IIIEE Theses 2012:19

The Arab State of Renewable Energy

Investigating Progress in Arab Electricity Markets

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Thesis for the fulfilment of the
Master of Science in Environmental Management and Policy
Lund, Sweden, September 2012

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ISSN 1401-9191

Acknowledgements

This thesis project occurred thanks to Tareq Emtairah, director of RCREEE and professor at the IIIEE. It is primarily due to your vision for a new discussion about renewable energy in the Arab region, and by inviting me to participate in mapping out this process. Thank you for the opportunity to contribute to your work.

A further thanks is owed to the staff at RCREEE, whose passion for the topic was evident during my time working with them. Your personal interaction provided insight into the Arab perspective on renewable energy.

I wish to give a whole-hearted thank you to Andrius Plepys, who supervised my thesis work. Throughout the past year we crossed paths several times on different projects and I gained a greater appreciation for your knowledge, humour, and wonderfully practical approach along the way.

To several other professors at the IIIEE who provided guidance for this work, both directly and also inadvertently, I have appreciated the perspectives and experience you offered.

I must thank my fellow students who have accompanied me in these studies over the past two years. Our time together has proven more meaningful than I would have predicted, and I feel a connection to you all. A special thanks deservedly goes to those who collaborated on this work. You made the experience immensely enjoyable.

Thank you Sweden, for the invitation to study and live here. It was an extraordinary year.

And finally, to those closest to me, I have appreciated your support (or just understanding) when I was weighed down with the workload and distracted by concerns that seemed secondary to regular life. I feel my learning has extended from academic to the personal, and I hope the short-term sacrifices will prove worthwhile for our future together.

Abstract

Renewable energy (RE) progress in the Middle East and North Africa has been varied, and is affected by multiple factors. This thesis investigates the current status of RE for 13 countries in the Arab region. An initial hypothesis proposes that price is not the only or main driver. Literature and interviews with participants from Arab government, regulators, funding partners, and industry inform to identify drivers and barriers to RE progress. A new index – designed to measure RE progress specifically for RCREEE member countries – provides structure for the research results. Five relevant areas are identified: *market*, *policy*, *institutional*, *investment*, and *technology-specific* to each renewable generation type. Historically closed and heavily subsidized Arab electricity markets are making RE investment unattractive. A new approach for assessing subsidies is proposed using Palestine's electricity prices as a benchmark, due to its unique position without subsidization. Analysis of this *implied subsidy* highlights the case of Morocco, which stands out by reducing or eliminating electricity subsidies altogether. Secondary issues are identified in the failure to align policy with actions, impacts of changing oil export and demographic patterns, and creation of institutional conditions that promote RE. Governance emerges as a prevailing common theme. Cases showing positive results are presented, offering a view on where other Arab states might intervene to support their RE development.

Keywords: renewable energy; electricity; Arab; governance

Executive Summary

Development of renewable energy offers an opportunity for countries with plentiful natural resources to take advantage of their value by generating useful energy, but it also offers environmental benefits by producing fewer CO_2 emissions. The Arab countries lag the world in general, despite having superior resources for solar power and in some regions wind. Aside from environmental motivation, RE has potential to improve energy security, energy independence, and long-term value for electricity producers.

This thesis sets out to investigate the current state of RE development in a group of Arab countries. The research focuses on the identified gap between the potential for renewable sources and current practices. An initial hypothesis proposes that price is not the only, or potentially main, driver. A review of existing literature and personal interviews with participants from regional governments, regulatory agencies, funding partners, and industry serves to shape the process of inquiry. These sources contribute to the identification of key drivers and barriers to RE progress.

In the research process, the importance of the role of governments will be demonstrated. Of the 13 countries under study, RE development patterns vary widely. Some governments have made proactive policy choices and attracted interest from external participants, while others are still in the early stages of opening their markets to the point where a dialogue with secondary actors might begin. Through the literature, a search of existing indicators is made to compare the success of countries in various measures, which leads to only partly satisfactory results. The products available today cast a wide net in their comparative analyses, and the unique aspects of the Arab region are often hidden in the results. A new index designed to measure RE progress specifically for RCREEE member countries will be briefly discussed, and the framework developed during that project will be used to organize the research results.

This thesis shows that a wide set of factors is influencing RE development and the impact of government touches upon most of them. Because government continues to play such a central role in the Arab states, the discussion acknowledges the impact of organizational structure. To facilitate success, it finds that governments need to address several significant obstacles. The research identifies five main areas that play a large role in RE progress: *market*, *policy*, *institutional*, *investment* for general consideration, and *technology-specific* for the various renewable generation types.

A central problem stems from the historically closed energy markets that are heavily subsidized. This single factor makes it difficult for RE to appear as an attractive alternative, unless further market distortions are attempted to neutralize the impacts of fossil fuel subsidies. A new approach is proposed to quantify government subsidies in the Arab electricity markets using Palestine prices as a benchmark due to its unique position dependent upon imported electricity and without a strong financial capacity to offer subsidies. This implied subsidy proves to be useful in identifying the subsidy policy stance of each country. It invites questions about Morocco, which stands out from the group by reducing or eliminating electricity subsidies altogether.

Secondary issues are identified around the failure to align policy with actions, the impacts of changing oil export patterns, and creating institutional conditions that promote RE.

A selection of cases is presented that have produced positive results in each of the key areas. Each demonstrates an innovative approach to the challenges in a particular Arab country.

These cases and the discussion of the research results offer a view on where other Arab states might choose to intervene to support their RE development.

A theoretical explanation for the nature of government involvement in RE development is suggested using governance theory. This is compared with the current reality and found to have notable divergences. The theory, which reflects ideals rather than nuanced realities, does not adequately capture the realities of the Arab situation. The exercise is helpful by allowing competing perspectives to stretch the research in slightly different directions. Overall, the utility of the theory is found to be secondary to the data collected from industry actors.

Challenges in the research process centre around the 3-dimensional complexity of the task: the group of 13 countries proves to be challenging to work with due to their disparities in economic status, geographical location, political conditions, and even data availability; considering the entire collection of RE technologies sometimes invites analysis at the micro- rather than macro-level; and the simultaneous handling of two related but distinctly different areas of enquiry – development of practical index and writing of academic research paper – prove to be a challenging combination.

An area for future research is suggested for development of a database on land access and regulatory processes relating to RE projects. From a project developer's perspective, a measure of the number of agencies involved and time required to secure permits would be very helpful in business strategy decisions. A second opportunity exists to extend the work on subsidies, comparing governments' costs of subsidization to potential economic and social benefits of investing in RE projects. The answers could offer policy assistance to Arab governments.

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Abbreviations

APICORP	Arab Petroleum Investments Corporation
AUE	Arab Union of Electricity
bb	billion barrels of oil
BOO	build-own-operate
BOOT	build-own-operate-transfer
CDM	clean development mechanism
CO_2	carbon dioxide
CSP	concentrated solar power
Dii	Desertec Industrial Initiative
DLR	Deutsches Zentrum für Luft- und Raumfahrt/German Aerospace Center
EU	European Union
E&Y	Ernst & Young
FIT	feed-in tariff
GHG	greenhouse gas(ses)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GW	gigawatt
IEA	International Energy Agency
IPP	independent power producer
IRENA	International Renewable Energy Agency

km	kilometer
kWh	kilowatt-hour
LAS	League of Arab States
MASEN	Moroccan Agency for Solar Energy
MENA	Middle East and North Africa
MSP	Mediterranean Solar Plan
MW	megawatt
MWh	megawatt-hour
NEPCO	National Energy Power Company
NGO	non-governmental organization
NREA	New and Renewable Energy Authority
PPA	power purchase agreement
ppm	parts per million
PPP	public-private partnership
PV	photo-voltaic
RCREEE	Regional Center for Renewable Energy and Energy Efficiency
RE	renewable energy
R&D	research and development
UN	United Nations
US cent	one one-hundredth of a United States dollar

1 Introduction

The opening chapter provides a brief context to the thesis research, and sets out the general background relating to renewable energy. The problem statement and research questions are presented, and the chosen methodology, analytical and theoretical frameworks are described. Scope for the project is laid out, limitations are stated, and some general writing conventions are mentioned. Finally the thesis disposition is provided.

1.1 Preface

It seems worthwhile at the beginning of this thesis, and the end of my research, to put the project into context. Which is mainly to explain how I found myself researching environmental policy in perhaps the world's most turbulent region at the moment.

The pace of change has been rapid in the Arab countries since a singular event in December of 2010 triggered what would come to be known as the 'Arab Spring'. The political landscape has been rapidly transformed, with a succession of protests leading to the ouster of leaders in Tunisia, Egypt, Libya, and Yemen, and with Syria currently embroiled in similar conflict. Add to that backdrop a transition of governance in Iraq, the secession of South Sudan from Sudan, ongoing territorial disputes for Palestine, and varying degrees of political re-shuffling done elsewhere, and it the result is a dynamic situation.

So why would I want to throw myself into the mix to investigate renewable energy (RE) in such an unstable region? From an environmental, financial, and societal perspective there is a significant opportunity for progress, and also many ways to foul things up. It was this unique proposition and an invitation to work with a leading research center in the region that drew me into the world of Arab RE. And it was not until I arrived in Cairo on the eve of the handover from military government to the Egyptian Republic's first freely elected president that I appreciated the significance of the current moment. And as I have learned, there are many challenges, but so too there are capabilities and intellectual resources among the region's people.

This thesis topic was a departure for me; my professional work in energy efficiency, renewables, and utility contracts in Canada involves an entirely different set of conditions and mode of thinking. But my current master's degree studies have continuously led me in new and unfamiliar directions so I embraced this thesis opportunity as a two-way exchange of ideas. We are all learning as we go, which is a key aspect of environmental science in the pursuit of true sustainability. And so, what follows is the expression of what I have learned during these few brief months of research.

1.2 Energy and sustainability background

Modern society depends on electricity for many activities, and the majority of consumption occurs in households and industry. In Arab countries in 2011, residential use accounted for approximately 40 per cent and industrial use 30 per cent of consumption. Electricity generation requires conversion of fuel into a high-quality energy source, which in many cases causes negative environmental impacts. In 2011, fossil fuel-fired generators produced 92 per cent of Arab states' electricity. RE sources offer an alternative to conventional electricity

generation, but all renewables currently make up only a small fraction of Arab electricity, at less than 8 per cent. A gap exists between the *potential* for renewables and current practices. As technology closes the price gap with grid-supplied electricity, it is predictable that cost effectiveness alone will not be a sufficient driver for adoption of renewables. Examples of slow adoption from other locations and technologies, such as solar water heating in Thailand (Techakitrungruang, 2011), and underdeveloped markets such as the Caribbean nations (Haraksingh, 2001; Iyare & Moseley, 2012) serve to illustrate. These examples suggest that policy is the dominant factor in RE diffusion, supported by experience in other regions such as the European Union (EU) (Jacobsson & Lauber, 2006).

A delay in the adoption of renewable electricity, which means a continued focus on centralized carbon-based fuels for generation, could result in higher risks for energy security, energy independence, and environmental degradation (Mints, 2009; Pachauri & Cherp, 2011). It could also have implications for the long-term electricity market, with existing industry participants becoming more entrenched and using favourable regulatory structure to fend off competition from new entrants, despite potential cost or efficiency savings. Other barriers might also persist, such as integration into the existing infrastructure built around conventional generation sources, and adequate access to finance for making the switch to RE.

Investing in RE generation is complicated by the required approach to the analysis. Almost no factors are common to any two markets – type and quality of resource, financing, permits, grid connection, electricity pricing – which demands that the analysis be extremely local. Government policies have potential to either hinder or support a virtuous cycle of RE adoption by methods other than financial incentives, primarily through niche markets developing economies of scale (Masini & Frankl, 2003), by reforming the current utility structures, and by enabling creative approaches to financing (Lund, 2011).

The pursuit of sustainability is more than an exercise in reducing harmful emissions or improving resource use; it needs to be balanced between the demands of society, environment, and also financial capability. Focusing on one aspect at the expense of the others can fall short of the goal if it becomes impossible to sustain the effort. Arab countries face a dilemma when planning for their future – can they afford to place RE development ahead of other pressing societal needs? How can they chart a course that best serves their overall needs?

1.3 Problem statement and research questions

Alternatives to conventional energy supply are available and gaining market share in some areas of the world. RE can offer advantages in the electricity sector, including increased independence in generation, less price variability of fuels, and lower environmental impact.

RE is not being adopted at the same rate in all areas of the world, including the Arab region where excellent resources exist. In addition, there is a lack of analysis regarding the barriers and opportunities related to RE uptake in the Middle East and North Africa (MENA).

The Arab countries of the MENA area are located in a geographical region that lags the world average in terms of RE development, at less than 8 per cent compared to a global average of approximately 19 per cent (AUE, 2012a; EIA, 2011). Throughout the area, potential exists to generate electricity from solar, wind, and other RE sources. While some projects have been initiated, the rate of new generation capacity is generally not meeting goals set by governments

in the region or by private power developers. This thesis aims to identify key factors affecting the rate of RE development in the Arab region.

The objective will be to draw upon available data and expert opinion in the Arab region to inform an analysis of potential actions and policy decisions that could be applied to maximize RE development.

The **research questions** are defined as:

1. What factors are currently most influential to renewable energy development in the Arab region?
2. Where can Arab states intervene to support their renewable energy goals to achieve maximum benefit?

1.4 Methodology and analytical framework

This thesis coincides with my work from May to September of 2012 with the Regional Center for Renewable Energy and Energy Efficiency (RCREEE), based in Cairo, Egypt. RCREEE serves a group of member states within the Arab region. The organization's goal is to offer a regional platform for promotion of renewable energies and energy efficiency, and to formulate and discuss policies. Between May and September 2012, my task there was to develop a RE progress index that will benchmark, compare, and measure on an annual basis the efforts of the members in developing RE within their domestic electricity industries. The RCREEE Arab Renewable Energy Progress Index will be introduced in early 2013. RCREEE's membership includes 13 countries: *Algeria, Bahrain, Egypt, Iraq, Jordan, Lebanon, Libya, Morocco, Palestine, Sudan, Syria, Tunisia,* and *Yemen*. This group of 13 countries, illustrated in Figure 1-1, will be the focus in the chapters that follow.

Figure 1-1. RCREEE's 13 member states

Source: RCREEE

Literature review

The research process began with literature review to gain a wide understanding of the situation and context of RE development in the Arab region. To cover the different perspectives, information was collected from three different sources: Arab governments and entities, third-party research and consulting firms, and industry associations and participants.

Literature review was conducted primarily using publicly available sources on the Internet, with some documents provided by interviewees and other sources, including the following:

- Documents from Arab governments, regulatory agencies, and aggregators of information (including LAS, NREA, EgyptERA, MEDGRID, MASEN, ONE, Central Bank of Egypt, reegle, REEEP), which discuss RE in the context of national regulations, plans, targets, and strategies
- Documents from RCREEE (including published country reports and sector reports, newsletters, statistics, and internal research documents and databases) to understand the status of each member country
- Documents from development partner organizations active in the Arab region (including GIZ, DANIDA, UNIDO, AfDB, Adetef, UNEP, MED-ENIP, MED-ENIC, MSP, Dii/DESERTEC, Masdar, GEEREF, EBRD)
- Documents from NGOs, research organizations, consulting firms (including IFC/World Bank, Plan Bleu, IPCC, IMF, Arab Finance, MEES, Bloomberg, PwC), which provided the external view on the situation from informed and interested viewpoints
- Indices, statistics, and databases (including Arab Union of Electricity, REN21, E&Y, Siemens, Climatescope, BTI, Economist, IRENA, IEA, EIA, CIA, GTZ, Index Mundi, BP, Carboun), which provided important quantitative data for the general energy markets and more importantly the RE sector
- Resources providing guidance on index development (OECD/JRC)
- Presentations by industry experts (including Schneider, Siemens, Elsewedy, SWEG, IEEE, Tractabel, E-Cube)
- Books dealing with the history of energy markets and transitions (Peter Tertzakian, Chris Martenson, Thomas Kuhn, Pierre de la Tramerye, Ludwell Denny) to provide a context for understanding the Arab region's current role
- Academic journal articles and industry publications
- News articles from Arab media sources and commentary from observers

Existing literature helped identify a research gap and confirmed the initial hypothesis: *an adequate method is not currently available to compare Arab countries' progress in RE development*. This led to a more narrowly focused research direction for the thesis.

The major outcome of the literature review was development of a structure to organize the different priority areas for RE development in the Arab region. These priority areas are grouped into *market*, *policy*, *institutional*, *investment* for general consideration, and *technology-specific* to be applied to each of seven relevant renewable technologies.

A second gap exists in the literature due to the dynamic situation in many member countries, where transitions of government have implications for long-term strategies relating to renewables, with significant lack of clarity. Since these transitional events have occurred largely within the past year and a half, the academic literature does not reflect the situation well. Instead, interviews and news media were used to fill gaps in the research.

Personal interviews

To deepen my understanding of the regional situation, I conducted 12 semi-structured interviews with members of government, regulators, industry, and international project partners. Interviews took place in Cairo, Egypt because there existed good availability of regional participants, an existing network of contacts, and good representation from the largest Arab electricity market. In addition, I attended a conference hosted by Egypt's New & Renewable Energy Authority (NREA) and France's Adetef agency discussing a newly developed RE investment decision-making tool for the Arab region, and had informal discussions with consultants and participants there. I also drew upon the results of a similar research project from 2010 (Environics, 2010), where a larger number of interviews were conducted in the same research area, and which I used to cross-check my findings.

The perspectives of each interview subject were interpreted and categorized using the market, policy, institutional, and investment priority areas developed earlier. The fifth priority area, technology-specific, was used only in some cases. For interview subjects who had a professional focus in one technology area, opinions were sought out only in that area. During discussions, through open questions and queries on key subject areas, views in each priority area were collected. The list of interviewees is included as *Appendix A*.

Data analysis

Once interview data had been collected, trends and disparities were identified among respondents. The cumulative results of the expert opinions provided important direction for two tasks: 1) creation of a composite indicator index for RE progress, and 2) identifying the most effective areas for intervention in Arab markets. These two tasks were foundational in the analysis that would answer the research questions.

Task 1 was work commissioned by RCREEE, and involved a substantial quantitative analysis component. The outcomes of that work would inform the first research question. However, *the focus of this thesis is not upon the mechanics of index construction* so those aspects will not be discussed in detail here. Rather, the index developed through this work provided an organizational structure useful for approaching the first thesis research question.

Task 2 was accomplished through an iterative process using literature analysis, interviews, and data analysis, resulting in several revisions to the scope and direction of inquiry. The five priority areas developed in Task 1 were helpful in organizing the thesis analysis section. This work provided a response to the second research question.

Analytical framework

The research in this paper combines quantitative and qualitative aspects in a *mixed-methods approach* because both can be used to lend support to an effective investigation of the research questions (Bryman, 2006). Overall, quantitative data took priority over qualitative data, due to the need to support research claims with statistical evidence. However, the qualitative interview results provided the directional guidance. The process began with an inductive analysis to discover the relevant relationships, connections, and important categories upon which to focus, which led to development of a preliminary hypothesis. A deductive approach was then utilized to test the hypothesis with further observations and through data collection to focus upon answering the research questions.

The preliminary step involved a widely spread literature review, with a narrowing focus on RE development in Arab states. Eventually when further reading would yield diminishing returns, expert insight into the research problem was sought out.

The next step involved conducting interviews with regional stakeholders and experts offering a diversity of views in order to develop an initial hypothesis, develop the research questions, and guide the subsequent data collection in a useful direction. This phase used a semi-structured interview style employing an open-question technique, because the breadth of subject matter would have likely resulted in poor response quality in a statistical survey. The mixed-methods approach was useful as a bridge at this stage, to triangulate or corroborate opinions from interviews in order to identify the research 'hot spots' worthy of focus in the next phase of research.

The third step, indirectly related to the thesis objectives, involved developing a set of indicators to measure progress in RE for RCREEE. This process relied on quantitative methods for collection, analysis, and processing of data. Information from experts was also used to inform measurement decisions and technical details in developing the quantitative index. After data were collected, the process required some interpretation of data and reflection on opinions and perspectives to answer the first research question.

The final step involved using the acquired research data to develop an analytical response to the second research question. It consisted of organizing the findings thematically, analyzing with the assistance of some appropriate theoretical frameworks, and drawing conclusions to answer the research questions.

Theoretical framework

The Arab RE sector can be better understood through the application of theoretical frameworks. An approach was considered in an attempt to explain the motivations, drivers, and activities of the main actors and focus research efforts into channels that would create order from the available information.

I used the basics of governance theory, as outlined by Pierre and Peters (2005) to understand the challenges specific to the Arab region with respect to their policy development. Governance considers the process and outcomes of governing, rather than the institutions, where multiple actors are involved because no one actor has absolute dominance in the relationship. This is a fundamental aspect relating to the changes occurring within these countries, with significant disruptive forces occurring currently and an unclear path for future social organization patterns. Chapter five will include a discussion of how the positions of governments toward RE development might be explained by governance theory.

1.5 Scope and limitations

The group of 13 countries – Algeria, Bahrain, Egypt, Iraq, Jordan, Lebanon, Libya, Morocco, Palestine, Sudan, Syria, Tunisia, and Yemen – will be the focus in the chapters that follow. This is due to the work I did for RCREEE, which focused on their member states, whereas the other nine League of Arab States (LAS) countries will not be discussed in detail. The intended audience is professionals involved in energy policy within the Arab region, either within government, research organizations, or industry, who can apply the results to their own RE objectives. As such, some background concepts and terms will be omitted due to the expectation of a well-informed reader.

Further with respect to boundaries, the discussion will deal with RE in the electricity sector only. Although different areas of the renewable sphere provide interesting challenges and opportunities, they fall outside the scope of this work. One of these excluded areas is liquid transportation fuels; they are an important part of the picture but will be discussed only with respect to their usefulness as a measure of energy and financial value in relation to electricity. The other major exclusion is solar water heating. This method of supplying hot water, mostly for residential and commercial users, has been proven to be cost effective in the right context and technically ready for large-scale adoption. It is a 'cross-over' technology, which could also be categorized as an energy conservation product integrated into buildings. Water heating is also a marginal sector in the Middle East because space heating is generally a non-issue, and heat sales and distribution are unattractive to utilities.

This thesis will not attempt to identify *which* RE sources are best suited to the Arab region. That task, while related, is complex and deserves its own treatment rather than a minor role within this analysis. Therefore one type of renewable will not be endorsed over another. Furthermore, individual RE technologies will not be examined with respect to materials and resource inputs. In other words, there will be no attempt to evaluate the feasibility of using RE from a life cycle or resource efficiency perspective (e.g. long-term availability of neodymium for wind turbine motors, or recycling of PV panels). Instead I will proceed from the assumption that RE is a *desirable* and *feasible* option for electricity generation compared to the existing options.

Ample literature exists in the area of RE development, produced both by government and industry, although less so in the Arab region. Statistical data is lacking for some countries due to their closed political stance and lack of resources dedicated to measurement. In some cases data are very scarce or non-existent, creating significant gaps. One of the goals of RCREEE is to provide accurate and comprehensive data for its member countries and the Arab region, and this thesis aims to contribute some new data and analysis in support of that goal.

The thesis will follow a path that discusses the 13 RCREEE member countries mostly in aggregate terms at a high level and not a great amount of specificity. This is a constraint due to the size of the group and number of technologies involved, and the approach will be to consider each country equally and interchangeably in the context of the research problem. But throughout, where required or merited, the discussion will focus on a specific country to more effectively illustrate a concept. So the rhythm of zooming in and back out will become a familiar pattern to the reader.

As a final note, to reduce unnecessary distraction throughout the thesis, three writing conventions have been adopted:

- the group of 13 member countries of RCREEE will typically be referred to as "RCREEE members", or alternatively "Arab states", "Arab region", or "MENA" within a broader context
- the term *renewable energy* will be denoted using its common acronym "RE"
- all energy statistics relating to the Arab countries are sourced from the Arab Union of Electricity (AUE, 2012a, 2012b) unless otherwise noted

1.6 Disposition

This thesis studies drivers and barriers to development of RE in the Arab region, proposes a diffusion model for RE for countries in the region, and investigates where Arab states can intervene to support their goals and maximize the benefit of RE. Chapter two provides an overview of the RE technologies available to the electricity market, offers essential Arab energy statistics, and discusses a proposed and existing index framework. The Arab case is introduced in chapter three, with my findings on what drivers and barriers are influencing RE development in the region. Chapter four builds on this, with analysis of the current market directions, changes that are occurring, and examples of positive Arab RE developments. In chapter five I make an attempt to explain motivations of actors through the lens of governance theory and close with a short discussion that suggests a course of action for Arab governments to support RE. Chapter six offers conclusions to summarize the results of the research and suggest directions for future investigation.

2 Renewable energy

Chapter two offers a very brief discussion on current energy systems and their environmental impacts, and points to RE as a potential substitute that can reduce environmental pressure. The relevant RE sources are described in the context of Arab electricity markets. General Arab electricity statistics provide context for the RE sector, and the concept of net oil balance is introduced. The chapter ends with a review of existing tools available to compare RE development.

2.1 Modern energy systems

The most valuable energy to society is storable, transferable, and with high exergy, or availability. In this respect, the most appealing energy carrier in current widespread use is oil and its liquid fuel derivatives. It possesses the best combination of these traits – stable in typical conditions, easily handled in shipping, and providing high energy value per unit volume. By all measures it is a fantastic fuel that has brought society forward with tremendous advances to productivity and economic growth (Tertzakian, 2006). During the postwar Armistice negotiations in 1919, French industrialist Henri Berenger warned his government, "He who owns the oil will own the world, for he will own the sea by means of the heavy oils, the air by means of the ultra refined oils, and the land by means of the petrol and illuminating oils." (de la Tramerye, 1923). His assessment would prove to be true during the century to follow. The reasonable estimate that half of all oil ever consumed has been consumed since 1988 (BP, 2012; Smil, 2010) is a testament to its growing success, but leads to an obvious question: can oil supply continue to meet demand in a world geared for sustained growth in consumption? Whereas neoclassical economic theory focuses on capital and labour, omitting energy and resources entirely (Daly, 1991), the reality is that demand growth requires higher oil production levels on a global scale, and debate continues over when the supply capacity will be exceeded. The exploration of unconventional, progressively deeper, and tighter oil deposits tells a lot about availability – the easy oil is disappearing.

The environmental sustainability of continuing to use oil at current and increasing rates is also questionable. Along with 50 per cent of mankind's oil consumption having occurred since 1988, another distinction exists. That same year, the average annual level of atmospheric carbon dioxide (CO_2) first exceeded 350 parts per million (ppm) and increased to 390 ppm during the following 23 years (Tans, 2012). This is significant since broad agreement within climate science suggests that CO_2 levels above 350 ppm very likely exceed the carrying capacity of the planet (Core Writing Team, Pachauri, & Reisinger, 2007; Hansen et al., 2008), resulting in undesirable effects including increase in average global temperatures (Hare et al., 2011) and increase in ocean acidity (The Royal Society, 2005). This has prompted a response at local, national, and international levels to address the impacts of anthropogenic climate change due to energy use. It has also generated a passionate debate about the wisdom, practicality, and even morality of continuing to rely on fossil fuels to maintain the status quo. Therein lies the problem: no obvious substitute for oil exists.

The best time to solve an energy crisis is always ten years ago. Or in other words, difficult circumstances are the symptom of a problem with roots in the distant past. And the options to deal with the problem are limited when it has not been attended to in the interim. It is a reminder that foresight is helpful for solving big problems, and energy systems have inertia that makes them slow to change.

RE sources offer an option to replace some of the current electricity generating infrastructure and to reduce the anthropogenic impacts of fossil fuel use (IEA & OECD, 2008; Sims, Rogner, & Gregory, 2003). Cost of generation is cited as a major factor limiting renewables from making a larger contribution to worldwide energy generation (Branker, Pathak, & Pearce, 2011; Breyer & Gerlach, 2012). While this is true in part, in reality energy systems are complex and influenced by a multitude of factors. Not surprisingly a switch to renewables, even for committed and motivated actors, is proving to be a challenge due to the embedded energy infrastructure.

2.2 Environmental context

RE offers one approach to improving environmental performance, and can be used in combination with other efforts. Figure 2-1 illustrates the relationship of the factors affecting environmental pressure (AEA Technology Environment & European Environment Agency, 2002).

A driver is some activity that generates demand for energy use. Energy intensity is a measure of the amount of energy required per unit of the task. Environmental intensity can be thought of as the impact on environment in the forms of emissions, discharges, or wastes.

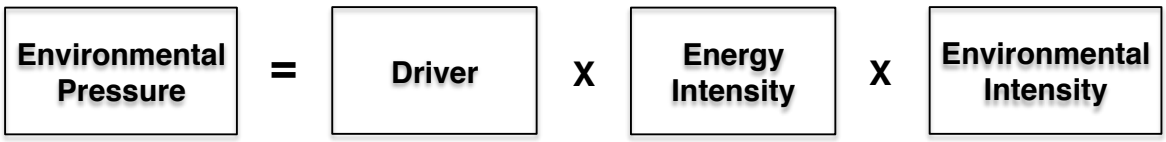

Figure 2-1. Relationship between environmental pressures and the three drivers for energy demand

Source: adapted from European Environment, 2002

Easing environmental pressure can take different paths depending on which area is being targeted for improvement. The analogous relationships to environmental pressure can be seen in the factors leading to environmental relief in Figure 2-2. These countervailing forces can be applied individually or within a coordinated environmental strategy.

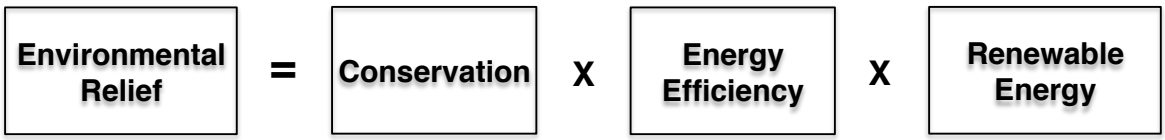

Figure 2-2. Relationship between environmental relief and the three modes of meeting energy demand

The current research focuses on the RE component of this equation. Conservation and efficiency are recognized as important complementary efforts, including smart grid development, metering, and energy storage, and these should be part of a systematic linking of policy developments. In fact, RE should be built around an energy system that has first been optimized through efficiency gains and reductions in consumption. But the reality is that supply-side solutions are often simpler to fund and implement. Therefore investigating RE is worthwhile even while these higher-effort alternatives are also in progress.

2.3 Renewable energy technologies

The International Energy Agency (IEA) offers a definition of renewable energy being "derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth." (2010). While distinctions can be made regarding time scale, with a stipulation that the energy replenishment rate must be meaningfully faster than its extraction, this is a reasonable description. IEA includes as sources energy produced from solar, wind, geothermal, biomass, hydropower and ocean resources, and biofuels and hydrogen derived from renewable resources. The inclusion of hydrogen is open to debate, since it is an energy carrier rather than an energy conversion source.

Electricity can be generated from most RE sources. Some methods are less effective for this conversion because of the high quality of energy required for electricity; for instance thermal techniques require substantial amounts of heat to move turbine blades or evaporate liquids in order to convert thermal energy to a high quality electrical state. This requires a process of conversion from solar energy to thermal to mechanical to electrical energy. Other methods are more direct, such as wind energy, which is converted to mechanical to electrical energy. The best options in a particular location are highly dependent upon the natural resources available. As opposed to methods that use imported fuels, RE is a highly local source, which makes assessing its practicality a very local endeavor.

The discussion that follows provides a brief overview of the renewable sources available to the Arab region, including any notable features. The treatment is brief and not exhaustive since the particular features of each RE technology are not the focus of this research. Each of the sources is considered as an equivalent component in the larger RE system, with no attempt being made to judge which technology is preferable for each country.

Wind

Wind is generally the leading RE source based on price where wind resources are good, mainly due to its modularity and ease of installation. The output is highly intermittent, which is a challenge for utilities when planning the dispatch of their generating plants. A higher degree of flexibility is required in a grid with wind power, where relatively quick ramp-up and ramp-down of base supply is required. Some regions of Arab countries have extraordinary wind resources available, such as the West Sinai Desert of Egypt and the Sahara Desert in Morocco. A recently completed wind atlas shows areas with potential for 40 per cent capacity factor (DLR, 2012) with highly predictable winds due to the consistent weather of the desert.

Solar PV

Solar photovoltaic (PV) technology is one of the methods being used to generate electricity from the sun. PV is currently achieving competitive pricing in some residential markets; this has occurred to a large extent due to political invention of subsidies, feed-in tariffs, and promotional programs. Most countries are currently somewhere within this phase. Looking to the future, the next phase for PV is anticipated, which will see commercial PV power plants.

Although PV power is intermittent, good forecasting can predict output with reasonable accuracy and scheduling base load is possible. In some markets, the peak load hour coincides with peak solar, especially where cooling loads are a major portion of usage. This matches PV output well and is an attractive option for dealing with peak loads. Land use is a major aspect, as well as solar resource availability, meaning equatorial or nearby countries with desert areas have an advantage over others. For instance, annual solar radiation in parts of the Sahara

Desert is up to 2.5 times greater per square metre than in Germany (RWE, 2012). Research and development has been effective in decreasing prices for PV on a continuous basis, bringing it into a competitive position in some electricity markets.

Solar CSP

Concentrated solar power, or CSP, is another technique of collecting solar energy to convert to electricity. This occurs through first creating steam, then generating electricity. CSP has an advantage over PV in that it can be designed to hold thermal energy for some time after collection, typically in a molten salt solution. This makes CSP attractive when energy storage is of interest, so electricity can be generated (at least partially) upon demand rather than simply when the sun shines. CSP lags PV in terms of installed capacity in the Arab region due to several factors. Discussions with engineers involved in pilot projects in Egypt pointed to the challenges of building a plant that requires complex design, as opposed to PV which is more modular and scalable. Technical issues are still unresolved, including the harsh effects of desert sand on the surface of the reflectors, which may result in shortened lifespan or reduced system efficiency. Despite these challenges, CSP is seen by many developers as the best RE source in the long term, including the massive scale multi-national Desertec Industrial Initiative (Dii) and the Mediterranean Solar Plan (MSP). The first Dii project is planned for Morocco. However, currently PV is experiencing a faster rate of innovation and driving manufacturing costs lower, which is widening the price per kWh gap between PV and solar CSP.

Geothermal

Geothermal energy is available in large quantities from the earth's outer layer. The most accessible energy can be found at shallow depths but is of low quality, best suited for thermal applications. Because heating is not a major concern for Arab countries aside from water heating, this resource has not generally been exploited. Deeper geothermal resources could provide temperatures of at least 150 degrees Celsius, suitable for generating steam for electricity in turbines. Geothermal energy can supply continuous electricity, which makes it appealing as a base load source. The greatest potential at shallow depths has been identified along the East African Rift System, a 60 km wide crack in the continental crust (IRENA, 2012a), with Yemen being the only Arab country situated to take advantage.

Hydro and wave and tidal

A debatable question is whether hydro power should be included within the RE group, due to potential negative environmental impacts of reservoirs and emissions resulting from dams, also known as large or stored water hydro. Accounting for externalities such as the net impact on emissions is a valid consideration for all renewables (Chomitz et al., 2009), but large hydro has been one of the most scrutinized. The World Commission on Dams is the governing authority for hydro power, and projects larger than 20 MW must follow the dam guidelines to qualify for emission credits on the European Union Emission Trading Scheme (European Parliament, 2004; World Commission on Dams, 2000).

Further highlighting the special status of hydro, when countries discuss plans for RE targets and development, hydro is generally excluded from their lists. Part of the reason is that large-scale hydro may be nearly fully exploited and not seen as a viable source for new energy, but these countries might also be implicitly acknowledging that it comes with unique potential drawbacks.

Where stored water hydro generation exists near other renewable sources, it could potentially be used in conjunction with those as a method of storage to smooth out generation peaks and valleys. This has been a successful strategy in other markets such as Denmark and Norway, where wind and hydro in combination have been used to those ends.

Run of river hydro is a different type, where water is not stored but flows through turbines continuously. Each location offers a smaller capacity but can be implemented without some of the drawbacks of large hydro, such as upstream flooding, complete disturbance of river life, and very large financing costs.

Wave and tidal power are best situated in areas where strong ocean currents exist. The best resources have been identified in the world's larger oceans and technology is only just being scaled up to commercial levels. It has not had an impact in Arab markets.

Biomass

In terms of electricity generation, biomass can utilize biological material that is used directly to produce electricity through combustion, or it can be converted into biofuel. This can include wood, agricultural waste, specialty crops, food waste, or human waste products.

A distinction is usually drawn between waste biomass and non-waste biomass. The trend is toward using waste biomass so food crops are not redirected for energy production. The debate is somewhat similar to hydro, where some forms of biomass may be considered less renewable than others. Biomass fuels are not currently widely utilized in the Arab region for electricity generation, but it is used as a heating source to varying degrees and mostly in wood form.

2.4 Essential Arab energy statistics

Turning to the Arab region, a brief presentation of relevant statistics for the electricity sector in general helps frame the conversation relating to RE.

Among the RCREEE member countries, Egypt is the largest with one-third of the Arab population with electricity consumption to match. The difference is sizable, as can be seen in Figure 2-3. The next three largest consumers are about equivalent to Egypt's electricity demand, and the remaining countries again nearly equal to Egypt. On a per capita basis, however, Bahrain clearly stands out with highest electricity use, and Yemen and Sudan occupying the low end.

Putting the electricity demands of the region into context, the 13 RCREEE countries currently have 97 GW of total installed capacity, which is comparable to the new capacity China is adding each year. Growth in per capita consumption for the Arab region has been 3.8 per cent in the Middle Eastern countries and 4.8 per cent in North African countries during the period between 2000 and 2010 (Observ'ER & EDF, 2011). One forecast of investment required to meet continuing demand predicts capital spending of US$250 billion for new generation capacity and transmission and distribution in the next five years (Aissaoui, 2012).

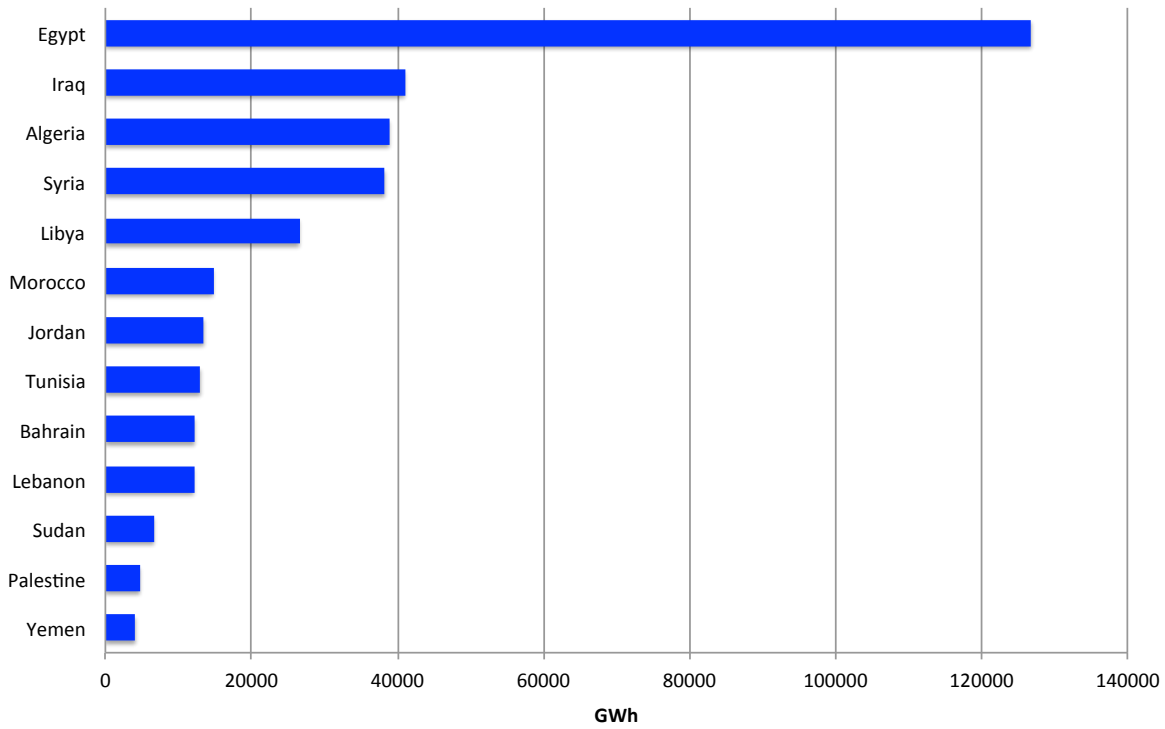

Figure 2-3. RCREEE members electricity consumption, 2011

Source: AUE, 2012a

The RCREEE countries, in aggregate, generate about 8 per cent of their electricity from renewable sources. Figure 2-4 breaks down the generation sources: hydro dominates with 7.1 per cent, followed by wind at 0.5 per cent, solar at 0.1 per cent, and all others at 0.2 per cent. Hydro is a mature industry, with most generation having been built several decades ago. It is not generally being looked to for appreciable amounts of new generation, while the others have significant growth targets attached.

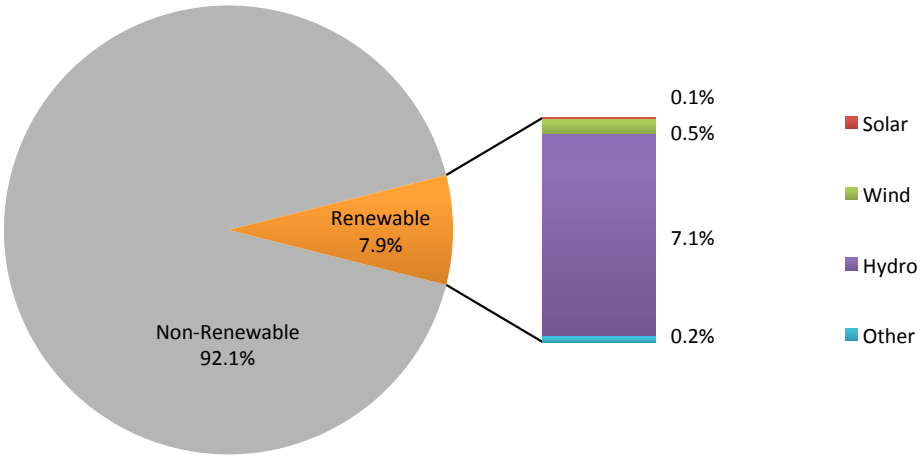

Figure 2-4. Renewable energy sources as share of all electricity generation for RCREEE members, 2011

Source: AUE, 2012a

Looking at the same data by country highlights the generation types currently in use. Referring to Figure 2-5, it is evident that some countries have little installed RE capacity, and that hydro power leads all sources. Sudan is clearly ahead when including hydro with 76 per cent of all generation, primarily due to its access to the Nile River. No other types of renewables currently exist in Sudan. For non-hydro renewables, the leader is Morocco, where wind contributes about 3 per cent to total generation. Notably, Egypt is the only country where solar represents any fraction, amounting to 0.15 per cent of the country's total electricity.

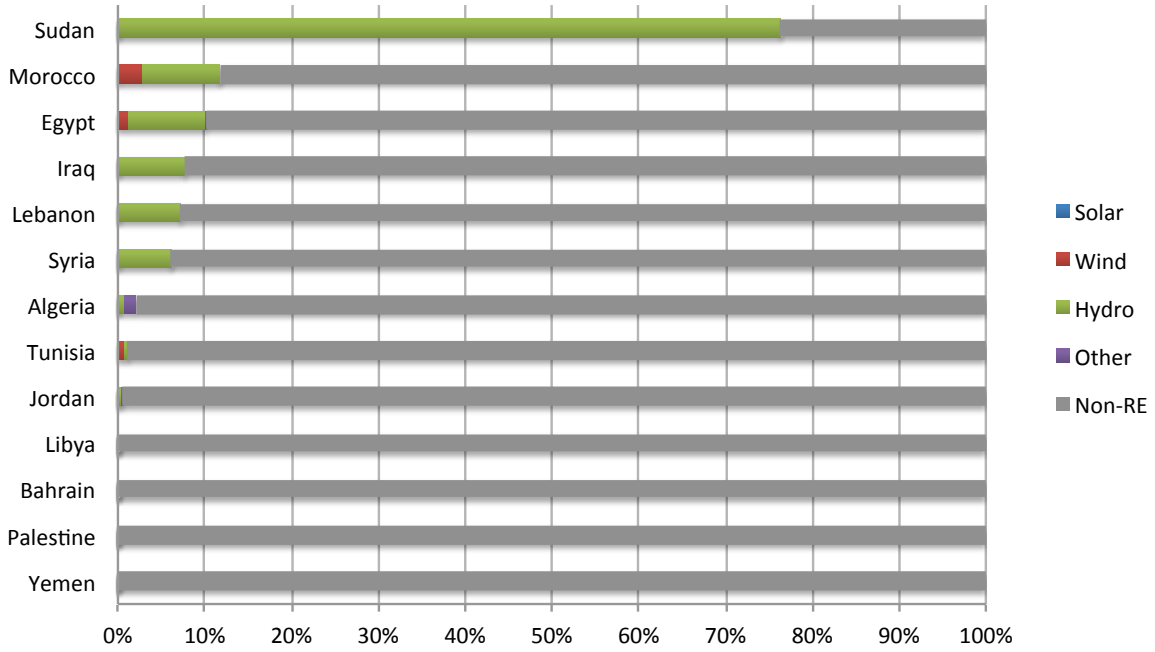

Figure 2-5. Renewable energy sources as share of electricity generation for RCREEE countries, 2011

Source: AUE, 2012a

Percentage comparisons alone can lead to inaccurate impressions. Table 2-1 provides an overview of each country's renewable mix in terms of both percentage contribution and volume of generation. The leader in each area is highlighted. This makes clear the dominant generation position of Egypt in all areas, with the exception of biomass where Algeria leads. In percentage terms, however, the leaders are spread across four different countries.

Table 2-1. Renewable energy stated in GWh and in percentage terms for RCREEE countries, 2011

	Renewable Energy as GWh of generation, 2011					
Country	*Solar*	*Wind*	*Hydro*	*Other*	*Fossil*	***Total RE***
Sudan	-	-	6452	-	2003	6452
Morocco	-	692	2139	-	21316	2831
Egypt	**219**	**1485**	**13046**	185	**132018**	**14935**
Iraq	-	-	4140	-	49728	4140
Lebanon	-	-	807	-	10469	807
Syria	-	-	2998	-	46039	2998
Algeria	-	-	378	**619**	47875	997
Tunisia	-	110	54	-	15057	164
Jordan	-	3	55	8	14581	66
Yemen	-	-	-	-	5156	0
Palestine	-	-	-	-	630	0
Libya	-	-	-	-	32559	0
Bahrain	-	-	-	-	13826	0

	Renewable Energy as % of generation, 2011					
Country	*Solar*	*Wind*	*Hydro*	*Other*	*Fossil*	***Total RE %***
Sudan	-	-	**76.3%**	-	23.7%	**76.3%**
Morocco	-	**2.9%**	8.9%	-	88.3%	11.7%
Egypt	**0.1%**	1.0%	8.9%	0.1%	89.8%	10.2%
Iraq	-	-	7.7%	-	92.3%	7.7%
Lebanon	-	-	7.2%	-	92.8%	7.2%
Syria	-	-	6.1%	-	93.9%	6.1%
Algeria	-	-	0.8%	**1.3%**	98.0%	2.0%
Tunisia	-	0.7%	0.4%	-	98.9%	1.1%
Jordan	-	-	0.4%	0.1%	99.5%	0.5%
Bahrain	-	-	-	-	**100%**	0%
Libya	-	-	-	-	**100%**	0%
Palestine	-	-	-	-	**100%**	0%
Yemen	-	-	-	-	**100%**	0%

Source: AUE, 2012a

A useful distinction can be made by grouping countries according to their availability of natural resources. Of particular interest is their petroleum status: net importers and net exporters. This provides insight into many areas, notably economy, energy, and environment. The current oil import or export status of RCREEE member states (BP, 2012; EIA, 2012) is shown in Table 2-2 by the net oil balance, which is calculated by subtracting domestic oil consumption from total exports. In cases where the result is positive, the country is considered a net exporter, and where negative they are a net importer. The 10-year trend provides a directional cue about which way countries are moving in the longer term.

The designation of countries being oil and energy importers or exporters will be a useful distinction in the analysis that follows in chapter three, where the same data will be used to highlight energy security issues faced by these countries. In a broad sense, the trend over the past ten years provides a directional view of the rise or decline of net oil exports. Of the member countries, only Iraq and Sudan are experiencing export growth, with most others declining, and three maintaining a flat trend.

Table 2-2. RCREEE member countries net oil balances, 2011

Country	Net oil balance, 2011 (000 barrels per day)	Status	10-year trend
Iraq	2078		↑
Algeria	1384		↓
Sudan*	358		↑
Libya	165	Net Exporters	↓
Syria	73		↓
Yemen	51		↓
Egypt	26		↓
Bahrain	-3.6		↓
Tunisia	-11		→
Palestine**	-29	Net Importers	↓
Jordan	-107		→
Lebanon	-107		→
Morocco	-198		↓

** data includes Sudan and South Sudan*

*** data includes West Bank only*

Source: BP, 2012; EIA, 2012

2.5 Existing sources for renewable energy performance data

REN21: Renewables global status report

The Renewable Energy Policy Network for the 21st Century, also known as REN21, publishes an annual renewables global status report. The annual document contains a significant amount of relevant information, with a list of RE support policies for many countries of the world including eight of 13 RCREEE members (REN21, 2012). This list tracks 12 policies within

three general groups: regulatory policies, fiscal incentives, and public financing. REN21 does not attempt to rank or quantify the results for each country, but simply reports whether some national-level policy exists in each case.

IRENA: Renewable energy country profiles

IRENA has recently begun to publish renewable energy country profiles for countries in several regions of the world: Africa, Pacific, Latin America, and Caribbean. The Africa profiles include six of the RCREEE member countries. These profiles provide up-to-date information from an array of sources to give a picture of the RE situation including energy supply, capacity, access to energy, targets, policies, projects, and endowment of RE resources available (IRENA, 2012b). Data varies from one country to another, is based on a combination of years, and is not organized with the ranking of countries in mind. The product is planned to be expanded and improved in the future. IRENA has recently announced an upcoming product in collaboration with the IEA that will act as a database for renewable energy policies and measures. While the data are of high quality and trustworthy, the consistency and completeness are lacking for the purpose of comparing RCREEE countries.

Ernst & Young: Renewable energy country attractiveness indices

Ernst & Young (E&Y) publishes RE country attractiveness indices quarterly. Their headline product is the all renewables index, which ranks and scores countries in terms of their attractiveness for investors. It uses data relating to nine RE areas. These indices are forward-looking with a view of up to five years into the future.

Although the E&Y index is a valuable resource, it does not serve all interests equally. It currently covers 40 countries, including three RCREEE members. The May 2012 index ranks Morocco at 25th, Egypt 31st, and Tunisia 34th on their scale (Ernst & Young, 2012). This leaves a gap when trying to track performance or potential of the remaining ten RCREEE members. The team that produces the index assigns a staff member to assess each country, and some of the results are based on that person's own experience and interpretation, comparisons with other countries, and survey results completed by different respondents at different times. The process of rating each country requires a considerable amount of effort and time from the evaluators.

Market competence index framework

A recent master's thesis research analyzed the E&Y index's construction and was deeply critical of its partially subjective approach (Elrefaei, 2012). The researcher attempted to construct an alternative index that removed subjectivity entirely from the scoring. It used data that were quantitative, verifiable, and publicly available, and proposed an index framework that reflects countries' RE market competence, then applied it to CSP as a test case. Eight of the RCREEE countries were considered in this study. Several of the index criteria were chosen to provide specific insight into the Arab region. This method misses reporting on some context-rich intangibles such as potential risks for participants in the RE market, but it gains from a simpler data collection approach and a quantitative assessment method. The framework produces a mixed result, with some indicators reporting on past performance and some assessing future potential.

RCREEE: Policies for renewable energy

A one-time report commissioned for RCREEE in 2010 provides an overview of the situation at that time for ten of the current RCREEE members (MVV Decon & Wuppertal Institut, 2010). The report focuses on policy status in the countries. Nine specific areas are assessed: strategy and targets, legal reform, agencies, capital support, operating support, CDM finance, standards and labels, consumer and investor information, and industrial policy. The analysis provides an excellent starting point for development of a new index product, but the assessment itself is qualitative and not focused on answering the question of renewable energy progress. No actual performance data are analyzed, so the results do not assess development progress among the member countries.

3 Renewable energy influencing factors

The structure used by the RCREEE renewable energy progress index is described in this chapter, with a description of the categories and factors that are used in the index. The factors help to identify drivers and barriers to Arab RE development, with the primary ones being discussed in each of five areas: policy, institutional, market, investment, and technology-specific. A summary of all the drivers and barriers is provided to close the chapter.

Renewable energy progress index structure

The Arab region is different than other markets when discussing RE. Comparisons with the EU are difficult due to the fundamentally divergent economic, political, and regulatory conditions of the two regions. A separate set of factors is relevant to Arab countries, some of which are inconsequential to EU markets. Examples include issues such as target-setting, access to financing, and political stability. The lack of an Arab-specific comparison and analysis tool led to the investigation that now attempts to meet this need.

The *renewable energy progress index* currently under development in collaboration with RCREEE builds on the work of other indices and reporting projects, with the goal of providing a high level regional view on RE development in the Arab states. It uses a structure to organize general categories that contain a group of relevant factors, and within the factors are found a more detailed group of indicators, or questions, that focus on very specific aspects. The structure is represented in Figure 3-1.

Figure 3-1. Structure for RCREEE renewable energy progress index

Source: B Samborsky / RCREEE

Indicators are important for providing quantitative feedback in this model, and they answer questions such as who, when, how much, or how many. Several indicators typically provide insight into a single factor. Due to the large number of indicators and specific technical questions that they are designed to answer, they will not be the subject of discussion. Instead the focus will be on the *factors* identified as being of interest to the RE discussion, which are more general than the indicator level. These factors represent drivers and barriers to RE. At the highest level are *categories*, best understood as broad themes relating to the RE topic.

The RCREEE index's category themes have been selected based on literature (Fritzsche, Zejli, & Tänzler, 2011; PwC, PIK, IIASA, & ECF, 2010; REN21, 2004; Werenfels & Westphal, 2010), interviews, and discussions with RE market participants. Each category has been flagged as being influential and relevant to the success of countries' efforts to develop RE. These five major categories are shown in Table 3-1, along with the factors that most influence

them. All of the drivers and barriers in the sections to follow are in some way represented within these five categories.

Table 3-1. Categories and factors for RCREEE renewable energy progress index

Category	#	Factor
Policy	1	Strategy
	2	Membership
	3	Energy subsidies
Institutional / Planning	4	Ease of doing business
	5	Political and economic transformation
Market	6	Market structure
Investment / Finance	7	Credit access
	8	Foreign direct investment
	9	Private investment, green sukuk, SRI
	10	Environmental credit
Technology-specific*	11	Installed base
	12	Resource quality
	13	RE Target
	14	Power offtake
	15	Taxation
	16	Grants or soft loans

** same factors apply for all 7 renewable energy types*

Source: Samborsky / RCREEE

Mapping the drivers and barriers

The RE market is attracting significant attention from governments, private developers, and foreign partner organizations. The complex regulatory landscape, changing technologies, and shifting governance structures make it challenging for these actors to know how to best proceed. The research and interviews have led to identification of the driving and opposing factors for Arab RE development, and Figure 3-2 is offered as a reading map for the following chapter as a brief outline of those factors. The conclusion of chapter three will re-state this map with greater detail to fill out each of the drivers and barriers.

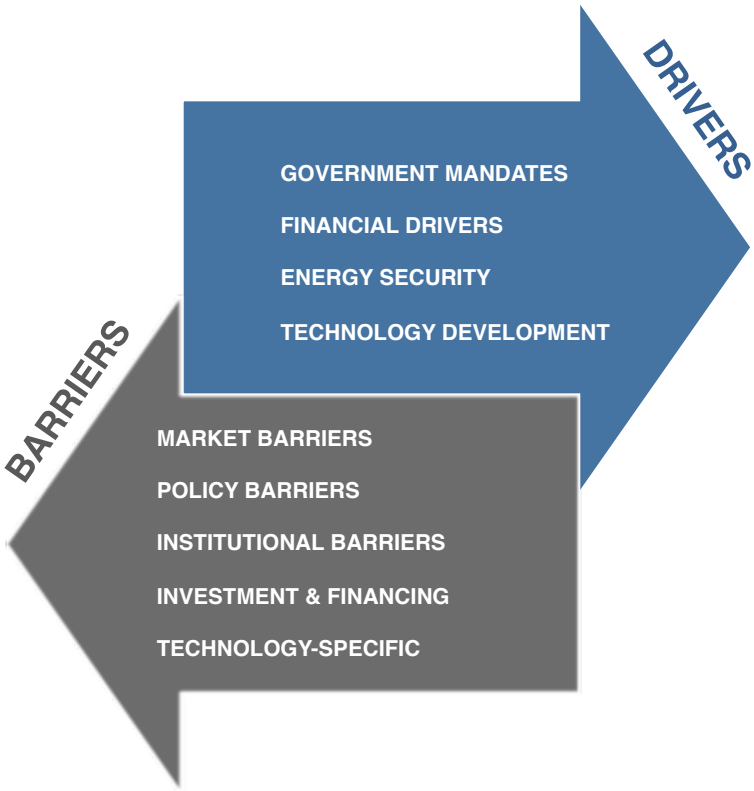

Figure 3-2. Simplified view of drivers and barriers to renewable energy development in the Arab region

3.1 Drivers for renewable energy

The development of RE in Arab countries is positively influenced by several drivers, including government mandates and environmental targets, financial mechanisms that support new projects, desire for energy security among countries in energy-deficit situations, and the evolving technologies that are closing the price gap with conventional sources.

3.1.1 Government mandates and environmental motivation

The drive to reduce environmental impact by shifting to RE sources is a peculiar scenario in the Arab region. It is true that an environmental motivation exists at national and international levels, but the countries of the Arab region are generally not preoccupied with achieving any environmental targets. As non-Annex I countries to the United Nations Framework Convention on Climate Change, it is understandable that they do not publicly offer ambitious goals. Those that derive a substantial portion of their income from oil exports are especially affected by the prospect of engaging in climate change response measures as set out in international agreements (UNFCCC, 2012a). But some of the Arab countries are also recognized as being especially susceptible to climate change due to vulnerability of agriculture, desertification, or rising sea levels.

Interview data collected during this research project showed that environmental motivation is lacking. For example, one interviewee suggested that the Arab region's contribution to world emissions is so small as to be inconsequential to the outcome of climate change. The dominant impression throughout interviews is that environment is thought of as a developed

nation issue, and that environmental regulation is seen as a barrier to regional development. This is in distinct contrast to the European or North American context where projects are often promoted on the basis of environmental benefit. Rather, the partners providing funding are those expressing an interest in GHG reduction targets, with environmental results either attached to their funding or as an implied outcome of the process. Typical examples are seen in the mandates of organizations like the European Bank for Reconstruction and Development or World Bank, where reductions in CO_2 emissions are key performance indicators for their loans.

The connection between these two – environment and development – comes with the business of environmental action. Arab governments recognize the foreign interest in solving global environmental challenges, and are willing to participate. The enabling factor is funding from those foreign partners. An interview with government representative highlighted this, when he confirmed that every RE project undertaken so far has had funding from a foreign government or agency. This total reliance is understandable for a developing sector, but will not lead to a sustaining model for the future.

The EU adopted Directive 2009/28/EC, better known as the Renewables Directive, in April 2009. It established a framework for generation of RE to meet each country's 20-20-20 goals. The directive includes a provision for European countries to build renewable generation sources in a third country, so long as the electricity is consumed within the EU (Europa, 2010). This set a new wave of planning into motion, with the MENA region being an attractive location for European electricity supply. The Mediterranean Solar Plan and DESERTEC are the two largest initiatives responding to the EU legislation.

The EU developments may explain how RE goals in Arab countries have developed without accompanying environmental goals, many of them also choosing the year 2020 as a major milestone. Table 3-2 outlines the current shares of electricity from renewable sources for RCREEE member countries, and electricity targets for those that have made commitments (OECD/IEA, 2011; REN21, 2012). Where multiple targets have been set, only the nearest date is shown.

Table 3-2. RCREEE member countries' share of renewables and electricity targets

Country	*Share (2010)*	*Targets*
Algeria	0.4%	Wind: 50 MW by 2015, solar PV: 800 MW by 2015, solar CSP: 300 MW by 2013
Bahrain	0%	-
Egypt	10%	Renewable generation: 20% by 2020, including 12% from wind (7200 MW), and 8% from hydro, solar, and other
Iraq	1.1%	-
Jordan	0.2%	Wind: 1000 MW by 2020, solar thermal 300-600 MW by 2020
Lebanon	12%	-
Libya	0%	Wind: 500 MW by 2015, solar PV: 100 MW by 2015, solar CSP: 200 MW by 2015
Morocco	18.3%	Wind: 1440 MW by 2015, solar: 2000 MW by 2020, small hydro: 400 MW by 2015
Palestine	-	Wind: 44 MW by 2020, solar PV: 45 MW by 2020, solar CSP: 20 MW by 2020, biomass: 21 MW by 2020
Sudan	81%	-
Syria	6%	Wind: 150 MW by 2015, solar PV: 45 MW by 2015, solar CSP: 50 MW by 2025, biomass: 140 MW by 2020
Tunisia	1.3%	Generation capacity: 16% by 2016, including 330 MW wind and 15 MW solar PV

		by 2011
Yemen	0%	Wind: 400 MW by 2025, solar PV: 8.25 MW by 2025, solar CSP: 100 MW by 2025, geothermal: 160 MW by 2025, biomass: 6 MW by 2025

Source: REN21 Global Status Report, 2012, OECD/IEA, 2011

For Arab countries, the benefits of RE development are symbiotic with those of the EU. Benefits to the Arab hosts could include easier access to international finance, collaboration with experienced partners, and potentially delivering solutions for their supply-side constraints. With no binding environmental demands, Arab states can be selective in their development plans; the EU partners have more pressing demands and are investing funds and efforts into the region with the hope of delivering environmental results. European development organizations are now particularly active in the Arab region, with a strong ongoing commitment from DANIDA, GIZ, and Adetef.

3.1.2 Financial drivers

CDM and other mechanisms

Developers of RE projects have the opportunity to participate in programs that offer compensation for generating electricity from lower emission sources than would otherwise be used. Under the Kyoto Protocol, the clean development mechanism (CDM) has allowed industrialized (Annex I) and developing (non-Annex I) countries to work together on such projects (World Bank, 2010). Since 2005, unilateral projects have been recognized, meaning developers could generate certified emission reduction credits and sell them on the free market ("CDM Projects," 2008) such as with the EU Emission Trading Scheme. Two major issues for Arab projects are the low baseline emission calculations that factor in current levels of supply and service rather than aligning with their growth expectations, and transaction costs that are high due to the demands of the registration process. Proof of additionality is an ongoing aspect of contention, precisely because it is never entirely possible to prove what course of action would have been taken if a project had not occurred, but the burden falls upon the applicant to make a compelling case.

The registration period for new projects was set to close at the end of 2012, which has increasingly limited the interest in recent years. However, at the 17th UN Climate Conference in 2012, parties decided to create a second eligibility period until the end of 2020 (UNFCCC, 2012b).

Lack of clarity still exists about the future of CDM, which is likely to receive some updates and modifications to counter the criticisms. Other mechanisms such as regional trading schemes may shift projects away from CDM in the future.[1] Participation in CDM among RCREEE member countries has been small so far, with registration occurring only in the past several years and 26 projects of all types registered to date by all countries combined

[1] A new type of market instrument called Nationally Appropriate Mitigation Actions (NAMAs) is a recent construct of the UNFCCC since 2007. Although no official definition exists yet, these voluntary policies, programmes, and projects for GHG reductions submitted by developing countries could potentially be financed by selling carbon credits – an alternative to CDM (Kossoy & Guigon, 2012; "NAMAs," 2012). The Green Climate Fund was also set up to offer funding support for eventual NAMA implementation.

(RCREEE, 2012). RE-related projects with the potential to be registered by end of 2012 (Perspectives GmbH, 2011) are listed in Table 3-3.

Table 3-3. CDM-eligible projects in RCREEE member countries

Country	Projects that could be registered before 2013
Jordan	Wind farm of Fujeij and Wadi Araba (60 MW)
Lebanon	60 MW wind power park in Hermel region Rehabilitation of hydropower facilities of Qadicha, Safa, and other hydro sites
Libya	Considering the current political situation in Libya, the prospects for project registration before end of 2012 are very low
Morocco	Jbel Haouch Ben Kreaa wind park (135 MW) Tanger-Tetouan wind park (200 MW) Wind PoA (550 MW)
Syria	Qatineh 50 MW wind energy project
Tunisia	Partial substitution of fossil fuels with biomass at "Les Ciments Artificiels Tunisiens" cement plant Biomass power generation project 190 MW wind farm project in Bizerte
Yemen	Mocha 60 MW wind park project

Source: Perspectives GmbH, 2011

The World Bank points to the results of their CDM projects (World Bank, n.d.), where nearly half the funding comes from private sources, as evidence that the program is attracting investment in developing countries. The financing sources are shown in Figure 3-3. These data also show the relatively small commitment from host countries in the projects, at 13 per cent, and that of foreign governments at 17 per cent.

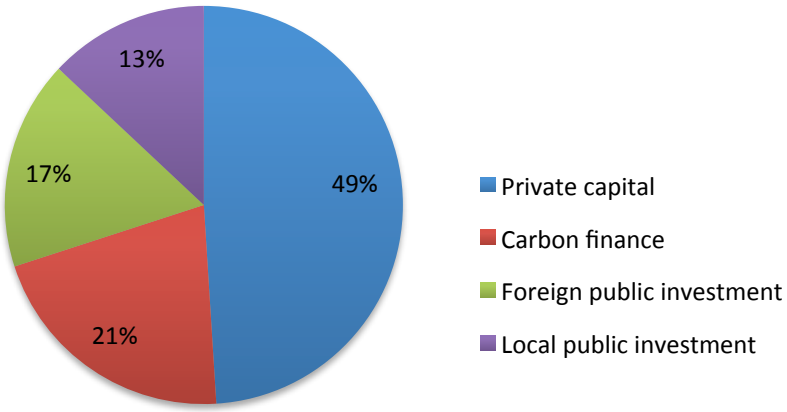

Figure 3-3. Origin of capital financing in World Bank CDM projects

Source: World Bank

Carbon finance investment in Arab countries, as the second largest source of capital for World Bank CDM projects, includes sovereign carbon funds such as the Danish and Spanish Carbon Funds, which are members of the Carbon Finance Unit of the World Bank.

Subsidies

Subsidies can be viewed as a driver for individual developers by offering incentives to build RE projects where the market price is unattractive. These might be offered in the form of a special tariff paid for each kWh generated, a grant or soft loan during construction phase, or a tax benefit. Many approaches exist to create incentives for RE developers. At the right price, private actors will participate.

But stepping back to the national level, subsidies are not a motivator. For the state, which is the provider of subsidies, they represent a financial burden. In the Arab region, the main (and sometimes sole) actor in RE development projects has thus far been government, which makes the payment of subsidies a non-issue. For this reason subsidies do not represent a significant driver to Arab RE at the moment. They will, however, play a larger role as plans for new installed capacity get seriously underway. The challenge for governments will be in finding the appropriate subsidies to offer to attract activity, but not to overpay for the results. The subsidy discussion is continued in greater detail in the barriers section to follow.

3.1.3 Energy security

Energy security plays out differently when making academic recommendations than in actual policy implementation. This gap brings up an important conflict in implementation, where actors must make a case for switching fuels where unknown risks replace known risks. The question arises whether this is a politically feasible argument. Cherp (2012) puts forward an argument that energy diversity does not equate to energy security, and the two must be understood separately. In the case of Arab states, some have an indigenous energy supply that is viewed as secure, while others are importers with a high level of dependence upon foreign suppliers. And so to the question of whether RE represents enhanced energy security, the answers will vary.

Arab countries would benefit from a re-examination of their energy models, especially those reliant upon oil for a large portion of their revenues. As an example Bahrain, with the highest per capita electricity consumption among RCREEE members, is experiencing several powerful trends that affect its future prospects. Figure 3-4 illustrates those long-term trends relating to its oil supply and consumption status. In 2010 Bahrain became a net importer of oil by a very slight margin for the first time. Its production levels are essentially flat, but the effects of increasing population and increasing consumption on an absolute and per capita basis are combining to drive net exports rapidly downward. Several mitigation measures are available to Bahrain, including conservation among users, increased energy efficiency efforts, and substituting RE sources for the conventional fuels used in their electricity generation. Currently, though, Bahrain derives none of its electricity from renewable sources.

A challenge facing Bahrain, if it chooses to pursue electricity from RE sources, is its geography. As a small country made up of 33 islands, with the largest island being just 55 km long and 18 km wide, the land area available to develop renewable projects is very limited. Any large-scale plans might need to be developed in collaboration with its nearest neighbour, Saudi Arabia, which could host projects and transmit electricity to Bahrain. With the highest per capita electricity consumption among RCREEE members, but a population of just over 1 million, Bahrain has an opportunity to make a big impact on its energy security situation if its government were to make RE a priority.

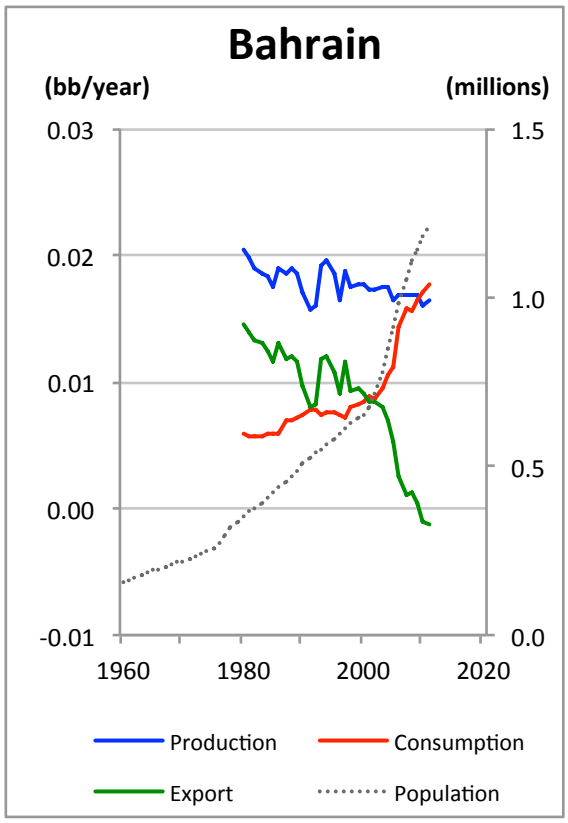

Figure 3-4. Bahrain trends for oil production, consumption, export, and population

Sources: BP, 2012; EIA, 2012; U.S. Census Bureau, 2012

The trends evident in Bahrain are not exclusive to that country. Throughout most Arab countries, net oil exports are near or below zero due to the same confluence of demographic, supply, and demand forces. The only countries with rising production are Iraq and Sudan; in the case of Iraq it is due to the long process of recovery from previous disruptions, and Sudan began commercially producing oil only in 1993.

Figures showing the oil and population trends for all 13 RCREEE members are included as *Appendix B*. Three general trends can be observed among the countries: those that have experienced peak oil production and are now on the back side of the curve (Algeria, Bahrain, Egypt, Sudan, Syria, Tunisia, Yemen), others that have experienced disruptions in their production, requiring significant time to recover (Iraq, Libya), and the rest that are non-producing or in insignificant volumes (Jordan, Lebanon, Morocco, Palestine). These data invite a sober discussion in Arab countries of the required shift for their economies, and the role that RE might play in replacing their depleting oil resources.

The measure of oil self-sufficiency of a country can be expressed by the ratio of net oil exports to domestic oil consumption. This data is shown in Table 3-4 and points to three general categories these countries fit into: oil-independent, balanced, or oil-dependent. On an annual net basis in 2011, the countries at the bottom of the table are 100 per cent reliant upon imports, while those near 0 per cent produce just enough to meet consumption, and the countries showing positive values export oil in excess of domestic consumption.

The countries with a high degree of oil-independence have low motivation to conserve their oil or to switch to another energy source for electricity generation. The appeal of RE might be

to reduce the lost sales revenue that their domestic consumption causes. For those countries in a balanced position, the maintenance of current production levels will allow the national energy bill to be covered. But most of those countries are experiencing declining oil output along with consumption growth, so the trend is downward for sufficiency. The third group is almost totally reliant on imports to meet their oil demand, which creates strain on government finances and leads to uncertainty regarding future pricing and availability. Motivation should be high to substitute oil with energy from local renewable sources, if the price to generate is reasonable. When supply channels are insecure or markets are volatile, countries are often willing to pay a premium for local energy. So the motivations can be different between the various member countries, but some type of RE development driving force can exist for each.

Table 3-4. RCREEE member countries oil self-sufficiency, 2011

Country	Oil self-sufficiency (%)	Status	10-year trend
Algeria	402%	Oil-independent	↓
Sudan*	375%		↑
Iraq	289%		↑
Libya	53%	Balanced	↓
Yemen	29%		↓
Syria	28%		↓
Egypt	4%		↓
Bahrain	-7%		↓
Tunisia	-12%		→
Morocco	-97%	Oil-dependent	↓
Jordan	-100%		→
Lebanon	-100%		→
Palestine**	-100%		↓

** data includes Sudan and South Sudan*

*** data includes West Bank only*

Sources: BP, 2012; EIA, 2012

3.1.4 Technology development

Arab countries can become beneficiaries of first movers in RE technology adoption. Significant amounts of money and research have gone into development to improve efficiencies, decrease manufacturing costs, and improve the durability of various products. The most dramatic technology developments are currently happening in the field of solar energy.

PV worldwide installed capacity increased dramatically between 2000 and 2011, from 1.5 GW to 67 GW. The past five years have seen an average growth rate of over 50 per cent (IEA, 2012a). The increase in PV has been driven by large-scale programs in several countries. Currently Germany has the largest installed base with 36 per cent of the world's PV, followed by Italy, Japan, United States, and Spain (BP, 2012). The advances made by serving these markets have been financed by the early adopters, and Arab countries are in a position to benefit from this progress. The innovation curve is working in the favour of upcoming

projects, with steady price declines for PV making the investment more attractive each year. A wait-and-see approach might work if the opportunity can be acted upon when prices reach grid parity in various markets.

CSP is currently lagging the advances of PV, but the Dii and MSP projects are making ambitious plans for large-scale concentrated solar in the longer term, and the technology development now underway should benefit the MENA region more than any other. EU countries and organizations are sponsoring these projects due to an interest in electricity exports. Arab governments can take advantage of the ongoing progress in RE technologies by preparing their markets to host these new energy projects.

3.2 Barriers to market development

Although compelling drivers exist, progress for RE is not a straightforward case. Factors that constrain development include affordability for developers and consumers, unsupportive policies throughout most of the region, institutional barriers to doing business, securing investment and high upfront costs, and challenges related to RE technologies and utility infrastructure.

3.2.1 Market barriers

Market structure

RE development could benefit from reformed electricity markets in the Arab states. Reform in this context is often seen as synonymous with unbundled electricity markets, but this is only one aspect of true market reform. Policy and pricing mechanisms can also play an influential role independently of market structure.

The electricity markets of the Arab region are generally state operated, closed to outside participants, and highly regulated. This is a reflection of the predominant organizational and governance structures in these countries. The trend of unbundling the three related sub-markets – generation, transmission, distribution – that has become commonplace in many other regions has not been attempted in the Arab market. The rationale for separating these segments is that efficiencies can be gained when each service operates independently from the others, and ideally with a healthy competitive market to drive the desired gains. This should also allow end users some degree of choice in how, and from whom, they purchase electricity. As for whether this will result in a better system, it depends on whose interests are being considered.

Three very different business models need to be applied for these markets. Generation requires a large upfront investment in fixed assets with known initial cost and operating life but largely unknown operating costs. The main variable is the cost of fuel for conventional plants using coal, oil, or natural gas. Transmission also requires a large investment commitment, but has a more predictable operating cost pattern and revenue stream. This type of utility is often attractive for investors seeking regular dividend payments, which is possible when rates are regulated for the services of transmission companies. Distribution companies, on the other hand, are motivated by the opportunity to build market share through increased usage and attracting new customers in a competitive deregulated environment. Many

permutations exist where some or all of these areas are publicly or privately operated. Regardless of the national views on which model is more effective, the current structure of the electricity industry in the Arab region represents a barrier to introduction of RE.

Grid parity

Grid parity is, in simple terms, a break-even point. It occurs when the cost for alternative electricity generation is competitive with supply from the electrical grid. As much as the term 'grid parity' is used to describe a significant milestone, it is really an ever-changing point that is difficult to calculate and even more difficult to recognise once it has arrived. Each different mode of energy conversion will have its own grid parity point; with respect to renewables, the debate centres around the questions of 'when?' and 'what happens next?'

The path to grid parity for each RE source in the Arab region is far from straightforward. There are three general ways in which parity can be reached: technology development, third party subsidy, or exogenous shock.

The trend toward lower prices due to advances in product design is clear, and grid parity through innovation seems an inevitable outcome. Indeed, the case of wind power in Morocco suggests that grid parity has arrived, due to the intersection of current electricity prices and cost to build new generation (Richards, 2011).

At the same time, efforts have been made by governments to stimulate demand with economic policy instruments such grants, rebates, tax credits, and likely in the future feed-in tariffs – achieving a subsidized grid parity (Claudy, Michelsen, & O'Driscoll, 2011; DECC, 2012; EC, 2007; OPA, 2010; Varma, Sanderson, & Walsh, 2011). The logic is that by getting more installed generation on the market, the industry can become cost competitive sooner, and some governments are willing to pay something to promote that outcome, with each country having its own reasons.

A third possibility exists that grid parity could be reached due to an exogenous shock – an event that drives the price of grid-supplied electricity up to a level that meets or exceeds renewable sources. This scenario highlights the risks associated with centralized generation and supply chains that are affected by events far removed from the point of electricity consumption for both nation states and households alike (Martenson, 2011; Pachauri & Cherp, 2011). Arab countries are not immune to world energy prices, and the trends displayed in the figures in *Appendix B* underscore the pressures faced by some countries as they transition from being net energy exporters to importers.

In reality, grid parity is being reached in different locations, at different points in time, and by a combination of these three modes.

System reliability

In the utility markets of Arab countries, the institutional setup has historically demanded that priority be placed on reliability. Other factors such as lowest cost of electricity generation, environmental performance, and efficiency have been secondary to the need for grid stability (personal communication with Khaled Fekry, 10 July 2012; personal communication with Yeh ia Shankir, 11 July 2012). This may be to avoid criticism from citizens about power outages, or to maintain services and productivity, or for other national policy goals. So the actions of planners, utility companies, and government agencies have been entirely acceptable when measured against that requirement, although the cascading effects of this are felt throughout

the economy. There is a close linkage between the policies that have been put in place and the institutional setup that supports the market.

Reliability should rightfully be strived towards, but the result for utility industries is that electricity planning is dominated by uptime statistics, with serious consternation over effects of any new (and especially unpredictable) load before allowing development. This reduces the pace of RE adoption significantly. Several strategies exist to balance the need for reliability and the introduction of new RE technologies; investment in improved infrastructure can provide better load management and reduce transmission losses, pricing policies can encourage customers to value electricity more realistically, and utilizing storage capacity or power trading agreements with neighbouring countries can help absorb RE generation into the electrical grid. The experience of countries that have achieved higher rates of renewable integration can be valuable in overcoming this barrier.

Pricing of electricity

Generally speaking, pricing problems cascade into the regional domain when actors naturally find and exploit arbitrage opportunities. An example from a related industry serves as an illustration. Heavily subsidized petroleum fuel in Egypt has reportedly been sold for profit over the border in neighbouring countries with higher prices. In 2012, media reported that Gazans had resorted to buying Egyptian black market diesel, which cut the price from US$1.85 to as little as $0.67 (Naylor, 2012). Although export controls exist, the opportunity is attractive enough to find means to circumvent those controls. This acts to further distort both markets' prices, and such disparities may even be defended by parties who have a profit motive. Similarly in the electricity sector, each country has pricing that is set independently and focused on their particular goals, with disparities between countries. Gasoline and diesel prices are highly visible in the marketplace and the fuel is a highly fungible product that can be transported over borders by individuals.

Electricity, on the other hand, is constrained by transmission infrastructure and a much less transparent pricing structure. Recognizing these differences helps explain why RE developers have been unable or unwilling to enter the Arab electricity markets in a meaningful way. The price arbitrage opportunity is much more difficult to take advantage of when it comes to electricity. Connected markets would allow for energy to be priced between countries and to find more efficient supply options than are currently available. Projects such as Medgrid have the objective of creating regional transmission networks to enable electricity trade across larger geographical areas. When governments set the prices at which electricity will be purchased from producers, there is a stability effect, but also a distortion of market pricing. Low prices tend to favour conventional power production at the moment, because initial costs are low with continuous fuel expenditures, which may subsidized by the state if it has the resources available. Comparively, RE requires high upfront investment with low expected operating expenditures. Private investment is thus only likely if grid parity makes today's prices competitive with existing sources, which is currently not the case throughout most of the Arab countries.

3.2.2 Policy barriers

Subsidies

Electricity price subsidies in Arab markets represent one of the major challenges to development of RE. In almost all segments some subsidy is evident, based on prices paid by end users. This has a detrimental effect due to the challenge it poses to investment in renewables.

Data on Arab residential and industrial electricity prices have been analyzed and are presented in Figures 3-5 and 3-6, respectively. These represent a typical customer, based on average monthly consumption from all 13 countries in the region. For residential customers the average is 483 kWh per month, and for industrial customers the average is 30579 kWh per month. Utility bills for these "average" customers have been calculated for all countries using their specific electricity pricing structures. In this way, the price per kWh has been identified for the same consumption level in all countries.

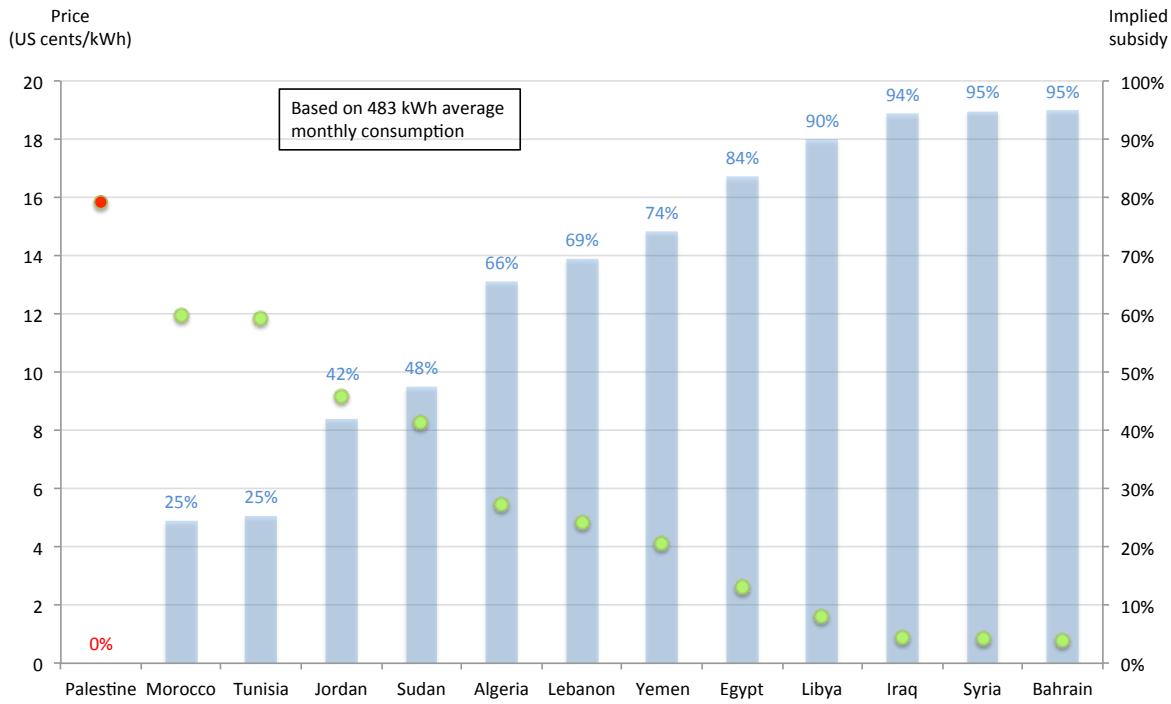

Figure 3-5. Arab residential electricity prices and implied subsidies benchmarked to Palestine, 2011

Source: Samborsky / RCREEE

One of the indicators for the RCREEE renewable energy progress index looks to compare the electricity subsidy levels of member states. Accurate values for the subsidy were not discovered in the current literature, since countries do not attempt to calculate and publish the amount of support provided in this area. It is a complex value and difficult for outside organizations to calculate. One existing method typically attempts to compare the national energy bill and the energy sales value in the local market, with the difference being the estimated subsidy. This method by necessity requires simplification in calculation of the national energy bill by using an average annual price from a database, which does not accurately reflect true fuel import prices paid by countries. Another method is the price-gap

approach used by the IEA, where average end-use prices paid by consumers are compared to reference prices that represent the full cost of the fuel (IEA, 2011). This method captures only subsides visible in end prices, but not through investment, research and development, and subsidies given to electricity producers.

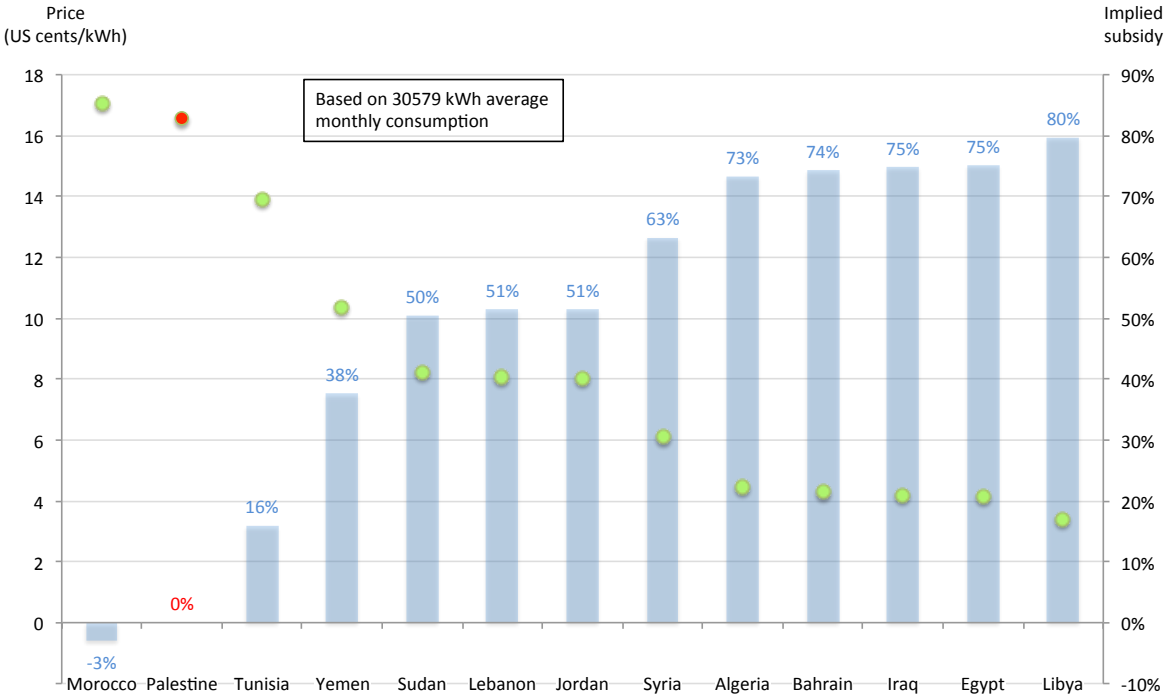

Figure 3-6. Arab industrial electricity prices and implied subsidies benchmarked to Palestine, 2011

Source: Samborsky / RCREEE

To provide a satisfactory measure of subsidy for RCREEE countries, I have developed a proxy indicator using Palestine's price as a benchmark. Palestine does not have generation capacity and receives its electricity from Israel.[2] Palestine's price reflects approximate actual electricity cost passed through by Israel, which can be compared to its neighbouring countries. The difference between Palestine's market price and prices paid in each country is referred to as the *implied subsidy*. The main variable with this method is the difference between countries' electricity fuel mix. Each country has a somewhat different mix. The implied subsidy can be considered as relevant even for a country with lower cost of generation because, in an ideal scenario, that country could sell electricity to a higher priced producer and profit by the amount represented by the subsidy.

The case of Morocco is noteworthy, specifically in its industrial pricing. Users there are actually paying a premium compared to the price in Palestine, with the highest prices of all RCREEE members. This policy decision in Morocco has several drivers, such as proximity and connection to the Spanish market, and legitimate attempts at market reform through progressive policies. The interesting effect is that RE development is being attracted to Morocco where the economics work without the need for government subsidies.

[2] Israel faces the same energy security issues as some Arab countries, being a net importer and relying on supply chains at risk of disruption (Trilnick, 2012). If Israel were to be included in the figures, it would have ranked second highest for residential price, at 14 US cents per kWh, and fifth highest for industrial price, 9 cents per kWh (IEA, 2012b).

The subsidies of today are the result of policy decisions in the past. It is an inherited problem that both dictates and limits future choices. Keeping electricity prices low is considered as a form of social assistance, allowing those who would otherwise not afford it to have access. Although subsidies have a financial cost to the government, they are argued as being a mechanism to improve outcomes for mobility, education, health, small business and industry, and export competitiveness.

Subsidies can be directed to different segments in the energy market, either upstream at the generator level, or downstream at the consumer level. Upstream, generators can be provided with fuel at below-market price, where the cost difference might be covered by government or by state-controlled petroleum companies. Another method, where generation is publicly owned, is for the government to direct the generator to operate at a loss by selling electricity at some price below the cost of generation. These approaches spread the cost of subsidization to all tax payers and, by implication, also to foreign agencies providing any type of assistance to the country. Without a profit motive, or at minimum some form of public accountability, the drive for efficient operations among utilities is likely to be low.

Downstream subsidies are a second approach. Since the natural public reaction to rising energy prices is disapproval, one option is to insulate the populace from higher tariffs through rebates or price caps. This puts an onus upon the state to provide the funds to consumers, directly or indirectly. A common criticism with this approach is that users place a lower value on energy and consume more than they would under a full price scenario, resulting in sub-optimal resource efficiency. This is anecdotally supported by observations of users' attitudes toward electricity consumption in various settings during a recent trip to Cairo.

Feed-in tariffs

The absence of feed-in tariffs (FIT) in Arab countries was commonly regarded as a significant barrier to RE gaining market share among interview subjects and in a large portion of the literature. A FIT is one type of subsidy aimed at generators, when producing electricity that has a higher levelized cost of energy than the default market option, usually from a RE source. This can motivate investment in new capacity if the FIT is priced high enough to compensate for the difference between production cost and retail sale price. Secondary objectives may relate to energy security, job creation, and environmental impact and can also affect the design of a policy (Couture et al., 2010).

Designing a FIT requires policymakers to define three important attributes (Lesser & Su, 2008):

- payment amounts specified for each technology,
- payment structure whether fixed or decreasing, and
- payment duration for a guaranteed period

The process of assigning these values requires policymakers to make some long-term predictions and interventions into markets, which has potential to result in picking winners and losers with respect to renewable technologies. The difficulty for policymakers lays in assigning a reasonable value for the FIT over its lifetime, which is typically tied to prices of fossil fuels to a large extent. These choices also commit a government to a policy path for an extended period – typically in the range of 10 to 20 years.

Governments risk distorting markets with policy design that promotes one type of RE preferentially. It is tempting to write legislation to address one niche area, but it is poor policy-

making practice and can result in unintended consequences and misallocation of capital. Cases in Ontario, Germany, and Spain are widely known examples of over-pricing the FIT. While high tariffs result in the intended actions by private developers of building additional capacity, it may be at the expense of financial resource efficiency. In the cases above, mis-pricing the FIT has resulted in the need to later adjust the offered FIT downward in response to budgetary or political pressure. Cancelling or changing the terms of a long-term policy commitment inevitably upsets market participants who have made business decisions based on the existence of the FIT.

A different approach is to let market participants compete for access to renewable resources and to create policy that provides the correct and appropriate level of motivation across all technologies and all regions. If one technology is not competitive, any subsidization to promote its use helps only that industry at the expense of resource efficiency and economic efficiency. Therefore it may be more beneficial for participants to concentrate elsewhere, where lower FIT levels are required. Bidding by developers for the lowest FIT required to develop RE resources is one way to discover the minimum payment amount required. This takes the burden of FIT price-setting away from government, but requires an approach that favours more collaboration with other actors and less centralized control by government.

Algeria FIT case

Currently Algeria is the only RCREEE member country with an operational FIT in place, introduced in 2004. Although Syria officially defined a FIT in November 2011 through the government's Decree No. 16202 (RCREEE, 2011), information about its implementation is not currently available, so cannot be commented upon. Algeria's legislative framework is quite advanced compared to other developing countries, with the government having taken international best practices and translated them into an Algerian framework (REEEP, 2012a). The implementation of RE has been extremely limited despite this legislation, with essentially no new projects aside from a few demonstrations and pilot projects such as solar PV to supply small communities off-grid.

The lack of development might be explained by a few important factors. Foremost, the Algerian price of electricity in 2011 was relatively low, at 5.5 cents US for residential customers and 4.4 cents US for industrial customers. The second important factor is the structure of the FIT, which appears to be modeled after the original German Stromeinspeisungsgezt system, later also adopted by Spain.[3] The tariff for each source is set as a percentage of the retail price, with hydro set at 100 per cent, CSP and waste at 200 per cent, and wind and non-CSP solar at 300 per cent of retail price (Gipe, 2009). This differentiated tariff favours some sources over others. The third factor is the maximum capacity per project eligible for tariff payment, which has been set at 50 MW. And fourth, the Algerian power market operator sets electricity prices, so any prospective developer needs to weigh the risks associated with an artificially-set price acting as the benchmark for their FIT payments.

The terms of the Algerian FIT result in an unattractive proposition to developers due to the risk associated with unknown future FIT payment levels dependent on electricity pricing. Participation has been meager, with no RE sources (other than hydro) registering in Algeria's energy statistics despite healthy resource potential in several sectors. The Algerian case illustrates the complexity of designing an effective FIT policy.

[3] Both countries have since moved to new systems, Germany in 2000 and Spain in 2007.

Unattractive market landscape

Private citizens are virtually absent from RE development in Arab countries, and understandably so. The value proposition for a homeowner is unattractive. The average residential price paid in the region is 6 US cents per kWh, with the lowest being 0.8 cents, shown in Figure 3-7. Of the 13 RCREEE countries, a FIT is available only in Algeria (PV-Tech, 2012; REN21, 2012), with the gap between conventional and renewable electricity remaining large in essentially all countries. Part of this can be attributed to an undeveloped installation and service sector, but electricity and source fuel subsidies play the biggest role.

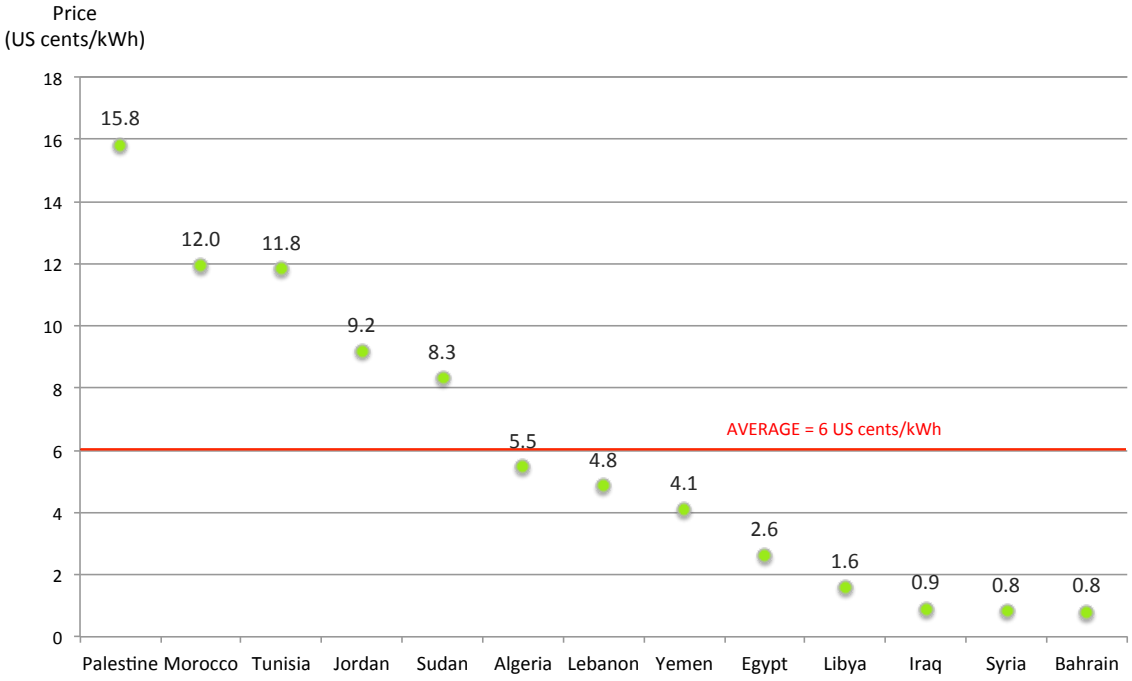

Figure 3-7. Residential electricity prices and average price for RCREEE members, 2011

Source: AUE, 2012b

Another disincentive exists for commercial and industrial generators. Using Egypt as an example, currently just one RE independent power producer (IPP) is active, due to the limitations placed upon them. The IPP must take responsibility for land acquisition, environmental impact assessment, construction permits, and finding a customer for offtake. The government typically does not allow tie-in to the grid, or limits feed-in to a small excess that is not consumed on-site. This is discouraging any company that is not contracted by government to develop RE in Egypt. When an expected FIT is introduced, it could motivate participation if priced high enough to overshadow the numerous burdens.

3.2.3 Institutional barriers

Policy-action conflict

Eight of the 13 member countries have a mandate for RE development, but to varying degrees they often lack the regulation and policies to support the mandate. Claims do not match efforts or the enabling conditions for reaching their goals.

A distinct gap exists between the stated goals of national governments and the current course of development. For instance, in 2008 Egypt's Supreme Council of Energy set a target of generating 20 per cent of its electricity from renewable sources by 2020 with 12 per cent supplied by wind, and 8 per cent from solar, hydro, and other sources combined (NREA, 2011). The plan is ambitious and well articulated. But what does this imply for the required rate of development in Egypt? For wind the target translates to 7200 MW within nine years, with 2375 MW developed by NREA and 4825 MW by private sector projects. This implies an average annual build-out rate of 739 MW to reach the goal. To put this accomplishment into perspective, at the end of 2011 the installed base for wind was 552 MW, with 250 MW currently in late planning stage (personal communication with Khaled Fekry, 10 July 2012). Figure 3-8 shows the unprecedented growth required to meet the wind power target for 2020.

The strategy will use several policy tools to promote development, including offering 20 to 25 year PPAs, using a competitive bidding process for new construction projects selected by government, and offering a FIT to attract private developers.

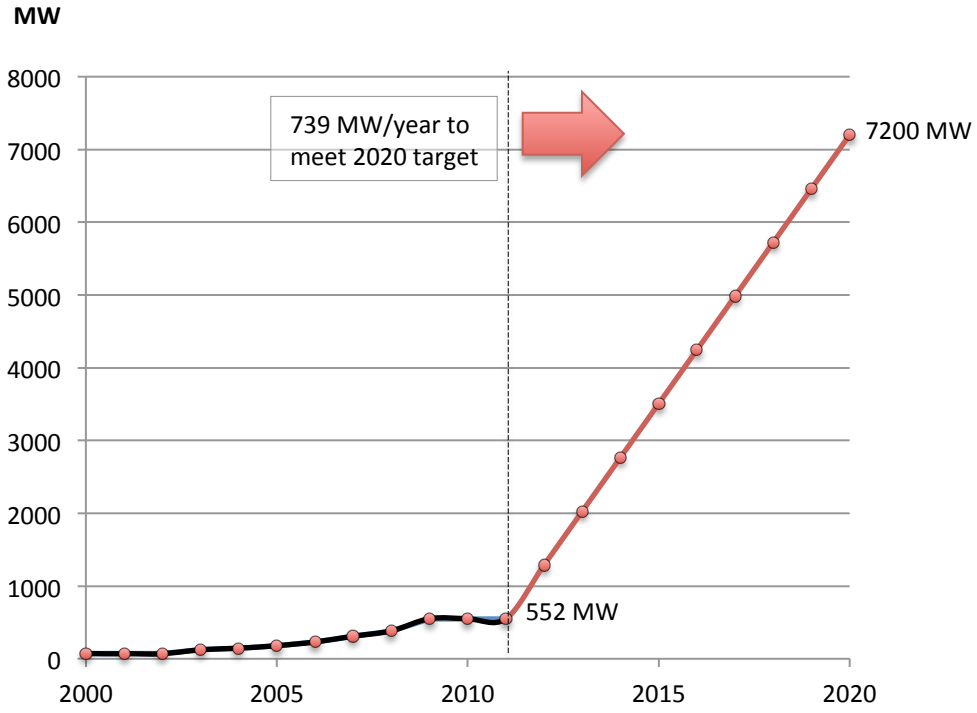

Figure 3-8. Egypt historical and targeted wind generation installed capacity (MW)

Source: BP, 2012; NREA, 2011

The unrealistic schedule points to a misalignment between the various actors, and should be flagged as a signal to reassess the plan. This example points to a conflict inherent to many similar plans, not exclusively in Egypt or the Arab world. There is a disconnect between the target-setting governing body, the policy-setting group, and the administrative entity that is charged with planning and implementation of projects. This is a function of the governance structure in place, where single-actor decisions occur in isolation due to the absence of well-developed consultative and feedback mechanisms.

Institutional setup

Institutional setup requires both organization and implementation. This means that institutions need to be organized to effectively support the goals of the state, and also the processes must align with the goals to deliver adequate results. Data on the quality of institutions as they relate to RE has not been adequately published in Arab countries. Part of the role of RCREEE is to measure this, provide a venue for discussion, and promote policy response where opportunities exist.

However, some larger scale projects have attempted to report on institutional conditions in a global context. These efforts can be used to develop a regional picture with respect to institutional capabilities of the member countries.

The World Bank publishes their *ease of doing business index* (World Bank & International Finance Corporation, 2012), which reports on basic issues relating to starting and operating a commercial enterprise. While this index is not tailored regionally, and does not relate to RE directly, it provides feedback on the general conditions existing in countries in relation to one another. Table 3-5 shows rankings of RCREEE member countries from the 2012 index of 183 countries, where higher rankings indicate better results.

The results of this index provide insight into conditions relating to typical business activities, such as registering property, obtaining licenses, contract enforcement, and trading across borders. These results do not provide particular insight into RE development in the countries, and certainly some results are poorly correlated in this respect, such as Bahrain. But this can be considered an indicator of general institutional readiness for dealing with private project developers, which is a precondition for progress.

Table 3-5. World Bank ease of doing business index rankings (1 to 183), 2012

Country	Rank
Bahrain	38
Tunisia	46
Morocco	94
Jordan	96
Yemen	99
Lebanon	104
Egypt	110
Palestine	131
Sudan	135
Syria	134
Algeria	148
Iraq	164
Libya	-

Source: WB/IFC, 2012

Bertelsmann Stiftung, the German think tank, provides another source of insight into institutional issues in the areas of political and economic transformation with their *transformation index* (Bertelsmann Stiftung, 2012a) comprised of two rankings that can also stand alone, the *status index* and *management index*. Focusing on what they term the developing and transition countries, Bertelsmann's bi-annual indices measure the state of 128 countries'

progress and setbacks "on the path toward a democracy based on the rule of law and a market economy flanked by sociopolitical safeguards" (Bertelsmann Stiftung, 2012b). The most recent results for 2012 are given in Table 3-6, using a scale of 1 to 10, where 10 indicates better results.

Table 3-6. Bertelsmann status index and management index scores (1 to 10) and rankings (1 to 128), 2012

	Status index		Management index	
Country	rank	score	rank	score
Lebanon	43	6.2	92	4.1
Bahrain	57	5.9	91	4.2
Jordan	81	5.0	84	4.4
Tunisia	82	5.0	87	4.3
Algeria	87	4.8	97	4.0
Egypt	88	4.8	88	4.2
Morocco	94	4.5	89	4.2
Libya	96	4.5	115	2.9
Iraq	104	4.2	94	4.1
Syria	107	3.9	113	3.2
Yemen	108	3.9	102	3.7
Sudan	119	3.3	118	2.6
Palestine	-	-	-	-

Source: Bertelsmann Stiftung, 2012

The status index focuses on political and economic transformation, with indicators like upholding the rule of law, level of participation in politics, currency stability, economic performance, and a host of others. The management index ranks the capability and effectiveness of management across all organizations. These two indices together offer a high level view of the institutional performance in the Arab countries.

On their own, any of the rankings or scores mentioned offer an incomplete view of the state of Arab institutions. However, due to the complexity and effort of conducting this type of research, for the time being these sources must be relied as upon proxy indicators to provide guidance in the RCREEE renewable energy progress index. As the research capabilities evolve, more relevant indicators could be developed for – and within – the Arab region.

3.2.4 Investment and financing barriers

Based on progress to date, virtually all RE projects in Arab countries involve some financial commitment on the part of foreign governments or development partners. Withdrawal of such support would represent a major barrier to countries that lack the budgetary allocations to meet their RE targets. To avoid this risk, Arab states can identify and move toward projects that stand on their own financially without external donor support. Absent that option, innovative funding models can replace or augment existing project financing. Few examples of such models exist at the moment. Chapter four highlights one new approach to financing called *green sukuk* that is unique to the Arab world. It is meant to satisfy Islamic finance rules and also target environmental investment themes.

Private investment

A recent report from the United Nations Environment Programme (2012) dealing with private financing of RE in developing countries suggests the barriers to private participation require governments to address three critical issues: 1) creating a level playing field, 2) providing easy market access, and 3) mitigating political and regulatory investment risk. These areas point to the barriers discussed in the three previous sections, and connect the role of government to the mobilization of private investment in RE. The same research included a survey of private finance practitioners to test their perceptions of the most effective incentive mechanisms. The highest ranked was national targets that serve to instill confidence in long-term RE policy direction, followed by governments offering a FIT. Also popular was the idea of accessing CERs through the CDM market to improve the payback, especially if higher rates were offered than currently exist. These are appealing options for private investors because they offer a simple structure and high degree of confidence for making investment decisions.

The private investment sector can play a larger role in development of RE in the future. Due to limits to government spending, private participation will be required in meeting the stated targets. The RCREEE index uses the level of private investment as an indicator of progress, in terms of percentage of new generation installed. This excludes the major funding sources to date – local government, foreign government, sovereign carbon funds, and foreign donor organizations. As conditions become more favourable, other groups will invest in regions that provide the best return on investment and highest level of confidence in local government. Some financing structures such as green bonds and socially responsible investment funds may be able to raise capital at lower costs than the host countries themselves could, and RE resources can be effectively utilized sooner than by public funds alone.

3.2.5 Technology-specific barriers

Resource assessment

Accurate assessment of renewable resources available has not been carried out in all Arab states. Surveys and maps are helpful when considering new wind, solar, or geothermal projects. Some countries such as Egypt have completed surveys in conjunction with organizations like DLR and the Risø National Laboratory. Others that have made slow progress but are motivated, such as Jordan, and have recently recognized the lack of accurate data as a barrier to project development (Cronin, Campbell, & Gardner, 2011). The data provide an extremely valuable tool to the industry when made freely available but require an initial investment of time, labour, and funds to acquire. In April 2012, DLR and IRENA presented the first global atlas for solar and wind energy (DLR, 2012), which brings together all existing data into one resource. This open access database is expected to accelerate RE development in areas that had previously been overlooked.

System – Intermittence, peak load, and redundancy

Each renewable technology has inherent limitations, some of which become significant barriers to adoption. The main drawback with solar and wind relates to the intermittence of generation. For solar the obvious limitation is the hours of sunshine per day. Although the hours of sun are known in advance, generation is also affected by cloud cover. Fortunately the Arab countries have predominantly clear skies throughout the year. As an example, Algeria

receives – from the coastal areas to the Sahara Desert – between 2650 and 3500 hours of sun annually (Sonelgaz, n.d.). This yields up to 2650 kWh per m^2 per year, similar or better insolation rates than in California deserts where solar energy is being developed on an industrial scale.

A concern voiced by industry participants is the lag between peak solar production and peak load on the grids. Some Arab countries see their maximum demand coincide well with peak sun due to air conditioning load, but in other countries it occurs well after sunset. Table 3-7 lists the peak hour and day for each country in 2011, with peak occurring near midday for some and almost as late as midnight for others. Blackouts during these peaks are a standard occurrence. An attractive solution would be storage of electricity. This has proven feasible in other regions where pumped hydro storage can be used, and CSP offers the possibility of several hours storage using molten salt, but the ultimate technical solution of affordable battery storage is not currently available.

Table 3-7. RCREEE member countries' time and date of peak electricity demand, 2011

Country	Time	Date
Algeria	21:00	8 Aug 2011
Bahrain	14:35	1 Aug 2011
Egypt	20:45	27 Jul 2011
Iraq	-	9 Dec 2011
Jordan	13:00	31 Jul 2011
Lebanon	21:00	19 Aug 2011
Libya	21:00	15 Aug 2010
Morocco	22:00	30 Jun 2011
Palestine	18:20	18 Dec 2011
Sudan	14:00	2 Aug 2011
Syria	17:30	31 Dec 2011
Tunisia	13:30	13 Jul 2011
Yemen	23:00	25 Sep 2011

Source: AUE, 2012a

Policy and pricing can be used to influence consumption and shift the hour of peak demand by introducing variable time-of-use pricing. Effective pricing structure should flatten the peak load to some extent depending on price, but requires a time-of-use metering system that is more sophisticated than flat rate billing. The advantage to the utility operator of reducing demand peaks is a reduced need for redundant generation capacity.

Grid connections

Plans for large-scale RE generation point to the need for transmission connections to neighbouring markets. The Mediterranean Power Pool is a project that plans to link the power grids of Algeria, Egypt, Libya, Morocco and Tunisia with Spain on one end and Jordan, Syria, and Iraq on the other (reegle, 2012). This would remove significant barriers in the electricity islands currently in place throughout the region to allow better load balancing of intermittent generation. It would also open up new markets for export, whereas capacity is currently constrained by only one transmission line from Morocco to Spain and another from Tunisia to Italy. Plans are moving ahead for a new connection from Tunisia to Italy to be operational

by 2016. In order for the large utility-scale CSP projects to advance, this is a crucial development.

Research and development – false barrier

Participants in both government and funding organizations have voiced the opinion that research and development (R&D) are important components of RE progress in the Arab region. The logic follows that greater local knowledge and solutions that are suited to the local market will get them to their goals faster. This may be a false premise and it is worth investigating. It has not been demonstrated that research done in an Arab country will provide superior value or lead to more rapid adoption of RE, more so than if the same work was done elsewhere.

The lack of a strong research base is explained by the relatively small number of domestic suppliers and manufacturers. One domestic producer of wind turbine components has pursued a strategy of building capacity through acquisition of foreign companies, believing it to be a shorter path to product advancement than starting a research division to accomplish similar goals.

This difference of opinion between organizations seems to be explained by their basic goals. Government puts considerable value on job creation for its citizens, NGOs have a mandate and funding for local capacity building, and industry is motivated to find the lowest cost path to fulfilling their business objectives. While all these are valid goals to pursue, the lack of complaints from industry in this area acts as confirmation that the problem is misdiagnosed. Small competitors may disagree but this might also be explained by a lack of capital to pursue the same strategy. The whole debate might be premature at the moment because of the low demand for products, which is satisfied by external suppliers. Some of the typical arguments for R&D – that it can stimulate technology innovations and can lead to manufacturing cost reductions – imply that the research programs should have high levels of expertise and long experience in the field. New R&D programs in Arab states would not likely produce greater benefits, in the near future, than the established efforts of current industry leaders. The best way to improve the local job creation situation may be to create foundational conditions that enable RE adoption to occur at a faster pace; only then can a domestic R&D segment support a growing Arab market. So for these reasons, the lack of a robust R&D sector can be considered a *false barrier* to development of the current Arab RE markets.

3.3 Summary of drivers and barriers

To summarize the factors influencing RE development in the Arab region that were discussed in this chapter, Figure 3-9 highlights the main points of each driver and barrier in a concise form.

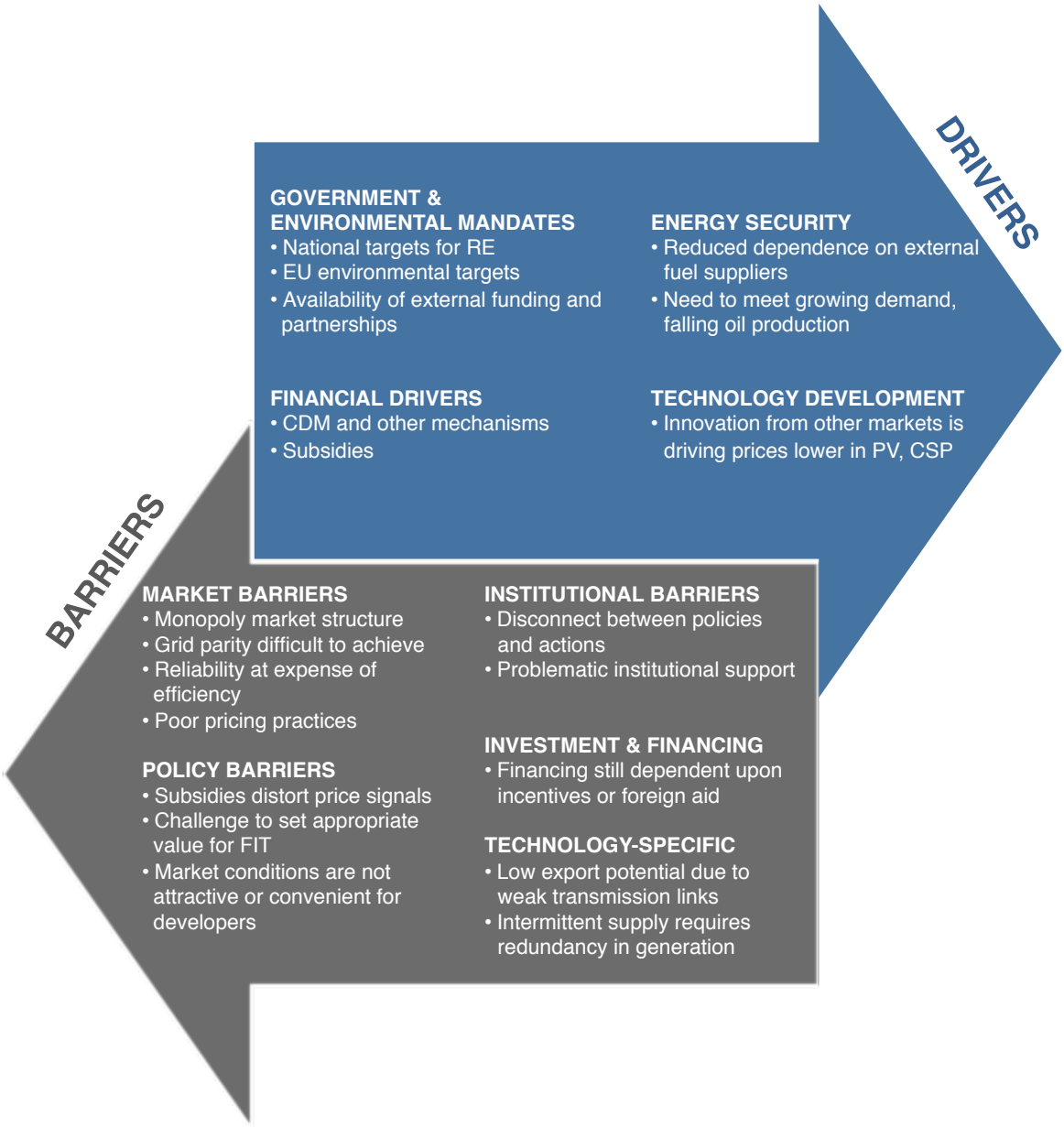

Figure 3-9. Detailed view of drivers and barriers to renewable energy development in the Arab region

4 Renewable energy markets: transitions and developments

In chapter four, some of the current market conditions in Arab electricity markets are described, and their potential impact on RE development. Transitions that are currently occurring and that could occur in the future are described. Examples are provided of RE developments occurring in the region that have overcome barriers to development.

4.1 Current market directions

A significant condition of any RE activity is for a country to have basic enabling conditions in place. These include several fundamental aspects, as discussed in chapter three relating to drivers and barriers. Assuming these conditions are present in a meaningful way, a strategic approach can be taken to RE development. For those countries that face more difficult conditions, the foundational activities, such as institutional setup, legal frameworks, and infrastructure must be attended to first.

A recent research note from Gulf area bank APICORP observes the common tendency for Arab states to take a phased approach to competitive energy markets. Private developers are invited to participate in generation first, while governments maintain a monopoly in transmission and distribution. This maintains the role of state as main actor, with power to set terms and prices for electricity purchases from IPPs (Aissaoui, 2012). This satisfies the basic needs around funding and expertise for construction while interacting with as few other actors as is possible. Control is still essentially concentrated with the state, with a twist of public-private partnership (PPP) added, but without the transparency that makes it a defensible model in more open governance structures. While this opens up the generation segment, assuming external partners can be attracted, the result is to push the problem further downstream; subsidized electricity cannot supply adequate revenue for operation of the utilities, so government must make up the shortfall. This presents a governance problem with different branches of the state apparatus at odds with each other and with no internal mechanism available to deal with the conflict. So the single actor model proves to be potentially more expensive than where communication channels exist.

Accounting trap

Although unspoken during interviews with industry participants, one of the main barriers to investment in RE by Arab governments could be a mundane one: accounting. Governments are under pressure to cover their financing obligations, especially the welfare states typical of the Arab region. From a budgetary perspective, it is easier to justify spending a forecast amount on electricity subsidies or imports to maintain the status quo than it is to allocate funding for new RE construction. The costs for conventional generation are spread much more evenly over the project lifetime, whereas renewable projects are heavy on the front end with lower operating costs. The former is exposed to unknown lifetime costs, primarily for fuel, while that latter is generally a known investment cost.

So why does RE not proliferate, even though potential exists for lifetime energy costs to be substantially lower than the current energy infrastructure? Currently generation contributes to a trade deficit due to fuel purchases over the lifetime of the generation facility. In this case, it should be kept in mind that government is not a monolithic construct, but rather a collection of bureaucratic functions that are sometimes aligned and other times at odds with each other.

So although someone within government likely sees the value of investing in renewables, he or she is constrained by the budgetary process that discounts future costs at the expense of inefficient current policies. The long-term result is a continued dependence on year-to-year financing that may strain the country's ability to provide adequate services for all societal needs, requiring choices to be made on where to spend and where to hold back.

The difficult part for states that are cognizant of this pattern and genuinely interested in breaking it is the mechanism to accomplish the change. The evidence to date, through the complete reliance on foreign partner funding for virtually all RE projects, indicates that free (or discounted) money must be offered or projects will not occur. This may be the case today, but this barrier could be overcome by making changes to governance structures. When the dialogue is between two actors only – the state and the funding partner – the options are limited. But if additional actors are allowed to participate, new possibilities open up. While this approach is not part of the old Arab agenda, it will be a necessary step for achieving RE targets. It involves a radical change in giving up some direct control of planning, construction and operation of the electric utility business, but stands to gain from an overall societal perspective.

Privatizing energy markets is an approach that has mixed appeal in the Arab world and mixed results in the broader world. Opening markets for private sector competition is one way forward, but some states will choose other paths. More important is the policy framework and institutional layout that guides activity in the generation, transmission, and distribution markets. Generally speaking, all of these are currently subject to political influence in Arab countries. Part of a new governance structure could be to give these segments – even if publicly owned – the legitimacy to direct their activities, along with accountability. This may take some time to truly integrate into the governance model.

Egypt's NREA is an example of an organization that began as a research and promotion entity, having evolved to include other functions and responsibilities. It is the primary research institution and provides data such as wind and solar resource assessments, assists in feasibility studies, and acts as partner in land use agreements. In addition, NREA is now the main actor in the RE industry in Egypt, as owner and operator of the majority of wind projects. It also is responsible for issuing tenders for upcoming renewable projects that are targeting private partners. Conflicts of interest are possible when NREA acts alternatively as information provider, planner, contract issuer, partner, and project developer. A separation of duties would allow for these various functions to be fulfilled more transparently. An example of how that could work from an institutional perspective will be presented in section 4.3.

BOOT and BOO models

The build-own-operate-transfer (BOOT) model, or in some cases the BOO variation, are currently of great interest in the Arab region as a method of financing and constructing new capacity to meet growing electricity demand (personal communication with Khaled Fekry, 10 July 2012). This offers benefits by adding generation without government investment where a private developer supplies financing, construction, and operating resources.

But reliance on BOO or BOOT could include some drawbacks, depending on the contractual conditions. In countries where a state-owned entity is the sole purchaser of electricity from generators, the contracts with private partners need to specify terms of purchase from the outset. For conventional projects such as natural gas-fired plants, the private developer needs a mechanism to pass through increases in fuel costs to the purchaser, which essentially creates a floor on costs for the private partner but leaves the government open to unlimited fuel price

risk. This case may or may not lead to higher prices for the government over the project life than if construction and operation was undertaken through government forces. Admittedly, this is a speculative conclusion because the particular conditions of any contracts have not been publicly disclosed.

With respect to RE projects, the same BOOT model is being applied, however in this case the fuel costs are not variable, but rather the future market price of electricity is variable. Since the market structure at the moment has the purchaser setting the price, some contractual assurances are sought by the developer that their costs will be recovered. This underscores the importance of a power purchase agreement (PPA) between the two parties, defining the obligation to purchase generated electricity for a fixed period of time. Furthermore, renewable developers will seek a certain minimum price per kWh, which can be provided by a FIT, subsidy, one-time payment, or another mechanism. This again could place risk upon the government, but potential risk is limited by the difference between the FIT price and market price. From a risk management perspective, this scenario is preferable to the fuel-related risk of conventional power plant BOOT models.

Satisfying market demand

An old marketing motto advises to give the customer what he wants. And in the energy market, the European customer is asking for electricity from low environmental impact sources, and they are willing to pay a premium. In 2011, for the first time in the EU, solar PV accounted for more new electricity capacity than any other type (REN21, 2012). This trend should provide ample motivation for Arab countries to focus on the business case and make use of their competitive advantage of strong solar resource.

Arab countries that are situated close to the European market have an inherent advantage with respect to electricity exports. This means the Maghreb countries of the western area of North Africa have the best opportunity, but access is currently limited to one interconnection between Morocco and Spain. Several additional links are being planned or studied by the Medgrid and DESERTEC projects, including Algeria to Spain, Algeria to Italy, Tunisia to Italy, Libya to Italy, and Egypt to Greece (Medgrid, 2012). High voltage direct current lines are being proposed, which offer transmission with losses of about 3 per cent per 1000 km (Siemens, 2012) making long distances potentially feasible.

The strategy of strengthening transmission infrastructure should be appealing to Arab states because it would connect them with a customer that places value on the environmental aspects of electricity; although Arab markets do not pay a premium for renewable energy and are governed by state subsidization, greater value could be realized through exports. It is unknown what path might be followed, but revenues from sales could be used to continue to offer domestic customers lower rates, or market competition might evolve. While the construction of transmission infrastructure is essential to reaching European markets, realistically most of the generated electricity would – in the near to medium term – be consumed within the Arab region. To deliver energy to the internal markets, regional transmission build-out is also needed, reducing the island effect among individual countries. With a transmission bottleneck to Europe remaining for the foreseeable future, Arab states will have decades to reform their markets and pursue the policies that best suit their citizens. But with interested European partners, the first source of predictable revenue is clearly from the export market.

4.2 Energy transitions

At the moment, RE is a dynamic sector. Bloomberg New Energy Finance wrote earlier this year about six transitions that are occurring right now (Liebreich, 2012). These transitions affect the Arab region as much as anywhere and are important to recognize:

- Economics of clean energy – a shift to power sales driving investment
- Impact of renewables on power sector – creating downward pressure on spot prices
- Emergence of mature supply chain – large industrial participants entering
- Advanced transportation – electric vehicle sales gaining a place in mainstream sales
- Biofuels – from first- to next-generation – non-food crops and waste favoured
- Shift from narrow to broad geographical base – Latin America, India, Japan, Africa, Middle East, on the way to becoming just another part of the energy mix

The message being delivered is that the RE industry is set to transition to a mature business model, with more sophisticated participants, and entering wider markets. Viewing the Arab region through this transitional lens, it also becomes clear that the countries are experiencing a *transition within a transition*. The larger context is the political and societal reorganization that is underway in many of the countries. This offers many potential branches in the development of institutions and activities. Inside that transition is the RE transition that had begun previously and is now caught in the whirlwind of larger events. It remains to be seen where RE will fit in the future plans and whether conditions will be favourable or not.

This transitional activity also then requires a reconfiguration of the fuel distribution networks and end-use equipment. Due to the inertia in the system, it seems likely that countries and energy suppliers will generally delay as long as possible to avoid new investment costs. The motivation for action may come in the form of an energy break point, potentially caused by a variety of triggers. A variety of forces could be at work, including supply shortages or reduced supply options, environmental concerns, societal pressure, business behaviours, and geo-political competition (Tertzakian, 2006).

The cycle of energy use, break points, and adjustments is illustrated in Figure 4-1. This describes the cycles that play out over multi-decade periods, repeating with each fuel source that is introduced into society. Although the model appears simple, the reality is a constant turmoil between the phases.

In the current world state, *growth and dependency* upon fossil fuels has been occurring over many decades. Supply chains have been built, products designed to use only petroleum products, business interests entrenched. Incrementally, scarcity has increased and *pressure buildup* has occurred. In the past, geopolitical forces created supply chain disruptions, and currently environmental and social forces are exerting a greater pressure due to concern over negative impacts to the atmosphere. The combination of forces is continually changing and from time to time leads to a *break point* in the energy cycle. The most notable oil break points have occurred in 1973, 1979, and 2008. Each time, price shocks occurred and forced changes upon the energy system. The break points naturally lead to a *rebalancing* phase, where habits change, products adapt to new price conditions, and substitution often occurs. Rebalancing can also be induced by new taxes, incentives, and regulations. Ideally alternatives can offer relief during rebalancing, but the time scale for substitution of new fuels is measured in decades rather than years. RE is one of the ongoing strategies to shift away from the current dependency on the dominant non-renewable sources.

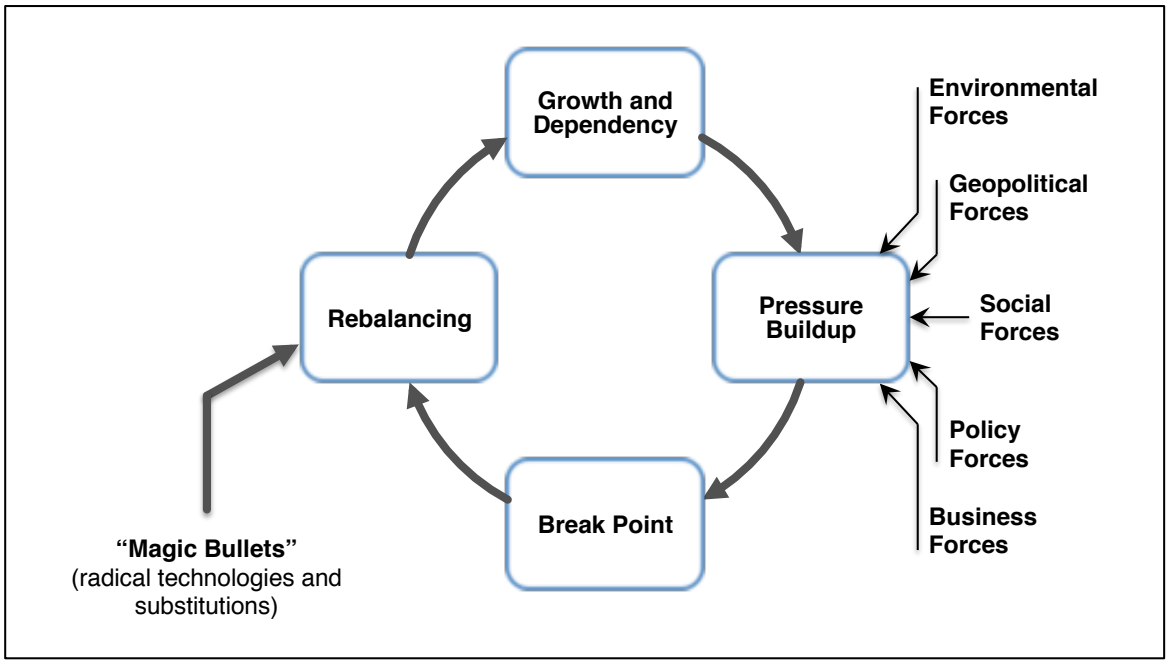

Figure 4-1. Energy evolution cycle

Source: Adapted from Tertzakian, 2006

4.3 Arab regional developments

Throughout the Arab region, governments, industry, and other participants have been actively working on approaches to overcome challenges in RE development. Some solutions achieve success only in a specific context but, generally speaking, there are common barriers and drivers for regional actors. The selected cases presented below reflect upon the identified barriers to development, and are intended to help visualize a way forward and potential entry points for governments looking to intervene.

Market

Jordan is almost entirely dependent upon energy imports and the financial costs are a recognized burden on the government. Jordan therefore has a high level of motivation to stimulate RE development. Additionally, a generation capacity shortfall is forecast for the near future. Utility market structure is unbundled, however all three segments are still state-owned.

Jordanian law grants ability to the Cabinet of Ministers, through the Ministry for Energy and Mineral Resources, to issue licenses to private power production companies, for renewable or conventional power (REEEP, 2012b). This is an attempt to fill the forecast future need for domestic supply through IPPs. The legislation also dictates that the National Energy Power Company (NEPCO) shall not be allowed to invest directly in RE as primary funder. This would contravene the government's policy of promoting IPPs. However, NEPCO may still buy shares in any company. This market structure outlines a direct pathway for potential participants and makes clear the roles of state, regulator, and utility. As a transitional plan toward open markets, Jordan's model is well designed.

Policy

Egypt has developed a new Renewable Energy Fund to shift funding support from conventional energy to RE. Introduced in a recently passed Electricity Law, the new fund is designed to provide funds generated from sale of natural gas to NREA. Plans are to use the fund to cover the gap between RE cost and market prices, reduce exchange rate currency risk, provide payment guarantees from transmission companies, and for RE project and technology development (REEEP, 2012b, personal communication with Khaled Fekry, 10 July 2012). This new policy instrument is in effect employing the *polluter pays principle*, by redirecting a portion of revenue from natural gas to renewables. The details of the fund's operation are unclear, but this could have two significant effects: firstly it could act as a stable revenue source for renewable projects falling within the scope of the fund, and secondly it begins to convey a price signal to the natural gas industry (in this case also a state-owned entity) that the country assigns some value to negative environmental externalities caused by fossil fuels. It is an early – if somewhat circuitous – step in reversing the existing subsidy imbalance in energy markets.

Institutional

In 2009, Morocco took a significant step toward supporting RE development in the country with the passing of Renewable Energy Development Law 13.09. The law aims to promote the contribution of RE resources for the local electricity market and for export, by public or private entities (Moroccan Investment Development Agency, 2011). This set a course for development on several fronts, and prompted the creation of a group of enabling bodies, namely the National Agency for the Development of Renewable Energy and Energy Efficiency, the Moroccan Agency for Solar Energy, and the Energy Investment Company. This new framework provides a clear governance structure and directs investors to the relevant governmental agencies.

Through their Agency for Solar Energy, Morocco has embarked on a 2000 MW solar mandate dubbed the Moroccan Solar Plan, and in parallel the National Electricity Office is pursuing their own 2000 MW program by 2020 for wind energy. These plans are proceeding without any FIT offered. Capacity factors of more than 40 per cent imply wind power has reached grid parity in Morocco (Richards, 2011). This is also due, in part, to the fact that Morocco has the highest industrial prices in the region at 17 cents US. Other countries such as Egypt possess equivalent solar and wind resources, but Morocco is demonstrating that a combination of factors – legislation, policy, but especially institutional setup – can attract interest without government offering significant financial incentives (Benkhadra, 2009).

Investment and financing

Dubai is working on development of a new concept, *green sukuk*, which conforms to two sets of standards: environmental credentials and Sharia compliance. The idea is to create environmentally friendly Islamic finance, an investment approach that is yet untested (Yee, 2011), and is being led by Dubai's Carbon Centre of Excellence. Traditional funding has become harder to secure in the past three years since world credit markets tightened. The sukuk are targeted at a different potential investor than traditional carbon market project funders such as sovereign bonds, bank loans, donor grants, and private equity.

It is possible that green sukuk could be perceived as having lower risk of default and be subject to lower financing rates than a country itself could arrange through bonds or loans. It might also be more readily deployed to attractive projects without encountering funder-

induced bureaucracy from foreign donors or international agencies, which would result in better returns. Another favourable aspect is the security provided to creditors investing in RE projects; if no other entity has a lien or claim on a project, the funding party can understand very clearly what the revenue-generating value of the asset would be if payments were defaulted upon. In this respect, the predictable lifetime, maintenance costs, and generating potential of RE projects make them appealing to funders looking for security in their investments.

The eventual specifications of green sukuk have not yet been developed or agreed, but it provides an example of opportunities to step outside the traditional project finance boundaries to fund RE projects.

5 The impact of governments and governance

In chapter five, the activities of Arab states are viewed through the lens of governance theory. The question is posed as to whether these countries currently have true governance or simply government. The theory is used in an attempt to explain the actions of governments. The chapter closes by taking a broader view of the RE discussion and summarizes the potential areas of intervention that have been identified.

The countries of the Arab region are currently experiencing a transition within a transition. The landscape for RE worldwide is evolving into a mature, traditional energy industry, with a shift from reliance on government support to stand-alone economics that attract sophisticated utilities and engineering firms. At the same time in the Arab region, a political and cultural transition is occurring, where organizational structures are being redesigned to serve a different set of needs and goals for society. For RE to succeed in this double transition, national policy makers will need to be sharp to foster the desired developments, and regulators will require a more sophisticated approach to management of these new markets.

Clean energy investors are looking to Africa and the Middle East as undeveloped markets with tremendous potential. Industry participants view the situation differently than government, with divergent perceptions of the needed drivers. While the region's electricity markets have traditionally been closed and self-sufficient, some changes will be necessary to meet future energy goals relating to security, economy, environment, and social well-being. While prior decisions have led to the present conditions, each government has a high degree of influence on what their future will look like relating to RE development.

5.1 Governance theory as an explanation of government involvement in renewable energy policy

The concept of governance is important to any country, and exceedingly so for a country undergoing a structural transition. This is the case with several countries in the Arab region. Governance has been described simply as the business of government (Osborne & Gaebler, 1993), but other theorists suggest there is more to it. It can be defined as the process of governing, rather than the institution, and where multiple actors are involved because no one has absolute dominance in the relationship. Pierre and Peters (2005) contend that governance consists of four essential activities. All are required to maintain a functional system:

1) articulating a common set of priorities that is agreed upon by society,
2) coherence of the goals, through coordinated and consistent processes,
3) steering, traditionally through regulation, subsidies, and other instruments but more recently through relationships with other actors, and
4) accountability for the actors who have ability to influence the governance activities.

A legitimate question to ask in the case of Arab states: *is it government or governance?* For extended periods, many states have been operating in a structure that marginalized all other potential actors. Political structures are changing, however, and necessitating a different approach to governance. Pierre and Peters propose five idealized models of governance (2005), as shown in Figure 5-1. In Arab countries, generally speaking, governments control the activities they have taken responsibility for, and they also exert a large degree of control over

any social actors who may wish to become involved. Thus, most states most closely resemble the *étatiste* model. However, the countries that have been most progressive and achieved RE success (or are building capacity with that goal in mind) tend to be more aligned with the values of the *state-centric* model. The big differentiator between these models is the extent to which actors other than the state are involved in the process.

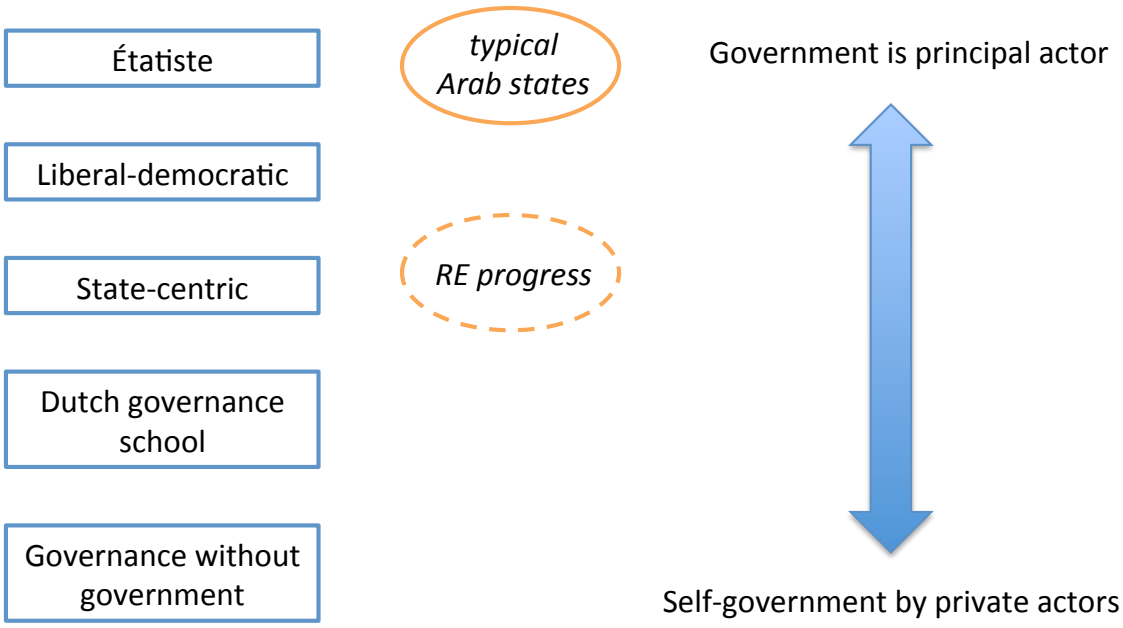

Figure 5-1. Five models of governance and Arab states' relationship on the continuum

Source: Adapted from Pierre & Peters, 2005

Stoker argues in an article on governance theory (1998) that governance is not really different than government in its outcomes, but rather the process is different. Arab states are being challenged by a shift from their default position as étatiste states toward a (more) collaborative structure. Whether begrudgingly or willingly, more interest groups, citizens, and outside entities are being given some influence in governance.

It seems unlikely that Arab countries will anytime soon swing to the *governance without government* end of the spectrum; the process is typically a gradual transition. It is also too soon to guess how the governance structures will evolve, but it's likely that some elements of several of the five models will be present. In all cases the two principal actors are state and society. However, the balance between them is complex, with numerous divisions within government, and a plethora of voices from citizens, business, and special interests.

<u>Applying governance theory to RE development suggests that:</u>

- Effective governance must articulate priorities relating to RE goals, act consistently on them, guide with well-designed policy, and assign responsibility for those who influence outcomes.
- The key differentiator between the various governance models is the interaction between various actors and the amount of influence each possesses in the system. More connections between actors such as IPPs, NGOs, consortiums, financiers, citizens, and neighbouring countries will likely result in more collaborative outcomes.

- Legitimacy is required to maintain the right to govern. Input legitimacy requires adequate participation, accountability, and allowance for deliberative discourse. Output legitimacy demands effectiveness of RE policies, government institutions, and compliance with stated societal energy priorities.

Reflection on governance theory leads to question whether democracy is a prerequisite for properly functioning institutions in areas such as provision of energy. From evidence elsewhere in the world, the answer seems to be no, it is not a prerequisite. China is a prime example of a command economy focusing and executing well on its renewable ambitions; China has ranked first in Ernst & Young's All Renewables Index for the past three years (Ernst & Young, 2012), and is expected to account for 40 per cent of all new renewable capacity over the coming five years (IEA, 2012c).

The case of China suggests that something other than traditional 'freedom' is influential in the success of energy markets. This strategy has had problems though; utilities have purchased only a fraction of potential wind power due to a bottleneck in transmitting electricity from generation sites to cities and a lack of motivation to upgrade their infrastructure. Wind turbines have been idle as a result. China's solution: mandate utilities to purchase between 5 and 15 per cent of their supply from renewable sources (BusinessGreen staff, 2012). While China exhibits control as the dominant actor in its energy markets rather than developing an open governance structure, it does demonstrate what can be accomplished when political will motivates action. Arab states, being in a different situation politically and economically, need to define their own approaches to energy governance based on their goals, resources, and capabilities.

5.2 Closing discussion

Countries are entirely free to set their domestic energy prices as they see fit. The larger implications, however, are largely out of their control and influenced by world energy markets. A refusal to acknowledge the realities of the outside world will work only as long as a country is comfortably energy self-sufficient. To miss the connection between world petroleum markets and RE in the Arab region would be an oversight. Contrary to a superficial assessment that Arab countries should be less driven to adopt RE due to their endowment of petroleum resources, a combination of other factors present a different view. Motivating factors include: population growth, increasing per capita electricity consumption, national ambitions to increase industrial output, generally flat or declining domestic oil production, climate adaptation stresses, and continuing subsidies eating into social spending.

While it is tempting to say that the market is efficient and price will drive activity when the business case becomes attractive, the analysis presented here demonstrates that factors other than cost also influence RE development. To put the situation into context, Germany currently generates more of its electricity from solar energy than any Arab country, despite receiving less than half the annual insolation. The efficient markets theory fails to explain this scenario. This highlights the bounded rationality of decision making by states, the path dependency caused by decisions made in previous times and contexts, and the disregard of the true value of energy – oil, electricity, renewable sources – over a period of decades.

Taking a broad and long-term view, the results of this research lead to a further hypothesis. Oil exporting Arab countries (and net importers even more so) will be under increasing financial pressure as three trends continue to play out: decreasing oil production, increasing per capita energy consumption, and increasing population. This will have an environmental

impact but also a social impact. In the formula proposed by Ehrlich and Holdren (1971) expressing environmental impact, $I = P \cdot A \cdot T$, three factors can be observed influencing impact: population, affluence, and technology. Impact can be conceived of in a broad sense, not just to imply the influence of emissions to air, water, and land, but of the limited supply of resources available to society. So in a future scenario if environmental impact is highly correlated to petroleum use, either through pricing or scarcity, then the same three factors described above will be directly influencing consumption. In this case, states will need to make choices to meet their constraints: decrease population, impose a limit on affluence through reduced energy use, or seek new technology to decrease impact. In reality some combination of the three would be likely. While RE cannot solve the problem of environmental impact alone, it does offer relief for the *T*-factor through energy sources with lower impact.

Returning to Tertzakian's energy evolution cycle described in chapter four, as pressure builds and an energy break point is reached the likely scenario for Arab countries is to rebalance on the demand side as well as to seek out the new technologies that will allow some semblance of past patterns to continue. RE does not appear ready to offer any "magic bullets" to allow for continued exponential growth. It does offer an opportunity to shift from current fuel sources that are energy dense but unreliable from a price perspective to ones that are more diffuse but permanently available and in some cases without cost. The diffuse nature of renewables is one of the factors that currently limits their appeal. While energy is cheap and available the situation is more or less tolerable, but it becomes problematic if any of the forces – geopolitical, social, policy, business, environmental – exert too much pressure. The survey of oil exports points to a trend among Arab countries of declining petroleum reserves and increasing dependency on outside sources to meet domestic energy needs. RE offers the opportunity for Arab countries to capitalize on their natural resources, develop a new energy industry, and help their societies in the long term. For countries that recognize the opportunity, the interest from neighbouring countries, the international community, and business partners can work strongly in their favour.

Reflecting upon the major factors influencing RE development and the barriers still affecting progress, a course of action can be suggested. Each Arab country has the ability to change its governance approach in several key areas. While some actions require extreme political daring, like eliminating energy subsidies, others can be implemented without much risk. The key intervention areas identified throughout this thesis are highlighted in Table 5-1.

Table 5-1. Intervention areas for Arab governments

Category	*Intervention area*
Policy	- Work toward reducing or removing electricity subsidies
Institutional / Planning	- Prepare groundwork for attracting RE developers by defining roles and responsibilities of institutions - Improve the processes of doing business - Improve governance by including multiple actors in RE planning and development processes
Market	- Provide clarity and transparency for market participants - Separate state from electricity markets
Investment / Finance	- Focus on financing options beyond foreign donor funds - Capitalize on environmental market value of renewable energy

The single most feasible action right now would be to concentrate on *institutional improvement* – laying a strong groundwork within the ministries, departments, and agencies that affect RE development. This would contribute to institutional readiness, making a country appealing to external developers and private funders. As technology improves and prices drop to bring various renewable sources toward grid parity, those countries with organized institutional structures will benefit most. Investment will flow to those locations, and financial incentives such as a FIT may not then be required. The question for Arab states is no longer whether renewable energy will become an opportunity for them, but rather when it will happen and who will act to benefit from it.

6 Conclusions

Development of RE offers an opportunity for countries with plentiful natural resources to take advantage of their value by generating useful energy, but it also offers environmental benefits by producing fewer CO_2 emissions. The Arab countries lag the world in general, despite having superior resources for solar power and in some regions wind. Aside from environmental motivation, RE has potential to improve energy security, energy independence, and long-term value for electricity producers.

This thesis set out to investigate the current state of RE development in a group of Arab countries. The research focused on the identified gap between the potential for renewable sources and current practices. An initial hypothesis proposed that price is not the only, or potentially main, driver. A review of existing literature and personal interviews with participants from regional governments, regulatory agencies, funding partners, and industry shaped the process of inquiry. These sources led to identification of the key drivers and barriers to RE progress.

In the research process, the importance of the role of governments became apparent. Of the 13 countries under study, the development patterns vary widely. Some governments have made proactive policy choices and attracted interest from external participants, while others are still in the early stages of opening their markets to the point where a dialogue with secondary actors might begin. Indicators were sought out to be able to compare the success of countries in various aspects, which lead to only partly satisfactory results. The products available today cast a wide net in their comparative analyses, and the unique aspects of the Arab region are often hidden in the results. A new index designed to measure RE progress specifically for RCREEE member countries was discussed, and the framework developed during that project was used to organize the research results.

This thesis showed that a wide set of factors is influencing RE development and the impact of government touches upon most of them. Because government continues to play such a central role in the Arab states, discussion acknowledged the impact of organizational structure. To facilitate success, it found that governments need to address several significant obstacles. The research identified five main areas that play a large role in RE progress: market, policy, institutional, investment for general consideration, and technology-specific for the various renewable generation sources.

A central problem stems from the historically closed energy markets that are heavily subsidized. This single factor makes it difficult for RE to appear as an attractive alternative, unless further market distortions are attempted to neutralize the impacts of fossil fuel subsidies. A new approach was used to quantify government subsidies in the Arab electricity markets using the Palestinian prices as a benchmark due to its position being entirely dependent on imported electricity and without a strong financial position to offer subsidies. This implied subsidy was useful in identifying the policy stance of each country. It invited questions about Morocco, which stands out from the group by reducing or eliminating electricity subsidies altogether.

Secondary issues were identified around the failure to align policy with actions, the impacts of changing oil export patterns, and creating institutional condition that promote RE.

A selection of cases was presented that have produced positive results in each of the five key areas. Each demonstrated an innovative approach to the challenges in a particular Arab

country. These cases and the discussion of research results offered a view on where other Arab states might choose to intervene to support their RE development.

A theoretical explanation for the nature of government involvement in RE development was suggested using a governance theory approach. This was compared with the current reality and found to have notable divergences. The theory, which reflects ideals rather than nuanced realities, does not adequately capture the realities of the Arab situation. The exercise was helpful in allowing a competing perspective to stretch the research in slightly different directions. Overall, the utility of the theory was secondary to the data collected from industry actors.

The effectiveness of the research was compromised somewhat due to the 3-dimensional complexity: the group of 13 countries proved to be challenging to work with due to their disparities in economic status, geographical location, political conditions, and even data availability; considering the entire collection of RE technologies sometimes overwhelmed and distracted by inviting analysis at the micro- rather than macro-level; and the combination of two related but distinctly different areas of enquiry – development of practical index and writing of academic research paper – proved to be a bigger project than anticipated.

An area for future research was suggested during an interview with one of the major suppliers of energy products in the Arab region. The interviewee mentioned that a database on land access and regulatory processes relating to RE projects for each country would be of interest and value but does not currently exist. From the project developer's perspective, a measure of the number of agencies involved and time required to secure permits would be very helpful in making business strategy decisions. It would also provide a useful regional comparison point for RCREEE's renewable energy progress index. A second opportunity exists to extend the work started here on subsidies, comparing governments' costs of subsidization to potential economic and social benefits of investing a portion of funds to build RE projects. For each country, where is the balance point – at what price of oil, what RE generation cost, under which financing conditions? The answers could offer policy assistance to Arab governments.

This points to one of the goals of RCREEE, which is to provide accurate and comprehensive data for its member countries and the Arab region. Several gaps were discovered for some key statistical data sets and this limited the investigation. More efforts to gather data in this area can be made, allowing more meaningful conclusions to be drawn about the state of RE in the region.

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Appendix A – Research interview subjects

Name	*Organization*	*Position*	*Date*
Hatem Elrefaei	RCREEE	Senior Technical Expert	3 July 2012
Ihab Shaalan		Consultant	7 July 2012
Maged K. Mahmoud	RCREEE	Senior Technical Expert	9 July 2012
Khaled Mohamed Fekry	New & Renewable Energy Authority	Head of Studies & Research Sector	10 July 2012
Ali Abo Sena	Egyptian National Cleaner Production Center	Deputy Director	10 July 2012
Emad Ghaly	Siemens S.A.E.	President, Renewable Energy Egypt Head of Wind Power Middle East	10 July 2012
Rana Hakam	Siemens S.A.E.	VP, Corporate Development Siemens One	10 July 2012
Wafaa Ismail Abdalla	Federation of Egyptian Industries	Energy Sector Head	11 July 2012
Noha Mohamed Zenhom	Federation of Egyptian Industries	Industrial Sector Engineer	11 July 2012
Yehia Shankir	SWEG	Sales Director	11 July 2012
Mohab Hallouda	World Bank	Sr Energy Specialist	17 July 2012

Appendix B – Survey of oil exports for RCREEE member countries

Sources:

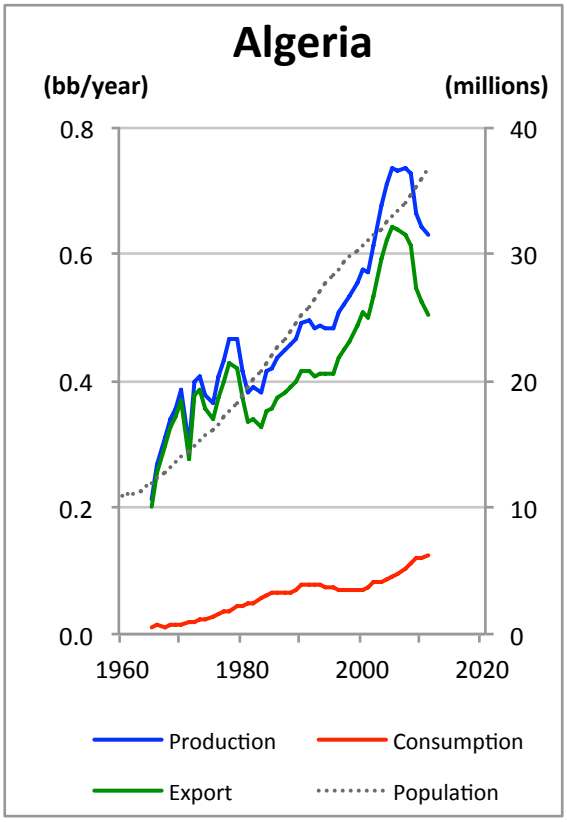
BP Statistical Review 2012 http://www.bp.com/statisticalreview

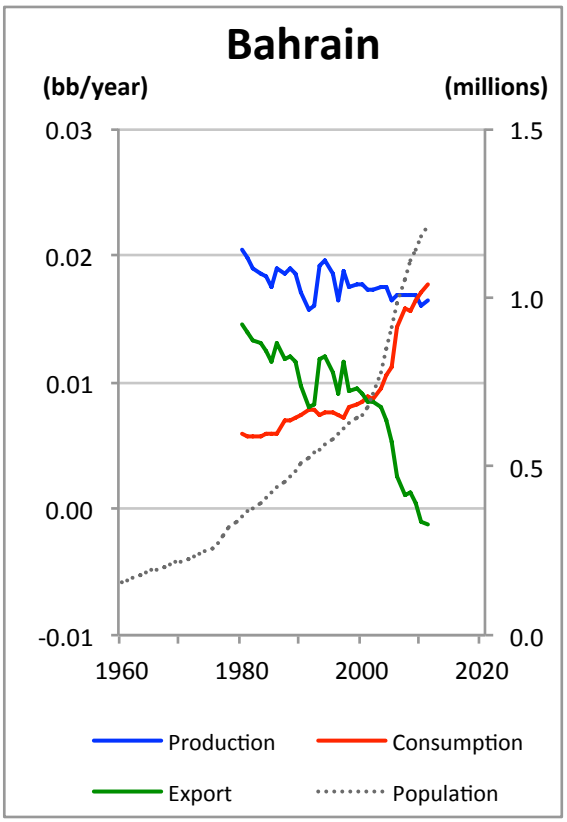
EIA International Energy Statistics http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm

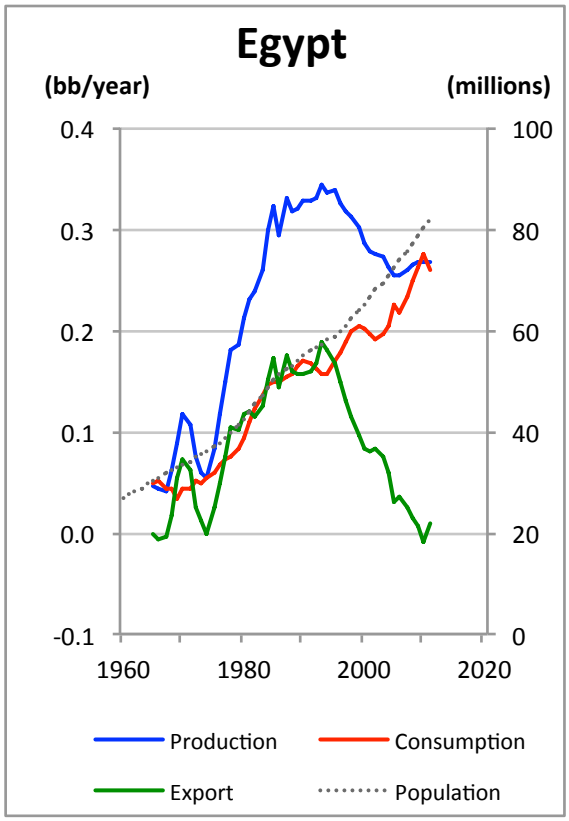
U.S. Census Bureau International Data Base
http://www.census.gov/population/international/data/idb/informationGateway.php

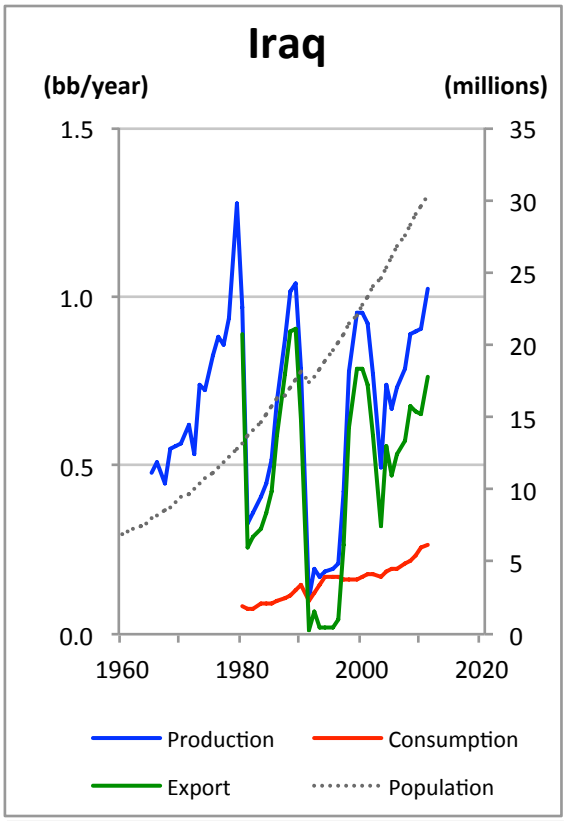
Legend:

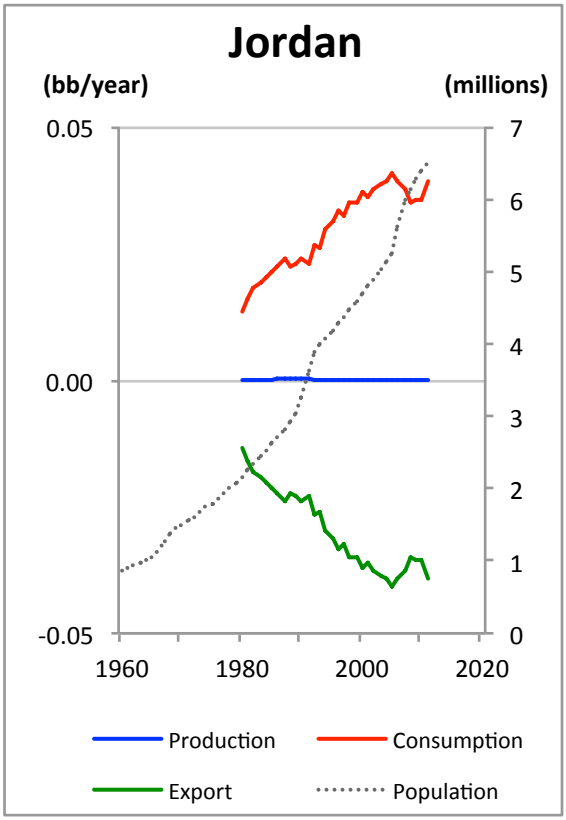
- Production (billion barrels oil per year)
- Consumption (billion barrels oil per year)
- Export net (billion barrels oil per year)
- Population (millions)

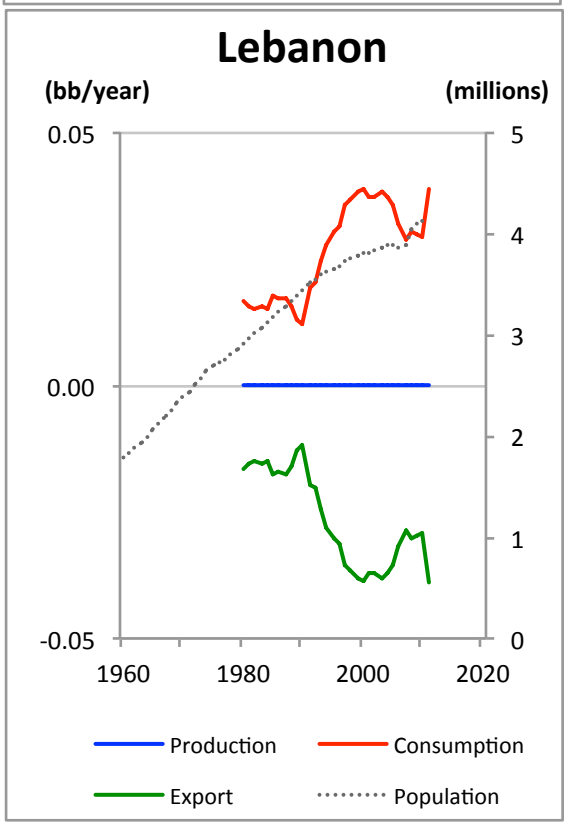


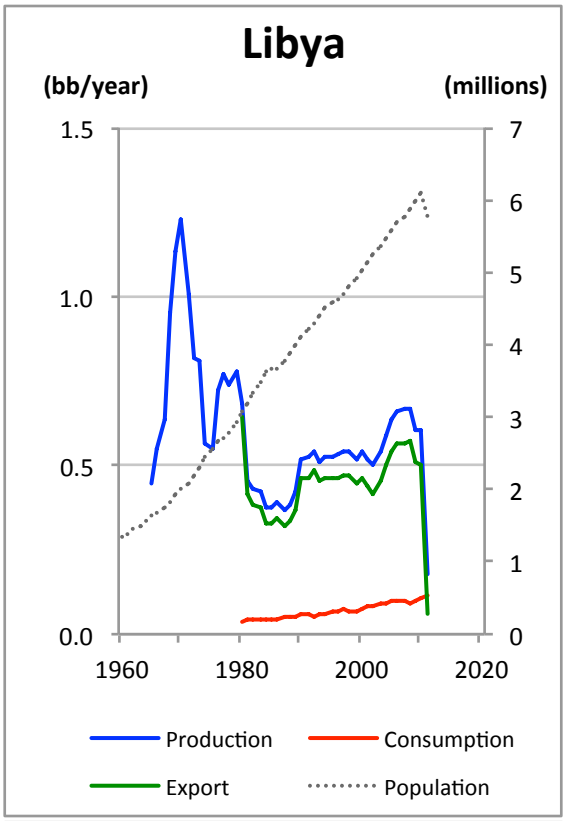


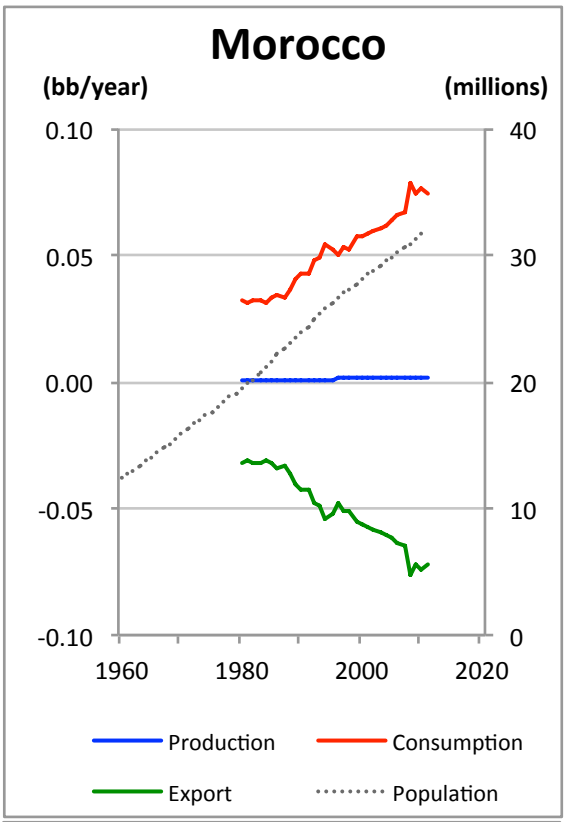

Egypt
(bb/year)
(millions)
0.4
0.3
0.2
0.1
0.0
-0.1
100
80
60
40
20
0
1960
1980
2000
2020
Production
Consumption
Export
Population

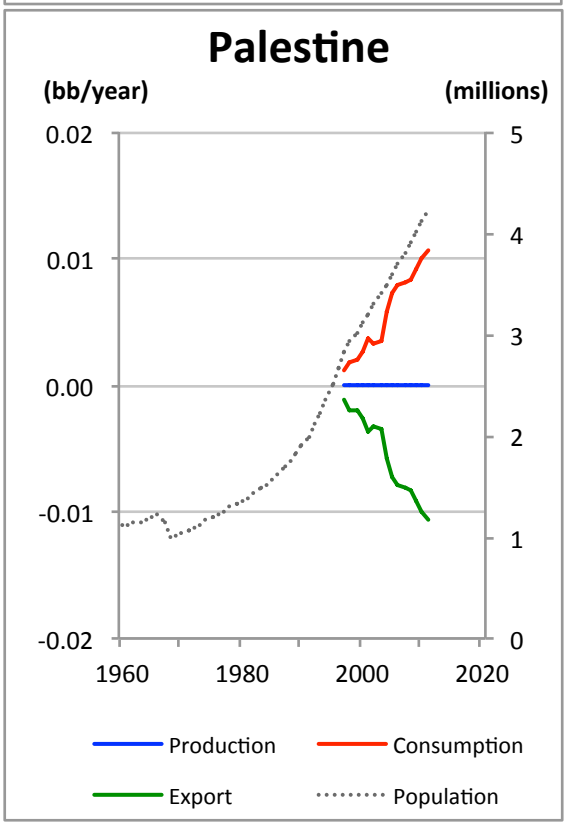

Iraq
(bb/year)
(millions)
1.5
1.0
0.5
0.0
35
30
25
20
15
10
5
0
1960
1980
2000
2020
Production
Consumption
Export
Population

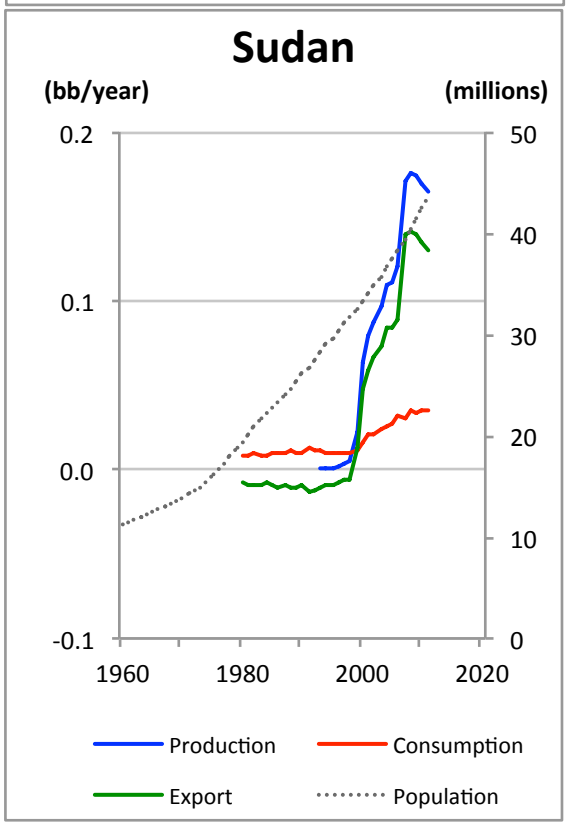

Jordan
(bb/year)
(millions)
0.05
0.00
-0.05
7
6
5
4
3
2
1
0
1960
1980
2000
2020
Production
Consumption
Export
Population

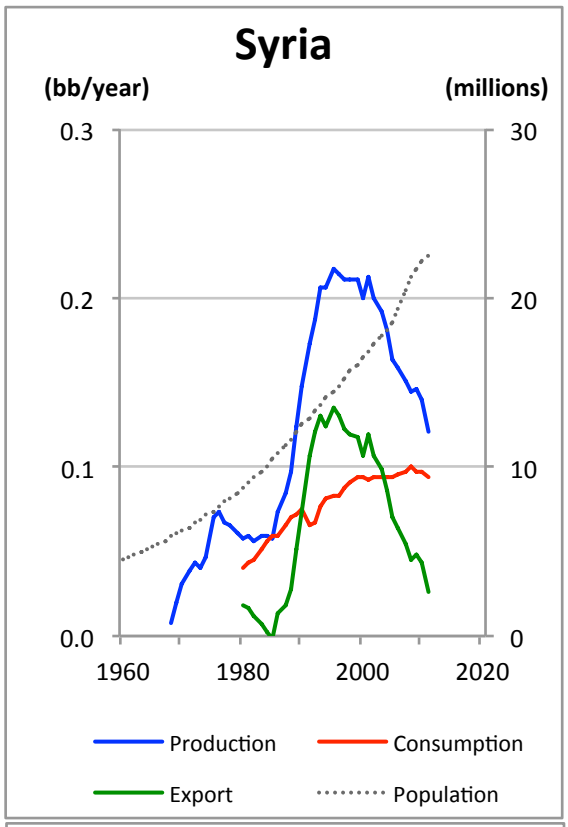

Lebanon
(bb/year)
(millions)
0.05
0.00
-0.05
5
4
3
2
1
0
1960
1980
2000
2020
Production
Consumption
Export
Population

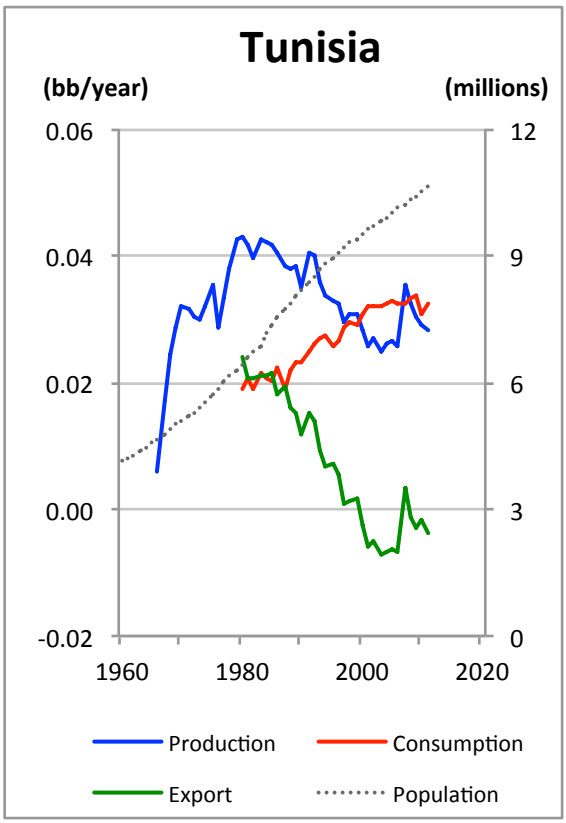

Libya
(bb/year)
(millions)
1.5
1.0
0.5
0.0
7
6
5
4
3
2
1
0
1960
1980
2000
2020
Production
Consumption
Export
Population

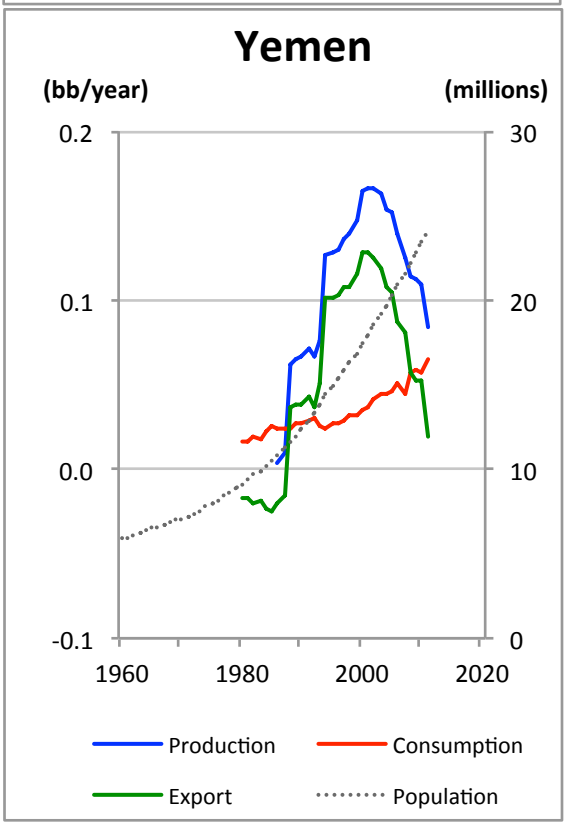

Morocco
(bb/year)
(millions)
0.10
0.05
0.00
-0.05
-0.10
40
30
20
10
0
1960
1980
2000
2020
Production
Consumption
Export
Population


Palestine
(bb/year)
(millions)
0.02
0.01
0.00
-0.01
-0.02
5
4
3
2
1
0
1960
1980
2000
2020
Production
Consumption
Export
Population


Sudan
(bb/year)
(millions)
0.2
0.1
0.0
-0.1
50
40
30
20
10
0
1960
1980
2000
2020
Production
Consumption
Export
Population


Syria
(bb/year)
(millions)
0.3
0.2
0.1
0.0
30
20
10
0
1960
1980
2000
2020
Production
Consumption
Export
Population


Tunisia
(bb/year)
(millions)
0.06
0.04
0.02
0.00
-0.02
12
9
6
3
0
1960
1980
2000
2020
Production
Consumption
Export
Population


Yemen
(bb/year)
(millions)
0.2
0.1
0.0
-0.1
30
20
10
0
1960
1980
2000
2020
Production
Consumption
Export
Population