Renewable Energy in the Arab World

Transfer of Knowledge and Prospects for Arab Cooperation

Prof. Dr. Odeh Al Jayyousi

FRIEDRICH EBERT STIFTUNG

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Foreword

Richard Probst

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The trend of renewable energy expansion has started to reach also the Middle East and North Africa (MENA) region. After first experiences have been made since the 80s, more and more countries currently come up with national renewable energy strategies. These ambitious strategies show the will of these countries to shift their energy production from fossil fuels to renewable energy sources. In the time of writing, many MENA countries are implementing - or have already realized - a number of large solar and wind power projects. But, will these achievements really be the start of a profound shift to a renewable energy future in the entire region? What lessons can be learnt from past experiences? How can the countries of the region build up institutional capacities and learn from each other?

The book “Renewable Energy in the Arab World: Transfer of Knowledge and Prospects for Arab Cooperation” assesses these important questions. The author, Dr. Odeh Al-Jayyousi, addresses the current discourse in the region, the future and the potential of renewable energy in the Arab World. He argues that the imperative for macro-shifts in minds and a transformation from "addiction to oil" to green energy needs first and foremost a strong political commitment. In addition to that, it needs an enabling environment to reach a critical mass and a tipping point in R&D, policy reforms, and technology. The author argues that renewable energy and its technology are likely to make shifts in the types of decentralized governance structures and the economic model. Additionally, he is right in underlining that a transformation towards a systematic use of renewable energy could open new regional cooperation models for the MENA region and being an important political tool for further cooperation.

In 2015 FES in the MENA region created a regional sustainability-project, working on Renewable Energy and Climate Change. The office of FES Amman serves as a regional link for MENA activities under this sustainability project. The establishment of this project is in line with the energy-political shifts within the region. The project supports and encourages a transition towards an energy supply based on renewable energy sources and the search for suitable policies to promote energy savings and energy efficiency measures. The team of FES Amman is very grateful for Dr. Odeh Al-Jayyousi' valuable contribution and thanks him as a long-standing partner ■

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"And have you seen the fire that you ignite? Is it you who produced its tree, or are We the producer? We have made it a reminder and provision for travelers."[1]

"Allah is the Light of the heavens and the earth. The example of His light is like a niche within which is a lamp, the lamp is within glass, the glass as if it were a pearly [white] star lit from [the oil of] a blessed olive tree, neither of the east nor of the west, whose oil would almost glow even if untouched by fire. Light upon light. Allah guides to His light whomever He wills. And Allah presents examples for the people, and Allah is knowing of all things."[2]

The Prophet Mohammad (PBuH) said:

"People are partners in three items, water, herbage, and fire."

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[1] The Holy Qur'an, Sahih International, Surat Al Waqi'ah 56, 71-73 **http://quran.com/56**

[2] The Holy Qur'an, Sahih International, Surat Al Nur 24, 35 **http://quran.com/24**

Dedication

To my parents and family
To my wife Saheer
To Muath, Noor, Leena, and Omar
To all who believe in a greener world

Acknowledgment

This book would not have seen light without the dedication and support of FES team, specfically, Anja Wehler-Schoeck, Richard Probst, and Amal Abu Jeries. I thank the contributers and reveiwers for the text, specifically, Dr. Al-Moayyaad Al-Sayyed, Dr. Ayoub Abu Dayyeh and Eng. Walid Shahin. Their valuable support throughout the process is apprecaited.

Introduction

Introduction

This book aims to shed light on the opportunities for the localization and exchange of knowledge on renewable energy in the Arab world.

At school, we are taught the Arab world has an oil wealth that qualifies it to progress and develop into a knowledge economy. But with time, we discover a curse attached to oil. Oil-rich countries were not able to build an integrated Arab economy that achieves welfare for the rich and poor alike. We found the opposite happened. The Arab world was marked by two conditions: extravagance and excessive spending on the one hand, and corruption and the absence of good governance on the other. During the past two decades, despite the information and communication revolution, the Arab world did not optimally invest in these information technologies. For instance, although the Arabian Gulf region is the highest consumer of desalinated water in the world, it did not develop and localize water desalination technology; instead, it remains the highest importer of this technology. And today, we stand on the threshold of a new century marked by the shift to renewable energy, and the use of clean energy.

Internationally, and in the light of new discoveries of fuels such as oil shale in America, which will reduce America's dependence on Arab oil, and with India and China's accelerated growth, and their need for more of the Arab world's oil resources, Arabs will find themselves confronted by a few issues, in order to maintain their ability to export oil, the abundance of which has become of limited future.

First: Will Arabs develop a new Arab vision to localize renewable energy resources and develop a new Arab structure that includes the rich and the poor, or what I have dubbed the Green Cooperation

Council (GCC), which will include all oil-producing and oil-poor countries including Jordan, Palestine, Iraq, Lebanon and Tunisia? There is an opportunity to link information and communication technologies with green energy to develop a regional Arab cooperation system based on common interests.

Second: Will investing in science, technology, innovation and scientific research become an Arab and national development priority? Accumulating knowledge and access to the critical mass of scientists, researchers, entrepreneurs and businessmen needed for the transition to a green economy based on renewable energy has been problematic. Investment in science, and scientific research, has to be an Arab and a national priority because the process of cognitive transformation and building a knowledge economy is an urgent need for the future.

Third: The duality of renewable energy and nuclear power in the Arab world will remain problematic unless an enlightened discourse with accurate information exists between decision makers and civil society. The energy mix in the Arab world is likely change in the future in light of diminishing oil resources, and the availability of clean renewable energy sources, or alternative conventional sources, such as gas in the eastern Mediterranean and oil shale in Jordan. But it is necessary to differentiate between the availability of raw energy sources and the capability to utilize them in an economic and environmentally friendly manner.

In short, the Arab world will witness profound changes on the renewable energy front due to the development of technology to optimize, store and transport this energy, alongside the availability of traditional energy sources, such as gas and oil shale that will in turn affect the nature of energy monopoly. The capability to transmit knowledge, innovation and technology (intellectual capitalism) will remain the determining factor in who will take charge of the future ■

1

Chapter One

Energy and Sustainable Development

“Like camels in the desert dying of thirst while their backs are loaded with water.”

1.1. Introduction

This line of Arabic poetry illustrates the paradox the Arab world lives, with scarce water and food, yet surrounded by an abundance of natural resources. The paradox is that water is loaded on the camels’ backs, while the camels are dying of thirst. This problem of spatial proximity of resources, yet the inability to transfer, convert, and benefit from such resources, continues to haunt many thinkers and policy-makers in Arab countries. This book is an attempt to study and understand the societal shift to a knowledge society, and how to overcome the knowledge gap in terms of energy technologies and policies which have a local dimension relating to research, development, innovation, and intellectual capital, and another policy dimension tied to governance and associated transparency, fairness, social justice, and the right of access to information. There is also a third level, which is the regional and international framework (Landscape Level), which includes institutions, legislation, economic interests, the economic relationship between East and West and hegemony and subordination.

There are many publications and much research that address the issue of renewable energy in the Arab region, but they revolve around technical minutiae such as energy efficiency, supply and demand, energy technologies, energy markets, and investment in the renewable energy sector. The Arab library, however, is almost devoid of research on the transfer of knowledge, energy policy, and governance in the renewable energy sector in Arab countries. The explanation for this may be that the Arab region is rich in fossil energy sources (oil and gas), which led to the phenomenon known as the "resource curse."3 It led to a failure in developing knowledge institutions to localize knowledge, initiative, and innovation. This was accompanied by enormous wealth from oil revenues, which manifested itself in the importation of Western goods, culture, and consumption patterns, without developing local technologies and absorbing technology in terms of energy production, water desalination, and information technology. In reality this constitutes missed opportunities during the past five decades.

But today, we have a new opportunity to reconsider our approach to localizing renewable energy technologies on economic and rational foundations that benefit from the human energy of the youth,[4] access to the world through the information and communication revolution, and the evolution of the concept of governance and social justice.

[3] The term "resource curse" is often used in economic literature to denote the negative economic effects of natural resources, especially oil. Large-scale production of oil has led to a rise in foreign currency reserves, hence a rise in the national currency's exchange rate, which in turn led to an increase in imports and a decrease in exports. This weakened the domestic agricultural and industrial sectors, which were nascent at the time when oil exports started, causing a rise in unemployment. Various governments tried to solve this situation by pumping more money in the national economy, which raised inflation without causing a real decrease in unemployment. This prompted many economists to propose isolating the oil sector from other economic sectors. For more on this subject refer to the book "Escaping the Resource Curse" by Macartan Humphreys (2007), Columbia University-New York.

[4] The young in the Arab world constitute more than 68% of the population, which is the base of the Arab population pyramid (UNDESA, 2012).

A diagnosis of the state of Arab countries in the areas of energy and governance reveals that some oil countries live under traditional centralized regimes, Bunker States, such as Algeria, Libya, and Yemen, while others live in a liberal system open to the West and globalization, such as the United Arab Emirates (UAE), Qatar and Saudi Arabia, along with other oil and gas-importing countries, such as Jordan, Lebanon and Tunisia. There are material differences in the structure of Arab countries at the level of governance, culture of innovation, technology, and scientific research in renewable energy. This is linked to the model of economic development in countries that produce and export oil, called Rentier States in economics. Renewable energy policy is associated with policies on industrialization, research and development energy security, and the sustainability of the current political order, which is governed by ineffective regional institutions. There are fundamental questions that must be addressed:

Are the institutions dealing with renewable energy in the Arab world capable of generating knowledge? Do energy sector institutions in the Arab world have the vision to be learning organizations? Are the Arab regional institutions able to develop a common vision for sustainable regional programs and initiatives? Can we, in the Arab world, adopt Western models in the transfer of knowledge and governance?

Contemplating on the initiatives and projects for electrical linkage and regional investment in energy, one wonders: Is it possible for regional initiatives and projects in renewable energy to open new horizons for regional integration (regionalism), since regional projects across the Mediterranean, North Africa and Europe need political stability and energy policies to stimulate private sector investment?

Governance systems in renewable energy in the Arab world are neither mature nor stable, and therefore, copying a Western model in the context of the Arab region is problematic. It is imperative to develop a model that suits the Arab region, and the nature of the enabling environment. For instance, the Feed-in-Tariff experiment cannot be copied without taking into account the economic, social and political context, as well as market regulations, flexibility of legal framework and the selection of optimal technology. Jordan, however, has succeeded in this experiment. About 30 MW were linked by the end of 2014, in less than two years, using local investments and with no cost to the state. There is no doubt these contexts should be studied in their different dimensions for the experiment to continue successfully.

This book is a modest effort to try to understand how the transition to a new economy in the Arab region depends on the accumulation of knowledge, the transfer of expertise, the development of a new culture of research and development, technology management, innovation and entrepreneurship, and the development of the private sector's role in renewable energy.

The objectives of this research can be summed up as follows:

- To document some successful Arab experiences in the renewable energy sector

- To develop a vision for the transfer of knowledge in the renewable energy sector among Arab countries.

- To examine the role of energy projects across national boundaries in promoting regional cooperation and integration.

1.2. Historical Background

The beginning of the twenty-first century witnessed an extensive debate on environmental issues such as energy, sustainability, and climate change, economic issues such as poverty and the global financial crisis, and finally health, such as the fight against AIDS, and swine flu. Environmental, economic, social and health issues have come to embody a state of imbalance or corruption in the land, through depletion of resources, excessive consumption, monopoly of goods, and greed. All of which disrupted the balance between the universe, humanity, and life.[5] Since nature, with its forests, plains, rivers, seas, soil, and air, represents a natural capital available to humans, hence, any dysfunction or abuse in investing in this natural capital would negatively affect life in its entirety.[6]

The twentieth century had witnessed a wide debate on the negative impact of the Western development model, its growth concept, its link between the pursuit of happiness and excessive consumption, and its conversion of luxuries into necessities. Environmentalists also criticized the Western development model and its negative impact on the degradation of natural resources, pollution of water, air and soil. This criticism is consistent with Islamic thought, which considers the Western approach to development had converted natural resources into commodities.[7]

Today, at the threshold of the twenty-first century, we see the rise of Asian countries such as China and India. China's spiraling growth, for instance, requires consumption, and constitutes a drain on the

[5] Adams, W. M. and S. J. Jeanrenaud, *Transition to Sustainability*, Gland, Switzerland: World Conservation Union. 2009. pp.8-30.

[6] Odeh Al Jayyousi (2012), Islam and Sustainable Development: A New World Views, Gower Publishing, London, UK.

[7] Jackshon, Tim (2009). Prosperity without Growth, Earthscan, UK.

planet's resources, including meat, iron, wood, and energy. Which leads us to question the feasibility of adopting the Western model in terms of excessive consumption and use of fossil energy (gas, coal, oil), which adversely affect human health and harm the planet and economy. Therefore, it becomes necessary to critically review the model of Western development, which has failed to deliver successful solutions to human, economic and environmental problems, due to its dependence on domination, exploitation and unfair speculation. Besides the financial crisis the world witnessed at the beginning of 2008, and all its global spill-over effects prove the need for a new model that achieves social justice, human well-being, food security, and protects the Earth's resources.[8]

The past hundred years have seen an increased production, but it led to an unprecedented deterioration of the ecosystem, which is a form of destruction and corruption of the land. From an economic point of view, when growth becomes economically ineffective as a result of negative side effects,[9] it becomes essential to review the model of development, and the metrics of growth measurement that currently rely on the Gross Domestic Product (GDP). This includes many harmful industries such as the tobacco and arms industries, as well as the pretexts for these industries, which are presented as necessary positive values. New metrics need to be adopted such as the sustainability index, the human development index, and the index of national happiness among other indicators.[10]

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[8] Al-Jayyousi, Odeh, The State of Ecosystems and Progress of Societies, In: OECD, *Statistics, Knowledge and Policy. Measuring and fostering the progress of societies*, 2008, pp. 441-451.

[9] It is important here to distinguish between growth and development. Growth aims to make things bigger, while development aims to make things better.

[10] Al- Jayyousi, Odeh. The State of Ecosystems, op cit. pp. 441-451.

The communist regime, which collapsed, had failed to achieve social justice, just as the current capitalist system has proved unable to protect the environment and its ecosystem services. The cost of environmental degradation in countries such as Jordan, Egypt, and Lebanon is estimated at about 2%- 5% of the gross national income.

Perhaps the most important lessons that can be learned from past civilizations are their inability to anticipate and respond to future risks to develop effective solutions to various pressing problems such as food security, for example. Dependence on a single crop, corn in agriculture, undermined those great civilizations[11] when they had faced a climatic disruption, such as drought. The Mayan civilization disappeared for several reasons, most notably the destruction of natural resources (natural capital) through over-logging, soil erosion, climate change, droughts, wars, focus on monument construction, failure to address the root-cause of problems, weak trade relations with friendly communities, and interest in luxuries. History is full of examples of civilizations that became extinct, such as the Anasazi and Easter Island, as a result of conflict between them, which raged after they had depleted most of the surrounding environmental resources.

When the concern for environment reappeared on the global political agenda in the eighties, the main global focus was on acid rain, depletion of the ozone layer, and global warming. Analysts started searching for causes. Report after report concluded that the current development model and industry-related progress activities are not sustainable. To have a sustainable future, humans cannot continue current practices with respect to energy, forest management, agriculture, protection of plant and animal species, urban growth

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[11] Diamond, Jared. Collapse: How Societies Choose to Fail and Survive. London. London: Penguin Books, 2005, pp.136-156.

management, and consumption and production patterns. It is also certain that we cannot continue the current rates of world population growth.

Energy, in particular, is an area, like the Arab region, where we are unable to sustain fossil resources. Most of today's energy is produced from fossil fuels: coal, oil and gas. In the mid-eighties the world burned the equivalent of 10 billion metric tons of coal each year (see Figure 1.1), and this rate was expected to increase to the equivalent of 55 billion metric tons by 2025, which would increase pressure on these non-sustainable resources, and subject the Earth to deeper climate change and global warming threats. Fossil fuels should therefore be used more efficiently; alternative sources of energy must however be developed simultaneously, in order to achieve economic development without drastic changes to the Earth's climate.

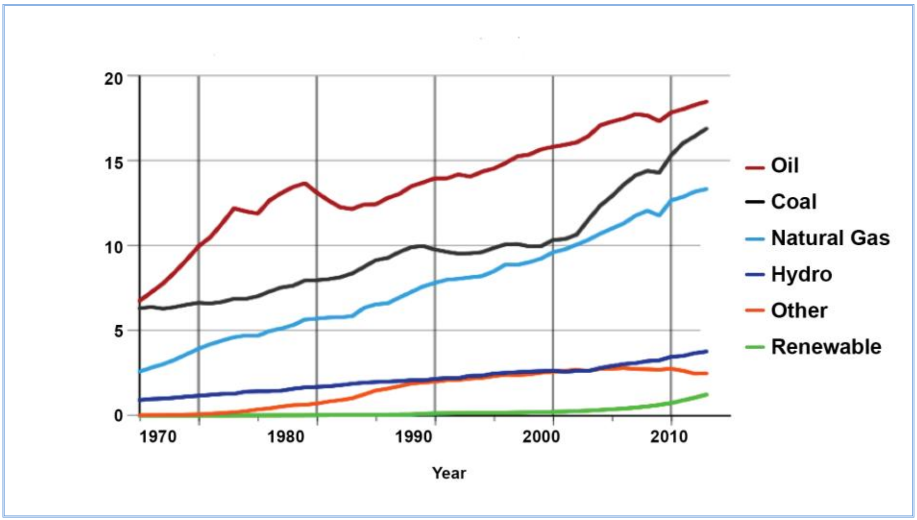


Figure 1.1: Global demand for oil and the enormous rise in the period 1970-2010 (Units in billion metric tons)

Interest in sustainable development is not merely a quantitative change in dealing with resources; it is essentially a qualitative change. More than a decade ago, the International Union for Conservation of Nature, through coordination with the United Nations, and representative governmental and private organizations, defined sustainable development as "development related to the biosphere and the application of human, financial and living and non-living resources to satisfy human needs and improve the quality of human life." Therefore, resources must be used to meet the needs of present and future generations. But many major industrialized nations, under the shadow of capitalism, seek to increase production and achieve high economic returns under the pretext of needs and lifestyles. This is why Robert Goodland and Herman Daly, of the World Bank, believe that development carried out by rich countries should be used to free resources for the growth and development of poor countries, where the need for such resources is most pressing. There is also a need for a large-scale diversion of resources to poorer countries.

Sustainable development requires a genuine interest in the future needs of people. There must be a new common vision, and common ethics based on equal opportunities, not only between people and nations, but also between successive generations and nature. Sustainable development requires new technology and new methods of trade, transfer of knowledge and goods, and new ways to meet the needs of the people regardless of their geographic location.

With the widening gap between the nature of technology and social organization, many people will remain poor despite sustained economic growth. Poverty would then lead to the deterioration of environmental resources and become, in due course, a factor that curbs growth. To achieve clean and equal economic growth, it is essential for commercial and industrial enterprises to design strategies that maximize the added value of their outputs, while using minimum resources and energy needed (increase input efficiency).

Human evolution is associated with the ability to harness different types of energy (fire, coal, oil, gas, etc.) for human prosperity and progress. But shifts from one type of energy to another is dictated by technical, natural and environmental considerations, because of limited natural resources and the effects of energy use in industrial and economic development. However, human dependence on one type of energy, notwithstanding its abundance, leads to problems in the economic structure, or the so-called resource curse. So, the idea of growth for its own sake has become a thing of the past. Humans realize the consequences of using fossil fuels (coal, oil and gas) in terms of carbon dioxide emissions and climate change, therefore the orientation toward sustainable development to change the development pattern and attitudes, and decouple growth from depletion of energy. For instance, growth in the Arab region is estimated at about 4%, while the fossil energy consumption is estimated at about twice that at 8%.

Humans also realize the link between water, food, energy, and the environment, and the need to understand the interdependence between different sectors to achieve security in energy, water and food. But the beginning of the oil era in the Arab region, about a half-century ago or more, was accompanied by a major shift in consumption patterns, steady growth in the import of luxury goods, failure to absorb oil technologies and oil-related industries, and water desalination despite the presence of a third of oil reserves in the Arab region and the presence of the world's largest consumer of desalinated water.

Today we are on the threshold of a new decade marked by the use of renewable solar or wind energy in the Arab region. Pioneering projects are launched in Arab countries such as Tunisia, Morocco, Egypt, the GCC countries, Algeria, and Jordan. At this juncture, it is important to reflect on a number of fundamental and vital issues related to the shift toward sustainability, which include government subsidies of oil and its impact on the transition to renewable energy and a green economy. It is also imperative to think of developing a base for research and development in renewable energy and developing the private and investment sectors for public-private partnership.

With the accelerating pace of sustainable development and population growth, dependence on energy from fossil fuel has become enormous. In Saudi Arabia, for instance, by 2030, about 20% of energy such as oil will be used in electricity generation.[12] This prompted many industrial and productive countries to invest in renewable energy, especially in Arab countries which enjoy high thermal radiation, in order to achieve energy security, and reduce climate change within the concept of the transition toward a green and sustainable economy.

But there remain important questions when reflecting on energy issues in the Arab region, which can be summarized as follows:

- Would it be possible to achieve regional cooperation and integration in the Arab region through regional energy projects?
- Can the Arab region invest in renewable energy to create new opportunities for small and medium enterprises, and absorb and localize industry, research and development in renewable energy?
- Would it be possible to simulate success stories in renewable energy applications in the Arab region in the context of an integrated management of knowledge within the knowledge economy?

Perhaps the experiences in different parts of the world, like the European Union (EU), China, India, Japan, and America may offer different models for transferring knowledge, linking it to institutional and societal culture, modern development, transformational leadership, and developing a learning institution in the energy sector. There is also

[12] "Electricity Generation Analysis in Oil Exporting Countries" by Arash Farnoush, 2013

a pressing need to study and reflect on the international experience in energy projects across continents and countries as a means to develop a new system of regional cooperation and solidarity, and achieve new norms and values that stress co-existence and sustainable development through joint action for an energy, water and food-secure zone.

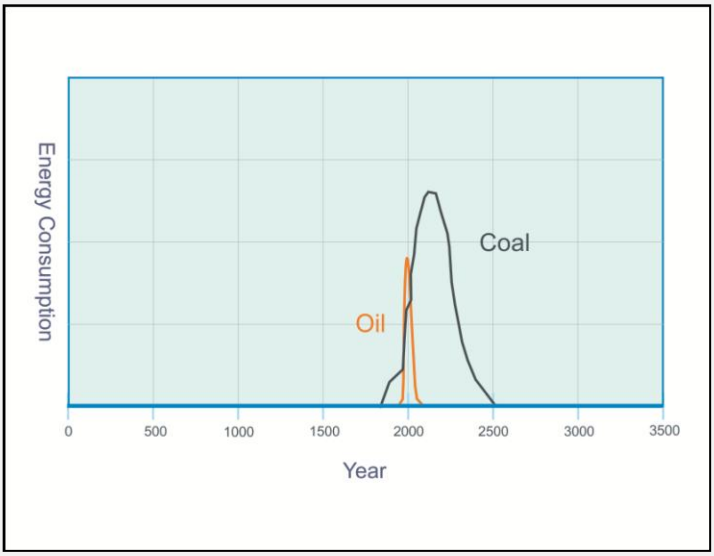
There are, for example, electrical interconnection projects in the Arab region between Egypt and Jordan, and there are proposals to transport oil, gas and water across countries, to achieve regional integration. But fundamental questions remain: To what extent would it be possible to develop a new governance framework in the Arab region that transcends national borders? And what conditions are necessary and sufficient to develop a new vision of shared infrastructure in the water, energy and food sector, such that an integrated and cohesive community may emerge with a new social contract based on a new economy -- an economy based on knowledge and learning from international experience?

There is a close historical link between human security, energy use, and the socio-economic structure of any society. The earliest documentation of energy in human history hails back to the Mesopotamian civilization (3500 BC), which relied on human muscle power to accomplish different tasks. With the development of agriculture, and the requirements of war, this source of energy was no longer sufficient, so slavery emerged to provide the labor force needed to construct canals, irrigation works and edifices. Early humans knew the power of wind, water and sun, but they lacked the science and technical know-how to employ this energy in development. But in the twenty first century, with the development of techniques for the use of renewable energy, the question becomes: can renewable energy provide energy security in the face of fluctuating oil prices and the impact of climate change and poverty?

Since the early seventeenth century, coal contributed to the development of industry as a source of energy. Then oil and gas became increasingly important in the twentieth century as shown in Box 1. But the negative effects of using of fossil fuels and the United Nations Framework Convention on Climate Change (UNFCCC) pushed industrialized countries to reconsider the use of coal and shift to renewable energy.

Box 1: The short life of oil in human history

Civilization depends on cheap energy from oil, coal and natural gas, which can be employed in different and increasingly numerous uses. The question is, are these materials sustainable on the long term? The figure below shows the limitations of oil compared to coal.



In Box 1 above, rotate 180 degrees the term on y-axis "Energy Consumption", coal is one of the most abundant fossil energy sources, since it is derived from biomass and wood, which are composed of carbon and hydrogen; but it is a less clean than oil or gas. It is necessary, therefore, to make a transition to green energy in order to reduce the effects of pollution and adapt to potential post oil era. So the world now sees initiatives to shift toward alternative energy. For example, the use of renewable energy in Denmark increased by 80% over the last three decades, due to the presence of a government vision and innovative enterprises. China is also increasing its dependence on renewable energy; it is now the world's top producer of solar panels to generate electricity, with 1.5 million people working in the renewable energy sector. But the problem with renewable energy that with government subsidies for fossil fuels, the price is not competitive and neither is the industry. Despite investment volume and studies in renewable energy, the shift to renewable energy would require profound changes in energy policies, economic structures, industry and governance.

MENA is endowed with enormous wealth from fossil energy sources. They have more than half of the world's crude oil supplies and one-third of its natural gas reserves. They were the world's principal suppliers of oil for the past five decades. So in light of cheap oil prices, there was no incentive to switch to alternative energy. The abundance of cheap oil contributed to increasing consumption and raising the standard of living and industrialization in many countries, especially the Gulf Cooperation Council.

But when oil prices rose to $147 a barrel in 2007, eyes turned to renewable energy. Even giant oil companies became active investors in solar and wind energy. Projections indicate that by 2030, this region will become a consumer of energy due to the sharp rise in energy consumption, which would come at a great economic cost. The increase in oil prices in the global market since the beginning of 2000 led to an increase in the prices of petroleum products in the region's energy importing countries. By contrast, the energy-exporting countries will reallocate or transfer part of this oil for domestic consumption, thereby losing its opportunity cost.

Box 2: Arab States and Energy: Three Groups

Energy has an impact on the economic, trade and development system. Countries in the Arab region can be classified into three groups:

Group I: Oil-exporting countries that earn revenues from oil exports, such as the Gulf Cooperation Council, Algeria, Libya and Yemen.

Group II: Countries that changed from oil-exporters to oil-importers such as Syria, Egypt, and Tunisia. This shift had implications for the general budget.

Group III: oil-importing countries such as Lebanon, Jordan, Morocco and Palestine.

Source: Energy subsidies: A roadmap for reforms in the southern Mediterranean MED-ENEC (2013)

1.3. The Oil Curse Phenomenon

Since the eighties, many researchers were occupied with the unfortunate phenomenon named the “oil curse phenomenon”. A number of people working in institutions that give aid to developing countries noted that oil, instead of improving the situation in countries that are endowed with it, continues to experience this unfortunate phenomena in these countries as outlined below:

First, the country's dependence on oil revenues increases to the point where it becomes completely reliant on them after a short period of time.

Second, the national economy that is not related to the oil industry deteriorates progressively and shows negative growth instead of improving with the increase of the country’s oil revenue.

Third, the governing regime regresses in most cases toward the lack of democracy, monopoly action of decision-making, expansion of the police and security services in order to maintain the regime in power, and other frightening phenomena of the disconnect between the ruling factions and the opposition.

Economically, researchers discovered that growth in non-oil sectors is inversely proportional to the growth of oil sector revenues’ proportion of the gross national product; what is new in this important observation is that it proves numerically what was known qualitatively in economic circles, especially after the phenomenon of the Dutch disease. This serious phenomenon that afflicted the Dutch economy in the sixties (after the discovery and production of gas) raised concerns among economists throughout the world. The Dutch disease was the main reason for Norwegian authorities’ extreme reservations at the start of oil operations in the North Sea.[13]

[13] *Al Namouthaj Al Narweij (*The Norwegian Model) *Alam Al Ma’rifah* (World of Knowledge) Publications, Translated by Farouq Al Qassem, Issue 373, 2010

To explain the phenomenon, economists offered the following explanations:[14]

First, when oil or gas are discovered in any country, human nature pushes most people to hasten to take advantage of this instant wealth by participating in oil-related operations either directly, by engaging in the sector, or indirectly by providing operators with the services they need. High wages in the oil sector lead to higher wages in other sectors in the country, and consequently the cost of production becomes much higher than the counterpart cost of competitors, whether in neighboring countries or internationally. As a result, non-oil industries in the country lose their markets and in due course shrink or are completely destroyed, which raises the unemployment rate in the country. From another perspective, the sudden rise in oil revenues produces a significant rise in the national currency's exchange rate, which creates a strong attraction for international investors to invest their money in the oil-producing country. This adds to the upward pressure on the national currency's exchange rate relative to neighboring countries and countries that compete commercially. For this reason, in addition to the rise in wages as noted earlier, the cost of the country's products increases.

Second, the country's most able and talented people rush to join the oil sector. This reduces the level of talent remaining in traditional non-oil industries, which reduces the quality of products compared with the competition in other countries that do not have the same difficulties. The situation is compounded because government authorities may be unaware of these developments if they were not prepared for them in advance. As the country's oil revenues increase, the authorities tend to deal with the economic problems superficially

[14] Ibid

(for example, through grants and compensation for some endangered industries), which increases the country's dependence on larger oil revenues instead of addressing the root causes of the malady by preventing the rise in production costs of non-oil commodities and managing the crisis.

From a political perspective, high oil revenues provide opportunities for the country’s rulers to strengthen their grip on power using methods made possible by the oil revenues. For instance, rulers can provide many immediate benefits that make citizens satisfied with the government, through grants or donations, which do not strengthen production in the country, and often harm the national economy. Examples of these measures include increasing salary levels, which increase consumption and in turn, increase imports.

The vast disconnect created by some regimes, between the interests of citizens and the interests of groups that benifit from poor governance, leads in most cases to the leakage of billions of dollars to foreign banks. For this reason, the citizens’ oil wealth is spirited away to places where it cannot be used in the country nor retrieved later. The greatest loss this drain of national wealth represents is the ugliest and most dangerous experience of the oil curse. In these unfortunate circumstances, all notions of good governance disappear, as a guarantee of citizens’ security or the rule of law, including judicial independence, integrity of government bodies, and objectivity of decisions in the state apparatus. Under these circumstances, efficiency in government and civil institutions also disappears, because its role as a necessary pillar of the system of governance and justice is eliminated. Because oil is a fast track to wealth for some groups and individuals, and in most cases it becomes a cause of conflict between individuals, parties, groups, tribes or regions that aspire to control power over oil resources because they see this as a way to achieve their own narrow interests quickly.[15]

In the worst case scenario, the bad consequences of the oil curse do not stop at this point, but go beyond it to much more dangerous levels because they erode social mechanisms and moral values that unite the country around the common good. Under these circumstances the worst justifications for destructive behavior arise, and individual greed and corruption become justified as an ordinary part of business and commerce.

Box 3: Economic Growth and Demand for Energy

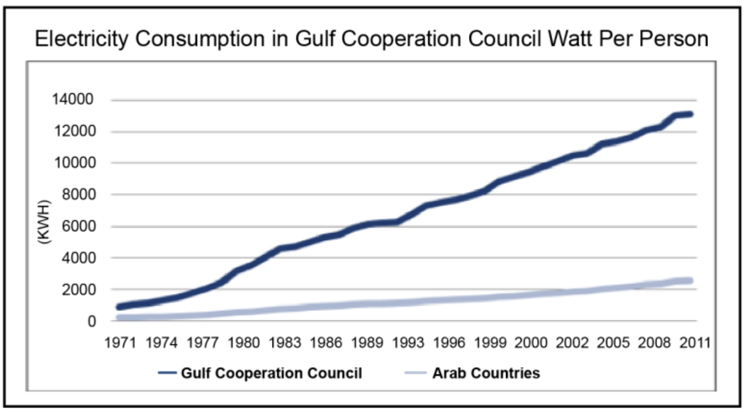
It is noted that demand for energy in the Arab region grows faster than economic growth. During the period 2000-2009, demand for energy increased from 144 - 210 MTOE, an increase of 46%, while during the same period, demand for electricity increased from154 - 294 TWh, an increase of 91%. This increase is due to several reasons: population growth, rise of standards of living, and consumption patterns. The greater energy consumption occurred in the GCC oil-producing countries as shown in the Box 4.

Source: Energy subsidies: A roadmap for reforms in the southern Mediterranean MED-ENEC (2013)

[15] Ibid

There is a wide variation in the Arab region between countries that produce oil and gas, and those that do not. In the Gulf countries, high and disproportionate energy consumption patterns prevail. Electricity consumption there more than doubled during the period from 1999 - 2011. GCC countries should not remain content to depend on the availability of long-term supplies; they should seek to transfer their oil resources to value-added products, particularly natural gas which has a high export cost. By contrast, countries that do not produce oil or gas suffer from the high-energy bills and costly energy consumption subsidies. At the same time, more than 20% of the Arab region's population still does not have modern energy services, with frequent power cuts in many parts of the Arab world.

Box 4: Electricity Consumption in GCC Countries



Source: ESCWA (2014), Aims of sustainability: the Arab perspective, Conference on Sustainability, Amman, 2nd-4th April 2014

In conclusion, there is steady population growth and energy consumption in Arab countries, government subsidies of fuel, rising poverty and unemployment, and failure to achieve the Millennium Development Goals (see Boxes 4.5, 6) *(but energy security is part of post UN Agenda)*. All this leads to pressure on the environment, represented by higher consumption, greater pollution, and deterioration of space, air, soil, and water (the ecosystem services of the environment). This will push governments to develop legal and institutional frameworks and initiatives, as well as small and medium projects in renewable energy.

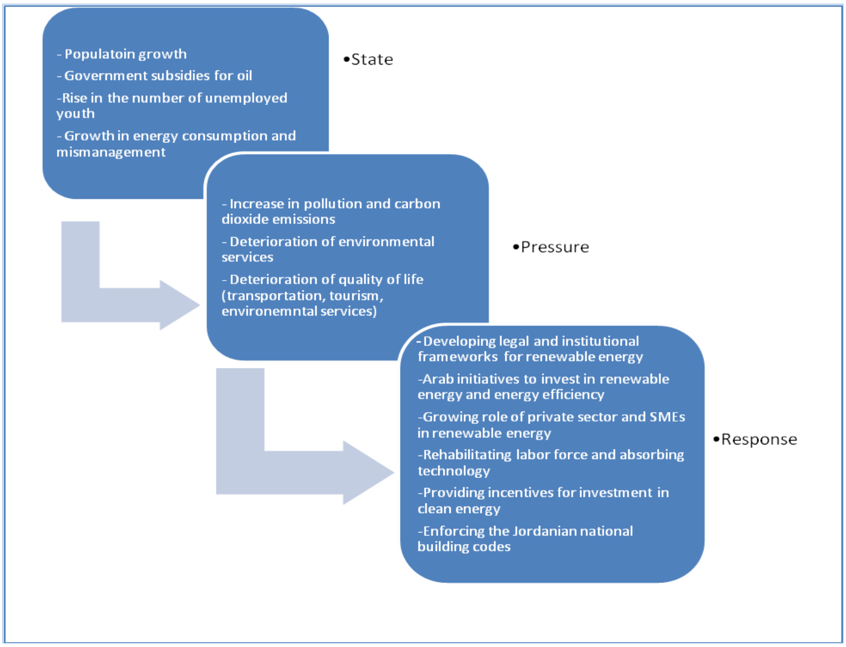
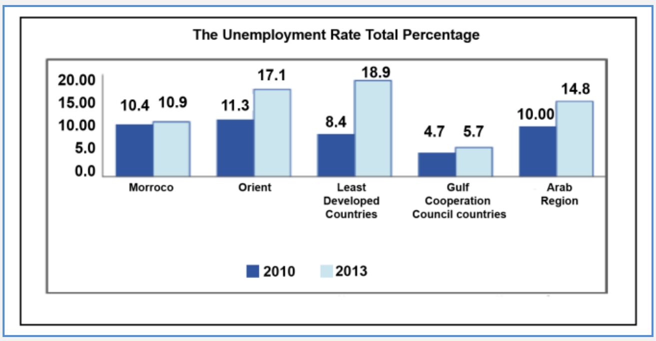


Figure 1.2: General model for analyzing the state, pressure and response to shift to renewable energy

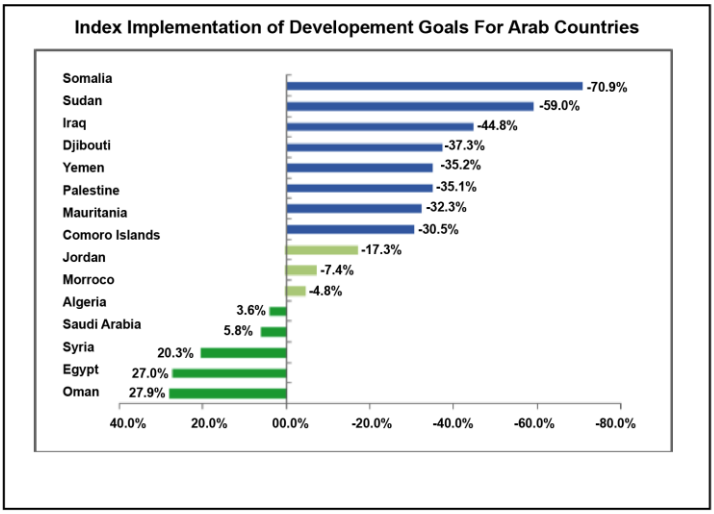
Box 5: Gross Unemployment Rate in the Arab Region

The lack of appropriate employment opportunities, particularly for young people, was one of the main motors of the revolutions in Tunisia and Egypt in 2010-2011. Economic policies in the region were not able to absorb entrants into the labor market, as evidenced by rising unemployment rates, which reached 15% in 2013. In the least developed countries, as well as the countries of the Mashreq, unemployment rates were particularly high, at 19% and 17% respectively. As a result of the economic and political situation in some countries, labor market conditions deteriorated and unemployment rose, especially among the more educated youth. In Tunisia in 2011, for example, the unemployment rate among university degree holders stood at 32% and the proportion of females among them was larger at 44%. Youth unemployment in the Arab region is among the highest in the world, with one out of every four young people unemployed. Unemployment among young women in the region is even worse, at an average of about 40%, and it is noteworthy that the situation grew worse between 2013 and earlier.



Source: ESCWA (2014), Aims of sustainability: the Arab perspective, Conference on Sustainability, Amman, 2nd-4th April 2014

Box 6: Degree of fulfillment of Millennium Development Goals in Arab countries



Source: ESCWA (2014), Aims of sustainability: the Arab perspective, Conference on Sustainability, Amman, 2nd-4th April 2014

2

Chapter Two

Methodology of Research and the Conceptual Framework

Economic transformation is vital for sustainability. The Stone Age did not end because people ran out of stones!

2.1. Introduction

The attempt to develop a theoretical framework for the subject of renewable energy in the Arab world needs a deep understanding of the concepts of region and regionalism as a unit of analysis. The Nation State in the Arab world is a relatively recent idea, and many countries still have fundamental and structural dilemmas in governance, absorbing knowledge, science and technology, innovation, and entrepreneurship in small and medium enterprises (SMEs). The system of Nation States, therefore, does not have the critical mass to generate a fundamental shift, unless we look at the regional system. For example, energy security in Jordan and the provision of gas is linked to neighboring countries such as Qatar, Saudi Arabia and Egypt. We know there is virtual water in the import and export of food across borders, and similarly there is virtual energy and capital in importing and exporting different commodities between North and South.

There is cross linkage in energy issues at the international, regional and national levels due to the inherent interconnection between energy issues and sustainable development, and the interconnection between water, energy, and food. It would be possible to consider renewable energy issues in the Arab region in four dimensions: need, technology, institutions, and knowledge as shown in Figure 2.1. This virtual energy is growing in light of globalization and e-business because they provide virtual trade and e-learning.

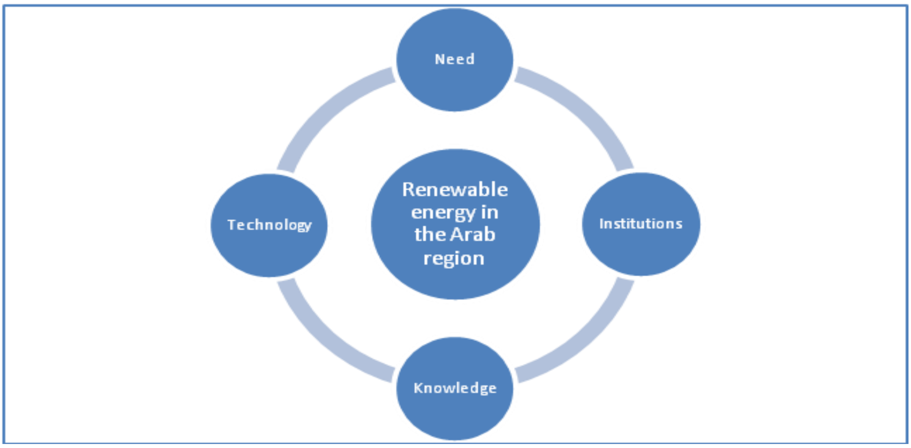
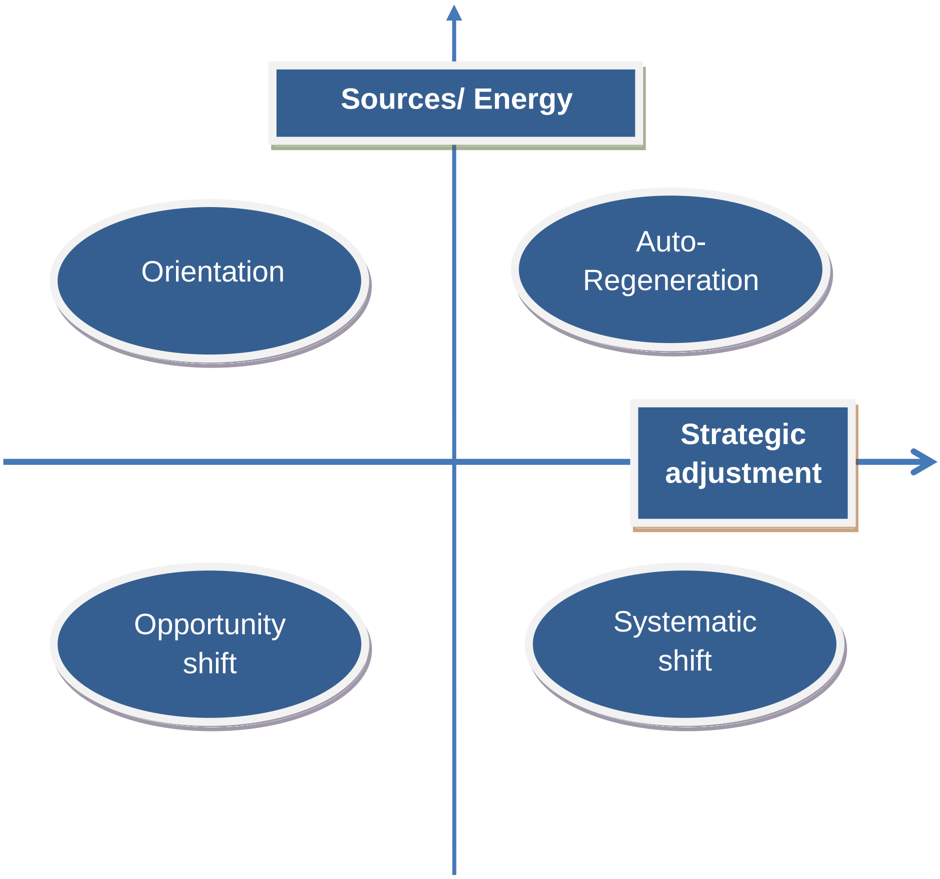


Figure 2.1: The different dimensions for studying renewable energy

New and renewable energy resources such as hydrogen and biofuel may provide frameworks for decentralized governance in the future, through bypassing the centrality of dependence on fossil fuels from oil, gas and coal. We face a set of constraints in developing these green technologies; i.e, the transfer and utilization of these technologies, developing systems for transferring knowledge, innovation, science, and technology, and systems for adaptation and regional cooperation and integration as shown in Figure 2.2. The figure shows the options for the future, which consist of the systematic shift or guided shift, or what is called reorientation or transformation.

Chapters four and five will show how close the Arab region is of this conceptual framework because each Arab country has different options that include reorientation (amending the energy mix), strategic adjustment (importing or exporting gas across the border), systematic shift (shift to clean energy), or opportunity shift (transfer of cheap energy and regional cooperation) as shown in Figure 2.2



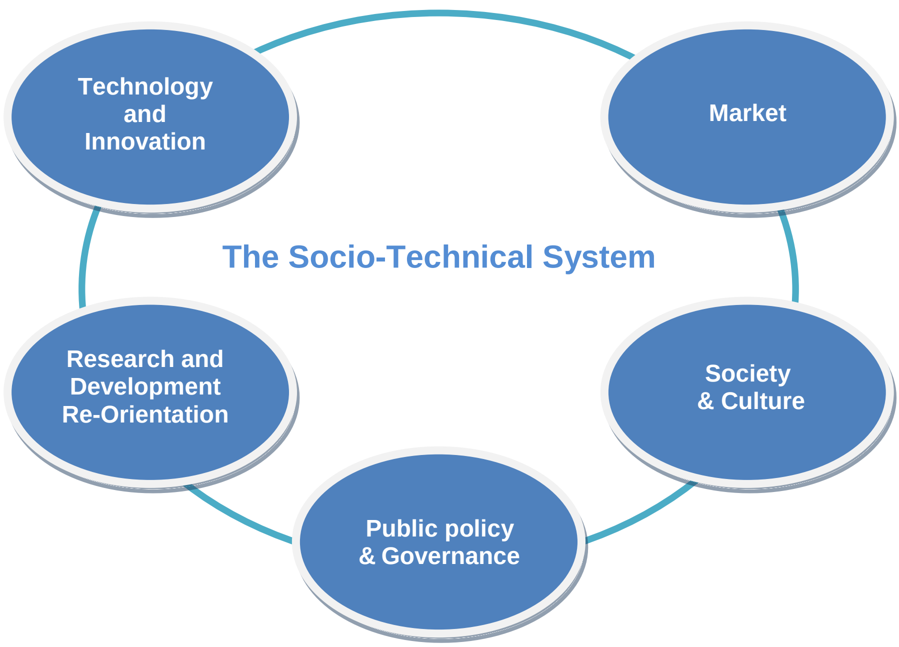
Source: Smith et al. (2005), Al-Jayyousi, 2015).

Figure 2.2: Conceptual framework for the interconnection between sources of energy, strategic adjustment, and the transfer of knowledge

These options are linked to the socio-technical system according to Figure 2.3. This system varies depending on the nature of each country, its specificity, and its research, science and innovation enabling environment.

2.2. Conceptual Framework

The research methodology of this book depends on understanding the interrelationships of the socio-technical system, which is linked to science, technology, the market, society and public policy. Figure 2.3 illustrates the mental map of the socio- technical system at the national level.



Source: Geels, (2004) Al-Jayyousi, 2015

Figure 2.3: The mental map of the socio-technical system of renewable energy.

The transfer of knowledge at the regional level requires an understanding of the socio-technical system for each country in the Arab world in the context of the Arab energy security strategy, which is linked to the security of water, food and the environment in a complex global economic system of interconnected interests at the three levels: the global (landscape) level, the local (regime) level, and the niche level as shown in the Table 2.1. Table 2.1 (p.50) shows the methodological framework for analyzing energy in the Arab world and makes the interconnection between the focus of analysis with the level of analysis and the methods of knowledge transfer and management clear.

At the international (landscape) level, the focus of analysis is on international and regional organizations and international issues. The transfer of knowledge takes place through North-South, East-West, or South-South joint research programs or through major projects for the transfer of energy across countries, which promotes interdependence and common understanding within the regional cooperation integration context.

At the local (regime) level, the focus of analysis is the environment of technology, industrialization, and the nature of market operation in terms of freedom of investment and incentives. It also includes society, culture, and public policy. The method of knowledge transfer includes conferences, research, and publication in the context of the scientific agenda and the strategy for science and technology.

The third (niche) level includes studying the system of education, research, entrepreneurship, and technology management and innovation as the focus of analysis. It would also be possible to study knowledge transfer and management through centers of excellence, patents, business parks, and i-parks.

Table 2.1: The methodological framework and the three levels of analyzing renewable energy in the Arab world

Level	Focus of Analysis	Method of Knowledge Transfer
International and regional framework (landscape)	▪ Political system and governance ▪ Regional and international organizations ▪ Climate change	▪ International cooperation ▪ East-West research projects ▪ Mega projects
Local framework (regime)	▪ Technology and industrialization ▪ The market ▪ Society and culture ▪ Public policy	▪ International agenda ▪ Science and innovation strategy ▪ Conferences ▪ Publications
Local environment (niche)	▪ Education ▪ Science and scientific research ▪ Innovation ▪ Entrepreneurship	▪ Centers of excellence ▪ Patents ▪ Business parks

To study these levels, case studies will be presented in Chapter Four on renewable energy applications in some pioneering countries, and then a framework will be presented for knowledge management in Chapter Five.

3

Chapter Three

Renewable Energy and Future Opportunities

Every challenge is an opportunity for transformation, innovation and leadership.

3.1. Introduction

Renewable energy, in its different kinds, is a suitable area for the transfer of technology between the Arab world and the countries of North and South. Renewable energy technologies, characterized by diversity and decentralization, make it particularly suitable to develop energy in rural areas, or in projects between the Arab world and Europe, within a regional vision that embraces mutual interest exchange in technology, localizing manufacturing and energy industry. In this context, it would be possible to take advantage of the clean development mechanism (CDM), adopted in the Kyoto Protocol, in renewable energy applications to reduce greenhouse gases.16

The state of environmental degradation and loss of environmental vision will be very costly for the next generation. Similarly, urban air pollution, oil spills, and global warming (the greenhouse effect) are all good reasons to reconsider environmentally friendly alternatives.

[16] Unfortunately, this mechanism has declined recently to the point where it is no longer relevant because a ton of carbon has decreased to considerably less than one euro.

Although alternative energy sources are not completely free of pollution, there is a wide range of options whose environmental harm is much less than conventional energy sources.

One of the most promising technologies is solar energy that converts heat from solar radiation directly into electrical energy through photovoltaic (PV) cells. This is a new and emerging technology that is also a strategic industry. There are four main incentives that motivate countries to move to renewable energy: energy security, climate change, cost, and job creation. At the energy security level, it is expected that diminishing oil and gas reserves[17] and steadily rising global energy consumption will eventually deplete this vital source of energy, so it is important to start thinking now of finding sustainable future alternatives.

A second driver that pushes the market toward renewable energy is concern about climate change. Renewable energy can contribute to securing our energy requirements while decreasing greenhouse gas emissions. There is consensus among scientists that the quantity of greenhouse gases, such as carbon dioxide and methane, are increasing in the Earth's atmosphere and this increase in the quantity of gases is causing global warming. Many scientists believe this rise in the Earth's temperature imposes negative, even potentially disastrous results. Hence, that now is the right time to address this issue, and there are actions that can be taken, which include the use of pollution-free renewable energy.

The third market driver is the cost of renewable energy. That cost decreased steadily for several decades, some forms of which are expected to continue decreasing in cost, due to improvements in

[17] For instance, gas in Bahrain is almost depleted; reserves are hardly sufficient for Bahrain's needs.

production technologies, which were the result of investment in research and development, innovation, commercialization of patents, and the development of business incubators and SMEs.

The fourth incentive is investment in renewable energy which can reduce unemployment rates and create new job prospects to accommodate the youth graduates. (See Figure 3.1)

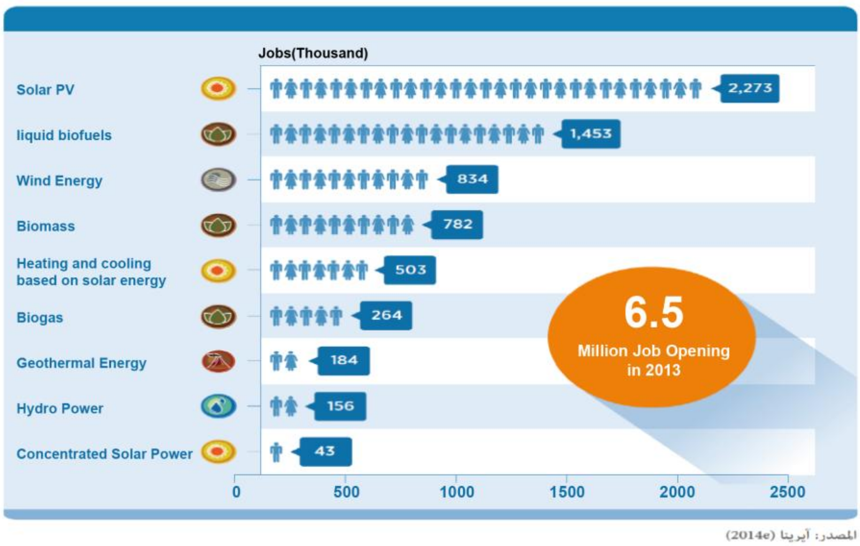


Figure: 3.1 IRENA (2014)

It is possible to compare the number of jobs created by different forms of energy for every terawatt-hour, see for example:

(www.plux.co.uk/nuclear-jobs-compared-with-renewables).

3.2. Renewable Energy in the Arab World: Opportunities and Challenges

3.2.1. Assessment of Energy Subsidies

Economic systems in the Arab world vary immensely, including in the objectives and modalities of energy subsidies. Implicit and explicit subsidies (see boxes 7 and 8) have, however, produced a number of common undesirable consequences throughout the region[18], mainly:

Efficiency: High energy consumption and low energy efficiency rates in countries with high GDP is evident. Figure 3.2 also shows that the Arab world's economic systems are among the world's highest consumers of energy. This growth is not a phenomenon limited to Gulf countries. The density of energy consumption in many economic systems such as Jordan, Egypt, and Syria has also increased during the same time period. (See Figure 3.3)

Consumption growth: The rapid growth in consumption of different primary fuels and electricity is clear. Total electricity and energy consumption in the Arab region had tripled between 1980 - 2008, making the Arab world the second most important growth market for energy consumption in the world.

Decrease in investments: Investments in the energy sector decreased since government subsidy ceilings often do not compensate producers, reducing the returns on their investments.

Informal trade of fuel: Increased incentives for informal trade take placeas a result of sharp differences in prices between neighboring Arab countries, and differences between subsidy systems which was

[18] Arab Human Development Report, Energy Subsidies in the Arab World, Bassam Fattouh. and Laura El-Katiri, a series of research papers published by UNDP (2012).

the case between Iraq, Jordan, Saudi Arabia and Lebanon, and the ongoing situation between Tunisia and Libya.

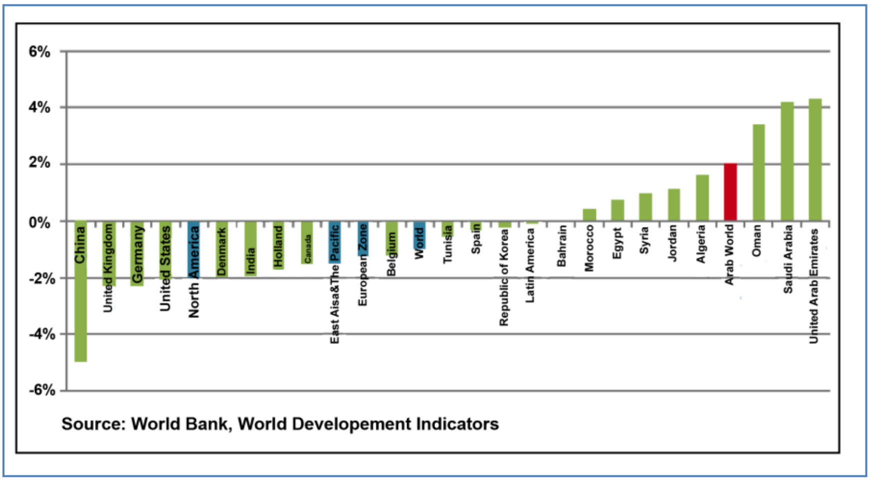


Figure 3.2: Average composite energy use per $1,000 of domestic product of Arab and selected other countries.

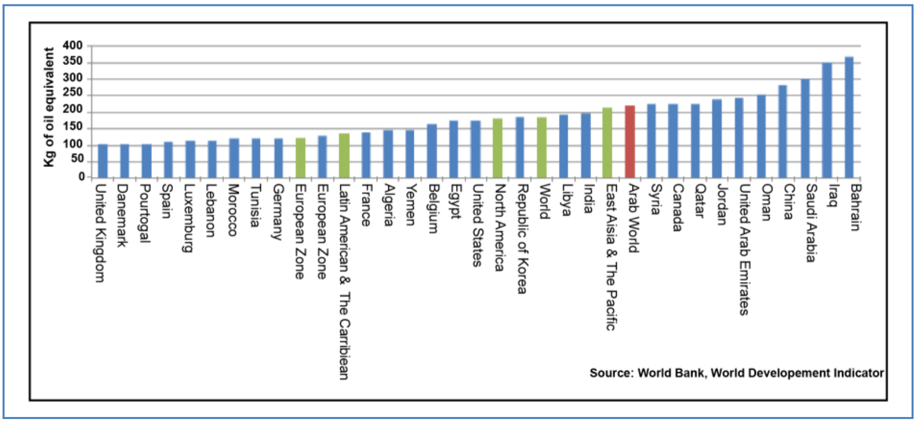
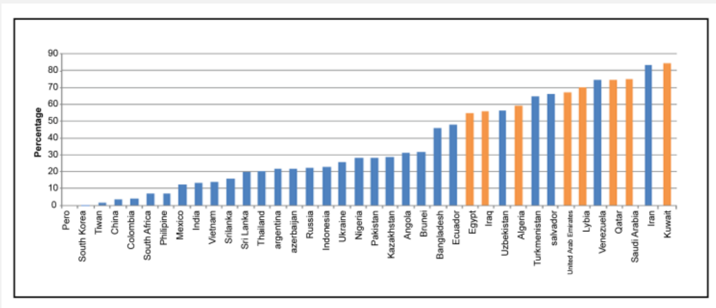


Figure 3.3: Energy use (as equivalent volume) per $1,000 of domestic product in different countries

Box 7: Average local subsidy rates of types of fuel in different countries.



The figure above shows the Arab world includes six of the world's top ten countries in terms of energy subsidies, led by Kuwait, Saudi Arabia, and Qatar. These countries charge their populations less than one-third of world prices for fuel and electricity.

Box 8: Government subsidies of the energy sector: A major burden higher than the international level

Government subsidies of the energy sector in 6 Arab countries are estimated at $50 billion annually as the table below shows.

Country	Subsidies ($ million)	% of GDP
Algeria	20,264	10.7
Egypt	24,422	10.6
Jordan	1,719	6.0
Lebanon	1,911	4.5
Morocco	661	0.7
Tunisia	1,376	3.0

Source: World Bank, subsidies in the energy sector: An Overview, (World Bank Publication, 2010).

3.2.2. Opportunities and Challenges Using Renewable Energy

There are a number of opportunities and challenges related to the use of renewable energy in the Arab world, and these factors vary with time. Alternative energy sources are likely to play an important role in human life, reducing carbon dioxide and other greenhouse gas emissions, and helping meet a high proportion of energy requirements.

They are permanent long-term sources because they are associated mainly with the sun and the energy emanating from it. Despite their long-term sustainability, alternative energy sources are not always readily available. They are not a ready reserve for us to draw from as we please whenever we want. The intensity of solar radiation, for example, varies with time and in duration in the course of one day. It starts at zero at sunrise, gradually increases in intensity until it peaks at noon, then starts to decline gradually to reach zero again at sunset. Variations in intensity occur not only in the course of the day, but also from one day to another. Today, thanks to the progress of technology, heat storage in molten salt allows electricity to be generated at night also. Similarly, smart electricity network systems have evolved to integrate wind and solar energy projects together, so when the sun is not shining the system automatically switches to generating electricity from wind. This enabled Germany, for example, to generate 59.1% of its electricity need on October 3, 2013, through a hybrid energy system combining solar and wind energy.

Solar energy technologies receive considerable interest in Arab countries for several reasons that include the gradual decrease in cost of production, the trend toward diversification of energy sources, reducing the depletion of national oil resources, and the sharp fluctuations in conventional energy prices which put pressure on development programs in the non-oil producing countries.

In addition to solar, wind and hydroelectric power, there is bio-energy, which is the potential energy in plants, crops, forest residues, and human and animal waste. This energy can be harnessed either by burning, to produce heat energy, or by producing liquid or gaseous fuel- named biofuel, for use in electrical power plants. Biofuel need to be extracted from organic waste, not from food crops in order to avoid creating a food crisis in poor countries, particularly in light of limited renewable water resources and arable land.

At the end of 2011, the total global installed capacity of electrical power plants from different biofuel was about 72 GW. The leader in using this energy source was the EU with 26.2 GW, followed by the U.S. with 13.7 GW, and Brazil 8.9 GW. China came in first place among Asian countries with about 4.4 GW, followed by India with 3.8 GW. There is interest in using biomass from sugar cane residue as a source of electric power in several African countries such as Uganda, Cameroon, Kenya and others.

Compressed forest residues in the form of dry wood are used to fuel some power plants in the U.S., the EU, China, South Korea and Japan. Blocks composed of crop residues and sawdust, of which world production reached about 1.3 million tons, are also used as biofuel in Thailand, China, Malaysia and India.

Biogas is used commercially in some European countries as a source of electric power in homes and small private projects with limited capacity power plants (4.5-1000 KW), and in plants of capacities ranging from 250 KW - 45 MW to supply various installations and industries with electricity.

The production of energy from alternative sources is not highly concentrated and as a result use of these resources requires much equipment of large surface areas and volumes. This is one of the reasons for the high initial cost of alternative energy systems, which constitutes at the same time one of the barriers to their rapid spread. For example, the production of 1 GW of PV energy requires 400 dunums (400,000 sq meters) of land.

In fossil fuels, energy is stored in hydrocarbon materials and the common method of using this energy is to convert it into heat, then engage in a series of conversion operations to get the final form of energy. For example, the production of electricity from fossil fuels requires converting energy initially into heat, then into kinetic energy, and finally into electrical energy. Conversely, with alternative energy sources, electrical energy can be produced directly by PV cells or thermally by thermal conversion processes or mechanically using windmills. Moreover, the diversity of alternative energy sources makes it possible to meet the requirements of different forms of energy that are needed for the end-users. Solar energy can provide us with a significant portion of our thermal energy needs (hot water, heating, steam), while wind energy can meet part of our kinetic energy needs (water pumps, air compressors). In addition, today, reverse cycle solar systems can operate cooling systems from solar energy.

With the exception of the main EU countries, most political and economic policy-makers do not consider renewable energy as a priority. This is due to many reasons, such as the high initial cost, the fact that some technologies still need to be developed. The cost of PV cell applications is still one of the main barriers against expansion in the use of solar energy. The present unit cost (Kilowatt-hour) of generating electricity using this technology is between $ 0.45 and $ 0.50. Some countries, such as Germany, work to reduce it to $0.30 by 2010 and to $0.10 per kilowatt- hour by 2020. Moreover, the production of electricity from solar energy requires a significant capital investment, which is one of the barriers that currently prevent the expansion of its use; but these costs are expected to decrease with time, as is the case with other new technologies.[19]

According to the International Energy Agency (IEA) statistics, renewable energy contributes 17.9% of global energy production, of which 16.1% is from hydroelectric energy, and the remaining 1.8% is from wind, solar, geothermal, ocean, and tides energy. By contrast, coal accounts for 39.8%, oil 6.7%, gas 19.6% and nuclear energy 15.7%. Studies expect that by 2050, the share of renewable energy sources out of total primary energy consumption in the world will be about 50%. In Arab countries, renewable energy accounts for 7.6% of total electrical energy, of which 7.04% comes from hydroelectric power, and the remaining 0.28% from wind, solar, and bio-energy.

[19] IRENA (2014), Remap 2030: A Renewable Energy Roadmap, IRENA- Abu Dhabi, UAE.

There are integrated initiatives to invest in renewable energy in the UAE such as the Masdar initiative (see Box 9).[20]

Box 9: Masdar initiative: A Comprehensive Initiative for Innovation and Technology Transfer

Masdar is a multi-faceted integrated initiative for economic development, adopted by the government of Abu Dhabi through Mubadala Development Company, to promote advanced energy sources and sustainable development efforts to adopt the use of solar energy technologies in the UAE.

The Concentrated Solar Power (CSP) generation project will supply the electricity grid with power, thus helping meet the high demand. Masdar's research network supports solar energy projects implemented by the Abu Dhabi Future Energy Company, by funding research and development of advanced solar energy with six international universities and research centers in North America, Europe and Japan. Research includes thin-film PV cells, spherical cells, towers to attract solar radiation and thermal storage of solar energy.

Renewable energy receives considerable attention today in light of growth in the market of equipment related to its applications in a number of developed or developing countries, especially in the field of electricity generation. The main features of development in the

[20] RCREEE (2013), Country profiless, available at: www.recreee/member-state, also see: REN21 (2013), MENA Renewable Status Report, available at: www.ren21.net/portals/0/documents, 2013.

renewable energy markets indicate an increase in the aggregate capacity of renewable energy applications (except hydroelectric sources), an increase of approximately 23.8%. The increase is noticeable in wind power projects and the use of solar PV cell systems (40 GW and 30 GW respectively in 2011).[21] Naturally this reflects positively on the reduction of global warming emissions and climate change. At the end of 2011, the proportion of renewable energy's contribution to global production amounted to about 20% of which 15% was from hydroelectric power.

Wind energy is considered local, in the sense that it is available in locations where the wind speed structure has specific characteristics. It is located in prime locations in the Arab region that include Jordan (Gulf of Aqaba), Tunisia, and Algeria (the Mediterranean coast and some interior locations), Sudan (the Red Sea coast), Oman (Indian Ocean coast), Egypt (the Gulf of Suez), Morocco and Mauritania (the Atlantic coast), Yemen, and some sites in the Arabian Gulf. There are wind stations connected to the network in Tunisia, Egypt, Morocco and Jordan

Annex II refers to projects implemented, under implementation, or in the planning phases that aim to produce electricity from wind power in the Arab region. Annex III summarizes the most important projects to produce electricity from solar energy, either thermal or PV in the Arab region.

[21] REN21 (2014), MENA Reewable Policy Network for the 21st century, Global Status Report, 2014.

Box 10: Renewable Energy Technologies: Concentrated Solar Power (CSP)

The idea of CSP is based on collecting direct rays from the sun and focusing them on a specific area (since scattered rays cannot be concentrated) to get a high temperature between 400°C and 1000°C. Consequently, it would be feasible if the concentration of direct rays of the sun at the project site were not less than 2,200 KWH per square meter during the year, and if an adequate area and infrastructure were available at the site, including electric power transmission lines, sources of water, paved roads, and possibly also of fossil fuels in a hybrid circuit station that includes a solar component. The capacity of currently existing stations ranges between 50 and 280 MW. Stations can be designed to connect to the electricity grid to operate with a thermal storage system, or hybridization with fossil fuels to meet loads.

Indian and Chinese companies are expected to enter the CSP industry, after they have entered into the wind energy systems and solar cell equipment market. This may open the industry that is now limited to Spanish and American companies and spread the technology. The total is estimated to reach about 11 GW by 2017.

Source: IRENA, Concentrating Solar Power: Technology Brief, E-10, (2013).

Box 11: The Prospect of Converting Waste to Energy

There are a number of limited pilot projects for the production of electricity. In Jordan, biogas is extracted from the solid waste dump site to operate a power plant of 3.5 MW capacity; Egypt extracts biogas from a water and sewage treatment plant to operate a generating plant of 18.5 MW capacity; In Lebanon there is a possibility to use biogas from the sewage treatment plant in Tripoli to cover half of the area’s electrical energy needs; In the UAE, there is a project to produce electricity from sewage treatment plant; and in Yemen, one to produce electricity from urban waste in Sana'a. There are also possibilities in the Arab world to take advantage of agricultural waste.

For example, biofuel can be derived from (a) the olive industry (six million trees in Lebanon, 10 million trees in Jordan, and 60 million trees in the Syrian Arab Republic); (b) the remnants of sugar cane and beetroot sugar industry. In 2007, sugar crop production was estimated at 21.8 million tons in Egypt, 7.5 million tons in the Sudan, 3.9 million tons in Morocco, 1.1 million tons in the Syrian Arab Republic, 37 thousand tons in Lebanon, and 55 thousand tons in Iraq; (c) residues of the dairy industry.

The commercial spread of projects to produce electricity from bio-energy would require the development of government policies that include incentives (tax and customs exemptions, providing land for the project at nominal prices, government guarantees to address risks of investment, long term guarantees for electricity purchase, and simplifying administrative procedures) to attract the private sector, which can be active in this area.

The cost of investment in renewable energy projects, with the exception of hydropower and wind power in some locations, is still relatively high, despite the commercial spread of some applications. The unit cost of energy produced from a renewable source is still one of the main limiting factors against the spread of its use, and attracting the private sector to enter the field. It would be useful to estimate the investment cost of the aggregate capacity (KW) and the unit cost of producing power (cents/ KWH). Table 3.1 provides an overview of the standard specifications, capital cost, and the unit cost of energy produced from different renewable energy sources in 2013.

Table 3.1: The unit cost of energy by source in the Arab world (Source, ESCWA, 2013)

Source/ type of technology	Standard specifications	Capital cost ($ / KW)	Unit cost (cents/ KWh)
Parabolic trough	Capacity factor %: 40-80 (with a storage system for 6-15 hours) up to 25 KW	6,300 – 10,500	
Biomass: - **Station based on ordinary boiler/ steam turbine and stopper**	25 -100 MW Conversion efficiency %: 27 Capacity factor %: 70-80	3,030 – 4,660	7.9 – 17.6
Other sources: - **Hydroelectric** • **Small capacity (without connection to the grid)** • **High capacity (connected to the grid)** - **Geothermal**	1.0 KW – 1 MW 10 – 18,000 MW or more Station bigger than 300 MW (reservoir, river) Station less than 300 MW Capacity factor (%) 60-90 Capacity (%): 23 -29	3,500 – 1,175 Less than 2,000 2,000 – 4,000 2,100 – 6,100 5,290 – 5,870	5 – 40 10 – 5 5.7 – 10.7 21-28

Source/ type of technology	Standard specifications	Capital cost ($ / KW)	Unit cost (cents/ KWh)
energy - Ocean (tide)			
Wind energy (on land) • **Small stations** • **Large stations (on land)**	Capacity (KW): up to 100 Capacity (MW): 1.5 – 3.5 Diameter of rotation of blade (m): 60 – 110 and over capacity factor (%): 20 - 40	3,000-6,000 1,410 – 2,475	20 – 15 5.2 – 16.5
Wind energy (at sea)	Turbine capacity (MW): 1.5 – 7.5 Diameter of rotation of blade (m): 60 – 110 and over capacity factor (%): 35 - 45	3,760 – 5,870	11.4 – 22.4
Photovoltaic cells on roof of building	Maximum capacity: 3 – 5 KW residential 100 KW commercial 500 KW industrial Conversion efficiency (%): 12-20	2,480 – 3,270	22 – 44
Power station with photovoltaic cell system	Maximum capacity: 2.5 – 100 MW Conversion efficiency (%): 15 – 27	1,830 – 2,350	20- 37
Concentrated solar thermal power: • **Parabolic trough** • **Central tower**	50 – 500 MW Capacity factor (%): 20 – 25 (without thermal storage system) 40 – 50 (with a 6-hour storage system) 50 – 300 MW	4,500 7,100 – 9,000	18.8 - 29

Box 12: Solar Heaters as an Opportunity for Entrepreneurship

At the level of domestic use, Palestine is in first place with solar heaters in use in more than 71% of homes, (about 67.7% in the West Bank), of which about 91% are manufactured locally. Statistics indicate that 0.5 million square meters of solar water heating systems are in service. In Jordan, there are about one million square meters of solar heating systems installed in residential and commercial sectors.

Egypt has about 650,000 square meters of solar collectors installed, Syria about 200,000 solar heaters (equivalent to about 511,000 square meters of solar collectors), Tunisia has more than 400,000 square meters of solar collectors that are expected to reach 750,000 square meters by 2014, Morocco has about 240,000 square meters of solar systems, and Lebanon about 200,000 square meters. In Lebanon, an affordable financing mechanism was established to support the greater use of solar water heaters with the aim of reaching about 1 million square meters of solar heating systems by 2020. Libya plans to install solar collectors on an area of 40,000 square meters, and in the Gulf, Saudi Arabia, where several applications are spread in mountainous areas, implemented a pilot 30-MW capacity heat system to provide hot water and heating for a place that accommodates about 41,000 university students, in early 2011.

In the UAE and Kuwait, private companies work to develop and spread the use of solar cooling technology. Masdar Company of the UAE stands out in this area. In 2010, it launched in collaboration with other companies, a pilot solar system to cool 1,700 square meters of office space at Masdar City, and to limit the emission of about 70 tons of carbon dioxide per year, through a system that will be under assessment for two years. Qatar plans to use solar energy in cooling the stadiums and spectator areas during the FIFA World Cup tournament, which it will host in 2022.

3.2.3. Problems with the Use of Renewable Energy Systems: Solar Energy as an Example

The most important problem facing researchers in solar energy use is that of dust, and cleaning solar energy equipment. Ongoing research on this topic shows that more than 50% of solar energy efficiency is lost if collectors that receive sunlight are not cleaned for a month. The best way to dispose of dust is continuous cleaning, at intervals not exceeding three days. The methods vary from country to country depending on the nature of the dust and the nature of the weather in the country.

The second problem with solar energy is storing it for use at night or on cloudy or dusty days. Storage of solar energy depends on the nature and quantity of solar energy, the type and period of use, and the total cost of the storage method. It is preferable not to use storage equipment in order to minimize the cost, and instead to use solar energy directly when it is available only. Storage of solar energy is a topic that needs more research and developments. Storage of energy in molten salt and rocks is considered the best method available, at present. As for storage of electrical energy, the current common method is the use of liquid batteries (acid and lead batteries). Today, there are more than ten methods to store solar energy, such as melting metals, conversion of matter, binary mixing methods, and others. The best place to store it is considered the national electricity grid itself.

The third problem with solar thermal energy is corrosion in solar collectors due to the presence of salts in the water used in heating cycles. Closed circuits and the use of salt-free water are the best solutions to reduce the problem of corrosion in solar collectors.

Albeit all problems, the Arab world's potential for using solar energy is enormous, as the Arab countries are among the richest in solar energy in the world. Taking the average incidence of solar energy radiation on the Arab World today, which amounts to 5 KW-hour/square meter, and assuming that solar cells work on a conversion factor of 5%, if an area of 1,600 square kilometers in the western desert of Iraq (roughly the area of Kuwait) is covered with solar cells, it would be possible to generate electrical energy equal to 400 MW × 104 hours a day, more than five times what is needed in the whole world today at the peak consumption period. Besides, it is also important to consider the potential job opportunities that can be provided by renewable energy.

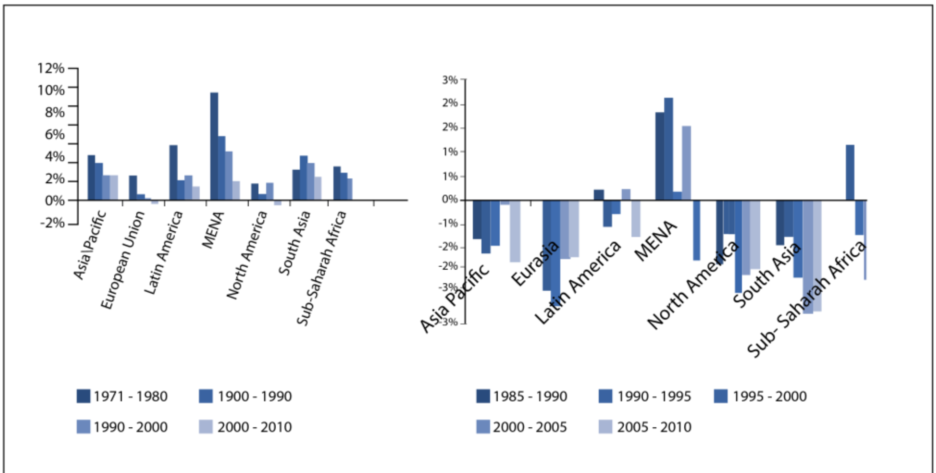
3.3 Features and Indicators of Renewable Energy in the Arab World

The most important issues of the energy situation in the Arab region are the following six points. [22]

First: increase in the consumption of fossil fuels.

Energy consumption in the MENA region has increased more than any other region in the world since the seventies, as a result of which the region is considered the second highest growth region in the world after Southeast Asia. Total demand for oil in the Gulf region grew fivefold since the eighties, making it one of the highest energy demand growth regions as shown in Figure 3.5.

[22] AFED, Arab Environment 6: sustainable energy, report of the Arab forum for the environment and development (2013).



Source: World Bank (2013a)

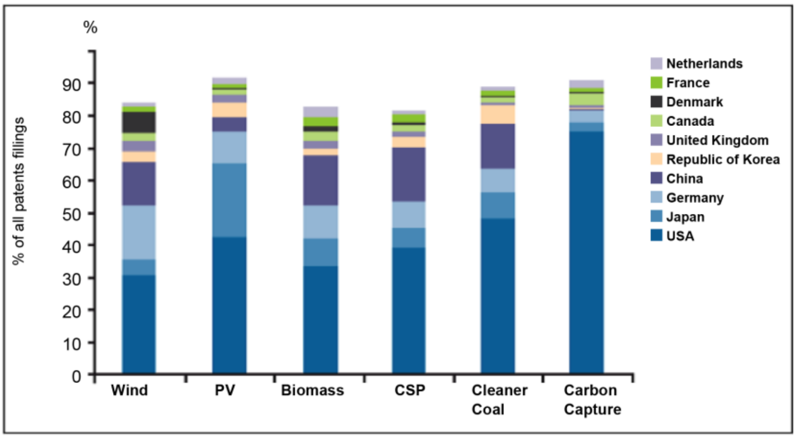
Source: World Bank (2013). *World Development Indicators* databse. Available at: http://data.worldbank.org/data-catalog/world-development-indicators

Figure 3.5.A: Density of energy in different regions of the world 1985 – 2010

Figure 3.5.B: Energy consumption rates in different regions of the world 1970 – 2010

Second: MENA Region Dependence on Fossil Fuel to Generate Electricity

Figure 3.6 below shows the MENA region is one of the most dependent regions on traditional energy sources to generate electricity. Statistics indicate that growth of energy demand in the Arab region was around 3% per year in the period 2010 - 2030, while the increase in demand for electricity grew at a rate of 6%. Table 3.2 shows the total quantity of electricity produced in Arab countries and the quantity produced from renewable energy out of that.



Source: Lee et al.,2009, p.15.

Figure 3.6: Contribution of different types of fuel in electricity generation in different regions

Source: World Bank (2013). *World Development Indicators* databse. Available at: http://data.worldbank.org/data-catalog/world-development-indicators

Third: Increase in Economic Cost of Energy

Energy security was not a priority; but with the increase in oil consumption for electricity generation, there is an "opportunity cost" for the use of fossil fuels to generate electricity. The impact of the increase in oil prices since 2000 led to a high cost for Gulf economies. For example, if renewable energy sources are used to generate electricity in Saudi Arabia, that would save 2.4 million barrels per day, which would mean an estimated $60 billion in annual returns at the rate of $10 per barrel, in addition to the annual oil export revenues, which are estimated at $215 billion.[23]

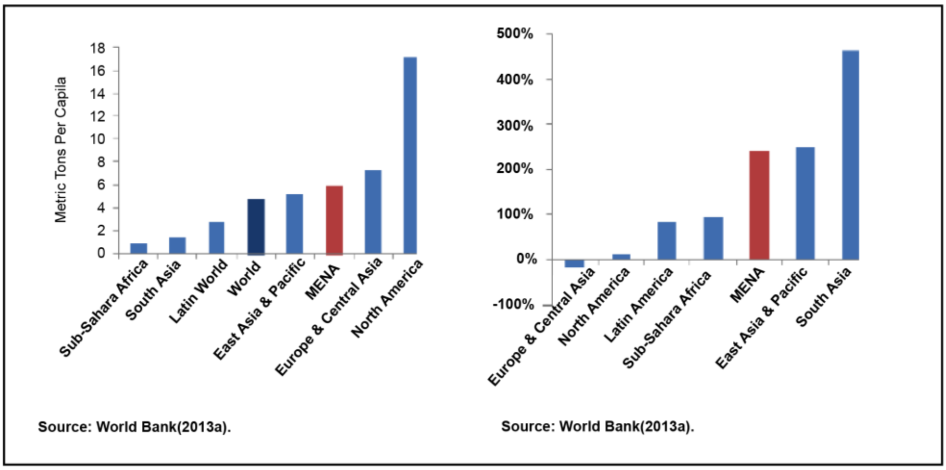
[23] Reality and Prospects for Renewable Energy in Arab Countries. D. Ait Kamal and A. Alifi Mohammed. First Scientific Conference: Sustainable Development Efficiency in Using Available Resources, Algeria (2008).

Table 3.2: Total quantity of electricity and proportion produced from renewable sources out of that in Arab countries- (Source: ESCWA, 2012)

Country	Electric energy produced from thermal stations (GWH)	Electric energy produced from renewable sources (GWH)	Total electric power produced (GWH)
Jordan	14,713	64 (source: hydro, solar, wind)	14,777
UAE	88,184	-	88,184
Bahrain	13,230	-	13,230
Tunisia	14,632	189 (source: hydro, solar, wind)	14,821
Syria	43,809	2,604 (source: hydro)	46,413
Sudan	1,241	6,275 (source: hydro)	7,498
Iraq	44,140	4,766 (source: hydro)	48,906
Oman	14,597	-	14,597
Palestine	431	-	431
Qatar	26,362	-	26,362
Kuwait	57,029	-	57,029
Lebanon	10,374	837 (source: hydro)	11,211
Libya	32,559	-	32,559
Egypt	124,786	13,996 (source: hydro, wind)	138,782
Morocco	18,391	4,290 (source: hydro, solar, wind)	22,681
Saudi Arabia	239,892	-	239,892
Yemen	6,400	-	6,400
Total	**750,752**	**33,021**	**783,773**

Fourth: Environmental Cost

The environmental cost is commonly overlooked when calculating the price of oil; but environmental pollution, climate change, desertification, degradation of water, and beach pollution are side effects, which impact the value of natural capital and the ecological footprint. The ecological footprint has risen significantly since the sixties as a result of urbanization, industrialization and the rising standard of living, as observed in Figures 3.7.A and 3.7.B.



Source: World Bank (2013). *World Development Indicators* databse. Available at: http://data.worldbank.org/data-catalog/world-development-indicators

Figure 3.7.A: Carbon dioxide emissions per year 1980 – 2009

Figure 3.7.B: Carbon dioxide emissions per capita by region in 2009

Fifth: Low electricity tariffs in the Middle East and North Africa

Electricity tariffs in the Arab region are very low compared with world prices. For example, the electricity tariff per Kilowatt in Kuwait is 1 U.S. cent and it has not changed since 1970. In other Arab countries such as Iraq, Syria and Yemen, the tariff per kilowatt-hour is less than 2.5 cents, which is less than the price in most countries as shown inFigure 3.8.

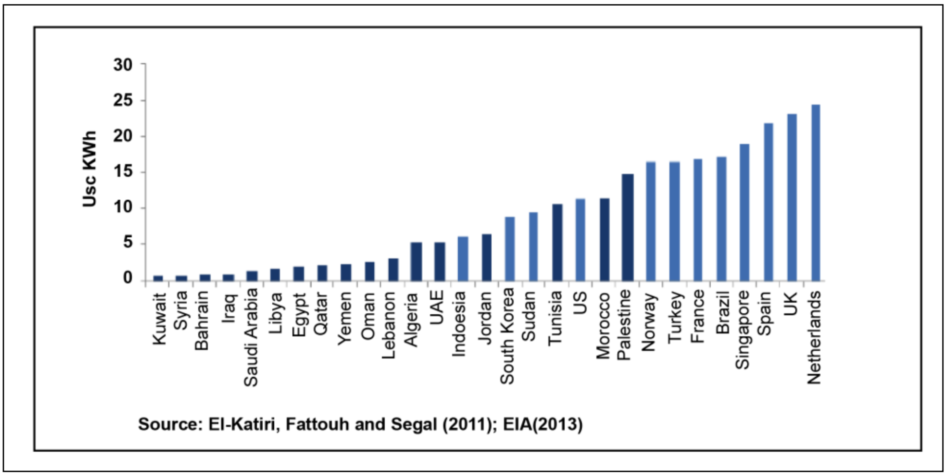
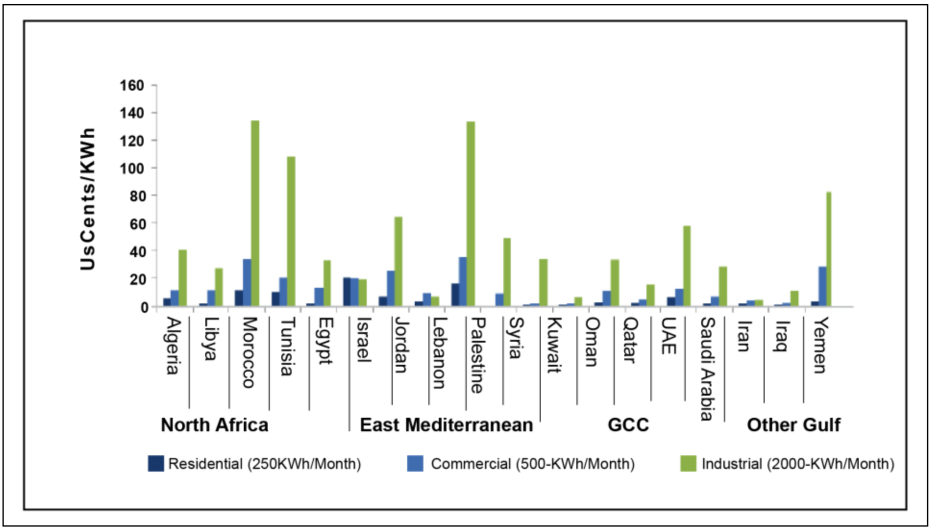


Figure 3.8: Average electricity tariffs for domestic use in different countries

By contrast, when comparing the price of renewable energy with conventional energy in the Arab region for domestic use, it becomes noticeable there is no return on investment in renewable energy given the low electricity tariffs. The price ranges from 11-48 cents per kilowatt-hour for large installations using PV cells, and 18.8 for installation on rooftops. With wind power, the price ranges between 6-14 cents per KW hour. But when looking at the tariffs for industrial and commercial uses, the picture becomes more positive in favor of renewable energy because the consumer pays 35 cents per kilowatt hour, and 133 cents per kilowatt-hour respectively. This makes the use of renewable energy for these purposes economically feasible, according to the Figure 3.9 below.

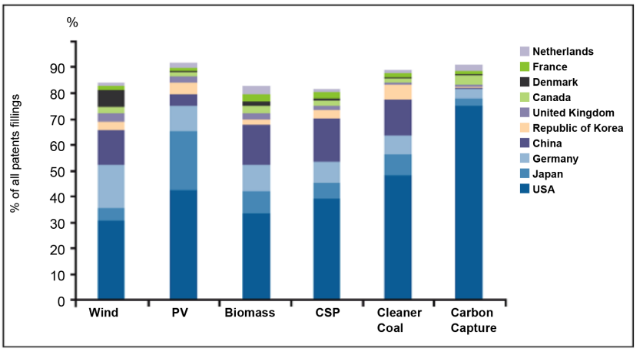


Source: Arab Union of Electricity (2012), available at:
www.auptde.org/usefullinks.aspx?lang=ar

Figure 3.9: Average power tariffs in Arab countries according to type of use

Sixth: The Absence of Arab State Contribution in Scientific Output and Patents in Renewable Energy Sector

There are initiatives to establish knowledge hubs for the transfer of renewable energy technologies, but this requires the development of various academic programs at the technical and trade level to create a critical mass of technicians and scientists who work according to a national plan and a national project, and within an Arab vision to absorb and commercialize technology. Despite growth in the number of research projects in renewable energy, there are a limited number of patents and these are mostly hold in Western countries, China, Japan or Korea, as shown in Figure 3.10.



Source: Lee et al.,2009, p.15.

Figure 3.10: Patents in renewable energy in the world

3.4. Renewable Energy and its Role in Reducing Emissions

Solar power plants reduce emissions while meeting at the same time the demand of electricity. Additional CO2 reduction can be reached through the shifts in energy consumption by improving energy efficiency measures. It is expected that electricity generation from thermal power plants based on fossil fuels will continue for many decades in Arab countries, which own 56.8% of proven reserves of crude oil and 26.51% of proven natural gas reserves in the world.

After calculating the quantities of carbon dioxide resulting from various types of combustion of fossil fuels in conventional thermal power plants, the outcome of the production of each kilowatt-hour of these emissions was determined, in light of the following facts:

Carbon dioxide emissions resulting from the combustion of 1 kg of diesel oil amount to 3.2133 kg of emissions; combustion of 1 kg of heavy fuel oil produces 3.043 kg of carbon dioxide emissions; combustion of 1 kg of natural gas produces 2.6993 kg; and combustion of 1 kg of coal produces 2.6 kg of carbon dioxide emissions. The total quantity of carbon dioxide emissions resulting from electricity generation in the Arab world in 2020 is estimated at about 1,150 million tons, an increase of 123% from 2010 as shown in Table 3.3.

Table 3.3: Carbon dioxide emissions in Arab countries[24]

Country	Heavy oil	Diesel oil	Natural gas	CO_2 emissions from heavy oil	CO_2 emissions from diesel oil	CO_2 emissions from natural gas	Total CO_2 emissions	CO_2 emissions from genera-ting GWH
(1,000 tons)								
Jordan	906	99	2,055	2,855	318	5,548	8,722	593
UAE	1,240	4,326	37,721	3,905	13,842	75,629	75,438	855
Bahrain	0	0	3,431	0	0	9,264	9,264	700
Tunisia	1	1	3,197	2	3	8,632	8,637	590
Syria	3,919	12	5,337	12,344	39	14,409	26,792	612
Sudan	42	179	59	133	573	160	867	709
Iraq	4,180	4,930	5,109	13,167	17,775	13,794	42,736	968
Oman	0	0	4,095	0	0	11,058	11,058	758
Palestine	0	83	0	0	267	0	267	620
Qatar	0	0	0	0	0	0	16,291	618
Kuwait	9,500	1,152	4,537	29,925	3,686	12,251	45,862	804
Lebanon	0	0	0	0	0	0	7,697	742
Libya	1,692	3,521	3,026	5,331	11,266	8,168	24,765	761
Egypt	6,059	171	63,318	19,085	546	50,308	69,940	560
Morocco	1,224	29	0	3,856	93	0	42,415	839
Saudi Arabia	22,439	52,910	48,915	70,684	33,894	41,820	146,398	610
Yemen	1,242	272	486	3,912	871	1,312	6,094	952
						Total	**516,250**	

[24] The Role of Renewable Energy in Reducing Climate Change in the ESCWA region, Report of the Economic and Social Commission for Western Asia (2012)

Box 14: The DESERTEC Foundation Initiative: Regional Cooperation in Renewable Energy but Uncertain Future

In January 2009, the DESERTEC Foundation was launched as a global civil society non-profit organization. It comprises a number of scientists, politicians, and economists from the Mediterranean region and prepares for a sustainable future by enhancing trade in electricity in Europe and the MENA region by implementing 20 electricity lines, each one of which transmits 5 GW, according to the German Aerospace Center. This was expected to be realized through private investment to meet local demand, export to Europe through a super grid of high-voltage direct current cables, use the system of buying power at a concessionary tariff, support the industrial capacity of countries that implement the projects, contribute to job creation, and limit carbon dioxide emissions. Procedures to achieve this include cooperation with the Union for the Mediterranean in implementing the Mediterranean Solar Plan (MSP), organizing information campaigns, and preparing a solar atlas for related desert regions that would be accessible to all.

On 31 October 2009, in Munich, the launch of the industrial initiative was announced, with the participation of 12 major energy companies with DESERTEC, to implement electric power generation projects from solar energy at an estimated cost of €300 billion. Production was expected to start in 20 years, which would provide 21% of Europe’s electricity needs by 2050. The founders aim to engage other companies from North and South Mediterranean countries. However, this project is currently experiencing major challenges in terms of funding and political commitments which makes its future uncertian.

4

Chapter Four

Case Studies in Renewable Energy in the Arab World

To move toward a sustainable future, it is important to learn from history and past experiences.

4.1. Introduction

For more than three decades, there have been many initiatives, projects and studies on renewable energy in the Arab world; but these initiatives and projects did not have enough momentum to create a tipping point and develop a critical mass of researchers and patents. Moreover, local knowledge was not developed and absorbed to respond to the nature and needs of each country, due to Arab countries' limited renewable energy use compared with Western countrie as shown in Figure 4.1.

There are several problems that prevent the development of learning organizations where technicians and experts are able to generate knowledge, and where institutions and the communities of practice in energy work to develop in-depth learning processes through review, evaluation analysis, and self-criticism in transparency and integrity.

The following is a selection of case studies from Jordan, Morocco, and Tunisia with summaries of lessons learned from several countries in energy policy, energy technology management and innovation through different projects and initiatives. Perhaps one of the most important dilemmas of the Arab region is limited documentation of successful and failed experiments upon which to build and from which to learn, in order to shift to a knowledge and green economy.

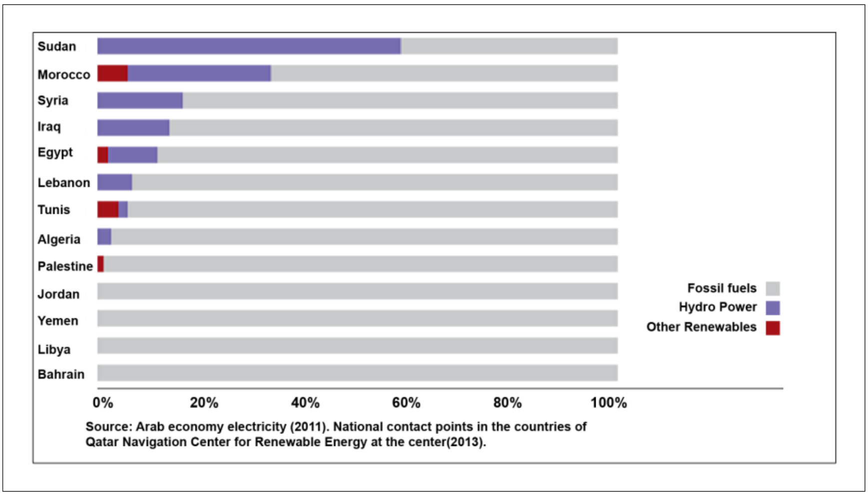


Figure 4.1: Limited renewable energy production in the Arab world (with the exception of hydro power in Sudan, Syria, Morocco, Iraq and Egypt)

Two types of inequality characterize the Arab region: the main inequality, which is clear between richer countries that are more needy for energy in the north, and those in the south; the other inequality is in energy resources. Although limited progress has been made in the region, the present energy trends are not sustainable. They need to be reversed through concerted steps to avoid the rise in carbon emission and pollution. Opportunities for job creation exist in energy efficiency, environmental or green construction, and access to basic services and renewable energy industries and technology.

There are successful examples of best practices such as ratification of special laws on renewable energy in Algeria and Jordan, and the completion of a number of wind and solar energy projects; but the current efforts of Egypt, Morocco and Tunisia are not sufficient as a long-term basis in most cases. The Arab region's dependence on traditional energy may increase dramatically; in 2007, dependence on local power reached 42%, and according to research conducted by the Observatoire Méditerranéen de l'Energie – Mediterranean Energy Observatory (OME), this rate should stabilize by 2030, or even drop to 40% (40% for oil, 30% for gas and 70% for coal). It would be possible to reduce this pressure and to reduce regional dependence to 18% by 2030.

For renewable energy development, improving energy efficiency is vital. Energy efficiency and investment depend heavily on business and citizen behavior. There are institutional, organizational, technical, and financial obstacles, however, arising from issues of information and training, that hinder the development of this potential. It should be recognized that in most cases, renewable forms of energy are less competitive than their conventional counterparts, because of government subsidies for conventional energy.

One of the basic aspects of developing renewable energy is support for distributing the process of generating electricity, especially solar generation, through training, funding and enactment of appropriate laws. Given the diversity of circumstances in different countries, Arab countries have common and unique responsibilities. Shared responsibilities consist of planning for a future of sustainable energy. Unique opportunities related to implementation and technology adoption and acquisition exist but a business model and strategic intent are to be developmed. What is needed is a regional vision with robust strategies that are to be adopted by all nation states.

Trends indicate strong growth in demand for energy in the region, and a need to develop a joint program for renewable energy in the Arab world to form a new region that embraces countries that are rich and poor in energy.

Starting regional cooperation that focuses on a new model of power system, consistent with sustainable development, in order to meet the needs of the present without compromising the ability of future generations to meet their needs is one way this challenge can be met. This requires harmonizing legislation and adopting flexible tools as a necessary condition for creating a competitive environmentally friendly energy market. It is possible to build on joint Arab experiments in electrical interconnection and joint projects within the Arab League and the Gulf Cooperation Council (GCC) such as the 400 MW capacity link between Jordan and Egypt. To root and localize a culture of green technology, it is crucial to support green civil society action, research and social innovation centers and incubators for renewable energy.

Therefore, increasing support for action research and development (R&D) and encouraging technological innovation offers major productivity benefits that are able to turn the economic benefits of renewable energy projects to levels that attract investors and the private sector. Accumulative knowledge can be achieved as part of a joint regional R&D platform that combines universities and research centers on sustainable energy with global research centers.

There is the EU experience in this regard, such as Erasmus energy plan in the Mediterranean region, which enables students from all parts of the region to receive training in sustainable and renewable energy technologies. Developing renewable energy provides suitable jobs within the region and with other regions, and it cannot be achieved effectively except through societal dialogue between East and West and North and South. It would be important to grant freedom of trade in renewable energy and green friendly services and goods, to promote green industries as part of the current and future trade negotiations.

There is a number of regional initiatives to support the development of renewable energy, which aim to link and integrate East and West.[25]

a) Mediterranean Solar Plan (MSP)

The main objective of MSP is to meet energy needs in the southern states and transfer part of the electricity generated to European countries, which is another important aspect of the financial and economic benefits of the projects. It is possible to export environmentally friendly electricity to Europe under Article 9 of the EU Renewable Energy Directive. Such exports depend on interconnection and require the introduction of specific regulations to prevent opportunistic behavior or market distortion.

MSP aims to create the capacity to generate an additional 20 GW by 2020 from renewable resources (especially solar and wind) and to develop electricity grids and connections between North and South and within the South. Energy sufficiency and technology exchange are under consideration at present as supportive measures. According to the OME forecasts for 2020, the objectives of MSP would mean an additional new renewable capacity of 11 MWs.

MSP faces a number of problems that include: security and stability, enhancing project benefits by using local electricity tariffs, carbon and renewable energy credits or subsidies, and ensuring the necessary funding.

[25] European Social and Economic Committee Energy Efficiency Plan 2011 (CESE 2011)

b) Medgrid Project for Joint Development of Electricity Exchange in the Mediterranean Region

It is vital to complete and strengthen electricity-interconnecting grids across the Mediterranean. At present the only existing interconnection is that between Spain and Morocco, which has a capacity of 1,400 GW. According to Euro-Mediterranean Electricity Cooperation (MEDELEC), the federation of electricity authorities around the Mediterranean, the maximum transmission capacity the network can have on the basis of existing investment plans amounts to 5 GW, hence realizing the objectives of MSP would require a major effort to increase interconnection capacity between the southern states and the European northern shore. Medgrid aims to strengthen the regulatory and institutional frameworks for the exchange of electricity, evaluating the return on investment in the grid infrastructure, developing technical and technological cooperation with the southern and eastern Mediterranean countries, and promoting advanced transmission technology.

c) Desertec Initiative: Constraints and Uncertain Future

Dii initiative aims to provide 15% of Europe's demand for electricity from solar generators in the deserts of southern Mediterranean countries by 2050. Since its inception in 2009, however, Desertec initiative moved to the goal of joint development, with focus on the development of renewable energy in general, not specifically solar power, and the export between North and South. In practical terms, the Desertec initiative and MSP have the same vision but within a longer time frame. However, this initiative is experiencing major challenges in terms of the funding, technicalities and regional commitments. The future of this project is uncertain till to date which is due to shifts of energy policy, funding models and political commitments.

4.2. Renewable Energy Experiments in Arab Countries:

Although there are a number of good emerging examples of application in Renewable Energy in the Arab World including Saudi Arabia, Kuwait, Qatar, United Arab Emirates, Egypt and other countries, this section will focus on three cases. These include, Jordan with emphasis on institutional capital; Tunisia with a focus on energy efficiency and Morrocco with reference to implementation of RE capacities.

a) Jordan: The Institutional capital and tipping points:

Jordan was a pioneer in instantiating and experimenting with renewable energy since the early 1980s with a sound institutional infrastrcuture based at the Royal Scientific Society (RSS). Hence, the key question remains: "How can Jordan, after about three decadesin technology adoption, move forward in renewable energy?" This section will shed light on the instiutional infrastructure of the National Energy Resource Center (NERC) as an enabler for knowledge innovation and technology adoption.

The energy policy of the Government of Jordan (GoJ) was shaped through the adoption of the Master Strategy of Energy Sector in Jordan for the period 2007-2020. The main goals of the Energy Strategy are the provision of reliable energy supply by increasing the share of local energy resources in the energy mix, reducing the dependency on imported oil, diversifying the energy resources and enhancing environmental protection. These goals will be achieved through maximizing the utilization of domestic resources such as oil shale and natural gas, expanding the development of renewable energy projects, generating electricity from nuclear energy and promoting energy conservation and awareness.

The 2007 Energy Strategy has set ambitious goals for the development of renewable energies. By 2020, the share of renewable energies in primary energy supply is to be increased from the current 2% to 10%. A number of single targets have been set such as for wind power (installation of about 1200 MW), solar power (600 MW) and solar water heaters (share of 30% by 2020) in addition to waste-to-energy (30-50 MW).

The government has underlined its commitment to reach the ambitious targets set in the Energy Strategy and has issued the Renewable Energy and Energy Efficiency Law on 17^{th} April 2012. With this law, for the first time in Jordan, unsolicited or direct proposal submission is allowed, where investors have the opportunity to identify and develop renewable grid-connected electricity production projects such as wind parks, solar systems or others on their own and propose these to the Ministry of Energy and Mineral Resources. As a result of this process, 580 MW renewable energy projects are planned up to 2015 in which 200 MW from direct proposals, 70 MW PV solar projects and 70 MW wind projects will be constructe.

Electricity Generation: the actual electricity generation capacity in the kingdom is 3857 MW and electricity peak demand reached 2957 MW in 2014. In order to meet the growing energy demand in the country that has been increasing at the rate of 5% per annum, the Government of Jordan has taken several steps to support and allow private entities as independent power producers (IPPs) to build electricity generation facilities for sale to the grid. The government has successfully attracted foreign investment in a number of IPPs. The first IPP, 370 MW Amman East Power Plant and second IPP 373 MW plant at Al Qatrana started operation in 2009 and 2012 respectively.

Energy Efficiency*:* Improving energy efficiency is an integral part of the 2007-2020 Energy Strategy which calls for a 20% improvement in energy efficiency in all sectors by 2020. Energy Efficiency By-Law was issued on 14th Nov. 2012, where Solar Water Heaters (SWHs) are mandatory as of April 2013 for new buildings. The Energy Services Company (ESCOs) market has to be licensed and regulated as well as labeling is mandatory to all electric appliances. Tax Exemptions By-Law was issued on 14th Feb. 2013, exempting all Renewable Energy and Energy Efficiency Systems and Equipment's from sales tax and custom duties.

Jordan has been a leader in renewable energy, and is most interested in it due to the scarcity of energy sources. Jordan imports more than 96% of its annual energy needs, at a cost of up to 20% of GDP.

Consequently, a special policy was developed to introduce renewable energy sources in the energy system by allocating 5% of total energy to that derived from renewable energy sources over 10 years. This would be achieved by developing renewable energy sources in electricity generation principally from private investment, enhancing and promoting the use of solar energy for domestic uses as well as the services and agriculture sectors, and using solar energy to pump water in rural areas.

Jordan enjoys an abundance of solar energy ranging from 5-7 kilowatt-hour/m^2 a day, and up to 317 sunny days a year, with a daily average sunshine of up to 8 hours. The total quantity of energy produced per year amounts to 2,536 kilowatt-hour/m^2. There is a wide range of uses for solar energy in Jordan such as the solar tower system, which is an ambitious system for using solar energy to generate electricity on a commercial basis.

Solar energy is widely used to heat water in Jordan through solar water heaters, but power generation using PV cells did not start in a systematic and effective way until the Energy and Minerals Regulatory Commission, the regulatory energy authority in Jordan, issued instructions and regulations related to renewable energy in 2012, which allowed the use of renewable energy to produce electricity and connect it on-grid using net meters.

There are a number of sound research centers devoted to renewable energy in the Arab World but there is limited regional cooperation among these centers that can develop a critical mass of scientists and research teams, community of practice, patents, and innovations or breakthrough. In Jordan, the National Energy Research Center (NERC) was established in 1972 as a center of the Royal Scientific Society (RSS), at the time named the Solar Energy Section. It became a specialized center in 1982 and was renamed the Solar Energy Research Center. In 1989, its activities evolved to include everything related to renewable energy, and it was renamed the Renewable Energy Research Center. The Center received the competencies and equipment needed to carry out its functions, which were upgrading renewable energy and raising the efficiency of energy consumption through research, development, training, technology transfer and networking with local, regional and global research agencies. In 2000, it became a national energy research center and moved from the umbrella of the RSS to that of the Higher Council for Science and Technology. The NERC gained a high reputation at the local, regional and international level, and His Majesty King Abdullah II, awarded it the King Hussein Medal for Outstanding Performance of the second-class, in recognition of NERC's efforts to promote renewable energy and improve energy efficiency.

At the end of 2010, the center was merged with three other centers and became a program within the National Center for Research and Development at the Higher Council for Science and Technology. At the end of 2012 NERC was returned to the RSS. NERC was established for the purpose of research and development and training in new and renewable energy, and raising the efficiency of energy sources in different sectors. The Center is tasked with the following functions and responsibilities:

1. Conducting studies and research and launching pilot projects in the following areas:

    - Using local sources of new and renewable energy such as oil shale, wind energy, solar energy, bio-energy, and geothermal energy to increase the contribution of these sources in meeting the Kingdom's energy needs.

    - Developing tools, guidelines and incentives to improve energy efficiency, reducing the total cost of energy to the national economy and protecting the environment from pollution.

2. Managing and operating laboratories, research and experimentation units and stations, to develop and utilize new and renewable energy sources, and selling station-generated power to the concerned authorities.

3. Organizing seminars, training courses, and conferences to develop the local capabilities and scientific expertise necessary to exploit new and renewable energy sources.

4. Cooperating with local, regional and international bodies to enhance the center's ability to achieve its objectives and fulfill its functions.

5. Creating an energy databank to facilitate conducting studies and research, and to link it with the national information system and any other local or external agencies involved or related to the center's work and objectives.

The NERC provides the required services to various economic sectors, such as studies on energy-saving, testing the efficiency of power-consuming devices, and calibrating different energy devices, given there is no agency in Jordan specialized in this area; this is not within the powers of a research institute such as the Higher Council for Science and Technology.

The many achievements of the center are associated with the RSS since the seventies. The center continues to work with the RSS on a number of common issues such as the work of the RSS Cleaner Production Unit to implement cleaner production as a comprehensive strategy to protect the environment while taking the economic dimension into account by conserving raw materials and energy.

The NERC works on many projects with the Jordanian government, to the point where it has become the technical arm of the government. It participated in drafting a number of laws and regulations related to rationalizing energy consumption and renewable energy, such as the Renewable Energy and Energy Efficiency Law 2012, and regulations issued pursuant thereto; the Energy Efficiency Policy - EE Roadmap commissioned by the Minister of Energy and Mineral Resources, which was the first document of its kind in the area of policies to improve energy efficiency in cooperation with the League of Arab States in line with the Arab Guidance Framework for Energy Efficiency; and preparing the national plan to improve energy efficiency in the electricity sector.

The NERC has become a recognized and credible agency in implementing European projects and conducting different measurements (air speed and solar radiation) for many local and international institutions such as the Ministry of Energy and Mineral Resources and the World Bank. The center also performs many activities in raising awareness, training, implementing different pilot projects, and assisting the government in measures such as reviewing reports, studies and laws sent by various government agencies and giving its opinion on them since NERC is the technical arm of the government. The NERC also participates in meetings with donors and parties interested in energy matters, as an advisor to the government, along with other government institutions, especially the Ministry of Energy and Mineral Resources. The NERC also participates in studies and projects undertaken by international donor institutions in Jordan, as the only agency technically qualified to perform tasks pertaining to energy.

In addition, NERC provides different services and implements projects related to rationalizing energy consumption, and improving efficiency, such as free preliminary studies of industrial facilities, hotels, and hospitals, to identify possible opportunities for energy conservation, and conducting detailed studies that include collecting and analyzing all energy consumption data, such as electricity bills, fuel, water, the facility's production capacity, and the rate of operation of energy-consuming equipment at the facility. Moreover, NERC participates actively in national committees specialized in issues of renewable energy and energy efficiency. For instance, the Center took part in the Royal Commission on Energy, which prepared the National Energy Strategy 2007 – 2020, the Energy Efficiency Strategy 2004, and other legislation and regulations related to the center's work such as customs exemptions, examining energy efficiency and others.

NERC also participates in committees that prepare codes related to energy, such as the solar power code, energy-efficient buildings code, and the green buildings guide. The Center prepared drafts of these codes, which are expected to be approved and enacted in 2011. The Center also participated actively in the Specifications Committee that issued energy label specifications for a number of electric household appliances, including refrigerators, washing machines, air conditioners, and lighting equipment. Currently, the Center is working in cooperation with the authorities concerned on implementing the energy specifications label program and the minimal specifications of electric home appliances. NERC also participates in many local committees related to the environment in cooperation with the Ministry of Environment, such as the Clean Development Mechanism (CDM) Committee, and the National Committee on Trade and the Environment. The following outlines NERC activities in various fields in renewable energy.

1. NERC's Activities in the Area of Photovoltaic Cells

The Photovoltaic Cells Section designs and implements electrical power generation systems operated by solar cells for parties that request it in the Kingdom. To date, nearly 100 systems have been implemented for the electrification of schools, health centers, border security posts, and tourist sites in remote areas, as well as the electrification of water treatment and pumping systems, and communication systems.

The Center measures solar radiation in different parts of the Kingdom and studies its findings. It also tests components of solar cell systems, which are solar cell panels, phase converters, and battery charging regulators at the solar cells laboratory, which was established in 1993. The Center verifies the technical specifications of the solar cell system components examined and issues certificates of inspection to requesting parties.

The Center cooperates with local, regional and international institutions, by participating in research projects funded by donors. Since its establishment, the Center participated in several research projects related to studies of solar radiation and applications of solar cell systems.

The NERC hopes to maximize solar cells use in the Kingdom by encouraging investors to build large electricity-generating stations, and encouraging citizens in cities to install solar cells on the rooftops of their homes and sell the electric power generated to the public electricity grid.

2. NERC's Activities in the Area of Wind Power

The NERC has worked on a long-term project, since 2000, to create a database on wind characteristics in all parts of the Kingdom, based on government guidelines for wind energy use in the Kingdom, hence the need to provide accurate information on wind characteristics and to search for new and promising sites. The Center measured wind characteristics at 36 locations using the measurement equipment available, which were fitted with the latest computerized equipment, by moving the measurement systems from one location to another. And with the support of the Royal Court, NERC acquired 13 new systems that it works to install at new locations. Six were installed in 2009, and the rest in 2010, to measure wind speed and direction at different altitudes ranging from 10 m-60 m from ground level.

NERC currently works with the EU to build a station for checking and calibrating fans and their components, provide the laboratories needed at Al Fujeej area in order to build national capacity in wind energy, and prepare a trained and qualified technical staff to ensure the continuity and sustainability of wind projects in the Kingdom through workshops and training courses.

The Center provides technical consulting services in wind energy use, preparing technical studies of sites proposed by the beneficiary, or proposes new sites for the construction of wind farms and highlights them to the investor, determining the fans' technology to be used in these locations to achieve the required efficiency, and hence positive economic returns to the investor.

The Center implements water pumping and treatment projects using wind energy; it installed and maintains a number of wind-powered pumping systems for the Water Authority. In addition, NERC works to design and manufacture small fans and their parts, and transfer the manufacturing technology to the industrial private sector. This is done by designing and developing fan blades, using the latest computer software for manufacturing the molds using CNC Machines and cooperating with the private sector to manufacture the blades from fiberglass, and developing 200-1000 watts DC current generators for use within the small electric fan system without the need to use a speed adapter. The Center also participated in implementing a number of research and applied projects funded by aid donors, in cooperation with local and international organizations, particularly European institutions.

3. NERC's Activities in Energy Rationalization

The NERC has worked since its creation to spread the culture and procedures of rationalizing energy consumption and improving the efficiency of its use in different energy-consuming sectors. Each year, the Center holds several seminars and training courses, participates in exhibitions, organizes scientific days on rationalization of energy consumption and the means and techniques of improving the efficiency of energy consumption, and conducts energy efficiency studies in industrial, commercial and public buildings. These studies affirmed the practicability of saving 20% of total energy consumption in these sectors.

In line with the national strategy to improve energy efficiency, which was ratified by the Council of Ministers in 2004, in order to reduce energy consumption without affecting the standards of living and production, NERC has worked independently, and in cooperation with various stakeholders, to implement the provisions of the strategy and reduce the national energy importation bill. The NERC took part in all committees formed pursuant thereto, such as the codes committee, the awareness and information committee, the transportation committee, the standards and metrology committee, and the taxes committee, which exempted equipment for energy rationalization and renewable energy from taxes and customs duties by means of a Council of Ministers Resolution in 2008. The Center also participated actively in the committees tasked with preparing codes related to energy, including the solar power code, the energy-efficient buildings code, and the green buildings guide. NERC actually prepared the drafts for these codes, which were issued in 2010, 2012, and 2013 respectively.

In research and pilot projects, NERC currently works with the Ministry of Planning on a project for home lighting and street lighting, supported by the French Development Agency (AFD) and the participation of many agencies such as the Ministry of Energy, the Greater Amman Municipality, and the Jordan Electricity Company.

The project aims to study the economic feasibility of replacing incandescent bulbs with energy-saving bulbs for a sample of homes selected in advance, and apply it to the housing sector in Jordan. The project also includes replacing low-efficiency street lights with high-efficiency ones in selected streets in Amman.

The NERC also implemented a project to study the use of solar energy for cooling and heating. The project was implemented in a Dead Sea area hotel, through support from the EU, which provided opportunities for research and applied projects in this area.

4. NERC's Activities in Bio-Energy and Bio-Gas

The NERC conducts scientific R&D, and technology transfer in biomass, in order to find alternative energy sources and protect the environment. The project aims to study the reserves available domestically per year and per day, and the geographic distribution of their production in the Kingdom, study their physical and chemical characteristics, study their calorific value, and study heat treatments to produce energy from biomass. NERC also conducts scientific research and development to produce anaerobic low-cost fermenting agents, devise environmentally friendly sustainable solutions for the increasing quantities of organic waste from animal farms, and spread awareness of biogas technologies by organizing courses and workshops for small farmers. This activity comes as a continuation of the Center's success in the project for national capacity building and training in the management of solid waste and biogas.

In the area of biofuel, NERC conducts scientific research and development and national capacity building in producing bio-fuels from organic materials, including the production of diesel from organic materials using rapid distillation technology, and technology transfer. A leading project on the regional level is pilot unit establishment to produce 1,000 liters of diesel per hour, 400 KW of electricity, and the production biodiesel from the oils of some energy fruits (Jatropha), irrigated with brackish water treated by reclaiming farmland. In addition, studies are conducted on water requirements, the suitability of Jordan's climate for this tree, the production of seeds and oil, and the mechanical treatment needed to produce biodiesel.

In sum, it is evident that Jordan has a sound institutional setting for R&D in renewable energy led by NERC but it is insightful to reflect on the reasons behind limited research groups, patents, regional cooperation and virtual alliances among R&D centers, and the need for rooting of a scientific community and research culture in renewable energy.

b) Morocco:

Morocco has limited energy resources and is dependent on imported energy. In 2011, the country imported 95.6% of its energy demand. Petroleum imports account for 20% of total imports and 50% of the current trade deficit. Imports of electricity in 2012 were close to 5,000 GWh compared with 1,000 Gwh in 2005. In fact Morocco spends approximately US 3 billion a year on fuel and electricity imports. Unlike other North African countries, Morocco has very few fossil fuel resources within its borders. Although it has large reserves of unconventional oil shale and some reserves of shale gas, these cannot be exploited given the lack of established specific industrial processes that can competitively produce oil and gas from these unconventional sources (Reegle, 2014).

Furthermore, Morocco has experienced a considerable growth of electricity demand. Energy consumption has risen at an average annual rate of 5.7% from 2002 to 2011 due to economic growth and increase in per capita energy consumption[26]. This increase in consumption was also due to investments in electrification projects which reached 97% electricity access rate in 2009 (which is an impressive growth considering that the rural electrification level was only at 18% in 1995) (Reegle, 2014).

Besides, Morocco is highly dependent on one major fuel, i.e. petroleum. This lack of diversity of the energy mix and dependency on one finite and imported fuel is considered a lack of resilience. However, the deployment of Renewable Energy (RE) increases the diversity of the energy sources and, through distributed and decentralized generation, contributes to the flexibility of the system and its resistance to shocks.

Investing and promoting Renewable Energy can offer major benefits to the local economy as infrastructure investments are localized and much of the revenue remains within the regional domain rather than flowing out to pay for imported fuel resources. In fact, Morocco has an average yearly solar radiation level greater than 2300 kWh/m^2/y, which is up to 30% higher than the best sites in Europe (Reegle, 2014)[27]. In addition, Morocco also has about 3,500 km of coastline where winds reach an average speed of up to 11 m/s which is among the highest in the world.

Through a $13 billion worth of investment in the expansion of wind, solar and hydroelectric power generation capacity, and through a series of new energy policies and regulations, the country is committed to achieve a very ambitious target: 42% (or 6,000 MW) of the country entire capacity to generate electricity from renewable energy sources

[26] Rcegle (2014), Energy Profile: Morocco, Available online from: http://www.reegle.info/countries/inorocco-energy-profile/MA [Accessed January 2015].

[27] Rcegle (2014), Energy Profile: Morocco, Available online from: http://www.reegle.info/countries/inorocco-energy-profile/MA [Accessed January 2015].

by 2020. In order to promote renewable energy deployment, Morocco has so far adopted a broad strategy that includes three main pillars of action:

1. Promulgation of actual regulations and laws to favour renewable energy expansion for electricity generation;

2. Establishment of institutions with the capacity to manage, supervise and promote renewable energy projects;

3. Implementation of projects and major financial investments to build the required renewable energy facilities.

A summary of the main regulations concerning RE include the following:

One of the most important steps of the renewable energy policy development in Morocco was the introduction of *law 13-09* which was promulgated in 2010 designed to promote and liberalize the renewable energy sector. This law allows electricity to be produced and exported by any private producer as long as they utilize renewable energy sources. Through this policy the Moroccan government opened up the energy market by facilitating new entries and by supporting independent renewable energy producers. The law basically offers medium and large electricity producer the right to input their energy into the national grid.

In 2011, the Moroccan government announced a reform under which fuel prices would be liberalized and the poorer sections of society compensated through cash transfers (Bridle, 2013)28. In late 2013 and early 2014, important steps were taken to eliminate the effective subsidy on gasoline and fuel oil, as well as to reduce

[28] Bridle, R., kiston, L, Wooders, P. (2014), Fossil fuel subsidies: a barrier to renewable energy in 5 Middle East and North African countries, USD and GSA publication.

significantly the subsidy on diesel fuel, and in June 2014 to eliminate the subsidy on fuel used for electricity generation.

The Solar Integrated Project was launched in 2009 in association with the creation of the National Solar Energy Agency. The target of this project is to reach a total installed capacity of 2000 MW with the development of large scale Concentrated Solar Power (CSP) and Photovoltaic facilities in 5 different areas covering a total of 10 000 ha (or a total final production of 4,500 GWh (18% of current national electricity production)[29].

The Moroccan Integrated Wind Energy Programme was launched in 2010 and included the target of bringing the wind capacity from 280MW in 2010 to 2000MW by 2020 through the construction of major wind farms across five different sites in Morocco. With investment costs estimated at US$3.5 billion this project is expected to deliver an annual production of 6600 GWh, corresponding to 26% of current electricity generation and produce annual savings of 1.5 toe (tons of oil equivalent) and approximately 5.6 million tonnes of $C0_2$ (Currie, 2012).

Lastly, it should be mentioned that also hydropower plays a considerable role in the Moroccan energy mix. In 2008, Morocco hydro power delivered 1,360 GWh of electricity (as a reference the same year 298 GWh were produced by wind).

Hydropower is planned to deliver 14% of the total electricity capacity of the country by 2020 target which is aimed to be achieved with the construction of two new large hydropower facilities and

[29] Whitley, S.; Granoff, D. (2014), The Moroccan Agency for Solar Energy and the Moroccan Solar Plan, Green Growth Best Practice (GGBP).

through the development of several micro-hydropower projects (producing off- grid electricity) (Cirlig, 2013).

In sum, Morocco is a good example of implementing the reforms, programs and laws in renewable energy to ensure a sustainable development.

c) Tunisia

Tunisia is one of the successful models in the transition to green and sustainable energy. In 2004, 7,000 m^2 of solar panels for heating water were installed, which elevated achievement in this area to about 120,000 m^2 of collectors since 1982, the year in which the manufacturing and marketing of solar water heaters began in Tunisia. Also in 2004, a new funding mechanism was developed to support the spread of solar water heaters, by providing loans to those who wish to install such equipment, which are collected later through electricity bills. The objective of the mechanism, which entered the implementation stage in 2005, is to support the use of solar heaters in the residential sector by subsidizing the acquisition of the solar heater to the value of 100 Tunisian Dinars per square meter, and the rest is paid back over five years, without interest through the electricity bill. Around 30,000 square meters of solar collectors were installed, and it is expected to install approximately 100,000 m^2 by the end of the 2006.

Since the beginning of the nineties, Tunisia has initiated projects to illuminate the countryside using solar PV energy, to improve living conditions in areas far from the national grid, by providing the basic electric power needs to rural homes in these areas. In 2004, 170 homes were lit this way, which elevated the coverage in this area to about 12,000 homes, 200 schools, several border posts, and clinics spread over most of the states. Some beaches, parks and villages were also lit using this technology.

Tunisia began moving toward energy conservation and sought to make good use of renewable energy, such as wind and solar energy, by working on many leading programs in this area. This was a choice supported internationally, especially after the surge in oil pricing in the recent years. The Tunisian Solar Plan, adopted in October 2009, was the most recent of those conservation efforts. The plan covers many areas related to energy efficiency and renewable energy in line with the MSP, which is the major incubator for such projects in the Mediterranean basin.

Box 14: Tunisian Solar Plan: Green Energy and International Cooperation

According to the OME, Tunisia has the capacity to achieve clean energy projects that amount to 26% of all projects to be implemented, ahead of other Maghreb and Arab countries, except for Jordan, which has a 32% construction capacity in renewable energy. As a party in the MSP's five-year pilot phase (2009-2014), Tunisia will have implemented 26 alternative energy projects to produce 3,042 MW of solar electricity. Following completion of the first phase, the MSP will make possible the planned north-south exchange of green energy through the integrated European grid. The most important objective of the Tunisian Solar Plan is to provide the equivalent of about 660 kilotons of oil per year, and avoid the emission of 1.3 million tons of carbon dioxide annually.

Source: Tunisian Observatory for Environment and Sustainable Development, the national report on the status of the environment, the Ministry of Environment (2010).

The estimated cost of the Tunisian Solar Plan 2010-2016 is about $3 billion. It includes 40 projects, a large part of which is devoted to harnessing solar energy for heating water, cooling and developing electricity generation for domestic consumption and export, making Tunisia an international base for the production and export of solar energy produced power.

Box 15: Tunisia: Savings through Energy Efficiency

In the context of the strategic energy plan for the year 2000 Tunisia developed national programs to increase Energy Efficiency (EE) and legal and institutional frameworks for the energy sector that included financial incentives to encourage energy efficiency and the use of renewable energy. These programs led to total savings of $40 million / year from the national energy bill.

Source: Tunisian Observatory for Environment and Sustainable Development, the national report on the status of the environment, the Ministry of Environment (2010)

From another perspective, the wind energy project power-generation, which was being implemented over the span of two years, included the construction of 91 giant wind turbines to generate power from wind. The use of these facilities and equipment in the conversion of energy into electricity produced for integration and transmission through the grid of the Tunisian Company for Electricity and Gas (STEG) is expected to save the equivalent of 120,000 tons of oil for fuel and 43,000 cubic meters of water annually.

These projects are part of the Tunisian strategy for sustainable development, the promotion of renewable energy and resisting global warming. Preliminary studies indicate success in reducing emissions by 300,000 tons of carbon dioxide.

Studies show that Tunisia possesses high capabilities to apply solar thermal technology to generate electricity. This required identifying several locations to install concentrators of solar power (CSP), depending on the solar radiation available, soil quality, and other elements that include the electrical power distribution among the grids, and the supply of central cooling water. All of these elements are taken into account when selecting suitable sites for these projects. The prospects for the Tunisian Solar Plan look promising. Research has overcome the problem of storing the large quantities of renewable energy, especially after Tunisian expertise in this area succeeded in providing high-capacity storage batteries. This is what the environmental center in the island of Djerba, south of the country, works to implement on an area of 9,167 square kilometers, which lies on the “always sunny lines.” The project also seeks to create five centers to equip experts, technicians and workers in this field.

In sum, Tunisia presents a good example for implementing programs in energy effieciency. Lessons learned in this domain can be shared with other countries in the Arab world through regional and international organizations ■

5

Chapter Five

Managing Knowledge and the Requirements of Technological Innovation

Taking charge of the future will only occur when science and technology are localized and become an Arab national priority.

5.1. Introduction

In light of the market economy, globalization, knowledge economy, and the presence of many regional and international energy organizations, it is necessary to develop a platform and a vision for knowledge management in the renewable energy sector in the Arab world, to achieve the following objectives:

- Achieve comparative advantage to maximize competitiveness in the energy sector, and support an integrated Arab renewable energy market.
- Develop a new institutional framework for a renewable energy region in the Arab world, which ensures the development of fair and transparent policies.
- Support green economy and provide job opportunities in renewable energy for SMEs.
- Stimulate R&D, entrepreneurship, innovation, patents, and regional research teams in renewable energy as well as develop industrial parks, centers of excellence, and renewable energy complexes.

- Develop an enabling environment for industry, while integrating the value and supply chain within the Arab world, and Arab scientists abroad.

- Support the Arab knowledge community in renewable energy through Arab electronic publications, networking, and renewable research programs in renewable energy.

- Reach the tipping point of localizing and commercializing knowledge, services, and technology related to renewable energy and link it to information technology and communications.

Box 16: The Tipping Point

A critical tipping point is expected to occur with increasing investments in R&D and marketing in the renewable energy sector. How can the transfer of knowledge, and the transfer of localization of renewable energy technology reach the critical tipping point between these countries with large and unique investments in renewable energy? There are large investments in power generation from solar cells in Algeria, Morocco, Egypt, the UAE, and Saudi Arabia; there are pioneering experiments in the use of solar water heaters in Jordan, Palestine and Tunisia; there is specialized research in linking information technology with clean energy technologies in Kuwait, the UAE, and Jordan; wind energy is used with success in Egypt, Jordan and Morocco; and research is being conducted in the science of materials used in renewable energy. But the Arab world needs a number of elements to reach the tipping point, the most important of which is having a strategic Arab objective in the development plans to localize renewable energy, enhance integration between Arab countries, deepen the role of research centers nationally, regionally and internationally, and ensure the existence of sustainable funding for the implementation of research projects that meet local needs. For these projects to see the light, there must be an integrated environment linking industry with scientific research centers, through the support of business incubators, parks, entrepreneurship in SMEs, and patents in renewable energy. This requires identifying local priorities, developing a professional research culture that serves Arab development goals and a clear long-term vision by paying attention to the younger generation of researchers (fresh graduates with higher degrees) to develop post-doctoral programs in Arab and international research centers.

5.2. Knowledge Economy in the Arab region

Knowledge management has provided numerous opportunities for organizations in advanced societies to achieve a competitive advantage through innovative technology, means of production, and working methods that helped reduce costs and increase profits. This led to what is termed Knowledge Industry (KI) and the appearance of terms such as knowledge economy, knowledge management, and knowledge societies, which has become the topic of the hour for the business sectors in advanced countries.

Interest in knowledge management and its effect on development in advanced countries coincided with the publication of the two UN reports on Human Development in Arab Countries in 2002 and 2003, which pointed out the state of "knowledge" is one of the principal barriers against development in the Arab world. Galbreath (1999), affirms the one fact that will not change in the 21st century, is the rapid and continuous change in all aspects of life. Developments in science and communication technology led not only to freeing labor markets and international investment, the globalization of the economy, and enhancing international competition, but also to the interest of advanced industrial countries in working to change their societies into knowledge societies, and creating new economic systems based on knowledge, where material assets (natural resources, capital, and raw materials) lost their value as guaranteed assets, human capital gained profit value, and became a principal criterion for success and progress in all fields. Ghalioun (2005) also affirms the rising role of science and knowledge in the restructuring of social and economic life in contemporary societies.

Notwithstanding the enormous knowledge development in advanced countries, Arab countries still progress slowly toward absorbing knowledge and generating it in an empowering manner that catches them up with knowledge countries. They also suffer from the problem of belated development. Dore (1973) believes that knowledge economy is the product of a long historic and technological development in developed capitalist societies, and developing countries have not passed through this process yet.

Despite the Arab societies' persistent efforts to keep up with international developments in orienting themselves toward knowledge economy by creating an appropriate business environment, a suitable infrastructure, developing education policies, and developing training programs to upgrade human resources. The UNDP report on Human Development in Arab Countries in 2003 indicated the effort to introduce structural changes in market and business structures was not accompanied by changes in institutional culture (UNDP, 2003), and in the prevailing methods of authoritarian administration and centralization (Sabri, 2004),[30] which were derived from the patriarchal structure of Arab society (Barakat, 2008; [31] Sharabi, 1990).[32] This significantly affects the ability to motivate qualified human resources to employ their knowledge and creativity for the development toward a knowledge society.

Swanstrom (2002) [33] sees that knowledge economy is a branch of basic science, which aims to achieve the well-being of society through the study of systems for the design and production of knowledge, and

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[30] Sabri, H. (2004). "Socio-cultural Values and Organizational Culture", In: K. Becker (ed.).*Islam and Business.* New Jersey: Haworth Press, 123-145.

[31] Sharabi, Hisham, (1990), Introduction to the study of Arab Society, 4th edition, Beirut, Dar Al Talee'ah

[32] Barakat, Halim, (2008), Contemporary Arab Society: An exploratory Social Study, 10th edition, Beirut, Center for Economic Unity Studies.

[33] Swanstrom, E. (2002). *Knowledge Management: Modeling and Managing the Knowledge Process [IMPORT]*. John Wiley & Sons.

then conducting the interventions necessary for the development of these systems through scientific research and the development of practical and technical tools and applying them directly in the real world. The knowledge economy's areas of interest include the production and storing of knowledge, i.e. innovation, acquisition, dissemination, use, and adoption of knowledge. It is also interested in the industry of knowledge through education, training, consulting, conferences, publications, and R&D. Swanstrom (2002) argues that modern organizations seek to acquire technological and scientific knowledge, introduce modern technology in work, and to create new goods and services that enable them to achieve a competitive advantage.

The knowledge-based economy is considered an advanced stage of the knowledge economy. It gives a special status to knowledge, technology, and work to apply them in economic and social activities in a community called information community. The benefits of information technology in the telecommunications sector, and genetic engineering all make the economy based on science and knowledge. Countries that still seek to produce knowledge through innovation, acquisition, dissemination, use, and storage, are passing through the stage of the knowledge economy. Meanwhile, major industrialized countries, which benefited from the achievements of the scientific and technological revolution, and employed them in industries that generate new knowledge, discoveries, and advanced technologies, have reached the stage of knowledge-based economy, or even post-knowledge economy.

The global transformation from information society and economy to knowledge society and economy began in the last decade of the last century. The UNDP (2003:36) defines knowledge society as "a society that is based primarily on disseminating, producing, and employing knowledge efficiently, in the economy, society, politics and private life, culminating in human development. This definition includes the view of Temple,[34] Nonaka, [35] and Romer, [36] that knowledge has two complementary facets: explicit and implicit. Explicit knowledge consists of information and ideas carried by individuals or espoused by the community in a specific historic context, which regulates human behavior individually and institutionally, in all areas of human activity. Explicit knowledge includes, for example, symbolic structures that are passed through formal education and lessons learned from work and life experiences. It also includes the institutional knowledge of a community over history, culture and strategic directions and organizational forms.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) 2005 [37] report points outs that knowledge society is a society that has the capacity to produce, process, transfer, disseminate, and use information to build and apply knowledge for human development. As for the knowledge-based economy, it is the stage of maturity and sophistication of the information economy. It focuses on the value of the human intellectual capacity as knowledge-producing intellectual capital. Hence the presence of knowledge workers - as Drucker suggests [38]- in this economy is very important to the success of institutions in a dynamic ever-changing environment.

[34] Temple, P. (1999). "The knowledge Driven Economy: Fact or Fantasy?" *Economic Outlook,* April.

[35] Nonaka, I. (1994). "A Dynamic Theory of Organizational Knowledge Creation",

Organization Science, 5 (1). 14-37.

[36] Romer, P. (1995). "Beyond the Knowledge Worker", *World Link*, January/ February. 56-60.

[37] UNESCO - United Nations Educational, Scientific & Cultural Organization. (2005). *Towards Knowledge Societies*. Paris: UNESCO Publishing, p.27.

[38] Drucker, P. (2003). *The Essential Drucker*, New York: Harper Business.

Politis confirms[39] the important role of administrative leadership in knowledge societies and work to transform businesses into knowledge organizations in order to cope with technological developments and sharp competition in the business environment. In addition, Tichy and Devanna [40] indicate the challenge of knowledge for communities lies in the extent to which the leadership is able to conduct the institutional development, by bringing together the scattered knowledge in the minds of individual innovators, support them in creating knowledge, persuade them to publish their knowledge, and employ it efficiently in the service of the community and building human development.

There is no doubt the characteristic of power in the twenty-first century will not be the same as those that governed the last century, such as population size, land area, raw materials, industrial base, and military power, albeit these factors are still important; but they are not decisive in this day and age. The decisive and most important criterion that can activate all of these factors is knowledge, in all its components such as technology, informatics, space technology, genetic engineering, nanotechnology and others. This technology is no longer secret; it is available on a large scale, but it is important to take advantage of it and turn it into marketable products at economic prices. The U.S, Japan and EU countries are competing to transform technological innovations into value added product and services. Possession and development of technology and its application depend on the large-scale collective behavior of communities and nations.

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[39] Politis, J. D. (2001). “The Relationship of Various Leadership Styles to Knowledge Management”, Leadership & Organization Development Journal, 22 (8): 354-364.

[40] Tichy, N. M. and M. A. Devanna. (1986). The Transformational Leader. New York: John Wiley & Sons.

Hofstede [41] believes this is because the majority of Arab societies are strongly patriarchal collectivist societies, while Western societies are individualistic societies based on the value of the individual, his activity, and his association with institutions that work to develop and stimulate creativity. They act as an umbrella as well as provide scientific, economic and political support for the individual.

Hill [42] states that contemporary Arabs have failed in scientific and technological innovation, and they failed in the transfer of technology as science, and in absorbing it in Arab countries. What they have done during the past oil decades was import technology, and sometimes import the means of producing it, to build the infrastructure for producing some technology without being able to own and absorb science and to have the capacity for the development and generation of technology products and culture. This cancelled the economic benefit of these products with the passage of time because the host countries did not have the capacity to upgrade these products.

The 2003 Arab Human Development Report (UNDP, 2003) shows that Arab countries invested more than $2500 billion between 1980 and 1997 in the construction of factories and infrastructure, but these investments have not led to a real transfer of technology, because what was transferred was means of production not the technology itself. The lack of effective systems for innovation and the production of knowledge, and the absence of appropriate policies to support access to the knowledge society led to this stagnation of the culture of innovation and technology management.

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[41] Hofstede, G. (1991). Cultures and Organizations, Software of the Mind. London: McGraw-Hill.

[42] Hill, C. and Others. (1998). "A Quantitative Assessment of Arab Culture and Information Technology Transfer", Journal of Global Information Management, 6 (3). Summer, 29-38.

This problem was deepened by the misconception that building a knowledge society is possible through the import of the results of science, without investing in knowledge production locally, and creating scientific traditions conducive to the acquisition of knowledge on the Arab level.

The Arab nation entered the twenty-first century with 100 million poor people, an unlimited population explosion, an alphabetic illiteracy rate around 41% for men and 61% for women, 70% cultural illiteracy, and more than 99% technological illiteracy. This, however, should not be a cause for more weakness, which will lead to more dependency and more of material and spiritual poverty. History teaches us that nations can devise practical and fair solutions to their social, economic, political and moral problems if they are conscious of these problems and their causes, and if their people are free to seek fair solutions.

Moreover, the current trends in the world indicate that civilization today, and in the future, will be based on information and knowledge. It is a civilization that will rebuild the fundamentals of education on the basis of the new added valueof knowledge. It will produce a rapid shift to a society based on highly virtual and ICT-based knowledge. Its core axis will be knowledge workers and managers of knowledge. All of this will require a new model of management and leadership that accepts change in order to face competition in global markets, capital, labor, and information technology.

Technological cooperation focuses on the development of human resources by increasing the ability of a country to absorb, generate and apply knowledge. In developing countries, this transfer focuses on improving the use of technology and promoting the spirit of investment. It has become evident that little technology can be transferred successfully from one culture to another through appropriate adaptation to the cultural context, past experience, and technical skills of the recipient institution. All this can be done through a central organization that works to identify needs, build capacity, and adapt and indigenize technology. This leads to the conclusion that the most important requirement for fruitful technological alliance is the presence of a governmental and social environment that encourages and supports the development of commercial and industrial enterprises and Foreign Direct Investments (FDI).

The questions addressed in this chapter are: "Will development in renewable energy technology and pioneering experiments in the Arab world, make possible the generation and transfer of knowledge between Arab states? Will this lead to a shift in the contemporary Arab economic structure in the post-oil age? Is it possible to conceive of a new regional framework in the Arab region that embodies a renewable energy region or what can be named the green cooperation council?

Thornngate[43] states that knowledge management includes a number of activities, which focus on gaining institutional knowledge from the institutions' own experience, and that of others. It includes the wise application of knowledge to realize the mission of the organization and the State. These activities are implemented through the integration of technology, the organizational structure, organizational strategies that are supported by current knowledge, and the production of new knowledge. The critical element of knowledge management is to achieve support for cognitive systems (with respect to organization, the human element, computerization, legislation, etc.) in order to acquire, store, and use knowledge, in the process of

[43] Thorngate, W. (1996). Measuring the Impact of Information on Development. International Development Research Centre, Canada.

learning, problem solving, and decision-making. KPMG [44], the leading consulting firm, defines knowledge management as the systematic and sustained attempt to use knowledge in the organization to improve its performance.

Hirsch and Levin[45] posit that knowledge management is an overall framework that constitutes an umbrella for the organization. Accountants found the concept of knowledge management is a new field that helps them define intangible assets. This field also helped administrators develop new applications and management practices that are compatible with the new economy, knowledge-based economy and the economy of e-business. Knowledge management, according to Allee[46] is the systematic, explicit, and clear management of knowledge-related activities, practices, policies and programs within the organization. Knowledge management should also be concerned with a set of processes that work to germinate and nurture knowledge, adopt it, share it with others, and renew it in order to support and enhance the organizational performance and value creation. Knowledge management includes achieving knowledge sustainability and intellectual capital, utilize, invest, and disseminate them. Knowledge management must also lead to the provision of the necessary facilities to achieve this management. It would be difficult to give one comprehensive consensual definition of knowledge management, because there are many differences in identifying one specific designation for this new term. Many researchers speculate that the term expresses a new field that is still at the stage of evolution and

[44] KPMG Management Consulting (1999). Knowledge Management: Research Report 2000, London: from KPMG website www.kpmg.com.

[45] Hirsch, P. and Levin D. (1999), "Umbrella advocates versus plice: a life-cycle model", Organization *science*, vol. 10 pp. 199-212.

[46] Allee V. (2000), "Knowledge networks and communities of practice", *OD Practitioner* Vol 32, No. 4 pp. 1-15.

self-discovery. Svieby [47] insists there is no standard definition of knowledge management, but there are two tracks of activities and efforts that are interested in the concept of knowledge management. These are:

The information track that believes knowledge management is the same as information management. Proponents of this outlook view knowledge as the information processed inmanagement information systems.

The people track, on the other hand, considers that knowledge expresses the operations that are reflected by complex, dynamic, and somewhat changing skills.

Others believe that knowledge management is a systematic process of acquiring, selecting, organizing, screening, and updating information and submitting it in a manner that leads to the development of an understanding and awareness by workers of specific areas of interest. Knowledge management helps an organization to own a precise vision and a clear understanding of its experience and the expertise of its staff. Knowledge management activities focus on the acquisition, storage, and use of knowledge in various areas, such as dynamic learning, problem solving, strategic planning, decision-making, maintaining intellectual capital, flexibility, and elevating an organization’s level of intelligence.

Knowledge management works concurrently with the practices and applications of organizational learning, and they both contribute to value creation and developing and improving the organization's output.

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[47] Sveiby K. (2001), Knowledge Management – Lessons from the Pioneers. Available at: www.providersedge.com/docs/km_articles/km_-_lessons_from_the_pioneers.pdf

5.3. Knowledge Management in the Renewable Energy Sector

Knowledge management operations of renewable energy work in relay and complement one another. Each operation depends on the other, supports and complements it at the level of research, manufacturing, marketing and institutional learning among Arab countries. Knowledge management operations can be summarized as follows:

A. Diagnosing knowledge. Diagnosis is important in a knowledge management program, in the view of which other operations' policies and programs are developed. The most important challenge that faces business organizations is the process of diagnosis, and the success of the knowledge management project depends on the accuracy of that diagnosis which uses mechanisms to search, discover and access. Diagnosing knowledge is considered key to any knowledge management process and a fundamental operation that contributes directly to launching and determining the form and depth of other operations. Knowledge needs to be diagnosed in the Arab world in order to achieve cognitive integration. So every institution or country needs to define human capital (experts and technicians), research centers, education and training curricula, and the private and consulting sectors in the renewable energy sector.

B. Knowledge planning. This process relates to drawing various plans related to knowledge management, supporting the goals of knowledge management, individual and national activities, efforts to provide the capabilities and competencies necessary to conduct of operations efficiently and effectively, providing specialized teams of experts, and determining the necessary technological facilities. Teece

[48] points out that adopting any input in knowledge management requires the prior identification of objectives and strategy of knowledge management, implementation of knowledge management strategy, selection of knowledge management indicators, and measurement and evaluation of knowledge management levels, in the light of the indicators adopted. There is no doubt that efforts of regional institutions such as the Regional Center for Renewable Energy and Energy Efficiency (RCREEE) and the International Renewable Energy Agency (IRENA) make an effective contribution in this regard.

C. Knowledge dissemination. This operation is achieved through scientific publication in journals specialized in renewable energy and through specialized conferences and exhibitions, such as the Abu Dhabi International Renewable Energy Conference (ADIREC).

D. Generating and acquiring knowledge. The process of generating knowledge is related to operations that focus on innovation and discovery. It represents knowledge through joint research programs and graduate studies in Arab countries and the world. It takes place through workshops, conferences, industrial development, connecting it with scientific and technical research centers, and professional programs adopted in the green buildings and sustainable energy sector.

E. Distribution of knowledge. The distribution of knowledge means ensuring that appropriate knowledge reaches decision makers, technicians, researchers, and the largest possible number of working people in the Arab world. There are several conditions for the

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[48] Teece D. (1997), "Dynamic capabilities and strategic management", *Strategic management Journal,* Vol. 18 No. 7 pp. 209-533.

distribution of knowledge, which include: the existence of the means to transfer knowledge through scientific meetings, conferences, workshops, research and publication, higher education, technical consulting, and training.

F. Applying knowledge. Applying knowledge means converting knowledge into operational processes. The cognitive contribution should be directed at improving performance in decision-making and job performance through pioneering projects, industry, and implementation of projects.

According to the Economic and Social Commission for Western Asia (ESCWA, 2004) the institutions and countries that use knowledge best, have a competitive advantage. Knowledge, in its entirety, must be applied to activities because some organizations and countries suffer from a gap between knowledge and practice.

Suitable knowledge must be employed in solving real problems facing a country. Moreover, applying knowledge should aim to achieve the broader goals that lead to growth, adaptation, and prosperity according to knowledge networks, and the level, nature, and methods of learning, as shown in Table 5.1.

Table 5.1: Proposed Model for Knowledge Management of Renewable Energy in the Arab world

	Level 1	Level 2	Level 3	Level 4
	Reaction	Cognitive awareness	Acceptance of contribution	Transfer of knowledge and absorbing and developing it
Knowledge base	Fragmented knowledge	Systematic and classified individual knowledge	Integrated intra-institutional knowledge	Sharing knowledge within the institution and beyond it
Technology	Disjointed information	Existence of infrastructure and internet	Effective official and unofficial teams within the organization	Continuous improvement of information management
Learning	Space and time-specific information	There exists systematic learning in the organization	An outlook to learning. A learning team from within and outside the organization	Information systems for decision-making
Outsourcing knowledge management	Limited awareness of knowledge	Knowledge management team Internal institutional learning	Measurable knowledge indicators	Strategic information management Development and creativity
Knowledge management operations	Focus on knowledge management in a limited and piecemeal way.	Pioneering projects. Operations for the transfer and preservation of knowledge management system	Integrated and studied operations of best practices and successful operations	Continuous.

Table 5.2 Types of knowledge networks within the knowledge management system

Type	Function/ Duties
Information network	Information exchange without an agenda or a specific project.
Knowledge network	Exchange of knowledge aiming at creating new knowledge and developing new skills and methodologies.
Professional community	The professional community debates and shares knowledge in the context of a specific agenda and activity.
Specific task network	A network of different types of knowledge to solve a specific problem within a specific time framework
Specific goal network	A network to follow up on an important issue without specifying a time limit.
Social change network	Includes a network for social learning within different networks and with specific goals and a specific program.
Creativity and social learning network	Includes social and technical learning and creativity beyond the scope of any one country. It includes the transfer of knowledge, dialogue and an integrated and coordinated effort for a work program.

Box 17: First Steps of Change Toward Sustainable Development

In the late eighties, military spending in developing countries mounted to $170 billion a year, which is estimated as equal to the total income of 180 million people throughout their productive years. When the need arises, money is found to address and respond to those needs. Accordingly, if governments realize that environmental degradation will constitute a security risk similar to that of armed conflict, then sustainable development technology may require these governments to spend a sizeable share of their budgets on the procurement and trainings needed. Industrialized countries' governments realize that it is economically viable to protect their own environments by spending money on preventing pollution beyond their borders. Japan, for example, launched initiatives to rehabilitate coal-operated power plants in China, in order to reduce greenhouse gas emissions that can harm Japan's environment. These types of actions may encourage technological cross-border cooperation. Technological cooperation may be enhanced by the fact that a growing number of developing countries respect and protect patents and other intellectual property rights. This means the transfer of technology has become safer and that no barriers stand in the way of effective cooperation. Clear intellectual property rights are a fundamental prerequisite for the spread of technology throughout the entire world.

Source: Dunne P. and Tian N. (1021), "Military expenditure and economic growth: A survey", *The Economics of Pease and Security*, Vol. 8 No. 1.

5.4. The Transfer of Renewable Energy Sector Knowledge in the Arab World: Toward a New Arab Energy Region

There is a need to create a new green region, such as the Commonwealth, which here is referred to as the 'Green Cooperation Council (GCC)', comprising the oil-producing countries of the Gulf Cooperation Council (GCC), and non-oil producers such as Yemen, Jordan, Palestine, Egypt and North African countries.

There are distant islands of scientific excellence in the renewable energy sector in different Arab countries, but they do not constitute a critical mass, and they are not linked to local market needs and local industries. They are subsidiaries of European or international projects that are not linked to development or needs of the local economy, which would enable us to absorb technology and excel, as per the *Blue Ocean Strategy* (see box below). These islands of R&D cannot attract sustainable funding for the long term, so they lose the ability to unify efforts in a national project throughout the Arab world.

The EU's experience in supporting joint ventures and forming research teams with clear strategy and financing, merits consideration and study, because it stimulates scientific research teams to build knowledge networks and encourages entrepreneurship in an integrated system that includes:

1- Industry and socio-economic development plans.

2- Universities and research centers.

3- Business parks and incubators.

4- Entrepreneurship.

Box 18: The Blue Ocean Strategies

Red Ocean strategies represent industries that exist today, in the conventional market space. The boundaries of these oceans are demarcated, well known and agreed upon, as are competition laws. Companies within these oceans seek to overcome their rivals in order to gain the largest share of demand. Because the market is congested with competitor corporations, the prospects of profit and growth diminish, goods pile up, and the competition enters into the red ocean. By contrast, Blue Oceans are determined by opening new and previously untapped markets, thereby creating demand and growth opportunities.

Source: Chan W. and Mauborgne, Blue Ocean Strategy: How to create uncontested market space and make the competition irrelevant, (Harvard Business school Press, 2015) pp. 256.

It is vital to co-create a long-term STI agenda and provide an enabling environment with a sustainable government funding and research institutions, such as the Qatar Foundation, Masdar Initiative, and the King Abdullah University of Science and Technology (KAUST). A necessary condition for transforming the Arab region is to define key strategic initiatives in RE which are in line with national and regional priority areas, such as the water-food-energy nexus, and the use of information technology for renewable energy. This in turn will form a critical mass and a tipping point. Such a future will not see the light unless science, technology and innovation become an Arab national and regional priority.

6

Chapter Six

Future Outlook: Toward an Arab Renewable Energy Region

"Bureaucratic socialism collapsed because it did not allow prices to state economic reality; the market economy may destroy the environment and ultimately destroy itself if it does not allow prices to state the ecological truth."

Ernst Ulrich von Weizsäcker, the Wuppertal Institute for Climate, Environment and Energy, former member of the German Parliament for the social democratic party (SPD)

6.1. Introduction

As we stand at the threshold of social, economic and political transformations in the Arab world, the region finds itself faced with fundamental challenges in energy security, adaptation, and inclusion of modern technology in the world of new and renewable energy. These challenges have historical roots that include the circles of international influence, the interests of states and corporations, domination of raw materials, the science culture, R&D, patent commercialization, the Arab brain drain to the West, and the absence of a scientific environment that empowers innovation and entrepreneurship and encourages scientific imagination, creativity, and life-time learning.

One of the most important challenges facing the Arab media in the age of information and renewable energy is the emergence of what is termed the technology gap, which is the informational dysfunction between those who have advanced technology and those who are deprived of it, particularly in non-oil producing Arab countries where illiteracy and unemployment are widespread and the infrastructure is lacking. There is consensus that the technology gap combines all forms of social, economic and cultural disparities. It cannot be considered a purely technological problem because technology has always been a socio-cultural product, both in its inception and employment. Therefore eliminating the technology gap is associated with the abolition of other economic, social and cultural gaps, both globally and within Arab countries.

There are two levels of addressing the knowledge gap: the first is the strategic level, which includes the policies and plans adopted by the national institutions and civil society organizations in the Arab world. They work seriously to develop a comprehensive strategic vision that allows them to realize two main goals: the first is to determine how to best use technological innovations, which are currently dominated by multinational companies. For this to be achieved it needs to be based on national research to identify priorities in the transfer of technology to the Arab world, coupled with an accelerated utilization of Arab capital to establish joint Arab projects to localize technology. The second objective is the need to employ positive aspects of the common Arab cultural heritage in the context of a civilization project, based on creating economic and social structures that are completely contrary to the traditional formal structures that prevail at present. This can only be achieved by spreading rationalism as a framework of thought and method of work in political relations between Arab rulers and peoples and in social relations between Arab individuals and states on the national level and with the outside world.

Box 19: Scientific Imagination and Intellectual Capital

Scientific imagination is an incentive and prelude to creativity, and the guide to the path of scientific research. This is how human imagination led to the invention of the airplane, solar cells, wind turbines, radio transmission, and space satellites. Scientific imagination offers hopeful solutions from diligent scientific research and an unfettered imagination. Such an imaginary and empowering environment creates an intellectual and cultural framework for programming the human brain the same way a computer is programmed. This contains nothing new in terms of approach, because the role of social culture historically has been to program the brain to embrace what we consider virtues and shun what we consider vices.

The value of intellectual capital lies in the ability to bring about a radical and revolutionary change in education, to achieve an education that enhances intelligence. We, as an Arab system, should pay for outputs of learning, not learning inputs. The most important of these outputs is creativity and imaginative thinking, and creating a catalyst that motivates us to be creative, entrepreneurial and decision-makers who think in the context of the greater Arab nation.

Source: Al Arabi Magazine (Kuwait), Issue 539, 2003.

One of the most complex topics in R&D is energy and its relationship to sustainable development. Energy is essential for development and human progress, but its use in all its forms at present, without looking at the environmental costs associated with its use, poses a major threat to all efforts that aim to achieve sustainable development. The use of fossil fuels is linked to global warming, that is caused by greenhouse gas emissions. This creates an urgent need to search for clean energy alternatives that meet the human needs for progress and growth while preserving the environment. Responsibility for this falls on all those who work to shape the future for generations to come. Therefore, it is necessary to redirect energy plans on the national level toward rational and coherent resource management policies, and give them longer time frames. They should be based on three pillars:

1. Improving energy efficiency to produce quick benefits.

2. A rational energy strategy (rationalization of consumption), which is a transition to a more sustainable common formula for energy resources and consumption patterns. This should be done systematically and carefully to avoid major damage to economic development.

3. A long-term energy strategy in developing countries. This requires the development and use of local resources, and the reform of energy pricing policies. Industrialized nations can help these countries access the latest hardware, and technology cooperation is one of the main components in a global energy strategy.

6.2. Public-Private Sector Partnership (PPP) and Self Organization

Creating a partnership between the public and private sectors, in renewable energy, to reach a state of learning and self-organization becomes an effective tool of change, particularly since the industry began to address the challenge of sustainable development. Industry can play a useful role in developing standards, which gives the start signal for competitive forces. Such standards have played an important role in producing large energy savings in many countries.

Energy auditors can verify the accuracy of project performance and industrial sectors by linking performance to the standards established by different sectors. Preferably, there would be a formal organization that develops special standards for the use of energy and guidelines that require the management of companies to follow environmentally sound methods. Customers should also help companies by selecting environmentally friendly alternatives that save energy.

Many forms of government subsidies and incentives lead to market distortion, including direct subsidies of energy prices and tax exemptions. Therefore, subsidies must be removed to let prices reflect the full economic cost of energy through a corrective economic course based initially on incentives, loans and concessional grants to encourage investment in renewable energy and energy conservation projects. International donor organizations can also help businesses and civil society organizations in developing countries to embark on energy efficiency programs and renewable energy projects.

The following is an outlook for an Arab vision for the future of renewable energy in the Arab world and the transfer of knowledge:

First: The Shift toward a Knowledge and Green Economy

The community's ability to recognize the challenges and develop a national or regional vision or a national compelling project that aims to achieve energy security is a necessity for the sustainability of the community. The shift in thinking in the Arab region and the start of building regional institutional frameworks, such as RCREEE or IRENA, is a positive prelude for the development of an information system that contributes to formulating of public policies with an Arab vision within an Arab understanding of energy reality.

Box 20: RCREEE.

The Regional Centre for Renewable Energy and Energy Efficiency is an independent regional non-profit organization that aims to activate and increase renewable energy and energy efficiency practices in the Arab region. Since its establishment in Cairo in 1008, the Center’s team has worked in cooperation with regional governments and international organizations to initiate and direct the dialogue on sustainable energy policy, strategies, and technology, and develop capabilities to increase the Arab countries’ share of future energy.

RCREEE

Regional Center for Renewable Energy and Energy Efficiency

المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

There is a correlation between the shift toward a knowledge economy and the shift toward renewable energy. This shift requires adopting a new strategy based on local data, building on the strengths and comparative advantage of each country within an Arab project to link the supply chain, which includes the availability of raw materials, research and development, entrepreneurship, manufacturing and marketing.

Box 21: IRENA.

The International Renewable Energy Agency is an intergovernmental organization that works to encourage the adoption of renewable energy worldwide. It aims to facilitate the transfer of technology and renewable energy, and provide expertise for applications and policies. IRENA was founded in 2009 with 75 member countries. Abu Dhabi was chosen to host the headquarters of the Secretariat. IRENA aims to become the main driving force in promoting the transition towards renewable energy on the global level, as the global voice of renewable energy. It provides advice and support to industrial and developing countries, and helps them improve regulatory frameworks and build capacities. It also facilitates access to related information including reliable data about the potential of renewable energy, best practices, and effective financial mechanisms. Irina also provides advice and support to governments on renewable energy policy, capacity building, and technology transfer.

Second: Governance and the Transfer of Knowledge

The transfer, absorption, and management of knowledge in renewable energy are closely linked to the form and structure of the socio-technical and political system. The Arab region has different models of governance, some of which are of a central and traditional nature, which inhibits creativity and entrepreneurship, and promotes rentier culture and the lack of transparency. Other Arab countries follow a more liberal Western model and market mechanism. There is no national regional Arab project, and consequently, it was not possible to localize the industry and commercialize technology in the absence of an Arab vision for entrepreneurship and excellence within Arab integration.

By contrast, non-oil-producing countries, although they have intellectual and human capital, have remained unable to localize knowledge in the absence of a vision, adequate funding, research and development, and the presence of a critical mass to achieve cumulative knowledge and knowledge transfer (see Figure 6.1)

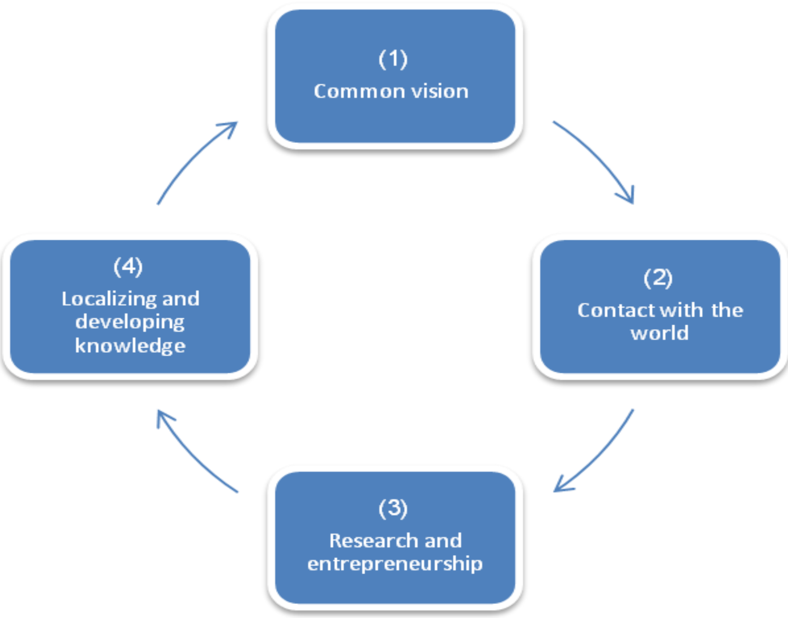

Figure 6.1. Model for the localization of knowledge in light of a shared vision

Third: Decentralization and New and Renewable Energy

The world is likely to witness a new energy revolution in the coming two decades when tipping points in renewable energy taken palce. International relations will change after the oil age, because geopolitical and strategic importance will shift from traditions and centralized governance systems to decentralized systems, bound by different relations. These deep and radical changes will result from the large volume of investments in hydrogen, solar and wind energy; once the oil peak has been reached. Partnerships and international alliances with oil-rich countries, such as those between the Gulf Cooperation Council (GCC) countries and Western Industrial countries may change. The governance of renewable energy will differ from the oil era. Perhaps some of the most important features of renewable energy age in the Arab world are:

- A new mode of governance for renewable energy marked by decentralization, transparency and accountability.
- Individual and smallholdings of renewable energy sources.
- Participatory relationships between the power generation and distribution sectors and the state.
- Adaptive management as a result of the rapidly changing technology and external environment.
- Exchange of knowledge and technology through SMEs.
- Research teams for regional projects among Arab countries in advanced technology such as nanotechnology, biotechnology and renewable energy.

Fourth: Virtual Energy and Globalization

When considering the water, food and energy nexus in the context of virtual water, the concept can be linked to the idea of virtual energy and international e-trade in the context of the globalized market, communication and information (see Figure 6.2). So when a country such as Jordan, Egypt, or Saudi Arabia imports cars from Germany, Korea or the U.S., this includes a hidden/virtual energy import and e-commerce.

There is an exchange of benefits between exporting and importing countries on the domain of water, food and energy through international trade. Renewable energy may reduce the relative severity of virtual energy flow as a result of local source development and decentralization, which would ease the effects of climate change, and thus serve the objectives of sustainable development and the international UN agenda beyond 2015.

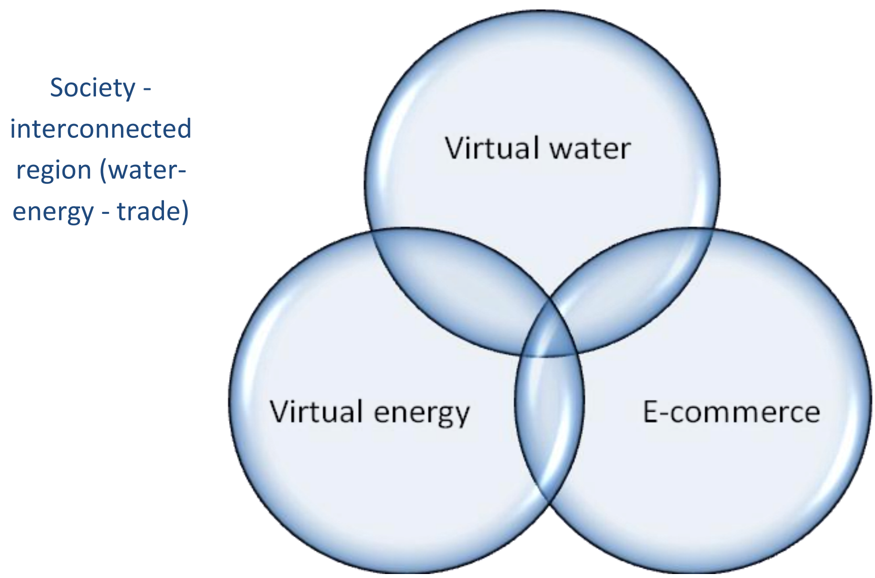

Figure 6.2: Virtual water and energy in the future world

Fifth: Toward an Arab Renewable Energy Region

India and China have emerged as economic giants with salient economic transformations worldwide. The East and South are changing their lifestyles to western models and hence their demand for energy is increasing. Consequently, it is now necessary to make a shift toward renewable energy in the Arab region.

The creation of international organizations for renewable energy such as IRENA in the UAE, and the RCREEE in Egypt provides an important reference point for the generation and management of knowledge on renewable energy in the Arab region. This, in turn, contributes to building bases of knowledge, programs and strategies for the development of knowledge systems in energy in Arab countries (see Figure 6.3). It also reinforces creating models for learning organizatios in the ministries of energy of every Arab country, which in turn would lead to a renewable energy region (or green community) in the Arab world linked by the supply chain in terms of resources, technology, and common interests.

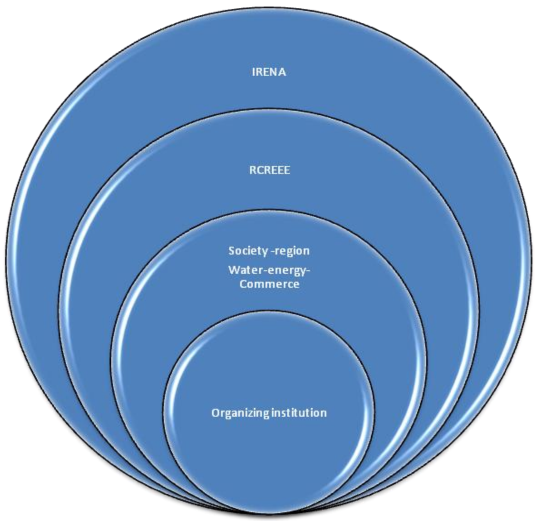

Figure 6.3: Integration of international and regional institutions working in the renewable energy sector

Sixth: Scientific Coalitions in Education and Research and Development

Looking at scientific research centers in the Arab world, it is possible to see opportunities to create virtual scientific alliances, whereby each center integrates and specializes in a particular field of renewable energy see Figure 6.4

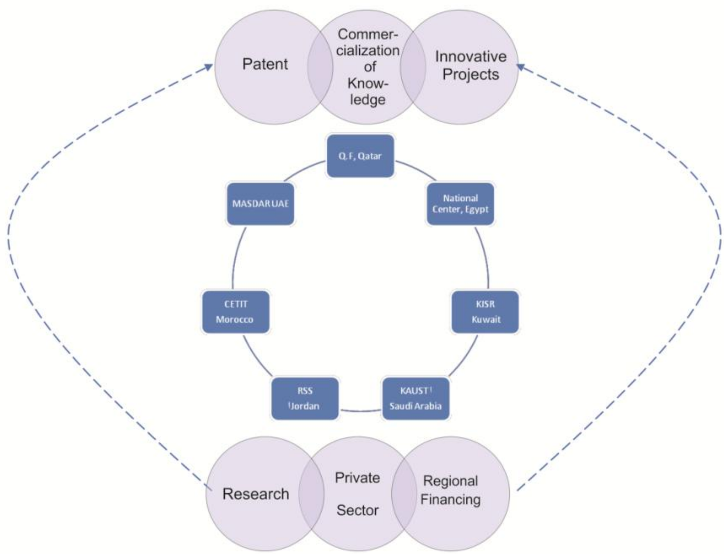

Figure 6.4: scientific research institutions in the Arab world and opportunities for research integration

But creating R&D green alliances, value chains will evolve to support regional projects that serve the common interests for all countries. Regional infrastructure like green transport network between GCC countries is likely to change the supply chain. For example, clean electricity transmission, green cars or green products will induce a change of the entire supply chain. Without a critical mass of scientists, applied research, patents, and an entrepreneurial industrial sector it would be impossible to make the macro-shift to the renewable energy era and take charge of the future.

Seventh: Conditions for Knowledge Transfer

The culture of knowledge transfer and the shift toward a knowledge economy need a number of conditions (see Figure 6.5), among which are the following:

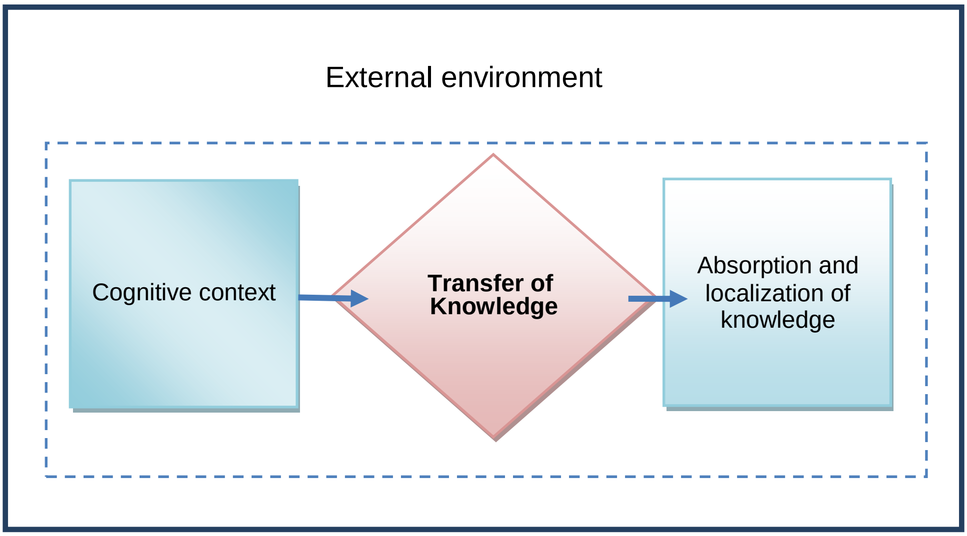

Figure 6.5: General framework for the transfer of knowledge in the Arab world (Source: The Author)

- External environment: Benefiting from technology, knowledge and experiments everywhere in the world in the energy sector.

- Cultural context: which is the environment of each country in terms of human capital, the means available, and scientific content.

- Transfer of knowledge: which includes scientific alliances through joint research, projects, publication, translation, and Arab and international conferences and exhibitions.

- Absorption and localization of knowledge: realizing the value of absorbing and localizing technical knowledge as a socio-political decision in the context of a vision and technology strategy for the Arab nation.

Box 22: Abu Dhabi Energy Conference: A Space for Knowledge and the Transfer of Expertise

The Abu Dhabi International Renewable Energy Conference is an ideal platform that embraces a wide range of discussions on policy. It brings together ministers, government officials, businessmen, academics and representatives of international organizations for discussions that focus on the relationship between energy and water sectors in line with the overall outlook of the Abu Dhabi Sustainability Week.

The conference was organized through cooperation between the UAE and the Renewable Energy Policy Network for the 21st Century (REN 21), which is an international network that aims to accelerate the shift to renewable energy. REN21 is responsible for organizing the meetings of the International Renewable Energy Conference.

Source: www.worldfutureenergysummit.com

Eighth: An Enabling Environment for the Transfer of Knowledge

There are a number of objective conditions for the transfer of renewable energy technology that include a framework for regional and international cooperation, governance systems, the R&D system, innovation, and the role of civil society (as shown in Figure 6.6). This enabling environment provides a fertile environment for entrepreneurship in SMEs, the private sector, researchers, and companies, to implement projects that serve the public interest in accordance with the competitive advantage of each country and its national priorities.

The diligent search to find alternatives to fossil fuel is only part of the continuing role of Arab states as exporters of energy, in order to maintain the economic level which these countries enjoy now and to keep up with the rest of the world in this area. The following recommendations are proposed:

1. Stimulate research on solar energy by providing clear strategy and financial support.
2. Establish an information bank on solar radiation, temperature, wind intensity, dust quantity, and other information necessary for the use of solar energy.
3. Launch mega national or regional pilot project that benefit the region by training Arab cadres in the use of new different energy technologies in favor of diversification in order to take advantage of all solar energy applications.
4. Activate scientific exchange and consultation between Arab countries.
5. Evaluate and update existing studies on the use of solar energy in the Arab World
6. Research the best methods for rationalizing energy conservation and support citizens who use solar energy in their homes.
7. Encourage cooperation with countries advanced in their energy knowledge, and take advantage of their expertise.

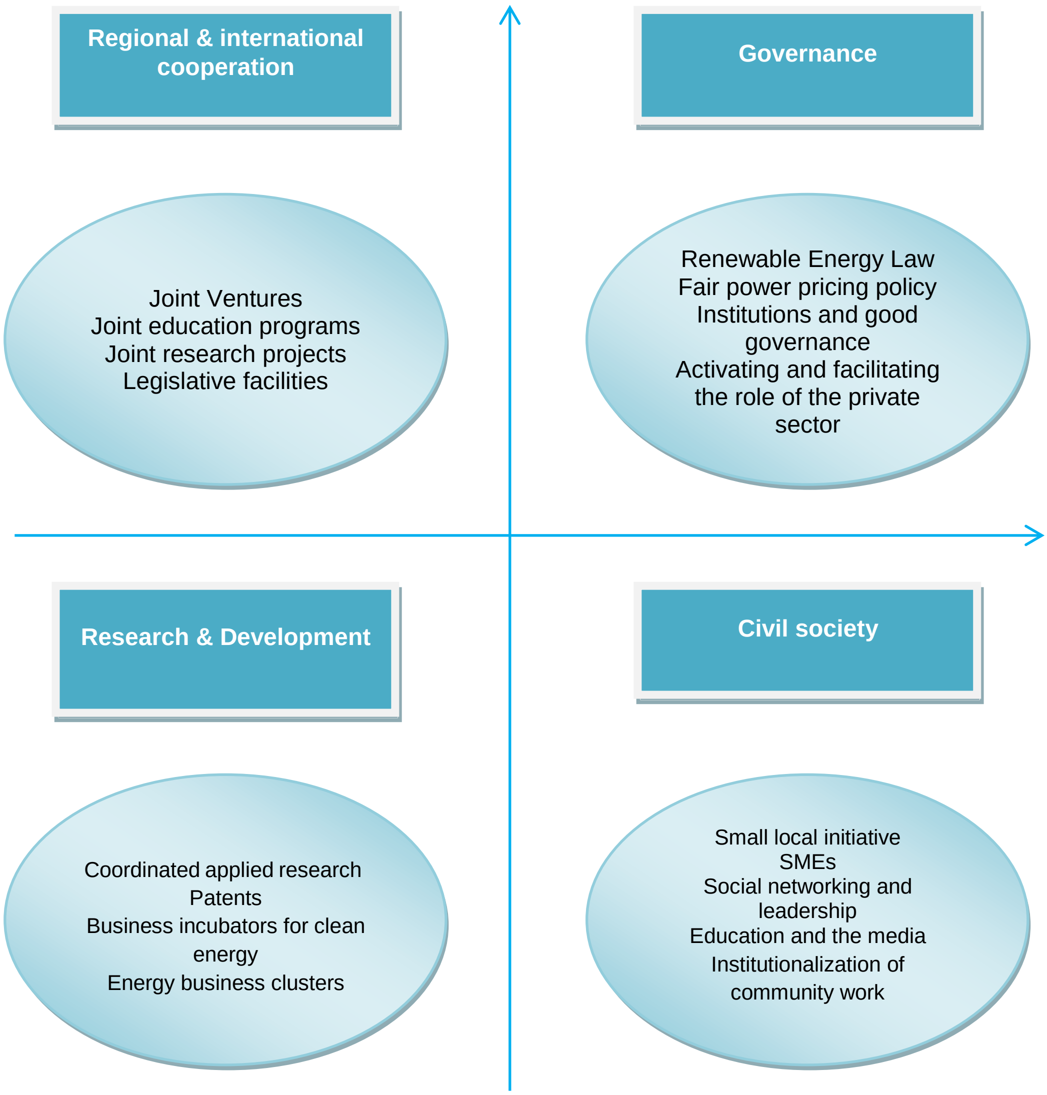

Figure 6.6: levels and conditions of the transfer of knowledge in the renewable energy sector in the Arab world

Learning from the Other

Israel invested in the process of integrating knowledge, technology, and local development, and succeeded in localizing knowledge and technology in an effective way that enabled it to achieve military superiority over Arab states. Despite our focus on the military power, we neglected to pay attention to the civil and highly developed technological dimension, which includes:

Exports of electronic products increased from about US$1 billion in 1986 to nearly US$6 billion in 1999.

Development and expenansion its use of solar energy in heating homes and other uses until it reached one million solar energy units installed in hotels and factories. This produced an annual saving of $1.75 billion. More than 80% of homes use solar water heaters, compared with only 15% in Jordan.

The work on the development nanotechnology, which focuses on the precision, small size, low cost, and low energy consumption of the product. Diamonds are considered the most appropriate test for the manufacture of devices based on this technology.

Israel uses "knowledge-intensive industry," which relies on high-knowledge for accuracy and diversity of product lines. This revived its economy beyond its capacity, as these techniques use only half of the raw materials and energy used in many industrialized countries.

Source: Kuwaiti Al Arabi magazine #539, 2003.

Conclusion

Conclusion

Based on the analysis above, it is clear that renewable energy enjoys considerable interest in the Arab region in the overall context of the three levels: the landscape level, regime level, and the niche level. But energy policy in these countries is characterized by the following:

- Individual pilot initiatives but within an ineffective legislative institutional framework.

- The presence of deep-rooted interests in the current economic system (economic elites) and the lack of systematic institutionalized disclosure policies.

- The presence of traditional centralized frameworks and unclear responsibilities.

- Passion for large projects with a global reputation.

Without change at the three levels mentioned above, Arab initiatives such as Masdar cannot bear fruit. They will only confirm the case of degradation and lack of innovation. The overall conditions of energy policy in the oil-producing countries are similar, despite socio-economic differences due to the nature and structure of their economies, which are based on the exploitation of natural resources. There are pioneering initiatives for renewable energy policies in the Arab world, but their implementation faces obstacles, because the markets are not open to all and electricity prices do not reflect the market mechanism. On the contrary, the closed market system, fixed prices, government subsidies of fossil fuel energy, and the central governance system consolidate the monopoly of influence and the interests of the oil and gas sector in the hands of the elite, in the absence of a capable private sector and civil society, and participatory decentralized decision making.

The poor performance of the renewable energy sector and knowledge management in the Arab world is mainly due to the nature of the central governance systems and lack of harmony between the legal, economic and social frameworks. The framework of human leadership in the world cannot be articulated in the context of a nation-state, nor can it be limited to this context in isolation from the moral and human responsibilities toward the planet, future generations, and to the world's poor. If we wish to achieve sustainable development under a just and enlightened government, it is crucial to change our mindsets and consumption patterns so as to avoid the possibility of ending up with dysfunctional water well in an extravagant palace!

Annexes

Annex I:

Institutional Framework for the Energy Sector in the Arab Region

Country	State
Jordan[(A)]	Authorities Concerned: Ministry of Energy and Mineral Resources, Department of Alternative Energy and Energy Rationalization National Energy research Center (NERC), conducts activities and research in renewable energy Jordan hosts the ESCWA Technology Council since its establishment in 2011, which focuses on research and development in clean and renewable energy technology Main legislation/ measures: On February 1, 2010, a special law on renewable energy and energy efficiency was enacted with the aim of drawing a legal framework to expedite growth in the use of renewable energy and improve energy efficiency, by offering facilities to investors. By this legislation, a fund was created to finance renewable energy projects officially, provided that its operations are supervised by a council of representatives from the public and private sectors, headed by the Minister of Energy and Mineral Resources [(B)]. Exempting renewable energy equipment from customs duties and sales tax, allocating expanses of

Country	State
	state-owned land for wind energy, and encouraging the private sector to build wind farms.
UAE[(A)]	Authorities Concerned: The Electricity Administration at the Ministry of Energy The Abu Dhabi Future Energy Company (Masdar) a private company that is a subsidiary of the Government owned company Mubadala conducts commercial projects and research through the Masdar Institute for Science and Technology in cooperation with a number of universities. In cooperation with a number of American, European, and Japanese research centers, many agencies in Abu Dhabi, Dubai, Sharqah, Ras al-Khaimah, and Fujairah conduct research in solar, wind, and bio-fuel energy. Main legislation/ measures: Council of Ministers' Decision for Services No 12/155M/2009 regarding diversifying sources of energy and focusing on the use of renewable energy. Creating an incentives program for the use of solar cells on the rooftops of buildings and houses. Abu Dhabi hosts the International Renewable Energy Agency (IRENA) since its establishment in 2010.

Country	State
Oman [A]	Authorities concerned The General Authority for Electricity and Water Main legislation/ measures Many policies and incentives were put in place to encourage the optimal use of renewable energy.
Palestine[B]	Authorities concerned: The Palestinian Center for Energy and Environmental Research. Its duties include drawing policies to regulate the energy sector. Main legislation/ measures: Adopting policies to spread the use of renewable energy. The private sector performs a leading role in this activity in two stages: the first (2012-2015) includes conducting studies and implementing small scale projects with a total capacity of 25 MW in the context of the Palestinian Solar Energy Initiative. It lasts three years and aims to spread solar cell systems on the rooftops of houses. The second, (2016-2020) aims to implement projects of a total capacity of 105 MW. The plan foresees setting the price of electricity produced by renewable sources that are connected to the grid and reviewing these prices annually. A Council of Ministers Decision was issued regarding the general strategy for renewable energy. It stipulates encouraging the use of renewable energy

Country	State
	and increasing its contribution to the total energy to 25% by 2020, imposing a concessionary tariff on renewable energy (solar, wind, and biogas extracted from waste and animal waste), and drawing agreements to purchase electricity from subscribers who depend on a renewable source of energy and investors who have a license to build a power generation project using renewable energy. The decisions are expected to come into force after the Council of Ministers ratifies them in 2012/ 2013 and to stay in force for 20 years.
Qatar (A)	Authorities concerned: The Ministry of Energy and Industry (Strategic Planning and Policies Affairs), Qatar Petroleum (Renewable Energy Section) The Qatar Center for Science and Technology, Qatar University, and a number of educational and industrial centers conduct research and development activities Qatar will host the conference of parties to the United Nations Framework Convention on Climate Change (UNFCCC) (the Kyoto Protocol) in its 19th session, to be held in November – December 2012.
Kuwait (A)	Authorities concerned: Ministry of Electricity and Water

Country	State
	Research centers and institutions conduct activities and prepare studies and research projects in some areas of renewable energy.
Lebanon(A)	Authorities concerned: Ministry of Energy and Water The Lebanese Center for Conservation of Energy implements activities in renewable energy, particularly solar-powered water heating and energy efficiency under the supervision of the Ministry of Energy and Water. The Center was established with financing from the UNDP, after a draft law had been prepared officially for its establishment, but the law has not been enacted yet.
Tunisia (A)	Authorities concerned: Ministry of Industry and Technology, the National Agency for Regulating Energy Main legislation/ measures Law No. 72 of 2004 which aims, among other things, to upgrade renewable energy, particularly wind, to generate electricity and to use solar thermal energy. Law no. 106 of 2005 which aims, among other things, to regulate energy. Its function is to provide grants to support regulating and converting energy and to upgrade renewable energy.

Country	State
	Law No 7 of 2009, which aims, among other things, to give concessions to organizations that produce electricity from renewable energy for their own consumption. Decree 2773 of 2009, which aims to regulate the conditions for transferring electricity produced from renewable energy and selling the surpluses to the Tunisian Electricity and Gas Network.

Annex II: Electricity Generation Projects from Wind Energy in the Arab region

Country	Projects
Jordan[(A)]	In service a wind station with a 1.5 MW capacity Under construction: two projects to build wind farms with a 40 & 90 MW capacity A plan to build a 1,200 MW total capacity wind farm by 2020.
UAE [(B)]	Under construction: a 30 MW wind farm at Sir Bani Yas Island Studies underway to establish a 200 MW wind farm on the Red Sea coats in Egypt in cooperation between Masdar and the New and Renewable Energy Authority (NREA) of Egypt. Private investments: Masdar's contribution to the implementation of a marine wind farm in Britain (1,000 MW) and another in the Seychelles.
Bahrain[(C)]	In service: three wind turbines (660 KW) that help provide electricity to the World Trade Building. Plan to build a double pilot plant (solar/ wind) (5 MW) expected to

Country	Projects
	become operational in 2013.
Tunisia (D)	In service: Wind farms of 174 MW and an additional 70 MW almost completed but not in service yet.
Syria (B)	Plan to build 1,000 MW wind farms by 2015 and 2,500 MW wind farms by 2030.
Oman (E)	In service: A pilot project to pump water in remote areas using wind turbines (10 KW) since 1996. Studies: Implementing a case study for a dual diesel/ wind system of 10 turbines each with a capacity of 100 KW to produce electricity and conducting a technical-economic evaluation of the project to build a 9 MW wind farm at the Daqm area where average wind speed is 5.33 meters/ s, and the speed factor is 0.63.
Kuwait (F)	Plan: 10 MW wind farm
Libya (G)	Under construction: Three wind farm projects with a total capacity of 240 MW to become operative by 2014, Plan: to raise the cumulative capacity of wind farms to 1,750 MW by 2030
Egypt (A)	In service: wind farms with a 550 MW capacity connected to the grid at

Country	Projects
	Zafaranah and Hurghada. Under construction: a 200 MW wind farm at Gabal El Zeit on the Red sea coast. Studies: Construction of a 720 MW wind farm by the government, construction of 1,250 MW wind farms by the private sector on a BOOT basis, construction of 120 MW wind farms through FDI, and construction of a 200 MW farm in cooperation with Al Masdar of Abu Dhabi. A plan to raise the cumulative capacity of wind farms to 7,200 MW by 2020.
Morocco[c]	In service: 291 MW wind farms Plan: to raise the cumulative capacity of wind farms to 2,000 by 2020.
Saudi Arabia [D]	A feasibility study was completed to build two wind farms with different capacities at Yanbu' and Thulm
Yemen [A]	To build and depend on a 60 MW wind farm.

Annex III.

Projects to Generate Electricity from Solar Energy

Country	Projects
Syria (C)	In service: Cell systems of 0.08 MW and there is a line to produce PV panels of 15 MW each year. Planned: To install a 1 MW PV system and to install 700 MW cells by 2020, and 2,000 MW by 2030.
Sudan (A)	PV cell systems with a 0.5 MW in 1,000 villages.
Iraq (c)	In service: A system for lighting highways and powering traffic lights through PV cells. Under preparation: Powering housing and industrial complexes and solar stations for generating electricity in isolated villages with a 50 MW capacity.
Oman (B)	In Service: Limited Applications Of PV Cells For Use In Lighting, Water Pumping, And Seismic Monitoring Stations. In Progress: In July 2011, Petroleum Development Oman Contracted An American Company To Implement A Thermo Solar Project Using A Solar

Country	Projects
	Concentrator With A 7MW Capacity To Be Compatible With A Gas-Powered Steam Boiler. In Addition, The General Authority for Electricity and Water launched a tender in 2011 for a solar/ thermal station with a PV cell system (200 MW) on a BOOT system, to be completed in 2013. Planned: That the private sector would invest directly in solar energy, the production of silicon, PV panels, metals frames, and building solar stations (400 MW).
Palestine[D]	In service: 80 KW PV cell systems and 300 KW cell systems. Planned: Production of electricity (240 GW/H) from renewable sources in the West Bank by 2020.
Qatar [E]	Under construction: A Qatari company announced in October 2011 the signing of a contract to produce polysilicon in Qatar to the value of $1 billion to produce 8,000 MT of multi-crystalline grade high-purity polysilicon as a first step. It is due to be completed in the second half of 2013 Decided: To use solar energy in lighting and cooling the stadiums and spectator stands during the world cup tournament, which Qatar will host in 2020.

Country	Projects
Kuwait [B]	In service: Total installed capacity does not exceed 400 KW of solar energy. In progress: Kuwait Petroleum Corporation announced its intention to launch a tender in the first quarter of 2012 to implement a 5 MW solar station with PV cells, and another station with solar concentrators to produce steam. Under study: The Ministry of Economy, Trade, and Industry tasked the Japan External Trade Organization to prepare a feasibility study for a solar thermal station that would be complementary to the combined cycle with a 280 MW capacity, the solar component of which would be 60 MW. Planned, The Ministry Electricity and Water built an electrical complex (70 MW) connected to the grid using renewable energy sources (10 MW cell station, 10 MW wind farm, 50 MW solar thermal station) at a site near the border with Iraq.
Lebanon[c]	In service: 3 MW PV cell systems in many government-run schools. Decided: to build 50 MW PV cell systems and implement a government initiative to light the

Country	Projects
	streets using solar energy.
Libya(c)	In service: 0.218 MW PV cells Decided: To build 1,000 MW cell systems, of which 100 MW would be connected to the grid in the period 2010 – 2015, and solar concentrators with a capacity of 1,200 MW, of which 300 MW in the period 2010 – 2015.
Jordan (A)	In service: PV cells with 5.5 + 0.5 MW Decided: to build an 8.5 MW solar station and a 100 MW solar station in the first stage, to be raised to 200 MW in the second phase.
UAE (B)	In service: cell systems on rooftops of Masdar City with 1 MW capacity to contribute 30% of the electricity required, and a 10 MW solar station with PV cell systems. Research and studies: The Beam Down Solar Tower Research Program and a research program for a 100 KW solar center based on the central tower system to produce steam that would power the turbines. Private investment: Masdar Company contributed in the ownership of JEMA Solar of Spain central tower technology with a 20

Country	Projects
	MW capacity, and officially operating it in 2011 Under construction: a solar thermal station (Shams 1) with a 100 MW capacity, and a 100 MW solar station with PV cell systems (Nour 1).
Bahrain [B]	One of the petrol companies built a dual solar station (4 KW) and wind farm (1.7 KW) to store energy and produce hydrogen, which would be converted by means of a fuel cell 912 KW) into electricity that would be used to operate and light a factory. Studies: in July 2011 a contract was signed with a German consultant to provide consulting services on the use of renewable energy in electricity generation (using solar and wind energy) with a connection to the grid.
Tunisia [c]	In service: Solar cell systems with a total capacity of 1 MW Planned: Two projects for concentrated solar thermal energy to produce electricity at a 25 MW capacity (public sector) and 75 MW capacity (private sector).

A. ESCWA: The Role of Renewable Energy in Reducing Climate Change in the ESCWA region,

B. Imen Jeridi, Renewable Energy in the GCC Countries, Resources, Potentials, and Prospects.

C. The Secretariat of the Arab Ministerial Electricity Council, A Guide to the Potential of Arab Countries in Renewable Energy and Raising the Efficiency of Electricity Production and Consumption.

D. The Regional Center for Renewable Energy and Energy Efficiency, Bulletin 7, Cairo, June 2010.

E. Al Raya Newspaper: http://www.raya.com/news/pages/09efd0a0-3b11-4c38-8426-9b929889ec38

F. The New and Renewable Energy Authority, Annual Report 2009/2010, Egypt

G. ESCWA Local manufacturing of Electricity Generation Equipment from Solar and Wind Energy: Potentials and Horizons

Annex IV.
Renewable Energy Programs in the Arab Region
(Clean Energy Mechanism)

Country	Project	State
Jordan (A)	Reducing methane gas emissions from waste	Registered in 2009
UAE (A)	A solar station with cell system (10 MW, Masdar initiative) Solar thermal station under construction (Masdar initiative) Producing steam under low pressure by reclaiming lost energy using renewable energy sources for heating	Registered in 2009 Registered in 2009 Registered in 2009
Tunisia (B)	Program for solar water heating	Registered in 2011
Syria (C)	Extracting biogas from waste dumps in Homs (limits the emission of 67,900	Registered in 2009 Registered in

	tons of CO_2) Extracting biogas from the waste dump in Aleppo (limits the emission of 65,000 tons of CO_2)	2009
Country	Project	State
Egypt (D)	Wind farm at Zafaranah (120 MW in cooperation with Japan. Produces 452 GWH annually and limits emissions by 285,000 tons of CO_2. Wind farm at Zafaranah (80 MW in cooperation with Germany. Produces 30 GWH annually and limits emissions by 171,000 tons of CO_2. Wind farm at Zafaranah (120 MW in cooperation with Denmark. Produces 399 GWH annually and limits emissions by 225,000 tons of CO_2. Wind farm at Zafaranah (85 MW in cooperation with Spain. Produces 283	Registered in June 2007. Steps underway to prepare the monitoring report to be submitted to the Executive Council to issue the first batch of certificates Registered in March 2010. Steps underway to verify the certificates of emissions reduction. Registered in September 2010. Steps underway to verify the certificates of emissions

	GWH annually and limits emissions by 150,000 tons of CO_2. Using waste gases to produce electricity and thermal energy annually and limits emissions by the equivalent of 110,000 tons of CO_2.	reduction. Registered in August 2011 Registered in 2008.
Morocco(C)	Eight projects related to renewable energy including 5 wind farms, a solar cell system project, a biomass project, and another related to solid waste.	

Annex V.

The Option of Using Nuclear Energy to Produce Electricity

The Journal of Nuclear Energy Science pointed out in September/October 2008, and several other statements by proponents of nuclear energy option that, based on these analyses:[49]

The nuclear energy option is the most price-competitive among all other options based on conventional renewable power plants.

The nuclear option is environmentally friendly when used as a source of basic electrical power load, and eliminates environmental pollution.

The nuclear option, will save the oil burned by thermal power plants for exporting purposes.

Upon studying these analyses, it is clear that they are not true or that their benefits are exaggerated due to the following:

Calculations of competitiveness must take into account the cost over the plants' complete life span, and the community as well as future generations. They should also add the civil liability cost of nuclear harm, which is estimated at €2.1 billion, as stated in the Vienna, Paris and Brussels Convention in 2004, given that the cost of the Chernobyl disaster reached $235 billion so far, and Fukushima is open to even greater figures. In addition, calculations need to add the security cost of protecting nuclear facilities, the cost of disposal of spent fuel, the cost of decommissioning nuclear power plants at the end of their virtual life, which is a problem without a solution as of yet, and other unforeseen dangers (such as cost of desalinated water, the cost of raising the efficiency of the electricity grid, the risk of failure to market surplus of electricity, and the risk of operating the plant as happened with most nuclear reactors in the world). For this reason, private insurance companies have refused to insure nuclear power plants over the past fifty years. The Comptroller and Auditor-General of the UK (who oversees the cost of

[49] Source: Al Qubaisi and Averdah (2010): International Center for Water and Energy Systems - UAE

decommissioning old nuclear power plants and cleaning the sites) was quoted in 2008 as saying that the cost of closing down, removing, and cleaning the sites from nuclear radiation of nuclear power plants in the UK, whose capacity in 13,974 MW, will amount to £73 billion/$110 billion, which is likely to increase every year, which will be reflected in a rise in the economics of the cost of building nuclear stations and the cost of the Kilowatt in it to $7,836. Reference the following link:

http://www.nao.org.uk/whats_new/0708/0708238.aspx?alreadysearchfor=yes

The cost mentioned above, estimated from 19 sites, and over 100 years of accumulated knowledge and experience of the dangers related to nuclear stations and related financial costs, which are fundamental facts that cannot be denied. The British government has not yet approved the disbursement of these funds.

The contribution of the electricity generation sector to CO_2 emissions is estimated at less than a third. Even if the capacity of nuclear energy were to double by 2050, the drop in CO_2 emissions would not exceed 5%. Hence, the myth that nuclear option supports the reduction of harmful gases is unfounded looking at these numbers. The technical analysis of the feasibility of this would be the rate of decrease, which can contribute 3.2% of the total pollution of the state in 2020. This reduction does not justify spending $40 billion on the nuclear option, whose capacity of 5,600 MW could be produced by conventional plants that do not cost more than $3.6 billion. The ratio of 0.5% of global pollution produced by a state also does not justify such spending, when the U.S., for instance, whose population does not exceed 5% of the world's population, consumes 25% of the world's resources, and whose CO_2 emissions amount to 20% of the global total, yet it has not invested in the nuclear option over the past thirty years.

In addition, nuclear power plants are considered outside the scope of sustainable development methodology. They were not adopted in the Kyoto Protocol, or the Copenhagen conference in December 2009, as part of the Clean Development Mechanisms (CDM). The nuclear option raises grave dangers without effectively contributing to the reduction of pollutant emissions. The problem remains unsolved. It would be possible to use the high cost of the nuclear option in the many solutions available to create a new structure for clean and sustainable energy, and cut pollution rates. Recent research has revealed the concentration of uranium in the world has dropped below a thousand ppm, which makes nuclear plants more polluting for the environment than conventional plants that run on gas or oil.

The study neglected to mention that oil saved would be spent on importing nuclear fuel and then disposing of the nuclear waste.

Economic Feasibility of Nuclear Stations

Economic feasibility consists of four elements: 1. The initial cost: the value of the initial investment. 2. Operating and maintenance costs. 3. Disposal costs: the cost of spent fuel and decommissioning stations at the end of its virtual life. 4. The cost of insurance covered by the government to compensate for damages resulting from the risks of nuclear power plants and controlling their radioactivity. (Paris & Vienna Convention 2014).

At the end of 2007 there were 439 nuclear reactors with a total capacity of 372 GW. The average virtual life of a reactor is 25 years. According to the International Atomic Energy Agency (IAEA), there are 31 reactors under construction, which 20 less than the number monitored at the end of 1999. This means the number of new reactors in the world is dwindling continuously. This is the opposite of what is published by nuclear plant building companies. The reality is that not a single atomic reactor was built in the U.S., which has the largest number of them; or in rich Europe, except for one in each of France and Finland. Their completion faces difficulties and neither has been completed yet. In 2000, Germany decided to eliminate all atomic stations there by 2020, and other countries introduced in the policies programs for the elimination of atomic reactors such as Sweden since 1980, Italy since 1987, and Belgium since 1999. Other countries have debated the removal of nuclear reactors, and countries such as Austria, the Netherlands and Spain, who have enacted laws that prohibit the construction of new reactors on their soil. Some countries, such as France, have not done anything, which makes it a unique case among developed countries, but France’s objective circumstances prevent it from taking any such steps due to its heavy dependence on atomic energy, and its lack of sufficient resources or alternatives of fossil fuels.

In 2003, a team from Massachusetts Institute of Technology (MIT) conducted an economic study of nuclear power plants compared with traditional stations. The study found the initial/capital cost, and operating costs of these stations, continues to increase, and they are much higher than conventional fossil fuel-powered plants (oil and gas). Nuclear reactor building companies have sought to cover these facts and give an unreal image of the cost of nuclear plants in the U.S. However, in 2007, the Keystone Center for Economic Studies (Keystone Center) in the U.S., reviewed the MIT report and the updated its data. The results of the Keystone study are as follows:

- The initial cost of nuclear stations, according to the Keystone report varied between $4,300/KW - $4,550/KW (2007 prices).

- According to a study by Moody published in October 2007, the initial cost varies between $5,000/KW and $6,000/KW.

- In early 1008, the economic costs exceeded Moody’s expectations, reaching $5,000/KW - $7,000/KW.

(http://www.rmi.org/rmi/Library/E08-01_Nucleartllusion (&Imran Sheikh Amory B.Lovin)

But today, particularly after the Fukushima disaster in 2011, the nuclear age entered a critical stage as the world's attention has focused more than ever on safety, the high cost of nuclear power, and the availability of other less costly, more sustainable, and safer alternatives such as renewable energy. [50]

[50] Personal communication (Dr. Ayoub Abu-Dayyeh).

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This book aims to shed light on the opportunities for the localization and exchange of knowledge on renewable energy in the Arab world. During the past two decades, despite the information and communication revolution, the Arab world did not optimally invest in these information technologies. Nowadays, we stand on the threshold of a new century marked by the shift to renewable energy, and the use of clean energy. Nevertheless, the region is far away from developing its own technologies or investing in the exchange and transfer of knowledge about these promising technologies. This book is intended to shed light on the following questions:

Will Arabs develop a new Arab vision to localize renewable energy resources and develop a new Arab structure that includes the rich and the poor, which will include all oil-producing countries including Jordan, Palestine, Iraq, Lebanon and Tunisia? Will investing in science and scientific research become an Arab and national development priority? The duality of renewable energy and nuclear power in the Arab world will remain problematic unless an enlightened discourse with accurate information and transparency exists between decision makers and civil society. The energy mix in the Arab world will change in the future in light of diminishing oil resources, and the availability of clean renewable energy sources. However, it is necessary to differentiate between the availability of raw energy sources (also other conventional energy resources) and the capability to utilize them in an economic and environmentally friendly manner.

In short, the Arab world will witness profound changes on the renewable energy front due to the development of technology to optimize, store and transport energy, alongside the availability of traditional energy sources as such gas and oil-shale, which will in turn affect the nature of energy monopoly. The capability to transmit knowledge, creativity and technology (intellectual capitalism) will remain the determining factor in who will take charge of the future.

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