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Renewable Energy Trade within Regional Comprehensive Economic Partnership (RCEP) Countries: An Exploratory Analysis

Kaliappa Kalirajan and Yichang Liu
Crawford School of Public Policy
The Australian National University

Abstract

Though the availability of cost effective and potentially efficient renewable energy technologies is a necessary condition for the promotion of green growth nationally and internationally, it is the intended nationally determined contributions (INDC) to make use of such technologies is crucial. International trade in low carbon renewable energy goods provides an effective way of achieving INDCs nationally, even when individual countries may not have sufficient infrastructure readily available to them to fulfill INDCs. It is in this context, examination of whether renewable energy goods exports have been flowing without constraints in the Asian region and whether the RCEP regional cooperation mooted by the ASEAN can potentially facilitate minimizing those constraints at the regional level. The short answers to those questions are no and yes respectively. The answer is no mainly due to the existing institutional rigidities of which the major one is the non-tariff measures. The answer is yes mainly due to the possibility of improving the technical cooperation in producing renewable energy goods and consultations in removing non-tariff barriers through the effective functioning of RCEP.

Keywords: INDC, Renewable energy exports, RCEP, non-tariff barriers, meta-frontier gravity model.

JEL Classifications: F14, F18, and Q27.

Renewable Energy Trade within Regional Comprehensive Economic Partnership (RCEP) Countries: An Exploratory Analysis*

Introduction

The United Nations Framework Convention on Climate Change's (UNFCCC) 21st Conference of the Parties (COP21) in Paris in December 2015, a majority of countries has committed to scaling up renewable energy and energy efficiency through their Intended Nationally Determined Contributions (INDCs). Out of the 189 countries that submitted INDCs, 147 countries mentioned renewable energy, and 167 countries mentioned energy efficiency. This commitment implies that systemic changes are necessary to remodel current energy mixes. Renewable energy trade offers a unique, economically oriented policy solution to global climate challenges and will facilitate the greater deployment of efficient renewable energy technologies. Increased trade in renewable energy technologies will facilitate industries to expand production capacity and will encourage the policymakers to further open up renewable energy markets to healthy economic competition, which would also bring about further technology improvement through research and development. Given the fact that the Asian region is not only a substantial contributor to global CO_2 emissions, but also a world leader in technology innovation and manufacturing in renewable energy industries, these industries will provide sustained high-tech development opportunities to national and regional economies, while also playing a vital role in achieving the INDCs.

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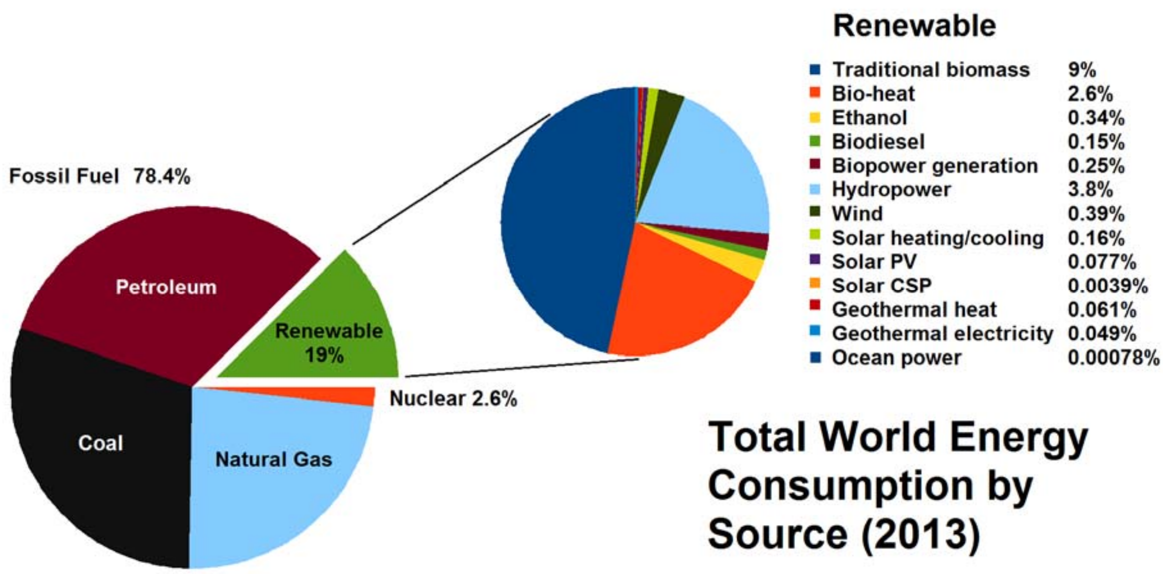
* RCEP member countries: Australia, Brunei Darussalam, Cambodia, China, India, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, New Zealand, Philippines, Singapore, South Korea, Thailand, and Vietnam

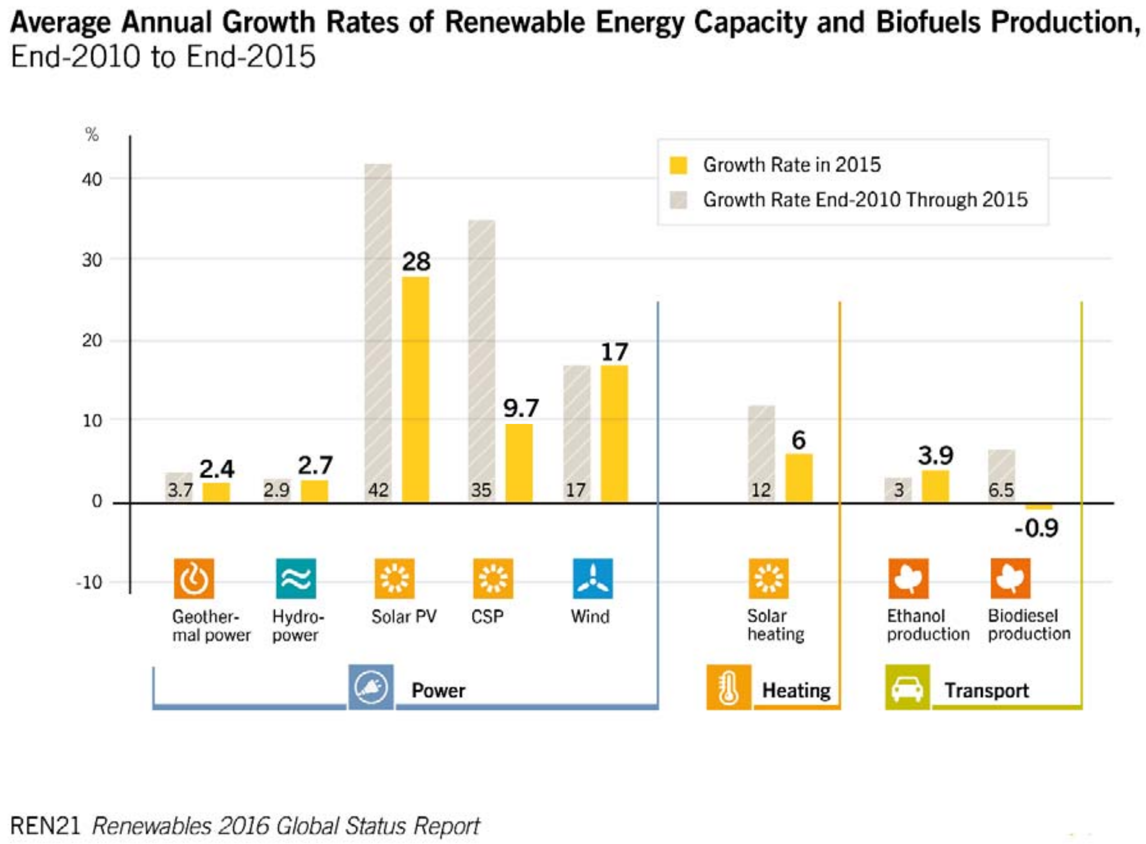
Figure 1: Energy Consumption by source, 2013



Source: REN21 (2016).

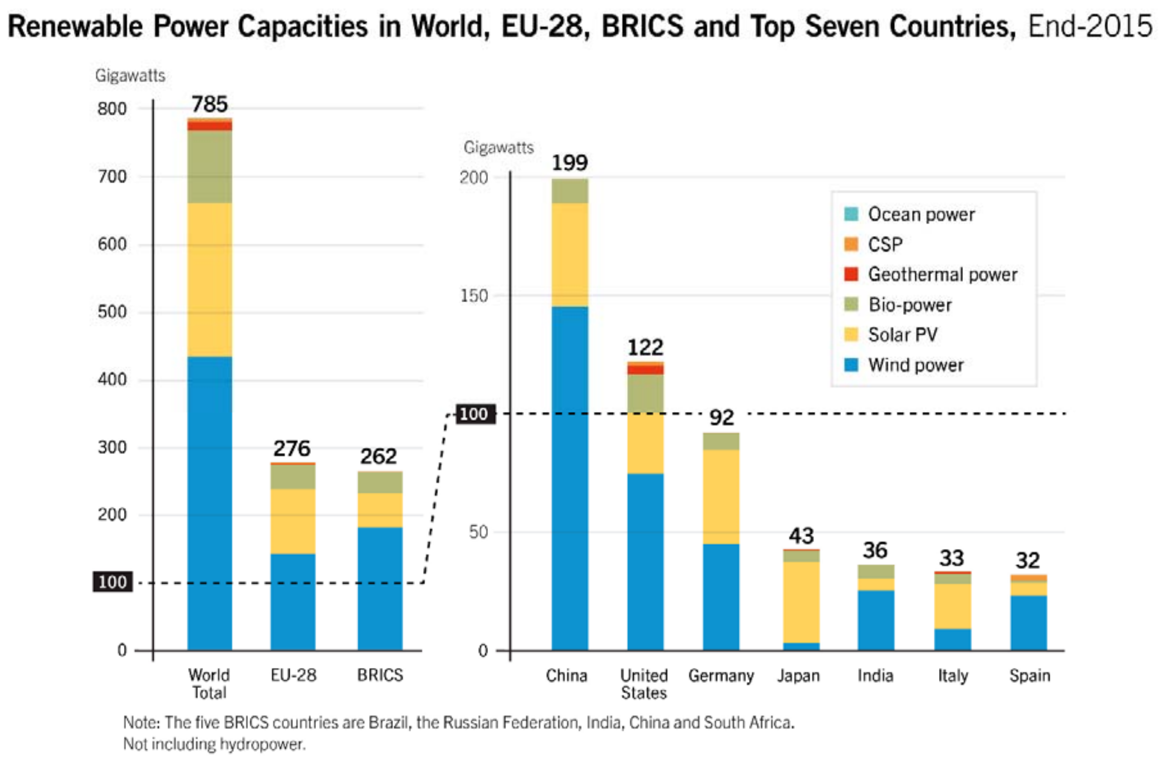
Given significant amounts of untapped renewable resources, growing demand for energy, and the need to mitigate greenhouse gas emissions from fossil fuel use, there are strong incentives and needs to ensure continued research and development concerning renewable energy technologies. Therefore, Asia needs to accelerate the renewable resources and energy technology market liberalization. Regional cooperation in trade in renewable resources and technologies is a crucial instrument to improve renewable energy market sustainability. The geoeconomic and geopolitical consequences of reginal cooperation in trade in renewable energy goods in the Asia Pacific are significant and dynamic. The volatility of fossil fuel markets and the demand for more stability justify improving global energy governance for which the regional cooperation in trade in renewable energy goods is vital.

Figure 2: Renewable Energy Capacity and Biofuels Production, 2010-2015



Government policies on research and development concerning low-carbon technologies, carbon pricing, and natural gas pricing will crucially shape the balance of renewable and non-renewable energy sources in the supply mix. In this context, whatever new energy and environmental paradigm eventually evolves, it is imperative, bearing in mind the INDCs, to mitigate harmful emissions stemming from what is otherwise a desirable fuel in terms of cost. Kumar (2016) has carried out an extensive technology deployment cost analysis for identifying the appropriate low carbon technologies that would facilitate achieving the INDCs by the major energy consuming Asian countries. The access to low carbon technologies with affordable deployment costs can be effectively achieved through collaboration among countries, such as the Trans Pacific Partnership (TPP) and Regional Comprehensive Economic Partnership (RCEP). The implication is that trade, which is the core ingredient of these regional cooperation agreements, offers a growth oriented approach to concerned countries to increase the phase of achieving their INDCs. Renewable energy trade will facilitate the greater deployment of clean energy technologies in countries that are supply-deficit in low carbon technologies, and such a transaction will help the countries towards achieving their INDCs within their committed time frame (Figure 3).

Figure 3: Renewable Power Supply around the World, 2015.



REN21 *Renewables 2016 Global Status Report*

Besides participating in renewable energy trade, achieving most of the INDCs may require international support to achieve ambitious targets, thus encouraging the use of market and non-market means for instituting technology transfer agreements and setting standards. Globalization of low carbon technologies increases the forms of voluntary cooperation among the governments and reduce the innovation and trade related risks. The investments on low carbon energy transition is often perceived as risk, mainly due to uncertainty of public policies. The country reports prepared for the last two phases of CCGA and other studies (Anbumozhi, Kawai and Lohani, 2015) point to problems varying from intellectual property rights concerns, trade barriers, and developing countries' limited access to knowledge and finance. The biggest barrier to the global commercialization of low-carbon technologies is the failure of governments to create sensible policy incentive structure at the border and behind the border. Because the benefits of low carbon technologies mainly accrue to the public, private markets have difficulties in value them properly. It is therefore essential that governments step up technology market place and utilize the regional cooperation free trade channels to accelerate the diffusion of low carbon technologies. Technology and information transfer to achieve the INDC targets could be enhanced by removing the several barriers identified in TNAs But the following issues require deep considerations (i) coordination between INDC executive committees and technology trade centers (ii) identifying conflicting policies and (iii) unlocking the potentials of regional cooperation. This study will concentrate on the latter issue by considering the recently formed RCEP countries. Specifically, this study will examine the determinants of trade in renewable energy goods among the RCEP member countries; will gauge the export potential of each member countries; and will identify the ways to improve the export potential through market and non-market forces.

The following section highlights the conceptual framework to establish the link between achieving INDC and regional cooperation. The next section discusses the empirical framework to examine the objectives of this study of examining the determinants of renewable energy goods exports among RCEP member countries along with the description of the data sources. The following questions are answered in the next section: whether the member countries have been reaping their full export potentials with their trading partners? If not, what are the barriers, and what are the ways to eliminate such barriers so that the phase of achieving INDC is increased? A final section brings out the policy conclusions of this study.

INDC and Regional Cooperation: Conceptual Framework

It is acknowledged now that the implementation of Intended Nationally Determined Contributions (INDCs) by the Asian countries is not only their contribution to fulfilling global commitments, but an opportunity to make decisive, inclusive and coordinated actions for reshaping the national and regional energy systems. As the energy sector currently accounts for about two-thirds of greenhouse gas emissions, it is vital for achieving the INDCs. In recent years, tremendous strides have been made to advance low carbon energy systems – innovating, scaling up investment, bringing down the system costs, implementing the right policy frameworks and interconnecting large amounts of variable renewable energy supply into the grid. Reflecting this many countries have put forward ambitious plans to increase renewable energy in power generation in INDCs. Combined, the low-carbon renewable energy plans of China, India and ASEAN will result in an increase in from approximately 9,000 TWh in 2012 to 20,000 TWh in 2030[1]

Further, a number of promising initiatives that is currently being implemented, will reinforce the INDCs. For example, about 40 implementing agreements will carry out technology programs in the areas of renewable energy (solar, wind, bios, geothermal), fossil fuels (clean coal, enhanced oil recovery, carbon capture and storage), fusion power (tokamaks, materials, technologies, safety) and energy efficiency (building, electricity, industry, and transport). Technology focused alliances, such as the International Solar Alliance, Global Geothermal Alliance, Mission Innovations and others will play an important role in enabling countries to harness the full potential of low-carbon renewable energy resources at their disposal. The movement on 100% renewable energy is growing with over 600 cities have committing to this target, and an increasing number of companies joining this initiatives. Thus, INDCs can provide an important impetus to enhance the efforts to achieve the global efforts to mitigate carbon emissions, double the share of low-carbon renewable energy in the supply mix and accelerate green growth.

The importance of the cooperation across countries to increase the phase of achieving the INDCs by individual countries is recognized by many countries that have submitted INDCs. Thus, there is growing awareness of the urgent need to turn INDCs into reality through concrete actions. The actions that are needed are those in which new technological paradigms decouple growth from environmental problems, such as the greenhouse gas emissions (Altenburg and Pegels, 2012). INDCs can and must change the current paradigms in energy supply and use which are patently unsustainable, but this will take a revolution and low-carbon renewable energy technologies will have a crucial role to play. Yet despite the fact that energy related goods account for more than ten percentage of international trade, policy makers, academics and the business communities perceive several barriers to the diffusion of these renewable technologies at national and regional levels. It

[1] WRI (2015) Monitoring Implementation and Effects of GHG Mitigation Policies: Steps to Develop Performance Indicators

is imperative to identify the market and non-market instruments to reap the opportunities and to eliminate the barriers within INDC for low-carbon renewable energy technology diffusion at the local, national and regional levels.

One of the important market channels to facilitate low carbon renewable technology transfer is trade in renewable energy goods and regional cooperation is crucial for maintaining unconstrained trade flows across countries. In this context, the recently ASEAN initiated regional grouping with its 6 partners with whom it has made Free Trade Agreements, which is the Regional Comprehensive Economic Partnership (RCEP), can play an important role in facilitating the RCEP member countries to achieve their INDC as per their targets. As RCEP is a comprehensive economic partnership arrangement, it is expected to improve the functioning of the non-market channels in transferring the renewable energy technologies across countries too. Generally, trade flows are very much influenced negatively by the 'behind the border' constraints of which the non-tariff barriers are the major factors that emanate from the institutional rigidities, and the 'beyond the border' constraints of which the tariff rates are important. It is imperative to demonstrate the negative impacts of these constraints on exports potentials of RCEP member countries to policymakers, so that such constraints can be eliminated, which has implications for fulfilling INDC across the RCEP region.

Based on the low carbon renewable energy goods export performance, the RCEP member countries were classified into two groups for empirical analyses in this study: one group with relatively larger export values of renewable energy goods to RCEP members - China, India, Japan, Korea, Malaysia, and Singapore; and the other group with the rest of the RCEP member countries - Australia, Indonesia, New Zealand, Philippines, Thailand and Vietnam. The interesting research questions are: How far export potential of each member countries are from their group potential and how far each group potential is from the regional potential frontier.

Empirical Methodology: Meta-frontier Framework

This section provides a basic empirical framework for the analysis of the meta-frontier for gauging the export potential. The purpose of the meta-frontier analysis is to have an objective comparison of the renewable energy goods export potential of a group of countries relative to another group of countries. We selected two groups of countries for the estimation of the regional frontiers: the first group includes the selected high performing countries of RCEP members in terms of exports of renewable energy goods, and the second group includes the rest of the member countries. We assume the technology to be the same for all the countries within a group.

Drawing on Battese et al. (2004), the meta-frontier function is defined as a deterministic parametric frontier of a specific functional form, such as the Cobb-Douglas, with the condition that the values of this frontier are not smaller than the deterministic part of any group frontiers. Figure 4 illustrates the meta-frontier in a one input and one output case. The meta-frontier envelopes the individual group frontiers such that the value of the meta-frontier for a given input is always higher than or equal to that of the individual deterministic group frontiers. This framework can be applied to work out the objective of comparing the export potential across groups of countries, by measuring the potential relative to a benchmark meta-frontier, which is an envelope of the group frontiers.

Group-frontier Model:

Suppose that there are 'K' number of country groups and a separate stochastic frontier gravity (SFG) model is defined for each group. The underlying assumption is that the exporting countries in each group exhibit the same technology. If there are 'N_k' exporting countries in *k*th group and each country has 'M_k' number of bilateral partners, we can write the SFG model for *k*th group as:

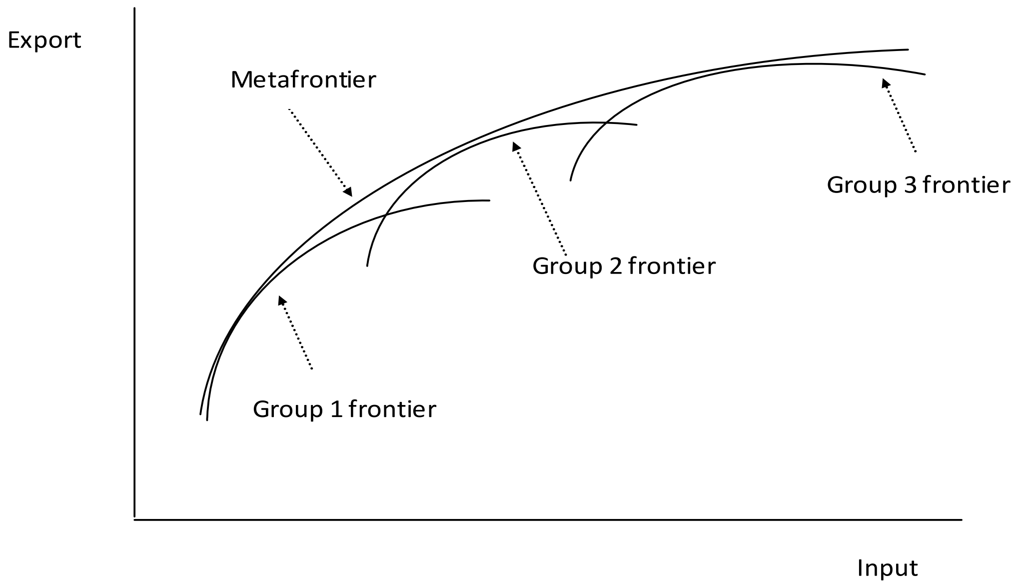
$$X_{ij(k)} = f\left(z_{ij(k)}, \beta_{(k)}\right) e^{v_{ij(k)} - u_{ij(k)}} \tag{1}$$

$$i = 1, 2, \ldots . N_k, \;\; j = 1, 2, \ldots . M_k, \qquad k = 1, 2, \ldots . K$$

where, $X_{ij(k)}$ is the exports of *i*th country to *j*th partner for *k*th group; $z_{ij(k)}$ is a vector of various determinants of exports; $\beta_{(k)}$is the vector of unknown parameters for the *k*th group; $v_{ij(k)}$ is a double sided error term assumed to follow a normal distribution with mean zero and constant variance; and $u_{ijt(k)}$is a single sided error term representing mostly the combined effect of the non-tariff barriers (Kalirajan 2008) that emanate from the institutional rigidities in the importing countries on which there are no full information, and is usually assumed to have a truncated normal distribution with the mean (μ, σ^2) truncated above zero[2].

[2] The use of the variable 'import coverage ratio' involving the imports affected by SPS and TBT measures in the total renewable energy goods did not significantly contribute to the variations in exports. Also, the exporting countries may not know *a priorily* in most cases whether such measures will be applied to their exports. Hence, the use of the one-sided error term can be justified.

Figure 4: Illustration of a Meta-frontier



Eq. (1) can be simplified if we assume that the exponent of the frontier gravity model is linear in the parameters, $\beta_{(j)}$.

$$X_{ij(k)} = f\left(z_{ij(k)}, \beta_{(k)}\right) e^{v_{ij(k)} - u_{ij(k)}} = e^{z'_{ij(k)}\beta_{(k)} + v_{ij(k)} - u_{ij(k)}} \tag{2}$$

This SFG model for the kth group can be estimated using a maximum likelihood method and the realized export potential of *i*th country to *j*th partner relative to *k*th group can be obtained as (Battese et al. 2004):

$$\text{Realized Potential} = RP_{ij}^{k} = \frac{X_{ij(k)}}{e^{z'_{ij(k)}\beta_{(k)} + v_{ij(k)}}} = e^{-u_{ij(k)}} \tag{3}$$

Meta-frontier Model:

We can formulize the deterministic meta-frontier model as:

$$X_{ij}^{*} = f\left(z_{ij}, \beta^{*}\right) = e^{z'_{ij}\beta^{*}} \tag{4}$$

where, X_{ij}^{*} is the meta-frontier export value and β^{*} is a vector of the meta-frontier parameters, satisfying the constraints:

$$z'_{ij}\beta^* \geq z'_{ij}\beta_{(k)} \quad (5)$$

We estimate the meta-frontier model by solving the optimization problem as[3]:

$$\min_{\beta^*} \sum_{i=1}^{N}\sum_{i=1}^{M} \left| lnf(z_{ij};\beta^*) - lnf(z_{ij};\hat{\beta}_{(k)}) \right|$$

$$\text{s.t.} \quad lnf(z_{ij};\beta^*) \geq lnf(z_{ij};\hat{\beta}_{(k)}) \quad (6)$$

where, $\hat{\beta}_{(k)}$ is a vector of the estimated parameters for all the groups and this problem is solved using data for all groups. '*N'* is the total number of reported exporting countries and '*M'* represents the total number of bilateral partners. Since $\hat{\beta}_{(k)}$ vector is fixed for this problem and $f(z_{ij};\beta^*)$ is assumed to be log linear in the parameters, following O'Donnell et al. (2008), we can re-write the linear programming (LP) problem of Eq. (6) as:

$$\min_{\beta^*} \bar{z}' \ \beta^*$$

$$\text{s.t.} \quad z'_{ij}\beta^* \geq z'_{ij}\hat{\beta}_{(k)} \quad \text{for all } i \text{ and } j \quad (7)$$

where, $\bar{z}'$ is the arithmetic average of the z_{ij} vector that includes all the bilateral observations.

Empirical Specification:

The purpose of our meta-frontier analysis is to have an objective comparison of the renewable energy goods export potential of a group of countries relative to another group of countries. We selected two groups of countries for estimation of the regional frontiers as discussed earlier. We assume the technology to be the same for all the countries included within a group.

The empirical specification of our gravity model includes the basic explanatory variables suggested by traditional gravity models and the variables that are relevant to renewable energy goods exports, particularly non-tariff measures. These include the Gross Domestic Product (GDP) of the trading partners, the distance between them, tariff, exchange rate, time trend, proxy for non-tariff measures, and common language variables.

The meta-frontier analysis was performed for the exports of 16 renewable energy goods from the APEC 54 List of environmental goods given in Table 1, and estimations were carried out using

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[3] We followed Battese et al. (2004) by minimizing the sum of absolute deviations of the distance between the meta-frontier and a group frontier.

the data for the years 2006-2014. Drawing on Kalirajan (2012), we first estimated the stochastic frontier gravity (SFG) models in a Cobb-Douglas framework for the two groups of countries separately, using the general empirical specification as:

$$ln\, X_{ij} = \alpha + \beta_1 lnY_i + \beta_2 lnY_j + \beta_3 ln(distance_{ij}) + \beta_4 ln(common\ language_{ij}) + \beta_5 ln(TRI_j) + \beta_6 ln(exchange_i) + \beta_7 time - u_{ij} + v_{ij} \quad (8)$$

X_{ij} is the value of renewable goods exports between country *i* and its trading partner j; Y represents per capita GDP; TRI_j is the average tariff imposed by the importing country for the specific renewable energy goods; u_{ij} is the single sided error term for the combined effects of 'behind the border' constraints of non-tariff barriers, on which full information is not available; and v_{ij} is the normally distributed statistical error term. The software FRONTIER 4.1 is used to estimate the stochastic frontier gravity models.

Table 1: List of the Renewable Energy Goods from the APEC 54 List

HS Code	Description
840290	Steam or other vapour generating boilers; super-heated water boilers.
840490	Parts for auxiliary plant for boilers, condensers for steam, vapour power unit.
840690	Parts for steam and other vapour turbines.
841182	Gas turbines, except turbo-jets and turbo-propellers, of a power exceeding 5,000 kW.
841199	Parts of gas turbines (841182).
841290	Engine and motor parts, nesoi (Wind turbine blades and hubs).
841919	Instantaneous or storage water heaters, non-electric other than instant water heaters.
841990	Parts of machinery, plant or laboratory equipment involving temperature change, nesoi.
850164	AC generators (alternator), of an output exceeding 750 kVA.
850231	Other electric generating sets: Wind-powered.
850239	Electric generating sets and rotary convertors: other.
850300	Parts suitable for use solely or principally with the machines of heading 8501 or 8502.
850490	Parts for electrical transformers, static converters and inductors.
854140	Photosensitive semiconductor devices, including photovoltaic cells.
901380	Optical devices, appliances and instruments, nesoi.
901390	Parts and accessories for optical devices, appliances and instruments, nesoi.

Data:

The selected panel data set contains 6 ASEAN countries' (without Brunei, Cambodia, Laos and Myanmar because of lack of sufficient consistent valid data on all relevant variables) and other 6 RCEP members' (Australia, China, India, Japan, Korea and New Zealand) total exports of Renewable Energy Goods among each other, from 2006 to 2014. In this case, every country has 99 observations (9 years for each trading partners, and 11 partners) except Philippines and Viet Nam, which have 95 and 98 observations respectively (Philippines lacks 4 export values to New Zealand from year 2009 to 2012, while Viet Nam lacks export value in 2008, also to New Zealand).

The total real export value of 16 kinds of Renewable Energy Goods is obtained from the United Nations Comtrade Database (UN Comtrade) in current US dollar. Real GDP per capita of all countries are obtained from the World Development Indicators (WDI), of which the unit is constant 2010 US dollar. The relative exchange rate used in this paper is direct foreign exchange quotation, and the conversion formula is the ratio of foreign country's (importer) official exchange rate (LCU per US$, year average) to domestic (exporter) official exchange rate, which are gained from WDI. Population figures come from WDI. Data of distance can be found from CPEII, which measures the distance between two countries' capital. Tariff level of each commodity code (16 in total) is downloaded from the Tariff Download Facility and this paper only uses arithmetic mean of each specified tariff to roughly estimate the total tariff level of all Renewable Energy Goods in the importing countries. As it is difficult to get the full information on all non-tariff barriers, which reduces the export potential, it is included in the gravity equation as a one sided error term truncated above zero with mean μ and variance σ^2.

Discussion of the results

As the first step, the group frontier gravity models were estimated using the specification given in equation (8) separately for the two selected groups of RCEP countries. Necessary specification tests for the distribution of the one sided error term and the application of the stochastic frontier gravity model were done and are reported in Table 2. The coefficients of 'gamma', which is the ratio of the variance of the country-specific one-sided error term, u and the total variance, for all stochastic frontier models are significant and reasonably large, showing that the use of stochastic frontier gravity models is appropriate for the sample data and there are country-specific 'behind the border' non-tariff barriers. The null hypothesis that the specification of the single sided error term is half normal (H_0: $\mu = 0$) was rejected for all models because the calculated statistics were higher than the critical values for each model. This suggests that for the data the truncated normal distribution is preferable than the half normal distribution. Further, the likelihood ratio tests also reject the null hypothesis that the stochastic frontier gravity models for the two groups are identical. This indicates that the meta-frontier framework should be used to compare the individual country export potential in the two groups.

Table 2: Results of the Specification Tests on the Estimation

Null Hypothesis: H_0	Chi-Square value / t-value	Decision
The stochastic frontier gravity model is appropriate for the data set. H_0: $\gamma = \mathbf{0}$	Group 1: t- value = 9.55*** Group 2: t- value = 10.27***	Reject Reject
The distribution of the one-sided variable u representing non-tariff barriers is half normal, H_0: $\boldsymbol{\mu} = \mathbf{0}$	Group 1: Chi-Square value = 28.35*** Group 2: Chi-Square value = 31.27***	Reject Reject
The group stochastic frontier gravity models are identical without significant differences.	Chi-square value = 48.23***	Reject

Note: *** indicates statistical significance at the 1 percent level.

Source: Authors' calculations.

The realized potential of selected countries with respect to their group frontiers is presented in Table 3. In the case of Group A, China has been enjoying the highest level in realizing its export potential (80%) with RCEP member countries on average over the sample years. Japan has the next highest percentage of realized export potential with its RCEP trading partners with the mean over the sample years of 77%. Singapore on average from 2006 to 2014 has realized 72% of its export potential.

Table 3: Realized Export Potential (mean) with respect to the Group Frontier

Group A Countries	Realized Potential (%)
China	80
Japan	77
Singapore	72
India	66
Malaysia	63
Korea	61
Group B Countries	**Realized Potential (%)**
Indonesia	68
Philippines	62
Australia	57
Thailand	51
Vietnam	49
New Zealand	48

Source: Authors' calculations

These simple results of realized export potential relative to the group frontiers are not comparable meaningfully across groups, though are comparable within each group. Therefore, to compare the performance across groups, it is necessary to work out a common benchmark. The Meta frontier provides such a common benchmark, through which how each group has performed with respect to the Meta frontier is examined. Thus, next the meta-technology ratios to obtain the comparable estimates of realized potential relative to the meta-frontier were calculated. In this calculation, the optimization problems of equations (6) and (7) using the estimates of the group frontier gravity models and data on all the countries in the two groups were done. The software, SHAZAM was used to solve the optimization problem using the linear programming technique and the results are presented in Table 4.

Table 4: Realized Export Potential with respect to the Meta Frontier

Countries	Realized Potential (%)
Group A	
China	70
Japan	68
Singapore	64
India	62
Malaysia	57
Korea	55
Group B	
Indonesia	56
Philippines	54
Australia	54
Thailand	46
Vietnam	43
New Zealand	44

Source: Authors' calculations.

Results in Table 4 indicate a considerable gap between the realized export potential of Group A countries and Group B countries. The Group A countries' performance in terms of realized export potential when measured from the Meta frontier is higher than that of the countries in Group B. Nevertheless, the results imply that a significant gap in the overall renewable energy technology existed during the sample period in both groups, though Group A showed a smaller gap relative to Group B. Thus, there is an urgent need for technology transfer from Group A to Group B, though still Group A could improve its export potential by eliminating their institutional and infrastructural rigidities to help Group B countries in improving their export potential.

These results also suggest that Group A countries were more able to tackle the non-tariff barriers of their importing counties than the countries in Group B, which warrants a detailed analysis for which data are not consistently available for all the selected RCEP members. Within Group A and Group B, there are wide variations in realizing the export potential of renewable energy goods. Some conjectures can be made drawing on the nexus between the non-market channels and export potential. Although currently there is a huge potential market for renewable energy goods due to INDCs, new entrants and existing players from emerging Asian countries have constraints that need to be addressed.

Policy Conclusions

It is acknowledged that when countries are able to work together, it will have increasingly important implications for national, regional and worldwide prospects of a more sustainable energy future. Collaboration among countries with respect to developing new and innovative strategies could increase the phase of moving towards low carbon-intensive energy systems. Such collaborative actions that countries take would have impacts beyond their borders and are by nature facilitate more a win-win situation for all countries globally. Though the availability of cost effective and potentially efficient low carbon technologies is a necessary condition for the promotion of green growth nationally and internationally, it is the intention of determined commitments to make use of such technologies by nation is crucial. International trade in low carbon renewable energy goods provides an effective way of achieving INDCs nationally, even when individual countries may not have sufficient infrastructure readily available to them to fulfill INDCs. It is in this context, examination of whether renewable energy goods exports have been flowing without constraints in the Asian region and whether the RCEP regional cooperation mooted by the ASEAN can facilitate minimizing those constraints at the regional level. The short answers to those questions are no and yes respectively. The answer is no mainly due to the existing institutional rigidities of which the major one is the non-tariff measures. The answer is yes mainly due to the possibility of improving the technical cooperation in producing renewable energy goods and consultations in removing non-tariff barriers through the effective functioning of RCEP. In this context, the following conjectures can be made drawing on the empirical results of this study.

First, the availability of skilled labor and suitable graduates above a critical mass level is the first and most important input for the growth of the renewable energy goods and services. For example, the available stock of suitable indigenous graduates and investment facilities have enabled China and India to compete in the world market and venture into the new markets of renewable energy goods, such as solar panels and related services. Though the availability of high quality graduates has been possible due to high standard institutions in China and India, the general quality of graduates is still lower than a developed country's standards, which is reflected in their MTRs. Emerging countries in Group B, have also been able to increase the number of engineering graduates but the quality and suitability of the graduates for the renewable energy goods export industry is still a concern. Cooperation among RCEP members has the potential to help the new and existing players in renewable energy sector to invest in quality education, research and development, and training through harmonizing education standards across the region. Secondly, active involvement by governments in the promotion of research and development concerning renewable energy technologies have been more successful in countries, such as Japan, China, and Singapore, than other countries in the region. These developments help make these countries competitive in the export market. The private sector in these countries has contributed to in the provision of basic infrastructure services and education too. The collaborative role of government and the private sector in the emerging Asian countries can improve their competitiveness in renewable energy goods exports. Third, R&D activities and enforcement of intellectual property rights are essential for the players in the renewable energy sector to move into high end markets. Foreign direct investment (FDI) is an important source for emerging Asian economies to increase their competitiveness and R&D activities, which can be easily facilitated through the RCEP cooperation framework. Moreover, the business environment in the emerging Asian countries can be improved by removing unwarranted government interventions and inefficient regulations, and improving labor laws for the renewable energy goods services and export industry. Existing players can expand into high end and new markets while new entrants may find their place in low end products on the basis of cost advantage.

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