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Role of Policies in Stimulating Renewable Energy in Arab Countries

Sahar Aboud*

Abstract

Despite the abundance of literature on renewable energy (RE), studies about the role of policies in stimulating RE, especially for Arab countries, are still limited. This study aims at examining the role of RE policies as a key determinant of RE investment in 11 Arab countries using panel data covering the period 2010-2019 to identify areas for policy intervention to stimulate RE investment in Arab countries. The study uses RE share in total energy supply as a proxy for RE investments. The analysis finds there is heterogeneity among Arab countries concerning their efforts toward reaching an enabling environment for RE investment, but all of them are exhibiting an improvement. Results confirm the importance of policies, either using the RE policy index or its sub-indices in stimulating RE investment in Arab countries, as their variables are statistically significant. But despite the significance of policies, Arab countries have low coefficients that reflect weakness in some sub-indices, particularly carbon pricing and greenhouse gas monitoring, incentives and regulatory support, attributes of financial and regulatory incentives, and counterparty risk. To boost RE investment, Arab countries need to work vigorously on these pillars.

دور السياسات في تحفيز الطاقة المتجددة في البلدان العربية

سحر عبود

ملخص

بالرغم من وفرة الأدبيات الاقتصادية عن الطاقة المتجددة، فإن الدراسات مازالت محدودة حول دور السياسات في تحفيز الاستثمار في الطاقة المتجددة خاصة للبلدان النامية ومنها البلدان العربية. تتناول هذه الدراسة بالتحليل دور السياسات كأحد المحددات الأساسية للاستثمار في الطاقة المتجددة في 11 بلدًا عربيًا باستخدام السلاسل الزمنية المقطعية للفترة 2010-2019 لتحديد المجالات التي من شأن تدخل السياسات فيها أن يشجع الاستثمار في الطاقة المتجددة في البلدان العربية. وتستخدم الدراسة نصيب الطاقة المتجددة من إجمالي عرض الطاقة كمؤشر بديل للاستثمار في الطاقة المتجددة. ورغم ما يظهره التحليل من تباين جهود البلدان العربية فيما يتعلق بتهيئة البيئة الداعمة لاستثمارات الطاقة المتجددة، إلا أن كافة البلدان العربية تشهد تحسنًا في هذا الصدد. وتؤكد النتائج أهمية السياسات في تحفيز الاستثمار في الطاقة المتجددة في البلدان العربية سواء على مستوى المؤشر الإجمالي للسياسات أو مكوناته الفرعية وجاءت متغيراتها معنوية إحصائيًا. وبالرغم من معنوية المتغيرات، فإن تواضع معاملاتها يعكس الضعف في بعض المؤشرات الفرعية وتحديدا تسعير الكربون ومتابعة الغازات الدفيئة، والحوافز والدعم التنظيمي، والحوافز المالية والتنظيمية، والمخاطر المرتبطة باحتمالية عدم الالتزام. وعليه، من أجل دفع عجلة الاستثمار في الطاقة المتجددة، يلزم على البلدان العربية العمل بقوة على هذه المجالات.

* Lecturer of Economics, Institute of National Planning, Egypt.
E-mail: sahar.aboud@inp.edu.eg

1. Introduction

Renewable energy (RE) can be a powerful engine for economic recovery from the ongoing coronavirus crisis through creating new opportunities for sustainable economic growth and employment. In addition, RE can be a cornerstone in achieving the 2030 Agenda for Sustainable Development and meeting the commitments made under the 2015 Paris Agreement, which seeks to "hold the increase in the global average temperature to well below 2°C above pre-industrial levels". (UNFCCC 2015; Article 2)

There is an upward trend in global investment in RE. A total of $2.7 trillion have been invested in RE during 2010-2019 (excluding large hydro), which is more than triple the amount invested over the past decade (UNEP 2019).

Despite this increase, it is still significantly lower than the investment needed to meet the commitment under the Paris Agreement. The International Energy Agency (IEA) estimates that more than $6 trillion in cumulative investments in renewable power until 2040 are required to meet this goal (IEA 2016).

There is consensus concerning the role of policies in stimulating RE investment. This role can be achieved by designing stronger and more coherent climate mitigation policies, which stimulate both the demand and supply of RE using different tools. These policies include carbon pricing, fiscal and financial incentives, the phasing-out of fossil fuel subsidies and R&D support OECD (2016).

There is a notable increase in supportive governmental intervention all over the world, with around 80 percent of high-and upper-middle-income countries adopting supportive RE policies (Polzin et al. 2019)

In 2018, around 111 countries have applied the feed-in tariff, at least 48 countries applied RE auctions, and about 66 countries implemented net consumption policies (REN21 2019).

Most studies have demonstrated the importance of policies in supporting investment in RE over the past decade, and this pivotal policy role is expected to continue.

The policy mix used by each country is subject to a variety of variables, including the nature of the market, the development of RE technologies, and policy priorities.

During the past decade, many Arab countries have made significant progress toward a sustainable energy future, through developing enabling policy frameworks for RE with ambitious targets and financial incentives.

These efforts resulted in a huge increase in accumulative investments in RE (excluding hydro) in the Arab region to be around $15 billion during the past decade compared to only $1.2 billion in 2008 (RECREEE and UNDP 2019).

However, with this shift, the share of Arab countries in global investment in RE is still limited and far from the value needed to achieve their targets, so the need to mobilize investments in RE is essential.

Despite the abundance of literature on RE, studies about the role of policies in RE investments, especially for developing countries including Arab countries, are still limited.

Therefore, the study aims at examining the role of RE policies as a key determinant of RE investment in 13 Arab countries using panel data covering the period 2009-2019 to identify areas for policy intervention to stimulate RE investment in Arab countries.[1] The countries are Jordan, United Arab Emirates, Egypt, Morocco, Tunisia, Algeria, Sudan, Iraq, Oman, Kuwait, Lebanon, Libya, and Saudi Arabia.

This research paper is organized as follows: Section I reviews the existing literature on the role of policies in stimulating RE investment. Section II briefly presents some stylized facts about RE investments in Arab countries. Section III describes the methodology and data used and discusses the results. The final section concludes with some policy implications.

[1] Due to the unavailability of data, the final sample is composed of 11 Arab countries: Algeria, Egypt, Jordan, Lebanon, Morocco, Saudi Arabia, Tunisia, Kuwait, the United Arab Emirates, Oman, and Sudan for the period 2010-2019.

2. Literature Review on the Role of Policies in Stimulating Investment in RE

Despite growing literature on the importance of RE, studies are still limited about determinants of RE investments, especially for developing countries including Arab countries. As reviewed below, most studies examine the effect of a specific policy or a group of policies and are usually applied in developed or emerging countries.

Wenfeng et al. (2018) used a group of aggregate and specific RE policies to evaluate their effect using a panel dataset covering 29 countries (EU, China and India) from 2000 to 2015. The study indicates that four aggregate policies—fiscal and financial incentives, market-based instruments, policy support and research & development (R&D)—and three specific policies—price policy, grants and subsidies, and strategic planning—are significant to improve RE capacity.

Dina et al. (2018) used data from 13 OECD economies for the period 2004–2016 to investigate the impact of four policy instruments, namely (i) feed-in tariffs, (ii) taxes, (iii) loans, and (iv) grants and subsidies, on private investment in RE, in addition to other explanatory variables including government R&D, fuel prices, and RE prices. Applying a multilevel random-intercept and random-coefficient model provides evidence of the effectiveness of feed-in tariffs and loans on private investment in RE, while there is no evidence of the impact of taxes, grants, and subsidies.

Geraldine et al. (2017) assessed the impact of climate mitigation policies and the quality of the investment environment on investment and innovation in RE. The authors used data across OECD and G20 countries on more than 70 explanatory variables. These variables were grouped into three categories: (i) climate mitigation policies; (ii) investment environment variables; and (iii) control variables. Results showed that beyond adopting climate mitigation policies, policymakers must strengthen the business investment environment and make it consistent with climate mitigation policies to mobilize investment and innovation in RE.

Haščič et al. (2015) investigated the role of two categories of public interventions—finance (bilateral, domestic, and multilateral) and public policy instruments (feed-in tariffs, RE quotas, the Clean Development Mechanism)—in

mobilizing flows of private climate finance worldwide using the Heckman method. The econometric analysis focused on six RE sectors (biomass, geothermal, marine, small hydro, solar, and wind) for 769 country pairs during the period 2000-2011.

Results concluded that both public finance and policies played a significant role in mobilizing private finance worldwide. For developed countries, public policies played a more important role than public finance, while for developing and emerging countries the effect of policies is limited compared to the effect of public finance.

Polzin et al. (2015) used a sample of OECD economies for the period 2000-2011to explore the impact of public policy measures on RE diffusion through investments in electricity-generating capacity implemented by institutional investors (i.e., investment/pension funds, banks, and insurance companies). To boost investments, the policy mixture must contain economic/fiscal incentives (such as FITs) as well as market-based incentives like GHG emission trading systems, which directly impact the risk/return structure of RE projects. Complementing these with regulatory measures such as codes, standards, and long strategic planning could strengthen the environment for RE investments.

Eyraud et al. (2013) examined factors affecting green investment in 35 advanced and emerging countries from 2004 to 2010. There is a positive relationship between green investments and economic growth, low interest rates, and high fuel prices. Some policy interventions, such as carbon pricing schemes, or feed-in-tariffs, have a positive and significant effect on green investment while biofuel support was not followed by higher green investments.

Burer and Wustenhagen (2009) surveyed 60 investment professionals from European and North American venture capital and private equity funds to assess the effectiveness of various policies in stimulating investment in innovative clean energy technologies.

Based on interviews, investors agreed that a mixture of policies was required to extend investor interest in clean energy, and technology-push and market-pull policies were supplementary. They confirmed the importance of policy consistency. Finally, clean energy investors consider supportive policy as crucial to encouraging investment in clean energy technologies, although a decent policy

environment is credibly important. Nevertheless, some investors were deeply worried about any government involvement. The authors of the study suggested that policymakers can intensively communicate the benefits of good policies and clarify their rationale.

Polzin et al. (2019) reviewed 96 empirical studies to measure the effectiveness of various policy instruments on two main decision metrics for investors: investment risk and investment return. This study concludes that effective policies should address both risk and return simultaneously. Also, the credibility and predictability of policies affect the investment decision. A focused analysis of the particular design of feed-in tariffs, auctions, and renewable portfolio standards confirmed that they were most effective when designed in a way that minimizes risk and maximizes return.

Besides the RE policies, other studies confirm the role of other variables in determining the value of RE investment such as the state of the national business environment and governance issues.

OECD (2015a, b) confirmed the importance of a supportive macro business environment for renewable investment decisions. The absence of discrimination against foreign investors, support for competition policy, and intellectual property protection, contract enforcement, transparency, streamlined and clear regulation and procedures, access to finance, and land are all factors that increase investor confidence to invest in RE.

Bellakhal et al. (2017) investigated the relationship between governance, trade openness, and RE investment within the MENA region using panel data for 15 MENA countries for the period 1996-2013. The study used six variables to reflect the level of governance: corruption, bureaucracy quality, government stability, internal conflicts, investment profile, and law and order. The results confirmed that governance issues largely determine investments in RE within the MENA region. In addition, this effect seems to be conditional on the trade regime. The results confirmed that bad governance and distorted trade policy both explain the low level of investment in RE across MENA countries.

In addition to the role of RE policies, non-policy variables affect renewable investments such as level of development, local energy supply, availability and cost of renewable resources, and commitments to environmental agreements.

Romano and Scandurra (2016) tried to analyze the determinants of investments in RE sources with differentiation between hydroelectric and other renewable sources. They used a dynamic panel analysis of renewable investments in a sample of 32 countries (OECD, Brazil, Russia, India, China, and South Africa), in the years 2000-2008. Results confirm that key factors promoting investments in RE vary according to generation sources. Investments in hydroelectric sources contribute to improving the environmental conditions, while the other sources are not significant. Policies are useful in supporting investments in RE. An increase in the share of nuclear and thermal electricity generation depresses investments in renewables.

Considering the above, RE policies are important to stimulating investment in RE. Their impact, however, is dependent on several factors including the general policy of climate change, support for conventional energy, the overall environment for investment, and governance considerations. Designing policies in a coherent manner takes the aspects of return and risk into account; and achieving stability, credibility, and predictability are considered a prerequisite to attracting investments in RE, especially large-scale projects.

3. Some Stylized Facts about RE Investments in Arab Countries

Arab countries have promising RE business opportunities that are estimated at over 30 percent of the global solar and wind growth. Also, shifting to renewable is required to achieve global and national sustainable development agendas and meet the growing demand for energy.

During the past decade, several Arab countries have made significant progress toward a sustainable energy future, through developing enabling policy frameworks for RE with ambitious targets. Based on the announced targets for 2035, the region will have more than 190 GW of operational capacities. The most ambitious target in terms of the share of the power mix is Djibouti, where the target would reach 100 percent renewables by 2035, followed by Morocco (52 percent) followed by the United Arab Emirates and Egypt (ESCWA 2019).

Regionally, the Arab countries announced their commitment to a sustainable energy future through the adoption of the Pan-Arab Renewable Energy Strategy 2030 in 2013. The strategy has been expanded in 2018 to become the Pan-Arab Sustainable Energy Strategy (ASES). The ASES provides wide renewable opportunities within the Arab electricity markets (IRENA 2014).

Despite the rise in total installed capacity within Arab countries of new renewables (excluding hydro), which surpassed seven GW in 2018 compared to only 1.1 GW in 2010, the RE share in the overall installed capacity did not exceed six percent on average in 2018. Notably, Arab African countries enjoy a higher overall share reaching 12 percent, indicating a relatively faster development pace. Sudan is leading with around 49 percent share attributed to its large hydro capacity. If hydro is excluded, Morocco and Jordan have the highest shares at around 14 percent, followed by Mauritania with a share of 12 percent. Seven Arab countries (Jordan, Egypt, UAE, Algeria, Morocco, Yemen, and KSA) hold 90 percent of the current PV capacities in the region, while five Arab countries (Morocco, Egypt, Jordan, Tunisia, and Mauritania) hold 99 percent of the current wind capacities within the region (RECREEE and UNDP 2019)

RE share in total energy supply for Arab countries is still limited as reflected in Table 1, especially compared to India, Brazil, and Turkiye.

Table (1): Shares of Different Energy Sources in Total Energy Supply in 2019

Country	Oil	Natural gas	Coal	Biofuels and waste	Wind, solar, etc.	Hydro	Nuclear
Bahrain	12.6	87.4					
Tunisia	39.3	41.1		9.8	1.1	0.1	
Morocco	56.5	3.9	29.8	5.9	3.3	0.5	
Egypt	37.4	54.7	2.8	3.5	0.5	1.2	
UAE	7.4	89.1	2.9	0.1	0.6		
Jorden	54.27	37.26	2.27	1.06	5.12	0.02	
Lebanon	94.6		1.8	1.9	0.7	1	
Oman	2.43	97.56			0.001		
Qatar	7.58	92.4		0.02			
Algeria	35.67	63.7	0.49	0.016	0.09	0.02	
Saudi Arabia	62.6	37.37		0.004	0.017		
Kuwait	45.4	54.5			0.1		
Sudan	34.5			61.1		4.4	
India	25.1	5.9	44.5	20.4	1.2	1.6	1.3
China	19.2	7.4	61	3.7	2.8	3.2	2.7
Turkiye**	28.8	26.9	27.2	2.4	10.1	4.8	
Brazil	36.1	11	5.3	32.2	2.2	11.8	1.4
Mexico**	38.9	45.8	4	5	3.4	1.3	1.6

** Data for 2020
Source: Author calculations based on the International Energy Agency (IEA) database.

So, many Arab countries adopted supporting policies to scale up RE investments such as competitive bidding, auctioning, direct proposals, net-metering, and feed-in tariffs. The market structures have improved, providing private investment opportunities to ease access to the power generation market. Most Arab countries established institutions responsible for RE development, and some of them started drastic fuel subsidy reforms like Egypt and Morocco (RECREEE and UNDP 2019).

These great efforts resulted in a huge increase in the aggregate accumulative investments in RE projects in the last decade (excluding hydro) to be around $15 billion compared to only $1.2 billion in 2008 (RECREEE and UNDP 2019).

Despite this shift, the share of Arab countries in global investment in RE is still limited either compared to other regions, especially Asian countries, or to the value needed to achieve the ambitious renewable targets, so the need to mobilize investment in RE is essential (UNEP 2019).

A key challenge to the region is to extend the market volume for decentralized RE solutions in several sectors, such as solar pumping for irrigation and hybridization of renewables with diesel for electricity and heat generation in industry and commercial sectors (RECREEE and UNDP 2019).

Assessing the RE policy environment remains challenging, especially in developing countries including Arab countries, where information is limited and monitoring the implementation process or policy efficiency is not an easy task.

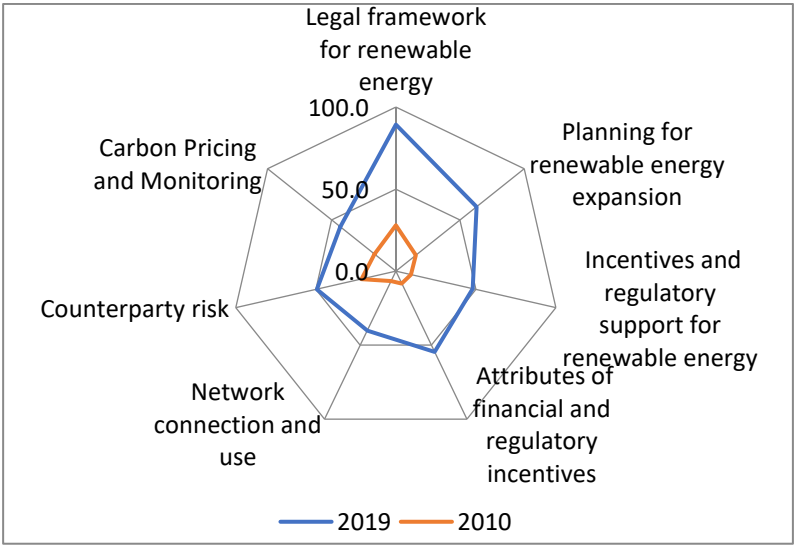
The World Bank introduced a simple composite index for sustainable energy called the Regulatory Indicators for Sustainable Energy (RISE). It consists of four pillars: access to electricity, clean cooking, RE, and energy efficiency. RISE scores reflect how countries support sustainable energy through capturing policies and regulations. The RISE score ranges from 0 (worst) to 100 (best) (World Bank 2020).

Generally, RISE may be a comprehensive index that reflects the attractiveness of a country to RE investment. RE pillars include seven sub-pillars: legal framework for RE, planning for RE expansion, incentives and regulatory support for RE, attributes of financial and regulatory incentives, network connection and use, counterparty risk, carbon pricing, and monitoring.

Using scores for Arab countries in the RE pillar available from the RISE database during the last 10 years, two main facts can be concluded:

a. There is a notable improvement in the RE environment across Arab countries in all sub-pillars related to RE (Figure 1)
b. Despite the improvement, there is a huge difference in performance across sub-pillars. While the legal framework supporting renewable has witnessed considerable improvement in all Arab countries, the network connection and use are still lagging, followed by carbon pricing and monitoring (Figure 1).

Figure (1): Progress of Arab Countries in RE Sub-pillars for 2010, 2019



Source: Calculated from World Bank, RISE 2020, Regulatory Indicators for Sustainable Energy - https://rise.esmap.org/

Benchmarking the RE environment in the Arab countries against other developing countries particularly China, India, and Brazil as shown in Table 2 reveals that the Arab countries are still far from some other developing countries.

Not only is there heterogeneity between the Arab countries and other developing countries, but there is also heterogeneity within the Arab countries regarding their performance to improve the RE environment either on the overall pillar or sub-pillars as follows:

a. Regarding the RE pillar: Tunisia, United Arab Emirates, Egypt, Morocco, and Jordan were the top five in 2019, so they are considered to have mature policy environments. However, Yemen, Sudan (except for Hydro), and Kuwait still have a weak environment supporting RE (Table 2).
b. Regarding the RE sub-pillars: There is a great variation among Arab countries across the different sub-pillars. Except for the legal framework and planning for renewable, the other sub-pillars show wide variation.

Table (2): Scores of Arab Countries and Some Developing Economies in RE Pillar in RISE and its Sub-pillars for 2019

	Countries	RE	RE Indicator 1: Legal framework for RE	RE Indicator 2: Planning for RE expansion	RE Indicator 3: Incentives and regulatory support for RE	RE Indicator 4: Attributes of financial and regulatory incentives	RE Indicator 5: Network connection and use	RE Indicator 6: Counterparty risk	RE Indicator 7: Carbon Pricing and monitoring
Arab countries	Tunisia	79	100	60	75	75	31	64	100
	United Arab Emirates	78	80	63	75	67	50	92	100
	Egypt, Arab Rep.	77	100	63	48	92	83	76	50
	Jordan	75	100	47	45	92	50	64	100
	Morocco	71	100	80	65	83	40	81	50
	Lebanon	67	100	77	80	50	26	58	50
	Oman	51	60	58	40	50	66	38	0
	Qatar	47	80	38	25	17	0	60	100
	Algeria	45	100	63	45	17	57	23	0
	Saudi Arabia	39	80	48	19	50	20	58	0
	Bahrain	33	100	46	19	25	13	13	0
	Kuwait	28	60	38	0	25	7	17	50
	Sudan	25	60	17	0	0	0	8	0
Other developing economies	India	89	100	73	93	95	87	75	100
	Mexico	82	80	68	65	75	83	66	100
	Brazil	81	80	92	82	75	100	83	50
	Turkiye	80	100	93	60	92	82	84	50
	China	69	100	56	83	42	82	70	50

Source: World Bank, RISE 2020- Regulatory Indicators for Sustainable Energy - https://rise.esmap.org/

Note: Scores 67–100 indicate a relatively mature policy environment (highlighted in green). Scores 33–67 indicate serious efforts to develop a policy framework (highlighted in yellow). Scores 0–33 indicate policy adoption remains at an early stage (highlighted in red).

All Arab countries, whether good performers or not, have good prospects for improving their RE environment.

4. Methodology, Data and Results

Methodology

This research paper aims to examine the link between policies and RE investments in Arab countries. Theoretically, policies play an important role in stimulating RE investments. The study tries to test this hypothesis using a composite index reflecting the RE policy environment then rerun the model using the sub-indices or the component of the composite index to test for the most significant indices for RE investment.

The model will use a panel estimation strategy. As panel data contain more information, greater variability and less collinearity between the variables allow for exploiting the time-series dimension of the data and control for possible heterogeneity and omitted variables on cross-sectional estimation.

Since static regression models can suffer from many problems, including structural instability and spurious regression, a dynamic specification of the model is employed that allows for slow adjustment. The inclusion of a lag dependent variable as an explanatory variable provides dynamic adjustment in an econometric model. However, the lagged dependent variable correlates with the cross section-specific effect and the problem of endogeneity appears. This endogeneity issue affects the consistency of least squares-based estimations. The use of instrumental variable (IV) methods or the generalized method of moments (GMM) produces consistent parameter estimates for the data with finite periods and large cross-section dimensions (Romano and Scandurra 2016).

Before applying any analysis technique, we must check the normality assumptions for the dependent variables as follows: using two tests, which are one-sample Kolmogorov Test and Shapiro-Wilk test. Both tests show that the normality assumption for all the dependent variables is not achieved.

In case of violation of the normality assumption, a good candidate for the estimation process is the generalized method of moments (GMM) developed by

Arellano and Bond (1991). The GMM estimation was formalized by Hansen (1982), and since then has become one of the most widely used methods of estimation for models in economics. In models for which there are more moment conditions than model parameters, GMM estimation provides a straightforward way to test the specification of the proposed model. This is an important feature that is unique to GMM estimation.

The consistency of the estimation depends on whether lagged values of the endogenous and exogenous variables are valid instruments in our regression. Also, this methodology assumes that there is no autocorrelation in the errors, therefore a test for the previous hypotheses is needed.

Two tests are employed to check the consistency of the estimation. The Sargan test, proposed by Arellano and Bond, is used to test over-identifying restrictions for the instruments. The null hypothesis of the Sargan test assumes that the over-identifying restrictions are valid. Failure to reject the null hypothesis in this test gives support to our model. The Arellano-Bond test is employed to test if there is autocorrelation between errors. The null hypothesis is the absence of first-order autocorrelation. Failure to reject the null hypothesis means there is no autocorrelation and the model is accurate.

The model will test the following two equations:

$$Ln\ share\ RE_{it} = b_o + b_1 * RE(-1) + b_2 * lnGDPPC_{it} + b_3 * energyimport_{it} + b_4 DB\ score_{it} + b_5 REpolicy\_it + \varepsilon\_it \quad (1)$$

$$Ln\ share\ RE\_it\% = b\_o + b\_1 * RE(-1) + b\_2 * lnGDPPC\_it + b\_3 * energyimport\_it + b\_4\ DB\ score\_it + b\_5\ sub1\_it + b\_6\ sub2\_it + b\_7\ sub3\_it + b\_8\ sub4\_it + b\_9\ sub5\_it + b\_10\ sub6\_it + b\_11\ sub7\_it + \varepsilon\_it \quad (2)$$

where for country *i* at time *t*, lnshareREit is the logged share of RE in total primary energy supply (TPES), and ln GDDPC is the lagged value of GDP per capita. Energy imports as a percentage of energy use. DB is a score in the Doing Business database in each country. RE policy index is a measure of specific policies and

regulations adopted by the country to develop RE and attract investment in RE projects, and εit represents the error term.

Data

Due to the unavailability of data, the final sample is composed of 11 Arab countries: Algeria, Egypt, Jordan, Lebanon, Morocco, Saudi Arabia, Tunisia, Kuwait, the United Arab Emirates, Oman, and Sudan for the period 2010-2019.

Variables definition and summary statistics are reported in Appendices 1 and 2. The dependent variable is the value of RE investment. However, data on RE investment are not available for all years and all Arab countries. In general, two proxies are often used in the literature: RE production and RE consumption. The study follows Marques et al. (2010) and Bellakhal, R. et al. (2017) and uses the contribution of RE to the total primary energy supply as a proxy for RE investment (lnshareRE). This variable reflects the shift towards RE in energy supply. It is measured by the natural logarithm of the ratio between the total RE produced and the total primary energy supply. Data have been gathered from two sources: the OECD concerning the value of RE, and the Energy Information Administration (EIA) concerning the total primary energy supply.

In addition to the lag of RE as an explanatory variable, the other four explanatory variables are weakly correlated as shown from the correlation coefficients presented in Appendix 3.

ln GDPPC is the natural logarithm of real GDP per capita. There is abundant literature on the relationship between income and pollution across different stages of development, based on the Environmental Kuznets Curve (EKC). In general, high-income countries are supposed to have stricter environmental policies and encourage RE production and consumption (Wolde-Rufael 2009; Copeland and Taylor 2003; Lieb 2003).

Energy imports are the percentage of energy imports in total energy use. It reflects the dependence on external sources in meeting the domestic demand for energy in each country. The expected coefficient is negative. As the country's energy imports increase, it should diversify its energy mix and increase the share of renewable sources.

Doing Business (DB) is the score of a country in the Doing Business index issued by the World Bank. The index reflects how the investment environment is friendly to the business sector generally. Doing Business measures 41 indicators gathered in 12 dimensions of business regulation affecting local firms existing in the largest business city of 190 economies. The Doing Business score ranges between 0 (worst) to 100 (best). The conducive business environment will positively affect RE investments. (OECD 2015a, b)

The RE policy variable is the score of each country in the RE pillar included in World bank RISE. The score of RE reflects the RE policy environment. The higher score reflects a good RE policy. The expected coefficient is positive. As mentioned in the literature review, implementing good policies will stimulate RE investment so the expected sign will be positive.

Results

The descriptive statistics of the data shown in Appendix 2 reveal a high standard deviation in the policy variable followed by the DB variable, which reflects the heterogeneity among Arab countries in both variables. It also confirms the low level of RE share in the total energy supply, where RE policies are mature or in the early stage. This may refer to two issues: first is the lag of some Arab countries in setting supportive policies for RE, and second is that countries with mature policies may have challenges in implementation or effectiveness.

The results of the model estimation are presented in Table 3, which contains the results of estimation for the two equations 1 and 2. Before interpreting the coefficient, we test the consistency of both models. Using both Sargan and Arellano and Bond tests, their results confirm the absence of autocorrelation and over-identification problems, as shown in Appendix 4.

The results are consistent with the literature in confirming the importance of RE policies either using the RE policy index or using its sub-indices in promoting RE investment in Arab countries, as their variables are statistically significant. The low value of the estimated coefficient for RE policy may indicate there is room for improvement either in adopting RE policies in bad performers according to RISE or in improving the design and the implementation process for suitable policies, including monitoring and evaluation to assess the effectiveness of adopted policies.

The coefficient signs for the sub-indices have mixed results. While planning for RE expansion (sub2), legal and regulatory framework for RE (sub1), and network connection and use (sub5) are affecting the RE positively, incentives and regulatory support (sub3), attributes of financial and regulatory incentives (sub4), carbon pricing and greenhouse gas monitoring (Sub7) and counterparty risk (sub6) have a negative coefficient. The negative and significant relation confirms that there is a need for Arab countries to work vigorously on these pillars to boost RE investment.

The income effect on RE investment is negative and statistically significant in both models. This result is in line with Bellakhal (2017) and Marques et al. (2010) who found a negative effect of income in promotion of RE within the MENA region. Here, the negative sign may reflect the fact that Arab countries include both oil-exporting and oil-importing countries, so the income effect is rather weak in the Arab countries compared to the more prevalent substitution effect. While the oil-importing countries have an incentive to substitute oil for a cleaner alternative at least to reduce their import bills, the oil-exporting countries are less motivated to do so. Thus, it is only normal that we find that the best performers in stimulating RE (except for UAE) are among the lower-income countries, while the higher-income mainly big oil-exporting countries are lagging. This also explains the negative and significant relation between energy imports and RE energy.

The DB score has a significant but negative coefficient. This is unexpected and may confirm that there is still a need to improve the business environment in general in most Arab countries to enhance their attractiveness to investment.

Table (3): GMM Estimation Results

VARIABLES	Eq(1)	Eq(2)
RE(-1)	0.619*** (0.000)	0.616*** (0.000)
Ln GDPPC	-16.22*** (0.000)	-15.78*** (0.000)
Energy import	0.0370*** (0.000)	0.0367** (0.024)
DB score	-0.0697** (0.029)	-0.0217 (0.894)
RISE	0.0763** (0.000)	
Sub1		0.0210 (0.374)
Sub2		0.0991** (0.0347)
Sub3		-0.0107** (0.000)
Sub4		-0.0217 (0.429)
Sub5		0.0178** (0.000)
Sub6		-0.0271 (0.477)
Sub7		-0.0245** (0.000)
Constant	149.3*** (0.000)	143.1*** (0.000)
Observations	99	99
Number of ID	11	11

p-value in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4. Conclusion and Policy Implications

RE can be a powerful engine for economic recovery from the coronavirus crisis in addition to its importance for the 2030 Agenda for Sustainable Development and the 2015 Paris Agreement. Over the past decade, many Arab countries made serious progress toward a sustainable energy future, setting ambitious targets for RE applications, especially in electricity generation. An improved capacity is observed to provide institutional support, streamline administrative procedures, and set financial and fiscal incentives.

However, the share of Arab countries in global investment in RE is still limited to achieving their targets and reaping the benefits from RE opportunities, so the need to mobilize investments in RE is essential.

Despite the abundance of literature on RE, studies are still limited about the role of policies on RE investments, especially for developing countries including Arab countries. Therefore, the study aimed at examining the role of RE policies as a key determining factor of RE investment in 11 Arab countries using panel data for the period 2010-2019.

The study concludes that there is heterogeneity among Arab countries concerning their efforts to enable the environment for RE investment, but all Arab countries—whether good or bad performers—have good prospects for improving their RE environment. Estimation results are consistent with the literature, confirming the importance of policies either using RE policy index or using its sub-indices in promoting RE investment in Arab countries, as their variables are statistically significant.

The coefficient signs for the sub-indices have mixed results. Planning for RE expansion, legal and regulatory framework for RE, and network connection and use, affect RE investment positively. Carbon pricing and greenhouse gas monitoring, incentives and regulatory support, attributes of financial and regulatory incentive, and counterparty risk have a negative coefficient. The negative and significant relation confirms that to boost RE investment, Arab countries need to work diligently on these pillars.

However, generally speaking, many areas can be mentioned such as strengthening climate mitigation policies, particularly carbon monitoring and

pricing, setting quantitative targets for other RE applications such as transport, heating, and cooling, and tailoring the needed policies and incentives for stimulating demand and supply for these applications, hence expanding the market volume for decentralized RE solutions in different sectors.

Finally, those policies and regulations that are critical to attracting investment in RE must be backed by awareness of the importance of sustainable energy, strong institutions, access to finance, an open flow of information, and last but not least a strong private sector.

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Appendix (1): Data Sources and Variables Definitions

Variable	Definition	Source
lnshareRE	Percentage of RE in total primary energy supply (TPES)	OECD and EIA
GDDPC	GDP per capita (constant 2010 US$)	WDI database
Energy imports	Energy imports as percentage of energy use	WDI database
DB	Doing Business Index	WDI database
RE Policy index	RE pillar in RISE index	World Bank
Sub1	Legal and regulatory framework for RE	
Sub2	Planning for RE expansion	
Sub3	Incentives and regulatory support	
Sub4	Attributes of financial and regulatory incentives	
Sub5	Network connection and use	
Sub6	Counterparty risk	
Sub7	Carbon pricing and greenhouse gas monitoring	

Appendix (2): Summary of Descriptive Statistics of Variables

	N	Minimum	Maximum	Mean	Std. Deviation
RE Value	110	0.086	12609.5	1755.108	3449.139
RE %	110	0	81.2326	9.027984	19.35373
ln (RE Value)	110	-2.4534	9.4422	4.77912	3.301711
GDPPC	110	1401.478	41460.28	12685.99	13213.62
Ln (GDPPC)	110	7.2453	10.6325	8.902319	1.048373
Energy Import (% energy use)	110	-391.059	97.8655	-81.5834	155.1483
DB Score	110	44.2486	81.5888	60.20284	9.554598
RE Policy	110	2	79	33.79	23.529
Sub-indices					
Sub1	110	0	100	56.55	34.36
Sub2	110	0	80	35.79	25.243
Sub3	110	0	89	24.23	25.584
Sub4	110	0	92	28.89	33.999
Sub5	110	0	83	21.38	23.422
Sub6	110	0	92	38.1	25.218
Sub7	110	0	100	30.45	40.691

Appendix (3): Correlation Matrix

	RE %	ln (GDPPC)	Energy Import	DB Score	Rise
RE %	1	-0.540**	0.235*	-0.449**	-0.231*
Ln (GDPPC)	-0.540**	1	-0.750**	0.565**	-0.169
Energy Import	0.235**	-0.750**	1	-0.11	0.415**
DB Score	-0.449**	.565**	-0.11	1	0.399**
Rise	0.231**	-0.169	0.415**	0.399**	1

Significant at 0.05 level of significance

Appendix (4): Sargan and Arellano and Bond Tests

Sargan test H0: over identifying restrictions are valid		Arellano and Bond test H0: No autocorrelation					
Equation (1)	Equation (2)	Equation (1)			Equation (2)		
Chi2(43)=6.06 Prob> chi2 = 1.000	Chi2(43)=5.706 Prob> chi2 = 1.000	order	Z	Prop>z	order	Z	Prop>z
		1	-0.99	0.3199	1	-0.99	0.3202
		2	1.11	0.266	2	1.10	0.2681