Renewable Electricity Policy in Asia:

A Qualitative Comparative Analysis of Factors Affecting Sustainability Transitions

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Abstract. A qualitative comparative analysis was undertaken of 18 Asian countries to determine factors that influence the pace of their sustainability transitions toward increased renewable energy for electricity. We develop a policy index based on renewable electricity targets, feed-in tariffs, and emissions trading schemes in these countries. Countries with a relatively low level of current renewable electricity generation but with relatively high scores on the policy index are wealthier and more democratic. Likewise, countries with a relatively high level of renewable electricity generation and with lagging renewable electricity policy tend to be poorer, more authoritarian, and endowed with higher levels of fossil-fuel resources. Thus, our analysis points to factors other than GDP per capita that could explain the relative stasis or progress of a country toward a sustainable energy transition. Implications for the literature on the political and societal (or "landscape") dimensions of sustainability transitions are discussed.

I. Introduction

Although many countries have developed policies to support sustainability transitions (STs) in a range of industries, the reforms have often fallen far short of the full mitigation of environmental problems. The issue of the slow pace of STs is particularly pressing for greenhouse-gas emissions, which have continued to climb at a global level, and for developing countries in Asia. Although some countries and world regions have achieved stability or even reductions in both per capita and total emissions, the developing countries of Asia have emerged as major contributors to global greenhouse-gas emissions and as rapidly growing contributors. For example, between 1990 and 2010, the carbon-dioxide emissions of China increased by 257%, of Indonesia by 194%, of India by 180%, of Thailand by 160%, and of Taiwan by 118% (Olivier et al. 2011). Because electricity generation is now the leading source of emissions, ST policies with respect to electricity in this world region deserve special attention.

This study will examine the comparative strength of ST policies for renewable electricity (defined below) in a data set of 18 East, Southeast, and South Asian countries. It is assumed that growth in renewable electricity generation in general can help to reduce greenhouse-gas emissions. However, the relationship between growth in renewable electricity generation and reduction of fossil-fuel generation is not one-to-one (York 2010, 2011). Especially in Asia, rapid economic growth and, in some countries, ongoing electrification are causing enormous increases in electricity demand. As we studied the electricity planning documents for this group of countries, it became clear that many countries are responding to projections of increased demand by increasing not only their goals for renewable electricity but also their goals for fossil-fuel sources.

This study contributes generally to research on STs by developing the analysis of the broad socioeconomic conditions that lead to delayed, blocked, or slowed transitions. Although lack of industrial policy and failure to produce electricity at market-competitive prices are often significant barriers for firms and technologies located in niche positions with respect to an existing sociotechnical regime, it is also the case that political and societal barriers can affect the underlying political support for STs. Through comparative analysis, this research project will contribute to the literature on such broader "landscape" factors that enhance or retard policies favorable to renewable electricity generation. The term "landscape" is used in the sense of the multi-level perspective (Geels 2011) and will refer specifically here to geographic, natural resource, demographic, economic, and political factors that affect the policy field for renewable electricity.

Our central research question is to understand the joint effects of societal and political variables on a country's degree of ST toward renewable electricity. Our research question specifically asks: how do the variables act in conjunction to predict Asian countries' varying performances for sustainable electricity policies? In the process of addressing the research question, we also show which Asian countries have the highest and lowest current levels of renewable electricity generation, and which have the most and least advanced renewable electricity policies.

2. Background Literature

The problem of how to achieve more rapid innovation and more successful STs is receiving increasing attention in the literature on STs (Markard et al. 2012). Although some industrial transitions occur with little or no government intervention and are driven by marketplace innovation, the transition of electricity and related large sociotechnical systems generally requires government policy to spur demand and to correct for environmental externalities that are not captured in conventional pricing arrangements for energy from fossil fuels. Strategic niches where innovation occurs, such as solar energy, require government protection and support, at least until they are able to scale up and to achieve pricing parity or until policy internalizes externalities of competing technologies through instruments such as carbon pricing (Smith et al., 2005; Smith and Raven, 2012). In heavily regulated industries such as electricity generation and distribution, government policy support is especially important. Thus, the issue of STs for electricity is a good site to develop general knowledge about the role of broad societal and political factors that shape the pace of STs.

Increasingly the literature on STs recognizes the importance of such factors (e.g., Elzen et al. 2011; Flor and Rotmans, 2009; Geels, 2011; Grin 2010; Meadowcroft 2009, 2011). Of particular relevance to this study is the role of domestic stakeholders, specifically the level of cooperation or resistance from the incumbent industry that is undergoing sunsetting or a transition. Sometimes STs are embedded in broad social conflicts over the future direction of society, such as occurred in the conflict between nuclear and wind energy in Denmark (Jørgensen 2012). In the United States and to some extent also in Canada and Australia, the broad social conflicts over renewable energy are closely connected with political disputes between a conservative political movement that is linked to funding from the fossil-fuel industries and an environmental movement that is linked to the labor movement (Hess 2012). However, even in European countries that are globally recognized as leaders of STs, such as the

Netherlands, there is growing recognition that ST policies have not been as successful as originally anticipated (Kern 2012, Kern and Smith 2008, van der Loo and Loorbach 2012). As recognition of the role of political and societal factors in STs has grown, leaders of the field have called for more research into the topic (e.g., Coenen 2011, Raven et al. 2013).

To address the political and societal dimensions of STs, this project builds on an approach that is anchored in the political sociology of science and technology (Moore et al. 2011). Unlike actor-based approaches to technological change, political sociology focuses more on the relations among social fields (e.g., industry, the state, civil society, and science) and issues of political power and inequality that emerge in those relationships. For this project we are particularly interested in characterizing the political opportunity structure for renewable electricity policies. Thus, we have attended to the differences among countries in terms of wealth, population, democracy, and fossil-fuel endowments (and the potential concomitant industrial influence of the domestic fossil-fuel industry).

3. Method

The research project uses QCA (qualitative comparative analysis), a method that is complementary to a more fine-grained approached anchored in case studies. Our project uses a data set of eighteen countries in East, Southeast, and South Asia with a population of over 2,000,000. Pakistan, China, and Mongolia formed the eastern and northern border of the sample. Laos was originally included in the country-by-country analysis but excluded from the analysis for reasons given in the appendix. We did not include countries from Central and West Asia.

3.1 Dependent Variables

Two dependent variables were used. The first is the existing level of renewable electricity generation as a percentage of all net electricity generation for a country, and the second is based on an index that we constructed to measure progress toward renewable electricity policy. These two variables are shown on columns 8 and 9 of Table 1.

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TABLE 1 ABOUT HERE

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Renewable electricity is defined as including both small and large hydropower as well as biomass, geothermal, solar, and wind. Although electricity from renewable sources emits lower levels of greenhouse gases than from fossil fuels, it is not completely carbon neutral. Hydroelectric reservoir emissions remain a relatively small contributor to overall global greenhouse gas emissions, but we recognize that large hydropower facilities do emit greenhouse gases, especially during the years immediately after they are first filled and especially in tropical climates (Barros et al. 2011). Nuclear power is also a source of low-carbon electricity, but policies governing it are complicated, require separate treatment, and are not discussed here. Thus, our focus is on renewable electricity generation defined to include hydropower.

The first dependent variable is measured for the year 2010, the most recent year for which complete data were available from the U.S. Energy Administration (2013) data set. We used numbers only from the data set in order to increase consistency. The number in the eighth column of Table 1 is the renewable electricity generation for each country as a percentage of all electricity generation, and the number in parentheses is that number in comparison with the percentage of the country with the highest level. Thus, the first dependent variable, the number in parentheses, has a range of possible scores from 0 to 100 (Myanmar=100). For comparison purposes, the first column shows non-hydro renewable electricity generation, and again the number in parentheses in the second column is that number calibrated to the country with the highest level, the Philippines.

The second dependent variable, the policy index (column 9), was constructed based on three major elements of demand policy: the renewable electricity portfolio goal or standard, feed-in tariff, and emissions trading. We focus here on demand policies (policies that increase demand for renewable energy) for which there is accessible and comparable information available because the policies are important for the transition to green energy (Rogge and Reichardt 2013, Schmidt et al. 2012). Furthermore, the literature in innovation policy studies on policy mixes suggests the importance of including multiple policy instruments under a broad policy strategy such as increased renewable-energy generation (Flanagan et al. 2011, Rogge and Reichardt 2013). We do not include supply policies (e.g., industrial and other business development policies) in the policy mix, an analytic strategy that we argue would require a separate analysis, would pose strong data-gathering challenges, and would likely be less important to a ST in export-oriented economies than in those where manufacturing is domestically oriented (such as the U.S.). Our index was constructed for this project because no other suitable index is available. An alternative index, that of Germanwatch (2013), is less precise, provides lower variance for Asian countries, and does not cover nine countries in our sample (Taiwan, Sri Lanka, Mongolia, North Korea, Cambodia, Pakistan, Myanmar, Vietnam, Bangladesh).

The first element of the index involves the renewable portfolio standard or target (column 3). There is no standard source that provides estimates of the renewable portfolio targets or goals for 2020 for all Asian countries in our data set. Furthermore, the quality of information sources on renewable energy targets, goals, or portfolio standards is very uneven, and in some cases official government documents are not available. Thus, one goal of our research project is to develop an estimate of the target percentage for renewable electricity for the year 2020 based on available sources. The mere existence of a goal, standard, or other policy statement does not necessarily translate into long-term action, and there is also variation between well-developed plans and broad statements of goals. However, we think that it is important to include this measure because it is a significant indicator of a country's demand policy. To get the information, we cross-checked government sources, media news stories, and energy reports. We also used peer-reviewed studies of renewable energy in Asia where available (e.g., Bakhtyar et al. 2013; Jupesta et al. 2011; Wang 2013). In some countries there is an explicit, clear standard comparable to ones found in European countries and American states, and the standard makes sense in comparison with estimates of current renewable electricity capacity (column 2). However, in other cases there was only a government announcement of a target, and there were no supporting documents available on a government web site or in other official government reports. In general, we have tended to err on the side of optimism, so that any errors generated will tend to be consistent across the data set. A full explanation of our decisions is provided in the appendix.

To derive the number in column 4 of Table 1 (ratio of the renewable portfolio target or goal to existing renewable capacity), we began with the actual renewable electricity capacity of each country, based on the U.S. Energy Administration data-set with some corrections as discussed below (column 2). Based on the analysis described in the appendix, we entered the renewable portfolio goal (column 3), then we then calculated the ratio of the existing renewable capacity to the standard (column 4). We then calibrated the ratio to a 0 to 100 scale based on the country with the highest percentage of renewable electricity capacity goal to all electricity capacity for the year 2020, with Mongolia set at 100 (the numbers in parenthesis in column 4).

For feed-in tariffs (columns 5 and 6), we relied on the data developed by Gipe (2012). Although feed-in tariffs are not the only form of demand support, they are an important general measure of how much support is available for a policy goal of increased renewable electricity generation. The tariffs for solar and wind energy ranged from $0 per kWh to $.59 per kWh. We then calculated the average of solar and wind feed-in tariffs and again standardized to the country with the highest percentage (Japan = 100).

The third element of the index is the existence of a carbon emissions trading scheme (ETS, column 7). The effectiveness of such schemes can be limited, but their existence provides another measure of a country’s commitment to reaching its renewable electricity goals. Furthermore, research on ETSs in Europe shows that they can affect firm strategy and innovation (Chan et al. 2012, Voss 2007). This score was weighted at half the level of the other two, because it is a less developed policy instrument in Asia. The highest score, 50, was given to a country that has a national plan and regional plans already in effect; a score of 35 was given to a country with one or more major regional plans; 20 for a country with plans for implementation; and 10 for a country with a voluntary scheme (see column 7). We could have used ordinal variable (40-30-20-10-0), but we decided that the weighting toward the higher levels of commitment with an interval scale was more accurate.

We then constructed a weighted measure (the second dependent variable, or the renewable policy index, column 9) based on the ratio of improvement in renewable energy generation as found in the renewable electricity targets or standards (40%), the feed-in tariff (40%), and an emissions trading scheme, including at the regional level (20%). Thus, the range of possible scores was 0 to 250.

3.2 Independent Variables

We selected seven independent variables intended to examine societal and political landscape factors: “democracy,” a score based on how democratic or authoritarian the country is; “area,” the land area of the country in square kilometers; “fossil fuel,” the relative rank of the country’s factor endowment in coal and natural gas; “wealth,” the gross domestic product per capita in 2010; “growth.rate,” the rate of growth of GDP for 2010; “pop,” the population in millions for 2010; and “rate,” the existing level of renewable electricity generation as a percentage of all electricity generation for a country for 2010. (See Table 2.) The “rate” and “index” variables are calibrated from columns 8 and 9 of Table 1. For the democracy variable, we used the Economist Intelligence Unit's Index of Democracy, third edition (Economist Intelligence Unit 2010). Fossil-fuel rank is based on coal and natural gas reserves as a percent of world reserves, then divided by the country's total electricity generation for 2010 (British Petroleum 2012). The choice of the fossil-fuel variable is due to existing research that suggests it is a factor that affects legislative support for green-energy policy in other settings (Coley and Hess 2012).

3.3 Qualitative Comparative Analysis

Qualitative Comparative Analysis (QCA) is an appropriate method for the analysis of small data sets for which the goal is to study the configurations of independent variables associated with high and low outcomes on a dependent variable. This method was developed by Ragin (1987) and gradually is gaining popularity among various social science fields. Unlike multivariate regression analysis, which is appropriate for larger data sets and focuses on factors that are predictors of a certain outcome, this approach views causes in conjunctures, which means that two or more conditions must take place synchronously to explain the outcome. The simultaneous occurrence or sets of simultaneous occurrences are called "paths." QCA output includes all paths that result in a particular outcome in order to allow researchers to interpret conditions in terms of their necessity and sufficiency.

In the process of analysis using QCA, theoretical concepts are operationalized as variables. Each data point in the variable is assigned a level of membership that ranges from 0 to 1. The most primitive form of QCA is the crisp-set, in which all cases are coded to 0 and 1 with no intermediaries. Further evolution of the technique resulted in the technique used in this study: fuzzy-set QCA, which allows for continuous variables being formed after a calibration procedure. The analyst has to specify thresholds of full membership and full non-membership and the crossover point (Ragin 2000). Although ideally threshold levels should be theoretically informed, Ragin (2008) acknowledged that this is rarely achieved in practice. For the purpose of this research, threshold levels were determined based on variables' distributions. The calibrated scores are displayed in Table 2.

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TABLE 2 ABOUT HERE

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Because QCA does not assume causal symmetry, the paths that result in successful cases are not necessarily the same as the ones that result in non-successful cases. For instance, if a small democratic country with high GDP per capita is predicted to have high scores for the index, one cannot assume conversely that a large, authoritarian country with low GDP per capita would yield low scores in the same index. Therefore, we analyze paths that lead to both high and low levels of both dependent variables. Fuzzy-set QCA (fsQCA) yields three different solutions terms: complex, parsimonious, and intermediate. In order to maintain a balance between parsimony and complexity, this research only presents fsQCA's intermediate solutions. It is important to note that despite the different in paths returned, the three forms of solutions always concur logically and rule out possible contradictory information.

In the tables that present the results of the QCA, the variables appear in upper-case letters to indicate that they are high, and they appear in lower-case letters to indicate that they are low. Although the use of upper and lower case may appear to signal categorical variables, they should be interpreted as “higher” or “lower” on a continuous variable. If neither word appears in a cell in the table, then the variable is not relevant for the path.

4. Results

4.1 Dependent Variable 1: Rate of Renewable Electricity Generation

The asterisk in each line is read as an “and,” and the plus at the end of the line is read as an “or.” The “or” relates one line in the table to the next line. For example, for Table 3, line one, it is read as follows: The first path to high renewable electricity generation include countries with low democracy, high land area, high fossil-fuel reserves, low GDP per capita, and low GDP growth rate. Pakistan and Myanmar conform to this particular configuration.

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TABLE 3 ABOUT HERE

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The QCA in Table 3 indicates that the paths to higher levels of renewable electricity generation are countries that are low in democracy (high in authoritarianism), relatively large, with relatively larger endowments of coal and natural gas, relatively poor (low in GDP per capita), and relatively high in population. Conversely, countries with lower levels of renewable electricity generation tend to be wealthy democracies. Specifically, Japan, Malaysia, and South Korea all have a GDP per capita of over $16,000 per year. Mongolia is considerably less wealthy (GDP per capita of $4741) but above the median in this data set; it faces salient air-quality issues that may be driving its transition policies.

From the descriptive statistics in Table 1 is it clear that some countries already have 30% or more of their net electricity generation from renewable energy sources (Myanmar, North Korea, Pakistan, Sri Lanka, and Vietnam). The high level of renewable electricity generation is due almost entirely to hydropower, except for the Philippines, which also has substantial geothermal energy. Because these countries are poor and face rapidly growing demand for electricity, the high percentage of renewable electricity generation could decline with growth. All 18 Asian countries that we studied other than North Korea are experiencing strong economic growth (3-15% GDP growth rate) in comparison with wealthy, developed countries in other parts of the world, and the rapid economic growth is placing burdens on electricity demand. Furthermore, in some countries electrification of areas still not on the grid is also driving demand growth to such an extent that they could see the percentage of renewable electricity decline as new sources of thermal and nuclear generation are added. In the appendix, we noted that some of the planning documents admit as much in some countries. Furthermore, as we read various reports on electricity projections, it became clear that most Asian countries were pursuing an "all of the above" strategy that included new fossil-fuel production (often natural gas).

4.2 Dependent Variable 2: Progress on Renewable Electricity Policy

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TABLE 4 ABOUT HERE

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The QCA in Table 4 indicates that countries with advanced renewable electricity policies (defined by the policy index) are wealthier and more democratic than countries that lack such policies (six out of seven paths). (See Table 4.) Conversely, countries that have a lower score for renewable electricity policies are more authoritarian, poorer, and more heavily endowed with coal and natural gas resources (five out of seven paths).

The highest scoring countries (over 150 on the index in Table 1) are Japan, Mongolia, and South Korea. Mongolia's high score is due in part to its efforts to escape from the heavy reliance on coal and the pollution problems that coal generation is causing for the country. Japan and South Korea are both wealthy countries with limited fossil-fuel resources, and they are heavily invested in technology development, including clean technology. Conversely, countries with a score below 60 are Bangladesh, Cambodia, Indonesia, Malaysia, Myanmar, North Korea, Pakistan, Singapore, Thailand, and Vietnam. Four of the countries—Bangladesh, Cambodia, Myanmar, and North Korea—have very low per capita GDP and might be expected to have a low performance because they are small and poor. One would expect Indonesia, Malaysia, Singapore, Thailand, and Vietnam to have the resources, in terms of total GDP and per capita GDP, to engage in a more concerted effort to develop renewable electricity. However, these countries have a relatively poor performance to date.

5.0 Discussion

Discussions of Asia and development frequently make reference to the group of Asian Tigers (Hong Kong, Singapore, South Korea, and Taiwan). These four countries, in addition to Japan, have the highest per capita income in the group of Asian countries studied here (countries with a population over 2 million). However, our research suggests that there is no straightforward relationship between per capita GDP and progress on policies that support renewable electricity demand. Although Japan, South Korea, and Taiwan scored highly on our index, and Taiwan was also a high scoring country, Singapore does not score so well. Likewise, the overall correlation between the strength of renewable electricity policy and per capita GDP is weak (r=.34).

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TABLE 5 ABOUT HERE

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The QCA indicates that societal factors other than wealth contribute to the development of green transition policies in Asia in the renewable electricity field. (See Table 5.) Strikingly, countries that are not only wealthier but also more democratic tend to have a relatively low level of current renewable electricity generation and relatively high levels of policy in support of increased renewable electricity. The countries often relied on relatively inexpensive fossil fuels to support their historical transition to high levels of per capita income, but they now have the resources and political will to shift toward a higher reliance on renewable electricity sources. Likewise, countries that are poorer, more authoritarian, and with higher levels of fossil-fuel endowments tend to have a relatively high level of renewable electricity generation and lower score on renewable electricity policy (as defined by the midpoint on the QCA). Thus, our analysis shows that the wealth of a country (GDP per capita) is an important factor that predicts a positive score, but other societal and political factors also affect the relative stasis or progress of a country toward a ST for electricity, notably the strength of democratic institutions and the strength of coal and natural gas reserves.

In the data set as a whole, the countries with the highest factor endowments of coal and natural gas reserves relative to total electricity generation are (in order of highest to lowest) Mongolia, Myanmar, Indonesia, Pakistan, Malaysia, India, Bangladesh, China, and Vietnam (Table 2). Several of these countries also have lower levels of renewable electricity policy (e.g., Myanamar, Indonesia, Pakistan, and Vietnam have a score below 50, Table 1). China and India do have high fossil-fuel endowments and a mid-range policy score, but they are large countries that have the global spotlight on them because of their contribution to global greenhouse gas emissions, and they are engaged in energy diversification strategies and clean-tech industrial development. Singapore is anomalous because of its high income and low policy score, but it also imports natural gas from neighboring Indonesia. Thus, the connection between a country's fossil-fuel reserves and its renewable energy policy is one important finding from this comparative analysis in addition to the other landscape factors such as population, wealth, and democracy.

6.0 Conclusion

Of the political and societal factors, global climate policy negotiations have drawn attention to disparities in wealth between rich and poor countries and the problem that low-income countries lack the capacity to engage in a ST. As a result, low-income countries can claim that they are justified in requesting support from wealthy countries due to climate debt. Our analysis is consistent with this approach, because GDP per capita income is an important factor. However, we also suggest that the study of STs should include a much wider range of societal factors in the analysis of what affects the pace of STs, specifically the strength of democratic institutions and the role of fossil-fuel endowments and industries.

Our analysis of societal and political factors that affect STs also provides a complementary perspective to much of the literature on STs. The literature on innovation policy has drawn attention to the important role of policy mixes that encourage the innovation that drives STs for renewable energy (e.g., Rogge and Reichardt 2013). In general, innovation studies focus on the important technological and economic barriers that emerge when policies attempt to encourage innovation and to integrate innovations into regimes and large technological systems (e.g., Geels 2011). Although this literature draws attention to one of the fundamental problems for STs, we suggest that attention also needs to be paid to the complementary problem involving broader political and societal factors that affect the capacity of a government to support a ST, an approach that is gaining increasing attention in studies of STs (e.g., Elzen et al. 2011). In effect, we are proposing an approach for studying variation in the landscape dimensions of STs.

The concept of a landscape in ST studies is generally understood as the exogenous environment that affects the niche-regime relationships such as the relationship between renewable energy and fossil fuels in the electricity sector (Geels 2011). The term “landscape” encompasses long-term trends as well as macro-societal factors such as geography, demography, demography, economy, and political culture. Our approach suggests a way to analyze systematically the concept of the landscape through comparative analysis that reveals how differences in the landscape can affect ST dynamics involving the relationship between a renewable energy niche and the incumbent electricity regime.

One of the important landscape factors may be the strength of the fossil-fuel industry. In some northern European countries, there is a relatively high level of political consensus in favor of developing a transition to renewable and low-carbon energy sources, and the level of political contestation may be relatively low. In such circumstances it makes sense to treat STs as managerial challenges that involve selecting the appropriate policies to bring about innovation and reconfigurations of niche-regime relationships. However, even where there is broad support, the implementation of ST policies that result in a wide shift away from fossil-fuel dependence has not always been as successful as originally envisioned (e.g., Kern and Smith 2008, van der Loo and Loorbach 2012). Thus, when one studies STs from a broad comparative perspective, one must recognize that although in some European countries great progress has been made, in other countries the STs are highly contested politically (e.g., Haas et al. 2011, Meadowcroft 2011). For example, in the United States, the fossil-fuel industry has mounted a wide-ranging political mobilization against renewable energy policies and even climate science. Strength of the fossil-fuel industry also varies widely across American states, and states with a stronger fossil-fuel industry tend to have weaker policies in support of a renewable energy transition (Coley and Hess 2012). The data set of Asian countries considered here also draws attention to the role of a country's fossil-fuel industry in affecting the pace of the ST in the electricity sector.

Thus, there is an important opportunity for comparative analysis that would elucidate the conditions under which governments are more or less responsive to the need to undertake a ST. The stalled ST to renewable and low-carbon energy in North America has meant that it is especially important to understand the transition to low-carbon energy systems in other world regions. Likewise, the general shift of global economic dynamism to Asia and the increases in carbon emissions from Asian countries also require an increased focus of attention on this region of the world. Future research would do well to expand the approach that we have developed here to other world regions (e.g., the Middle East, Africa, Central Asia, and Latin America), and it could also benefit from more detailed analysis of the political dynamics of STs in Asian countries.

Appendix

This section provides supplementary information on demand policies in alphabetical order by country to explain the data set used in Table 1. Feed-in tariffs are only discussed where we saw additional background information to be necessary beyond what is provided in the table.

Bangladesh. We used the official government target of 10% renewable energy generation capacity by 2020, in contrast with the estimated current level of 4% (Bangladesh Ministry of Power, Energy, and Resources 2008). The feed-in tariff variable is recorded as 0 because although the government announced a feed-in tariff plan in 2013, estimates of the amount paid were not yet available (Financial Express 2013).

Cambodia. The government has a 5% long-term goal of renewable energy generation, a level slightly below current estimates of actual generation (Norton Rose Group 2010). Electrification will coincide with diversification from heavy reliance on hydropower.

China. In the Twelfth Five-Year Plan, the Chinese government set a goal for 2015 of a 16% reduction in energy intensity and an increase in non-fossil fuel consumption of 11.5%, but this may include all forms of energy consumption (Government of China 2011). We based our estimate on the goal of increasing renewable electricity generation capacity (all types, including hydropower) to 500 GW by 2020, that is, to about one third of the total projected capacity of 1600 GW total (Martinot and Junfeng 2010). Thus, we use 31.3% as the short-term or 2020 RPS goal for China, that is, a modest increase from 2010 renewable generation of about 25.9% in a country with rapid consumption growth that includes increasing coal consumption between 2010 and 2020 (Watts 2012). The country has no plan for a reduction in overall CO2 emissions, but in 2012 it began to discuss an energy ceiling of 4.2 billion tons by 2015 (Watts 2012). The country also was piloting a cap-and-trade program for CO2 emissions in various cities (Wang 2013).

India. India has a target for 2020 of 15% of its energy from renewable sources in addition to hydropower. If we assume that hydropower remains constant at 19.5% of energy capacity but that non-hydro renewables grow from 7.5% of total capacity to 15%, then the effective renewable electricity target for 2020 can be estimated at 34.5%. The country has other, related targets, such as reductions in energy intensity and increases in solar capacity. The country also has an energy efficiency trading scheme for over 500 of the largest industrial producers, called "Perform, Achieve, and Trade," and it also has a pilot particulate trading scheme in three states (Halliday 2012). Although the schemes are not directly oriented toward greenhouse gases, they are likely to reduce carbon-dioxide emissions indirectly, and thus they are counted in Table 1.

Indonesia. Under the country's Vision 25/25 energy plan, the goal is to have 25% of the electricity capacity from renewable energy by 2025. Without energy efficiency measures, the target in the plan would be reduced to 17% (Indonesia Ministry of Energy and Mineral Resources 2011, Jupesta et al. 2011). Consistent with other countries, we used the more optimistic target.

Japan. Japan has a 20% renewable electricity standard for 2020 (Ministry of Economy, Trade, and Industry 2012). Renewable energy could grow more rapidly depending on the extent to which politically controversial proposals to reduce nuclear energy after Fukishima are enacted. The country has also decided not to renew the Kyoto Protocol treaty in favor of bilateral agreements; and it has only a voluntary emissions trading scheme at the national level. For the Tokyo area there is an emissions trading framework that will cut emissions by 25% below 2000 levels by 2020 (Biggs and Nakayama 2010).

Laos. Policy initiatives focus on electrification rather than the greening of electricity. The country is not included in the QCA analysis because it is mostly off-grid and because energy statistics indicate that almost all current electricity is from hydropower. Therefore, any attempt at non-renewable diversification would in effect cause the country to have a negative renewable energy target.

Malaysia. We used the report by the country's Sustainable Development Energy Authority from 2012, which establishes a goal of 11% renewable electricity capacity by 2020, 17 % by 2030, and 73% by 2050 (Chen 2012).

Mongolia. The country's largest export is coal, and as of 2010 its renewable energy capacity was less than 1% of total electricity capacity (Kohn 2012). High levels of air pollution are motivating a transition to cleaner sources. A wind farm under construction in 2013 will contribute 5% of the country's energy from renewable sources, so we used this as the country's baseline for renewable energy. The country has a goal of increasing its renewable energy capacity to 20-25% by 2020 (Batsuuri 2011).

Myanmar. As of 2010, the country's net electricity generation was 68.7% from hydropower; both coal and natural gas generation are growing more rapidly than hydropower, and electrification is a primary concern. The country has plans to develop renewable electricity, including both hydropower and non-hydro sources, but there is no specific target or feed-in tariff (Asian Development Bank 2012).

North Korea. The country has a high percentage of hydroelectric power for its electricity, and it has recently shown some interest in developing renewable energy sources (Nakano 2011). However, the country does not have the relevant renewable-energy policies in place.

Pakistan. The government has a target to achieve 10% renewable energy or 2700 MW in capacity by 2015 (Asian Development Bank 2005). However, as of 2010 the country already had 6,592 MW in hydroelectric capacity and 6 MW of non-hydroelectric renewable energy out of 22,269 MW total electricity generation capacity (U.S. Energy Information Agency 2013). In other words, 30% of the electricity generation capacity (and 35% of electricity generated) is already from renewable sources. Thus, the target of 10% cannot be interpreted as a renewable portfolio standard goal. Instead, we interpret the 2700 MW as referring to additional renewable capacity, which would be about 10% of existing energy capacity. If other sources of electricity generation grow at the same rate or higher than renewable sources, then the goal of 2700 MW of new capacity would maintain constant the percentage of renewable electricity or even result in a decline in overall percentage. Thus, we have assumed that Pakistan is at best going to maintain a constant percentage of renewable electricity. Official documents and other reports give no indication that the plan is otherwise.

Philippines. The Renewable Energy Act of 2008 included provisions for a feed-in tariff and a renewable portfolio standard (Legaspi 2012). The Philippine Energy Plan 2009-2030 calls for tripling renewable energy production by 2030 (Philippine Department of Energy 2012, Philippine Information Agency 2012). According to draft rules of the RPS, the government will mandate a 1% annual increase over a ten-year period (Philippine Department of Energy 2011).

Using the U.S. Energy Administration percentage of 33% for 2010 (in Table 1) and assuming a full percentage point ratchet per year, the 1% annual increase in the mix of electricity would move the renewable electricity to 43% by 2020. This estimate for 2020 roughly coincides with but is somewhat higher than the goal of tripling renewable electricity generation capacity to 15.3 MW by 2030, which would be about 46% of total projected capacity but ten years after 2020 (Philippine Information Agency 2013). Thus, the reasonable assumption is that the goal for 2020 is as high as 43% and as low as a half-way point between 33% and 46%. We used 40%.

Singapore. In 2010 the Economic Strategies Committee report proposed that 5% of peak electricity demand be met by renewable energy sources by 2020 (Singapore Government 2010). The U.S. Energy Administration statistics estimate renewable capacity at only .2% of total capacity, but we adjusted it because the Singapore government estimates 2.5% for "renewables and other." Singapore also has pledged to reduce its CO2 emissions but we interpret the pledge as only a reduction in energy intensity. The country has a favorable rank internationally for carbon intensity, but there is no carbon tax or trading scheme in place (Singapore Government 2012).

South Korea. The government plans to increase solar and wind capacity by 44-fold and 37-fold respectively and to increase the renewable energy portfolio to about 11% by 2020. The investments also include increases in electricity generation plants powered by coal and natural gas (New York Times 2008). In 2012 the country also approved a carbon emissions trading plan that will begin in 2015 (Lee 2012, Reuters 2012).

Sri Lanka. The country has a plan for 2020 of 43% renewable electricity generation and carbon neutral growth (Abeygunawardana 2010). The goal is based on their estimate of 40%

renewables (large hydro) in 2010, which contrasts with the estimate of 52% in the U.S. Energy Information Agency database (2013). As a result, we adjusted downward the estimate to 40% to coincide with their figures. The feed-in tariffs are estimated from the "other" category in the same report.

Taiwan. In 2010 the government announced a target for 2025 of renewable electricity generation of 16% (Sun 2010). Because the target of 16% is for 2025, we took two-thirds of the difference between current estimated capacity and the 2025 target, therefore estimating 13.2% for 2020. Taiwan is also developing a carbon offset program for the largest industrial polluters (Reuters 2012), and the government also plans to reduce emissions rates to 2000 levels by 2025 (Taipei Economic and Cultural Office in Miami 2013). The latter is counted in Table 1 as an emissions trading scheme.

Thailand. The country had one of the first feed-in tariffs in Asia, and it has a renewable energy target of 20% by 2020 under its Renewable Energy Development Plan. Although there are also differences in targets across government agencies, the goal of 20% was selected as the most prominent (Tongsopit and Graecen 2012). The country plans to launch a voluntary emissions trading market in 2014 (Reuters 2012).

Vietnam. In the country's "Power Development Plan" there is a goal to increase renewable electricity capacity in 2020 to 17,400 MW for hydropower, 1000 MW for wind, and 500 MW for biomass (Socialist Republic of Vietnam 2011). The overall goals based on 75,000 MW capacity projected for 2020 are 31.1% for hydropower and other renewables, whereas current estimates from the government document for 2008 are 36.8% for all renewables. The figures are consistent with those of the U.S. Energy Information Agency (2013) for 2010, at

36.4%. In other words, due to the rapid growth, the percentage of electricity from renewable sources will likely decline, and there is currently no goal to change that trajectory. Vietnam does have a plan to reduce energy intensity to 8-10% below 2010 levels by 2020, and it will launch by 2018 an emissions trading market for greenhouse gases covered under the Kyoto Protocol (Reuters 2012).

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Table 1 Summary of Indicators Used in Renewable Policy Index Score

Column Number	1	2	3	4	5	6	7	8	9
Country	Non-Hydro Renewable Generation % All bKWH (% Philippines)	Renewable Energy Capacity % All MW	Renewable Portfolio Target (% All MW)	Target to Capacity Ratio (% Mongolia)	Feed-In Tariff ¢/KWh: Solar, Wind	Feed-In Tariff ¢/KWh: Average (% Japan)	Emissions Trading Scheme (score 0-50)	Renewable Electricity Generation % All bKWh (% Myanmar)	Renewable Policy Index Score
Bangladesh	0.2 (1.3)	4	10	2.5 (50)	0, 0	0 (0)	0	3.9 (6.2)	50
Cambodia	2.5 (16.1)	5.3	5	0.9 (18)	0, 0	0 (0)	0	5.2 (8.2)	18
China	1.5 (9.7)	25.9	31.3	1.2 (24)	18, 9	13.5 (36.0)	Cities (35)	19.7 (31.1)	95
India	2.4 (15.5)	27	34.5	1.3 (26)	39, 0	19.5 (52.1)	Nation (50)	15.0 (23.7)	128
Indonesia	5.9 (38.1)	17.8	25	1.4 (28)	0, 0	0 (0)	0	16.7 (26.4)	28
Japan	3.2 (20.6)	10.6	20	1.9 (38)	50, 25	37.5 (100)	Tokyo (35)	11.0 (17.4)	173
Malaysia	1.1 (7.1)	8.3	11	1.4 (28)	21, 0	10.5 (28.0)	0	6.5 (10.3)	56
Mongolia	0	5.0	25	5 (100)	30, 15	22.5 (60.1)	0	0.1 (.2)	160
Myanmar	0	46.7	0	0 (0)	0,0	0 (0)	0	68.7 (100)	0
N. Korea	0	52.6	0	0 (0)	0, 0	0 (0)	0	63.1 ()	0
Pakistan	0	29.6	29.6	1 (20)	0, 14	7 (18.7)	0	35.2 (55.6)	39
Philippines	15.5 (100)	33.1	40	1.2 (24)	24, 21	22.5 (60.1)	0	27.4 (43.3)	84
Singapore	2.7 (17.4)	.2 -> 2.5	5	2 (40)	0, 0	0 (0)	0	2.7 (4.3)	40
S. Korea	0.6 (3.9)	3.4	11	3.2 (64)	59, 11	35 (93.4)	Plan (20)	1.4 (2.2)	177
Sri Lanka	0.2 (1.29)	52.0 -> 40	43	1.1 (22)	18, 17	17.5 (46.7)	0	53.8 (85.3)	69
Taiwan	1.9 (12.3)	7.7	13.2	1.7 (34)	25, 15	20 (53.4)	Plan (20)	3.8 (6.0)	107
Thailand	2.2 (14.2)	8.9	20	2.2 (44)	1, 3	2 (5.3)	Volun. (10)	6.0 (9.5)	59
Vietnam	0.1 (0.6)	36.4	31.1	0.9 (18)	0, 4	2 (5.3)	Plan (20)	30.2 (47.7)	43

Table 2. Cases and Calibrated Variables

Country	Population	GDP Growth	GDP per capita	Fossil Fuel	Area	Democracy	RE Generation Rate	Index
Japan	0.92	0.00	1.00	0.05	0.57	1.00	0.33	1.00
South Korea	0.31	0.17	1.00	0.05	0.03	1.00	0.02	1.00
North Korea	0.05	0.00	0.01	0.12	0.04	0.00	1.00	0.00
China	1.00	1.00	0.76	0.73	1.00	0.00	0.77	0.92
Mongolia	0.01	0.26	0.50	1.00	1.00	0.79	0.01	1.00
Taiwan	0.05	1.00	1.00	0.05	0.01	1.00	0.04	0.96
Vietnam	0.73	0.61	0.10	0.69	0.50	0.00	0.96	0.08
Cambodia	0.02	0.04	0.02	0.05	0.10	0.07	0.07	0.00
Thailand	0.58	0.94	0.78	0.32	0.75	0.93	0.08	0.52
Malaysia	0.07	0.79	0.97	0.98	0.50	0.56	0.10	0.44
Singapore	0.01	1.00	1.00	0.05	0.01	0.37	0.03	0.05
Indonesia	1.00	0.11	0.48	0.99	1.00	0.92	0.67	0.01
Philippines	0.78	0.90	0.28	0.05	0.39	0.48	0.93	0.85
Bangladesh	0.96	0.07	0.01	0.82	0.06	0.36	0.04	0.22
India	1.00	1.00	0.14	0.95	1.00	1.00	0.59	0.99
Pakistan	0.98	0.00	0.04	0.99	0.97	0.04	0.98	0.05
Sri Lanka	0.04	0.96	0.57	0.05	0.02	0.96	1.00	0.68
Myanmar	0.29	0.00	0.00	0.99	0.89	0.00	1.00	0.00

Table 3: Paths to High and Low Levels of Renewable Electricity Generation as a Percentage of All Electricity Generation

High levels								
democracy	* AREA	* FOSSILFUEL	* gdp.per.capita	* gdp.growth.rate		+	(2)	Pakistan, Myanmar
	AREA	* FOSSILFUEL	* gdp.per.capita	* gdp.growth.rate	* POPULATION	+	(2)	Pakistan, Indonesia
democracy	* AREA	* FOSSILFUEL		* GDP.GROWTH.RATE	* POPULATION	+	(2)	China, Vietnam
democracy	* area	* fossilfuel	* gdp.per.capita	* GDP.GROWTH.RATE	* POPULATION	+	(1)	Philippines
Solution coverage:	0.517							
Solution consistency:	0.952							
Low levels								
DEMOCRACY	* area	* fossilfuel	* GDP.PER.CAPITA	* gdp.growth.rate	* population	+	(1)	South Korea
DEMOCRACY	* AREA	* FOSSILFUEL	* GDP.PER.CAPITA	* gdp.growth.rate	* population	+	(1)	Mongolia
DEMOCRACY	* area	* FOSSILFUEL	* GDP.PER.CAPITA	* GDP.GROWTH.RATE	* population	+	(1)	Malaysia
DEMOCRACY	* AREA	* fossilfuel	* GDP.PER.CAPITA	* gdp.growth.rate	* POPULATION	+	(1)	Japan.
Solution coverage:	0.291							
Solution consistency:	0.973							

Table 4: Paths to More and Less Advanced Renewable Energy Policies

Advanced Policies

DEMOCRACY	*	area	*	fossilfuel	*	GDP.PER.CAPITA			*	population	*	rate	+	(2)	Taiwan, South Korea
DEMOCRACY	*	area			*	GDP.PER.CAPITA	*	GDP.GROWTH.RATE	*	population	*	rate	+	(2)	Taiwan, Malaysia
DEMOCRACY	*	area	*	fossilfuel	*	GDP.PER.CAPITA	*	GDP.GROWTH.RATE	*	population			+	(2)	Taiwan, Sri Lanka
DEMOCRACY	*	AREA	*	fossilfuel	*	GDP.PER.CAPITA			*	POPULATION	*	rate	+	(1)	Thailand, Japan
DEMOCRACY	*	AREA	*	FOSSILFUEL	*	GDP.PER.CAPITA	*	gdp.growth.rate	*	population	*	rate	+	(1)	Mongolia
DEMOCRACY	*	AREA	*	FOSSILFUEL	*	gdp.per.capita	*	GDP.GROWTH.RATE	*	POPULATION	*	RATE	+	(1)	India
democracy	*	AREA	*	FOSSILFUEL	*	GDP.PER.CAPITA	*	GDP.GROWTH.RATE	*	POPULATION	*	RATE	+	(1)	China

Solution coverage: 0.684

Solution consistency: 0.912

Laggard Policies

democracy	*	AREA	*	FOSSILFUEL	*	gdp.per.capita	*	gdp.growth.rate			*	RATE	+	(2)	Pakistan, Myanmar
		AREA	*	FOSSILFUEL	*	gdp.per.capita	*	gdp.growth.rate	*	POPULATION	*	RATE		(2)	Pakistan, Indonesia
democracy	*	AREA	*	FOSSILFUEL	*	gdp.per.capita			*	POPULATION	*	RATE	+	(2)	Pakistan, Vietnam
democracy	*	area	*	fossilfuel	*	GDP.PER.CAPITA	*	GDP.GROWTH.RATE	*	population	*	rate	+	(1)	Singapore
democracy	*	area	*	FOSSILFUEL	*	gdp.per.capita	*	gdp.growth.rate	*	POPULATION	*	rate	+	(1)	Bangladesh
DEMOCRACY	*	area	*	FOSSILFUEL	*	GDP.PER.CAPITA	*	GDP.GROWTH.RATE	*	population	*	rate	+	(1)	Malaysia

Solution coverage: 0.751

Solution consistency: 0.968

Table 5. Summary Patterns

	High Renewable Electricity Generation	Low Renewable Electricity Generation	Advanced Renewable Electricity Policies	Lagging Renewable Electricity Policies
Democracy	Lower	Higher	Higher	Lower
Wealth	Lower	Higher	Higher	Lower
Fossil Fuel Reserves	Higher			Higher
Size and Population	Larger and Higher			