Chapter 14
Does Institutional Quality Affect Renewable Energy in Oil-Rich Developing Countries? Evidence from Azerbaijan

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Abstract This study investigates the effect of government effectiveness as a proxy of institutional quality, CO_2 emissions, and economic growth on renewable energy consumption for Azerbaijan from 1996 to 2019, employing FMOLS method. Estimation results revealed that government effectiveness and CO_2 emissions both have statistically insignificant effect on renewable energy consumption. In addition, we found that economic growth has a statistically significant and positive influence on renewable energy consumption. According to empirical results, some policy recommendations for promoting renewable energy consumption are presented in this study.

Keywords Renewable energy · Government effectiveness · Institutional quality · FMOLS · Azerbaijan

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14.1 Introduction

Currently, the environmental issues in the world get more severe and the ways to address these environmental problems are becoming harder. The main disastrous outcome of rising environmental problems is global warming and climate change (Mukhtarov et al., 2022). This is the eventual footprints of the world nations that utilized the "take, make waste" approach for years, therefore the level of pollution and greenhouse gas emissions skyrocketed thanks to their linear growth strategy which did not consider environmental responsibility (Troster et al., 2018). As a consequence of these, nowadays several troubles such as decreasing biodiversity, ocean acidification, land system change, and others are sharply rising (Hua et al., 2016). It was stated by Nordhaus (1975) that a 2 °C rise in world temperature could cause irreversible problems for the habitants of planet Earth. In this regard, many actions such as Paris and Kyoto agreements were adopted by world nations (Mukhtarov et al., 2022b). Furthermore, clean and renewable energy was promoted by UNDP as one of the sustainable development goals. Considering all of these, several actions including research and investigations should be taken by society with the purpose of eliminating the detrimental effects of global warming.

With regard to global warming, one of the main indicators of it is greenhouse gas emissions (Mukhtarov, 2022; Kumar et al., 2022; Huang et al., 2022). Therefore, taking into account the importance of finding ways to reduce greenhouse gas emissions, currently, many researchers are investigating this topic with the intention of discovering potential solutions to decrease them (Watari et al., 2022; Rüdisüli et al., 2022; Lamb et al., 2022). However, the measures and policy implications of those investigations should be implemented in a way that will not deteriorate the quality of life across countries. One of the best ways to reduce CO_2 is to shift toward the alternative energy (Mukhtarov et al., 2022; Liu et al., 2021; Xie et al., 2021). This is because this energy is a very valuable substitute for conventional energy. Moreover, it can be plausibly stated that the reason behind the claim which states the transition to renewable energy will cause to decline in greenhouse gas emissions is that the main sources of renewable energy are solar and hydropower that does not produce any harmful gases to the air (Zeng et al., 2017; Mukhtarov et al., 2020). Therefore, shifting toward renewable energy could lead to a decrease in harmful emission levels. In this regard, analyzing the factors affecting clean alternative energy will be of special value to the world (Kou et al., 2022; Zhou et al., 2021; Zhe et al., 2021; Meng et al., 2021).

However, as the linear growth model which concentrates on aggressive growth without considering environmental effects has been dominant all over the world for years, shifting to new and sustainable growth model through using renewable energy is tough. Therefore, there is no clear unanimously accepted consensus among all countries toward decreasing conventional energy use significantly (Shahzad et al., 2021). To help on this issue, international institutions such as the UN, the International Energy Agency (IEA) as well as local institutions are attempting to facilitate shifting from conventional to renewable energy.

The roles of institutions are very remarkable for the economic development of the country, as well as for the maintenance of high environmental standards (Salman et al., 2019). Especially, well-operating institutions will be very effective on this issue by formulating, regulating, and implementing rules and policies on renewable energy issues (Sinha et al., 2020). According to Mohsin et al. (2021), the difference in institutional quality among nations will lead to difference in the stage of economic development in these nations. Moreover, the qualitative development of a state can foster economic prosperity and environmental quality by encouraging alternative and clean energy (Smirnova et al., 2021).

This study has several contributions. Firstly, considering the literature, there are very few studies that focused on evaluating the effect of institutional quality on renewable energy transition. On the other hand, to the best of our knowledge, no study was pursued on this phenomenon in the case of Azerbaijan.

14.2 Renewable Energy in the World and Azerbaijan

Fluctuations in oil prices put pressure on Azerbaijan to diversify its economy. At present, the struggle of mankind against climate change is intensifying and globalizing. Reducing the amount of harmful emissions into the atmosphere and replacing them with "green energy" has become one of the most important issues on the world agenda. Countries around the world are making a number of plans to reduce the operation of nuclear power plants, as well as to replace coal and gas-fired power plants with "green energy" sources (Dinçer et al., 2022; Ding et al., 2021; Haiyun et al., 2021; Dong et al., 2022). Among energy sources, the only increase in 2020 was recorded in renewable energy sources. Although global energy demand fell by 5% last year due to the pandemic, the production of renewable energy sources rose by 7%. The International Energy Agency (IEA) forecasts that an average of $440 billion will be invested annually in the renewable energy sector over the next 10 years. Production of alternative energy sources will increase by 50% over the next 5 years to 33% of global electricity production in 2025.

Azerbaijan owns its significant development after 2000 to its oil and gas resources. A country has been at the center of main oil and gas projects and managed to attract large amounts of foreign investment in this area. According to the Ministry of Energy, in February 2022, daily oil production in Azerbaijan amounted to 684.1 thousand barrels. Adriatic Pipeline (TAP) also provided an uninterrupted flow of Azerbaijani natural gas to the European market in increasing volumes and a total of 10 billion cubic meters of natural gas from Azerbaijan entered Europe via the TAP.

GDP per capita (in current USD) increased from 663 USD in 2000 to 5400 USD in 2021. However, a significant plunge in oil prices starting from 2013, proved that economic growth is heavily dependent on oil prices. A continuous decrease in oil prices has led to the devaluation of Azerbaijani Manat. For the first time since 2000, GDP fell sharply, and in subsequent years, it never returned to the 75 billion USD level of 2014 (GDP was 55 billion USD in 2021).

Azerbaijan has huge untapped renewable energy potential. According to the Ministry of Energy and International Renewable Energy Agency, the potential of economically viable and technically feasible renewable energy sources of the country is estimated at 27,000 MW (3000 MW for wind energy, 23,000 MW for solar energy, 380 MW for bioenergy potential, and 520 MW for mountain rivers).

From the high fossil fuel-dominated energy mix of Azerbaijan, it can be said that the country has not used its vast renewable energy potential widely. As it is depicted in the table above, approximately 95% of the total electricity production comes from natural gas, while share of wind, solar, waste, and hydro are nearly 6% which is significantly lower than the world average (which is 28% according to BP statistical review).

Only 17% of the total installed capacity is renewable and hydropower plants. Azerbaijan is planning to add 1500 MW of new renewable energy capacity (till 2023 440 MW, 2023–2025 460 MW, 2026–2030 600 MW) in order to reduce carbon emission by 40% by 2050 in accordance with a new commitment adopted by Azerbaijan in November 2021, at the COP26 conference in Glasgow. According to the new target, share of the installed capacity of renewable energy in the country's overall energy balance will be 30%. Azerbaijan also took a commitment to create a "Netto Zero Emission" Zone in the liberated territories.

Azerbaijan has already started the implementation of several renewable energy projects through Power Purchase Agreement. In December last year, the Ministry of Energy and Azerenergy OJSC and ACWA Power of the Kingdom of Saudi Arabia signed an "Investment Agreement" for a wind power plant with a capacity of 240 MW and the groundbreaking ceremony of this plant (Khizi-Absheron Wind Power Plant) was held with the participation of President Ilham Aliyev on January 13. As a result of the first foreign-invested project, the wind farm will generate about 1 billion kWh of electricity per year, save 220 million cubic meters of gas and prevent the release of more than 400,000 tons of CO_2 into the atmosphere.

Moreover, in April 2021, the Ministry of Energy and Azerenergy OJSC and Masdar Company of the United Arab Emirates signed an "Investment Agreement" for a 230-MW solar power plant project. The agreement envisages the production of 500 million kWh of electricity per year, which, in turn, will save 110 million cubic meters of natural gas, reduce carbon emissions by 200,000 tons, create new jobs, as well as attract new investors to other projects. The foundation of this power plant is also expected to be laid in 2022.

Moreover, on June 3, 2021, the Republic of Azerbaijan's Ministry of Energy and bp signed an implementation agreement on cooperation in the field of project appraisal and execution for the construction of a 240-MW solar power plant in the Jabrayil region. The evaluation of the solar energy project from a technical and commercial standpoint, financial issues and the adoption of a final investment decision are all part of the implementation agreement's cooperation.

To define long-term growth directions and future targets Azerbaijan adopted a new strategical document namely "Azerbaijan 2030: National Priorities for Socio-economic Development." Fifth paragraph of this document deals with the promotion of renewable energy in all sectors of the economy, fighting against climate change.

Besides, law of the Republic of Azerbaijan "On the use of renewable energy sources in the production of electricity" which is approved on May 31, 2021, also played a vital role in the promotion of renewable energy projects and it will be a main reference point for the further developments.

14.3 Literature Review

Based on the result of literature review process, it can be stated that the empirical investigations on the association between institutional quality, environmental effects, and renewable energy are very few. An example of this could be the research by Sarkodie and Adams (2018). In this paper, the authors examined the effects of economic development and political institutional quality on environmental degradation in South Africa for the period 1971–2017. The outcome revealed that institutional quality has a crucial role on the environment, and it will be very effective in promoting renewable energy transition. On the other hand, Azam et al. (2021) did a similar investigation. By using the GMM method, the study attempted to find the influence of institutional quality on energy consumption and environment on 66 selected developing countries for the time span 1991–2017. The paper measured the institutional quality index by considering three main factors which are political stability, administrative capacity, and democratic accountability. The outcome revealed that institutional quality has a positive impact on energy utilization which comes from oil and fossil fuel.

Meanwhile, many studies have predicted that renewable energy will play a positive role in improving environmental quality through CO_2 emission reduction paths (Al-Mulali et al., 2016; Dogan & Ozturk, 2017; Li & Shao, 2021). Currently, most of the papers indicate the importance of including the institutional mechanism by introducing it as the key indicator for promoting renewable energy development (Kostis et al., 2022; Li et al., 2022; Zhao et al., 2021; Yüksel et al., 2021). Li and Shao (2021) revealed that three institutional indicators which are the legal structure of the country, property rights, and legal restrictions on transactions locally and internationally in credit, labor, and products market are a significant determinants of alternative and clean energy. Moreover, Opeyemi et al. (2019) revealed that a better legal system and good finance for private sector can lead to improved renewable energy for the sub-Saharan African countries. According to the other study which was conducted by Uzar (2020) for selected 38 nations, it was found that in the long-run institutional quality affects renewable energy use positively. On the other hand, a similar research was conducted by Mehrara et al. for Economic Cooperation Countries (ECO) for the time span 1992–2011. The outcome revealed that developing institutional circumstances and human capital would significantly and positively influence the renewable energy transition.

14.4 Model and Data

14.4.1 Data

This study uses the annual data period from 1996 to 2019 for empirical evaluation. The dependent variable is renewable energy (RE) consumption, which is measured as a proportion of total final energy consumption. The CO_2 emissions (CO_2) are expressed by kilotons (kt) of carbon dioxide per capita. Economic growth is indicated by real GDP per capita (US dollars at 2010 prices). Government effectiveness (GE) shows "perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies". The data of RE and CO_2 are obtained from Our World in Data, accordingly. The data for *Y* and GE are taken from the World Bank database. In empirical analysis, all variables are used in logarithmic form.

14.4.2 Methodology

We analyze the effect of government effectiveness as an indicator of institutional quality, economic growth, and CO_2 emissions on renewable energy consumption using the FMOLS technique. The following steps will be covered in our empirical estimation. First, we will look at the variables' non-stationarity features employing the Augmented Dickey–Fuller unit root test (Dickey & Fuller, 1981, ADF).

Second, Park's Added Variables (Park, 1992) cointegration test is utilized to evaluate the cointegration relationship. Then, the Fully Modified Ordinary Least Squares (FMOLS; Phillips & Hansen, 1990) method is employed to see long-run effect of government effectiveness, economic growth, and CO_2 emissions on renewable energy consumption.

The above-mentioned approaches are widely utilized in many studies, and in order to conserve space and avoid confusing readers with econometric complexity, they are not discussed in this study. Dickey and Fuller (1981), Phillips and Hansen (1990), Park (1992), and others provide comprehensive information on these methods.

14.5 Empirical Results and Discussion

First, we need check the stationarity of the variables. For this, we employ the ADF unit root test. Table 14.1 shows the results of the unit root test. We found that the EG, GE, *Y*, and CO_2 are non-stationary at their levels but they are stationary at first

Table 14.1 Results of ADF unit root tests

	Panel A: level		Panel B: First difference		
Variable	*k*	Actual value	*k*	Actual value	Result
EG	0	−2.415	0	−5.764***	*I*(1)
GE	0	−0.360	0	−4.491**	*I*(1)
Y	1	−1.685	1	−2.746*	*I*(1)
CO_2	0	−1.645	0	−10.461***	*I*(1)

Notes: Maximum lag order is set to two and optimal lag order (*k*) is selected based on Schwarz criterion in the ADF test; *, **, and *** accordingly indicates rejection of null hypothesis at 10%, 5%, and 1% significance levels; critical values are taken from the table prepared by MacKinnonun. Time period: 1996–2019

Table 14.2 The results of FMOLS and cointegration test

		FMOLS		Park's added variables		
	Coefficient	*t*-statistic	*p*-values	Chi-squared	df	*p*-value
GE	−0.05	−0.1123	0.912	3.832	2	0.147
Y	0.92	4.4416	0.000			
CO_2	−0.37	−0.2802	0.782			

Notes: Dependent variables is RE

difference, being integrated of order one, *I*(1), therefore, we can test them for the cointegration.

For the testing cointegration link, we used Park's Added Variables test. The results are provided at the right side of Table 14.2. The cointegration test confirmed that the variables have a long-term link. As a result, we can say that the variables have a cointegrating relationship. Lastly, we apply the FMOLS technique to estimate the long-run coefficients. The estimation results of FMOLS are given at the left side of Table 14.2.

As can be seen from Table 14.2, the effect of government effectiveness as a proxy of institutional quality is to be found statistically insignificant. The insignificant influence of institutional quality on renewable energy consumption indicates that Azerbaijan, as a developing country, performs poorly on institutional quality indicators. As is widely known, bureaucrats in countries with low institutional quality who are trying to maximize their personal interests may fail to evaluate the environmental impact of certain authorized projects. Therefore, low institutional quality cannot avoid the loosening of environmental policies. As a result, renewable energy transition cannot be stimulated. In addition, the impact of real GDP per capita on renewable energy consumption is positive and statistically significant at the 1% level. This shows that a 1% increase in real GDP per capita results in 0.92% increase in renewable energy consumption. It implies that Azerbaijan's expanding revenues from traditional energy sources have been diverted to renewable energy sources. We also find that CO_2 emissions have a negative and statistically insignificant influence on renewable energy use. The insignificant influence of CO_2 emissions on renewable energy consumption also verifies the country's aversion to renewables. Rising CO_2

emissions and environmental deterioration do not compel the country to pursue a more ecologically friendly energy path.

14.6 Conclusion and Policy Recommendation

This study analyzes the influence of government effectiveness as an indicator of institutional quality, economic growth, and CO_2 emissions on renewable energy consumption in Azerbaijan. The results of ADF unit root test indicate all variables have the same integration order, which is $I(1)$. Therefore, the cointegration link between the variables can be evaluated. Long-run co-movement was evaluated employing Park's Added Variables and found a long-run cointegration relationship. The FMOLS method was utilized to evaluate possible long-run links. The empirical results stated that government effectiveness as a proxy of institutional quality, and CO_2 emissions are statistically insignificant. In addition, the impact of economic growth is revealed as positive and statistically significant.

Azerbaijan has made crucial steps in the implementation of utility-scale renewable energy scales through Power Purchase Agreement. The government is committed to purchasing the energy produced and offers investors a range of investments, tax breaks, and other favorable terms. Although Feed-in tariff is the most effective mechanism to promote production from renewable sources, it seems the government of Azerbaijan would not be inclined to implement this mechanism since it leads to a significant increase in retail prices. Or government has to subsidize a difference between retail and feed-in tariff prices. However, the development of small and micro-scale renewable energy projects is also vital and the country has to create a favorable environment for prosumers. Considering the European experience, the following suggestions on mechanisms to promote renewable energy production can be listed:

- **Net metering schemes**

  Under this scheme, excess electricity which is injected into the grid by the consumer can be used to offset electricity used by consumer when renewable energy system does not generate electricity. Current wholesale and retail tariffs, this system would be beneficial for consumers with higher consumption levels (monthly around 800–1000 kWh). If injected energy could be enumerated at retail tariffs instead of wholesale ones, typical households would also benefit from the scheme.
- **Reimbursement of a certain part of the initial investment cost (30–50%) by third parties (Energy Efficiency Fund, international organizations, and especially government)**

  In European practice, in many countries, prosumers are rewarded with a number of grants and subsidies for initial investment costs for renewable energy production facilities and energy storage batteries. Given that the cost of these

facilities is high enough for those interested in becoming prosumer in Azerbaijan, some of these investment costs must be covered by the state or another third party.

- **Establishment of incentives mechanisms for the installation of energy storage batteries to reduce network loads and ensure system security**

  Energy storage batteries have a special place in the new energy directives of the European Union. Europe encourages prosumers to use more energy instead of injecting it to the grid. The additional energy produced can be used by the prosumers to operate heat pumps, air conditioners, and other equipment. Government can cover some or full part of battery investments (Serezli et al., 2021; Bhuiyan et al., 2022; Adalı et al., 2022; Fang et al., 2021; Yüksel et al., 2022).

- **Allocation of low-interest loans for renewable energy producers and tax exemptions**

  Considering higher level of interest rates in Azerbaijan, financial availability can be a serious problem for those willing to get prosumer status. Government or relevant state agencies have to provide low-interest loans. Renewable energy production facilities and sales revenue of prosumers from injecting electricity also have to be exempted from all taxes and duties.

References

Adalı, Z., Dinçer, H., Eti, S., Mikhaylov, A., & Yüksel, S. (2022). Identifying new perspectives on geothermal energy investments. In *Multidimensional strategic outlook on global competitive energy economics and finance*. Emerald Publishing Limited.

Al-Mulali, U., Ozturk, I., & Solarin, S. A. (2016). Investigating the environmental Kuznets curve hypothesis in seven regions: The role of renewable energy. *Ecological Indicators, 67*, 267–282. https://doi.org/10.1016/j.ecolind.2016.02.059

Azam, M., Liu, L., & Ahmad, N. (2021). Impact of institutional quality on environment and energy consumption: Evidence from developing world. *Environment, Development and Sustainability, 23*(2), 1646–1667. https://doi.org/10.1007/s10668-020-00644-x

Bhuiyan, M. A., Dinçer, H., Yüksel, S., Mikhaylov, A., Danish, M. S. S., Pinter, G., Uyeh, D. D., & Stepanova, D. (2022). Economic indicators and bioenergy supply in developed economies: QROF-DEMATEL and random forest models. *Energy Reports, 8*, 561–570.

Dickey, D., & Fuller, W. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica, 49*, 1057–1072.

Dinçer, H., Yüksel, S., & Martínez, L. (2022). Collaboration enhanced hybrid fuzzy decision-making approach to analyze the renewable energy investment projects. *Energy Reports, 8*, 377–389.

Ding, Z., Yüksel, S., & Dincer, H. (2021). An Integrated Pythagorean fuzzy soft computing approach to environmental management systems for sustainable energy pricing. *Energy Reports, 7*, 5575–5588.

Dogan, E., & Ozturk, I. (2017). The influence of renewable and non-renewable energy consumption and real income on CO2 emissions in the USA: Evidence from structural break tests. *Environmental Science and Pollution Research, 24*(11), 10846–10854. https://doi.org/10.1007/s11356-017-8786-y

Dong, W., Zhao, G., Yüksel, S., Dinçer, H., & Ubay, G. G. (2022). A novel hybrid decision making approach for the strategic selection of wind energy projects. *Renewable Energy, 185*, 321–337.

Fang, S., Zhou, P., Dinçer, H., & Yüksel, S. (2021). Assessment of safety management system on energy investment risk using house of quality based on hybrid stochastic interval-valued intuitionistic fuzzy decision-making approach. *Safety Science, 141*, 105333.

Haiyun, C., Zhixiong, H., Yüksel, S., & Dinçer, H. (2021). Analysis of the innovation strategies for green supply chain management in the energy industry using the QFD-based hybrid interval valued intuitionistic fuzzy decision approach. *Renewable and Sustainable Energy Reviews, 143*, 110844.

Hua, Y., Oliphant, M., & Hu, E. J. (2016). Development of renewable energy in Australia and China: A comparison of policies and status, renew. *Energy, 85*, 1044–1051. https://doi.org/10.1016/j.renene.2015.07.060

Huang, D., Du, Y., Xu, Q., & Ko, J. H. (2022). Quantification and control of gaseous emissions from solid waste landfill surfaces. *Journal of Environmental Management, 302*, 114001.

Kostis, P., Dinçer, H., & Yüksel, S. (2022). Knowledge-based energy investments of European economies and policy recommendations for sustainable development. *Journal of the Knowledge Economy*, 1–33.

Kou, G., Yüksel, S., & Dinçer, H. (2022). Inventive problem-solving map of innovative carbon emission strategies for solar energy-based transportation investment projects. *Applied Energy, 311*, 118680.

Kumar, A., Singh, P., Raizada, P., & Hussain, C. M. (2022). Impact of COVID-19 on greenhouse gases emissions: A critical review. *Science of the Total Environment, 806*, 150349.

Lamb, W. F., Grubb, M., Diluiso, F., & Minx, J. C. (2022). Countries with sustained greenhouse gas emissions reductions: An analysis of trends and progress by sector. *Climate Policy, 22*(1), 1–17.

Li, J., Yüksel, S., Dınçer, H., Mikhaylov, A., & Barykin, S. E. (2022). Bipolar q-ROF hybrid decision making model with golden cut for analyzing the levelized cost of renewable energy alternatives. *IEEE Access, 10*, 42507–42517.

Li, S., & Shao, Q. (2021). Exploring the determinants of renewable energy innovation considering the institutional factors: A negative binomial analysis. *Technology in Society, 67*, 101680. https://doi.org/10.1016/j.techsoc.2021.101680

Liu, J., Lv, J., Dinçer, H., Yüksel, S., & Karakuş, H. (2021). Selection of renewable energy alternatives for green blockchain investments: A hybrid IT2-based fuzzy modelling. *Archives of Computational Methods in Engineering, 28*(5), 3687–3701.

Meng, Y., Wu, H., Zhao, W., Chen, W., Dinçer, H., & Yüksel, S. (2021). A hybrid heterogeneous Pythagorean fuzzy group decision modelling for crowdfunding development process pathways of fintech-based clean energy investment projects. *Financial Innovation, 7*(1), 1–34.

Mohsin, M., Kamran, H. W., Nawaz, M. A., Hussain, M. S., & Dahri, A. S. (2021). Assessing the impact of transition from nonrenewable to renewable energy consumption on economic growth-environmental nexus from developing Asian economies. *Journal of Environmental Management, 284*, 111999. https://doi.org/10.1016/j.jenvman.2021.111999

Mukhtarov, S. (2022). The impact of carbon pricing on international competitiveness in the case of Azerbaijan. *Environmental Science and Pollution Research, 29*(22), 33587–33594. https://doi.org/10.1007/s11356-022-18606-3

Mukhtarov, S., Mikayilov, J. I., Humbatova, S., & Muradov, V. (2020). Do high oil prices obstruct the transition to renewable energy consumption? *Sustainability, 12*(11), 4689.

Mukhtarov, S., Mikayilov, J. I., Maharramov, S., Aliyev, J., & Suleymanov, E. (2022b). Higher oil prices, are they good or bad for renewable energy consumption: The case of Iran? *Renewable Energy, 186*, 411–419. https://doi.org/10.1016/j.renene.2021.12.135

Mukhtarov, S., Yüksel, S., & Dinçer, H. (2022). The impact of financial development on renewable energy consumption: Evidence from Turkey. *Renewable Energy, 187*, 169–176.

Nordhaus, W. D. (1975). *Can we control carbon dioxide?* IIASA Working Paper. IIASA. Copyright, by the author(s). Retrieved from http://pure.iiasa.ac.at/365/

Opeyemi, A., Uchenna, E., Simplice, A., & Evans, O. (2019). Renewable energy, trade performance and the conditional role of finance and institutional capacity in sub-Sahara African countries. *Energy Policy, 132*, 490–498.

Park, J. (1992). Canonical cointegrating regressions. *Econometrica, 60*, 119–143.

Phillips, P., & Hansen, B. (1990). Statistical inference in instrumental variables regression with I (1) processes. *Review of Economic Studies, 57*, 99–125.

Rüdisüli, M., Bach, C., Bauer, C., Beloin-Saint-Pierre, D., Elber, U., Georges, G., Limpach, R., Pareschi, G., Kannan, R., & Teske, S. L. (2022). Prospective life-cycle assessment of greenhouse gas emissions of electricity-based mobility options. *Applied Energy, 306*, 118065.

Salman, M., Long, X., Dauda, L., & Mensah, C. N. (2019). The impact of institutional quality on economic growth and carbon emissions: Evidence from Indonesia, South Korea and Thailand. *Journal of Cleaner Production, 241*, 118331.

Sarkodie, S. A., & Adams, S. (2018). Renewable energy, nuclear energy, and environmental pollution: Accounting for political institutional quality in South Africa. *Science of the Total Environment, 643*, 1590–1601. https://doi.org/10.1016/j.scitotenv.2018.06.320

Serezli, E., Yüksel, S., Tamer, İ., & Dinçer, H. (2021). The role of innovative renewable energy investment strategies on macroeconomic stability. In *Financial strategies in competitive markets* (pp. 165–178). Springer.

Shahzad, U., Dogan, B., Sinha, A., & Fareed, Z. (2021). Does export product diversification help to reduce energy demand: Exploring the contextual evidences from the newly industrialized countries. *Energy, 214*, 118881. https://doi.org/10.1016/j.energy.2020.118881

Sinha, A., Sengupta, T., & Alvarado, R. (2020). Interplay between technological innovation and environmental quality: Formulating the SDG policies for next 11 economies. *Journal of Cleaner Production, 242*, 118549. https://doi.org/10.1016/j.jclepro.2019.118549

Smirnova, E., Szczepańska-Woszczyna, K., Yessetova, S., Samusenkov, V., & Rogulin, R. (2021). Supplying energy to vulnerable segments of the population: Macro-financial risks and public welfare. *Energies, 14*(7), 1834. https://doi.org/10.3390/en14071834

Troster, V., Shahbaz, M., & Uddin, G. S. (2018). Renewable energy, oil prices, and economic activity: A Granger-causality in quantiles analysis. *Energy Economics, 70*, 440–452.

Uzar, U. (2020). Political economy of renewable energy: Does institutional quality make a difference in renewable energy consumption? *Renewable Energy, 155*, 591–603. https://doi.org/10.1016/j.renene.2020.03.172

Watari, T., Northey, S., Giurco, D., Hata, S., Yokoi, R., Nansai, K., & Nakajima, K. (2022). Global copper cycles and greenhouse gas emissions in a 1.5 °C world. *Resources, Conservation and Recycling, 179*, 106118.

Xie, Y., Zhou, Y., Peng, Y., Dinçer, H., Yüksel, S., & an Xiang, P. (2021). An extended Pythagorean fuzzy approach to group decision-making with incomplete preferences for analyzing balanced scorecard-based renewable energy investments. *IEEE Access, 9*, 43020–43035.

Yüksel, S., Dinçer, H., Çağlayan, Ç., Uluer, G. S., & Lisin, A. (2022). Bitcoin mining with nuclear energy. In *Multidimensional strategic outlook on global competitive energy economics and finance*. Emerald Publishing Limited.

Yüksel, S., Mikhaylov, A., Ubay, G. G., & Uyeh, D. D. (2021). The role of hydrogen in the Black Sea for the future energy supply security of Turkey. In *Handbook of research on strategic management for current energy investments* (pp. 1–15). IGI Global.

Zeng, M., Li, C., & Zhou, L. S. (2017). Progress and prospective on the police system of renewable energy in China. *Renewable and Sustainable Energy Reviews, 20*, 36–44.

Zhao, Y., Xu, Y., Yüksel, S., Dinçer, H., & Ubay, G. G. (2021). Hybrid IT2 fuzzy modelling with alpha cuts for hydrogen energy investments. *International Journal of Hydrogen Energy, 46*(13), 8835–8851.

Zhe, L., Yüksel, S., Dinçer, H., Mukhtarov, S., & Azizov, M. (2021). The positive influences of renewable energy consumption on financial development and economic growth. *SAGE Open, 11*(3), 21582440211040133.

Zhou, P., Luo, J., Cheng, F., Yüksel, S., & Dinçer, H. (2021). Analysis of risk priorities for renewable energy investment projects using a hybrid IT2 hesitant fuzzy decision-making approach with alpha cuts. *Energy, 224*, 120184.