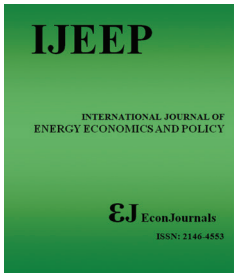
Yunikewaty; Siswahyudi, Dwi

Article

The role of green energy technologies development, carbon finance, carbon tax and economic growth on environmental conditions in ASEAN Countries

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Yunikewaty/Siswahyudi, Dwi (2023). The role of green energy technologies development, carbon finance, carbon tax and economic growth on environmental conditions in ASEAN Countries. In: International Journal of Energy Economics and Policy 13 (5), S. 558 - 565. https://www.econjournals.com/index.php/ijeep/article/download/14667/7516/34441. doi:10.32479/ijeep.14667.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2023, 13(5), 558-565.

The Role of Green Energy Technologies Development, Carbon Finance, Carbon Tax and Economic Growth on Environmental Conditions in ASEAN Countries

Yunikewaty[1]*, Dwi Siswahyudi[2]

[1]Faculty of Economics and Business, Palangka Raya University, Indonesia, [2]Study Program of Building Engineering, Faculty of Engineering, State University of Malang, Indonesia. *Email: yunikewaty@feb.upr.ac.id

Received: 18 May 2023 **Accepted:** 16 August 2023 **DOI:** https://doi.org/10.32479/ijeep.14667

ABSTRACT

Green technology and carbon finance have the potential to greatly add significance towards traditional financing practices related to carbon emissions because of information based nature, thus, exploration of green technologies and carbon finance assist economies in the formulation of effective policies. By employing the panel data of ASEAN economies from 2011 to 2019, the study used CUP-FM and CUP-BC methods to empirically analyze the said relationship. The outcomes of the study revealed that green technologies, carbon finance, carbon taxes, economic growth decrease GHG emissions. It implies that the synergetic effect of green technologies, carbon finance, carbon tax and economic growth play an essential role in improving environmental conditions. Consequently, ASEAN region can reshape the policies by integrating green technologies and carbon finance and also looks into country's local condition to improve the urban environmental efficiency, hence, achieving carbon neutralization goal.

Keywords: Green Technologies, Carbon Finance, Carbon Taxes, GHG Emissions, Economic Growth
JEL Classifications: O14, B16, H23, Q53, Q54

1. INTRODUCTION

There are numerous issues the world is facing now. Among them, some are having long-term effects while others have a short run. One of the factors which are getting worse with the passage of time is environmental degradation. This degradation is resulting in an increase in global warming. This global warming results in affecting every sector of life in terms of health issues, financial issues as well as operations (Al-Ghussain, 2019; Bai et al., 2022; Kapa et al., 2022; Miar et al., 2022; Nendissa et al., 2022; Taridala et al., 2023; Tiawon and Miar, 2023; Yunus et al., 2023). The United Nations has introduced its Sustainable Development Goals with the view to support almost all the major sections of life which effecting humanity like hunger, food and health. Keeping in view the importance of the environment as well as its hazardous effects on humanity the UN has also dedicated its goal number 13 titled "Climate Action" to the environment (Chau et al., 2022; Chien et al., 2022; Raihan et al., 2022; Rehman, Ma, and Ozturk, 2021; Yusuf, Abubakar, and Mamman, 2020). The UN time to time continues its efforts with the view to create awareness regarding environmental sustainability, especially keeping humanity's health issues in view. Moreover, the Paris Conference on environmental issues is also one notable event for the developed as well as developing economies to be aware of and accelerate their efforts to stabilize the environment by mitigating the hazardous i.e., greenhouse, carbon and other related gases emission (Chien et al., 2023a,b; DeConto et al., 2021; Opoku and Boachie, 2020).

There are numerous factors which result in the effecting environmental degradation like the emission of hazardous gasses i.e., greenhouse, carbon and other related. The current study aimed to focus on GHG emissions. There are numerous forms of

GHGs like carbon dioxide, methane, and water vapor. All these gases emission results in creating heat in the environment. This increase in heat results in global warming which further results in health issues, the melting of glaciers as well as depletion of natural resources (Chien, 2023; Chien et al., 2023c). Further, all these gasses result in affecting the environment in a negative way. There is an urgent need to control the emission of these gases to safeguard the world's future. Resultantly, the current study focused on the topic of GHGs emission. Besides that, the country's conditions also result in an increase or decrease in GHGs emission likewise the country with a high volume of manufacturing industry results in more emission of gases and causes environmental degradation. On the other side the agriculture country results in environmental sustainability. ASEAN is a combination of developed and developing economies. The member countries like China are world factory and causing GHG emission at a high volume. There is an urgent need to address this issue with the view to bringing stability to the environment to safeguard the future generation. There is numerous ways proposed by literature to mitigate the GHG emission like carbon finance (Muganyi et al., 2021), carbon taxes (Ding et al., 2020; Zhang et al., 2023a), RE in any form (Chen et al., 2023; Vu et al., 2023a,b), green investment and other related factors. One of the prime sources to control the emission of GHG is RE. RE is produced from natural resources and results in mitigating GHG emission. Besides that, RE supporting factors like green financing are also environmental supports. Accordingly, the current study also focuses on carbon finance, carbon taxes, and RE in the form of output as well as consumption. The GHGs i.e., carbon emission in ASEAN are given in Figure 1. Primary Energy Demand in ASEAN (2018–2040) is presented in Figure 2.

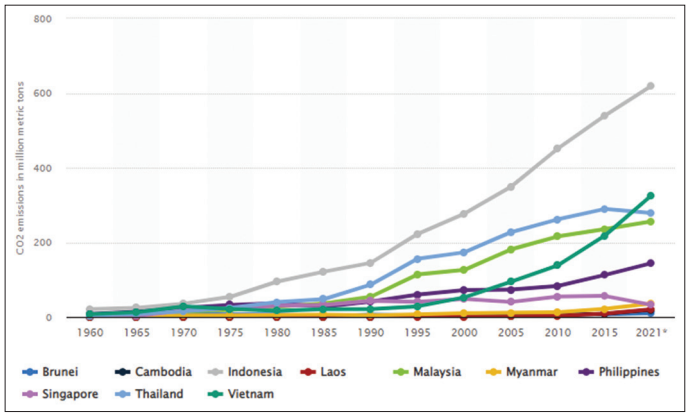
There exists studies which assessed the understudy constructs, such as Balsalobre-Lorente et al. (2018) and Inglesi-Lotz and Dogan (2018) worked on the nexus between RE output CO_2 i.e., GHG emission. Whereas, Saidi and Omri (2020) worked RE consumption and CO_2 i.e., GHG emission. Similarly, Guo et al. (2022), worked on the green finance and carbon emissions while Doğan et al. (2021) and Dogan et al. (2022), worked on the environmental taxes and carbon emissions. This implicates that the mentioned studies indeed assessed the construct but individually, whereas the present study investigates RE consumption, RE output, carbon finance, carbon taxes, economic growth and industrialization in a single framework in ASEAN region with fresh dataset. This way the study highlights the cruciality of GHG exploration in order to bring stability in the environment. Moreover, it also helps professionals through which they may be able to review and upgrading the policies in a better way and bring stability in environment by mitigating the GHG emission with the view to safeguard our future generation.

2. SYNTHETIC ANALYSIS OF LITERATURE

There is an urgent need to explore hazardous gas emission with the view to mitigating their emission to safeguard the environment. One of the vital factors contributing towards mitigating GHG emission is RE output. In this context, Balsalobre-Lorente et al. (2018), explored RE production, natural resources and their linkage with GHG emission. Outcomes from the analysis proposed that the more the RE output is the less the greenhouse and other related gasses emissions. Additionally, Inglesi-Lotz and Dogan (2018), investigated production of renewable as well as non-RE and GHGs emission in the form of carbon emissions in 10 Sub-Sahara Economies. The gathered sample was tested by employing panel estimation techniques. The results received from the analysis proposed that RE production has negative and non-RE has a positive nexus with the greenhouse gasses emission. The production of RE is directly associated with its pricing. The high energy can't be used more due to financial burden; thus, the energy production is affected by the prices which further affect the greenhouse and other gasses emissions. In this context, Additionally, Hussain et al. (2023) investigated RE prices and GHG emissions in USA data set. The results received from the analysis proposed that the energy prices strongly affect energy production which further affect the greenhouse and other related gasses emissions in a positive way.

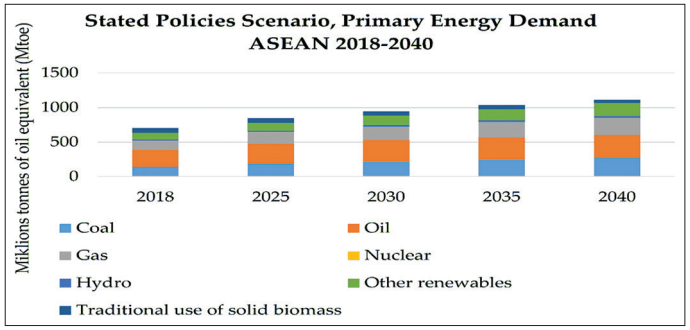
There are numerous reasons behind the increased usage of energy such as production of energy from traditional resources. The increase in consumption results in an increase in energy production demand. This increase in energy production results in the emission of GHG which affect the environment. In this context, Zhang et al. (2023b), explored the connection between consumption of RE and GHGs emissions in the form of carbon emissions. The results received from the analysis proposed that the consumption of RE led to more production of energy which results in mitigating the greenhouse gas emission, thus, the world should shift to RE

Figure 1: Greenhouse emission in ASEAN



Source: Statista

Figure 2: Primary energy demand in ASEAN (2018-2040)



Source: International Energy Agency (IEA)

sources from traditional resources to mitigate the greenhouse and other related gasses emission. Additionally, Saidi and Omri (2020) checked RE in terms of consumption, economic growth and carbon emissions. The study was conducted on the 15 countries which are consuming the maximum RE. The results received from the analysis proposed that there is a significant nexus between all the selected variables. Further, the consumption of RE led to mitigating hazardous gasses i.e., greenhouse gas emissions. Further, the study also suggests that countries switch to RE with a view to environmental sustainability. Similarly, Doğan et al. (2021) checked economic complexity, consumption of RE and GHGs emissions in 28 OECD economies. The results received from the analysis proposed that RE positively affect greenhouse gas emission and results in environmental sustainability. Moreover, Bhattacharya et al. (2017), checked RE consumption and GHGs emissions in 85 developed as well as developing economies. The results gauged though GMM technique proposed that the RE consumption reduces the greenhouse and other related gasses emission.

There are numerous ways proposed by literature to mitigate greenhouse and other related gases emission with the view to stable the environment. One of the vital factors is carbon finance. The literature proposed that there is a significant nexus between GHG emission and carbon finance. In this context, Zhang et al. (2022), investigated carbon finance and GHG emissions in China data set and selected the tenure of 2008-2017. By employing slack-based model, it is revealed that green finance affects greenhouse and other related gas emissions in a positive way. Further, the study also recommended that the countries should pay more focus towards green i.e., carbon financing. Similarly, Guo et al. (2022), checked whether there is any sort of association between green i.e., carbon finance, chemical fertilizer usage and GHGs emissions in the form of carbon emission in the sample country. The results received from the analysis proposed that green i.e., carbon finance effect GHG emission in a positive way. The more the investment in green i.e., carbon finance results in mitigating the greenhouse gas emission. Moreover, Chen and Chen (2021) investigated carbon finance and GHG emissions in the form of carbon emission through spatial dynamic panel model, it was revealed that there is a negative association between carbon finance and greenhouse gas emissions.

Governments all around the globe ensure different ways to stabilize the environment one of the vital ways that not only results in mitigating GHG emission but also result in government revenue is carbon taxes. In this context, Doğan et al. (2022) proposed that the environmental taxes affect greenhouse and other related hazardous gas emissions in a negative way. Moreover, Niu et al. (2018) argued that carbon tax shocks results in mitigating the greenhouse and other related gasses emission particularly in China. The study further suggests to pays special attention towards environmental taxes with the view to bringing stability to the environment.

The economic condition of any country is the indicator of the fulfilment of the plan decided. The countries ensuring their efforts for environmental sustainability by mitigating the GHG emission are in need to have special support from their economy. In this context, Mirza and Kanwal (2017), investigated consumption of energy, economic growth and GHG emission in the form of carbon emission in Pakistani tenure between 2000 and 2019. The results received from the analysis proposed that the is a significant nexus between economic growth and greenhouse and other related gas emission, particularly in Pakistan. Similarly, Yao et al. (2019) investigated RE, economic growth and GHG emission in17 major developing as well as developed economies. Analysis proposed that there is a negative nexus between RE and greenhouse gas emissions. Further, there is also a negative association between economic growth and greenhouse and other related gas emission. Additionally, Leal et al. (2019), Olubusoye and Musa (2020) investigated economic growth between GHG emission in African context. The results received from EKC analysis proposed that economic growth negatively influences greenhouse i.e., carbon emission. The study further recommends paying special attention towards environment-friendly projects with the view to bringing stability to the environment. Moreover, Moslehpour et al. (2023) proposed the results with the help of LMDI technique and revealed that EG negatively influence the greenhouse i.e., carbon emission.

There are numerous reasons for the increase in GHG emission and one of the vital ones is the increasing volume of industrialization. In this context, Moslehpour et al. (2021) investigated urbanization, industrialization, economic growth and carbon emissions in China in the tenure between 1990 and 2015. Results received from the analysis proposed that industrialization results in increasing GHG emission. Further, the study also recommends switching to RE usage with the view to mitigating greenhouse gas emissions. Similarly, Pata (2018) and Shahid et al. (2023), investigated urbanization, industrialization and carbon emissions in Turkey context. The results received from the analysis proposed that there is significant nexus between industrialization and greenhouse gas emissions. Further, industrialization results in an increase the greenhouse as well as carbon emissions and causes environmental degradation, thus, countries should formulate special policies with the view to controlling the GHG emission as a result of industrialization. Moreover, Sadiq et al. (2023), investigated industrialization and GHG emissions. The study was conducted on 3 economies of ASEAN region. The results received from the analysis proposed that industrialization results in an increase the GHG emission.

3. METHODS AND MATERIALS

The research examines the impact of RE output. RE consumption, carbon finance, carbon taxes, economic growth, and industrialization on GHG emissions in ASEAN countries. The researchers gathered the secondary data from 2011 to 2019 using the OECD, central banks, and WDI databases. The researchers developed the study equations using the understudy constructs given below:

$$GHGE_{it} = \alpha_0 + \beta_1 REO_{it} + \beta_2 REC_{it} + \beta_3 CF_{it} + \beta_4 CT_{it} + \beta_5 EG_{it} + \beta_6 IND_{it} + e_{it} \quad (1)$$

Where;
GHGE = Greenhouse Gas Emission
REO = Renewable Energy Output

REC = Renewable Energy Consumption
CF = Carbon Finance
CT = Carbon Taxes
EG = Economic Growth
IND = Industrialization

In addition, the researchers used the environmental conditions as the main variable and measured with total greenhouse gas emissions (% change from 1990). Moreover, the study also utilizes three independent variables to predict environmental conditions such as green technologies development proxies as RE consumption (% of total consumption) and RE output (% of total output), carbon finance proxies as the ratio of green finance to total finance and carbon taxes measured as carbon taxes (percentage of revenue). Finally, the researchers also used two control variables to predict the GHG emissions such as economic growth proxies as GDP growth (%) and industrialization proxies as "Industry value added" (% of GDP).

The researchers used descriptive statistics and also applied the correlation to identify variable basic characteristics. Additionally, the researchers BP-LM test established by Breusch and Pagan and the P-CD test established by Pesaran was also used in the study. The equation for the LM test is given below:

$$\mathrm{LM}_2 = \sqrt{\frac{1}{\mathrm{N(N-1)}}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\left(T_{ij}\hat{\rho}_{ij}^2 - 1\right) \rightarrow N(0,1) \quad (2)$$

While the research also established the equation for the CD test that is established by Pesaran given below:

$$CD = \sqrt{\frac{2}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}T_{ij}\hat{\rho}_{ij}^2 \rightarrow N(0,1) \quad (3)$$

Finally, the research established the BP-LM test equation is given below:

$$LM_1 = \sum_{i=1}^{N-1}\sum_{j=i+1}^{N}T_{ij}\hat{\rho}_{ij}^2 \rightarrow X^2\frac{N(N-1)}{2} \quad (4)$$

CADF test was also considered to examine the unit root among variables. The researchers have developed the CADF equation given as under:

$$X_{it} = \alpha_i + b_i X_{it-1} + c_i\bar{X}_{it-1} + d_i\Delta\bar{X}_t + e_{it} \quad (5)$$

Moreover, the researchers also used the CIPS to examine the unit root among variables (Sarkodie and Strezov, 2019). The CIPS equation is established as under:

$$\Delta W_{i,t} = \varnothing_i + \varnothing_i Z_{i,t-1} + \varnothing_i\bar{Z}_{t-1} + \sum_{l=0}^{p}\varnothing_{il}\Delta\bar{W}_{t-1} + \sum_{l=0}^{p}\varnothing_{il}\Delta W_{i,t-1} + \mu_{it} \quad (6)$$

Where, $\bar{W}$ exposed the average cross-section given below:

$$W^{i,t} = \varnothing^1\overline{REO}^{i,t} + \varnothing^2\overline{REC}^{i,t} + \varnothing^3\overline{CF}^{i,t} + \varnothing^4\overline{CT}^{i,t} + \varnothing^5\overline{EG}^{i,t} + \varnothing^6\overline{IND}^{i,t} \quad (7)$$

Moreover, the CIPS test equation is mentioned below:

$$\widehat{CIPS} = N^{-1}\sum_{i=1}^{n}CADF_i \quad (8)$$

Moreover, the researchers also applied the (Westerlund and Edgerton, 2008) approach to examine the co-integration in the model. The equations for the approach are given as under:

$$\mathrm{LM}_{\varphi}(\mathrm{i}) = \mathrm{T}\hat{\varphi}_{\mathrm{i}}\ (\hat{\mathrm{r}}_{\mathrm{i}}/\hat{\sigma}_{\mathrm{i}}) \quad (9)$$

$$\mathrm{LM}_{\tau}(\mathrm{i}) = \hat{\varphi}_{\mathrm{i}}/\mathrm{SE}(\hat{\varphi}_{\mathrm{i}}) \quad (10)$$

Finally, the researchers also checked the association among constructs using CUP-FM and CUP-BC. These statistical approaches to finding the association among variables are established by (Bai et al., 2009). It provides robust estimations and also produces the factor loadings, covariance matrix estimation, and continuous parameters until convergence is achieved. The equation is given as under:

$$\beta_{cup} = \left[\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{y}_{it} + \hat{\beta}_{cup}\right)\left(x_{it} - \bar{X}_i\right)' - T\left(\lambda'_i\left(\hat{\beta}_{CUP}\right)\hat{\Delta}_{F\varepsilon i}\left(\hat{\beta}_{CUP}\right) + \hat{\Delta}_{u\varepsilon i}\left(\hat{\beta}_{CUP}\right)\right)\right] \times\left[\sum_{i=1}^{N}\sum_{t=1}^{T}\left(x_{it} - \bar{X}_i\right)\left(x_{it} - \bar{X}_i\right)'\right] \quad (11)$$

Where, $\hat{\Delta}_{F\varepsilon i}$ *and* $\hat{\Delta}_{u\varepsilon i}$ are one-sided estimated covariance.

4. RESEARCH FINDINGS AND DISCUSSION

Table 1 indicate that the average value of GHGE was 126.219%, REC average value was 28.285%, while REO mean value was 31.648%, and CF average value was 101.382%. In addition, the outcomes indicated that the CT average value was 2.702%, while EG mean value was 3.905%, and IND average value was 36.416%.

Table 1: Descriptive statistics

Variable	Obs	Mean	SD	Min	Max
GHGE	120	126.219	262.905	−99.632	691.893
REC	120	28.285	23.138	0.006	84.080
REO	120	31.648	32.756	0.032	133.992
CF	120	101.382	8.100	64.61	122.374
CT	120	2.702	4.813	0.000	20.136
EG	120	3.905	3.975	−17.913	10.508
IND	120	36.416	10.63	22.142	73.673

Table 2: Descriptive statistics by years

Year	GHGE	REO	REC	CF	CT	EG	IND
2011	94.162	27.951	33.825	92.324	2.755	5.516	36.859
2012	129.030	31.190	33.252	95.713	2.939	5.832	37.328
2013	129.056	32.872	32.613	97.087	2.986	5.122	36.610
2014	129.071	32.345	31.971	98.855	2.838	4.915	36.489
2015	129.093	28.480	29.882	100.664	2.817	4.653	35.493
2016	129.113	31.360	28.568	100.481	2.678	5.231	34.966
2017	129.133	31.654	27.375	103.232	2.620	5.456	35.851
2018	129.153	32.348	26.627	104.585	2.879	5.188	36.907
2019	129.173	32.514	25.403	103.738	2.580	4.929	36.749

Table 3: Descriptive statistics by countries

Countries	GHGE	REO	REC	CF	CT	EG	IND
Brunei	−96.019	0.042	0.010	98.745	0.089	0.251	63.973
Cambodia	−37.270	77.801	58.192	107.303	0.040	5.557	29.911
Indonesia	−99.630	13.728	24.607	105.438	1.705	4.297	40.428
Lao	691.893	87.708	52.230	95.805	0.685	5.837	30.990
Malaysia	−96.333	11.552	4.434	102.128	1.983	3.706	38.328
Myanmar	−45.294	52.731	64.847	99.504	0.494	3.710	34.820
Philippines	−15.399	23.637	28.919	101.205	4.703	4.549	30.208
Singapore	413.408	1.995	0.695	101.062	16.301	3.360	24.259
Thailand	227.558	8.741	23.250	101.505	0.615	2.000	35.431
Vietnam	319.274	38.548	25.667	101.127	0.404	5.786	35.811

Table 4: Matrix of correlations

Variables	GHGE	REO	REC	CF	CT	EG	IND
GHGE	1.000						
REO	−0.324	1.000					
REC	−0.091	0.792	1.000				
CF	−0.189	0.052	−0.106	1.000			
CT	−0.287	−0.358	−0.427	−0.026	1.000		
EG	−0.147	0.295	0.337	−0.143	−0.016	1.000	
IND	−0.432	−0.307	−0.386	−0.038	−0.433	−0.294	1.000

Table 5: CSD test results

Variables	Breusch-Pagan LM	Pesaran Scaled LM	Pesaran CD
GHGE	31.902***	5.745***	3.764***
REO	24.657***	5.664***	11.677***
REC	12.674***	6.773***	8.553***
CF	20.462***	5.983***	6.783***
CT	10.882***	4.738***	5.981***
EG	31.877***	3.673***	3.892***
IND	10.999***	7.688***	21.228***

Table 6: CADF and CIPS unit root tests result

Variables	CIPS		CADF	
	Level	1st difference	Level	1st difference
GHGE	----	−4.784***	----	−4.783***
REO	−2.673***	----	−3.743***	----
REC	−2.281***	----	−3.102***	----
CF	----	−5.182***	----	−4.363***
CT	----	−5.092***	----	−4.901***
EG	−3.647***	----	−2.336***	----
IND	----	−4.288***	----	−5.484***

Table 2 shows descriptives by years and reveal that that the GHGE highest value was recorded in 2022, REC biggest value was recorded in 2011, while REO largest value was recorded in 2022, and CF highest value was recorded in 2022. In addition, the outcomes indicated that the CT largest value was recorded in 2013, while EG largest value was recorded in 2012, and IND biggest value was recorded in 2012.

Country-wise descriptive statistics are presented in Table 3. The outcomes indicated that the GHGE highest value was recorded in Laos, REC biggest value was recorded in Myanmar, while REO largest value was recorded in Laos, and CF highest value was recorded in 2022. In addition, the outcomes indicated that the CT largest value was recorded in Cambodia, while EG largest value was recorded in Laos, and IND biggest value was recorded in Brunei.

Table 4 shows that RE output, RE consumption, carbon finance, carbon taxes, economic growth, and industrialization have a negative linage with GHG emissions in ASEAN countries. Table 5 revealed that the t-values crossed the limits of larger than 1.96. These outcomes indicated that CSD does not exist.

In addition, the researchers also used the CADF and IPS (CIPS) tests to examine the unit root among variables. Table 6 revealed that REO, REC, and EG are stationary at level. In contrast, GHGE, CF, CT, and IND are stationary at first difference. The outcomes from Table 7 exposed that t-values cross and P-values are fulfilling the recommended criteria. These values exposed that the co-integration exists.

Finally, the association among constructs was assessed using CUP-FM), and CUP-BC. Table 8 reveal that the RE output, RE consumption, carbon finance, carbon taxes, economic growth, and industrialization have a negative linage with GHG emissions in ASEAN countries.

The results showed that RE output decreases GHG emissions, hence, consistent with findings (Chien et al., 2022; Lima et al., 2020). It shows that when a country that is proficient in RE production and generates a huge amount of energy from the RE system can supply clean and affordable energy for the country's inhabitants. The increasing use of such energy improves human processes and overcomes the GHG emissions from these processes. So, increasing energy output reduces GHG emissions. Also, the increasing energy output from RE generation systems increases the individuals' ability to have access to cleaner energy as compared to fossil fuels like coal, oil, and gas. With the decline in fossil fuel consumption, there is a decrease in fossil fuel emissions from domestic and economic human activities. This means that the large output from RE generation allows business organizations to rely on fossil fuels no longer and, therefore, get rid of GHG emissions and clean the environment. RE and GHG emission negative link

Table 7: Co-integration results

Model	No shift		Mean shift		Regime shift	
	Test stat	P-value	Test stat	P-value	Test stat	P-value
LM_{τ}	−4.496	0.00	−5.785	0.00	−6.392	00
LM_{ϕ}	−4.373	0.00	−5.902	0.00	−6.881	0.00

Table 8: CUP-BC and CUP-FM

Constructs	CUP-FM		CUP-BC	
	Coeff	t-stat	Coeff	t-stat
REO	−0.673***	−4.902	−0.893***	−4.492
REC	−1.191***	−4.277	−2.102***	−4.542
CF	−1.243***	−5.569	−3.281***	−5.102
CT	−2.774***	−4.115	−2.991***	−3.541
EG	−1.442**	−2.219	−2.001**	−2.212
IND	−3.920***	−4.091	−3291***	−4.446

also posits that the consumption of resources containing harmful gases causes GHG emissions and has the potential to pollute the natural environment. When the administrators change their minds and prefer to utilize RE instead of traditional energy sources, they reduce GHG emissions from business undertakings (Khattak et al., 2023; Sharma et al., 2021; Vasylieva et al., 2019).

Carbon finance and carbon tax negative impact also dictates that carbon finance from financial institutions provides financial aid to firms or particular individual clients in order to develop the ability to overcome carbon-related environmental issues through technical changes in the processes. As a result of such changes, there is a reduction in GHG emissions from business processes. Moreover, some individuals are conscious of the environmental problems and the losses which they may have to bear as a result. But they are unable to bring changes in their processes and technologies which may help them overcome environmental problems. The availability of carbon finances provides assistance and assures eco-friendly changes which reduce GHG emissions (Debrah et al., 2022; Lin et al., 2022). It also highlights that carbon taxes, if they are effectively enforceable in an economy with a proper legal check, they promote environmental programs with the objective of reducing carbon (Nong et al., 2021; Wang et al., 2022). Study of Lan et al. (2022) also states that whenever the regulators make environmental taxes enforceable through proper legal proceedings and through a check, the total carbon-emitting activities decrease within the economy, and the economy shows decreasing GHG emissions.

5. CONCLUSION AND IMPLICATIONS

The study aims at analyzing the role of RE output and consumption, carbon finance, carbon tax, economic growth and industrialization in mitigating GHG emissions. Utilizing the statistics from ASEAN countries, it has been revealed that when there is increasing RE output, natural resilience improves against GHG emissions, and the resultant access to clean energy increases the potential to mitigate GHG emissions. Similarly, with the increasing tendency of businesses and individuals to transition from fossil fuels to RE consumption, they overcome GHG emissions during operations. The results revealed that with access to carbon finance, firms could afford ecologically friendly resources and procedures. It reduces the firms' GHG emissions. The results also indicated that in the areas where the carbon tax is enforceable, there is a reduction in environment-polluting activities and mitigation of GHG emissions. The study concluded that the increasing economic growth assures infrastructure development, including roads, transportation, and energy system, as technological and financial development. This all helps reduce GHG emissions. Moreover, industrialization, which accelerates developmental activities within the country, overcomes GHG emissions.

The study has some limitations as well. It is expected that authors pay attention and remove these limitations. First, in this study, a few solutions to the GHG emission problem, like RE output and RE consumption, carbon finance, and carbon tax, have been examined. There are several other micro and macro-economic factors which play a critical role in mitigating GHG emissions. But these variables have no place in this research, and therefore, authors are recommended to add some more factors into the study framework. Moreover, this study examines the role of RE output and RE consumption, carbon finance, carbon tax, economic growth and industrialization in mitigating GHG emissions with analysis from ASEAN countries. The researchers must collect data from countries located in different regions.

The study clears the ways for the researchers how they must perform in future because of the literary contributions. The study sheds light on the relationship of green technologies development like RE output and RE consumption, carbon finance, and carbon tax with GHG emission along with the variable of economic growth and industrialization equally affecting the mitigation of GHG emissions. The study adds to the literature, as it initiates to examine the role of RE output and RE consumption, carbon finance, and carbon tax economic growth and industrialization in mitigating GHG emissions in ASEAN countries instead of any single state.

This article is also immensely significant for ASEAN countries and other ones where GHG emissions touch a terrifying height. This study debates the ways how to mitigate GHG emissions. The study implies that environmental regulators must be attentive to raising RE output so that GHG emissions can be controlled. It gives a guideline that regulatory policies should be designed to encourage RE consumption to reduce GHG emissions. It also suggests that the government must try to encourage carbon finance to reduce GHG emissions. The study also conveys that government should participate in environmental regulation through carbon taxation so that GHG emissions can be mitigated. The research guides the regulators in making regulations related to control GHG emissions using green technologies, green finance, and environmental taxes**.** There is also a guideline that there must struggle policymakers to make the country grow well to mitigate GHG emissions. Moreover, there is a suggestion that industrialization should be promoted to combat GHG emissions.

REFERENCES

Al-Ghussain, L. (2019), Global warming: Review on driving forces and mitigation. Environmental Progress and Sustainable Energy, 38(1),

13-21.
Bai, J., Kao, C., Ng, S. (2009), Panel cointegration with global stochastic trends. Journal of Econometrics, 149(1), 82-99.
Bai, X., Wang, K.T., Tran, T.K., Sadiq, M., Trung, L.M., Khudoykulov, K. (2022), Measuring China's green economic recovery and energy environment sustainability: Econometric analysis of sustainable development goals. Economic Analysis and Policy, 75, 768-779.
Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D., Farhani, S. (2018), How economic growth, renewable electricity and natural resources contribute to CO_2 emissions? Energy Policy, 113, 356-367.
Bhattacharya, M., Churchill, S.A., Paramati, S.R. (2017), The dynamic impact of renewable energy and institutions on economic output and CO_2 emissions across regions. Renewable Energy, 111, 157-167.
Chau, K.Y., Lin, C.H., Tufail, B., Tran, T.K., Van, L., Nguyen, T.T.H. (2022), Impact of eco-innovation and sustainable tourism growth on the environmental degradation: The case of China. Economic Research-Ekonomska Istraživanja, 36, 2150258.
Chen, S.L., Su, Y.S., Tufail, B., Lam, V.T., Phan, T.T.H., Ngo, T.Q. (2023), The moderating role of leadership on the relationship between green supply chain management, technological advancement, and knowledge management in sustainable performance. Environmental Science and Pollution Research, 30, 56654-56669.
Chen, X., Chen, Z. (2021), Can green finance development reduce carbon emissions? Empirical evidence from 30 Chinese provinces. Sustainability, 13(21), 12137.
Chien, F. (2023), The impact of green investment, eco-innovation, and financial inclusion on sustainable development: Evidence from China. Engineering Economics, 34(1), 17-31.
Chien, F., Chau, K.Y., Sadiq, M. (2023b), Impact of climate mitigation technology and natural resource management on climate change in China. Resources Policy, 81, 103367.
Chien, F., Chau, K.Y., Sadiq, M., Hsu, C.C. (2022), The impact of economic and non-economic determinants on the natural resources commodity prices volatility in China. Resources Policy, 78, 102863.
Chien, F., Hsu, C.C., Zhang, Y., Sadiq, M. (2023a), Sustainable assessment and analysis of energy consumption impact on carbon emission in G7 economies: Mediating role of foreign direct investment. Sustainable Energy Technologies and Assessments, 57, 103111.
Chien, F., Sadiq, M., Li, L., Sharif, A. (2023c), The role of sustainable energy utility, natural resource utilization and waste management in reducing energy poverty: Evidence from South Asian countries. Utilities Policy, 82, 101581.
Debrah, C., Chan, A.P.C., Darko, A. (2022), Green finance gap in green buildings: A scoping review and future research needs. Building and Environment, 207, 108443.
DeConto, R.M., Pollard, D., Alley, R.B., Velicogna, I., Gasson, E., Gomez, N., Ashe, E.L. (2021), The Paris climate agreement and future sea-level rise from Antarctica. Nature, 593(7857), 83-89.
Ding, J., Chen, W., Wang, W. (2020), Production and carbon emission reduction decisions for remanufacturing firms under carbon tax and take-back legislation. Computers and Industrial Engineering, 143, 106-119.
Doğan, B., Chu, L.K., Ghosh, S., Truong, H.H.D., Balsalobre-Lorente, D. (2022), How environmental taxes and carbon emissions are related in the G7 economies? Renewable Energy, 187, 645-656.
Doğan, B., Driha, O.M., Balsalobre Lorente, D., Shahzad, U. (2021), The mitigating effects of economic complexity and renewable energy on carbon emissions in developed countries. Sustainable Development, 29(1), 1-12.
Dogan, E., Hodžić, S., Šikić, T.F. (2022), A way forward in reducing carbon emissions in environmentally friendly countries: The role of green growth and environmental taxes. Economic Research-Ekonomska Istraživanja, 35(1), 5879-5894.
Guo, L., Zhao, S., Song, Y., Tang, M., Li, H. (2022), Green finance, chemical fertilizer use and carbon emissions from agricultural production. Agriculture, 12(3), 313-327.
Hussain, H.I., Kamarudin, F., Anwar, N.A.M., Ali, M., Turner, J.J., Somasundram, S.A. (2023), Does income inequality influence the role of a sharing economy in promoting sustainable economic growth? Fresh evidence from emerging markets. Journal of Innovation and Knowledge, 8(2), 100348.
Inglesi-Lotz, R., Dogan, E. (2018), The role of renewable versus non-renewable energy to the level of CO_2 emissions a panel analysis of sub-Saharan Africa's Big 10 electricity generators. Renewable Energy, 123, 36-43.
Khattak, M.A., Ali, M., Azmi, W., Rizvi, S.A.R. (2023), Digital transformation, diversification and stability: What do we know about banks? Economic Analysis and Policy, 78, 122-132.
Lan, J., Khan, S.U., Sadiq, M., Chien, F., Baloch, Z.A. (2022), Evaluating energy poverty and its effects using multi-dimensional based DEA-like mathematical composite indicator approach: Findings from Asia. Energy Policy, 165, 112933.
Leal, P.A., Marques, A.C., Fuinhas, J.A. (2019), Decoupling economic growth from GHG emissions: Decomposition analysis by sectoral factors for Australia. Economic Analysis and Policy, 62, 12-26.
Lima, M., Mendes, L., Mothé, G., Linhares, F., de Castro, M., Da Silva, M., Sthel, M. (2020), Renewable energy in reducing greenhouse gas emissions: Reaching the goals of the Paris agreement in Brazil. Environmental Development, 33, 100504.
Lin, C.Y., Chau, K.Y., Tran, T.K., Sadiq, M., Van, L., Phan, T.T.H. (2022), Development of renewable energy resources by green finance, volatility and risk: Empirical evidence from China. Renewable Energy, 201, 821-831.
Miar, M., Neneng, S., Sui, J.M. (2022), The Impact Covid-19 Outbreak, Green Finance, Creativity and Sustainable Economic Development on the Economic Recovery in G20 Countries. International Journal of Energy Economics and Policy, 12(6), 432-440.
Mirza, F.M., Kanwal, A. (2017), Energy consumption, carbon emissions and economic growth in Pakistan: Dynamic causality analysis. Renewable and Sustainable Energy Reviews, 72, 1233-1240.
Moslehpour, M., Chaiyapruk, P., Faez, S., Wong, W.K. (2021), Generation Y's sustainable purchasing intention of green personal care products. Sustainability, 13(23), 13385.
Moslehpour, M., Firman, A., Lin, C.H., Bilgiçli, İ., Tran, T.K., Nguyen, T.T.H. (2023), The moderating impact of government support on the relationship between tourism development and growth, natural resources depletion, sociocultural degradation, economic environment, and pollution reduction: Case of Indonesian economy. Environmental Science and Pollution Research, 30(19), 56863-56878.
Muganyi, T., Yan, L., Sun, H.P. (2021), Green finance, fintech and environmental protection: Evidence from China. Environmental Science and Ecotechnology, 7, 100-107.
Nendissa, D.R., Iriany, A., Sui, J.M., Khoiriyah, N., Suphattanakul, O., Wisetsri, W. (2022), The Role of Renewable and Nonrenewable Energy on Agricultural Economics in Indonesia. International Journal of Energy Economics and Policy, 12(3), 352-360.
Niu, T., Yao, X., Shao, S., Li, D., Wang, W. (2018), Environmental tax shocks and carbon emissions: An estimated DSGE model. Structural Change and Economic Dynamics, 47, 9-17.
Nong, D., Simshauser, P., Nguyen, D.B. (2021), Greenhouse gas emissions vs CO_2 emissions: Comparative analysis of a global carbon tax. Applied Energy, 298, 117223.
Olubusoye, O.E., Musa, D. (2020), Carbon emissions and economic growth in Africa: Are they related? Cogent Economics and Finance, 8(1), 1850400.

Opoku, E.E.O., Boachie, M.K. (2020), The environmental impact of industrialization and foreign direct investment. Energy Policy, 137, 111-128.

Pata, U.K. (2018), The effect of urbanization and industrialization on carbon emissions in Turkey: Evidence from ARDL bounds testing procedure. Environmental Science and Pollution Research, 25(8), 7740-7747.

Raihan, A., Muhtasim, D.A., Farhana, S., Pavel, M.I., Faruk, O., Rahman, M., Mahmood, A. (2022), Nexus between carbon emissions, economic growth, renewable energy use, urbanization, industrialization, technological innovation, and forest area towards achieving environmental sustainability in Bangladesh. Energy and Climate Change, 3, 100080.

Rehman, A., Ma, H., Ozturk, I. (2021), Do industrialization, energy importations, and economic progress influence carbon emission in Pakistan. Environmental Science and Pollution Research, 28(33), 45840-45852.

Sadiq, M., Moslehpour, M., Qiu, R., Hieu, V.M., Duong, K.D., Ngo, T.Q. (2023), Sharing economy benefits and sustainable development goals: Empirical evidence from the transportation industry of Vietnam. Journal of Innovation and Knowledge, 8, 100290.

Saidi, K., Omri, A. (2020), The impact of renewable energy on carbon emissions and economic growth in 15 major renewable energy-consuming countries. Environmental Research, 186, 109567.

Sarkodie, S.A., Strezov, V. (2019), Economic, social and governance adaptation readiness for mitigation of climate change vulnerability: Evidence from 192 countries. Science of the Total Environment, 656, 150-164.

Shahid, M.N., Azmi, W., Ali, M., Islam, M.U., Rizvi, S.A.R. (2023), Uncovering risk transmission between socially responsible investments, alternative energy investments and the implied volatility of major commodities. Energy Economics, 120, 106634.

Sharma, G.D., Shah, M.I., Shahzad, U., Jain, M., Chopra, R. (2021), Exploring the nexus between agriculture and greenhouse gas emissions in BIMSTEC region: The role of renewable energy and human capital as moderators. Journal of Environmental Management, 297, 113-128.

Vasylieva, T., Lyulyov, O., Bilan, Y., Streimikiene, D. (2019), Sustainable economic development and greenhouse gas emissions: The dynamic impact of renewable energy consumption, GDP, and corruption. Energies, 12(17), 3289-3306.

Vu, T.L., Paramaiah, C., Tufail, B., Nawaz, M.A., Xuyen, N.T.M., Huy, P.Q. (2023b), Effect of financial inclusion, eco-innovation, globalization, and sustainable economic growth on ecological footprint. Engineering Economics, 34(1), 46-60.

Vu, T.L., Phan, T.T.H., Sadiq, M., Xuyen, N.T.M., Ngo, T.Q. (2023a), Nexus of natural resources, urbanization and economic recovery in Asia: The moderating role of innovation. Resources Policy, 81, 103328.

Wang, X., Khurshid, A., Qayyum, S., Calin, A.C. (2022), The role of green innovations, environmental policies and carbon taxes in achieving the sustainable development goals of carbon neutrality. Environmental Science and Pollution Research, 8, 8393-8407.

Westerlund, J., Edgerton, D.L. (2008), A simple test for cointegration in dependent panels with structural breaks. Oxford Bulletin of Economics and Statistics, 70(5), 665-704.

Yao, S., Zhang, S., Zhang, X. (2019), Renewable energy, carbon emission and economic growth: A revised environmental Kuznets Curve perspective. Journal of Cleaner Production, 235, 1338-1352.

Yunus, L., Iswandi, M., Baco, L., Zani, M., Limi, M. A., Sujono. (2023), How Does Sustainable Energy System, Creativity, and Green Finance affect Environment Efficiency and Sustainable EconomiGrowth: Evidence from Highest Emitting Economies. International Journal of Energy Economics and Policy, 13(1), 261-270.

Yusuf, A.M., Abubakar, A.B., Mamman, S.O. (2020), Relationship between greenhouse gas emission, energy consumption, and economic growth: Evidence from some selected oil-producing African countries. Environmental Science and Pollution Research, 27(13), 15815-15823.

Zhang, W., Zhu, Z., Liu, X., Cheng, J. (2022), Can green finance improve carbon emission efficiency? Environmental Science and Pollution Research, 29(45), 68976-68989.

Zhang, Y., Li, L., Sadiq, M., Chien, F. (2023a), The impact of non-renewable energy production and energy usage on carbon emissions: Evidence from China. Energy and Environment, 34(5). https://doi.org/10.1177/0958305X221150432.

Zhang, Y., Li, L., Sadiq, M., Chien, F.S. (2023b), Impact of a sharing economy on sustainable development and energy efficiency: Evidence from the top ten Asian economies. Journal of Innovation and Knowledge, 8(1), 100320.