www.rericjournal.ait.ac.th

Does Energy Transition Lead to an Enhancement in Energy Security? The case of Six ASEAN Countries

Arista Sony*, [1], Nachrowi Djalal Nachrowi[#], Djoni Hartono[#] and Lin Yola*

ARTICLE INFO

Article history:
Received 27 September 2023
Received in revised form
07 January 2024
Accepted 16 January 2024

Keywords:
Decarbonization
Energy citizenship
Energy democracy
Energy security
Energy transition

ABSTRACT

This study examines the impact of the energy transition on the energy security of six ASEAN countries. The quantitative PLS-SEM method is applied in this study to investigate the relationships among energy democracy, energy citizenship, energy transition, and energy security. The energy transition model investigates the secondary panel data from 2000 to 2020 for six major oil consumption countries to find crucial factors. These six ASEAN countries primarily consume 80% of their energy from fossil fuels, contributing to 4.45% of global CO_2 emissions. This study empirically found that energy citizenship significantly impacts the energy transition by 38.3% and energy security by 22.6% through the energy transition. Energy democracy negatively impacts the energy transition at 56.3% and energy security at 64.7%. The energy transition impacts 59.1% of energy security. Encouraging energy citizenship to consume renewable energy reduces CO_2 emissions from 1,468 $MtCO_2$ to 906 $MtCO_2$. Promoting energy democracy reduces CO_2 emissions from 1,468 MtCO2 to 518 $MtCO_2$. The energy transition of six ASEAN countries is encouraged through energy citizenship and democracy to strengthen energy security by enhancing renewable energy and decreasing the dominance of fossil fuels.

1. INTRODUCTION

The addiction to fossil fuels for energy inevitably results in CO_2 emissions, global warming, and climate change, causing catastrophic disasters, fatalities, environmental harm, and economic losses [1], [2]. Global warming and climate change pose substantial difficulties to societies across the globe, and they are intrinsically connected to the use of energy and the production of greenhouse gases (GHGs) [3]. The main factor contributing to this upsurge is the utilization of fuel oil and industrial procedures that facilitate industrial and transportation operations, resulting in a substantial increase in world temperatures nearing 1.5ºC [4]. A recent analysis defines the successive needs, spanning each decade, necessary for gradually eliminating fossil fuel consumption and adopting renewable energy sources to mitigate climate change, called the energy transition [4]. The energy transition is a crucial strategy to alleviate the strain on our planet [5]. It is essential for human development and prosperity, as it aims to fulfill the commitments made in the 2015 Paris Climate Agreement and is a subject of debate among economists on a global scale [4], [6], [7].

The addiction to fossil fuels has also been experienced in six ASEAN countries: Indonesia, Philippines, Malaysia, Singapore, Vietnam, and Thailand. Consuming fossil fuel energy becomes a major energy source to drive their industry and economic growth [8]. Their fossil fuel supply grew from 2,996 TWh in 2000 to 6,017 TWh in 2020, increasing CO_2 emissions from 682 million metric tons of carbon dioxide ($MtCO_2$) to 1,468 $MtCO_2$ [9]. The impact of fossil fuel addiction is severe and occurs in the form of natural disasters, economic losses, and deaths. In its 2022 report, the World Meteorological Organization (WMO) stated that the Asia area witnessed significant catastrophes, resulting in deaths and economic damages totaling USD 1.2 trillion [2]. Furthermore, Thailand, Philippines, Vietnam, and Myanmar have been identified as the nations most vulnerable to climate-related hazards between 1999 and 2018 [10]. Lau [11] reported that between 2008 and 2010, two cyclones impacted more than 2.6 million individuals, while three floods in 2010, 2011, and 2012 affected approximately 500,000 people in Myanmar. In 2016, Vietnam had its most severe drought in a hundred years. This climatic phenomenon leads to a decrease in the water level of the Mekong River, resulting in the salinization of the impacted regions. Satellite imagery reveals that many individuals residing in ASEAN countries are exposed to hazards resulting from the increase in sea levels and the sinking of land. This catastrophic calamity is particularly evident in low-lying nations such as

*School of Strategic and Global Studies, Universitas Indonesia, West Java, 16424 Indonesia.

[#]Faculty of Economics and Business, Universitas Indonesia, West Java, 16424 Indonesia.

[1]Corresponding author:
Tel: +62 81218161506, 213900538.
Email: arista.sony01@ui.ac.id

Indonesia, Thailand, Vietnam, and the Philippines [12]. Indonesia and the Philippines have declared their intentions to relocate their capitals. The ongoing catastrophic flooding in these countries [13] influenced this decision [13]. Thailand is contemplating relocating its capital city, Bangkok, due to subsidence, which causes the metropolis to sink at a rate of 3 cm a year [14]. Ultimately, the dependence on fossil fuels exerts significant strain on the limits of our world, leading to environmental, social, and economic injustices [5].

According to the International Energy Agency (IEA) Report 2023 [9], CO_2 emissions from the six ASEAN countries' fossil fuel consumption will double in 2050 from 1.4 $GtCO_2$ to 2.7 GtCO2. Based on this projection above, the impact of increasing fossil fuel consumption and CO_2 emissions results in severe environmental damage. However, the energy transition becomes a challenge for six ASEAN countries, with shifting to renewable energy sources potentially disturbing their future energy security in achieving economic growth. Integrating energy and social perspectives is still lacking and needs to be addressed [15]. For these reasons, this study examines the impact of the energy transition on the energy security of six ASEAN countries. The result is expected to provide the energy transition framework with crucial factors to recommend the prioritized factors to execute the energy transition by six ASEAN countries without harming their sustainable energy in the future.

Energy transition, energy justice, and energy security theory apply to this study to answer the abovementioned problem. Recently, energy transition theory has evolved from the material aspect of fossil fuels to renewable energy and expanded into two integrated fields of study: energy and social science [15] [16]. Energy justice recently gained prominence as an interdisciplinary study program that aims to incorporate ideas of justice into several aspects of energy, including policy, production and systems, consumption, activism, security, and climate change [17]. Applying energy justice to the energy transition becomes a central tenet of investigating the transition from fossil fuels to renewable energy, focusing on energy justice in determining energy services-electricity in the future—are accessible, affordable, and just for all people without harming our ecology [18], [19].

This study is structured into six sections: introduction, literature review, methodology, result, discussion, and conclusion.

2. LITERATURE REVIEW

Economic expansion has caused environmental disasters [1]. From 2010 to 2020, global energy supply increased from 450 EJ to 600 EJ, while CO_2 emissions climbed from 30 to 36 $GtCO_2$, according to the IEA Report 2022 [20]. Several studies proved the link between economic expansion and environmental degradation. Anser *et al.* [1] examined Southeast Asian energy consumption, CO_2 emissions, globalization, and economic growth. This study found a link between economic growth and CO_2 emissions, supporting regional CO_2 control programs. Hesary and Rasoulinezhad [21] found that Asia's economic growth has positive energy transition results, while CO_2 emissions have negative results, suggesting the implementation of green growth and sustainable development policies. The study by Indra Land *et al.* [22] supports rising CO_2 emissions in the six ASEAN countries. About 80% of their energy comes from fossil fuels. These governments continue deforestation, subsidize fossil fuels, and build new coal power plants, which could cause catastrophic calamities.

Energy justice has been a popular interdisciplinary energy research topic in the past decade, concentrating on how to use it in the energy transition. Heffron [23], defines energy justice as distribution, acknowledgment, and processes to judge energy services—electricity access—on economic, social, and environmental factors. In four dimensions, energy security measures a nation's ability to provide and demand energy sustainably. Sovacool and Mukherjee [24] claim that a nation's energy security derives from availability, affordability, technology development, sustainability, and regulation to evaluate its energy system. Amin *et al.* [25] define energy security as accessibility, affordability, and acceptability. The energy transition involves energy justice, determining the country's energy security, and regional and global alignment with social, economic, and environmental sustainability.

The energy transition encompasses the objectives and the antecedent factors. According to Sweeney [26], an urgent need for transition exists to move towards an energy system that prioritizes cleanliness, renewable resources, and low carbon emissions. This transition must effectively tackle significant social and environmental issues and has emerged as an undeniable element within the current public discourse. There is a recurring focus on devising strategies to enhance energy pathways. Various variables drive these transition strategies, including fuel cost fluctuations, environmental and security concerns, technological breakthroughs, and efforts to enhance energy availability [27]. Meanwhile, the six ASEAN member states play a vital role in international climate change efforts. Population growth, greenhouse gas emissions, and climate change susceptibility are to blame [28]. Heffron [29] says the energy transition is essential to social progress and economic sustainability. Society must prioritize preventing exclusion and disadvantage to achieve the 2030, 2040, and 2050 goals. The shift should prioritize diversity. Carley and Konisky [17], argue that adopting lower-carbon energy sources will perpetuate pre-existing beneficiaries and disadvantages. This setting usually benefits those who adopt greener energy sources, phase out fossil fuels, and create new jobs and inventions. People with bad outcomes or few opportunities are called "losers". Su and Tan [30] and Hepburn *et al.* [31] noted that several countries are working to achieve the energy transition by using renewable energy. The change above and its expansion present serious issues about economic, social, and environmental sustainability. Accelerating the energy transition is crucial. Reorganizing energy use, lowering carbon emissions, and efficiently managing energy usage should be considered. Talan *et al.* [32], state that energy security and integrating renewable energy technology are crucial to a sustainable economy. The energy transition is crucial to reduce CO_2 emissions and climate change. This transition requires clean energy and the active participation of individuals, communities, society, and governments to achieve sustainable economic growth.

The energy transition involves switching from high-carbon to renewable energy. Smil [33] reported that the energy transition followed a global pattern from wood to coal, coal to fuel, and fuel to clean energy sources. Carley and Konisky [17] distinguished three energy transition categories: energy, energy justice, and just transition. The energy transition involves switching to a different energy source. Energy justice is an environmental justice element that emphasizes energy systems and the entire energy resource life cycle—extraction, production, consumption, and waste management. The fundamental principles of energy justice are fair access, affordable costs, and sustainability. All people need environmentally sustainable energy to live well. It emphasizes the significance of allowing individuals to actively engage in and take responsibility for energy-related decision-making processes to make substantial improvements. The US labor movement coined 'fair transition' in the late 1990s. It bridges the energy transition with energy justice studies. Designing, implementing, and assessing socio-energy system transformations that affect renewable energy transition requires fairness and justice. Wang and Lou [34] divide energy transition into five strands: labor-oriented concept transition, integrated framework for environment, climate, and energy justice transition, socio-technical just transition theory, governance strategies transition, and public perception just transition. The energy transition also includes physical shifts away from diminishing resources, a commitment to justice, and the integration of climate, energy, and environmental factors, which typically incorporate social elements.

2.1 The Exogenous Constructs of Energy Transition

The energy transition requires social inclusion. Wahlund and Palm [35] report increased intellectual and policy conversations about public involvement in energy transitions. Both "energy democracy" and "energy citizenship" have been stressed in these discussions. These topics are closely related to the energy transition, renewable energy framework decentralization, and local energy resource ownership.

2.1.1 Energy Citizenship

Energy citizenship involves actively promoting and using renewable energy systems. These new systems also address energy poverty. DellaValle and Czako [36] assert that Current academic research on energy citizenship emphasizes citizens' active participation in energy transformation. This engagement goes beyond energy investment and consumption decisions to include social and political actors who can develop energy systems. Wahlund and Pamp [35] define energy citizenship as prosumers, individual action involvement, smart devices and small-scale technologies, conscious energy use and behavioral changes, energy literacy improvement, and self-governance. Van Wees *et al.* [37] argue that the active engagement of citizens and energy communities is essential to achieving a sustainable energy system. Citizens also help create an energy society through social innovation, crucial to technological energy systems. They are the topic and object of this innovation while becoming vital energy market contributors. Local energy generation, greenhouse gas mitigation in educational institutions, and municipal energy system reform to promote intelligent and low-carbon cities were used to operationalize energy citizenship. This study used the Positive Energy District concept to improve urban sustainability in Nantes, Hamburg, and Helsinki [37]. Reducing carbon dioxide emissions and encouraging renewable energy achieved it. Researchers worked with technology suppliers, electric grid operators, politicians, and local energy groups to support development. The proposed solutions include creative techniques to improve the environment, energy infrastructure, and e-mobility. In conclusion, energy citizenship promotes sustainable energy production and use by encouraging individuals to manage and own their energy systems. Hypothesis is then formulated:

H1: Energy citizenship impacts the energy transition.

2.1.2 Energy Democracy

According to Sweeney [26], energy democracy, with three components, is needed for the energy transition. Opposing major energy companies' strategic plans is the first step. This opposition includes returning energy economy-specific parts to public ownership after privatization or marketization. The global energy system must be redesigned to increase renewable and low-carbon energy use. Additionally, aggressive energy conservation is needed. The reorganization effort in the energy sector should also prioritize producing employment possibilities and local economic success while boosting community engagement and democratic government. Szulecki [41] defines energy democracy as a theoretical framework for analysis and decision-making. This phenomenon is characterized by popular sovereignty, participatory government, and civic ownership. Implementing this paradigm requires relevant indications. Energy democracy envisions reorganizing the energy system politically, economically, and socially using renewable energy. Democratic processes for energy decisions, justice in energy access, civic energy ownership among ignored groups, and dispersed and renewable energy resources are part of this reorganization [26], [38], [39]. In summary, energy democracy has emerged as a social movement aimed at democratizing fossil fuel energy use by transitioning to renewable energy sources while promoting inclusivity within society.

Burke *et al.* [40] and Szulecki [41] explore energy democracy, which has attracted attention recently. It includes social movements that become decision-making processes, tying energy infrastructure changes to political, economic, and social developments. The term is used in climate justice, trade unions, science, and politics. Recent local and national discussions have supported it. The operationalization of energy democracy involves resistance, reclaiming, and restructuring. In conclusion, energy democracy is a sociopolitical effort to reduce fossil fuel use. Communities and governments must work together to provide renewable energy to all for their energy security while preserving the environment. The hypotheses are then formulated:

H2: Energy democracy impacts the energy transition.

H3: Energy democracy impacts the energy security.

2.2 The Present Study of the Energy Transition

2.2.1 Applying energy justice as energy transition

Integrating energy justice in energy transition research is a crucial principle. Heffron and McCauley [18] argue that "Energy Justice" has become popular in interdisciplinary research over the past decade. Guruswany [42] stated that energy justice supports sustainable development. However, energy justice and sustainable development need to go beyond a single strategy. It requires sustainable energy sources to assist the "Energy Oppressed Poor (EOP)" in overcoming energy poverty and scarcity. McCauley *et al.* [43] stated that energy justice requires academics to address justice issues throughout the energy system, including production and consumption. Energy justice, originating from the environmental justice movement, attempts to ensure equitable access to cost-effective and sustainable energy for all citizens, irrespective of their geographical location. Like environmental justice, energy justice has three principles: distributional, procedural, and recognition [44]. Heffron and McCauley [45] suggest justice integration of climate, energy, and environment for a just transition. This definition of just transition refers to a fair and equitable approach that helps society shift away from carbon-based energy. The primary objective seeks fairness and equity in tackling global justice concerns like race, income, and gender in developed and developing countries. The inherent character of this transformation necessitates its implementation on a global level while successfully addressing various scales of reality. Distribution, recognition, procedural, and adding restorative justice become the conceptual framework of energy justice. The literature on energy, climate, and environmental justice intersects. They also establish the "JUST Transition Concept" which includes distributional, procedural, restorative, universal (recognition and cosmopolitan), space (location), and temporal (transition timeframe) justice [23]. Heffron [18] remarked that energy justice is becoming an interdisciplinary energy research subject. Energy justice focuses on five forms of justice and provides an enhanced framework for action [19]. Distributive justice involves fair energy sector gains and disadvantages. Energy revenue gains may be distributed unevenly among stakeholders. Procedural justice examines legal procedures, including compliance, fairness, and related inquiries. One example of restorative justice is redressing energy sector differences like decommissioning. Recognition of justice is an ethical notion that defends the rights of others, primarily local and indigenous peoples. Cosmopolitan justice holds that we are all global citizens on one earth. As a result, he asserted that the transnational consequences of energy-related actions must be considered. Acheompong and Opoku [46] define energy justice as rural-urban equality in power, clean energy, and cooking technology and its relevance to democracy. Heffron *et al.* [47] energy justice is judged by economics, politics, and the environment. Energy justice is measured by the availability of contemporary cooking energy, electricity, justice, female secondary school enrollment as a proportion, and information [8]. The energy transition idea ensures equal access to electricity as an energy service for all through distributive, recognition, and procedural energy justice principles

2.2.2 The influence of energy transition on energy security

Six-member countries of the Association of Southeast Asian Nations (ASEAN) potentially rely on renewable energy sources to strengthen their energy security. According to Vidinopoulus *et al.* [48], stated that ASEAN countries heavily depend on fossil fuels, even though the region possesses ample undeveloped renewable resources. The present study elucidates a methodology for enhancing renewable energy consumption within the ASEAN region. The study results indicate a degree of certainty regarding the feasibility of implementing a decarbonization strategy for the ASEAN region's energy system. However, the existing policies and efforts need to be revised to attain any significant level of decarbonization by the year 2050. Moreover, the study by Mohsin *et al.* [49] examines the impact of economic growth, renewable energy, and nonrenewable energy consumption on greenhouse gas (GHG) emissions. The results indicate a statistically significant positive relationship between economic growth and energy consumption. Furthermore, an increase in the utilization of renewable energy is associated with a decrease in carbon emissions. A favorable link is seen between economic growth and the utilization of renewable energy sources, which holds in both the short and long term, suggesting a valid feedback hypothesis. The results suggest that nonrenewable energy resources play a substantial role in generating greenhouse gas emissions. In contrast, renewable resources have a beneficial effect on mitigating the emissions of greenhouse gas. Furthermore, the study highlights the potential of Asian economies to promote environmental conservation by implementing comprehensive regional environmental policies and utilizing renewable energy sources. Poudel *et al.* [50] noted a recent increase in the renewable energy-based mini-grids. Renewable energy sources are critical in enhancing electricity accessibility in developing nations, particularly in geographically isolated areas. Pandey and Asif [51] analyzed South

Asia's energy and environmental challenges to enhance socioeconomic conditions and achieve the Sustainable Development Goals (SDGs). The report suggests that South Asian countries should capitalize on their substantial potential for renewable energy and integrate their energy sectors with the ongoing sustainable energy revolution. Shang *et al.* [52] studied in ASEAN countries the relationship between the consumption of renewable energy, health expenditures, and load capacity factors. Their study, in ASEAN countries, assesses the renewable energy consumption and health expenses impacting the enhancement of the load capacity factor between 1980 and 2018. The findings from the long-term analysis demonstrate that renewable energy consumption and investments in healthcare have a noteworthy impact on enhancing load capacity factors in ASEAN nations. Conversely, the economic expansion on load capacity factors influence is found to be detrimental. The findings suggest that devoting a significant portion of its budget towards renewable energy and the health sector would benefit the government in enhancing the load capacity factor. In summary, the energy transition facilitates economic growth and the establishment of sustainable energy systems within nations. Economic growth and sustainable energy are achieved through exploring and adopting alternative sources of clean energy, which serve as the foundation for ensuring energy security. For the reasons above, hypotheses are formulated;

H4: Energy transition impacts energy security

3. METHODOLOGY

3.1 Method

This study applies a quantitative methodology known as Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze secondary data collected from six ASEAN countries, covering the period from 2000 to 2020. It examines the influence of the energy transition on energy security. Two distinct phases were carried out for the data analysis: the measurement model analysis and the structural model analysis. These phases seek to predict the correlation between latent constructs of energy citizenship, energy democracy, energy transition, and energy security.

3.2 Theoretical Model

This study investigates the interconnections among energy citizenship, energy democracy, energy transition, and energy security using a theoretical model. The model includes four hypotheses labeled H1 to H4, as depicted in Figure 1.

3.3 Operationalizing of Constructs

This study consists of four constructs: energy citizenship, energy democracy, energy transition, and energy security, with three constructs playing roles as exogenous and one construct as endogenous. Each construct refers to the prior study. Energy citizenship and energy democracy are defined as the actors, such as individuals, communities, and governments, actively involved in the energy system to produce and consume renewable energy against fossil fuels [35]. According to Wahlund and Pamp [35], Szulecki [41], Sweeney [26], and Allen *et al.* [41], energy democracy and citizenship are the social factors that support the energy transition. Energy transition is the transition from high-carbon energy to renewable energy, considering the impact on climate, energy, and the environment [45]. The energy transition posits the justice of access to energy services for all people [16], [18], [45], [53]. The last construct, energy security, is the capacity of the nation to provide energy supply and demand and is evaluated based on the five dimensions of availability, affordability, technological advancements, environmental sustainability, and regulation 24]. The constructs definition is depicted in Table 1.

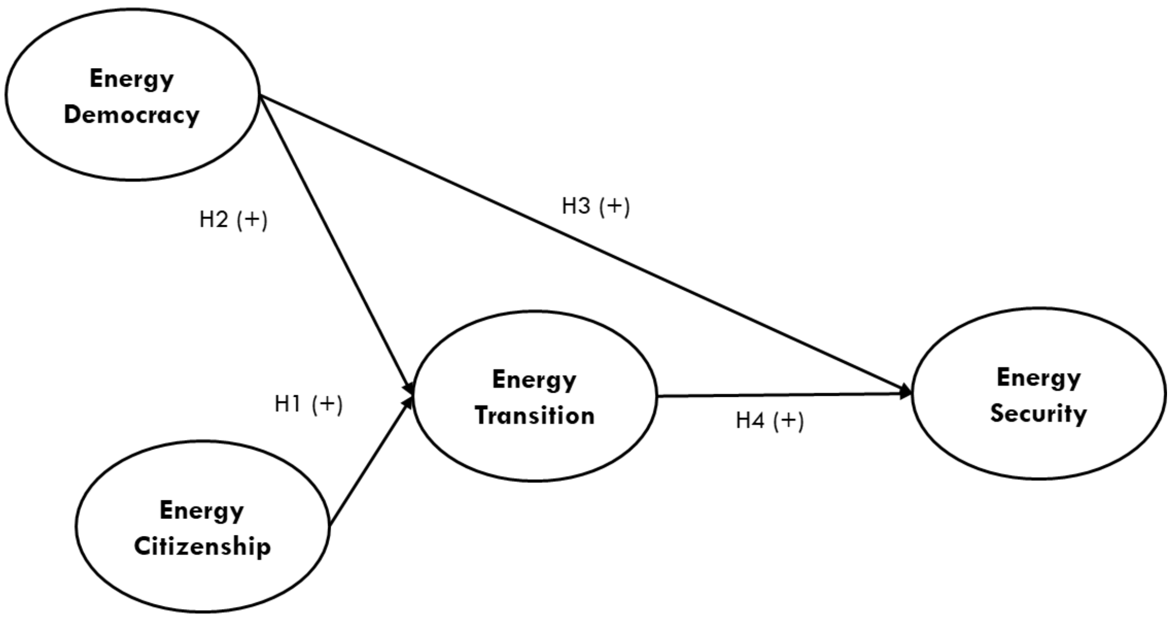

Fig. 1. Energy transition theoretical model of six ASEAN countries.

Table 1. Definition of constructs and references.

Variables	Definition	References
Energy Citizenship	The active involvement of individuals plays a critical role in facilitating the shift towards using renewable energy sources. Institutional support also plays a vital role in enabling individuals who produce and consume renewable energy to tackle the problem of energy poverty effectively.	[35]
Energy Democracy	Increasing renewable energy sources is a central tenet of energy democracy. The purpose of energy democracy is to achieve a more sustainable and equitable future by providing individuals and communities with increased control over production and use.	[26], [41]
Energy Transition	Implementing energy justice to the energy transition encompasses three key components: distributive justice, recognition justice, and procedural justice. The transition toward renewable energy aligns with these concerns, focusing on fairness and equity in energy services.	[16], [18], [45], [53]
Energy Security	The ability of a country to meet its energy supply and demand requirements is assessed through an analysis of five key dimensions: availability, affordability, technological breakthroughs, environmental sustainability, and regulation.	[24]

3.4 Data and Analysis

The data utilized in this analysis are obtained from international organizations, including the World Bank, ourworldindata, International Energy Agency (IEA), and Asian Development Bank (ADB). The current study employs the software tool SmartPLS 4.0 to perform a Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis. The objective is to investigate the main structures of interest and identify the critical driving constructs in an exploratory fashion [54], [55]. The PLS method and bootstrapping modes are utilized for 5,000 iterations of sampling to determine the route coefficients and their statistical significance [54]. Table 2 presents a visual representation of the latent structures, dimensions, indicators, data sources, and references within the framework of relationships and illustrated by 68 indicators.

Table 2. Constructs, dimensions, indicators, data sources, and references.

Construct	Dimension	Component	Indicator	Unit	Code	Data Sources	References
Energy Citizenship	Prosumers	Percapita RE Generation	Per Capita Electricity Generation from Hydro (kWh)	kWh	ECR1	ourworldindata	[35], [36]
		Percapita RE Generation	Per Capita Electricity Generation from Solar (kWh)	kWh	ECR2	ourworldindata	
		Percapita RE Generation	Per Capita Electricity Generation from Wind (kWh)	kWh	ECR3	ourworldindata	
		Percapita RE Generation	Per Capita Energy Consumption from Hydro (KWh)	kWh	ECR4	ourworldindata	
		Percapita RE Generation	Per Capita Energy Consumption by Other renewables (kWh - equivalent)	kWh	ECR5	ourworldindata	
		Percapita RE Generation	Per Capita Energy Consumption from Renewable (MWh)	MWh	ECR6	ourworldindata	
		Percapita RE Generation	Percapita Energy Consumption from Solar (KWH)	kWh	ECR7	ourworldindata	
		Percapita RE Generation	Per Capita Energy Consumption from Wind (KWh)	kWh	ECR8	ourworldindata	

Table 2. Constructs, dimensions, indicators, data sources, and references.

Construct	Dimension	Component	Indicator	Unit	Code	Data Sources	References
	Conscious Energy Use and Behavior Change	Percapita Energy Use	Per Capita Energy Use (TWh per Person): Energy use not only includes electricity, but also other areas of consumption including transport, heating, and cooking	TWh/ Person	ECR9	ourworldindata	
	Individual Action-Oriented Participant - Energy Poor Subsidized by Government	Government Ex. Health	Government Expenses Health (% of GDP)	%	ECR10	ADB	
		Government Social Protection	Government Expenses Social Protection (% of GDP)	%	ECR11	ADB	
	Increasing Energy Education Literacy	Education	Government expenditure on education, total (% of GDP)	% of GDP	ECR12	ourworldindata	
		Education	Individuals using the Internet (% of the population)	%	ECR13	ourworldindata	
	Access to Smart Devices and Small-Scale Technology	Access to R&D	Scientific and technical journal articles	Numbers	ECR14	ourworldindata	
	Self-Governance-Civil Society Participatory	Civil Participatory	Civil Society Participation Index (0-1)	Index	ECR15	ourworldindata	
		Civil Liberties	Civil Liberties (Scores)	Scores	ECR16	ourworldindata	
Energy Democracy	Resisting	Production	Renewables TES (TWh)	TWh	EDR1	IEA	[26], [38], [41], [56], [57]
		Production	Biofuel and Waste TES (TWh)	TWh	EDR2	IEA	
		Production	Hydro TES (TWh)	TWh	EDR3	IEA	
		Production	Wind and Solar etc. TES (TWh)	TWh	EDR4	IEA	
		Production	Solar PV Electricity Generation (GWh)	GWh	EDR5	IEA	
		Production	Wind Electricity Generation (GWh)	GWh	EDR6	IEA	
		Production	Hydro Electricity Generation (GWh)	GWh	EDR7	IEA	
		Production	Geothermal Generation (GWh)	GWh	EDR8	IEA	
		Consumption	TFC Biofuel and Waste (TWh)	TWh	EDR9	IEA	
		Consumption	TFC Electricity (TWh)	TWh	EDR10	IEA	
		Consumption	TFC Wind Solar etc. (TWh)	TWh	EDR11	IEA	

Table 2. Constructs, dimensions, indicators, data sources, and references.

Construct	Dimension	Component	Indicator	Unit	Code	Data Sources	References
		Consumption	TFC Electricity Consumption (TWh)	TWh	EDR12	IEA	
	Reclaiming	Investment	International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems (millions of constant United States dollars)	$	EDR13	ourworldindata	
		Innovation	Innovation Index	Index	EDR14	Global Innovation Index	
	Restructuring	Participatory Democracy	Index of Participatory Democracy (0 to 1, 1 More Democratic) 0 to 1	Index	EDR15	ourworldindata	
Energy Transition	Distribution Justice	Energy Services Access	Number of people with access to electricity (million)	Million	ETR1	ourworldindata	[16], [18], [45], [53], [57]
		Energy Services Access	Access to electricity (% of population)	% of Population	ETR2	ourworldindata	
		Energy Services Access	Clean Fuels: Proportion of population with primary reliance on clean fuels and technologies for cooking (%) - Residence Area Type: Total	%	ETR3	ourworldindata	
	Recognition	Energy Services at Rural	Access to electricity, rural (% of rural population)	% of Rural Population	ETR4	ourworldindata	
		Energy Services at Urban	Access to electricity, urban (% of urban population)	% of Urban Population	ETR5	ourworldindata	
	Procedures	Regulation Quality	Regulation Quality (Percentile Rank)	Rank	ETR6	World Bank	
		Gov. Effective	Government Effective (Percentile Rank)	Rank	ETR7	World Bank	
		Rule of Law	Rule of Law (Percentile Rank)	Rank	ETR8	World Bank	
		Voice of Av. & Acc.	Voice of Availability & Accessibility (Percentile of Rank)	Rank	ETR9	World Bank	
		Women Representative	Proportion of seats held by women in national parliaments (%)	%	ETR10	ourworldindata	
Energy Security	Availability	Security Supply & Demand	Total Energy Supply/Capita	MWh	ESR1	IEA	[24], [58]
		Security Supply &	Total Final Consumption/Capita	MWh	ESR2	IEA	

Table 2. Constructs, dimensions, indicators, data sources, and references.

Construct	Dimension	Component	Indicator	Unit	Code	Data Sources	References
		Demand					
		Security Supply & Demand	Electricity Demand/Capita	MWh	ESR3	ourworldindata	
		Security Supply & Demand	Electricity Generation/Capita	MWh	ESR4	ourworldindata	
		Production	Fossil Fuel TES Oil Coal NG	TWh	ESR5	IEA	
		Production	Oil Total Energy Supply	TWh	ESR6	IEA	
		Production	Natural Gas Total Energy Supply	TWh	ESR7	IEA	
		Production	Coal Total Energy Supply	TWh	ESR8	IEA	
		Consumption	Total Final Consumption Oil	TWh	ESR9	IEA	
		Consumption	Total Final Consumption Natural Gas	TWh	ESR10	IEA	
		Consumption	Total Final Consumption Coal	TWh	ESR11	IEA	
		Dependency	Total Energy Supply (TES)/Total Energy Consumption TFC	%	ESR12	IEA	
		Dependency	Net Electricity Import	TWh	ESR13	IEA	
		Diversification	Renewable Total Energy Supply	%	ESR14	IEA	
		Diversification	Renewable Energy Share in Final Energy Consumption	%	ESR15	IEA	
		Diversification	Share of renewable energy in total primary energy supply (%, 2019)	%	ESR16	IEA	
	Affordability	Stability	Currency LCU	LCU	ESR17	World Bank	
		Access	Per Capita Electricity Generation from Fossil Fuel (kWh)	kWh	ESR18	ourworldindata	
		Equity	Energy Intensity: Primary energy consumption per GDP (kWh/$)	kWh/$	ESR19	ourworldindata	
		Affordability	Crude Price	$	ESR20	ourworldindata	
	Technology Innovation	Technology Innovation	Carbon Intensity of Electricity	gCO_2/ kWh	ESR21	ourworldindata	
			Research and Development Expenditure	% of GDP	ESR22	IEA	
	Environment and Sustainability	Environment and Sustainability	Forest Area	Billion Ha	ESR23	ourworldindata	
	Regulation	Corruption	Control of Corruption (Percentile Rank 1-100)	Rank	ESR24	World Bank	
		Political	Political of Stability (Percentile of Rank 1-	Rank	ESR25	World Bank	

Table 2. Constructs, dimensions, indicators, data sources, and references.

Construct	Dimension	Component	Indicator	Unit	Code	Data Sources	References
			100)				
		Trade	Trade Openness	% of GDP	ESR26	ourworldindata	
		Subsidies	Fossil-fuel subsidies (consumption and production) per capita (nominal United States dollars)	$	ESR27	ourworldindata	

4. RESULT

4.1 Descriptive Data Analysis

According to International Energy Agency (IEA) in 2022 data, the total energy supply of oil, coal, and natural gas (measured in terawatt-hours, TWh) showed substantial growth from 2,938 TWh in the year 2000 to 6,017 TWh in 2020. There was also a notable growth in the Total Energy Supply (TES) from renewable sources, rising from 1,281 TWh in 2000 to 1,345 TWh in 2020. The demand for fossil fuels has led to an unbalanced increase in CO_2 emissions, causing them to double from 682 $MtCO_2$ in 2000 to 1,468 $MtCO_2$ in 2020. The population of six ASEAN countries experienced a substantial increase, rising from 461 million in 2000 to 591 million people in 2020, representing a growth of 28%. The significant increase is in Gross National Income (GNI) from USD 783 billion in 2000 to USD 3.465 billion in 2020 associated with reliance on fossil fuels. Therefore, six ASEAN countries primarily relied on fossil fuels to fuel their economic expansion and ensure the stability of their energy requirements.

4.2 Structural Equation Model Analysis

Figure 2 illustrates the correlation between four latent components that are subjected to examination by PLS-SEM. The set of 68 indicators comprises 15 indicators of energy democracy, 16 indicators of energy citizenship, 10 indicators of energy transition, and 27 indicators of energy security. These indicators are utilized to forecast the potential effects of the energy transition on energy security. Furthermore, SmartPLS 4.0 analyzes the relationship among latent constructs by employing Algorithm and Bootstrapping techniques to assess the outer and inner models.

The result of the calculation of construct reliability and validity tests from Figure 2 is depicted in Table 3. Table 4 shows construct reliability and validity test result after doing the Fornell Larcker criterion and the cross-loading discriminant validity test result. Table 5 shows that the model fit result is far from the standard below 0.1.

The evaluation of the outer model encompasses several criteria. These include internal consistency reliability, which is assessed using the Cronbach Alpha coefficient (with a threshold of 0.6) [59], as well as composite reliability (with a threshold of 0.6) [54]. Additionally, for exploratory research, the criterion for outer loading is set at a minimum of 0.4 [54], [60], [61]. Convergent validity is evaluated using the Average Variance Extraction (AVE), with a threshold of 0.5 [54], [62]. The measurement of the association between Cronbach's Alpha and Composite Reliability [20], as well as the assessment of Discriminant Validity, can be conducted using Rho_A. To establish Discriminant Validity, it is necessary for a construct to have a square root value of Average Variance Extracted (AVE) that surpasses the correlations it shares with other constructs within the model. When analyzing latent constructs, it is essential to consider that the discrepancy between loadings should be at least 0.1, as suggested by Chin's research [63].

Using the PLS Algorithm, 68 indicators are investigated for reliability and validity tests. The 38 indicators do not come up with outer loading values below 0.4, and the remaining 30 indicators with outer loading>0.4. It is depicted in Figure 3.

Table 3. Construct reliability and validity test result.

Variables	Cronbach's Alpha	Composite Reliability (Rho_A)	Composite Reliability (Rho_C)	Average Variance Extracted (AVE)
Energy Citizenship	0.671	0.907	0.702	0.276
Energy Democracy	0.671	0.853	0.666	0.230
Energy Security	0.593	0.975	0.564	0.505
Energy Transition	0.744	0.943	0.843	0.530

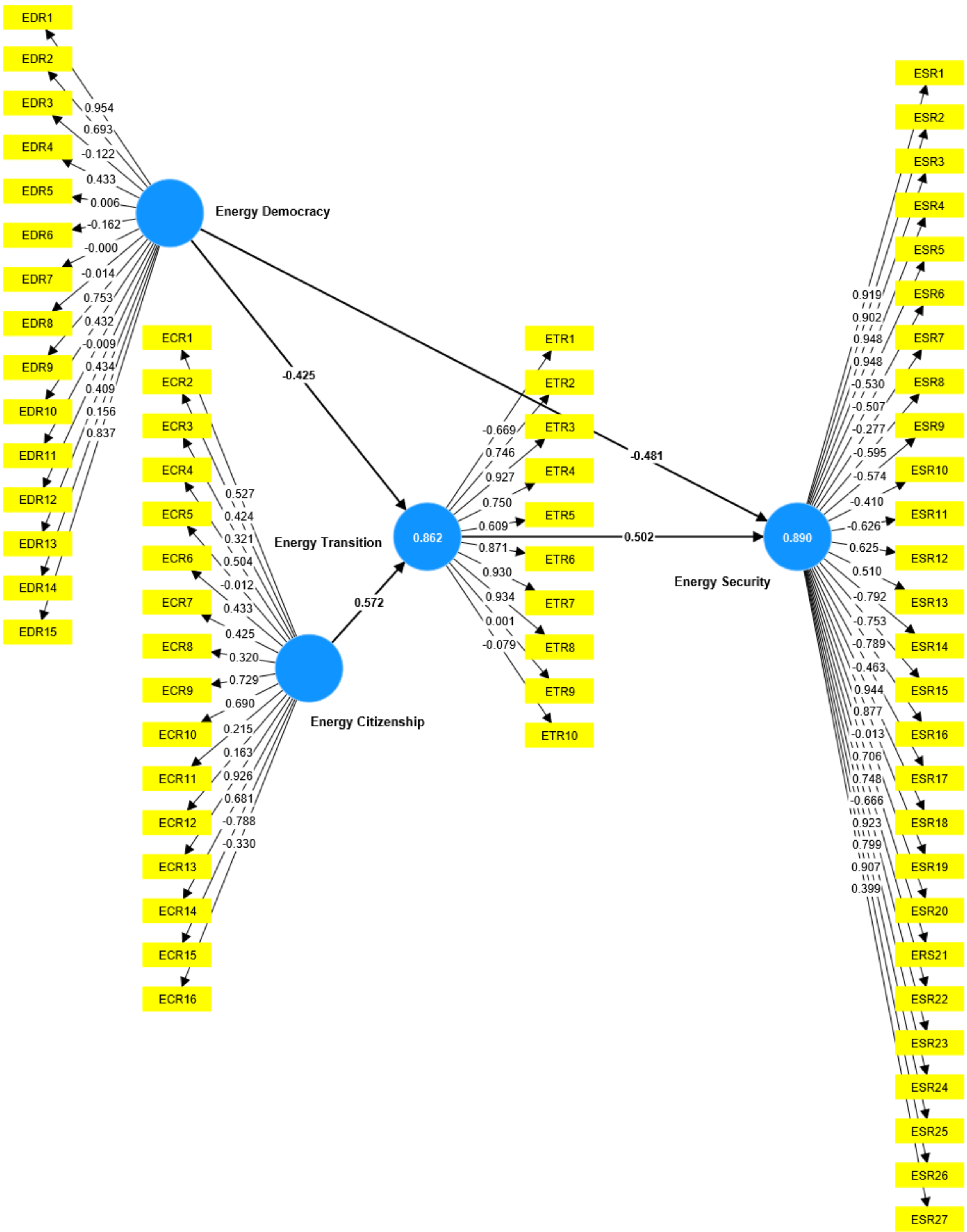

Fig. 2. Constructs, outer loading, and path analysis energy transition model of six ASEAN countries.

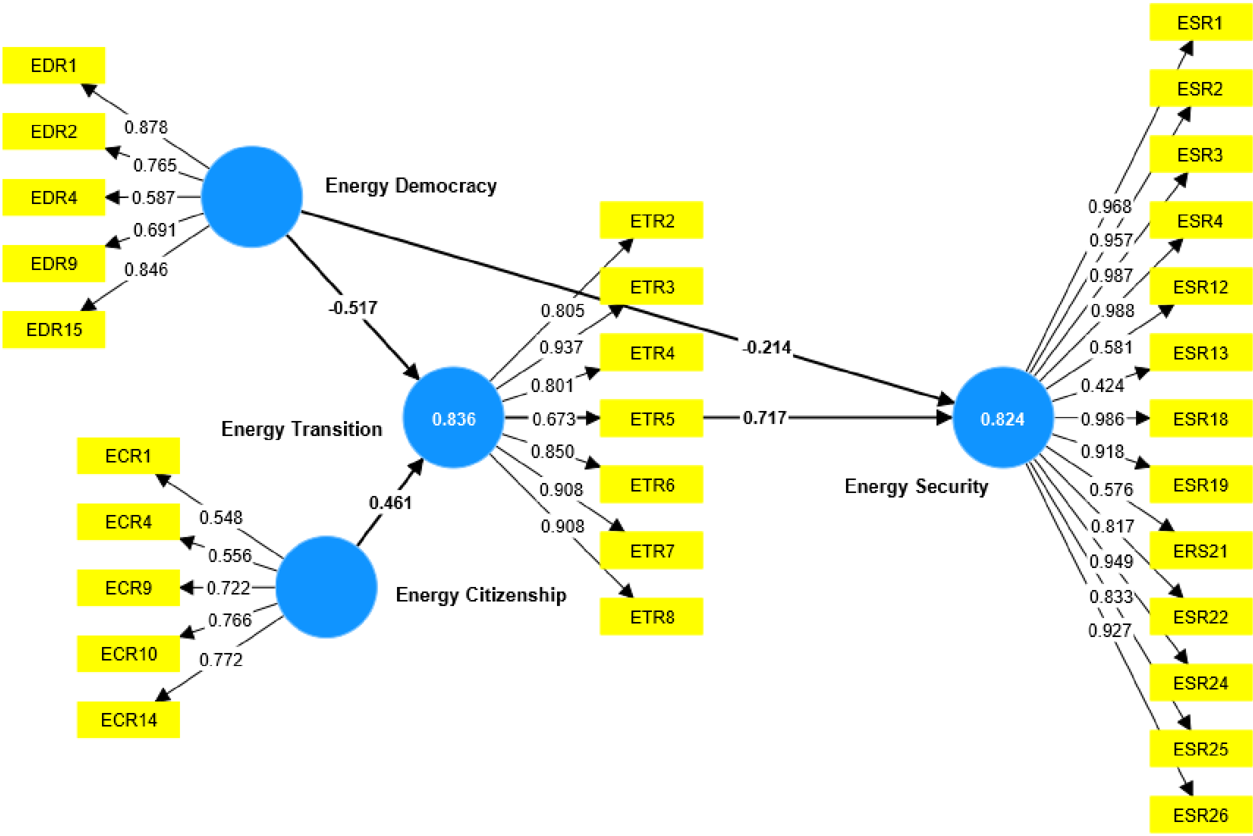

Fig. 3. Reliability and validity test result.

Moreover, the discriminant validity test was applied to the theoretical model to see the collinearity of the indicators and constructs done by the Fornell-Larcker criterion and cross-loading test. From 30 indicators are reduced to 22 indicators to fulfill the discriminant validity test, as shown in Figure 4. Construct reliability and validity test is shown in Table 4, which Cronbach Alpha > 0.6, Composite Reliability > 0.6, and Average Variance Extracted (AVE) > 0.5. Meanwhile, the model fit is introduced in Table 5, which shows that the SRMR estimated model of 0.150 is still over 0.1 but improving from the original design's SRMR estimated model of 0.223.

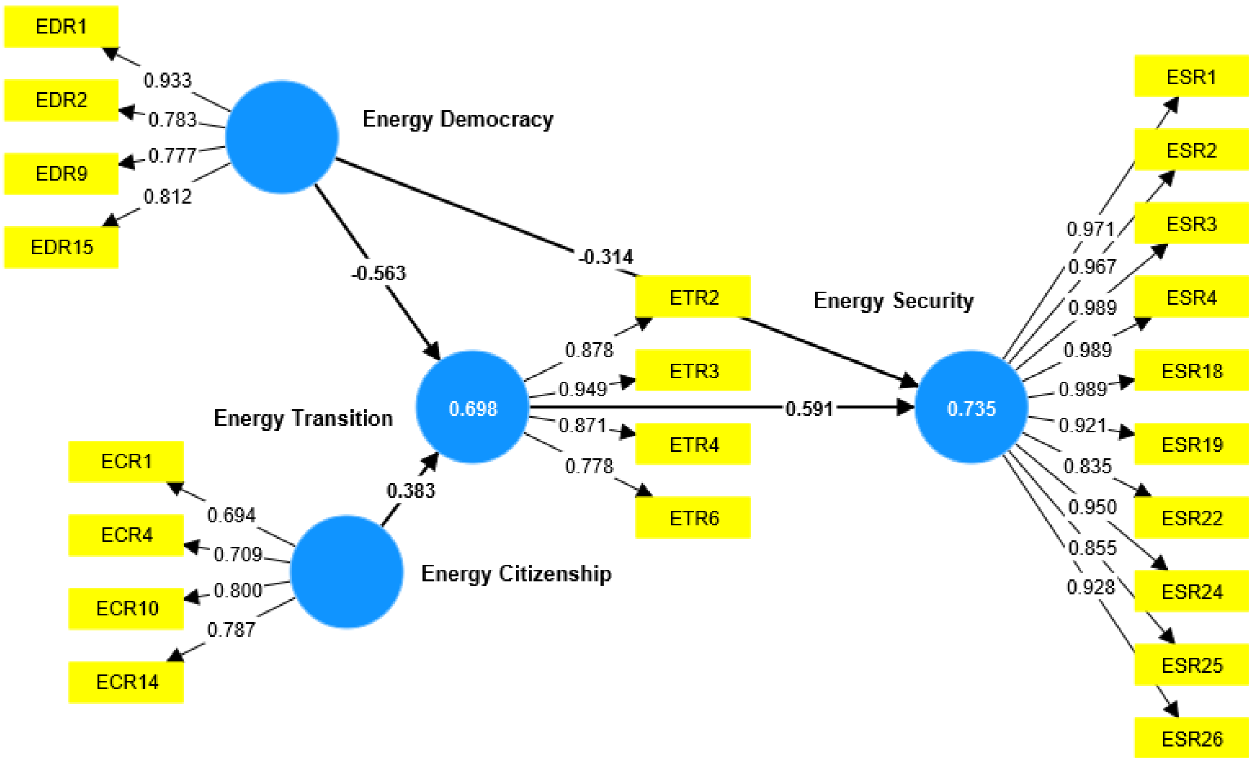

Fig. 4. Final result validity and reliability test of energy transition model of six ASEAN countries.

Table 4. Construct reliability and validity test result.

Variables	Cronbach's Alpha	Composite Reliability (Rho_A)	Composite Reliability (Rho_C)	Average Variance Extracted (AVE)
Energy Citizenship	0.773	0.799	0.836	0.561
Energy Democracy	0.854	0.878	0.897	0.686
Energy Security	0.985	0.989	0.987	0.885
Energy Transition	0.893	0.903	0.926	0.759

Table 5. Model fit result.

Variables	Saturated Model	Estimated Model
SRMR	0.147	0.150
NFI	0.463	0.463

Based on the reliability and validity test results, the evaluation continues to seek the significance between the constructs through bootstrapping for four hypotheses. A T statistic greater than 1.96 and a p-value less than 0.05 are considered significant between the constructs. For these reasons, the hypothesis resulted in Figure 5 and Table 6. The results show that energy citizenship significantly impacts energy transition with a positive result of 0.383 (38.3%). Energy democracy significantly impacts energy security with a negative result of 0.314 (31.4%). Energy democracy significantly impacts energy transition with a negative result of 0.563 (56.3%). Energy transition significantly impacts energy security with a positive result of 0.591 (59.1%).

In terms of R^2, it is evident that energy transition can be explained by both energy democracy and energy citizenship simultaneously, accounting for 0.698 (69.8%). The remaining portion is explained by other factors. Similarly, energy security can be explained by both energy transition and energy democracy concurrently, contributing to 0.735 (73.5%), with the remaining explained by other factors. Meanwhile, the direct, indirect, and total effects are depicted in Tables 7, 8, and 9.

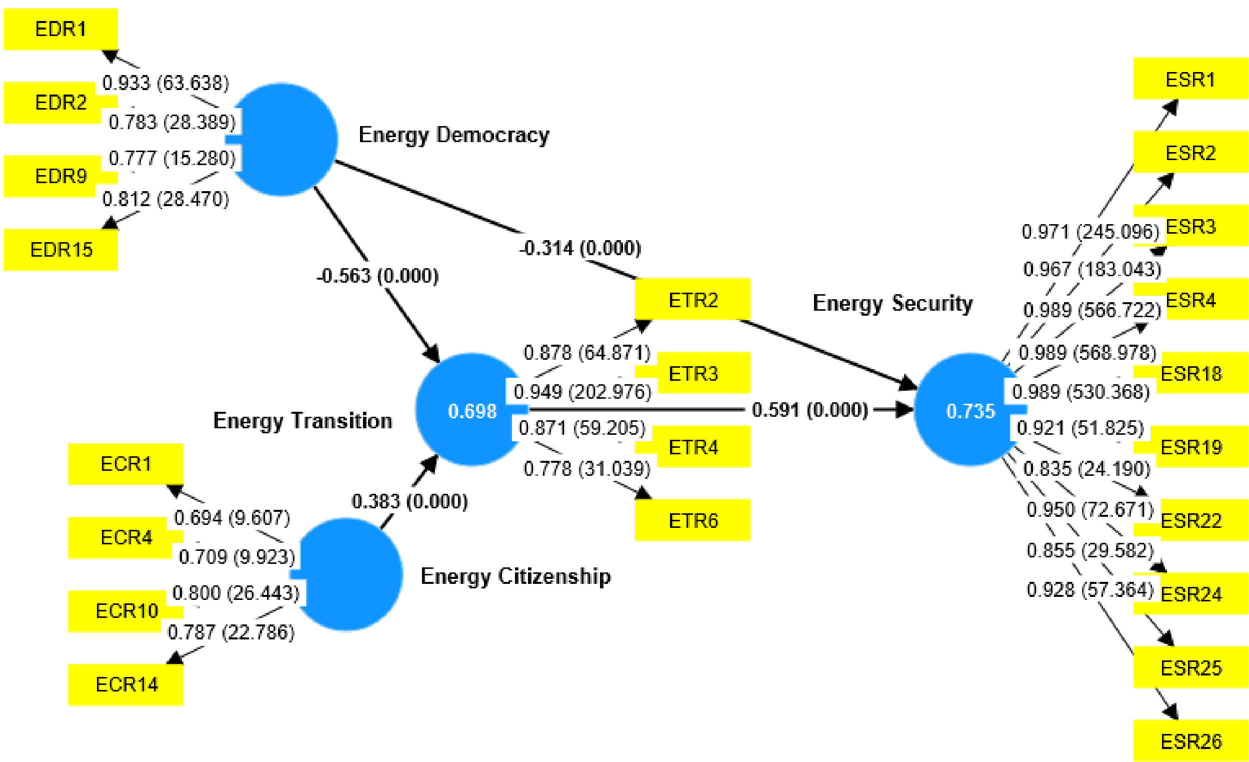

Fig. 5. Hypotheses result done by bootstrapping PLS-SEM.

Table 6. Hypotheses result.

Variables	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistic (O/STDEV)	ρ Value
Energy Citizenship->Energy Transition	0.383	0.388	0.050	7.589	0.000
Energy Democracy->Energy Security	-0.314	-0.317	0.050	6.290	0.000
Energy Democracy->Energy Transition	-0.563	-0.559	0.048	11.737	0.000
Energy Transition->Energy Security	0.591	0.590	0.040	14.710	0.000

Table 7. Direct effect between constructs.

Variables	Energy Citizenship	Energy Democracy	Energy Security	Energy Transition
Energy Citizenship				0.383
Energy Democracy			-0.314	-0.563
Energy Security				
Energy Transition			0.591	

Table 8. Indirect effects between constructs.

Variables	Energy Citizenship	Energy Democracy	Energy Security	Energy Transition
Energy Citizenship			0.226	
Energy Democracy			-0.333	
Energy Security				
Energy Transition				

Table 9. Total effect between constructs.

Variables	Energy Citizenship	Energy Democracy	Energy Security	Energy Transition
Energy Citizenship			0.226	0.383
Energy Democracy			-0.647	-0.563
Energy Security				
Energy Transition			0.591	

5. DISCUSSION

This study examines the impact of latent constructs of energy citizenship, energy democracy, and energy transition on energy security within the context of six ASEAN countries. The study's findings indicate that energy citizenship substantially influences the energy transition, significantly impacting energy security. However, energy democracy significantly impacts energy transition and security, providing both negative results. These six countries as the largest consumer of fossil fuel energy in ASEAN countries, accounting for 80% of their energy mix, has contributed approximately 4.45% of global CO_2 emissions—80% of fossil fuel energy in energy security to drive their industrial and economic development.

The crucial factors supporting the energy transition are energy democracy and energy citizenship [35]. Energy citizenship significantly impacts the energy transition with positive results. This study found empirical evidence that encouraging energy citizenship among individuals involved in the energy system by consuming renewable energy supports the energy transition by 38.3%. Per Capita Electricity Generation reflects energy citizenship from Hydro (ECR1), Per Capita Energy Consumption from Hydro (ECR4), Government Expenses for Health (% of GDP) (ECR10), and Scientific and Technical Journal Articles (ECR14) are indicators of energy citizenship. It is noted that hydro energy is the potential dominant technology in six ASEAN countries [36]. Government expenses for health are revealed as subsidized by the government's potential to heal society, and scientific and technical journal articles as media education access to understanding renewable energy technology, supporting the energy transition [36]. Meanwhile, energy democracy significantly impacts energy transition. Renewable Total Energy Supply (EDR1), Biofuel and Waste Total Energy Supply (EDR2), Total Final Consumption of Biofuel and Waste (EDR9), and Index Participatory Democracy (EDR15) reflect energy democracy. Renewable energy, Biofuel, and Waste energy, and the Index of Participatory Democracy measured energy democracy. Communities and governments are actively involved in supporting renewable energy in energy democracy. In the paradox, energy transition has the opposite side due to 80% fossil fuel energy filling the energy services-electricity access on energy transition. For these reasons, energy democracy is still the opposite of energy security, which pertains to 80% of fossil fuel energy. Energy security with fossil fuel basis has the opposite direction from renewable energy as against to decrease domination fossil fuel energy [35], [41], [26]. According to Indra *et al.* [22], six ASEAN countries heavily rely on fossil fuel energy, put incentives on fossil fuel energy, and make massive investments in coal for power generation. Furthermore, renewable energy share is lower than fossil fuel, as described in the relation between energy democracy and security indicators.

Energy transition significantly impacts energy security. Access to Electricity (ETR2), Access to Clean Fuel (ETR3), Access to Electricity Rural (ETR4), and Regulation Quality (ETR6) reflect energy transition. Then, Total Energy Supply/Capita (ESR1), Total Final Consumption/Capita (ESR2), Electricity Demand/Capita (ESR3), Electricity Generation/Capita (ESR4), Per Capita Electricity Generation from Fossil Fuel (ESR18), Energy Intensity: Primary energy consumption per GDP (ESR19), Research and Development Expenditure (ESR22), Control of Corruption (ESR24), Political of Stability (ESR25), and Trade Openness (ESR26) reflect energy security. Thus, the energy transition and energy security have a positive association. It is explained by energy services-electricity dominated by 80% of fossil fuel energy to secure their energy security from 2000 to 2020 supported by good governance such as control of corruption, political stability, and trade openness. Furthermore, energy transition with a basis dominated by fossil fuels energy services-electricity supports energy security with heavy reliance on fossil fuel.

In terms of total direct effect, it revealed that encouraging energy citizenship potential reduces CO_2 emission of six ASEAN countries by 38.3% from 1,468 $MtCO_2$ to 906 $MtCO_2$ in energy transition, which is dominated by fossil fuel energy services-electricity. Fostering energy democracy potential to replace fossil fuel energy services-electricity 56.3% in the energy transition and potentially reduces CO_2 emissions from 1,468 $MtCO_2$ to 518 $MtCO_2$ on energy security. Energy democracy significantly impacts energy security with a negative result of 64.7%. Encouraging energy democracy potential decreases the domination of 80% fossil fuel energy security from six ASEAN countries from 1,468 $MtCO_2$ to 518 $MtCO_2$. In addition, energy transition significantly impacts energy security by 59.1%, increasing energy services-electricity in the energy transition is followed by an increase of 59.1% in energy security with a basis of fossil fuel energy even the opposite. In sum, the total effect of energy citizenship on energy transition, energy transition to energy security, is a positive direction. However, the total effect of energy democracy on energy transition and energy security is negative results against the decreasing domination of fossil fuels.

5. CONCLUSION

This study examines the influence of energy transition on energy security through four latent constructs of energy citizenship, energy democracy, energy transition, and energy security. The aim is to identify the key factors that should be prioritized to implement an energy transition that effectively affects energy security. Energy democracy and citizenship are recommended to be prioritized in successful energy transition implementation. Promoting energy democracy and reducing reliance on fossil fuels are significant drivers for facilitating the transition from high-carbon energy to renewable energy, mainly hydro and biofuel. Renewable energy is capable of replacing conventional energy systems and ensuring the provision of electricity services to all individuals, thus contributing to energy security in the six ASEAN countries. Energy democracy and citizenship are crucial elements to support six ASEAN countries' energy transition and security for a sustainable future through renewable energy in response to CO_2 emissions, global warming, catastrophic disasters, economic damage, and climate change.

The energy transition theoretical model is evaluated, resulting in the model fit of 0.223 and improved to 0.150 by conducting measurement model and structural model analysis. On this side, the theoretical model provided an enhanced understanding of the relationship between the four constructs and projected the energy transition effect on energy security.

The study found determinants of four constructs for predicting the impact of energy citizenship, energy democracy on the energy transition, and energy security, resulting in potential CO_2 emissions reductions as an ongoing concern of the six ASEAN countries that rely on 80% fossil fuels.

It is recommended to undertake further study encompassing other constructs, incorporating a wider variety of data from 2000 to 2020, and applying the model to a different geographical context.

NOMENCLATURE

Abbreviations

GHG	Greenhouse gas
$MtCO_2$	Million metric tons of carbon dioxide
$GtCO_2$	Giga metric tons of carbon dioxide
kWh	kilowatt hour
TWh	Terawatt hour
GWh	Gigawatt hour
MWh	Megawatt hour

TES	Total energy supply
TFC	Total final consumption
GDP	Gross domestic product
GNI	Gross national income
AVE	Average variance extracted
STDEV	Standard deviation
SRMR	Standardized root mean squared
NFI	Normed fit index
USD	United States dollar
IEA	International Energy Agency

REFERENCES

[1] Anser M.K., Usman M., Godil D.I., Shabbir M.S., Sharif A., Tabash M.I., and Lopez L.B., 2021. Does globalization affect the green economy and environment? the relationship between energy consumption, carbon dioxide emissions, and economic growth. *Environmental Science and Pollution Research* 28(37): 51105–51118.

[2] World Meteorological Organization, 2021. *WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019).* Geneva 2, Switzerland: World Meteorological Organization.

[3] Nejat P., Jomehzadeh F., Taheri M.M., Gohari M., and Muhd M.Z., 2015. A global review of energy consumption, CO_2 emissions and policy in the residential sector (with an overview of the top ten CO2 emitting countries). *Renewable and Sustainable Energy Reviews* 43: 843–862.

[4] Taghizadeh-Hesary, F., Rasoulinezhad, E., Shahbaz, M., and Vinh Vo, X., 2021. How energy transition and power consumption are related in Asian economies with different income levels?. *Energy* 237: 121595.

[5] Steffen W., Richardson K., Rockström J., Cornell S., Fetzer I., Bennett E., Biggs R., Carpenter S., de Vries W., de Wit C.D., Folke C., Gerten D., Heinke J., Mace G., Persson L., Ramanathan V., Reyers B., and Sörlin S., 2015. Planetary boundaries: guiding human development on a changing planet. *Science* 347(6223): 1259855.

[6] López-Claros A., Dahl A.L., and Groff M., 2020. *Global Governance and the Emergence of Global Institution for the 21st Century.* Cambridge University Press.

[7] Haini H., 2021. Examining the impact of ICT, human capital and carbon emissions: evidence from the ASEAN economies. *International Economics* 166(10): 116–125.

[8] Mercedes M. and V. Cantarero. 2020. Of renewable energy, energy democracy, and sustainable development : a roadmap to accelerate the energy transition in developing countries. *Energy Research and Social Science* 70(7): 101716.

[9] International Energy Agency (IEA), 2023. *CO2 Emissions in 2022.* Retrieved February 2, 2024 from the World Wide Web: https://iea.blob.core.windows.net/assets/3c8fa115-35c4-4474-b237-1b00424c8844/CO2Emissionsin2022.pdf.

[10] Eckstein D. and S. Kreft. 2020. *Global Climate Risk Index 2020. Who Suffers Most from Extreme Weather Events?* Retrieved February 2, 2024 from the World Wide Web: https://www.germanwatch.org/sites/default/files/20-2-01e Global Climate Risk Index 2020_14.pdf.

[11] Lau H.C., 2022. Decarbonization roadmaps for ASEAN and their implications. *Energy Reports* 8: 6000–6022.

[12] Board J., 2021. *Millions More in Southeast Asia Face Sea Level Rise Risks than Previously Thought: Satellite Imagery Study. Channel News Asia.* Retrieved February 2, 2024 from the World Wide Web: https://www.channelnewsasia.com/sustainability/sea-level-rise-southeast-asia-satellite-imagery-climate-change-1989406.

[13] Staff F., 2022. *Explained: Why Indonesia Is Moving Its Capital from Jakarta to Nusantara. Firstpost.* Retrieved February 2, 2024 from the World Wide Web: https://www.firstpost.com/world/explained-why-indonesia-is-moving-its-capital-from-jakarta-to-nusantara-10299131.html.

[14] Martin N., 2013. *Under Water. Deutch Welle (DW).* Retrieved February 2, 2024 from the World Wide Web: https://www.dw.com/en/thailand-needs-to-act-as-bangkok-sinks-faster/a-16739739.

[15] Sovacool B.K., Ryan S.E., Stern P.C., Janda K., Rochlin G., Spreng D., Pasqualetti M.J., Wilhite H., and Lutzenhiser L., 2015. Integrating social science in energy research. *Energy Research and Social Science* 6: 95–99.

[16] García-García P., Carpintero Ó., and Buendía L., 2020. Just energy transitions to low carbon economies: a review of the concept and its effects on labour and income. *Energy Research and Social Science* 70(1): 101664.

[17] Carley S., Engle C., and Konisky D.M., 2021. An analysis of energy justice programs across the united states. *Energy Policy* 152(8): 112219.

[18] Heffron R.J., 2022. Applying energy justice into the energy transition. *Renewable and Sustainable Energy Reviews* 156(11): 111936.

[19] Heffron R.J. and D. McCauley. 2017. The concept of energy justice across the disciplines. *Energy Policy* 105(3): 658–667.

[20] International Energy Agency, 2022. *Southeast Asia Energy Outlook 2022.* Retrieved February 2, 2024 from the World Wide Web: https://iea.blob.core.windows.net/assets/e5d9b7ff-559b-4dc3-8faa-42381f80ce2e/SoutheastAsiaEnergyOutlook2022.pdf.

[21] Taghizadeh-Hesary F. and E. Rasoulinezhad. 2020. Analyzing energy transition patterns in Asia: evidence from countries with different income levels. *Frontiers in Energy Research* 8(7): 1–13.

[22] Overland I., Sagbakken H.F., Chan H.Y., Merdekawati M., Suryadi B., Utama N.A., and Vakulchuk R., 2021. The ASEAN climate and

energy paradox. *Energy and Climate Change* 2: 100019.

[23] Heffron R.J. and D. McCauley. 2018. What is the “just transition”? *Geoforum* 88(8): 74–77.

[24] Sovacool B.K. and I. Mukherjee. 2011. Conceptualizing and measuring energy security: a synthesized approach. *Energy* 36(8): 5343–5355.

[25] Bin S., Chang Y., Khan F., and Taghizadeh-hesary F., 2022. Energy security and sustainable energy policy in Bangladesh: from the lens of 4As framework. *Energy Policy* 161(11): 112719.

[26] Sweeney S., 2014. *Working toward Energy Democracy. State of the World 2014.* Washington, Covelo, London: The Worldwatch Institute.

[27] Araújo K., 2014. The emerging field of energy transitions: progress, challenges, and opportunities. *Energy Research and Social Science* 1: 112–121.

[28] Aleluia J., Tharakan P., Chikkatur A.P., Shrimali G., and Chen X., 2022. Accelerating a clean energy transition in Southeast Asia: role of governments and public policy. *Renewable and Sustainable Energy Reviews* 159 (January): 112226.

[29] Heffron R.J., 2021. *Inclusive Energy Transition. Commonwealth Sustainable Energy Transition Series 2021/01.* London: Commonwealth Secretariat.

[30] Su X. and J. Tan. 2023. Regional energy transition path and the role of government support and resource endowment in China. *Renewable and Sustainable Energy Reviews* 174(1): 113150.

[31] Hepburn C., Qi Y., Stern N., Ward B., Xie C., and Zenghelis D., 2021. Towards carbon neutrality and China’s 14th five-year plan: clean energy transition, sustainable urban development, and investment priorities. *Environmental Science and Ecotechnology* 8: 100130.

[32] Talan A., Rao A., Sharma G.D., Apostu S., and Abbas S., 2023. Transition towards clean energy consumption in G7 : can financial sector, ICT and democracy help ?. *Resources Policy* 82(3): 103447.

[33] Smil V., 2010. *Energy Transitions: History, Requirements, Prospects.* California, Colorado, and England: Greenwood.

[34] Wang X. and K. Lou. 2021. Just transition: a conceptual review. *Energy Research and Social Science* 82(3): 102291.

[35] Wahlund M. and J. Palm. 2022. The role of energy democracy and energy citizenship for participatory energy transitions: a comprehensive review. *Energy Research and Social Science* 87(1): 102482.

[36] DellaValle N. and V. Czako. 2022. Empowering energy citizenship among the energy poor. *Energy Research and Social Science* 89(5): 102654.

[37] van Wees M., Revilla B.P., Fitzgerald H., Ahlers D., Romero N., Alpagut B., Kort J., Tjahja C., Kaiser G., Blessing V., Patricio L., and Smit S., 2021. Energy citizenship in new energy concepts. *Environmental Sciences Proceedings*. Rome, 29 September-1 October 2021: MDPI.

[38] Allen E., Lyons H., and Stephens J.C., 2019. Women’s leadership in renewable transformation, energy justice and energy democracy: redistributing power. *Energy Research and Social Science* 57(7): 101233.

[39] Delina L.L., 2018. Energy democracy in a continuum: remaking public engagement on energy transitions in Thailand. *Energy Research and Social Science* 42(3): 53–60.

[40] Stephens J.C., Burke M.J., Gibian B., Jordi E., and Watts R., 2018. Operationalizing energy democracy: challenges and opportunities in vermont’s renewable energy transformation. *Frontiers in Communication* 3(10): 1–12.

[41] Szulecki K., 2018. Conceptualizing energy democracy. *Environmental Politics* 27(1): 21–41.

[42] Guruswamy L., 2010. Energy justice and sustainable development. *Journal International Environment Law and Policy* 21: 231.

[43] McCauley D., Heffron R., Stephan H.R., and Jenkins K.E.H., 2013. Advancing energy justice: the triumvirate of tenets. *International Energy Law Review* 32(3): 107–110.

[44] Jenkins K., Mccauley D., Heffron R., and Stephan H., 2014. Energy justice, a whole systems approach. *Queen’s Political Review* 2(2): 74–87.

[45] McCauley D. and R. Heffron. 2018. Just transition: integrating climate, energy and environmental justice. *Energy Policy* 119: 1–7.

[46] Heffron R.J. and D. Mccauley. 2022. The “just transition” threat to our energy and climate 2030 targets. *Energy Policy* 165(3): 112949.

[47] He R.J., Mccauley D., and De Rubens G.Z., 2018. Balancing the energy trilemma through the energy justice metric. *Applied Energy* 229(8): 1191–1201.

[48] Vidinopoulos A., Whale J., and Hutfilter U.F., 2020. Assessing the technical potential of ASEAN countries to achieve 100% renewable energy supply. *Sustainable Energy Technologies and Assessments* 42(4): 100878.

[49] Mohsin M., Kamran H.W., Atif Nawaz M., Sajjad Hussain M., and Dahri A.S., 2021. Assessing the impact of transition from nonrenewable to renewable energy consumption on economic growth-environmental nexus from developing Asian economies. *Journal of Environmental Management* 284(1): 111999.

[50] Poudel B., Parton K., and Morrison M., 2022. The drivers of the sustainable performance of renewable energy-based mini-grids. *Renewable Energy* 189: 1206–1217.

[51] Pandey A. and M. Asif. 2022. Assessment of energy and environmental sustainability in South Asia in the perspective of the sustainable development goals. *Renewable and Sustainable Energy Reviews* 165(4): 112492.

[52] Shang Y., Razzaq A., Chupradit S., Binh An N., and Abdul-Samad Z., 2022. The role of renewable energy consumption and health expenditures in improving load capacity factor in asean countries: exploring new paradigm using advance panel models. *Renewable Energy* 191: 715–722.

[53] Williams S. and A. Doyon. 2019. Justice in energy transitions. *Environmental Innovation and Societal*

Transitions 31(11): 144–153.

[54] Hair Jr. J.F., Hult G.T.M., Ringle C.M., and Sarstedt M., 2021. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM).* Los Angeles: Sage publications.

[55] Hair J.F., Risher J.J., and Ringle C.M., 2019. When to use and how to report the results of PLS-SEM. *European Business Review* 31(1): 2–24.

[56] Burke M.J. and J.C. Stephens. 2017. Energy democracy: goals and policy instruments for sociotechnical transitions. *Energy Research and Social Science* 33(9): 35–48.

[57] Acheampong A.O., Evans E., and Opoku O., 2023. Energy justice, democracy and deforestation. *Journal of Environmental Management* 341(12): 118012.

[58] Sovacool B.K., 2013. An international assessment of energy security performance. *Ecological Economics* 88: 148–158.

[59] Cronbach L.J., 1971. *Test Validation.* 2nd ed. Washington D.C: American Council on Education.

[60] Hair J.F., Sarstedt M., Pieper T.M., and Ringle C.M., 1999. The use of partial least squares structural equation modeling in strategic management research: a review of past practices and recommendations for future applications. *Long Range Planning* 45(5–6): 320–340.

[61] Byrne B.M., 2021. Structural equation modeling with Amos, EQS, and Lisrel. *International Journal of Testing* 1(1): 55–86.

[62] Bagozzi R.P., Yi Y., and Phillips L.W., 1991. Assessing construct validity in organizational research. *Administrative Science Quarterly* 36(3): 421-458.

[63] Chin W.W., 1998. The partial least squares approach to structural equation modeling. *Modern Methods for Business Research* 295(2): 295–336.