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The Effect of Environmental, Social, and Governance (ESG) Performance in Shaping Indonesia's Energy Transitions

Yogeeswari Subramaniam[1], Ravi Palanimuthu[3] & Muzafar Shah Habibullah[2]
[1]Faculty of Management, Universiti Teknologi Malaysia, Malaysia, [2]Putra Business School, Malaysia, [3]Department Of Management Studies, Manonmaniam Sundaranar University, India

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Abstract
ESG factors are essential for determining an equitable and sustainable energy future. Using the Autoregressive Distributed Lag approach, this study investigates the effect of ESG performance on Indonesia's energy transition. The results show that the governance index has a positive effect on energy transition, while the environmental and social indices have a negative impact in the short run. In the long run, however, all three ESG indexes support the transition to clean energy. ESG must be given top priority by Indonesian authorities in energy transition initiatives to enable a smooth transition and support a sustainable and secure energy future for the nation.
Keywords: ESG, Energy Transition, Indonesia

Introduction
At the 26th Conference of Parties, Indonesia committed to combating climate change by establishing emission reduction goals and aiming for zero emissions by 2060(IEA, 2022). Despite a significant rise in carbon emissions over the previous two decades, the nation's energy sector ranks eighth globally in terms of emissions (IEA, 2022; IEA 2023b). To reach its emission targets, Indonesia must dramatically decarbonize its energy sector.

Globally, fossil fuels, particularly coalstill dominate the energy mix, contributing more to the world’s energy supply than clean and renewable sources. This underscores that the global shift toward sustainable energy is progressing more slowly than anticipated. In Indonesia, a notable transition is underway, with reduced reliance on traditional biomass and increased access to cleaner, more efficient energy sources such as liquefied petroleum gas. Despite these positive developments, fossil fuels remain a major component of the country’s energy supply. To support the transition toward a sustainable energy future, Indonesia, in collaboration with the Ministry of Energy and Mineral Resources, has introduced the IEA’s

Energy Sector Roadmap to Net Zero Emissions by 2060 (IEA, 2022, 2023). This roadmap outlines a strategic framework for designing and implementing energy policies that drive reform. Nevertheless, it is crucial that the transition plan incorporates Environmental, Social, and Governance (ESG) considerations to ensure long-term sustainability and equitable development.

The environmental component of the framework seeks to combat climate change and advance environmental sustainability via the promotion of renewable energy sources and the reduction of carbon emissions. The social aspect of the energy transition lays a heavy emphasis on social equality, participation, and community involvement to guarantee that everyone in society has access to affordable and clean energy. The governance component emphasizes the need for good governance practices, such as accountability, transparency, and robust regulatory frameworks, in ensuring equitable distribution of energy resources and investments in sustainable energy.

By integrating ESG factors into the energy transition, Indonesia can build a comprehensive and sustainable energy system that promotes social justice, equitable energy access, and responsible governance. This study examines how ESG variables influence Indonesia's energy transition, providing insights to support the development of strategies and policies that foster sustainable and inclusive energy practices.
The remainder of the article is structured as follows: Section 2 reviews the literature, Section 3 outlines the method, Section 5 presents the findings, and Section 6 concludes.

Literature Review
The influence of ESG factors on energy transition can be explained through several theories. Energy Transition Theory highlights the systemic shift from fossil fuels to renewable energy driven by technological, social, and political factors. Institutional Theory (Scott, 2008) emphasizes that effective governance and regulatory frameworks are crucial for supporting clean energy adoption. Stakeholder Theory underlines the role of multiple actors, including governments, businesses, and communitiesin shaping sustainable practices. Together, these theories provide the foundation for understanding how ESG dimensions contribute to Indonesia's path toward a sustainable energy future.

Numerous studies have explored the link between the environment and energy transition. Findings by Wu et al. (2020), Gani (2021), and Puttachai et al. (2022) indicate that environmental degradation spurs demand for cleaner energy solutions. The adverse effects of fossil fuels on health and the environment have accelerated the push toward renewable energy.The social dimension, including factors like income, employment, and education, has also been shown to influence energy transition. Studies by Adedoyin et al. (2020) and Zhao et al. (2023) reveal that economic growth, human capital development, and social equity drive the adoption of renewable energy.Governance factors such as regulatory quality, political stability, and accountability are equally critical. Research by Vringer et al. (2021), and Shahbaz et al. (2022) emphasizes that strong governance frameworks are essential for enabling clean energy investments and effective policy implementation.

This study contributes in three ways: (i) it uses principal component analysis (PCA) to construct ESG indices, offering a more robust measure than single indicators; (ii) it addresses the gap in ESG-energy transition research specifically in the Indonesian context; and (iii) it provides empirical insights into both the short- and long-term effects of ESG factors on Indonesia's energy transition, guiding policymakers toward more integrated and sustainable strategies.

Method

The transition from traditional to sustainable energy systems requires the integration of ESGfactors to guide reforms and ensure long-term sustainability. The empirical model is outlined as follows:

$$lnET_t = \alpha_0 + \beta_1 lnENV_t + \beta_2 lnSOC_t + \beta_3 lnGOV_t + e_t \quad (1)$$

Where ET represents energy transition, ENV, SOC, and GOV are environment, social and governance variables, respectively.α_0 is the constant, t is the time, and e_t is the error term.

The autoregressive distributed lag (ARDL) estimate technique developed by Pesaran et al. (2001) is used in this work to examine the interaction between energy transition, environmental, social, and governance components. For small sample sizes, the ARDL method is recommended (Ghatak and Siddiki, 2001; Narayan and Smyth, 2005), who define small samples as datasets with fewer than 50 observations. As our dataset comprises 27 annual observations, it fits within this threshold, thereby justifying the use of the ARDL technique in line with established methodological guidance

Data Collection

This study gathers data from the World Bank (2023) and the International Energy Agency (IEA, 2023a) covering the period from 1996 to 2022. PCA is used to construct indices for environmental, social, governance (ESG), and energy transition variables. These indicators are selected based on their relevance to international frameworks such as the UN Sustainable Development Goals and the World Economic Forum's Energy Transition Index. PCA is applied to objectively combine multiple correlated indicators into composite indices, reducing dimensionality and minimizing subjectivity.The Table 1 below presents the components within each variable used to calculate the indices.

Table 1
The elements for each variable

Variables	Elements	Source
Energy Transition Index	Carbon emissions (CO2 metric tons per capita), renewable energy (% GDP), energy use, energy intensity, and electricity consumption from coal, oil and gas	
Environmental index	Forest area (forest area, % of land area), air pollution (CO2 emissions, metric tons per capita), food production index (index), natural resources depletion (% GNI), agricultural land (land area in percentage of total land), and biofuels production (total biofuels production in thousand barrels per day).	World Bank (2023) & IEA (2023a)
Governance index	Control of corruption (estimated), government effectiveness (estimated), political stability (estimated), rule of law (estimated), regulatory quality (estimated), and G6-voice and accountability	
Social index	Prevalence of undernourishment (%of population), Unemployment (% of total labor force), income (GDP per capita in constant 2010 US dollar), school enrolment (secondary, % gross), access to electricity (% of population) and income inequality (GINI index).	

Results and Discussions

Unit Root Tests

The standard method for testing cointegration and unit roots is used in this study. Table 2 summarises the findings. The results show that all variables are stationary at their first differences, indicating that none of the variables are integrated of order 2. The Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests, in particular, reveal that the variables *ET, EVA, GOV, and SOC* are non-stationary at the level but become stationary at first differences, showing that they are integrated of order 1.

Table 2
Unit root tests

	ADF		Phillips and Perron	
	Level	**1st Diff**	**Level**	**1st Diff**
$lnET$	-4.043	-4.479**	-3.233	-8.683**
$lnENV$	-1.902	-3.711***	-1.117	-6.120***
$lnSOC$	-3.631	-3.813**	-4.674	-3.908***
$lnGOV$	-4.150	-6.653***	-3.833	-10.302**

Cointegration Results

The results of the bounds test are shown in Table 3. The F-statistics value for lnENV as the dependent variable is 7.389, demonstrating statistical significance at the 1% level. This reveals a long-term relationship between the variables and the existence of a cointegrating vector.

Table 3
Bounds Test

Dependent variable		Computed F-statistics
$lnET$		4.983**
$lnENV$		2.025
$lnSOC$		1.642
$lnGOV$		1.008
Critical bounds	Lower Bound I (0)	Upper Bound I (1)
1%	*6.687*	*8.985*
5%	*5.054*	*4.524*
10%	*3.332*	*2.087*

Long-run and Short-run Results

After demonstrating the presence of long run cointegration, we investigate diagnostic tests based on the estimated ARDL regression, such as Ramsey's RESET test, Lagrange multiplier test of residual serial correlation, normality test, and heteroskedasticity. Table 4 shows the results of various diagnostic tests. The findings support the null hypothesis of serial correlation ($\chi^2_{sc} = 0.7766$), normality biasness ($\chi^2_n = 1.0731$), functional form biasness ($\chi^2_{ff} = 4.5358$), and heteroskedasticity ($\chi^2_{hc} = 0.3430$). Furthermore, the model's parameter stability is assessed using CUSUM and CUSUM squares (CUSUMQ).

Table 4
Estimated long-run and short-run results

Long-run Dependent variable lnET				**Short run Dependent variable *lnET***			
Regressors	**Coefficient**	**t-statistics**	**p-value**	**Regressors**	**Coefficient**	**t-statistics**	**p-value**
$lnENV$	0.945	5.602	0.000	$\Delta lnENV$	-0.435	1.920	0.073
$lnSOC$	0.237	1.840	0.084	$\Delta lnSOC$	-0.553	3.731	0.002
$lnGOV$	0.610	3.846	0.070	$\Delta lnGOV$	0.319	2.223	0.041
Constant	3.116	2.309	0.035	Constant	1.660	4.423	0.000
				ECT_{t-1}	-0.447	-3.876	0.001
				R-squared	0.802		
				Adj. R-squared	0.760		
				F-statistics	19.225		
				P-value	0.000		
Diagnostic tests							
Serial correlation LM test	0.7766 (0.814)						
Breusch-Pagan Heteroskedasticity test	0.3430 (0.723)						
Ramsey's RESET	4.5358 (0.325)						
Normality test	1.0731 (0.187)						
CUSUM	Stable						
CUSUMSQ	Stable						

Table 4 presents the results of the short-run impact. The coefficient for the environmental variable is statistically significant at the 1% level and indicates a negative effect of 0.44% in the current period. This suggests a reliance on fossil fuels for transportation, which impedes the immediate transition to cleaner and more sustainable energy sources.

Interestingly, the social variable has a significant negative impact on energy transition, contributing approximately 0.55% to the overall effect. In the short run, this negative effect can be attributed to the prioritization of addressing acute societal issues, such as malnutrition or unemployment, over long-term sustainability goals. This diversion of resources and attention towards resolving immediate social challenges may temporarily shift the focus away from energy transition initiatives.

In the short run, the governance index has a positive impact on energy transition. Indonesia's establishment of strong policies, incentives, and targets creates an environment conducive to the adoption of renewable energy sources and advancements in energy efficiency.
The significant error correction term (ECTt-1) value of 0.45 indicates that 45% of previous deviations are corrected each period, reflecting a rapid adjustment toward long-run equilibrium. This highlights the complex short-run interaction of environmental, social, and governance factors in shaping Indonesia’s energy transition.

Table 4 presents the long-term impacts of ESG variables on Indonesia's energy transition. Environmental factors play a crucial role, as supported by Riti et al. (2018) and Wu et al. (2020). Increased investment in renewable energy R&D and the sustainable use of forest biomass can diversify the energy mix, reduce fossil fuel dependence, and strengthen energy security. The social index shows that a 1% increase leads to a 0.24% improvement in energy transition. While indirect, components like education, electricity access, and food security foster conditions that support clean energy adoption. Government programs, such as rooftop solar initiatives, help close the electricity gap and promote rural energy access, aligning with findings from Adedoyin et al. (2020) and Yi et al. (2023).Governance has a strong positive effect, enabling renewable energy development through transparency, regulatory stability, and investor-friendly policies. The Feed-in Tariff program exemplifies how governance supports clean energy investment. With strong governance, Indonesia can achieve sustained progress in its transition to a low-carbon future.

Conclusions

This study investigates the impact of ESG variables on Indonesia's energy transition from 1996 to 2022, using the ARDL approach. The cointegration test confirms a long-run relationship among the variables. In the short term, environmental and social indices show negative effects, reflecting challenges to Indonesia's energy transition. However, in the long run, ESG factors positively influence the transition, highlighting their critical role in supporting sustainable energy development.
The findings emphasize the need for Indonesia to integrate ESG considerations into energy and investment policies to ensure a successful transition. Key implications include:
(i) prioritizing environmental regulations and support for renewable energy and clean technologies;
(ii) promoting public participation and raising awareness of energy issues; and

(iii) strengthening international collaborations to access global expertise and financing for sustainable energy initiatives.

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