Socio-economic Analysis on Sustainable Development of Renewable Energy in Developing Nations

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Introduction

Abstract

From the viewpoint of sustainable development, it goes without saying that one factor is the need for a revision of the energy mix, of which a linchpin is the hastening of renewable energy deployment. From this viewpoint, the Asian nations which are recognized as important regions of global growth, will need to consider the best approach for the development and exploitation of their unique renewable resources. Further, the individual socio-economic basis of each nation will also be an important consideration for the realization of renewable energy deployment, as will the policy decisions, technologies deployed and direct investment-based capital deployment approach. Until industrial recovery is realized, it is important that policy is brought to bear on this issue, and furthermore, it is absolutely necessary to develop the people who will be future managers of such a system – and this need is an urgent one. Toward meeting this need, we will consider the ability of Asian nations to deploy renewable energy, both in the sense of their current situation, and future capabilities. Among these nations, we consider Indonesia as a leading nation, and also include the nations of Vietnam and Myanmar etc., expected to experience an economic expansion in the near future. For each nation, we consider not only the prospects for renewable energy deployment, but also in terms of analyzing their individual issues, with the aim of delivering tailor-made policies cognizant of national characteristics. We aim to achieve this through a seamless renewable energy deployment and policy ecosystem combined bird's-eye-view approach, and, applying our findings, we aim to aid other nations, particularly those whose development is expected to be slower, such as those in Africa. Our overall goal is to engender a global level deployment of renewable energy, and to address the need for such a movement – this is the impetus behind this current research.

The organizational structure of this research is built upon a core group of members of the Resources and Energy Policy Research Group, one of the research groups within the School of Advanced Integrated Studies in Human Survivability (GSAIS). Along with the core group, a transdisciplinary, multi-tiered research system has been developed, organically collaborating with the following interdisciplinary research groups: The ``International Development Research Group'', focusing on international development in developing nations; The ``Sustainable Economics Research Group'', focusing on sustainable socio-economic analysis in developing nations; and The ``Global Commodity Issues Research Group'', focusing on risk analysis pertinent to renewable energy development investment in developing nations.

One particular care that has been taken in the development of this study was to ensure that the research was not only progressed by the University, but also included research update meetings and mid-term reporting such that the research body is a cooperative effort between the

University (GSAIS) and JICA. Further, in light of the extraction of suggestions toward policy recommendations as one of the outcomes of this research, a "Developing Countries Renewable Energy Development Research Promotion Committee" was implemented, consisting of practitioners of policy-related government agencies, policy-implementing independent administrative agencies, and implementing agencies. Finally, a reporting regime was established to report both the progress of the research and to enable frank discussion and feedback on two occasions, firstly in September 2018 in the middle of the second year and in October 2019 in the middle of the third year. The idea behind these two initiatives is to receive feedback from multiple viewpoints including stakeholders such as policy makers, policy implementers, businesses and researchers in order to improve the quality of this research.

The structure of this report is as follows. In order to consider the meaning of developing renewable energy in developing countries, Chapter 1 makes one attempt to question the essence of renewable energy development in developing countries from a philosophical approach, before entering into a concrete research study. Chapter 2 reports the development trend survey on renewable energy in Southeast Asia and Africa to collect basic information for field research and socio-economic analysis in this research. Chapter 3, which covers four countries: Indonesia, Vietnam, Myanmar and Kenya, summarizes the results of field surveys (or field surveys) from both practical and academic sides regarding renewable energy development policies and the status of system development in order to obtain suggestions on issues/barriers, solutions and support methods related to the introduction of renewable energy. In Chapters 4 to 6, based on the development trend survey in Chapter 2 and the field survey results in Chapter 3, from a macro and micro perspective, academic socio-economic analysis is conducted on the current state and outlook of the social structure related to the introduction of renewable energy in the target countries. Chapter 4 examines the approaches that policy proposals can take in order to utilize technical knowledge for democratic decision making of host countries when making energy policy proposals to developing countries as technical cooperation. In order to investigate the impact of renewable energy on workers involved in electricity production from a macro perspective, Chapter 5 conducts a social structural analysis regarding the introduction of renewable energy using the Social Life Cycle Assessment. In addition, the social structure related to the introduction of renewable energy is uncertain and poses risks. Chapter 6 carries out risk analysis related to the introduction of renewable energy such as investment risk, weather risk, and energy risk from a micro perspective. Chapter 7 discusses the need for a "policy ecosystem" as an autonomous and endogenous system that also includes human resource development, as a viewpoint for policy proposals regarding the introduction of renewable energy. Finally, we summarize this research project and describe its future direction.

Chapter 1 Inquiring into the Essence of Renewable Energy Development in Developing Countries

Abstract

As an introduction, this chapter engages with a philosophical reflection on the essence of technology which as such underlies renewable energy development in developing countries. In particular, through consideration of Heidegger's theorizing of technology, we can see how the decision-making in energy development can be distorted unawares due to the situation of Ge-stell or enflaming, the form through which the modern technology manifests itself. Furthermore, by introducing Hannah Arendt’s critical insight on totalitarianism and active life and juxtaposing them with Heidegger's inadequate account on the practical solution to the danger inherent in Ge-stell, I attempted to highlight the path to possibility of council system as a solution.

First, I highlighted the transition of the theoretical discourse behind the "2030 Agenda for Sustainable Development". Through the transition, development came to be seen no longer an economic matter, but a political matter that determines what is appropriate social welfare. Hence, I reviewed the problems of aggregate democracy based on the theory of social choice and confirmed the premise that social decision-making must be complemented by non-strategic communication. Since it is non-strategic, development policy cannot procure it as a mere means. Can the tension between development and decision making be bridged? If so, how could it be? This chapter provides a preliminary discussion of this with reference to Heidegger's theory of technology, Arendt's theory of fabrication, and the council system.

According to Heidegger, we must first prepare a free relationship to technology. In general understanding, technology is the act of human beings to procure what is instrumental to us. However, given the current environment crisis exacerbating even further with technological advances, it must be said that it is becoming quite difficult to still retain such uncritical understanding of technology. Heidegger observes that in the essence of modern technology lurks danger of what he calls ``Ge-stell’’ or ``enframing’’ which subsume everything it encounters under its servitude, even to the extent that human beings are now, unaware, conscripted to it. As human beings are thrown in the enormous vortex of means-end relationships, they are constrained and urged to develop natural energy and subconsciously restrain each other even further. The solution Heidegger offers to this danger is to wait for a great philosopher poet to frame it in the beautiful manner and save us all by doing so. Though Heidegger’s analysis provides us insightful perspective to understanding how development can be manipulated unawaredly, since it lacks the communicative dimension, it is not easy if not impossible to derive political implications from his solution to the danger inherent in the essence of modern technology.

Arendt sees Heidegger was no exception to the déformation professionnelle of great thinkers as exemplified also by Plato. She pointed out that Plato's vision to apply rule of truth in political realm was a response to the Socrates trial and the consequential death penalty and observed that the tradition of Western philosophy was characterized by its hostility to politics from its origin. According to Arendt, Plato's allegory of the cave was conceived by such political motives. Plato then envisioned a model of nation ruled by philosopher king who dominates with the force of truth. Accordingly, he posited that people should be dominated as if pranks of wood are cut up and assembled into the shape of a chair according to the idea of a chair maker. The idea is that such domination through ideals and subsequent force of fabrication process replaces the domination through the force of sheer violence. This vision was also inherited in Aristotle's political conception in which the contemplation of truth is placed at the top of the hierarchical structure of domination as the best way of life.

In Rome, the ideas of Plato and Aristotle was drawn in as a tradition with the authority derived from the act of creation and was adopted as a structure of doctrine and religion in the Christian era. Since then, authority, religion, and tradition have been enshrined and inherited as trinity in Western thought. Albeit, toward the end of Middle Age, religion began to lose its validity. Every attempt of revolutions to resurrect the authority into the political realm out of the trinity tied to religion all turned out to be unsuccessful. Nevertheless, the model of domination by the analogy of fabrication persisted, preparing the soil for totalitarian domination by ideology and terror. How could the analogy of the fabrication survived without the authority within which it was inaugurated to begin with?

According to Arendt, the beginning of modernity is marked by Galilei's observation of telestial objects through a telescope. Descartes being shocked by this event and attempting to properly measure up its magnitude, brought skepticism to modern philosophy at the cost of reality in the world. Then on, only the form of logical reasoning in absence of others became the only commonality in modern minds. The model of reasoning, which is characterized by a loss of common sense, no longer requires the source of binding truths like the authority of tradition, thus conditioned the acceptance of ideology in the minds of the modern men in loneliness. The tradition came to an end when the ideology became associated with terror which is the essence of totalitarianism.

In the closing paragraphs, I explored the possibility of Arendt's conception of council system as a clue to solving the problem inherent in modern development. Just as Heidegger points out the danger of enflaming in concealing the essence of modern technology, Arendt points out that the "thoughtlessness" in modern society is an aspect of the decline of the public sphere, disabling the collective decision-making altogether. In the face of such challenge, if citizens can institute a place to cultivate critical thinking and give themselves the opportunity to exchange opinions as equals, it should contribute to the rehabilitation of public spheres. is there. Such opportunities are what the council system has generated in the course of many revolutions.

Chapter 2 Survey on Trends of Renewable Energy Development in Southeast Asia and Africa

Abstract

Chapter 2 gives an overview of development trends in renewable energy in Southeast Asia (10 ASEAN countries and East Timor) and sub-Saharan African countries (45 countries). In particular, it summarized the background information about the literature, such as reports of international organizations to collect the basic information for field studies in Chapter 2, and socio-economic analyses in Chapter 3 and later.

The importance of renewable energy has been confirmed in the international community, not only from the perspective of ensuring long-term stability of energy but also from the perspective of reducing CO2 emissions as a measure against climate change. Between 2010 and 2016, renewable energy consumption increased by 18%. Its share of final energy consumption has increased from 16.6% to 17.5%. Faster change is needed to meet climate change goals.
On a capacity (MW) basis, the scale of renewable energy generation increased between 2010 and 2016 by approximately 1.93 times globally, and 1.95 times in ASEAN, while it increased by 1.69 times in all Africa. On an amount of power generation basis, it was about 1.47 times for the world total, about 1.87 times for the ASEAN total, and about 1.31 times for all Africa. It can be seen that the development is not yet sufficiently advanced in Africa.

Energy demand in Southeast Asia is expected to grow significantly in the future. However, the tendency is small compared to the degree of economic growth in the region. This is because this area aims to use energy efficiently. Among Southeast Asia, the countries with the highest power generation capacity are Indonesia, Thailand, Vietnam and Malaysia. Cambodia, Myanmar and Laos are in the stage of promoting rural electrification. In sub-Saharan Africa, the electric power infrastructure is not well developed. South Africa and Nigeria have large economies and large electricity capacities, but many countries are expected to improve their electrification rates first. For this reason, renewable energy is often discussed as a solution to the problem of off-grid rural electrification rather than at the national level of national security as in Southeast Asia.

The renewable energy introduction targets (total primary energy supply, total final energy consumption, electricity, heating and cooling, and transportation) of the countries in both regions were surveyed regarding the presence or absence. 69.6% of the countries have set some

introduction target for renewable energy generation. 41.1% of the countries are targeting the introduction of renewable energy in the transportation sector.

The characteristics of renewable energy promotion measures in both regions were analyzed by dividing them into two items, institutional and policy support measures and those related to financial incentives and public investment policies. Regarding institutional and policy support measures, in Southeast Asia, FIT, RPS, and Transportation Obligation are carried out in about 50% of the countries, respectively, and are introduced more often than in sub-Saharan African countries. In particular, Indonesia, the Philippines, and Vietnam have all three types of policies. No specific trends can be found in Africa, but many countries have made Tendering. Countries, such as South Africa, Nigeria, Kenya, Ghana and Senegal, have or have had four or more institutional support measures.

As for financial support measures, 55% of the countries have Tax Reduction on renewable energy projects. Nearly 40 % of the countries make public investment. In Southeast Asia, Investment and Tax Credit are also made in Indonesia, the Philippines, and Vietnam. In Africa, Kenya is implementing three types of support measures.

As the impact of climate change on each region of the world by 2060 (GDP change estimated from climate change up to 2060), especially in Southeast Asia (including India), climate change will have a particularly large negative economic impact. Active use of renewable energy is considered as one of the measures to deal with climate change. ASEAN has declared a target to secure 23% of primary energy by renewable energy by 2025. Regional cooperation is essential to achieve this goal. ASEAN has already established an active cooperation system for the introduction of renewable energy and has signed a memorandum on long-term cooperation with IRENA. ASEAN is also trying to implement the ASEAN Power Grid: APG, to strengthen power trading across regional boundaries. It is necessary to continue exploring the possibilities of power interconnection within the ASEAN region and with other regions, and to have further research and discussion on the energy mix with a view to introducing renewable energy in Southeast Asia.

There are four issues remaining in this research project. In terms of policy, whether there are just enough policies at the national level, and how useful are the policies actually? In terms of technology, how technically it is possible, including economic efficiency, and how to develop human resources. This research project will carry out socio-economic research in later chapters in order to fill this gap.

Many of the issues that hinder the development of renewable energy in developing countries are directly or indirectly caused by the lack of appropriate human resources in public and private sectors. In the medium to long term, comprehensive and systematic human resource development measures in the renewable energy field are required. It will be important for Japan to laterally support the initiative of the governments and the private companies concerned of developing countries. One way of doing this is to support regional efforts that transcend national boundaries. By proactively establishing and supporting opportunities to share and spread the experiences of each country in the form of regional workshops, renewable energy development in the entire region can be further promoted.

Chapter 3 The Field Surveys in Indonesia, Vietnam, Myanmar and Kenya

Abstract

From the start of the joint research project with JICA in July 2017 until October 2019, our team in charge of the field surveys (Ialnazov, Keeley and Boliko) conducted in total 7 field surveys out of which 3 in Indonesia, 1 in Vietnam, 2 in Myanmar, and 1 in Kenya. The duration of the field surveys varied from 2 days to 3 weeks (see Table 1) and included semi-structured interviews (based on the field survey questionnaire) with key stakeholders in the energy sectors of the above 4 countries: First field survey in Indonesia (Jakarta) 6-7 July 2017; Second field survey in Indonesia (Jakarta) 15 Oct. – 1 Nov. 2017; Third field survey in Indonesia (Jakarta and Bali) 15 – 26 May 2018; Fourth field survey in Vietnam (Hanoi) 12-16 Nov. 2018; Fifth field survey in Myanmar (Naypyidaw) 25-29 Dec. 2018; Sixth field survey in Myanmar (Naypyidaw and Yangon) 8-11 July 2019; Seventh field survey in Kenya (Nairobi and various places) 23 Sept. – 13 Oct. 2019. Note that seventh field survey included semi-structured interviews in Nairobi from 23 to 27 Sept. and in the countryside from 28 Sept. to 13 Oct. 2019

Through the interviews we managed to achieve a deeper understanding of the following five issues: 1. The main characteristics of each country's energy sector (energy demand growth rate, factors leading to its growth, projections about the future growth of energy demand, how does the government try to meet the growth of energy demand, to what extent does the government rely on independent power producers (IPPs) to expand energy supply, current and projected electricity generation mix, the main players or key stakeholders, etc.); 2. The legal framework, the main laws and regulations as well as renewable energy (RE) promotion policies (not only the feed-in tariff (FIT) policies but also other government policies and regulations); 3. Main motivations and enabling factors to expand the share of renewable energy (in particular, solar and wind energy); 4. Main problems or barriers to the expansion of renewable energy (in particular, solar and wind energy); 5. Proposals for further involvement by JICA to solve the problems/ or deal with the barriers.

Our main results are summarized as follows: 1. In the existing literature energy security, energy access and economic benefits are listed as the main motivations of developing countries

to expand the share of RE in their energy mix. However, based on our field surveys we found that policy makers in the field surveys in Indonesia, Vietnam, Myanmar and Kenya (also referred to as IVMK) would like to see larger shares of RE also because of growing awareness of its huge potential and rapidly declining costs (Ialnazov and Keeley, 2020); 2. At the same time, policy makers in IVMK are aware of a number of problems associated with higher share of RE (in particular, the intermittent sources of RE such as solar and wind power). The situation in Indonesia and Vietnam is quite different from that in Myanmar and Kenya as Indonesia and Vietnam face more rapidly growing energy demand. In that case developing sources of stable energy supply such as fossil fuels (e.g. coal, oil and natural gas) seems a better solution than investing into the unreliable sun and wind.

Furthermore, various pre-existing conditions give competitive advantages to fossil fuels vs. renewables in Indonesia and Vietnam. Large subsidies to fossil fuels keep their costs at an artificially low level. Based on our field surveys, among the large number of barriers to the expansion of renewable energy (Gabriel, 2016), we found that the vested interests as well as the power of incumbents such as the state-owned energy companies in Indonesia (PLN) and Vietnam (EVN) can explain to a large extent the lack of progress in the development of RE. In both countries, PLN and EVN seem to incur higher costs as a result of the expansion of wind and solar energy. Note that the incentives of EVN seem to be changing a bit after 2018 as EVN has been recently involved directly in the development of new solar power plants in Vietnam.

In conclusion, we believe that one of the solutions to the lack of progress in the development of RE is to change the incentives and the mindset of the powerful incumbents and turn them from barriers to into enabling factors of the energy transition. To achieve that transformation, the support from international donors such as USAID, GIZ, the World Bank, JICA, etc. is indispensable. In particular, we identified in the Japanese text of Ch. 3 various ways in which JICA could support the further development of RE in IVMK.

Chapter 4 Policy Framing of Power System Integration Revisited: What are the Priorities for ASEAN?

Abstract

This chapter examines the approaches that can be taken in policy proposals, so that technical knowledge is utilized for the democratic decision making of host countries when making energy policy proposals as technical cooperation to developing countries. First, it was shown that it is important to conduct a theoretical examination and to make policy recommendations so as to broaden the range of options that can be adopted after understanding the political context facing the target country. Next, in order to understand the political context facing the target country in

policy proposals for renewable energy development, we introduced a framework that analyzes the interaction between technology and socio-technical systems, and conducted an analysis targeting Indonesia. Lastly, regarding the approach in which experts are involved in policy design, we examined the problems in the case of Southeast Asia and considered the direction to overcome them. The implications are that, when making policy proposals as technical cooperation for developing countries, the framework of problems subjectively set by cooperators is often presupposed, which may also hinder renewable energy development, therefore external experts can play important roles in criticizing whether the problem setting is done properly and in presenting multiple options that can be taken for the target country.

Chapter 5 Social Structure Analysis Related to the Introduction of Renewable Energy

Abstract

The adoption of renewable energy technologies in developing nations is recognized to have positive environmental impacts; however, what are their effects on the electricity supply chain workers? This article provides a quantitative analysis on this question through a relatively new framework called social life cycle assessment proposed by Benoît-Norris et al (2012), taking Malaysia as a case example. Impact assessments by the authors show that electricity from renewables has greater adverse impacts on supply chain workers than the conventional electricity mix: Electricity production with biomass requires 127% longer labor hours per unit-electricity under the risk of human rights violations, while the solar photovoltaic requires 95% longer labor hours per unit-electricity. However, our assessment also indicates that renewables have less impacts per dollar-spent. In fact, the impact of solar photovoltaic would be 60% less than the conventional mix when it attains grid parity. The answer of “are renewables as friendly to humans as to the environment?” is “not-yet, but eventually.” The details of the chapter is reported in Appendix.

Chapter 6 Risk Analysis for Renewable Energy Introduction

Abstract

This chapter presents the results of a risk analysis on the introduction of renewable energy from three perspectives of investment risk, weather risk, and energy risk. The first analysis uses the Philippines as a case study by country to empirically verify the relationship between risk and return of energy companies regarding renewable energy investment in emerging countries. The

research examines the risk and return profiles of energy companies with renewable energy (RE) investment in developing countries taking the Philippines as our country case study. First, we analyze the impact of the global RE project specific risk and country risk on RE projects using a simple capital asset pricing model (CAPM) by benchmarking stock returns of these companies to either the global S&P Global Clean Energy (S&P GCE) index or to the local Philippine Stock Exchange (PSE) index. Our findings show that a ``pure'' RE company of the Energy Development Corporation (EDC) is affected by both these risks examined on short- and mid- to long-term investment interval, while those with partial investment in renewables are affected only on the short-term. Next, we calculated these companies' abnormal returns by using the Jensen's alpha. Results show that EDC's alpha values are positive on all short- and medium-to-long term investments and on both indices, suggesting that Philippine RE companies are possibly underestimated on both the global RE market and the Philippine stock market. Lastly, we examined the latest feed-in tariff (FIT) level by using the beta results of EDC and the FIT structure of solar PV. Results show that the FIT rate generates profit to both the global and local RE companies' risk and returns from the investors' perspective, but is higher than the desired FIT rate from the policymakers' perspective. This paper aids in investment decision-making by showing that differences in investment timeframes and RE shares could impact investment outcomes in developing countries. The details are reported in Appendix.

In the second analysis, we study weather risk hedging strategy for solar power. We propose two models for pricing solar power derivatives: temperature-based and power generation-based models, and propose a hedging strategy for solar power volume risk in an incomplete market environment. We discuss the basis risk that arises from solar temperature volume risk hedging. Based on indirect modeling of solar power generation using temperature and direct modeling of solar power generation, two types of call options are designed: accumulated non cooling degree days (ANCDD) and accumulated low solar power generation days (ALSPGD). We provide pricing formulas for two options under the good deal bound (GDB) framework that can include the incompleteness of the solar power derivative market by deriving the partial differential equations of the two options. After estimating the parameters of temperature-based and power generation-based models, respectively by using Czech solar power generation and Prague temperature, we numerically calculate the call option prices of ANCDD and ALSPGD as upper and lower price boundaries, respectively using the finite difference method. Results show that the call option price based on the solar power generation process is higher than the call option price based on the temperature process. This is consistent with the fact that the power generation approach costs more because it takes into account more comprehensive risks than the temperature approach. Finally, the basis risk premium, that is, the value obtained by subtracting the temperature-based call option price from the power generation-based call option price, increases as the temperature rises, but decreases when the initial temperature exceeds approximately 25°C. It is because when the temperature exceeds 25°C, the uncertainty of the influence of temperature on the amount of solar power generation decreases due to the offset of the increase in the amount of solar power generation due to the increase of solar radiation and the decrease in the amount of solar power generation due to the decrease in the efficiency of the solar cell panel.

The third analysis focuses on the impact of energy risk on clean energy businesses, including renewable energy. We theoretically and empirically investigate the relationship between the environmental value embedded in the Clean Energy Index and the energy value obtained from the energy price. We propose a supply-demand correlation (CR) model of the clean energy index and energy prices that considers the impact of energy on the clean energy business, including renewable energy. Empirical studies are conducted to estimate the model parameters by using the stock index including S&P Global Clean Energy Index (GCE), Wilderhill Clean Energy Index (ECO), S&P/TSX Renewable Energy and Clean Technology Index (TXCT), S&P 500, and energy prices including WTI crude oil and Henry Hub (HH) natural gas. The correlations between GCE or ECO and WTI crude oil or HH natural gas prices are positive, indicating that the correlations are an increasing function of the corresponding energy prices. Considering that the electricity spot price tends to rise in accordance with the energy price, the value of the renewable energy business that sells electricity in the spot market is enhanced by the rise in the energy price. Thus the result seems reasonable. In contrast, the correlation between S&P 500 and WTI or HH prices is still positive, but it is also shown to be a decreasing function of energy prices. This sharp contrast is not applicable to GCE and ECO companies, but it could result from the fact that high energy prices could harm the operations of S&P 500 listed companies. For TXCT, the correlation with WTI is positive and a decreasing function of WTI, but the correlation of HH tends to be positive and an increasing function of HH. Considering the GCE and ECO results, TXCT may not be fully functional, suggesting that it may be under development as a clean energy index.

From the first research of investment risk analysis in promoting renewable energy in developing countries, although it is a case study of a specific country such as the Philippines, the existence of investment opportunities for renewable energy in developing countries was highlighted from the perspective of risk and return. We obtain the implications that investing in renewable energy in developing countries may be attractive to investors, and conversely there is a loss of national wealth from the perspective of the government setting FIT levels. Next, the second research, the hedging strategy for weather risk, shows the existence of basis risk due to the difference between the hedging instrument and the hedged item. In order to solve this issue, there is an implication that a balance between the financial player, which is the seller of hedging products, and the business operator, which is mainly the buyer of hedging products, is necessary. From the third research, the analysis of the impact of energy risk on renewable energy business, we obtain the result that energy risk is in line with renewable energy business risk and not contradictory to it. It is suggested that this may be a stone's throw against the realization of the world's 100% renewable energy world. Risk analysis from various angles will be necessary to direct renewable energy projects in developing countries where uncertainty is increasing.

Chapter 7 Renewable Energy Deployment Perspectives of Policy Recommendations

Abstract

In order to consider policy recommendations for the increased deployment of renewable energy, there are three fundamental aspects which must be optimized; Energy self-sufficiency improvement and security, new industrial development and industrial policy, and climate change and meeting international responsibilities. Through the optimization of these 3 fundamentals, the goal of maximization of socio-economic utility can be achieved. This chapter seeks to confirm the appropriate staging of these fundamentals within the framework and to clarify their importance moving forward.

In order to carry out this research study, and in developing the methodology, the three perspectives of an “on-site principle”, a “diverse model”, and “trans-discipline” research have been the focus, to maximize research outcomes. In particular, for developing nations, considering their expected impending economic growth, the relationship between industrial policy and renewable energy has been studied in depth, and the lesson of Japan’s economic growth has also been considered as part of this evaluation. In addition, in order to derive sustainable policy recommendations for an ever-changing economic society, we have based the study firmly on the above detailed “Optimization of the 3 fundamental policy recommendations framework” and the “The 3 perspectives for maximizing research outcomes; Methodology” and further, have incorporated a mechanism to establish a constant, periodic “policy evaluation and review”. In this way, we establish an independent, endogenous system: the “policy ecosystem” as an essential part of this research study.

Furthermore, for the actual development and implementation of policies, it is necessary to have appropriate human resources in place. For this reason, in parallel with policy development and implementation, necessary human resource development measures such as the effective use of Official Development Assistance (ODA) are also required to be incorporated into the above-mentioned “policy ecosystem” (for specific details with regard to human resources development measures, refer to section 2.4.2 “Human resources development related to renewable energy”).

Concluding Remarks

Abstract

Regarding this research, the underpinning question behind the development and deployment of renewable energy in in developing nations is “So, what is energy in the first place?” According to a previous investigative report, “Current status of renewable energy deployment in developing nations – a general trend survey”, perspectives and suggestions for policy proposals and development were identified resulting from a field survey cognizant of social structure analyses, policy process analyses and risk analyses of Indonesia, Vietnam, Myanmar and Kenya. In this chapter, which goes beyond the frame of developed, emerging and developing countries, we provide a birds-eye view of the “surrounding environment for the promotion of renewable energy deployment for humankind and for global society”. Cognizant of this goal, I would like to wish for the successful further development of this research and to make my “closing statement”.

Changes to global society, including humankind, are progressing more rapidly than anticipated. These changes are experienced through a sense of speedy progress which is accelerating, and a strong experience of large positive and negative variations both up and down and left and right. Considering these issues from the point of view of humankind, we consider the big issues which mankind is facing, first among them climate change. In addition, we also consider abnormal weather events including increasingly warm summers and cold winters, as well as the emergence of major droughts and immense hurricanes. On the other hand, when considering humankind itself, the concept of the Anthropocene, that is the impact of one species’ activity during their lives can be very significant toward global society (and in fact is already having an impact). Taking this concept one step further, recent studies from the US and Europe have identified that of those people born in Japan in 2007, over half will live to the age of 107. In other words, we can understand that the lifespan of humans is changing, potentially beyond a gradual extension of existing economic and social structures. Understanding this, the need for the construction of economic and social systems which can accommodate 100-year lifespans becomes apparent.

Further, considering the economic society which surrounds humankind and the efforts toward engendering the 4th industrial revolution and Society 5.0, it is not hard to imagine the transition of humanity from the 1st cognitive revolution to a phase of ‘3 innovations’, i.e., digital technology innovation, mobile online innovation and virtual reality innovation. Built based on these 3 innovations, we can observe the transition to the 2nd cognitive revolution. Indeed, from the point of view of millennials, Z generation and Alpha's, the world largest nation is not America, China or India, but the Empire of Facebook with a population of 2 billion. Applying a little hyperbole, we can understand this through the lens of an economic society in which people are in some ways free from space constraints (Mobile Online Innovation), free from physical constraints (Virtual Reality Innovation) and free from time constraints (Digital technology Innovation).

Irrespective of their status as a developed nation, an emerging nation or a developing nation, each nation is concerned with securing the resources and energy required for national production and the maintenance of their social systems. At the same time while concerned about global environmental issues, nations seek to further their social development while growing their economy. However, along with balancing these issues, international exchange of assets, services, financial instruments and information leading to the increased complication of international rules and regulations, has engendered a situation where nations have an unavoidable impact on one another. The most important concept to understand then, is the fact that as human beings, we are on the same boat, 'The Earth'. It is not a matter of winning or losing between nations, and the pursuit of global co-existence and co-prosperity must become the prime goal, as it is impossible to get off this boat. In summary, the survivability of our boat, the Earth, becomes the most important issue.

The issue of global warming has been debated by the IPCC, with commitments then decided at COP24, however these are only international commitments which could be considered as an international trend toward supply side-oriented policy. In other words, the compliance of each nation according to their own sovereignty is key. For each nation, the community, citizen's voluntary compliance and acceptance become the basis for demand side-oriented policy construction and an important factor in ensuring successful achievement of commitments. In addition to global issues such as global warming, humankind is said to be entering into a new geological century called the Anthropocene with global issues including population issues, food issues, energy issues and others which are becoming more diverse, more complicated and more serious, requiring a global consensus. On the other hand, even under these conditions, trends in the economic society lead to a progression to the 4th industrial revolution and super smart society (Society 5.0) – at the same time, millennials and Generation Z - the digital natives - are increasing, leading to a mobile online revolution in social network services (SNS). Furthermore, it is important to keep in mind that certain types of social innovation are transcending information and social barriers, meaning that in some respects they transcend national sovereignty in terms of policy receptiveness and the changing environment (a global flattening of access to information regarding policy consumers). This means that the demand side of policy becomes sensitive and contributes to an increase in the influence of voluntary reactions, including self-responsibility on a global basis.

For this research, we place the “demand side of policy” at the forefront of our considerations and go one step further to consider issues from the viewpoint of “acceptance of economic society”, with Chapter 4 and 5 rounding out this approach. Considering the analysis in Chapter 4, the development of renewable energy and its integration into the entire electricity system requires an approach cognizant of all of the elements that make up the socio-technical system. We can understand that such a state can only be realized following an adjustment of the elements in such a way that they achieve acceptability in economic society. It goes without saying that it is necessary to bear in mind that this policy process analysis requires the participation of stakeholders on both the supply and the demand side, i.e. both sides of the policy debate. In addition, regarding the “S-LCA analysis” as undertaken in Chapter 5, power generation from renewable energy sources imparts a larger burden on human rights than existing power sources considering the number workers engaged in the supply chain. This clearly suggests that economic society’s acceptance of policy, and, particularly from the viewpoint of the demand side of policy, that it will not always engender a desirable outcome. In other words, we attempt to contribute to policy development from both the supply and demand side through the undertaking of stakeholder analysis and S-LCA analysis to better incorporate social acceptance.

As discussed above, regarding social acceptance, and specifically global societal acceptance, the incorporation of the guarantee of ‘security’ in the policy system needs to be comprehensively summarized. This is an important factor and gives promise to future birds-eye level research developments. The concepts of “national security”, “energy security”, “food security”, “labor security”, “human security”, etc. are all well known, however, recently the concept of the environment, summarized as “environmental security” is increasing in importance. In spite of this, no research which looks at this issue from the viewpoint of guaranteeing economic society and global society’s acceptance. For this reason, it is important that such research be undertaken and considered in Japan as well. In this research, we have undertaken risk analysis from the perspective of renewable energy deployment and the further promotion of renewable energy introduction in developing nations. From now on it is essential to consider global society’s acceptance through global risk analysis – specifically on a global community (community earth) basis, from a bird’s eye point of view. Toward this goal, from the perspective of undertaking global risk analysis, using a more specific target, analysis approaches such as “ESG Investment Risk Analysis” become an interesting potential research approach for investigation. As is well known, ESG refers to the Environment, Society and Governance, and is useful for analyzing associated activities and phenomenon. Recently, issues such as global environmental issues, an aging, shrinking population and corporate scandals have rapidly increased the profile of the ESG methodology. The responses to these issues have been undertaken in earnest on a national basis, a corporate basis or a community basis, i.e. at multiple individual levels, however, it is unclear what the implications are from the point of view of risk analysis and a consideration of acceptability and the guarantee of effectiveness. Therefore, we seek to undertake an evaluation of current events and future efforts in order to derive solutions by considering the national, corporate and community layers of ESG activities, how they are undertaken and what results are achieved from a quantitative cash flow (CF) analysis basis. Further, with regard to ESG activities from the point of view of economic and technological cooperation, supportive foreign investment shifts from a national basis to a community basis and through this process corporation's social and economic activities (sometimes as a part of their CSR activities) become two sides of the same coin. In any case, from its original meaning, ESG is a corporate, community based, distributed, bottom up approach, rather than a government led one, and, as such, analysis focusing on the cash flow of corporate ESG investments may be worthy of investigation. In summary, we are attempting to uncover the ESG related economic and technological cooperation impacts, as well as the assurance of effectiveness (social acceptance) from the point of view of "ESG investment related risk analysis". For example, you could replace the words "Japanese Company" with "Japanese ODA" in the quoted references below.

In addition to the analysis conducted above, there are 2 research issues which need to be undertaken related to the achievement of the SDGs in developing nations from the point of view of policy planning, development and implementation for economic and technological cooperation. These research issues are: Environmental security from the perspective of global societal acceptance; ESG investment risk analysis from the perspective of global risk analysis

In any case, from now on, in addition to the abovementioned acceptance of economic society, it is necessary to aim for a ``Multi-layered policy design'' cognizant of the following aspects: Ensuring policy effectiveness (governance/compliance); Policy sustainability (ecosystem); among others.

Appendix

sustainability

MDPI

Article

Are Renewables as Friendly to Humans as to the Environment?: A Social Life Cycle Assessment of Renewable Electricity

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Abstract: The adoption of renewable energy technologies in developing nations is recognized to have positive environmental impacts; however, what are their effects on the electricity supply chain workers? This article provides a quantitative analysis on this question through a relatively new framework called social life cycle assessment, taking Malaysia as a case example. Impact assessments by the authors show that electricity from renewables has greater adverse impacts on supply chain workers than the conventional electricity mix: Electricity production with biomass requires 127% longer labor hours per unit-electricity under the risk of human rights violations, while the solar photovoltaic requires 95% longer labor hours per unit-electricity. However, our assessment also indicates that renewables have less impacts per dollar-spent. In fact, the impact of solar photovoltaic would be 60% less than the conventional mix when it attains grid parity. The answer of "*are renewables as friendly to humans as to the environment?*" is "*not-yet, but eventually*."

Keywords: renewable energy; supply chain; social responsibility; social life cycle assessment; labor conditions; Malaysia; solar PV; Biomass; Hydro

1. Introduction

Countries around the globe are competing for the increased adoption of renewable energy technologies, and developing nations are leading this trend in the aim of meeting the growing electricity demand in a sustainable manner. Various studies have demonstrated the positive environmental externalities and macroeconomic effects of such initiatives, including their impacts on GDP, unemployment, and balance of trade [1–4]. However, there are fewer studies that examine the social impacts of renewable energy development quantitatively. This should be a point of concern for developing nations, where worker often suffer from poor labor conditions as part of global supply chains. For this reason, the adoptions of renewable energy technologies should be assessed not only from environmental and economic perspectives but also from the social responsibility perspective as well.

The question the authors intend to discuss through this analysis is, "*are renewable energy technologies as friendly to humans as to the environment?*" This analysis tries to answer this substantial question quantitatively with the help of a relatively new framework called the *social life cycle assessment*. The rest of the article is structured as follows in conformity with ISO 14040/14044. Section 2 explains the goal and scope, methods and data employed in this analysis. Section 3 presents the results of the impact assessment. Finally, based on the results, Section 4 presents the interpretation and conclusions.

2. Methods

2.1. Goal and Scope

The goal of this analysis is to assess the adverse social impacts of renewable electricity production in a developing nation, and to compare them to that of the conventional electricity production mix. For this, the authors choose Malaysia as the case example. Estimated to increase its gross domestic product at about 5–6% annually until 2020, the electricity generation in Malaysia is also expected to grow significantly with 3.5% annual growth [5]. To meet the growing electricity demand in a sustainable manner, the Malaysian government has launched the National Renewable Energy Policy in 2010, setting a renewable energy target of 11% of the total energy mix by 2020. Local policymakers acknowledge the need to capture the environmental, economic, and social impacts of renewable energy development to accelerate this rapid expansion, which push them to publish statistical data on renewable energy projects for research purposes. This makes the country a very fitting case for this analysis. While this analysis focuses on Malaysia, the results should be representative of how renewable development in southeast Asian nations would affect the labor in the electricity supply chain, due to the similar renewable cost structures in these nations.

The products assessed in this analysis were electricity from solar PV, biomass power, hydropower and the current electricity production mix in Malaysia. The system considered in this study was *cradle-to-gate*, or the product life cycle from resource production to the electricity production but without consideration of waste disposal or decommission after the life of the plant.

2.2. Social Life Cycle Assessment

Life cycle assessment (LCA) is a commonly-used analytical framework to quantify the impact of a product or a service over its lifetime. LCA has been primarily applied to the assessment of environmental emissions, most notably to compare the carbon dioxide emissions. Social life cycle assessment, or S-LCA, is an emerging framework to assess the social impacts of products or services through LCA. S-LCA has been developed in conformity to the international standard of LCA, ISO14040/44, and its first guideline was published by United Nations Environmental Programme and Society of Environmental Toxicology and Chemistry [6]. S-LCA looks into social impact on the workers in the product supply chain, for categories including health and safety, human rights, cultural heritage, working conditions, and governance. Results from S-LCA enable the identification of areas of improvement and comparison of products from the standpoint of their social performance, which could be valuable for both policymaking and corporate decision-making is to facilitate the enhancement of social conditions.

For its helpfulness in policymaking, S-LCA has been increasingly applied to various products and services in the last several years, including tourism, farming, and recycling systems [7–10]. However, few have applied S-LCA to assess the impact of the introduction of science and technology; in fact, none of the preceding studies have applied the framework to make a comparison of different electricity generation systems.

The authors believe S-LCA can be an ideal framework to quantitatively discuss the intersections between science and society that have policy implications. S-LCA can be especially beneficial in the energy sector, where the supply chains are cross-border and the interactions between human rights, standard of living and natural resources are complex. The authors hope that this analysis fills this gap.

2.3. Social Hotspots Database

Social Hotspots Database (SHDB) was used in this analysis as the database to calculate the social impact of the supply chain of renewable electricity. SHDB is a follow-up initiative to the UNEP/SETAC

Guidelines developed by New Earth, and is the first commercially available database for S-LCA to enable the identification of the social impact along the product supply chain [11,12]. SHDB is based on the global trade analysis project (GTAP) input-output model, and the database is composed of sector and country-specific tables of indicators for 57 sectors in 133 countries to support identifying hotspots in supply chains based on potential social impacts. SHDB enables the efficient application of S-LCA by providing data for: (1) labor intensity in worker hours per unit process; (2) risk for, or opportunity to affect relevant social themes or sub-categories related to human rights, labor rights, and decent work, governance and access to community services; and (3) gravity of a social issue [13]. With SHDB, social impacts of a product system can be measured in "Risk Hours (RH)." Risk Hours represents the weighted cumulative labor hours where workers in the supply chain may be at risk for each specific social issue. The authors used the 2013 version of SHDB, which is based on the GTAP model published in 2008 and social risk data from years 2010–2012 [14]. Considering major renewable energy development projects in Malaysia took place around 2011 [15], the 2013 SHDB would provide timely valid risk data for this analysis.

2.4. Impact Assessment Method

SHDB provides an impact assessment method for S-LCA named Social Hotspot Index (SHI). SHDB and SHI have 22 midpoint impact categories (called Social Themes) and five endpoint impact categories (called Social Category) as illustrated in Figure 1. For each theme and for many indicators, impact subcategories called Characterized Social Issues are available as summarized in Table 1.

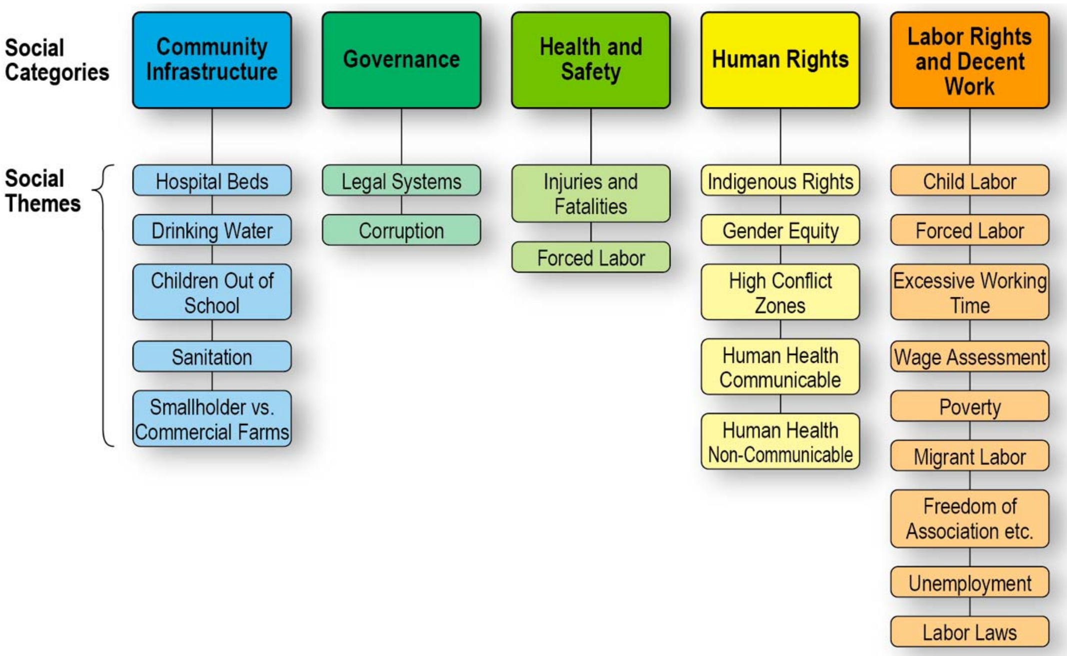


Figure 1. Social Hotspots Database midpoint and endpoint impact categories [16].

Table 1. Characterized Social Issues by Social Theme and Category [13].

Social Theme (Name of Table)	Data Indicator	Characterized Issue
Labor Laws/Conventions	Number of Labor Laws	Risk of Country not passing Labor Laws
	Number of Labor Laws by sector	Risk of Country not passing Labor Laws by Sector
	Number of Labor Conventions ratified (out of 81 possible)	Risk of Country not adopting Labor Conventions
	Number of Labor Conventions ratified by sector	Risk of Country not adopting Labor Conventions by Sector
	Year of last Minimum Wage Update	Risk of Minimum Wage not being updated

Table 1. *Cont.*

Social Theme (Name of Table)	Data Indicator	Characterized Issue
Wage Assessment	Minimum Wages (USD)	Risk of Country Average Wage being < Minimum Wage
	Average Unskilled Wages (USD) in country	
	Non-Poverty Guideline (USD)	Risk of Country Average Wage being < Non-Poverty Guideline
	Average Unskilled Wages (USD) in country	
	Minimum Wages (USD)	Risk of Sector Average Wage being < Minimum Wage
	Average Unskilled Wages (USD) by sector	
	Non-Poverty Guideline (USD)	Risk of Sector Average Wage being < Non-Poverty Guideline
	Average Unskilled Wages (USD) by sector	
Population living in Poverty	Percent of Population living on <$2/day	Risk of Population living on <$2/day
Child Labor	Child Labor % in country	Risk of Child Labor in country
	Child Labor % by sector	Risk of Child Labor by sector
Forced Labor	Qualitative	Risk of Forced Labor in country
	Qualitative	Risk of Forced Labor by sector
Excessive Working Time	Percent working >48 h/week in country	Risk of Population working >48 h/week in country
	Qualitative	Risk of Population working >48 h/week by Sector
Freedom of Association, Collective Bargaining, Right to Strike	Qualitative	Risk of not having Freedom of Association Rights
	Qualitative	Risk of not having Collective Bargaining Rights
	Qualitative	Risk of not having the Right to Strike
Unemployment	Unemployment Average % from 2000–2009	Risk of High Unemployment in country
	Unemployment % by sector	Risk for High Unemployment by sector
Legal System	World Bank Worldwide Governance Indicator—Rule of Law	Risk of Fragility in Legal System
	Bertelsmann Transformational Index - Rule of Law, Independent Judiciary	
	CIRI Human Rights Index—Independent Judiciary	
	Global Integrity Index—Judicial Accountability	
	Global Integrity Index—Rule of Law	
	Global Integrity Index—Law Enforcement	
	World Justice Project—Average	
Indigenous Rights	Presence of indigenous population, X	Not characterized
	Indigenous Population, %	Amount of Indigenous Population
	ILO Convention adopted for Indigenous Population, Y or N	Risk of country not adopting Indigenous ILO convention and UN Declaration
	UN Declaration for Indigenous Population, endorsed (Y), abstained (A), against (N)	
	Number of Laws enacted to protect Indigenous Population	Risk of country not passing Laws to protect Indigenous Population
	Qualitative	Risk for Indigenous Rights Infringements by Sector
Gender Equity	Social Institutions and Gender Index	Risk of Gender Inequity
	Global Gender Gap	
	World Bank Gender Development Indicator	
	World Bank Gender Empowerment Index	
	CIRI Human Rights Index—Economic	
	CIRI Human Rights Index—Political	
	CIRI Human Rights Index—Social	
	Adolescent fertility rate (births per 1000 women ages 15–19)	Not characterized
	Fertility rate, total (births per woman)	Not characterized

Table 1. *Cont.*

Social Theme (Name of Table)	Data Indicator	Characterized Issue
	Share of women employed in the nonagricultural sector (% of total nonagricultural employment)	Not characterized
	% Unemployment, (% of female labor force unemployed/% of male labor force unemployed)	Not characterized
	% of women workers vs. men by sector	Risk of Gender Inequity by sector
High Conflict Zones	Heidelberg Conflict Barometer—# of conflicts	Risk for High Conflict
	Heidelberg Conflict Barometer—maximum intensity of conflicts (1–5)	
	Heidelberg Conflict Barometer—change in conflicts (positive = worsening)	
	Number of Refugees—UN Refugee Agency	
	Center for Systemic Peace Indicator	
	Minority Rights Group Indicator	
	Top Risers from last year in Minority Rights Group Indicator, X	
	Qualitative	Risk for High Conflict specific to sectors
Human Health—Communicable Diseases and Other Health Risks besides Disease	Life expectancy at birth (years) 2008	Risk of low life expectancy
	Mortality rates for injuries (per 100,000 population) 2004	Risk of high mortality rates due to injury
	Proportion of undernourished % of total population, (−) = <5% 2005–2007	Risk of high undernourishment
	Deaths due to indoor and outdoor air and water pollution (per one million population) 2004	Risk of death due to air and water pollution
	Population affected by natural disasters, average per year per million 2000–2009	Risk of death due to natural disasters
	Cases of HIV (per 1000 adults 15–49 years) 2010	Risk of HIV 2010
	Cases of Tuberculosis (per 100,000 population) 2008	Risk of Tuberculosis 2008
	Cases of Malaria (per 100,000 population) 2008	Risk of Malaria 2008
	Cases of Dengue Fever (per 100,000 population) 2005	Risk of Dengue Fever, 2005
	Cases of Cholera 2008	Risk of Cholera 2008
	Mortality rates from communicable diseases (per 100,000 population) 2004	Risk of mortality from communicable diseases
Children Out of School	Children out of School—male	Risk of Children not attending School–male
	Children out of School—female	Risk of Children not attending School–female
	Children out of School—total	Risk of Children not attending School–total
Access to Improved Drinking Water	Access to Improved Drinking Water, %—rural	Risk of not having access to Improved Drinking Water—rural
	Access to Improved Drinking Water, %—urban	Risk of not having access to Improved Drinking Water—urban
	Access to Improved Drinking Water, %—total	Risk of not having access to Improved Drinking Water—total
Access to Improved Sanitation	Access to Improved Sanitation, %—rural	Risk of not having access to Improved Sanitation—rural
	Access to Improved Sanitation, %—urban	Risk of not having access to Improved Sanitation—urban
	Access to Improved Sanitation, %—total	Risk of not having access to Improved Sanitation—total
Access to Hospital Beds	Access to Hospital Beds—# beds/1000 pop	Risk of not having Access to Hospital Beds

Based on the inventory data for 705 indicators, SHDB weights and calculates the SHI as Equation (1).

$$SHI = \frac{\sum_{T=1}^{n} R_{avg} W}{\sum_{T=1}^{n} R_{max} W} \quad (1)$$

where n represents the number of Social Themes, R_{avg} represents the average risk of the Social Theme, R_{max} represents the maximum risk for a theme and W represents the weighting factor [17]. The weighting factor is assigned based on the risk levels: 10 for very high, 5 for high, 1 for medium and 0.1 for low. For normalization of the results, the SHDB simply weights all Social Categories equally.

This social life cycle impact assessment methodology is illustrated by Shemfe et al. as Figure 2 [17]. The 22 midpoint impact categories of SHDB are part of the international auditable certification for the promotion of labor rights, SA8000 [18]. Although currently there are no ISO norms specifically for S-LCA, SHDB is based on the principles of LCA ISO norms (ISO 14040/14044) and is in conformity to the UNEP/SETAC Guidelines [19].

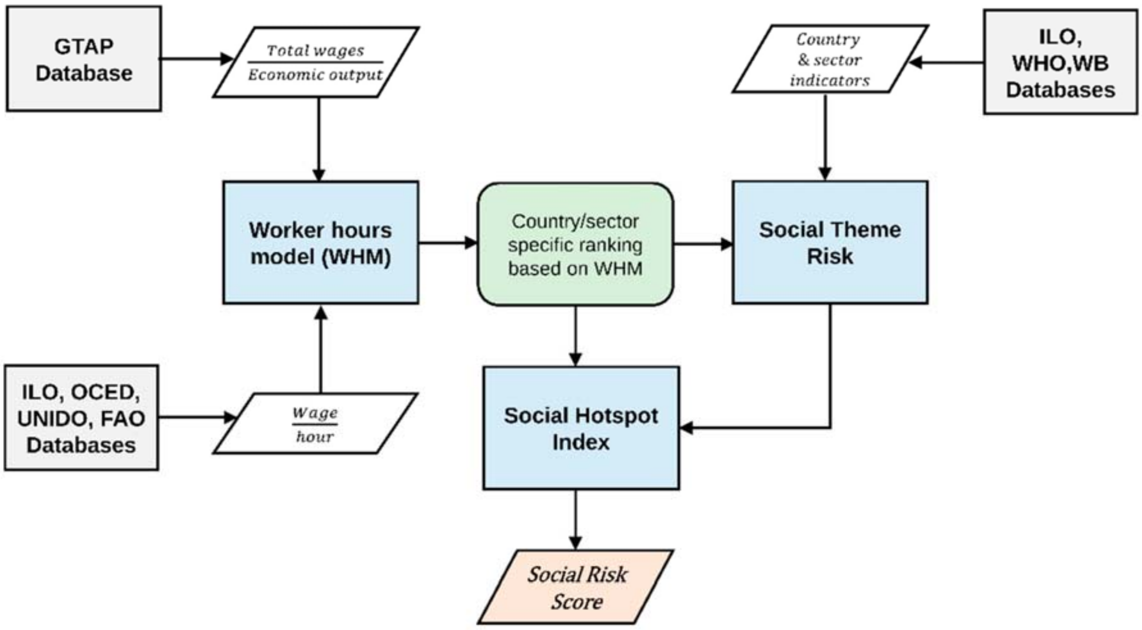


Figure 2. Methodology of the Social Life Cycle Impact Assessment with SHDB [17].

2.5. Data Collection

The authors collected the life-cycle cost structure data for renewable energy sources in Malaysia from a report published by ASEAN Centre for Energy in 2016 [20], which reports the levelized costs of electricity (LCOE) of renewable electricity based on surveys of 21 solar photovoltaic (PV), five biomass, and five hydro power plants in Malaysia. In this report, LCOE is defined as the net present value of the unit cost of electricity over a lifetime, calculated by dividing the net present value of all costs over the lifetime of the project by the total electricity output of the project [20]. Due to the difficulties in assuming different lifetimes for every project, a lifetime of 20 years was assumed for all plants. A discount rate of 10% is used for all projects, which applies to social impacts as well. Each cost breakdown is then assigned a GTAP model section code as well as a harmonized commodity description and coding systems 6-digit trade category code (HS-6) by the authors.

The countries-of-origins data for each capital expenditure (CAPEX) sector were collected from the economic atlas, which are derived from the countries reporting to the United Nations Statistical Division (COMTRADE), and raw trade data on services are from the International Monetary Fund (IMF) Direction of Trade Statistics database [21]. The authors referenced the import trade statistics of Malaysia in 2016 for each respective HS-6 code, with the cut-off importing a share value of 5%.

2.6. Product Modeling

Based on the data collection method detailed in the previous section, the levelized cost structure of each renewable electricity in Malaysia in 2016 is modeled as Figure 3. For solar PV, plants are classified based on their capacity as small (below 100 kW output), medium (above 100 kW but below 1000 kW), and large (above 1000 kW). For biomass and hydro power electricity, the cost modeling was based on the country average data. The costs reported by ASEAN Centre for Energy were converted into USD2002 by multiplying by 0.74957 to adjust for inflation. Because of the lack of necessary trade data, the mineral products from Brunei were calculated as the ones from Malaysia. Since the mineral products from Brunei only amounts to 0.2% of the LCOE of hydroelectricity, this change does not affect the results significantly. For the conventional electricity model in Malaysia, the default product model provided by SHDB for electricity in Malaysia was used without modifications. (The cost structures and the country-of-origins models are attached as Supplementary Materials as Tables S1 and S2.)

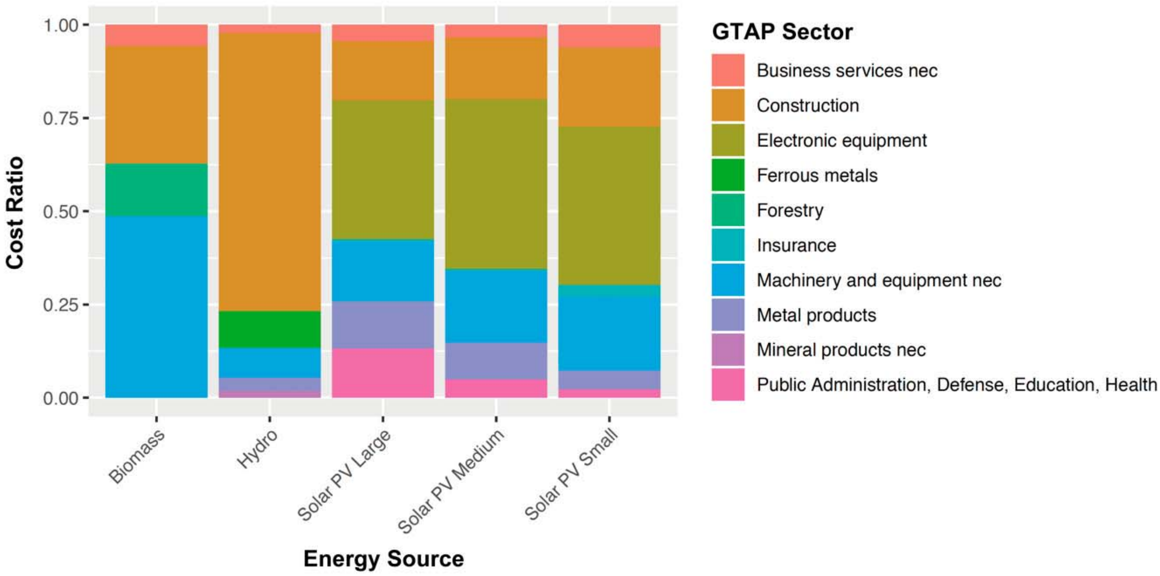
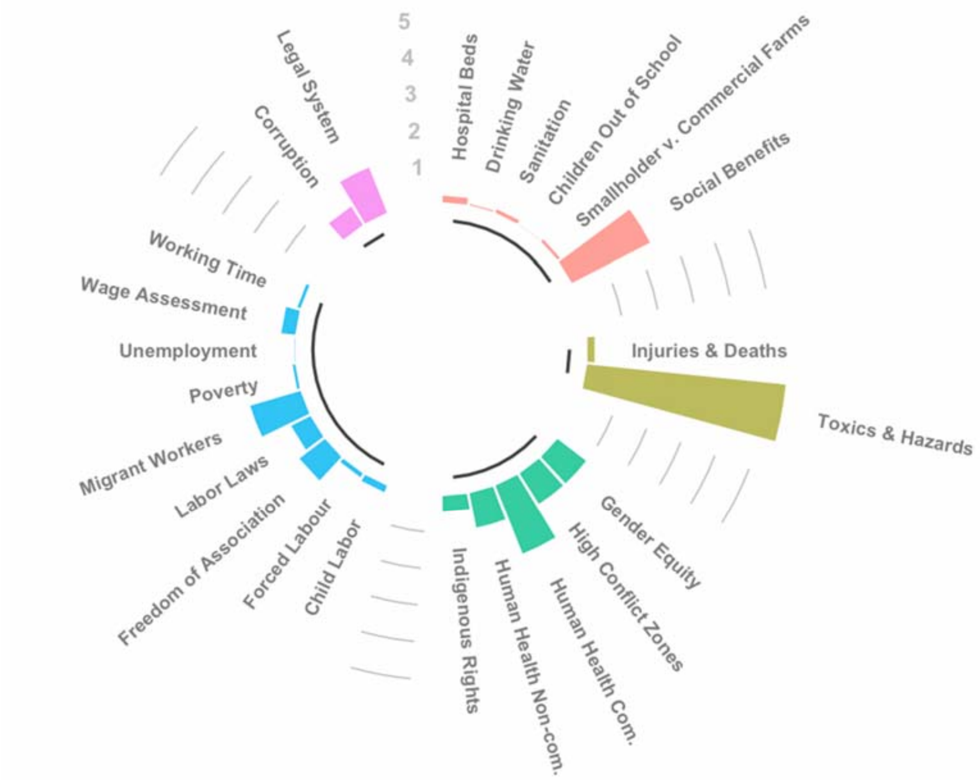


Figure 3. GTAP sector cost ratios of renewable electricity in Malaysia in 2016.

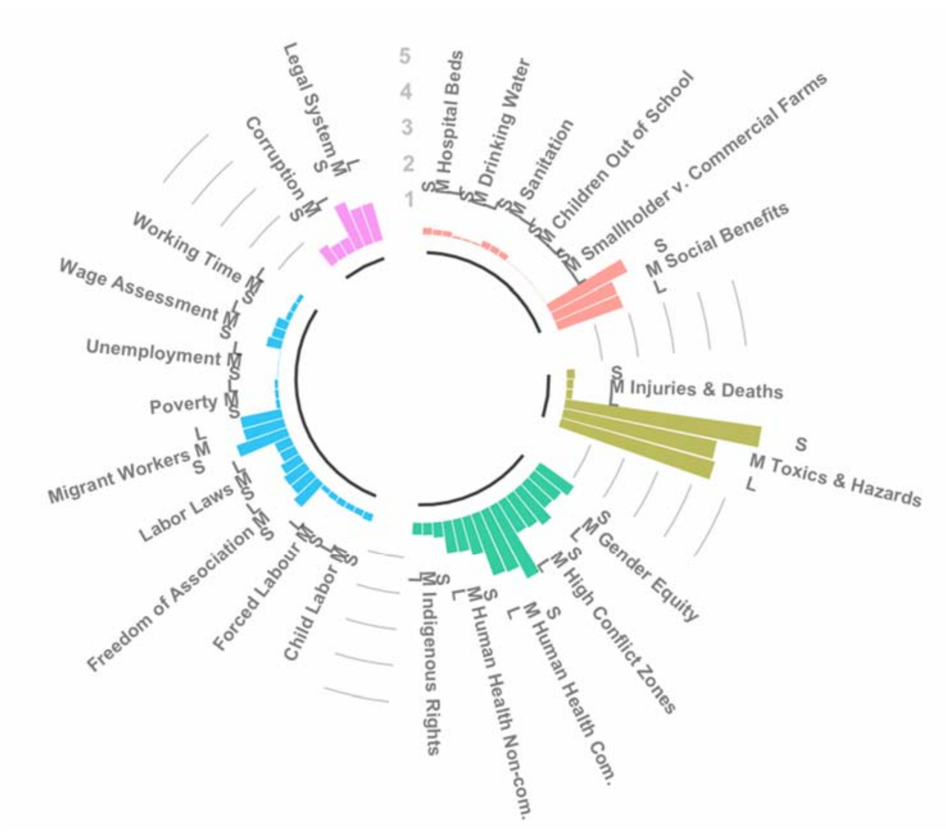
3. Results

3.1. Social Life Cycle Impact Assessment

The social impact of 1 kWh of electricity from five renewable sources (biomass, solar PV small, solar PV medium, solar PV large, and hydro) as well as the conventional production mix were assessed with SHDB on openLCA 1.7.2. The calculated Risk Hours inventories were then weighted and converged into 24 Social Themes and 5 Social Categories with the Social Hotspot Index as illustrated in Figures 4 and 5.

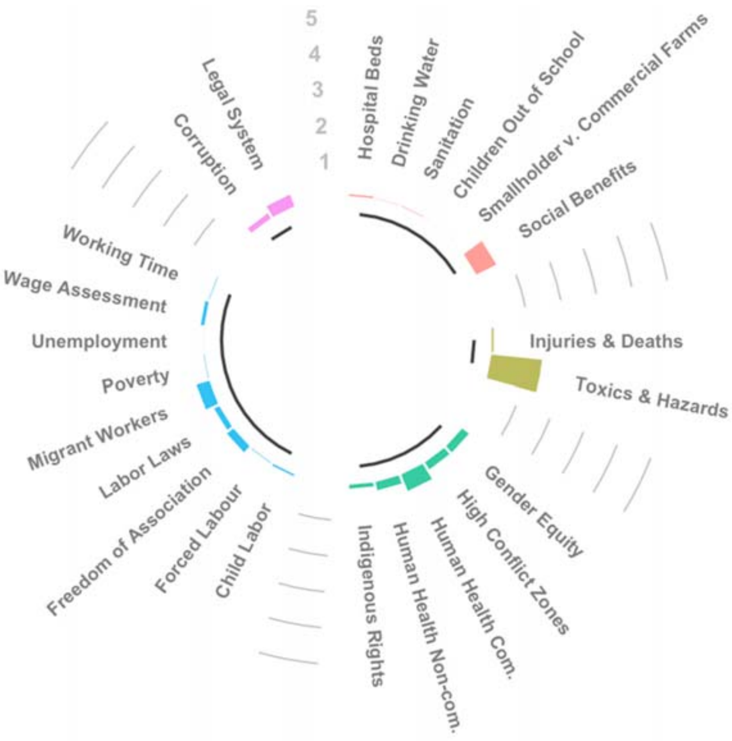


(a) Biomass



(b) Solar PV (S: below 100 kW, M: between 100-1,000 kW, L: above 1 MW)

Figure 4. *Cont.*



(c) Hydro

Figure 4. Midpoint life cycle impact assessment results: (**a**) Biomass; (**b**) Solar PV; (**c**) Hydro.

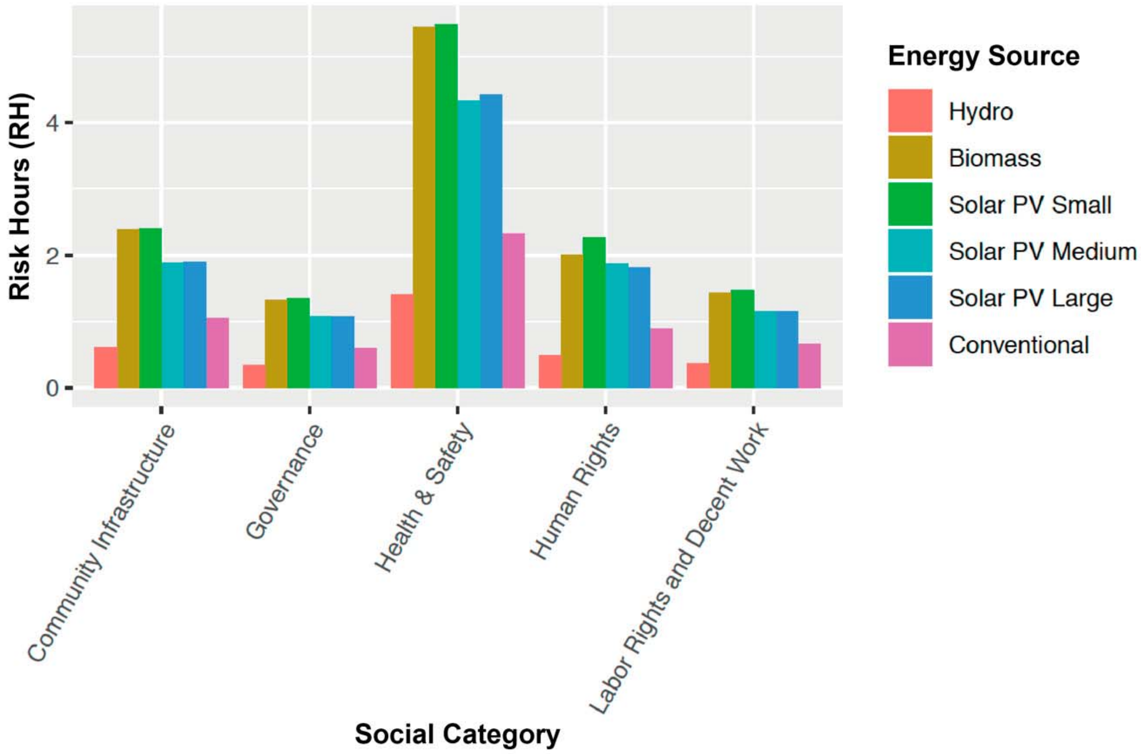


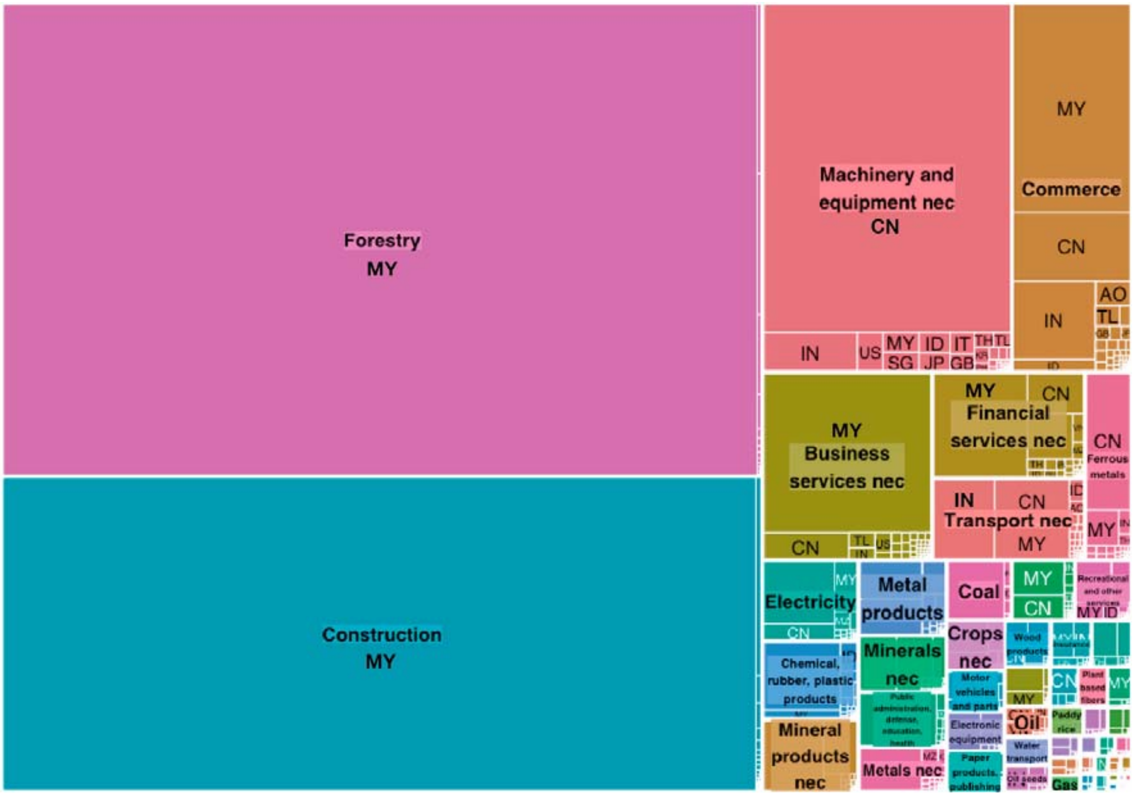
Figure 5. Comparison of social impacts of various electricity production method by Social Categories.

Figure 5 indicate that regardless of the energy sources, renewable electricity has similar social impact patterns: the health and safety category has the greatest adverse social impact in the supply chain due to the great impact from toxics and hazards. A similar pattern is also observed for the conventional electricity mix.

3.2. Process and Country Contributions

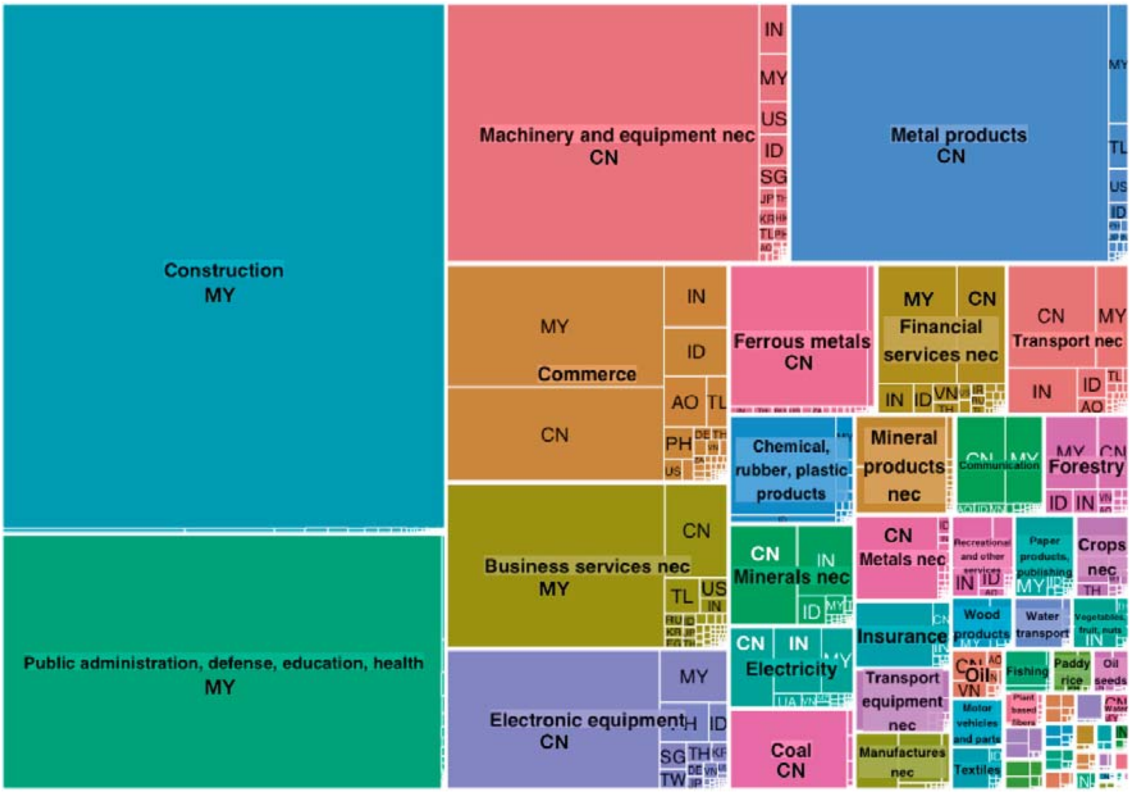
The calculated process and country contributions of biomass, solar PV and Hydro are illustrated in Figure 6a–c, respectively. Here, the areas for each process are drawn in proportion to the total Risk Hours of each sector/country.

Figure 6 shows that the construction in Malaysia is the largest social footprint contributor for both hydro and solar PV electricity. In particular, construction is responsible for more than 60% of the social footprint of hydroelectricity. For solar PV, electronic equipment and metals from China are the second largest contributor when combined, which reflects the fact that a large share of the solar panels, and its mounting parts come from China. Another large contributor to solar PV was the public administration in Malaysia, which reflects the licensing cost for a significant portion of the capital expenditures for solar PV plants in Malaysia. On the contrary, the largest social footprint contributor of biomass electricity came from the forestry in Malaysia, followed by the construction in Malaysia.

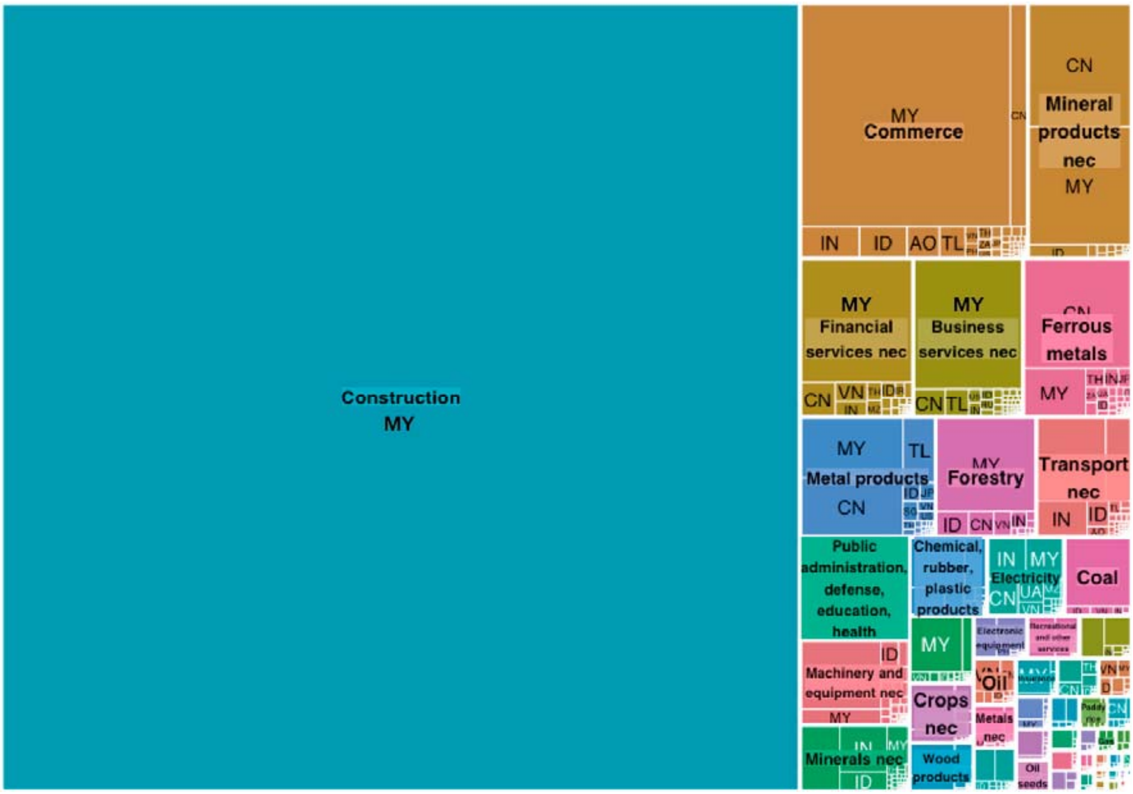


(a) Biomass

Figure 6. *Cont.*



(b) Solar PV (Large)



(c) Hydro

Figure 6. Process and country contributions: (**a**) Biomass; (**b**) Solar PV; (**c**) Hydro. (MY: Malaysia, CN: China, IN: India, ID: Indonesia).

4. Discussion

4.1. Normalized Social Footprint per Unit-Electricity vs. Unit-Cost

Figure 7 shows the calculated normalized social footprint for each electricity source, (a) per 1 kWh and (b) per 1 USD of generation cost. According Figure 7a, the electricity from renewables had a greater adverse social impact per unit-electricity than the conventional electricity mix per kWh, except for hydroelectricity. Biomass (19.5 RH) exhibited 227% of the social impact of conventional electricity (8.6 RH). Solar PVs exhibited differing degrees of social impact: small-scale solar PV (defined as < 100 kW output) had the greatest social impact among the five assessed renewable energy sources with 20.7 RH; mid-scale and large-scale solar PVs (defined as 100–1000 kW and > 1 MW, respectively) had a similar social impact with 16.7 and 16.6 RH, respectively, which are 14% less than biomass but 95% more than the conventional electricity mix per 1 kWh. Hydro, on the other hand, exhibited a significantly reduced social impact with 4.9 RH, which is 43% smaller than the conventional electricity mix.

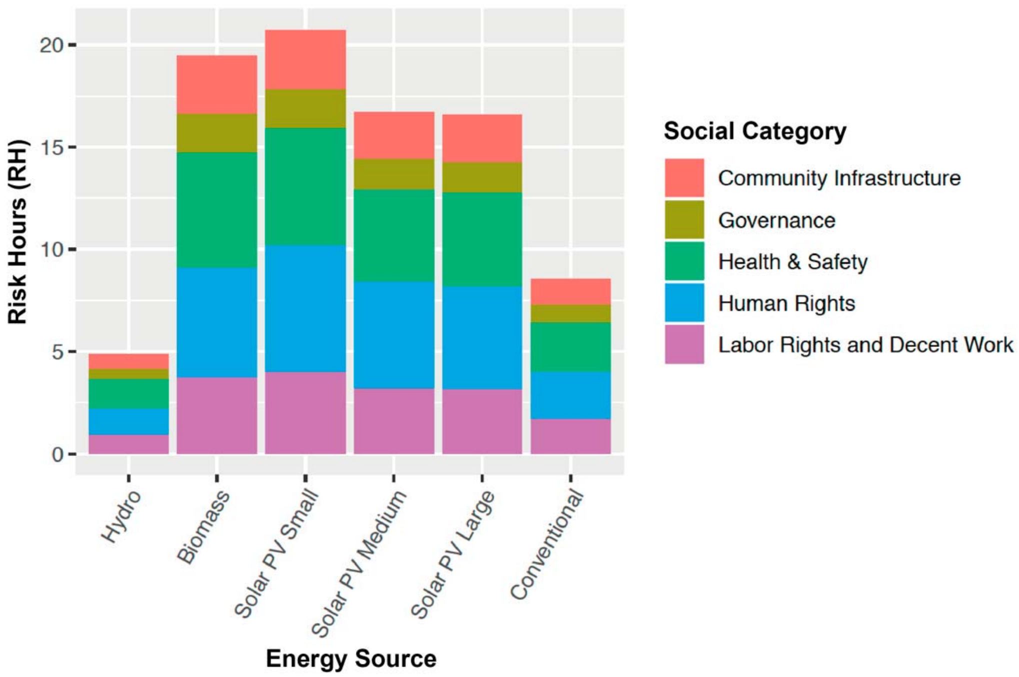
This result may be mainly attributed to the high cost of renewable electricity. According to ASEAN Centre for Energy (2016), the costs of electricity for each energy source in Malaysia are as follows:

solar PV small ($0.20/kWh) > solar PV medium ($0.17/kWh) > solar PV large ($0.15/kWh) >> biomass ($0.10/kWh) >> conventional ($0.03/kWh) ~ hydro ($0.03/kWh)

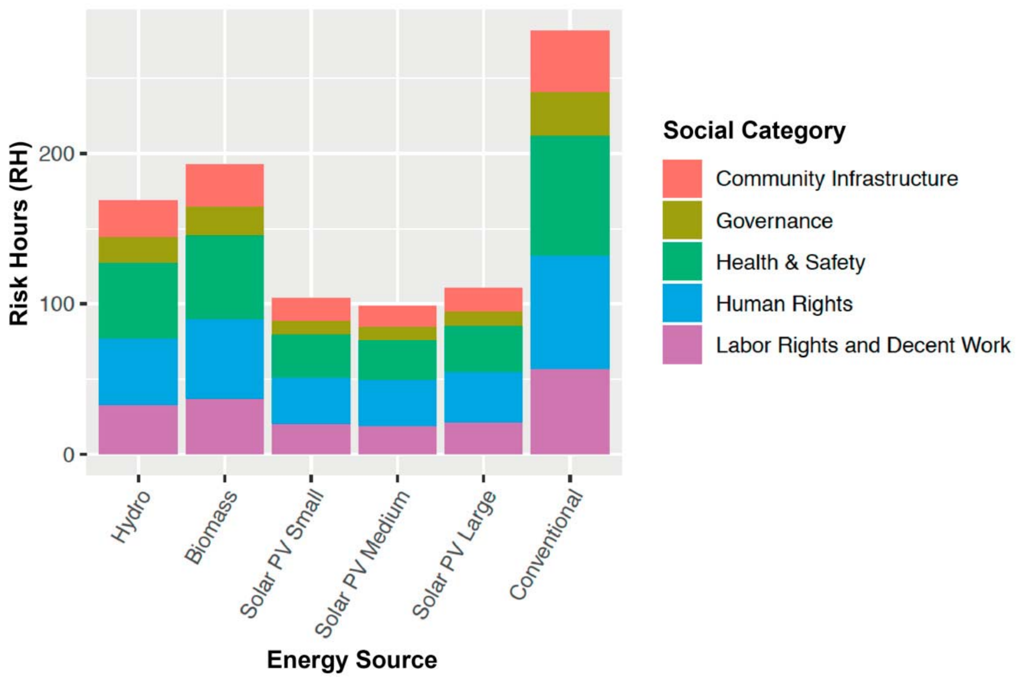
As such, comparing the social impact per unit generation cost, rather than per unit electricity generated, reveals that the solar power plant is much less impactful than all other energy sources. These comparisons are illustrated in Figure 7b, where solar PV has a 60% smaller social impact than conventional electricity per dollar spent, as follows:

conventional (281.5 RH) >> biomass (192.6 RH) > hydro (168.6 RH) >> solar PV large (110.5 RH) > solar PV small (103.5 RH) > solar PV medium (98.2 RH)

This comparison of social footprint per unit electricity vs. unit cost indicates that while the electricity from solar PV and biomass in Malaysia have a agreater adverse social impact than the conventional energy mix per unit electricity at present, labor conditions for these renewable electricity sources per unit cost are significantly better than those of conventional electricity generation. This suggests that when the generation costs of these renewable sources eventually drop and reach grid parity, the social impact of electricity generation will be mitigated through the development of these sources.



(a) Per 1 kWh of Electricity



(b) Per 1 USD of generation cost

Figure 7. Normalized social footprints: (**a**) per unit electricity, (**b**) per unit cost.

4.2. Geographical Social Hotspots of Renewable Electricity

Figure 6 shows that a great proportion of the social footprint of renewable electricity came from outside of the country as a result of the global supply chain. Figure 8 illustrates the social footprint contribution proportions of China, the largest overseas contributor, and of Malaysia.

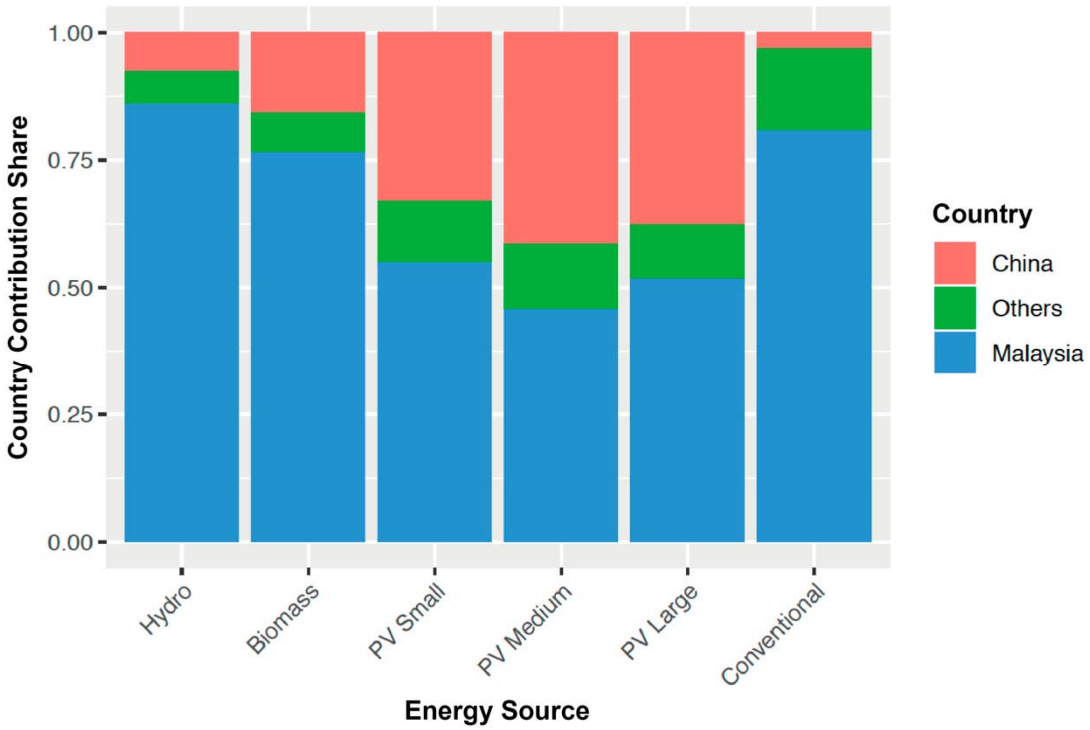


Figure 8. Geographical Social Hotspots of Renewable Electricity.

The results show that renewable electricity has a less adverse social impact domestically, while the effects are transferred to the exporting countries, in this case China. This indicates the possibility to improve the social impact of renewable electricity across the globe by improving labor conditions in a few exporting countries.

5. Conclusions

What do all these data suggest? Based on Figure 7a, it can be concluded that electricity generation through renewable energy technologies causes significantly greater stress among workers, with the exception of hydroelectricity. However, on the other hand, when the social impacts per generation cost were compared, renewables had far lower impacts than the conventional electricity mix as illustrated in Figure 7b. This is a fascinating result, because it suggests that while renewables are not as friendly to humans as to the environment at the moment, they will have the potential to be much more favorable to humans than the conventional energy mix in the future when costs of renewable electricity eventually drop. In fact, it is estimated that when solar PV achieves grid parity in the future, labor conditions through the electricity supply chain will be as much as 60% less than the conventional electricity generation in Malaysia. It was also discovered that these adverse social effects are transferred to few exporting countries, including China, as illustrated in Figure 8. This could provide an opportunity to reduce the social impacts of renewable electricity across the nation, by improving labor conditions in a few exporting countries.

Are renewable energy technologies as friendly to humans as to the environment? Based on the findings, the authors conclude that the answer is, "*not-yet, but eventually.*" This analysis suggests a clear path toward the reduction of the adverse impacts of renewables: to continue the efforts to reduce the cost of renewable energy technologies, while improving the labor conditions in key exporting countries like China.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/11/5/1370/s1, Table S1: Cost Structures and the Country of Origins Model: (a) Biomass; (b) Solar PV; (c) Hydro, Table S2: SHDB product models: (a) Biomass; (b) Solar PV; (c) Hydro.

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Supplementary Materials

Table S1. Cost Structures and the Country of Origins Model: (a) Biomass; (b) Solar PV; (c) Hydro.

(a) Biomass

Breakdown	GTAP Sector	HS-6 Cat.	Import Origin	Levelized Cost [10^{-3} USD/kWh]
Boiler, Gasifier, Pyrolysis System	41	841911	(Total)	20.24
			Italy	7.02
			UK	4.93
			China	3.97
			Japan	2.25
			USA	2.07
Generator, Gas Engine, Steam Turbine	41	850239	(Total)	14.27
			China	6.42
			Singapore	4.52
			Japan	1.43
			Germany	0.96
			USA	0.94
Fuel Preparation, Handling and Storage	41	842890	(Total)	7.60
			China	2.79
			Singapore	1.47
			Japan	1.14
			Germany	0.92
			Italy	0.67
			USA	0.61
Meter, Protection, Pollution, Others	41	853530	(Total)	7.26
			Singapore	2.01
			India	1.83
			South Korea	0.67
			China	0.55
			Italy	1.64
			UK	0.55
Grid Connection	46	-	(Domestic)	6.27
Installation	46	-	(Domestic)	21.35
Pre-construction	46	-	(Domestic)	4.35
O&M Cost	54	-	(Domestic)	5.63
Fuel Cost	13	-	(Domestic)	14.39
Total				**101**

(b) Solar PV

Breakdown	GTAP Sector	HS-6 Cat.	Import Origin	Levelized Cost [10^{-3} USD/kWh]

				Small [< 100 kW]	Med. [100 kW – 1 MW]	Large [> 1 MW]
PV Module	40	854140	(Total)	85.01	77.41	55.88
			Singapore	46.32	42.18	30.45
			China	10.43	9.50	6.86
			Germany	13.63	12.41	8.96
			Taiwan	9.46	8.62	6.22
			South Korea	5.17	4.71	3.40
Inverter	41	850440	(Total)	27.89	22.05	14.12
			China	13.87	10.97	7.02
			Singapore	8.52	6.73	4.31
			Hong Kong	3.30	2.61	1.67
			USA	2.20	1.74	1.11
Mounting Structure / Roof Mounting	37	761090	(Total)	10.10	16.72	18.95
			China	8.73	14.46	16.38
			Taiwan	0.55	0.92	1.04
			USA	0.82	1.35	1.53
Energy Meter	41	902830	(Total)	1.48	1.01	0.30
			China	0.76	0.52	0.15
			India	0.29	0.20	0.06
			Singapore	0.17	0.12	0.03
			Hong Kong	0.16	0.11	0.03
			USA	0.10	0.07	0.02
Electrical Protection System	41	853530	(Total)	5.66	5.19	2.17
			Singapore	1.57	1.44	0.60
			India	1.43	1.31	0.55
			South Korea	0.52	0.48	0.20
			China	0.43	0.39	0.16
			Italy	1.28	1.18	0.49
			UK	0.43	0.40	0.17
Balance of System	41	854411	(Total)	4.58	4.31	7.40
			China	2.11	1.98	3.40
			Singapore	0.88	0.83	1.42
			Japan	0.71	0.67	1.15
			USA	0.88	0.83	1.42
Grid Connection Costs	46	-	(Domestic)	3.56	8.12	15.37
Transport and Freight Insurance	53	-	(Domestic)	6.53	1.01	1.03
Design, Engineering, Project Management	54	-	(Domestic)	9.89	4.74	1.48
Installation	46	-	(Domestic)	36.99	17.76	6.65
Civil Works	46	-	(Domestic)	1.98	2.20	1.77
Land Acquisition and Development	54	-	(Domestic)	0.00	0.05	2.81

Consulting Services, Licenses, Permits	56	-	(Domestic)	4.55	8.46	19.95
O&M Cost	54	-	(Domestic)	2.20	0.85	2.25
Total				200	170	150

(c) Hydro

Breakdown	GTAP Sector	HS-6 Cat.	Import Origin	Levelized Cost [10^{-3} USD/kWh]
Conveyance System	35	730449	(Total)	2.87
			Japan	0.71
			Singapore	0.69
			China	0.44
			Italy	0.37
			Spain	0.25
			Germany	0.22
			UK	0.17
Turbine and Generator	41	841012	(Total)	2.26
			Belgium	0.97
			Austria	0.78
			Germany	0.52
Power House	34	681091	(Total)	0.33
			China	0.25
			Brunei	0.06
			Singapore	0.02
Electrical Protection System	41	853530	(Total)	0.03
			Singapore	0.01
			India	0.01
			Italy	0.01
Headworks	34	252390	(Total)	0.22
			China	0.10
			Singapore	0.06
			Japan	0.01
			USA	0.05
Others	37	731829	(Total)	1.04
			China	0.29
			Singapore	0.26
			Japan	0.23
			Taiwan	0.12
			France	0.07
			USA	0.08
Grid Connection		-	(Domestic)	3.12
Transport and others		-	(Domestic)	0.06
Installation				5.28
Civil works				11.16
Pre-construction		-	(Domestic)	1.99
O&M Cost	54	-	(Domestic)	0.61
Total				**29**

Table S2. SHDB product models: (a) Biomass; (b) Solar PV; (c) Hydro.

(a) Biomass

GTAP Sector		Country	Cost [10^{-3} USD2002/kWh]
No.	Description		
13	Forestry	Malaysia	10.79
41	Machinery and equipment nec	China	10.29
		Singapore	6.00
		Japan	3.62
		Germany	1.41
		Italy	6.99
		USA	2.71
		India	1.37
		South Korea	0.50
		UK	4.11
46	Construction	Malaysia	23.97
54	Business services nec	Malaysia	4.22

(b) Solar PV

GTAP Sector		Country	Cost [10^{-3} USD2002/kWh]		
No.	Description		Small [< 100 kW]	Med. [100 kW–1 MW]	Large [> 1 MW]
37	Metal products	China	6.55	10.84	12.28
		Taiwan	0.41	0.69	0.78
		USA	0.61	1.01	1.15
40	Electronic equipment	Singapore	34.72	31.62	22.82
		China	7.82	7.12	5.14
		Germany	10.21	9.30	6.71
		Taiwan	7.09	6.46	4.66
		South Korea	3.88	3.53	2.55
41	Machinery and equipment nec	Singapore	8.35	6.83	4.77
		India	1.29	1.13	0.45
		South Korea	0.39	0.36	0.15
		China	12.87	10.39	8.05
		Italy	0.96	0.88	0.37
		UK	0.32	0.30	0.12
		Japan	0.54	0.50	0.87
		USA	2.38	1.98	1.92
		Hong Kong	2.59	2.03	1.28
46	Construction	Malaysia	31.88	21.05	17.83
53	Insurance	Malaysia	4.89	0.76	0.78
54	Business services nec	Malaysia	9.06	4.23	4.90
56	Public Administration, Defense, Education, Health	Malaysia	3.41	6.34	14.95

(c) Hydro

GTAP Sector		Country	Cost
No.	Description		[10^{-3} USD2002/kWh]
34	Mineral products nec	China	0.26
		Singapore	0.06
		Japan	0.01
		USA	0.04
		Brunei	0.05
35	Ferrous metals	Japan	0.54
		Singapore	0.52
		China	0.33
		Italy	0.28
		Spain	0.19
		Germany	0.17
		UK	0.13
37	Metal products	China	0.21
		Singapore	0.19
		Japan	0.17
		Taiwan	0.09
		France	0.05
		USA	0.06
41	Machinery and equipment nec	Belgium	0.73
		Austria	0.58
		Germany	0.39
		Singapore	0.01
		India	0.01
		Italy	0.01
46	Construction	Malaysia	16.20
54	Business services nec	Malaysia	0.46

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Research article

Examining risk and return profiles of renewable energy investment in developing countries: the case of the Philippines

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Abstract: This paper examines the risk and return profiles of energy companies with renewable energy (RE) investment in developing countries taking the Philippines as our country case study. First, we analyze the impact of the global RE project specific risk and country risk on RE projects using a simple capital asset pricing model (CAPM) by benchmarking stock returns of these companies to either the global S&P Global Clean Energy (S&P GCE) index or to the local Philippine Stock Exchange (PSE) index. Our findings show that the Energy Development Corporation (EDC), a "pure" RE company, is affected by both these risks examined on short- and mid- to long-term investment interval, while those with partial investment in renewables are affected only on the short-term. Next, we calculated these companies' abnormal returns by using the Jensen's alpha. Results show that EDC's alpha values are positive on all short- and medium-to-long term investments and on both indices, suggesting that Philippine RE companies are possibly underestimated on both the global RE market and the Philippine stock market. Lastly, we examined the latest feed-in tariff (FIT) level by using the beta results of EDC and the FIT structure of solar PV. Results show that the FIT rate generates profit to both the global and local RE companies' risk and returns from the investors' perspective, but is higher than the desired FIT rate from the policymakers' perspective. This paper aids in investment decision-making by showing that differences in investment timeframes and RE shares could impact investment outcomes in developing countries.

Keywords: renewable energy investment; CAPM; developing countries; Philippines

JEL Codes: G12, G15, Q20

1. Introduction

Global warming is a critical issue for the survivability of human beings. As one of the most effective actions from the industrial perspective, more than 170 countries now have already set up their renewable energy (RE) targets and an estimated 150 countries have created policies that support renewables (KPMG, 2016). In terms of generations, the developing countries of China, India and Brazil alone had electricity generation by renewables of 634.2, 121.5, and 104.5 TWh, respectively, whose sum consists of a 35% share of renewables globally of 2480.4 TWh in 2018 (BP, 2019). This trend is applicable to the current situation in the Philippines where the relative abundance of RE resources in the Philippines compared to other countries in Table 1.

Table 1. RE Potential by Fuel Type. This shows the RE potential of the Philippines as estimated by the Philippines Department of Energy.

Fuel Type	Potential Capacity, Grid Use (in MW)
Hydropower	10,000
Ocean Energy	170,000
Geothermal	4,000
Wind	76,600
Solar	5 kWh/ m^2/day
Sugar cogen, rice husk, and coconut revenues	500

Although the introduction of REs is accelerating in developing countries, we have the challenges that could affect RE investments in developing countries like the Philippines: It is important in making investment decisions for renewables that the risks involved are properly evaluated and likewise compensated for. When undertaking investments, debtors and investors are keen into knowing an asset/project's cost of capital or the asset/project's risk and returns. Knowing the proper cost of capital also gives an effective tool to the policymakers so that they too can structure the incentive rates like the feed-in tariff (FIT) to ensure it bears the right balance between sufficient enough to attract investments but won't be too high to burden taxpayers.

The cost of capital for small and medium-sized RE companies in the Philippines mostly uses a higher percentage of own funding or equity finance given that banks are still unfamiliar with RE projects and are reluctant to lend (Saculsan and Mori, 2018). With an immature capital market that cannot provide long-term finance and without a "ready and guaranteed" power market for the output of renewables, renewables put it at a disadvantage compared conventional energies like coal in the Philippines (KPMG, 2013). In order to solve these issues, determining the risk and returns of equity finance for RE projects in the Philippines will be the primary focus of this paper.

The risk and return relationship of equity finance for RE projects is evaluated in financial markets. Thus we have literature of the performance of RE companies in financial markets. The value of RE companies based on the stock prices is often discussed with the relation with energy prices. Sadorsky (2012a) employs multivariate GARCH and dynamic conditional correlation (DCC) models to analyze the volatility spillovers between oil prices and the stock prices of clean energy companies and technology companies. Managi and Okimoto (2013) found a positive relationship between oil and clean energy prices after structural breaks around the beginning of 2008 by using Markov-switching VAR model. These studies are quite interesting. However, as the literature focusing on the performance of RE companies is limited. Inchauspe, Ripple, and Trück (2015) examine the dynamics of excess returns for the WilderHill New Energy Global Innovation Index, which lists firms in the RE sector and is used as a global benchmark and find evidence for underperformance of the RE sector relative to the considered pricing factors after the financial crisis. Sadorsky (2012b) uses a variable beta model to investigate the determinants of RE company risk listed in the global fund based on the WilderHill Clean Energy Index. The empirical results show that company sales growth has a negative impact on company risk while oil price increases have a positive impact on company risk. These studies are important in the sense that the risk and return relationships for global RE companies are examined based on global clean energy indices. But they do not focus on the local RE markets in developing countries, in particular the Philippines. We fill the gap with the existing literature on the performance of RE companies.

The contributions of our paper is threefold: First, we empirically show that on short- and mid- to long term investment interval, a "pure" RE company, the Energy Development Corporation (EDC), is affected by both the global RE project specific risk and country risk, while those with partial investment in renewables are affected only on the short-term. Next, the empirical study results show that EDC's Jensen's alpha values are positive on all short- and medium-to-long term investments and on both indices, suggesting that Philippine RE companies are possibly underestimated on both the global RE market and the Philippine stock market. Lastly, we show that the FIT rate generates profit to both the global and local RE companies' risk and returns from the investors' perspective, but is higher than the desired FIT rate from the policymakers' perspective.

The paper is organized as follows: Section 2 describes the data and methodology used for this paper zooming-in the profiles and characteristics of Philippine RE companies. Section 3 presents the regression results and findings. Section 4 looks into the current FIT structure and comparing this with the new FIT structure using the generated betas as benchmarked to either the global RE's S&P GCE index or the local PSE index. Section 5 concludes and summarizes the findings of this paper. Section 6 discusses the limitations and possible future research regarding this topic.

2. Data and methodology

2.1. Data samples

The primary data for this paper is derived from the weekly and monthly average stock returns of companies listed in the Philippines Stock Exchange (PSE) website (PSE, 2016). The selected companies are all classified under the group "Electricity, Energy, Power, and Water (EEPW)". To be conservative and consistent in our research approach, the authors excluded on the list the companies that are not regularly traded and/or not listed in the above category even if they have or may have RE investment. This is done because of the complexity and difficulty in fleshing out all the companies with renewables in their portfolio from the data at hand. For example, big conglomerates like San Miguel is categorized as a "Holdings Company" in the PSE but is actually the biggest energy company with some renewables in its energy portfolio. There are also RE companies like Vivant that is not regularly traded in the PSE. Overall, the authors came up with ten companies that passed these three criteria: (i) classified as an energy company in the PSE listing; (ii) have a RE investment; and

(iii) are regularly traded (SEC, 2019). Note that EDC was voluntarily delisted in 2018 and AC Energy acquired Phinma Energy in 2019.

Table 2. Profile of Listed Energy Companies with Renewables in their Energy Portfolio. This is a brief profile of each of the selected companies in the Philippines highlighting renewables in their investment portfolio. The information is taken from these companies' financial reports and their respective company websites. RE companies under study as listed and classified under the EEPW category in the PSE website. Additional information about the company were gathered from company reports.

Company	Code	Brief Description	RE Investment
Energy Development Corporation	EDC	Primarily renewables company with almost equal investment shares between the Philippines and other countries	Geothermal, wind, solar and hydropower. **EDC is part of the First Gen Corporation Group*
First Gen Corporation	FGEN	Natural gas but owns 40% indirect economic interest of EDC	The largest clean and RE IPP in the country; wind, solar , hydropower, and geothermal
First Philippine Holdings Corporation	FPH	Major investments in power generation, real estate development, manufacturing, and construction and other services.	About 1,459.6 MW of wind, solar, and hydropower, with shares on EDC and FGEN **mostly just partnerships or indirectly through its subsidiaries*
Aboitiz Power Corporation	AP	Power distribution and generation	Geothermal, large hydro, and run-of-river hydro
Alsons Consolidated Resources, Inc.	ACR	Investment holding company, and oil and coal exploration	Hydropower **mostly in Mindanao*
Petro Energy Resources Corporation	PERC	Oil exploration and development and mining activities	Solar and wind
Phinma Energy Corporation	PHEN	Oil and gas	Wind and geothermal
Basic Energy Corporation	BSC	Primary an investment holding company; oil and gas exploration; eco farms	Geothermal and biofuels
Petron Corporation	PCOR	Refining of crude oil and the marketing and distribution of refined petroleum products including gasoline, LPG, diesel, jet fuel, kerosene, asphalts, and petrochemicals.	Hydropower **mostly engaged in refinery investments abroad*
Manila Electric Company	MER	Coal	Hydroelectric through a joint venture **mostly, if not all are coal*

Among these ten companies, the Energy Development Corporation (EDC) is particularly taken as a focal company reference given its business scope that is "purely renewables". EDC is primarily engaged in the business of "exploring, developing, operating, and utilizing geothermal and other indigenous RE sources for electricity generation" (EDC, 2016). It is worth noting however that EDC is a subsidiary of the Lopez-group First Philippine Holdings (FPH) through its First Gen Group (FGEN) having an effective 50.6 percent economic interest and a 67.1 percent voting interest in EDC.

The monthly average data, which we pertain as the mid- to long-term investment interval, is from August 1, 2016 to July 31, 2017. The weekly average data or the short-term investment interval, on the other hand, is from August 1, 2016 to August 11, 2017. The difference in timeframe is due to the availability of S&P GCE data on RE returns globally. Also, RE (except large geothermal) is relatively at the early stage of development in the Philippines. The RE law was only passed in 2008 while incentives to promote renewables like FIT was only accomplished 4 years after in 2012.

2.2. Methodology

In setting the cost of equity, the capital asset pricing model (or CAPM) is the basic and the most widely used finance methodology. CAPM is used for pricing stocks and gauging the extent to which markets are integrated (Treynor, 1961; Sharpe, 1964; Mossin, 1966). Central to CAPM is the calculation of an appropriate beta or systematic risk because this is the kind of risk that cannot be eliminated through diversifying the assets portfolio. CAPM is called the single-factor model for asset pricing because it purports that the return to an investment is a linear function of the beta.[1] By using CAPM, we fill the gap in existing literatures where not so much are written to analyze the risk and return profiles of RE companies/projects in developing countries, in particular the Philippines.

The averages of the stock returns of these companies are benchmarked using either of these two index: (i) the S&P Global Clean Energy index (here referred to as S&P GCE) or (ii) the local Philippine Stock Exchange (here referred to as PSE) index. The S&P GCE is chosen to represent the RE project specific risk because this index is one of the most popular clean energy index use globally that tracks the performance of companies that invest in clean energy specifically in RE projects.[2] Aside from this, the S&P GCE index was also chosen because of the ease of access and availability of data online. These RE project specific risks (e.g., grid risk, technological risks, policy risks, credit risk) are specifically identified to be the risks commonly faced by investors when investing in RE projects worldwide (Wing and Jin, 2015). On the other hand, the PSE is chosen to represent the country risk vis-à-vis Philippine local conditions because this is the national and the only stock exchange in the Philippines with about 261 listed companies as of September 2014 (PSE, 2017).

[1] Some empirical studies have challenged the validity and efficacy of CAPM given its underlying theoretical assumptions including investors are risk averse who are maximizing utility in the same time horizon, which beg the question if it can be applicable to the real world more so in developing countries' conditions (Basu and Chawla, 2010). Many studies have already provided empirical studies that question the suitability of CAPM to quantify the returns and risk variables of a still immature and volatile market that characterize most developing countries (Pamane and Vikpossi, 2014; Ali et al., 2010; Sehgal, 1997; Madhusoodanan, 1997; Chiang and Doong, 1999; Bautista, 2003; De Ocampo, 2003; Mobarek and Mollah, 2005). Global market integration happens when a company's stockholders hold globally diversified portfolios (Bodnar et al., 2003), while the market segmentation happens when a country's stockholders investment is confined only to its own country. The choice between the global and the market indexes makes a substantial difference in CAPM estimates in developing countries (Mishra and O'Brien, 2005). While we recognize these limitations, CAPM is still a simple and powerful tool for practitioners to analyze the relationship between risk and return of RE projects in the developing countries. Thus our analyses employ CAPM in the first order approximation.

[2] From the S&P GCE website (S&P GCE, 2019), the index provides liquid and tradable exposure to 30 companies from around the world that are involved in clean energy related businesses. The index comprises a diversified mix of clean energy production and clean energy equipment and technology companies.

These country risks (e.g., political risk, economic risk) refer to the risks associated when investing in a particular country, in this case, the Philippines (Investopedia, 2019a).

For the calculation of beta, the authors made use of a simple linear regression, which indicates the relative risk of a RE company versus a benchmark market (i.e., global S&P GCE or local PSE index) over a period as shown in the formula.

$$\text{Regress } r_i \text{ on } r_m \quad (1)$$

β = the slope of the regression estimate
r_i = one of the companies' average weekly or monthly stock price returns
r_m = market portfolio index (e.g., S&P GCE or PSE index) average weekly or monthly stock returns

Furthermore, the companies' Jensen's Alpha (or simply "α") is included to measure the average return of a portfolio or investment above or below the predicted returns under the CAPM methodology (Investopedia, 2019b). Simply put, this is the excess market returns of an investment. The value of the alpha is shown as the intercept of the regression estimate of the CAPM. It can also be computed using the equation below.

$$\alpha = r_S - \left[r_f + \beta\left(r_b - r_f\right)\right] \quad (2)$$

α= Jensen's alpha
r_S = the average sum total of a company's average weekly or monthly stock price returns
r_f= risk free rate
β = the computed beta based on either of the two indices mentioned;
r_b = the average sum total (either S&P GCE or PSE index) average weekly or monthly returns

We also looked into the t-stat value and standard error to check for the statistical significance of the results. In this case, a greater than absolute value of 2 means the computed value is statistically significant. Publicly available data on FIT regulations, for example, as issued by the Philippine Department of Energy (DOE) and Energy Regulatory Commission (ERC) are used. At last take note that although many scholars have proposed alternative methodologies to fill in this weakness of CAPM to account for the risks that is not captured by the beta of the CAPM (e. g., arbitrage pricing theory (APT) of Ross (1976), the multi-factor model of Fama and French (1996), the downside or D-CAPM of Estrada (2002), among others, this paper does not intend to propose any alternatives to CAPM because of data limitation of the country reference study, the Philippines.

3. Empirical study results and discussions

3.1. Examining the beta in terms of the global renewable S&P GCE and the local PSE over the short-term and mid- to long-term investment intervals

First, we analyzed the regression results of generated betas from the weekly average stock returns, which represent the short-term investment interval, given in Table 3. The results have adjusted R-square higher than 90% for all companies except AP and MER in cases when these companies are benchmarked to either the global S&P GCE index or the local PSE index. The adjusted R-square indicates the percentage by which the dependent variable (i.e., company's stock returns) can be predicted or explained by the independent variable (i.e., index's stock returns). In this case, 90% of the movement in the stock returns are predicted or explained by the movement in the benchmark index used.

In terms of beta results, whether benchmarked to the global renewables S&P GCE or the local PSE, all companies generated positive and statistically significant betas close to 1. This entails that all companies stock price returns and thereby their risks can be predicted by the movement in both the global renewables market and the Philippine local market. This may be because of the characteristics of RE projects that are characterized by relatively short-term events like weekly events compared to the other generation sources like fossil fuel-fired power plants, resulting in no distinction between project risk and country risk.

Now zooming in the regression results of our proxy to a "pure" RE company, EDC, as shown in Table 3, EDC's beta results are almost similar when benchmarked to both indices although a bit closer to 1 when data is benchmarked to the global renewables S&P GCE index. These beta results as well as the models itself are both statistically significant with less than 5% error of beta. Also, the two models' adjusted R-squares are 98.9% indicating that the stock returns for short-term investment could be predicted by the movement in both of the two index used. Thus, looking at a short-term investment interval, we see that energy companies with RE investment are strongly affected by both global RE project specific risk (represented by the S&P GCE index) and the country risk (represented by the PSE index).

Next in Table 4, we analyzed each company's monthly average stock returns to represent the mid- to long-term investment interval. When benchmarked to the global renewables S&P GCE index, beta results are more variable and have larger gaps from one company to another. Among these companies, only EDC and ACR have betas close to 1 although EDC alone is statistically significant. These results are also similar even when the stock returns were benchmarked to the local PSE index, only this time EDC and PERC have betas close to 1 and EDC alone is statistically significant.[3]

In both market index, EDC is the only company that have positive and statistically significant beta. However, EDC's adjusted R-squares are 55.8% and 35.2% when benchmarked to the global renewables S&P GCE and local PSE respectively, as shown in Table 4. This suggest that the variability in the stock returns could only be "partially" explained by the movement in these benchmark markets on a mid- to long- term investment interval.

Overall, judging from positive and statistically significant beta, the results imply that on both short and mid- to long-term investment intervals, EDC is the only RE company that is affected by both the global RE project specific risk and country risk in the sense that S&P GCE and PSE markets reflect the global RE project specific risk and country risk, respectively. Meanwhile, energy companies with partial investment in renewables tend to work as defensive assets to market portfolio, which are affected by these two risks for the short-term investment interval only but not for the mid- to long-term investment interval. This implies that when investing in the RE projects in developing countries, it is important to examine in advance how much the RE projects' share in the prospect companies is from the viewpoint of RE project specific risk and country risk.

[3] One may think that the company MER moves against the markets when monthly data are used. But the betas of MER are not statistically significant from the corresponding errors. The implication is that MER does not move with the markets.

Table 3. Beta Results using Weekly Average Stock Returns. Results show that adjusted R-squares are higher than 90% for all companies except AP and MER in both cases where these companies are benchmarked to the global S&P GCE and the local PSE indices. This suggests 90% of the movement stock returns for short-term investment is predicted or explained by the movement in the benchmark index used. In terms of beta results, whether benchmarked to the global S&P GCE or the local PSE, all companies generated positive and statistically significant betas close to 1.

Company	β-S&P GCE	S.E. of Beta	Adj. R^2	S. E. of the Model	Company	β-PSE	S. E. of Beta	Adj. R^2	S. E. of the Model
EDC	1.002	0.015	0.989	0.032	EDC	1.003	0.015	0.989	0.032
FGEN	0.992	0.016	0.986	0.035	FGEN	0.994	0.016	0.987	0.033
FPH	1.000	0.028	0.961	0.060	FPH	0.999	0.029	0.958	0.062
AP	0.776	0.088	0.599	0.188	AP	0.774	0.089	0.595	0.189
ACR	0.993	0.036	0.938	0.076	ACR	0.993	0.036	0.937	0.077
PHEN	0.993	0.011	0.993	0.024	PHEN	0.994	0.011	0.994	0.023
PERC	1.013	0.029	0.960	0.062	PERC	1.012	0.030	0.957	0.064
BSC	0.999	0.032	0.952	0.067	BSC	1.000	0.032	0.951	0.067
MER	1.010	0.104	0.647	0.221	MER	1.015	0.103	0.651	0.220
PCOR	0.995	0.016	0.986	0.035	PCOR	0.996	0.015	0.988	0.032

Table 4. Beta Result using Monthly Average Stock Returns. Data on monthly average or the mid- to long-term investment interval only has 11 observations covering one-year period from August 2016 to August 2017. The authors wish to expand the data timeframe in the future researches when data becomes available. When each company's monthly average stock returns are benchmarked to the global S&P GCE index, beta results are shown to be more variable and have larger gaps from one company to another. Among these companies, only EDC and ACR have betas close to 1 although EDC alone is statistically significant. These results are also similar even when the stock returns were benchmarked to the local PSE index. This time EDC and PERC have betas close to 1 although EDC alone is statistically significant.

Company	β-S&P GCE	S.E. of Beta	*Adj. R^2*	S.E. of the Model	Company	β-PSE	S.E. of Beta	*Adj. R^2*	S.E. of the Model
EDC	0.946	0.256	0.558	0.033	EDC	0.853	0.337	0.352	0.040
FGEN	0.277	0.196	0.091	0.025	FGEN	0.069	0.234	−0.101	0.028
FPH	0.301	0.248	0.045	0.032	FPH	0.126	0.287	−0.088	0.034
AP	0.314	0.131	0.322	0.017	AP	0.188	0.171	0.021	0.020
ACR	1.040	0.633	0.145	0.082	ACR	1.918	0.450	0.632	0.054
PHEN	0.529	0.344	0.121	0.045	PHEN	0.470	0.388	0.044	0.047
PERC	0.669	0.845	−0.039	0.120	PERC	0.847	0.905	−0.013	0.108
BSC	1.324	0.764	0.167	0.099	BSC	0.542	0.939	−0.071	0.112
MER	−0.939	1.073	−0.024	0.139	MER	−0.415	1.203	−0.097	0.144
PCOR	0.208	0.532	−0.093	0.069	PCOR	0.711	0.531	0.073	0.064

3.2. Examining renewable companies' profitability thru the Jensen's alpha

We then computed for the Jensen's alpha based on the CAPM regression estimate (see Table 5). Jensen's alpha (α) is a measure of profitability, or the average return of a portfolio or investment above or below the predicted returns under the CAPM methodology (Investopedia, 2019b). Put simply, this is the investment's excess returns relative the returns predicted by CAPM.[4] When comparing, we determine the "profitable" companies based on which has (greater) positive or (lesser) negative alpha values.

On a short-term investment interval, more companies are likely to more profitable when their beta is benchmarked to the local PSE index. These include companies such as EDC, FPH, ACR, PERC, PHEN, BSC, and MER. Among these companies only EDC, FPH, PERC, BSC, and MER have positive alpha values although none of which are statistically significant. The result is opposite on a mid- to long- term investment where all of these companies with the exception of only MER are likely to be more profitable if their beta is benchmarked to the global S&P GCE than otherwise. Two companies, EDC and BSC, have positive alpha values although both not statistically significant. On the other hand, AP has negative alpha value but is statistically significant.

The results show that on a short-term investment interval, RE companies are more profitable to the national market portfolio than to the global RE market portfolio. While on a mid- to long-term investment interval, Philippine RE companies are more profitable to the global renewable market portfolio than the national stock market portfolio. Taking into account this information can help investors make their investment strategies such that different time intervals could provide profitable returns to renewable investments. More importantly, EDC's alpha value is positive for both short- and medium- to long-term investments and both S&P GCE and PSE indices. It shows that Philippine RE companies are possibly underestimated in both the global RE market and the Philippine stock market.

Table 5. Jensen's Alpha Results. Jensen's Alpha (or simply "α") is computed to measure the average return of a portfolio or investment above or below the predicted returns under the CAPM methodology. Take note that those with * are companies with positive and greater alpha value compared opposite investment interval, while the company, which is in this case is AP with ** is the only company with statistically significant alpha value.

Company Name	Mid- to Long-Term		Short-Term	
	S&P GCE	PSE	S&P GCE	PSE
EDC	0.004*	0.001	0.003	0.004*
FGEN	−0.026	−0.027	−0.005	−0.005
FPH	−0.003	−0.004	0.001	0.002*
AP	−0.012**	−0.014**	−0.025	−0.025
ACR	−0.016	−0.02	−0.005	−0.004
PERC	0.064	0.061	0.014	0.015*
PHEN	−0.013	−0.015	−0.005	−0.004
BSC	0.027*	0.022	0.001	0.001*
PCOR	−0.009	−0.01	−0.003	−0.003
MER	−0.008	−0.005	0.014	0.015*

[4]The weekly and monthly data availability assumes $r_f = 0$ here but the impact on α is limited by the order of the data.

4. Evaluating the incentive for renewable energy investment through FIT

In the Philippines, the cost of equity is one of the basis in providing the incentives for RE investment as in Table 6. For most countries including the Philippines this incentive is usually in the form of the feed-in tariff (FIT). FIT refers to a long-term guaranteed payment, typically with rate higher than the conventional energy, calculated per kWh of energy produced from REs. It is considered the most popular RE incentive around the world with 75 countries and 29 states or provinces implementing this as means to promote and attract the investment to RE technologies (REN 21, 2017). Knowing the appropriate FIT rate from the calculated beta through CAPM could help policymakers decide the FIT rate at the level that is sufficient to boost investments in the sector while ensuring fairness to the taxpayers who will have to shoulder the cost. However we have a question whether the level of the FIT rate is appropriate or not from the point of the risk and return. To answer this question, we evaluate the FIT from the points of RE project risk and country risk.

Table 6 Eligible FIT projects as of January 2015 in the Philippines. The wind power has the biggest total approved FIT Capacity (IRENA, 2017).

	Capacity allocation/installation target (MW)	Number of eligible projects	Total approved FIT capacities	Subscribed allocation (%)
Biomass	250	5	21.651	6
Hydropower	250	3	12.6	5
Solar	500	1	22	4
Wind	200	3	249.9	124

FIT calculation in the Philippines basically follows the RE technology market-based weighted average cost of capital (WACC)[5] to determine return on invested capital (Philippine Department of Energy). Since debt is pretty much guaranteed and thus less risky comparing to equity from the point of default risk, it is not so much as tricky as the determination of the cost of equity where more risks are involved. The complexities of these risks and assigning each the appropriate values are matters altogether that gives the evaluators the headaches. Also, from the perspectives of investors and project developers who are after profits and even the government who is trying to strike the balance between luring investments into the RE sector yet would not compromise the public coffer, knowing the appropriate cost of equity could help create a strategy that is beneficial for each if not for everyone, thus, we are focusing here on the evaluation of the cost of equity in the calculation of FIT. As mentioned previously, the CAPM evaluates the cost of equity through the following equation:

$$r_i = r_f + \beta(r_m - r_f) \quad (3)$$

[5] WACC is defined by a calculation of a firm's cost of capital in which each category of capital is proportionately weighted. All sources of capital, including equity and debt, among others are incorporated into the WACC calculation: $\mathrm{WACC} = r_i \frac{E}{V} + r_d \frac{D}{V}$ where r_i = cost of equity, r_d = cost of debt after tax, E = the amount of equity funding equivalent, D = the amount of debt funding equivalent and $V = E + D$.

where r_i= cost of equity, r_f = risk-free rate, β = beta or the systematic risk-free, r_m = expected market returns and $r_m - r_f$ = MRP.

The MRP follows the total risk premium (TRP) and is set at 8.600%. The TRP equals the estimated default spread of 190 basis points plus the historical risk premium for a mature equity market (estimated from historical US data). Note that 190 basis points for the Philippine come from the average of 219 basis point in 2012 (Damodaran, 2012) and 161 basis point in 2017 (Damodaran, 2017) as an example. Because most of the RE companies in the Philippines are still not listed in the Philippine Stock Exchange market, MRP estimate of RE investment relies on a sophisticated capital market of a developed country such as the U.S. The 5.270% risk-free rate (r_f), on the other hand, was benchmarked on the daily average of Philippine Dealing System Treasury Fixing (PDST-F) rates for the CY 2014 as published by Philippine Dealing and Exchange Corporation (PDEx) in its official website (PDEx, 2019).[6] Lastly, the beta of 1.0 is estimated from the levered and re-levered betas of listed comparable companies from Bloomberg database.

The authors recalculated the cost of equity as derived from the FIT structure for solar PV using the beta results from EDC, as proxy for all RE companies/projects (see results in Table 7, the second and the third columns). For purposes of comparison, two analyses were done. In the first analysis, all figures were retained except for the beta. In the second analysis, the MRP was set to 8.400% to reflect the latest computed Philippine market risk premium, as published by Damodaran (2017).

Table 7. Cost of Equity/FIT Structure from Generated Betas. The data is reported as annual basis unless noticing by brackets. Result of recalculated cost of equity as derived from the FIT structure for solar PV using the beta results from EDC as proxy for all RE companies/projects in the Philippines. Quarterly MPRs and risk free rates are one fourth of the annual ones for simplicity. Note that the current Cost of Equity/FIT level is greater than the computed Cost of Equity/FIT with ** from the new generated betas.

	Cost of Equity (viz. FIT)	Cost of Equity-EDC- S&P GCE	Cost of Equity-EDC- PSE
Market Risk Premium (MRP) $(r_m - r_f)$	8.600%	8.600% 8.400%**	8.600% 8.400%**
Beta (β)	1.000 (monthly)	0.946 (monthly) 1.002 (weekly)	0.853 (monthly) 1.003 (weekly)
Risk Free Rate (r_f)	5.270%	5.270%	5.270%
Cost of Equity/FIT	13.870% 3.468% (quarterly)	13.406% 3.472% (quarterly)	12.606% 3.474% (quarterly)
*Cost of Equity/FIT***	N/A	13.216% 3.422% (quarterly)	12.435% 3.424% (quarterly)

In the first analysis, the cost of equity computed from the generated betas on the mid- to long-term investment duration is lower than current FIT rate. The lowest FIT rate generated is at 12. 606% when

[6] Our empirical study covers the period from years 2016 to 2017. As the available and nearest data from the period, we use the risk free rate of 5.270%

beta is benchmarked to the local PSE index. In contrast, using generated betas on short-term investment interval resulted to a slightly higher cost of equity at 3.472% (S&P GCE) and 3.474% (PSE) respectively compared with only 3.468% when beta was 1.000 at current FIT rate. However as the second analysis the actual market premium was set to 8.400% recently. Thus the costs of equity in the short-term basis are 3.422% and 3.424% for S&P GCE and PSE, respectively which are lower than 3.468% for FIT.

In general, the current cost of equity/FIT rate is shown to be greater than the computed rates when benchmarked to either S&P GCE or PSE. This implies that the latest FIT level generates profit for both the perspectives of the Philippine RE companies' risk and returns and the global RE companies' risk and returns. This is particularly the most highlighted in a mid- to long-term perspective for Philippine companies' risk and returns because of the both effect of the lowest beta and the actual MPR. Although these results sound good for the investors who are after profits, this signals that policymakers may have to adjust the current FIT rate to reflect the lower cost of equity that is necessary to attract investments in the renewables sector. The FIT is basically funded from taxpayers who are now burdened to pay more for the development of renewables in the Philippines. These results and implications are the most important contribution of this paper.

5. Conclusions

Although clean energy projects are growing globally with bright prospect, investment in RE remains to be a challenge for developing countries. As a developing country with huge potentials for renewables but is struggling to attract investments in the sector because of the difficulty to access finance, administrative hurdles, local opposition to build renewable facility, uncertainty with FIT approval, among others, we take the Philippines as a country case study to analyze the risk and return profiles of energy companies with RE investments. By doing so the authors aim that the findings of this paper can help investors and policymakers alike in their investment decision-making and in setting appropriate incentive schemes that will promote renewables in the country.

First, the authors examine the impact of the global project specific risk and country risk to the Philippine energy companies/projects through the simple CAPM. Of the ten companies under study, a "pure" RE company, Energy Development Corporation (EDC), is taken as a focus of analysis. We specifically explored the calculation of the beta (β) through CAPM by employing a simple linear regression of each company's stock returns benchmarked to a market index, which is either the global renewables S&P Global Clean Energy (S&P GCE) or the local Philippine Stock Exchange (PSE). The S&P GCE market index represents the project specific risks in investing to renewables worldwide while the PSE market index represent the risks confined only to local conditions. Weekly and monthly average returns data from August 2016 to August 2017 were used to represent short and mid- to long-term investment intervals, respectively. Beta results show that on a short-term investment interval, all energy companies with RE investment are strongly affected by both the global RE project specific risk and country risk. However, for a mid- to long-term investment interval, EDC is the only RE company that is affected by these two risks as this is the only company that has statistically significant close to 1 beta results. Meanwhile, energy companies with partial investment in renewables tend to work as defensive assets to market portfolio, which are not affected by both risks. It implies that to invest in RE projects in emerging economies, it is important to examine in advance how much the RE project's share in the prospect company is from the viewpoint of RE project specific risk and country risk.

Next, EDC's abnormal returns, as derived from Jensen's alpha calculation, is shown positive for both short- and medium-to-long term investments whether benchmarked to S&P GCE index or PSE index. This shows that Philippine RE companies' expected returns are possibly underestimated in both the global RE market and the Philippine stock market. It may imply that the investing of RE businesses are promising from the perspectives of global RE business and the Philippine's business.

Lastly, we use the beta results of EDC as proxy to determine the incentive for investing in renewables in the form of the feed-in tariff (FIT), using the rate structure of solar PV as a case study. The result shows that the latest FIT rates are greater than the FIT rates computed from the generated betas accompanied by the recent MRP. This implies that the latest FIT level generates profit for both the perspectives of the global RE market and the Philippine companies' risk and returns. This gap is highlighted more in a mid- to long-term perspective for Philippine companies' risk and returns. Although this may sound good for the investors who are after profits, this signals that policymakers may have to adjust the current FIT rate to reflect the lower cost of equity so as not to burden the taxpayers who have to pay more for the development of renewables in the country. In opposite, it implies that renewable power generators get profits from the businesses due to the FIT level.

6. Discussions

While, overall, the paper provided a rich analysis of the use of CAPM in evaluating the RE investment and incentive of a developing country like the Philippines, the authors recognize that the study was limited in scope. Due to data availability, we are only able to include ten companies with only one company that is truly a "pure" RE company while the remaining others have only partial if not very little investments to renewables. Also, due to the relative early development of renewables in the Philippines, the timeframe is only limited to one year. In which case the small samples and short observation period may lead to some measurement errors.

In terms of market portfolio use as a benchmark, the S&P GCE index that is used to represent the project specific risk to renewables is a market portfolio not only confined to RE investments worldwide. Because it is impossible to gather and combine all RE assets into one global market portfolio we opt to use S&P GCE as our proxy. Also, the PSE index is not as sophisticated and developed compared that of course of developed markets, say, the US. As of the present there are only about 261 companies listed in the Philippine Stock Exchange. In one study, Krištofík (2010) pointed that using the stock price index as the market portfolio in developing countries like the Philippines is "rarely a good proxy" as it doesn't truly reflect the real local business environment of these countries. It is so because local businesses are subject to strong foreign impacts in much greater measure than their counterparts in developed countries and that most of the companies listed in the stocks are controlled by a monopoly of family groups or few shareholders.

Despite its weakness, the analysis presented in this paper add to the still few literatures on asset valuation of renewables in developing countries. At the same time the paper raises many issues and questions we can explore and further elaborate like, perhaps, expanding the CAPM to tailor fit the conditions of a developing country. As the first study in the Philippines that has, so far, utilize the tools of CAPM to analyze its RE investment, the authors hope that there will be succeeding future studies of the same topic.

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Conflict of interest

All authors declare no conflicts of interest in this paper.

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