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FINANCIAL BARRIERS TO DEVELOPMENT OF RENEWABLE AND GREEN ENERGY PROJECTS IN ASIA

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Abstract

The expansion of green renewable energy has been very limited in all the Asian countries, despite their various differences. The contributing factors are numerous, but, the financial factor has been the single major factor determining whether or not a country opts for such energy. This is notwithstanding awareness about the unsustainability of fossil energy-dominated energy mixes, both for environmental and economic reasons. The main culprit is Asia's bank-dominated financial system with its underdeveloped capital market, which leaves Asian banks as the major source of funding for green renewable energy projects. Considering these projects as very risky with low rate of return on their invested capital, their reluctance to finance them has been the major barrier to the expansion of green renewable energy in Asia. Addressing the financing challenge is both possible and necessary to remove the barrier to green energy expansion in Asia.

Keywords: renewable energy financing, sustainable development, sustainable energy

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1. INTRODUCTION

Despite a prevailing belief, renewable energy is not a synonym for green or environmentally clean energy, as it consists of non-pollutive (e.g., wind, solar, and geothermal) and pollutive (e.g., biomass and biofuel) types. Hence, the sheer increase in their consumption is not necessarily good news for addressing global warming and other environmental challenges, unless their bulk is non-pollutive.

Asia is the world's largest economy with the highest growth rate, which is expected to last into the foreseeable future. Added to its rapidly expanding economy, its large and growing population with improving living standards, by and large, ensures an increasing demand for energy to secure Asia's first global rank as the largest energy consumer (6,602.2 million tons of oil equivalent, hereafter mtoe, in 2016) in the foreseeable future (BP 2017). As is the case in other continents, the Asian energy mix is dominated by fossil energy, whose unsustainable nature is not a matter of disagreement among the continental governments thanks to the growing environmental and also economic and health damages of their heavy consumption of oil, gas, and coal. Thus, they acknowledge the need for moving away from such pollutive energy in favor of environmentally clean types of energy to prompt their efforts for adding to their countries' energy mixes green energy, especially renewable types, but also non-renewable, nuclear energy in some cases, or expanding its share. Needless to say, their progress in this regard has differed from one Asian country to another, which has put some of them at the forefront of the global efforts to tackle global warming through reducing their greenhouse gas (GHG) emissions (e.g., the PRC) and some others on the list of the countries lagging behind (e.g., Indonesia).

Despite such significant differences, Asia as a whole is way behind where it should be in the field of green energy, mirroring the unfortunate global reality in this regard. This is evident in the insignificant share of non-fossil energy (nuclear and renewable) of the global energy mix in 2016 (14.47%) equal to 1,922 mtoe of which the total share of renewables, including the pollutive ones such as biomass, is even smaller (10.01%) equal to 1,329.9 mtoe (BP 2017). In that year, the total shares of non-fossil energy and renewables of the Asian energy mix were 9.58% (642.9 mtoe) and 8.11% (535.6 mtoe), respectively (BP 2017).

This dissatisfactory result cannot be attributed to only one single factor, regardless of its importance, but rather, a combination of factors. Nevertheless, the financial factor seems to be the most influential one. In fact, the comparative cheapness of fossil energy, including the availability of funds for realizing its projects, has been the single most important determinant in the Asian countries' limited success in expanding their green renewable energy sectors, although an increasing number of Asian countries, such as the PRC and India are taking major steps to change this reality.

Despite this positive Asian trend, the financial barriers are the main obstacles to the development of environmentally clean renewable and thus green energy (hereafter environmentally clean renewable energy, green renewable energy, or green energy) projects in Asia. Chief among them is the issue of financing of such projects, which are, by and large, capital intensive and thus require large borrowings. Given that the capital market, including venture capital, is not well-developed in many Asian countries, and that the Asian financial system is bank-dominated, the continental banks are the main source of funding for these projects. However, many Asian banks are reluctant to finance them for mainly two inter-related reasons: high risks and a low rate of return on invested capital compared to fossil-energy projects. As a result, the difficulty of securing adequate funding for green renewable energy projects has detracted from

their attractiveness as viable and profit-making investments to serve as a major disincentive for energy developers interested in such projects.

The scarcity or limited availability of adequate financial means has made the continuity of the status quo or making limited changes to it a more economically "realistic" option for many Asian countries, compared to switching to green energy, which requires a huge amount of initial investment. This factor has postponed or delayed a major switch to environmentally clean energy to an unspecified time in the future, notwithstanding the apparent negative consequences of large-scale consumption of pollutive fossil energy not only on the Asian countries' environment but also economy and public health.

Yet, despite their significance, financial barriers could be overcome through various measures. Examples include a host of new ways of non-bank financial solutions and tools such as green bonds, green credit rating, and community-based financing, as discussed in detail in other chapters as well an additional measure to be briefly discussed in this chapter. The latter avails to the low-income Asian countries' affordable green energy technologies, such as small hydro generators and vertical wind turbines or encouraging their domestic production.

2. ASIAN REGIONS' OVERALL SITUATIONS

Asia is not a homogenous continent and consists of regions (e.g., Asia and Pacific region) and within them sub-regions (e.g., South Asia, Southeast Asia, and East Asia) with varying degrees of infrastructural development, industrial and scientific advancements, trained human resources, and financial means necessary for embarking on projects. Despite variations in the mentioned areas between and within these regions, by and large, these factors determine the Asian countries' ability to embark on major projects, including green energy ones. Hence, barriers to such projects are not confined only to the financial ones, although, as will be discussed, the financial barriers are the single most important ones.

The existence of the mentioned factors plays the major role in prioritizing projects. This reality has decreased the urgency of switching to green energy and/or expanding its share of the Asian countries' energy mixes while negatively affecting, and therefore limiting, its scale and scope when efforts to that effect are made. This is reflected in the Asian energy mix, which is dominated by fossil energy, as per Table 1, covering the entire continent from the world's single largest fossil-energy-producing and exporting region (Middle East) and much smaller, but still significant oil and gas-exporting ones (Central Asia and Caucasus) to the world's largest energy-consuming region (Asia and Pacific region).

The small share of renewables, both pollutive (e.g., biomass) and non-pollutive (e.g., hydro), of the total energy consumption is true regardless of the continental countries' characteristics in terms of land, population, income, and level of economic development and technological advancement (Table 2). This is evident in the case of the developing Asian countries, such as large and low-income India (6.29%) and Pakistan (9.7%), large and middle-income Indonesia (3.3%) and Turkey (14.79%), small high-income Singapore (0.23%) and large and high-income Iran (1.10%) and Saudi Arabia (0%), demonstrating a spectrum of industrial and technological capabilities.

Table 1: Primary Energy Consumption in Asia 2016 (MTOE)

	Oil	Gas	Coal	Nuclear	Hydro-electricity	Renewables	Total Renewable Energy*	Total Consumption	Percentage of Renewable Energy*
Asia and Pacific region+	1,501.8	609.1	2,708.6	105.9	358.2	136.7	494.9	5,420.3	9.13
Central Asia and Caucasus++	22.7	84.8	36.6	0	4.8	0.1	4.9	148.9	3.2
Middle East+++	459.0	499.0	47.7	1.4	19.9	5.9	35.8	1,033.0	3.46
Total Asia	1,987.2	1,192.9	2,792.9	107.3	382.9	142.7	535.6	6,602.0	8.11

*Total Renewable Energy and Percentage of Renewable Energy are calculated by this author.

+ Australia and New Zealand are excluded by this author as two countries of Oceania.

As part of the Asia and Pacific region, South Asia in this table covers the three largest regional countries, i.e., Bangladesh, India, and Pakistan. Relevant data on the smaller South Asian countries (Bhutan, the Maldives, Nepal, and Sri Lanka) is unavailable.

++ Central Asia excludes the Kyrgyz Republic and Tajikistan, and the Caucasus excludes Armenia and Georgia as data on them is unavailable.

+++Including Turkey added by this author.

Source: Author's creation based on the data provided in: BP (2017) The BP Statistical Review of World Energy, p. 9. https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf.

As relatively small and large Asian countries, affluent and highly-developed Republic of Korea (1.71%) and Japan (8.28%), respectively, indicate the same energy pattern. Despite its heavy investment in its renewable energy sector and the sector's impressive rapid expansion, this is also true in the case of the PRC (11.43%). Of course, comparatively, some Asian countries have a much larger renewable energy share, such as Viet Nam (21.29%), but still such energy accounts for a fraction of their energy mix, which is dominated by fossil energy.

Table 2: Primary Energy Consumption in Selected Asian Countries 2016 (MTOE)

	Oil	Gas	Coal	Nuclear	Hydro-electricity	Renewables	Total Renewable Energy*	Total Consumption	Percentage of Renewable Energy*
PRC	578.7	189.3	1,887.6	48.2	263.1	86.1	349.2	3,053.0	11.43
India	212.7	45.1	411.9	8.6	29.1	16.5	45.6	723.9	6.29
Indonesia	72.6	33.9	62.7	–	3.3	2.6	5.9	175.0	3.3
Iran	83.8	180.7	1.7	1.4	2.9	0.1	3.0	270.7	1.10
Japan	184.3	100.1	119.9	4.0	18.1	18.8	36.9	445.3	8.28
Pakistan	27.5	40.9	5.4	1.3	7.7	0.4	8.1	83.2	9.7
Saudi Arabia	167.9	98.4	0.1	–	–	†	_	266.5	0.0
Singapore	72.7	11.3	0.4	–	–	0.2	0.2	84.1	0.23
Republic of Korea	122.1	40.9	81.6	36.7	0.6	4.3	4.9	286.2	1.71
Turkey	41.2	37.9	38.4	–	15.2	5.2	20.4	137.9	14.79
Viet Nam	20.1	9.6	21.3	–	13.7	0.1	13.8	64.8	21.29

*Total Renewable Energy and Percentage of Renewable Energy are calculated by this author.

Source: Author's creation based on the data provided in: BP (2017) The BP Statistical Review of World Energy, p. 9. https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf.

The regional breakdown of Asia mirrors the same pattern of energy consumption as evident in Table 3, which covers the major Asian regions in terms of population, economic activities, and energy consumption.

Table 3: Share of Renewable Energy of the Largest Asian Regions (2016)

	Primary Energy Consumption	Renewable Energy*	Percentage of Renewable Energy
West Asia1	1,033	25.8	2.49
Central Asia and Caucasus2	163.4	5.3	3.24
South Asia3	839.5	53.9	6.42
Southeast Asia4	589.3	33.2	5.60
East Asia5	3,925.2	393.5	10.02

1-West Asia consists of the Middle East and Turkey.

2-Central Asia excludes the Kyrgyz Republic and Tajikistan and the Caucasus excludes Armenia and Georgia as data on them is unavailable.

3-South Asia includes Bangladesh, India, and Pakistan as data on the remaining smaller countries (Bhutan, the Maldives, Nepal, and Sri Lanka) is unavailable.

4-Southeast Asia includes Malaysia, Indonesia, Philippines, Singapore, Thailand, and Viet Nam as data on the smaller regional countries (Brunei Darussalam, Cambodia, Lao People's Democratic Republic, and Myanmar) is unavailable.

5-East Asia consists of the PRC; Hong Kong, China; Taipei,China; Japan; and the Republic of Korea.

*Renewables include hydro-electricity.

Source: Author's creation based on the data provided in: BP (2017) The BP Statistical Review of World Energy, p. 9.https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf.

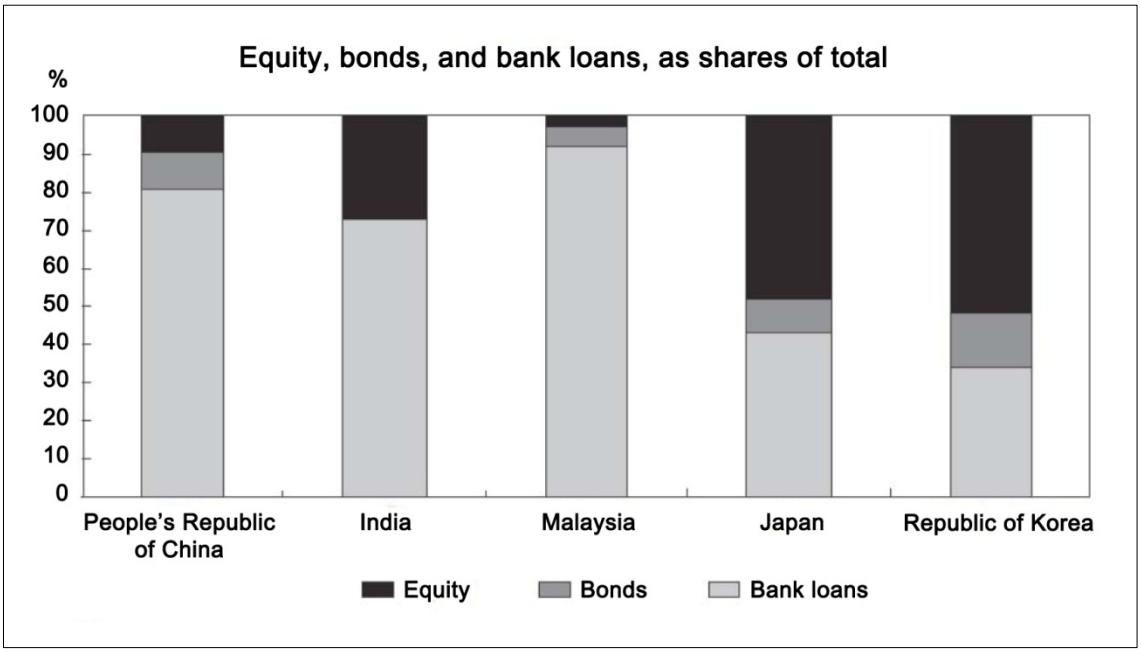
The mentioned energy pattern is in place, notwithstanding the major efforts to promote non-fossil energy, both nuclear and renewable, in many Asian countries as part of their individual efforts and/or commitments to that effect because of their membership in regional organizations such as ASEAN (Association of South East Asian Nations) and APEC (Asia-Pacific Economic Cooperation). For example, as set in the 2014 APEC Economic Leaders Declaration, APEC has a declared objective of doubling by 2030 the share of renewables in the APEC energy mix, including in power generation, through the efforts of its 21 member countries, of which 16 are Asian, including Eurasian Russia (APEC 2017). However, by and large, the overall impact of such policy will be insignificant because of the small share of renewable energy of the APEC region's energy mix, which was 9.61% in 2013, the earliest year on which such data is available for all APEC members (APERC 2016). Additionally, the share consists of green and non-green renewables and includes that of five non-Asian APEC members, i.e., Canada, Chile, Mexico, Peru, and the United States, to detract from its real positive impact on Asia. Thanks to their own initiatives, certain Asian countries, such as India and the PRC, have made more significant achievements in expanding the share of green renewable energy of their energy mixes, as is apparent in the PRC's turning itself into the world's largest producer of wind turbines and solar panels over a short period of time. In 2017, it produced about two-thirds of the world's solar panels and half of its wind turbines (Pham and Rivers 2017). The PRC overtook the United States in 2016 to become the world's largest renewable power producer (BP 2017: 43).

In short, Asia is the main scene of long-term growth of renewables and green energy, should the current trend continue. In particular, the Asia and Pacific region has been the leading region in this field, as reflected in its share of 60% of the global growth in renewable energy in power generation (not including hydro) of 14.1% in 2016 (BP 2017: 43).

3. FINANCIAL BARRIERS

The financial barriers are the single major barriers to the expansion of green renewable energy, although they are not the only barriers. While these barriers may vary from country to country, by and large, they stem from the Asian bank-dominated financial system. Given that this system lacks a well-developed capital market and thus the availability of venture capital is limited in many Asian countries, banks are the main source of funding for major projects, including green renewable energy ones. Yoshino and Taghizadeh-Hesary have discussed this major characteristic of the Asian financial market in detail in their recent works to make a comprehensive account of it in this chapter redundant and unnecessary. Suffice to state that their following figure on the size and forming components of this market illustrates this characteristic by demonstrating that bank loans account for the bulk of the available financing for such projects (Yoshino and Taghizadeh-Hesary 2014: 4).

Figure 1: Size of Financial Markets in Asia



Source: Shigesuke Kashiwagi, Nomura Holdings Inc., FSA Financial Research Center International Conference, Tokyo, Japan (February 2011).

Accordingly, despite variations in the degree of dominance of the banking system in the five covered Asian countries, this characteristic is clearly apparent in the financial system of the two largest and fast-growing Asian countries, namely, the PRC and India, as well as the expanding medium-sized Asian economy (Malaysia) to reveal the dominant continental reality in terms of available source of funding for major projects. Needless to say, the most economically-advanced Asian countries, namely Japan and the Republic of Korea, have more developed financial systems with a comparatively smaller role for banks, reflecting a more developed capital market, which is not mainly limited to banks.

Yet, despite differences between the capital markers of these Asian countries and those of the remaining ones, the mentioned characteristic is evident all over the continent, of course, to a varying extent and in different forms. Hence, in a sense, it is the case even in Japan with its large developed capital market where "the share of cash and deposits is much larger than that of securities and stock" (Yoshino and Taghizadeh-Hesary 2017: 6) to limit relatively the importance of the size and thus the role of its capital market compared to the European one, while the less-developed financial systems of the other Asian economies are similar, though not identical, in this regard. As a result, these economies' banks "dominate the financial system, pension funds and insurance companies provide a second level, and the share of the capital market is small" (Yoshino and Taghizadeh-Hesary 2017: 6). In this case, "banks, insurance companies, and pension funds will be the main source of finance for projects and businesses" in the overwhelming majority of the Asian countries (Yoshino and Taghizadeh-Hesary 2017: 7), including green renewable energy projects. This reality has a major implication for such projects' growth because of its impact on the availability of funds for their financing while determining what projects could be financed with the available funds. In this regard, the following elaboration of Yoshino and Taghizadeh-Hesary (2017: 7) is noteworthy:

Banks loans are suitable for financing short- to medium-term projects because the resources of banks are bank deposits, which typically are short-term or medium-term resources—usually 1 year, 2 years, and at most 5 years (deposits longer than 5 years are very rare). Hence if banks allocate their resources to long-term infrastructural projects (bridges, highways, ports, airports, etc.) and mega energy projects (such as large hydropower projects) there would be a maturity mismatch. Therefore, because banks' liabilities (deposits) are short- to medium-term, their assets (loans) also need to be allocated to short- to medium-term projects rather than to long-term projects. Insurance and pensions are an alternative for long-term investments (10, 20, 40 years). Large projects, such as big hydropower, gas-, or coal-based power plants can be financed by insurance companies or pension funds, as they are long-term (10–20 year) projects.

Briefly, the bank-dominated Asian financial market, whose main source of financing for green renewable energy projects is its banks, determines as the single major factor the growth, the extent and the type of green renewable energy projects, i.e., those whose required funds are short- to medium-term projects, accounting for the bulk of these projects such as wind farms. In such market, the financial realities of Asia's market economy as set by its banks, but not the purposeful decisions out of environmental necessities with direct implications on economic growth made by the Asian government, dictates what kind of energy can be developed instead of what is needed for environmental and energy reasons and, by default, sustainable economic development.

Within this restricted financial market, the availability of funds for green renewable projects is further limited given the risk aversion characteristic of the main potential funders: Asian banks. Restricting the availability of venture capital, this characteristic is a consequence of a much larger problem affecting all the small and medium-sized enterprises (SMEs) in which the majority of these projects fall. Yoshino's following account on the latter sheds light on this restrictive factor (Yoshino and Taghizadeh-Hesary 2014: 2):

Asian economies are often characterized as having bank-dominated financial systems and capital markets that are not well developed, particularly in the area of venture capital. Consequently, banks are the main source of financing. Although the soundness of the banking system has improved significantly since the 1996 Asian financial crisis,

banks have been cautious about lending to SMEs, even though such enterprises account for a large share of economic activity. Start-up companies, in particular, are finding it increasingly difficult to borrow money from banks because of strict Basel capital requirements. Riskier SMEs also face difficulty in borrowing money from banks.

"Riskier SMEs" include green renewable energy projects for a host of reasons. They include the risk of their technologies, which are still new in many cases and thus untested as reliable investment as far as Asian banks are concerned. This is notwithstanding the fact that the existence of a large number of successful projects of such technologies in many parts of the world weakens the validity of this argument.

As well, the intermittent nature of most of green renewable technologies further increases the risk, given that their input of energy is not secured due to their natural nature, which makes them beyond human control. This factor makes their technologies unreliable as a grid-connected source of electricity while increasing the cost of green energy projects even when the cost of their technologies themselves could be affordable. The fact that adequate wind and sunshine is not available all the time, whether during a given day, month, or season, make the electricity generation of wind turbine, solar panel, and concentrated solar projects intermittent. This shortcoming makes them unsuitable for baseload generation, which requires the availability of specific amounts of electricity 24 hours a day. To address this shortcoming, backup fossil-fueled generators are added to grid-connected wind and solar projects to cover the known daily electricity generation gaps. Excluding exceptional cases (e.g., hydropower in New Zealand), greenhouse gases-emitting coal-fired or diesel-fired generators are usually used for gap-filling as the cheapest options, although more expensive gas-fired ones could also be used**.** This non-green requirement adds a high cost to wind and solar energy projects. Consequently, for financial reasons, wind and solar electricity generators are not the best options on their own as grid-connected ones to meet base load electricity demand, although they are used by a growing number of Asian countries for environmental reasons.

Other reasons include a lower rate of return of green renewable energy projects compared to fossil fuels ones for various reasons. Examples include the mentioned additional cost of realizing green renewable energy projects, higher prices of their generated electricity than the fossil-fueled ones to challenge their competitiveness, and the much smaller amount of available governmental subsides for these projects compared to those of fossil energy. However, as reported by the International Energy Agency (IEA), the impressive global growth of wind and solar energy in 2016 suggests that this assumption is losing ground. Accordingly, "renewables accounted for almost two-thirds of net new power capacity around the world in 2016, with almost 165 gigawatts (GW) coming online" (IEA 2017). IEA also reports the growing competitiveness of wind and solar-generated electricity in many countries, including the Asian ones such as the PRC, India, and the United Arab Emirates (IEA 2017).

Asian banks' risk-aversion feature has been reinforced by the tightening regulations on credit lending, including credit risk measurement, by the Basel Committee on Banking Supervision to make them further reluctant to lend to green renewable projects. This reality and its implications are well summarized by Yoshino and Taghizadeh-Hesary as follows:

Due to the limitations of the Basel capital requirements on lending by financial institutions, and because banks consider most renewable energy projects to be risky, banks are reluctant to finance them. Hence, relying on banking finance is not a solution for financing green energy projects and we need to look for new channels of financing

this sector to fill the financing gap for such projects. Bank lending has to be allocated to safer sectors and businesses (Yoshino and Taghizadeh-Hesary 2017: 2).

In short, Asian banks' categorizing green renewable energy projects as risky with lower rate of return compared to fossil fuels ones make them reluctant to funding such projects.

Hence, the resulting difficulties in securing funds for these projects make them unaffordable for potential investors to make affordability the single major factor in slowing down the expansion of green renewable energy in Asia even though availability, accessibility, and plausibility of other energy options are also major contributors to such outcome. It should be pointed out that affordability, and thus the financial factor, is not the single major barrier to all types of renewables, as traditional bioenergy (biomass) such as wood, charcoal, and animal waste has been used extensively for thousands of years in every continent as the widely-available fuels. In modern times, traditional bioenergy has been used, especially in rural parts of many developing Asian countries, particularly for cooking as the available inexpensive fuel. In the ASEAN region, for example, its 10 forming Southeast Asian countries consumed 49.25 mtoe of traditional bioenergy in 2015, the most recent year on which such data exist (ACE 2017). It accounted for 7.83% of their total primary energy supply of 628.45 mtoe.

Even modern bioenergy sources are increasingly being consumed in some Asian countries as a cheaper alternative to liquid fossil fuels. Examples include just about all of the Southeast Asian countries, such as Thailand, where biofuel consumption has been increasing on a steady basis, from 647,000 tons of oil equivalent (toe) in 2010 (Sustainable Technology Forum 2017) to 1,610,000 toe in 2016 (Statista 2017a).

In fact, the major growth of renewables not just in Asia, but globally, has been in pollutive and thus non-green bioenergy. This type of energy is being promoted as a less pollutive and more sustainable alternative to fossil fuels for a wide-range of applications from household needs (e.g., biogas) to transportation (bioethanol and biodiesel). This is due to its ease and low cost of production, especially when it is done without regard to environmental considerations (e.g., clear-cutting of forests for wood and charcoal production, palm oil production for producing biofuels, and exhausting fresh water resources for biofuel production). Consequently, as reported by the International Renewable Energy Agency (IRENA):

About three-quarters of the world's renewable energy use involves bioenergy, with more than half of that consisting of traditional biomass use. Bioenergy accounted for about 10% of total final energy consumption and 1.4% of global power generation in 2015 (IRENA 2017).

Various recent reports indicate a growing expansion of bioenergy globally in both developed and developing countries, including in Asia, such as World Energy Resources: Bioenergy 2016 (World Energy Council 2016).

Against this background, the financial factor acts as a major barrier to the expansion of renewable energy in cases where switching to this type of energy involves environmentally clean and thus green energy, such as solar (both solar panels and concentrated solar), wind, and geothermal. In such cases, the switch is a deviation from the entrenched energy practice, which uses various derivates of oil, gas, and coal, as well as traditional and modern bioenergy to which given countries are accustomed. Switching demands significant investments in the required new technology and/or adaptation of their economies and societies to new types of energy, which are capital intensive to require financing.

In other words, the financial factor is effective as the single major barrier mainly when the cost of switching is simply unaffordable for potential investors to make embarking on large-scale renewable energy projects on their own out of the question. This happens in the case of opting for non-pollutive green renewables, which require advanced technologies that are unavailable locally or that are available at unaffordable prices to demand a significant amount of funding. In absence of non-bank financers, lack of large financing only permits the realization of affordable small-scale projects with no major impact on any given Asian country's energy consumption pattern since they are too limited in scale and scope to address the energy-caused environmental degradation, first and foremost, global warming, while meeting their respective societies' energy requirements.

4. TECHNOLOGY AVAILABILITY

Of course, the contributing factors to such comparatively high cost vary from one country to another. Above all, this is due to the availability of the locally-made required technologies only in a small number of technologically-advanced Asian countries such as Japan; the Republic of Korea; Taipei,China; and the PRC to a varying extent. However, other Asian countries, including those with extensive industrial capabilities and a degree of achievement in developing indigenous green renewable technologies at home (e.g., India and Iran), have to rely on imports for such technologies in all, most or some areas, depending on the case, from the mentioned Asian suppliers or the Western ones. India, for example, has a thriving domestic wind and solar manufacturing sector, but it still needs to import such technologies for various reasons, including the current inability of the sector to catch up with the growing demand thanks to the country's many wind and solar projects. As a result, a recent KPMG report predicted that India would need to import "$42 billion of solar equipment by 2030, corresponding to 100 GW of installed capacity" (Sarkar 2016). This reliance to various extents on imported technologies increases the cost of realizing green energy projects and adds an import burden on their economies to make green energy projects unaffordable for some Asian countries and restrict them for others, especially in the case of large-scale projects.

The technologically-advanced Asian countries with locally available clean renewable energy technologies may also find the cost of a large-scale switch to green energy too high when they have the option of comparatively cheaper fossil-fueled alternatives. For them, the latter is more economically sensible for large-scale consumption due to, generally speaking, the low yield of clean renewable technologies compared to fossil fuel ones, notwithstanding the pollutive and environmentally un-sustainable nature of oil, gas, and coal.

The PRC is a good example of an Asian country with a growing use of clean renewables, particularly solar and wind. In its efforts to curb its GHG emissions, the PRC has turned itself into the world's largest producer of wind turbines and solar panels, as mentioned earlier. With this large-scale production working toward meeting the growing domestic demand and with an eye to becoming a world major technology giver and thus exporter, it has significantly decreased the cost of production of green energy technologies to make them affordable at home and competitive abroad. As a result, in December 2016, the PRC's National Development and Reform Commission announced decreasing "tariffs paid to solar farms by as much as 19% in 2017 from this year's levels, and by as much as 15% for wind mills in 2018 from current prices" to reflect declines in construction costs of solar and wind projects (Shen 2016). Despite this major achievement, the PRC's continued use and large-scale construction of

fossil-fueled power generators (mainly coal- and gas-fired) reflects the comparatively high cost of total replacement of its power generators with clean ones. Their scale is evident in the PRC's ongoing building of 272,940 MW of coal-fired generator capacity (Shearer, Ghio, Myllyvirta, Yu, and Nace 2017).

In consequence, total replacement of the PRC's fossil-energy demand with green renewable energy is not the objective of the PRC government in the near and even predictable distant future, as the under-construction power generators and those built over the last 20 years have a life span of around 50 years. Needless to say, cost is not the only contributing factor to the continued large-scale consumption of fossil energy. Apart from electricity, which can be generated with green energy, the PRC's huge and expanding demand for liquid fuel for its rapidly expanding vehicle fleet thanks to its growing middle class, has justified using oil and gas for transportation, for example. The number of vehicles in use on the PRC roads jumped from 90.86 million in 2010 to 194 million in 2016 (Statista 2017b).

Drawing on the current global practices, the highly water and energy-intensive and pollutive process of biofuel production, as detailed in many reports such as Biofuel and Sustainability Challenge: A global assessment of sustainability issues, trends and policies for biofuels and related feedstocks (Elbehri, Segerstedt, and Liu 2013), removes biofuels as an environmentally and economically sensible option for a large-scale replacement of the PRC's huge demand for liquid fuel. Nevertheless, for various reasons, such as fuel diversification, lessening reliance on oil, and curbing CO_2 emissions, the PRC has increased its biofuel production from 925 thousand tons of oil equivalent (ttoe) in 2006 to 2,053 ttoe in 2016 (BP 2017). The pollutive and energy/water-intensive nature of biofuel production is, of course, the case in all Asian and non-Asian countries to serve as an example why renewables are not rapidly replacing non-renewable fossil energy even when no major barrier exists.

5. ADDITIONAL FINANCIAL CONCERNS

Apart from the discussed financial factor serving as the main barrier to the expansion of green energy in Asia, certain additional financial concerns negatively affect decisions on such energy not just in Asia's low-income regions and countries, but also in the affluent ones, although to differing extents. They include the real or perceived high cost of switching to green energy to replace the existing fossil-fueled power generators, namely oil (diesel and furnace fuel), gas, and coal-fired, in order to end or significantly reduce the consumption of fossil energy in fueling their major sectors, industrial, commercial, agricultural, service, transportation, and household. In this regard, the main concern is the required initial cost, which is usually the cheapest for fossil-fueled generators. This is a major preventive factor for all of the Asian countries, due to its pushing up or possibly pushing up the production cost of goods and services in their countries using the energy generated by green energy to affect their domestic markets and/or detract from the competitiveness of their exports, depending on the case.

In consequence, the issue of cost is not only a barrier to the switch and/or its extent in low-income, technology-taker Asian countries with small or non-developed industrial sector and its affiliated educational and research capability, but also in the developed and major trading Asian countries with advanced technological capabilities. Thus, the Republic of Korea and Japan with indigenous capabilities for developing and producing green renewable technologies are also mindful of this cost as reflected in their fossil-energy dominated energy mixes. It is also evident in the low pace and

small-scale of the expansion of their renewable energy of their energy mixes as demonstrated in Table 4.

Table 4: Growth of Renewable Energy in Japan, the Republic of Korea, and Taipei,China from 2006 to 2016 in MTOE

	2006			2016		
	Total Renewable Energy	Total Energy Consumption	Percentage of Renewable Energy of Total Energy Consumption	Total Renewable Energy	Total Energy Consumption	Percentage of Renewable Energy of Total Energy Consumption
Japan	21.5	520.3	4.13	36.9	445.3	8.28
Republic of Korea	1.2	225.8	0.53	4.9	286.2	1.71
Taipei,China	1.8	113.6	1.58	2.5	112.1	2.23

*Total Renewable Energy consists of hydro-electricity and renewables added together by this author.

Source: Author's creation based on the data provided in:

BP (2007) The BP Statistical Review of World Energy, p. 41. https://www.bp.com/content/dam/bp-country/en_ru/documents/publications_PDF_eng/Statistical_review_2007.pdf.

BP (2017) The BP Statistical Review of World Energy, p. 9. https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf.

The Fukushima accident of March 2011 revealed this concern in the case of Japan. Corrected for a significant drop of around 11.5% in Japan's energy consumption from 503.0 mtoe in 2010 to 445.3 mtoe in 2016 due to its declining energy consumption caused by demographic factors (negative birth rates and shrinking and aging population) and lowered economic activities because of a global economic slowdown, the shutting down of the Japanese nuclear energy reactors that were generating about 30% of the country's electricity demand prior to the accident, led to a major increase in Japan's fossil-energy consumption. However, as demonstrated in Table 5, it did not prompt a major increase in renewable energy consumption, despite a plan to that effect.

Table 5: Energy Consumption in Japan in 2010 and 2016 in MTOE

Year	Oil	Gas	Coal	Nuclear	Hydro-electricity	Renewables	Total Energy Consumption
2010	200.3	85.1	123.7	66.2	20.6	7.2	503.0
2016	184.3	100.1	119.9	4.0	18.1	18.8	445.3

Source: Author's creation based on the data provided in:

BP (2012) The BP Statistical Review of World Energy, p. 41. https://www.bp.com/content/dam/bp-country/de_at/pdfs/20120620_statistical_review_of_world_energy_full_report_2012.pdf;

BP (2017) The BP Statistical Review of World Energy, p. 9. https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf.

This result is notwithstanding Japan's capability to produce solar panels and wind turbines, for instance.

Given the Japanese experience, this cost factor raises questions about the Government of the Republic of Korea's June 2017 decision to replace its nuclear energy and coal with LNG and renewables over a few decades (World Nuclear News 2017). While it is technically possible and, in fact, good news for its aim of ending the consumption of the most pollutive type of fossil energy (coal), the share of renewables

of such replacement will likely be small, although potentially much larger than its current share, to put the burden on LNG as the cheaper alternative. As Table 6 demonstrates, the current small share of renewable energy, including hydro, of the Republic of Korea's energy mix and its low-paced expansion over time supports this doubt as nuclear energy, not renewables, has accounted for the bulk of its non-fossil energy for the last two decades.

Table 6: Share of Renewable Energy, including Hydro-Electricity, of the Republic of Korea's Energy Mix 2006-2016 in MTOE*

2006		
Renewable Energy	**Total Energy Consumption**	**Share of Renewable Energy of Total Consumption**
1.2	225.8	0.53
2011		
Renewable Energy	**Total Energy Consumption**	**Share of Renewable Energy of Total Consumption**
1.7	267.8	0.63%
2016		
Renewable Energy	**Total Energy Consumption**	**Share of Renewable Energy of Total Consumption**
4.9	286.2	1.71%

*Renewable Energy consists of hydro-electricity and renewables added together by this author.

Source: Author's creation based on the data provided in:

BP (2007) The BP Statistical Review of World Energy, p. 41.

https://www.bp.com/content/dam/bp-country/en_ru/documents/publications_PDF_eng/Statistical_review_2007.pdf; BP (2013) The BP Statistical Review of World Energy, p. 41.

https://www.bp.com/content/dam/bp-country/fr_fr/Documents/Rapportsetpublications/statistical_review_of_world_energy_2013.pdf; BP (2017) The BP Statistical Review of World Energy, p. 9.

https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf.

The low-income and less affluent Asian countries may have additional financial concern. The main one could be the lack of adequate domestic financial means or their limited availability to put a barrier to any major project, including energy ones. In such case, unless they can secure foreign funding, switching to environmentally clean renewable energy would be out of the question apart from small-scale projects, which could be locally funded or funded through regional and international funding agencies with development mandates such as the ADB. In this regard, recent examples include ADB's approving "a loan of $200 million with sovereign guarantee for Ceylon Electricity Board to develop Sri Lanka's first 100-megawatt wind park" (ADB 2017).

6. COST OF NOT SWITCHING

Expanding the share of renewable energy and, particularly, the green one is surely an option for the Asian countries today, to be decided by each individual country. However, preserving the status quo, that is the domination of their energy mixes by fossil energy with or without a share for green renewables, certainly does involve a huge cost for them. This could be an immediate one or one in the short, medium, or long-term. Global warming is a blatant example of the environmental damage of GHG, whose main contributor is about two centuries of large-scale consumption of CO_2-emitting fossil energy all over the world with an upward direction to worsen the situation

in all continents, including Asia. Despite a prevailing view justifying the continued status quo on the ground of the importance of economic considerations over the environmental ones, viewing economy and environment as two separate and unrelated realms, global warming does have an economic cost, which is growing unless a major reduction in GHG and particularly CO_2 emissions is achieved. Many well-researched and fully-documented reports on various aspects of the direct and indirect negative economic impact of this phenomenon have been published, including a major recent one by the Intergovernmental Panel on Climate Change (IPCC 2014). This reality makes a thorough elaboration on this topic in this chapter repetitious and unnecessary. Hence, a few examples should suffice to make this point.

As an example, global warming is damaging agriculture in many ways. Depleting fresh water resources through rapid vaporization, which then causes water scarcity and pushes up the cost of irrigation, as well as triggering or worsening droughts to totally destroy farming in some cases, is one way. Another is prolonging the life cycle of insects that damage crops. These two developments result in an increased cost of agrarian activities and products used for daily consumption as food and as raw material for a range of industrial activities to affect the lot of consumers and uplift the production cost of their respective industrial products, thereby reducing their competitiveness. Rising sea levels damaging the coastal areas of countries with coastal lines on open seas is yet another blatant example of global warming negatively affecting their respective residents, infrastructures, and commercial and industrial premises. Unless serious efforts are made to contain and reverse global warming, the coastal areas of Asia will be severely damaged as a result of this phenomenon by 2050 and will put at risk 40 million people in India, 25 million people in Bangladesh, over 20 million people in the PRC, and about 15 million people in the Philippines, according to a 2016 United Nations Environment Programme report (UNEP 2016).

In short, financial barriers have surely prevented the expansion of green energy and prolonged the energy status quo, which is certainly putting a huge financial burden on Asian countries. Its extent will increase over time as the environmental damages caused by extensive use of fossil energy will expand. Consequently, there is a positive correction between environmental damages and financial burdens on the Asian countries.

7. FEASIBLE MEASURES TO OVERCOME FINANCIAL BARRIERS

Despite their significance, financial barriers could be overcome through various measures. In fact, such measures are discussed in length in other chapters to include new ways of non-bank financial solutions such as carbon pricing (Ch. 8), green technology financing (Ch. 15), and community-based financing (Ch. 16) to name a few. As a result, this chapter only briefly suggests an additional measure.

8. DEVELOPING LOCAL APPROPRIATE TECHNOLOGIES

Given that the majority of the Asian countries are developing ones, it makes sense to integrate green energy projects into their development plans. These projects could therefore be categorized not just as energy ones, but as part of these countries' sustainable development plans to address their energy needs while expanding their

technological and industrial sectors and generating employment and income for their populations. Within this framework, it will be the concerned Asian governments instead of the Asian banking system, that are the source of funding for green energy projects, drawing on their available funds for economic development and not those for green energy projects per se.

In this case, developing green energy projects could consist of locally developing their required technologies and building green energy facilities with such indigenous technologies. As an economic incentive, the return on the government-provided capital will be in the form of renewable green energy to decrease the beneficiary countries' dependency on locally-produced or imported pollutive energy to sustain their economic development while enlarging their industrial activities and generating sustainable and constructive employment.

Depending on their countries' specifics, including industrial and technological development, the interested Asian governments could focus on certain green energy projects whose respective technologies are locally available or could be developed locally. In particular, this is a way forward for Asian countries, which are not currently technology-givers and thus lack the advanced scientific and industrial sectors to embark on their own on renewable energy projects requiring already-realized advanced technologies. The focus should be on small-scale production of certain green energy technologies, which are more suitable for these countries, both technologically and financially, given their specific situations, while helping them advance themselves technologically and industrially. Briefly, they are much easier to be built, installed, maintained, and repaired locally at a much lower comparative cost than the ones produced in green energy technology-supplying countries.

Examples include small and medium-sized wind turbines with vertical blades, which can operate with much weaker wind speed than the large, expensive horizontal turbines. Other examples include small hydro generators (run-off hydro generators), which do not require diverting rivers with its certain negative environmental consequences and phenomenal cost. As well, solar water boilers for household, commercial, and industrial use do not require the sophisticated technology of converting sunbeams into electricity as is done in solar panels and concentrated solar facilities, and thus could easily be built in many Asian countries. These boilers reduce the demand for energy in liquid, gaseous, and electric forms for boiling water, which is in large demand in all the Asian countries.

9. CONCLUSION

As it is the case in all other phenomena, many factors have prevented development of green renewable energy projects in Asia. Yet, among them, the financial factor has played the single major role by making embarking on such projects more difficult and challenging than those on non-renewable energy, if not impossible in many cases, by denying the required funds. In particular, the bank-dominated nature of the Asian financial system is the root cause. The underdevelopment of its capital market with a few exceptions (mainly Japan and the Republic of Korea) has left the Asian banks as the main source of funding for these projects, which are reluctant to fund them for the mentioned reasons. In absence of venture capital or its inadequacy and limited governmental-provided funds, funding the capital-intensive green energy projects has become very difficult. This difficulty has served as a disincentive for those interested in undertaking these projects, with the result being a limited expansion of green renewable energy in Asia, in general. Needless to say, many Asian countries are

mindful of this unsustainable reality and are taking impressive measures to expand their green energy sectors significantly although they are still far from drastically decreasing the share of fossil energy from their energy mixes. The PRC and India are the major players in this regard, while many other countries are making an effort to catch up. This reality has prolonged the domination of environmentally-unfriendly fossil energy over the Asian countries' energy mixes. Apart from their non-renewable nature to make their resources finite, their pollutive nature has made them an unsustainable source of energy, as is evident in expanding environmental problems caused by CO_2 emissions, in particular. Consequently, global warming as the most blatant manifestation of this unsustainability is not only worsening the environmental damages, but also negatively affecting the Asian economies, as is the case in other continents. Of course, these damages happen to a varying degree as determined by the extent of their own fossil-energy consumption and the effect of other countries' consumption affecting them, in addition to the effectiveness of their measures to deal with global warming and, in general, climate change.

Given this reality, it is necessary to remove the financial barriers to the development of green renewable energy. Needless to say, the specifics of any given Asian country determine the best course of action toward this end. Within this context, as mentioned earlier, the detailed suggested solutions in other chapters covering a wide-range of means to tackle the financial challenge, which the Asian countries can employ to meet their specific circumstances and needs.

In particular, this chapter's suggested local development of certain types of green energy technologies is suitable for all the Asian countries, especially those aiming at addressing their development challenges and achieve sustainable development. In conclusion, financial barriers to the development of green renewable energy projects in Asia are certainly formidable obstacles to realizing such projects, but not the non-removable ones. They can be removed at least by the ways mentioned in this book, in addition to others to be suggested by all the interested parties in sustainable development and environmental health.

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