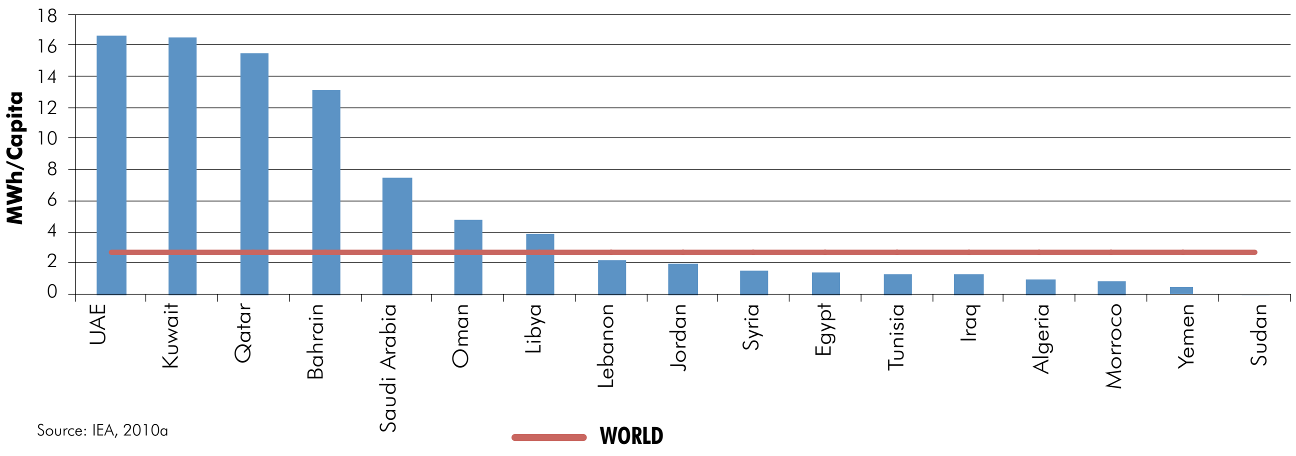


FIGURE 2 PER CAPITA ELECTRICITY CONSUMPTION IN ARAB COUNTRIES (2008)



Source: IEA, 2010a

contribute to local, regional and global ecosystem degradation. Human health is threatened by high levels of air pollution emissions from the burning of fossil fuels. Anthropogenic greenhouse gas (GHG) emissions, mostly from the production and use of fossil energy, are causing climate disruption, with serious impacts on agriculture, water availability, and infrastructure.

Alleviating poverty, mitigating climate change, and providing access to affordable and safe energy services without undermining economic development or ecosystems health will require drastic shifts in the Arab energy system. This chapter will describe current trends in the Arab energy system and propose a set of policies to shift to more sustainable patterns of energy production and consumption.

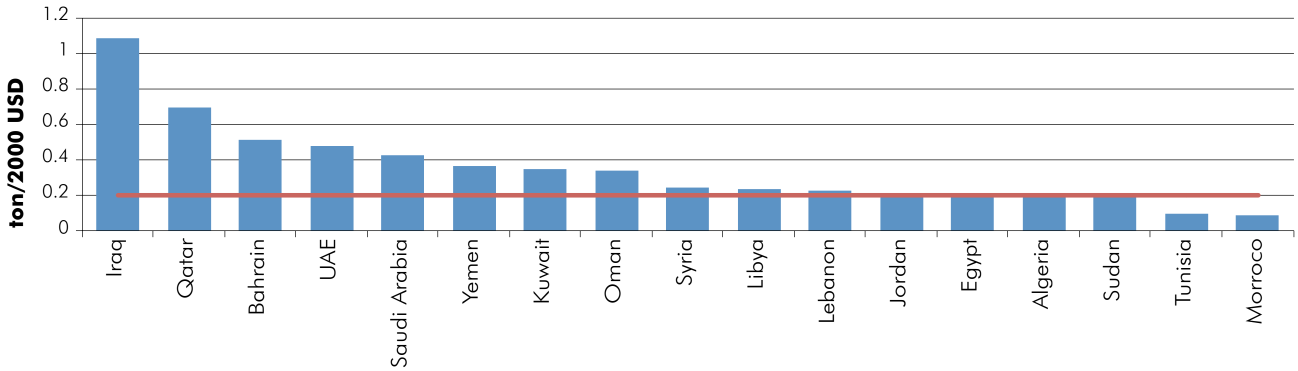
Given the large disparities in the Arab region, the transition to a green economy will vary considerably across different countries. Two groups of Arab countries could be considered in this context. The first are those countries which have attained high levels of gross domestic product (GDP) growth, but often at the expense of their natural resource base, reflected in high carbon intensity and large per capita ecological footprint. The challenge for these countries is to reduce their per capita ecological footprint without impairing their level of GDP growth. For those Arab countries that still maintain a relatively low per capita ecological footprint, the challenge is to achieve better human development without drastically increasing their ecological footprint.

II. CURRENT ARAB'S ENERGY SCENE

A. The Significance of the Energy Sector to Arab Economies

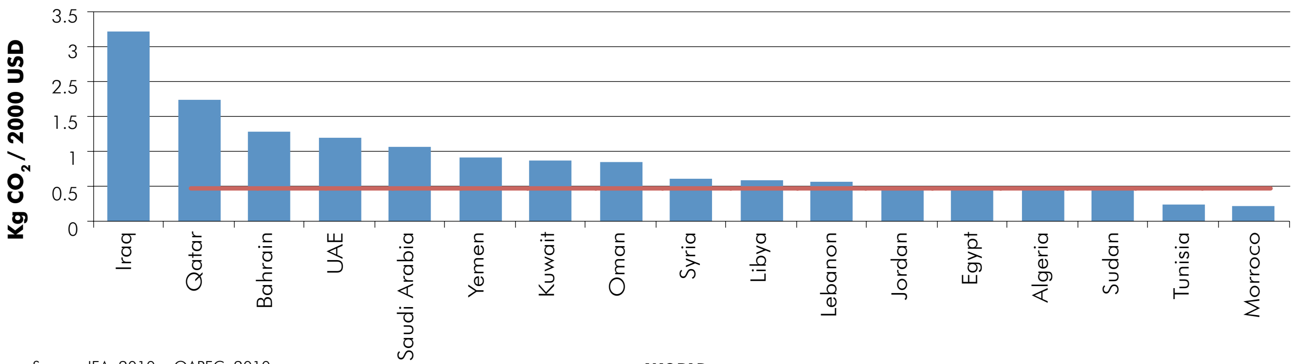
The energy sector in the Arab region has been and will continue to play a critical role in the region's socioeconomic development. Oil and gas revenues, estimated at US$571 billion in 2008 (AMF, 2010), have been the major source of income in most Arab countries, especially in the Gulf region. According to the Arab Monetary Fund (AMF), the oil and gas sector makes up about 38% of total Arab gross domestic product (GDP). The contribution of the oil and gas sector to the GDP of selected Arab economies is indicated in Figure 1. Additionally, the petroleum industry plays an important role indirectly in the social and economic development of many non-oil producing countries in the region, through workers' remittances, trade, and bilateral or multilateral aid projects (OAPEC, 2009). The Arab oil and gas sector represents the largest economic sector in countries of the Gulf Cooperation Council (GCC) and the region as a whole. Over the past three decades, the major oil and gas exporters in the region have witnessed an unprecedented economic and social transformation. Oil proceeds have been used to modernize and expand their infrastructure and improve human development indicators. The GCC countries in particular have become an important center for regional economic growth.

FIGURE 3 ENERGY INTENSITY IN SELECTED ARAB COUNTRIES (2008)



Source: IEA, 2010a; OAPEC, 2010

FIGURE 4 CARBON INTENSITY OF SELECTED ARAB COUNTRIES (2008)



Source: IEA, 2010a; OAPEC, 2010

According to the Organization of Oil Arab Exporting Countries (OAPEC), members' revenues from oil exports in 2009 totaled US$352.8 billion, a decline of 39.7% from the preceding year's revenue. The drop in revenues has forced some Arab countries to drastically slow down planned projects for expanding crude oil production capacity (OAPEC, 2009).

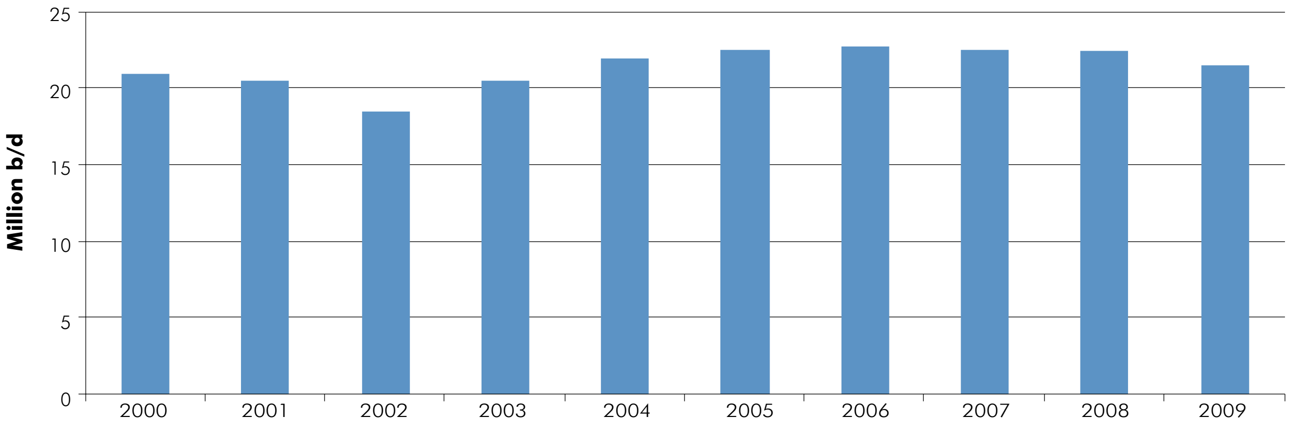
B. Major Energy/economy indicators

Per capita energy consumption varies greatly between oil producing and non-oil producing countries. The per capita consumption in Qatar is 18.8 tons of oil equivalent (toe), highest among Arab countries and four fold the average per capita consumption (4.56 toe) level of the Organization of Economic Co-operation and Development (OECD) countries (IEA, 2010a). Per capita energy consumption in 14 Arab countries is lower than the world average (1.83 toe). Although the Arab region is rich in energy resources, almost one-fifth of the Arab population relies on non-commercial fuels like wood, dung, and agricultural residues – to meet their daily heating and cooking needs, particularly in Comoros, Djibouti, Somalia, Sudan, and Yemen, as well as 5 to 10% in Algeria, Egypt, Morocco, and Syria (ESCWA, 2005).

Figure 2 indicates that the 2008 average per capita electricity consumption in Arab Countries (5343 KWh) was double the world average (2782 KWh). The per capita electricity consumption in the United Arab Emirates (UAE) and Kuwait was about 6 times that of the world average (IEA, 2010a).

The availability of fossil fuels at low production costs pushed oil-producing countries to invest in energy-intensive industries such as desalination, petrochemicals, and aluminum smelting. Figure

FIGURE 5 CRUDE OIL PRODUCTION IN ARAB COUNTRIES, 2000-2009 IN MILLION B/D



Source: OAPEC, 2005; OAPEC, 2010

3 indicates that the average primary energy intensity in the region is 0.45 toe per thousand, 2000 US$ (It means that energy intensity - total energy consumption per unit of GDP - is equal 0.45 Ton Oil Equivalent per one US$, using the value of US$ at year 2000) compared to a world average of 0.19 toe (IEA, 2010a; OAPEC, 2010). This is also reflected in carbon intensities, where the region is among the world's highest, as Figure 4 demonstrates.

C. Arab Energy Resources

Parts of the Arab region have some of the largest oil and gas reserves in the world, in addition to an abundance of renewable energy resources such as solar and wind. This section gives a brief account of these resources.

i. Oil

The Arab countries hold nearly 58% of the world's oil reserves (OAPEC, 2009). The proven oil reserves of Arab countries at the end of 2009 totaled 683.6 billion barrels, representing a 5.6% increase over 2000 (646.8 billion barrels). Proven reserves in the Kingdom of Saudi Arabia, estimated to be 264.6 billion barrels, ranks the Kingdom at the first place in the world. They constitute 38.71% of Arab reserves and 22.5% of world's aggregate reserves (OAPEC, 2005; OAPEC, 2010).

Crude oil production in Arab countries averaged 21.3 million b/d in 2009, a 6.5% decrease from 2008, but still accounted for 30% of world crude production (OAPEC, 2010). During the last decade, the average total daily Arab oil production was estimated to be 21.6 million b/d. Figure 5 indicates crude oil production in Arab countries over the period 2000-2009.

ii. Natural Gas

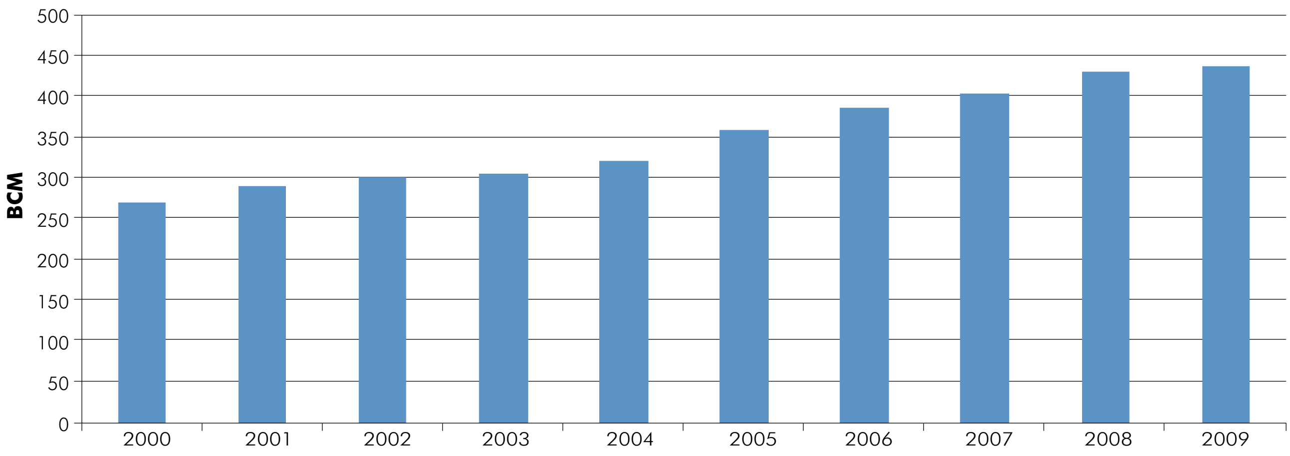
The Arab region holds nearly 29% of the world's gas reserves. Proven Arab natural gas reserves recorded a gain in 2009 compared to 2000. They increased from 36.91 to reach 54.48 trillion cubic meters (cum), representing 29.1% of world reserves. Qatar has the largest Arab gas reserves amounting to 25.4 trillion cubic meters, which represents 46.6% of Arab and 13.6% of world reserves, respectively (OAPEC, 2005; OAPEC, 2010). Further, Qatar is the fourth largest exporter of natural gas in the world and the largest exporter of liquefied natural gas (LNG).

The last decade has witnessed a steady growth of natural gas production in the Arab region. Figure 6 demonstrates an increase from 270.6 billion cubic meters in 2000 to 432.6 billion cubic meters in 2009 (OAPEC, 2010).

iii. Coal

The Arab region has limited coal resources and they are found in a small number of Arab countries, namely, Algeria, Egypt, Lebanon, and

FIGURE 6 MARKETED NATURAL GAS IN ARAB COUNTRIES (BILLION CUBIC METERS)



Source: OAPEC, 2005; OAPEC, 2010

Morocco. El-Maghara mine, located in the Sinai Peninsula in Egypt, is the only operating coal mine. Coal production in Egypt totaled 21.5 thousand tons in 2008 (IEA, 2010a). Morocco has plans to re-exploit coal from some of the country's closed mines. Total Arab consumption of coal was about 20.7 thousand tons in 2009, mainly in the steel industry (OAPEC, 2009).

iv. Nuclear

Nuclear energy is not part of any Arab country's mix of power generation, although plans are underway to contract with multinational consortiums for the procurement and construction of nuclear power plants. The United Arab Emirates signed an agreement with a consortium led by the state-owned South Korean Electric Power Corporation to supply four nuclear power plants, each producing approximately 1400 MW of electricity (WNA, 2011). The first reactor is expected to come online in 2017. Kuwait and France signed a cooperation agreement for the peaceful use of nuclear energy (UPI, 2010). Egypt has signed an agreement with Russia to pave the way for building the first mega nuclear power plant in the country, on a site west of Alexandria on the Mediterranean shore (OAPEC, 2009).

The Arab policy to invest in nuclear power needs to be scrutinized. The viability of Arab countries to manage the entire lifecycle of nuclear power is questionable. Critical safety issues remain to be resolved. Apart from the risk of accidents in nuclear power plants, nuclear waste storage and disposal is still unresolved, and would pose serious risk to public health because of the lack of local capability to manage this waste. International concerns about nuclear weapon proliferation associated with nuclear fuel cycle and uranium enrichment has resulted in global restrictions on these technologies, which would force Arab countries to rely on the international supply market for nuclear fuel even if local uranium reserves were available. In other words, Arab states would have to forego mining their own uranium reserves. Furthermore, local technical capabilities to build, operate, and maintain nuclear power plants in Arab countries is extremely weak, which raises major energy security and dependency concerns over the heavy reliance on foreign expatriate labor. In a region known to invest very little in research and development (R&D) relative to other regions of the world, it is improbable that Arab countries will be able to develop domestic human resource capability in nuclear science and engineering that will be able to transfer, adapt, and adopt nuclear power know-how anytime in the foreseeable future. In addition, local preparedness, response, and risk management systems are weak, which would compound the risk in the case of a nuclear accident. These arguments don't necessarily mean that Arab countries should completely dismiss nuclear power. Rather, Arab governments may still wish to consider investing in education and R&D capability in nuclear power technology in

THE CONCEPT OF ENERGY RE-USE

Mazen Bachir

The scarcity of clean water resources and the costs associated with potable water production (e.g., seawater desalination) have resulted in new market trends for water and wastewater treatment. These recent trends are focused heavily on the concept of energy re-use.

Membrane technology has been at the forefront of water re-use applications, given the high purity of product water achievable through the use of micro-filtration, ultra-filtration (wastewater re-use) and potentially nano-filtration.

This achievement, however, has come at the cost of higher energy demand. Despite traditionally low and subsidized energy costs in the Arab region, the associated cost of energy can, and should, no longer be ignored in a time of economic crisis, resource scarcity, and impending climate change disruptions.

While energy recovery technologies continue to improve the performance of water purification plants (e.g., seawater desalination applications), they are neglected in wastewater treatment, as the focus is solely on product water quality, with little regard to processing and operating cost.

The necessity to introduce the concept of energy re-use is justifiable in a time when energy costs are rising. Within the desalination industry, recent trends and technology advances have resulted in energy recovery systems coupled with high-pressure pumps. Pressure exchange devices are now used in reverse osmosis plants to ensure that the energy 'waste' embedded in the high-pressure reject stream is recovered. This would permit a lower energy demand that is needed to pressurize the feed stream, thus reducing overall energy consumption by as much as 30-35%.

While successfully implemented globally and in the Middle East and North African region, employing sludge digestion in wastewater treatment plants to recover energy has not yet been largely adopted. Sludge digestion is the treatment of the solid organic waste by-products generated from wastewater treatment. Digesting sludge and incorporating cogeneration technology results in lower volumes of solid waste by-products, while allowing the recovery of energy by thermally converting organically released gases. Sludge digestion allows the recovery of no less than 50% of the energy contained in digested organic matter.

Ideally, sludge digestion can be incorporated into a new plant design. However, sludge digestion can also be considered the most useful add-on for almost any existing wastewater treatment plant. The energy savings created by sludge digestion more than pay for the investment.

Among the benefits offered by sludge digestion are:

- Reduced sludge volumes and dry solids content.
- Enhanced biological treatment and plant capacity.
- Reduced odor and air pollution emissions.
- Stabilization of sludge, leading to easier disposal and/or easier down-stream treatment.
- Energy recovery, which can be used instantly on-site to reduce the overall power requirements.

Even in countries where energy costs are low, sludge digestion can still be used in advantageous ways, over and above those named above:

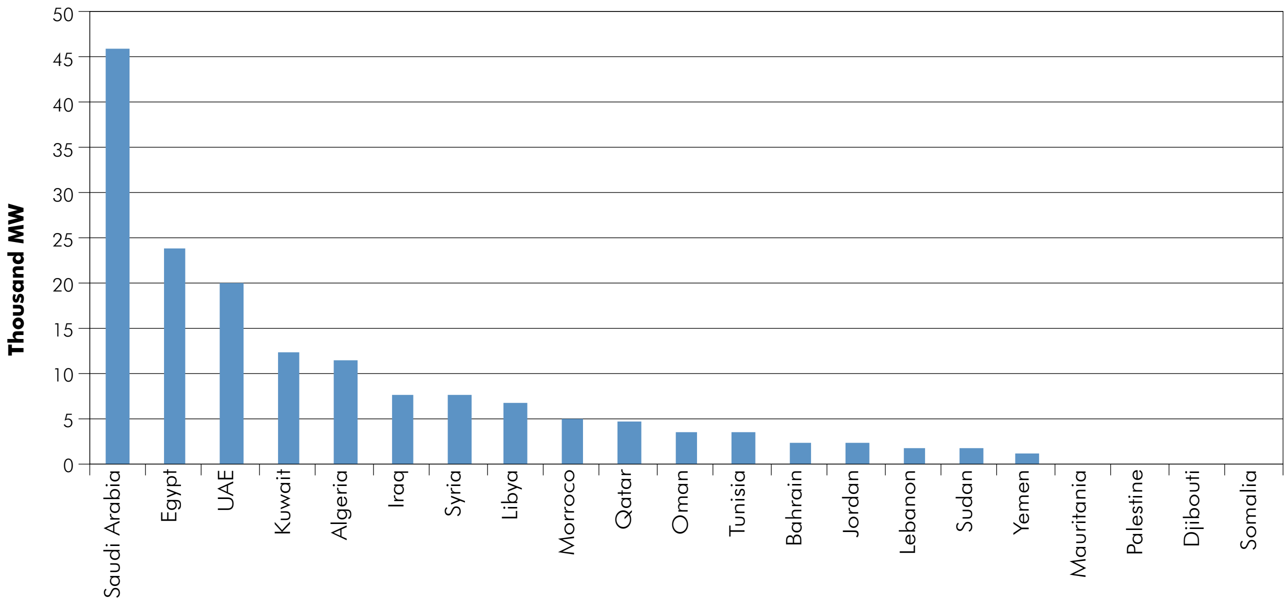
- Increasing plant capacity: By incorporating an external anaerobic digestion process, the biological capacity of existing plants can be increased. The oxygen requirements associated with the stabilization of sludge can be used for treating higher biological loads. Energy derived from digester off-gas can be used to partly power the plant itself.

- Enhancing sludge drying: Alternatively, should the energy derivation concept not be economically necessary, the heat generated from the digester off-gas can nonetheless be used to greatly reduce the area required by sludge drying beds, through enhanced solar heating of the sludge. This is especially attractive in countries with traditionally hot climates.

Mazen Bachir is Managing Director and Chief Technical Officer, Passavant-Roediger GmbH.

order to keep their long-term options open. As an alternative to nuclear power, Arab countries have the option to invest now in the huge potential of solar and wind power, and should strive to take a leading position in developing and deploying renewable energy technologies in the region and aspire to become major exporters of green energy. Nuclear energy might not be the most viable policy option for long-term energy supply or security in the Arab region.

FIGURE 7 INSTALLED CAPACITY OF ELECTRICITY GENERATION IN ARAB COUNTRIES IN 2009



Source: OAPEC, 2001; OAPEC, 2010

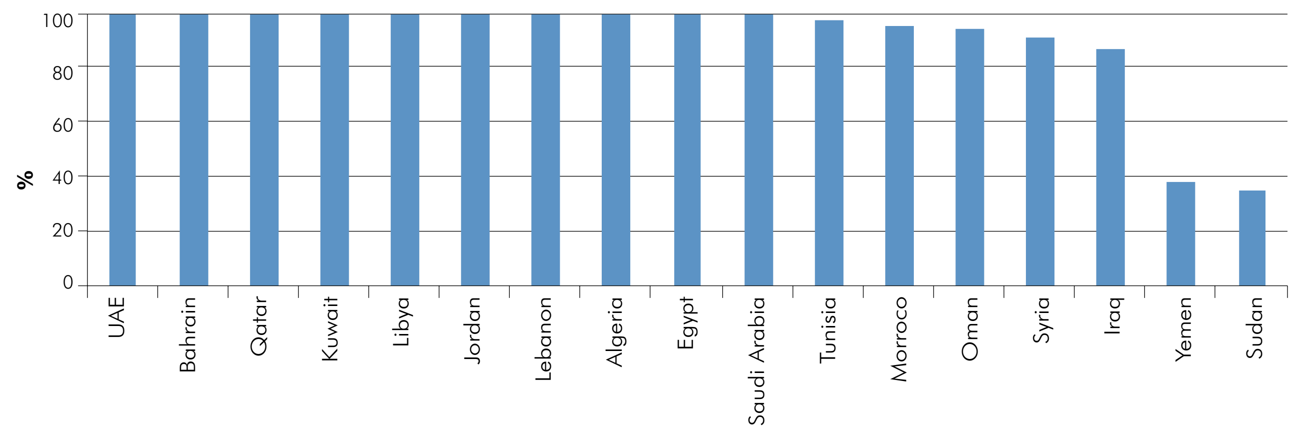
v. Renewable Energy Sources

The Arab region enjoys tremendous renewable energy resources. Arab countries have an installed hydroelectric power capacity of 10,683 MW (OAPEC, 2010). Large hydropower plants exist in Egypt and Iraq, while small plants exist in Algeria, Jordan, Lebanon, Mauritania, Morocco, Sudan, Syria, and Tunisia. The production of hydro electricity in 2008 reached nearly the equivalent of 21 TWh (IEA, 2010a).

Average wind speeds of 8-11 m/sec in the Gulf of Suez, Egypt, and 5-7 m/sec in Jordan have been recorded, making these locations suitable sites for power generation from wind. Grid-connected wind power at commercial scales of 550 MW and 280 MW have been installed in Egypt and Morocco (NREA, 2011), respectively, while stand-alone wind units are in use for small applications in Jordan, Morocco, and Syria.

A large part of the Arab region falls within the

FIGURE 8 ELECTRIFICATION RATES IN ARAB COUNTRIES (%) IN 2008



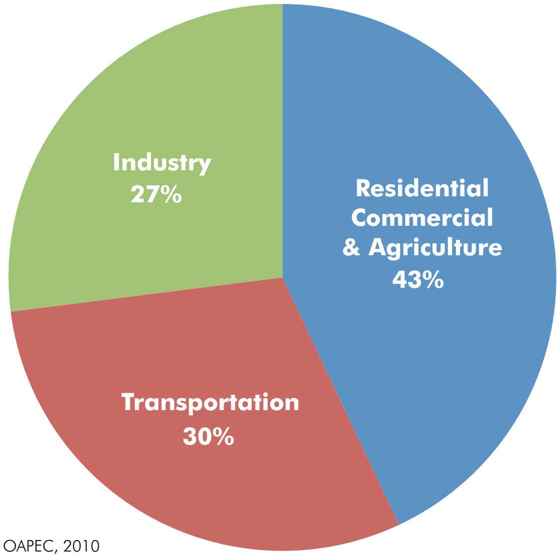
Source: UNDP, 2010

so-called 'sun belt,' which benefits from the most energy-intensive sunlight on the globe (in terms of both heat and light). Solar energy resources in Arab countries vary between 1,460-3,000 KWh/m²-year. Solar energy generation using photovoltaic (PV) technology is used in several standalone applications especially for water pumping, telecommunications, and lighting in remote sites. The largest PV program in the region exists in Morocco, where 160,000 solar power home systems have been installed in about 8% of rural households with a total capacity of 16 MW (Abdel Gelil, 2007). Photovoltaic pumping applications are relatively developed in Tunisia with a total existing peak capacity of 255 KW (Komoto et al., 2009).

Solar water heaters are achieving different degrees of market penetration, and are currently most successful in the residential and commercial sectors in Egypt, Jordan, Lebanon, Morocco, and Palestine. It should be noted that solar water heaters are mostly used in Arab countries that have relatively few or no hydrocarbon resources.

Saudi Arabia and North Africa have vast stretches of desert areas with abundant sunlight, which can be exploited for the production of solar power. To date, installed capacity of solar power remains negligible, with less than 3 MW of photovoltaic (PV) power in Saudi Arabia and a 10 MW installed capacity in the United Arab Emirates (UAE). There are no concentrated solar power (CSP) plants yet in the region, although some countries have announced plans to invest in CSP plants.

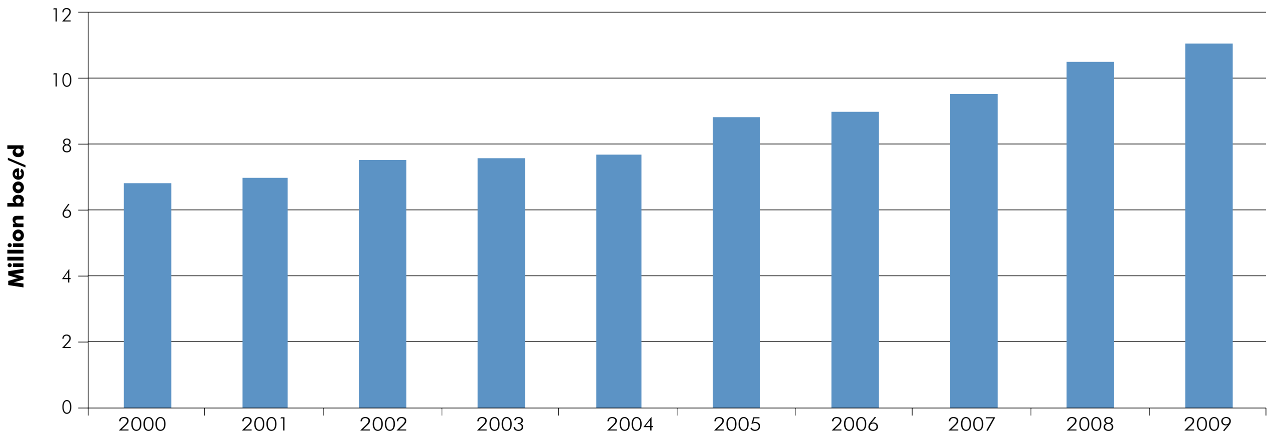
FIGURE 9 BREAKDOWN OF ENERGY CONSUMPTION BY SECTOR IN ARAB COUNTRIES



Source: OAPEC, 2010

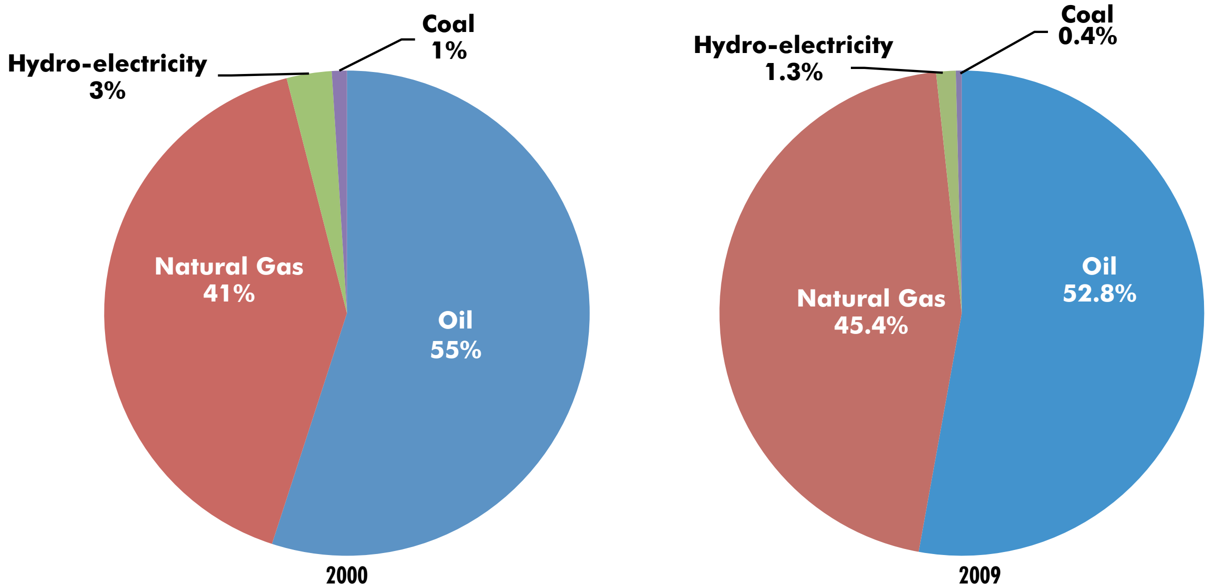
Construction is underway for a 100 MW Shams 1 solar thermal project in Masdar City. Masdar has also started the tendering process for a 100 MWp grid-connected PV plant in Abu Dhabi. In Saudi Arabia, King Abdullah Petroleum Studies and Research Center awarded the construction of a 3 MWp PV system and Aramco awarded a 10 MWp shade mounted PV plant located in Dhahran, which will be the largest shade mounted PV plant in the world.

FIGURE 10 GROWTH OF ENERGY CONSUMPTION IN ARAB COUNTRIES (MILLION BOE/D)



Source: OAPEC, 2005; OAPEC, 2010

FIGURE 11 CHANGE IN ENERGY CONSUMPTION PATTERNS IN ARAB COUNTRIES OVER THE PERIOD 2000-2009



Source: OAPEC, 2001; OAPEC, 2009

The government of Oman has launched a study for the development of a 150 MW solar plant. In Bahrain, the national Oil and Gas Authority (NOGA) is developing a project to install a 20 MW grid-connected solar PV system.

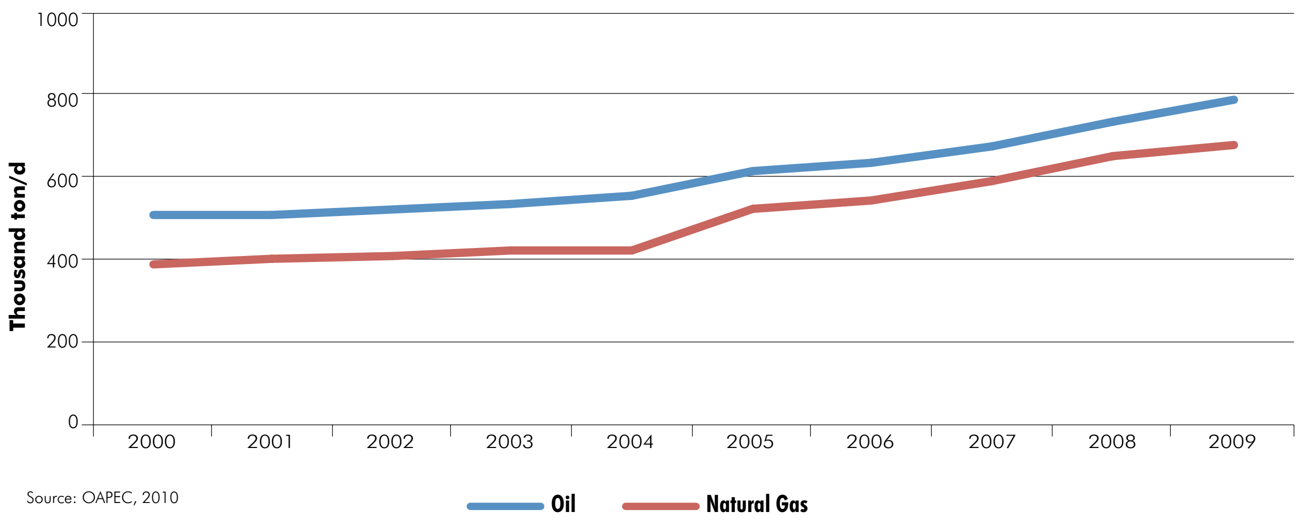
Furthermore, Egypt is commissioning a 140 MW integrated solar combined cycle (ISCC) power plant with a capacity of 120 MW combined cycle from natural gas and 20 MW from solar input, at Kuraymat near Cairo. Other ISCC hybrid plants are underway in Algeria and Morocco, and feasibility studies have been undertaken for an ISCC plant in Kuwait. Qatar has announced an ambitious but, as yet, unspecified plan for a US$1 billion solar project (Freshfields, 2010). Another project remarkable for its scale is a proposed US$9 billion Moroccan solar power initiative, which includes the installation of 2 GW of solar power capacity to meet 10% of Morocco's electricity demand by 2020 (Recharge, 2010).

In addition, plans have been proposed to generate solar electric power in Arab countries for domestic consumption as well as export to Europe. A group of companies from the European Union (EU) has founded the 'DESERTEC Industrial Initiative' (DII) to lobby for this initiative. DESERTEC aims to generate up to 550 GW of electricity over the next 40 years, from installations that will initially be located in Algeria, Egypt, Libya, Morocco, and Tunisia, and later on in the region stretching from Turkey through Jordan to Saudi Arabia (DESERTEC Foundation, 2011). An initial US$5.5 billion in funding was announced in December, 2009, by the World Bank's Clean Technology Fund. The power will be used to meet local demand, as well as for export to Europe, through high-voltage, direct current cables laid under the Mediterranean Sea (DESERTEC Foundation, 2011). Another important initiative is the 'Mediterranean Solar Plan,' designed to develop 20 GW of renewable electricity capacity by 2020 on the Southern Mediterranean, as well as the necessary infrastructures for electricity interconnection with Europe (ENPI, 2011). This was launched in 2008 within the scope of the 'Barcelona process: Union for the Mediterranean (UfM)'.

D. The Electric Power Sector

The electric power sector in the Arab region has been greatly developed in the course of the last decade and has contributed to its socioeconomic development. The total installed capacity has increased from 99,788 MW in 2001 (excluding Comoros and Palestine) to 165,203 MW in 2009 (excluding Comoros). Electric power

FIGURE 12 OIL AND NATURAL GAS CONSUMPTION IN ARAB COUNTRIES (THOUSAND TOE/D)



Source: OAPEC, 2010

generation is dominated by thermal power plants, which account for more than 93% of total installed capacity. As indicated in Figure 7, the highest installed electric power capacity is in Saudi Arabia (45,477 MW) followed by Egypt, and the lowest is in Djibouti and Somalia (80 MW) (OAPEC, 2010).

The rate of electrification in Arab countries is relatively high with Yemen and Sudan being the two exceptions, as indicated in Figure 8. Electrification rates in Arab countries are higher than the world average. Some oil-producing countries, such as the UAE, have electrification rates as high as 100% (UNDP, 2010).

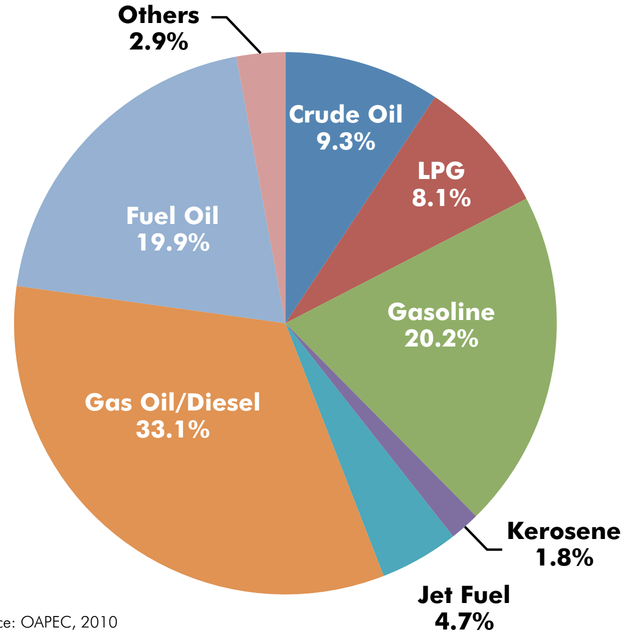
E. Energy Consumption

The rise in energy consumption and demand in Arab countries is driven by urbanization, increased economic activity, population growth, and industrialization. Arab countries rely heavily on oil and gas to meet domestic energy demand, accounting for nearly 98.2% of the total Arab energy consumption in 2009 (OAPEC, 2009).

As demonstrated in Figure 9, transport is the major energy-consuming sector in the Arab region, accounting for about 30% of total consumption, followed by the industry sector (27%) (IEA, 2010a). The residential, commercial, and agricultural sectors make up the remaining 43%. This pattern of energy consumption determines the major sources of GHG emissions, and in many instances, informs policy priorities and measures that will be needed to reduce such emissions.

The growth in domestic consumption in the region over the past decade is indicated in Figure 10. In 2009, total energy consumption amounted

FIGURE 13 BREAKDOWN OF PETROLEUM PRODUCTS CONSUMPTION IN ARAB COUNTRIES IN 2009



Source: OAPEC, 2010

ENERGY-SAVING LAMPS IN LEBANON

Pierre El-Khoury

On March 10, 2010, the Government of Lebanon approved the national action plan submitted by the Ministry of Energy and Water (MEW) to allocate US$9 million to finance energy conservation programs in the country. The allocation was diverted from a budget initially assigned to subsidize diesel fuel. One of the main goals of the plan is to replace, free of charge, 3 million incandescent lamps, with 3 million compact fluorescent lamps (CFL) in households across Lebanon, at a cost of US$7 million.

CFL lamps have been demonstrated to have lower power consumption than incandescent lamps while costing less over their lifetime. They also provide effective illumination. The replacement program will be part of an effort to phase out incandescent lamps. One million residential electricity subscribers, out of a total of 1.4 million, will benefit from this plan and will take part in this first-of-its-kind Clean Development Mechanism (CDM) project. The initiative is accompanied by an awareness campaign urging the public to adopt energy conservation measures.

The project is rolled out as per the Clean Development Mechanism (CDM) procedures in order to claim CO_2 reduction credits. The savings according to CDM calculations are 970 GWh of electricity, equivalent to US$181 million. CO_2 emissions will be reduced by 806,000 tons. In addition, the project will reduce the load demand by 160 MW of capacity at peak load. The reduction in peak load demand translates into crucial savings for the government's public budget. The public will benefit from reduced air pollution emissions as well as from lower energy bills.

Distribution of the CFLs has already started in October 2010, and will be completed in 6 phases. Public stakeholder consultation meetings have been conducted in each area of the country while simultaneously conducting an awareness campaign. The lamps are being distributed across Lebanon through municipalities and in collaboration with collectors of electricity bills at Electricité du Liban (EDL).

Pierre El-Khoury is Project Manager, Lebanese Center for Energy Conservation.

to 10.9 million barrels of oil equivalent per day (boe/d) compared to 6.8 million boe/d in 2000 (OAPEC, 2009; OAPEC, 2005).

As mentioned earlier, energy consumption in the region has been dependent on oil and natural gas, which account for about 98% of total energy consumption. Oil continues to be the main source of energy despite the increasing use of natural gas. Oil meets over half of the Arab countries' energy demand, accounting for nearly 53% in 2009. However, the last decade has witnessed a gradual shift to natural gas from 41% in 2000 to nearly 45% in 2009. However, the last decade has witnessed a gradual shift to natural gas from 41% in 2000 to nearly 45% in 2009 (OAPEC, 2001; OAPEC, 2009), as demonstrated in Figure 11.

Figure 12 indicates the trends in oil and gas consumption in the Arab region. During the past decade the average annual growth of oil consumption was 6.4% compared to 9.8 % for natural gas (OAPEC, 2010; OAPEC, 2005).

Consumption of petroleum products in Arab countries has reached 4.8 million b/d in 2009. Crude oil is still used directly as a fuel in power plants and refineries in several Arab countries, accounting for 9.3% of total petroleum products' consumption. Figure 13 indicates petroleum products consumption patterns in Arab countries (OAPEC, 2005; OAPEC, 2009). The transport sector is the major consumer of petroleum products, accounting for about 58% of total consumption.

F. Current Arab energy policies

As discussed earlier, relying heavily on fossil fuels means that current trends in the Arab energy sector are unsustainable. Achieving more sustainable patterns of energy production and consumption requires adopting green energy policies to minimize economic vulnerabilities, meet the rising demand cost-effectively, reducing air pollution, and addressing carbon emissions. This is well stipulated in the "The Arab Regional Strategy for Sustainable Consumption and Production" (LAS, 2009), which identified a set of strategic objectives, among which are improving energy efficiency, increasing the share of renewable power in the energy sector, and disseminating renewable energy technologies especially in rural and remote areas. The same strategy delineates a comprehensive list of needed policy interventions to achieve those objectives. These include, but are not limited to, introducing reforms in existing energy policies affecting regulations and incentives using subsidies, taxes, and pricing in order to internalize environmental and social costs, while maintaining energy subsidies for the poor; improving energy

AL-SHAHEEN OIL FIELD GAS RECOVERY AND UTILIZATION PROJECT

Nidaa Hilal

In many oil fields, large volumes of hydrocarbons are produced with crude oil when it is brought to the surface. This was true in Al-Shaheen field in Qatar, where much of the 300,000 oil barrels produced daily has a high proportion of this "associated gas" (AG). When the field, sitting 70 Kilometers off the northeast coast of Qatar, was built in 1992, there was little demand for gas. Thus, associated gas was usually burned off, in a process known as "flaring," which contributes to greenhouse gas emissions and climate change. Furthermore, flaring is a waste of resources and revenue. But demand for gas has grown ever since, and Qatar, being a top producer,ranked among the highest emitters of CO_2 per capita in the world.

Al-Shaheen field operations alone were responsible for 20% of Qatar's flaring, with only 3% of AG utilized for onsite consumption. In 2004, Maersk Oil Qatar (MOQ) and Qatar Petroleum (QP) launched Al-Shaheen Oil Field Gas Recovery and Utilization Project to be qualified under the Clean Development Mechanism (CDM). At the 2,214 square kilometer field lying over the North Gas Field, the world's largest, new facilities were installed for the gathering and delivery of AG to North Field Alpha platform, and its subsequent transfer to the Mesaieed gas processing plant. Since then, about 6.2 million cubic meters of AG is produced at the field daily, including dry gas, liquefied petroleum gas (LPG), and condensate. Of that amount, 3.5 million m^3/d is transferred to Mesaieed for local consumption and export, 850 million m^3/d is consumed onsite for power and heat generation, and only1.1 million m^3/d is flared.

To date, the project is Qatar's largest for reducing CO_2 emissions, cutting an average of 2.5 million tons of CO_2 per year. It is also contributing to the country's energy efficiency efforts by increasing power supply without raising fossil fuel consumption. Moreover, MOQ and QP believe they are setting a new mechanism for funding green technologies and encouraging development of clean-technology demonstration projects in Qatar and the Middle East.

Nidaa Hilal is writer at Al-Bia Wal-Tanmia (Environment & Development) magazine

efficiency, particularly in energy intensive industries, transport, and power generation; promoting large-scale development of renewable energy technologies; and supporting air quality management through better urban planning.

To achieve these objectives, the same strategy recommended a wide array of policies and measures to be considered by Arab countries in order to move towards a more economically and environmentally sustainable management of the energy sector. These policies and measures seek to:

- Increase access to energy for all communities mainly in rural and remote areas.
- Review existing energy policies and incentive measures, including energy tariffs to ensure the integration of environmental and social costs, and to support the sound management of the sector while maintaining energy subsidies for the poor.
- Promote investments in cleaner technologies for oil and gas exploration and production, and adopt measures for reducing the sector's environmental as well as social impacts.
- Promote intra-regional electric grid interconnections and natural gas network projects.
- Encourage private sector participation in the establishment and management of energy facilities, including power plants and distribution networks.
- Improve energy efficiency of energy production and consumption, particularly in energy intensive industries, transport, and power.
- Promote the production and use of cleaner fuels.
- Develop and promote the use of renewable energy technologies.
- Support the promotion of cleaner production in the energy sector.
- Support air quality management through better urban planning and land use, and the establishment of regional and sub regional systems and networks for sustainable transport and use of cleaner vehicles.

A partnership on energy for sustainable development (SD) has already been established

through the Council of Arab Ministers Responsible for the Environment (CAMRE) in close cooperation with regional organizations, including the Organization of Arab Petroleum Exporting Countries (OAPEC), the United Nations Environment Program (UNEP), and the United Nations Economic and Social Commission for Western Asia (UN-ESCWA).

Similarly, the Arab Economic and Social Development Summit held in Kuwait in 2009 has exclusively stressed the promotion of Arab cooperation in the field of energy, particularly in improving energy efficiency, supporting energy research, and promoting renewable energy development as a means of achieving sustainable development (General Secretariat of Arab Electricity Ministers, 2010).

G. Barriers for Shifting to Green Energy

Despite pronouncements by Arab countries for a more sustainable energy strategy, there are barriers that still need to be addressed to achieve progress. The high per capita energy consumption by oil producing countries as well as the higher energy and carbon intensities than world averages pose serious challenges to shifting to more sustainable patterns of energy use. Non-oil producing countries, on the other hand, must provide reliable energy services in rural areas as part of their efforts to eradicate poverty and improve the quality of life. In general, Arab countries are experiencing rapidly rising demand for energy driven by population growth, urbanization, and economic development. Decoupling economic growth from escalating energy and carbon intensity while making the transition to more sustainable forms of energy systems must be addressed. It has been recognized that a number of barriers need to be overcome in order to promote sustainable energy in Arab countries.

A set of barriers often put green energy solutions at an economic, regulatory, or institutional disadvantage relative to fossil forms of energy. The situation in the Arab region is no exception. These barriers could be classified as follows:

- ***Policy barriers***

1. The policy barriers to promoting energy efficiency and renewable forms of energy include:

2. Lack of or weak political will both at the government and corporate level.

3. Lack of national energy policy with specific targets and mandates to promote energy efficiency or renewable energy. Only 9 Arab

OPINION

DIVERSIFYING POWER RESOURCES AND NATIONAL ECONOMY

Suleiman Al-Herbish

With oil set to be the main energy resource for the foreseeable future, another aspect of the next 50 years for the Organization of the Petroleum Exporting Countries (OPEC)- and one to which people do pay too little attention- is the increase in the consumption in Member Countries. The President and CEO of Saudi Aramco, Khalid A. Al-Falih, said in Boston recently that domestic energy demand was expected to rise by nearly 250 percent by 2028— from about 3.4 million barrels a day of oil equivalent in 2009 to around 8.3 mboe/d— and that this would greatly reduce the amount of oil left for exports. The same holds true for Iraq—If Iraq is going to start producing around four million barrels a day, then you have to imagine how much they are going to consume, because they are in the process of rebuilding the country and are relying entirely on oil.

Next, there is the issue of the "resource curse" and the need for diversification. OPEC's first resolution states: "The Members must rely on petroleum income to a large degree, in order to balance their annual national budgets." If I were to write this now, I would recommend the opposite. I would say that Member Countries "should not rely on..." In other words, they should diversify. This clause has been a constraint on our Member Countries from day one. Along with diversification, of course, is the need to develop human resources.

Nevertheless, in my opinion, this calls for a stronger Organization, and there is a case for the strengthening of the framework through which OPEC pursues it policies, together with the budgetary support. This is not a new issue. The First Solemn Declaration of 1975 stated: "The Sovereigns and Heads of State attach great importance to the strengthening of OPEC." More recently, the Long-Term Strategy of 2005 called for strengthening the Secretariat, and I am sure the forthcoming updated Strategy will recognize this as a continuous process.

Diversifying power resources goes hand in hand with diversifying national economies.

Suleiman Al-Herbish is Director General, OPEC Fund for International Development OFID

countries have announced such targets so far.

4. Weak legal and institutional frameworks. Few Arab countries have a well-developed legislative framework to promote energy efficiency and renewable energy technologies. Only Algeria has had a feed-in-tariff framework to promote renewable energy resources.

5. Slow and incomplete liberalization process of energy and electricity markets. In most Arab countries, energy markets are still dominated by state monopolies. Grid connection and access are not evenly provided to renewable sources of energy technologies.

6. Weak domestic research and development (R&D) programs. Public and corporate R&D expenditures are low and renewable energy and energy efficiency research institutions in Arab countries are severely underfunded.

- ***Market barriers***

Energy efficiency and renewable energy markets in Arab countries are distorted due to a number of factors including:

1. Weak capacity for managing and disseminating information about market opportunities for energy efficiency or renewable energy technologies. Market intermediaries such as industry associations are rare.

2. Low level of consumer awareness leading to low market demand. There has been widespread skepticism about performance and reliability of renewable energy technologies due to past technology failures, weak products' performance, or lack of information.

3. Lack of national standards, testing, and certification schemes that have led to installations of poor quality technologies causing a variety of technical problems and leading to consumers' distrust. For

LEBANON SUBSIDIZES SOLAR WATER HEATERS

Pierre El Khoury

In 2010, the Ministry of Energy and Water (MEW) in Lebanon launched the first solar water heater (SWH) subsidy program based on providing financial support to first time buyers. Through a partnership with the Central Bank of Lebanon (DBL), commercial banks are offering SWH buyers interest-free loans with a repayment period of up to 5 years. In addition, MEW is offering grants to buyers in order to accelerate market penetration of solar water heaters. Consumers who purchase SWH systems from companies qualified by the Lebanese Center for Energy Conservation (LCEC) are eligible to benefit from a US$200 grant. The grant from MEW will cover the first 7,500 solar water heaters with a budget of US$1.5 million. The calculated savings resulting from the installation of 7,500 solar water heaters could reach 22.5 GWh per year.

The SWH subsidy program by MEW-DBL seeks to facilitate the installation of more than 20,000 SWHs. The goal of the interest-free loan is to accelerate the market development of solar water heating in Lebanon. The Lebanese Center for Energy Conservation is seeking to meet a set target of 190,000 m^2 of new installed collector area between 2010 and 2014, and an annual sale of 50,000 m^2 reached by the end of the project. Market growth of SWH is expected to reach the set target of 1,050,000 m^2 of total installed capacity by 2020. This has been estimated to correspond to over 1,000 GWh of avoided, new fossil fuel power capacity by using solar power instead of electricity for water heating. The estimated cumulative greenhouse gas (GHG) emission reduction will exceed 3 million tons of CO_2 by the end 2020.

These targets have been set by a national initiative launched by the Ministry of Energy and Water, in partnership with the Global Solar Water Heating Market Transformation and Strengthening Initiative, a joint collaborative program of the United Nations Development Program (UNDP), the United Nations Environment Program (UNEP), and the Global Environment Facility (GEF).

The program was successful in creating a positive momentum in the market, which witnessed a soaring demand for solar water heaters reaching as high as 300%. The latest revision of the national database of solar water heater companies published by LCEC now has more than 88 qualified companies.

The final target is to meet the objective of "a solar water heater for every house" in Lebanon.

Pierre El Khoury is Project Manager, Lebanese Center for Energy Conservation

example, the lack of national standards, testing and certification schemes for solar water heaters in Egypt has led to installations of poor quality products causing a variety of technical problems. This has caused widespread negative perception among consumers, and severe financial problems to local manufacturers.

4. Weak capacity of local assembly/manufacturing, distribution, installation, and maintenance of energy efficiency (EE) and renewable energy (RE) technologies. Few countries, such as Egypt, have developed local capacity in manufacturing and assembling EE and RE technologies. This has caused countries to rely more on higher cost imported systems, which led to low levels of market penetration due to weak purchasing power.

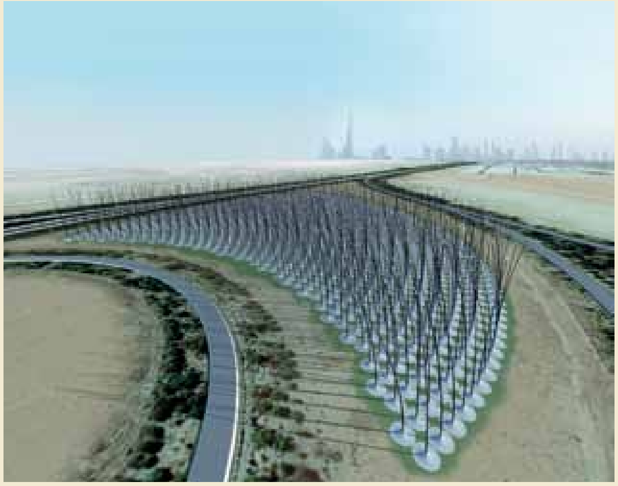
5. Lack of education and training programs for EE and RE professionals at all levels. RE and EE are rarely introduced in educational curricula or in vocational training institutions.

6. The unavailability of credit and lack of proper financing schemes. Consumers or project developers may lack access to credit to purchase or invest in renewable energy and/or energy efficiency because of poor creditworthiness or distorted capital markets. This is also true in rural areas where third party finance or "micro credit" is absent. Lebanon, Morocco, and Tunisia started to overcome these barriers by introducing innovative financing schemes.

7. The misallocation of subsidies has introduced market distortions while doing little to assist

STALKS INSTEAD OF WIND FARMS IN MASDAR CITY

Cue the Windstalk is a new concept developed by New York design firm Atelier DNA. Rather than using huge blades to sweep the wind from the sky, the 55-metre resin stalks, reinforced with carbon fibre, are made up of a series of ceramic disks and electrodes connected by a single central cable. When the stalk sways in the wind, the disks are compressed together, creating a charge in adjacent electrodes. Effectively, it works on piezoelectric (kinetic energy) principles: converting motion into power.



The resulting current is collected by the cable and stored in two batteries at the base of the stalks. Atelier DNA claims that the total electricity output of a Windstalk array could equal that of a traditional turbine farm, largely because the stalks can be much more densely situated.

The design won second place in the Land Art Generator Initiative, which awards installations which combine artistic merit with large scale clean energy generation. Although at present it is just a concept, the Windstalk has already been earmarked for Abu Dhabi's Masdar City, the world's first zero-carbon, zero-waste metropolis. The $20 billion dollar project's first phase is due to be completed by 2015, with 1,203 Windstalks tasked with feeding 20MW into the grid.

Al-Bia Wal-Tanmia (Environment & Development) magazine
Sam Jones, http://www.forumforthefuture.org/greenfutures/articles/windstalks-aesthetic-alternative-turbines

the poor. Subsidies have played a critical role in the development of rural areas and in increased access to modern energy services to the poor. The number of people below the poverty line in the region is high especially in some countries of low per capita income. Therefore, removing energy subsidies might lead to negative social impacts. However, inefficient subsidies systems tend to benefit the rich more than they do the poor. Subsidy reform is critical to promote green energy solutions. Jordan and Morocco have successfully managed to smoothly phase out their energy subsidies. Policy reforms are needed in order to ensure that subsidies reach the targeted population.

- ***Economic barriers***

Economically, EE and RE technologies often face unfair competition in the market due to economic barriers. These include:

TABLE 1 ANALYSIS OF ENERGY POLICIES IN SELECTED ARAB COUNTRIES

	Targets	Legal frameworks	Agency	Financial incentives	Obligations	Energy service companies	Awareness
Algeria		X	X	X	X		X
Egypt	X			X	X	X	X
Jordan	X	X	X	X			X
Lebanon		X	X	X			X
Morocco	X	X	X	X		X	X
Palestine			X				X
Syria		X	X			X	X
Tunisia	X	X	X	X	X	X	X
Yemen	X						

Source: Kraidy, 2010

OPINION

NUCLEAR REACTORS OR HERNIA SURGERY?

Najib Saab

The debate on the use of nuclear power in Europe inspired the Italian cinema company MOROL Productions to produce a documentary entitled, 'The Nuclear Question.' This documentary was shown at the Rome Film Festival in October 2009, and received awards for presenting the nuclear question from ethical, environmental and economical perspectives.

A quarter of a century following the Chernobyl disaster and its repercussions, and three decades after the Three Miles Island nuclear accident in the US, the film poses several questions: is there a moral justification for accepting the potentially disastrous results of nuclear accidents in order to meet raising energy demands? Is the nuclear energy option inevitable? Or was Italy's 1987 decision to ban nuclear reactors, based on a referendum following the Chernobyl disaster, a wise decision?

When MOROL approached me in August 2010 to request an interview for another documentary on nuclear energy in the Arab region, I welcomed the idea, and found it useful to contribute to a serious discussion on the subject. At that time, the thought of a global nuclear disaster on the scale of what happened seven months later in Fukushima was considered mere fiction.

"Are you afraid of the devastating effects of nuclear radiation in the Arab region, considering the possibility of an accident similar to Chernobyl at an Iranian nuclear reactor?" This opening question surprised me, because before the Lebanese should fear, for example, the effects of an accident 2000 km far in Iran, they should fear a nuclear accident in the Israeli Dimona reactor, which is only 200 km away, that is if we limit the fears to a mere accident. The Dimona reactor produces fuel for nuclear warheads and is located in a country which is at war with its neighbors, and which refuses to sign the Treaty of Non-Proliferation of Nuclear Weapons. Iran has signed that treaty, but still is suspected to pursue its nuclear program with military ends. What guarantees can the Lebanese and the Arabs have against an intentionally triggered nuclear apocalyptic attack, especially from a country with which most are officially in a state of war?

Furthermore, at the opposite end of the Mediterranean, dozens of nuclear reactors exist in France, and it is enough for one accident to occur for radiation to reach Arab countries across the sea. Moreover, Turkey is preparing to construct nuclear reactors on the Akoya coast close to Cyprus, only 300 km away from Beirut.

These reactors are all closer to us, I pointed out to my interviewer, and he commented that, in spite of this, many Arab countries have begun to build nuclear power stations. "This is true", I told him, "and Arab countries have multiple motives, as some suffer from a deficit in energy sources, yet own stocks of uranium, and plan to extract it and use it to produce electricity from nuclear energy, as is the case in Jordan. Still, the 'nuclear club' imposed on Jordan the condition of buying ready-to-use enriched uranium in order

1. Heavy government subsidies to the oil and gas industry make it difficult for new or disrupting technologies, such as EE and RE products and services, to achieve high rates of market diffusion.

2. High custom duties on EE and RE technologies add to the high initial capital costs, impairing economic feasibility. For example, custom duties have been a major barrier for the dissemination of compact fluorescent lights (CFL) in Egypt until their very recent removal. Promoting local manufacturing of these products proved to be a sound policy to reduce initial costs.

3. The external costs of fossil fuels use compared to clean energy technologies are ignored. The heavy reliance on oil and gas is associated with environmental degradation, negative public health outcomes, energy insecurity, and international price volatilities, all of which impose economic costs on Arab governments' budgets. The environmental impacts of adopting fossil fuels often result in public health costs (i.e., productivity loss, hospitalization costs), declines in forests and fisheries, and ultimately infrastructure losses associated with climate change. World Bank studies have found that the costs of environmental degradation in 7 Arab countries range from as little as 2.1% to as much as 7.4% of GDP for different countries and years (Croitoru and Sarraf, 2010). The studies have estimated these

to allow building a reactor." Feasibility studies often ignore the cost of dismantling nuclear reactors and dealing with the waste and possible disasters, which, apart from the environmental and human risks, would increase the liabilities and overweigh potential economic benefits.

Moreover, other Arab countries, rich in conventional energy like oil and gas, still want to 'purchase' nuclear technology under the banner of diversifying energy sources and accelerating development. The danger lies in luring some countries into buying ready-made nuclear technology and equipment, under the pretext of a regional balance of power, which may lead to wasting national wealth in an absurd race. This race is not based on developing and owning technology, but on buying ready equipment from 'international sales representatives', including heads of state, who offer both nuclear reactors and military equipment on the same plate, sometimes as part of so-called peace initiatives.

It seems my answer provoked my interviewer, so he asked: "Are you against Arabs acquiring advanced technology, including nuclear?" Of course I want Arabs to develop and own all technologies, and invest in science, literature and art. But what does buying nuclear reactors mean, when Arab citizens still have to travel to hospitals in Europe and USA for treatment of the simplest injuries or diseases?

Before we talk of nuclear reactors, what have we achieved in the field of scientific research, whether in medicine, engineering, physics, economics or sociology? The Arab region still ranks amongst the lowest in the world in terms of budget allocation to scientific research. A stark manifestation is that while Arab countries produce 60 percent of desalinated sea water in the world, they continue to fully import desalination technology, equipment and spare parts, and in most cases also foreign scientists, managers, technicians and workers. So we have to ask whether the construction of nuclear reactors should be accorded a priority over building a factory to produce membranes for water desalination, let alone complete desalination plants? Is building a nuclear reactor more important than developing medical services, so that citizens are not forced to travel to foreign hospitals like the Mayo Clinic for surgeries as simple as removing hernia or a gallbladder? And what will be the level of response to potential nuclear disasters, in countries which have still to show capability to adequately respond to a slight excess in rainfall, often flooding their capitals, wiping structures and humans?

Ultimately, is it not more useful to invest in renewable energies, especially sun and wind, which are clean, safe and abundantly available in the Arab region, before seeking to produce nuclear electricity, fully depending on imported equipment, technology, and enriched uranium?

Arabs have the right to develop and own technology, including nuclear, on the condition they identify priorities and applications according to real needs and in compliance with safety and security considerations. We should beware, however, of falling victims to an artificial nuclear race that only serves international salesmen.

Najib Saab is secretary general of AFED and Editor-in-cheif of Al-Bia Wal-Tanmia (Environment & Development) magazine

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losses to account for 4.8% of GDP in Egypt (1999), 3.7% in Morocco (2000), and 3.6% in Algeria (1998). Yet the capacity to internalize these costs into national accounting is lacking in the Arab region.

III. POLICIES CONDUCIVE TO GREENING THE ENERGY SECTOR

Shifting to more sustainable patterns of energy production and consumption will require a new approach for balancing the demands of energy security, poverty reduction, clean air, and climate stabilization, while continuing to underpin economic development. Investing in a green energy system should be conceived as a basis for addressing these demands and managing the tension with each other. Making the shift from a 'brown' economy to a 'green' economy in Arab countries can be achieved by introducing policy reforms and institutional changes. The needed enabling conditions should be able to address the market, political, and economic barriers discussed earlier, while suggesting specific regulations and incentives for transformation.

Some Arab countries have already introduced various energy policies and programs targeting buildings, transportation, and industries. These policies include regulatory directives, voluntary agreements, and incentives. According to the Regional Center for Renewable Energy and

BIODIESEL IN UAE FROM MCDONALD'S WASTE OIL

Neutral Fuels, a company specialized in energy-efficient operational solutions, has begun to produce biodiesel by converting vegetable oil from local McDonald's restaurants in the United Arab Emirates. The biodiesel produced is used to fuel McDonald's logistics trucks, and can be used by any normal diesel engine. The oil received from McDonald's is the waste from food preparation, and therefore reduces carbon emissions by 60 to 80% as compared to traditional diesel fuel.

This biodiesel program is not the first of its kind, as it is already in operation by McDonald's in Germany, the UK, and areas in Brazil and the US. The process works better in the UAE, though. Robin Mills, a Dubai-based energy analyst, explained in an interview with the BBC that the danger of biodiesel is that there is the possibility of it clogging up, forming a gel and eventually freezing at low temperatures. Of course, low temperatures are not a problem in the UAE, thus eliminating this risk.

One problem the country does face is that the UAE subsidizes the price of fuel at the pump, making it harder for companies like Neutral Fuels to compete and make a profit. Nonetheless, chairman of Neutral Fuels Karl Feilder takes this as an opportunity "to be even more efficient and even more competitive."

The UAE is the world's eighth largest oil producer, rendering it quite surprising that the biodiesel project is gaining support. Other restaurant chains are beginning to express an interest in the program as well.

"Nowadays companies are becoming more environmentally conscious and they want to, as much as they can, be environmentally sustainable," says Abdulla Al Jallaf, managing director of Neutral Fuels in Dubai, which became the first commercial producer of 100% biodiesel in the Middle East. The operation has been supported by Dubai Government's Department of Economic Development (DED).

McDonald's is currently Neutral Fuels' only client and the project is restricted to the UAE, but there are hopes to expand the project across the wider region.

Energy Efficiency (RCREEE), several Arab countries have already identified the barriers to energy efficiency and have taken measures that promote reductions in energy demand (Kraidy, 2010). Table 1 summarizes these measures taken by some Arab states to increase energy efficiency.

A. Regulations

Regulations are usually introduced when it is recognized that economic instruments alone would not be sufficient to achieve energy policy objectives. In general, regulations impose specific measures using legal mandates and/or governmental decrees. A range of regulatory measures that can be adopted by Arab countries may include:

i. Renewable energy portfolio standards

Renewable portfolio standards (RPS) are state policies or regulations mandating a country to generate a certain percentage of its electricity from renewable energy sources. The RPS mechanism generally places an obligation on power utilities, public or private, to produce a specified fraction of their electricity from renewable energy sources. Each country would generally fulfill this mandate using a combination of renewable energy sources, including wind, solar, biomass, geothermal, hydro, or other renewable sources. Some RPS mandates will specify the technology mix, but it is more prudent to let utilities determine the best combination of renewable energy sources to invest in to meet the standard based on technology viability and economic feasibility. Being a market mandate, RPS relies mostly on the private sector for its implementation. Since power utilities in most Arab countries are owned by governments, RPS implementation would require accelerating institutional reforms in the energy sector to allow for independent power producers (IPP). This would also require the establishment of a regulatory body to issue rules and ensure compliance by different IPPs. By 2010, over 100 countries had some type of policy measures for renewable energy targets, compared to 55 countries in 2005 (REN21, 2010).

A number of Arab countries have already set renewable energy targets, as indicated in Table 2. The Lebanese government has declared that it intends to meet a renewable energy portfolio standard of 12% by the year 2020 (REN21, 2010). Wind power is regarded as the most economically feasible source for renewable power. In Tunisia, wind power is expected to account for about 85% of renewable energy share by 2020. Egypt has an annual wind power generation capacity of around 550 MW (NEEAP, 2010a). In Jordan, it is estimated that the deployment of renewable energy sources through a RPS will account for 10% of the country's primary energy production by 2020 (REN21, 2010).

ii. Energy efficiency standards

Improved end-use energy efficiency in residential and commercial buildings, manufacturing, and transport is globally recognized as one of the surest and most cost-effective strategies to reduce energy consumption and greenhouse gas (GHG) emissions (for the same amount of utility derived). Energy efficiency (EE) standards are being adopted worldwide to help manage electricity demand growth, decrease electricity prices, reduce emissions, and address system reliability concerns (IEADSM, 2010).

Several Arab countries have announced energy efficiency targets. Morocco has set a target of achieving 12% savings from EE by 2020, Lebanon 5-10% by 2020, Algeria 16% by 2020, and Egypt 10% by 2020 and 15% by 2030 (Kraidy, 2010). Tunisia has set a target of 20% by 2011, and it is estimated that between 2005 and 2008, the clean energy plan has shaved $1.2 billion off the Tunisian government's energy bill (NEEAP, 2010b). In the Palestinian Territories, the 2009 General Electricity Law stresses the promotion of energy efficiency in various economic sectors and sets a target of achieving 10% energy savings by 2020.

iii. Energy-efficient building codes

Energy efficiency building codes and standards are generally used to set minimum requirements for energy-efficient design and construction for new and renovated buildings that impact energy use and the resulting emissions over the lifetime of the building. Energy-efficient buildings, in addition to their advanced architectural features,

TABLE 2 **ARABS' RENEWABLE ENERGY TARGETS**

Country	*Targets*
Algeria	Wind: 100 MW by 2015; solar thermal: 170 MW by 2015; solar PV: 5.1 MW by 2015; cogeneration: 450 MW by 2015; solar CSP*: 500 MW by 2010
Egypt	Renewable generation: 20% by 2020, including 12% from wind (about 7,200 MW) and 8% from hydro and solar photovoltaic (PV)
Jordan	Wind: 600-1,000 MW; solar PV: 300-600 MW; waste-to-energy: 20-50 MW
Kuwait	Renewable capacity: 5% by 2020
Lebanon	Renewable capacity: 12% by 2020
Libya	Wind: 280 MW by 2012 and 1,500 MW by 2030; solar CSP: 50 MW by 2012 and 800 MW by 2030; solar PV: 150 MW by 2030
Morocco	Solar hot water: 400,000 m^2 by 2012 and 1.7 million m^2 by 2020; wind: 1,440 MW by 2015; small hydro: 400 MW by 2015
Palestine	Renewable capacity: 20% by 2020
Tunisia	Wind: 330 MW by 2011; solar PV: 15 MW by 2011; solar hot water: 740,000 m^2 by 2011

* CSP: Concentrated solar power
Source: REN21, Global Status Report 2010

offer economic and environmental benefits. They are more comfortable and cost effective to operate. Energy efficient buildings can also create economic opportunities for business and industry by promoting demand for new energy efficient-materials and technologies.

The buildings sector in the Arab region offers an attractive field for energy efficiency and emission reduction, given the scale of building activity. In Lebanon, thermal standard requirements for buildings have been established to improve the thermal performance of building envelopes, which should be reflected in improved comfort and reduced energy needed for space heating and cooling (Ministry of Public Works and Transport, 2005). A regional project on Energy Efficiency in the Construction Sector in the Mediterranean Countries (MED-ENEC) has been initiated with funding from the European Union to increase the use of energy efficiency measures and renewable energy systems in buildings in southern and eastern Mediterranean countries (MED-ENEC, 2011). Apart from policy advice and business development, special emphasis is placed on the support for large, more energy-efficient building programs.

Mandates for solar hot water in new construction could represent a strong and growing trend at both national and local levels. National building codes should require minimum levels of solar hot water in new construction and renovation.

iv. Vehicle fuel efficiency standards

Transport is the major energy-consuming sector in Arab countries, accounting for about 30% of total consumption (see Figure 9). Moreover, gasoline and diesel fuels for transport vehicles account for 53% of all petroleum products (see Figure 13). Therefore, Arab countries should set and enforce average fuel economy standards for new vehicles and impose performance standards on imported vehicles. Vehicle fuel efficiency standards have been demonstrated to be effective in reducing fuel consumption and greenhouse gas emissions over the lifetime of the vehicle. It should be noted that no Arab country yet has vehicle fuel economy efficiency standards. Given that vehicle fleet size is growing rapidly in Arab countries, implementing vehicle fuel economy standards should be a priority.

v. Appliance, equipment, and lighting efficiency standards

Regulatory authorities in Arab countries should mandate efficiency performance standards for electric appliances, equipment, and lighting in residential buildings, commercial offices, and industrial facilities. Moreover, incandescent light bulbs should be phased out. Such standards, coupled with energy performance labels, are now being adopted worldwide in order to achieve the largest possible improvement in energy efficiency. Where they have been implemented, these measures have often resulted in significant energy savings and emissions reduction.

Residential equipment categories should include central and room air-conditioning, heaters, lighting fixtures, water heating, refrigerators, freezers, clothes washers and dryers, and dishwashers. For commercial buildings, equipment categories should include central air-conditioners, chillers, heat pumps, fans, water heating, lighting, refrigeration, and office equipment (computers, copiers, printers, scanners, monitors, and vending machines). Efficiency standards for industrial facilities should address motors of various types and sizes, electric resistance and radio frequency devices, heating, ventilating, and air-conditioning systems (HVAC), and incandescent, fluorescent, and high-intensity discharge lighting.

Energy-related standards adopted in the region vary from one country to another. Syria, for example, has established a 15-year efficiency-labeling program for refrigerators in 2003, with potential savings projected to total 51 GWh of electricity per year as a result of implementing these standards. In 15 years, the labeling program would cut electricity usage by 750 GWh, a quantity that would have required the construction of a 100 MW power plant (Bida and Kraidy, 2010). Lebanon's energy policy will ban the import of inefficient incandescent lamps by 2014. The country has also launched a project to distribute 3 million energy efficient compact fluorescent lamps to residential units across Lebanon for free. Egypt has established energy efficient standards for refrigerators, washing machines, and air-conditioning units (Plan Bleu, 2007).

MARKS & SPENCER-DUBAI ADOPTS EFFICIENT LIGHTING SOLUTIONS

Marks & Spencer in Deira City Center, Dubai, is one of the leading brands represented by Al Futtaim Group. Adopting more sustainable practices, Al Futtaim's most recent was a new store concept developed for Marks & Spencer per the guidelines of their international team. Lighting was a key parameter of this concept, and an innovative solution was designed by Philips central design team.

Philips energy efficient and LED light fixtures were installed throughout the sales area, changing rooms, and back of the store. The goal was ensuring optimum quantity of luminary to achieve the desired lighting features. Savings were achieved by reducing the connected electrical load and by trimming the maintenance schedule.

Dynalite lighting controls were also used in the changing rooms to create interactivity with the shoppers and ensure additional energy efficiency.

Marks & Spencer now enjoys optimum crisp bright light with a typical energy saving of 20% on its lighting electricity usage, in comparison with other stores using conventional light sources. It is also believed that the LED lighting solution will reflect the true colors of clothing, hence creating a more enticing shopping environment for the customers and adding to the bottom line results for sales.

B. Incentives

i. Subsidy reforms

Targeted energy subsidies are needed to lift low-income households and rural communities out of poverty. However, broad fossil fuel and electricity subsidies in Arab countries often fail to focus on the poor. Such untargeted subsidies lead to overuse of energy, impose a burden on public finances, and constrain the ability of regulatory agencies to rein in demand. The indirect effects include lower economic productivity, increased air pollution, and higher rates of GHG emissions.

The gradual phase out of fossil fuel consumption subsidies can be a powerful tool for governments to shape the long-term evolution of their energy system. The savings from reducing or removing government subsidies can be used as financial incentives to spur investments in energy efficiency and renewable sources of energy. These incentives will be needed to accelerate market diffusion of renewable energy technologies during the early phase of market development. According to the International Energy Agency (IEA, 2009), the complete removal of subsidies would lead to a 5.8% reduction in CO_2 emissions by 2020.

ii. Providing incentives for end-user purchase of energy efficient equipment

Arab governments should consider initiatives that offer incentives for the purchase of energy-efficient equipment and appliances by households and institutional buyers. For example, financial incentives can be made available for interior lighting, building envelope, heating, cooling, ventilation, or hot water systems that would lead to a reduction in a building's total energy and power consumption. A graduated scale can be used whereby the amount of financial incentive is proportional to the decrease in energy consumption relative to the conventional baseline. Such incentives that reduce the purchasing cost of energy efficiency products and services play a key role in stimulating demand for them and developing a robust energy efficiency value chain.

Financial incentives for energy efficiency may include a variety of forms including tax incentives, grants, low-interest loans, rebates, bond programs, leasing/lease purchase programs, and performance-based incentives (DSIRE, 2011). Some initiatives have already been implemented. Energy-efficient bulbs have been distributed for free in Lebanon and the United Arab Emirates, and at subsidized costs in Egypt and Morocco. In Tunisia, low-interest loans are offered for replacing old, inefficient refrigerators that have been in use for more than 10 years, whereby a total of 400,000 units have been replaced.

Promoting energy efficiency standards and labels on appliances would provide strong incentives for producers to improve energy efficiency of their products, while providing consumers with the knowledge they need to make more informed purchasing decision. In combination with setting up efficiency standards and labeling for appliances

and equipment, Arab governments should launch a sustained educational and awareness campaign about these efficiency labels as part of an effort to educate buyers and consumers.

iii. Promoting a shift to renewable energy sources

For the installation of renewable energy systems, incentives that reduce the initial capital cost play a key role in stimulating demand and developing a robust supply chain. Subsidies for solar water heaters (SWH) are now common in several Arab countries including Egypt, Lebanon, and Tunisia. Capital grants, rebates, low-interest loans, and value-added tax (VAT) exemptions are made available to subsidize the initial purchasing cost of SWHs or renewable energy installations. To further increase the wide scale adoption of renewable energy production in Arab countries, incentives and policies for selling renewable power to the grid and reducing and/or removing electricity and fossil fuel subsidies are needed.
The feed-in-tariff (FIT) policy has been widely adopted in many countries and regions in recent years. The feed-in tariff policies have spurred innovation and increased interest and investment in renewable energy resources, mainly wind, solar, and biofuels. They have had the largest effect on wind power but have also influenced solar photovoltaic (PV), biomass, and small hydro development. Strong momentum for feed-in tariffs continues around the world as countries enact new policies or revise existing ones (UNEP, 2010). In the Arab region, only Algeria has so far enacted a feed-in-tariff policy, while it is under consideration by Egypt, Lebanon, Saudi Arabia, UAE, Tunisia, and Yemen.

Few countries in the region have established special renewable energy and energy efficiency funds to directly finance investments, set standards, and offer technical support through research, education, and public awareness. The National Energy Efficiency and Renewable Energy Account, NEEREA, in Lebanon, has been recently established to offer both financial and technical support for energy efficiency and renewable energy projects in the country. NEEREA works cooperatively with the Central Bank of Lebanon to evaluate applications for grants and low-interest loans for these projects.

iv. Promoting demand response management to reduce peak loads

Demand response management refers to mechanisms to manage electricity consumption by end-consumers in response to supply conditions or market pricing. Demand management permits cutting back load during times of system emergencies, system peaks, or high market prices. The most commonly used demand response program entails interruptible electricity service for commercial and industrial end-users during peak loads. It is primarily used as a strategy to reduce energy demand and to impact the shape of the load curve.

Demand management gives customers more control over their energy costs, and allows them to realize energy savings that would result from changing their consumption behavior. Demand response can also avoid costly outages when the demand for power peaks. In these instances, end consumers agree to curtail their consumption of

ARAMEX DUBAI LOGISTICS CITY: LEED GOLD CERTIFIED WITH PHILIPS LIGHTING

As a 29-year old global provider of comprehensive logistics and transport solutions in more than 54 countries, Aramex understands the importance of warehousing within the wider supply chain, and the environmental footprint of those facilities. The company is investing in cutting-edge green technology to ensure meeting customers' storage requirements and inventory management needs with minimal carbon footprint. Dubai Logistics City emerged as one of Aramex's key facilities to become energy efficient under "A LEED Gold Certified" project, in partnership with Philips.

The challenge was to provide a simple yet smart lighting solution to meet the application requirements, while consuming 40% less energy than stipulated by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers' (ASHRAE) standards. The project required luminaries-based, stand-alone lighting controls for occupancy detection in the warehouse area and daylight optimization in the offices.

Philips made an intelligent selection and customization of standard luminaries. For the lighting controls, it customized the standard TMX204 luminary with an occupancy sensor in the warehouse area to provide the ideal scenario: light when and where needed. The Smartform TBS460 luminaries in the office spaces have been fitted with Luxsense controllers, which save energy by automatically regulating the luminary in accordance with the level of daylight available. Fugato Compact and Performance downlights with PL-R lamps were used for circulation areas.

Dubai Logistics City project reflects Aramex's continuous commitment to reduce its carbon footprint, optimize power consumption, and raise awareness among other activities in its 307 locations around the globe.

Both Aramex and Philips are AFED corporate members.

power according to a preplanned scheme in return of financial incentives. Some consumers may have options for on-site power generation that may not be connected to the grid, giving them more flexibility to manage their power consumption.

v. Promoting shift to low-carbon fuels

To reduce GHG emissions, alternative, low-carbon fuels can be used as substitutes for conventional fuels in transport and power generation. Short and medium-term options already adopted in several Arab countries include the shift to cleaner and cheaper natural gas for both power production and in transport.

This may require conversion of vehicle engines and new fueling infrastructure, depending on the type of fuel. Alternative fuels—such as liquefied petroleum gas (LPG), compressed natural gas (CNG), biofuels, and electricity—offer reductions in GHG emissions from 10-100% over the full fuel cycle depending on how they are produced and used (PEW, 2007). Arab governments, in partnership with the private sector, should develop appropriate incentives to promote the transition to low carbon fuels. Egypt has taken a leading role in the shift to natural gas for transport by building a nationwide network for gas storage and distribution.

Plug-in hybrids and all-electric cars have higher costs and limited driving range and lack a fuel supply and refueling infrastructure at the present time. For biofuel production, redistributing farmland for harvesting agro fuel feedstocks must be avoided at all costs. The conversion of agricultural waste into biofuels is the most sustainable and desired option. Low-carbon fuels can provide long-term solutions, but economic, technological, and structural hurdles must first be overcome and environmental benefits demonstrated.

A clean fuel partnership should be established in Arab countries to bring together a wide range of organizations with a stake in the shift to cleaner vehicles and fuels. Such a partnership could benefit from similar initiatives in Europe and other regions, and its members may include government regulators, vehicle dealers and producers, fuel and energy industries, automotive technology providers, transport operators, consumer groups, environmental organizations, academic centers, and investors, (PEW, 2007). The objective of such a partnership is to promote transport solutions that ensure sustainable growth, while mitigating negative externalities of the sector. It should also support integrating land use developments with mobility needs, promoting the shift to energy-efficient modes of

GEOTHERMAL HEATING AND COOLING IN JORDAN

Adi I. Asali

Jordan, like many Arab countries, faces the problem of soaring energy prices accompanied by a lack of available resources. The Middle East and North Africa (MENA) Geothermal Ground Energy and Investment Company has dedicated its efforts to introducing geothermal heating and cooling systems to Arab countries as an economic, energy saving, and environmentally sustainable solution to the region's energy problems.

Two geothermal systems were designed and are currently being installed by MENA Geothermal at the American University of Madaba (AUM), Jordan, to meet the full heating and cooling demands of two College of Science and College of Business buildings. The geothermal heating and cooling systems at AUM, once completed, will be the largest in the Arab region. In addition to the enormous savings in operating costs, the system will eliminate all carbon dioxide emissions emitted by conventional systems.

Geothermal Energy Fundamentals

The Earth acts as an enormous energy storage tank that is able to absorb about 50% of the sun's energy. As a result, the temperature below the earth's surface remains relatively constant throughout the entire year. Because heat naturally flows from high temperature to low temperature zones, geothermal systems use electrically powered heat-pumps to transfer heat back and forth between heated or cooled buildings and earth.

During the heating cycle, constant underground temperatures provide an excellent heat-source that is significantly warmer than the cold air outside. A geothermal system uses a ground loop to extract

FIGURE B1 AUM'S OPERATING COST COMPARISION CONVENTIONAL VS. GEOTHERMAL (HEATING COOLING)

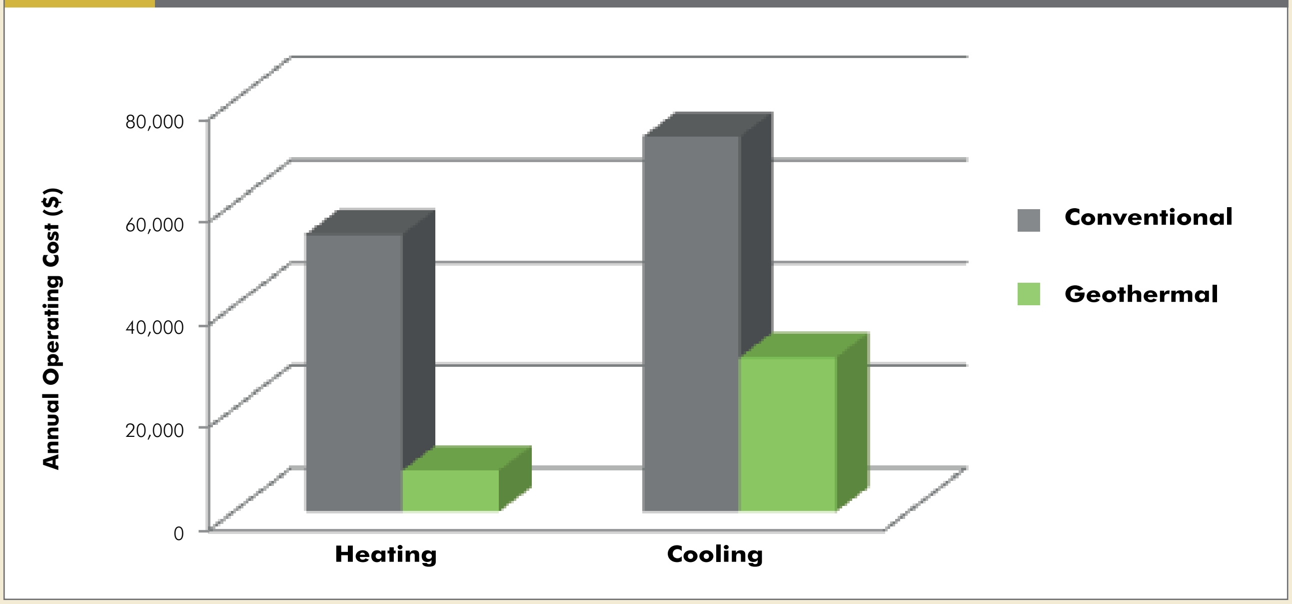
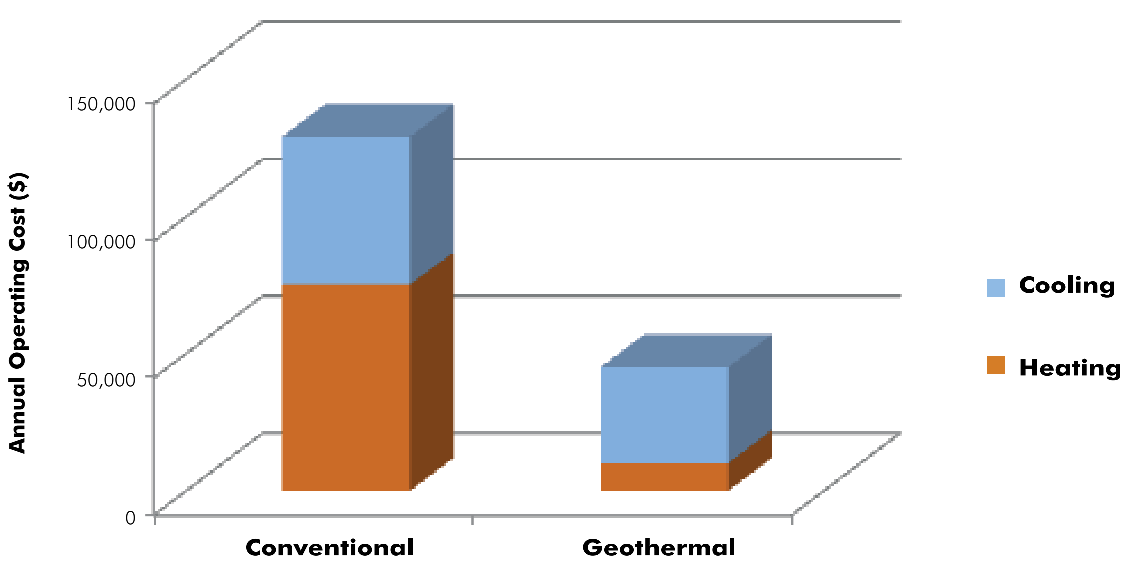


FIGURE B2 AUM'S OPERATING COST COMPARISION CONVENTIONAL VS. GEOTHERMAL (TOTAL)



heat from the ground and utilizes this heat to warm up the building and its domestic hot water supply. In the cooling cycle, a geothermal system simply works in reverse. The constant underground temperatures provide an excellent heat-sink that is significantly cooler than the hot air outside. Instead of extracting heat from the ground, heat is extracted from the building and is either rejected into the earth loop, or used to preheat the building's domestic hot water supply.

In short, geothermal heating and cooling systems provide an efficient and environmentally sustainable method for heating and cooling residential and commercial buildings, and for supplying part of their domestic hot water.

Geothermal System Features at AUM

The College of Science's geothermal system is designed to meet a cooling load of 1020 kW (291 tons), and a heating load of 880 kW (251 tons), while the College of Business's geothermal system is designed to meet a cooling load of 660 kW (189 tons) and heating load of 470 kW (134 tons). Due to the large size of both geothermal systems, it was determined that a vertical borehole configuration would be the best option to use while designing the ground loops of the systems. A total of 420 boreholes (255 for the science building, and 165 for the business building) were drilled at roughly 100 meters deep to supply the energy required for heating, and to absorb the energy rejected during the cooling by the system.

The geothermal heating and cooling system at AUM is designed to achieve a coefficient of performance (COP) of 4.0 in heating and cooling cycles. That is, for every unit of electricity consumed by the geothermal system, four units of heating or cooling are supplied to the building.

Annual Energy and CO_2 Savings. Compared to conventional heating and cooling systems used in Jordan, AUM's geothermal heating and cooling system is expected to have annual savings of over 200,000 kWh of electricity in the summer months (cooling), and 90,000 liters of diesel fuel in the winter months (heating). In total, AUM will generate annual savings of over $85,000. Moreover, the geothermal system is expected to eliminate 365 tons of CO_2 emissions every year.

Adi I. Asali is a Mechanical Engineer, MENA Geothermal.

transportation, and improving vehicle and fuel technologies (LowCVP, 2010).

C. Knowledge Management

As mentioned earlier, the demands placed on a national energy strategy to address society's economic, security, and environmental goals are pressing. How Arab countries manage and obtain their energy resources plays a determining role in socioeconomic development, balance of payments, and environmental quality, among others. Therefore, knowing how to balance the diverse and multiple goals of an energy strategy, with the attending tensions and competing demands, requires having the capability to create interdisciplinary and multi-sectoral knowledge and the capacity to utilize this knowledge at different scales.

Science and engineering will always play a key role in advancing our knowledge about new technologies or processes that lead to increased efficiencies, better integration, and lower costs. However, developing an energy strategy demands a great deal more than technological advances. To develop a sound energy strategy will require considerable investment in applied, integrative, and policy-oriented knowledge that can elucidate the costs and benefits of different energy choices economically, socially, politically, and environmentally. Developing the capacity to utilize this knowledge effectively requires processes and institutions to communicate these understandings to policy makers as well as to the public.

Moreover, the crafting of regulations and incentives to influence society's patterns of energy production and consumption depends significantly on such practice-based, policy-oriented studies. These studies are needed to develop an understanding of the effects of public policies and to ensure that they are perceived to be fair. Therefore, Arab countries should establish communities of research and teaching at the intersection of science, technology, and public policy. These communities may emerge at academic institutions, non-governmental organizations, and think tanks.

Energy use is vital to every sector of the economy, e.g., agriculture, industry, transport, housing and construction, and tourism. Therefore, crafting an energy strategy should not be left entirely to the Ministry of Energy. Governmental cooperation should take place at the highest levels to ensure policy integration and coordination. This also poses a challenge in integrating different perspectives and sources of knowledge related to the type of energy end-use, pricing, and assessment of each sector's demand growth.

D. Public awareness

Much of energy consumption behavior is influenced by societal and cultural values. Therefore, public education and awareness campaigns are critical to creating a green culture and mass social learning in support of energy efficiency and renewable sources of power.

Strong evidence suggests that households and institutional consumers of energy lack knowledge about their own consumption of energy and about the opportunities available to improve energy efficiency. Therefore, sustained public awareness is a key component of any energy strategy.

Furthermore, for the regulations and incentives discussed earlier to be effective in changing behavioral patterns, they have to be accompanied by easy-to-understand information to help households and institutional consumers make 'green' decisions about energy purchases and installations. Informational materials should inform consumers how to take advantage of incentive programs, provide updates about new and existing incentives, and offer basic templates for computing the costs and benefits of purchasing decisions.

An example of a public outreach program is the United Arab Emirates' 'Heroes of the UAE', a jointly developed by the Emirates Wildlife Society in association with the Worldwide Fund for Nature (EWS-WWF) and the Environment Agency-Abu Dhabi, which aims to alert the public to the fact that drastic action must be taken now to drastically curb energy consumption and avert dangerous shortages. The campaign also seeks to point out that straightforward, practical, and successful solutions are readily available (The UAE Heroes Campaign, 2011). The Lebanese Center for Energy Conservation (LCEC) is another example of an outreach program that seeks to influence consumer behavior through skillful design of media ads.

SOLAR PHOTOVOLTAIC POWER FOR PUBLIC SCHOOLS IN LEBANON

Reliable energy is critical for economic growth, social development, fiscal sustainability, and regional and global integration. Indeed, several studies undertaken by the World Bank in many countries show a very clear correlation between access to energy and gross domestic product (GDP) growth.

Although Lebanon is 100% electrified, most regions of the country, mainly near the borders, suffer from very long electricity black-out periods and have very low voltage levels, which doesn't enable them to use electrical appliances or even enjoy adequate lighting levels.

While generally an inconvenience for everyone, for children these black-outs can have negative effects, particularly on their education. Since public schools cannot afford adequate alternative energy sources, children have no access to sufficient lighting or to reliable power to permit the use of classroom technologies.

With a mandate to deploy sustainable energy projects in Lebanon, the country energy efficiency and renewable energy demonstration project for the recovery of Lebanon (CEDRO), which is managed by the United Nations Development Program (UNDP), initiated in 2010 projects for the installation of solar photovoltaic (PV) systems in 25 public schools and community centers in Akkar, Bekaa, and in the South. Kherbet Selem public school in the south of Lebanon was selected for the pilot project.

The solar PV system is designed to supply power to the school independent of the grid. However, it is connected to the grid to allow the system's batteries to be charged when they are low on stored energy. In the future, a feed-in option will be installed to allow the solar PV system to supply power to the public grid during school days off or when there is power surplus.

The installed solar PV system consists of three mono-crystalline modules and has a capacity of 1800 Watt-peak (Wp). The solar modules comprise of cells that produce electrical direct current (DC) when exposed to sunlight. The electricity produced is stored in batteries and then converted to alternative current (AC) by an inverter. The batteries will supply essential power load to the building in the event of a grid power failure. The amount of power supplied will be sufficient to meet the load requirements of all necessary electrical equipment. In addition, more efficient lighting fixtures have been installed to provide the same required illumination for classrooms and offices, while consuming less energy.

The back-up batteries are required to provide uninterrupted power supply in the case of a grid failure. Therefore, the solar PV system will work as the school's own generator and will supply the essential load. When solar radiation is low, power will be withdrawn from the public grid to charge the batteries. When the school is not occupied, during 3 months of the year, it will be possible for the solar PV system to feed renewable power into the public power grid.

E. Research and development (R&D)

The energy sector depends heavily on R&D for advancements in materials, technology, and implementation. The green energy industry in general, and renewable energy and energy efficiency industries in particular, need a skilled workforce of technicians, designers, engineers, and managers to follow up and examine evolving issues and research requirements. Although some countries in the Arab region have begun renewable energy projects, there is a need for substantial collaborative efforts in research and development. Countries and research units that move quickly could build a sizable and sustainable competitive advantage. Arab countries generally lack sufficient research institutions, and R&D spending by the pubic and private sectors is low compared with other nations.

Collaborative R&D projects on greening the energy sector should be undertaken by regional and international research and academic centers. These projects should target power and transport sectors management as well as building systems' integration including practices by architects and engineers that can lead to zero-energy buildings. The American University of Beirut (AUB), Lebanon, has joined the Zero Net Energy Innovative Housing (ZENITH) project. The ZENITH (or ZeroBuild) project is focused on developing sustainable building energy technologies and systems. The ZeroBuild project will reinforce the cooperation capacities of the American University of Beirut (AUB) and the Lebanese Center for Energy Conservation (LCEC) and will enable them to develop and implement green energy practices.

IV. SOCIOECONOMIC AND ENVIRONMENTAL IMPLICATIONS OF CURRENT ENERGY POLICIES

A. Economic Implications

Any increase in economic activity is expected to lead to an increase in energy consumption, the magnitude of which depends on the income elasticity of demand. Though, in the last several decades, a number of developed countries have been able to decouple energy consumption and economic activity. Even China has been moving recently in this direction. Higher energy efficiency can reduce energy consumed to produce the same level of energy services (energy intensity). Since 1990, global energy intensity has decreased at a rate of 1.3% per year due to both structural effects as well as physical energy efficiency improvements (El-Ashry, 2010).

Thus, any energy policy must be designed to take into account the implications of such a relationship. Long-term expansion strategies for the different energy sources are necessary so that the growth in energy demand due to the growth in its different determinants, most notably economic activity and population, can be satisfied in a timely manner. In line with strategies in other countries, these plans can and should incorporate smooth transition paths from a fossil fuel based economy to one focused on renewable clean energy sources. Such a move carries major benefits that will be discussed in the sections below.

Past studies have shown renewable energy to be more labor intensive than conventional forms of electricity production (LBNL, 2007). Estimated figures depend on the mix of renewable technologies considered and other assumptions. In line with experiences in the rest of the world, it is expected that a shift to clean energy in Arab countries would lead to a net growth in jobs related to green energy products and services. The Pew Charitable Trusts (2009) finds that from 1998 to 2007, clean economy employment in California grew faster than employment in the economy as a whole, accounting for approximately 125,000 jobs. By 2010, this number has grown to 300,000 Californians engaged in jobs related to green products or green services, or 3.8% of the state's workforce (California Employment Development Department, 2010).

Analyses by the United Nations Environment Program (UNEP) confirm these trends. According to UNEP (2011), "national studies show that green investments tend to be more employment intensive even in the short to medium term." The same report indicates that employment in the renewable energy sector has become quite substantial with more than 2.3 million people worldwide estimated to be working either directly or indirectly in the sector in 2006.

Although a few of the current energy policies in Arab countries encourage the use of renewable energy technologies, they do not provide the

WIND ENERGY IN SYRIA- A PERSONAL EXPERIENCE

Maan Kaadan

In 1990, I produced my first small 2.4 kW wind turbine. With additional development over a 2-year period, I was able to produce a 10 kW wind turbine in 1992, which has been used to power submersible pumps. I sold two of them to private farmers.

In 1994, I began producing 50 kW wind turbines, which were capable of driving up to 40 hp pumps. Sales were not significant, though. I sold eight 50 kW and a few 10 kW wind turbines. The availability of highly subsidized diesel fuel at the time made my wind turbines uncompetitive. Potential private sector buyers found the turbines expensive, while the public sector did not have an interest in the technology. Some public sector organizations did purchase a few wind turbines informally, not as part of an official policy to adopt a new technology.

I stopped my development work on wind turbines in 2000 because there was no convincing business model.

In 2008, the Syrian government reduced the subsidies on diesel, pushing the diesel fuel price up from 7 Syrian Pounds (SL) to 25 SL per liter. I began receiving many inquiries from farmers who wanted to switch from diesel to wind energy, and new orders for wind turbines were placed.

I re-launched my wind-turbine-making business. I was able to install two 30 kW wind turbines at a cost of US$30,000. Only well-to-do farmers could afford to purchase these turbines. Despite advocating renewable energy adoption, the Syrian government did not offer any incentives to potential buyers such as low-interest loans. An opportunity to support Syrian-made wind turbines and stimulate economic opportunities locally and regionally was lost.

Therefore, I quit my business once again for the last time. The total installed capacity of wind energy operating in Syria is equal to the sum of my installations, which stands at 650 kW.

To bring about change in energy policy, public policy makers need to understand the benefits and costs of new sources of energy and develop the institutional capacity to evaluate their feasibilities. When I was advocating wind energy in the early 2000s, a high-ranking government official made the claim that wind turbines need wind speeds up to 11-12 m/s to produce the nominal power. Since the average wind speeds in most Syrian sites are between 6 and 8 m/s, it was thought that the potential for wind energy generation is not promising. The failure to understand the difference between average and nominal wind speeds is emblematic of the institutional barriers to informed public policy. It was explained that what matters is not so much average wind speeds, but the actual upper and lower end of the speed of wind at a particular location.

Installation of wind power or PV (photovoltaic cells) in Syria will contribute twice as much to the reduction of greenhouse gas emissions than it would if installed in the UK or Germany (http://www.goumbook.com/tag/syria/).This public official offered his support for wind energy in the country. However, the institutional knowledge disappeared with his departure due to retirement. The education process for public government officials had to start from scratch.

Maan Kaadan is A Syrian mechanical engineer.

regulatory and institutional framework or incentive measures for the creation of a competitive energy efficiency and renewable energy industry. Energy efficiency and use of clean and renewable sources of energy in the production process increases the competitiveness of the region. Moreover, the development of such a clean energy industry would lead to energy and economic diversification, as opposed to heavy reliance on oil.

In recent years, Arab countries have seen a substantial increase in investments in clean energy; in 2007 investments totaled US$475 million, while in 2009 they have jumped to US$2.5 billion (El-Ashry, 2010). But, even this figure represents less than 2% of global investments in renewable energy (DOE, 2010).

Egypt is a leading example in the region in the commercial use of wind power. It continues to develop a wind energy-manufacturing sector in cooperation with international organizations such as the United Nations Industrial Development Organization (UNIDO) and bilateral donor countries such as Germany. As early as 1992, when the second wind plant was installed in Hurghada, 45% of the wind turbine components were locally manufactured.

A number of Arab countries have been adopting an energy pricing policy that aims at securing energy access to all segments of the population at affordable prices, as well as promoting industrialization as a means to economic diversification. Apart from being heavily subsidized, domestic prices of oil and petroleum products, electricity, and natural gas have been stagnant for a long time, a practice that has resulted in substantial wasteful consumption.

TABLE 3 **FUEL CONSUMPTION SUBSIDY AS A PROPORTION OF THE FULL COST OF SUPPLY (2009)**

Country	Subsidy Rate
Algeria	41.4
Egypt	56.3
Iraq	47.4
Kuwait	53.3
Libya	52.0
Qatar	63.2
Saudi Arabia	78.9
UAE	55.7

Source: IEA, 2010b

The GTZ's International Fuel Prices survey in 2009 ranked Bahrain third with Iran on top, followed by Saudi Arabia among countries subsidizing gasoline and diesel prices. Iran has since removed its fuel subsidies. The pump prices of both gasoline and diesel in Bahrain were lower than the price of three international benchmarks, namely, lowest EU prices (in Spain), the US market, and the price of crude oil in the world market (Abdel Gelil, 2011).

Subsidies tend to promote inappropriate consumer behavior, send wrong signals to consumers and suppliers, impair economic viability of energy efficiency and renewable energy technologies, aggravate environmental pollution and GHG emissions, and pose a rapidly increasing burden on government finances, particularly in the electricity sector.

It is well established that energy demand is price sensitive, especially demand for electricity. So, price reform will save large quantities of energy, especially in the long run, and consequently can make a substantial reduction in GHG emissions from countries with distorted prices. On the other hand, improving energy efficiency offers a viable solution for consumers to compensate for price increase.

The World Bank review of "win-win" policy reforms makes three important points about energy subsidies:

- They are burdensome; they represent from 2 to 7 times higher government expenditure than expenditures on health in some countries such as Egypt, India, Indonesia, and Pakistan.
- They are poorly targeted; the poor's share of the subsidy is usually less than their share of the population.
- They increase emissions of CO_2; for example, countries that subsidize diesel fuel emit twice as much CO_2 per capita as other countries with similar per capita income.

Lebanon presents a typical case that is worth examining. The country's annual transfers to Electricite du Liban in 2006 were just under a billion US$, which corresponds to 4% of GDP

LAFARGE MAROC: FIRST CEMENT COMPANY TO BUILD A WIND FARM

The first wind farm at the cement manufacturer Lafarge Maroc was commissioned in June 2005, to supply its cement plant in Tetouan, Morocco with electrical power. This wind farm supplied a little less than 40% of the plant's power requirements. It was also the first innovation worldwide for a cement factory.

Eligible for the Clean Development Mechanism (CDM) established by the Kyoto agreement, the project was certified in September 2005. By replacing the electricity produced via thermal power plants, the wind farm reduced emissions of greenhouse gases (GHG) by about 30,000 tons of CO_2 per year.

The effectiveness of this first wind farm, combined with the rising cost of electricity, encouraged the company to seize the opportunity offered by the new regulatory framework in Morocco authorizing self-generation of electric power up to 50 MW from 10 MW.

Therefore, Lafarge Maroc decided to triple the existing wind farm in two phases. The first phase became operational in December 2008, while the second phase started operation in 2009, when the second line of the cement plant in Tetouan was about to be launched. The company now owns a 32 MW wind farm, and is currently preparing the CDM certification for the wind farm expansion which will reduce greenhouse gas emissions (GHG) by about 58,000 tons per year. Lafarge wind farm supplies about 65% of the energy needed by the plant, or about 20% of the overall power consumption of its existing 4 cement plants.

The overall cost of this wind farm was about 500 million Moroccan Dirham (MAD) or US$63.7 million. The investment is not highly profitable, but it contributes to securing continuous electricity supply for the plant and to fulfilling the company's concern for sustainable development.

or more than 20% of government revenues (Ministry of Finance, 2010; World Bank, 2008). If subsidies were to be removed, dependence on imports would be reduced leading to an improvement in the country's fiscal position. The revenue savings could be reallocated to tackle other urgent needs in other sectors, such as health and education.

According to the Egyptian General Petroleum Corporation (EGPC), direct fuel subsidies in Egypt totaled nearly US$8 billion in 2005/2006. Recent escalation of international oil prices has magnified this impact, particularly when imports of gasoline and diesel were needed. As a point of comparison, in 2003/2004, the cost of liquid fuel subsidies was roughly equal to the annual revenues from the Suez Canal. Pump prices of diesel are almost 10 times lower than in Cyprus, and more than 5 times lower than the corresponding prices in Lebanon, Morocco, and Tunisia (American Chamber of Commerce, 2004).

Similarly, in Syria the total annual energy subsidy for light fuel oil, diesel, gasoline, natural gas, liquefied petroleum gas (LPG), and electricity costs US$6 billion. Subsidies have been as high as 340% of real prices. The government seeks to phase out subsidies gradually in order to achieve international price levels within the next decade (Abdel Gelil, 2007). Table 3 displays energy subsidies as a proportion of the full cost of supply in selected Arab countries.

For net oil-exporting countries, fossil-fuel subsidies represent the opportunity cost of selling the subsidized amount of fuel at market prices, whereas in net oil-importing countries these subsidies represent direct government expenditure. Alternatively, part of the subsidies could be removed and the other part redesigned to achieve the stated goal of the subsidy mechanism. For example the International Energy Agency (IEA) suggests providing subsidies for rural electrification that make energy services available and affordable to the poor. Since 2003 Jordan has

removed all direct fossil-fuel subsidies (except LPG for households) and introduced cross-subsidies in favor of rural areas, water pumping, street lighting, and low-income households. Jordan no longer has access to Iraqi oil, once received at concessionary prices, forcing the introduction of price reforms. Other Arab countries have also announced plans to reduce their subsidies; Egypt plans to eliminate energy subsidies to all industries by the end of 2011, while the United Arab Emirates have started reducing gasoline subsidies in April 2010 and plans to bring them in line with international market levels (IEA, 2010b).

Most of the Arab economies, if not all, are vulnerable to volatility of the global oil market. Oil producing countries depend mainly on oil exports revenues to finance their development plans with severe adverse economic impacts when international oil prices fall. On the other hand, oil-importing countries such as Jordan and Morocco would be greatly affected due to any increase in oil prices. Energy efficiency, diversification of energy sources, and encouraging investment and wide dissemination of renewable energy technologies are key to reducing the vulnerability of Arab economies to the volatility of oil prices, and enhance energy security in addition to delivering environmental benefits.

Greening of the energy sector requires substituting investments in carbon-intensive energy sources with investments in clean energy as well as energy efficiency improvements. Many opportunities for improving energy efficiency pay for themselves and reduce running costs, while investments in renewable energy technologies are already growing in today's market as they are becoming increasingly competitive. Other measures may cost more and can result in countries becoming economically competitive with the adoption of a modest price on carbon emissions. Moreover, green energy options would be more competitive when the societal or external costs of fossil fuel technologies are taken into account. The current global carbon market with any potential future development post-2012 on carbon emissions and pricing may offer a strong incentive for shifting to green energy.

B. Social Implications

Despite the Arab region's rich energy resources, "in 2002, about 65 million people in the Arab countries (21.4%), mostly in rural areas, [had] no access to electricity; a further 60 million are severely undersupplied, both in rural and poor urban areas" (ESCWA, 2005). Energy poverty is associated with poor attainment in education and health and retards the integration of poor communities in rural areas in productive economic activities. To provide these communities with access to modern energy services, distributed renewable generation systems can be more cost-effective than conventional centralized energy supply systems. Although renewable technologies typically have higher capital costs, these costs can be more than offset by the savings in transmission and distribution costs and in savings in power losses associated with them, as well as by operating costs.

Traditional biomass fuels, used for cooking and heating, are associated with high levels of indoor pollution and poor health (IEA, 2009). Expanding rural electrification through the use of traditional or decentralized renewable energy sources helps poor rural families turn away from biomass use. This would address the energy poverty afflicting many in Arab countries and contribute to social development goals. When deployed in rural areas, renewable energy technologies promise to make a significant contribution to promoting development, improving living standards and health in rural and remote areas. Green energy sources would free up the time used to collect biomass to other more productive activities such as education for children. A one-time subsidy for connection to natural gas or electricity in Morocco was used as an incentive for consumers to switch from biomass to cleaner sources of energy (World Bank, 2010). In some cases, such energy subsidies were successful in poverty alleviation; petroleum subsidies in 2005-2006 have reduced the incidence of poverty by 8% in Yemen and by 5% in Morocco (IEA et al., 2010c).

Cost effective solutions include decentralized solar photovoltaics, with low operating costs and flexible, small-scale projects. A leading example of such a shift is the rural electrification program in Morocco. It sought to provide PV solar electricity to a total of 34,400 villages inhabited by approximately 12 million people living in rural areas during the period (1995-2007). Because of the increased costs in connecting rural households to the electricity grid, grid extension is not feasible, and individual photovoltaic solar home system (SHS) was the best choice. Further, the "PROMASOL" project to scale up the use of solar water heaters in the commercial facilities in Morocco aimed to save about 800,000 barrel of imported oil over 4 years. This is equivalent to nearly US$700 million and a reduction of about 1.3 million of CO_2 equivalent. PROMASOL has had definite impacts that have gone far beyond the mere objective of contributing to the reduction of the country's dependency on fossil fuels. On the environmental front, PROMASOL is also expected to reduce about 920,000 tons of CO_2 per year until 2020.

With regard to its economic impacts, PROMASOL has increased the installed capacity of SWHs from about 35,000 m^2 of solar panels in 1998 to more than 240,000 m^2 in 2008, and the number of companies importing and/or manufacturing SWHs from about five to more than 40. In terms of its social results, the program is projected to create about 13,000 new jobs by 2020 (Allali, 2011).

C. Environmental Implications

The current fossil fuel-based energy system in the Arab region, as well as in other regions of the world, causes sever environmental damages along every stage of the energy value chain including exploration, extraction, transportation, processing, and conversion. Fossil fuel infrastructures are responsible for most air pollution exposure, hydrocarbon and trace-metal pollution in groundwater and soil, oil spills in oceans and rivers, and most greenhouse gas emissions. The costs to Arab societies are not only limited to the direct consequences on environmental degradation and negative health care outcomes, but they also entail costs affecting the entire productive capacity of Arab economies. Climate change will particularly threaten the economic and social gains achieved in Arab countries. It has been demonstrated that "climate strongly influences (so climate change directly affects) the availability of water; the productivity of farms, forests, and fisheries; the prevalence of oppressive heat and humidity; the geography of disease; the damages to be expected from storms, floods, droughts, and wildfires; the property losses to be expected from sea-level rise; the investments of capital, technology, and energy devoted to ameliorating aspects of climate we don't like; and the distribution and abundance of species of all kinds" (Holdren, 2008; AFED, 2009). The costs to Arab countries from climate change impacts in most of these dimensions under a business-as-usual scenario will be substantial. Arab countries may have already begun experiencing some of the effects of climate change.

A transition to a green energy sector offers many benefits, though, depending on the technologies used, in some cases environmental issues might arise. These benefits can result from the shift in patterns of electricity generation. First, carbon dioxide emissions can be greatly reduced and in some cases totally avoided. Typically, displaced emissions are considered to range between 0.22 ton CO_2/MWh and 0.73 ton CO_2/MWh, depending on the technology used (LBNL, 2007). Second, nitrogen oxides, sulfur dioxide, and particulate matter, all of which are harmful to human health and cause environmental problems, reduced visibility, and ground-level ozone, can potentially be reduced (IEA et al., 2010). Acid rain caused by sulfur dioxide can make lakes and rivers too acidic for animal and plant life, and also damage crops and buildings. Nitrogen oxides combine with other chemicals to form ground-level ozone or smog, which can irritate the lungs causing bronchitis and pneumonia. Third, water consumption that is usually used in traditional power plants for cooling purposes can be conserved. Note, however, that some designs for concentrating solar power plants (CSP) use significant amounts of water (NREL, 2010). Fourth, damage to land and water in the form of oil spills that kills plants and animals, or damage resulting from mining, drilling, refining, and transporting fossil fuels can be avoided. Some renewable energy technologies do affect land and water but to a much lesser degree; wind turbines can affect bird and bat species, and hydro projects have in some cases affected wildlife and ecosystems.

The economic costs of environmental degradation as a fraction of GDP in selected Arab countries were estimated by a World Bank study to range between 2.1% in Tunisia up to 4.8% in Egypt (Larsen, 2010). This was associated with health care costs of inadequate potable water, sanitation, and hygiene, health effects of outdoor air pollution in urban areas, and degradation of renewable natural resources (land and freshwater). Coastal degradation (affecting mainly recreation and tourism), health effects of household air pollution from use of solid fuels for cooking, and waste management were associated with substantially lower costs (Larsen, 2010).

V. CONCLUSIONS AND RECOMMENDATIONS

The energy sector in the Arab region has been and will continue to play a critical role in the region's socioeconomic development. Both Arab oil exporters and importers are highly vulnerable to the volatility of the global oil market. Greening the energy sector in the Arab countries would entail a myriad of economic, social, and environmental benefits.

Given the large disparities in the Arab region, the transition to green energy will vary considerably across different countries. Countries of high levels of GDP growth such as the GCC group with high carbon intensity and large per capita ecological footprint need to reduce their energy intensity without impairing their level of human development. Countries that still maintain relatively low per capita ecological footprints, should strive to achieve better human development without drastically increasing their ecological footprints.

The transition towards a green energy system aims, among others, at reducing energy poverty. This means providing energy to about 60 million people who currently lack electricity in the Arab region. Renewable energy technologies and supportive energy policies promise to make a significant contribution to improving living standards and public health in rural and remote areas.

Another direct benefit of shifting to green energy is to create "green jobs." Global experiences indicate that shifting to renewable energy technologies tends to generate more jobs than conventional energy technologies.

Adopting energy efficiency improvements

and renewable energy sources reduces the vulnerability of Arab economies to oil price volatilities, enhances energy security, and contributes to economic diversification. Improving energy efficiency would reduce energy demand and improve the trade balance, thus improving economic competitiveness. Green energy solutions reduce carbon emissions as well as exposure to air pollution.

A number of policy, market, and economic barriers need to be overcome in order to promote green energy in the Arab countries. This analysis recommends Arab countries to:

1. Remove the current barriers to transitioning to a green energy system including the lack of investment in R&D, education and capacity building, and integrated policymaking.
2. Reform the current legislative and institutional framework to facilitate transitioning to a green economy.
3. Provide an incentive system that encourages investment in energy efficiency and renewable energy technologies.
4. Adopt energy efficiency, demand-side management, and renewable energy as the cornerstones of a new energy policy, based on coordinated efforts involving government, the private sector, the financial sector, and the other concerned stakeholders.
5. Continuously adjust energy prices to reflect the real economic cost, scarcity, long-range marginal cost, and environmental damage. Energy pricing reform is an effective tool for the rationalization of energy consumption and shifting to low carbon development, while at the same time resulting in substantial increases in government revenues. These revenues should be reallocated to spur expansion in energy efficiency and renewable energy technologies.
6. Initiate a policy debate to formulate a new institutional mechanism to secure coherence of energy and climate policies in the Arab region.

Arab countries should embark on a massive long-term, regional program to scale up the use of wind and solar energy. Such a program would help diversify Arab economies and ensure the security of energy supplies, while guaranteeing Arab countries a sustainable and leading market position as green energy exporters.

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NOTE

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