III. AEMI and ASEAN Energy Poverty

Adoracion Navarro,[1] *Maxensius Tri Sambodo*[2] and *Jessie L. Todoc* (lead)[3]

Abstract

Based on available statistics, between 127 and 130 million people in South-East Asia lack access to electricity. At least 228 million still rely on traditional biomass for cooking, and lack access to clean and modern cooking facilities, with dire consequences for their quality of life and human development. Discussions for an integrated Association of Southeast Asian Nations (ASEAN) energy market cannot overlook this energy poverty situation in the region. In fact, the overall goal of AEMI to achieve balanced and equitable economic growth and development for all countries in the region cannot be realized while people continue to suffer from energy poverty. This chapter maps the energy poverty situation in the region, and reviews the links between energy access and economic and human development. It also draws a connection between AEMI and the eradication of energy poverty or attaining universal energy access, in terms of benefits and strategies, particularly with regard to mapping investment requirements and taking inventory of financing options. The chapter concludes with some recommendations for near-term actions.

A. Introduction

The International Energy Agency (IEA) defines energy poverty as a lack of access to modern energy services, i.e., access to electricity and clean cooking facilities. Reddy and Reddy (1994) as cited in Masud and others (2007), said that energy poverty could be defined as "the absence of sufficient choice in assessing adequate, affordable, reliable, high-quality, safe and environmentally benign energy services to support economic and human development". This definition of energy poverty also implies the strong link between access to modern energy services and economic and human development.

In South-East Asia, more than 127 million people lack access to electricity while at least 228 million still rely on traditional biomass for cooking and lack access to modern cooking facilities. An IEA (2009) projection indicates that in the absence of concerted efforts, 63 million (9 per cent) of the ASEAN population will still lack electricity in 2030, despite wider-spread prosperity and more advanced technology.

The discussion on ASEAN Energy Market Integration (AEMI), building on ongoing ASEAN Energy Cooperation, cannot ignore the issue of energy poverty if its ultimate goal is the balanced and equitable economic growth and development of all countries in the region. Indeed, the objectives of AEMI cannot be achieved while people continue to suffer from energy poverty. Thus, among other targets, AEMI should aim for universal access or energy access for all by 2030.

[1] Senior Research Fellow, the Philippine Institute for Development Studies (PIDS), Philippines.

[2] Researcher, Indonesian Institute of Sciences Economic Research Center (LIPI), Indonesia.

[3] Country Manager – Philippines and Program Manager, SEA Energy Access and Alternative Energy, International Copper Association Southeast Asia, Philippines.

This chapter examines the issue of energy poverty in ASEAN with four objectives in mind: (a) mapping out energy poverty across ASEAN; (b) analyzing whether AEMI could provide a framework for eliminating energy poverty by 2030 (the so called universal access to energy); (c) identifying the policy components and infrastructure needs for AEMI to deliver such a promise; and (d) spelling out the design elements needed within AEMI to allow the realization of such an approach. The chapter is organized into seven sections. Section B maps out the energy poverty situation in ASEAN while section C reviews the links between energy access and development. Section D details how the issue of energy poverty is addressed in the ASEAN and discusses how AEMI could provide a framework for eliminating energy poverty. Section E suggests key design elements of AEMI strategy for moving towards the elimination of energy poverty, including a methodology for monitoring progress. Section F provides an indication of the investment requirements for achieving universal access and discusses the financing options. Section G provides a summary, reiterating the severity of energy poverty in the region, what AEMI should do about it and some recommendations for near-term actions.

B. Energy poverty in ASEAN

Worldwide, approximately 1.3 billion people still lack access to electricity while 2.6 billion rely on traditional biomass stoves and open fires for cooking and heating (REN21, 2013). In the ASEAN region, the total number of people without electricity is about 127.4 million, of whom about 49 per cent are in Indonesia, while 42 million people also lack electricity access in Myanmar and the Philippines (table 1). Only four countries (Brunei Darussalam, Malaysia, Singapore and Viet Nam) have electrification and urban electrification rates of about 100 per cent. In Indonesia, 128 million people also still rely on traditional biomass for cooking or lack access to modern and clean cooking facilities, while the figure is close to 100 million in both the Philippines and Viet Nam (table 2). In rural areas, the population without electricity access is much greater than in urban areas. Cambodia and Myanmar have the lowest rural electrification ratios. Thus, looking at electricity access among the 10 ASEAN members, improving the rural electrification ratio is still a major challenge at the national and regional levels. This challenge is compounded in populous and archipelagic countries such as Indonesia and the Philippines.

Table 1. Electricity access in ASEAN, 2010

Region	**Population without electricity** (Million persons)	**Electrification rate** (%)	**Urban electrification rate** (%)	**Rural electrification rate** (%)
Brunei Darussalam	0.0	100	100	99
Cambodia	10.0	31	91	16
Indonesia	63.0	73	94	56
Lao PDR	2.2	63	88	51
Malaysia	0.2	99	100	98
Myanmar	26.0	49	89	28
Philippines	16.0	83	94	73
Singapore	0.0	100	100	100
Thailand	8.0	88	98	82
Viet Nam	2.0	98	100	97

Source: IEA, 2012.

Table 2. Population relying on traditional biomass for cooking

Regions and selected countries	Percent of population	Million
Developing Asia	51	1,814
India	66	772
Bangladesh	91	149
Pakistan	64	111
Indonesia	55	128
Philippines	50	47
Viet Nam	56	49
Rest of developing Asia	54	171
All developing countries	49	2,558
World	38	2,588

Source: REN21, 2013.

There are supply and demand side reasons as well as institutional reasons why some countries are able to increase their electrification ratio more rapidly than others. First, the growth of electricity production is relatively lower than economic growth. Electricity production depends on several factors such as availability of investment funding and energy resources, the investment climate in the electricity sector, road infrastructure and geographical location (landlocked). Second, due to high fees for connection to the power grid and/or expensive monthly tariffs, poor households cannot obtain benefits from the power grid extension. Third, rural electrification programmes are not sustainable. Due to their low capacity to manage and adoption of inappropriate technology, many households in rural areas find themselves back in the dark after obtaining electricity for a few months.

The Asian economic crisis in 1997-1998 had a negative impact on the growth of electricity production across the ASEAN countries (table 3). Between 1991 and 1996, six countries recorded double digit growth, with Cambodia showing the highest growth and the Philippines recording the lowest. During the economic crisis, Thailand recorded electricity production growth of below 1 per cent, while Indonesia recorded almost 7.4 per cent electricity production growth while even Viet Nam, Singapore and the Philippines showed notably higher growth. This indicates that the economic crisis affected the countries differently. Surprisingly, post-crisis, the growth of electricity production was lower than before the crisis except in the case of Viet Nam. This indicates a negative situation in countries that still had a relatively low electrification ratio. For example, in Cambodia, with the lowest electrification ratio, the growth of electricity production decreased from just under 26.8 per cent between 1991 and 1996 to less than 9.7 per cent between 1999 and 2010. A similar situation prevailed in Indonesia where 63 million people were without electricity, 44 per cent of whom were in rural households.

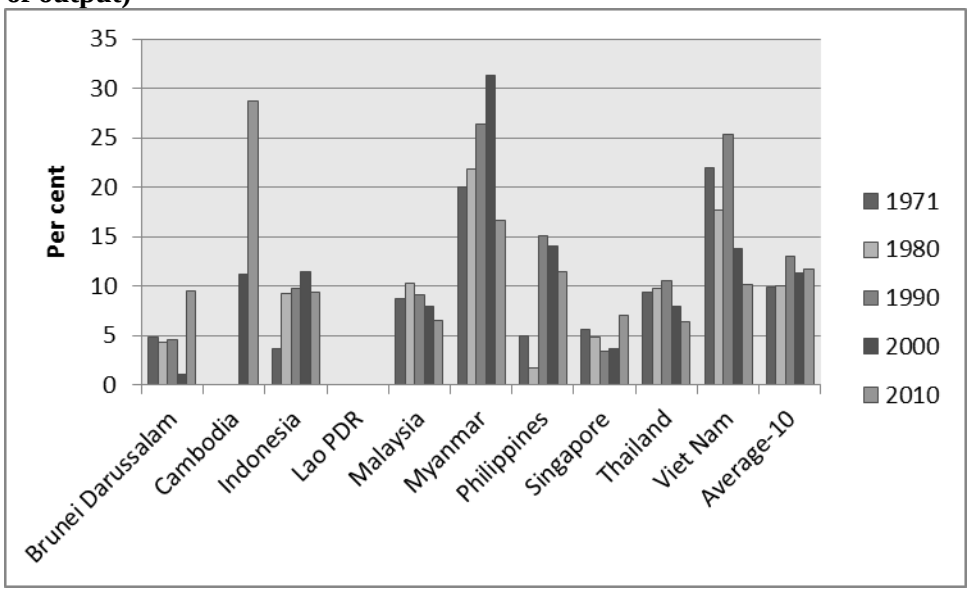
Table 3. Average annual growth of electricity production (%)

Country	Pre-crisis (1991-1996)	During crisis (1997-1998)	Post-crisis (1999-2010)
Brunei Darussalam	10.47	8.70	3.79
Cambodia	26.77	22.94	9.67
Indonesia	12.94	7.38	6.71
Lao PDR	n.a.	n.a.	n.a.
Malaysia	14.37	8.73	6.32
Myanmar	8.20	2.90	5.25
Philippines	5.87	6.42	4.20
Singapore	7.40	8.55	4.01
Thailand	12.56	0.18	4.91
Viet Nam	11.91	13.14	13.12

Source: Calculated from World Development Indicators, World Bank.

Improving electricity access cannot be fully realized if the transmission and distribution (T&D) losses are high. High T&D losses indicate a high level of inefficiency. This affects the quality of power supply. Low T&D can improve reliability of power supply and increase service area. Countries with a low electrification ratio tend to have a high level of T&D loss such as Cambodia and Myanmar (figure 1). Surprisingly, however, countries with a high electrification ratio such as Viet Nam, the Philippines, and Brunei Darussalam had higher T&D losses than Indonesia in 2010. In the 10 ASEAN countries, the average T&D losses tended to increase; even in Singapore, the T&D loss in 2010 was higher than in 2000.

Figure 1. Electric power transmission and distribution losses (per cent of output)

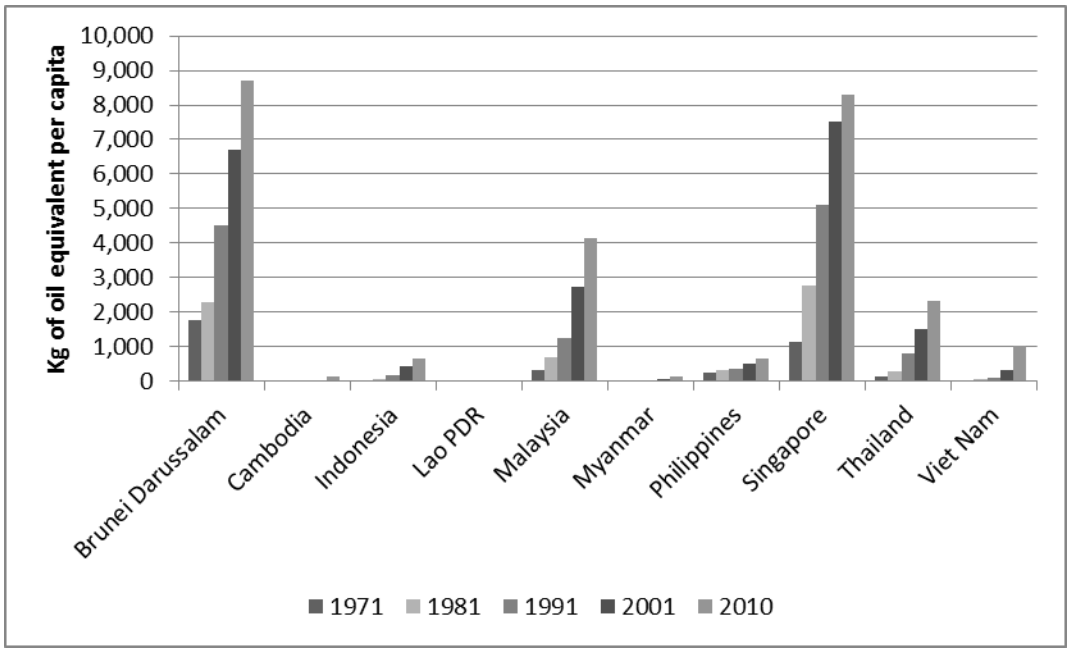


Source: World Development Indicators, World Bank.

Taking a broad perspective of energy poverty, it appears that there is imbalance across the countries. As shown in figure 2 and table 4, there is a huge gap in terms of energy use per capita among ASEAN countries. Energy use per capita in Brunei Darussalam and Singapore was above 8,000 kg of oil equivalent, while Malaysia and Thailand were above 4,000 kg and 2,000 kg of oil equivalent respectively. Energy use per capita for the other countries was below 1,000 kg of oil

equivalent. Table 4 also shows that the stage of economic development (together with energy policy) determines intensity and efficiency of energy use. While other countries showed increasing GDP per capita, Brunei Darussalam moved in the opposite direction. Because energy use increased between 1995 and 2010, it appears that energy intensity (ratio of energy use to GDP) in Brunei Darussalam tended to increase. Other countries that also indicated an increasing level of energy intensity are Malaysia and Thailand. On the other hand, in Cambodia, Indonesia, Singapore and Viet Nam, energy intensity tended to decrease as the respective rates of growth in GDP per capita were higher than the growth of energy use per capita. In the Philippines, energy use per capita decreased while GDP per capita increased. Thus, it appears that only the Philippines was successful in using energy more efficiently. The links between energy access and development are reviewed further in section 3.

Figure 2. Energy use



Source: World Development Indicators, World Bank.

Table 4. Energy use per capita vs. GDP per capita in ASEAN

Country	Energy use per capita (kgoe)			GDP per capita (Constant 2005 US dollars at PPP)		
	1995	2010	Growth per annum (%)	1995	2010	Growth per annum (%)
Brunei Darussalam	7,838	8,274	0.36	50,304	45,319	-0.69
Cambodia	263	350	1.92	841	1,937	5.72
Indonesia	674	864	1.67	2,785	3,873	2.22
Malaysia	1,635	2,569	3.06	9,496	13,767	2.51
Philippines	482	433	-0.71	2,515	3,554	2.33
Singapore	5,337	6,456	1.28	32,880	52,314	3.14
Thailand	1,050	1,768	3.53	5,755	7,987	2.21
Viet Nam	304	681	5.52	1,231	2,875	5.82

Source: World Development Indicators, World Bank.

Note: No data available for the Lao PDR and Myanmar.

C. Energy and development

Providing access to modern energy services enhances countries' attainment of the Millennium Development Goals (MDGs). Figure 3 reviews the links between energy and MDGs. Winkler and others (2011) emphasized the fact that improvement of electricity access and affordability were important. Kanagawa and Nakata (2008) showed the relationship between energy and poverty indicators such as health, education, income and environment, and indicated that access to electricity depended on infrastructure conditions, capacity of supply, government policy and international cooperation. However, the United Nations Secretary-General's Advisory Group on Energy and Climate Change (AGECC) (2010) argued that existing energy systems were inadequate to meet the needs of the world's poor and are jeopardizing the achievement of the MDGs. AGECC (2010) suggested two goals. First, ensure universal access to modern energy services by 2030. In this regard, AGECC (2010) agreed with the IEA suggestion of a minimum threshold of about 100 kWh of electricity and 100 kgoe of modern fuels (equivalent to approximately 1,200 kWh) per person per year. Second, reduce global energy intensity by 4 per cent by 2030.[4]

Figure 3. A snapshot of energy linkages to MDGs

MDG	Energy Linkages
1 Eradicate extreme poverty and hunger	Energy inputs such as electricity and fuels are essential to generate jobs, industrial activities, transportation, commerce, micro-enterprises, and agriculture outputs. Most staple foods must be processed, conserved, and cooked, requiring energy from various fuels.
2 Achieve universal primary education	To attract teachers to rural areas electricity is needed for homes and schools. After dusk study requires illumination. Many children, especially girls, do not attend primary schools in order to carry wood and water to meet family subsistence needs.
3 Promote gender equality and empower women	Lack of access to modern fuels and electricity contributes to gender inequality. Women are responsible for most household cooking and water-boiling activities. This takes time away from other productive activities as well as from educational and social participation. Access to modern fuels eases women's domestic burden and allows them to pursue educational, economic, and other opportunities.
4 Reduce child mortality	Diseases caused by unboiled water, and respiratory illness caused by the effects of indoor air pollution from traditional fuels and stoves, directly contribute to infant and child disease and mortality.
5 Improve maternal health	Women are disproportionately affected by indoor air pollution and water—and food-borne illnesses. Lack of electricity in health clinics, lack of illumination for nighttime deliveries, and the daily drudgery and physical burden of fuel collection and transport all contribute to poor maternal health conditions, especially in rural areas.
6 Combat HIV/AIDS, malaria, and other diseases	Electricity for communication such as radio and television can spread important public health information to combat deadly diseases. Health care facilities, doctors, and nurses, all require electricity and the services that it provides (illumination, refrigeration, sterilization, etc.) to deliver effective health services.
7 Ensure environmental sustainability	Energy production, distribution, and consumption has many adverse effects on the local, regional, and global environment; these effects include indoor, local, and regional air pollution; local particulates; land degradation; acidification of land and water; and climate change. Cleaner energy systems are needed to address all of these effects and to contribute to environmental sustainability.
8 Develop a global partnership for development	The World Summit for Sustainable Development (WSSD) called for partnerships between public entities, development agencies, civil society, and the private sector to support sustainable development, including the delivery of affordable, reliable, and environmentally sustainable energy services.

Source: UNDP, 2005.

[4] Energy intensity is measured by the quantity of energy per unit economic activity or output (GDP).

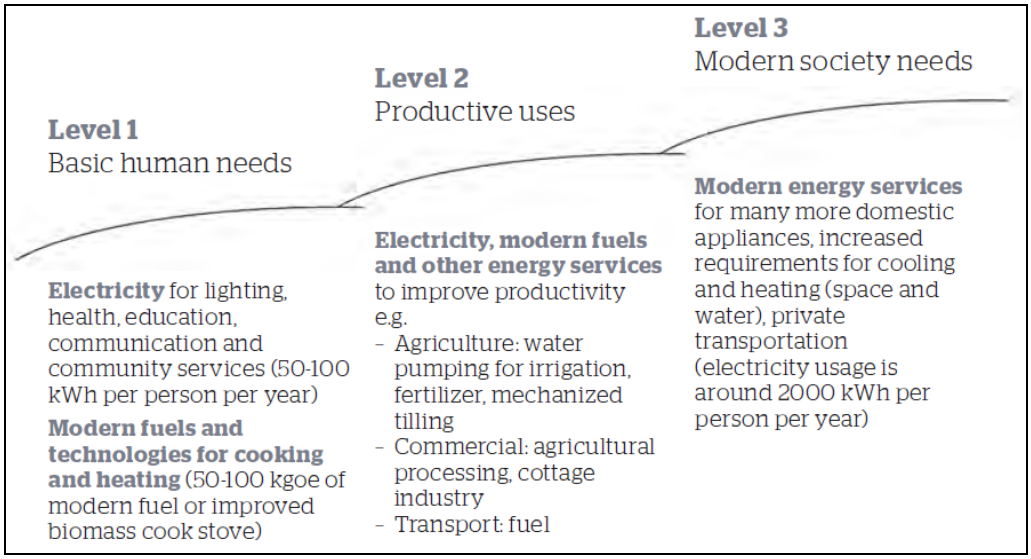
Table 5 shows that Myanmar has the lowest electricity consumption per capita in ASEAN, while Brunei Darussalam has the highest. Following the minimum threshold of 100 kWh, nine ASEAN members were above the standard in 2010 (no data were available for the Lao PDR at the time of this study). In the context of modern society's needs (figure 4), only Brunei Darussalam, Malaysia, Singapore and Thailand had electricity consumption per capita above the standard. Thus, to obtain 2,000 kWh per capita consumption per year, most of the ASEAN members need to increase electricity production. Interestingly, Viet Nam has shown impressive results, as its electricity consumption increased more than 350 per cent between 2000 and 2010.

Table 5. Electric power consumption (kWh per capita)

Country	1971	1980	1990	2000	2010
Brunei Darussalam	1,754	1,699	4,355	7,577	8,723
Cambodia	n.a.	n.a.	n.a.	33	144
Indonesia	14	47	165	395	639
Lao PDR	n.a.	n.a.	n.a.	n.a.	n.a.
Malaysia	310	657	1,146	2,720	4,136
Myanmar	20	34	43	73	121
Philippines	236	373	361	502	641
Singapore	1,155	2,718	4,983	7,575	8,307
Thailand	120	291	709	1,462	2,335
Viet Nam	41	55	98	295	1,035

Source: World Development Indicators, World Bank.

Figure 4. Incremental levels of access to energy services

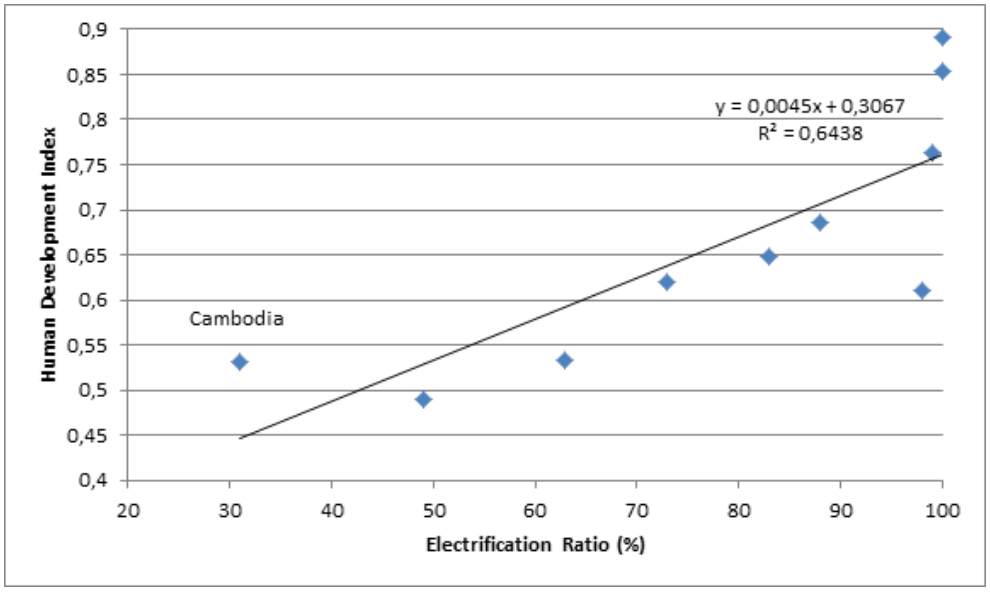


Source: AGECC, 2010.

Figure 5 plots the positive correlation between electrification ratio and human development index (HDI). In the case of Indonesia and Viet Nam, although the electrification ratio in Viet Nam was higher than in Indonesia, the latter country has a higher HDI than Viet Nam. A similar result is obtained between Cambodia and Myanmar. This indicates that access to electricity is a necessary

condition for improving quality of life, but it is not sufficient. Countries need to develop other basic services for improving people's welfare.

Figure 5. Electrification Ratio and Human Development Index in 2010



Sources: World Development Indicators, the World Bank; and Human Development Report, UNDP.

D. AEMI and energy access

Both the need and the commitment to address energy poverty are already visible in the ASEAN regional energy cooperation framework and in the concept of East Asia energy market integration. In the ASEAN Plan of Action for Energy Cooperation (APAEC) 2010-2015, the approaches to achieve the APAEC objectives include "strengthening coordination, participation in all program areas to narrow the development gap, improve energy access and to facilitate economic integration of the ASEAN region" (ASEAN Centre for Energy, 2010).

The commitment "to accelerate the implementation" of APAEC 2010-2015 by aiming "to strengthen coordinating efforts between ASEAN Member States" was reiterated during the twenty-second ASEAN Summit, held on 24-25 April 2013. The same summit, with the apt theme "Our people, our future together", also reiterated commitment of the ASEAN members "to narrowing the development gaps by implementing the IAI Work Plan (2009-2015) and the ASEAN Roadmap towards realizing the Millennium Development Goals with special focus on achievable goals and possible scenarios and priorities beyond 2015," including "addressing cross-cutting issues of the MDGs." These "scenarios and priorities beyond 2015" should very well include energy market integration, and "cross-cutting issues of the MDGs" should include energy poverty. Indeed, the twenty-second ASEAN Summit "noted the importance of realizing a truly people-centered ASEAN as a central element of a post-2015 vision of ASEAN."[5]

[5] Statement by the Chairman of the twenty-second ASEAN Summit. Available at www.asean.org/news/asean-statement-communiques/item/chairmans-statement-of-the-22nd-asean-summit-our-people-our-future-together (accessed 7 August 2013).

On the other hand, energy market integration in the East Asian region was recognized as a desirable objective during the second East Asia Summit in 2007. In the Cebu Declaration on East Asian Energy Security, signed on 15 January 15, 2007, the East Asian member States specifically declared that they would "encourage the open and competitive regional and international markets geared towards affordable energy at all economic levels" (East Asia Summit, 2007). The Cebu Declaration specifically called for gearing the energy markets towards affordable energy for all, including the poor.

The proposed AEMI takes off from the existing efforts toward greater ASEAN energy cooperation. However, AEMI is much more than regional energy cooperation as it involves integrating markets. Since the type of integration within the larger East Asia Summit framework is expected to take a long time, so AEMI is proposed as a more gradual approach towards regional energy market integration.

Inasmuch as AEMI will involve the liberalization of the flow of energy products and investments across ASEAN, and the interconnection of physical infrastructures in certain parts of the region, the policy requisites will include: (a) energy trade and investment liberalization; (b) reforms in domestic energy market structures; (c) harmonization of energy standards and regulations; and (d) coordination of energy sector planning and development.

The benefits from the implementation of these policy reforms may have an impact on energy poverty through channels such as price effect, productivity and wealth effects, and knowledge dissemination. The expected lower real prices of energy as a result of trade and investment liberalization can make the prices of energy products and services more affordable to the poor. Structural reforms in energy markets have the potential to improve the total factor productivity and raise the overall economic development of a country. These productivity and wealth effects will benefit the total population and will make more resources available for programmes, such as rural electrification programmes, that aim to deliver energy services to the unserved section of the population. Formulating and implementing domestic investment programmes to address energy poverty can also benefit from the knowledge to be gained from region-wide harmonization of energy standards and regulations as well as coordinated energy sector planning and development.

An estimation of the benefits that will stem from AEMI was not available at the time of this study; however, an estimation of the benefits from energy market integration (EMI) in the East Asia Summit (EAS) region by Bhattacharya and others (2010) demonstrated the price, productivity and wealth effects. (The EAS region considered in this study comprises 16 countries – the 10 ASEAN members plus Australia, China, India, Japan, New Zealand and the Republic of Korea.) The results show that the EAS region as a whole will gain, although the distribution of economic benefits will not be balanced across the region.

Notwithstanding the unbalanced distribution, the positive impacts of EMI on economic growth and development will have beneficial effects in terms of raising access to goods and services, including energy access. A study by Sheng and Shi (2013) on the impact of EMI on equitable economic growth showed that EMI is likely to promote the economic growth of individual countries as well as facilitate equitable growth within a region.

Using panel data regressions, the study adopted a convergence analysis in which two concepts of convergence were employed – the dispersion of real per capita income across countries falling over time, and a poor country or region growing faster than a rich one. To measure EMI, an energy trade index and a competition index were defined and measured. The EMI indexes were then used in the regressions. The results provided support for convergence in economic growth as EMI tends to

increase the rate at which income per capita in developing countries catches up with that of their more developed neighbors. The authors also concluded that developing countries would gain more than the developed countries from active involvement in EMI.

E. AEMI strategy

1. Key design elements

AEMI can address energy poverty by specifically incorporating it in the AEMI agenda up to 2030. The following are the key design elements of the AEMI strategy towards removing energy poverty or achieving universal access by 2030:

(a) Promotion of AEMI among developed and less developed economies in the region;

(b) AEMI must make sure energy goods and services are covered in the trade and investment agreements under AEC;

(c) Putting mitigation measures for fossil fuel subsidy reforms in place;

(d) The adoption of international standards on technologies (products and systems) that address energy poverty or increase energy access;

(e) Continuation and enhancement of regional cooperation on renewable energy distributed generation and off-grid systems, including especially micro- and mini-grids.

(a) Promotion of AEMI among developed and less developed economies in the region

One of the potential benefits of energy market integration is the reduction in income disparity across countries in the region (Sheng and Shi, 2011). A more integrated energy market will help poor countries catch up with their rich neighbors. "Energy market integration tends to increase the rate at which income per capita in developing countries catches up with that of their more developed neighbors" (Sheng and Shi, 2013). Thus, AEMI "should be promoted more confidently and positively, not only among developed countries but also [by] involving least developed countries (LDCs)...[In fact,] developed countries can also play an important role by helping LDCs to overcome difficulty through capacity-building programmes" (Sheng and Shi, 2011).

(b) AEMI must make sure energy goods and services are covered in the trade and investment agreements under AEC

General trade and investment liberalization is covered in the existing bilateral and multilateral free trade agreements. Following Bhattacharya and others (2010), the remaining task under AEMI is to make sure energy goods and services as well as investments in the energy sector are covered in the scope of these agreements. "A detailed review of energy trade and investment in the current regional agreements and frameworks will provide background for policy discussions and potential areas for improvement in the existing agreements" (Bhattacharya and others, 2010).

(c) Putting mitigation measures for fossil fuel subsidy reforms in place

"The development of a comprehensive long-term road map, which integrates economic, political and social issues, so as to achieve market-oriented energy pricing mechanisms, is crucial for progress in regional energy market integration" (Bhattacharya and others, 2010). A key feature of energy market integration, including the envisioned AEMI, is energy pricing reform, particularly the reform of fossil fuel price subsidies. However, fossil fuel subsidy reforms have mixed impacts on energy poverty.

Overall, subsidy reforms are necessary because of their positive or desirable impacts on the economy as well as health and environment (IMF, 2013). Households can gain improved energy access due to expanding distribution and improved quality of services, as a result of reduced subsidies or subsidy reforms.

On the other hand, subsidy reforms could increase energy poverty by increasing risk of reduced energy access through income and price effects. "Effective incomes would be expected to go down in the short term, as price increases push up costs, and…the poor struggle to adapt. Some households can suffer from reduced energy access if energy becomes expensive and there are no affordable alternatives" (Beaton and others, 2013). For example, kerosene is often important for low-income households, particularly those that do not have access to electricity. Reforming, if not removing altogether, subsidies on kerosene has high income effects on the poor. In the Philippines, diesel-fired generating sets (gen-sets) provide electricity to small islands, including those with small distribution networks. The gradual removal of subsidies on fossil fuels would have had income and inflationary impacts on the households living in these communities.

AEMI should, therefore, include measures that mitigate the impact of energy pricing reforms. For fossil fuel subsidy reforms, these mitigation measures include infrastructure programmes (e.g., rural electrification programmes that extend utility distribution networks or install decentralized systems) and facilitation of investment on energy access (e.g., private sector micro- and mini-grids) (Beaton and others, 2013). For example, rural electrification programmes mitigate the income and price effects of energy-pricing reforms by contributing or having positive impacts on poverty reduction.[6] Navarro (2013) found "a positive relationship between rural electrification and poverty reduction in the Philippines." This same study demonstrated that increased access to electricity of households in Philippine rural areas as a result of various rural electrification programmes was associated with a substantial increase in per capita income and per capita spending (Navarro, 2013).

Energy access programmes should include the provision of affordable alternative energy sources that can mitigate the impact of subsidy reform on low-income groups (IMF, 2013). In the Philippines, the USAID-AMORE[7] programme has designed schemes so that solar home systems and solar lanterns become affordable substitutes to kerosene that had been deregulated. In fact, the basis for pricing these cleaner alternatives for providing lighting to poor households in Mindanao was the price at which households were procuring kerosene (AMORE, 2011).

"Well-targeted measures to mitigate the impact of energy price increases on the poor are [also] critical for building public support for subsidy reforms" (IMF, 2013).

(d) The adoption of international standards on technologies (products and systems) that address energy poverty or increase energy access

Market integration is often accompanied by harmonization of international product and systems standards in order to facilitate cross-border trade and investments, which is one key feature of market integration. Standards benefit customers and end-users primarily by ensuring quality and safety of products as well as systems or installations. They also benefit enterprises. One benefit of standards to enterprises providing energy access goods and services is sustainable growth deriving from customer satisfaction, resulting in repeat sales and referrals (Ngigi, 2013). With market integration, another benefit of standards (for example, to consumers) – i.e., harmonized standards

[6] See Navarro, 2013, for an overview discussion on the impact of rural electrification on poverty.

[7] United States Agency for International Development-Alliance for Mindanao and Multi-Regional Renewable Rural Electrification and Development (USAID-AMORE), Phase III.

through the adoption of international standards – is access to quality goods and services. Another benefit to enterprises is increased access to markets beyond national borders and, thus, increased sales.

Solar PV systems, for example, have been the most economical way of providing basic electricity services, such as lighting and clean drinking water, to individual households in very remote rural areas. According to the International Electrotechnical Commission (IEC 2010), with the cost of solar panels decreasing, solar PV is becoming a competitive way, compared to mini-hydro and biomass, of meeting community or village demand or for mini-grid application. Indeed, solar PV has proven itself cost-effective in many off-grid applications.

The IEC Technical Committee (TC) 82 has developed international standards for solar PV systems that may be adopted by countries in ASEAN – for example, in Indonesia, the Lao PDR, Myanmar and the Philippines, which have a large portion of their respective populations still without access to electricity and modern fuels. TC 82 "Solar photovoltaic energy systems" prepares international PV standards for systems that convert solar energy into electrical energy and for all the elements in the entire PV energy chain, including off-grid lighting systems. IEC TC 82 standards are used by qualification testing laboratories throughout the world in testing products submitted by manufacturers who wish to enter the PV marketplace. Included among users are teaching and research universities and colleges, and government laboratories with an interest in PV technologies.

Standards are also written for balance of systems components – such as inverters and charge controllers – and for grid safety when operating DC to AC inverter systems connected to the utility grid. Systems standards are also written for use by systems integrators in the commissioning of small and large photovoltaic generating systems. Technical specifications are also written for use in specifying, commissioning and operating PV and hybrid stand-alone systems or micro-grids in developing countries. Customers here are systems integrators, system owners, utilities, the World Bank and Governments that provide funding for such systems.

IEC has also released TS (Technical Specification) IEC/TS 62257-9-5 for solar-powered light-emitting diode (LED) lighting devices, such as solar lanterns. "Part of the effort to expand access to modern off-grid lighting among low-income households in developing countries, the new specification represents an important step in aiding governments to harmonize their national standards, paving the way for market expansion for quality-assured devices" (IEC, 2013).

On the other hand, EVN and ICASEA (2013) list the IEC standards that govern the selection and design of off-grid system components and procedures for system sizing. These include standards for mini-grids that offer a means of providing electricity from renewable and other sources to those who do not have access to electricity because they live in remote or rural areas, or on islands not connected to the main grid. Mini-grids are expected to supply 40 per cent of new capacity by 2030 (IEC, 2013).

Table 6. IEC Standards for off-grid systems

Standards	Features
IEC 62257-1:2003:	Contains recommendations for small renewable energy and hybrid systems for rural electrification specifically Part 1: General introduction to rural electrification.
IEC 62257-8-1:2007:	Contains recommendations for small renewable energy and hybrid systems for rural electrification specifically Part 8-1: Selection of batteries and battery

	management systems for stand-alone electrification systems – Specific case of automotive flooded lead-acid batteries available in developing countries.
IEC 62257-7-3:2008:	Contains recommendations for small renewable energy and hybrid systems for rural electrification specifically Part 7-3: Generator set – Selection of generator sets for rural electrification systems.
IEC 62257-3:2004:	Contains recommendations for small renewable energy and hybrid systems for rural electrification specifically Part 3: Project development and management.
IEC 61427:	This standard is about secondary cells and batteries for renewable energy storage, general requirements and methods of test. This IEC specifies the particular operating conditions experienced by secondary batteries in photovoltaic applications during their use.
IEC 62124:	This standard is about photovoltaic (PV) stand-alone systems and design verification. This standard verifies system design and performance of stand-alone PV systems.

Source: EVN and ICASEA, 2013.

(e) Continuation and enhancement of regional cooperation on renewable energy distributed generation and off-grid systems, including especially micro- and mini-grids

In many remote rural areas in ASEAN that have not been reached by electricity grids, particularly in Indonesia, Myanmar, the Philippines, Thailand and Viet Nam, access to electricity can only be made economically and technically possible by the development of off-grid and distributed generation systems, including micro- or mini-grids and stand-alone individual households systems (e.g., solar home systems or SHS). AEMI should continue the national efforts and build on them to further ASEAN regional cooperation in this regard, including those by HAPUA and RE-SSN. In fact, ASEAN could learn from successful experiences within these countries and present these as model approaches in the framework of existing regional cooperation to boost national efforts. In addition to knowledge-sharing and dissemination of best practices, another area for regional cooperation is the harmonization of national standards on off-grid systems through the adoption of recognized and applicable international standards (e.g., those by IEC, as shown in table 6).

2. Monitoring progress[8]

Part of the AEMI strategy should be to monitor the progress towards reaching the energy poverty reduction target or the attainment of universal energy access.

The IEA has devised an Energy Development Index (EDI) in order to better understand the role that energy plays in human development (IEA, 2010). EDI tracks progress in the transition of a country or region transition to the use of modern fuels. By publishing EDI updates on an annual basis IEA hopes to raise the international community's awareness of energy poverty issues and to assist countries in monitoring their progress towards modern energy access. Indeed, a robust set of indicators for measuring energy poverty is needed in order to provide a rigorous analytical basis for policy-making. These indicators should include:

(a) Improvement in the availability of information about the range and impacts of options for action, and the actions that countries are taking to increase access to energy;

[8] This section is derived extensively from IEA, 2010 (pp. 29-35).

(b) Helping countries to monitor actions that they take to meet their agreed target;

(c) Enhancing the effectiveness of the implementation of such policies at the national and local levels.

The EDI is calculated in such a way as to mirror the UNDP Human Development Index and comprises four indicators, each of which captures a specific aspect of potential energy poverty:

(a) Per capita commercial energy consumption, which serves as an indicator of the overall economic development of a country;

(b) Per capita electricity consumption in the residential sector, which serves as an indicator of the reliability of, and consumer's ability to pay for, electricity services;

(c) The share of modern fuels in total residential sector energy use, which serves as an indicator of the level of access to clean cooking fuels;

(d) The share of a population with access to electricity.

A separate index is created for each indicator, using the actual maximum and minimum values for the developing countries covered. Performance in each indicator is expressed as a value between 0 and 1, calculated using the following formula:

$$\text{Indicator} = \frac{\text{Actual value} - \text{minimum value}}{\text{Maximum value} - \text{minimum value}}$$

The EDI is then calculated as the arithmetic mean of the four values for each country.

An EDI maybe calculated specifically for ASEAN as part of AEMI, considering only the maximum and minimum values of each component indicator for this region.

A correlation can also be drawn between EDI for ASEAN and the energy market competition index (EMCI), which was proposed as a measure of energy market integration (Sheng and Shi, 2013). Using the principal components analysis (PCA), EMCI is a function of energy consumption productivity (GDP/energy consumption) and electricity share (electricity consumption/total energy consumption). Increasing energy access should increase energy consumption productivity and electricity share, and thus the energy market competition index.

Another important component of AEMI strategy towards eliminating energy poverty is a mapping of investment requirements and an inventory of options to finance those investments.

F. Investment requirements and financing options

Financing has become the major issue for promoting rural electrification and increasing electricity access for three reasons. First, due to geographic and topographic challenges, the construction of grid connections to rural areas is often extremely expensive. Second, off-grid connections also need huge investment because most technologies are not domestically produced. Third, administrative tasks, including monitoring, evaluating and collecting retribution, are not easy. Finally, a lack of, or inadequate, income due to a lack of economic opportunities makes it difficult for poor people to obtain access to electricity (both connection and installation). The vicious cycle of energy poverty was addressed by McCawley (1978), who pointed out six main elements of the rural electrification

problem: technical difficulties; quality of service; administration; level of demand; high costs; and the financing programmes. The six elements are interconnected. AEMI should facilitate the financing of rural electrification to overcome energy poverty.

1. Investment requirements

Comprehensive data on investment requirements for eliminating energy poverty in ASEAN are unavailable, but two issues of the International Energy Agency (IEA)'s *World Energy Outlook* provided aggregate estimates for Developing Asia, which can provide clues to the likely size of ASEAN investment requirements. Developing Asia includes all the ASEAN members.[9]

In the *World Energy Outlook 2010*, IEA estimated that the bulk of the investment for electrification by 2015 would be incurred more rapidly in developing Asian countries than in sub-Saharan Africa, even though the latter region has a lower electrification rate. As of 2009, the electrification rate in sub-Saharan Africa was 31 per cent, whereas in Developing Asia, it was 78 per cent. The investment requirements from 2010 to 2015 were expected to be US$ 80 billion in sub-Saharan Africa and US$ 127 billion in Developing Asia. Investment in electrification was projected to grow more rapidly in Developing Asia, primarily because economic growth was expected to be more rapid in these countries than in sub-Saharan Africa.

In the *World Energy Outlook 2011*, IEA estimated the investment required to achieve the goal of universal access to electricity and clean cooking facilities by 2030, which was referred to as the "Energy for All Case" in the projections. Access to electricity was defined not only as first supply connection to a household but also as involving minimum consumption of 250 kilowatt-hours (kWh) per year for a rural household and 500 kWh per year for an urban household. The IEA report also projected investment requirements in the "New Policies Scenario", which was a scenario based on broad policy commitments and plans that had been announced by countries around the world to address energy security, climate change and local pollution, and other pressing energy-related issues. (See Annex B of the *World Energy Outlook 2011* for an enumeration of these commitments and plans.) However, IEA explained that the projected investment levels in the New Policies Scenario would not be enough to achieve universal access to modern energy services by 2030.

In the Energy for All Case, the additional investments between 2010 and 2030 in Developing Asia would total US$ 241 billion (table 7). On a global scale, achieving universal access or energy for all would require a total investment of US$ 641 billion, implying an investment of more than 5.3 times the investment in electricity access in 2009.

Table 7. Additional investment required to achieve universal access to electricity (billion in 2010 US dollars)

Region	2010-2020	2021-2030	Total
Africa	119	271	390
Sub-Saharan Africa	118	271	389
Developing Asia	119	122	241
India	62	73	135

[9] Developing Asia, as categorized by IEA, includes: Bangladesh; Brunei Darussalam; Cambodia; China; Taiwan Province of China; India; Indonesia; the Democratic People's Republic of Korea; Malaysia; Mongolia; Myanmar; Nepal; Pakistan; the Philippines; Singapore; Sri Lanka; Thailand; Viet Nam and other non-OECD Asian countries (Afghanistan; Bhutan; Cook Islands; Timor-Leste; Fiji; French Polynesia; Kiribati; Lao People's Democratic Republic; Macau, China; Maldives; New Caledonia; Papua New Guinea; Samoa; Solomon Islands; Tonga and Vanuatu).

Rest of Developing Asia	58	49	107
Latin America	3	3	6
Developing countries*	**243**	**398**	**641**
World	**243**	**398**	**641**

Source: IEA, 2011.

Note: *The developing countries total includes Middle Eastern countries.

India accounted for 46 per cent of total population without electricity access as of 2013, based on REN21 (2013), and for 56 per cent of additional investments required to achieve universal access by 2030 (table 7). ASEAN accounted for 20 per cent of total population without electricity access. If the additional investments required to achieve universal access by 2030 were just proportional to population without electricity access, then ASEAN would need about US$ 48 million to achieve universal access by 2030.

However, IEA arrived at the above estimates by first determining the regional cost per megawatt-hour (MWh) from estimates of regional costs and consumer density. It then assessed the necessary combination of on-grid (grid extension), mini-grid and isolated off-grid solutions. Mini-grids provide centralized generation at a local level and use village-level distribution networks. Off-grid solutions are stand-alone systems that do not entail transmission and distribution costs. The cost per MWh of delivering electricity through the grid is lower than through mini-grids or off-grid solutions, and IEA estimated that grid extension was the most suitable option for all urban zones and around 30 per cent of rural areas. The remaining 70 per cent of rural areas were projected to be connected through mini-grids (65 per cent) or stand-alone off-grid solutions (35 per cent).

2. Financing options

In meeting energy poverty reduction targets, defining the sources of financing depends, in part, on the types of technical solutions that are best suited for the types of demand – for example, on-grid connection extensions, mini-grid distribution system and off-grid electrification. ASEAN countries would benefit from a bottom-up approach in defining the suitability of technical solutions as well as the corresponding financing requirements and strategies. The financing options for putting these technical solutions in place are government budget, multilateral and bilateral official development assistance, and private sector financing. These options can be pursued individually or as a combination of two or more options. According to *World Energy Outlook 2011* (IEA, 2011), the global demand for universal access could be financed using these options, depending on the level of household energy expenditure, as outlined in table 8.

Table 8. Financing options for pursuing universal access to electricity

	Level of household energy expenditure	**Main source of financing**	**Other sources of financing**
On-grid	Higher	Private sector	Developing country utilities
	Lower	Government budget	Developing country utilities
Mini-grid	Higher	Government budget, Private sector	Multilateral and bilateral guarantees
	Lower	Government budget	Multilateral and bilateral concessional loans

Off-grid	Higher	Multilateral and bilateral guarantees and concessional loans	Private sector, Government budget.
	Lower	Multilateral and bilateral concessional loans and grants	Government budget.

Source: Adopted with modifications from IEA, 2011.

For on-grid electrification, the investment requirements of higher energy expenditure households can be primarily financed by the private sector, with supplemental financing from developing country utilities. The investment requirements for on-grid electrification of lower energy expenditure households, on the other hand, can be financed by government budgets, supplemented by the budgets of developing country utilities.

For mini-grid electrification, higher energy expenditure households can be given electricity connection mainly through government budgets and private sector financing, and secondarily through multilateral and bilateral guarantees. The multilateral and bilateral guarantees can serve as credit enhancements for private sector financing. Connecting lower energy expenditure households to mini-grids, on the other hand, can be primarily through government budgets, which can be supplemented by multilateral and bilateral concessional loans.

Off-grid electrification is a technical solution that can justify soft financing, as this solution is usually for very remote rural areas. For higher energy expenditure households, the presence of multilateral and bilateral guarantees is very important for any private sector financing that may be feasible; multilateral and bilateral concessional loans can be the primary financing source and government budgets can provide supplemental financing. For lower energy expenditure households, off-grid electrification can be mainly financed by multilateral and bilateral concessional loans, and grants, with government budgets providing support.

An emerging financing option for increasing energy access is carbon finance. In carbon finance, projects that help to reduce greenhouse gas emissions earn carbon credits that are then sold within the Clean Development Mechanism (CDM). The CDM is a mechanism for emissions trading, which was defined in the Kyoto Protocol to the United Nations Framework Convention on Climate Change in 2007. IEA (2011), however, warned that existing substantial obstacles to using carbon finance for increasing energy access must first be overcome. Such obstacles include the long, uncertain and expensive process for determining the emissions baseline, assessing and registering projects, and monitoring and certifying the carbon credits. Nevertheless, procedural improvements are emerging and the World Bank Carbon Finance Unit has been developing methodologies such as the standardized approach in small-scale CDM methodology for grid rural electrification, i.e., the replacement of stand-alone rural power generation and traditional fuels with more efficient grid extensions and new local mini-grids (Spors, 2011).

G. Conclusion

1. AEMI and ASEAN energy poverty

The strong connection between AEMI and energy poverty has been established, both at the macro and the energy sector levels. At the macro level, energy market integration can contribute to national economic growth and development by facilitating the catching up of less developed

economies to those more developed. However, this will not be possible without addressing the issue energy poverty or increasing energy access, as "lack of access to modern energy services is a serious hindrance to economic and social development, and must be overcome if the UN Millennium Development Goals (MDGs) are to be achieved" (IEA, 2010).

At the energy sector level, integration of energy markets would allow national Governments to more easily address the energy policy challenges that face any country, including: security of energy supply and/or demand; economic efficiency of the energy sector; social equity, particularly access to affordable energy; and reduced emissions of pollutants (Andrews-Speed, 2011). Energy security has been the first priority among these policies, and energy security itself rests on three pillars: the adequacy and reliability of physical energy supply; environmental sustainability; and affordable access (ADB, 2013).

Indeed, AEMI cannot come about without addressing the situation of the more than 127 million people in the region without access to electricity and at least 228 million people without access to modern cooking fuels and technologies. To be sure, ASEAN recognizes the severity of the energy poverty situation in the region and is committed in closing the gap on energy access through energy cooperation that, to all intent and purposes, is the precursor to energy market integration.

2. Recommendations for future action

This study recommends the five actions listed below that need to be taken within or alongside AEMI in order to accelerate energy access on the one hand, and to mitigate the possible impacts of AEMI on the other hand. This is addressed to the various ASEAN energy sector bodies, including, in particular, SOME, AMEM, the relevant subsector networks, HAPUA and ACE.

(a) *Estimate the direct and indirect impacts of energy prices subsidy reform on the poor*

Assessing the impacts of fossil-fuel subsidy reform is "an important foundation for persuasively communicating the necessity for reform and for designing policies to reduce the impact of higher fuel prices on the poor" (IMF, 2013, p. 26). Beaton and others (2013) discussed the qualitative and quantitative approaches to assessing the impacts of subsidy reform.

(b) Disseminate and share knowledge and experiences on fossil-fuel subsidy reform and mitigating impacts

"South-East Asian countries have a wealth of experience in reducing and reforming fossil-fuel subsidies, and can learn from one another's experiences. Opportunities for increased policy dialogue and sharing case studies would help replicate successes and share the lessons that have been learnt"(Beaton and others, 2013, p. 94).

(c) RE-SSN and HAPUA should continue and expand cooperation on off-grid and decentralized renewable energy systems, and perhaps coordinate with each other to accelerate the elimination of energy poverty.

Off-grid systems that are fuelled by renewable energy sources, whether decentralized stand-alone systems or micro- and mini-grids, are the most economical solutions to providing electricity access in still many cases (because of the non-viability of grid or line extension). As they are aware of this fact, RE-SSN and HAPUA should make this a priority topic in their respective work programmes, including the possibility of joint-discussions.

A potential area for joint discussion is the adoption of regional and national standards on off-grid and decentralized systems, including micro- and mini-grids, based on existing international standards.

(d) Estimate the investment requirements for achieving universal energy access by 2030 and study financing options.

In cooperation with IEA/OECD, it is recommended that ACE determine the investment requirements needed for achieving universal energy access by 2030 in ASEAN or among ASEAN members. This undertaking should not be limited to estimating the investment requirements in United States dollar terms, but more importantly the technological options behind such investments. Equally important are the potential sources of financing for those investments. This is to put real value on, and stress the urgency of the tasks ahead. Above all, insofar as AEMI is concerned, such an undertaking should point to aspects of cooperation in the area of energy access, as AEMI cannot be realized if some people in the region remain without access to clean energy.

(e) Start a collaborative research project to investigate the best practices in promoting rural electrification programmes.

Research needs to address the technical difficulties, quality of service, administration, level of demand, high costs and financing programmes. This study aims to become the "White Book" in promoting rural electrification programmes in the ASEAN.

References

ADB (2013). *Asian Development Outlook 2013*. Asian Development Bank, Manila.

AGECC (2010). *Energy for Sustainable Future*. United Nations Secretary-General's Advisory Group on Energy and Climate Change. New York.

AMORE (2011). "AMORE Solar PV electrification: Prospects and opportunities," presentation at the RE Business Stakeholders' Forum, 12 August 2011, Pasig City, the Philippines.

Andrews-Speed, P. (2011). "Energy market integration in East Asia: A regional public goods approach", ERIA Discussion Paper Series 2011-06. Economic Research Institute for ASEAN and East Asia, Jakarta.

ASEAN Centre for Energy (2010). "ASEAN Plan of Action for Energy Cooperation 2010-2015." Available at: http://aseanenergy.org/media/filemanager/2012/10/11/f/i/file_1.pdf (accessed 8 July 2013).

Beaton, C., I. Gerasimchuk, T. Laan and K. Lang (2013). *A Guidebook to Fossil-Fuel Subsidy Reform.* International Institute for Sustainable Development, Winnipeg, Manitoba, Canada

Bhattacharya, A., F. Kimura, S. Kojima and X. Shi (2010). "Energy market integration in the East Asia Summit region: Review of initiatives and estimation of benefits." ERIA Research Project Report 2009, No. 13. Economic Research Institute for ASEAN and East Asia, Jakarta.

East Asia Summit (2007). "Cebu Declaration on East Asian Energy Security, 15 January 2007." Available at: www.asean.org/news/item/cebu-declaration-on-east-asian-energy-security-cebu-philippines-15-january-2007-2 (accessed 8 July 2013).

EVN and ICASEA (2013). *Technical Manual for Interconnecting Wind Power to Vietnam Power System*. Vietnam Electricity and International Copper Association Southeast Asia, Hanoi and Jakarta.

IEA (2012). *World Energy Outlook 2012*. International Energy Agency, OECD/IEA, Paris.

——— (2011). "Energy for all: financing access for the poor", special excerpt from *World Energy Outlook 2011*. International Energy Agency, OECD/IEA, Paris.

——— (2010). "Energy poverty: How to make modern energy access universal", Special excerpt of the *World Energy Outlook 2010*. International Energy Agency, OECD/IEA, Paris.

——— (2009). *World Energy Outlook 2009*. International Energy Agency, OECD/IEA, Paris.

IEC (2013). "Electrical energy…the IEC helps keep the power on". International Electrotechnical Commission, Geneva.

——— (2010). "TC 82 (Solar Photovoltaic Systems) Strategic Business Plan.". International Electrotechnical Commission, Geneva.

IMF (2013). *Energy Subsidy Reform: Lessons and Implications*. International Monetary Fund, Washington D.C.

Kanagawa, M. and T. Nakata (2008). "Assessment of access to electricity and the socio-economic impacts in rural areas of developing countries," *Energy Policy*, vol. 36; pp. 2016-2029.

McCawley, P. (1978). "Rural electrification in Indonesia – Is it time?" *Bulletin of Indonesia Economic Studies*, vol. 14, No. 2; pp. 34-69.

Masud, J., D. Sharan and B. Lohani (2007). *Energy for all: Addressing the energy, environment, and poverty nexus in Asia*, Asian Development Bank, Manila.

Navarro, A. (2013). "Cost efficiency and effectiveness of the Sitio and Household Electrification Programs," PIDS Discussion Paper Series No. 2013-32, PIDS. Philippine Institute for Development Studies, Makati City, Philippines.

Ngigi, A. (2013). "Standardization and certification of energy products: The experience of DEEP EA Project." IT Power East Africa., Nairobi.

Reddy, A.K.N., and B.S. Reddy (1994). Energy and Social Issues in World Energy Assessment. United Nations Development Programme. New York.

REN21 (2013). *Renewables 2013 Global Status Report*. REN21 Secretariat, Paris.

Sheng, Y. and X. Shi (2013). "Energy market integration and equitable growth across countries", *Applied Energy*, vol. 104; pp. 319-325.

——— (2011). "Energy market integration and economic convergence: implications for East Asia", ERIA Discussion Paper Series 2011-05. Economic Research Institute for ASEAN and East Asia, Jakarta.

Spors, F. (2011). "Standardised Approach in New Draft Small Scale CDM Methodology for Grid Rural Electrification", presentation at UNFCCC Standardisation Workshop, June 2011, Bonn. Available from http://cdm.unfccc.int/methodologies/Workshops/cdm_standards/s2_wb.pdf (accessed 12 July 2013).

UNDP (2005). *Energizing the Millennium Development Goals: A Guide to Energy's Role in Reducing Poverty*. United Nations Development Programme, New York.

Winkler, H., A. F. Simoes, E. L. Rovere, M. Alam, A. Rahman and S. Mwakasonda (2011). "Access and affordability of electricity in developing countries." *World Development*, vol. 39, No. 6; pp. 1037-1050.