ASEAN ENERGY MARKET INTEGRATION (AEMI) FORUM: ENERGY POVERTY AND SMALL SCALE RENEWABLE ENERGY

Forum held under Chatham House Rule

HOTEL ARYADUTA, JAKARTA, 3 - 4 JUNE 2015

TABLE OF CONTENTS

AEMI PROJECT OVERVIEW

Jakarta, 3 - 4 June 2015

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A. MOTIVATION

Context[1]

1. ASEAN is facing an energy challenge. Primary demand for energy is set to grow steadily at 4.4% per year up to 2030, in the face of increased economic activity, population growth, rising electrification rates, and expansion of the transport sector. The implication is that energy demand will double by 2030, after having already expanded 2.5 times since 1990. Demand for all hydrocarbons is set to expand: oil by 50%; natural gas by 80%; and coal by 300%, as it replaces gas and oil, notably for electricity generation. According to the Asian Development Bank, even in a best-case scenario for energy efficiency and renewable energy, ASEAN energy production cannot meet such rapidly increasing demand.

2. This soaring energy demand is combined with declining energy production within ASEAN. ASEAN oil production is expected to fall by almost one third by 2030, after having declined by 10% per year in the last decade. Also ASEAN's surplus of natural gas and coal available for export will continue to decline, as ASEAN production is outpaced by its domestic demand. Currently, renewables represent only 3% of primary energy mix in ASEAN-5 (Indonesia, Malaysia, the Philippines, Singapore and Thailand) and this ratio is set to fall, as gains from the use of renewable energy will only displace current use of biomass.

3. Moreover, ASEAN's environmental sustainability is set to decline. ASEAN energy-related greenhouse gas emissions are expected to double by 2030, after having increased by 57% during the last decade. This is due in part to the expected 8% annual increase in coal consumption for electricity generation. Moreover, ASEAN energy intensity is lagging world averages. It improved only by 12%, compared to 26% worldwide. Moreover, ASEAN industrial energy intensity[2] has been worsening steadily in the last three decades (decreasing on average by 0.2% per year in 1980-2011). As a result, ASEAN currently consumes more than twice the amount of energy per

[1]Sources: AEMI Group (2013), *ASEAN Energy Market Integration (AEMI): From Coordination to Integration*; Asia Development Bank (ADB) (2013), *Asian Development Outlook 2013: ASEAN's Energy Challenge*; International Energy Agency (IEA) (2012), *World Energy Outlook*; International Monetary Fund (IMF) (2013),*Energy Subsidy Reform: Lessons and Implications*; International Institute for Sustainable Development (IISD) (2013),*A Guidebook to Fossil-Fuel Subsidy Reform for Policy-Makers in Southeast Asia*; The World Bank (2010),*Subsidies in the Energy Sector: An Overview*.

[2] It means output per unit energy use at constant price. Thus, when the intensity decreasing means that to produce same unit of output, industries need more energy.

unit of GDP than the average industrial countries (OECD). End-users appliances (e.g., incandescent light, bulbs, air conditioners; industrial motors) are highly inefficient compared to best available technologies.

4. Finally, ASEAN energy poverty is higher than the world average. More than one fifth of ASEAN population (some 130 million people) is without access to electricity, and nearly half (45%) relies on traditional use of biomass for cooking (about 230 million people). Lack of access to modern energy services is a serious hindrance to economic and social development, and must be overcome if sustainable and equitable growth is to prevail within the ASEAN Economic Community.

Challenges

5. International organizations (ADB, IEA) propose ASEAN energy market integration as the most efficient way for ASEAN to address its energy challenges. They also recognize that the creation of an efficient ASEAN-level regional energy market is a major challenge, as it requires harmonization of energy pricing and subsidies for energy product and services; rationalization of tariffs and non-tariff barriers; expansion of market connectivity through gas pipelines and power grid; and formulation of a common strategy for energy security. Moreover, for the integrated ASEAN energy market to be socially equitable and environmentally sustainable, member states need to agree common policies to deploy renewable energy; enhance energy efficiency; and secure access to clean energy sources. ASEAN energy market integration therefore involves all of these elements.

6. A group of concerned ASEAN academics held a session at Chulalongkorn University (May 2013, Bangkok) and constituted themselves into the AEMI Group, agreeing to work together to make the case for ASEAN Energy Market Integration (AEMI) within the forthcoming ASEAN Economic Community (AEC). The vision is to allow for the free flow of energy products, services, investment and skilled labor in the framework of the AEC. The approach is consistent with the purpose of the AEC, to transform ASEAN into a single production market with a free flow of goods, services, investment and skilled labor. AEMI is a logical extension of such provisions to the energy sector.

7. The AEMI Group committed to working together to develop the AEMI concept, analyze its rationale, assess its potential benefits, and propose an approach for its deployment within the AEC through 2030. Through their studies, the AEMI Group demonstrated that the development of AEMI is an imperative requirement for the success of the AEC, given the vital role that energy plays in sustaining economic growth and in securing the wellbeing of people. Moreover, if designed properly and implemented efficiently, AEMI has the potential to deliver economic, social and environmental benefits to all ASEAN member states. It could improve

energy efficiency, help creation and deployment of renewable energy and address energy poverty across ASEAN.

8. The AEMI Group published a Book: *"AEMI: From Cooperation to Integration"* (2013) distributed to ASEAN Senior Officials, policymakers and academics (in Bangkok, Jakarta, Manila, Kuala Lumpur, Singapore, and Tokyo). The work of the AEMI Group was supported since its inception by Chulalongkorn University (Bangkok, Thailand).

Policy-making

9. The AEMI Group was successful in opening a dialogue with ASEAN policymakers on energy market integration. It made the case for the successor of the current ASEAN Plan of Action for Energy Cooperation (APAEC, 2010-2015), to move from regional energy "cooperation" into energy "integration", to take the energy dialogue beyond the current piecemeal bilateral trading arrangements, into fully integrated energy policies within the framework of the AEC.

10. The AEMI Group worked closely with the ASEAN Secretariat and relied on the data and publications from the ASEAN Center for Energy (ACE). It was invited to address the 31st Senior Officials Meeting on Energy (SOME) in Bali (June 2013). The SOME endorsed the AEMI initiative and encouraged the AEMI Group to report back their results on the subsequent SOME.

11. More recently, the SOME adopted "ASEAN connectivity and energy market integration" as the main theme for the upcoming APAEC 2016-2020 and instructed the drafting committee to prepare the document accordingly. This agreement is to be concluded by the ASEAN Energy Ministers by December 2015.As a result of this development, the AEMI Group currently focuses its analytical work on defining an AEMI Blue Print. It has already identified the set of issues that needs to be addressed in the design of the next APAEC, with a view to formulating policy recommendations directly relevant to its drafting in 2015 and to its deployment to 2020.

B. STRUCTURE

Focus

12. The adoption of "connectivity and energy market integration" as the main theme of the new APAEC represents a major shift in ASEAN perspective, and a challenge to its policymakers. The proper formulation of AEMI Blue Print would provide ASEAN greater energy security, enhanced economic efficiency, and improved opportunities to fight energy poverty and to address environmental problems.

13. The purpose of the AEMI Project is to bring together energy experts from ASEAN member states and beyond, to further develop the concept of AEMI and design its Blue Print components. Building on the work accomplished by the AEMI Group, it would undertake policy analysis and formulate recommendations for the next APAEC (2016-2020) from the drafting stage in 2015 through the period of implementation to 2020.

14. The AEMI Project is geared towards enhancing ASEAN energy policy dialogue, and engaging policymakers (including the ASEAN Center for Energy, the ASEAN Secretariat and all ASEAN energy bodies), non-government organizations, as well as energy and environment experts from the region and beyond.

Approach

15. The AEMI project will convene a series of thematic Forums to assess ASEAN energy challenges, identify opportunities and challenges in implementing AEMI, and formulate policy recommendations for the new APAEC. These Forums will be designed to engage an interaction policy dialogue between academics, energy practitioners, civil society organizations, ASEAN policymakers as well as international organizations.
16. Each thematic Forum corresponds to one of the components identified for the AEMI Blueprint. These themes include: expanding renewable energy; improving energy efficiency; securing clean energy access to isolated remote areas; tackling energy subsidies while enhancing affordability of energy to the poor; improving market connectivity; fostering clean energy technology; and advancing energy security. Table 1 provides a preliminary list of such thematic Forums.

17. Special attention will be given to convening a Forum to assess the impact of small-and-medium-scale renewable energy projects in remote and isolated areas across ASEAN, and to investigate ways to help forge a role for ASEAN in global renewable energy development. In particular, the Forum would assist in developing a survey to be conducted in at least 20 local communities that have recently installed renewable energy sources across a minimum of four ASEAN member states.

Outputs

18. A *Forum Report* will summarize the conclusions from each Forum, highlight the emerging policy recommendations, and outline next steps to further develop them (including surveys at the national levels, interactions with ASEAN policy makers, and investigations with national energy entities). Moreover, a survey of renewable energy will be produced.

19. An *AEMI Policy Paper* will be drafted on each of the Forum themes, focused on analyzing policy options and making policy recommendations for the APAEC (2016-2020).

20. The *AEMI Website* will be created to e-Publish *AEMI Policy Papers*, post information related to the ASEAN energy, distribute Forum outputs, and receive comments and suggestions.

Support

21. The project is funded by the Norwegian Ministry of Foreign Affairs, building on the AEMI work initiated and supported by Chulalongkorn University, Thailand. It is housed at the ASEAN Studies Center (ASC), Chulalongkorn University, where the AEMI Secretariat will also be located.

22. The project is jointly coordinated by Dr. Nawal Kamel (ASC) and Dr. Indra Øverland, the Norwegian Institute of International Affairs. An AEMI Advisory Committee will review progress, provide advice and supervise the budget. Furthermore, an AEMI Review Committee will provide guidance on the technical aspects of the AEMI project, and include prominent energy experts and practitioners from ASEAN and beyond.

Partnerships

23. The AEMI project will seek to expand the current AEMI Group, which currently includes academics from most ASEAN countries. The project will seek to include active participation of ASEAN academic institutions and research institutes currently present within the AEMI Group, and to expand this network further. Table 2 provides the list of AEMI Group members as of January 2015.

24. The AEMI project will also strive to broaden the AEMI network to gradually include relevant civil society organizations, multilateral organizations, foundations, as well as (neutral) bilateral and multilateral donors. It will also build linkages with ongoing related international initiatives on green energy and technology, and on access to renewable energy.

Table 1: Potential Forums Themes

(1) ADDRESSING ENERGY POVERTY (a) How would AEMI help access to energy and eradicate energy poverty across ASEAN? (b) What is the investment need to improve access to electricity and clean energy fuel across ASEAN? (c) Which policy incentives would encourage private sector investments in energy infrastructure projects? (d) How to quantify the implications of eradicating energy poverty on narrowing the development gap across ASEAN (an objective of the AEC), and on improving GDP prospects across ASEAN? (e) What policy recommendations for APAEC (2016-2020)?
(2) TACKLING ENERGY PRICING AND SUBSIDIES (a) What are the options to "decouple" energy pricing from welfare objectives to assist the poor in most vulnerable ASEAN communities (e.g., tax breaks, social security mechanisms, and rebates on energy bills). (b) Can AEMI help implement ASEAN-wide subsidy instruments to protect the poor while allowing the energy market function efficiently? (c) What are the policy recommendations for the APAEC (2016-2020)?
(3) EXPANDING RENEWABLE ENERGY (a) What are the options for establishing ASEAN-level targets? (b) How to quantify the impact of such targets on key environmental and economic indicators? (c) What are the policy incentives to encourage the use of Renewable Energy in the context of AEMI? (d) What are the policy recommendations for the APAEC (2016-2020)?
(4) SMALL-SCALE RENEWABLE ENERGY AND ENERGY POVERTY (a) The Forum will discuss a project implemented by surveying at least 20 local communities in at least four ASEAN countries that have recently installed renewable energy sources. The design of this survey will be presented for review and input at a workshop before the survey is carried out. (b) The survey would address the following questions: (i) Are previously energy-poor communities within ASEAN in fact "leapfrogging" directly from biomass energy to clean energy? (ii) What developmental benefits has the deployment of renewable energy actually delivered in these local communities? (iii) How could ASEAN use its remote, energy-poor communities to play a constructive and

pro-active role in global climate policy by creating a market niche and setting precedents?

(5) IMPROVING ENERGY EFFICIENCY

(a) What are the options for establishing ASEAN-level targets?

(b) How to quantify the impact of such targets on key environmental and economic indicators?

(c) What are the policy incentives to encourage Energy Efficiency in the context of AEMI?

(d) What are the policy recommendations for the APAEC (2016-2020)?

(6) ENERGY TARIFFS AND NON-TARIFFS BARRIERS

(a) What are the tariffs and non-tariffs barriers to the free flow of energy goods, services and investments across national borders in the framework of AEMI?

(b) What are the policy recommendations for the APAEC (2016-2020)?

(7) INFRASTRUCTURE NEEDS FOR CONNECTIVITY

(a) What are the investments needed to build the physical, financial and legal/regulatory connectivity through the ASEAN Power Grid and the Trans-ASEAN Gas Pipeline?

(b) What are the investments needed for the ASEAN Power Grid to be able to absorb the full potential from Renewable Energy sources, so that renewables can compete on an equal footing with traditional sources?

(c) What are the policy recommendations for APAEC (2016-2020) for investments in energy infrastructure and smart grids?

(8) FORMULATING ENERGY TECHNOLOGY STRATEGY

(a) What are the ASEAN-level policy incentives to develop and deploy clean energy technology?

(b) What incentives for the private sector in creation and deployment of clean energy technology in ASEAN?

(c) Could AEMI facilitate the creation of an *ASEAN Clean Energy Technology Fund*?

(d) What policy recommendations for the APAEC (2016-2020)?

(9) ADVANCING ASEAN ENERGY SECURITY

(a) What are the core components of an ASEAN energy security strategy?

(b) Would the ASEAN energy strategy address oil and gas physical reserves and deployment conditions?

(c) Would the ASEAN energy strategy include reserve margins for power generation, to maintain electricity provision through national and local grids?

(d) What are the strategic policy recommendations for the APAEC (2016-2020)?

(10) DEVELOPING ANALYTICAL TOOLS FOR ASEAN ENERGY POLICY

(a) Which econometric tools and methodologies could best quantify AEMI economic, welfare and environmental benefits across ASEAN (e.g., impact on energy prices, economic growth, energy savings, reduction in greenhouse gas emissions and energy security)?

(b) Which tools could best assess the impact of adopting ASEAN targets on Renewable Energy and Energy Efficiency?

(c) What are the policy recommendations for the APAEC (2016-2020)?

Table 2: AEMI Group Members

(As of January 2015)

BRUNEI	Dr. Lim Chee Ming	Associate Professor, Institution of Engineering and Technology, Universiti Brunei Darussalam (UBD), Bandar Seri Begawan.
CAMBODIA	Dr. Srinivasa Madhur	Director of Research, Cambodia Development Resource Institute (CDRI), Phnom Penh.
INDONESIA	Dr. Maxensius Tri Sambodo	Researcher, Indonesian Institute of Sciences (LIPI)-Economic Research Center, Jakarta. Visiting Fellow, Institute of Southeast Asian Studies (ISEAS), Singapore.
	Dr. Tri Widodo	Professor and Head of Economics Department, Faculty of Economics and Business, Universitas Gadjah Mada (UGM), Yogyakarta.
LAO PDR	Dr. Phouphet Kyophilavon	Associate Professor and Vice Dean, Faculty of Economics and Business Management, National University of Laos (NUOL), Vientiane.
MALAYSIA	Dr. Aishah Bte. Mohd Isa	Research Fellow, Energy Policy and Research (IEPRe), Universiti Tenaga Nasional (UNITEN), Kuala Lumpur.
	Ir. G. Lalchand	Associate, Akademi Sains Malaysia (ASM), Kuala Lumpur.
	Dr. Leong Yow Peng	General Manager (Corporate Planning & Innovation), National Power Utility, Kuala Lumpur.
	Ir. Tuan Ab. Rashid Bin Tuan Abdullah	Director, Institute of Energy Policy and Research (IEPRe), Universiti Tenaga Nasional (UNITEN), Kuala Lumpur.
MYANMAR	To be determined	To be determined
PHILIPPINES	Dr. Adoracion M. Navarro	Senior Research Fellow, The Philippine Institute for Development Studies (PIDS), Manila.
	Dr. Ma. Joy V. Abrenica	Associate Professor, School of Economics, University of the Philippines (UP)-Diliman, Manila.
	Mr. Jessie L. Todoc	Consultant, Sustainable Energy, Manila.

SINGAPORE	Dr. Philip Andrews-Speed	Principal Fellow, Energy Studies Institute (ESI), National University of Singapore (NUS), Singapore.
	Dr. Xunpeng Shi	Senior Research Fellow, Energy Studies Institute (ESI), National University of Singapore (NUS), Singapore.
	Dr. Youngho Chang	Assistant Professor, Division of Economics, Nanyang Technological University (NTU), Singapore.
THAILAND	Dr. Bundit Fungtammasan	Associate Professor and Vice President for Research, Joint Graduate School of Energy and Environment (JGSEE), King Mongkut's University of Technology Thonburi (KMUTT), Bangkok.
	Dr. Chaiwat Muncharoen	Director, Asian Greenhouse Gas Management Center (AGMC),Asian Institute of Technology (AIT), Bangkok.
	Dr. Kitti Limskul	Associate Professor, Faculty of Economics, Chulalongkorn University (CU), Bangkok.
	Dr. San Sampattavanija	Lecturer, Faculty of Economics, Chulalongkorn University (CU), Bangkok.
	Dr. Watcharapong Ratisukpimol	Lecturer, Faculty of Economics, Chulalongkorn University (CU), Bangkok.
VIETNAM	Mr. Nguyen Duc Song	Researcher, Demand Forecast and DSM Department, Institute of Energy, Hanoi.
	Dr. Nguyen Thi Mai Anh	Lecturer, Department of Industrial Economics, School of Economics and Management, Hanoi University of Science and Technology (HUST), Hanoi.
	Dr. Tran Van Binh	Lecturer, Department of Industrial Economics, School of Economics and Management, Hanoi University of Science and Technology (HUST), Hanoi.

Discussion Paper

AEMI Forum: Energy Poverty and Small Scale Renewable Energy

Jakarta, 3 – 4 June 2015

DISCUSSION PAPER

A. FORUM OBJECTIVE

1. The task of AEMI in the energy poverty area is to develop relevant policy recommendations for ASEAN on improving access to electricity focusing on ASEAN Power Grid and renewable energy (both on mini-grid and off grid) and eradicating energy poverty, with an emphasis on renewable energy and a view to the new ASEAN Plan of Action for Energy Cooperation (APAEC) (2016-2020). This forum is convened to plan AEMI's work in this topic area for the coming two years, in particular to agree on an analytical approach and division of labor among its participants from ASEAN research institutions. A follow-up forum in this topic area will be convened in 2016 or 2017 to finalize the results of the work.

2. More specifically, the research to be undertaken will be designed to address the following objectives:

   (i) To provide policy recommendations for the new APAEC (2016-2020)
   (ii) To evaluate how AEMI can enhance electricity access across ASEAN with special reference to power interconnection – ASEAN Power Grid (APG) between West Kalimantan, Indonesia and Sarawak, Malaysia; and experiences from CLMV countries especially from Cambodia and Vietnam.
   (iii) To assess how off-grid and mini-grid can be promoted to complement the APG mechanism with special reference Indonesia and Philippines.
   (iv) To highlight the potential role of ASEAN's energy poor island communities as a launch market for renewable energy and an opportunity for ASEAN to take on a leadership in a global context.
   (v) To assess the climate aspect of rural electrification, in particular whether remote energy poor communities can leapfrog directly from no electricity to local supplies of renewable energy.
   (vi) To assess the status of households and community welfare before and after gaining access on electricity by conducting a fieldwork study in selected villages (covering on grid, off grid, and mini grid).
   (vii) To assess the sustainability of electricity access, including technology selection, maintenance and operation, standardization and coordination, utilization of capacity, ecology, investment and pricing.

B. ASEAN Energy Poverty and Rationale for Small-scale Renewables

In 2012, 140 million people in ASEAN (equivalent to 22.6% of the region's total population) do not have access to electricity. Surprisingly, this number has risen from about 127.4 million in 2010. This indicates that ASEAN as a whole has not progressed towards meeting the Sustainable Energy for All (SEA4ll) objectives. This initiative was launched by the UN General Assembly in September

2011. As seen from Table 1, the ratios of access to electricity in rural areas lags far behind the urban areas in Cambodia, Indonesia, Laos, Myanmar, Philippines and Vietnam.

According to the International Energy Agency (IEA), energy poverty is defined as lack of access to modern energy services, i.e. access to electricity and clean cooking facilities. Similarly, Reddy and Reddy (1994) as cited in Masud et al. (2007:47), define energy poverty 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". Thus without serious effort by the ASEAN member countries to combat energy poverty, it will be difficult for ASEAN to achieve "RICH" status by 2030.[3]

Table 1. Electricity Access 2012

Country	Population without electricity, millions	National Electrification rate (%)	Urban electrification rate (%)	Rural electrification rate (%)
Brunei Darussalam	0	100	100	99
Cambodia	10	34	97	18
Indonesia	60	76	92	59
Laos	1	78	93	70
Malaysia	0	100	100	100
Myanmar	36	32	60	18
Philippines	29	70	89	52
Singapore	0	100	100	100
Thailand	1	99	100	99
Vietnam	4	96	100	94

Source: IEA, World Energy Outlook 2014

On the other hand, a UNDP (2005) study shows that providing access to modern energy can enhance countries' attainment of the Millennium Development Goals (MDGs). Kanagawa and Nakata (2008) show that energy has close relationship with poverty indicators such as health, education, income and environment. By using the rural level data in Bangladesh, Barnes et al. (2010) found that the use of electricity significantly improves household incomes. Similar, positive association was found by Kooijman – van Dijk and Clancy (2010) using rural level data in three countries, Bolivia, Tanzania and Viet Nam. They found that electricity access in rural areas directly provided both non-financial benefits and financial benefits to rural household such as improving quality of goods and services. Electricity access also reduces travel time and waiting time. Then, electricity access enables household to use mobile phone and electric machines for sewing and working wood (Kooijman – van Dijk and Clancy, 2010).

3 RICH = Resilient, inclusive, competitive and harmonious. ADB (2014:xxiv) states that "*resilience* refers to the capacity to handle volatilities and shocks from within or outside the region, reducing the likelihood of economic crises; *inclusiveness* refer to the need for ASEAN to achieve equitable economic development, providing opportunities through cooperation strategies that reduce income gaps within and across countries, and promoting citizen welfare; *competitiveness* requires a business environment where successful firms operate in efficient markets under effective national and regional regulation; and *harmony* stems from environmentally sustainable development and growth, with proper consideration of the need to mitigate and adopt to climate change".

Studies have also shown that there is a connection between electricity access and welfare (Munasinghe 1988; Reiche, Covarrubias & Martinot 2000; Peng & Pan 2006; Al Mohtad 2006; Kanagawa & Nakata 2008). Reiche, Covarrubias & Martinot (2000) investigated the social impact of a rural electrification program on increasing standard of living, declining in traditional energy consumption such as fire wood, lead to better condition on health and quality of environment, increasing in job opportunity, and in causing improvement in business productivity. Kanagawa and Nakata (2008) studied electricity access in poor India region and showed that electricity access had a direct and indirect impact on poverty indicators such as health, education, income and the environment.

There are three ways to improve the electrification ratio (IEA, 2011): (i) grid extension, (ii) mini grid,[4] and (iii) off-grid. In cities or in regions with high population density, grid extension can draw on existing infrastructure to provide the lowest cost option. Further, mini grid can be low voltage and it can be generated by small power generator. Cooperative and local business entities can manage it (IEA, 2011). Finally, the off-grid electricity can be promoted in remote areas where settlements are scattered and it is impossible to develop a grid extension or mini grid (IEA, 2011). At the ASEAN level, ASEAN Power Grid is one of the mechanisms for alleviating energy poverty, but it may have many limitations. Table 1 shows, energy poverty is concentrated in rural areas where grid extension has less of an advantage. Because most energy-poor households are located in rural and remote areas, promoting small-scale renewables can be an effective way to increase the electrification ratio. As seen from Table 2, different types of small-scale renewable energy have different comparative advantages in supporting daily life and economic activities. It is therefore also important to consider carefully exactly which type of renewable energy source to install when trying to use renewable energy to alleviate rural energy poverty.

Table 2: Application of Renewable Energy for Supporting Economic Activities

Type of technology	Lighting/ Refrigerator	Communication	Cooking	Heater/ Cooler	Micro industry	Water pump
Solar Home System (SHS)	√	√			√	
Pico Solar Photovoltaic (SPV)	√	√				
Solar thermal				√		
Solar cookers			√			
Solar crop dryers				√		
SPV Pumps						√
Small hydro	√	√				
Small wind		√			√	√
Mechanical wind pumps						√
Household-scale biogas digester	√	√	√	√		
Biomass gasifier	√	√			√	√
Improved cookstove (ICS)			√			

Source: IRENA (2012)

[4] With range of capacity between 10 – 1,000 kilo watt (IRENA, 2012)

C. Methodology

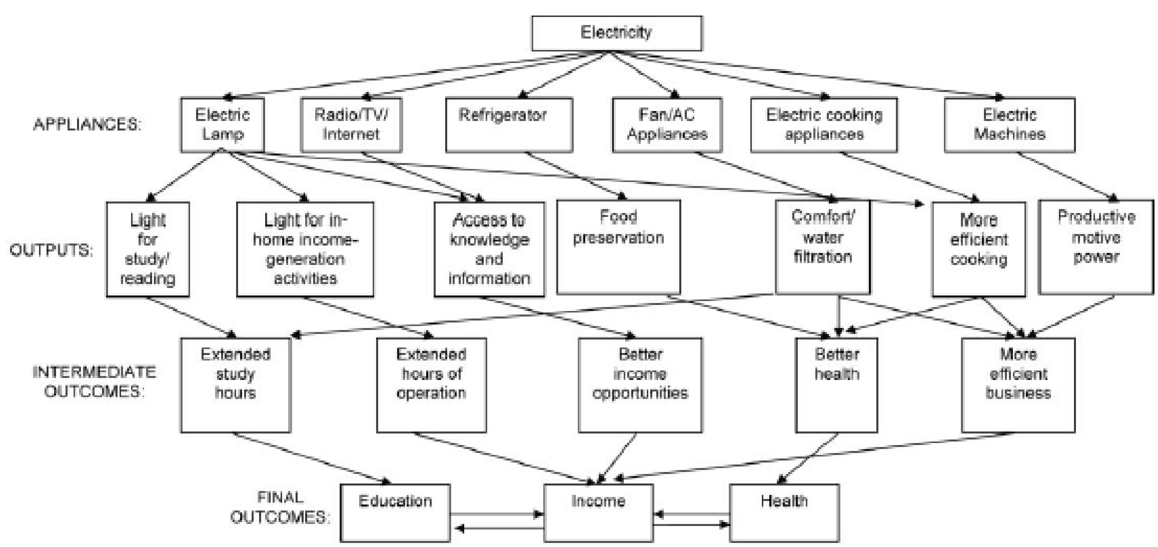
C.1 Country Focus

Five of the ASEAN countries have large numbers of people without electricity access: Indonesia, Myanmar, Philippines, Laos, and Cambodia. In addition, we also include Vietnam in the study for two major reasons. First, there will be the APG new interconnection project in 2017 between Vietnam and Cambodia. Thus, Indonesia – Malaysia will represents beneficiaries of APG from the eastern part of APG while Vietnam and Cambodia represent the northern part of APG. Second, Vietnam represents the success story, because in spite of a lower GDP per capita than Indonesia and the Philippines, the ratio of electrification in rural areas is approaching 100%. Thus, it is necessary to understand this achievement.

C.2 Framework

There are three elements of assessment that we are going to conduct: (i) understanding the characteristics of energy poor households; (ii) understanding and evaluating the selection criteria that government sets in providing electricity access (on grid, mini grid and off grid); and (iii) assessing impacts from electricity access both quantitatively and qualitatively. However, Khandker et al (2013) argued that it is difficult to measure direction and magnitude of electrification programs with regard to selected outcome due to the complex relationship between electricity equipment, output and intermediate outcome. As seen from Figure 1, gaining access to electricity has lead households to buy electric equipment such as lamps, radios, television sets, refrigerators, rice cookers and small scale electric machines. They produce different outputs such as for lighting, information, more efficient cooking, and food preservation. Intermediate outcomes from those outputs such as extended study hours, extended hours of operation, better income opportunity, better hygiene, better health, better information and communication and more efficient business. Thus the final outcomes will be improvement in education, income and health.

<u>Figure 1</u>: Transmission of Electricity Benefits to Welfare



Source: Khandker, Barnes & Samad 2013, pp. 668

C.3 Sample selection

The main objective of the survey is to collect data at the household level, then we plan to assess the impact of electricity access (including small-scale grids) on social welfare.[5] The unit of analysis is households in remote areas and households who will be beneficiaries or the potential beneficiaries of APG. We prepared three strategies for data collection. In strategy A, the control group is households that do not have electricity access, while the treatment group is consists of nearby households that will have access to electricity the following year. We collect a random sample of about 100 households from each village.

Strategy A

Group	**Time t**	**Time t + 1**
Control	Do not have electricity	Do not have electricity
Treatment	Do not have electricity	Have electricity

Note: we survey the same households in time t + 1

In strategy B, we are not sure whether the treatment group will obtain electricity in time t + 1 or not, thus, we obtain households that have electricity and do not have electricity in time t. Technically, strategy A is more reliable than strategy B, because we compare the same household at time t and t + 1. However, if at time t + 1, the treatment group fails to obtain electricity, as in strategy B, there will be little point in the study. We can combine strategy A and B into strategy C. It seems that strategy C will provide low risk in terms of the success of the impact assessment, but it is necessary to expand the sample size.

Strategy B

	Time t	Time t + 1
Group M	Have electricity	Have electricity
Group N	Do not have electricity	Do not have electricity

Strategy C

	Time t	Time t + 1
Group X	Have electricity	Have electricity
Group Y	Do not have electricity	Have electricity
Group Z	Do not have electricity	Do not have electricity

Before conducting fieldwork, it is necessary to obtain information from the national electricity authority about villages that have access to electricity and do not have access on electricity. It would be good if we can select locations where the two groups (have and do not have electricity) are neighbor and they are very close to the APG network (in the case of Indonesia, Vietnam, and Cambodia). Then, we also need to obtain information regarding the main source of electricity supply. It is good if we can cover a variety of power sources such as through grid connection, mini-grid, and off-grid. It is also necessary to diversify the source of renewable energy sources such as solar panels, microhydro, and biomass (expect for on-grid). If we can randomly select 200 households for each country the composition could be as follows:

[5] Please refer to appendix 3 for detail information regarding information and questionary that we are going to collect.

No	Type	Number of household
1	Without electricity	25
2	On grid	25
3	Mini-grid solar	25
4	Mini-grid hydro	25
5	Mini-grid biomass	25
6	Off-grid solar	25
7	Off-grid hydro	25
8	Off-grid biomass	25

C.5 Method of Analysis

C.5.1 Qualitative analysis

We will divide the qualitative analysis into two elements. First, we will assess the impact of electricity access on education, health, social activity, environment and economic activity. Then, we also assess the sustainability of existing small-scale renewables in terms of: (i) technology selection; (ii) maintenance and operation; (iii) standardization and coordination; (iv) utilization of capacity; (v) environment/ecology; (vi) investment; (and) (vii) pricing. The information will be obtained from household, community, and local government level. (Please refer to Appendix 2 for detailed information).

C.5.2 Quantitative analysis

A. Statistical analysis

We can apply descriptive statistics and parametric (or non-parametric) test to investigate the differences in selected indicators (expenditure, health, and education) between the two groups (with and without) or among groups with difference type of electricity access.

B. Econometric approach

We propose two economic approaches that can be applied to our data: (i) Seemingly unrelated regression (SUR); and (ii) the fixed effect model. Please refer to Appendix 3 for a detailed discussion. However, in the forum, we will discuss other methods that can be also applied.

D. Research outline

1. Overview of global agenda on energy poverty
    a. ASEAN agenda in combatting energy poverty under the APG framework
    b. Renewable energy in combatting energy poverty: mini grid and off grid model

2. Review of the literature on energy poverty: concept, theory, experiences (lesson learned)
    a. Globally
    b. Within ASEAN
    c. National level (Review on renewable energy programs that are financed by national budget and international donor will be provided)

3. Empirical analysis of the role of ASEAN Power Grid (APG) in alleviating energy poverty
    a. Experiences from West Kalimantan, Indonesia and Sarawak, Malaysia
    b. Experiences from Cambodia and Vietnam
    c. Understanding the limitations of APG in combating energy poverty

4. Evaluating sustainability of the small scale renewable energy program: a country case study
    a. technology selection
    b. maintenance and operation
    c. standardization and coordination
    d. utilization of capacity
    e. ecology/environmental assessment
    f. investment and pricing

5. Impact assessment of electricity access on social welfare - country studies
    1. Quantitative assessment
        i. Location description
        ii. Sampling technique
        iii. Summary – Descriptive Statistics
        iv. Regression model (regression, ANOVA)
        v. Building model
        vi. Model Diagnostic
        vii. Empirical results
        viii. Conclusion
    2. Qualitative assessment
        i. Education
        ii. Health
        iii. Employment
        iv. Social activity
        v. Economic activity

6. Evaluating the sustainability of the small scale renewable energy program - 4 countries analysis[6]

[6] It includes Indonesia, Cambodia, Philippines, and Vietnam.

7. Impact assessment of electricity access on people welfare – 4 countries analysis

8. Policy Implications and Recommendation for the ASEAN, addressing key issues including:
    i. Better APG access for the poor
    ii. Ensuring Sustainability of small scale renewable energy
    iii. Strengthening the of renewable energy for economic activity, employment, and environment

E. Tentative time frame 2015 – 2016

Agenda	Activity	Product/Objective	Date and place	Person in charge
I. AEMI Forum I	Discussing research design and expert meeting	Agreement on research methodology	3 - 4 June 2015, Jakarta (1.5 Days)	Maxensius Tri Sambodo
II. Fieldwork I	Each country team conducts fieldwork	Data collection and APG information from Indonesia, Vietnam, and Cambodia	July – August 2015, country level	Collaborators
III. Country report I*	Data analysis	Draft report – country level	1 October 2015	Collaborators
IV. Interim Report*	Synthesizing all country reports	Draft report – 4 countries	December 2015	Indra Overland and Maxensius Tri Sambodo
V. AEMI Forum II	Policy Forum or dialogue	Policy recommendations	March 2016, Jakarta	Indra Overland
VI. Fieldwork II	Each country conducting fieldwork study	Data and information collection	June – July 2016, country level	Collaborators
VII. Country report II*	Data analysis	Draft report – country level	September 2016	Collaborators
VIII. ASEAN Report* II	Synthesizing all country reports	Draft report – 4 countries	November 2016	Indra Overland and Maxensius Tri Sambodo
IX. Final Report*	Report Preparation	Final Report	December 2016	Indra Overland and Maxensius Tri Sambodo

Note: Please refer to Participants – Collaborators; * intellectual property right belong to author/authors

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APPENDIX 1

ASEAN PERSPECTIVES

During the forum discussion, the collaborator from each country needs to provide basic information regarding the rural electrification program as in the example in Box 1.

Box 1
Rural electrification in Vietnam

- National target: Achieve over 99% electrification by 2020 (given in Prime Minister Decision No 2081 QD/TTg on Rural, Mountainous and Island Electrification Program for the Period 2013-2020 (8 November 2013). Specific objectives are:
  - Supply electricity to 57 communes that are currently without electricity
  - Supply electricity to 12 thousand hamlets of these 57 communes
  - Number of households that will be supplied electricity is about 1,290 thousand in these 57 communes.
- Objectives of the first period (2013-2015).
  - Supply electricity to about 140 thousand households in 2,500 hamlets of 40 communes
- Objectives in the second pẻiod (2016-2020)
  - Supply electricity to about 1,126 thousand households in 9,640 hamlets of 17 communes
  - About 21,300 households will be supplied electricity off-grid
- Investment: Total required investment: 28,809 billion dong (1.5 billion USD). Of which 27,328 billion dong for national grid extensions and updrade and 1,481 billion dong for off-grid (renewable energy)
- Key players are Ministry of Industry and Trade, Vietnam Electricity, provincial people's committee, donors such as WB, ADB, KfW, JICA
- Key barriers: financing, technology, etc and possible solutions for rural electrification: financial, technical, institutional, etc
- Roles of RE in rural electrification: small hydropower, solar PV, small wind, etc. There is a project supplying renewable electricity for communes located in remote areas in the following provinces: Tra Vinh, Soc Trang, Lai Chau and Dien Bien. ADB will provide loan of 1,775 billion dong to this project.
- According to the EVN's report (30 Sept 2014), There are only 42 communes having no electricity among 54 communes in early 2013. Of which EVN is responsible for 27 communes and Provincial People's Committees are responsible for 15 communes. More specifically EVN is responsible for 16 communes in Nghe An province and 11 communes in Lai Chau while Provincial People's Committees are responsible for 6 communes in Cao Bang; 4 in Dien Bien and 5 in Quang Nam.

APPENDIX 2

SURVEY

Main Interview Questions

Local-Provincial-Central Government
Agenda for promoting electricity access
Main problem in energy infrastructure
Status of APG, Mini grid and Off Grid
Managing sustainability of electricity supply
Budget in promoting electricity access
The role of renewable energy
Organization on rural electricity development
State Own Electricity Company
Programs on electrification ratio (APG, on grid, mini grid, and off grid)
Investment for energy poor regions
The role of renewable energy (small scale)
Household/Community
Pattern of electricity consumption
Obstacle in electricity access
Expectation on sustainable power supply
Electricity and economic activity
Managing electricity at village level
Ecology impact (waste, pollutions, etc.)
Private Sector
Investment prospect in power sector
Demand conditions
Related industries
Obstacles and expectation

Questionnaire

Location		
1	Province	
2	District/City	
3	Sub-district	
4	Village	

Household			
1	Name	3	Age head of household
2	Number of family member		

Employment Status for Head of Household
1. Number of working day in a week: ……day 2. Number of working hours in a week: …… hour 3. Main employment status... 4. Salary per month from main job.... 5. Side job...

Housing
Status 1. Owner 2. Contract 3. Rent 4. State property 5. Parent property 6. Other
Type of roof
Type of wall
Type of floor
Total area of floor ……… m^2
Source of drinking water
Distance from drinking water to sanitary
Availability of toilet
Source of lighting
Total expenditure for per month for: 1. Electricity 2. Kerosene 3. Fire wood

Asset Ownership		
	2015	**2016**
Any saving in the bank		
Type of saving		
Total amount of saving		
Fixed asset ownership		

Food and Non-Food Expenditure (in the last week)
Food expenditure Non-Food 1. Housing 2. Health 3. Education 4. Transportation 5. Cloths 6. Electronic **7.** Tax

Social Protection Program
1. Cash transfer 2. Free access on health 3. Free access on education 4. Access on micro credit 5. Access to free food 6. Social works 7. Foreign worker (any family member)

Electricity Access
1. Has access on electricity 2. When 3. Type of connection (on grid, mini-grid, off grid) 4. Installation cost 5. Type of monthly payment 6. Distance from house to grid network 7. Type of mini-grid or off-grid 8. Reasons do not access on electricity

Health information
1. Any health problems, how long 2. Does it affect economic activities, how **3.** Any effort to see doctor, how

Education (above 5 years old)
1. The highest education level in the family 2. Access to school, how far and how long 3. Reasons for not go to school 4. Any transportation to the school 5. Any family member cannot write and read 6. Having access on information (newspaper, etc.) **7.** Number of hour for studying (studying at night)

Community Level - Public Facilities Nearby
1. Any school, what level 2. Public health center, how far 3. Grid connection, how far 4. Traditional market, how far 5. Telecommunication network **6.** Public transport

Note:

APPENDIX 3

ECONOMETRIC MODEL

A. Seemingly unrelated regression (SUR)

We developed an econometric model to assess quantitative impact of electricity access to people welfare. We can apply this strategy in the first both for Strategy B and Strategy C. We assume that increasing in welfare can be captured by increasing in household's expenditure both on food and non-food. We developed the model as follows:

$$Y_1 = x_1^{'}\beta_1 + U_1 \quad 1)$$

$$Y_2 = x_2^{'}\beta_2 + U_2 \quad 2)$$

Where Y_1 represents food expenditure and Y_2 represents non-food expenditure (we exclude energy spending from non-food expenditure). We have similar independent variables for the two equations namely: number of family member, number of working hours, total floor area, electricity access (1 for has access; 0 for no access), access to anti-poverty program such as rice, free health service, cash transfer, and other program. We defined electricity access both access through on-grid, off-grid, and mini grid. Because both food and non-food expenditure are connected, the error terms from the two equations are correlated. We can gain more efficient estimators by estimating the two equations jointly. Then we conducted seemingly unrelated regression (SUR).

B. The Fixed Effect Model

In the second year, we conducted the similar survey to the same households that we surveyed in the first year. We can apply this method for Strategy A, B and C. We can apply the Khandker et al (2013) model. We formulated the output on electricity access as follows:

$$Y_{ijt} = \beta^y X_{ijt} + \gamma^y V_{jt} + \delta_h^y E_{Hijt} + \delta_k^y E_{Kijt} + \delta_v^y E_{Vjt} + \chi^y T_t + \varepsilon_{ijt}^y \quad 3)$$

where t indicates time index (0 for baseline-year 2015, and 1 for 2016/17); Y_{ijt} represent output (total real expenditure, we deflated the nominal value by consumer price index) for household i in village j; E_{Hijt} is electricity access – *on grid* (1 if household i in village j has electricity connection and 0 otherwise); E_{Kijt} is electricity access – off grid (1 if household i village j has electricity connection and 0 otherwise); E_{Vjt} is a status of electricity access in the village level *on grid* (1 if village j has connection on grid connection and 0 otherwise); X_{ijt} is the characteristic of household such as number of family member, access on rice for the poor, and floor area; V_{jt} is the village characteristics such as grid network, and T represents time period (2015 and 2016/17); $\beta^y, \gamma^y, \delta_h^y, \delta_k^y$ and δ_v^y are the parameter estimate from equation (1); and ε_{ijt}^y is a *non-systematic error.*

However, there is a problem when we directly estimate the equation (3). The variables E_{Hijt}, H_{Kijt}, E_{Vjt} and Y_{ijt} are simultaneously determined by a group of characteristics both observed and unobserved. For example, decision to have connection on electricity is not only affected by infrastructure condition especially the on grid (V_{jt}), but also by household characteristics (X_{ijt}). For example, poor households do not have capacity to pay connection fee. This is not only because of low of income level but also due to the number of family member. Thus, equation for on grid and off grid connection can be written as follows:

$$E_{Hijt} = \beta^e X_{ijt} + \gamma^e V_{jt} + \chi^e T_t + \varepsilon^e_{ijt} \quad (4)$$

$$E_{Kijt} = \vartheta^f X_{ijt} + \vartheta^f V_{jt} + \chi^f T_t + \varepsilon^f_{ijt} \quad (5)$$

Similarly, the equation at the village level can be presented as follows:

$$E_{vjt} = \gamma^v V_{jt} + \chi^v T_t + \varepsilon^v_{ijt} \quad (6)$$

Thus for the outcome equation, ε^y_{ijt} is represent the combination of three error terms components:

$$\varepsilon^y_{ijt} = \mu^y_j + \eta^y_{ij} + e^y_{ijt} \quad (7)$$

where μ^y_j and η^y_{ij} are represent the unobserved village condition and unobserved household characteristic, in addition e^y_{ijt} is a *non-systematic error* that are not correlated with the two error terms. Further, the error components on equation (4), (5) and (6) can be represented as follows:

$$\varepsilon^e_{ijt} = \mu^e_j + \eta^e_{ij} + e^e_{ijt} \quad (8)$$

$$\varepsilon^f_{ijt} = \mu^f_j + \eta^f_{ij} + e^f_{ijt} \quad (9)$$

$$\varepsilon^v_{jt} = \mu^v_j + e^v_{jt} \quad (10)$$

There is possibility of correlation among $\varepsilon^y_{ijt}, \varepsilon^e_{ijt}, \varepsilon^f_{ijt}$, and e^v_{jt} then the variables $E_{Hijt}, E_{Kijt}, E_{vjt}$ and Y_{ijt} can be correlated due to unobserved factors at village and household level. This can cause an endogeneity problem. This can be happened because *on grid* access can be found in villages that have good access on road and those village will obtain high priority to have electricity access compare to remote and undeveloped villages. Similarly, when a village obtains electricity access, more households have economic opportunity compare to villages without electricity or network connection. Families with better economic opportunity will have more capacity to pay connection and installation fee. The two problems can cause an endogeneity problem and it needs to be solved because it can cause bias on the parameter estimate.

Through the panel data analysis, the endogeneity problem can be solved with the assumption the trend from unobserved (*unobserved heterogeneity*) is fixed during the period of analysis both at household and village level. For one year period of estimation, this assumption may be hold. Thus, the Fixed-Effect Model can eliminate the unobserved heterogeneity. Then the equation 3 can be rewrite as follows :

$$Y_{ij1} - Y_{ij1} = \beta^{y}(X_{ij1} - X_{ij0}) + \gamma^{y}(V_{j1} - V_{j0}) + \delta_h^{y}(E_{Hij1} - E_{Hij0})$$
$$+ \delta_k^{y}(E_{Kij1} - E_{Kij0}) + \delta_v^{y}(E_{Vj1} - E_{Vj0}) + \chi^{y}(T_1 - T_0) + (\varepsilon_{ij1}^{y} - \varepsilon_{ij0}^{y})$$

or

$$\Delta Y_{ij} = \beta^{y}\Delta X_{ij} + \gamma^{y}\Delta V_j + \delta_h^{y}\Delta E_{Hij} + \delta_k^{y}\Delta E_{Kij} + \delta_v^{y}\Delta E_{Vj} + \chi^{y}\Delta T + \Delta\varepsilon_{ij}^{y} \quad (11)$$

Equation (11) will bring unbiased estimates if the *time-invariant heterogeneity* assumption is fulfil. However, the *time-invariant heterogeneity*, assumption may fail for several reasons. For example, the unobserved factors that affect the outcome variable of household and villages may change. For example, the timing on grid connection or installation connection may differs across villages and household. Village in remote area may have some delay on connection due to longer preparation time in transporting the equipment. Further, some households will obtain first priority for electricity connection because they have more financial capacity or they may think that after they obtain electricity their business will grow. Thus, differences in time connection and characteristics of respondents and villages may affect the dynamic of electricity connection and projection of growth. Under the time-variant heterogeneity, condition, the error structure on equation (7) can be written as follows:

$$\varepsilon_{ijt}^{y} = \mu_{jt}^{y} + \eta_{ijt}^{y} + e_{ijt}^{y} \quad (12)$$

Thus equation (11) can be rewritten as follows:

$$\Delta Y_{ij} = \beta^{y}\Delta X_{ij} + \gamma^{y}\Delta V_j + \delta_h^{y}\Delta E_{Hij} + \delta_k^{y}\Delta E_{Kij} + \delta_v^{y}\Delta E_{Vj} + \chi^{y}\Delta T + \Delta\mu_{ij}^{y} + \Delta\eta_{ij} + \Delta e_{ij}^{y} \quad (13)$$

where $\Delta\varepsilon_{ij}^{y} = \Delta\mu_{ij}^{y} + \Delta\eta_{ij}^{y} + \Delta e_{ij}^{y}$ will have correlation with electricity access. Under that situation, the OLS's estimate will be inconsistent. In order to measure the problem, researcher can think the correlation between unobserved heterogeneity and the initial conditions of household, village and its characteristics. The initial characteristic of village will affect the village in obtaining electricity access and those characteristics will give different responses for each household. Thus, equation 13 can be rewrite as follows:

$$\Delta Y_{ij} = \beta^{y}\Delta X_{ij} + \gamma^{y}\Delta V_j + \delta_h^{y}\Delta E_{Hij} + \delta_k^{y}\Delta E_{Kij} + \delta_v^{y}\Delta E_{Vj} + \alpha_h^{y}X_{ij0} + \alpha_v^{y}V_{j0} + \chi^{y}\Delta T + \Delta\varepsilon_{ij}^{y} \quad (14)$$

In conclusion equation (14) will give an unbiased estimate.