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The impact of Islamic financial development on renewable energy production in Islamic countries

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Abstract

Purpose – This study aims to determine the impact of the development of Islamic finance on renewable energy production in Islamic countries. Two variables representing Islamic finance (Islamic financing and Sukuk) and five control variables (economic growth, foreign investment, CO2 emissions, trade openness, and consumer price index) are also studied.

Methodology – Ninety-panel data from 10 Islamic countries over a period of 9 years (2013-2021) were analyzed using panel data analysis with the fixed effect model approach.

Findings – The results show that Islamic countries with good development of Islamic banking and Sukuk tend to experience an increase in renewable energy production. Other empirical findings show that economic growth, CO2 emissions, and consumer price index are the next variables that affect renewable energy in Islamic countries.

Implications – The results of this study have implications for the policies of Muslim countries to further encourage Islamic finance to be channeled into the renewable energy sector. The government should establish a clear regulatory framework for green Islamic investment and financing, and if necessary, they are needed to provide incentives to the green investment sector.

Originality – Previous studies that directly examine the effect of Islamic financial development on renewable energy are still limited. Most of the previous studies have examined the impact of Islamic financial development on environmental issues such as sustainable development, climate change, or environmental quality.

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Introduction

Climate change has become an issue that has surfaced in the global area lately. This follows the phenomenon of increasing the amount of world carbon emissions in the last two decades. According to the International Energy Agency Report (2021), global carbon emissions were recorded at 36.3 gigatonnes of CO2 in 2021, an increase of 46.96 percent compared to two decades ago (International Energy Agency, 2021). Although this number decreased in 2020 as a result of the Covid-19 pandemic, carbon emissions are predicted to continue to increase in the future in line with the increasing global energy needs.

Consisting of 57 countries with a geographical area spanning from Southeast Asia to Central Asia, the European Union, Middle East and North Africa (MENA), Sub-Saharan Africa,

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and the Caribbean, with a population reaching 1.8 billion or covering 24% of the world's population, countries Organization of Islamic Cooperation (OIC) countries are one of the largest contributors to carbon emissions in the world. OIC countries produced a total carbon emission of 7.875 gigatonnes in 2012 - around 20% of total global carbon emissions (Climate Watch, 2015). Therefore, reducing carbon emissions will be the focus of OIC countries in the future.

The energy sector is one of the main priority areas in reducing carbon emissions in OIC countries in the next few years. Energy is a basic need that concerns many other sectors, such as transportation, industry, and lifestyle. Therefore, global energy demand is predicted to increase many times in 2050 compared to 2000, and in developing countries, the increase in energy demand is projected to reach 90 percent (Khan & Akram, 2018). Despite being a global staple, the number of carbon emissions in the world resulting from fossil-based electricity generation has continued to increase in recent years. In 2021, the increase in carbon emissions from fossil energy will reach 6 percent from the previous year as a result of increased energy demand during the COVID-19 Pandemic era (International Energy Agency, 2021).

Recently, OIC countries still depend on fossil energy for their energy supply because most of their territory is the largest producer of oil and coal in the world. In 2017, more than 81 percent of their energy supply was met by fossil fuels consisting of 48 percent natural gas, 19 percent fuel oil, 15 percent coal, and 14 percent hydel (Khan & Akram, 2018). Even though the pressure to switch to renewable energy in OIC countries is increasing, the renewable energy market share is only 4 percent of their total energy mix or only 2 percent of the global installed capacity of 920 GW (Khan & Akram, 2018). To overcome this problem, the commitment to make an energy transition towards energy that is environmentally friendly and low in carbon emissions continues to be echoed in OIC countries. This energy transition program is hoped to meet energy needs without damaging the environment.

The renewable energy transition scenario can indeed provide socio-economic and environmental benefits, such as creating many jobs from this sector while reducing carbon emissions, but its implementation faces a number of obstacles, especially in terms of financing (Brunnschweiler, 2010; Geddes et al., 2018). The energy transition program towards environmentally friendly energy requires large funding. The world needs investment funds of around 62 trillion USD to run a low-carbon renewable energy transition program (McGinn, 2022). It is difficult for finances in many countries (especially developing countries) to bear the burden of funding investments in energy transition projects. The existence of this significant financing gap has prompted many policymakers to worry that investment for the application of low-carbon energy technologies on a large scale will materialize slowly enough (Geddes et al., 2018). Therefore, contributions from the private sector, especially the financial sector, are needed to fill the sizable financing gap (Shahbaz et al., 2021).

The financial sector is considered to have a positive role for countries in developing effective low-emission energy transition projects (Fangmin & Jun, 2011). According to Belaid & Elsayed (2019), transitioning to environmentally friendly renewable energy requires a more advanced and strong financial system to encourage and develop promising renewable energy technologies. In the absence of a well-developed financial sector, the state will find it difficult to finance projects. The resulting financing is one of the most important obstacles in promoting renewable energy projects in developing countries (Becker & Fischer, 2013). The Islamic finance sector has a crucial role in the economic system in countries with a majority Muslim population, such as OIC countries. The Islamic finance sector is growing rapidly in Muslim countries compared to the conventional financial sector. Thirty years ago, Islamic finance was barely visible in many countries, but in 2022 the value of Islamic finance is projected to reach 3.6 trillion USD spread across 80 countries (Shafaki, 2022). Islamic banking is the Islamic finance sector with the largest proportion and contributes USD 1.7 trillion or 70 percent of total Islamic finance assets. Even though Islamic finance currently only represents around 1 percent of total global finance, the increase is higher than conventional finance (especially in OIC countries), with growth reaching 11.9 percent in 2019 (Domat, 2020). The increase in the Islamic finance sector in OIC countries provides funding potential for developing renewable energy.

Islamic finance has great potential in funding renewable energy projects in OIC countries. However, there still needs to be more research that empirically reveals the impact of Islamic finance developments on renewable energy production. Most of the previous studies have focused on the conventional financial sector such as banking credit, the stock market, or the bond market (Anton & Nucu, 2020; Belaid & Elsayed, 2019; Brunnschweiler, 2010; Fangmin & Jun, 2011; Ji & Zhang, 2019; Kim & Park, 2016; Le et al., 2020; Samour et al., 2022; Shahbaz et al., 2021; Zafar et al., 2019). In addition, previous research that directly examined the effect of Islamic finance developments on renewable energy was still limited. Most of the previous research only linked the development of Islamic finance to environmental issues (Aassouli et al., 2018; Abdullahi, 2019; Campisi et al., 2018; Kassim & Abdullah, 2017; T. Khan & Mohomed, 2017; Moghul et al., 2015; Solarin, 2019). To fill this research gap, this study aims to empirically examine the impact of Islamic financial development on renewable energy production in OIC countries. In addition, this study also includes control variables in the form of economic growth, foreign investment, CO2 emissions, trade openness, and consumer price index in accordance with previous studies. To check the robustness of the resulting model, this study replaces the dependent variable (renewable energy) with a new dependent variable in the form of renewable energy without hydropower in accordance with previous studies (Ji & Zhang, 2019).

Literature Review

Legitimacy Theory

The theory used in this research is Legitimacy Theory. Legitimacy theory is a theory that describes the relationship between companies and society and the environment. Legitimacy theory says that organizations continually try to ensure that they carry out activities in accordance with the boundaries and norms of the society in which they exist (Zelditch Jr, 2018). The process of gaining legitimacy is related to a mutually agreed social contract between the company and the community. In carrying out its business, every social institution including companies holds a social contract in which sustainability and growth are based on giving something that society wants and distributing economic, social and environmental benefits to groups in power.

In the context of developing renewable energy, legitimacy theory can be interpreted as how society views renewable energy as a legitimate and acceptable energy source because it has a lower environmental impact compared to fossil energy sources. In addition, using renewable energy can also increase a country's energy independence and positively impact the economy, social, and environment. Ultimately the company tries to convince the public that they have contributed to the development of renewable energy through their business operations, including investment.

Renewable Energy Definition

According to the International Energy Agency (2021), renewable energy is energy produced from natural processes that occur continuously to be used as alternative energy. Unlike fossil energy, renewable energy does not produce carbon emissions that have an impact on climate change and global warming. Fossil energy can produce greenhouse gas emissions in the form of carbon dioxide, methane, and nitrogen oxides through the burning of fossil energy. Renewable energy includes geothermal, biofuels, river flows, solar heat, wind, biomass, biogas, ocean waves, and ocean depth temperatures.

Renewable energy needs to be developed to meet the increasing demand and supply of energy. Not only that, the development of renewable energy can also positively impact the environment. The use of fossil energy, which pollutes the environment to meet electrical energy needs, can be reduced by directing the development of green technology-based electrical energy. In addition, currently, the availability of fossil energy is decreasing due to continuous use, but on the other hand, fossil energy is a type of energy that cannot be renewed. In the next few years, renewable energy is predicted to replace fossil energy to supply global energy needs.

Renewable Energy Trend in Islamic Countries

In 2017, fossil fuels (e.g., oil and coal fuels) still dominated energy use in OIC countries, with a proportion reaching 81.2%, while hydroelectric energy was only 14.4%, renewable energy non-hydropower by 4%, and nuclear power by 0.4%. Therefore, Islamic countries that are members of the OIC have recently begun to be interested in developing renewable energy to reduce their dependence on fossil fuels. This is evident from the amount of renewable energy production increasing yearly in OIC countries. Obtained from 13 members who dominate renewable energy production in OIC countries, including Bangladesh, Brunei Darussalam, Indonesia, Jordan, Kuwait, Malaysia, Nigeria, Oman, Pakistan, Saudi Arabia, Sudan, Turkiye, and the United Arab Emirates, the following are development trends renewable energy 13 OIC countries.

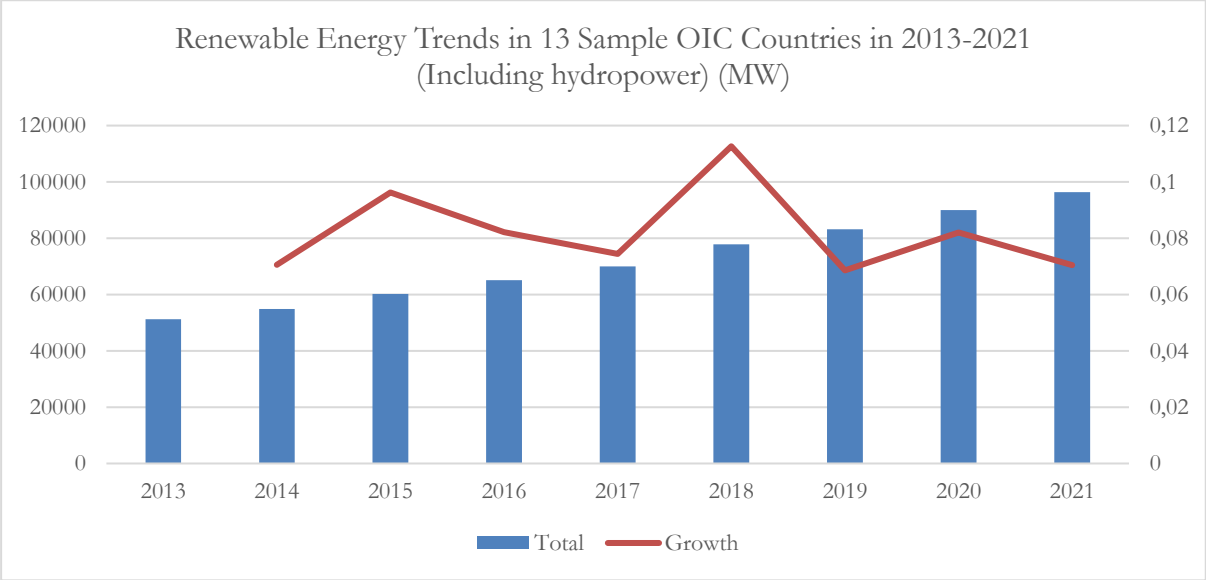

Figure 1. Renewable Energy Trends in 13 Sample OIC Countries in 2013-2021 (Including hydropower) (MW)

Based on Figure 1, the trend of renewable energy production in 13 OIC countries in 2013-2021 shows an increase every year. In 2013, electrical energy generated from renewable energy, including hydropower, was only 51261.84 MW, but in the following nine years, the figure had almost doubled to 96331.04 MW. Meanwhile, the percentage of renewable energy growth in the 13 OIC countries tends to fluctuate from 6-11% per year. The highest growth occurred in 2018 at 11.2%, while the lowest growth occurred in 2019 at only 6.8%. Even so, the contribution of renewable energy from OIC countries to the world still needs to grow, namely only around 7-8% in 2021.

Renewable Energy and Financial Development

Previous studies that researched empirically the effect of financial developments on renewable energy were still focused on the conventional financial sector (Anton & Nucu, 2020; Belaid & Elsayed, 2019; Brunnschweiler, 2010; Fangmin & Jun, 2011; Ji & Zhang, 2019; Kim & Park, 2016; Le et al., 2020; Samour et al., 2022; Shahbaz et al., 2021; Zafar et al., 2019). In previous studies, the banking sector, especially in terms of lending, was chosen as a proxy for measuring developments in the financial sector in addition to other macro-financial sectors such as economic growth and foreign investment. According to Daszyńska-Żygadło et al. (2021), the financial instruments used by banks are the most effective in financing. This is based on ranking various instruments used by banks in the process of financing renewable energy that is environmentally friendly by assessing the structure and value of financing needs based on renewable energy in future scenarios. The banking sector, especially credit, plays an important role in seeking investment for renewable energy needed to meet future energy demands and simultaneously reduce CO2 emissions (Amuakwa-

Mensah & Näsström, 2022). Empirical studies conducted by Brunnschweiler (2010), Fangmin & Jun (2011), Belaid & Elsayed (2019), Shahbaz et al. (2021), and Samour et al. (2022) confirmed that bank financing has a positive and significant influence on the development of renewable energy in many countries, although, Le et al. (2020) found that the effect of bank credit is not significant in developing countries.

Although credit is a commonly used proxy to assess developments in the financial sector, the capital market sector (such as the stock and bond markets) also has great potential in developing renewable energy. Kim and Park (2016) concluded that countries with well-developed financial markets (particularly credit banks and capital markets) tend to experience good growth in the renewable energy sector, which is environmentally friendly due to easier and greater access to external funding. In addition, Ji and Zhang (2019) stated that the development of the financial sector (credit banks, capital markets, foreign investment) is very important and contributes an overall of 42.42 percent to variations in the growth of environmentally friendly renewable energy in China. In this study, in particular, the capital market is the dominant sector that influences the development of renewable energy in the country.

Anton and Nucu (2020) revealed different results where the three dimensions of financial development (banking sector, bond market, and capital market) had a positive effect on the development of environmentally friendly renewable energy. However, after being tested partially, the development of the market sector capital is a sector that is not significant in influencing the development of energy that is low in carbon emissions. In another study, Zafar et al. (2019) explained that the development of the banking sector succeeded in reducing carbon emissions in G-7 countries but increasing carbon emissions in N-11 countries. Likewise, stock market development actually increases carbon emissions in G-7 countries but decreases in N-11 countries.

Hypothesis

Previous studies that directly examine the effect of Islamic financial development on renewable energy are still limited, but several previous studies have examined the impact of Islamic financial development on environmental issues such as sustainable development, climate change, or environmental quality. Solarin (2019) examines the long-term relationship between Islamic financing and carbon emissions in Malaysia. The results show that Islamic financing has an important role in reducing pollution in Malaysia through green financing schemes for industry, even though industrial employment is increasing. In another study, Abdullahi (2019) found that properly implementing Islamic finance and economics can minimize environmental damage in various countries. In Bangladesh, Islamic banking has played an important role by providing beneficial financial services to support environmental improvement (T. Khan & Mohomed, 2017). Based on the results of the previous literature review, this study developed the following hypothesis:

H_1:Islamic financing has a positive and significant effect on renewable energy production in Islamic countries.

Apart from Islamic financing, Islamic financial development in the form of green Sukuk has also been extensively studied in previous studies. Kassim and Abdullah (2017) concluded that the mechanism and potential for sharia investment in the form of Sukuk could provide many benefits in various sectors, such as education, health, and the environment, although there are many challenges in its implementation. In line with this, Aassouli et al. (2018) explain that expanding green Sukuk funding in Sub-Saharan African countries can be an alternative way to improve environmental quality and human development in the region. In addition, renewable energy projects can also be funded through green Sukuk investment schemes (Moghul et al., 2015). Campisi et al. (2018) find empirical evidence of how incentives and Sukuk portfolios can work to fund renewable energy projects for wind energy in Italy. Based on the results of the previous literature review, this study developed the following hypothesis.

H_2: Sukuk has a positive and significant effect on renewable energy production in Islamic countries

Research Methods

Data and Variable

A total of 90-panel data from 10 OIC countries (as cross-section data) with a research period of 9 years from 2013-2021 were used in this study. This study only uses a 9-year research period because the available data only exists in 2013-2021. The research population includes all Muslim-majority countries that are members of the OIC with a total of 57 countries, but due to limited data in most countries, this study only took 10 OIC countries as research samples. These countries are Bangladesh, Brunei Darussalam, Indonesia, Jordan, Malaysia, Oman, Pakistan, Saudi Arabia, Sudan, and the United Arab Emirates. Data sources are of secondary type, all of which come from Statistical, Economic and Social Research and Training Center for Islamic Countries (2023) data. The data collection technique uses documentation techniques where data is obtained by downloading from the official SESRIC website and then tabulated according to the specified variable measurements. A summary description of the data is presented in Table 1.

Table 1. Data Descriptions Summary

Variable	Obs	Mean	Std Deviation	Max	Min
Renew1 (MW)	90	3129.94	4092.45	12888	0.7
Renew2 (MW)	90	980.31	1288.73	5367	0.7
Financing (Million USD)	90	32806.47	44608.1	176494.2	88.2
Sukuk (Million USD)	90	5783.09	8990.19	39603	27.5
GDP (USD)	90	13975.6	14187.98	46349	453
FDI (Millions USD)	90	5809.67	6509.3	23883	-2172
CO2 (Million Tons)	90	206.5	217.28	679	6.9
Trade (% of GDP)	90	78.08	48.05	190	16.1
Price (CPI)	90	693.54	3891.93	36131	82.15

According to Ji and Zhang (2019), the dependent variable in this study is renewable electrical energy divided into two dependent sub-variables. First, total renewable electrical energy (renew1) is measured by adding up the total capacity of renewable electrical energy (Megawatts/MW). Second, renewable electricity without hydropower (renew2) is measured by adding up the capacity of renewable electrical energy from non-hydropower energy such as solar energy, bioenergy, wind energy, etc (Megawatts/MW). Most of the OIC countries, especially those in MENA rely on non-hydropower (such as solar energy) as a renewable power plant compared to hydropower energy because a geographical location in the form of a desert supports it. Therefore, the growth of renewable electricity from non-hydropower in OIC countries is fairly rapid.

The explanatory variable for Islamic financial development is represented by Islamic financing and Sukuk. Islamic financing is measured by total Sharia-compliant financing to industry (in Millions of USD) (financing) while Sukuk is measured by total Sukuk holdings (in Millions of USD) (Sukuk). Based on previous literature, economic growth, foreign investment, carbon emissions, trade openness, and consumer prices are also included in the regression model as control variables (Belaid & Elsayed, 2019; Ji & Zhang, 2019; Kim & Park, 2016; Le et al., 2020; Samour et al., 2022). Economic growth (GDP) is measured by GDP per capita (USD), foreign investment (FDI) is assessed by foreign direct investment (inward flows) (Million USD), carbon emissions (CO2) are represented by total CO2 emission (Millions of tonnes) (CO2), trade openness (trade) is measured from total exports and imports (% of GDP) (trade), and the consumer price index (price) is calculated from the consumer price index (2010=100) (end of the year) (price). All variables (except trade openness) are logarithmically normalized.

Model Development

Panel data regression recognizes three models to estimate the effect of independent variables on the dependent variable, namely the common effect model (CEM), the fixed effect model (FEM), and the random effect model (REM). These three models use different statistical approaches. In the

CEM and FEM models, the approach used is Ordinary Least Squares (OLS), while the REM model uses the Generalized Least Squares (GLS) approach.

According to Gujarati & Porter (2011), if the amount of time series data tends to be large, but the data cross-section is small, then the OLS approach is more suitable for the model than the GLS. In this case, the researcher assumes that the number of samples in the cross-sectional data tends to be small because it only includes ten countries studied (17.57 percent) of the 57 populations of Muslim countries that are members of the OIC but have a fairly long time span of 9 years. Therefore, this study uses the OLS approach to estimate the model.

As previously mentioned, in the OLS approach, there are two regression estimation models, namely CEM and FEM. However, the CEM model has a weakness, namely that there is no variation in both the time and individual dimensions because the behavior of the data between individuals is the same in various periods so that the output of the panel data regression will apply to each individual (Gujarati & Porter, 2011). To overcome this problem, the OLS approach with the FEM model is more appropriate. The FEM model can accommodate differences in characteristics between individuals, which is a problem in the constant coefficient model (Pooled Regression). These characteristic differences are accommodated through the intercept.

The fixed effect model is one of the models in panel data regression which, in the estimation process, will produce intercepts that vary between individuals but do not vary between time. In contrast, the slope coefficient of the independent variables is fixed both between time and between individuals (Gujarati & Porter, 2011). The intercept difference in the fixed effect model can be formed by using a dummy variable. The use of this dummy variable causes the fixed effect model to be estimated using Ordinary Least Squares (OLS) so that the model is consistent and unbiased. Meanwhile, the important assumptions that the model with the OLS approach must fulfil are homoscedasticity and multicollinearity (Kuncoro, 2003). According to (Gujarati & Porter, 2011), the general form of the regression equation model with the OLS approach is as follows:

$$Y_{it}=\alpha+\beta X_{it}+\varepsilon_{it}+\gamma_i \quad (1)$$

Note: Y_{it} is the dependent variable i and t period, α is the combined intercept, β is the regression coefficient or slope, X_{it} is the explanatory variable i and t period, ε_{it} is the error i and t period, γ_i is the error i, i is the individual (i=1,2,3,…, n); t: time period (t= 1,2,3,…,t). From the regression equation model above, the regression equation model developed in this study is as follows:

$$\text{Model 1: } \text{Log(Renew1)}_{i,t}=\alpha+\beta_1\text{Log(Financing)}_{i,t}+\beta_2\text{Log(Sukuk)}_{i,t}+\beta_3\text{Log(GDP)}_{i,t}+\beta_4\text{Log(FDI)}_{i,t}+\beta_5\text{Log(CO2)}_{i,t}+\beta_6\text{Trade}_{i,t}+\beta_7\text{Log(Price)}_{i,t}+\varepsilon_{it}+\gamma_i \quad (2)$$

$$\text{Model 2: } \text{Log(Renew2)}_{i,t}=\alpha+\beta_1\text{Log(Financing)}_{i,t}+\beta_2\text{Log(Sukuk)}_{i,t}+\beta_3\text{Log(GDP)}_{i,t}+\beta_4\text{Log(FDI)}_{i,t}+\beta_5\text{Log(CO2)}_{i,t}+\beta_6\text{Trade}_{i,t}+\beta_7\text{Log(Price)}_{i,t}+\varepsilon_{it}+\gamma_i \quad (3)$$

Note: Log(Renew), and Log(Renew2) represents the dependent variable, while Log(Financing), Log(Sukuk), Log(GDP), Log(FDI), Log(CO2), Trade, and Log(Price) is the explanatory variable as explained in the previous section. i: Muslim countries that are members of the OIC (i= 1,2,3,…, 13); t: period (t= 2013,2014,.., 2021); α is the combined intercept; $\beta_1, \beta_2, \ldots, \beta_7$: is the regression coefficient or slope; ε_{it} the error i and t period, γ_i is the error i.

Data Analysis

The OLS approach requires homoscedasticity and non-correlation so before estimating the model, multicollinearity tests and heteroscedasticity tests need to be performed on this approach. The multicollinearity test in this study was carried out using a correlation test where if the correlation coefficient value between variables ranges from -0.8 – 0.8 then it is assumed that there is no strong relationship between the explanatory variables (Ghozali, 2016). Meanwhile, the heteroscedasticity test was carried out using the Breusch-Pagan-Godfrey method. If the Prob. Chi-Square >0.05, then there are no symptoms of heteroscedasticity in the regression model (Ghozali, 2016). The next data

analysis is testing the hypothesis on each variable with a partial t-test. The partial t-test aims to see the individual effect of each dependent variable on the dependent variable. If the p-value of each dependent variable is <1, 5, or 10 percent, then the independent variable has a significant effect on the dependent variable and vice versa. Meanwhile, the coefficient value in the regression model is used to see the direction and magnitude of the influence. If the regression coefficient is positive, then partially, the independent variable has a positive effect on the dependent variable, and vice versa.

Results and Discussion

Empirical Result

Table 2 and Table 3 provide the results of the correlation and multicollinearity tests as prerequisites in the model with the OLS approach.

Table 2. Correlation Test Result

	Financing	Sukuk	GDP	FDI	CO2	Trade	Price
Financing	1.000000						
Sukuk	0.767425	1.000000					
GDP	0.391152	0.136780	1.000000				
FDI	0.571074	0.601250	0.064558	1.000000			
CO2	0.582618	0.702566	0.071415	0.693527	1.000000		
Trade	0.433686	0.217977	0.795203	0.161762	0.021863	1.000000	
Price	-0.057336	-0.017069	-0.361721	-0.098115	-0.275085	-0.201990	1.000000

Based on the results of the correlation test, there are two or more independent variables that have a strong relationship such as GDP with Trade (0.79), Financing with Sukuk (0.76), Sukuk with CO2 (0.7), and FDI with CO2 (0.69). According to Ghozali (2016), the correlation limit between the two explanatory variables that can be tolerated is -0.8 to 0.8, although several other researchers state -0.7 – 0.7. This study uses the assumption that the correlation limit between independent variables is -0.8 – 0.8 so that all explanatory variables are declared to fulfill the multicollinearity assumption.

Table 3. Heteroscedasticity Test Result for Model Renew1

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.052535	Prob. F(7,82)	0.4016
Obs*R-squared	7.419872	Prob. Chi-Square(7)	0.3865
Scaled explained SS	5.877680	Prob. Chi-Square(7)	0.5541

The results of the heteroscedasticity test using the Breusch-Pagan-Godfrey method in Model 1 show that the Prob. Chi-Square(7) is 0.3865 > 0.05. This means that the regression model has met the assumption of homoscedasticity so that the next stage of regression testing can be carried out.

Based on the results of regression tests using FEM, Islamic financial development as represented by total Sharia-compliant financing to industry (Log(Financing)) and total Sukuk holdings (Log(Sukuk)) has a positive and significant influence on the production of renewable electricity in 10 countries OIC in 2013-2021. The Log(Financing) variable has a probability of 0 < 0.01 with a regression coefficient of 1.026088. This means that for every increase in total Sharia-compliant financing to the industry by 1 percent in OIC countries, it can increase renewable electricity production by 1.026088 percent, ceteris paribus. Thus H1 is declared accepted. Meanwhile, suppose the value of Sukuk holdings increases by 1 percent in OIC countries. In that case, it has the potential to increase the production of renewable electricity by 0.914720 percent and H2 is declared accepted.

Table 4. Fixed Effect Model Result for Model Renew1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	4.602601	2.022871	2.275282	0.0258**
Log(Financing)	1.026088	0.173059	5.929129	0.0000***
Log(Sukuk)	0.914720	0.102680	8.908414	0.0000***
Log(GDP)	-1.465873	0.446488	-3.283119	0.0016***
Log(FDI)	0.075564	0.062200	1.214853	0.2283
Log(CO2)	-2.217472	0.884532	-2.506944	0.0144**
Trade	-0.055048	0.341903	-0.161006	0.8725
Log(Price)	0.374440	0.216268	1.731372	0.0876*

Adjusted R-squared: 0.960583; F-statistic: 136.5586; Prob(F-statistic): 0.00000; Observations: 90
Note: ***) significant at 0.01; **) significant at 0.05; *) significant at 0.1

Within the economic system, the development of the financial sector has a crucial role as a provider of funds to finance strategic projects, including projects related to environmental issues (Kim & Park, 2016). Islamic finance has principles governing how business activities carried out by industry (including banking) are not only concerned with profit but must also have a positive impact on the social environment. Therefore, the financing portfolio in Islamic banking should be channeled to the green sector (e.g. renewable energy), even though in reality, most Islamic banks have not channeled much green financing to industry (Bukhari et al., 2019). For example, in Bangladesh, the proportion of Islamic banking green financing to total financing is only 3 to 5 percent (Julia et al., 2016). Nonetheless, these empirical findings at least serve as evidence that Muslim-majority countries with high development of Sharia-compliant financing tend to experience good growth in the renewable energy sector because the industry has easier and greater access to external funding. In addition, Sharia-compliant financing can also be an alternative option for industries in some Muslim-majority countries where conventional financing is also developing side by side (e.g., Indonesia) to obtain renewable energy financing.

Islamic finance principles also stipulate explicitly that Islamic banking may not invest in non-ethical industries such as alcohol, tobacco, and pornography. Islamic banking is encouraged to invest in sectors that are beneficial to society and the environment, including renewable energy (Sekreter, 2017). One form of this investment is by issuing Islamic bonds or "Sukuk". This research proves that there is a tendency to invest green sharia in the renewable energy sector in countries with good sharia investment development. Currently, many Islamic countries have invested in the green sector through the issuance of Sukuk. Malaysia launched green Sukuk products on 27 June 2017 and was one of the first countries to introduce green investment products. Green Sukuk is a Sharia investment scheme that the industry can utilize to fund environmentally friendly projects such as the development of renewable energy infrastructure (Hadad-Zervos, 2018).

The control variable in the form of economic growth (Log(GDP)) has a probability value of $0.0016 < 0.01$ with a regression coefficient of -1.465873. This means that economic growth has a negative and significant effect on producing renewable electrical energy in OIC countries during 2013-2021. In other words, if GDP per capita in OIC countries increases by 1 percent, there will be a decrease in the production of renewable electricity by 1.465873 percent, ceteris paribus. According to Le et al. (2020), to achieve the fastest possible economic growth, developing countries often rely heavily on cheap and dirty energy sources, most of which are non-renewable. Therefore, developing countries are still very dependent on energy consumption that is not environmentally friendly, so they tend to pay no attention to environmental impacts to increase their economic growth (Madyan et al., 2022). In this case, even though the growth of renewable energy in OIC countries is quite rapid, its role has not been able to replace fossil-based energy sources. Some OIC countries, especially MENA, still depend on their economic income from fossil-based energy such as oil or coal.

The results of other studies show that foreign investment (Log(FDI)) and trade openness (Log(Trade)) do not have a significant effect on renewable electrical energy in OIC countries during 2013-2021. In developing countries, foreign investment and international trade activities (export-import) have led little to innovation in renewable energy technology (Salim et al., 2017). On the other hand, most developing countries also need clear technical, policy, and financial capacities for

renewable energy investment compared to developed countries (Ghimire & Kim, 2018). This is why foreign investment in renewable energy encounters many obstacles in developing countries. Therefore, Belaid and Elsayed (2019) suggest that more foreign investment can be directed to the renewable technology sector through strong schemes and regulations in countries that have seriously undertaken an energy transition.

Empirical findings show that, statistically, carbon emissions (Log(CO2)) have a negative and significant effect on producing renewable energy in OIC countries. This shows that high carbon emissions reduce renewable energy production in OIC countries. Most of the highly polluting energy (e.g., petroleum and coal) is produced in developing countries (e.g., MENA) (Shahbaz et al., 2021). This happens because the demand for energy arising from economic development is higher in developing countries, thus encouraging them to consume more energy sources that are not environmentally friendly (Pata, 2018). High non-renewable energy consumption encourages increased carbon emissions in developing countries, but on the other hand, renewable energy investment also encounters serious obstacles in developing countries (Bekun et al., 2019). This has an impact on the inefficiency of renewable energy transition programs in developing countries because the demand for energy is high, but encounters many investment constraints in the renewable energy sector.

The study results show that prices, as measured by the consumer price index, have a positive and significant influence on the production of renewable electrical energy in OIC countries during 2013-2021, with a significance level of 10 percent. The consumer price index (CPI) describes the high and low prices of goods in a country. The higher the CPI, the higher the price of goods in that country, and vice versa. The price of goods in most countries in the world is more or less affected by the price of fuels such as petroleum because the cost of fuel adds to production costs. Therefore, when the price of goods rises, it is also possible that the price of fossil fuels is rising (Anton & Nucu, 2020). Rising prices of fossil fuels make investors switch to the renewable energy sector because rising prices encourage minimum returns on investment in shares, which will also increase to make market valuations lower and, in the end, share prices will fall (Brunnschweiler, 2010).

Robustness Check without Hydropower

Ji & Zhang (2019) informed that to test the robustness of the model formed, the dependent variable in the form of renewable electrical energy was replaced with renewable electrical energy without hydropower. According to Ji & Zhang (2019), hydropower is China's most important renewable energy source but has uneven growth because it is only concentrated in Southwest China. In addition, even though hydropower can solve several environmental problems at once, building it requires large investment funds.

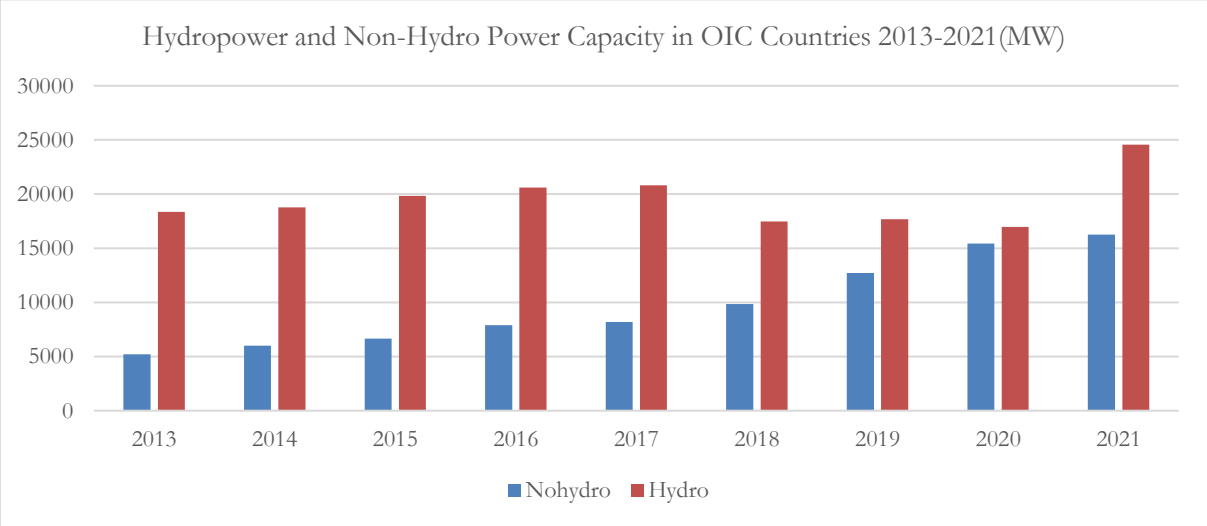

Figure 2. Hydropower and Non-Hydro Power Capacity in OIC Countries 2013-2021

In this case, hydropower in OIC countries has the same problem. Even though hydropower is still a mainstay in renewable energy projects in several OIC countries, its development tends to be uneven and only focuses on regions/countries with large hydropower sources, such as Indonesia, Malaysia, or Pakistan. Meanwhile, in the countries of MENA, hydropower development is not significant because it is not supported by a geographical structure where hydropower sources are limited in these regions (See Figure 2). Some OIC countries are starting to switch to other renewable energy sources with lower costs, such as solar or wind energy. Therefore, it is interesting to see how the empirical findings that have been reported in the previous section work without hydropower. Before carrying out the robustness test, the model must meet the assumption of heteroscedasticity. The results are reported in Table 5.

Table 5. Heteroscedasticity Test Result for Model Renew2

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	3.314372	Prob. F(7,82)	0.0037
Obs*R-squared	12.93588	Prob. Chi-Square(7)	0.0737
Scaled explained SS	11.74948	Prob. Chi-Square(7)	0.1091

Based on the heteroscedasticity test for Model Renew2, the Prob. Chi-Square(7) is 0.0737 > 0.05 which means that the regression model has escaped the assumption of heteroscedasticity. Meanwhile, the results of the robustness test with FEM are reported in Table 6.

Table 6. Robustness Check with Fixed Effect Model for Model Renew2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	1.985900	2.276384	0.872392	0.3859
Log(Financing)	1.026364	0.194747	5.270242	0.0000***
Log(Sukuk)	0.989594	0.115549	8.564300	0.0000***
Log(GDP)	-1.291142	0.502443	-2.569728	0.0122**
Log(FDI)	0.059043	0.069995	0.843530	0.4017
Log(CO2)	-1.555831	0.995384	-1.563045	0.0924*
Trade	-0.357606	0.384751	-0.929447	0.3557
Log(Price)	0.538009	0.243371	2.210653	0.0302**

Adjusted R-squared: 0.931437; F-statistic: 76.56756; Prob(F-statistic): 0.00000; Observations: 90
Note: ***) significant at 0.01; **) significant at 0.05; *) significant at 0.1

The empirical results of the robustness test show that the model tends to be consistent even though the dependent variable has been replaced. The variables Log(Financing), Log(Sukuk), Log(GDP), Log(CO2) and Log(Price) still have a significant influence on renewable energy in OIC countries, even though the dependent variable is replaced. Apart from that, the Adjusted R2 value also remains high and only changes about 3 percent from before. This shows that the model is quite sturdy.

Conclusion

Overall, this research has at least become preliminary evidence that portrays how countries with well-developed Islamic finance can support renewable energy transition programs in Islamic countries. Islamic finance in the form of Islamic financing and Sukuk can be an alternative choice for industries in Muslim countries to obtain renewable energy investment funding in addition to conventional finance. Considering that currently, the need for investment in renewable energy projects is very large, Islamic finance can play a role in filling the existing funding gap, especially in Muslim countries with lower-middle-income economies. Therefore, Muslim countries are advised to direct financing and investment in Islamic finance to green sectors that are beneficial to the

environment and society in accordance with the principles of Islamic finance. The establishment of clear and strong Sharia investment regulations and mechanisms will encourage investors to fund renewable energy projects in the future. If necessary, the government can provide investment funding incentives to green projects as part of a commitment to reduce carbon emissions to convince investors.

This study has several limitations, so it can be perfected for further studies in the future. *First of all*, the number of samples was limited (10 out of 57 OIC countries) because many countries needed to provide the data needed in this study so that further research could expand the number of samples and the study period. *Second*, this study only highlights the total production of renewable energy, so it will be interesting if, in future research, it can analyze the influence of the development of Islamic finance on the renewable energy sub-sector based on its generating power, such as wind power, hydropower, solar power, etc. to provide a clearer picture and specific. *Third*, it is also possible for future research to examine the Islamic social finance sector (e.g., Waqf) against renewable energy in Muslim countries. *Last*, knowing how the different impacts future research can examine the development of Islamic finance toward renewable energy in lower-middle- and high-income Muslim countries.

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