ENERGY SECURITY IN ASIA: PROSPECTS FOR REGIONAL COOPERATION

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ABSTRACT

Three case studies illustrate some of the secondary consequences of the search for energy security and its relationship to regional trade and cooperation: the role of the People's Republic of China, the emerging market in biofuels in Southeast Asia, and diverse feed-in tariffs for renewable energy. The three main ways regional cooperation can strengthen national policies on energy security are (i) sharing information and knowledge to create a sound evidence base for policies, (ii) agreeing on common policies, and (iii) developing subregional markets in electricity and gas. The priorities of the knowledge base should be energy efficiency and renewable energy; in many cases it will be advantageous to work further toward harmonized policies. In the long term, the biggest impact of regional cooperation on national energy security will be creating regional networks; developing subregional markets will likely be the most effective approach. An Asian infrastructure cell at the Asian Development Bank could identify technically feasible projects of Asian interest and determine country support; serve as the secretariat for an Asian infrastructure fund; further monitor the development of subregional markets in electricity and gas; and encourage a harmonized approach through facilitating information exchanges, dialogues, and regional agreements.

Keywords: energy security, regional cooperation, energy sustainability, renewable energy, Asia and the Pacific

JEL Classification: F10, F15, Q40, Q43, Q48

I. INTRODUCTION

Conventional energy resources in Asia and the Pacific will not be enough to fuel future economic growth, so the region will need to procure supplies on the international market in the face of fierce competition. Reliance upon imported energy inevitably introduces a vulnerability to interruptions in supply and to rapid movements in price either of which can disrupt economic activity. It will be a preoccupation of policy makers to ensure the physical security of supplies as far as is feasible.

The limited capacity of the atmosphere to absorb greenhouse gases (GHGs) creates a more tightly binding constraint than does physical resource scarcity. The responsibility for climate change is complex and contested. Some developing countries are becoming very large sources of GHGs, and if the ambition of *Asia 2050: Realizing the Asian Century*[1] is met, Asia will be responsible for a very large share of emissions. Asian economies will need to adapt their policies to contribute to the management of climate change. It is much easier to achieve a secure supply of energy in the absence of the climate change constraint; the extent to which it operates will strongly affect the measures that need to be introduced to ensure security. In particular, the need for regional collaboration will be far greater when the climate constraint is operating. Recognition of the need to manage climate change has an implication for the definition of energy security; it becomes not only security in the sense of physical and economic security but security in the sense that procuring energy does not leave the world vulnerable to catastrophic environmental damage.

Allocating responsibilities for mitigating climate change is a hugely complex exercise in international and intergenerational equity that can be solved by political negotiations and international agreements. There is an intimate relationship between energy security and climate change policies that tries to indicate what the consequences of national policies for energy security will be and the way in which regional collaboration can support those policies.

In addition to the scarcity of resources and climate change, the social and political aspects that also need to be considered within the general idea of security are the consequences for the poor of insecure access to energy and the costs of policies to improve security. To manage this dimension of energy security requires extending access to modern energy on terms that are affordable and sustainable. The poor are the least able to cope with higher energy prices brought about by any constraint that may be imposed to improve security of supply, e.g., diversification to more costly sources such as renewable energy. In addition to extending access, compensating measures are needed to shelter poor communities from these impacts. The notion of energy security therefore needs to be further broadened to recognize an element of social security.

II. REGIONAL RESOURCES IN A GLOBAL CONTEXT

A. Proven Reserves

Asia and the Pacific are poorly placed in terms of known, proven reserves of oil. This is a serious problem given the high expectations for future oil supply. Table 1 shows proven reserves of oil in the region; they amount to only 7% of the known resources of the world. Moreover, the ratio of reserves to production is much lower than that for the rest of the world, so not only are the proven reserves small,

[1] Asian Development Bank (ADB) 2011.

they are depleting rapidly. The majority of proven reserves are in the Middle East (57%), Venezuela (12.9%), Africa (9.6%), and the Russian Federation (5.6%).

Table 1 also contains a summary of proven natural gas reserves; this is slightly more positive as Asia and the Pacific hold some 14%, mainly in Central and West Asia. At present, the output from these localities is mainly exported to the Russian Federation. Again the reserves–production ratio is somewhat less than the world average because of the large reserves with a high ratio located in the Russian Federation. In view of its favorable endowment, the future need of this country for natural gas from Central and West Asia is uncertain, so the reserves in this subregion constitute an important possible contribution to the security of supply in Asia.

B. Undiscovered Oil and Gas

The story appears to be much the same for undiscovered oil and gas. The United States Geological Survey (USGS) recently completed a detailed study of 171 geological provinces across the world with the intent to assess undiscovered conventional oil and gas resources.[2] The estimates for oil are reproduced in Table 2. The definitions of regions are not congruent with those used by the Asian Development Bank (ADB), so an exact match is not possible, but the general impression is that Asia is again not well placed. About 75% of the undiscovered conventional oil in the world is in four regions: South America and the Caribbean, Sub-Saharan Africa, the Middle East and North Africa, and the Arctic provinces in the proximity of North America. In the USGS assessment, the Arctic and the former Soviet Union are reported together so the oil-bearing areas of Central and West Asia are included, but of the mean estimate of 66 billion barrels of oil, about 43% is in the Arctic provinces, so little can be attributed to Central and West Asia. The share of the rest of Asia is only 9% of the total. Of the estimated volume of oil, about 16 billion barrels are thought to be in the People's Republic of China (PRC) and 5 billion barrels in Australia. Other significant resources are offshore Brunei Darussalam (3.6 billion barrels) and the Kutei Basin (3 billion barrels).

Table 1: Proven Reserves of Oil and Natural Gas in Asia, 2009

	Oil		Natural Gas	
Subregion/Country	Billion barrels	Reserves–Production ratio	Trillion cubic meters	Reserves–Production ratio
Central and West Asia				
Azerbaijan	7.0	18.6	1.3	88.8
Kazakhstan	39.8	64.9	1.8	56.6
Turkmenistan	0.6	8.0	8.1	115.7
Uzbekistan	0.6	15.2	1.7	26.1
South Asia				
Bangladesh	-	-	0.4	18.0
India	5.8	21.1	1.1	28.4

continued on next page

[2] Schenk 2012.

Table 1 continued

Subregion/Country	Billion barrels	Reserves–Production ratio	Trillion cubic meters	Reserves–Production ratio
East Asia				
People's Republic of China	14.8	10.7	2.5	28.8
Southeast Asia				
Brunei Darussalam	1.1	17.6	0.4	30.7
Indonesia	4.4	11.8	3.2	44.3
Malaysia	5.5	20.4	2.4	38.0
Thailand	0.5	3.8	0.4	11.6
Viet Nam	4.5	35.7	0.7	85.2
ADB developed member				
Australia	4.2	20.7	3.1	72.7
Subtotal	88.8	22.6	26.9	48.6
World	**1,333.1**	**45.7**	**187.5**	**62.8**
Share of world (%)	7.0		14.0	

– = no data available, ADB = Asian Development Bank.
Source: British Petroleum (BP). 2010. *BP Statistical Review of World Energy*. http://www.bp.com/statisticalreview

Similar estimates for undiscovered gas are shown in Table 3. The largest volume lies in the combined Arctic and the former Soviet Union regions, but 58% of this is in the Arctic. It is not clear from the consolidated data how much are in Central and West Asia, but it is probably a fairly modest proportion. Of the undiscovered gas in Asia and the Pacific, about 8 trillion cubic meters (m^3) are in the provinces of Australia and 4 trillion m^3 are in the PRC. The rest are mostly distributed across Southeast Asia and a little in South Asia.

C. Unconventional Oil and Gas Resources

Unconventional oil and gas resources such as heavy oil, tar sands, shale gas, shale oil, tight gas, and coal-bed methane have recently received much attention. Estimates of unconventional resources can be very large; the mean estimate for recoverable heavy oil from the Orinoco Oil Belt in Venezuela, for example, is 513 billion barrels.[3] The size of this resource alone exceeds the mean estimate of conventional resources of 565 million barrels in Table 2. Production from these resources has already had a dramatic impact on the production of oil and gas in North America that is exerting and will continue to exert significant influence on international markets.

[3] Schenk et al. 2009.

Table 2: Mean Undiscovered, Technically Recoverable Oil and Natural Gas Liquids

Region	Oil		Natural Gas Liquids	
	Mean estimate (Million barrels)	Share (%)	Mean estimate (Million barrels)	Share (%)
Arctic + the Former Soviet Union	66	12	40	24
Middle East and North Africa	111	20	31	18
Asia and the Pacific	53	9	25	15
Europe	10	2	3	2
North America	83	15	19	12
South America and the Caribbean	126	22	21	13
Sub-Saharan Africa	115	20	28	17
Total	**565**	**100**	**167**	**100**

Source: Schenk, C.J. 2012. An Estimate of Undiscovered Conventional Oil and Gas Resources of the World. *US Geological Survey Fact Sheet 2012–3042*. Denver: US Geological Survey. http://pubs.usgs.gov/fs/2012/3042/.

Table 3: Mean Undiscovered, Technically Recoverable Resources of Natural Gas

Region	Mean estimate (Trillion cubic meters)	Share (%)
Arctic + Former Soviet Union	57	29
Middle East and North Africa	33	17
Asia and the Pacific	32	16
Europe	5	3
North America	20	10
South America and the Caribbean	24	12
Sub-Saharan Africa	26	13
Total	**198**	**100**

Source: Schenk, C.J. 2012. An Estimate of Undiscovered Conventional Oil and Gas Resources of the World. *US Geological Survey Fact Sheet 2012–3042*. Denver: US Geological Survey. http://pubs.usgs.gov/fs/2012/3042/

Domestic crude oil production in the United States (US) began to decline in 1986, but this trend has recently been reversed. US crude oil production increased from 5 million barrels per day (bbl/day) in 2008 to 5.5 million bbl/day in 2010. The *Annual Energy Outlook* of the Energy Information Administration (EIA) of the US Department of Energy foresees the continued development of tight oil, with a range of estimates for crude oil production in 2035 from 5.5 million bbl/day to 7.8 million bbl/day.[4] According to the EIA, the US will remain a substantial net importer of oil but at a considerably lower level than in the recent past.

Similar changes are occurring in the natural gas industry. Shale gas production increased in the reference case of the *Annual Energy Outlook 2012* from 175 billion cubic meters per year (m^3/year)

[4] Government of the United States, EIA 2012.

in 2010 (23% of total US dry gas production) to 480 billion m^3/year in 2035 (49% of the total); natural gas production will exceed consumption in the reference case around 2022.

For both unconventional oil and gas, however, there is considerable uncertainty about future technical performance that can affect the expected supply considerably to either higher or lower levels. These developments will have a considerable impact on the rest of the world. The high availability and low price of natural gas is reducing coal use for power generation in the US that is then available for export to international markets and can compete with higher priced natural gas in those markets. Low gas prices in the US therefore have some influence on international gas prices via the intermediary of coal. If exports of natural gas from the US do begin in the 2020s, they will also contribute to enhancing competition on international markets.

The technological and environmental uncertainties that surround forecasts of future production from unconventional resources in the US have a similar influence on estimates of the size and viability of unconventional resources elsewhere. Some estimates suggest a very large global potential. Table 4 shows International Energy Agency (IEA) estimates of both conventional and unconventional gas.[5] There is a considerable divergence in the estimated volumes of conventional resources from those given previously based on the assessments of the USGS; the IEA estimates are in fact closer to the 5% likelihood estimates of the USGS. The discrepancy is a valuable reminder of the uncertainties attached to such appraisals, but note that the Asian endowment of gas resources as a proportion of the total is somewhat similar in both cases and therefore the conclusions drawn earlier still hold.

Table 4: Technically Recoverable Natural Gas Resources at the End of 2011
(Trillion cubic meters)

	Total		Unconventional		
Region	Conventional	Unconventional	Tight gas	Shale gas	Coal- bed methane
Eastern Europe/Eurasia	131	43	10	12	20
Middle East	125	12	8	4	-
Asia and the Pacific	35	93	20	57	16
OECD Americas	45	77	12	56	9
Africa	37	37	7	30	-
Latin America	23	48	15	33	-
OECD Europe	24	21	3	16	2
World	**421**	**331**	**76**	**208**	**47**

– = no data available, OECD = Organisation for Economic Co-operation and Development.
Source: International Energy Agency (IEA). 2012b. *World Energy Outlook.* Paris.

The main conclusions to draw from this table are that reserves of unconventional gas may be large and that Asia is better placed in its share of unconventional gas than it is for conventional gas. The IEA estimates for shale gas draw heavily upon a study commissioned by the EIA of 48 shale gas basins in 32 countries applying lessons learned in resource appraisals from North America to less well-characterized areas.[6]

[5] IEA 2012b.
[6] Kuuskraa et al. 2011.

A large part of the potential in Asia and the Pacific lies in the PRC in two large sedimentary basins containing thick, organic-rich shales with excellent potential for shale gas and in five other sizable but less prospective basins. The assessment of the two larger basins by EIA consultants in collaboration with institutions in the PRC estimated nearly 900 trillion m^3 of un-risked gas-in-place with 180 trillion m^3 of risked gas-in-place implying a probability of success across the basins of 20%. The risked recoverable resource from the two basins was estimated at 45 trillion m^3. The same report found that Australia has major shale gas potential in several basins with technically recoverable resources of 14 trillion m^3. There are also smaller but important other unconventional gas resources in Asia not covered by the EIA study.

D. Coal

Coal has many attractions as a secure source of energy: It is low in cost and known reserves are very large and widespread. It is also abundant in Asia although the main resources are localized in a few countries. Table 5 shows estimates of the main proven coal reserves in Asia at the end of 2009.[7]

Table 5: Main Proven Reserves of Coal in Asia, 2009
(Million tons)

Subregion/Country	Anthracite and Bituminous	Subbituminous and Lignite	Total	Reserves–Production ratio
Central and West Asia				
Kazakhstan	28.2	3.1	31.3	308.0
Pakistan	–	2.1	2.1	500.0
East Asia				
People's Republic of China	62.2	52.3	114.5	38.0
South Asia				
India	54.0	4.6	58.6	105.0
Southeast Asia				
Indonesia	1.7	2.6	4.3	17.0
Thailand	–	1.4	1.4	72.0
ADB developed member				
Australia	36.8	39.4	76.2	186.0
Subtotal	182.9	105.5	288.4	66.0
World	**411.3**	**414.7**	**826.0**	**119.0**
Share of world (%)	44.0	25.0	35.0	

– = no data available, ADB = Asian Development Bank.
Source: British Petroleum (BP). 2010. *BP Statistical Review of World Energy*. http://www.bp.com/statisticalreview

Asia has a large share of the world endowment, and it can reasonably expect to source coal from other regions if the need arises. The difficulty of course is that it is an environmentally damaging fuel in several respects. Consequently, this means that it is and will remain the lowest price bulk fuel as other fuels will always carry an environmental premium. Setting aside the damaging environmental impacts, the low price can be construed as another attraction of the fuel.

[7] British Petroleum (BP) 2010.

III. REGIONAL ENERGY TRADE NEEDS REGIONAL REGULATIONS: THREE CASE STUDIES

Energy is already a large contributor to interregional trade, and its impact is likely to become more significant as exchanges develop through networks and as the larger energy deficit economies seek supplies from those with energy surpluses. These exchanges will be made in a region that generally has a great diversity of regulatory regimes, both in terms of general stringency and specific content. These three case studies illustrate (i) the important role of the PRC as a stimulus to interregional energy trade in commodities, finance, and technology; (ii) the emerging market of biofuels in Southeast Asia; and (iii) the substantial divergence in practices observed for feed-in tariffs for renewable energy.

A. The Critical Role of the People's Republic of China

The PRC needs to improve access to energy supplies and to diversify away from coal that is a large contributor of its GHG emissions and a significant cause of poor air quality in cities. The average air quality in 45 major cities in 2011 was rated as poor; the use of coal in power stations, industries, and as a domestic fuel is a main cause.[8] The large resources of cleaner energy elsewhere in Asia are of obvious interest, and the PRC is assisted in its external policies by its strong national balance sheet, good technological ability, and excess capacity in many relevant technological areas. It therefore has the means to supply financing and technology to neighboring countries to develop reserves of energy largely for export and some for local use. In certain cases, the export effort is aligned more on the export technology for revenues than for energy security, but in both cases the result is a significant contribution to interregional trade.

1. Investments in the Energy Sector of Myanmar

The PRC has been very active in Myanmar in coal, hydro, and gas. A typical example for coal is the 600-megawatt (MW) Kalewa mine–mouth power station under construction by the China Guodian Corporation (one of the five power companies established with the partial assets of the former State Power Corporation) and Tun Thwin Mining Company, Ltd. (Myanmar's largest coal company). The power plant is intended to provide electricity for a large copper mine owned by a mining company from the PRC.[9] Similarly, in February 2010, a memorandum of understanding was signed between the Department of Hydro Power Planning under the Ministry of Electric Power No.1, the Htoo Group of Companies, and Huaneng Lancang River Hydropower Company, Ltd. of the PRC for a 270 MW coal-fired power plant under construction by Huaneng Lancang River Hydropower for Htoo Trading that will supply electricity to Yangon's industrial zones.[10]

Companies and utilities from the PRC have been engaged in planning and constructing hydropower plants in cooperation with the Government of Myanmar over a long period. Myanmar supplies the southern PRC power grid from the 600 MW Shweli Hydropower Plant commissioned in November 2005 and from the Dapein Hydropower Plant to Dehong in Yunnan. The Shweli plant is very large; it generates 1,420 MW in a cascade of three plants. The Yunnan Machinery & Equipment Import & Export Company started work on the Shweli I Plant in February 2004, but following funding difficulties with the Myanmar government, the developer entered into a consortium with Huaneng Lancang River Hydropower Company, Ltd. and Yunnan Hexing Investment Company, Ltd. The

[8] Li 2011.
[9] Tun Thwin Mining Company 2013.
[10] Government of Myanmar, Ministry of Environmental Protection (MOEP) 2010.

consortium took the name Yunnan United Power Development Corporation, and Shweli was converted to a build–own–transfer project. The last generating unit was commissioned in 2009.[11]

Many projects are in various stages of development. Some 45 companies from the PRC are involved in approximately 63 hydropower projects in Myanmar including several related substation and transmission lines.[12] This includes the 7,100 MW Tasang Dam on the Salween River proposed by Sinohydro Corporation and the Thai MDX group for exporting electricity to Thailand.

The government and oil companies from the PRC have demonstrated increasing interest in the hydrocarbon resources of Myanmar in recent years. The China National Petroleum Corporation (CNPC), Sinopec, and the China National Offshore Oil Corporation (CNOOC) are all engaged in oil exploration projects and have successfully competed against India and the Republic of Korea to gain access to new gas fields and potential reserves of gas in the Gulf of Martaban. CNPC and the Ministry of Energy of Myanmar have signed an agreement to build a $2.3 billion crude oil pipeline and a $2 billion natural gas pipeline; construction started in October 2009.[13]

The onshore gas pipeline is being built by CNPC concurrently with an oil pipeline originating at a newly constructed oil terminal on the west coast providing the PRC with an oil import route that bypasses the Strait of Malacca. The construction of the two pipelines was originally proposed in 2004; the catalyst for construction was the signature on the purchasing rights to gas. Southeast Asia Pipeline, Ltd., a subsidiary of CNPC, is responsible for designing, constructing, operating, and maintaining the oil and gas pipelines. Construction of the Myanmar and the PRC sections began in June and September 2010, respectively, and the project was commissioned in 2013. Both pipelines will start from Kyaukryu and enter the PRC at Ruili in Yunnan Province. The gas pipeline will extend across Yunnan, Guizhou, Chongqing, and Guangxi. The oil pipeline is designed to transport 22 million tons of oil per year, and the gas pipeline is designed to transport 10 billion–13 billion m^3 of gas annually.[14] Kong analyzes the geopolitical drivers behind the Myanmar–the PRC oil and gas pipelines.[15]

2. Gas in Turkmenistan

Turkmenistan is gas rich. This is clearly an opportunity for the PRC as it seeks to increase access to energy, diversify its supplies, and shift to cleaner sources. There may also be some benefits in reducing dependence on seaborne imports in long routes with attendant geopolitical risks.

The extent of gas resources in Turkmenistan has been a contentious issue. The 2010 report of British Petroleum (BP) had an estimate of 8.1 trillion m^3;[16] the Government of Turkmenistan has always insisted that the figure was much higher although it has not permitted independent verification. Recently Gaffney, Cline & Associates completed an assessment of the South Yolotan natural gas field in the Amu Darya Basin and concluded that it is the world's second-largest known field with an estimated 21.2 trillion m^3 of gas reserves.[17] This figure appears to have been incorporated into the most recent BP Statistical Review that puts reserves at 24.3 trillion m^3. This assigns to Turkmenistan the

[11] China Natural Gas 2013.
[12] Earth Rights International (ERI) 2008.
[13] Hong 2011.
[14] China National Petroleum Company (CNPC) 2010.
[15] Kong 2010.
[16] BP 2010.
[17] Watkins 2011.

fourth-largest known reserves of gas and almost ties with Qatar for third place (the Russian Federation is first and Iran is second).

Access to and the exploitation of the gas reserve has always been a closely guarded privilege of the central government, and little foreign investment has either been sought or achieved. The most successful foreign partner by far has been the PRC; CNPC has been operating in Turkmenistan since 2002, but the first substantial development was the Amu Darya Natural Gas Project. In 2007, CNPC signed a production sharing agreement to explore and develop gas fields on the right bank of the Amu Darya River and a natural gas sale-and-purchase agreement with the Turkmen State Agency for Management and Use of Hydrocarbon Resources and Turkmengaz. This was the first production-sharing agreement to be signed by a foreign company in Turkmenistan. The agreement specifies that Turkmenistan will export 30 billion m^3 of natural gas to the PRC annually for 30 years.[18] In 2012, CNPC and Turkmennebitgaz signed a framework agreement to increase Turkmenistan's gas deliveries to the PRC to 65 billion m^3/year, but the time frame has not been specified publicly. In August 2008, the area of the concession was extended. In December 2009, the first natural gas processing plant was commissioned with a capacity of 5 billion m^3/year. Commercial production began in 2010.

Gas is transferred to the PRC through the Central Asia–the PRC pipeline that runs from Gedaim in Turkmenistan through Uzbekistan, and Kazakhstan to Horgos in Xinjiang Uygur Autonomous Region where it connects with the national gas system. The system comprises two parallel pipelines that, with the present compressor capacity, can carry 30 billion m^3 annually which matches the sales agreement. With additional compressors, the lines could carry 40 billion m^3. In 2011, the second west–east gas pipeline was completed allowing gas to be conveyed to the large demand centers in the Yangtze River Delta and Pearl River Delta. The PRC has also provided Turkmenistan with financial support through two concessions: one for $4 billion in 2009 and the second for $4.1 billion in 2011. These are to be repaid from gas sales.

The project has obvious benefits for the PRC but also for Turkmenistan. The main policy driver for Turkmenistan was to diversify export routes and escape the quasi-monopoly of purchase by the Russian Federation. Prices offered by the Russian buyers were low and volumes were unpredictable. In 2009, Gazprom considerably reduced its purchases of gas from Turkmenistan causing considerable economic difficulty. Several alternative routes were investigated including one through Afghanistan, but the lack of internal security in the country made it infeasible. Various routes to Europe through the Russian Federation or the Caspian Sea were also explored, but the routes through the Russian Federation did not meet the diversification requirements either of Turkmenistan or of European buyers, and the route through the Caspian Sea was impeded by the inability of the relevant states to agree to a legal regime.

The Central Asia–the PRC pipeline avoids these difficulties but introduces new geopolitical issues. Kazakhstan and Uzbekistan also have the possibility of supplying to the PRC, so they are both potential competitors and transit states. In the absence of an open access regulatory regime, this means that all developments are subject to intricate political negotiations according to complex and possibly obscure political objectives. It has the important consequence that it considerably enhances the interests of the PRC in the economic and political stability of Central and West Asia and in effective regional cooperation. This search for regional cooperation is expressed in part through the Shanghai Cooperation Organisation, a permanent international intergovernmental organization established in 2001 that includes Kazakhstan, the PRC, the Kyrgyz Republic, the Russian Federation,

[18] CNPC 2013.

Tajikistan, and Uzbekistan as full members. Turkmenistan is as yet only an observer, but it appears that the PRC has pushed for it as well as others to become members to strengthen cooperation across the entire region.[19]

In principle, the revenues from gas sales should enable Turkmenistan to invest in alternative sources of growth and revenue, diversify the economy away from gas, and extend its range of trading partners. In practice there seems to be little evidence that this is happening.

Recently, Turkmenistan and the PRC have begun to re-explore the possibility of export through Afghanistan. Bilateral meetings between Afghanistan and CNPC were reported to have been held during the Shanghai Cooperation Organisation summit in Beijing in 2012 to discuss an export route from Turkmenistan through northern Afghanistan, and Tajikistan into the PRC.[20] The project is still at a very preliminary stage but would contribute to the 65 billion m^3/year target. The additional volumes of gas would come from the Bagtyyarlyk gas field and from South Yolotan where CNPC is operating. The relationship and the implications for the Turkmenistan–Afghanistan–Pakistan–India (TAPI) gas pipeline are unclear, but potentially, TAPI would cross politically less stable territory. If the route considered by CNPC came to fruition, it would greatly shift the geopolitical balance in the region and would give the PRC a direct interest in the political stability of Afghanistan.

The main conclusions to be drawn are that energy trade to enhance security depends upon political stability and therefore extends the rationale and the interest of major participants in supporting that stability and in extending economic cooperation and growth.

3. The Indonesian Crash Program

In 2006, to address the critical need for investment in the electricity sector and to meet the long-term power requirements of the economy, the Government of Indonesia embarked upon an ambitious program to expand electrical generation capacity known as the 10,000 Megawatt Electricity Fast Track (Crash) Program. The plan aimed to improve electricity supply and reduce the consumption of oil by adding 10,000 MW of new capacity by 2010, mainly operating with low grade domestic coal as fuel. The State Electricity Company (Perusahaan Listrik Negara [PLN]) prepared numerous detailed proposals for new power plant projects that were offered to investors as part of the program.[21] Ten projects with a total of 7,460 MW were identified in Java, and another 23 projects with a total of 2,513 MW were identified in the outer islands. The program was implemented by PLN, and the majority of contractors were companies from the PRC as a consequence of the low prices offered for the plant and the good financial conditions incorporating export financing from the PRC with some loans from Indonesian banks. PLN also floated a $1 billion international bond issue to help with funding.

4. The Sarawak Corridor of Renewable Energy

Utilities and construction companies from the PRC have also had a long involvement in Sarawak, Malaysia, where there have been interesting recent developments that may signal a new theme in the PRC's trade dynamics within the region. There is a large hydropower resource in Sarawak arising from its abundant rainfall and favorable topography, and rivers that flow between steep, narrow, interconnected ridges up to 1,200 meters high. The intention is to exploit this resource through an

[19] Hamm et al 2012.
[20] Socor 2012.
[21] IEA 2010.

ambitious regional development corridor known as the Sarawak Corridor of Renewable Energy (SCORE). The core of the corridor is its hydropower resource estimated at 20,000 MW, but there is also a coal potential that could support a further 5,000 MW. It is hoped that this low cost energy will encourage investments in energy-intensive industries that will catalyze the development of the corridor. Investment incentives are provided by the federal and state governments.[22]

A major step forward in developing SCORE was the recent completion of the large dam at Bakun on the Balui River. It is a concrete-faced, rock-fill dam with eight 300 MW turbines constructed by the PRC Three Gorges Project Corporation with Sinohydro as the main subcontractor. When the project was originally conceived, it was envisaged that power would be evacuated to Malaysia through an underwater high-voltage direct current link, but subsequently, views on the commercial rationale have fluctuated. Currently, the project is not an economic prospect of the government's Economic Transformation Program, although this conclusion might change if external benefits of climate change were introduced into the assessment.[23]

A second dam at Murum (944 MW) also developed by the Three Gorges Project Corporation with Sinohydro has been completed and has been operational since 2013.[24] Five more dams are planned by the Sarawak State Government at Balleh (1,400 MW) and Pelagus (410 MW)—both in the upper Rejang River Basin in central Sarawak where the Bakun and Murum dams are sited—and at Baram (1,200 MW), Limbang (245 MW), and Lawas (100 MW), all in northern Sarawak in proximity to Brunei Darussalam.[25] This is in conformity with the Sarawak Integrated Water Resources Management Master Plan developed by the Chief Minister's Department in 2010.[26]

The expectation of the master plan is that the availability of power will (i) produce new jobs; (ii) enhance state revenues; (iii) complement infrastructure development (roads, ports, airports); (iv) improve welfare in interior regions through electrification, water supply, health care, education, transportation, and stimulate small-scale industries; (v) promote economic development and create business opportunities; (vi) develop new growth nodes and townships; and (vii) improve human resource skill and knowledge base.[27] So far, the take-up by industry has been disappointing, and Rio Tinto, that was expected to locate a large aluminum smelter in Sarawak, has recently withdrawn.[28]

An interesting recent decision has been the nomination of Sinohydro Corporation as the engineering, procurement, and construction contractor of a ferro-alloy smelter to be built in Samalaju Industrial Park in Sarawak for a Malaysian company. Sinosteel Jilin Electro-Mechanical Equipment Company, Ltd. has been nominated as subcontractor for the commissioning of the project. Sinohydro is a large civil engineering group, and Sinosteel is one of the PRC's largest manufacturers of submerged electric arc furnaces.[29] This development reflects the changing industrial dynamics that are contributing to the export of energy intensive industries from the PRC to other parts of Asia driven by rising costs for power and labor, growing demand for various energy-intensive materials, and higher environmental standards within the country. The very large China Dalian International Economic & Technical Cooperation Group has apparently expressed interest in investing in oil and gas in Sarawak

[22] SCORE 2012.
[23] Government of Malaysia, Performance Management and Delivery Unit (PERMANDU) 2012.
[24] Government of the People's Republic of China, Sinohydro Corporation 2010.
[25] Wong 2010.
[26] Sarawak Integrated Water Resources (SIWRS). 2012.
[27] Sarawak Energy Berhad (SEB) 2010.
[28] Sarawak Report 2012.
[29] The Star 2013.

and also in building hotels and shopping complexes to support the activities of energy-intensive industries.[30] If successful, this could be a spur to further investment and regional trade.

5. Potential Negative Consequences of Expanded Energy Trade

There can be no doubt that the PRC's search for energy security is potentially a most powerful catalyst for regional trade, but substantial concerns have been raised about some aspects of implementation in practice. The contractual, environmental, and social practices associated with developments in Myanmar have been widely criticized. Contractual practices are said to be below international standards, and there is much criticism of environmental and social policies.[31] The SCORE project has also been controversial with many claims of corruption, doubtful construction standards, environmental damage, and poor practices in resettling affected communities.[32] The Crash Program in Indonesia has been criticized for the low efficiency of the technology and its basic environmental controls.[33]

Without prejudice to the accuracy or otherwise of these allegations, it is quite plausible that when stronger economies invest in weaker economies, they are likely to face higher levels of corruption and lower levels of regulation of all types. Most corporations are profit-maximizing entities that will exploit those weaknesses to some extent; that is why regulation exists. An expansion of regional trade has to go hand-in-hand with the strengthening of regulation and regulatory compliance across the entire spectrum of business activities. Regional cooperation can assist in this process by identifying best practice, by benchmarking practice against the best, and by contributing to joint monitoring and evaluation. Large-scale energy development across a region with unequal energy endowments has the potential to raise the quality of life for partners at all social levels, but this can happen only through transparent and well-adapted regulation combined with sensible policies of compensation and redistribution for affected parties.

B. Biofuels in Southeast Asia

The climatic conditions of Southeast Asia are favorable for biomass production, and the possibility to produce bioethanol and biodiesel for the transport sector has received much attention. Biofuels in Southeast Asia have several attractions. They can contribute to domestic energy security; create opportunities for agricultural employment and new value chains in a region that is still largely agricultural; and represent an opportunity to benefit from the growing demand for renewable fuels in Europe and North America driven by aggressive subsidy policies.

1. The Present Status of Biofuels

First generation biofuels are produced from cereal crops (e.g., wheat, maize); oil crops (e.g., rape, palm oil); and sugar crops (e.g., sugar beet, sugarcane) using established technology. Bioethanol can be made from fermenting sugar from sugarcane or from starch; the starch is usually hydrolyzed enzymatically to sugar followed by fermentation to bioethanol. The manufacture of biodiesel from the esterification of fatty acids obtained by hydrolysis of vegetable and animal fats is a purely chemical procedure. A focus of modern research in the field is to demonstrate technologies for industrial-scale

[30] Saai 2012.
[31] Burma Rivers Network 2012, Pa-Oh Youth Organization 2011, and ERI 2008.
[32] Clean Biz Asia 2012, Sovacool and Bulan 2012.
[33] McBeth 2010.

production of biofuels from sustainable feedstocks such as agricultural residues, waste, forestry residues, crops grown on poor land specifically for energy, and algae. Various options are being developed and demonstrated to convert these sustainable feedstocks into biofuels as well as chemicals, plastics, heat, and power. In Southeast Asia, the main feedstocks for biodiesel are palm oil (in Indonesia, Malaysia, and Thailand) and coconut (in the Philippines). The main feedstock for ethanol is sugarcane (in Indonesia, the Philippines, and Thailand), but molasses and cassava are also used in Thailand.

Ambitions for the penetration of biofuels into transport vary considerably within the subregion. Table 6 shows published targets for some of the larger countries.

In Indonesia, the Ministry of Energy and Mineral Resources has also obliged the phased-in use of biofuels in industry. Heavy industry was required to use at least 5% biodiesel by 2010, rising to 10% by 2015, and to 15% by 2020. Subsidized prices for fossil fuels have, however, severely restricted the penetration of biofuel into industry, and the outcome in 2010 fell well short of the target.

Table 6: Targets for Using Biofuels in Transport in Selected Countries in Southeast Asia

Country	Biodiesel	Bioethanol
Indonesia	2009: 1%	2009: 1%–5%
	2010: 2.5%–3%	2010: 3%–7%
	2015: 5%–7%	2015: 5%–10%
	2020: 10%	2020: 10%–12%
	2025: 20%	2025: 15%
Malaysia	2010: 5%	
Philippines	2007: 1%	2009: 5%
	2009: 2%	2011: 10%
	2011: 5%	
Thailand	2008: 2%	2008: 20%
	2011: 5%	
	2012: 10%	

Source: Dermawan, A., K. Obidzinski, and H. Komarudin. 2012. Withering Before Full Bloom? Bioenergy in Southeast Asia. *Working Paper Series* No. 94. Bogor, Indonesia: Center for International Forestry Research.

A common policy instrument to support biofuels in transport is the identification and regulation of a specified blend of gasoline with ethanol or of diesel with biodiesel. This can be an advisory service so that consumers with a preference for blends can use them, or it can be mandatory so that all users are obliged to conform. Blending mandates are a quantity-driven instrument as opposed to a price-driven instrument and are at least initially sheltered from price volatility, although large or prolonged excursions in price may undermine their legitimacy. Blends of biodiesel and conventional hydrocarbon-based diesel are generally designated by a "B" number: 100% biodiesel is referred to as B100, and 2% biodiesel with 98% petrodiesel is B2 with obvious intermediate cases. B20 and lower generally can be used in diesel equipment with little modification. Ethanol fuel mixtures are similarly designated by "E" numbers that describe the percentage of

anhydrous ethanol in the mixture by volume. Table 7 indicates the status of blending mandates in some Asian economies as of 2012.

2. The Experience of Thailand

Thailand has been a pioneer in the region in exploring policies for biofuels, and like most pioneers, it has met with setbacks, though these can be of interest. The Thai experience demonstrates some of the opportunities of the technology and its vulnerability in the absence of a long-term, stable policy framework. Biofuel entered Thai energy policy around 2004 when petroleum prices began to recover from temporary lows. The Alternative Energy Plan 2008–2022 set targets for ethanol production at 3 million liters/day from 2008 to 2011, 6.2 million liters/day in the medium term from 2012 to 2016, and 9 million liters/day in the long term from 2017 to 2022. The targets for biodiesel production (B100) were set at 1.35 million liters/day from 2008 to 2010, 3.02 million liters/day in 2011, 3.64 million liters/day in 2016, and 4.5 million liters/day in 2022.

The ethanol targets were not underpinned by mandatory measures that would determine volume but rather by a mix of tax incentives and subsidies to ethanol producers, gasohol refineries, and automobile manufacturers that were intended to make ethanol–gasoline mixtures economically viable. In particular, ethanol producers benefited from an exemption from excise duty on ethanol when selling ethanol for gasohol production in the domestic market, and the sale of E85 (85% anhydrous ethanol) was so highly subsidized that the retail price was 53% lower than premium gasoline. Automobile manufacturers were compensated for the costs of manufacturing vehicles compatible with E85 through a relief from import duties.[34]

Table 7: Blending Mandates in Selected Asian Economies, 2012

Economy	Ethanol	Biodiesel
Southeast Asia		
Indonesia	E3	B2.5
Malaysia		B5
Philippines	E10	B2
Thailand		B5
Other Asia		
China, People's Republic of	E5 in 10 provinces	
India	E10	
Korea, Republic of		B2.5
Taipei,China		B2

Source: Renewable Energy Policy Network for the 21st Century (REN21). 2012. *Renewables 2012 Global Status Report*. Paris: REN21 Secretariat.

Consumer preference did not favor alcohol blends; consequently, the demand for anhydrous ethanol has fallen well below the target of 3 million liters/day; penetration has been restricted, among other reasons, by the subsidies available to natural gas vehicles and to liquefied petroleum gas for transport. Use of B5 biodiesel is in principle mandatory, but the supply has not been available to match

[34] Preechajarn and Prasertsri 2011.

the requirements of the mandate. The policy response has been to rescind the mandatory requirement and to regress to a sliding scale of B2, B3, and B4 according to feedstock availability.

Partly as a consequence of the failure to meet targets, the new 10-year Alternative Energy Development Plan (2012–2021) was developed. The new plan maintains the original 2021 target of 9.0 million liters/day by 2021, and the biodiesel consumption target is revised up from 4.5 million liters/day to 5.97 million liters/day by 2021.[35] These targets will be challenging without radical policy reform.

3. Prospects for Regional Cooperation in Biofuels

If biofuels are to meet the expectations for a sustainable contribution to low-carbon energy supply, then a whole range of supportive policies will be required that are amenable to regional cooperation.

It is essential to establish a stable, long-term policy framework for biofuels that will give comfort to investors in the profitability of their ventures in a risky global environment. The record of the region to date has not been good in this respect. It is also desirable that national policies should converge as far as is practical; it will not promote stability if countries compete for investment with ever more favorable terms. It is also important that criteria be agreed internationally for what constitutes a sustainable source of biofuel; this has to be an international initiative because much of the biofuel produced in Asia will be exported to the US and Europe and will therefore need to meet their criteria. The economies of the region should, however, be proactive in contributing to this debate, and this can be effectively done through joint regional positions based on the similarity of the agriculture sectors and the social structures in rural areas. The sustainability criteria need to be carried through into practical land-use planning using modern geographical information systems, and again, the exchange of experience and information on these technologies is a valuable cooperative activity. It would be helpful to develop common standards for biofuel specifications across Southeast Asia because the use of different specifications inhibits trade. It is also necessary to identify and remove nontariff barriers to trade.

The region should also be proactive in its approach to second generation biotechnologies using agricultural wastes. It is undesirable that the region should become a technology taker for a technology that is so profoundly linked to details of agricultural practice and social characteristics. Sharing the costs and risks of research in the use of typical waste materials from tropical and subtropical areas is a sensible step and could probably be conducted jointly with companies from the US or the European Union (EU) that are interested specifically in developing second generation technologies appropriate to the region.

The implementation of biofuel technologies, especially second generation technologies, will need to proceed in parallel with the creation of new value chains starting from small farmers, passing through wholesalers, storage, processing, grading, and quality control to assure regular supplies of materials that meet agreed specifications. This will require coordinating agriculture, forestry, and rural development policies. It is desirable that there should be some consistency in this coordination across nations as trade in waste materials is likely to develop. These recommendations broadly comply with the conclusions of the IEA International Road Map for Biofuels.[36]

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[35] Government of Thailand, Department of Alternative Energy Development and Efficiency (DEDE). 2012.
[36] IEA 2012a.

C. Feed-In Tariffs for Renewable Energy

1. The Design of Feed-In Tariffs

Few sources of renewable energy are commercially competitive without policy support. Policy is therefore the main driver in the deployment of renewable energy, and good policy design is essential if the deployment of renewables is to be efficient, effective, and sustained. There is considerable scope for choice in the design of feed-in tariffs. The first is between a fixed and a premium tariff. A fixed feed-in tariff comprises a set of prices paid to qualifying generators regardless of the prices that prevail in the wider market, so the generator is shielded from volatility in electricity prices. A premium feed-in tariff is paid on top of the price for electricity; the idea has merit because it distinguishes two sources of value—the value of the electricity and the separate value of its renewability. The disadvantage of a premium tariff is that it diminishes the stability of revenues for the investor and increases perceived risks. Experience tends to suggest that it is reducing risk that makes feed-in tariffs effective, so although in theory a premium tariff is superior (and economically more efficient), in practice it may be less effective in stimulating deployment.

The second choice is between flat or stepped tariffs. With a flat tariff, the same unit payment is made to all generators regardless of plant size or the type of technology. A stepped tariff permits payments to be differentiated by a variety of characteristics including size, technology, and possibly location. The logic of a stepped tariff is to even out the subsidy so that large generators, those with lower cost technology, or those in favorable locations do not benefit more than others that are less favorably placed. Consequently, stepped tariffs in principle should reduce the cost of support as they avoid over-compensating plants with the lowest cost renewable generators.

Another choice is in the duration of support and the timing of review periods which involves policies to modify tariff levels in the light of technological change and the possibility of automatic digression in anticipation of lower future costs. Policy design should also be coherent with wider objectives for climate change, industrial development, and employment. A helpful analysis of options was provided by the United Kingdom in its consultation on feed-in tariffs.[37]

Given the broad range of options and the implications of feed-in tariffs for the wider national economy, it is not surprising that there is great variation in practice. Even in the EU that is economically and climatically reasonably homogeneous and that has a commitment to policy harmonization, there is considerable variation.[38] The World Resources Institute in cooperation with ADB made a comparison of feed-in tariffs in the Philippines, Sri Lanka, and Thailand during a workshop in 2012.[39]

2. Experience in Sri Lanka

Sri Lanka has offered financial support to renewable generators since the early 1990s. Initial tariffs were based on system avoided costs along the lines of the original Public Utility Regulatory Policy Act legislation in the US, and power purchase agreements for 15 years were available for plants producing less than 10 MW. This policy was moderately successful in stimulating investment in mini-hydro but was inadequate for other sources of renewable energy. In 2007, the government established the Sri Lanka Sustainable Energy Authority with the task of accelerating the deployment of renewable energy.

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[37] Government of the United Kingdom, Department of Energy and Climate Change 2009.
[38] Canton and Lindén 2010.
[39] World Resources Institute and ADB 2012.

The authority developed feed-in tariffs for mini-hydro, wind, biomass with energy plantations (dendro power), agricultural and industrial waste, municipal solid waste to energy, and waste energy recovery. Tariff levels varied according to the estimated costs of the technology, and contracts were for 20 years. The investor may choose between a flat-rate tariff over the 20-year period or a three-tier tariff that divides the contract period into three and front loads the repayments. The costs of the tariffs are rolled into the Ceylon Electricity Board prices along with all other costs and are recovered through the selling price to final users. The feed-in tariffs appear to have been successful in stimulating investment in mini-hydro and wind technologies but not for other technologies. The absence of a solar tariff is unfortunate as Sri Lanka has over 20 years of experience with off-grid solar photovoltaics and has built over 100,000 solar home systems with a total capacity of about 3 MW.

3. Experience in Thailand

Thailand is another "first mover" in renewable energy policy in Asia. The National Energy Administration promoted isolated micro-hydro installations in the 1970s using local labor and simple technology, but the first formal intervention into the grid-connected market was the Regulation to Purchase Power from Small Power Producers that was approved in 1991. It obliged the Electricity Generating Authority of Thailand to purchase the output from private producers of cogenerated electricity and power from renewable sources at a price equal to the system avoided cost. The initial limit on the size of qualifying producers was 60 MW but was later raised to 90 MW. The main uptake was from cogeneration plants on industrial sites and from the use of agricultural wastes as fuel, particularly bagasse, rice husks, and wood wastes.

The program was rescinded during the economic crisis in 1997 because reduced demand for electricity had led to considerable overcapacity in generation; it was reintroduced some years later. Compliance with the technical requirements concerning grid connection that were a part of it were onerous for most small renewable plants, consequently an additional Very Small Power Producer Program was introduced in 2001 for plants of less than 1 MW that permitted grid connection under the less restrictive sales regime of net metering. The Ministry of Energy was created in 2002 and introduced a renewable portfolio standard in 2004 that required the electricity generating authority to source 160 MW of new capacity from renewable energy. The administrative procedures to implement this policy were never completed, and it failed.[40]

A premium feed-in tariff was introduced in 2006 known in Thailand as the "adder." Initially the adder was determined by competitive bidding; this procedure favored low-cost technologies using agricultural and forestry wastes as fuels. In 2007, the regime was revised to encourage more participants. The upper limit on very small producers was raised to 10 MW, the scheme of adders was made more complex and differentiated according to source, targets were set by source, and special incentives were introduced for the three southern most provinces that were experiencing a local power shortage and where investors perceived some political risk. In June 2010, as a consequence of the falling cost of photovoltaic systems, the cabinet passed a resolution to stop accepting applications for solar installations and to substantially reduce the adder for solar plants for those projects that had not signed power purchase agreements. The resolution changed the tariff from a premium tariff to a fixed feed-in tariff meaning that the payments to generators are no longer affected by electricity prices.

[40] Amranand 2008.

4. Implications for Regional Cooperation

The great scope for design variation for feed-in tariffs and the peculiar circumstances of each country tend to lead to rather diverse prescriptions; even the EU that is comparatively homogeneous, with pooled sovereignty and an emphasis on harmonized policy, the variation is still wide. Common policies in this area in Asia are very hard to imagine. However, there is a degree of similarity in culture and physical endowments subregionally, and there is much scope for cooperation in the exchange of experience, information, and analysis. There is also a need to harmonize not policy structure but policy effort. As subregional energy markets and trade develop, it will be necessary to establish a fair regulatory environment. Much attention will begin to turn to the extent and the legitimacy of subsidies. If country A has strong policies for renewable energy that increase its costs of supply and under the rules of a regional market is obliged to accept electricity from country B that has not made the same effort, then this constitutes an unfair advantage for country B. There are therefore many reasons, small in their own way but cumulative in effect, why countries should seek to learn from each other in this field and attempt to achieve a fair balance of effort.

D. Conclusions for Regional Cooperation

These three case studies were selected to show some of the secondary consequences of the search for energy security and its relationship to interregional trade and regional cooperation. The case study of the PRC's energy-related investments outside its borders, either to secure supplies or to profit from the sale of financial services and technology, demonstrates that this can have very important benefits for regional trade and growth. It also draws attention to the need to bring more harmony into regulatory regimes regarding health, safety, the environment, and social solidarity. Without this shift to a more level regulatory regime, there is a constant danger of exporting economic, environmental, and social externalities to weaker countries. The case study also indicates the need to ensure revenues from energy sales are used to diversify economies and to improve human resources. This is not yet obviously the case, for example, in Myanmar, Sarawak (Malaysia), or Turkmenistan. Primarily, the responsibility for this must rest with the national government, but it is also in the interest of other countries to ensure political stability and economic growth. This can be influenced over the longer term by skillful regional cooperation.

The case study of biofuels demonstrates the value of regional solidarity and cooperation in helping to manage the volatility of international markets. The biofuel sector in Asia is very exposed to international influences primarily through price for ethanol and through volume for biodiesel, but volume and price eventually must come together. There are benefits in creating a more effective and efficient market within either the subregions or the Asia and Pacific region, although the former option is likely to be more practical. At present, the isolated national markets for biofuels face the volatility of international markets independently; if an efficient market were created in Southeast Asia that established common technical standards and removed barriers to trade, there would be better resilience to international fluctuations. There are also many other potential benefits from exchanges of experience through joint research on advanced biotechnology.

The lessons from the case study on feed-in tariffs concerns mainly the need to align "flanking" policies if trade within the primary regional markets is to be fair, most especially in the electricity market that has historically been the market within which prices have cleared and that still is, with the notable exception of oil products that are now essentially allocated to mobility.

So in three very different but fundamentally important manners, these case studies bring home the diverse ways in which regional cooperation in energy security can help manage and enhance development and growth.

IV. PRINCIPLES FOR SUBREGIONAL COOPERATION

There are three main ways in which regional cooperation can strengthen national policies on energy security. The first is by sharing information and knowledge to create a sound evidence base for policy. The second is to agree common policies using shared knowledge and information, and the third is to develop subregional markets in electricity and gas by genuine interconnection of national grids, and agreement on competitive subregional markets.

The following discussion is general. Some subregions are approaching the level of cooperation envisaged here; for others it is still a distant prospect. It is not practical to develop a recipe for cooperation for all subregions that recognizes their special circumstances. The following is therefore a general model that will need to be adapted to each particular case. A detailed analysis of energy cooperation within the Greater Mekong Subregion (GMS) has been prepared using very similar methodology to that described here; it takes stock of what has been achieved and makes recommendations for future cooperation and the way in which ADB can support progress.[41] This study may be helpful in giving practical form to the rather general discussion that follows. It may also be that similarly detailed studies would be useful in other subregions.

A. Strengthening the Evidence Base for Policy

There is considerable sharing of knowledge and information around the region and subregions, but it is generally unstructured and desultory. Dissemination is casual, and there is no systematic procedure for validation, storage, and access. This is not only the case subregionally but is true of many national administrations also.

It is proposed that each subregion should create a knowledge center for energy policy not aimed at general statistical data but at less-structured, qualitative material that documents research and practice. Such material can be tagged using modern software to make it searchable, and access should be permitted to all interested parties. Some parts of the knowledge base might be password protected, but the more restrictions are placed on access, the less useful the material becomes. An institution within the subregion would need to be identified as ready to host the knowledge base. The costs of maintaining the knowledge base should be borne by the economies in the subregion, but the costs of designing the structure of the information system, writing the software, and initial training might be funded by donors as part of regional cooperation. If subregions employ a common information and communication technology approach, then subsequent linking of the systems, if considered useful, would be relatively easy.

The priorities of the knowledge base should be energy efficiency and renewable energy which are difficult and complex policy areas and where reliable experience is helpful for decision makers. Other areas of interest are technologies for clean coal, carbon capture and storage, and nationally appropriate mitigation activities.

[41] ADB 2013.

B. Moving to Harmonized Policies

A strong evidence base is a useful tool for national policy makers, but in many cases it will be advantageous to go further and work toward the development of harmonized policies. In the critical areas of energy efficiency and renewable energy, this might take the form of an agreement to construct national plans with targets, specific instruments of intervention linked plausibly to the targets, timelines, and arrangements for monitoring and evaluation. It should be accepted that the implementation of these plans is to be monitored and evaluated in peer reviews by experts from other economies in the subregion. This process creates solidarity and a level of commitment to policy areas that are not easy to implement.

In the longer term, the deployment of the subregional knowledge base in the design and agreement of common or harmonized policies is vital to its active maintenance and development. Using the knowledge in a joint activity constitutes an acknowledgment of its value and strengthens the willingness to continue to contribute.

Evidently, in order to move from shared evidence to harmonized policies, there needs to be an appropriate link to the political level. The means of achieving this is discussed in a separate section on governance.

C. Developing Subregional Markets in Electricity and Gas

In the long term, the biggest impact of regional cooperation on national energy security will come from the creation of regional networks. Having regional networks will allow the full deployment of renewable energy, the optimal dispatch of plant, the reduction of reserve margins, optimal scheduling of a diverse set of sources of natural gas, and the best interface between the gas and electricity networks.

From a practical point of view it seems that developing subregional markets is likely to be the most effective approach. This seems desirable from the cultural, demographic, and topographical structures of the region and also receives support from the European experience where subregional markets in the Nordic countries, Iberia, and Central Europe are recognized building blocks of the integrated European electricity system.

Creating a regional market is not simple; among the issues to be considered are the following.

- **Legislative and regulatory framework.** This includes clarifying the government's role in the industry, policies on adequate competition, and provision for private participation.
- **Financial viability of the industries.** A market cannot function unless prices are correct and the entities are profitable. This requires attention to tariff reform and to the elimination of subsidies.
- **Unbundling industries.** Minimum requirements are independent transmission and distribution system operators and ring-fenced accounting of different activities.
- **Removing obstacles to competition.** This includes preferential access to fuels and adequate transmission infrastructure.
- **Market access.** Renewable generators (and others) should have access to wholesale markets in their economies and across frontiers which requires a definition of eligible consumers, third-party access, and nondiscriminatory charging.

- **Regulation and licensing.** This includes regulatory independence and published methodologies.
- **Technical and commercial rules and agreements.** These include grid codes, using system agreements, and technical standards.
- **Market arrangements.** This includes term and spot contractual arrangements, financial settlements, and provisions for balancing and ancillary services.
- **Infrastructure requirements.** There need to be agreed plans for the transmission system and the interconnectors, and also for the metering and communication systems.
- **Imports and exports.** National rules on imports and exports and on the use of the interconnectors with neighboring systems must allow trading by third parties. Exchanges governed by utility agreements will restrict trade.

Much of what is required needs to be done by national governments but in a coordinated and harmonized fashion.

Of all the subregions in Asia and the Pacific, the GMS has come closest to meeting these requirements, but even there compliance is weak and there is little or no genuine scope for trade. The first step has, however, been taken and a subregional institution of the GMS is under development to take the process forward. The general requirements for governance are discussed in the next section.

D. Governance

Cooperation needs to be managed technically, officially, and politically. The basic tools for doing this are well established and used for example in the Association of Southeast Asian Nations (ASEAN). Technical coordination is achieved by working groups, official coordination through meetings of senior officials, and political negotiation and agreement is achieved at ministerial meetings. There is no need to radically revise this model, but it is necessary to ensure that the elements of the structure have clear terms of reference, are adequately resourced for their tasks, and relate to each other effectively. The absence of a fixed secretariat and the delegation of follow-up to national officials who already have heavy workloads within their own administrations are not satisfactory procedures. The reluctance of national governments to put resources in cash or in kind behind regional activities is another serious obstacle. Within the context of a region that will be producing half of the wealth of the world by 2050, this is a stance that needs to change.

The three pillars of cooperation proposed here are the joint knowledge base, linked policies in appropriate fields, and subregional energy markets. The joint knowledge base is best hosted by a dedicated institution like the ASEAN Centre for Energy located in Jakarta with core funding from the Energy Endowment Fund established from equal contributions of the 10 member countries.[42] Supervising such a center is adequately assigned to the functions of meetings of senior officials.

The development of joint, common, or linked policies requires a more dynamic relationship between official and political levels than is now evident in regional cooperation. It requires that ministerial meetings accept a role for senior official meetings in making proposals for policies subregionally. Such a proposal might, for example, be to coordinate national energy efficiency action plans to follow similar principles and to become subject to peer review within the subregion, or to enter into joint research on second generation biotechnology. Such proposals would need to be formulated on detailed analyses; they might be the subject of technical cooperation funded by donors.

[42] ASEAN Centre for Energy (ACE) 2013.

What would be novel is for the work to be project managed by the participating countries if it is to be "owned" and accepted by them. Present institutional arrangements do not allow this. ASEAN and the GMS come closest, but as noted above, the tendency is to delegate to national officials who have neither the time nor the resources to perform the task properly. It is hard to escape the conclusion that a permanent secretariat is essential if meetings of senior officials are to transform into a genuine source of regional policy initiatives. This secretariat might be located within the same center designated to host the knowledge base. There are some advantages to this as it makes for a closer relationship between the construction of the knowledge base and its deployment in policy support. Normally, it is desirable that core funding is provided by the member countries and that program funding is sought from the international donor community.

The third level of cooperation is the creation of subregional markets. This requires the same constructive dynamics between senior officials charged with strategic oversight of the process and the ministerial meetings that must agree on the necessary legislative steps. It also requires a great deal of technical work to develop common codes and standards, and to design and develop regional principles for regulation. Eventually, a specialized regional power coordination center to manage trading, settlement, and dispute resolutions will be needed. It is probably sensible that a core technical competence be co-located with the center to support the development of standards, codes, and regulations and to monitor national reforms. Such developments would normally be supported by technical assistance supervised by senior officials, but projects would be managed by the regional power coordination center. There is no close relationship between the knowledge base and the energy markets and no reason to attribute all these functions to a single entity.

V. PRINCIPLES FOR REGIONAL COOPERATION

The assessment in Section IV indicates that the main feasible elements of regional cooperation would be linking subregional knowledge bases and the preliminary steps toward linking subregional energy markets. It may seem premature to envisage linking subregional energy markets when, for the most part. these markets do not yet exist, but it is not necessarily so. As long as there is recognition that the final (or possibly intermediate) goal is a set of well-integrated subregional markets with certain critical links among them, it is not vital in what order those elements are put together.

The linking of subregional knowledge bases (if it is thought desirable) would not pose other technical problems and is not treated further here. Linking subregional energy markets is more delicate. It is proposed here that it proceeds through the concept of "projects of Asian interest" which is meant to encompass projects of interest to more than one subregion. This could include, for example, gas pipelines from Central and West Asia to South Asia; gas from Myanmar to South Asia; linking the pipelines from Myanmar to the PRC and Southeast Asia with the west–east pipelines from the Caspian Sea to the PRC; restructuring the Trans-Asia Gas Pipeline to provide real connectivity extending toward East Asia; jointly developing hydropower in the Himalayan Region for South, Southeast, and East Asia; and constructing an oil pipeline from the Indian Ocean shores of Myanmar inland to East and Southeast Asia to avoid the Malacca Strait.

For this to work, there must be first a means of identifying candidate projects, second a means to implement projects, and lastly a means to govern the process. The matter is complex and would need careful attention; the following discussion is intended simply to identify some of the issues and open a debate.

A. Identifying Projects of Asian Interest

To identify suitable candidate projects requires a technical analysis of the possibilities and an analysis of what initiatives can muster political support and are practical and fundable. The technical analysis might be initiated through a technical cooperation project with suitable terms of reference to determine a short list of technically fundable interconnections of definite economic interest and where a viable financial case can be constructed. This analysis needs to be followed up by country commitments where they can be obtained and on this basis, by establishing a short list of feasible candidates. From this short list, the final selection will depend upon the interest and willingness of international financial institutions, donors, and commercial finance houses.

B. Implementing Projects of Asian Interest

Implementing any project on this scale will need the support of a consortium of partners, including most probably private capital. Concessionary finance will probably be needed to give comfort to private partners as well as to compensate for gaps between the economic and financial performance. Transmission projects are difficult to finance on a project basis at the best of times and especially when more than one country is involved. The case for concessional finance in such circumstances is therefore strong.

It would be helpful if the likely providers of concessional finance were to commit funds to the concept before the selection and approval of specific projects. This might be done by establishing an Asian infrastructure fund with terms of reference that confine lending to projects of Asian interest. Contributions to the fund would not necessarily prevent the veto of its use in any particular case. The existence of the fund with clear terms of reference and governance would facilitate the later financing of specific projects as it would avoid project-specific negotiations among donors in every individual case.

C. Governance

The arrangements would need to be well governed. There are two aspects: the identification and selection of projects of Asian interest and the governance of the Asian infrastructure fund. The technical aspects might in principle be managed by one of the economies in the region as agreed by the region as a whole; the governance of the fund could not plausibly be managed in the same manner. In fact, it is difficult to imagine that even the technical aspects could easily be assigned to a representative member. Agreement would be very difficult, and demonstrating neutrality would be problematic.

The most practical arrangement is to locate both aspects within ADB. ADB is perceived within the region as an "honest broker"; it has the merits of regional knowledge, financial expertise, and technical competence. An Asian infrastructure cell located in ADB would be responsible for identifying and characterizing technically feasible projects and for determining country support; it would also serve as a secretariat for the infrastructure fund. The fund itself would be managed by a board of governors with representatives from contributors to the fund and chaired by ADB. Arrangements would need to be in place for the views of ADB members to be formally communicated to the board managing the fund.

The cell would also be charged with monitoring the development of subregional markets in electricity and gas, and with encouraging a harmonized approach through facilitating information exchanges, dialogues, and opt-in but binding regional agreements.

Finally, it is likely that if such an initiative were to be undertaken, it would be best done within the context of connectivity as a whole, including transport infrastructure and possibly human settlements, and it should be linked to the evolving model of economic corridors as engines for regional development.

VI. THE LANDSCAPE OF REGIONAL COOPERATION

Table 8 summarizes the discussion above and indicates the necessary regional, subregional, and national inputs and activities and those from ADB, and shows the outputs at each level. The critical national outputs are emphasized because regional cooperation is undertaken to advance national interests; if it does not do so, it will not work.

The same information is displayed schematically in the following figure. Obviously, if the principles of such a scheme were adopted then the interrelationships between entities would be much more complex than is shown, but the figure provides a visual impression of the main links and decision points and the principal outputs and responsibilities.

Table 8: Landscape of Regional Cooperation

Level	Inputs / Activities			Outputs
	Technical	Official	Political	
Regional	Linking subregional knowledge bases (no institutional implications)	Advice on prospective projects of Asian interest Formulating country positions concerning candidate projects of Asian interest	Sanction on participation in projects of Asian interest	Reduced costs of gas and electricity supply Greater security of gas and electricity supply Facilitation of large-scale, renewable developments
Subregional	Establishment, maintenance, and dissemination of knowledge bases Project management of subregional technical assistance for policy formulation Operation of regional market and preparation of technical advice	Participation in designing and proposing harmonized policies Oversight of policy technical assistance Oversight of subregional energy markets	Agreement on harmonized policies Agreement on the progressive phases of regional market development	Active regional markets with enhanced trade Subregional coordination centers for power markets and gas where appropriate Coordinated expansion planning; some coordinated development of common resources (e.g., river basins) Harmonized policies on renewable energy, electrical energy, RD&D , and climate change High-quality knowledge base located in the subregion
National	Contributions to knowledge base Technical aspects of the reform of national utilities	Sanctions of material for knowledge base Oversight and guidance of national reforms	Legislative basis for national reform Legislative basis for implementation of harmonized policies	Access to high-quality knowledge base for policy formulation Improved policies for renewable energy, electrical energy, RD&D, and climate change

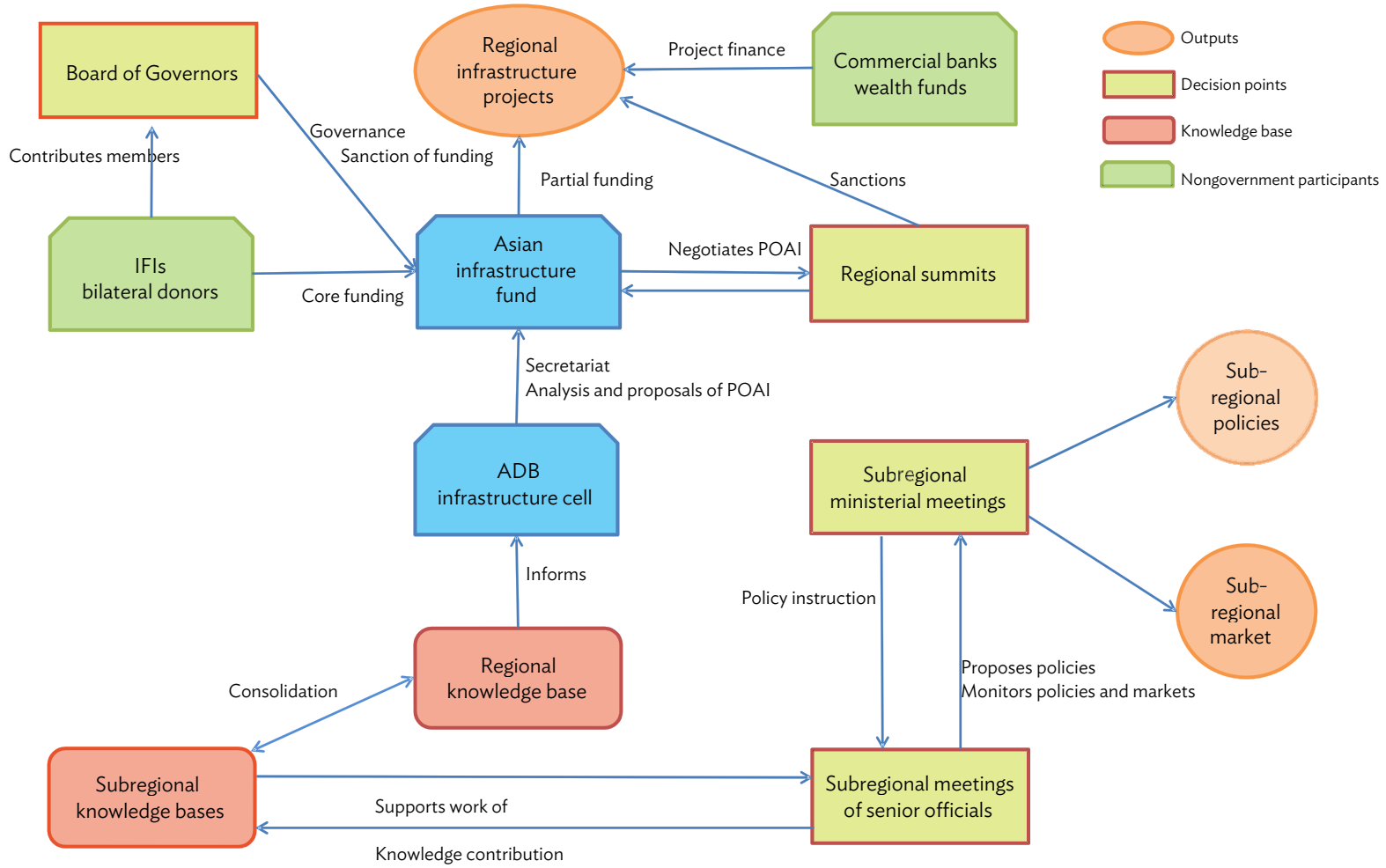
continued on next page

Table 8 continued

Level	Inputs / Activities			Outputs
	Technical	Official	Political	
	Compliance with requirements of harmonized polices Compliance with requirements of regional energy markets	Implementation of harmonized policies		Lower costs of supply of energy Improved security of supply More effective input to managing global challenges
ADB	Identification of technically and politically feasible projects of Asian interest Technical assistance to support subregional knowledge bases Technical assistance to support harmonized policies	Fostering and animating meetings Negotiating technical assistance for (sub)regional cooperation Providing a longer-term and wider vision	Advocacy for regional solutions Governance of Asia infrastructure fund Fostering of harmonized market rules and opt-in but binding regional agreements on market structure and practice	Enhanced contribution to regional development Focus on knowledge solutions Better policy making throughout the region Effective regional contributions to global challenges

ADB = Asian Development Bank, RD&D = research, development, and demonstration.
Source: Author's compilation.

Schematic Representation of the Landscape of Regional Energy Cooperation



ADB = Asian Development Bank, IFI = international financial institution, POAI = projects of Asian interest.
Source: Author's compilation.

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Energy Security in Asia

Prospects for Regional Cooperation

This paper illustrates the consequences of the search for energy security and its relationship to regional trade and cooperation. It asserts three main ways regional cooperation can strengthen national policies on energy security: (i) information and knowledge sharing to create a sound evidence base for policies, (ii) agreement on common policies, and (iii) subregional development of electricity and gas markets. In the long term, the biggest impact of regional cooperation on national energy security will be creating regional networks; developing subregional markets will likely be the most effective approach.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to approximately two-thirds of the world's poor: 1.6 billion people who live on less than $2 a day, with 733 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

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