

THE GREENWAVE PROJECT: ABU DHABI'S ROAD TO 7%

*Renewable Energy Policy Recommendations for the
Abu Dhabi Quality and Conformity Council*



Final Report

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Executive Summary

The Greenwave project is a collaborative effort between the Masdar Institute of Science and Technology and Columbia University's School of International and Public Affairs. Prepared for the Abu Dhabi Quality and Conformity Council (ADQCC) of Abu Dhabi, United Arab Emirates, the aim of this project is to serve as recommendations for an implementation plan to meet Abu Dhabi's goal of 7% electricity capacity from renewable sources by 2020. The falling price of solar photovoltaic systems over the past several years provides a firm economic justification for adopting 7% renewable energy electricity capacity, however policy intervention is required if the emirate aspires to exceed this target. This report examines policy tools available to the government of Abu Dhabi in order to meet this goal, and offers analysis discussing why Abu Dhabi should consider exceeding this percentage in an effort to address long-term sustainability in the emirate.

Abu Dhabi's emphasis on the development of renewable energy resources is rooted in an effort to diversify their economy in the face of a changing world. Volatility in fossil fuel markets, political instability in the region, and the growing threat of climate change necessitate immediate and decisive action from a government that has long been one of the world's most prolific producers of fossil fuels. The emirate's shift to a more renewable-rich mix of energy resources is a pivotal step to become a global center of renewable energy innovation. The timing could not be better. The cost of producing electricity from renewable resources is falling, while the average cost of liquefied natural gas, Abu Dhabi's main source of highly subsidized electricity, is projected to rise dramatically. Not only does adopting renewables make the economy more resilient to financial and political vulnerabilities – such as the reduction of global oil prices – it also makes good economic sense.

To achieve their renewable energy goals, Abu Dhabi must implement appropriate policy tools that incentivize the growth of renewable energy. This report begins by assessing peer reviewed literature and institutional reports that provide policy recommendations for implementing renewable energy in Abu Dhabi and the Gulf

region. The analysis focuses on three policy tools that are widely recommended to spur renewable energy growth:

- Feed-In Tariffs
 - Feed-in tariffs (FIT) are a performance-based policy tool to encourage wide-scale adoption of renewable energy. Governments mandate regional or national transmission companies to purchase the full production of renewable energy at fixed prices, in this context referred to as tariffs, determined by the government.¹ FITs encourage individuals to invest capital in renewable energy projects by providing a financial incentive. The specific structure of a FIT can vary depending on the policy objective that is prioritized; the section in this report covers the various ways it can be implemented as well as the major considerations for the Abu Dhabi context.
- Renewable Portfolio Standards
 - A Renewable Portfolio Standard (RPS) is a policy mechanism to increase renewable energy generation using a cost-effective, market-based approach; it requires electric utility companies to supply a specified minimum amount of customer load with electricity from eligible renewable energy sources. An RPS can create and stimulate market demand for renewable energy, as well as technological development and innovation to increase the generation capacity from renewable resources to a set target.² This report proposes an incremental target-setting scheme for Abu Dhabi to reach 1.5% each year through 2020, leading to 7.5% of electricity load being met by renewable resources in 2020.
- Competitive Bidding
 - Competitive bidding is discussed as Abu Dhabi has historically used this procurement method to spur renewable energy growth. However, this section of the report outlines a new approach for the emirate that aims to increase the emphasis on sustainability-oriented policy objectives, such as water conservation and the use

of local goods and services. This scheme proposes revising bidding scorecards to include and weight criteria to encourage bidders to source projects as locally as possible, as well as to achieve other sustainability-oriented goals in constructing the new renewable energy infrastructure.

The report explains each tool, compares the relative advantages and disadvantages, and discusses the appropriate means for implementing each in Abu Dhabi to best achieve the stated 7% target, as well as options for exceeding this percentage. These implementation schemes aim to not only offer Abu Dhabi a roadmap to become a renewable energy leader in the region, but also to realize the potential benefits of implementing renewable energy. These include: economic diversification, local economic growth and job creation, technological innovation, and regional and global leadership. Abu Dhabi can elevate its renewable energy leadership by implementing these policy tools individually or in combination.

Regardless of the policy approach taken, Abu Dhabi should legally mandate the 7% target. Officials must clearly define which government agency is responsible for implementation. **Clear ownership of the 7% target is essential for success.**

The report identifies several areas for action that will strengthen the chosen policy tool. These action items are cross-applicable regardless of the chosen policy tool, and include:

- Energy Sector Stakeholder Collaboration
Energy sector agencies in Abu Dhabi have identified the lack of communication and coordination among key energy agencies as a major barrier to achieve successful implementation of the 7% renewable energy electricity capacity goal. Efforts should be made to ensure open coordination across energy agencies in the emirate to allow the multiple stakeholders to establish a common agenda.
- Electricity Subsidy Reform
The Abu Dhabi government has taken incremental steps to lower electricity subsidies in order to incentivize more efficient electricity consumption as well as reduce government spending. Continuing this

reform will increase energy efficiency and reduce overall electricity demand, making long term energy goals easier to achieve. Further, reform will increase available funds that could be used for renewable energy investment.

- Licensing and Regulatory Reform

Clearing the way for increased private ownership in the renewable energy sector will send important market signals that demonstrate the legitimacy of the emirate's resolve to meet this goal.

- Research and Development

Masdar Institute has identified limitations in renewable technologies. Officials should dedicate funds to research and development to overcome these hurdles. Expertise in these emerging areas of clean energy research will strengthen the emirate's economic and political position as a leader and innovator in renewable energy.

- Energy Efficiency

Increased energy efficiency can help reduce Abu Dhabi's notoriously high demand for electricity. The impact of renewable energy will increase as a result of limiting future demand for energy, and provide a clear demonstration of the emirate's commitment to environmentally sustainable development.

A summary of our key findings and recommendations can be found in Table 1 below. This figure provides a succinct description of necessary action items and suggests which local energy office should take responsibility for execution. Further, it differentiates short- and long-term action items.

Policy Tools	Potential Regulating Authorities	Immediate actions	Actions by 2020	Justification
Create cross-coordination among energy sector actors	Abu Dhabi Energy Authority	The Executive Council should mandate the Energy Authority to host a biannual meeting where energy sector agencies discuss the renewable energy agenda	Provide continued oversight of policy tools used to deploy renewable energy and ensure targets are met	Establishing a clear mandate for the Energy Authority will create a venue for energy sector players to coordinate their activities and goals surrounding energy sourcing, regulations, and R&D. Assigning responsibilities to specific agencies will allow them to successfully and collaboratively meet established renewable energy targets.
Competitive Bidding for Renewable Energy	Masdar Power; and Regulation and Supervision Bureau (RSB)	Develop and establish sustainability-oriented evaluation criteria (i.e., local job creation) to embed in Request for Proposals	Open request for proposals and select winning bidder for project completion by 2020	Competitive bidding has been successful in Abu Dhabi for the gas sector, and has resulted in historically low global renewable energy prices in the UAE. Adapting the tool to prioritize both price and other policy objectives allows Abu Dhabi to deploy large amounts of renewable energy and to become a world leader in the field.
Feed in Tariff (FIT)	RSB; and Abu Dhabi Water and Electric Company (ADWEC)	Develop an economically appropriate tariff pricing scheme and a clear licensing framework for distributed renewable energy generation	Implement licensing and FIT scheme	FIT can be used to increase distributed renewable generation in order to promote awareness and public acceptance of renewable energy technologies.
Renewable Portfolio Standard (RPS)	Abu Dhabi Water and Electric Authority (ADWEA); and Executive Council	Legally mandate renewable capacity percentage targets, decide on carve-outs for different technologies	Measure achieved capacity and revise targets if necessary	RPS is beneficial, as it legally requires the procurement of a certain percentage of renewable energy in a short time frame. This can be adapted to work in Abu Dhabi by putting the responsibility for administering the program on ADWEA (ADWEC will ultimately procure the resources), and by deciding whether or not to create carve out percentage requirements for specific technologies to achieve additional policy objectives and diversify Abu Dhabi's energy mix.
Renewable Energy Licensing Scheme Revisions	Regulation and Supervision Bureau (RSB)	Revise and upload business license form for utility activities on RSB's website, make available in Arabic	Assign one full time RSB employee to manage communications with utility business applicants	To make renewable energy deployment easier, RSB should upload the business license application form for utility activities in Abu Dhabi on its website, rather than asking private companies to write an email to acquire the business license application. This will benefit both RSB and potential applicants by simplifying application process and saving time.
Research and Development	National Council; and Masdar Institute of Science and Technology	National Council allocates R&D funding to Masdar and the National Research Council	Review success of R&D projects and support commercialization and deployment of viable technologies	R&D for renewable energy technology can bring potential reductions in energy prices, improve efficiency, and increase potential for intellectual property revenues. Masdar Institute should be responsible for conducting R&D on renewable technologies. The Executive Council should directly assign funding to Masdar. The National Research Council should also be allocated a larger budget to fund renewable energy research.

Table 1. A summary of recommended actions to reach the 7% renewable energy target.

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Introduction

Since the discovery of oil, the emirate of Abu Dhabi has experienced staggering population growth and associated energy demand. While the economy is largely dependent on government revenue from oil exports, the emirate has recognized that pursuing environmental sustainability, resiliency, and economic diversification are essential to its future, as outlined in Abu Dhabi's primary sustainability roadmap, Vision 2030.³

The shift toward renewable energy has already begun in Abu Dhabi, as is evident from the establishment of the Masdar Institute of Science and Technology, the creation of renewable energy power plants like Shams 1, and the presence of the headquarters of the International Renewable Energy Agency (IRENA). The Abu Dhabi government is striving to become a regional and global leader in renewable energy innovation and development, and is thereby setting an example for other municipalities and nations to follow. The goal of 7% of Abu Dhabi's installed electricity capacity from renewable sources by 2020 will mark their first significant step toward increasing the emirate's stake in a clean energy future.

There are compelling reasons to justify the government's emphasis on increased renewable energy generation. In addition to mitigating global climate change; there are emirate-specific goals, including economic diversification, decreased reliance on fossil fuels, job creation, and leadership in clean energy technology innovation. Fossil fuel prices are expected to rise sharply in the near future, which increases cost burdens on the government through rising subsidies. Investment in proven, low-cost renewable energy, such as solar photovoltaic systems (PV), is a financial safeguard for Abu Dhabi. Decreasing renewable energy costs provide an economic justification for greater investment in renewable energy technologies. This report identifies areas for action and policy tools that the Abu Dhabi government can use to meet its goal of 7% electricity capacity from renewable resources by 2020. Successes and failures by other governments' actions inform these recommendations.

Commissioned by the Abu Dhabi Quality and Conformity Council as a component of The Greenwave Project, this report supplements the Masdar Institute of Science and Technology's renewable energy technology recommendations for the Abu Dhabi government.

Section 1: Regional Energy Politics and Context

The political landscape in the Gulf States is dominated by the oil wealth and political legitimacy of the ruling families based on their ability, through fossil fuel export revenues, to provide welfare benefits and cheap energy to the population. It is sound to affirm that any policy that might threaten this dynamic would be politically infeasible in the Gulf region. The United Arab Emirates (UAE), while is no exception to this scenario, has chosen a different path than its neighbors in charting a new future of its energy portfolio. On the one hand, a new policy direction is needed to deal with the fact that population growth is rapidly increasing and is coupled with increasing energy demand (surpassing what UAE production provides, if it wants to maintain export capacity).⁴ The UAE is not alone in facing an increasing need for energy that is tied to an increasing need for water. In the Gulf desert environment, Abu Dhabi's water demand has increased by 4% annually, and like its Gulf neighbors, the UAE relies heavily on desalinated water, an energy intensive process, which makes this spike more significant.⁵ Additionally, being a global leader and regional power in international affairs is important to the country, and renewable energy has an important role to play in the ongoing climate change negotiations and sustainable development discourse.

The emirate of Abu Dhabi has launched efforts to invest, deploy and promote renewable energy in light of the rapidly increasing energy demand and the fact that now domestic consumption is outpacing domestic production of fuel, (from 2000 to 2010, consumption level in UAE went from producing 396,000 barrels per day (bpd) to 682,000 bpd, and was not matched by a rise in production).⁶ Therefore, renewable energy technologies are expected to provide a fuel supplement for domestic consumption as well as – on the global stage – position the emirate as a model example of sustainability and a leader in the growing renewable market. Moreover, any political opposition to new energy policies would be geared towards fossil fuel subsidy reform, and not so much on investment and innovation for renewable energy. As the more renewable energy generation is developed, the issue of price will be the primary one on the political agenda; UAE nationals are used to their “national-birthright” to cheap energy. Once solar generation, transmission and distribution become priced, opposition may arise if it increases consumer costs.⁷

Abu Dhabi was appointed the headquarters of the International Renewable Energy Agency (IRENA) in July 2009.⁸ This became the first international organization headquartered in the

Middle East. Abu Dhabi achieved this distinction through intense diplomacy and promising \$135 million in support, including for building Masdar City, the world's first carbon-neutral, zero-waste city powered entirely by renewable energy.⁹ This contributes to an understanding of the political environment of energy in the country: IRENA headquarters is an example of the UAE's positive performance and handling of foreign affairs, enhancing international prestige and proving to be a global player.

Furthermore, it is important to understand that the UAE's target of 7% is relatively ambitious when measured against the lower levels of renewable energy in developing countries and the Middle East region. Minister of Foreign Affairs of the UAE, Sheikh Abdullah Bin Zayed Al Nahyan at the launch of IRENA said, "It was very important for us to offer IRENA a value proposition that would help the agency achieve its goals by engaging with developing and developed nations alike." Dr. Sultan Al Jaber, Chief Executive Officer of Masdar and a key architect of the UAE's bid to host IRENA, added that the efforts by the UAE to encourage non-signatory nations to join IRENA not only strengthened the UAE bid but also strengthened the organization itself, which grew from 75 member states at the time of its foundation in January 2009 to over 130 countries to date. Moreover, the Abu Dhabi Fund for Development created a special endowment of up to US \$50 million annually to be used for loans in support of renewable energy projects in the developing world.¹⁰

The Abu Dhabi government's aim to position the emirate as a supporter and developer of renewable energy has led to several pioneer initiatives, as aforementioned. Efforts have been made to promote public awareness over renewable energy. For example, Abu Dhabi hosts an annual sustainability week, with events such as the annual Masdar City Festival.¹¹ From May 4 to 5, 2014, the UAE hosted the Abu Dhabi Ascent, a high-level two-day meeting to generate momentum for the United Nations Climate Summit.¹² Its foreign image also boosts domestic legitimacy, as the population values the international role the country can play on the global stage. The OPEC-member country stands out in its regional and international prestige as clean energy leader in this context of sitting on top of 10% of the world's oil reserves.

The viability of policy reform in Abu Dhabi will depend on what components of its existing political framework and well-established bureaucratic structure that it targets. Indeed, the UAE and all Gulf States are heavy top-down bureaucracies that rely on their large state revenue to ensure provisions to their citizenry. If the security of the government budget is

ensured, while its ability to provide jobs and welfare benefits to population remains unaffected by a change in policies or prices, then economic justification can support a new policy framework. Furthermore, pegging the United Arab Emirates as a global champion for renewable energy and its capital, Abu Dhabi, as an international hub for innovation and market invigoration would also be a driving factor to the Emirate's adoption of a new direction in energy sustainability.

Section 2: Literature Review – Current Policy Perspectives

This report seeks to synthesize the common themes in academic and institutional literature relating to the achievement of Abu Dhabi's 7% renewable energy goal. Reports were selected on the basis of applicability to Abu Dhabi specifically or the Gulf Region. The reports analyzed include:

- "Renewable Energy Prospects: United Arab Emirates" report by Masdar Institute and International Renewable Energy Agency (IRENA)¹³
- "Switch on the Lights—Unlocking the UAE's Solar Potential," by PwC¹⁴
- "Delivering on the Promise of Energy Efficiency in the Middle East," by Oliver Wyman Consulting¹⁵
- "Renewable Energy in the GCC: Status and Challenges," by Ferroukhi *et al*¹⁶
- "Renewable Energy Policy Options for Abu Dhabi: Drivers and Barriers," by Mezher, *et al*.¹⁷
- "Renewables 2014 Global Status Report," by the Renewable Energy Policy Network¹⁸

Key themes emerged in this literature review. Most of the identified recommendations fall under the following categories

- Fossil fuel subsidy reduction
- Use of incentives for private investment in the development of renewable energy technology and its implementation
- Use of incentives for development and implementation of renewable energy technology
- Re-definition of Abu Dhabi's regulatory framework to include renewable energy sources.

Most recently in April 2015, IRENA released a renewable energy roadmap for the United Arab Emirates titled "Renewable Energy Prospects: United Arab Emirates."¹⁹ The report provides several key factors and recommendations that will spur the growth of renewable energy in the country:

- A 10% share of renewables in the overall UAE energy mix by 2030 would achieve annual savings of USD 2.6 to 5.6 billion through avoided fuel costs and associated health and environmental benefits.
- Rapidly increasing natural gas prices and decreasing renewable energy costs provide a clear financial rationale for increased deployment of renewables.

- Encouraging industries and authorities to make investments based on actual, and not subsidized gas prices, can lead to greater renewable energy penetration.
- A clearly scheduled deployment program will be beneficial for the renewable energy sector and allow for reductions in the cost of energy procurement.

The other studies and reports reviewed largely corroborate these findings. They highlight major areas of the renewable energy landscape that will enable Abu Dhabi to more easily meet its renewable energy goals:

- Prices of renewable energy infrastructure are dropping rapidly, and the United Arab Emirates has recently achieved the lowest production rate of solar PV energy at less than 6 cents/kWh.²⁰ This is below the cost of new natural gas supplies, as well as below the cost of nuclear and coal, enabling Abu Dhabi to achieve a greater amount of energy from renewable resources than ever before.
- Abu Dhabi's fossil fuel reserves are being recognized as finite.²¹
- The population and economy of the emirate are rapidly increasing, and with it, there is growing energy demand, which also threatens to cut into hydrocarbon exports.²²
- Abu Dhabi's wealth and financial autonomy allow it to pursue becoming a leading global player in the field of renewable energy research, development, and innovation.²³
- With the recent plunging oil prices, the need to diversify the economy as well as sources of energy is of high priority.²⁴

A recommendation for fossil fuel subsidy reduction is universal among our studied experts. Experts contend that by retaining high subsidies, the cost of energy from renewables is artificially high by comparison, de-incentivizing investment in renewable programs or technology.^{25,26} An additional reason for subsidy reduction concern the environmental impacts of inaction. The low energy costs faced by consumers in Abu Dhabi have rendered its residents and companies some of the highest energy consumers per capita in the world. Without higher energy bills, they will continue to be some of the highest greenhouse gas contributors in the world.²⁷

Several reports recommended the use of incentives for private investment as a way to develop the renewable energy technology sector and its implementation of renewable energy programs and technology. By incentivizing private entities, the burden of success from initial capital outlay does not fall on the government, making it easier to convince policymakers to pursue the incorporation of renewables. Examples of incentives include providing subsidies,

soft loans (i.e., low interest loans), and other financial incentives to renewable energy sector stakeholders.²⁸

Lastly, implementing a clear regulatory framework that governs renewable energy technology and implementation was widely recommended among experts.²⁹ One of the major impediments in the advancement of any the 7% goal has been a distinct lack of “ownership” of the goal; without delegated entities to shepherd the process of research, development, and implementation progress has been exceptionally slow.

In addition to clarifying the regulatory framework, experts have supported more specific recommendations, such as:

- Create entities devoted to the development of policies and regulations³⁰
- Re-evaluate the price of electricity from conventional sources and renewable energy sources³¹
- Include mandatory regulations in the building sector
- Improve the accuracy of national data collection so that future regulations can be better targeted.³²

A detailed comparison of these expert report recommendations can be found in Table 2.

Table 2: Existing Policy Recommendations by Other Public & Private Entities:

<u>Policy Recommendation</u>	<i>Switch on the Lights—Unlocking the UAE's Solar Potential</i>	<i>Delivering on the Promise of Energy Efficiency in the Middle East</i>	<i>Renewable Energy in the GCC: Status and Challenges</i>	<i>Renewable Energy Policy Options for Abu Dhabi: Drivers and Barriers</i>	<i>Renewables 2014 Global Status Report</i>	<i>Renewable Energy Prospects: United Arab Emirates</i>
Fossil fuel subsidy reduction	Low electricity retail prices prevalent in the UAE can make solar power appear artificially expensive.	Review existing energy subsidies, and determine how and to what degree these could be replaced with incentives that promote greater energy efficiency.	Changes in subsidies or pricing mechanism of conventional fuels should take into account environmental impacts of continuing usage	✓	A level playing field can lead to a more efficient allocation of resources, strengthening initiatives for development and implementation of energy efficiency and renewable energy technologies	Subsidized energy pricing can have a slowing effect on the growth of consumer-led distributed generation and renewable energy for transportation.
Private investment		Encourage collaboration with the private financial sector in order to establish public-private tools to facilitate financing.	✓			A policy framework for distributed generation could mobilize private investment.
RE technology incentives	FIT identified as the most attractive policy option	Despite success in promoting energy efficiency, financial incentives are usually insufficient to capture full potential, Incentives need to be accompanied by policies that directly target the needs of each customer segment.		Calls for a policy mix utilizing a FIT and a quota system.	Support policies (e.g. FIT) have been primary drivers of renewable energy market. However, a long-term plans should be included for retaining attractiveness post-FIT.	Supports a clear deployment plan that would likely utilize FIT (for state-owned and private companies) or government-led competitive bidding.
Update to regulatory framework	Develop a clear and attractive regulatory framework	✓	Create entities devoted to the development of policies and regulations	Re-evaluate the price of electricity from conventional sources and renewable energy sources.	Include mandatory regulations in the building sector and improve the accuracy of national data collection	✓
Other Recommendations	Survey results revealed that a majority of market participants view government as the key driver for the development of solar power by providing a clear and attractive regulatory framework..	Calls for development of national energy efficiency strategies and clear standards of accountability within governing bodies			Contents that analysis of future energy systems must focus on adaptation of existing infrastructure and ongoing integration of large shares of renewable energy.	Recommends a mandated comparative cost analysis of supply technologies prior to energy investment decisions.

Table 2. A comparative view of the recommendations made in the literature included in this assessment. A red check indicates that the policy is recommended but no additional comments are made

Section 3. Conventional v. Renewable Energy: Cost Consideration

In order to foster a resilient economy, it is critical that Abu Dhabi's government considers the future of fossil fuel prices, as the majority of the emirate's income is derived from exporting these resources. With an electricity sector that is almost entirely fueled by natural gas, it is especially important to prepare for increasing gas costs, both from LNG and domestic sources. Already a net-importer of natural gas, imports and domestic production of this resource in Abu Dhabi are increasing with population and electricity demand increases. The emirate also uses natural gas for enhanced oil recovery, adding to increasing demand. Global LNG prices are expected to stay high in conjunction with domestic prices, which will increase due to the high sulfur content of Abu Dhabi's natural gas reserves, which makes refining more costly.³³ These factors indicate that in order to maintain low electricity prices for consumers, the amount Abu Dhabi spends subsidizing electricity rates for consumers will also increase, and the emirate will be left especially vulnerable to any spikes in LNG prices.³⁴

In light of this, Abu Dhabi's decision to diversify its energy mix to include a higher percentage of renewables is wise, as the prices of renewable energy production have dropped dramatically over the past few years. Solar PV module prices dropped 75% from 2009 to 2014. The UAE also recently achieved global historic low prices of less than 6 cents/kWh for the production of solar PV energy, making PV a viable economic option at today's cost of natural gas. Even in countries with less favorable solar conditions, many utility scale PV plants are able to achieve a cost of around 8 cents/kWh, which is competitive with fossil fuel energy.³⁵ With lower production costs, the emirate will have to spend less to subsidize electricity costs for consumers, freeing up significant additional revenue. This revenue can be used for further investment in research and development of clean energy, driving the UAE's Year of Innovation and spurring Abu Dhabi to become a global leader in clean energy technology, which could provide additional revenue in the future.^{36, 37} It is also critical to note that the Abu Dhabi Water and Electricity Company (ADWEC) is currently in the process of running a complex model to determine the currently economically viable level of renewable energy for the emirate. With such low PV prices, this percentage is expected to be much higher than 7%.³⁸

Section 4: Policy Tools

This section evaluates three policy tools that have been applied by various governments for renewable energy deployment. The advantages, disadvantages, and best practices of each policy as well their applicability to Abu Dhabi are discussed.

4.1 Feed-in Tariffs (FITs)

Feed-in tariffs (FITs) are a performance-based policy tool to encourage wide-scale adoption of renewable energy by creating an artificial demand. The term “feed-in tariff” is derived from a 1990 German law called “Stromeinspeisungsgesetz,” literally translating to “electricity feeding-in law.”³⁹ FITs have been recognized as an efficient tool to advance the rapid deployment of renewable energy resources.⁴⁰

In this model, governments mandate regional or national transmission companies to purchase the full production of renewable energy at fixed prices, in this context referred to as tariffs, determined by the government.⁴¹ Thereby, the utilities are required to feed-in the electricity generated from renewable energy resources into the electricity grid. The tariffs are either fixed above market energy price, or are designated as bonus tariffs on top of the base market price. Feed-in tariffs are fixed at a level that allows the producers to recover their initial investment and also earn a profitable rate of return. The payments can either be in the form of electricity alone or electricity plus renewable energy certificates (RECs), and are generally awarded as long-term purchase agreements over 15-20 years.⁴² The purchase agreements often have various payment levels for each kilowatt-hour and can vary according to the technology (e.g., wind, solar, biomass).⁴³ Often, FITs include technology improvement factors mandating investors to either improve their technology or receive reduced payments over time, by allowing utilities to raise electricity rates annually at a rate equal to or less than the rate of inflation.⁴⁴ The funding for long-term purchase agreements can either be provided from government funds or utility companies may be mandated to purchase the electricity produced, thereby passing the costs on to consumers.⁴⁵

FITs encourage individuals to invest capital in renewable energy projects by providing a financial incentive. A producer could be a small wind farm, a home with solar rooftop panels or a large biogas plant, among other small or large-scale renewable energy technology generation systems.

The main purpose of FITs is to attract private investment and thereby promote renewable energy deployment. Numerous other policy objectives need to be considered when implementing FITs, as this type of policy can integrate environmental, economic, technology, and industry objectives (e.g. economic diversification, environmental benchmarks).⁴⁶ Therefore, the specific structure of a FIT can vary based on which policy objective is prioritized. Due to the considerable success in promoting renewable energy development worldwide using FITs, countries will continue utilizing this policy tool.⁴⁷ Countries such as Germany, Austria, Turkey, United Kingdom, Norway, United States (US), China, and India have utilized the FIT policy tool in varying degrees.⁴⁸

Advantages

Various advantages to the deployment of FIT policies have been identified, including:

- Promote the usage of renewable energy resources
- Drive innovation and development of RE technology, eventually leading to price reductions⁴⁹
- Contribute to meeting countries' renewable energy, energy security and emissions reductions goals⁵⁰
- The establishment of FIT policies indicates a government's commitment to developing a green-technology sector.⁵¹
- The programs can reduce the regulatory and economic barriers to ownership.
- Allows for the investments of non-traditional developers
- Encourages regional investments towards economic and social welfare
- Promotes large-scale RE energy market developments as well as small-scale distributed energy market penetration (e.g. small solar parks in villa complexes)
- Drives market growth through the long-term purchase agreements
- Reduces investors risk through the long-term purchase agreements
- Supports future market stability through the long-term purchase agreement
- Varies based on technology and location, increasing the success rate of the policy⁵²
- Most cost-effective way to bring renewable energy online⁵³
- Create sustainable jobs⁵⁴

Disadvantages

Certain challenges have been identified in the implementation of FIT policies, including:

- The complexity of its design and difficulties in determining an accurate pricing scheme that can vary based on scale and technology
- The establishment of a pricing scheme requires future estimations and long-term forecasting of the market, which can be “notoriously imprecise and inaccurate”⁵⁵
- If the rate is too high, electricity prices will increase. If the rate is too low, renewable technology will not be developed as quickly as potentially desired⁵⁶
- If the tariff is too high, owners will be excessively compensated, the market will overreact, and the program can exhaust its resources, creating a policy-driven industry “boom and bust” cycle.⁵⁷
- Policy needs to be designed such that the guarantee in investment cost recovery does not result in windfall profits⁵⁸
- Changes in technology demand constant adjustment of policies and prices
- Potential need for policy and price adjustments to conform to ongoing technology changes
- Continuous adjustments to policy and price are undesirable and increases overall market risk⁵⁹
- The policies do not address the barrier of high up-front costs, something that rebate programs and other “capacity-based” incentives can offer.⁶⁰

FIT Case Study: Jordan

Jordan was the first country in the region to introduce FITs in December 2012. These tariffs are based on the cost of generation model. The tariffs differ among technologies, which include wind, solar PV, concentrated solar, biomass, and biogas.⁶¹

According to a study by the Jordan Electricity Regulatory Commission, individual households can decrease their bill by as much as 70% with the addition of one kW of solar panel capacity due to the FIT incentive scheme. They will be able to pay back the upfront costs of the solar panels in 5-7 years based on the return on investment.⁶²

For larger scale renewable energy providers, the FIT structure is more complex. As the government solicits projects through competitive bidding, the FIT tariffs can affect or even determine the prices that bidders propose for projects.⁶³ The higher the tariff rate, the more aggressive the bid from potential renewable energy providers will be.

FIT Adaptability to Abu Dhabi

As evident from the above discussion, designing and implementing a successful feed-in tariff policy is complex. Careful planning is necessary to address global and regional disruptions in the energy market. For instance, the recent drop in prices of solar PV power generation removes the need for financial incentives for investment provided by a FIT. The below checklist contains considerations for a successful FIT in Abu Dhabi.

Feed-in Tariff in Abu Dhabi Checklist	☐ Extend eligibility for RE investment to non-traditional developers ☐ Provide simple long-term purchase agreements to investors ☐ Guarantee price certainty through stable, long-term purchase agreements ☐ Mandate utilities to purchase renewable energy and to provide grid access ☐ Establish a cost-based tariff differentiation based on scale and technology ☐ Establish a tariff degression scheme wherein tariffs reduce over time ☐ Establish market controls, such as cap participation or capacity ☐ Establish periodic tariff adjustment procedures ☐ Create a licensing framework for distributed generation ☐ Incorporate consistent revisions and amendments to FIT
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4.2 Renewable Portfolio Standards (RPS)

A Renewable Portfolio Standard (RPS), is a policy mechanism to increase renewable energy generation using a cost-effective, market-based approach. An RPS requires electric utility companies to supply a specified minimum amount of customer load with electricity from eligible renewable energy sources. The goal of an RPS is to stimulate market and technology development, and implements a timeline that mandates an incremental increase in energy generation sourced from renewable resources. Furthermore, an RPS can create market demand for renewable and clean energy supplies.⁶⁴ Currently, there is a wide variation in policy design of existing RPS tools, with regard to the minimum requirement of renewable energy, implementation timing, eligible technologies and resources, and other policy design details.⁶⁵ In many RPS policy designs, utilities must obtain renewable energy certificates or credits (RECs) for the required percentage of their generation. A REC is created for each megawatt-hour

of electricity (or equivalent energy) generated from a qualifying renewable energy source. In order to allow utilities some flexibility in complying with the requirement, RECs may be bought, sold or traded separately from the associated energy. Existing functional REC markets work to ensure that the lowest-cost energy is used to comply with the standard. RECs also provide a steady stream of income for owners of renewable power plants, further incentivizing their development. Though RPS is generally agnostic to specific renewable energy technologies, some RPS policies have technology specific carve outs, such as for solar or wind, to further encourage the development of that resource.⁶⁶

Advantages

An RPS policy scheme has many benefits; the greatest support behind this tool is that it is a market mechanism that encourages innovation, as renewable energy generators have incentives to develop low-cost renewable power plants.⁶⁷ This can be enhanced further if revenues from penalties for not procuring adequate RECs are imposed and channeled towards research and development or direct investment in renewable energy. RPS policies have been successful in spurring new markets and expanding industry in the United States, from Texas to New York, as well as in South Korea. They have been shown to accelerate economic growth and energy diversification in their ability to capitalize upon local resource capacity in the most efficient and lowest-cost mechanism for the introduced technologies. RPS policies have provided governments with a concrete way to legislate a goal or stated objective of integrating renewable energy resources into the national energy portfolio. Moreover, advancing this new energy market has spurred investment as well as the development of new public-private partnerships.⁶⁸ RPS schemes leverage resources in a way that enables the smooth and coherent development of the technology by enforcing eligibility requirements. Additional revenue streams for renewable producers provide an incentive for new players to enter the market. Importantly, RPS policies create a legally mandated requirement for renewable energy percentage requirements, ensuring that these targets will be met, and they allow for flexibility in achieving other policy goals by using carve-outs to incentivize certain technologies.

Disadvantages

RPS schemes have historically been criticized because they can increase the cost of electricity generation by forcing investment in new, relatively expensive technologies. However, this is becoming less of a problem as renewable energy prices are becoming more competitive with fossil fuel prices. Additionally, RPS schemes have in the past been written too broadly, allowing energy resources that are not traditionally considered to be renewable to qualify, which hinders the development of true renewable resources in the target area. RPS schemes have also been known to silo renewable energy development toward the lowest-cost technology, creating a lack of energy diversification. This issue can be resolved with carve-outs, which provide additional percentage mandates for specific technologies.⁶⁹

Potential RPS Scheme for Abu Dhabi

The proposed RPS scheme for Abu Dhabi would take an incremental approach to achieving and surpassing a stated percentage of renewable energy by 2020. It is important to note that RPS policies are very flexible, and therefore the carve-outs and mandated percentages can be changed to incentivize any chosen technologies in any amount.

As an example, an RPS in Abu Dhabi could follow a four year time-table that could be adapted to any projected percentage target by adjusting the figures accordingly. For example, beginning in 2016, electricity distribution companies will be required to meet a certain percentage of their load with eligible renewable resources. This requirement would increase by a specified percentage each year through the year 2020, which will lead to the ultimate target percentage of electricity load being met by renewable resources in 2020. Additionally, in 2016, a specified percentage of the overall renewable requirement may need to be met by desired technologies such as wind, CSP, or distributed generation sources under a certain capacity.

Adopting the 7% target as an example, this policy proposal follows a four year time-table that could be adapted to any projected percentage target by adjusting the figures accordingly. Beginning in 2016, electricity distribution companies will be required to meet 1.5% of their load with eligible renewable resources. This requirement will increase by 1.5% each year through the year 2020, which will lead to

7.5% of electricity load being met by renewable resources in 2020. Additionally, in 2016, 1% of the overall renewable requirement must be met by distributed generation sources under 25 kw in nameplate capacity (a “carve-out”). An additional carve-out is included for wind energy in order to promote energy mix diversification. A summary of the RPS requirements is shown in Table 3 below. In order to show compliance with RPS requirements, load-serving entities must procure renewable energy credits (RECs), or show that they have provided electricity to their customers directly from renewable energy. Renewable generators would create one REC for every MWh of power generated from eligible renewable energy resources. RECs would be traded between generators and load-serving entities in order to commodify the environmental benefits of renewable power, to provide additional revenue streams for renewable generators, and for load-serving entities to show compliance with RPS requirements. In Abu Dhabi’s current energy landscape, a REC market would not be robust enough to function properly, as ADWEC is currently the only load-serving entity, and electricity generators are all at least partially state-owned. As it is also possible to implement an RPS without creating a REC market if the desired renewable energy resources (e.g. solar PV systems) are economically competitive with traditional fuel sources and don’t require additional funding to be developed, it is recommended that Abu Dhabi not utilize a REC trading scheme. However, should the energy sector become more liberalized in the future, a REC scheme could provide additional benefits to an RPS tool.

**Table 3: Example Renewable Portfolio Standard
Requirements***

Year	% from Eligible Renewable Resources	% from Wind (of total percentage)	% from Distributed Generation (of total percentage)
2016	1.5 %	12 %	1 %
2017	3 %	14 %	1 %
2018	4.5 %	16 %	1 %
2019	6 %	18 %	1 %
2020	7.5 %	20 %	1 %

*The percentage targets in this table utilize 7% by 2020 as an example of the policy goal, but can be easily adjusted and adaptable to any higher percentage target.

The proposed RPS seeks to leverage the cost-comparative appeal of renewable resources that are now available at lower prices than before. Innovation can be achieved in Abu Dhabi with an RPS, as developers will seek to build power plants that are both technologically efficient and at lowest-cost. Moreover, RPS schemes promote economic diversification and job creation through invigorating a market for local renewable resources; success stories include over half of the states in the USA and South Korea's national RPS plan. RPS also has the advantage of legally mandating the renewable energy target percentage; as this report has identified lack of institutional ownership as a primary obstacle to achieving renewable energy goals. Interviewed officials insist that this type of a top down approach is very successful in Abu Dhabi, as a mandate from the Crown Prince would give energy stakeholders the security needed to reach the target.⁷⁰

Case Study: RPS in South Korea

South Korea adopted a renewable portfolio standard (RPS) in 2012 in order to “promote clean energy, reduce carbon emissions, and develop a local green-industry to accelerate economic growth”.⁷¹ The RPS is designed to increase renewable power generation from 2% by 2012 to 10% of total power generation by 2022 by requiring an additional one half of one percent of new renewable power added annually from 2012 to 2016, increasing to one percent per annum through 2022. This equates to an estimated 350 MW annually through 2016, increasing to about 700 MW annually thereafter. Electric utilities and independent power producers that have an excess of 500 MW of power generation capacity are required to comply with the RPS. Power providers can meet the RPS by installing qualifying technologies or by buying renewable energy credits.⁷² South Korea’s RPS also specifies a carve-out for solar PV in order to specifically promote its development.⁷³

The South Korean RPS has been very successful and shows how a similar policy could be successful in Abu Dhabi. Investments in renewable energy increased from \$616 million in 2007 to \$4.03 billion by 2011. Of this, PV accounted for over 80%, with wind accounting for 16.2%. The number of companies and key players active in Korea's new renewable energy sector increased from 41 in 2004 to 212 in 2010. Additionally, employees engaged in the renewable energy industry grew from only 689 in 2004 to 17,348 in 2010, noting that 11,556 are employed in the PV and wind power industries alone.⁷⁴

4.3 Competitive Bidding

Competitive bidding is a procurement method in which competing companies are invited to bid by openly advertising the scope, specifications and terms and conditions of the proposed contract as well as the criteria by which the bids will be evaluated, often through a Request for Proposals (RfP). The process aims to obtain goods and services at the most competitive price by following a bidding process that can be either open or closed.⁷⁵ A power purchase agreement (PPA) often results from the competitive bidding process for electricity generation, and has shown to be a useful tool to encourage private and foreign investors to invest in renewable energy projects.⁷⁶ The process requires evaluation criteria for the public authorities to assess the advantages of the proposed projects. Some criteria points may include the quality

of the project and technology, the cost of the electricity produced, the jobs created, and other benefits to the local economy.

Advantages

This method is typically favored by public entities as, by encouraging competition to bid for the lowest price, the price of the work is driven down, and it is largely considered a transparent process. Because industry is incentivized to make the lowest possible bid, price discovery is considered a strong advantage to the process. Therefore, competitive bidding informs the establishment of a feed-in tariff rate as it allows government agencies to gauge the pricing of renewable electricity generation based on received bids. If combined with a PPA, it allows for a minimizing of subsidies and also encourages investment in the deployment of renewable energy.⁷⁷ The UAE has seen major advantages from utilizing such a method for renewable energy projects already. The original Dubai Integrated 2030 Strategy set targets for reducing energy consumption by 30% by 2030 as well as a target of 5% renewable energy generation capacity by 2030. However, on January 21 2015, Dubai announced it would triple its 2030 renewable energy to 15%. This came as the result of a record-low bid of roughly 6 cents per kWh for solar energy from Acwa Power. This cost established solar energy as a cheaper alternative than fossil fuels for Dubai.⁷⁸ This price discovery would likely not have happened without a competitive bidding process. This new record-low bid confirms that the emirate will not need to subsidize new utility installations for future solar PV projects.

Disadvantages

The procedures that drive this process are also critical to its success or its failure. One important drawback is that there is often little information of what incentives are available, which undermines competition and discourages investors. Case studies have shown that projects secured through competitive bidding were never carried out largely due to the fact that bidders had issued power prices too low to profitably run the planned power plants, leading to project abandonment by the developers. For example, in the United Kingdom 1990 tendering scheme, less than one-third of all projects were installed over the following decade (by 2003). To prevent this, we recommended that policy-makers implement buy-ins that incentivize compliance. For example, Abu Dhabi could require that bidders provide an upfront cash deposit when

bidding. In the event that the selected bidder fails to comply with the terms of the agreement, this deposit would not be refunded.

It is essential to emphasize on the significance of local economic growth coupled with power cost reduction. For example, in the United Kingdom, all necessary equipment was imported from outside countries, which led to its bidding mechanism to be criticized for not enhancing local renewable energy development. More importantly, this can result from one important disadvantage that has been widely identified: the lack of regularity and inconsistency in the call for tenders. “Stop-and-go” development cycles in renewable energy industry have been created when legislators call for tenders irregularly; the establishment of a national industry can be offset by this lack of continuous support. Therefore, a strong degree of national energy planning is needed to support coherent and effective implementation of this tool, including annual targets for installed capacity for renewable energy power generation, such as RPS.⁷⁹

A Competitive Bidding Scheme for Abu Dhabi

Competitive bidding has proven to be an effective process for procuring clean energy in Abu Dhabi. However, a new approach should be adopted to embed local sustainability objectives (e.g., minimizing pollution, emphasizing local job development), as well as to promote innovative technology upgrades in contracted power facilities that are aligned with Abu Dhabi’s clean energy research and development pursuits. RfP guidelines should ask bidding candidates to provide the lowest cost renewable energy, but also heavily weight the fulfillment of other sustainability objectives achievable within their proposed system. RfP scorecards should give more points to bidders who use local resources; equipment, technology, and human capital from within the emirate. Guidelines that emphasize the use of local resources will encourage the establishment of relationships between the major private investors and local businesses, stimulating the economy and creating jobs in the renewable industry sector. The RfP guidelines should also provide weight to bidders that commit to regularly seek the implementation of the latest technological upgrades to their energy generation facilities. Upgrades would likely enhance system efficiency or higher sustainability standards.

RfP Description: Name of Reviewer:	Bidder 1 Score: 0 - 5	Bidder 2 Score: 0 - 5	Bidder 3 Score: 0 - 5	Weight: 1 - 5	Total Awarded Points	Max Points Possible
Evaluation criteria:						
Optimum area use and sustainable design				3		15
Waste management and sustainable supply chain				3		15
Water conservation				4		20
Cost per kWh				5		25
Use of local supply chain				5		25
Renewable energy industry job creation				4		20
Total:						

Table 4 An example RfP scorecard with weights given for local development, sustainability, and cost per kWh parameters.

Table 4 was designed to illustrate a simplified scorecard that could be utilized by Abu Dhabi to evaluate responses to an RFP, but could be adapted by local agencies to further specify criteria. Bidders' proposals would be evaluated according to sustainability, local development, and cost per kWh. Each bidder in this scenario is given a score from 0 to 5 for each criterion and then the score is multiplied by the weight value, which is a value from 1 to 5. A value of 5 in the weight column for example would indicate great significance of the assessed criteria. A scorecard with equal emphasis on local economic growth, energy cost, and sustainability would guarantee a multifaceted competitive bidding scheme for Abu Dhabi. This focus is essential to ensure that bidders would give equal considerations when drafting proposals to the criterion Abu Dhabi deems necessary for future sustainable development of the renewable energy sector.

Section 5: Areas for Action

This section outlines important considerations that are applicable across the spectrum of policy options recommended in this report. Each of these actions will send appropriate market signals to solidify private sector confidence in Abu Dhabi's renewable energy market and help position the emirate as an economic and political leader in renewable energy technology development.

5.1 Energy Sector Stakeholder Collaboration

Energy sector agencies in Abu Dhabi have identified the lack of communication and coordination among key energy agencies as a major barrier to achieve successful implementation of the 7% renewable energy goal. Efforts should be made to ensure open, collaborative coordination across energy agencies in the emirate. Coordination of this type allows multiple stakeholders to establish a common agenda, and ensures that government action on energy initiatives, including renewable energy implementation, incorporates the input of the entire energy sector. A group of collaborating agencies should include:

- Abu Dhabi Energy Authority
- Abu Dhabi National Oil Company (ADNOC)
- Abu Dhabi Quality and Conformity Council (ADQCC)
- Abu Dhabi Water and Electric Authority (ADWEA)
- Abu Dhabi Water and Electric Company (ADWEC)
- Abu Dhabi National Energy Company (TAQA)
- Abu Dhabi Transmission and Despatch Company (TRANSCO)
- Emirates Nuclear Energy Corporation (ENEC)
- Executive Council
- Federal Authority for Nuclear Regulation (FANR)
- Masdar
- Ministry of Energy (MOENR)
- Ministry of Foreign Affairs (MOFA)
- Regulation and Supervision Bureau (RSB)
- Supreme Petroleum Council

Regularly scheduled meetings of these agencies will allow each entity to communicate interests and ensure a unified energy agenda across the emirate.

5.2 Electricity Subsidies and Renewable Energy in Abu Dhabi

Recent changes in Abu Dhabi fuel subsidies

The emirate is beginning to move toward the goal of reducing electricity subsidies, as new, lower subsidy rates were announced in November of 2014 and came into effect in January 2015. Authorities stated the express purpose of subsidy reduction was to reduce consumption.⁸⁰ Those that consume resource past a determined threshold are charged a higher rate.

For expatriates living in a flat or villa, electricity prices increased from 15 fils per kWh to 21 fils per kWh for those with a daily consumption of up to 20kWh. For Emiratis living in an apartment who keep their usage under 30kWh per day, their price stays the same as the previous price of 5 fils per kWh, or 400kWh for villas.⁸¹ Beyond that threshold, and the price jumps to 5.5 fils per kWh. While the change in price is negligible for most Emiratis, some expatriates have expressed worry over their increase, stating that this change in price will ensure they are more conscious and careful about their consumption.⁸²

Reducing Electricity Subsidies

Abu Dhabi's current subsidies, which include both electricity and industrial and transportation use of fossil fuels, create a distorted energy market by creating artificially low domestic hydrocarbon fuel prices. While this may not discourage investment from utilities that are aware of the comparative net generation costs, subsidization directly exacerbates the lack of financial incentives for individual consumers or companies to invest in their own renewable energy development. Even if renewable energy is cheaper than natural gas, subsidization of electricity prices means they rationally will not consider solar PV installations on their roofs or sites.⁸³ In addition, reduced domestic consumption of fossil fuels allows Abu Dhabi to sell these resources at much higher world prices, increasing revenues for the emirate.

As shown in Figure 1, Abu Dhabi has extremely high electricity consumption rates, reaching nearly double those of the United States (US). This is largely due to highly

subsidized electricity rates, which discourage consumers to take energy efficiency measures or to conserve energy. These widely recognized issues with fossil fuel subsidies have led many countries to begin to reform their subsidy policies. The International Energy Agency (IEA) reports that as many as 27 countries across the world are currently considering reducing fossil fuel subsidies in order to increase the competitiveness of renewable energy.

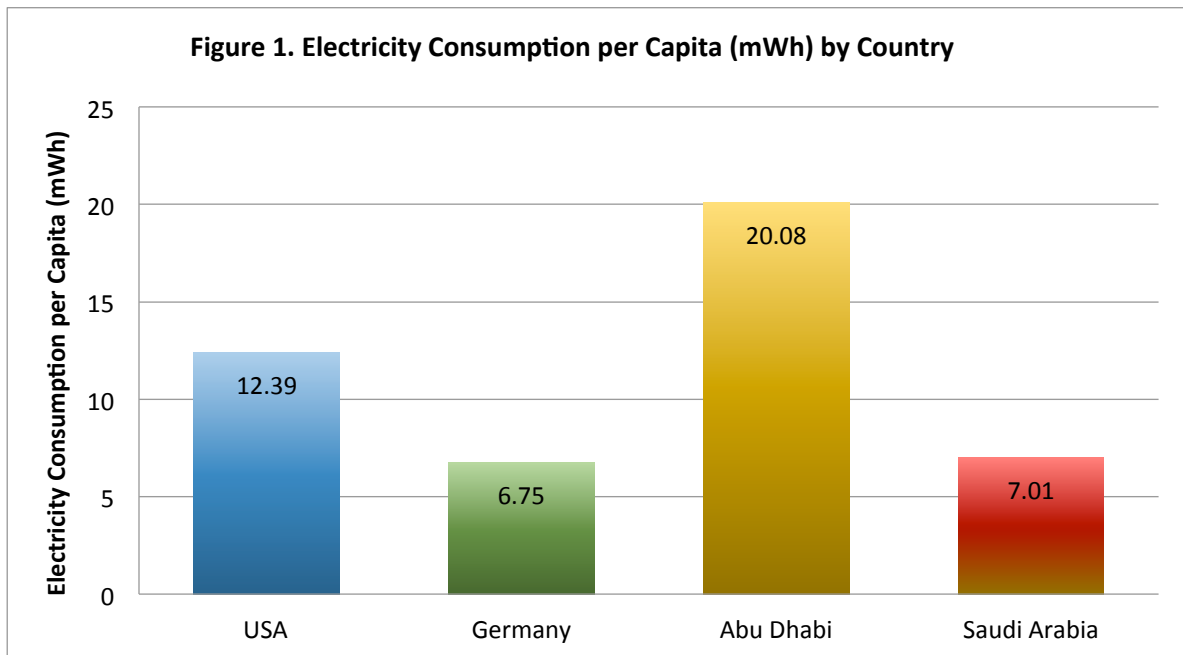


Figure 1: Electricity Consumption per Capita by Country
(Source: CIA World Factbook 2013, Statistics Center - Abu Dhabi [SCAD])

Abu Dhabi has recently enacted fossil fuel subsidy reform through an increase of power and water prices, and further reform is encouraged by the UAE Minister of Energy and other officials. It has been reported that there are plans to deregulate the market and move away from a publicly owned energy sector in the UAE.⁸⁴ Reducing electricity subsidies would also free up revenue for the emirate to invest in research and development of the next generation of innovative renewable energy technologies, and position itself as a global leader in the industry. These factors all indicate that fossil fuel subsidy reform is viable solution for Abu Dhabi, and should be pursued in order to demonstrate the emirate's commitment to a sustainable energy future. In addition, subsidy reform can be coupled with demand side management techniques (e.g. energy

efficiency programs) in order to further reduce overall demand and more easily achieve renewable energy capacity targets.

5.3 Relax Electricity-Related Licensing Regulations for Foreign Investors

The Abu Dhabi Regulation and Supervision Bureau (RSB) issues and requires a license for any utility-related activities in Abu Dhabi. This includes the generation, transmission, and distribution of electricity. RSB clearly defines the application process on its website, and the process is simple and transparent.⁸⁵ Some foreign investors, however, have found it difficult to obtain a business license to engage in utility-related activities in Abu Dhabi unless they apply as a joint venture with investors that are based in Abu Dhabi.⁸⁶ This difficulty discourages foreign actors to invest in Abu Dhabi's renewable energy market. Furthermore, the barrier to enter the Abu Dhabi's renewable energy market imposes additional challenges to the Abu Dhabi government, as it necessitates funding renewable energy projects largely from its internal budget due to the limited availability of foreign capital in the Abu Dhabi renewable energy market.

Reforming electricity-related licensing for foreigners will bring multiple economic benefits to Abu Dhabi by attracting foreign capital into Abu Dhabi's renewable energy market. First, the government of Abu Dhabi can reduce its budgetary spending on expanding renewable energy infrastructure in Abu Dhabi, as foreign capital can account for a larger share of the total market capital in the renewable energy sector. Second, the inflow of foreign capital will expand the renewable energy market in Abu Dhabi, diversifying its national economy. Historically, the economy of Abu Dhabi has been heavily dependent on fossil fuels exportations as the oil-related activities account for more than a half of GDP and up to 90% of government revenue.⁸⁷ The diversification of the emirate's economy will make the economy more resilient to financial crises, such reductions in the global oil price as is currently taking place. Third, the growing number of foreign investors will bring more investments and technological innovation to Abu Dhabi's renewable energy market. This will help Abu Dhabi maintain its position as a global leader in the both conventional and renewable energy market.

5.4 Research & Development

In conjunction with these types of reforms, Abu Dhabi should invest in research and development (R&D) toward new and better renewable technologies, as well as toward other sustainability issues. This will give the emirate the opportunity to develop intellectual property that can be sold for additional revenue on the world market and that can solidify Abu Dhabi's place as a world leader in renewable energy, especially during its year of innovation. Additionally, R&D can help overcome barriers to entry for renewable energy technologies, such as by lowering costs or reducing technical problems associated with renewable energy in the emirate and region. Abu Dhabi should quickly allocate an annual budget to its National Research Council in order to achieve these macroeconomic benefits of R&D. Listed below are items that have been identified as important for increased R&D. For more information, please see page ____ in Masdar Institute's technical report.

Technology R&D opportunities

Opportunities for R&D that are critically important to the region include:

- Dust-resistant solar PV panels
- Smart PV plants that are able to alert workers when cells aren't functioning in order to maximize power output
- Low-cost batteries for solar PV energy storage
- CSP improvement – although currently expensive, CSP provides a solution to the intermittency of renewable energy through storage capability
- Waste to energy
- Biofuels and petrochemical improvements
- Renewable energy grid integration technology
- Reverse osmosis for decoupling the water and energy sectors

These technologies will be critical to renewable deployment throughout the Middle East, as dusty (sandy) conditions currently reduce the efficiency of solar PV plants and require more regular cleaning of the solar panels. In addition, improvements to CSP will not only create new energy storage solutions, but will also likely lead to further drops in price for this technology. Waste management is a commonly cited problem for Abu Dhabi, and increasing the efficacy and efficiency of waste to energy technologies could provide a solution to this problem, increase renewable energy in

Abu Dhabi, and could lead to valuable intellectual property for the emirate. These types of technologies would also contribute to Abu Dhabi's goal to divert 85% of its municipal solid waste from landfills by 2030.^{88;89} Increased R&D for biofuels, petrochemicals, and reverse osmosis can help to reduce the significant impact of the transportation and water sectors on Abu Dhabi's electricity and energy consumption. R&D on increasing the lifespan of the grid integration equipment, such as power inverters, is an opportunity to expand Abu Dhabi's renewable energy market as well as to develop patents to be sold abroad.

5.5 Energy Efficiency

Under the UAE's Estidama program, new buildings in Abu Dhabi must meet energy efficiency standards. Abu Dhabi has implemented energy efficiency programs, including conservation targets in the electricity sector, peak demand reduction targets, energy efficiency labeling, and appliance standards; however, there are no targets addressing the transportation or water sectors.⁹⁰ Abu Dhabi should enforce stricter energy efficiency standards and increase energy efficiency targets across sectors, as this would be effective in reducing energy demand within Abu Dhabi and also make it easier for the emirate to meet its renewable energy capacity goals. Abu Dhabi should also strictly enforce its Estidama building codes in order to achieve the established goals of that program. Overall demand for energy decreases with strict efficiency standards, total capacity requirements drop, and the need for both fossil fuels and renewable energy decreases, such as is projected to occur with the Estidama scheme.⁹¹ This means that with energy efficiency measures in place, Abu Dhabi will be able to meet a percentage renewable energy capacity goal by 2020 with fewer power plants.

Conclusion

The government of Abu Dhabi can reach the 7% target by adopting a cost-saving policy approach that creates and stimulates a renewable energy market, promotes local economic development, and achieves domestic energy diversification. These features are critical to enabling the UAE to continue its ascent as a regional and global leader of a new energy future – as well to reduce long-term energy costs, now that solar PV is cheaper than new supplies of natural gas for electricity.

This approach requires implementing a mix of market-driven measures as well as investment policy tools. A Renewable Portfolio Standard scheme can create a market that encourages innovation and incentives healthy economic competitiveness. As has proven successful globally yet under-utilized in the Middle East, RPS can be launched in Abu Dhabi as an example for other countries in the region to emulate. Similarly, an appropriately priced FIT can spur the growth of renewable energy with optimal cost-effectiveness.

In order to reap the full benefits of these policy tools, renewable electricity-related licensing for foreign investors needs to be relaxed and reformed. This will enable the government to reduce its spending on expanding renewable energy while helping the emirate diversify its national economy. Expansion of power generation through renewable energy also presents the government an opportunity to cut down on its subsidy bill. The falling cost of solar power generation can help ease the subsidy burden.

With its vast desert stretches, abundant sunshine and commitment to advancing renewable energy and sustainable development, Abu Dhabi is presented ample opportunity. The existing initiatives have helped the emirate gain international attention. By pursuing policies that further investment in renewable energy R&D, as well as drive the growing regional market, the emirate can lead by example and truly become a global hub of innovation.

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