

# **Deployment of Solar Energy in Saudi Arabia:**

## **A Case Study**

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## Introduction

Saudi Arabia—the world’s largest producer and exporter of oil—intends to utilize renewable energy. The Kingdom of Saudi Arabia has allocated \$109 billion for the development of renewable energy and plans to introduce utility-scale solar energy into the Nation’s power system.<sup>1</sup> Saudi Arabia, however, has not approved a national renewable energy policy to date. Therefore, this paper will explore the optimal legal framework to encourage utility-scale solar in Saudi Arabia in the context of recent announcements from government officials. First, I will provide a brief overview on energy in the Kingdom followed by a discussion of the drivers that spurred Saudi Arabia to recognize the need to develop a sustainable renewable energy program. Second, I will provide the framework for successful deployment of renewable energy and apply this framework to Saudi Arabia’s market and existing statutes. This latter discussion will be divided into two parts: (1) policy considerations; and (2) technology considerations. Finally, I will provide a conclusion that summarizes my findings and recommendations.

### 1. Energy in Saudi Arabia: A Brief Background

It is no wonder that the word “oil” immediately pops into one’s head when mentioning the Kingdom of Saudi Arabia. Indeed, Saudi Arabia owns one-fifth of the world’s proven oil reserves, and the country is the world’s largest producer and exporter of pure petroleum liquids.<sup>2</sup> In fact, eighty to ninety percent of total Saudi revenue comes from oil export revenue, and this

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<sup>1</sup> Wael Mahdi & Marc Roca, *Bloomberg*, (May 2012), <http://www.bloomberg.com/news/2012-05-10/saudi-arabia-plans-109-billion-boost-for-solar-power.html>.

<sup>2</sup> US Energy Information Administration, *Country Analysis Briefs, Saudi Arabia* (last updated: January 2011), <http://205.254.135.7/countries/cab.cfm?fips=SA>.

revenue comprises forty percent of the country's Gross Domestic Product (GDP).<sup>3</sup> Thus, Saudi Arabia's economy is largely dependent on oil, notwithstanding the government's ongoing attempts to diversify the sources of income through development of petrochemical industries. Natural gas is another important energy source in the Kingdom of Saudi Arabia. According to the *Oil and Gas Journal*, Saudi Arabia has proven natural gas reserves estimated at 275 trillion cubic feet, which means it ranks fourth in the world in gas reserves. Natural gas is mainly used for petrochemical manufacturing.<sup>4</sup>

## 1.1 Electric Generation and Energy Consumption

Because of the country's wealth in its natural resources, oil and natural gas has served as the only sources of electric generation.<sup>5</sup> Historically, the massive petroleum resources, combined with high prices for oil exports and government subsidies on domestic oil use, have led the country to unprecedented economic growth and development. These factors have made Saudi Arabia the largest consumer of petroleum in the Middle East, particularly in the areas of transportation fuels and electric power generation. In addition, according to a study of the *Energy Information Administration*, Saudi Arabia was the fifteenth largest consumer of total primary energy in 2008, of which sixty percent was petroleum-based and the rest from natural gas.<sup>6</sup>

Saudi Arabia's massive economic and development boom, in combination with population growth, has led to a dramatic growth in the domestic demand for electric power.

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<sup>3</sup> US Energy Information Administration, *Country Analysis Briefs, Saudi Arabia* (last updated: January 2011) <http://205.254.135.7/countries/cab.cfm?fips=SA>.

<sup>4</sup> *Id.*

<sup>5</sup> Index mundi, *Saudi Arabia Electricity Production by Source*, [http://www.indexmundi.com/saudi\\_arabia/electricity\\_production\\_by\\_source.html](http://www.indexmundi.com/saudi_arabia/electricity_production_by_source.html).

<sup>6</sup> US Energy Information Administration, *Country Analysis briefs, Saudi Arabia* (last updated: January 2011) <http://205.254.135.7/countries/cab.cfm?fips=SA>.

Studies show that domestic oil consumption rose by fifty percent between 2000 and 2008. Around three-quarters of this increase was associated with electricity generation to meet an increasing demand of eight percent annually.<sup>7</sup> *Saudi Aramco*, the state-owned oil company, anticipates that the Kingdom will consume half of its export revenue within twenty years if this percentage of demand growth continues. This fact means that this rapidly growing domestic demand for electric power constitutes a vital problem facing the Nation. Thus it is critical for the government of Saudi Arabia to find a solution to meet the growing demand for electric power.<sup>8</sup>

There are two approaches that the Saudi Government could follow to satisfy this rapidly increasing demand for electric power. The first approach is to increase the production rates of oil; this solution might be effective for the short term. It would, however, harm the country's economy in the long term. The second solution is to develop alternative energy sources to replace the current fuel sources used for electric generation.

## **1.2 Drivers to Developing Renewable Energy Sources in Saudi Arabia**

The development of alternative energy resources would be the best solution not only to meet the growing demand for electric power, but also to address various social and economic problems. For instance, Saudi Arabia is experiencing relatively high unemployment, which would be alleviated by increased employment opportunities in emerging renewable energy industries. Indeed, a report published by *Al Riyadh Newspaper* suggests that generating 5 Gigawatts (GW) of solar energy by 2020 would create 15,000 job opportunities in the solar

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<sup>7</sup> Essam Al-Ammar & Abdelhakim Hammach, *Renewable Energy in Saudi Arabia* (May. 29, 2010), [http://www.renewablesb2b.com/data/ahk\\_saudi\\_arabia/downloads/files/RTV.pdf](http://www.renewablesb2b.com/data/ahk_saudi_arabia/downloads/files/RTV.pdf).

<sup>8</sup> *Id.*

industry in Saudi Arabia.<sup>9</sup> Furthermore, developing renewable energy as a source of electric generation would reduce greenhouse gas emissions and help Saudi Arabia meet its commitments under the Kyoto Protocol and other international agreements. Moreover, renewable energy will not only meet the increasing national demand for electric power, but also could provide excess power for export, particularly solar-generated electricity.<sup>10</sup> Thus solar energy constitutes the key renewable energy source and best alternative to fossil fuels in Saudi Arabia.

As mentioned above, oil is the first thing to come to mind when mentioning Saudi Arabia, but sunlight follows close behind. The Kingdom is located within the equatorial sunbelt, where more solar radiation hits the earth than any other place on the globe. The best available measurements indicate that Saudi Arabia receives an average of 2,200 thermal kilowatt-hours (kWh) of solar energy per square meter of land area every day, which is an abundant amount of freely available solar energy just waiting to be harnessed.<sup>11</sup> In an article written by Susan Kraemer and published on April 12, 2012 titled “*Saudis Could Export Solar for the Next Twenty Centuries*,” Ms. Kraemer described the Kingdom’s solar potential as follows:

“Every square meter of Saudi Arabia produces an extraordinary 7 kilowatts of energy daily in each 12 hours of sun power. If the Saudis were to use up each days solar energy supply, or 12,425 TWh of electricity, it would be a 72 year supply.”<sup>12</sup>

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<sup>9</sup> Alriyadh newspaper, *Saudi Arabia world largest solar exporter in 2020*, (Jan 9, 2012) <http://www.alriyadh.com/2012/01/09/article699417.html>.

<sup>10</sup> International Energy Agency, *Renewable Energy, Markets and Prospects by Region* (Nov, 2011)

<sup>11</sup> Andrew Burger, Clean Technico, *Could Saudi Arabia Become The Next Solar Market Hotspot*, (Jan. 8, 2012), <http://cleantechnica.com/2012/01/08/could-saudi-arabia-become-the-next-solar-market-hotspot/>.

<sup>12</sup> Susan Kraemer, Green profit, *Saudis could export solar for the next twenty centuries*, (Apr. 12, 2012), <http://www.greenprophet.com/2012/04/saudis-could-export-solar-for-the-next-twenty-centuries/>.

## 2. Dynamics of Successful Renewable Energy Deployment

Today, research, development, and demonstration (R,D&D) play a crucial role in the deployment of renewable energy technologies. In contrast, conventional energy technologies have undergone more than 150 years of research and learning.<sup>13</sup> During the phases of R,D&D, a wide range of barriers are encountered, threatening a successful deployment of renewable energy. The barriers to deployment of renewable energy can be divided into two main categories: economic barriers and non-economic barriers. Economic barriers are related to the maturity and costs of a given technology compared to competing alternative technologies. In contrast, non-economic barriers consist of all other barriers facing deployment of renewable energy, such as regulatory and policy uncertainty, institutional and administrative barriers, market barriers and financial barriers.<sup>14</sup> Deployment of renewable energy and the state of market progress can be broken down into three phases:

- Inception phase: when the first example of the technology is developed.
- Take-off phase: when the market grows rapidly, leading to large-scale deployment.
- Market consolidation phase: where deployment grows towards the maximum level.<sup>15</sup>

Furthermore, renewable energy policies proposed by governments are instruments that are aimed to overcome the barriers by various mechanisms, such as setting a legally binding target for electric power production generated from renewable energy sources or providing applicable mechanisms to reach that target. Nevertheless, each policy must be tailored to fit the current state of the national market in different jurisdictions and to adapt to the changing barriers

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<sup>13</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable* (Nov. 2011). at p 34, [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf).

<sup>14</sup> *Id.* at 32.

<sup>15</sup> *Id.* at 32.

as market development progresses (through the phases mentioned above).<sup>16</sup> In general terms, it can be said that a good policy is a country's roadmap for a successful deployment of renewable energy.

### **3. The Issue**

In order to encourage utility-scale solar energy in Saudi Arabia, what is the optimal role for the government and what is the optimal legal framework?

### **4. Discussions and Analysis**

According to Rajaa Kamel, a Business Development Director of a leading Saudi company in the solar energy field, there are two main barriers to introducing utility-scale solar into the Saudi Arabian power system. The first barrier is the lack of a regulatory framework and the uncertainty about the responsible regulatory agency, which typically sets the policies, establishes the standards for the industry, and ensures access to the electric grid. The second barrier to introducing utility-scale solar in Saudi Arabia is determining the best suitable solar technology for Saudi Arabia's environment.<sup>17</sup> In order to further analyze the situation, the discussion will be divided into two categories: (1) policy considerations, and (2) technological considerations.

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<sup>16</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable* (Nov. 2011), [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf). At p 31.

<sup>17</sup> Interview with Rajaa Kamel, Business Development Director, Dallah Albarka Corporation, Jeddah, Saudi Arabia (Mar. 2012). Currently Dallah is considering business opportunities in the solar energy field, possibly in the local supply chain.

## 4.1 Policy Considerations

In order for the utility-scale solar industry to overcome the barriers in Saudi Arabia and help to overcome the challenges facing the Kingdom, the government must take action and work on policies and regulations alongside research and development. That said, in April 2010, the government of Saudi Arabia announced its intention to undertake the development of alternative energy by launching a new specialized agency in the field of nuclear and renewable energy, *the King Abdullah City for Atomic and Renewable Energy* (“KA-CARE”). KA-CARE was created by a Royal Decree, pursuant to the recommendations of a Ministerial Committee, which was established to study the Nation's current and future demand for electricity.<sup>18</sup> The creation of KA-CARE can be viewed as the Saudi Arabian government’s first official step toward fulfilling its commitment to developing sustainable alternative sources of energy. Moreover, KA-CARE has prepared the Saudi Arabian National Policy on Renewable Energy. The policy has been submitted to the Council of Ministers for approval.<sup>19</sup> And although it is not published yet, it is expected to be the cornerstone for the whole solar industry. A policy, however, can constitute a non-economic regulatory barrier and can cause damaging effects if it is not set on the right terms, overlaps with existing laws and regulations, is set for a short term, or is non-transparent.<sup>20</sup> Thus in order for the Saudi Renewable Energy Policy to serve its intended purpose in paving the way to successful deployment, the policy should consider addressing the issues described below:

### 4.1.1 Setting a National Target

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<sup>18</sup> Royal Decree, No. A/35, [http://www.energy.gov.sa/\\_pdf/KACARE%20Royal%20Decree%20english.pdf](http://www.energy.gov.sa/_pdf/KACARE%20Royal%20Decree%20english.pdf).

<sup>19</sup> 1<sup>st</sup> Saudi Renewable Energy Conference and exhibition, (Feb, 2012)  
<http://www1.kfupm.edu.sa/sarece/Speakers.html>.

<sup>20</sup> Janet L. Sawin, *National Policy Instruments, Policy Lessons for the Advancement & Diffusion of Renewable Energy Technologies Around the World* (Jan, 2004), available at <http://www.renewables2004.de/pdf/tbp/TBP03-policies.pdf>.



The most important element of a renewable energy policy is RES-E target (electricity generated from renewable energy sources). As previously mentioned, the National Renewable Energy Policy is not published yet; however, several semi-official announcements have been issued recently from government sources and KA-CARE executives. These announcements suggest that a target of 54,000 MW of electricity generated from renewable energy sources be installed by 2020, mostly solar energy.<sup>21</sup> Most importantly, this target should be legally binding. The establishment of a renewable energy goal in Saudi Arabia would be an important first step. Setting the target, however, is not sufficient. Any final renewable energy policy should also set forth applicable mechanisms to overcome each barrier in the market and should revise the mechanisms as the market progresses in order to help assure the achievement of the target.<sup>22</sup>

#### **4.1.2 Institutional and Administrative Barriers**

Currently, two different Saudi Arabian government agencies - *King Abdullah City for Atomic and Renewable Energy* (“KA-CARE”) and the *Electricity and Cogeneration Regulatory Authority* (“ECRA”) – have legal authority relating to utility-scale solar energy. But the respective roles and responsibilities of these two agencies potentially overlap. Uncertainty in the regulatory framework and ambiguity about the responsible institution is considered one of the main barriers facing the development of renewable energy in the Kingdom because this situation could lead to administrative problems. For example, solar developers could face uncertainty about the rules for interconnecting solar energy to the grid because of uncertainty about the agency responsible for setting such rules. Such institutional and administrative barriers would

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<sup>21</sup> Renewable Energy World, <http://www.renewableenergyworld.com/rea/news/article/2012/05/saudi-arabia-launches-massive-renewable-program-with-hybrid-fits> (May, 2012).

<sup>22</sup> For the purposes of this I only accommodated the substantial barriers facing Saudi Arabia.

discourage prospective investors and could impede Saudi Arabia's efforts to attract both domestic and foreign investments in renewable energy development.

On one hand, ECRA is an independent agency that governs the electricity industry in Saudi Arabia by implementing the Saudi Electricity Law (the "Electricity Law"), which was issued by a Royal Decree in 2005. Generally, the Electricity Law addresses five main topics, including the licensing framework, tariffs, restructuring of the electric industry, and competition. Article 1 of the Electricity Law defines the electric industry as services or activities, including electricity generation, cogeneration and transmission of electricity, distribution, supply, and trading.<sup>23</sup> ECRA's mission is primarily to develop a complete legal framework for the electric industry in accordance with the Electricity Law. Moreover, Article 4 of the Electricity Law stipulates ECRA's duties and subparagraph 1 of this article grants ECRA the authority **"To issue the implementing regulations and procedures for the Articles of the law (Electricity Law) in relation to the duties of the Authority."**<sup>24</sup>

On the other hand, KA-CARE—the second governmental body—was granted jurisdiction over solar energy development. According to the Royal Decree, KA-CARE is intended as a specialized scientific institution entrusted with setting and implementing the national atomic and renewable energy policy. This agency is intended to contribute to the development of Saudi Arabia through utilization of research, science, and industries relating to alternative energy while maintaining the country's prosperity.<sup>25</sup> Furthermore, according to Article 3 subparagraph 1 of the KA-CARE's bylaws, in order for the KA-CARE to achieve its objectives, it is authorized to

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<sup>23</sup> The Saudi Electricity Law, Chapter 1, article 1, <http://www.ecra.gov.sa/pdf/electricitylawen.pdf>.

<sup>24</sup> The Saudi Electricity Law, Chapter 1, article 4, <http://www.ecra.gov.sa/pdf/electricitylawen.pdf>.

<sup>25</sup> Royal Decree, No. A/35, [http://www.energy.gov.sa/\\_pdf/KACARE%20Royal%20Decree%20english.pdf](http://www.energy.gov.sa/_pdf/KACARE%20Royal%20Decree%20english.pdf).

**“propose the national renewable energy policy and set the plans and strategy for implementing such policy and propose the relevant bylaws and regulations.”<sup>26</sup>**

A review of some of the details of the Electricity Law further highlights the nature of current uncertainty in the regulatory framework. Utility-scale solar electric generation will involve power generation, transmission, and distribution, and these activities are defined in Article 1 of the Electricity Law as part of the electric industry.<sup>27</sup> Thus solar energy developers will have to comply with the Electricity Law even though the law did not expressly include solar or renewable energy into its scope. For example, Chapter 3 of the Electricity Law further addresses the licensing framework for the electric industry and mandates licensing in order to carry out any electrical activity.<sup>28</sup> Developers in the electricity sector apply for enforceable licenses from the responsible authority, ECRA. This licensing framework and its implementing regulations cover six types of licenses: generation, co-generation, transmission, distribution, trade, retail, and authorization (the last of which must be granted for preparatory work), and the Law assigns ECRA with the authority to issue such licenses.<sup>29</sup> Thus a reasonable interpretation of the relevant laws is that a developer of a utility-scale solar plant would have to submit a license application following ECRA’s procedures, as the current law mandates. It is true that solar energy is not specifically referenced in the Electricity Law and is the focus of a specialized entity that governs renewable energy (KA-CARE). Utility-scale solar, however, involves electric generation, and such generation falls under the scope of electric industry definition as an electric activity and thus must be governed by current Electricity Law, implemented by ECRA.

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<sup>26</sup> Royal Decree, No. A/35, [http://www.energy.gov.sa/\\_pdf/KACARE%20Royal%20Decree%20english.pdf](http://www.energy.gov.sa/_pdf/KACARE%20Royal%20Decree%20english.pdf).

<sup>27</sup> The Saudi Electricity Law, Chapter 1, article 1, <http://www.ecra.gov.sa/pdf/electricitylawen.pdf>.

<sup>28</sup> The Saudi Electricity law, chapter 3, <http://www.ecra.gov.sa/pdf/electricitylawen.pdf>.

<sup>29</sup> The Saudi Electricity Law’s implementing regulations, chapter 3, <http://www.ecra.gov.sa/pdf/implementingregulations.pdf>.

In addition, the Electricity Law does not include an article defining the sources of energy used to generate electricity. This means that solar power falls into the subject matter of this law as long as it is used to generate electricity.

Under the current legal framework in Saudi Arabia, it appears that KA-CARE's responsibilities are directed to setting the "big picture" national renewable energy policy, plans, and strategy. It also appears that ECRA's responsibilities are focused more on the "nuts and bolts" of permits and licensing as well as enforcement.

The potential area of conflict, however, between ECRA and KA-CARE seems to arise in the development of new policies and implementing regulations. In addition, potential conflict arises regarding changes and amendments to existing regulations where ECRA's current rules do not fit the needs of the new renewable energy industry. Both agencies have the authority to issue rules and regulations,<sup>30</sup> and it is inevitable that the new solar industry will require adjustments to established electric regulation policies to function efficiently. Solar electricity differs from oil-fired and gas-fired electricity because of its intermittent nature, and in the U.S., rules in areas such as interconnection and transmission scheduling have been adjusted to accommodate the intermittent nature of the resource. Who will propose the regulations to implement the national renewable energy policy when such rules require changes in existing rules promulgated by ECRA? The answer to that question is not clear.

In essence, the existence of two governmental agencies relating to solar electric generation could have negative effects on the deployment of utility-scale solar electric generation because of the potential for overlap of functions. On one hand, The Electricity Law designates ECRA as the sole governmental agency with authority over the electric power industry, and

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<sup>30</sup> The Saudi Electricity Law, Chapter 1, article 1, <http://www.ecra.gov.sa/pdf/electricitylawen.pdf> / Royal Decree, No. A/35, [http://www.energy.gov.sa/\\_pdf/KACARE%20Royal%20Decree%20english.pdf](http://www.energy.gov.sa/_pdf/KACARE%20Royal%20Decree%20english.pdf).

ECRA provides a legal framework for operation and licensing. On the other hand, KA-CARE recently has been vested with the authority to propose the national renewable energy policy pursuant to the Royal Decree and to set the plans and strategy for implementing such policy and proposing the rules and regulations.<sup>31</sup> Until the lines of administrative authority are clarified, solar developers may face uncertainties in moving forward.

#### **4.1.3 Infrastructure Barriers:**

Infrastructure barriers mainly consist of technical difficulties that relate to the energy power system, including generation, transmission, and distribution. Perhaps the most recognizable infrastructure barrier facing renewable energy developers involves obstacles to connect to the transmission grid.<sup>32</sup> Grid interconnection plays an essential role in the process of transforming solar into a utility-scale project. Without the grid connection, electricity generated from solar energy sources cannot be transmitted or distributed and thus will not be utilized. Many governments around the world have addressed interconnection problems by mandating that renewable energy developers be provided with access to the transmission grid. For instance, China's Renewable Energy Law requires grid operators to buy all the grid-connected power produced with renewable energy within the coverage of their power grid and to provide grid connection service for power generation from renewable energy.<sup>33</sup>

The Electricity Law covers the issue of grid interconnection. Article 11 subparagraph 2 of the Electricity Law authorizes any licensee to connect to and to use the transmission and distribution system owned by other licensees in a non-discriminatory basis in accordance with

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<sup>31</sup> Royal Decree, No. A/35, [http://www.energy.gov.sa/\\_pdf/KACARE%20Royal%20Decree%20english.pdf](http://www.energy.gov.sa/_pdf/KACARE%20Royal%20Decree%20english.pdf).

<sup>32</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable* (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf). At p 33.

<sup>33</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable* (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf). At p 41.

the law and its implementing regulations.<sup>34</sup> Notwithstanding the fact that the law expressly enables any licensee to connect to the grid in a non-discriminatory basis, the implementing rules could be problematic for solar developers. The Electricity Law mandates the owner of the grid to prepare a grid code (the "Code"),<sup>35</sup> this Code sets out obligations of the grid owner as well as of users of the grid, and it provides a set of rules, regulations, and standards of performance.<sup>36</sup> In order for electricity developers to get access to the grid, they must be able to comply with the Code. Solar developers, however, may not be able to comply with it in its current form. The reason for the potential problems is that the Code was designed to operate as a tool to regulate competition as part of the restructuring of the electricity industry. The development of the Code was *not* written with the goal of promoting solar energy in mind. Therefore, the Code must be updated to accommodate solar developers.

The specific problem is that the right of access to the grid provided by the Electricity Law is a *guaranteed access* rather than *priority access*. There is an essential difference between a guaranteed access and priority access. A guaranteed access is aimed at ensuring solar developers with a connection to the grid. On the other hand, priority access is aimed at providing solar developers with the priority to connect to the grid over fossil fuel-fired generators in situations when the grid cannot accommodate all the incoming electricity.<sup>37</sup> The new National Renewable

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<sup>34</sup> The Saudi Electricity Law, chapter 6, article 11(2), <http://www.ecra.gov.sa/pdf/electricitylawen.pdf>.

<sup>35</sup> The Saudi Electricity Law, Chapter 1, article 11(2)(a), <http://www.ecra.gov.sa/pdf/electricitylawen.pdf>.

<sup>36</sup> The official website of the Saudi Electricity Company, <http://www.se.com.sa/SEC/English/Menu/PowerTransmissionNetwork/>.

<sup>37</sup> Typically, the accessibility to the grid can be obtained by grid connection agreements between grid owner and solar developers.

Energy Policy will have to fill this regulatory gap by granting solar developers priority access to the grid.<sup>38</sup>

#### **4.1.5 Financial Barriers:**

Another point, which must be considered in the development of the policy, is financial barriers.<sup>39</sup> The economic and non-economic barriers challenging the deployment of solar energy constitute high risks from a business perspective. Furthermore, high capital costs and unexplored markets impose risks that may deter private sector investment from entering the market and will pose a fundamental challenge in raising funds to finance solar projects. Undoubtedly, risks surrounding a business opportunity determine the feasibility of a project. A study prepared by Greet Hofstede illustrates the impact of Saudi Arabian culture on the financial challenges of promoting investment in renewable energy in the Kingdom. Hofstede's study measures the culture of a country according to five dimensions, one of which is "uncertainty avoidance." Uncertainty avoidance is defined as "the degree to which the members of a society feel uncomfortable with uncertainty and ambiguity," i.e. the willingness of individuals in a society to take risk. The study revealed that Saudi Arabia is ranked high in terms of "uncertainty avoidance," with a score of 80. In comparison, the world average score is around 56.6.<sup>40</sup> This characteristic of the Saudi Arabian culture should be an additional reason to pay more attention to financial incentives, which play a key role in reducing costs and mitigating risks to the private sector by offering mechanisms to promote the deployment of renewable energy.

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<sup>38</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable* (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf).

<sup>39</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable*, (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf). At p 33.

<sup>40</sup> Greet Hofsted, *Saudi Arabia*, <http://geert-hofstede.com/saudi-arabia.html>.

Financial incentives are particularly important in the demonstration phase of a solar project's life, where the public sector funds begin to decrease (after the research and development phase). At this point, the private sector is still suspicious of investing its own capital because the technology is still in its early stages, and technical and market risks are still perceived to be high. Such circumstances lead to a large financial gap. Financial incentives can include a variety of financial support products and mechanisms, such as direct cash grants, loans and loan guarantees offered by the government.<sup>41</sup> A suggested approach to address some of the financial barriers in Saudi Arabia would be to extend the public sector fund to the demonstration phase and maybe even to the commercialization phase. This approach would be consistent with the Saudi government's strong commitment to the deployment of solar energy as evidenced by the Kingdom's allocation of a large budget of \$109 billion to solar R&D.<sup>42</sup> Another potential approach is for the government to develop a loan guarantee program.

#### **4.1.6 Economic Barriers**

As introduced above, economic barriers are present if the cost of a given technology is higher than the cost of competing alternatives. In the past, this situation has been true for the majority of renewable energy technologies. The cost, however, has declined quickly as a result of research and learning.<sup>43</sup> Since the solar industry is a technology-oriented industry, economic barriers are heavily weighted when considering deployment. Economic support mechanisms are aimed at directly generating an additional revenue stream for renewable energy as the project

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<sup>41</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable*, (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf). At p 38.

<sup>42</sup> Wael Mahdi & Marc Roca *Bloomberg*, (May 2012) <http://www.bloomberg.com/news/2012-05-10/saudi-arabia-plans-109-billion-boost-for-solar-power.html>.

<sup>43</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable*, (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf). At p 34.



starts to operate.<sup>44</sup> These mechanisms are incorporated into policies, with the goal of promoting renewable energy through various approaches, including price-setting and quantity-forcing policies.<sup>45</sup> Price-setting policies endeavor to reduce costs by establishing a favorable pricing regime for renewable energy but failing to specify the quantity of generation. In contrast, quantity-forcing policies mandate a certain quantity of power generation to be supplied from renewable energy at unspecified prices.<sup>46</sup> The most relevant price-setting mechanisms used to date are feed-in tariffs (“FIT”) (widely implemented in European countries as well as many other countries around the world) and the PURPA legislation in the United States. The two main quantity-forcing mechanisms are the tendering scheme (central procurement), and quota systems (renewable energy portfolio standards).<sup>47</sup>

As noted above, the National Policy of Renewable Energy for Saudi Arabia has not been issued yet in final form. Based on a review of trade publications, however, it appears that the policy will begin the renewable energy program in Saudi Arabia with two rounds of auctions followed by the initiation of a FIT scheme.<sup>48</sup> It also appears that the Saudi government chose a hybrid system combining a quantity-forcing mechanism with a price-setting mechanism in order to accelerate the process of meeting a target of 54,000 MW installed renewable capacity by 2020.<sup>49</sup>

The Saudi government’s auction program appears to be based on a bidding approach, which is one of the support mechanisms that have been used by governments for renewable

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<sup>44</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable*, (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf). At p 34.

<sup>45</sup> Fred Beck & Eric Martinor, *Renewable energy policies and barriers*. at p 7.

<sup>46</sup> *Id.*

<sup>47</sup> *Id.*

<sup>48</sup> Renewable energy world <http://www.renewableenergyworld.com/rea/news/article/2012/05/saudi-arabia-launches-massive-renewable-program-with-hybrid-fits> (May, 2012).

<sup>49</sup> Renewable Energy World, <http://www.renewableenergyworld.com/rea/news/article/2012/05/saudi-arabia-launches-massive-renewable-program-with-hybrid-fits> (May, 2012).

energy deployment in other countries. Under this system, a government agency would announce that it wishes to install a certain quantity of a given renewable energy technology. Project developers then apply to build the project and submit bids indicating the price at which they are willing to develop the project. Tenders (requests for proposals) commonly contain specific requirements, such as shares of local manufacturing, technological specifications, and a maximum price per unit of energy. The bidder who meets the specific requirements with the lowest priced offer is typically selected and is authorized to develop the project.<sup>50</sup> Under an auction system, the successful solar developer usually signs a long-term contract, which is commonly known as a Power Purchase Agreement (PPA), with the purchaser. A bidding approach would be an excellent approach for Saudi Arabia to adopt because it combines two instruments to overcome economic barriers: its legal framework (1) establishes a guaranteed demand; and (2) it ensures revenue stability to generators because of the long-term nature of the PPA (even with the monopoly power provider).<sup>51</sup> Moreover, the procedure of a bidding regime stimulates competition among developers, which leads to cost-efficiency and cost reduction.<sup>52</sup> Bidding schemes, however, also have encountered substantial criticism. The process of bidding can encourage competing project developers to bid below cost in order to capture contracts. This outcome can result in the investment of funds in projects that do not materialize.<sup>53</sup> One suggestion to avoid this problem is to establish an oversight committee to oversee winning bids and to insure strict compliance with the terms of the bid. Fred Beck & Eric Martinor

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<sup>50</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable* (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf) . At p 35.

<sup>51</sup> ECRA, *Proposal for National Renewable Energy Plan For Saudi Arabia* <http://www.ewh.ieee.org/r8/sa/cms/images/techdins/2010april13/ieee%20-%20rep%20presentation-13%20apr%202010.pdf>.

<sup>52</sup> <http://eetd.lbl.gov/ea/ems/reports/57666.pdf>.

<sup>53</sup> Fred Beck & Eric Martinor, *Renewable energy policies and barriers*. at p 8.

Trade publications also have reported that the Saudi government plans to implement a FIT scheme after two rounds of auctions to further develop the renewable energy program.<sup>54</sup> During the past two decades, FIT have been the driving force behind renewable energy development in many European countries, especially in Germany and Spain, the leading countries in solar energy development.<sup>55</sup> A feed-in-tariff law obligates electric utilities to purchase renewable electricity at a fixed price over a long period of time (commonly 20 years), thus guaranteeing the generators of the qualifying renewable electricity a certain price per kWh. Adjustments in price may occur due to inflation. This approach has the advantage of guaranteeing a predictable revenue stream.<sup>56</sup> Setting the right price plays a key role in implementing a successful FIT program, for the reason that the stability provided by establishing set of right price leads to a sustained growth in renewable energy generation thereby guaranteeing demand.<sup>57</sup>

## **4.2 Technological Considerations**

### **4.2.1 The Saudi Arabian R&D Journey**

It is unknown to the majority of the international community that the government of Saudi Arabia has been conducting R&D in the solar energy field since 1977 when it signed its first agreement with the United States government. The Solar Energy Research American-Saudi (SOLERAS) agreement was a cooperative project in which the two governments invested \$50

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<sup>54</sup> Renewable Energy World, <http://www.renewableenergyworld.com/rea/news/article/2012/05/saudi-arabia-launches-massive-renewable-program-with-hybrid-fits> (May, 2012).

<sup>55</sup> <http://eetd.lbl.gov/ea/ems/reports/57666.pdf>.

<sup>56</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable* (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf) . At p 35.

<sup>57</sup> <http://eetd.lbl.gov/ea/ems/reports/57666.pdf>.

million in research and development to conduct experiments in the solar field.<sup>58</sup> In addition, in 1986, the Saudi Arabian government, in cooperation with the German government, initiated HYSOLAR, a program for research, development and demonstration as well as utilization of hydrogen as an energy source. Universities and institutions in both countries investigated ways to improve hydrogen production technologies.<sup>59</sup> The advancement of Saudi Arabia in the field of solar R&D in the 1980's was expected to lead to deployment of utility-scale solar energy. As a result of the subsequent economic boom in the oil industry, however, the Saudi government lost interest in developing the solar sector.<sup>60</sup>

More recently, due to the increasing domestic demand for electric power, the Saudi government has recognized the inevitability of diversifying its energy sources to sustain the Kingdom's rich economy. This change can be marked by Saudi Arabia's inauguration of the *King Abdullah University for Science and Technology* ("KAUST") in 2009. KAUST is intended to catalyzing the diversification of the Saudi Arabia economy and addressing the underlying challenges by becoming a globally renowned graduate research university that makes significant contributions to scientific and technological advancement, including advancement in renewable energy.<sup>61</sup> In an attempt to achieve its objective, KAUST and the University of Toronto (UT) signed their first licensing agreement in 2011 for quantum dot solar cell technology, which was developed by UT. This technology uses quantum dots to convert the sun's power into electrical energy. The Kingdom has been funding this type of research since 2008.<sup>62</sup>

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<sup>58</sup> Tatjana de Kerros, *The Entrepreneurialist Saudi Arabia: The New Solar Frontier* (July. 3, 2011) <http://theentrepreneurialist.net/2011/07/03/saudi-arabia-the-new-solar-frontier/>.

<sup>59</sup> *Id.*

<sup>60</sup> *Id.*

<sup>61</sup> KAUST, *Vision and Mission*, [http://www.kaust.edu.sa/about/vision\\_mission.html#vision](http://www.kaust.edu.sa/about/vision_mission.html#vision).

<sup>62</sup> KAUST, *Press Releases*, <http://www.kaust.edu.sa/media/pressreleases/uoft.html>.

#### 4.2.2 The Legal Framework for Technological Development:

Determining the most suitable technology for the deployment of utility-scale solar in the Saudi Arabian market is an essential step in identifying the optimal framework to promote utility-scale solar in Saudi Arabia. The foundation of this industry starts with the ability to rely on a sustainable technology with low costs. Recently, the world has witnessed significant technological breakthroughs and major cost reduction in the solar industry, which were fostered by public and private sector research and development and demonstration as well as government policy support.<sup>63</sup> When countries seek to introduce new technologies into their economies, they can benefit from international experience by accessing commercially available technologies that have been deployed in other markets. Countries, however, will face many barriers in their own market because technologies may have to be adapted to local conditions.<sup>64</sup> This is the case in Saudi Arabia, where most of the commercial technologies available today were not designed to withstand Saudi Arabia's climate, with its extremely high temperatures and the regular occurrence of sand storms. Also, adaptation must occur, particularly in the local supply chain, such as installation and maintenance services.<sup>65</sup> Research, development and demonstration will play a fundamental role in determining the most suitable technology and consequently the future of solar energy in Saudi Arabia.

Furthermore, renewable energy technology typically goes through three phases:

- Research;
- Development and demonstration; and

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<sup>63</sup> <http://www.renewables2004.de/pdf/tbp/TBP03-policies.pdf>.

<sup>64</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable* (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf) . At p 52.

<sup>65</sup> International Energy Agency, *Renewable Energy: Policy Consideration to Deploying Renewable* (Nov. 2011) [http://www.iea.org/papers/2011/Renew\\_Policies.pdf](http://www.iea.org/papers/2011/Renew_Policies.pdf) . At p 52.

- Commercialization.

If complications encountered during the research, development, and demonstration stages are not overcome, the commercialization of the renewable energy technology is likely to fail. Significant challenges, mostly linked to the lack of risk reduction policies and the resulting financial gaps, impede the smooth transition from demonstration to deployment of viable renewable energy technology in Saudi Arabia. Generally, the public sector is responsible for early, high-risk R&D while the private sector will take over commercialization. When the public funds start to decrease, the private sector will still be wary of investing its capital in projects, when technologies are at the early stage and technical and market risks are high. In such cases, neither the public nor the private sector takes the lead on necessary investment leading to a strong financial gap. This phenomenon is commonly termed the commercialization “valley of death”.<sup>66</sup>

The goal of overcoming the valley of death is to promote the commercialization of projects. One approach proposed, but not implemented to date in the U.S., is the *Clean Energy Deployment Administration* (“CEDA”). This approach represents an attempt to promote deployment of renewable energy by alleviating the risks in the commercialization phase.

CEDA proposal provides for the establishment of a new financing entity, which will offer typical financial support products such as loans and loan guarantees, to emerging technologies rather than fully commercialized technologies or technologies in the R&D phases. The rationale behind CEDA is to allocate resources in a key phase in the deployment process to promote

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<sup>66</sup> *Id.* at 48.

access to affordable financing for accelerated and widespread deployment, because sufficient private investment funds are lacking.<sup>67</sup>

## **5. Conclusion**

The optimal legal framework to encourage utility-scale solar energy in Saudi Arabia is a combination of two elements: a collaborative effort between government agencies and a continuation of R&D. The Electricity Law implemented by ECRA provides a complete framework to the electricity industry in general. It lacks a framework, however, for utility-scale solar developers, such as mechanisms to secure priority access to the grid. ECRA and KA-CARE can overcome this gap by working together cooperatively to update existing regulation and develop new regulations that ensure an optimal framework for solar developers. Such updates can include updating the grid code to be able to accommodate solar developers, new regulation should include the right of priority access. In addition, Saudi Arabia can compensate for technological challenges by providing government incentives such as cash grants and develop a loan guarantee program. Furthermore, a portion of R&D budget can be allocated to pursue demonstration and commercialization of utility-scale solar energy technology.

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<sup>67</sup> Allison S. Clements & Douglass D. Sims, A Clean Energy Deployment Administration: The Policy for Emerging Renewable Technologies, *Energy* 1.j Vol. 31(2010) . at p 406.

## Works credits

- Fred Beck & Eric Martinor *Renewable Energy Policies and Barriers* forthcoming in *Encyclopedia of energy*, Culter J. Cleveland, ed. (Academic Press/Elsevier Science, 2004).
- International Energy Agency *Renewable Energy: Policy Consideration of Deploying Renewable* (November, 2011).
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- Allison S. Clements & Douglass D. Sims *A Clean Energy Deployment Administration: The Right Policy For Emerging Renewable Technologies*.