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## Assessing Country's Reliance on Renewable Energy through Energy Profile and Political Economy Aspects: A Cross Countries Study from 1990 to 2012

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**ASSESSING COUNTRY'S RELIANCE ON RENEWABLE ENERGY  
THROUGH ENERGY PROFILE AND POLITICAL ECONOMY ASPECTS:  
A CROSS COUNTRIES STUDY FROM 1990 TO 2012**

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**Abstrak**

*Tulisan ini menguji hubungan antara ketergantungan negara terhadap energi terbarukan, profil energi, dan aspek ekonomi politik dengan menggunakan model data panel dinamis untuk sebuah panel global yang terdiri dari 43 negara. Komponen waktu dari dataset kami adalah inklusif 1990-2012. Untuk membuat pengamatan lebih spesifik, penelitian ini menyelidiki hubungan sejumlah sub-sampel yang dibangun berdasarkan wilayah dimana negara-negara tersebut berada. Dengan cara ini, penelitian ini berakhir dengan beberapa sampel daerah; yaitu Barat, Asia, Timur Tengah (ME), Afrika, Persemakmuran Negara-Negara Merdeka (CIS), dan Amerika Latin. Pada bagian empiris, penelitian ini melakukan analisis berbasis wilayah untuk menangkap variasi dan penjelasan logis di belakangnya. Hasilnya menunjukkan bahwa ketergantungan pada impor minyak, keterlibatan pada kesepakatan lingkungan internasional, pembangunan ekonomi, dan ketergantungan negara terhadap energi terbarukan merupakan sejumlah faktor yang signifikan secara statistik untuk mempengaruhi adopsi energi terbarukan di negara tersebut.*

**Kata Kunci**

*Keamanan energi, energi terbarukan, profil energi, politik energi, ekonomi politik*

**Abstract**

*This study examines the relationship between country's reliance on renewable energy, energy profile, and political economy aspects using dynamic panel data models for a global panel consisting of 43 countries. The time component of our dataset is 1990-2012 inclusive. To make the observation more specific, this study investigates the relationship of a number of sub-samples which are constructed based on the region where the countries belong. In this way, this study ends up with several region samples; namely Western, Asia, Middle East (ME), Africa, Commonwealth of Independent States (CIS), and Latin America. In the empirical part, this study performs a region-based analysis to capture any variations and logical explanation behind them. The results suggest that dependency on oil import, engagement on international environment agreement, economic development, and country size country's reliance on renewable energy are among the factors that are statistically significant to influence country's adoption of renewable energy.*

**Keywords**

*Energy security, renewable energy, energy profile, energy politics, political economy*

## **INTRODUCTION**

In the recent globalised world, competition has become a new normal where each country is gearing up to build massive industries and businesses to ensure its economic future survival. Apparent transformation from traditional rural towards a more modernised lifestyle across country aggregately increases energy consumption and demand for energy supplies. The World's Total Energy Consumption in 2014 shows that as expected, most developed countries require large amount of energy. This figure also provides interesting fact that some developing countries such as Brazil, China, India, Indonesia, and South Africa demonstrate similar gesture along with their emerging economy.

For so long, fossil energy sources (such as oil, coal, gas, and recently nuclear) have been the favourable sources to meet country's energy demand. Their popularity does not come out of the blue, it is due to their capacity to produce large amount of energy, easy access to the market, as well as the maturity of existing technologies using fossil sources have been very promising. Hand in hand with the extensive economic development across countries, the demand towards fossil energy sources escalates accordingly. This phenomenon places the fate of environment to be traded-off with country's economic expansion. Uncontrollable usage of fossil energy resources has led to the worsening of climate change and global warming due to its carbon emission, hazardous waste, and ecological degradation of its excavation activities.

The decline of fossil energy supply further complicates the issue, mounting concern among countries to seek reliable sources to accomplish their energy demands. For alleviating fossil energy's negative impacts without sacrificing the economic development plan as well as finding alternative energy sources, renewable energy (such as hydro, geothermal, wind, and solar energy) are introduced to serve the energy needs with less or no negative impact to the environment.

Notwithstanding the growing necessity of the use of renewable energy related to energy security and climate change issue in the last decades, the recent data from IEA in 2015 shows that renewable energy only covers 22% of global energy consumption.<sup>1</sup> This shows that the energy share is still dominated by non-renewable energy. Renewable energy's limitation of accommodating the modern energy demand (reliability concern) and complexities for building the plantation (affordability concern) are said to deprave its attractiveness compared to the conventional fossil energy. Nevertheless, most countries in the world still favour to use renewable energy and show significant progress on

renewable energy shares on its total energy usage despite the shortcomings it brings – indicating the country's preference is beyond cost and benefit consideration.

Embarking from that particular case, this study purposes to examine what factors which outline how much a country would rely on renewable energy. This study argues that political and economic factors within countries are essential in this issue; while at the same time consider energy profile as imperative to be taken into account. This study aims to contribute to the proliferation of renewable energy sources by identifying the factors that support and hinder country's transformation from conventional fossil energy to cleaner energy and what the policy implications should be put attention to.

## ***ANALYTICAL FRAMEWORK***

### **Overview of Related Literature**

Renewable energy is defined as the energy derived from the sources which supply is continuously available in the surroundings. In a broad sense, renewable energy comes from several sources, for example, water (hydro energy and ocean energy), wind (wind energy), sun heat (solar energy), crops (bioenergy), geothermal, etc. The existing literatures on renewable energy mainly discuss about two topics, which are the advantage and disadvantage of using renewable energy; and the determinants of rising demand towards renewable energy.

On the first topic, most studies emphasise the advantage of renewable energy for its low greenhouse gas emission. Lesser waste material, less contamination to water, and no risk of hazards and accidents are other features championing renewable energy when it is paralleled with nuclear power for electricity purpose (Sovacool, 2010). Besides its environmentally friendly character, renewable energy is also known for creating economic benefits in the sense of producing job opportunities and stimulating export, especially for the countries with abundant renewable resources for producing bioenergy like Brazil (ethanol) and Indonesia (biodiesel) (Ottinger & Miller, 2010).

Whereas renewable energy takes a lead in terms of providing cleaner and low-risk energy sources towards human life and environment, it is undeniable that its weaknesses somehow obstruct its expansion. Along with the difficulty of renewable energy technology to familiarise and its pricey costs (Dombi et al., 2014); other tangible inadequacy is uncertainty. Resources like solar and wind power cannot guarantee the energy supply due to natural discrepancy noting that sun does not always shine and wind does not always blow. These circumstances lower the desire of a country with consistent and high demand of energy to rely on this kind of energy sources (Curnow et. al., 2010).

In addition, the use of bioenergy contributes to deforestation owing to the development of agricultural lands for biofuel stock and palm trees for biodiesel production. Food commodities-based bioenergy also subsequently leads to increasing food prices, since it creates competition of demand over food commodities for energy production and food production purpose (Chakraborty, 2008).

On the second topic, previous studies highlight that political and economic factors play important role to trigger country's demand towards renewable energy. One political factor with significant influence is the role of the government. A study conducted in 48 states in US from 2001 to 2010 shows that government plays an essential part in drawing country's usage of renewable energy, particularly for electricity purpose, through giving federal assistance for its development (Park, 2015). A study of renewable energy policy in UEA as an oil exporting country shows similar argument. UEA government starts moving toward renewable energy for various reasons. Increasing internal energy demands due to economic expansion, declining on natural gas reserves, and low level of economic diversification which is heavily concentrated in oil sector and low improvement on other sectors create unsupportive environment to achieve sustainability strategy (Choucri et al., 2010).

Still related to political factor, regime and political party are likewise important. Democratic country *vis-à-vis* non-democratic country is considered to be more compassionate in climate change policies, thus having positive effects towards its willingness for using renewable energy (Battig & Bernauer, 2009). Contrary with prior study saying that political factor only weakly affects the renewable energy policies, political party is found to be crucial for the reason that strong ecological principal of a party along with the reality of decreasing supply of fossil fuel will generate concern towards the using of non-fossil energy (Apergis & Eleftheriou, 2015).

For the economic factor, GDP per capita and FDI are two influential factors for renewable energy consumption. In G7 countries, GDP per capita increase explains the dynamics of per capita renewable energy usage (Sadorsky, 2009a). In emerging economies, GDP per capita positively affects the shares of renewable energy in the total energy usage for the purpose of stimulating economic growth (Salim & Rafiq, 2012). The study on selected African countries conducted by Keho (2016) showed that significant use of renewable energy coincides with the demand for improving the living standards. Furthermore, FDI is positively associated with energy consumption, whereby sectoral

FDI propels different effect on the renewable energy consumption in countries with different types of income level (Omri & Kahouli, 2014). Amidst those variations, in general, FDI can be said to promote the reducing of non-renewable energy usage in all types of countries (Doytch & Narayan, 2016).

The literature review above shows that extensive studies have been conducted on renewable energy. However, most studies only consider a single variable or multiple variables under the same sphere that potentially correlate with renewable energy usage within a certain region (for example only economics, or only politics, not both economics and politics). This study does not perceive that employing single factor is not right, but rather not enough.

Different with the previous literatures which only consider single factor per se, this study argues that country's usage of renewable energy is accumulated from various domestic factors which are possibly interrelated. This study improves on the method by employing country-fixed effects to capture systematic differences in the preferences towards renewable energy usage across countries.

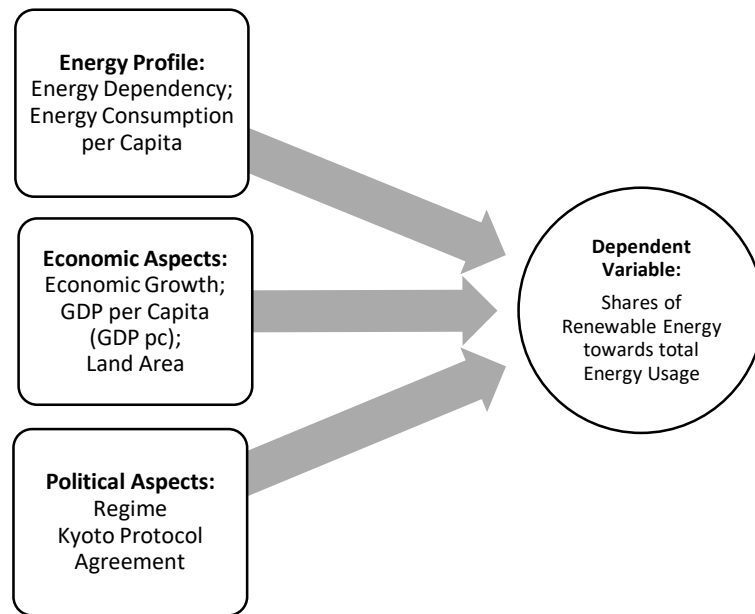
## **METHODOLOGY**

### **Regression Model**

This study utilises quantitative approach by employing cross-sectional time series regression model with country-fixed effects to analyse the issue. In this study, there are 43 cross-region countries in period of 1990 – 2012 being examined, with total of 989 observations gathered. The selection of 43 countries in this study is inspired by the countries listed on Global Energy Statistical Yearbook from Enerdata.<sup>2</sup> This study identifies three independent variables determining country's reliance on renewable energy, detailed in the following equation:

$$\text{Reliance on RE} = b_0 + b_1.\text{EnergyDependency} + b_2.\text{EnergyConsumptionperCapita} + b_3.\text{RegimeType} + b_4.\text{KyotoProtocol} + b_5.\text{EconomicGrowth} + b_6.\text{GDPpc} + b_6.\text{LandArea} + \epsilon$$

**Equation 1. Reliance on Renewable Energy.**



**Figure 1. Independent and Dependent Variables on Renewable Energy**

Firstly, this study considers energy dependency and energy consumption per capita to measure country's energy profile. Energy profile is included based on the assumption that it exemplifies country's strategy to satisfy domestic energy inquiries, whereby renewable energy will be one option. Energy dependency is measured by using net energy imports as a percentage of total energy use. The energy dependency data is gathered from Sustainable Energy for All Database, World Bank. A negative value of energy dependency indicates a country being observed is a net exporter, while the high and positive values suggest a country is a net importer. Furthermore, energy consumption denotes the value of energy use in kilogrammes of oil equivalent per capita, obtained from World Development Indicators, World Bank.

Secondly, this study puts attention towards political aspects. Political aspects variable measures country's regime to see whether regime is significant to renewable energy usage, as well as evaluate the existing claim that democratic country tends to be more sympathetic to employ greener energy rather than non-democratic ones. This study defines country's regime using Polity IV Database (ranging from -10 to +10, divided into three part of categorization, namely autocracy (-10 to -6), anocracy (-5 to 5), and democracy (5 to 10)). Moreover, this study senses that country's engagement in environment-related international agreement should also determine its energy policy.

Kyoto Protocol is chosen as the benchmark of this concern since it brings clear vision of alleviating global warming effects by reducing greenhouse gas emission. Whereas reducing industrial activities (as the biggest contributors of emission and detrimental waste) will not be a desirable choice, country is expected to consider moving towards renewable energy instead. In this study, Kyoto Protocol is designed as a dummy variable coded 1 for year ( $t + 1$ ) if a country has ratified, accepted, approved, or accessed Kyoto Protocol instruments; and coded 0 if otherwise.

Last but not least, economic aspects variable refers to economic growth, GDP per capita, and land area (sourced from World Development Indicators, World Bank) are also included in the equation. Economic growth is useful to capture the country's economic productivity-induced energy spike, while GDP per capita is incorporated derived from the concern that renewable energy is a "relatively expensive resource" thus postulates that only financially secure country will have the capacity to afford and operate such technologies. Additionally, land area is utilised to see whether the size of the country will inspire the use of renewable energy – considering that most renewable energy plantation require specific geographical characteristic, thus country with spacious territory has more possibility to meet that prerequisite.

For the dependent variable, this study measures reliance on renewable energy by perceiving the percentage of renewable energy shares towards total energy consumption of a country, sourced from Sustainable Energy for All Database, World Bank. This study assumes that higher the percentage of renewable energy within a country indicating that country puts stronger reliance on renewable energy. Higher percentage of renewable energy also signifies that particular country has moved from using conventional fossil energy and start developing greener energy.

### **Hypothesis**

Energy profile reflects a country's energy security. Nothing like energy exporting country which has no incentive to assure its energy security for its abundant energy reserve, this study assumes that a country with big energy consumption and high dependency on energy import will strive to ensure its energy reserve. Thus it has greater motivation to diversify its energy sources by developing renewable energy technology. This assumption drives this study to construct the first set of hypothesis:



*H1: Country's bigger energy consumption will be positively associated with reliance on renewable energy.*

*H2: Lower energy import dependency on will lead to less reliance on renewable energy.*

Based on the assumption that democratic government has more pressures to consider pro-environment interest groups concerns both domestically and internationally in making energy policy, hence this study assumes that:

*H3: The more democratised a country the bigger renewable energy shares will be.*

*H4: Country's engagement towards international environment agreement will be positively related to more reliance on renewable energy.*

Dovetailing with the factual assessment of renewable energy complexities and costs, this study considers that country's economic circumstances will simultaneously set off towards the same direction with renewable energy usage, or in other words:

*H5: The greater a country's level of economic development will drive to more reliance on renewable energy.*

*H6: The size of the country will have positive effect on country's reliance on renewable energy.*

*H7: Country's economic growth will be positively associated with reliance on renewable energy.*

## **DISCUSSION**

### **Energy Profile**

The factors related to countries' energy profile appear to explain countries' reliance on renewable energy. In global context, *energy dependence* effect is positive and statistically significant, indicating that greater levels of dependence on foreign energy resources are associated with higher percentage of renewable energy usage. As countries become less dependent on foreign energy sources, they are less likely to increase the proportion of renewable energy usage on their energy consumption profile. The abundant endowment of non-renewable energy sources may discourage countries and reduce its marginal incentive to shift toward renewable energy. In the opposite side, countries which more dependent on foreign energy sources may have bigger incentives to improve its energy security by diversifying its energy sources towards renewable energy. This study finds that increasing the value of energy dependence variable from its median (3.56%, net energy imports) to its 3<sup>rd</sup> quantile (43.41%, net energy imports) while controlling all other factors, raises the countries' reliance on renewable energy by nearly 0.086%.

*Energy usage* is negative and statistically significant in all models, except for Latin America countries. This finding reveals that there is a negative relationship between the levels of energy consumption and the salient of renewable energy utilisation. The higher the levels of country's energy consumption, the less noticeable proportion of inexhaustible energy that a country uses will be, and vice versa. Reducing the value of total energy usage from its mean (3314.3, kg of oil equivalent per capita) to its 25<sup>th</sup> percentile (1485.7, kg of oil equivalent per capita), increases the probability of countries' salient of renewable energy by about 1.366%.

In this case, the result on *energy dependence* corresponds with one of this study first set of hypothesis, whereas the *energy usage* seems to move another way. These results signify that country with high dependency on foreign energy will try to fulfil its energy demand by collecting energy from many available sources, including renewable energy. But this condition will only apply under the condition that its energy demand lays on the relatively constant stage. This study assumes that if the domestic demand towards energy significantly increases, the option of using renewable energy will be less popular due to its long process to produce. Noting that a country will need to provide immediate supply to satisfy the demand, the country would certainly champion and take the fossil energy as it is widely available in the foreign market.

### **Political Aspects**

*Regime* is negative and statistically significant in the model, indicating negative relationship between democracy and the percentage of renewable energy usage. Contrary with this study's expectation, this result suggests as country becomes more democratic it is less likely to choose renewable energy for fulfilling its energy need.

Seeing closely into analysis per countries group or regions, it appears that the effect of regime type on renewable energy usage varies across regions. *Regime* is positive and statistically significant for sub-sample of Western countries, while it is negative and statistically significant for sub-samples of Asian countries and Middle East (ME), Africa, and Commonwealth of Independent States (CIS). Nevertheless, regime is statistically indifferent from zero in South America.

In general, the trend of *regime* shifting towards full democracy occurred in almost all regions. While the increasing trend of the percentage of renewable energy usage is only prevalent in western countries. For western countries, the mean value of renewable energy usage increases from 13.676% in 1990 to 18.164% in 2012. On the contrary, in

emerging economies such as China, India, Indonesia, and Brazil, the trend of the proportion of renewable energy usage decrease, although politically their democracy levels surge.

The common thread of this finding is that democracy gives leeway space to the constituents to voice their interests. Even though under democratic regime the number of environmental activists as strong supporters for renewable energy are plenty (MacLean et al., 2015), but the general public tend to be neutral when confronted to the price factor. The general public in emerging economies verge to go for more affordable and easily accessible energy source to fulfill their need - championing fossil energy over the renewable ones.

In addition to that, many industries in emerging economies are also labor-intensive, in which energy has a big chunk on the total production cost. Thus the more expensive source of energy will be scratched from the list as it consequences to bulged production cost, lower productivity, and even reduction on local employment (Bohi & Toman, 1996). Specifically for Indonesia, the failure to control national energy consumption is likewise related to government lack of capacity to enforce energy conservation and efficiency; deficient political will to conduct further research and development on non-fossil energy; along with the futile energy conservation law which is factually difficult to adopt – causing the law to be neglected and violated by many (Hadiwinata, 2011).

Moving to *Kyoto Protocol* factor, the result implies that it is positive and statistically significant, suggesting that ratification, acceptance, approval or accession of *Kyoto Protocol* have positive impact on expansion of renewable energy use among countries. While global picture shows strong evidence that *Kyoto Protocol* has positive implications; the regional picture provides different results, conveying that its significant effect on the increase of renewable energy use proportion seems ostensible only in Western countries.

*Kyoto Protocol* adoption in domestic legal system undoubtedly provides more political power to push renewable energy usage. Aside from the fact that Annex I countries are obligated to decrease their emissions by certain percent as regulated within the agreement, it is imperative to be aware that the effectiveness of its implementation may vary, depends on the country's legal enforcement. This practice then gives logical explanation towards the exceptional *Kyoto Protocol* effect in Western countries, which is

possibly caused by both obligations to comply with the agreement and better legal compliance and legal enforcement in those countries compared to other regions. Therefore for other regions which countries are not entitled into the Annex I and are not receiving much of low-carbon technologies through the Clean Development Mechanism (CDM),<sup>3</sup> engagement to *Kyoto Protocol* gives no statistically significant effect towards the adoption of renewable energy. To this situation, many scholars criticized that many CDM projects are concentrated on the large emerging economies such as China and India but very much lacking in the small and medium-sized economies (Anbumozhi & Kawai, 2015).

**Table 1. Estimates of the determinants' effects (sub-sample based on region), 1990-2012 (country fixed effect).**

Variable	(1) Global	(2) Western (North America, Europe, Australia)	(3) Asia	(4) ME, Africa, CIS	(5) Latin America
Constant	-5.861e+03** (1.840e+03)	9.111e+03** (2.791e+03)	-1.830e+04*** (2.360e+03)	-1.071e+04 (9.387e+03)	-71.224080* (29.328828)
Economic growth	-2.056e-02 (1.998e-02)	-6.807e-03 (3.449e-02)	3.476e-02 (4.803e-02)	-2.052e-02* (8.676e-03)	0.151303** (0.050254)
GDP pc (log)	1.345e+00* (6.638e-01)	6.103e+00*** (9.931e-01)	-8.478e+00*** (1.323e+00)	1.555e+00*** (3.547e-01)	-13.734934*** (3.388023)
Energy dependence	7.674e-03** (2.394e-03)	5.675e-04 (3.476e-03)	1.486e-02 (1.455e-02)	2.115e-03‡ (1.118e-03)	0.006885 (0.006588)
Energy usage per capita (log)	-1.243e+01*** (8.026e-01)	-2.344e+01*** (1.375e+00)	-4.428e+00* (2.035e+00)	-3.056e+00*** (3.882e-01)	4.137546 (3.384842)
Regime	-2.394e-01*** (3.809e-02)	8.480e-01*** (2.072e-01)	-5.409e-01*** (5.135e-02)	-7.905e-02*** (1.816e-02)	0.011698 (0.082940)
Land area (log)	4.042e+02** (1.253e+02)	-5.660e+02** (1.760e+02)	1.147e+03*** (1.471e+02)	7.296e+02 (6.393e+02)	13.554298*** (1.432699)
Kyoto Protocol	8.771e-01*** (2.127e-01)	1.242e+00*** (2.902e-01)	4.985e-01 (4.475e-01)	-2.130e-01 (1.323e-01)	0.794264 (0.590152)

**Note:** Dependent Variable: Reliance on Renewable Energy; notes: \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$ ; †  $p < .10$ ; all tests are two-tailed; robust standard errors in parentheses.

Aside from that, technology factor also matters due to the fact that advanced technologies on renewable energy are mostly established by experts in Western countries. It is not the case that Western countries are unwilling to share their technologies, but rather about the barriers in other regions that make technology for renewable energy is difficult to establish. In Asia, for example, the tangible constraints are exchange rates-induced high prices of technologies, protectionism through tariff to defend local companies, poor demand, lack of transparency and financing (Koh, 2004).

In sum, despite the fact that some regional variations exist, the global trend insinuates that *regime* has statistically negative outcome in almost all regions except Latin

America, where at the same time *Kyoto Protocol* drives positive and statistically significant consequence only in Western countries towards renewable energy reliance.

### **Economic Aspects**

The finding from model 1 reveals that *economic growth* does not achieve statistical significance. Countries do not appear to promote more or less renewable energy usage based on its economic growth. *GDP per capita* is positive and statistically significant, suggesting that there is a positive correlation between the level of economic development and the salient of renewable energy usage. As countries are economically more developed, they are more likely to promote renewable energy usage over the other energy sources. Put oppositely, countries may less concern for promoting renewable energy when their economic capacity still immature.

However, when seeing closely into the region, interesting result appears. The general trend seems to only happen in Western and ME, NA, CIS countries; while Asia and Latin America advocate opposite result. Negative and significant effect of GDP per capita in Asia and Latin America is contradictory with previous finding of Salim and Rafiq (2012) and Keho (2016). This study suspects that this different result is caused by measurement on renewable energy usage, in which the previous studies used the amount of energy, whereas this study considers the percentage of renewable energy shares. As apparent on the case of China: In 1990, its renewable energy use was 766.99 (kg of oil equivalent per capita) and accounts for 33.54%, while in 2012 its renewable energy use was 2079.12 (kg of oil equivalent per capita) but only accounts for 18.36% from total energy usage.<sup>4</sup>

Furthermore, *land area*'s positive and statistically significant effect suggests that it is one of the crucial factors affecting the level of renewable energy use in most countries. Possession of land is directly proportional to the amount of opportunity to establish renewable energy production facilities, whether hydropower, geothermal, wind or solar cell. The larger the land area, generally the higher the potential of renewable energy sources owned. Increasing the value of land area from its median (579,530 km<sup>2</sup>) to its 3<sup>rd</sup> quantile (2,149,690 km<sup>2</sup>) while holding all other factors constant raises the country's reliance on renewable energy usage by around 40%.

Going deeper into intra-region analysis, unlike the global trend, the effect of land area on the reliance of renewable energy usage in western countries is negative and statistically significant. This finding suggests that proliferation of renewable energy usage

in small Western countries is generally more rapid than the big ones. On one side, smaller land area may become a disadvantage to develop renewable energy facilities which have prerequisites based on the national natural endowments, but on another side it may encourage countries, especially developed countries, to develop new renewable energy technology which can deal with the lack of natural endowments.

To wrap up the findings on economic aspects, although on the global portrait economic growth gives no substantial implication, the other two variables of *GDP per capita* and *land area* global result seem to resemble with the hypothesis, indicating that a country with high *GDP per capita*; wide *land area*; or even combination of both factors will possess higher percentage of renewable energy shares to its total energy usage compared to other.

### **Limitations**

The first limitation of this study is the fact that some data in its dataset is missing, for example like Argentina and CIS countries in the early 1990s. In which, the missing data for CIS countries is mostly caused by the dynamics and chaos during the fall of Soviet Union, where most CIS countries were just established - therefore most of their data were not accessible. Even though the number of observation is already high, this study realises that more complete dataset will provide stronger validation towards the general results.

The second shortcoming is the absence of renewable energy categorisation. In this study, renewable energy is recognised as a single entity without considering its different types, such as solar, biomass, wind, hydro, etc. Although the nonappearance of categorisation does not reduce the reliability of renewable energy data in this study – in some extent, providing clear renewable energy classification will make the regression results to be more detail, especially in what kind of renewable energy the independent variables channel its effect into.

### **CONCLUSION**

#### **Conclusion and Policy Implications**

Empirical evidence has pointed out positive and statistically significant effects of *energy dependence*, *GDP per capita*, *land area*, and *Kyoto Protocol* towards country's reliance on renewable energy. On the other hand, *energy consumption* and *regime* have adverse effects on the increase of renewable energy shares towards country's total energy consumption; while *economic growth* has no statistically substantial influence towards

that gesture. Conclusively, it is sufficed to say that energy profile, economic factors, and political factors (with the exception of *economic growth*) have substantial weight to the dependent variable.

The results of this study are considered to be trustworthy to clearly reject the first and third hypothesis (H1 and H3) about *energy consumption* and *regime*, since both variables turn out to be negative towards the dependent variable - contradictive to the initial assumptions that they will generate positive results. At the same time, H7 is likewise rejected because it gives positive influence but not statistically significant. On the other hand, this study approves the following hypotheses of H2; H4; H5; H6, considering the regression results conform to them. The essentiality of energy profile, economic aspects, and political aspects highlights that investigating country's reliance on renewable energy through the influence of a single independent variable only is both insufficient and inconclusive.

Still, this study recognises there is a possibility that the results of these three factors may change in the future because of several extreme situations. First is advanced innovation, for instance the discovery of cheap, effective, efficient, harmless, and accessible renewable energy alternatives and technologies which existence are surpassing the capacity of the prevailing energy sources. Second, the occurrence of undesirable natural phenomena incidents due to climate change which critically threatens human being - resulting in significant swift towards environmentally friendly energy as a top priority of a country regardless its energy profile, economic, and political conditions.

With regard to policy implications, GDP per capita positive effect exposes that a tangible challenge of adopting renewable energy still points to its affordability issue. In addition, the positive effect of country's size generally indicates that renewable energy trend still depends on the ownership of natural endowments. Nonetheless, seeing the different result appears on Western countries, this study suspects that Western countries' positive trend in renewable energy (despite their relatively smaller territories) is due to the level of technology. Therefore, affordability and technology concerns evidently summon a further research and development for making renewable energy accessible, affordable, and reliable; otherwise its proliferation will only be limited to those which financially and technologically mature – leaving most of developing and less-developed countries behind.

Additionally, engagement in international environment agreement seems to be positively directive towards more renewable energy usage, yet, its significant implementation is only noticeable in Western countries. It advises that the countries which have successfully adhered to the agreement are handed the obligation to assist and encourage other countries in actualising its commitment in the agreement. It also highlights the need to fix the flaw of the current mechanism by creating a proportional distribution of renewable energy knowledge and environmental aid projects not only to the noticeable emerging economies but also the small and medium ones.

For further development, this study suggests the future research to consider conducting the interaction analysis between these three variables to uncover how these variables actually interact to each other in affecting the reliance on renewable energy as well as referring to this study's limitations for making the regression results more specific and reliable.

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### **ENDNOTES**

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<sup>1</sup> The countries with biggest share of renewable energy resources are Norway (98%), New Zealand (79%), Brazil (73.4%), while the countries with the least shares of renewable energy sources are Saudi Arabia (0%), Algeria (0.98%), and South Africa (2%).

<sup>2</sup> Enerdata is an independent Research and Consulting firm established in 1991, which focuses on conducting research regarding global oil, coal, gas, power, carbon markets, and renewable energy. It has several representative branches in various countries of France, Germany, Russia, Japan, Korea, and China. See: <http://www.enerdata.net/enerdatauk/press-and-publication/publications/world-energy-statistics-supply-and-demand.php>

<sup>3</sup> This mechanism enables developing countries to support the effort of lowering the emissions. It creates a win-win solution for developing countries and developed countries. It gives opportunity for developing countries to receive aid and transfer technology from developed countries for realising sustainable development. At the same time, by contributing to this mechanism, developed countries could fulfil the obligation of lowering and limiting the carbon emissions quantitatively.

<sup>4</sup> These numbers are taken from the Database this study gathered for the regression model.