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The Impact of Renewable Energy on Sustainable Economic Growth in Vietnam

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ABSTRACT

This research is aimed to evaluate the impact of renewable energy on sustainable economic growth (SEG) by developing the role of mediating variable such as sustaining energy supply (SES). We use qualitative and quantitative technique such as Covariance - Based Structural Equation Model (CB-SEM) to analyze the data of collection from experts, economists, executives in Vietnam in 2020. The study has proved the five components of renewable energy such as solar energy (SEN), hydro energy (HEN), wind energy (WEN), bio energy (BEN) and geothermal energy (GEN) impact to the SES. Besides, the findings suggest a positively significant impact of sustaining energy supply (SES) on sustainable economic growth (SEG). This study contributed empirical work in the literature of renewable energy, sustaining energy supply (SES) and sustainable economic growth (SEG). The outcomes of this study can be used by policy makers, economists, top management in the governmental office and even the corporate. A mediating role of SES as a value-added contribution to this study and can be consolidated and strengthened more in coming research.

Keywords: Solar Energy, Bio Energy, Renewable Energy, Sustainable Economic Growth
JEL Classifications: Q21, Q25, Q43

1. INTRODUCTION

Energy is integral to the socioeconomic life all over the world. The association of existing energy supply behavior, energy resources and its perceived impacts on the living standards and environment attract significant interest to economists, policy makers, entrepreneurs and community of a nation. Currently, the major sources of energy used are still fossil fuels and coals whose is perceived limited and exhausted by use. Besides that, consuming energy from fossil fuels and coals cause land pollution, water pollution and global warming. To that effect, renewable energy is considered as a great alternative solution to address the stated problems in relation to environment and living standards of a nation's residents. According to Pye et al. (2015), the transition of energy from fossil fuel and coal based to renewable energy is seriously concerned in many countries and regions in the world not because the depletion of fossil fuel and coal resources but the climate change and pollution become a global serious problem. Renewable energy is determined as a source of energy which is not exhausted by use. Sources of renewable energy typically includes wind, solar, water, biomass and geothermal heat. According to REN21 (2019), "Renewable energy plays a significant role in sustainable and inclusive economic growth." In addition, renewable energy is considered as means of achieving multiple goals of a nation such as diversification of energy resources in a positive way, enhancement of energy access, climate change mitigation and air pollution reduction that benefit not only to the economy but also to the environment and living standard of residents of a nation in relation to sustainable development.

IPCC (2018) expressed that the current challenges of global sustainability is climate change and biodiversity imbalance (IPBES, 2019). Those negative impacts are considered tremendous threats to humankind, atmosphere and causes of ecological imbalance which directly affect to the human environment, threaten the sustainable development of the earth and damage the future generations. There are numerous causes of those problems, in which, traditional energy sources using fuels and coals are considered as critical reasons that generate emissions into the atmosphere which negatively impact on the living environment and people's livelihoods. REN21 (2019) stated that Asia Pacific is a leading region of renewable energy development worldwide. However, the deployment of renewable energy over this region faces numerous obstacles against traditional energy supply from fossil fuels and coals. Some major countries in the region such as China and India whose population size is large and renewable energy potential is great, are still very limited in the use of renewable energy against the total final energy consumption (TFEC) since the nature of clean energy is a form of energy that is harder to operate than traditional energy so somehow this becomes a barrier to the starting phase of renewable energy development progress. Vietnam is perceived a developing country getting over 97 million people ranked as the third most populous country in Southeast Asia. Vietnam is on its way to executing industrialization and modernization of the economy that lead to a sharp increase in energy demand by 10% from 2016 to 2020. The increase in demand for energy is expected continuous for the years to come to meet the development goals in relation to economy and society while protect environment for sustainable development. Further, Vietnam is in the beginning stage of executing numerous international agreements in relation to industrial, agricultural and technological industries' promotion and development which also contribute to increasing in demand for energy. In addition, Vietnam has a young population background and dynamic human resources so it's promising that the pace of industrialization and modernization of the country will take place faster than prediction. Those together with perceived rapid population growth rate at the birth rate 2.06 as of 2020 that will lead to rapid increase in demand for energy for the coming years. Krewitt et al. (2009) determined that population development and economic growth are the 2 key drivers of increasing demand for energy.

In 2016, Vietnam Government revised the content of the overall energy development program (PHP 7) with the goal of converting energy resources from fuels and coals to renewable sources to ensure energy security, climate change mitigation, environment protection and sustainable social development. Currently in Vietnam, the contribution of renewable energy components vary from different resources. In which, hydro power accounts for the largest share of all renewable energy sources, followed by biomass and wind energy. Some other sources of energy such as solar energy, biogas, and energy transformed from waste have also begun to develop while geothermal and tidal energy are still in their infancy. Vietnam has potential of renewable energy resources equivalent to 359,000 MW annual while the production capacity as of 2018 was only about 2,120 MW. According to MoIT (2020), there is a policy in place in relation to taxes-related preferences, investment model flexibility which aim to motivate investors, entrepreneurs to invest on building system and developing renewable energy in Vietnam. However, the current status still exists numerous challenges that effect to the interest of potential investor and development pace of renewable energy. The dominant challenges typically includes (1) Overall infrastructure and system, specifically, the transmission grid has not been synchronously developed with the pace of development of renewable energy sources; (2) There are not enough backup sources and energy storage system to integrate renewable energy on a large scale; (3) Renewable energy development policy has not been applied for a long time; (4) There is no mechanism to attract investment capital for renewable energy development through bidding. (5) There is no overall study on development of renewable energy' projects in Vietnam. Thus in overall, it's necessary to have a comprehensive study on the status of renewable energy in Vietnam context and its development potential taking into consideration that renewable energy will address the important issues related to economy and society. The findings of this study are expected to contribute an overall picture of the importance of renewable energy to the economy, society and its development potential in Vietnam. This will help existing investors to make more efforts to continue invest and develop the renewable energy segment that they are focusing on, and stimulate potential investors making investment decisions to develop renewable energy systems at their best confidence. In addition, it provides the policy makers a more comprehensive perception of the renewable energy picture and its importance roles to socioeconomic development for appropriate adjustment of policy to motivate investors to continue investing and developing. Besides that, this study findings are expected to contribute to the literature a comprehensive concept of renewable energy and its relationship with the sustainable economic growth in the context of Vietnam.

This study is subjected with the research questions included (1) "*What are the existing renewable energy in Vietnam?*"; (2) *"What sources of renewable energy are available for expansion?"*; (3) *"How renewable energy contribute to Vietnam economic development?"*; (4) *"What is the roles of renewable energy to environment protection in Vietnam context?"*; (5) *"How is the roles of renewable energy to standard living of Vietnam's residents?"*

This study is structured with abstract as the beginning part, followed by introduction. The main body of this study includes different sections presented in order such as literature review, research model and hypothesis, research methodology, results and discussion, conclusion. The last past is the references.

2. LITERATURE REVEW

2.1. Theory of Renewable Energy

Dawn Stover (2011) defined that renewable energy is a concept of energy which is generated from the continuous sources which are infinite such as solar, wind, rain, tide, wave and geothermal. Infinite is defined as two meaning categories include either (1) energy exists abundant that it cannot become exhausted such as solar energy, wind energy and water energy or (2) energy is self-renewed in a short time and continuous such as biomass energy which is defined as any non-fossil natural fuel and classified as organic or made from plant-derived materials being converted into clean energy sources for serving economic and social activities. Renewable energy sources exist throughout many geographical regions, as opposed to other energy sources that exist only in some countries. The rapid and effective introduction of renewable energy is important in energy security, climate change mitigation, and economic benefits. According to Stoeglehner et al. (2011), renewable resources are decentralized and perceived as the outcome generated from the interactions of natural components in a logical manner. It's unlikely to all fossil and nuclear resources which emanating from point resources like mines and wells, renewable resources appear per square meter of earth's surface in the form of solar radiation and biological resources. The role of space is very important in utilizing the renewable energy resources. In other words, space is crucial for generating energy from renewable sources. The main characteristic of renewable resources is lack of high energy concentration as fossil fuel-based resources therefore to harvest this everlasting energy required large areas and that require storage to align energy provision with energy demand (International Energy Agency, 2012).

According to Armeanu et al. (2017), technologies of renewable energy are categorized into two sectors which are (1) mainstream energy technologies such as hydro-power, wind energy, solar energy, biomass, bio-fuels, and geothermal energy and (2) emerging energy technologies includes marine energy, concentrated solar photovoltaic, enhanced geothermal energy, cellulosic ethanol, and artificial photosynthesis (Hussain et al., 2017). Those concepts are briefly described one by one that (1) Geothermal energy is the energy extracted from heat in the earth's interior. This energy is derived from the initial formation of the planet, from the radioactive decay of minerals and from the solar energy absorbed at the earth's surface; (2) Bio energy is energy produced from organic subjects which derived from plants or animals; (3) The concept of wind energy is that it's generated by using kinetic of the wind. Among the renewable energy sources, wind energy is perceived mature and developed commonly all over the world; (4) Solar energy is energy generated by the flow of light and heat radiation from the sun, the source of solar energy, has been utilized by humans since time immemorial; (5) Hydro energy is defined as the power derived from water power. Most hydro electric power comes from the potential of water accumulated in dams that spin a water turbine and generator. Kele and Bilgen (2012) expressed that sustainable energy supply is achieved only with renewable resources which are endless and free from harming the environment while remain economic efficiency in the long run and meeting the desires of community.

2.2. Theory of Sustaining Energy Supply (SES)

James et al. (2015) imply that sustainable energy supply is determined when the type of energy consumed at a negligible rate compared to its supply capacity and at manageable side effects, especially the environmental effects. In other words, sustainable energy supply is defined as an energy system that serves the needs of the present day without compromising the needs of future generations. Renewable energy sources play a significant role to promote sustainable energy supply which include hydro energy, solar energy, wind energy, wave energy, geothermal energy, bio energy, tidal energy and technologies designed to improve energy efficiency. Sustainability in energy supply is only achieved when its outcomes benefit different aspects in relation to society, economy and environment.

Rafael et al. (2020) did another approach of concept of sustainable energy supply starting by a introduction of sustainability concept which is "an act of equilibrium between social, environmental, and economic dimensions of human needs". However, the balance of these dimensions are continuously changing due to the dynamic concept of sustainability. In addition, according to IUCN; UNEP; WWF, (1980), determinations of measures of sustainable energy supply are controversial by different context and different perception. It's perceived that there are five aspects of sustainability in relation to energy supply which are described as following:

1. Environmental related sustainability which includes "natural biological processes, health, and ecosystem functionality, continuous productivity with minimal environmental impacts to reduce the negative impacts of the extraction of natural resources for energy production, consumption by society, and increase of the positive impacts. Global, national, and regional commitments show the important role of energy in sustainable development to reduce energy-related environmental degradation such as global warming, deforestation, air, land, and water pollution" (Iddrisu and Bhattacharyya, 2015; Maffia et al., 2020; Chen et al., 2013).
2. The economic related sustainability includes profitability of energy supply and affordability of the energy consumption. From the investment perspective, cost-effectiveness is crucial to ensure that investments on energy projects are economically that promote reinvestment in the system for sustainability. On the other hand, from the market perspective, accessibility ensures that the energy supplied is accessible to society. Overall, profitability and affordability are the 2 indicators which complement each other to ensure the sustainability of the supply system (Schau et al., 2011; Filer et al., 2020).
3. The social related sustainability reflects the energy distribution behaviors in society. It measures the aspects related to the energy supply such acceptability, accessibility, and ability to access to energy services for all segments of society (Vafadarnikjoo et al., 2020).
4. The technical related sustainability assesses the system capacity of energy supply to society at reliable, efficient manner by using the clean and renewable sources (Wang and Watanabe, 2020). "Technical sustainability is achieved if energy planning can meet the current and future energy needs of society (Corso et al., 2018). This is possible if the power supply is reliable, efficient, and based on renewable energy with locally available support services for the maintenance and execution of energy systems" (Stefenon et al., 2018).
5. Institutional related sustainability is determined as the capacity of an organization to produce valuable results so that they have enough inputs to continue production at a constant or incremental rate. This involves the formation of policies related to finance, implementation and administration (Brinkerhoff et al., 1992).

2.3. Theory of Relationship between Renewable Energy and Sustaining Energy Supply (SES)

According to REN21 (2019), development of renewable energy contributes to address the energy security issue beside diversify the energy resources and protect environment. These impacts of renewable energy development lead to stabilizing the nation's energy supply, sustaining socioeconomic development and protecting environment. Sovacool and Mukherjee (2011) implied that sustainable energy supply or energy security are the complex concepts with surrounding questions in relation to the fairness in supplying, affordability in purchasing, reliability, efficiency, and environment friendliness, proper management and social acceptance. In addition, Muñozet et al. (2015) expressed that sustainable energy supply or energy security is a multidimensional and interdependent concept that cover the various aspects of technology, economy, society, politic, environment and geography. Another concept of sustainable energy security proposed as "provisioning of uninterrupted energy services in an affordable, equitable, efficient and environmentally-benign manner" (Narula, 2014). The measures of sustainable energy supply is perceived included availability, accessibility, affordability, acceptability, and develop-ability or continuous development capacity dimension.

In addition, according to Valentine (2011), renewable energy contributes to resilience ability of energy supply due to its decentralized structure of resources that lessen the negative effects caused from technical-related and supply-related potential problems.

Based on the above reviews, typical hypotheses of relationship between renewable energy and sustaining energy supply created as follows:

H_1: "Solar energy (SEN) has positive relationship with sustaining energy supply (SES)"
H_2: "Hydro energy (HEN) and sustaining energy supply (SES)"
H_3: "Wind energy (WEN) and sustaining energy supply (SES)"
H_4: "Bio energy (BEN) and sustaining energy supply (SES)"
H_5: "Geothermal energy (GEN) and sustaining energy supply (SES)."

2.4. Theory of Sustaining Energy Supply (SES) and Sustainable Economic Growth (SEG)

Sebri (2015) stated that energy is perceived as a vital factor of achieving sustainable economic growth of a nation. Sustainable energy supply contributes to ensure energy security which is very crucial for sustainable socioeconomic development and enhancement of the living standards of the nation's residents. Daniel (1990) expressed that the goals of energy security is perceived to guarantee sufficient, reliable and sustainable energy supply at a more economical price against energy price that generated from fossil fuels and coals, while ensure the supply capacity abundant and no harm to environment. Those benefits are perceived create competitiveness to a nation. Fang (2011) stated that the more increase of consumption of renewable energy, the higher GDP as result. To be more specific, 1% increase of renewable energy consumption drives a growth by 0.120% of real domestic product (GDP) of a nation, by 0.162% of GDP per capita, by 0.444% per capita annual income of rural households, and by 0.368% per capita annual income of urban households in the context of 28 EU countries. Besides that, Vass (2017) renewable energy is a great alternative source of traditional energy from coals and fossil fuels which are expected to contribute to reducing emissions by roughly 8.2% in 2050. This is better relative to the forest sector with a 5.3% share. In addition, renewable energy reduces risk possibility of climate alteration while create job opportunities for the society. The study conducted in EU-28 states over the period 2003-2014 found that increase of production of renewable energies and increase of overall consumption of renewable energies have positively influence on the gross domestic product per capita and those enhance the economy of a nation while improve the living standards of residents. Energies generated from the hydro power, geothermal source, wind power, and solar power are sources of sustainable energy supply that positively influence sustainable economic growth of a nation. In which, biomass energy revealed the highest influence on economic growth among the rest of renewable energy sources.

Moreover, Steve (2011) implied that renewable energy is perceived to "raise poor countries to a new level of prosperity." In other words, renewable energy has the potential to develop the country's economy by stabilizing the supply capacity and promote the consumption demand.

Additionally, REN21 (2019) expressed that renewable energy is source of affordable, reliable and sufficient energy which contributes to address the problematic matters in relation to energy security, energy diversification and reduction of greenhouse gas emissions. Those benefits contribute to sustainable socioeconomic development and environment protection.

Based on the above reviews, hypothesis of relationship between sustaining energy supply and sustainable economic growth proposed as follows:

H_6: "Sustaining energy supply (SES) has positive relationship with sustainable economic growth (SEG)"

2.5. Theory of Sustainable Economic Growth (SEG)

In the "flat world" context nowadays, economic growth is perceived as a basis for welfare and societies, more importantly, "growth" is meant "sustainable growth" for sustainable development (Bezat-Jarzębowska and Rembisz, 2013). The concept of gross domestic products (GDP) was used as an important general economic indicator that assesses a country's economic development. In essence, GDP is the total market values of all finished products and services of all units concentrated in a country's economy over a specified period of time. The next indicator to assess economic growth is GDP per capita. By concept, GDP per capita is an economic statistic indicator showing a country's average production and business results per capita in a year. It's computed as dividing the nation's GDP by the country's total population at the same period of time. Zhengge (2008) implied that economic growth should be well balanced with the "adequate structure and technological progress of the industrial sectors in an ecosystem" for sustainable development. In addition, Azizov (2015) determined that the most priority of any country is to sustain stable economic growth at an optimal level. "The growth of the economy is one of the most important indicators showing the power and welfare of a country." "The dynamics of economic growth primarily depend on the macroeconomic policy of the country." "On a macro scale, the growth of the economy enhances people's living conditions and living standards, while economically it raises the quality and quantity of production to a higher standard." Further, Xepapadeas (2005) perceived the economic growth from the environmental perspective. He highlighted that economic growth should be controlled in a positive manner. It means that economy grows together with environment sustains for sustainable development (Brad et al, 2016). In other words, sustainable economic growth is achieved when the economic growth in line with the ecological durability and living standard of a nation's residents. The health of a nation's economy of economic growth can be assessed through some of the importation indicators such as gross domestic products (GDP), gross domestic product per capita (GDP per capita), inflation rate, unemployment rate and gross saving.

Based on the theoretical overviews that have done as above, authors propose the research model as shown in Figure 1. The model used to explore the relationships between renewable energy whose components include (1) solar energy (SEN); (2) hydro energy (HEN); (3) wind energy (WEN); (4) bio energy (BEN); (5) geothermal energy (GEN) and sustaining energy supply (SES); sustaining energy supply (SES) and sustainable economic growth (SEG). Overall, this model consists of SEN, HEN, WEN, BEN and GEN as independent variables, SES as a mediator and SEG as dependent variable as Figure 1.

The variables of this study were constructed that SEN has 4 items, HEN has 4 items, WEN has 4 items, BEN has 5 items and GEN has 4 items which are renewable energy related; SES has 4 items that related to sustaining energy supply and SEG has 4 items related to sustainable economic growth. In overall, this model has 5 independent variables, 1 mediating variable and 1 dependent variable and totally 29 items.

Finally, this model is hypothesized as following:

H_1: "Solar energy (SEN) has positive relationship with sustaining energy supply (SES)"

H_2: "Hydro energy (HEN) has positive relationship with sustaining energy supply (SES)"

H_3: "Wind energy (WEN) has positive relationship with sustaining energy supply (SES)"

H_4: "Bio energy (BEN) has positive relationship with sustaining energy supply (SES)"

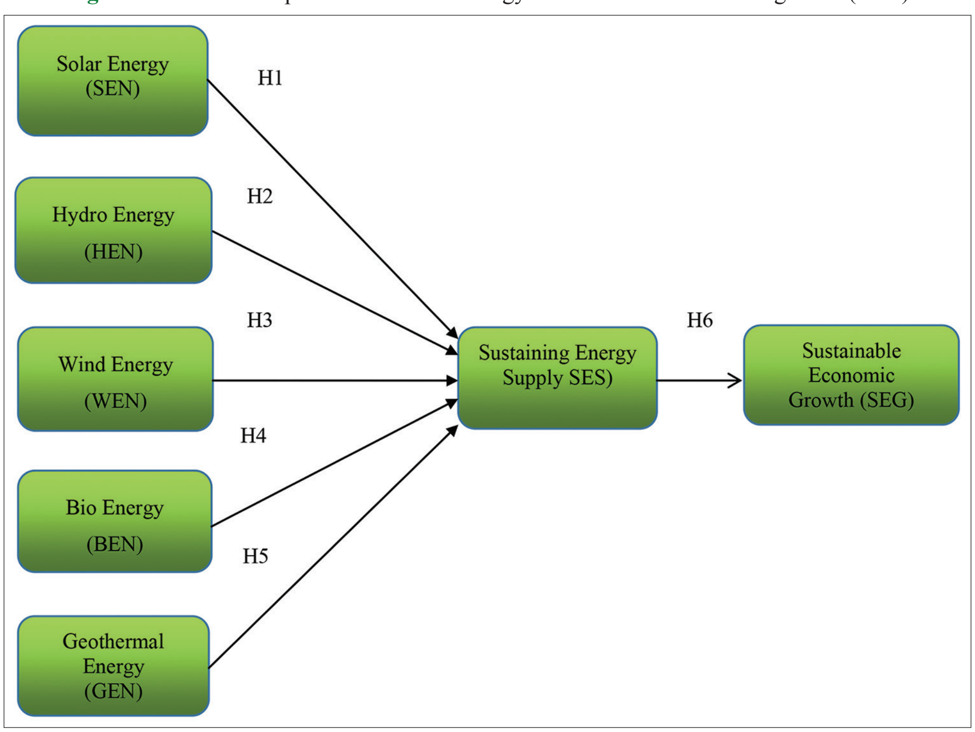
H_5: "Geothermal energy (GEN) has positive relationship with sustaining energy supply (SES)"

H_6: "Sustaining energy supply (SES) has positive relationship with sustainable economic growth (SEG)"

3. METHODOLOGY

The combination of qualitative and quantitative research methods is applied in this study to utilize the strength of each research method for the comprehensive assessment of the relationships of variables of the research model. Qualitative research method enables us to approach in-depth and detailed information about the views, visions and the relationship of renewable energy (SEN, HEN, WEN, BEN, GEN) on sustaining energy supply (SES) and its influence on sustainable economic growth (SEG). Another optimal point of qualitative research method is that through in-depth interview with expert at face to face form that enables authors to additionally collect different personal viewpoints at different perception in relation the field of study. Authors prepared interview questions at an open-ended mechanism to encourage interviewees to answer at the most comfortable, realistic and unrestricted way within a certain framework. The selected respondent types for interview are energy experts, economists,

Figure 1: Model of impact of renewable energy on sustainable economic growth (SEG)



Source: Author's construct

energy services providers, entrepreneurs and firms' executives. There were 35 respondents participated this interview, in which, 10 energy experts, 9 economists, 6 founders of entrepreneurs and 10 executives. The expected outcome of this phase is the final questionnaire which is suitable with research context and ready for quantitative research performing. The questionnaire was built using 5 Likert scale point which indicates that the point ranged from 1 (strongly disagree) be in ascending order to 5 (strongly agree). The qualitative research was conducted on February 2020.

This study used 2 types of data categorized as primary and secondary. In this research, the collected secondary data is related to the consumption of renewable energy and total energy of Asia Pacific region as a whole and Vietnam specific, besides that, production and supply related capacity and resource potential related capacity of renewable energy was also collected through various sources such as professional energy report Renewable Now (REN21), online energy-related magazines of Vietnam Ministry of Industry and Trade (MoIT). The primary data was collected by survey using questionnaire with initial sample size is 495. Hair et al. (2010) proposed the principal for sample size computation which is based on the number of items of the proposed research model. Accordingly, the sample size should be calculated as 5 to 10 times more than the defined items in the study. This study has totally 29 items thus a needed size of sample should be 290. However, to avoid risk potential may occur during the survey process such as missing responses from the target respondents, unsatisfied responses given, ect, so authors decided to initially proceed with 495 samples at the simple method of collecting random probability samples. Survey subjects include experts (about 35%), firms' executives (about 30%), and management levels (about 35%), with no age limit for respondents. The target areas that survey applied were cities and provinces such as Ho Chi Minh City, Binh Duong, Binh Thuan, Ninh Thuan, Khanh Hoa as those are considered as typical and emerged in relation to industrialization and modernization in the current context of Vietnam. The survey was conducted from March 5th to April 29th of 2020. The questionnaires were distributed to the target respondents through email and direct delivery. The collected questionnaires were screened and satisfied questionnaires selected. As a result, there was 477 met the specification as indicated criteria. Those data were then used for analysis using CB-SEM (Covariance-based Structural Equation Model).

4. RESULTS

4.1. Testing Research Model

According to Williams et al. (1991), testing research model is necessary to affirm that the research model and its components are accepted and suitable with the specific context of this study.

4.2. Assessing Reliability of the Scale

Reliability assessment is to check the consistency levels between multiple measurements of a variable, (Hair et al., 2010). This study assesses the consistency of the entire scale and its overall reliability of each factor of productivity values by simultaneously using Cronbach's Alpha and composite reliability indexes with expect to bring all necessary basis into consideration for the most appropriate conclusion to the study context. The analysis results show that Cronbach's Alpha coefficient of all variables are greater than 0.8 from 0.803 of SEG, 0.839 of SES, 0.848 of GEN, 0.882 of BEN, 0.890 of HEN, 0.922 of WEN and 0.933 of SEN. Thus, it can be concluded that the measurement scale of this research model is good (Nunnally, 1978; Peterson, 1994). However, authors would like to continue further investigation to reaffirm the reliability of the scale, therefore composite reliability value was used for this purpose. The analysis result show that all composite reliability values are >0.8 from 0.804 of SEG, 0.840 of SES, 0.849 of GEN, 0.882 of BEN, 0.890 of HEN, 0.922 of WEN and 0.935 of SEN. According to Hair et al. (2016), the aggregate reliability between 0.7 and 0.95 represents a satisfactory level of reliability. Therefore, in overall, these results confirm that the reliability of this scale is good and acceptable. Table 1 is summary of these results. Overall, it can be concluded that the reliability of the scale is satisfied.

4.3. Assessing Validity

Hair et al. (2010) defined that the purpose of assessing validity is to determine how well is the construct explained the variables under the construct. In addition, it's to assess practicality of the data collected and its reflection on the study context. According to Anderson and Gerbing (1988), the validity of research concepts includes convergent validity and discriminant validity of scales.

4.4. Convergent Validity

The convergence value is used to illustrate the full convergence of the measurement items on their respective structures. (Oliver et al., 2010).

Table 1: Cronbach's alpha and composite reliability results

Variables	Cronbach's alpha	Composite reliability
SEG	0.803	0.804
SES	0.839	0.840
SEN	0.933	0.935
HEN	0.890	0.890
WEN	0.922	0.922
GEN	0.848	0.849
BEN	0.882	0.882

Source: Authors' analysis

Table 2: Convergent validity

Variables	AVE
SEG	0.507
SES	0.567
SEN	0.782
HEN	0.669
WEN	0.748
GEN	0.584
BEN	0.600

Source: Authors' analysis

Table 3: SQRTAVE values

Variables	SEG	SES	SEN	HEN	WEN	GEN	BEN
SEG	**0.712**						
SES	0.637	**0.753**					
SEN	0.135	0.253	**0.884**				
HEN	0.210	0.292	0.070	**0.818**			
WEN	0.172	0.177	0.118	0.055	**0.865**		
GEN	0.613	0.591	0.195	0.228	0.155	**0.764**	
BEN	0.531	0.639	0.172	0.179	0.109	0.536	**0.774**

Source: Authors' analysis

determined that the evaluation of convergence is typically calculated by means of Average Variance Extracted (AVE). Hair et al. (2010) suggested that the AVE index should be over or equal to 50%, the extracted factors could be more explainable than any other extract combinations. Table 2 shows the results of EVA and external loading

Table 4: Maximum shared variance (MSV) compared with AVE values

Variables	MSV	AVE	MSV versus AVE	Conclusion
SEG	0.406	0.507	MSV < AVE	Satisfied and accepted
SES	0.408	0.567	MSV < AVE	Satisfied and accepted
SEN	0.064	0.782	MSV < AVE	Satisfied and accepted
HEN	0.085	0.669	MSV < AVE	Satisfied and accepted
WEN	0.031	0.748	MSV < AVE	Satisfied and accepted
GEN	0.375	0.584	MSV < AVE	Satisfied and accepted
BEN	0.408	0.600	MSV < AVE	Satisfied and accepted

Source: Authors' analysis

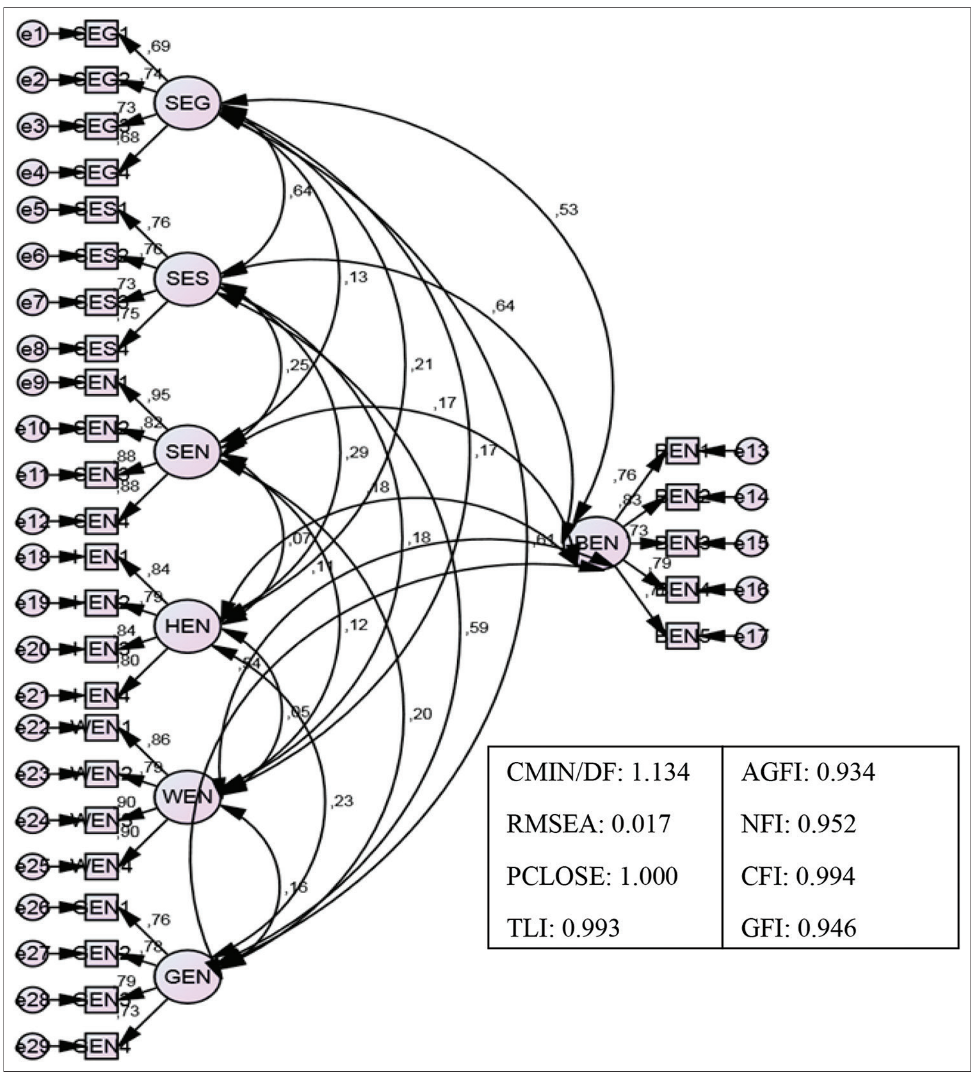
factors. In which external loading factors values are all >0.7 and EVA are all >0.5. These values exceed the level mentioned, it indicates a sufficient degree of convergent validity, which means that a specific latent variable explains more than half of the variance in comparison to their corresponding indicators (Hair et al., 2011). Accordingly, we can conclude that the observed variables are focused on the research concept that it is involved in or convergent validity is supported.

4.5. Discriminant Validity

The distinction is satisfied when the square root of AVE of each structure in the research model is greater than all the internal correlation values of the remaining structures. Table 3 has confirmed that the SQRTAVE values are all greater than the inter-construct correlation so the discriminatory test of research concepts is satisfied. Therefore, it can be concluded that the distinctiveness of the research concepts is determined satisfactorily. The research can move on to analysis of the next steps.

The additional step was taken to reaffirm discriminant validity of the measurement model was assessment of maximum shared variance (MSV) values. According to Hair et al. (2010), to establish the discriminant validity of the measurement model, MSV value

Figure 2: Confirmatory factor analysis



Source: Authors' analysis

should be smaller than AVE value. In this study, MSV values are all smaller than that of AVE so discriminant validity is supported. Table 4 summarizes the MSV values compared with AVE values for convenience.

In overall, it's possible to conclude that the reliability and validity of the research model of this study is supported based on the above analysis.

4.6. Confirmatory Factor Analysis (CFA)

The purpose of CFA is a statistical technique used to verify the factor structure of a set of observed variables. CFA allows the researcher to test the hypothesis that a relationship between observed variables and their underlying latent constructs exists (Figure 2).

4.7. Evaluation of Structural Model

Model-of-fit analysis was taken placed to determine its fitness and its validity. This analysis was conducted by assessing a set of model-of-fit indices such as RMSEA, GFI, AGFI, NFI, CFI, CMIN/DF, PCLOSE and TLI. Those values in this study satisfied the acceptance thresholds that were defined by the previous authors of the relevant studies. The Table 5 summarizes the model-of-fit indices with full name, the acceptance thresholds and results. Overall, it can be concluded that this model is fit and valid.

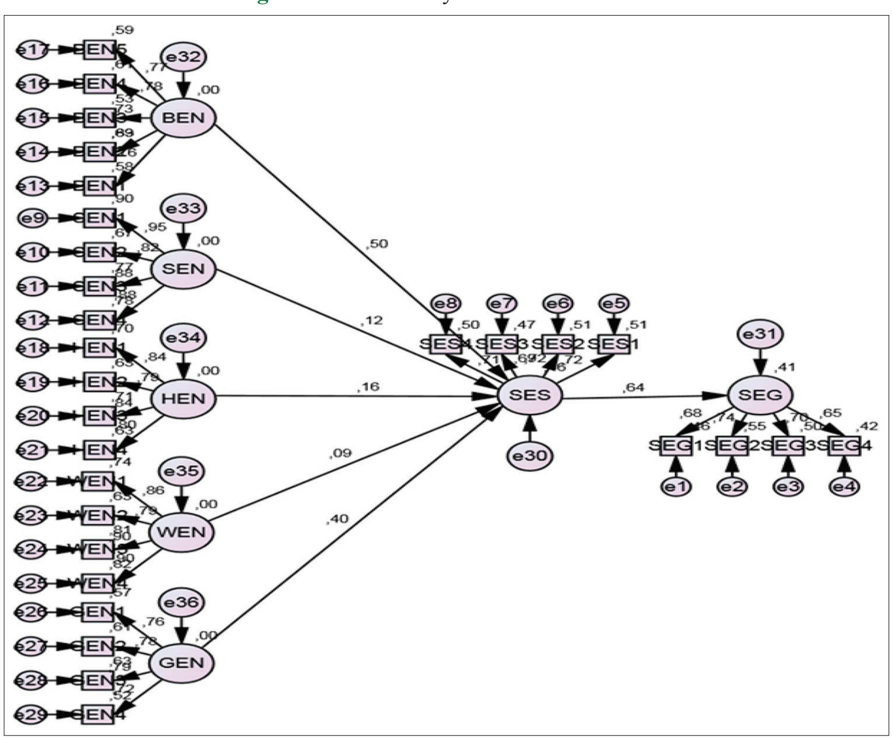
The next step was conducted to access the relationships of variables of the model by analyzing the standardized regression weights. In which, the estimate values and P-values are focused at most as its importance to this analysis purpose. Estimate values describe the regression weight of the relationships of variables while P-value describes significant of relationships. If P-value is smaller than 5% or 0.05, it means that the relevant relationships are significant. In this study, P-values are smaller than 0.05 from <0.001 (cases presented ***) to 0.006 so it can be concluded that the relationships of all variables of this model are significant. Overall, it's supported to conclude that the hypotheses of this study are accepted.

Table 5: Model-of-fit indices

Model-of-fit indices	Full name	Acceptance thresholds	Values	Concluded
RMSEA	Root mean square error of approximation	0.08 ≤ Value ≤ 0.10 (mediocre fit); Value < 0.8 (good fit) (MacCallum et al., 1996); Value ≤ 0.05 (close fit) (Hair et al., 2010)	0.017	Close fit
GFI	Goodness-of-fit statistics	Value > 0.90 (Shevlin and Miles, 1998)	0.946	Good fit
AGFI	Adjusted goodness-of-fit statistics	Value > 0.80 (Hu and Bentler, 1999) and Value ≥ 0.90 (Hooper et al., 2008)	0.934	Good fit
NFI	Normed-fit index	Value > 0.90 (Bentler and Bonnet, 1980) and ≥0.95 (Hu and Bentler, 1999)	0.952	Good fit
CFI	Comparative fit index	Value ≥ 0.90 (Bentler, 1990) and ≥0.95 (Hu and Bentler, 1999)	0.994	Good fit
CMIN/DF	Chi-square/df	Value < 3 (good); Value < 5 (acceptable) (Hair et al., 2010)	1.134	Good fit
PCLOSE	P of close fit	Value < 0.05 (close fit) (Browne and Cudeck, 1993)	1.000	Close fit
TLI	Tucker–Lewis index	Value > 0.9 (Hair et al., 2010)	0.993	Good fit

Source: Authors' analysis

Figure 3: Result analysis of research model



Source: Authors' analysis

The estimate values in the Table 6 that every factor of this model has a certain influence on its related factor in the established relationship. On the other hand, estimate value means that every unit of change of the impacting factors then it will equivalently impact to the impacted factors in proportion. Taking into consideration of the influences of independent variables such as BEN, SEN, HEN, WEN and GEN on the meditating variable which is SES, the results show that BEN has the greatest impacts on SES at the 0.504 as loading estimate of BEN to SES, the 2nd greatest influence one on SES is GEN at 0.398 as loading estimate, the 3rd one out of the five is HEN at 0.163 as loading estimate, the 4th one is SEN at 0.118 as loading estimate and the least one is WEN at 0.087 as loading estimate. In overall, among the 5 components of renewable energy, bio energy (BEN) is the most influencer to sustaining energy supply (SES), geothermal energy (GEN) is the 2nd influencer to sustaining energy supply (SES), then hydro energy (HEN), solar energy (SEN) and windy energy (WEN) have less influence on sustaining energy supply than the previous two factors.

Taking into consideration of the relationship between sustaining energy supply (SES) and sustainable economic growth (SEG), the result shows that SES has strong impact on the SEG at the loading estimate at 0.637. Besides, all observed variables are significant in the scale because the standardized loading estimates are >0.5.

Table 6: Standardized loading estimate and P-values

Path	Estimate	P-value
SES ← BEN	0.504	***
SES ← SEN	0.118	0.006
SES ← HEN	0.163	***
SES ← WEN	0.087	0.004
SES ← GEN	0.398	***
SEG ← SES	0.637	***
SEG4 ← SEG	0.649	
SEG3 ← SEG	0.705	***
SEG2 ← SEG	0.743	***
SEG1 ← SEG	0.675	***
SES4 ← SES	0.706	
SES3 ← SES	0.687	***
SES2 ← SES	0.717	***
SES1 ← SES	0.717	***
SEN4 ← SEN	0.882	
SEN3 ← SEN	0.879	***
SEN2 ← SEN	0.820	***
SEN1 ← SEN	0.951	***
HEN4 ← HEN	0.796	
HEN3 ← HEN	0.845	***
HEN2 ← HEN	0.793	***
HEN1 ← HEN	0.837	***
WEN4 ← WEN	0.904	
WEN3 ← WEN	0.900	***
WEN2 ← WEN	0.792	***
WEN1 ← WEN	0.858	***
GEN4 ← GEN	0.723	
GEN3 ← GEN	0.792	***
GEN2 ← GEN	0.780	***
GEN1 ← GEN	0.758	***
BEN2 ← BEN	0.829	
BEN3 ← BEN	0.729	***
BEN4 ← BEN	0.784	***
BEN5 ← BEN	0.765	***
BEN1 ← BEN	0.762	***

(P-value presented *** means <0.001 which is good and significant). Source: Authors' analysis

Table 6 is summary of standardized loading estimate and P-values of this study result (Figure 3).

5. CONCLUSION

The findings of this study revealed similarly to the findings of the previous studies in relation to the renewable energy concept and renewable energy resources. Moreover, the relationships of renewable energy sources and sustaining energy supply are positively confirmed and consistent with the findings of the previous relevant studies. In addition, the most important point of this study finding is that sustaining energy supply is found positively influencing to the sustainable economic growth in the context of Vietnam. This study significantly contributes to the literature in relation to renewable energy especially the in current context of Vietnam. The first contribution is providing a comprehensive concept of renewable energy in Vietnam context. Also, it determines the resources of renewable energy in Vietnam and its influences on sustainable energy supply. This reflects the perceptions of the relevant people in relation to the concept of renewable energy in the current situation in Vietnam, and awareness of the prospects of developing renewable energy in Vietnam on the basis of policy context, infrastructure, technology and consumer demand. Moreover, equally important is the awareness of the concept of sustainable energy supply by those involved people. This reflects how they perceived the importance of sustainable energy supply to the nation's economic growth, to environment and to the quality of life of residents. Through this can show their implications of the intention to participate in restructuring restructure the current energy sources in a sustainable way for sustainable development. The second contribution is providing an overall picture of the current production capability of renewable energy, potential capacity of renewable resources and consumption demand for renewable energy in Vietnam. This will be supportive to the economist, economic related policy maker, potential investors and existing investors in renewable energy and other stakeholders in relation to consideration of planning, policies and mechanisms for sustaining energy supply. According to Harrod (1997), the role of government policies and mechanisms is important for the growth of a nation's economy. It's perceived as a leverage in stimulating investment growth in society.

The findings of this study indicate that in Vietnam, bio energy is the most important energy source of sustainable energy supply. This finding is very consistent with the potential of bio energy in Vietnam due to its characteristics as a tropical country, where natural conditions are favorable for the development of agricultural and plant diversity. This contributes to sustain abundant biological materials for bio energy production. According to Industry and Trade Magazine (2020), Vietnam has potential capacity of bio energy equivalently to 318,000 MW while its production capacity only equivalently to 270 MW in reality, as of 2018. The 2nd important one to sustaining energy supply revealed is geothermal energy. This finding is suitable with the current nature of Vietnam in relation to natural conditions and natural resources. Hydro energy is revealed as the 3rd renewable energy source that contribute to sustaining renewable energy in Vietnam. However, hydro energy is concentrated to develop almost maximum in Vietnam. In addition to the advantages of hydro energy like other renewable energy sources, it still have disadvantages such as negatively affecting river ecological balance and flood control. Therefore, hydro energy should not be prioritized in sustainable renewable energy development projects in the future for the stated reasons. The next one is solar energy which is concluded as the number 4 in relation to the relationship with sustaining energy supply. However, Vietnam has a great potential to develop solar energy, especially in the central and southern regions due to its nature characteristic that results in generating the average hours of sunshine in those regions is higher than other regions. Similarly, windy energy is concluded as the last one that contributes to the sustaining renewable energy supply. However, Vietnam has great potential for developing wind energy because Vietnam is located in a tropical monsoon region with a coastline of more than 3,200 km, and southwest monsoon blowing in the summer. According to a study made by ESMAP World Bank, Vietnam's total wind power potential is equivalent to 513,000 MW. Through the results of this research, the author has a number of implications to contribute to economists, policy makers, potential investors and current investors the ideas for planning, investment and sustainable energy development. These implications include (1) The Government should consider macroeconomic policy and mechanisms to encourage investment from organizations and individuals at their best confidence; According to Eisenmenger et al. (2020), macroeconomic policy is determined as a leverage of economic growth and thus increase the population's incomes for improved standards of living for the people. In other words, sustainable economic growth is only achieved with "sustained macroeconomic stability, which is the main condition for stimulating private investments. Therefore, a macroeconomic policy needs an element to achieve stability." (2) The Government should have overall planning orientation including infrastructure, logistics system to ensure synchronous development to meet growth needs; (3) The Government should consider for special support policies for projects related to the development of bio energy, geothermal energy, wind energy and solar energy for sustainable development by optimizing potentials of renewable energy resources; (4) For investors: It is necessary to synchronize with the government's master plan to optimize the benefits of investment and create sustainable practical values for businesses, for the country's economy, for environment and for the community.

This study has typical limitation such as data collection, research geography and research context. Regarding to data collection, this study used 2 types of data which are categorized as secondary and primary. The limitation may happen depend on the sources of data collected which is more probable for secondary data as the data might have been updated after its collection for this study analysis. Regarding limitation related to research geography and research context, since this study was conducted in Vietnam context and at some typical cities and provinces as stated thus the findings could not be represented for other regions with different geographical and topographic conditions and different context. Moreover, the implications and recommendations in this study are based on the results of this study with the study context and the study space as presented above, therefore, these recommendations and implications may not be appropriate for implementation for other contexts.

In general, those limitations provide opportunity for future researches continue to contribute to the literature of overall renewable energy, renewable resources and its contribution to the sustainable energy supply and sustainable economic growth in different context and different research subject, meanwhile keep on heading towards balancing the ecosystems, sustainable economic growth and improving the quality of life for the community and achieving sustainable development for future generations.

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