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The Effect of Implementing a Feed-in Tariff in Abu Dhabi UAE

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Abstract

Although most countries in the world have been trying to introduce renewable energy into their power supplies to address issues related to the environment and energy security, the Middle East has the lowest overall renewable energy capacity in the world. However, there is currently a trend of accelerating renewable energy deployment with increased investment in the region for the purposes of improving energy security and independence and promoting long-term social and economic benefits. This study aims to examine the impact of implementing a feed-in tariff (FiT) in Abu Dhabi, United Arab Emirates. After a simulated test, it was found that the levelized cost of electricity (LCOE) and the current average unit cost of electricity were considerably divergent. That is to say, a large extra cost is incurred in order to deploy renewable energy in Abu Dhabi. In this context, the effectiveness of implementing a FiT in Abu Dhabi is confirmed. Furthermore, an estimation of the size of the renewable energy surcharge indicated that the impact of implementing a FiT would be enormous. For example, if the target rate of deploying renewable energy is set at 7%, a renewable energy surcharge equivalent to approximately one third of the total turnover of the electricity sector should be additionally imposed. It follows that the electricity rate will be raised by about thirty percent on average, unless subsidies are provided by the government.

Keywords: renewable energy, feed-in tariff, levelized cost of electricity (LCOE), Middle East, Abu Dhabi

JEL Classification: M16, M21, O13, Q56

1. Introduction

1.1 Background

These days, most countries in the world have been trying to introduce renewable energy into their power supplies to address issues related to the environment and energy security. As a result, the amount of renewable energy being brought online from solar, wind, and hydro sources has risen steadily. However, the distribution of installed generation capacity from these sources is far from even. At the end of 2013, China was at the forefront of renewable energy adoption, followed by Europe-Russia and North America. Africa and the Middle East hardly produced any renewable energy. In fact, the Middle East had the lowest overall renewable energy capacity in the world, as shown in Table 1.

Table 1. Generation capacity from main renewable energy sources in different areas as of end-2013 (in GW)

Area	Solar Power (PV + CSP)	Wind Power	Hydro Power	Total	Share
North America	14	71	194	279	19.11%
Latin America	0.2	5	160	165.2	11.32%
Europe and Russia	83	121	147	351	24.04%
Africa	0.5	1	25	26.5	1.82%
Middle East	**1.2**	**0.1**	**13**	**14.3**	**0.98%**
India	4.1	20	42	66.1	4.53%
Southeast Asia	17.4	0.5	50	67.9	4.65%
China	19	92	300	411	28.15%
Oceania	3	7	69	79	5.41%
Total	142.4	318	1000	1460.4	100.00%

Source: The Renewable Energy Policy Network for the 21st Century (REN21) (2014)

The low renewable energy capacity in the Middle East is a result of the relatively low cost (typically subsidized) of generating electricity using its abundant supply of fossil fuels such as oil and natural gas. Yet, the Middle East-North Africa region has been trying to accelerate renewable energy deployment with increased investment in that area for the purposes of improving energy security and energy independence, as well as promoting long-term social and economic benefits. Solar energy has started to attract greater attention in the region. According to the Middle East Solar Industry Association (2015), in 2014 the total number of solar projects planned in the region was four times greater than in the previous seven years combined, with two factors contributing to this trend: a sharp decrease in the expenses associated with solar energy systems, and an increase in the costs of generating electricity from natural gas. On top of that, the investment environment in the renewable energy sector has been recently improving. According to the International Renewable Energy Agency (2016), energy policies such as feed-in tariffs (FiTs) may be used to mitigate investment risks.

1.2 Previous Research

Mezher, Dawelbait, and Abbas (2012) conducted a review of policies in sixty-one countries, followed by an investigation of the applicability of implementing renewable energy policies in Abu Dhabi in the United Arab Emirates (UAE). They concluded that the high cost of renewable energy technologies was the main obstacle to deploying renewable energy.

Mokri, Ali, and Emziane (2013) performed an exhaustive review and analysis of solar energy deployment in the UAE. According to this review, several solar plants have already been installed in the UAE, including the Masdar 10 MW PV power plant and the Shams 1 concentrated solar power plant.

Al-Amir and Abu-Hijleh (2013) analyzed energy policies in the UAE that aimed to promote the deployment of renewable energy. They discussed a strategy for promoting renewable energy in the UAE with the relevant authorities and stakeholders. As a result, they proposed an energy strategy including a FiT as one of the long-term policies.

Nakayama, Sasaki, and Ito (2015) conducted an analysis of political issues concerning renewable energy projects and Sasaki and Nakayama (2016a) also examined potential risks, including political ones, of the renewable electricity transmission project between Iceland and the UK. Sasaki and Nakayama (2015; 2016b) examined the feasibility of renewable energy projects using quantitative analyses including the discounted cash flow method and the real options approach.

Wang, Almazrooei, Kapsalyamova, Diabat, and Tsai (2016) reviewed energy subsidy policies and analyzed utility subsidy reform in Abu Dhabi. They inferred that low utility prices might have caused high per capita carbon emissions in the UAE.

Juaidi, Montoya, Gázquez, and Manzano-Agugliaro (2016) gave an overview of energy balance and greenhouse gas emissions in the UAE for the purpose of sustainable energy development. They proposed that a policy to unlock the renewable energy market and develop the renewable energy sector was needed in the UAE.

1.3 Objectives and Research Questions

This study aimed to examine the impact of implementing a FiT in Abu Dhabi. According to previous research, there are obstacles to the deployment of renewable energy in the UAE typified by the high cost of technology. Energy policies are needed in order to remove those obstacles and promote the development of the renewable energy sector. In this context, a FiT is thought to be a good candidate.

Our research questions were as follows:

- In Abu Dhabi, what is the cost to deploy renewable energy (i.e, concentrating solar power technology)?
- What is the estimated amount of the renewable energy surcharge required to make ends meet?

2. Methods

We defined the levelized cost of electricity (LCOE) as:

$$\mathrm{LCOE} = \frac{\sum_{t=1}^{n} \frac{I_t + O_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}} \tag{1}$$

where I_t, O_t, E_t, r, and n are investment expenditures in the year t, operations and maintenance expenditures in the year t, electricity generation in the year t, discount rate, and project lifetime in years, respectively. In general, the LCOE represents the total cost of electricity including the allocated cost of initial expenditures. Therefore, we calculated a typical LCOE of renewable energy in Abu Dhabi and considered it to be the estimated cost of renewable energy. We then multiplied the difference between the LCOE and the current tariff by a certain percentage of gross electricity production in Abu Dhabi to obtain the estimated value of the total amount of renewable energy surcharge required for implementing a FiT in Abu Dhabi.

3. Prerequisites

We set the parameters for the numerical simulation (shown in Table 2) based on typical values from renewable energy projects in Abu Dhabi previously reported in the literature (IRENA, 2015; National Renewable Energy Laboratory [NREL], 2016). To examine the effects of changes in major parameters on the LCOE estimate, we also set the ranges of two parameters for the sensitivity analysis, as shown in Table 3.

Table 2. Simulation parameters

Investment Expenditures	(USD Million)	600
Ratio of Operations and Maintenance Expenditures to Investment Expenditures	(%)	1.0
Electricity Generation	(GWh)	210
Discount Rate	(%)	10.0
Project Lifetime	(years)	25 (including construction period)
Construction Period	(years)	2 (two equal disbursement)

Table 3. Sensitivity analysis

Ratio of Operations and Maintenance Expenditures to Investment Expenditures	From 0.5 to 1.5 %
Discount Rate	From 5.0 to 15.0 %

4. Results and Discussion

4.1 Simulation Results

We calculated the LCOE as 0.37 USD/kWh (see Table 4). According to the UAE Regulation & Supervision Bureau (2014), the current average unit cost of electricity is 0.09 USD/kWh (based on an exchange rate of 0.27 USD per UAE Dirham). Therefore, the calculated LCOE is about four times as high as the current average unit cost. This result shows that the LCOE of renewable energy is significantly higher than the recoverable cost, and filling this gap is essential to the deployment of renewable energy in Abu Dhabi.

Table 4. Simulation results

Elapsed Time	(years)	0	1	2	3	4	24	25
Electricity Generation	(GWh)				210	210	210	210
Investment Expenditures	(USD Million)		300	300				
Operations and Maintenance Expenditures	(USD Million)				6.0	6.0	6.0	6.0
LCOE	**(USD/kWh)**	**0.37**						

4.2 Sensitivity Analysis Results

4.2.1 Ratio of Operations and Maintenance Expenditures to Investment Expenditures

The sensitivity analysis results for varying the ratio of operations and maintenance expenditures to investment expenditures are shown in Table 5 and Figure 1. According to this, we can see that there was very little change in LCOE throughout the entire range of values tested. This parameter had too little impact on the LCOE to be judged a key factor in deploying renewable energy.

Table 5. Sensitivity analysis of ratio of operations and maintenance expenditures to investment expenditures

Ratio of Operations and Maintenance Expenditures to Investment Expenditures (%)	LCOE (USD/kWh)
0.5	0.35
0.6	0.35
0.7	0.36
0.8	0.36
0.9	0.36
1.0	0.37
1.1	0.37
1.2	0.37
1.3	0.37
1.4	0.38
1.5	0.38

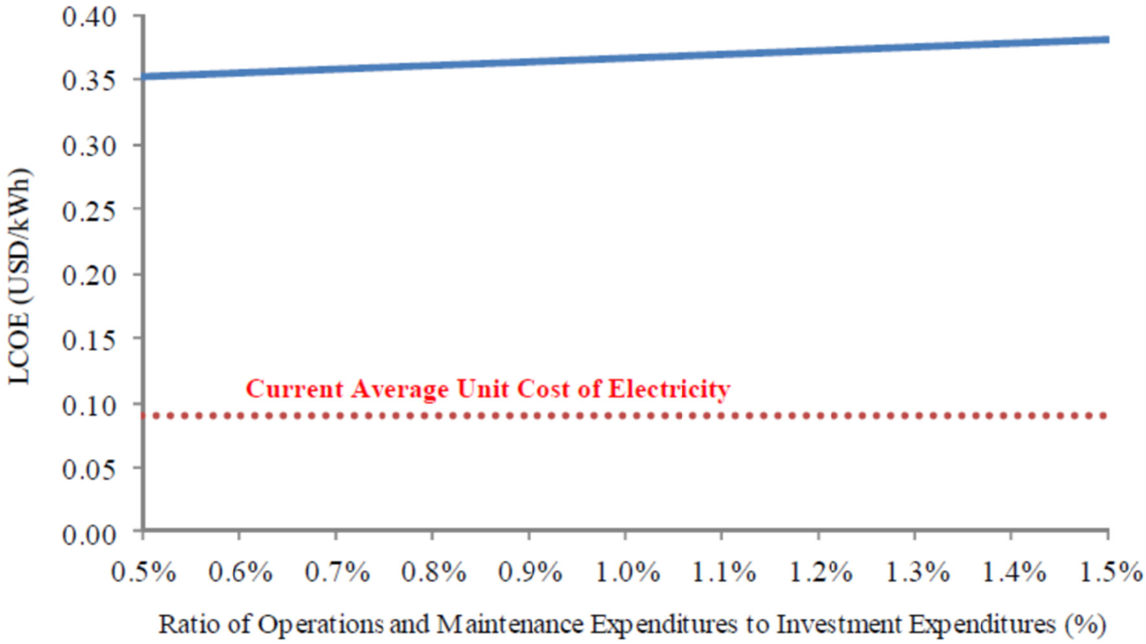

Figure 1. Sensitivity analysis showing the effect of changes in the ratio of operations and maintenance expenditures to investment expenditures (%) on the estimated LCOE (USD/kWh)

4.2.2 Discount Rate

The sensitivity analysis results for varying the discount rate are shown in Table 6 and Figure 2. At a 5.0% discount rate, the LCOE was calculated to be 0.25 USD/kWh, approximately two-thirds of the LCOE calculated at a 10.0% discount rate. We can also see that the LCOE at a 15.0% discount rate is calculated to be 0.51 USD/kWh, about 1.4 times the LCOE at a 10.0% discount rate. These results imply that discount rate has a relatively substantial impact on LCOE.

Table 6. Sensitivity analysis of discount rate

Discount Rate (%)	LCOE (USD/kWh)
5.0	0.25
6.0	0.27
7.0	0.29
8.0	0.32
9.0	0.34
10.0	0.37
11.0	0.39
12.0	0.42
13.0	0.45
14.0	0.48
15.0	0.51

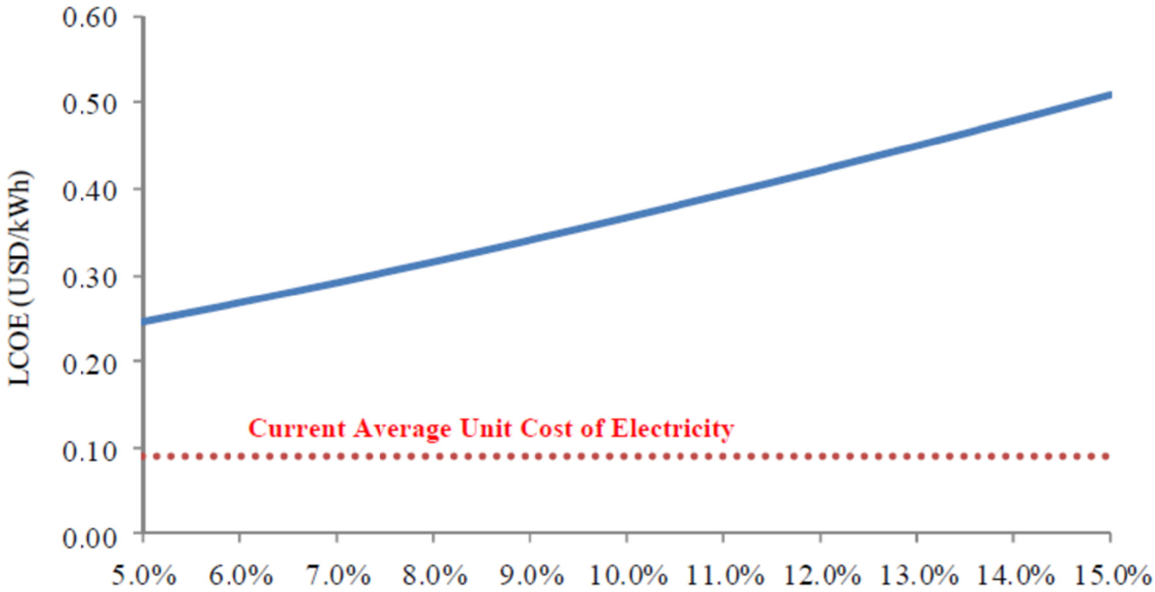

Figure 2. Sensitivity analysis showing the effect of changes in the discount rate (%) on the estimated LCOE (USD/kWh)

4.2.3 Summary

The complete results of the sensitivity analysis are presented in Table 7. The LCOE was above the current average unit cost of electricity (0.09 USD/kWh) throughout the entire range of values tested in the sensitivity analysis. It can be said that it costs too much in Abu Dhabi to deploy renewable energy without some subsidy to fill the gap between revenue and expenditure.

Table 7. Sensitivity analysis in regard to LCOE (USD/kWh)

Maintenance Expenditures to Investment Expenditures (%)	Discount Rate (%)										
	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
0.5	0.23	0.25	0.28	0.30	0.33	0.35	0.38	0.41	0.44	0.46	0.49
0.6	0.23	0.26	0.28	0.30	0.33	0.35	0.38	0.41	0.44	0.47	0.50
0.7	0.24	0.26	0.28	0.31	0.33	0.36	0.38	0.41	0.44	0.47	0.50
0.8	0.24	0.26	0.29	0.31	0.33	0.36	0.39	0.42	0.44	0.47	0.50
0.9	0.24	0.26	0.29	0.31	0.34	0.36	0.39	0.42	0.45	0.48	0.51
1.0	0.25	0.27	0.29	0.32	0.34	0.37	0.39	0.42	0.45	0.48	0.51
1.1	0.25	0.27	0.29	0.32	0.34	0.37	0.40	0.42	0.45	0.48	0.51
1.2	0.25	0.27	0.30	0.32	0.35	0.37	0.40	0.43	0.46	0.48	0.51
1.3	0.25	0.28	0.30	0.32	0.35	0.37	0.40	0.43	0.46	0.49	0.52
1.4	0.26	0.28	0.30	0.33	0.35	0.38	0.40	0.43	0.46	0.49	0.52
1.5	0.26	0.28	0.31	0.33	0.35	0.38	0.41	0.44	0.46	0.49	0.52

4.3 Estimate of the Amount of Renewable Energy Surcharge Required

According to the UAE Regulation & Supervision Bureau (2014), gross electricity production in Abu Dhabi in 2014 was 70,847 GWh. Therefore, supposing that all electricity production was converted into renewable energy, it would cost an additional USD 19.8 billion, equivalent to approximately four times the USD 4.78 billion total turnover of the Abu Dhabi electricity sector in 2014 (Regulation & Supervision Bureau, 2014). Assuming that the target rate of deploying renewable energy is set at 7%, the amount of the additional cost that would need to be recovered through a renewable energy surcharge is estimated to be USD 1.39 billion, equivalent to 29% of the total turnover of the electricity sector in 2014.

5. Conclusions

The simulation results indicated a significant gap between the LCOE and the current average unit cost of electricity. A large extra cost is incurred to deploy renewable energy in Abu Dhabi. In this context, the effectiveness of implementing a FiT in Abu Dhabi was confirmed. The estimated amount of the renewable energy surcharge required implied that the impact of implementing a FiT would be enormous. For example, if the target rate for deploying renewable energy was set at 7%, a renewable energy surcharge equivalent to approximately one-third of the total turnover of the Abu Dhabi electricity sector should be additionally imposed. It follows that electricity rates would be raised by about 30% on average unless any subsidies were provided by the government.

There are two key next steps indicated by the results of this study: a) designing a detailed scheme for implementing a FiT in Abu Dhabi, and b) determining a method of allocating the renewable energy surcharge to customers. Many political and economic issues need to be addressed, including consideration of those who are marginalized or have lower incomes as well as large customers. In both cases, it is vital to find socially acceptable solutions that can be implemented in a smooth manner.

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