Renewable energy policies implementation drivers and barriers for Abu Dhabi

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Abstract: Climate change and fossil fuel depletion are the main drivers for the recent focus on finding alternative energy resources. Renewable energy (RE) is an obvious choice to reduce carbon dioxide and other pollutants contributing to global warming. However, the high cost of RE technologies is the main obstacle facing the diffusion of RE power generation, therefore economical and political intervention is inevitable. In the United Arab Emirate (UAE) population and economic growth are the main reason of a fast increase of energy demand, leading to two problems, first the UAE has one of the highest carbon footprint in the world and second, the fast depletion of its main energy generation resource – fossil fuel, which highlights the need to establish a RE sector. In this study, literature reviews are conducted covering 61 countries focusing on their efforts to adopt RE resources in the power generation sector as well as policies implemented by their respective governments and decision makers. Furthermore, we investigated the applicability of the main RE policies implemented worldwide in the Abu Dhabi - the capital of the UAE- context. As a result of our analysis, we recommend to apply a mixed policy of Feed-in-Tariff (FIT) and the Quota system for RE electricity generation in order for the UAE to meet its 7% target by 2020.

Keywords: *Renewable Energy, Renewable Energy Policy, Masdar Initiative*

1. Introduction

Climate change and fossil fuel depletion are the main drivers for the recent focus on finding alternative energy resources. Renewable energy (RE) is an obvious choice to reduce carbon dioxide and other pollutants contributing to global warming. However, the high cost of RE technologies is the main obstacle facing the diffusion of RE power generation, therefore economical and political intervention is inevitable. These interventions usually include legislation, incentives to investment, energy generation targets, guidelines for energy conservation, strategies to stimulate the energy industry, and taxation [1]. Economic support policies that encourage investments in new technologies that promote the adoption of RE have been implemented in many countries. In particular, a variety of economic support policies for RE has been developed and implemented mainly in Europe and the USA. These policies include: Quotas, Feed in Tariffs (FITs), Bidding or Tendering, Tax incentives, and Subsidies.

In the Unite Arab Emirate (UAE), population and economic growth are the main reason for the fast increase of energy demand, leading to two problems, first the UAE has one of the highest carbon footprint in the world [2] and second, the fast depletion of its main energy generation resource – fossil fuel, which highlights the need to establish a RE sector. To address these issues, in this work we study the fundamental requirements to introduce relevant RE polices as a first approach to promote RE use in the UAE. In 2008, the first RE policy set by UAE government -at least seven percent of the emirate's power generation capacity will come from RE sources by 2020- provided a critical missing piece of the UAE‘s overall strategy in energy and sustainability. This policy marks the start of new energy era in the UAE; nevertheless, this policy does not state the mechanism of how to achieve this target.

This paper will first introduce the key features of the different (RE) policy options. Second, it will present a comparative analysis of the RE policies mechanisms as well as summarizing the requirements for their successful implementation. Third, the findings from the 61 surveyed countries focusing on RE technologies, capacities and policies are presented. Finally, the challenges and existing constraints for the development of RE Policy in Abu Dhabi are presented and discussed. The paper concludes with summary and recommendations.

2. Background

Even though it is widely agreed that support schemes need to be put in place to promote the use of RE, there is almost no consensus as to what are the best RE policies to use. In the following we introduce the different policy options including their respective advantages, disadvantages and recommendations for successful implementation.

Feed-in Tariffs (FITs), are performance-based regulation incentives aimed at increasing the adoption of RE sources. The term "feed-in tariff" derives from the German Stromeinspeisungsgesetz of 1990, which literally translated means "electricity feeding-in law." Germany implemented the Electricity Feed-in Law (1991) in order to create a market for renewable electricity by offering providers a fixed but attractive price for the recovery of generation costs and since then it stands as the paradigmatic example of effective FIT regulation [3].

Renewable Portfolio Standard (RPS), Renewables Obligation (RO), Mandatory Market Share (MMS) policy or Quotas are the different names given to a similar set of incentives for RE in various countries, RPS in USA, RO in UK, MMS in China and renewable quotas in European countries [4]. The shared theme of all these incentives is that the government sets a percentage of electricity to be generated by renewable sources, assigns an actor, such as electricity users, suppliers or generators, to meet the specific percentage and penalizes those who fail to meet their goals. These mechanisms are essentially market based and they are designed to achieve a cost-efficient generation of RE [5]. Quotas are presently applied in a number of countries around the world. The RPS in Texas has been very effective due to good local resource, presence of tax credits and strong penalties for non-compliance [6]. Although they have resulted in a growth of renewables in most countries, they have not achieved the same success as the FITs in Germany and Denmark [7].

Centralized Bidding or Tendering systems are one of the major policies for promotion of RE in the electric power sector. These mechanisms have been applied in the early stages of RE development in UK and are presently employed for wind power in China under the name of concession program [8]. As the name implies, the policy mechanism works by calling for bids from investors for RE projects. It is essentially a market-based policy, which strives to develop RE projects at the least possible cost. The policy of bidding for RE contracts was first started by UK in the form of Non Fossil Fuel Obligation (NFFO) in 1990. This policy was then discontinued in 1998 when it was realized that NFFO was not able to achieve required implementation of RE. In 2002, it was replaced by Renewables Obligation (RO). The other major example of a bidding system is the Chinese Concession System for wind power development. The system was started in 2003, and fifth bidding round was completed in December of 2007 [8]. Chinese RE Law of 2005 makes provisions for implementation of FITs, quotas and bidding systems [4].

Tax Credits is one way to lower the costs of RE through market compensation. The main types include investment, and production tax credits. They are largely used in Europe, USA, Japan, and India as well. Investment Tax Credits can cover the cost of the RE system itself, or even the total cost of the installation. Investment Tax Credits can prove to be useful at the early stages of the technology, where there are high costs, or at times when utilities are being deployed on remote areas. They aid lowering the level of risk involved and the costs of investing in RE technologies [9]. In the United States, businesses receive a 10 percent tax credit for purchases of solar and geothermal RE property, subject to certain limitations. Some U.S. states have Investment Tax Credits of up to 35% [10].

The high upfront investment cost of renewable makes them unattractive choices for investors. Removing this barrier by reduction in the initial capital outlay by consumers for RE systems is accomplished through direct ***subsidies or rebates***. These subsidies are used to share the initial capital cost of the system, so that the consumer sees a lower price [10]. Subsidies have been used by many countries for stimulating growth in RE sector. A combination of investment subsidies, low-interest loans, net metering and public education has resulted in an early success of PV in Japan [9]. Similar subsidies have been employed in many countries for RE development. In most cases, they are used in combination with other RE support mechanisms. This is in stark contrast with investment tax credits, which tend to favor large companies with greater tax liabilities [6].

In general, RE policies can be grouped into two categories, *Investment Focused Policies,* e.g., Rebates/Subsidies, Investment Tax Incentives and Bidding/Tendering, *and Generation Based Policies*, e.g., FITs, Quotas and Green Credits [11].

3. Current state of Renwable Energy and lessons learned.

When put in an international comparative perspective the UAE is found to be far behind the world's leaders in RE. Yet, the recent move of introducing an RE sector is an unprecedented initiative in the region that might play an important role in setting the stage for similar decisions by other comparable countries. We conducted a comprehensive analysis of the current state of RE in order to identify RE policy trends to help inform potential adaptation of RE initiatives in new projects or countries. The analysis was performed by reviewing RE data of 61 countries mainly focusing on RE technologies, capacities and policies implemented by the different countries. For demonstration purposes, Table 1. summarizes a selection of 7 countries out of the 61 studied as geographical representations to their regions; the table covers the following categories: RE policies, targets, projects, produced electricity and installed capacities.

As a result of this study, here, we highlight the main finding of the analysis based on the data from the 61 countries analyzed as follows: Europe is dominating the RE scene, since more than 50% of all countries that uses RE projects are European followed by Asia, America and finally Africa. Furthermore, most of the European countries use hydroelectric and wind power and very few use geothermal energy. This can be explained by the fact that hydro and wind are the most abundant energy source in Europe and geothermal energy is the least used energy source and this is due to the immaturity of most of the state of the art geothermal technology solutions.

Table 1 summurizes the RE policies, targets, RE sources used and their installed capacity of 7 countries

			RE Target		*RE Projects*			
Country	*RE Policy*	*RE mechanism*	*Primary energy*	*Electricity*	*Type*	*Electricity Produced*	*Installed Capacity*	*Reference*
China	FIT since 2005		15.4% by 2020	21% by 2020	Small hydro		60 (GW) as of 08	[12, 18, 20, 21, 23]
	Public investment	A total of USD731 million is allocated to support biogas			Wind	0.20%	26.01 (GW) as of 2009	
	Capital subsidies and grants	A subsidy of (USD2.93)/W to support the BIPV system installation.			Solar PV		0.3 (GW) as of 2009	
	Quotas, Energy tax, PCB, Tax credits							
Germany	FIT since 1990	Investment support for solar PV	18% by 2020	12.5% by 2010	Small hydro		1.4 (GW) as of 2008	[7,13, 14,15, 16, 17,20]
	Investment tax credit	Parts of the revenue of energy taxes finance RES			Wind	6.40%	25.78 (GW) as of 2009	
	PCB				Solar PV	1%	9.83 (GW) as of 2009	
	Net metering				Geothermal		0.006 (GW) as of 2008	
	Capital subsidies and grants	Only in exceptional cases 30% of invest.			Biomass	4.40%	4 (GW) as of 2008	
	Energy tax	Eco-tax on conventional electricity			Concentrated Solar Power		1.5 (MW) as of 2009	
	Public investment and Loans	R&D support			Hydropower	3.30%	4.7 (GW) as of 2008	
India	FIT since 1993		20% by 2020	12% by 2012	Small hydro		2 (GW) as of 2008	[12, 14, 18, 20, 24, 25]
	Quota system			15% by 2020	Wind	1.60%	10.93 (GW) as of 2009	
	Energy Investment Tax	Wind Power: per good. Biomass: total exemption			Solar PV		0.12 (GW) as of 2009	
	Capital subsidies and grants	For small hydro up to 25 (MW).			Biomass	0.20%	2.1 (GW) as of 2009	
					Hydropower	15%	32.892 (GW) as of 2009	
Japan	FIT	FIT for Solar PV		1.63% by 2014	Small hydro		3.5 (GW) as of 2008	[14,18,20, 21,22,]
	Capital subsidies and grants	Solar PV household subsidy			Wind	0.20%	2.21 (GW) as of 2009	
	Public investment and loans	National stimulus Package of 22 billion USD			Solar PV	0.20%	2.6 (GW) as of 2009	
	Green Certificate Trading				Geothermal	0.30%	0.54 (GW) as of 2008	

			RE Target		*RE Projects*			
Country	*RE Policy*	*RE mechanism*	*Primary energy*	*Electricity*	*Type*	*Electricity Produced*	*Installed Capacity*	*Reference*
	Quotas				Hydropower	7.50%	27.759 (GW) as of 2009	
UAE	Quotas, Bidding and Subsidies			7% by 2020	Solar PV		10 (MW)	[26]
					Solar thermal		100 (MW)	
UK	RO since 2002	TGC as part of RO scheme	15% by 2020	10.4% by 2010/2011	Small hydro		0.173 (GW) as of 2008	[7, 13, 14, 17, 19, 20]
	Public investment and Loans	R&D and offshore wind support. A total 10.4 billion GBP for low carbon economy.		15.4% by 2015/2016	Wind	1.30%	4.05 (GW) as of 2009	
	Energy Tax	Tax exemption for electricity from RE.			Solar PV		0.032 (GW) as of 2009	
	FIT, Quotas and NFFO				Biomass	2.80%	1.368 (GW)	
					Hydropower	2.30%	1.513 (GW)	
US	RO			20% by 2030	Small hydro		3 (GW) as of 2008	[13, 14, 18, 20, 21, 22]
	FIT since 1978				Wind		35.159 (GW) as of 2009	
	Energy Tax	Production of Tax Credit-extension			Solar PV		0.824 (GW) as of 2010	
	Public investment and Loans	30 billion $ in loan guarantee for RE projects as of 2009			Geothermal	0.40%	3.10 (GW) as of 2009	
	Tax credits	Payment in lieu of tax credits for investment on RE			Biomass		8 (GW)	
	Capital sudsides and grants				Concentrated Solar Power		188 (MW) as of 2009	
					Hydropower	6.30%	95.0 (GW) as of 2009	

Among all the RE projects in the studied countries, wind, hydro and biomass were found to constitute the biggest share of RE installed capacity, where Wind installed capacity ranges between 35-10 GW in the US, China, Germany and India, Hydropower ranges between 95-27 GW in the US, Russia, Brazil, China, India and Japan, and finally Biomass reaches up to 70GW in Costa Rica"

On the policy front, approximately 70% of the 61 countries are applying feed-in tariff policy which portrays it as an effective policy to encourage the use of RE sources. This wide use of FIT is due to its several advantages that include: offering investment security and market stability as well as it being very effective in increasing the amount of electricity generated from RE sources such as wind and solar.

As a whole, the most used RE source is hydroelectric energy. This suggests that, in general, hydro energy is the most abundant energy in comparison to the other projects such as geothermal, solar PV, solar thermal and biogas. All the countries that have more than 30% RE targets to be fulfilled between 2020 and 2050, has mainly wind and hydro projects where the hydro projects have the highest installed capacity.

An example of a successful RE implementation story, Costa Rica is already producing 99% of its electricity from renewable sources which makes it the first carbon-neutral country in the world.

4. Renewable Energy Policy in Abu Dhabi

The only operating RE solar PV plant in Abu Dhabi is the 10 MW plant in Masdar City which is also registered as a CDM project for carbon credit purposes. The 10 MW plant, consisting of 87,777 panels (50% thin film and 50% crystalline silicon) is projected to generate 17,500 MWh of clean energy each year (with a single kWh of clean energy being the carbon-offset equivalent of 0.8 kg depending on an area's network and its energy-producing source). The cost of kwh produced in the 10 MW PV plant is 48 US cents (2009).

4.1. Existing Barriers for the Development of RE

In [27], Patlitzianas made an overall review of the existing barriers that can impede the development of RE in the Gulf countries and including the UAE. The barriers of the UAE are grouped into three main categories: market technology, policy legislation, and cost. All of these categories are related to infrastructure and institutions. As a conclusion, the authors argue that the barriers that unfairly discriminate against RE are mainly the lack of commercial skills and information, the absence of relative legal and policy framework, the high initial capital costs coupled with lack of fuel-price risk assessment, as well as the exclusion of environmental externalities in the cost.

4.2. Toward a Comprehensive RE Policy for Abu Dhabi

Currently Abu Dhabi Government has set a target that 7% of its electricity generation to come from renewable sources. Solar power is the most favorable source of RE for Abu Dhabi. The 10-MW PV solar plant is already installed and operating, and supplying power to Masdar City operations and connected to the existing Grid. It is a small amount of electricity generated but its success opens the market to have individuals, private builders and property owners to consider RE technologies.

As a result of our analysis, we recommend to have a mix policy between Fee-in-Tariff (FIT) and Quota system in order to share the RE electricity generation. Currently, the Abu Dhabi government through the Abu Dhabi Executive Affairs Authority (ADEAA) is reviewing the energy policy in general and electricity generation in particular in conjunction with all the actors. In order to ensure that this policy is effective we need to take many things into considerations:

1. There has to be continues political support to encourage the adoption of RE.
2. Through the Masdar Initiative, the main RE technologies that can comply with the policy mechanism are Solar and Wind (mainly off-shore). The market has to develop the most effective options.

3. Must ensure that the electricity provider, ADWEC, buys the electricity generated from RE sources. Transco, the power transmission company, provides the grid connection of all RE sources.
4. Develop a trading mechanism between RE generators and ADWEC.
5. Using a Guarantee of origin certificates is a good example to use as a proof of generation and compliance under a more controlled environment.

5. Conclusion and recommendations

Abu Dhabi, with the Masdar Initiative, is regarded as a pioneer in its efforts to promote RE in the Middle East region especially in Gulf States that share similar characteristics such as abundance of solar resources and oil rich economies that can support such an initiative. The paper listed the RE policies and mechanisms for many countries in addition to their different RE technologies and installed capacities. One thing to notice is that UAE (Abu Dhabi) has a policy target of 7% RE share of electricity generation by 2020 but there are no additional legislations or mechanisms to promote power generation such as feed-in tariffs, renewable portfolio standards, capital subsidies or grants, investment tax credits, sales tax or VAT exemptions, green certificate trading, direct energy production payments or tax credits, net metering, direct public investment or financing, and public competitive bidding.

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