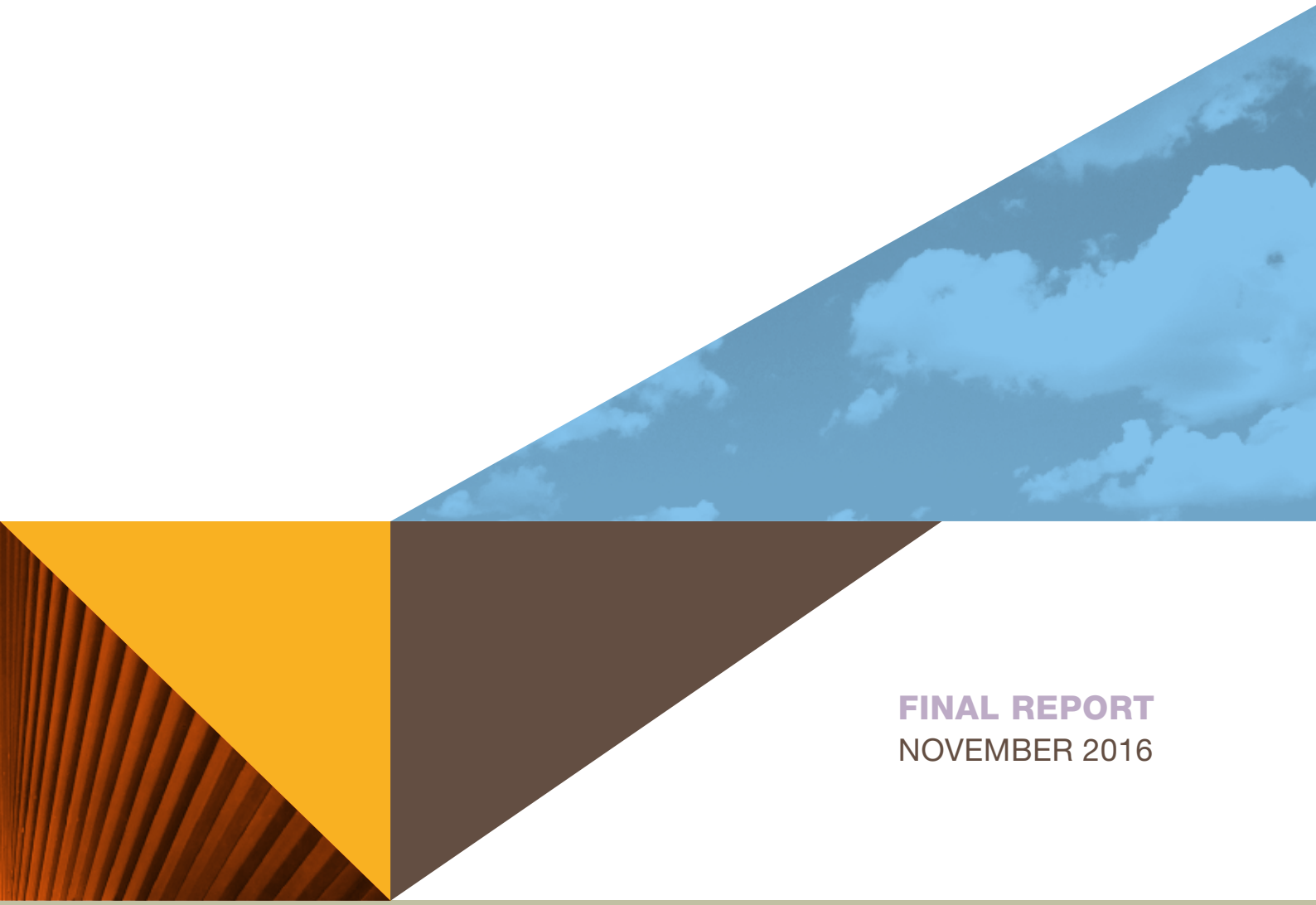
SCOPING STUDY ON INTRA-ASEAN VALUE CHAIN COOPERATION AND TRADE IN ENERGY EFFICIENCY AND RENEWABLE ENERGY TECHNOLOGIES



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Scoping Study on Intra-ASEAN Value Chain Cooperation and Trade in Energy Efficiency and Renewable Energy Technologies

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LIST OF ABBREVIATIONS

AC	Air Conditioners
ACE	ASEAN Centre for Energy
ADAS	One-Year Accelerated Depreciation Allowance for Energy Efficient Equipment and Technology
AEC	ASEAN Economic Community
AEDP	Alternative Energy Development Plan
AEM	ASEAN Economic Ministers
AFD	Agence Française de Développement (French Development Agency)
AFTA	ASEAN Free Trade Area
AGITA	ASEAN Trade in Goods Agreement
AMEM	ASEAN Ministers on Energy Meeting
APAEC	ASEAN Plan of Action for Energy Cooperation
ASEAN	The Association of Southeast Asian Nations
ASEAN SHINE	ASEAN Standards Harmonization Initiative for Energy Efficiency
ATIGA	ASEAN Trade in Goods Agreement
B2B	Business to Business
BAT	Best Available Technology
BoS	Balance of System
BPC	Berakas Power Company
BSRIA	Building Services Research and Information Association
BTU	British Thermal Unit
CFL	Compact Fluorescent Lamp
CLASP	The Centre for Law and Social Policy
COP	Coefficient of Performance
CTESS	Committee Trade on Environment “Special Sessions”
DC	Direct Current
DEDE	Department of Alternative Energy Development and Efficiency
DES	Department of Electrical Services
EASe	Energy Efficiency Improvement Assistance Scheme
ECA	Energy Conservation Act
EE	Energy Efficiency
EE&C	Energy Efficiency and Conservation
EEF	Energy Efficiency Factor
EER	Energy Efficiency Ratio
EG	Environmental Goods
EGA	Environmental Goods Agreement

LIST OF ABBREVIATIONS

EGS	Environmental Goods and Services
ESCO	Energy Services Company
EU	European Union
EVA	Ethylene Vinyl Acetate
EVN	Electricity Vietnam
FITs	Feed in Tariffs
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GREET	Grant for Energy Efficiency Technologies
GW	Gigawatt
HS	Harmonized System
HVAC	Heating Ventilating and Air Conditioning
ICA	International Copper Alliance
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IIEC	International Institute for Energy Conservation
IPP	Independent Power Producer
ISO	International Organization for Standardization
ITC	International Trade Centre
KeTTHA	Kementerian Tenaga, Teknologi Hijau dan Air/ (Ministry of Energy, Green Technology and Water)
LBNL	Lawrence Berkeley National Laboratory
LED	Light Emitting Diode
MEPS	Minimum Energy Performance Standards
MFN	Most Favoured Nation
MOIT	Ministry of Industry and Trade
NAFTA	North American Free Trade Agreement
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturers
PAMS	Policy Analysis Modelling System
PDP	Power Development Plan
PDR	People's Democratic Republic
PM	Prime Minister
PV	Photovoltaic

LIST OF ABBREVIATIONS

R&D	Research and Development
RAC	Room Air Conditioners
RE	Renewable Energy
REDS	Renewable Energy Development Strategy
RPS	Renewable Portfolio Standard
SCEM	Singapore Certified Energy Manager
SHINE	Standards Harmonisation Initiative for Energy Efficiency
SOME	Senior Official Meeting of Energy
SWH	Solar Water Heater
T&D	Transmission and Distribution
U4E	United for Efficiency
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
VAT	Value Added Tax
WCO	World Custom Organization
WTO	World Trade Organization

LIST OF EXHIBITS

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EXECUTIVE SUMMARY

ASEAN Member States have been very active in promoting Energy Efficiency (EE) and Renewable Energy (RE) technologies in order to fulfil their global commitment on climate change. In the ASEAN Plan for Action for Energy Cooperation 2016-2025 (APAEC), Energy Efficiency and Renewable Energy are key program areas to be addressed. In this vein, examples of actions include feed-in tariffs (notably in Thailand and Malaysia) and the liberalization of the electricity market. In relation to energy efficiency, ASEAN countries are progressively adopting Minimum Energy Performance Standards (MEPS) with energy efficiency standard and labelling programs.

ASEAN countries coordinate their energy policies through the ASEAN Energy Efficiency & Conservation (EE&C) and Renewable Energy (RE) Sub-Sector Networks (SSN), which are composed of government focal points, as well as representatives from the Senior Officials Meeting on Energy (SOME) and the ASEAN Ministers on Energy Meeting (AMEM).
Under the broader umbrella of the ASEAN SHINE program, a scoping study was initiated to foster greater understanding among ASEAN policy makers (ministries in charge of energy and ministries in charge of trade and commerce) on the benefits of increasing intra-ASEAN value chain cooperation and trade in the field of EE and RE technologies, and to build related regional capacities.

This study closely reviewed existing intra-ASEAN trade in selected EE and RE technologies (air conditioners, refrigerators, lighting, distribution transformers, electric motors, solar PV and solar thermal), and identified the potential to further enhance intra-ASEAN supply chain integration for these technologies. Key findings of this scoping study are delineated as follows:

ENERGY EFFICIENCY: AIR CONDITIONERS – REFRIGERATORS – ELECTRIC MOTORS – DISTRIBUTION TRANSFORMERS

Performance testing standards

Exhibit ES 1 provides an overview of the energy performance testing standards applied in ASEAN for selected technologies (see next page). With regards to air conditioners, all ASEAN countries have agreed to the gradual adoption of ISO 5151 2010 as the common testing standard, by 2020, with the support of ASEAN SHINE [1] program.

For refrigerators, the international standards for energy performance testing methods applied in most ASEAN countries (Philippines, Indonesia, Malaysia, and Singapore) is IEC 62552 and Vietnam is currently working towards aligning its national standard to IEC 62552. Adoption of IEC 62552 as the common testing standard in ASEAN countries is the way forward towards harmonization.

[1] ASEAN SHINE is an initiative funded by European Union's Switch Asia program; it aims at increasing the market share of higher efficient air conditioners in ASEAN through harmonization of test methods and energy efficiency standards, adoption of common Minimum Energy Performance Standards, and changing consumer purchasing attitudes in favour of energy efficient air-conditioners.

National standards for energy performance testing methods for AC induction motors in ASEAN countries are found in Indonesia, Malaysia, Thailand and Vietnam, with these countries moving towards aligning with the IEC 60034-2. Detailed gaps analyses between IEC 60034-2 and existing national standards would be useful, to help prepare detailed roadmaps for harmonization in ASEAN.

Current application of testing method IEC 60076-1 for distribution transformers in ASEAN is mostly implemented to meet the electric utilities requirement, rather than to enforce measuring energy performance to promote energy efficiency at national level.

Exhibit ES 1. Summary of Applied Performance Testing Standards for Selected Technologies in ASEAN

Country	National Energy Performance Testing Standards			
	Air Conditioners	Refrigerators	Distribution Transformers	Electric Motors
Brunei Darussalam	Under development	N/A	N/A	N/A
Cambodia	N/A	N/A	N/A	N/A
Lao PDR	N/A	N/A	N/A	N/A
Indonesia	Aligned to ISO 5151	Aligned with 62552-3:2007 (Reference to IEC 62552-2: 2015 is currently available under SNI 62552-2-2016)	SPLN D3.002-1 : 2007 (Aligned with IEC 60076-1) (electric utilities)	SNI IEC 60034-2-1:2014 (in line with IEC 60034-2)
Malaysia	Aligned to ISO 5151 (old version)	MS IEC 62552-3:2016 (aligned with IEC 62552-3:2015)	IEC 60076-1 (electric utilities)	Aligned to IEC 60034-2
Myanmar	N/A	N/A	N/A	N/A
Philippines	- Aligned to ISO 5151-PNS ISO 5151:2014 - PNS ISO 16358-1:2014	Aligned with 62552-3:2015: DPNS 62552-3:2016	PNS IEC 60076-1:2002	PNS IEC 60034-2-2:2016
Singapore	Aligned to ISO 5151	Aligned with 62552-3:2007	IEC 60076-1 (for electric utilities)	N/A
Thailand	Aligned to ISO 5151 (old version)	TIS 455-2537 and TIS 2186-2547	IEC 60076-1 (for electric utilities), and TIS384-2453	TIS 867-2550-2007 (aligned with IEC 60034-2)
Vietnam	Aligned to ISO 5151 (old version)	TCVN 7829:2016 (on going) – in line with with IEC 62552 (1/2/3)	TCVN 6301-1: 2015 in line with IEC 60076-1: 2011	TCVN 6627-2-1:2010 in line with IEC 60034-2-1 (2007)

Minimum Energy Performance Standards (MEPS)

The MEPS for air conditioners are mandatory in Indonesia, Malaysia, Singapore, Thailand and Vietnam, illustrating that these five countries are far ahead of the other ASEAN members.

Regarding refrigerators, there are two methods for setting energy performance affecting MEPS. Discrepancies in methods to define energy performance are found in applying the Energy Efficiency Factor (EEF), used in Malaysia and the Philippines, and in the linear energy consumption estimation, based on adjusted capacity in Singapore, Thailand and Vietnam. Analysis of the discrepancy between the two methods would help to formulate a common standard method in order to pave the way towards reaching a regional MEPS.

Only Vietnam has MEPS for electric motors and distribution transformers. In Malaysia and Thailand, efforts towards promoting EE for electric motors have been initiated through Voluntary Energy Efficiency Performance Standard Program.

Labelling

Exhibit E.S 3 provides an overview of the status of labelling programs for the selected technologies in ASEAN. The labelling programs in Malaysia, Singapore, Thailand and Vietnam for energy efficiency appliances and equipment follow a five stars / ticks rating system while Indonesia is developing its labelling program based on four star rating system. In these countries, a higher number of stars / ticks represents higher performance. However, the methods for assigning the rating and requirements on labels vary between countries. Currently, no process for a regional label has been considered.

Exhibit ES 2. MEPS for Selected Technologies in ASEAN

Country	MEPS			
	Air Conditioners	Refrigerators	Distribution Transformers	Electric Motors
Brunei Darussalam	Under development	None	None	None
Cambodia	None	None	None	None
Lao PDR	None	under development	None	None
Indonesia	mandatory	Under development	None	None
Malaysia	Mandatory	Mandatory	None	Voluntary Energy Efficiency Standards
Myanmar	Mandatory	None	None	None
Philippines	Mandatory	None	None	None
Singapore	Mandatory	Mandatory	None	None
Thailand	Mandatory	Mandatory	None	Voluntary Energy efficiency Standards
Vietnam	Mandatory	Mandatory	Mandatory	Mandatory

Exhibit ES 3. Labelling Programs for Selected Technologies in ASEAN

Country	Labeling			
	Air Conditioners	Refrigerators	Distribution Transformers	Electric Motors
Brunei Darussalam	Under consideration for development - voluntary - comparative	None	None	None
Cambodia	None	None	None	None
Lao PDR	None	None	None	None
Indonesia	Under development - 1-4 stars - voluntary	Under development - voluntary - 1-4 rating	None	Under development - voluntary - 1-4 rating
Malaysia	Voluntary - endorsement	Mandatory 1-5 star rating	None	None
Myanmar	None	None	None	None
Philippines	Comparative label is mandatory	Mandatory 1-5 rating, pending implementation	None	None

Country	Labeling			
	Air Conditioners	Refrigerators	Distribution Transformers	Electric Motors
Singapore	Mandatory, comparative label, 1-5 tick rating	Mandatory 1-4 tick rating	None	None
Thailand	Voluntary-comparative label	Voluntary - comparative 1-5 star rating	None	endorsement label - voluntary
Vietnam	Comparative Label is mandatory, endorsement label is voluntary	Mandatory - comparative label	Mandatory - endorsement	Mandatory - endorsement

MEPS for Lighting

Standards harmonization and development of regional targets for MEPS is underway as part of the ASEAN SHINE Lighting Chapter. Priority is being given to non-directional LED and linear fluorescent lamps. This selection was made for the following reasons:

- Linear fluorescent lamps command a large market share with stable annual sales across the ASEAN region. There are significant differences in MEPS levels across ASEAN countries, providing a significant opportunity for harmonization.
- LED lamps have a small but fast growing market share across the ASEAN region and there are only two countries (Malaysia and Singapore) with existing MEPS while in three countries (Indonesia, Philippines and Thailand) they are under consideration. LED lamps in today's market will tend to have higher efficiency levels than those required by these regulations. This aspect of LED technology therefore presents the ASEAN Member States with an opportunity to establish a near-term efficiency requirement that is higher and could be harmonized across the region (Coyne, et.al., 2016).

RENEWABLE ENERGY TECHNOLOGIES: SOLAR PV AND SOLAR THERMAL

The solar PV market is growing within ASEAN countries, especially with rooftop installations. Standards that are currently adopted in ASEAN are mostly related to connecting the solar PV system to the grid, the Balance of System (BoS) and safety of installations. No standards have been adopted regarding the performance of the module/cell itself. The standards for energy performance of modules/cells will be more important in the future when solar PV is already produced at economies of scale within the region; at present they are still heavily imported. It is therefore recommended for all ASEAN countries to adopt safety standards and to develop and adopt standards on the performance of the system.

Regarding solar thermal, despite indication of growing interest for this technology throughout the region, there are neither reliable official figures on the number of solar thermal units installed in each ASEAN country, nor information on energy performance standards, with the exception of Thailand and the Philippines. Thailand has adopted a proactive policy to support solar thermal applications in industry and buildings. It is recommended to organize consultation

among ASEAN countries, to share experiences, and to develop action plans to support the dissemination of this technology in industry and buildings.

FOSTERING INTRA-ASEAN TRADE ON EE AND RE TECHNOLOGIES

The difficulty of evaluating trade in energy efficiency and renewable energy products

The 6-digit HS code does not differentiate EE and non-EE products: The analysis of trade-flow provides only a single trade value (in US$ thousand) that includes both EE and non-EE products classified under a single 6-digit HS Code. Thus, if there is no performance standard as defined by regulation, all products are treated the same for import purposes (e.g. no differentiation of energy-efficient vs. non-efficient by HS code for tariffs). The World Trade Organization (WTO) assesses products to be “like” under Article XX of the GATT. Only if products are regarded as sufficiently different can they be justifiably regarded as “unlike” and differentiated on environmental (or ethical or other) grounds. We recommend that a standard or a “classification” to distinguish energy efficiency technologies (as well as components of renewable energy technologies) should be introduced to support intra-regional trade. In terms of recognizing EE and RE products, there is no regional labelling yet in place that distinguishes EE/ RE products. Having such regional labels in place would not only facilitate and further simplify intra-ASEAN trade of such technologies, but would also encourage access to EE/ RE technologies which are not yet available in the ASEAN market.

Absence of tariff barriers

With regards to tariffs for the technologies covered in this study, the preferential rate in ASEAN under ATIGA is to apply mostly “tariff free” rates for all products. Hence tariffs are no longer a significant barrier for intra-ASEAN trade. However, for products that are mostly imported from outside ASEAN countries, such as highly efficient electric motors, tariffs still play a role. In this case, Singapore as the main trading hub in ASEAN could play a role as a facilitator for intra-ASEAN trade, as the country has the lowest average MFN tariff, with most tariffs for these products set to zero. The Environmental Goods Agreement (EGA) offers little prospect of accelerating market transformation in favour of the aforementioned EE and RE technologies in ASEAN because intra-ASEAN tariffs are generally equal or close to zero. Specific opportunities should be investigated on a country-by-country basis rather than on a regional basis, particularly regarding the benefit of the EGA with respect to enhancing ASEAN trade with other countries or economic regions.

Non-tariff barriers

In this study, possible non-tariff barriers are explored through a review of trade policies and existing energy efficiency and renewable policies related to promotion of EE and RE in each ASEAN member countries .

In terms of trade policy and regulations, all ASEAN member countries have an applied e-custom system, which facilitates trade and imports in general. The average time from customs declaration to customs clearance varies from ten minutes to a maximum of three days, and there is no restriction/ prohibition seen for EE and RE technologies. Limitations on

investment in RE investments and local content requirements are only observed in Indonesia, Malaysia and Myanmar.

In terms of EE and RE policy, the six leading ASEAN countries have set EE and RE targets in their national energy policies, however, the key non-tariff barriers for EE and RE market transformation lie with different standards, which increases the cost of compliance for manufacturers/exporters.

CASE STUDY OF SOLAR PV IN VIETNAM

A case study in Vietnam on solar PV development analyzed non-tariff barriers, including trade aspects, that impede the adoption of solar PV technology. The key findings from the case study show that the development of solar PV projects has not fully matured in Vietnam due to several regions: technology barriers; policies and institutional barriers; issues with economic and financial resources; and lack of adequate data and information.

Technological Barriers: Solar PV is mostly imported, with a large number of solar PV panels and components coming from China. A significant share of components is imported from Korea and some European countries, where quality is higher, while costs remain reasonable. A limited number of local companies and research institutions are active in the solar PV industry. The infrastructure of the power sector has not yet developed to meet the requirements of solar PV integration; e.g., infrastructure for rooftop net metering is not yet available.

Policy and Institutional Barriers: The supportive policy framework for solar PV is limited. The only policies that can be applied for solar PV development are the Renewable Energy Development Strategy (REDS) and the Power Development Plan (PDP) VII-revised, though there are no related action plans. The underdevelopment of the policy framework, as well as the lack of support mechanisms cast doubt on the government's commitment to support solar PV development.

Economic and Financial Resource Issues: The financial support for solar PV development principally depends on the state budget through subsidies and/or feed-in tariffs. A more comprehensive approach to creating an enabling market environment is missing: support to local designers and installers in terms of capacity building and certification, active promotional campaign, building code, product standards, appropriate local financing instruments, etc. In addition, investors face obstacles to mobilize finance and procure loans from banks, especially in explaining and presenting project cash flows for mobilizing capital.

Lack of Adequate Data and Information: A comprehensive geospatial map of Vietnam's solar resources has not yet been published and the master plan for Vietnam's solar PV development has not yet been created. With insufficient policy support mechanisms for solar PV projects and no master plan for solar PV development, solar PV developers and investors have little understanding of investment procedures, having to guess their way through many procedural steps in an attempt to obtain permissions such as investment certificates, construction permits, electricity operation licenses, etc.

CONCLUSIONS AND RECOMMENDATIONS

Based on the review of tariff and non-tariff barriers, the interest of ASEAN countries, such as Thailand, Malaysia, or Vietnam, in participating in the EGA negotiations, can be better understood from a global perspective, rather than from a regional one, since the preferential tariffs in ASEAN allow zero or very low tariffs for most products, including the aforementioned EE and RE technologies.

In parallel, at the ASEAN level, the development of regional trade in EE and RE technologies is still highly dependent on the national regulations and policy frameworks of the six largest ASEAN countries, namely Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam. In that regards, a lack of harmonization is notably observed regarding energy performance testing methods, MEPS and labelling:

- MEPS and labelling requirements for selected technologies vary greatly across the region;
- Moreover, there is a lack of clear enforcement mechanism or framework for the standards and labelling (electric motors, lighting, refrigerators and distribution transformers), even for countries that have developed and implemented MEPS;
- Across the technologies studied, labelling is still in initial stages, including for the six largest ASEAN countries.

As a result, there is limited potential for mutual recognition of the energy performance when technologies are traded between countries. Such lack of mutual recognition directly impacts the potential for increasing intra-ASEAN trade in energy efficiency technologies.

In parallel, two generic strategies have high potential for supporting trade and facilitating the deployment of energy efficiency and renewable energy technologies in the region. The harmonization of standards, in particular the standards for energy performance testing methods, would provide a tangible way forward for ASEAN governments to facilitate intra-ASEAN integration in EE technologies. At present, not all ASEAN countries are referencing their national standards to the relevant international standard. However, the alignment of national standards to an international standard has already been achieved for air conditioners, where the reference used is ISO 5151:2010, paving the way for harmonization of standards for other products.

01

INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

1.1.1 Background

Intra-ASEAN Trade on Energy Efficiency and Renewable Energy Technologies

ASEAN has evolved into one of the world's most dynamic regions with accelerated economic performance in recent years, and that growth is attributed to economic co-operation and integration initiatives that have taken concrete shape within ASEAN during the past two decades. Gross Domestic Product (GDP) in the region has nearly doubled from 2007 to the present, with a combined GDP of over US$2.5 trillion, while average GDP per capita grew by almost 80% to over US$4,000 (The ASEAN Secretariat, 2015). These trends are largely attributable to regional integration, while ASEAN also became more influential, with widening markets regionally and globally. Apart from the ASEAN Preferential Trade Agreement signed in 1977, most regional economic integration initiatives have taken place since the 1990s.

In 1992 the ASEAN Heads of State and Government decided to establish an ASEAN Free Trade Area (AFTA). The objective of AFTA was to increase the ASEAN region's competitive advantage as a production base geared for the world market. A vital step in this direction is the liberalization of trade through the elimination of tariff and non-tariff barriers among ASEAN members. The expansion of intra-ASEAN trade is expected to offer wider choices and better quality consumer products to ASEAN consumers, at competitive prices. To date, ASEAN has taken great steps in introducing the ASEAN Trade in Goods Agreement, where most tariffs for all goods in the region are geared toward zero tariffs, but there is still much work to be done to unlock non-tariff barriers. Initiatives and ideas for further enhancement of economic and trade cooperation are regularly raised and discussed in annual ASEAN Economic (AEM) Minister Meetings. In 2015, ASEAN members formed the ASEAN Economic Community (AEC), marking the formal establishment of an integrated economic region.

ASEAN countries have been very active in promoting Energy Efficiency (EE) and Renewable Energy (RE) technologies in order to fulfil their global commitment on climate change. For example, feed-in tariffs (notably in Thailand, Philippines and Malaysia) and the liberalization of electricity markets have greatly contributed to an increased share of renewable energy in the regional energy mix. In energy efficiency, countries are progressively adopting Mandatory Energy Performance Standards (MEPS) with energy efficiency standard and labelling programs. Thailand has made considerable progress in terms of uptake of more efficient household appliances. Energy Efficiency and Renewable Energy are also key program areas in the ASEAN Plan for Action for Energy Cooperation 2016-2025 (APAEC). Thus, ASEAN member countries coordinate their energy policies through the ASEAN Energy Efficiency & Conservation (EE&C) and Renewable Energy (RE) Sub-Sector Networks (SSN), which are composed of government focal points, as well as the Senior Officials Meeting on Energy (SOME) and ASEAN Ministers on Energy Meeting (AMEM).

Linking the initiative to enhance intra-ASEAN trade and climate change mitigation actions, there is a potential to implement actions to integrate value chains of EE and RE technologies, through cooperation and trade among ASEAN members. This study will look closely at the existing intra-ASEAN trade in selected EE and RE technologies, identifying the potential to further enhance the intra-ASEAN supply chain integration for these technologies.

Trade of Environmental Goods and Services: Global Perspective

Environmental goods and services (EGS) can be broadly defined as consisting of activities 'that produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air, soil, as well as problems related to waste, noise and ecosystems' (UNCTAD, OECD, 1999). EGS play an important part in supporting economic development towards green economy. Energy efficiency and renewable energy technologies are a sub-set of EGS, due to vested benefits in GHG emissions mitigation.

In light of the Sustainable Development Goals, the Paris Agreement on Climate Change and the wider 2030 Sustainable Development Agenda, there is policy momentum for facilitating trade in EGS. In 2009, a group called "Friends of EG" among WTO members, which consist of several APEC economies (Canada, Chinese Taipei, Japan, New Zealand and the US), European Communities, Norway and Switzerland, submitted a list of environmental goods to the WTO Committee Trade on Environment "Special Sessions" (CTESS) negotiation meeting for "liberalisation" (elimination of duties) of these environmental goods.

Then, at the APEC Economic Leader Meeting in 2012, leaders endorsed a list of 54 environmental goods and agreed to reduce applied tariff rates on these environmental goods to five per cent or less by the end of 2015. They did this taking into account members' economic circumstances, and without prejudice to APEC economies' positions in the World Trade Organization (WTO). The list was based on the environmental goods submitted by the Friends of EG to WTO CTESS in 2009.

The endorsement of the APEC list of Environmental Goods laid the foundation for the Environmental Goods Agreement (EGA). However, as a regional 'political' commitment, this endorsement was not negotiated in the WTO and it excluded certain WTO key players, in particular the European Union (EU), which has long been a supporter of EG liberalisation through the WTO. Hence in July 2014, WTO Members - the "Friends of EG" who had collectively proposed the list of goods in 2009 - launched negotiations on a global EGA.

So far, eight rounds of EGA negotiations[2] have allowed nomination of 340 products in ten environmental categories. With the exception of Singapore, no ASEAN country has yet joined the EGA negotiations. Therefore, the potential of ASEAN countries joining the EGA negotiations is one of the significant areas to be addressed in this study.

1.1.2 Objectives

Under the broader umbrella of the ASEAN SHINE[3] program, the project aims to conduct an analysis of the potential for increasing intra-ASEAN value-chain cooperation and trade in the field of energy efficiency and renewable energy technologies, by identifying and documenting the benefits for ASEAN countries of intra-ASEAN value- chain cooperation and trade for selected EE and RE technologies.

[2] WTO members currently participating in these negotiations are Australia, Canada, China, Costa Rica, the European Union, Hong-Kong, Iceland, Israel, Japan, Korea, New Zealand, Norway, Singapore, Switzerland, Chinese Taipei, Turkey and the United States.

[3] Funded under the EU SWITCH-Asia affiliated program, ASEAN SHINE aims at increasing the market share of more efficient air-conditioners in ASEAN, through harmonization of test methods and energy efficiency standards, adoption of common Minimum Energy Performance Standards, and changing consumer purchasing attitudes to favour energy efficient air-conditioners.

More specifically, this study assesses opportunities for intra-ASEAN value chain cooperation and trade in seven selected clean energy technologies, in order to enhance uptake and transfer of EE and RE technologies in and between ASEAN countries.

Ultimately, this study aims to foster greater understanding among relevant ASEAN policy makers (the ministries in charge of energy, and of trade and commerce) on the benefits of increasing intra-ASEAN value chain cooperation and trade in the field of EE and RE technologies, and to encourage building of related regional capacities.

1.1.3 Selected Technologies

The selected Energy Efficiency (EE) and Renewable Energy (RE) technologies this study focuses on are: electric motors, distribution transformers, room air conditioners (RAC), refrigerators for household application, lighting, solar PV for generation, and solar thermal for water heating. These technologies were selected on the following basis:

- Electricity consumption: Electricity usage in residential and industrial sectors contributes significant energy consumption in ASEAN Countries. For example, air conditioners, refrigerators and lighting contribute to more than 50% of electricity usage in the residential sector, while electric motors contribute to about 65% of electricity consumption in the industrial sector (UNEP, 2014).
- Potential for energy savings: air conditioners, motors, refrigerators, lighting and transformers hold an important potential for energy saving in ASEAN countries, which is translated into potential reduction of GHG emissions (notably CO2) due to electricity savings.
- Policy priorities: The ASEAN Plan of Action for Energy Cooperation (APAEC) includes harmonization and promotion of energy efficiency standards and labelling on various kinds of energy-related products, and the prioritized focus includes room air conditioning and lighting.
- Projected growth: It is expected that by 2035, installed capacity of solar PV technologies in ASEAN will reach 9.9 GW, contributing to 6.6% of total renewable installed capacity in ASEAN Countries [ASEAN Centre for Energy (ACE), 2015]. Moreover, price decreases in solar PV technology have made the implementation of this technology more affordable in developing countries within ASEAN.

1.2 METHODOLOGY

1.2.1 Analysis Approach

The approach taken by this study has focused on analysis of several key aspects:

1. **Harmonization of Performance Testing Standards, Minimum Energy Performance Standards (MEPS) and Labelling:** tto facilitate trading in the selected technologies mentioned in section 1.1.3, it is important to harmonize standards among ASEAN Countries. In line with the ASEAN Plan for Action in Energy Cooperation 2016-2025, - and in the context of both trade, and of enhancing energy efficient measures and utilization of clean energy - it is important to promote cooperation among ASEAN member countries towards utilization of International Standards. For the energy efficiency technologies (room air conditioners, refrigerators, electric motors and distribution transformers) the focus is on moving the national standards for performance testing methods, MEPS and labelling towards the relevant international standard.

Currently standards regimes are not uniform among ASEAN member countries, which creates potential hurdles for intra-ASEAN trade flows. For example, if one country ("A") in ASEAN has a more stringent MEPS level for a room air conditioner, the room air conditioner exported to that country from another ASEAN country ("B") must comply with the MEPS in the importing country. Thus, a country that manufactures room air conditioners with MEPS less than the prevailing MEPS will not able to export its products to country "A".

On occasion, standards may be designed to protect domestic producers in addition to, or instead of, pursuing legitimate public policy objectives. The establishment of international standards for environmental goods, free of protectionist objectives, could provide a neutral process for eliminating trade-distorting effects of certain national or regional technical standards.

In light of the above, the following activities were conducted to assist in analysis of harmonization of standards:

a. Review of standards on performance testing methods, MEPS and labelling: the review was conducted to see if national standards for performance testing methods and MEPS are available in each ASEAN member country, and if they exist, whether they refer to the international standard;

b. Review of the existing labelling program in each ASEAN member country;

c. Regional analysis to identify the trend and gap towards the internationally acceptance standards, for performance testing methods and MEPS;

d. Identification of existing barriers to implement MEPS, performance testing standards and labelling, and assessment of how these barriers influence the intra-ASEAN economic integration;

e. Identification of potential energy saving that could be achieved by 2025 and 2030 for selected EE technologies, based on analysis conducted in the U4E[4] program. The analysis of potential energy saving uses CLASP's[5] and LBNL's[6] Policy Analysis Modelling System (PAMS) to forecast the impacts that would occur from implementation of policies that improve the energy efficiency of new household air conditioners and refrigerators. For electric motors and distribution transformers, individual models were developed, taking into account country level data, expected GDP growth, and industrialization levels.

4 United for Efficiency, http://united4efficiency.org

5 CLASP is a leading international resource and voice for energy efficiency standards and labels for appliances, lighting and equipment, http://clasp.ngo/

6 LBNL: Lawrence Berkeley National Laboratory

2. **Analysis of national policy/ regulations on EE and RE with relevance for intra-ASEAN trade integration:** The market growth for affordable EE and RE technologies is dependent on the existing policies and regulations that would either boost or impede the market, creating either advantages or barriers to trade. For example, some countries have implemented policies and regulations to provide financial incentives for the private sector to apply EE and RE technologies, while in other countries such financial incentives for EE and RE technologies are not in place, despite the need for such technologies in those countries.

   Hence, the analysis of national policies/regulation relevant to intra-ASEAN trade integration was conducted, specifically through the following:

   a. A review of policy and regulatory frameworks that promote EE and RE in ASEAN countries. This included a review of existing policies and regulations in each ASEAN country that; promote energy saving and conservation for all sectors, utilize renewable energy resources for power generation, determine national MEPS and the labelling, regulate preferential feed-in-tariff for electricity sales generated nationally by renewable energy resources, and offer any financial incentives and/ or fiscal instruments.
   b. An analysis of the positive and negative impacts of the above policies and regulations, as regards trade flows in selected technologies mentioned in section 1.1.3. Hence, how does the policy / regulation impact intra-ASEAN trade for selected technologies?

3. **Value Chain analysis on supply and demand side in the context of intra-ASEAN trade:** While looking at the benefit of intra-ASEAN cooperation in trade, one important aspect is the identification of potential value chain integration of EE and RE technologies in ASEAN member countries. As an example, country “A” in ASEAN may produce an inverter required in country “B” while country “B” does not have any local inverter manufacturers and intends to develop a domestic solar PV power market. In this case, there is potential for supply chain integration of the solar PV industry between country “A” and country “B”.

   Hence, the value chain analysis conducted covered the following activities:

   a. Illustration of value chain for selected EE and RE technologies describes key components and products (supply side) and application (demand side).
   b. Identification of the six-digit Harmonization Code (HS) of the product and key components for selected EE/ RE technologies; this 6-digit HS code is provided in the scope and limitations section of the Study. Further background information on the definition and application of HS code is provided in Exhibit 1.2.
   c. Market analysis of the selected EE and RE technologies in ASEAN countries with particular emphasis on the demand side (the application).
   d. Analysis of trade flow: The trade flow analysis was based on export data of each six-digit HS Code for selected EE and RE technologies where manufacturing sectors in several ASEAN countries are supplying the other ASEAN countries.

When selected EE and RE manufacturing sectors were not available within ASEAN, the import data was not taken into account.

e. Identification of existing trade flows, suggesting the available intra-ASEAN sourcing and market of EE and RE technologies, to show the potential of supply chain integration of these technologies in the ASEAN region.

Exhibit 1.1
Harmonization Commodity Description and Coding System (HS Code)

The HS Code is an internationally standardized system for classifying traded products. The World Custom Organization (WCO) developed the HS Code. At the international level, the Harmonized System (HS) for classifying goods is a six-digit code system, recorded in 99 chapters, grouped in 21 sections.

- The first two digits (HS-2, or two-digit HS code) identify the chapter in which goods are classified, e.g. 84 = "Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof"
- The next two digits (HS-4, or 4-digits HS Code) identify groupings within that chapter, 8415 = "Air conditioning machines, comprising a motor-driven fan and elements for changing the temperature and humidity, including those machines in which the humidity cannot be separately regulated"
- The next two digits (HS-6, or six-digit HS code) are even more specific, e.g. 8415.10 "Window or wall types, self-contained or split-system"
- Up to the HS-6 digit level, all countries classify products in the same way.

Global trade statistics are available only at the six-digit level and can be found in

COMTRADE and the ITC Trade Map. The analysis in this scoping study was based on information taken from the ITC Trade Map, which bases its information on COMTRADE. This study also focused on 6-digit HS Code because this is internationally harmonized, and facilitates the analysis among ASEAN member countries. National tariff schedules include tariff lines that extend beyond the 6-digit HS code and these are not internationally harmonized. Tariff line codes and corresponding product descriptions can therefore differ from one country to another.

Source: www.wcoomd.org, www.wto.org

4. **Barriers to Trade: Tariff and Non-Tariff Barriers:** in order to formulate further steps to enhance intra-ASEAN value chain integration, existing tariff and non-tariff barriers for these technologies must also be assessed.

   Tariff barriers: To provide an analysis of tariff barriers, the following activities were conducted:

   a. Review of tariffs applied in the trade flow analysis in ASEAN countries of the selected EE and RE technologies, based on six-digit HS code. The information on the prevailing tariff was taken from the ITC trade map, where the tariffs are

aggregated using simple averages of the underlying tariffs applied at the national tariff line.

b. Review of proposed commitment to preferential tariff [7] in ASEAN countries for selected RE and EE technologies, particularly in the ASEAN Trade in Goods Agreement (AGITA). This review was also based on six-digit HS code.

c. Review of the tariff-data of HS six-digit selected EE and RE Technologies from the World Trade Organization (WTO) website from Most-Favored Nation (MFN) countries. MFN tariffs are tariffs that countries promise to impose on imports from other members of the WTO. In practice, MFN rates are the most restrictive rates that WTO members charge one another.

d. Comparative analysis of the reviews conducted in a, b and c, to compare the actual tariff implementation of selected EE and RE technologies in ASEAN with the preferential tariff commitment made under ATIGA.

Exhibit 1.2:
MFN, Preferential and Bound Tariffs

Most-Favoured Nation (MFN) Tariffs: MFN tariffs are the tariffs that countries promise to impose on imports from other members of the World Trade Organization (WTO), unless the country is part of a preferential trade agreement (such as a free trade area or customs union). Hence MFN rates, in practice, are the highest (most restrictive) that WTO members charge one another.Some countries impose higher tariffs on countries that are not part of the WTO.

Preferential Tariffs: Virtually all countries in the world have joined at least one preferential trade agreement, under which they have promised to give another country's products lower tariffs than their MFN rate. In a customs union (such as the Southern Africa Customs Union or the European Community) or a free trade area (e.g., NAFTA), the preferential tariff rate is zero on essentially all products. **These agreements are reciprocal**: all parties agree to give each other the benefits of lower tariffs. Some agreements specify that members will receive a percentage reduction from the MFN tariff, but not necessarily zero tariffs. Preferences therefore differ between partners and agreements. ASEAN countries, through the ASEAN Trade in Goods Agreement, are privileged by preferential tariffs within the region. More detail on ATIGA is provided in Chapter 3.

Bound tariffs : Bound tariffs are specific commitments made by individual WTO member governments. The bound tariff is the maximum MFN tariff level for a given commodity line. When countries join the WTO or when WTO members negotiate tariff levels with each other during trade rounds, they make agreements about bound tariff rates, rather than actually applied rates. Bound tariffs are not necessarily the rate that a WTO member applies in practice to other WTO members' products. Members have the flexibility to increase or decrease their tariffs (on a non-discriminatory basis) so

[7] In a preferential trade agreement, a country promises to give another country's products lower tariffs than their MFN rate

long as they do not raise them above their bound levels. If one WTO member raises applied tariffs above their bound level, other WTO members can take that country to dispute settlement. If the country will not reduce applied tariffs below their bound levels, other countries could request compensation in the form of higher tariffs of their own. In other words, the applied tariff is less than or equal to the bound tariff in practice, for any particular product. The gap between the bound and applied MFN rates is called the binding overhang. Trade economists argue that a large **binding overhang** makes a country's trade policies less predictable.

Source: wits.worldbank.org

e. Analysis of possible implications that the Environmental Goods Agreement would bring to intra-ASEAN economic integration, based on the comparative analysis conducted above.

Non-tariff barriers: Through a country-specific synthesis of non-tariff barriers for selected EE and RE technologies, the following activities were conducted:

a. Review of existing non-trade barriers for selected EE and RE technologies, of which several key factors were assessed:
    1. Protection of national industry through local content requirements
    2. Limitation of Foreign Direct Investment
    3. Financial barriers, that is restricted access to financing
    4. Technical barriers, particularly related to the harmonization of standards. The issues raised in the analysis of the harmonization of standards (discussed in the first section) appeared again in this analysis
b. Regional analysis of non-tariff barriers in ASEAN, based on the above review, with conclusions on the prevalent non-tariff barriers for selected EE and RE, and their impact on the intra-ASEAN supply chain integration.

1.2.2 Case Study: Solar PV Value Chain in Vietnam

In order to provide a practical illustration of the potential intra-ASEAN supply chain integration for EE and RE technologies, the project undertook a case study of the solar PV value chain in Vietnam:

- The case study described the value chain of the solar PV industry in Vietnam, including manufacturers, project developers/ project owners/ end-users, and distributors. In terms of analysis of the value chain on the downstream side, distribution and sales channels such as installers, distributors, importers and assemblers were also included.
- The study also highlighted the prevailing barriers, particularly non-tariff barriers, to intra-ASEAN integration of the solar PV value chain in Vietnam.
- Analysis was conducted on the potential socio-economic impact of the enhanced value chain, from the perspective of intra-ASEAN integration.

1.2.3 Data Collection

Data for the study was collected from both primary and secondary data. The primary data was taken from:

- Meetings with ASEAN Secretariat/ officials, for updated information relevant to ASEAN trade regional initiatives on economic integration, and for their view on the EGA.
- Interviews with solar PV players in Vietnam.
- Meetings with solar PV project developers and manufacturers in Indonesia and Singapore, for comparative analysis with interview results from Vietnam.

The secondary data sources were:

- Literature and past studies conducted by ICA, UNEP, IEA, and other credible institutions and EE/RE programs at national and regional level in ASEAN countries
- Exhaustive trade flow information from the ITC Trade Map
- Reports and results of previous work on regional activities promoting selected technologies as listed in the previous section, and relevant to intra-ASEAN value chain cooperation and trade in Energy Efficiency and Renewable Energy technologies, such as work on:
    - Incentivizing or promoting intra-ASEAN industrial, commercial, and technical cooperation (ASEAN SHINE)
    - ASEAN Energy Efficiency & Conservation (EE&C), and Renewable Energy (RE) Sub-Sector Networks (SSN) Activities on Senior Official Meeting on Energy (SOME), and ASEAN Ministers on Energy Meeting (AMEM)
    - Mandatory Energy Performance Standards (MEPS)
    - Existing certification in certain RE and EE technology installation, e.g., solar PV installation and design.
- Information on ASEAN Economic Integration (research reports, studies and official reports from ASEAN meetings on economic integration)
- Market size, market trends and competition from various market reports on air conditioners, refrigerators, electric motors, distribution transformers, lighting, solar PV and solar thermal for water heating
- Data on policies and regulations on EE & RE in ASEAN countries, such as: regulation on fiscal/ incentives on EE & RE standards and labelling, feed-in-tariff
- Background information on the Environmental Goods Agreement (EGA)
- Information on harmonization codes.

1.3 SCOPE AND LIMITATIONS OF THIS STUDY

In the case of energy efficiency, the technologies targeted are widely used, while being characterized by a generally low level of efficiency. In the case of renewable energy, the technologies targeted are presumed to offer important potential in terms of market development. In turn, the energy saving potential and emissions reductions potential associated to these technologies are expected to be significant. The study focuses on the most promising technologies with regards to these aspects.

1.3.1 Selected Technologies as Focus of the Study

The technologies selected as focus of this study are categorized as follows:

Energy Efficiency technologies:

- Room Air Conditioners
- Refrigerators
- Electric motors
- Transformers

Renewable Energy:

- Solar PV
- Solar Thermal
- Lighting

The above technologies were selected on the basis of their importance to the economy of ASEAN countries, in terms of energy saving potential, contribution to a low-carbon development economy and potential for significant production and value chain contribution within the region. The sections below briefly introduce the technology definition, as well as the scope and limitation of each technology focused on in this study.

1.3.2 Room Air Conditioners (RACs)

The focus of the study is limited to specific types of room air conditioners (RACs) that cool and dehumidify room/ space; single split, multi-split and windows (the last of which only exist in a few ASEAN countries). RACs consume a significant share of the electricity in the residential and commercial sectors, so energy efficiency improvement in RACs in the selected South-East Asian economies could lead to great energy savings, providing justification for this appliance as a key focus of this study.

Split-type RAC: a split system comprises two items, the outdoor and indoor units. The outdoor unit consists of a compressor, condenser and cooling fans. The indoor unit consists of an evaporator and expansion control, and possibly air circulation fans, air filters, drainage arrangement (sometimes including a pump) and humidifier.

A single split RAC features only one evaporator/ indoor unit for every remote condensing unit and compressor, while multi-split refers to more than one indoor unit for every remote condensing unit and compressor. The single split RAC is further divided into those with and without inverter.

The inverter technology is the latest evolution of technology concerning the electro motors of the compressors. An inverter is used to control the speed of the compressor motor, so as to continuously regulate the temperature. Inverters in split RAC have increased efficiency in contrast to traditional air conditioners, extending the life of their parts and eliminating sharp fluctuations in the load.

Window-type RAC: Window air conditioners are supplied and installed as single items (indoor and outdoor units are integrated into one unit), in a casing, sometimes with a built-in sleeve.

The unit protrudes through the external wall or window of the room in which it is installed. This type is only suitable for single rooms and limited to an approximate maximum of 6kW cooling.

The six-digit HS code for the specific product used in this analysis of trade flow and tariff is as follows:

- 8415.10 - Window or wall types, self-contained or split-system.

1.3.3 Refrigerators (Residential Cold Appliances)

The focus of the study is limited to refrigerators, fridge-freezers and freezers powered by electricity and intended for food storage in residential use. Refrigerators may or may not have an internal freezer compartment. If included, the freezer compartment would be generally less than 14 liters. The appliances focused on in this study include:

- Refrigerators (fridges) to keep foods at generally between 1°C and 6°C (chilled)
- Combination fridge-freezers with a chilled compartment and freezer compartment in the same unit
- Freezers to cool and keep foods to generally below -18°C.

Collectively these are often referred to as 'residential cold appliances'. The technologies are very similar for fridges, fridge-freezers and freezers (both upright and chest freezers).

The working principle of a refrigerator is similar to an air conditioner but with a lower range of temperature for food storage purpose, and a condenser and evaporator compacted into one package assembly. The refrigerator has a condenser, compressor, expansion valve and evaporator.

The six-digit HS codes for the product reviewed in this study for trade flow and tariff are:

- 8418.21 - Refrigerator for household use, vapour-compression-type and
- HS 8418.29 - Household refrigerators, other type

1.3.4 Electric Motors

Electric motors are used to convert electricity to mechanical energy in rotating machines such as pumps, fans, and many other industrial machineries. Broadly, size and practical use of electric motors can be classified into three categories (Waide, Paul., et al., 2011):

- Small-sized motors (power rating ≤ 0.75 kW input power) used to convert electrical energy to mechanical rotation, in appliances such as small pumps and fans.
- Medium-sized motors (input power rating between 0.75 kW to 375 KW), manufactured in large volumes having low voltage. These are sold to original equipment manufacturers or sold as stand-alone motors which the final customer then integrates into a specific application on site.
- Large-sized motors with input rating above 375 kW which are high voltage motors operating in the 1 kV to 20 kV range (polyphase). These are mostly custom-made, synchronous and assembled onsite.

Given that the medium-sized category consumes about 70% of electricity used by electric motors globally (Waide, Paul., et al., 2011), this study has focussed solely on medium-sized, low voltage induction (AC) motors. Increased trade flow of energy efficient motors in this category would result in significant energy saving throughout the region.

The harmonized system for this product which are covered in this report are:

- HS 850152, AC Motors, Multi-phase, of an output exceeding 750 W but not exceeding 75 kW
- HS 850153 AC Motors, Multi-phase, of an output exceeding 75 kW

1.3.5 Distribution Transformers

Transformers are made up of two or more coils of insulated wire that transfers alternating current by electromagnetic induction from one coil to another, to change the original voltage or current value. Transformers allow electricity to be transmitted and distributed over hundreds of kilometres from the power generators to final consumers.

Significant transformer energy losses occur within the transmission and distribution (T&D) network. In 2011, energy losses in T&D networks globally amounted to about 1785.87 TWh, or about 8.1% of the total global electricity output. In the same year, the average T&D losses in ASEAN countries were around 8% of power output, hence close to the world average. In general, one third of network losses occur in transformers, and of these transformer losses, seventy per cent occur in distribution transformers. Due to this degree of magnitude, this study focuses on distribution transformers.

Distribution transformers are installed in the distribution circuit of electricity networks servicing both residential areas and commercial and industrial customers. Exhibit 1.2 shows the type of distribution transformers and their general usage.

Exhibit 1.3 Type of Distribution Transformers (Scholand, et.al., 2013)

Transformer group	Voltage	Phases	Typical Insulation	Common use
Medium Voltage Distribution (up to 2500 kVA)	≤ 36 KV (medium voltage)	Three Phase or Single phase	Dry-type or liquid filled	Stepping voltages down within a distribution circuit, from a primary to a secondary distribution voltage
Low Voltage Distribution	≤ 1 kV	Three Phase or Single phase	Dry-type	Stepping voltages down within the distribution circuit of a building, or to supply power to equipment

The HS codes for distribution transformers covered in this study are as follows:

- 850421 Liquid Dielectric Transformers, not exceeding 650kVA
- 850422 Liquid Dielectric Transformers, power handling capacity 650-10,000kVA
- 850490 Transformer parts (including the cores for transformers)

1.3.6 Solar Photovoltaic (Solar PV) Power System

The study covers solar PV system used to generate power, off-grid and on-grid. PV systems directly convert solar energy into electricity. The performance of PV system is measured in terms of its efficiency at converting sunlight into electricity.

The main component of a PV system is the PV cell, which is a semiconductor device that converts solar energy into direct-current (DC) electricity. PV cells are interconnected to form a PV module, typically up to 50-200 Watts (W). PV modules consist of multiple PV Wafers/ cells and most solar modules are made using silicon crystalline cells. Crystalline silicon (c-Si) modules represent 90% of the global annual market today, and therefore constitute a main focus of this portion of the study.

The solar PV power generation system consists of PV modules and the Balance of System (BoS), representing elements other than the PV modules. The key elements of BoS critical to energy performance of a solar PV system are inverters and the battery/ energy storage. Inverters are used to convert the variable direct current (DC) output of solar PV panel into alternating current (AC) that can be fed into the national electricity network or a local off-grid network. Increasingly, the battery in a solar PV power generation system is used to store surplus energy for later use (in the evening, for example).

The six-digit HS Code covered for solar PV for further analysis in this study is:

- 854140 PV Module, Wafer, Cells

1.3.7 Solar Thermal

The basic principle of a solar water heating system is the absorption of solar radiation by high absorbance material. In the case of solar water heaters, the heat produced from solar energy is used to heat water directly, for residential or commercial purpose. Solar water heating systems are gaining popularity in ASEAN, as concerns grow over the environmental sustainability of energy use.

A solar thermal collector is a solar collector specifically intended to absorb sunlight to provide heat. In the current solar water heater market, Flat-Plate Solar collectors and Evacuated Heat Pipe Tubes are widely used.

Flat-Plate Solar Collectors are durable, weatherproof boxes, which contain a dark absorber plate located under a transparent cover. Flat-plate solar collectors contain an air gap between absorber and cover plate, which allows heat loss to occur. These collectors are still the most common type of collector used for water heating in many countries, despite being inferior to evacuated tube collectors in many ways.

Evacuated Heat Pipe Tubes are designed such that convection and heat loss are eliminated. Further, evacuated heat pipe systems are capable of limiting the maximum working temperature, whereas flat-plate collected systems have no internal method of limiting the heat buildup, which can cause system failure. Finally, evacuated heat pipe systems are lightweight, easy to install

and require minimal maintenance. Flat-plate systems, on the other hand, are difficult to install and maintain, and must be completely replaced if one part of the system stops working[8]. This study covers solar thermal type flat plate and evacuated tube used to heat water intended for residential/ commercial use, given the prevalence of the former, and the practicality of the latter.

The six-digit HS Code in this study for trade flows and tariff analysis of solar thermal for water heating is:

- 8419.90 solar flat plate collector and solar evacuated tube collector, including parts.

1.3.8 Lighting

This study focused on two types of lighting products:

- Linear Fluorescent lamps: This lighting product has a large market share in the ASEAN market. Several ASEAN countries (Malaysia, Philippines, Thailand and Vietnam) have mandatory minimum energy performance standards (MEPS) for this product. However, there is significant difference in the four countries' existing MEPS. Hence, enhanced intra-ASEAN integration through harmonization of MEPS would positively influence energy saving in the region, offering a unique departure point for further analysis.
- LED Lamps: LED lamps have a small but fast growing market share across the ASEAN region. There are only two countries with existing MEPS, while in three countries it is under consideration/ development and therefore, through modest policy intervention, significant energy security and energy savings gains can be made. policy intervention, significant energy security and energy savings gains can be made.

The six-digits HS code specifically for Linear Fluorescent and LED lamps are not available. Hence, the analysis of the trade flow and tariff is based on:

- HS 940510, chandelier and other electric ceiling or all lighting fittings, excluding those of a kind used for lighting public open space or thoroughfares.

[8] http://www.clixoo.com/includes/pdf/Key_Suppliers_in_Solar_Thermal_Value_Chain_and_Venture_Capital_Companies.pdf

02

POLICIES AND REGULATORY FRAMEWORK FOR ENERGY EFFICIENCY (EE) & RENEWABLE ENERGY (RE) TECHNOLOGIES

This section provides an overview of existing policy and regulatory framework in ASEAN that directly and indirectly influences the intra-ASEAN integration in EE and RE technologies. This chapter begins by discussing the standard for testing energy performance methods as well as Minimum Energy Performance standards and labelling, as harmonization of these standards will largely facilitate the intra-ASEAN trade of EE and RE technologies. An overview of energy policy and incentives to EE and RE is given, and the summary of trade policy in ASEAN countries and in region as a whole is also illustrated in this chapter.

2.1 TESTING & ENERGY PERFORMANCE STANDARDS & LABELLING

This section is comprised of stocktaking of existing energy performance standards and labelling programs for selected EE and RE technologies in ASEAN Countries. This analysis will also highlight whether the energy performance standards are mandatory or voluntary in ASEAN countries and help to identify potential actions or plans to further enhance market integration.

Differences between testing standards and required energy performance of products are tangible barriers to market integration and trade. At the same time, manufacturers should be aware of what mandatory labelling is required in order to export to target countries. Voluntary labelling can represent another type of barrier if customers cannot easily make sense of and compare the labelling schemes of the different countries. Thus, as whole, national standards that refer to international standards, the adoption of similar minimum requirements on energy performance, and a common system of labelling, would greatly facilitate the exchange of products between ASEAN countries.

The following section explores the current situation in regards to the aforementioned existing standards in ASEAN countries and the progress of measures towards harmonization of those standards. Harmonization of standards will facilitate intra-ASEAN value chain integration in energy efficiency and renewable energy technologies. Tables summarizing the detailed information of standards for energy performance testing methods, MEPS and labelling are provided in Appendix A.1.

Minimum Energy Performance Standards (MEPS) are not a relevant assessment indicator for solar PV and Solar Thermal, because these technologies generate energy, rather than consuming it.

2.1.1 Air Conditioners

Energy Performance Testing Method: With regard to standards for energy performance testing methods for air conditioners, the six biggest economies (Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam) are aligned with ISO 5151. Singapore, though, is the only country already aligned with the most updated version of ISO 5151, issued in 2010. Through ASEAN SHINE[9] all ASEAN countries have agreed to the gradual adoption of ISO 5151 2010 as the common testing standard, by 2020.

[9] ASEAN SHINE is an activity funded by EU-SWITCH program; it aims at increasing the market share of higher efficient air-conditioners in ASEAN through harmonization of test methods and energy efficiency standards, adoption of common Minimum Energy Performance Standards, and changing consumer purchasing attitudes in favour of energy efficient air-conditioners.

MEPS and Labeling: The MEPS for air conditioners are mandatory in Indonesia, Malaysia, Singapore, Thailand, and Vietnam, which shows that these five countries are far ahead of the other ASEAN members.

The labelling programs in Malaysia, Singapore, Thailand and Vietnam all follow a five stars / ticks rating system. In all these countries and Indonesia (four stars), a higher number of stars / ticks represents higher performance. However, the methods of rating and requirements on labels vary between countries. Currently, no process for a regional label is underway.

Appendix A.1 provides a summary of existing standard/ testing methods and minimum energy efficiency performance standard (MEPS) for air conditioners. The MEPS for air conditioners in ASEAN countries are defined either by Energy Efficiency Ratio (EER) (BTU/Wh or kJ/Wh) and the Coefficient of Performance (COP) (W cooling/W).

2.1.2 Refrigerators

Energy Performance Testing Method: The international standards for refrigerator energy performance testing methods are IEC 62552 and ISO 15502. Refrigerator performance testing method adopted in Philippines, Indonesia, Malaysia, and Singapore are aligned with IEC 62552. Malaysia has recently updated the adopted performance standard to the most recent version of IEC 62552 (IEC 62552:2015) and Vietnam is working on aligning their national standard to IEC 62552. Thailand has national standard that differs from international standard. As most of the big economies in ASEAN have applied IEC 62552, adoption of this standard in ASEAN countries as the common testing standard for testing energy performance of refrigerator is seen as the way forward towards harmonization.

MEPS and Labeling: Two methods are found for estimating energy performance affecting MEPS and labelling: the Energy Efficiency Factor or Index (EEF or EEI) used in Malaysia, Philippines, as opposed to linear energy consumption estimation, based on adjusted capacity, in Indonesia, Singapore, Thailand and Vietnam. It is shown that the big six ASEAN countries (Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam) lead in development and implementation of MEPS for residential refrigerators. However, MEPS for refrigerators are only mandatory in the Philippines, Singapore, Thailand and Vietnam while in Indonesia, the MEPS for refrigerators is being drafted, with plans for implementation as mandatory regulation.

The standards for testing methods for measuring performance, labelling and MEPS for refrigerators are provided in Appendix A.2.

2.1.3 Electric Motors

Energy Performance Testing Method: The international standard for AC induction motors energy performance testing method is the IEC 60034-2 (Rotating Electrical Machines Part 2: Methods for Determining Losses and Efficiency of Rotating Electrical Machinery from Tests). National standards for energy performance testing method for AC induction motors in ASEAN countries are found in Indonesia, Malaysia, Thailand and Vietnam, with these standards moving towards aligning with the IEC 60034-2. Detailed gaps analyses between IEC 60034-2 and existing national standards would be useful, to help prepare detailed roadmaps for harmonization in ASEAN.

MEPS and Labeling: International Energy Efficiency Performance of AC electric motors IEC 60034-30-1-2014 defines four classes of energy efficient motors: IE4 for Super premium efficiency, IE3 for Premium Efficiency, IE2 for High Efficiency and IE1 for Standard Efficiency. This classification is often used for determining MEPS for AC induction motors.

With regards to MEPS, Vietnam and Malaysia both have national regulations for MEPS for AC induction motors. Thailand also aims to implement MEPS for AC induction motors on a voluntary basis, with embedded tax benefits for installation of motors with an energy efficiency class IE3 for 2, 4, 6 and 8 pole motors with an output range from 0,73kW – 185kW. In other countries, MEPS for AC induction motors are still being discussed and under development. In general, IE3 motors currently represent a very marginal portion of the motor market in ASEAN.

Vietnam has developed a voluntary comparative label for AC induction motors, while Thailand has a voluntary label under the Thailand Green Label scheme. Indonesia is in the process of adopting a comparative voluntary label for motors.

The standards for testing methods for measuring performance, labelling and MEPS for AC induction motors are provided in Appendix A3.

2.1.4 Distribution Transformers

Energy Performance Testing Method: Distribution transformers: The international standard for Distribution Transformer energy performance testing method is IEC 60076-1 and it is applied mostly as standard to comply with electric utilities requirement in Malaysia, Philippines, Singapore and Thailand. Indonesia utility (PLN) has their standard (S-PLN) for Distribution Transformer that aligned with IEC 60076-1. Only Vietnam has national standard that is aligned with IEC-60076-1. This shows that the current application of testing method IEC 60076-1 is mostly to meet the electric utilities' requirements, but not to promote energy efficiency at national level.

MEPS and Labeling: Scope (1 phase/ 3 phase), methods (no load versus load loss) and levels for the MEPs vary among ASEAN countries. Only Vietnam, Thailand, and Indonesia are putting MEPS in place for distribution transformers. Most of the existing MEPS were issued by utilities in respective countries. With the exception of Vietnam, no labelling program was identified. This represents an area for further cooperation in harmonization, and will result in energy saving and increased trade.

The standards for testing methods for measuring performance, labelling and MEPS for Distribution Transformers are provided in Appendix A 4.

2.1.5 Lighting

Energy Performance Testing Method: The International standards for linear fluorescent lighting performance testing method applies in ASEAN is IEC 60969/ 1988[10] and IEC 60081, while and for non-directional LED lighting the performance testing method is IEC 62612/2013.

[10] This standard specifies the performance requirements, together with the test methods and conditions required, to show compliance of tubular fluorescent lamps and other gas-discharge lamps with integrated means for controlling starting and stable operation (self-ballasted lamps intended for domestic and similar general lighting purposes.

In ASEAN, programs and measures regarding harmonization standards are quite advanced for compact fluorescent lamps (CFL), but not for the linear fluorescent lamps and non-directional LED. To date, the testing for energy performance standard for linear fluorescent light only applies in Malaysia, Philippines, Thailand and Vietnam, while for LED is only in Singapore (with National standard) and Malaysia. For LED, inly Malaysia follows international standard IEC 62612. Appendix A.5 provides a summary of existing status for the energy performance testing method standard for linear fluorescent lamps t and non-Directional LED in ASEAN countries.

MEPS and labelling

Based on another study conducted under the ASEAN SHINE lighting program with support and guidance of UNEP en.lighthen initiative ((Coyne et.al, 2016), it is indicated that Linear fluorescent lamps and LED lamps were highlighted as important products to target because:

- Linear fluorescent lamps command a large market share with stable annual sales across the ASEAN region. Moreover, this product has mandatory MEPS in Malaysia, Philippines, Thailand and Vietnam but have variations based on tube diameters, color temperatures, phosphor type and even lumen output. This condition therefore providing a significant opportunity for harmonization - to realize significant energy savings as well as regional trade opportunities (Coyne et.al, 2016).
- LED lamps have a small but fast growing market share across the ASEAN region. Malaysia and Singapore have adopted MEPS, but again these are not the same for the two economies. Singapore has set the requirement at the same level as its MEPS for CFLs, and Malaysia has updated its single MEPS level to a range of levels based on some common LED product forms. LED lamps in today's market will tend to have higher efficacy levels than those required by these regulations (but their price may currently be higher than CFLs). This aspect of LED technology therefore presents the ASEAN Member States with an opportunity to establish a near-term efficacy requirement that is higher and could be harmonized across the region (Coyne, et.al., 2016).

2.1.6 Solar PV

Sixty-nine National Standards have been identified in the big six-ASEAN countries concerning solar PV energy systems. Fifty-three of these are aligned with IEC standards. Most of the standards adapted are non-concentrating (Ansay, G. 2015). The situation with regards to the adoption of international standards varies greatly:

- Indonesia has a total number of seventeen (17) SNI/RSNI solar PV national standards, of which six (6) are aligned with IEC standards.
- Malaysia has a total number of twenty-two (22) MS IEC National solar PV standards, of which 20 are aligned with IEC Standards. Most of the standards were related to guidelines for decentralized rural electrification (DRE)
- The Philippines has a total number of fourteen (14) PNS solar PV national standards, all of which are aligned with IEC standards. Most of the standards were related to non-concentrating modules.
- Singapore has ten (10) national solar PV energy system standards aligned with IEC standards. Most of these are related to non-concentrating modules.

- Thailand has a total number of three (3) National Standards, of which two (2) are aligned with IEC standards.
- Vietnam has a total of three (3) TCVN national standards with only one (1) TCVN national standard aligned with IEC standards.

The solar PV standards that are currently adopted in ASEAN as shown above are mostly related to connecting the solar PV system to the grid, the Balance of System (BoS) and safety installation. This situation may remain, as the current priority for solar PV is the safety and harmonization for grid connection, rather than the performance of the module/ cell itself. The standards for energy performance of modules/ cells will be more important in the future when solar PV is already massively produced in the region; at present they are still heavily imported.

As mentioned above, MEPS are not a relevant assessment indicator for solar PV and Solar Thermal, because these technologies generate energy, rather than consuming it.

2.1.7 Solar Thermal

At this stage, information regarding existing national standards for solar thermal is still limited to the Philippines and Thailand, both of which follow the ISO Standards: ISO 9806/EN 12976-2, ISO 9459-5 (dynamic system test method) and ISO 9459-2 (complete system testing group method). In other ASEAN countries, national standards were not identified and in general existing products in their markets follow the ISO standard mentioned above.

2.2 POLICIES/ REGULATORY FRAMEWORK TO PROMOTE RE AND EE

This section covers key trade and energy policies in the ASEAN countries on a broader scale and not specific for each selected technology. Energy policies play an important role in the development of markets (for example by providing incentives for the adoption of certain technologies) while they can also represent a barrier to trade, in particular when referring to mandatory standards. This section focuses on areas where barriers to trade and value chain cooperation can be identified.

2.2.1 Brunei Darussalam

The electric industry in Brunei is governed by the Electricity Act 1973 and Electricity Act (Amendment) Order, 2002. The Department of Electrical Services (DES), under the Prime Minister's Office, is responsible for the generation, transmission and distribution of electricity. In addition to DES, an independent power producer (IPP), the Berakas Power Company (BPC), also generates electricity in this country.

In moving to reduce their dependence on fossil fuel as the main source of energy, the Brunei Government is currently exploring ways to increase renewables usage and reduce carbon emissions, including investigation of a smart grid and solar plants. The government aims to have at least 10% of power generation from renewable energy by 2035, and is also developing a "Feed-in-Tariff" policy, to accelerate the use of renewable energy.

2.2.2 Cambodia

The key challenge for the Cambodian energy sector is to increase the electrification rate significantly. The government aims to electrify at least 70% of households in the country by 2020.There is, however, no specific target of how much renewable energy will share in the total energy mix, and no mention of a particular deadline. This likely indicates that market development for RE in Cambodia will take time to grow significantly.

Cambodia is still developing Energy Efficiency and Conservation (EE &C) policies under the 2014 ASEAN+3 Mitigation Cooperation Program, supported by the Government of Korea. The program aims to transfer Korean experience to accelerate the development and implementation of a standards and labelling national framework for energy efficiency in Cambodia. This development is expected to further enhance the capacity in Cambodia to enforce national standards for energy efficiency technologies. In order to avoid creating barriers to trade, these standards being developed should be geared towards alignment with ASEAN and international standards.

2.2.3 Indonesia

An extensive legal framework, including policies to promote **Energy Efficiency and Conservation and Renewable Energy**, is already in place in Indonesia. The Law No. 30/ 2007 concerning energy provides the overall umbrella for energy management and utilization of renewable energy resources and energy conservation.

In order to support the above priorities, there are specific **regulations for promoting green investment** in Indonesia, including:

- Direct incentives (development of feed-in tariff for electricity generated from renewable resources including solar PV power generation, and regulation by the government to provide incentives for energy conservation measures); and
- Indirect incentives provided by the Ministry of Finance, regarding taxation and custom facilities for renewable energy technologies.

In most cases, however, the information on taxation and customs incentives for these technologies are not communicated transparently and widely, with the result that unfortunately these incentives are not well utilized. In certain cases, the lack of coordination among ministries and State-Owned Enterprises also impedes the implementation and enforcement of these regulations.

2.2.4 Lao PDR

Currently, no energy efficiency standard or mandatory label exists in Lao PDR. The country has no substantial manufacturing capacity for energy efficiency and renewable energy equipment; at present, such equipment is typically imported. Discussions with local government officers point to plans for developing local manufacturing, notably for appliances, but no official document was found to support this.

2.2.5 Malaysia

Since 2000, the development of energy-intensive industry in Malaysia has driven higher energy demand growth rates compared to GDP growth rates. Hence, the need to promote energy-efficient use of energy to ensure domestic energy security is clear and this requires sound energy efficiency policies, backed by good strategies and implementable programs. To support these, the Malaysian government has issued policies, including incentives, regarding energy efficiency and renewable energy development. The following are key policies now in force supporting energy efficiency and renewable energy development in Malaysia:

- **Efficient Management of Electrical Energy Regulation** in 2008
- **Feed-in tariffs (FITs)** under the **Renewable Energy Act of 2011** (last updated in 2015), under the authority of the Ministry of Energy, Green Technology and Water: feed-in tariffs apply notably to solar energy.
- **Incentives** to encourage the generation of Renewable Energy, under the **Promotion of Investment Act 1986** (application extended in 2015), which includes exemption from income tax (on 100% of statutory income for 10 years), and investment tax allowance.
- **Additional Import Duty and Sales Tax Exemption for renewable energy** Companies generating RE can also apply for import duty and sales tax exemption on imported machinery, equipment, materials, spare parts and consumables used directly in the generation process, where those are not produced locally. For locally purchased machinery, equipment, materials, spare parts and consumables, full exemption is given on sales tax.
- **Tax incentives through the Energy Efficiency initiative** (KeTTHA, 2014); this was introduced in the 2001 government financial budget, with the aim of promoting EE projects through the provision of: investment tax allowance, accelerated capital allowance, import duty exemption and sales tax exemption for energy efficiency products.
- **Renewable energy target:** The Malaysian Government targets that renewable energy should account for 24% of the total national energy mix by 2050.

The incentives stated above towards green energy investment and energy efficiency will facilitate the entry, market development and transformation towards energy efficiency and renewable energy technologies in Malaysia.

2.2.6 Myanmar

In March 2016, Myanmar adopted its Energy Efficiency Policy, Strategy and Roadmap, which also covers renewable energy. Under the Policy and Strategy, sectorial programs and activities have been recommended, including the development of local manufacture for energy efficiency equipment in the commercial sector. Myanmar aims to encourage investors to enter the energy efficiency equipment market for new products or in competition with the existing products (LED and SWH), ensuring minimum energy performance standards. For that purpose, the strategy is to provide incentives for the establishment of manufacturing facilities for energy efficiency

equipment. The Myanmar Policy Strategy and Action Plan also recommends the Promotion of solar PV systems for supplementing on-grid supply through the development of a net metering program and the promotion of solar water heaters in hotels and buildings.

This intended development of energy efficiency and renewable energy suggests that Myanmar will require transfer of skills and will benefit from facilitated circulation of products (e.g. components), to become a real part of the ASEAN value chain for energy efficiency and renewable energy.

2.2.7 The Philippines

The Philippines has the highest electricity tariff among ASEAN countries. In parallel, imported oil and coal each represent over 40% of the energy mix. In response to this, the Philippines government has made the development of energy efficiency and renewable energy a priority, and the country has put in place an extensive list of incentives for Renewable Energy developers and RE business / commercialization. These incentives include, among others, income tax holidays, tax and duty free for imported RE technologies, and 0% VAT for electricity from renewable energy sales and purchases. This shows that the Philippines is fostering supportive conditions to allow the transfer of energy efficiency and renewable energy technologies to the country, as well as to attract investment in the deployment of these technologies.

2.2.8 Singapore

The Energy Conservation Act (ECA) is the major policy for energy efficiency for Singapore. It came into force in March 2013. As a small economy and territory, Singapore has limited natural renewable energy resources, so energy efficiency is a key strategy for Singapore to enhance energy security (Singapore's Compendium, May 2014).

The Singaporean Government has already set up programs and incentives schemes in order to promote Energy Efficiency and Conservation (EEC) & RE implementation. Some of these schemes are:

- **Grants for Energy efficiency technologies (GREET)**: Co-administered by the National Environment Agency and the Economic Development Board, the GREET aims to encourage owners and operators of new and existing industrial facilities to invest in energy efficient equipment or technologies.
- **Energy Efficiency Improvement Assistance Scheme (EASe)**: Offered to companies that wish to conduct an energy assessment, the EASe funds up to 50% of the cost of an energy appraisal, when energy efficiency specialists are engaged to identify areas for energy efficiency improvement.
- **Singapore Certified Energy Manager (SCEM) Program and Training Grants**: The SCEM program is designed for engineering professionals who intend to build their career as energy managers, equipping them with a thorough understanding of the key energy issues either in the building or industry sector. The program will help participants to develop the technical skills and competencies needed to manage and track energy usage for their organizations.

- **One-Year Accelerated Depreciation Allowance for Energy Efficient Equipment and Technology (ADAS)**: This tax incentive scheme encourages companies to replace old, energy-consuming equipment with more energy efficient ones and to invest in energy-saving equipment, with the capital expenditure on the qualifying energy saving equipment being written off or depreciated in one year instead of three.

The government's policy and incentives show that Singapore's strategy for enforcing energy efficiency as its energy security policy is not only directed at its industry and infrastructure, but also towards the country's human resources, by an emphasis on increasing skills and awareness regarding energy efficiency.

2.2.9 Thailand

The basis of energy efficiency measures and deployment of renewable energy in Thailand is the **Thailand Integrated Energy Blue Print**, which is built upon three pillars: National Energy Security, economical use of energy and environmentally–friendly use of energy.

Thailand's Alternative Energy Development Plan (AEDP 2012-2021) set targets to increase the share of renewable energy to 25% of final energy consumption by 2021. The objectives of the AEDP are to substantially replace fossil fuels with renewable energy, reduce dependence on energy imports, promote green energy communities, support domestic renewable energy industries, and support R&D in Thailand, to increase the competitiveness of Thai technologies in the global market (DEDE, 2012).

In order to enhance the implementation of Energy Efficiency and Conservation activities, the Government of Thailand also introduced financial incentives (Egkamol, 2013), such as:

- Direct Subsidy: 20% subsidy for EE project to private companies (max 3 million Baht), and subsidy for EE equipment for government's buildings
- ESCO Fund: Co-investing with privates through benefit sharing for energy efficiency measures
- Tax incentives in purchasing EE products and developing EE business
- EE loans that encourage banks to offer loans for EE projects based on the success from revolving fund programs.

In addition, in 2013 and 2014, Thailand revised its feed-in tariffs respectively for solar PV (rooftops only – other solar PV now being excluded from the feed-in tariff support) and very small power producers (less than 10 MW) using renewable energy to provide investors with more certainty.

2.2.10 Vietnam

Vietnam has put in place comprehensive regulations, policies and a national program on energy efficiency and energy savings. The EE technologies were first introduced in the 1990s as part of the technical and financial programs (AFD Hanoi, 2012). According to the Energy Conservation and Labelling Office of the Ministry of Industry and Trade and the AFD report, relevant Vietnamese policies and strategies include the Government Decree on Energy Conservation and Energy Efficiency No. 102/2003/ND-CP), 3 September 2003, which requires the Ministry of Industry and Trade (MOIT) to undertake EE and EC programs.

With regards to renewable energy, Vietnam provides feed-in tariff for wind, biomass, and waste to energy. Solar energy however is not yet listed, although the government has developed the draft legislation for the solar PV feed-in tariff.

There is no clear indication in existing direct and indirect fiscal incentives for EE and/or EE measures in Vietnam. Enabling policies in Vietnam are further outlined in the case study on Vietnam solar PV value chain contributions and trade, provided in Chapter 5 of this study.

2.3 SUMMARY OF ENERGY SAVING POTENTIAL

Exhibit 2.1 provides a summary of energy saving potential that would be achieved annually in 2025 and 2030 using selected energy efficiency technologies, across ASEAN countries[11].The savings potential assumes minimum energy performance standards (MEPS) will be implemented in 2020 at a level equivalent to the best global MEPS currently implemented at the present day (2015).

Exhibit 2.1: Summary of Energy Saving Potential (Annual Target) in 2025 and 2030 by using selected EE technologies

No.	Country	Room Air Conditioner (GWh)		Refrigerator (GWh)		Motor (GWh)		Transformer (GWh)	
		2025	2030	2025	2030	2025	2030	2025	2030
1	Brunei Darussalam	9.5	14.8	11.7	22.1	18.9	37.9	33	65.6
2	Cambodia	55.7	101.5	14.3	27.6	31.3	87.6	32.9	64.5
3	Laos	28.8	59.9	5.3	11.8	24.7	68.4	31.5	61.7
	Malaysia	2000	3200	600	1100	800	1700	1600	3200
5	Myanmar	75	122	45.2	82.1	50.1	113.5	85.2	166.8
6	Indonesia	2300	4000	5700	11800	1500	3300	2500	4900
7	Philippines	1300	3000	800	1800	400	800	900	1800
8	Singapore	400	700	100	200	200	500	300	500
9	Thailand	1400	1900	1600	3000	1500	3400	1600	3200
10	Vietnam	600	1100	1800	3600	1400	3500	600	1200

Source: united4efficiency.org

[11] U4E initiatives: www. United4efficiency.org

2.4 TRADE POLICIES THAT MAY INFLUENCE INTRA-ASEAN INTEGERATION

This section provides a summary of selected trade policies, which potentially influence intra-ASEAN integration in selected EE and RE Technologies. This also provides an analysis of the impact of energy policies described in the previous section to intra-ASEAN trade and market integration.

2.4.1 Policy Issues Related to Tariffs

Average MFN tariff and overall bound tariff: Exhibit 2.2 summarizes prevailing overall bound tariff and MFN tariff among ASEAN countries. Except Brunei and Singapore, ASEAN countries' average MFN tariffs are higher than 5%. This means ASEAN countries are still relatively protective of their economies in terms of imports, except for preferential trade zones applying preferential tariffs such as ATIGA.

For most ASEAN countries, the gap between the overall bound tariff and average MFN tariff (binding overhang) is also quite large, which will likely reflect unpredictability of trade policies in most ASEAN nations[12].

ASEAN Trade in Goods Agreement (ATIGA): this agreement aims to achieve free flow of goods in the region, resulting in less trade barriers and deeper economic linkages among member States, lower business costs, increased trade, and a larger market and economies of scale for businesses. Through ATIGA, Brunei, Indonesia, Malaysia, Philippines, Singapore, and Thailand have committed to eliminating intra-ASEAN import duties on 99.65 percent of their tariff lines, including for selected Energy Efficiency and Renewable Energy Technologies. Cambodia, Lao PDR, Myanmar, and Vietnam have reduced their import duties to 0-5 percent on 98.86 percent of their tariff lines.

High average MFN rate in ASEAN member countries may not affect the EE and RE technologies that are regionally produced in ASEAN and already have existing trade-flow among ASEAN nations, but it would create a barrier to availability and access to those EE/ RE technologies that are not currently available within the region. Singapore is an ideal trading hub for EE and RE technologies in ASEAN, because it applies low MFN tariff rates and 0% for all ASEAN countries.

Exhibit 2.2: MFN tariff, overall bound tariff, and tariff under ATIGA (ASEAN, 2015)

Country	Overall Bound Tariff (%)	Average MFN tariff (%)	Tariff under ATIGA (%) for selected EE/RE
Brunei Darussalam	25.4	1.7	0
Cambodia	20.1	11.7	0
Indonesia	37.4	7.8	0
Lao PDR	N/A	9.7	0
Malaysia	23	5.6	0
Myanmar	18.5	5.3	0

[12] Trade economists argue that a large binding overhang makes a country's trade policies less predictable. source: http://wits.worldbank.org/wits/wits/witshelp/Content/Data_Retrieval/P/Intro/C2.Types_of_Tariffs.htm

Country	Overall Bound Tariff (%)	Average MFN tariff (%)	Tariff under ATIGA (%) for selected EE/RE
Philippines	25.7	6.4	0
Singapore	6.9	0	0
Thailand	28.1	13.4	0
Vietnam	17.5	10.4	0

Source: www.wto.org

2.4.2 Policy Issues Related to Non-Tariff Barriers

With regard to non-tariff trade barriers and policies, all ASEAN member countries have an applied e-custom system, which facilitates trade and imports in general. The average time from customs declaration to customs clearance varies from ten minutes to a maximum of three days, and there is no restriction/ prohibition seen for EE and RE technologies. Limitation on investment in RE investments and local content requirements are only observed in Indonesia, Malaysia and Myanmar.

However, regional labelling is not yet in place, which would distinguish an EE/ RE product. Having such a regional label in place would facilitate and further simplify not only intra-ASEAN trade of such technologies, but also access to EE/ RE technologies that are not yet available in the ASEAN market.

Exhibit 2.3: Summary of Non-Tariff Barriers in ASEAN Countries

Country	E-custom ?	Cost of import procedures	Average time from custom declaration to custom clearance	Any import restriction/ prohibition/ special permit for EE/RE product?	Limitation of Foreign investment in EE/RE measures?	Local content requirement for EE/RE product/ measures?
Brunei Darussalam	Yes	US$ 700/ container	10 hours and 18 minutes	No	No	No
Cambodia	Yes	US$4/ declaration	24 hours	No	No	No
Indonesia	Yes	No	Max 3 days	No	Yes, for RE project with installed capacity more than 1 MW, Foreign ownership share is limited	Under consideration by Govt for certain RE product including Solar PV modules
Lao PDR	Yes	10,000 kip/ licence	N/A	N/A	N/A	N/A
Malaysia	Yes	US$ 420/ container	15 Minutes	No	Yes, for power generation foreign ownership is limited	No

Country	E-custom ?	Cost of import procedures	Average time from custom declaration to custom clearance	Any import restriction/ prohibition/ special permit for EE/RE product?	Limitation of Foreign investment in EE/RE measures?	Local content requirement for EE/RE product/ measures?
Myanmar	Yes	N/A	3 days	No restriction/ prohibition but most goods need licence to enter Myanmar	Power generation below 10 MW only allow 100% local ownership	No
Philippines	Yes	US$ 915/ container	Maximum 2 days	No	No	No
Singapore	Yes	No	10 minutes	No	No	No
Thailand	Yes	US$ 760/ container	19 hours seaport, 29 minutes border crossing	No	No	No
Vietnam	Yes	20,000 dong/ declaration	N/A	No	No	No

Source: www.wto.org

03

VALUE CHAIN ANALYSIS FOR SELECTED RE/EE TECHNOLOGIES

This chapter provides the value chain analysis for each selected clean energy technology (air conditioners, refrigerators, electric motors, distribution transformers, lighting, solar PV and solar thermal). Beginning with an illustration of the value chain for each technology, this chapter describes key components and products (supply side) and their application (demand side). It further identifies the existing value chain of the supply side in the ASEAN region as a whole, and in each ASEAN country, while analyzing the differences in value chain parts among countries. The market analysis of each technology in ASEAN countries is given and the demand side (application/ end use) of the technology in the market is discussed.

The trade flow of each technology in ASEAN countries is analyzed based on the six-digit HS code relevant to the technology. Identification of existing trade flow suggests the available intra-ASEAN sourcing and market of EE and RE technologies would show the potential of supply chain integration of these technologies in the ASEAN region. However, the following limitation is to be noted as applying to EE technologies:

The environmentally friendly characteristics of EE products are not reflected in the six-digit HS Code. For example, the inverter and non-inverter air conditioner are classified under the same six-digits HS Code (HS 841510). This condition limits the analysis of the Trade Flow information in Chapter 3 by assuming that the flow of the EE technology would follow the trade flow of the same group of products under a six-digit HS Code, which may not reflect the actual state.

This chapter also provides an analysis of the tariff and non-tariff barriers for these selected technologies. The tariff of each technology, based on the preferential tariff, MFN tariff and the average tariff applied, are compared to see whether tariffs are still a barrier for each respective technology in the intra-ASEAN integration. The non-tariff barriers are discussed to identify the most common non-tariff barriers found in ASEAN member countries and how they would impact intra-ASEAN integration.

3.1 VALUE CHAIN MAPPING, MARKET AND TRADE FLOW

In this section, the mapping of simplified value chains for each technology is depicted, including both supply and demand sections. In addition, the market situation of each technology in ASEAN is presented. The trade flow is also discussed[13] , in order to give better understanding of the potential of each ASEAN member country with regards to production, manufacture, and assembly of the selected EE and RE technologies, as well as the potential export of products to other ASEAN member countries.

3.1.1 Distribution Transformer

Value Chain

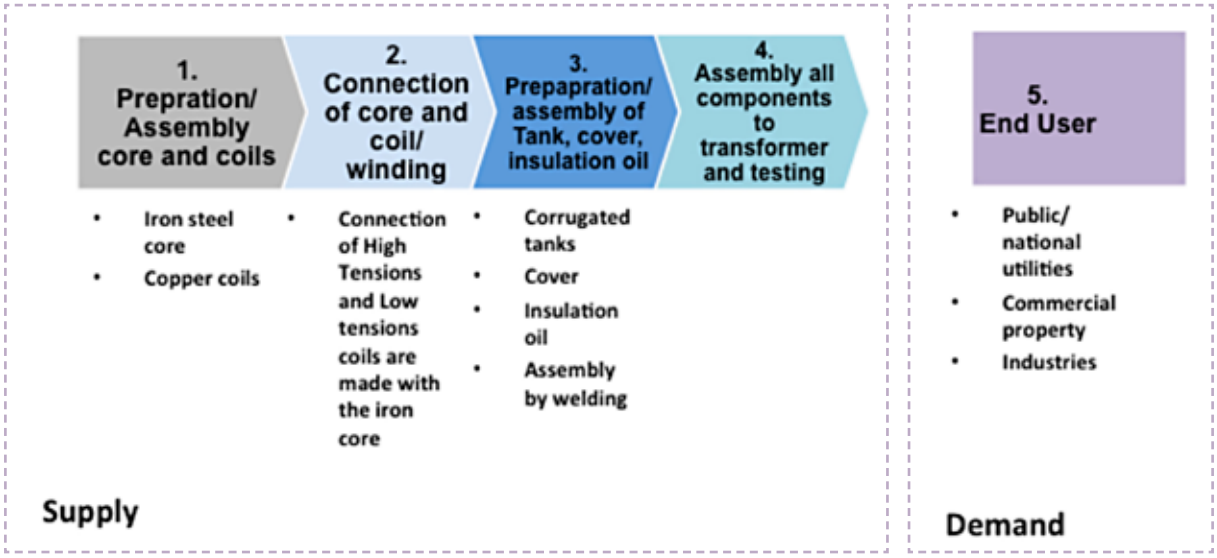
The simplified value chain of a distribution transformer (wet-type) is illustrated in Exhibit 3.1. On the supply side, the components are the iron steel core, copper coils, tank and cover. Other transformer parts installed after the assembly of core-coil, integrated with the tank and cover, are the Bucholz relay, thermometer, radiator and the insulation oil (for the oil-filled transformer). In the dry type transformers, air or gas is used as insulation material instead of oil.

[13] All trade flow information provided in Exhibits in this chapter, including the exports data for all 6-digits HS Code, are sourced from International Trade Centre (ITC) Website, www.trademap.org

On the demand side, in ASEAN the major end-users of the distribution transformer (mostly the wet-type transformer end users) are national/ public utilities and power companies. Since the advantage of dry-type transformers is that they are less flammable, the end-users of this type of transformer are certain industries prone to fire hazards and large commercial properties.

Traditionally, the whole of the supply chain showed in Exhibit 3.1 where raw material entered at one end of the chain (no.1) and the finished product came out at the other end (no. 4), took place in a distribution transformer manufacturer. However, today, manufacturers increasingly outsource the supply of transformer parts and sub-assemblies because it has become more cost effective, allowing transformer manufacturers focus their skill set on design and assembly expertise.

Exhibit 3.1: Simplified value chain of a distribution transformer (wet-type)



Market in ASEAN

The market for distribution transformers in ASEAN in 2015 is illustrated in Exhibit 3.2 (Goulden Reports, 2015). The biggest markets having more than US$ 5 million are Thailand, Malaysia, Indonesia, Vietnam, Singapore, the Philippines and Cambodia. The major drivers for the transformer market growth in ASEAN countries' companies are as follows:

- The Philippines, Indonesia, and Myanmar and Vietnam are countries that lack a sturdy electricity grid (The Nation, 2016). Governments in these countries have grid extension and expansion programs that include installation of distribution transformers.
- Indonesia, Malaysia, the Philippines and Vietnam are actively improving the rural electrification rate with rural electrification programs including installations of isolated grids to be connected to small-scale power generation, a system that requires distribution transformers (The Nation, 2016). These initiatives will considerably bolster the market for distribution transformers in the region.
- Other key end-users of distribution transformers are commercial properties. The increasing urbanization rates in Vietnam, Indonesia and Myanmar will demand

increased loads of electricity for the construction of new shopping malls, offices, shops, hotels and data centers, in cities which keep the market for distribution transformers afloat.

Moreover, both residential and commercial infrastructure development in large and mid-sized cities in Indonesia, Vietnam and the Philippines is expected to create high demand for distribution transformers.

Exhibit 3.2: Markets for Distribution Transformers in ASEAN, 2015 (Goulden Reports, 2015)

No.	Country	(in US$ Thousand)
1	Brunei Darussalam	6,103.5
2	Cambodia	53,724.5
3	Indonesia	187,640.3
4	Laos	18,757.4
5	Malaysia	194,370.6
6	Myanmar	15,339.6
7	Philippines	65,393.4
8	Singapore	72,331.6
9	Thailand	466,708.0
10	Vietnam	102,452.7
	Total	**1,182,821.6**

Flow of Trade in ASEAN

- **Distribution Transformer (liquid type)**[14]

In ASEAN, production/ manufacturing of distribution transformers is found in Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam.

Considering the local production of transformers available in these countries, the trade flow analysis of distribution of transformers in ASEAN focuses on the flow of export from these countries to their ASEAN counterparts. Exhibit 3.3 and 3.4 show the export flow of liquid type (HS 850421 and HS 850422) distribution transformers in ASEAN Countries. Thailand export value for wet distribution transformers (both HS 850421 and HS 850422) ranks the highest in ASEAN, followed by Singapore. Most major export destinations for Thailand's wet

[14] The analysis is limited to liquid type due to its prevalence compared to dry type in the power systems market in ASEAN.

distribution transformers are ASEAN countries sharing boundaries with Thailand: Cambodia, Laos, Malaysia and Myanmar. In addition, Singapore is also importing significant quantities of wet transformers from Thailand with power handling capacity of more than 650 KVA but not exceeding 10,000 kVA.

- **Transformer parts**

Transformer parts such as corrugated tanks, bushing, tap chargers, high-tension and low-tension coils are all classified under six-digit HS code 850490 (definition: parts of electric transformers, static converters and inductors). Exhibit 3.5 illustrates the exports from these countries to other ASEAN countries for transformer parts, HS 850490. Based on the observation of this trade flow, there are more trade exchanges of transformer parts in ASEAN than of the finished distribution transformer products themselves. ASEAN countries included as the top 25 exporters of transformer parts in 2015 are Malaysia, Philippines, Singapore and Thailand.

Exhibit 3.3: Export from transformer producer countries in ASEAN to their ASEAN counter-parts (HS 850421, Liquid dielectric transformers having a power handling capacity not exceeding 650 kVA)

HS 850421 Exporter	Importer ((US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia	30				259		47	317			653
Malaysia			72					473		8	553
Philippines											0
Singapore	200		1182		461	1296	342		72	3.3	3556.3
Thailand	122	2946	29	975	546	311	16			91	5036
Vietnam			355		55		427	31	83		951

Exhibit 3.4: Export from transformer producer countries in ASEAN to their ASEAN counter-parts (HS 850422 Liquid dielectric transformers having a power handling capacity >650 kVA and < 10,000 KVA)

HS 850422 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia	106				246		1011	1054		3926	6343
Malaysia			2				1366	685	197		2250
Philippines	0	0	0	0	0	0	0	0	0	0	0
Singapore			1163		1230	174	347		235	1431	4580
Thailand	572	829	302	725	4572	2697	514	3299		463	13973
Vietnam			1121		191		2324	299	88		4023

Exhibit 3.5: Export from transformer part exporter countries in ASEAN to their ASEAN counter-parts (HS 850490, parts)

Exporter	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	Total export value among producers in ASEAN
Malaysia	43		8420			18	419	13223	4121	863	27107
Singapore	120	25	23589	4	29715	3314	4632		14658	11473	87530
Philippines		73	49		792	3		1085	4902	75	6979
Thailand	16	83	2712	3011	4037	385	1762	2649		2570	17225

3.1.2 Room Air Conditioners (RAC)

Value Chain

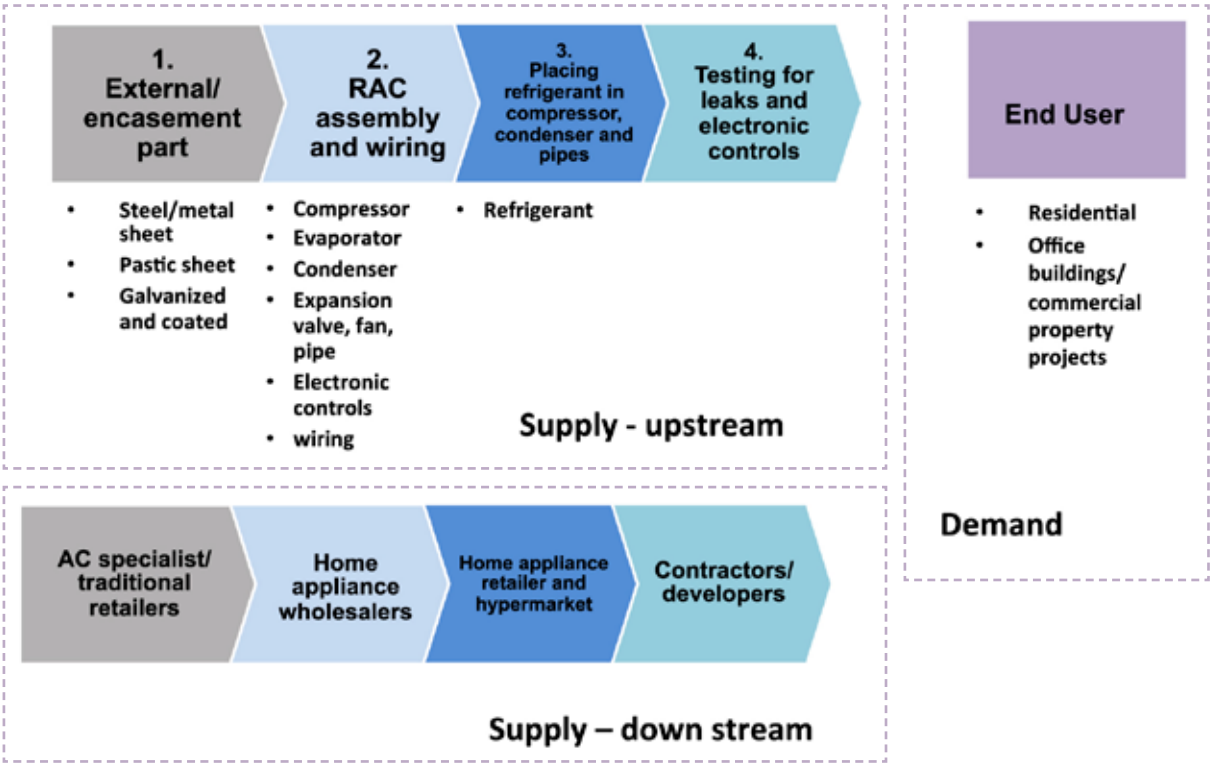
The simplified value chain of a room air conditioner (RAC) is given in Exhibit 3.6. On the supply side, the upstream section shows the manufacturing process. The encasement parts of RAC are made of steel/ metals, and often mixed with and/ or plastic sheets. The metal parts are galvanized and coated for corrosion protection.

Once the encasement parts are made, the RAC is ready for assembly. Compressors, evaporator, condensers, other supporting parts such as pipes, expansion valve and fan are installed. Often, these parts are already pre-built. Evaporator and condenser are connected via copper wire with the compressor. Other electronic controls are also installed and connected with an electric motor that runs the compressor. Refrigerant is placed in the compressor, evaporator and pipes once the RAC is installed. At the end of the manufacturing process, testing for refrigerant leaks and electronic controls are done.

The downstream section of the supply side illustrates the distribution channel prior to utilization by end-user.

RAC is distributed through air conditioner specialists (local installers specialize in air conditioners), home appliance wholesalers, home appliance retailers and hypermarkets, and in certain cases through contractors and/ or developers' business-to-business transaction (B2B) for residential and commercial property projects.

Exhibit 3.6: Simplified value chain of a RAC



Market in ASEAN

The market for RACs in the big six ASEAN countries in 2012[15], in terms of value (US$ million) is illustrated in Exhibit 3.7 (BSRIA, 2012). The window-type only exists in quantity in the Philippines while the multi-split types are only prevalent in Singapore.

The penetration of RAC with inverter is higher compared to non-inverter in Singapore - electricity tariffs for residential users in Singapore is relatively higher compared to other ASEAN countries, hence, consumers are better educated towards choosing more efficient technologies that would reduce monthly electricity bills.

In Indonesia, Thailand, Malaysia and Vietnam, uneducated impulse buying for cheaper products, without considering the lower operating cost and energy consumption, means that non-inverter RAC still dominates the market. In certain cases, higher installation cost for RAC with inverter, and lack of fully trained installers who are willing to install the inverter units, can also cause the inverter RAC to be less popular.

Enforcement of labelling and MEPS, in addition to the removal of any electricity subsidy, would help in increasing the growth of RAC with higher energy efficiency, including RAC with inverters.

[15] Data for the big six ASEAN countries is officially available.

Exhibit 3.7: Market for RAC in ASEAN, 2012, in US$ Millions (BSRIA, 2012)

RAC Type	Indonesia	Thailand	Malaysia	Vietnam	Philippines	Singapore
Multi-split	0	0	0	0	0	138.7
Single split	**460.2**	**615.8**	**299**	**262.6**	**104.7**	**30.2**
With inverter	45.9	70	67	71.2	68.4	16.9
No inverter	414.3	545.8	232.4	212.4	36.3	13.4
Window	1.2	0	0	0	98.2	1.2

Exhibit 3.8 provides an overview of share of distribution channels in each country. In Indonesia and Thailand, RAC sales channels are dominated by AC specialist/ traditional retailers and home appliance wholesalers, while in Vietnam, the Philippines and Singapore, hypermarkets and home appliance retailers have taken over the sales channel.

The AC specialist/ traditional retailers are often made up of electrical shops and small local RAC installers, which are still dominated by single-family owners. A significant share of RAC sold to residential/ commercial property projects are identified in Malaysia and Singapore.

Exhibit 3.8: Overview of RAC distribution channels in big 6 ASEAN countries, 2012 (BSRIA, 2012)

Distribution channels	Share of market volume distribution (%)					
	Indonesia	Thailand	Malaysia	Vietnam	Philippines	Singapore
AC specialist/ Traditional retailers	65%	60%	30%	10%	25%	30%
Home appliance wholesalers			25%	30%		
Home appliance retailers/ hypermarket	25%	15%		40%	60%	40%
Others (contractor, developers)	10%	25%	35%	20%	15%	30%

Share of local production and imported RAC is given in Exhibit 3.9. Philippines and Singapore import all the RAC products, while Thailand and Malaysia are dominated by local product. Indonesia and Vietnam's share of local product are still below 25% compared to the import.

Exhibit 3.9: Overview of shares of local production versus RAC imports, 2012 (BSRIA, 2012)

	Share of Local Production versus RAC Import (% Volume)					
	Indonesia	Thailand	Malaysia	Vietnam	Philippines	Singapore
Local production	13%	80%	78%	23%	0	0
Import	87%	20%	22%	77%	100%	100%

Flow of Trade in ASEAN

Exhibit 3.10 shows the export flow of RAC window or wall types, self-contained (HS 841510) in ASEAN Countries. Thailand export value for window or wall types RAC rank the highest in ASEAN. Amongst ASEAN countries, Vietnam is the country with significant import value of RAC, specifically from Thailand and Malaysia.

The major export destinations of Malaysian products as second biggest exporter of RAC in ASEAN, are Vietnam, Singapore, and apparently, Thailand also imports considerable value of RAC from Malaysia.

Exhibit 3.10: Export flow of RAC (HS 854140)

HS 841510 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia	12			33	82			160	238		525
Malaysia	3,267	88	42,029			350	15,909	73,693	68,592	132,312	336240
Philippines					9			136		9	154
Singapore	1,147	29,516	2,990	209	1,246	9,041	187		893	14,566	59795
Thailand	1,112	13,490	165,029	13,587	60,005	7,618	29,687	138,766		257,472	686766
Vietnam			52		8		12,602	3	2,556		15221

3.1.3 Refrigerators

Value Chain

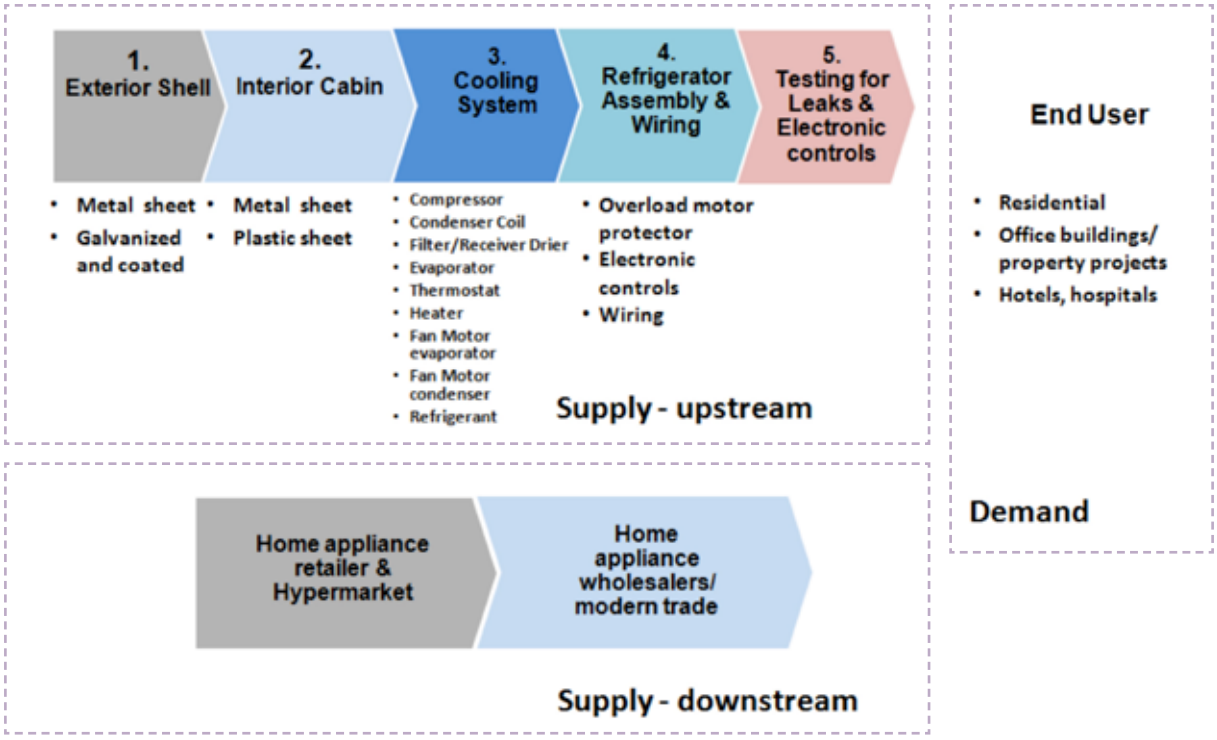
The simplified value chain of a refrigerator is illustrated in Exhibit 3.11. On the supply side, the upstream section shows the manufacturing process. The exterior shell is usually made with metal and coated with paint. The interior cabin is usually made from plastics. Usually, metal sheets, chemicals for the paint, and plastics are procured locally from third party suppliers. Key components such as compressors and motors involving technologically advanced manufacturing are normally pre-built.

A typical refrigerator manufacturing process requires the assembly of three parts, namely the exterior shell, the interior cabin and the cooling mechanism. Standard procedures for manufacturing the outer shell involve cutting and welding sheets of metal into appropriate sizes and spraying them with a coat of paint. The interiors of the refrigerators are usually made of plastic that require molding and shaping before being placed on the assembly line. Tubes for

refrigerant, water and electrical wires must be installed within the inner cabinet and connected to the mechanical parts. The back panel is then assembled with the compressor and storage tank for refrigerant. Finally, the doors are installed and fitted with seals. The assembly line will put together all these components. The next procedure is testing for leaks and electronic control to ensure that the refrigerator working properly.

The downstream section of the supply side illustrates the distribution channel prior to utilization by end-user. After the refrigerators pass their post-production quality inspections, they are packed with foam and boxes and shipped to distributors/ overseas markets. Refrigerators are distributed through retailers/ hypermarkets and home appliance wholesalers. In certain cases, refrigerators are marketed through contractors and/ or developers, via business-to-business transaction (B2B) for residential and commercial property projects, as well as projects such as hotels and hospitals.

Exhibit 3.11: Simplified Value Chain of a Refrigerator



Market in ASEAN

In ASEAN, production/ manufacturing of household refrigerators is found in Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam but mostly not using a local brand. According to Asia Research report (Kabe, 2012) the market for refrigerators in main ASEAN countries (Indonesia, Malaysia, Philippines, Vietnam, and Thailand) is dominated by Japanese and South Korean brands. Exhibit 3.12 shows the market share of Japanese and Korean brand refrigerators in five ASEAN countries in 2011.

Exhibit 3.12: Market Share of Refrigerators in 5 ASEAN countries (Kabe, 2012)

Country	Japanese Brand (%)	Korean Brand (%)
Indonesia	46.9	20.9
Malaysia	63.8	n.a.
Philippines	32.8	19.2
Vietnam	76.9	7.9
Thailand	53.4	n.a.

It is seen that mostly Japanese brands dominated the market of refrigerator in these five countries, except for in the Philippines. There was a local brand in the Philippines that dominated the local market, with a market share of about 25%[16]

Thailand has become the centre of local RAC manufacture for foreign brands in ASEAN. It was estimated that from all Japanese brands manufactured in ASEAN, 80% are manufactured in Thailand (Kabe, 2012). Similarly, from all Korean brands manufactured in ASEAN, 40% are manufactured in Thailand. The Japanese, South Korean, Chinese, as well as European brands are competing to increase production of various household appliances including refrigerators, through establishment of local manufacturing facilities in Thailand.

However, Vietnam's labour cost is becoming cheaper than Thailand's. This has attracted foreign investors looking for an alternative location to establish manufacturing facilities. It is predicted that Vietnam's share will increase rapidly as a competing country to Thailand (and other ASEAN countries) with regards to foreign direct investment for establishment of manufacturing facilities in ASEAN.

In ASEAN, production/ manufacturing of household refrigerator is found in Indonesia, Malaysia, Singapore, Thailand and Vietnam.

Flow of trade in ASEAN

Exhibit 3.13 and 3.14 show the export flow of household refrigerators, compression-type and others (HS 841821, HS 841829) in ASEAN Countries. Thailand dominated the export of household refrigerators, with its export value in ASEAN, especially for HS 841821, at about 88% of total ASEAN exports. Thailand exports household refrigerators to all ASEAN countries, and mostly to Vietnam, Malaysia, and Philippines.

For HS 841829, Thailand export value is also the first rank in ASEAN, being the major export destination to Myanmar and Laos.

[16] http://www.euromonitor.com/refrigeration-appliances-in-the-philippines/report

It is also seen that although the Philippines has local refrigerator manufacturing facilities, local production may only meet the domestic needs, as there is no export flow coming from this country.

Exhibit 3.13: Export from refrigerator producer countries in ASEAN to their ASEAN counter-parts (HS 841821, household refrigerators, compression-type & others)

HS 841821 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia					3,978	1,150	9,278	1,179	155	17	15,757
Malaysia	19		15				1	237	6		278
Philippines											-
Singapore	58	193	106		444	472	31			113	1,417
Thailand	375	4,479	5,610	10,221	46,990	3,225	22,946	11,166		102,594	207,606
Vietnam	37				7,236		2,455	8			9,736

Exhibit 3.14: Export from refrigerator producer countries in ASEAN to their ASEAN counter-parts (HS 841829, household refrigerators, other type)

HS 841829 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia					1	655	621	1	73	33	1,384
Malaysia	6							23	34	1,156	1,219
Philippines											-
Singapore	270	737	282		248	151	78		46	199	2,011
Thailand		571	1	504	97	2,075	3	24		6	3,281
Vietnam	13							1	2		16

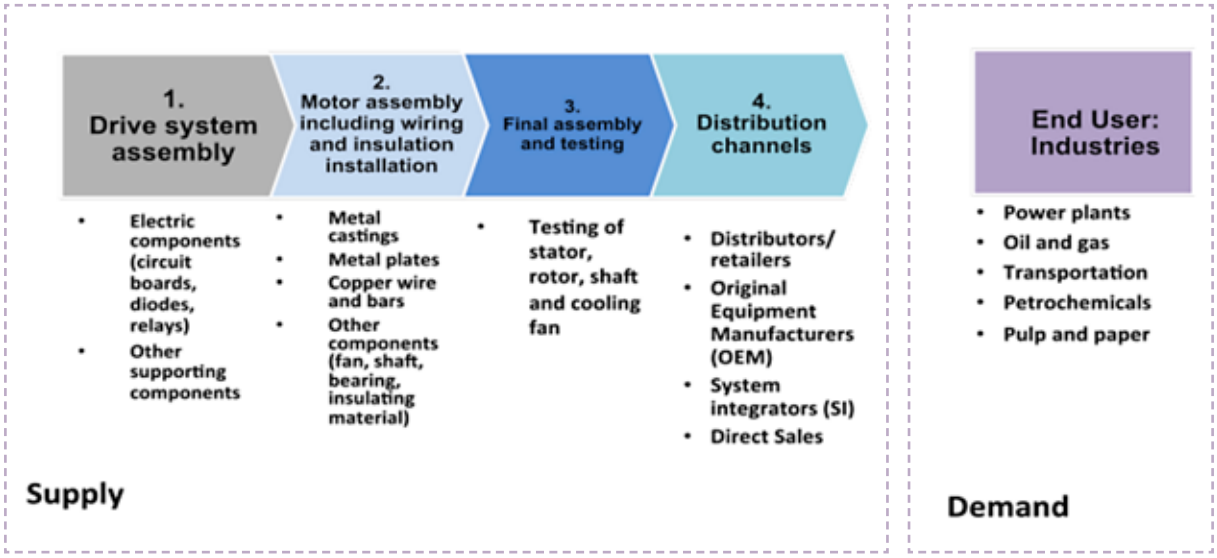
3.1.4 Electric Motors

Value Chain

Exhibit 3.15 gives a simplified illustration of a low voltage AC electric motor value chain. The manufacturing process starts with the drive system and motor assemblies. The drive system mainly comprises the electric components that would connect the motor to power sources. The drive governs the starting phase and protects the motor from electric shocks. The motor assembly process mainly integrates the motor components, i.e., stator, rotor, shaft, cooling fan and insulation material.

After final assembly and testing, electric motors reach the end-users in ASEAN countries via several distribution channels: distributor/retailers, original equipment manufacturers (OEM), system integrators (SIs), and direct sales. The end users are mainly industries in the following sectors: power generation, oil and gas, transportation, chemicals and petrochemicals, food and beverages, and water and wastewater.

Exhibit 3.15: Simplified Value Chain for low voltage electric motors



Market in ASEAN

Exhibit 3.16 illustrates the ASEAN market for low voltage electric motors in 2010 (Frost and Sullivan, 2012). Significant market size is identified in Indonesia and Thailand and is expected to continue in ASEAN, due to the continual growth of industrial sectors in these two countries.

Exhibit 3.16: Low voltage electric motor market in ASEAN countries (Frost & Sullivan, 2012)

Country	Market size (US$ Million) 2010 base year
Indonesia	79.7
Malaysia	55.4
Philippines	18.8
Singapore	33.5
Thailand	125.8
Vietnam	28.4
Other ASEAN Countries	27.4

In ASEAN, low voltage motors are widely used in transportation, heating, ventilation and air conditioning (HVAC), oil and gas and power generation industries. Other industries that also use low voltage motors in a wide range of applications are chemicals and petrochemicals, water and wastewater, and food and beverage.

Exhibit 3.17 provides the share of low voltage motors in various industrial sectors and their application in each sector (ASEAN).

Exhibit 3.17: End users and market size of low voltage electric motors (Frost & Sullivan, 2012)

Industrial sectors	Application in the sectors	Share of low voltage electric motor market (2010)
Transportation (including shipping and automotive)	Machineries in ship-building, automotive, and other transportation sectors	19%
Heating, ventilation and air conditioning (HVAC)	Fan and pumps in climate-control operations of residential and commercial buildings	17%
Oil and gas	Fans and pumps in upstream, downstream, and machineries in the refining process in oil and gas explorations	15%
Power generation	Pumps in cooling systems, compressed-air applications, and conveyors for raw-material feeding	14%
Water and Wastewater	Pumps in municipal water supply/ distribution, municipal waste water treatment, industrial waste water treatment, desalination, sewage treatment	13%
Chemicals and Petrochemicals	Machineries and pumps in agrochemicals, pharmaceuticals, polymers, paints, and oleo chemicals	12%
Food and beverage	Various food and beverage machineries. Filling, mixing, grinding, and bottling	11%

The following are key analyses identified as drivers of low voltage electric motors in ASEAN countries, which are related to the characteristic of each country's industrial sector growth (Frost and Sullivan, 2012).

- The key driver for low voltage motor growth in Indonesia is transportation, oil and gas and food and beverage sectors. Indonesia is expected to surpass the automotive giant, Thailand, as the largest automotive exporter of the region, and oil and gas, and power sectors continue to spur the motors market. Meanwhile, Indonesia's food and beverage and packaging industry seem to grow in tandem.
- In Malaysia, there is a rapid growth of low voltage motors in the oil and gas industry owing to well-developed infrastructure and abundance of this resource. The presence of foreign direct investment in petrochemical and chemical sector also boosts the low voltage motor market in this country. A major contributing

factor to this is the business-friendly environment, provided and supported by a government that attracts foreign direct investments. As a result of the partial and full liberalization of the automotive industry in 2015 and 2020 respectively, many new foreign participants will be enticed to make Malaysia their production hub or export destination. This will also drive low voltage motor market growth.

- Shipbuilding is a booming end user of low voltage motor in The Philippines. Steady growth of low voltage motors is seen in food and beverage, chemical industries and automotive equipment manufacturing.
- The upstream petrochemical sector dominates the low voltage motor market in Thailand. The country has become a net exporter of chemical and petrochemical products. Thailand also sees motors demand from HVAC, oil and gas, and water and wastewater sectors.
- Singapore's low voltage motors demand arises from three industrial sectors - power, water and wastewater, and chemicals. Most of the major market participants have distributors in the country. Amongst ASEAN countries, customers in Singapore tend to be more willing to adopt energy efficiency equipment as many multinational companies have their base in Singapore and customers are relatively less cost-sensitive when it comes to investment in a new energy-related technology.
- The power sector is the most attractive emerging sector for Vietnam's low voltage market demand. Since Vietnam entered the WTO list of countries in 2007, there has been steady growth in all end user industries, aided by a favorable investment environment and conditions provided by the government for foreign manufacturers. Hence, motors manufacturers are looking to shift their production base to Vietnam as it boasts competitive advantages, such as low wages and a relatively strong base of skilled work force.

Low voltage motors are mostly imported in ASEAN countries. In Philippines, the major sources of AC motors include China, Japan, Chinese Taipei and USA (Foreign Trade Statistics of the Philippines, 2009). Only one local motor company is identified in Indonesia, and the market is currently spurred by low-cost electric motors from China (Sipma, et al., 2015).

Distribution channels: In ASEAN, the retailers/ distributors account for 55% of the total market distribution channel of low voltage motors. The original equipment manufacturers (OEMs) follow with about 18% market share. About 12% of the market is channeled through system integrators (SIs). Engineering procurement construction contributes to both OEMs and SIs in turnkey projects and green field investments. Direct sales, which constitutes about 15% of the total market, is a less preferred mode of procurement currently, owing to the fact that the major motor manufacturers are international brands and typically operate through large distributor networks. The proportion of direct sales is likely to be due to the growing presence of local manufacturers in this region, despite the current dominance of imported international brands.

Flow of Trade in ASEAN

There is some production/ manufacture of electric motors in ASEAN, mainly in Malaysia, Singapore, Vietnam and Thailand, however most electric motors in ASEAN are imported. Exhibit 3.18. and 3.19 illustrating export flow of electric motors (HS 850152) in ASEAN, show that

for these products, Singapore's export value is in the first rank. The majority of electric motor products (HS 850152) from Singapore are exported to Malaysia and Indonesia, while more than half of the products from Vietnam are exported to Thailand. ASEAN's flow of trade of HS 850153 electric motors (AC Motors, multi-phase, of an output exceeding 750 W) shows a similar pattern as HS 850152 for Singapore. Hence, we could observe that Singapore export values are the highest amongst other ASEAN countries most probably because of its positioning as a hub for ASEAN trade, with very low or no import tariff and efficient custom and trade procedures.

Exhibit 3.18: Export from electric motors producing countries in ASEAN to their ASEAN counterparts (HS 850152, AC Motors, multi-phase, of an output exceeding 750 W but not exceeding 75 kW)

HS 850152 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia					8			51		4	63
Malaysia	10		3,966				4	4,583	2,420	333	11,316
Philippines									122		122
Singapore	249	15	6,054		4,406	65	1,129		1,099	3,312	16,329
Thailand		64	908	220	1,564	645	698	1,195		527	5,821
Vietnam		4	303		548		244		5,957		7,056

Exhibit 3.19: Export from electric motor producing countries in ASEAN to their ASEAN counterparts (HS 850153, AC Motors, multi-phase, of an output exceeding 75 kW)

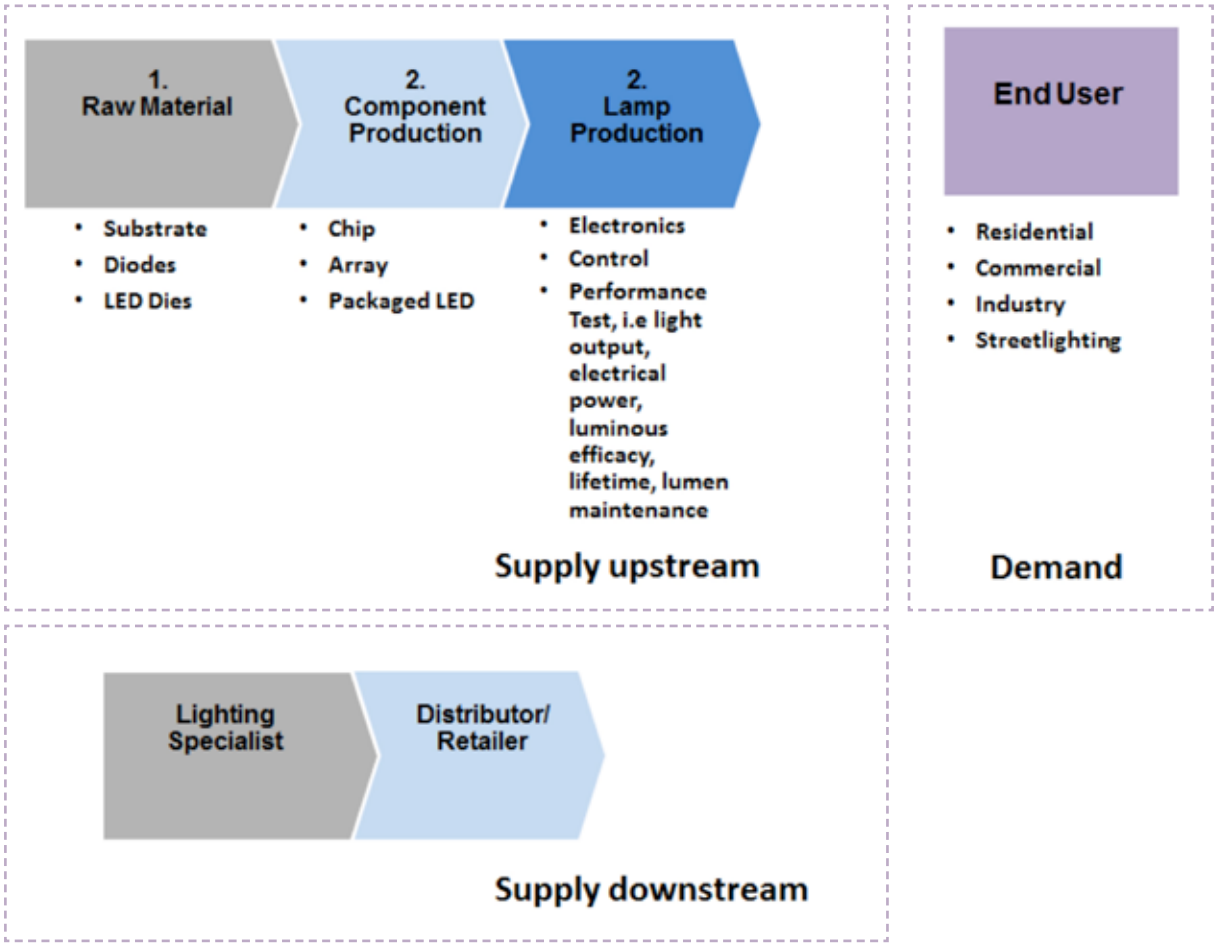
HS 850153 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia								475			475
Malaysia	31		96				8	178	33	214	560
Philippines			190		242				1,283		1,715
Singapore	19	304	7,137	1	1,986	199	810		20,530	1,353	32,339
Thailand				96	3	22				97	218
Vietnam					427			75	3		505

3.1.5 Lighting

Value Chain

The simplified value chain of LED is illustrated in Exhibit 3.20. On the supply upstream, the process consists of preparation of raw material, followed by component production and lamp production. The raw material of LED is diodes, which is made of very thin layers of semiconductor material, called wafers. Impurities are also placed within semiconductor layers. The different semiconductor materials (called substrates) such as gallium arsenide (GaAs), gallium phosphide (GaP), or gallium arsenide phosphide (GaAsP), and different impurities, result in different colours of light from the LED. The main process of making LED is cutting, of which wafers are cut in very small segments, called die. LED arrays are assemblies of LED packages or dies, and these can be placed on a chip.

Exhibit 3.20: Simplified Value Chain LED

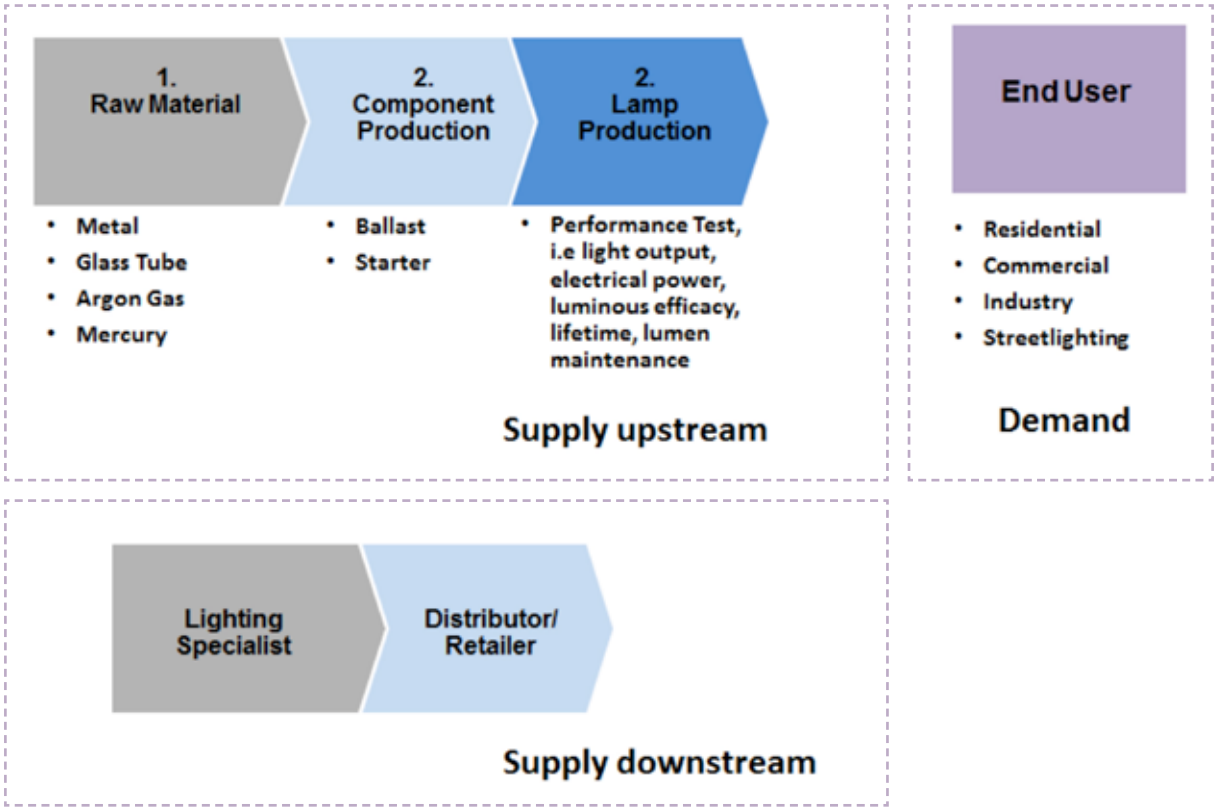


To complete the device, it is necessary to bring electricity to it and from it. Thus, wires must be attached onto the substrate. These wires must stick well to the semiconductor and be strong enough to withstand subsequent processing such as soldering and heating. LEDs are encased in transparent plastic. The wires and die are suspended inside a mould that is shaped according to the optical requirements of the package (with a lens or connector at the end), and the mould is filled with liquid plastic.

The simplified value chain of a linear fluorescent is illustrated in Exhibit 3.21. Fluorescent lamps are made of glass tubes that contain mercury vapour and argon gas. When electricity flows through the tube, it causes the vaporized mercury to give off ultraviolet energy. This energy then strikes phosphors that coat the inside of the lamp, giving off visible light.

Before the lighting product is send to market, several performance tests will be run in order to ensure that the product will work properly. Performance tests are normally run on the light output, the electrical power required to operate the lamp, and luminous efficacy or efficiency. Performance tests usually involves “lifetime”, the total time for which a lamp can be operated before it becomes useless. Lumen maintenance determines how much of a lamp’s light output remains after a period of controlled operation, compared to when it was new.

Exhibit 3.21: Value Chain Linear Fluorescent



Distribution channel: The downstream section of the supply side for linear fluorescent lights and LED lights are similar, consisting of lighting specialists and retailers. In residential sectors, lighting is mostly distributed through retailers. In commercial market, lighting specialist provides services that cover design, implementation and maintenance for project owner or customer. Often, lighting manufacturers/ distributors have their own lighting specialists, with capability to do energy modeling with regard to illumination level, so that project owners/ customers will be able to directly work with the products.

The end-users of lighting can be divided into four groups, namely residential sector, industrial customers, commercial sector such as hotels, malls, hospitals, and specific users for streetlights.

Market in ASEAN

Exhibit 3.22 shows the survey result (Coyne, S, et.al., 2016) of the annual sales of lamps and the fraction of annual sales of linear fluorescent and LED lamps in ASEAN. It is shown that in ASEAN, linear fluorescent lights are still more prevalent than LED. Although LED is more energy efficient, the product has just recently entered the market and the price is still more expensive than linear fluorescent. However it is predicted that this market share of LED will gradually increase through natural market growth, over the next few years.

Exhibit 3.22: Annual sales of lamps for all ASEAN member states (Coyne, S, et.al., 2016)

Country	Annual Sales (Mio)	Annual Sales (%)	
	All lighting types	Linear Fluorescent	LED
Brunei Darussalam	n.a	n.a	n.a
Cambodia	7,5	50	n.a
Indonesia	100	n.a	n.a
Lao PDR	2	65	1
Malaysia	50	33	n.a
Myanmar	31	n.a	n.a
Philippines	113	23	n.a
Singapore	25	50	n.a
Thailand	97	46	10
Vietnam	150	n.a	n.a

Flow of trade in ASEAN

In the trade data of lighting appliances, there is no specification information of HS Code for different types of light, i.e. linear fluorescent or LED. Therefore, in this analysis, HS Code is assumed applicable to all type of lighting appliances, including linear fluorescent and LED.

Exhibit 3.23 shows the exports from lighting producer countries in ASEAN to their ASEAN counterparts for HS 940510 (chandelier and other electric ceiling or all lighting fittings, excluding those of a kind used for lighting public open space or thoroughfares). Malaysia dominates the export to ASEAN countries, followed by Thailand. Mostly of these products (about 70%) are exported to Singapore. The majority of products from Thailand are exported to Myanmar. For lighting products HS 940540 (electric lamps and lighting fittings), seen in Exhibit 3.24, Singapore export value is the first rank amongst ASEAN countries, with its products mostly exported to Indonesia and Malaysia. The total export value from Singapore is accounted 66% of the total export value in ASEAN.

Exhibit 3.23: Export from lighting producer countries in ASEAN to their ASEAN counter-parts (HS 940510, Chandelier and other electric ceiling or all lighting fittings, excluding those of a kind used for lighting public open spaces or thoroughfares)

HS 940510 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia					12	5	25	173	130	479	824
Malaysia	496	311	3,942			791	302	24,641	2,962	1,265	34,710
Philippines					7			55	19		81
Singapore	679	1	7,070		1,461	240	237		640	195	10,523
Thailand	5	1,804	2,655	1,178	348	4,072	165	1,229		807	12,263
Vietnam			190		25		9	24	59		307

Exhibit 3.24: Export from Lighting producer countries in ASEAN to their ASEAN counter-parts (HS 940540, Electric lamps and lighting fittings)

HS 940540 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia					167		19	614	715	19	1,534
Malaysia	247	49	2,850			527	271	4,001	919	1,866	10,730
Philippines								220			220
Singapore	3,366	52	17,939	1	10,429	1,089	1,908		5,414	1,756	41,954
Thailand	13	424	353	631	420	674	329	1,771		312	4,927
Vietnam	2		6		17		8	3,729	215		3,977

3.1.6 Solar PV

Value Chain

The simplified value chain of solar PV power system is given in Exhibit 3.25. The manufacturing process starts from making of ingot and wafers. Poly-silicon, which is made of metallurgical grade silicon through certain chemical process, is melted into poly-crystalline silicon ingots. These ingots are then sliced into wafers. These wafers are etched and cleaned, and require chemical doping to create the “semiconductor” properties on their surface. An anti-reflective coating is added and finally the cells are fused together with metal contacts so the cells are able to collect electrons for electricity. Once coating is done, PV cells are sorted and checked for quality control.

PV modules are assembled from PV cells. In this stage, the solar cells are laid out on a back sheet and interconnected. Solar grade glass, which constitutes the bulk of the module’s mass, is added atop of the cells and back sheet. A junction box is added to the box allowing for electricity interconnections to be made. If the PV module design calls for a frame, this is added last.

Individual PV modules are eventually wired together in PV arrays and installed with the Balance of System (BoS) to build a solar PV power system. The end application of solar PV is for utility application (on-grid connection), solar PV rooftop in residential or commercial properties, and for off-grid application, often in remote area where grid-extension does not exist or is not economical to be built.

In terms of solar PV cells/Modules and components supply, the following are brief observation made in the big six ASEAN countries:

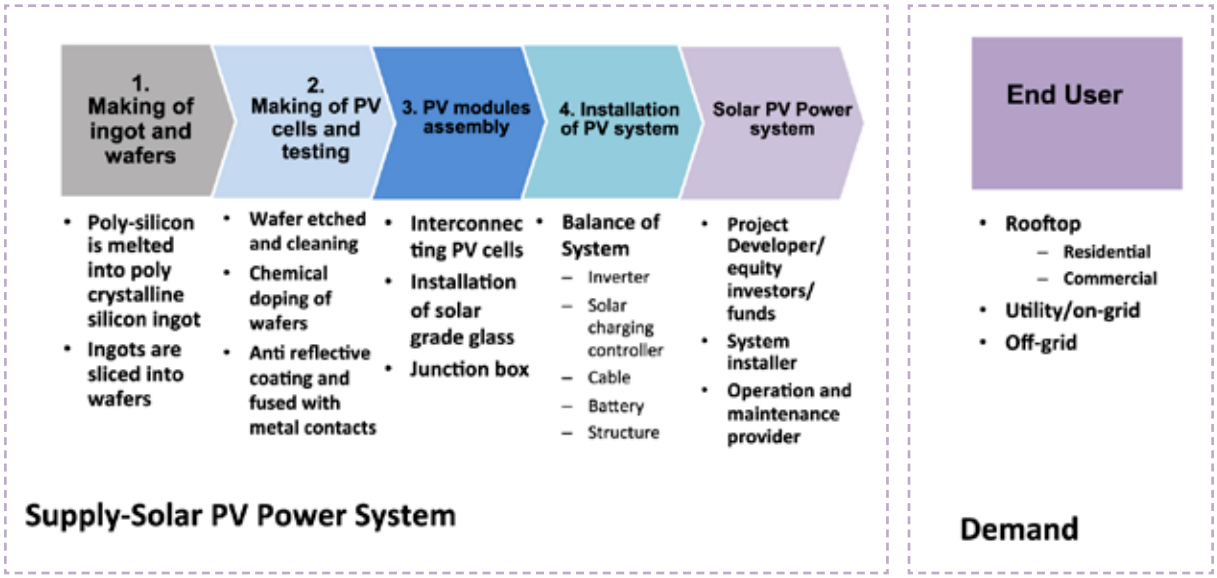
- In Indonesia, local companies that claim producing solar PV modules are still importing the PV cells, and local activities are limited only to encapsulation and framing the modules. Most of the Balance of System (BoS) components such as inverter, structure, battery, etc. are still imported.
- Malaysia has one factory that produces metallurgical grade silicon, the raw material to create poly-silicon, and another factory that produces poly-crystalline silicon. Both are foreign direct investment companies, of which one is from Korea and another is from Japan. Manufacturers of solar PV cells are available locally (about eight

companies) and few of them are 100% local ownership. The BoS is available locally but mostly is foreign direct investment companies.

- In Thailand both local and foreign players are available in Thai market for solar PV modules/cells, and BoS. There is no local production of metallurgical grade silicon.
- Local manufacturers of solar PV Modules, cells and wafers are found in Philippines and Singapore, while the BoS are imported but available locally.
- PV companies are mostly importing PV Cells and assembling modules in Vietnam. Most of the BoS components such as inverter, structure, battery, etc. are still imported.

The key actors identified in solar PV power system development are project developer/equity investors, system installer, service provider for Operation and Maintenance. These actors play a kind of "distribution channel" roles in driving the solar PV power market growth in ASEAN.

Exhibit 3.25: Simplified Solar PV Value Chain



Market in ASEAN

In the absence of updated and detailed information on the production of solar PV modules in terms of value, and emphasizing the focus of the solar PV industry as solar PV system and not only the solar PV modules, the information of the solar PV power market is provided in terms of installed capacity (kW) . Compared to its potential, installed capacity of solar PV generation in ASEAN countries are still limited (see Exhibit 3.26) Higher growth is expected in this region, but requires stable electricity regulations and investment policies.

Exhibit 3.26: Installed capacity of Solar PV power generation in ASEAN (Sources: Various)

No.	Country	Installed capacity (MW), 2014	Source
1	Brunei Darussalam	1.2	Tabrani, 2015
2	Cambodia	1.6*	http://www.evwind.es/2015/07/21/cambodia-has-big-renewable-energy-potential/53444
3	Laos	1	ADB, 2012
4	Malaysia	166.1	SEDA, 2015
5	Myanmar	N/A	N/A
6	Indonesia	61.6*	Abdul Rosyid, 2015
7	Philippines	219.2	http://www.pv-magazine.com/news/details/beitrag/conergy-completes-201-mw-of-solar-pv-in-the-philippines_100023945/#axzz4AI2L7cjQ.
8	Singapore	26.5*	http://www.ema.gov.sg/statistic.aspx?sta_sid=20140730tzT7HYFaefda.
9	Thailand	945	http://www.ema.gov.sg/statistic.aspx?sta_sid=20140730tzT7HYFaefda.

* The original information is in nominal power, Watt-peak (Wp). Actual watt (W) is estimated as 20% lower than the nominal power

Flow of trade in ASEAN

Flow of trade for solar PV (HS 854140) in ASEAN is tabulated in Exhibit 3.267. This table indicates that export value of solar PV (HS 854140) from Malaysia accounts more than 60% of the total export value of big 6 ASEAN member states. The majority of solar PV (HS 854140) from Malaysia is exported to Singapore and Thailand. Also, the majority of solar PV (HS 854140) from Singapore is exported to Thailand. This is supported by the supply chain information that Solar cell crystalline silicon production (material to produce solar cells) in ASEAN is identified in Malaysia.

Exhibit 3.27: Export from Solar PV producer countries in ASEAN to their ASEAN counter-parts (HS 854140, Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes)

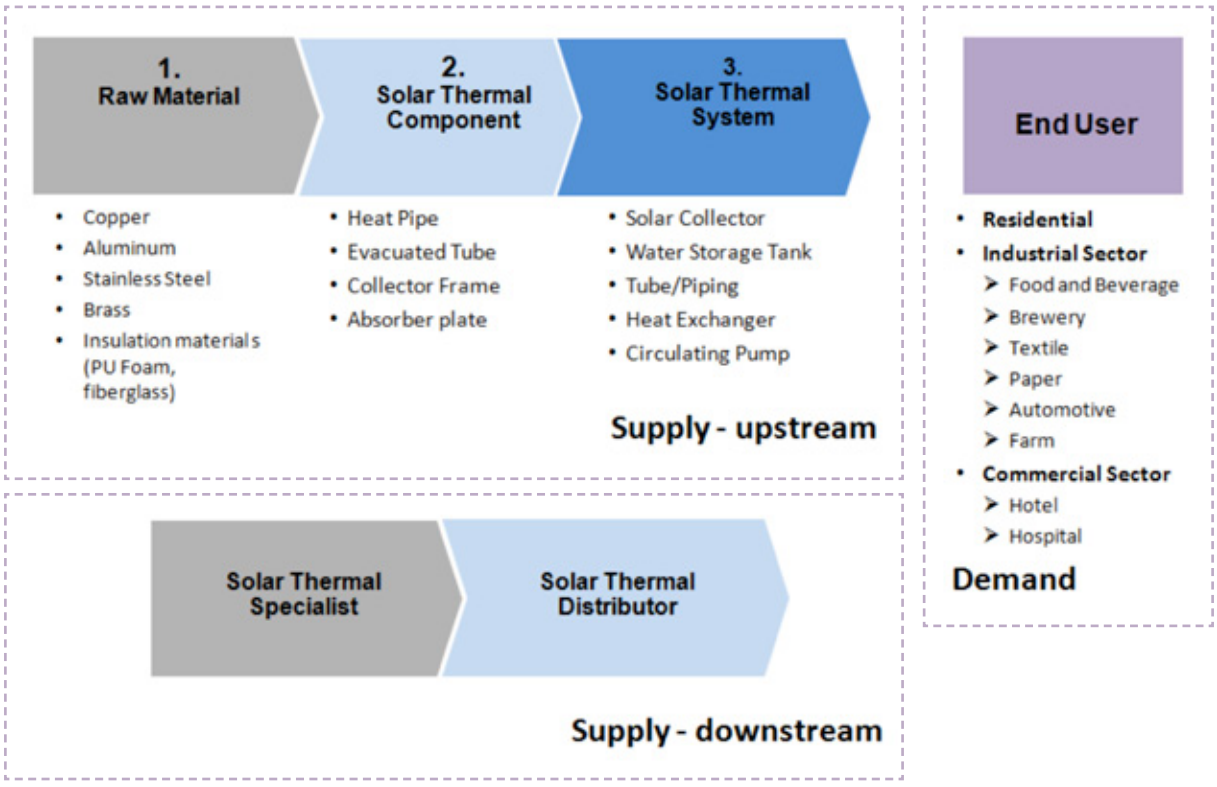
HS 854140 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia					102		5,741	21,465	1,547		28,855
Malaysia	2	11	501	54			79,102	154,062	126,734		360,466
Philippines			176		792			140	1,951		3,059
Singapore	116	70	44,039			419	31,530		73,120	5,785	155,079
Thailand		460	267	1,790	20,448	191	3,386	10,151		781	37,474
Vietnam			1,407		1,252			151	480		3,290

3.1.7 Solar Thermal

Value Chain

Exhibit 3.28 illustrates the simplified value chain of a solar thermal system. On the supply side, the raw materials are essential metals for manufacturing solar thermal system components, such as copper, aluminum, stainless steel, brass and also insulation materials such as polyurethane foam (PU foam) and fiberglass, provided by suppliers.

Exhibit 3.28: Simplified value chain of a Solar Thermal System



These raw materials are processed to produce the components of a solar thermal system, including heat pipe, evacuated tube, collector frame, absorber plate and others. In some cases, suppliers provided pre-fabricated components. The manufacturing process of solar thermal equipment includes the assembly of the components, such as the solar collector, water storage tank, tube/ piping, heat exchanger and circulation pump into a solar thermal system.

The downstream section of the supply side illustrates the distribution channel prior to utilization by end-user. In general, a solar thermal specialist provides extensive services, which include designing, implementation and maintenance of solar thermal systems for the project owner. It is found that solar thermal distributors often have their own solar thermal specialist, to assist project owners to install the products efficiently.

The end-users of solar thermal systems can be divided into three categories; these are the residential sector; industrial customers such as food and beverage industries, breweries, textile, paper, automotive and farming businesses; and the commercial sector, such as hotels and hospitals.

Market in ASEAN

The dominant markets for solar thermal in ASEAN are found in the Philippines, Vietnam and Thailand. There is limited information regarding market and distribution channels of solar thermal systems in other ASEAN countries.

In the Philippines, the application is specifically in solar water heating with the various market in high-income earning residential consumers, hotels, hospitals and the tourism industry (IIEC, 2011). In 2001, there were already more than 433 solar water heaters installed, especially in resorts, sports complexes, hotels, restaurants and sauna baths, and in high-income residential areas where hot water is used for dishwashing and bathing. The installed capacity of systems usually ranges between 200 and 400 liters (prefabricated systems) for residential customers, who purchase 75% of total installations (IIEC, 2011).

By 2006, about 3.8 million SWH systems were installed in Vietnam. Evacuated tube type SWH installations in the domestic sector have a large share of SWH business in that country. In Ho Chi Minh City, the annual growth rate of SWH installations has been 40-50% since 2008, in response to the government's financial incentive scheme. Vietnam has set a target to install 1,760,000 m2 of collector area for SWH by 2015, and 9,100,000 m2 of collector area by 2025 (IIEC, 2011).

Thailand is the most advanced country in ASEAN for installing solar thermal systems. Solar collectors currently distributed in Thailand are either locally manufactured or imported from China, Israel, Italy, Australia or Germany, with domestically fabricated collectors moving up towards 50% of the market (local to imported; 43% to 57%); (Ipsos Business Consulting, 2013). Solar water heaters are mostly installed in the residential sector via two sources; householders buy a home from a property developer with a pre-installed product, or hire a subcontractor to install a system. Out of 40 providers currently operating in Thailand, the majority sells only flat plate solar collectors, despite their relative inefficiency, mostly because evacuated tube collectors are more fragile, and require more maintenance after installation. By 2012, Thailand

recorded a total area of 20,8152 of solar collectors in operation. The market has experienced a substantial annual expansion rate of 17.4% due to the solar thermal subsidy program, which from 2008 until 2012 provided 30% financial support to project owners who used the technology (Ipsos Business Consulting, 2013).

Flow of trade in ASEAN

The trade flow of solar thermal (HS 841990) in ASEAN is shown in Exhibit 3.29. Singapore has the highest exports to other ASEAN countries, followed by Malaysia. Thailand also exports solar thermal product to all other ASEAN countries, but the figures show that the Thailand's total export value is only equal to 30% of Singapore's total export value to other ASEAN countries. As 70% of Thailand's exports go to Vietnam, the we can deduce that there are significant imports of solar thermal products from outside ASEAN, which are then re-exported to other ASEAN countries from Singapore, demonstrating that country's advantage as a trading hub.

Exhibit 3.29: Export from Solar Thermal producer countries in ASEAN to their ASEAN counter-parts (HS 841990, Solar Flat Plate Collector & Solar Evacuated tube collector including parts)

HS 841990 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia					106	12	45	863	419	1,191	2,636
Malaysia	274	16	17,891			11	1,620	25,092	3,562	1,618	50,084
Philippines			11		3			7	67	2	90
Singapore	78	11	25,540	21	18,487	645	2,884		8,171	1,249	57,086
Thailand	1	14	2,157	517	889	310	188	520		12,345	16,941
Vietnam			34		117		84	518	13		766

3.2 BARRIER ANALYSIS / RECOMMENDATIONS FOR MITIGATING BARRIERS

By restricting market access, differences in tariff regimes represent a potential barrier to inducing a positive market transformation in favour of energy efficiency and renewable energy technologies in ASEAN countries. In addition to tariffs, additional factors can further influence trade, supply chain integration, and thus the large deployment of these technologies. The following section discusses the relevance of these potential barriers.

3.2.1 Tariff Barriers

An analysis of tariff barriers provided in this section is based on six-digit HS code and the preferential tariff. The preferential tariff in ASEAN countries is highlighted, and the actual tariff applied, based on Trade Map[18] is compared with the MFN tariff for each technology.

A. TRANSFORMERS

MFN Tariff: The MFN tariffs higher than 5% for distribution transformers' six-digits HS codes (HS850421, HS850422, HS850433, HS 850490) are identified for Cambodia, Indonesia, the Philippines, and Vietnam.

[18] www.trademap.org

Preferential tariff: There are no records in the ATIGA preferential tariff schedule for preferential tariffs in the ASEAN Free Trade Zone for products with the distribution transformer six-Digit HS Code (HS850421, HS850422, HS850433, HS 850490). However, the ITC Trade Map of 2015 shows that Cambodia and the Philippines apply regional tariffs to these six-digit HS Codes; Cambodia applies a tariff of 2 to 5 %, the Philippines 1.7 to 5 %.

B. ROOM AIR CONDITIONERS

MFN Tariff: The application of MFN tariff for RAC (HS 841510, air conditioning machines window or wall types, self-contained) varies within ASEAN countries. Malaysian and Thailand are applying the highest ASEAN MFN tariff at 30%, followed by Vietnam at 25%. Indonesia, the Philippines, Cambodia and Lao PDR are also applying relatively high MFN tariffs, ranging from 10% to 20%. On the other hand, Singapore applies a 0% MFN tariff, with Myanmar and Brunei Darussalam only applying 1% and 5%, respectively.

Preferential tariff: Regarding preferential tariff for RAC in ASEAN, the Philippines and Vietnam both apply a preferential tariff of 5% for RAC (HS 841510), despite an agreed 0% rate under ATIGA.

C. REFRIGERATORS

MFN Tariff: For compression type refrigerators (HS 841821), Malaysia, Thailand and Vietnam are still applying relatively high MFN tariffs (25-30%), while Brunei Darussalam and Singapore only apply 5% and 0%, respectively. Indonesia, Lao PDR, Myanmar, and the Philippines all apply a 10% MFN tariff, and Cambodia 15%. For other types of refrigerators (HS 841829), almost all ASEAN countries apply the same percentage MFN tariff as for HS 841821, except Vietnam, which applies the highest MFN tariff of 35%.

Preferential tariff: Even though submission to ATIGA shows the preferential tariff for selected technologies in ASEAN was set to be at 0% by 2015, it can be seen that three countries (Cambodia, Philippines and Vietnam) are still applying a 5% tariff for refrigerators (HS 841821, HS 841829).

D. ELECTRIC MOTORS

MFN Tariff: For electric motors under HS 850151, Vietnam, Indonesia, Thailand and Cambodia are still applying relatively high MFN tariffs of between 9% and 15%. Both Brunei Darussalam and Laos are applying an MFN Tariff of 5%, and Myanmar and the Philippines are applying a 1% tariff. Malaysia and Singapore have already reached zero tariffs. For electric motors under HS 850152, all ASEAN Countries are applying similar MFN tariff as for HS 850151, except Malaysia (high tariff at 15%) and Vietnam (medium tariff, 4.3%). For electric motors under HS 850153, Indonesia and Cambodia are applying relatively high MFN tariffs (10% and 15%), while Malaysia, Singapore, and Vietnam are applying 0%. Myanmar, the Philippines and Thailand are applying a 1% MFN tariff, and Brunei Darussalam and Lao, 15%.

Preferential Tariff: Despite preferential tariff committed to under ATIGA for HS 850151, HS 850152, and HS 850153s, Cambodia is still applying a 5% tariff for all these products. Vietnam is applying 4% tariff for HS 850151 only, and Myanmar 1% tariff for HS 850153.

E. LIGHTING

MFN Tariff: For lighting products under HS 940510, most ASEAN member states are applying relatively high MFN tariffs (from 7.5 to 22.5%), with Malaysia applying the highest. Only Myanmar and Singapore have low tariffs (1% and 0%). Both Brunei Darussalam and Lao PDR apply a 5% tariff.

For lighting products under HS 940540, half of ASEAN member states are still applying relatively tariffs above 5%, while Singapore, Myanmar and the Philippines are applying relatively low tariffs of 0%, 1%, and 4%, respectively. For lighting product HS 940510, both Brunei Darussalam and Lao PDR have a 5% tariff.

Preferential tariff: Based on observation of actual tariff applied for HS 940510 and 940540 in 2015 in ASEAN Countries, Cambodia and the Philippines are still applying tariffs of 5% and 4.2%, respectively. For the product HS 940540, Cambodia is applying a tariff of 4.4%, and the Philippines, 3.1%.

F. SOLAR PV

MFN Tariff: The majority of ASEAN member states are applying relatively low MFN tariff (0% - 1%) for solar PV under HS Code 854140, with only Myanmar, Cambodia, and Lao PDR still applying medium tariffs of 7.5%, 7%, and 5%, respectively.

Preferential tariff: The submission to ATIGA has set the preferential tariff for selected technologies in ASEAN at zero by 2015. Cambodia, however, is still applying a tariff of 1% for ASEAN countries, for solar PV product (HS 854140).

G. SOLAR THERMAL

MFN Tariff: For solar thermal product (HS 841990), the majority of ASEAN countries are applying low MFN tariffs (0 – 5%), with only Lao, Malaysia and Cambodia still applying relatively high MFN tariffs (10%, 13.8% and 15%).

Preferential Tariff: Despite the committed preferential tariff of 0% under ATIGA, Cambodia is still applying a tariff of 1% for this product.

Key findings on tariff barrier analysis:

Based on the observation of MFN tariff and actual tariff applied in ASEAN countries, it can be concluded that for household products such as air conditioners and refrigerators, where manufacturing facilities are located in ASEAN countries and trade flows are already established in the region with preferential tariff under ATIGA, the MFN tariffs are mostly seen to be higher. This has the impact of protecting the domestic and regional products and at the same time facilitating intra-ASEAN trade integration of these products.

Air conditioners and refrigerators with higher energy efficiency could take advantage of this trade environment, provided that it is possible to manufacture the EE technologies locally in ASEAN member countries. Local manufacturing of AC and refrigerators is already quite widespread in the big six ASEAN Countries, hence potential for technology transfer of EE could be realized, by not importing products but by bringing in international experts to build the capacity of the local

manufacturing supply chain.

For electric motors - which are mostly imported - access to energy efficient motors could benefit Singapore as an intermediary trading hub, for lower import cost.

Despite the commitment to apply zero tariffs under ATIGA, several countries are still imposing low tariffs. Hence, enforcement of ATIGA may need to be re-assessed.

3.2.2 Non-tariff Barriers

The non-tariff barriers constitute key topics such as harmonization of standards and policies, which are discussed further in the following chapter, and are briefly introduced below.

Non-tariff Barriers: In analysing the non-tariff barriers for selected EE and RE technologies, the following can be concluded. Firstly, protection of national industry through local content requirements and limitation of foreign direct investment is still seen in a few ASEAN countries where there are no tariff barriers (unlike household products), e.g. solar PV in Indonesia. This will impede access to low-cost, legitimate products in these countries, despite the low tariff under ATIGA and efficient custom processes.

Secondly, there are limitations on investment in RE technologies in Indonesia, Malaysia and Myanmar. As ownership of renewable energy power generation is limited for foreign investors, the level of financing available for these technologies is restricted to a smaller pool of capable local investors and players. This condition creates a barrier for market growth that will indirectly influence the growth of intra-ASEAN integration in RE technologies.

Thirdly, despite the official ASEAN regional cooperation on Rules of Origin and Mutual Recognition Agreement on Safety Standards, there is no identifiable regional effort underway to promote a regional labelling that would facilitate recognition of EE products based on energy efficiency performance.

04

POTENTIAL FOR INCREASING INTRA-ASEAN VALUE CHAIN COOPERATION AND TRADE IN EE AND RE TECHNOLOGIES

This chapter provides a high-level analysis on the influence of the existing policy and regulatory frameworks related to EE and RE technologies and trade on intra-ASEAN integration, as discussed in Chapter 2. This chapter offers preliminary findings on the implications of these policies and regulations from the regional perspective of ASEAN. It also gives a bird's eye view of the positioning of ASEAN member countries in terms of value chain integration and trade of EE and RE equipment, and identifies the market and trade barriers that exist in various value chains, based on the value chain assessments in Chapter 3.

4.1 ASEAN MARKET FOR EE AND RE TECHNOLOGIES: AN INTRA-ASEAN PERSPECTIVE

4.1.1 Energy performance standards, MEPS and Labeling

RAC, refrigerators and lighting are household products for which the target markets are very wide, ranging from individuals/household use to business, from residential to commercial and business properties. These products are mostly sold in the retail market and require little design customization to meet people's needs. Setting up standards for these products is easier than for those products with more tailored specifications and narrower targeted markets, such as electric motors and distribution transformers.

Hence, it is understandable that the study identifies more countries putting in place national standards and/ or adoption of international standards for energy performance methods for RAC, refrigerators and lighting, than those working on standards for distribution transformers and AC induction electric motors. Setting up standards for mass products is simply easier. Thus some "low hanging fruit" are identified for immediate action, by replacing conventional RAC, refrigerators and lighting with more energy efficient ones in the ASEAN region.

It is clear that Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam, lead the way in setting up national standards for measuring energy performance testing methods and adopting international standards to the national standards. This is particularly obvious for RAC, refrigerators and lighting, but similar patterns are also seen for MEPS and labelling, showing that there is awareness and commitment in these countries, and they are making solid efforts towards achieving their national energy policy targets. Nevertheless, in terms of a regional perspective, advanced work in progressing individual commitments to align with international standards regionally and setting up a regional MEPS is only found for RAC technologies. In other technologies, the study identified that:

- MEPS and labelling level requirements vary considerably across the region;
- There is lack of enforcement of MEPS (in electric motors, lighting, refrigerators and distribution transformers), even for countries that have developed and implemented their MEPS;
- Across the technologies being studied, labelling is still in the initial stage, even for the big six ASEAN countries.

Furthermore, a lack of harmonization of standards for energy performance testing methods, MEPS and labelling, as well as the lack of a regional mutual recognition agreement for energy performance standards, are creating significant non-tariff barriers in the way of intra-ASEAN

trade for EE technologies. Thus as ASEAN regional cooperation progresses beyond RAC, focussing on energy efficiency for other mass household products such as refrigerators and lighting, is expected to yield substantial regional energy savings.

With regards to solar PV in ASEAN, there are no national standards issued, nor international standards adopted, on energy performance testing methods for solar PV cells and modules. The standards that are currently adopted are mostly related to connecting the solar PV system to the grid and to the Balance of System (BOS). Having a regional standard on energy performance rating for modules/cells will be very important in the future, when solar PV modules/ cells are mass-produced in the region.

4.1.2 Policies/ Regulatory Framework to Promote RE and EE

Exhibit 4.1 illustrates a summary of the status across the region of key EE and RE policies and regulatory frameworks and of incentives for RE and EE technologies. Malaysia, Indonesia, the Philippines, Singapore, Thailand and Vietnam all have energy efficiency policies and a regulatory framework, including MEPS and labelling, although the level of detail and enforcement vary across these countries. Fiscal incentives such as tax exemption for importing EE/ RE products are identified in Indonesia, Singapore, the Philippines and Thailand.

These regulations and incentives facilitate the growth of market of EE and RE technologies, giving indirect support to intra-ASEAN trade integration of these particular technologies. Where there is a lack of policies promoting EE and RE, and of incentives for these technologies, the market for utilisation of EE technologies and RE deployment in the region is discouraged. Moreover, EE and RE will always depend on how the electricity market is regulated, and in ASEAN region the electricity market is heavily policy-regulatory driven.

The enforcement and implementation of these incentives for EE and RE, though, are not without barriers. Based on discussion with a few key players about RE products in select countries, importers still find difficulties in clearing their imported RE product, despite existing incentives and tax facilities for environmentally friendly products. For example, in Indonesia, RE project developers often spend considerable time in custom clearance due to failure of the system to recognize the environmentally-friendly characteristics of the products, despite existing regulations on custom tax exemption for RE technologies. Establishment of a regional labelling for EE/RE technologies would thus facilitate market access notably through trade for these technologies.

Exhibit 4.1 Summary of existing status on key EE and RE policies and regulatory framework; and incentives for RE and EE Technologies in ASEAN Countries

Country	Key Energy Efficiency and Renewable Energy Policy and Regulation		Renewable Energy & Energy efficiency incentives/ tax	
	Energy Efficiency and energy conservation policy/ regulation/ law	Renewable energy target	Feed-In tariff for Solar PV	Fiscal incentives (tax exemption, subsidies, etc.)
Brunei Darussalam	No, under development	Yes, 10% power generation by 2035	No	No
Cambodia	No, under development	No	No	No
Laos	No, under development	Under development	No	No
Indonesia	Yes	Yes, 23% of energy mix by 2025	Yes	Yes, but under utilized
Malaysia	Yes	Yes, 24% from energy mix by 2050	Yes	Yes
Myanmar	Yes	No	No	No
Philippines	Yes	Yes, 50% of energy mix by 2030	Yes	Yes
Singapore	Yes	No	No	Yes
Thailand	Yes	Yes, 25% of total power generation from renewable energy by 2021	Yes	Yes
Vietnam	Yes	Yes, 6% of total power generation by 2030	Under development	Under development

4.2 Value Chain Analysis/ Barriers to Trade/ Market Transformation

Based on the analysis of value chain conducted in Chapter 3 for selected technologies, the following observations were made:

- Local manufacturers and intra-region trade flow are available for RAC, refrigerators, lighting and distribution transformers. Electric motors are mostly imported while most of solar PV value chain is imported, with the exception of the assembly of the solar modules and panels. Manufacturers of solar cells in ASEAN are only found in Malaysia, the Philippines and Singapore.
- Refrigerators and lighting are household appliances for which local market and intra-ASEAN trade flow are already established. Hence, promoting the economic and environmental value of refrigerators and lighting with higher energy efficiency ratings to consumers in the ASEAN market could be facilitated through existing marketing channels and established distributors.
- In Indonesia, Thailand, Malaysia and Vietnam, impulse buying for cheaper products, without considering the lower operating cost and energy consumption, is still a common market behavior. This is evident from the dominance of non-inverter RAC compared to the cheaper-to-run inverter models.
- Utilization of more energy-efficient technologies is sometimes hindered through lack of skilled labor to install the technology properly, for example in Indonesia, where low utilization of non-inverter RAC is partly due to the lack of skilled technicians who know correct installation procedures for the inverter RAC.
- While Singapore positions itself as a trading hub, applying very low to zero tariffs for imports, Vietnam has attracted foreign investment for establishing manufacturing facilities by promoting the country's cheap labor cost relative to Thailand and Indonesia. It may be possible for ASEAN to develop a "positioning role" for each ASEAN member countries, in terms of intra-ASEAN trade integration.

4.2.1 Tariff and non-Tariff Barriers to Trade

With regards to tariffs for the technologies covered in this study, the preferential rate in ASEAN under ATIGA is to apply mostly "tariff free" rates for all products. Only a few countries (such as Cambodia and the Philippines) are still applying tariffs (low, less than 5%) for these technologies to their ASEAN counterparts. Hence tariffs are no longer a significant barrier for intra-ASEAN trade. However, for products that are mostly imported from outside ASEAN countries, such as highly efficient electric motors, tariff still plays a role. In this case, Singapore as the main trading hub in ASEAN could play a role as a facilitator for intra-ASEAN trade, because the country has the lowest average MFN tariff, with most tariffs for these products set at zero.

Participation of ASEAN Countries in EGA: Recently, a few ASEAN countries have shown interest in participating in the EGA. Since in ASEAN countries the current tariffs for most of the equipment under the scope of the study are already nil (or close to zero), the interest

of countries (such as Thailand, Malaysia, or Vietnam) can be understood only from a global perspective (rather than from a regional one). Discussion with Trade and Facilitation units of various ASEAN countries, the Market Integration Directorate (MID) and the ASEAN Economic Community (AEC) Department suggest that these countries are not looking for additional benefits within the region, but rather for additional benefits linked to their trade cooperation with non-ASEAN countries.

Non-tariff barriers: The key non-tariff barriers for EE and RE market transformation in the context of intra-ASEAN trade, are the unstable electricity regulatory and policy frameworks, and the lack of targets and direction in implementing EE and RE, creating doubts and imposing risks for foreign investors who wish to develop EE and RE projects. In terms of recognizing EE and RE products, there is no regional labelling yet in place that distinguishes EE/ RE products. Having such regional labels in place would not only facilitate and further simplify intra-ASEAN trade of such technologies, but would also encourage access to EE/ RE technologies which are not yet available in the ASEAN market.

05

CASE STUDY: SOLAR PV IN VIETNAM

5.1 BACKGROUND AND RATIONALE

The ASEAN member countries have developed and implemented several renewable energy initiatives, including solar PV programs to address the challenges of sustainable energy growth and climate change. For example, Malaysia, the Philippines and Thailand have established feed-in-tariffs to provide incentives for solar PV project developers to build and operate solar PV power generation and increase the renewable energy mix in the national grid. To date, installed capacity of solar PV power generation in Thailand has reached 945 MW (Tongsopit, S., et.al., 2015), in Malaysia ,166 MW (SEDA, 2015) and in Indonesia about 61 MW (Rosyid, A., 2015)[19] . In regional scope, the ASEAN Plan for Action in Energy Cooperation 2016-2025 has targeted to reach 23% of renewable energy in the total energy mix, of which it is intended that solar energy will account for 15% of the total renewable energy (IRENA & ACE, 2016).

Compared to its compatriots in ASEAN, Vietnam is lagging behind in solar energy development. Despite the estimated solar power generation potential of 13,000 MW in Vietnam (ADB, 2015), the nominal capacity of Vietnam solar PV is only 4.5 Wp[20]. The prospects for solar PV development in Vietnam are based on the Power Development Plan (PDP), which includes the strategy of developing and creating rural power by 2020. The Vietnamese government has also put incentive schemes in place to boost renewable energy development, including solar PV, as illustrated in Exhibit 5.1. A power feed-in tariff has been issued for wind power and biomass based power, but is not yet available for solar power.

This case study is prepared to look for non-tariff barrier aspects, including trade aspects, in Vietnam that still impede the adoption of solar PV technology.

Exhibit 5.1: Existing incentive schemes to boost renewable energy development in Vietnam (Sources: Compiled from REDS and MOIT, 2015) [21]

Incentive types	Regulation	Description
Renewable power (including Solar PV)		
Tax	Import tax	Exempted from import tax for import goods Exempted from import tax for fixed assets
Corporate income tax	25% - 50% (depending on types of energy and location of project)	Exempted from corporate income tax 10% reduction of corporate income tax for 15 years for newly established RE enterprises; can be extended to 30 years Exempted from corporate income tax for the first 4 years, 50% reduction of corporate income tax for the following 9 years
Loan	Commercial loan at market interest rate	Loan of up to 80% of capital investment, with preferential interest rate for 5 years

[19] Based on estimation that installed capacity (in Watt or W) is 20% less than the nominal capacity (in Watt-peak or Wp)

[20] https://energypedia.info/wiki/Solar_Energy_Country_Analysis_Vietnam Solar Energy Country Analysis Vietnam

[21] Decision on Supportive Mechanism for Renewable Energy, Available online from http://tietkiemnangluong.com.vn/tin-tuc/hoat-dong-chuong-trinh/t25867/ho-tro-phat-trien-cac-du-an-dien-mat-troi.html

Incentive types	Regulation	Description
Renewable power (including Solar PV)		
Environmental protection fee	Depending on types of waste and quantity of pollutants in affluent	Exempted from environmental protection fee
Depreciation	Depending on type of fixed assets	Depreciation rate is 1.5 times quicker than the typical depreciation rate
Land lease	Depending on location of the project	Exempted from land use fee and land lease fee

5.2 ADDITIONAL POLICY SUPPORT UNDERWAY: SPECIFIC INCENTIVES FOR SOLAR PV

To accelerate the utilization growth of solar energy in Vietnam, a supportive mechanism for solar PV projects has been developed by the Ministry of Industry and Trade (MOIT) and submitted to the Prime Minister for consideration and approval. Under this mechanism, investors and project developer of ground mounted, rooftop solar PV, solar PV on islands and on-grid solar PV are expected to benefit from preferential selling price and guarantee for their investment. The following are some of the key elements of the proposal:

- Electricity Vietnam (EVN), the Vietnam state utility, would be responsible for buying all electricity from on-grid Solar PV and net metering projects. The power purchase contract must obey the standard contract of MOIT, which would be effective for at least 20 years. After that period, the seller and the buyer can negotiate to extend the contract, or sign a new contract as regulated in the law.
- The investor in a Solar PV project would benefit from investment credit, import tax and corporate income tax, as regulated in existing law and regulations.
- The investor in a Solar PV project would qualify for a reduction in land use and land hire fee. In addition, the Provincial Peoples' Committees would be responsible for arranging the land use plan for developing such Solar PV projects.
- The purchasing price of power at agreed locations would be 11.2 US cents/ kWh. The power price would be applied for on-grid Solar PV projects with solar cell efficiency greater than 16% and installation capacity lower than 100 MW.
- For rooftop Solar PV with a net metering system, the purchasing price of the excess power would be 15 US cents/ kWh (VAT excluded). The power-purchasing price would be adjustable in accordance with exchange rate of USD/ VND. The deficit power would be sold by the ladder-type power price scheme, in accordance with law and regulations.
- Off-grid Solar PV projects would benefit from incentives of investment credit, tax, corporate income tax, land use and land hire.

In August 2016 the Vietnamese government agreed with the draft mechanism proposed by the MOIT to support solar PV, with some revisions, as follows:

- The preferential tariff for on-grid solar power would be provisionally applied within the next three years (from 2016 to 2018)

- Only projects listed in power development master plans, or located in areas potentially favorable for promoting Solar PV, would be eligible to enjoy the preferential tariff.
- For rooftop Solar PV projects, the MOIT was required to update the prices of solar power equipment and recommend an appropriate rate (Vietnamese Government, 2016).

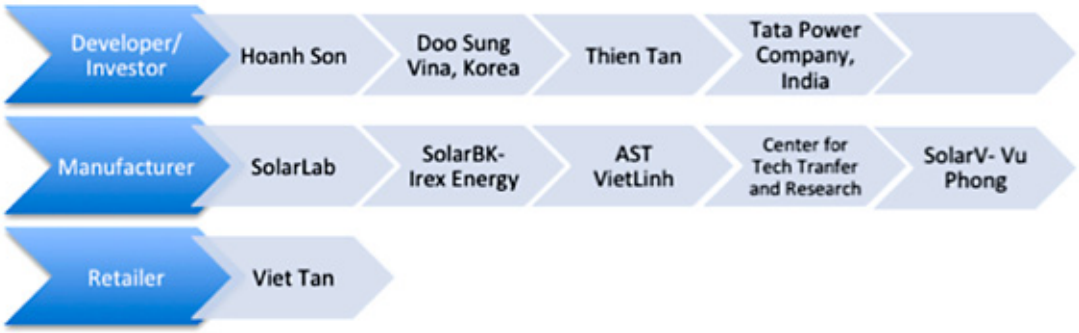
Revision of the draft incentives was made so that future solar PV development will align with the country's power development master plan. This will also assist solar PV project developers to target optimal project locations in their business plans.

The narrow time frame (2016-2018) for applying the preferential tariff means that only developers with well-advanced project proposals, plans and financing in place can present applications for these preferential tariffs.

5.3 VALUE CHAIN OF VIETNAM'S SOLAR PV INDUSTRY

Up to this point, the Solar PV market in Vietnam has attracted more than 30 investors, both international and domestic. Most domestic investors are private, and either limited companies or joint stock companies. These investors normally utilize foreign technology, which partly originates from the underdevelopment of the domestic market, especially the lack of domestic manufacturers of solar power technology. The solar PV industry landscape consists of the project developers/ investors, manufacturers and retailers. Key players at various points in the value chain are indicated in 5.2.

Exhibit 5.2: Key players in Solar PV value chain in Vietnam



Most of the solar panels and batteries on the market are imported. The inverter, controller and other components are locally manufactured to some extent. However, there are now several domestic manufacturers of solar PV components, as well as local research institutions that conduct research and development activities to assist the development of the local solar PV industry. Products and components produced by these domestic companies/ institutions are summarized in Exhibit 5.3.

Local Solar PV industry players: SolarBK-Irex Energy, which is considered to be the biggest solar PV manufacturer in Vietnam, has exported its solar PV components both within the ASEAN region and other countries. For example, their solar panels are exported to Singapore, USA,

Costa Rica, Holland, UK and Tunisia, and their solar cells are exported to Indonesia, Malaysia, USA, Costa Rica, Korea and India. Meanwhile, smaller companies, such as Viet Tan, have no international market for their products. Although Viet Tan intends to extend its market into neighbouring countries like Laos and Cambodia, Chinese suppliers who have the advantage of lower prices currently dominate these markets.

Exhibit 5.3: Solar PV Local companies/ institutions in Vietnam (Sources: interviews)

Role	Company/ Institution	Products/Research focus
Solar PV Research Centres	Solar Lab, under the Institute of Physics, Vietnam Academy of Science and Technology	• Designed and manufactured the first single crystal, polycrystalline solar cell and Solar PV modules in Vietnam • In 2013, successfully developed the Smart Integrated Photovoltaics – Madicub • Installed around 70 Solar PV villages, 30 solar charger stations, thousands of solar water-way lights and more than 4,000 household solar systems
	Centre for Technology Transfer and Research, government owned, established in 2015 under the Hanoi Department of Science and Technology	• Developed small and highly efficient solar panels, with current annual capacity of 12 MW. This is expected to expand to 20 MW.
Manufacturers	RedSun, established under an agreement between Energy Conservation Centre HCM City and New Era Technology Company Ltd, in 2009	• Produce Solar PV Panels with present capacity of 75 MW • Distribute domestically and export to Cambodia, Germany and New Zealand
	SolarBK- Irex Energy, established in 2012	• Products: driver, smart auxiliary controller, solar cells, mono-crystalline & polycrystalline solar panels • Installed production capacity of 300 MW/year with current production rate about 200 MWp/ year • Products already meet international standards including IEC 61215:2005, IEC 61730:2004, UL 1703

Role	Company/ Institution	Products/Research focus
		• Also import from ASEAN & out of ASEAN Countries • Export to US, Korea, India and some ASEAN countries
Design & Manufacturer	AST VietLinh, established in 1986	• Produce related components: back-up generator, inverter solar charger, DC-AC inverter, AC-DC inverter, DC-DC inverter and solar regulator • Produce Solar PV products, grid tie solar inverter • Provide and install on-grid and off grid Solar PV all
		around the country, and in Cambodia, Germany and New Zealand
Manufacturer, construction and investment	SolarV- Vu Phong, established in 2009	• Produce chargeable solar lamps, solar generators, inverter, battery charger and solar panels • Import solar panels from Singapore • Capacity: 100,000 products/ components per year • By 2015, already installed and provided 2,340 kW for solar power projects all over the country • Market: domestic
Supplier & installer	Viet Tan	• Established in 1997 • Supply and install solar energy components and products • Principal retailer of AST VietLinh • Solar power projects for extremely poor communities in Ca Mau, QuangBinh, Bac Lieu, and some military units

Imported Solar PV panels and components: The main source of imported solar PV panels and components is China. However, other countries from Asia and Europe have started to enter Vietnam's solar PV industry because products from these countries have higher quality and reliability. (Exhibit 5.4). Recently, when the Japanese, Korean and EU products/ components are available on the market, the retailers and manufacturers tend to import products/components from these countries. Although their price is not as cheap as Chinese products/ components, they have an advantage of reliable performance, reasonable price and "not-Chinese" origin, especially Korean products and components (IES, 2015).

Exhibit 5.4: Sources of imported Solar PV components

No	Type of Solar PV components	Exporting Country
1.	Back sheet	Singapore, Korea
2.	EVA, ribbon	Malaysia, Korea
3.	Wafer	Japan, Korea, China, Taiwan
4.	Back sheet, EVA, Ribbon, J-B, Frame, Glass and some auxiliary components	Japan, Korea, China, Taiwan
5.	Micro processor	USA, EU

5.4 PREVAILING BARRIERS TO INTER-ASEAN INTEGRATION OF SOLAR PV VALUE CHAIN

The development of solar PV projects has not fully matured in Vietnam due to several barriers, including: technology barriers; policies and institutional barriers; issues with economic and financial resources; and lack of adequate data and information.

5.4.1 Technology barriers

- The technology currently in Vietnam has mostly been imported, with large numbers of existing solar PV panels and components coming from China. Local companies and research institutions are starting to play roles in the solar PV industry; however, a large share of components is also imported from Korea and some European countries, where quality is higher, for a still reasonable cost.
- The infrastructure of the power sector has not yet developed to meet the requirement of solar PV integration; infrastructure for rooftop net metering is not available.

5.4.2 Policy and institutional barriers

- The supportive policy framework is limited. The only policies that can be applied for solar PV development are the Renewable Energy Development Strategy (REDS) and Power Development Plan (PDP) VII-revised. And there are still no action plans for these, a situation that creates many frustrations for solar PV developers as well as manufacturers. Due to the lack of an exclusive action plan, as well as clear instructions on construction, installation and development for rooftop solar power systems and ground mounted solar power plants, the solar PV investors are questioning the feasibility of their projects and hesitating to invest into solar power projects.
- Since the promulgation of REDS and PDP VII-revised, there has been no progress on solar PV supportive mechanism, especially in term of financial incentives. Although the draft incentive was partly agreed by the government, it should be noted that the on-grid solar power tariff was accepted on the condition that only

projects currently planned are eligible to benefit from the preferential price, and the preferential price can only be applied for three years from 2016. The rooftop solar power tariff requires revision in line with the decreasing market price of solar devices/ equipment.

- The underdevelopment of policy framework as well as the unsubstantial nature of current support mechanisms cast doubt on the government's commitment to support solar PV development. The supportive mechanisms are limited and financial incentives on power purchasing price will only be available for planned projects within very short terms (2016-2018). The existing mechanism and even the draft mechanism are not attractive enough for compensate investors for the high investment cost of solar PV projects.

5.4.3 Economic and Financial Resource Issues

- The market for solar PV has not yet developed. The financial support for solar PV development principally depends on the state budget, rather than creating a competitive solar power market. Meanwhile, financial support is limited, including tax and land hire, land fee. The most effective incentive of a reasonable power tariff scheme is only applicable for planned on-grid solar power projects up and running by 2019. At the same time, the proposed power tariff will require the government to commit to a huge budget, while the sources of that budget are still being questioned.
- In addition, the ability to mobilize finance and make arrangements of loans with banks present hurdles for investors, especially the ability to explain and present project cash flows for mobilizing capital. These are new skill sets for many companies. Only one of three surveyed companies, the Centre for Technology Transfer and Research, said that it has no difficulty in gaining access to capital investment. (This is understandable as it is a government facility).

5.4.4 Lack of Adequate Data and Information

- A map of Vietnam's solar resources has not yet been published and the master plan for Vietnam's solar PV development has not been created. With insufficient support policy mechanisms for solar PV projects and no master plan for solar PV development, solar PV developers and investors have no understanding of investment procedures. They have to guess their way through many procedural steps in an attempt to obtain such permissions as investment certificate, construction permission, electricity operation license, and so on.
- This situation is the same for the science and technology of solar PV. Lack of experience in technology as well as knowledge of solar PV in general and on-grid solar PV in particular are barriers to local investment in solar PV.
- This is a new field for investors, who are not familiar with the organization, trading and operation of solar power plants, which makes investment into solar PV projects a higher risk endeavour.

Hence, as explained above, several barriers still hinder a faster deployment of solar PV in Vietnam. In removing many of these barriers, support of the Government will play an essential role.

Exhibit 5.5: Comments from Vietnam solar industry, recurrent Government incentives[22]

Solar PV Manufacturers & Retailers on Supportive Mechanism/ Incentives

"One of the barriers for promoting the solar PV in Vietnam is the lack of supportive incentives. The promulgation of the supportive mechanism for solar power will encourage investors and manufacturers of solar projects at all levels, from rooftop solar to solar farm. The favourable solar power purchasing price will create a huge change, and even the promotion of net metering mechanism will be very useful for small projects, especially the rooftop solar power systems installed in households, residential buildings and offices." (Viet Tan)

"If the Government's draft Decision on the promotion of solar energy is issued (power purchasing price 12 US cents/ kWh and 16.7 US cents/ kWh), the market of solar PV solutions will grow strongly in terms of size and product quality. Investors will have to compete to hold their market share. Solar BK- Irex Energy, as one of the leading solar energy companies in Vietnam, has the competitive advantage to dominate the market, and extend its investment into solar farm projects. In addition to incentives on power purchasing price, support on initial investment costs will be very useful for small to industrial sized solar energy projects. It is expected that the new financial mechanisms will effectively boost the size of the market, and foster companies in a sustainable way." (Solar BK - Irex Energy).

5.5 SOCIO-ECONOMIC IMPACT OF ENHANCED VALUE CHAINS IN INTRA-ASEAN INTEGRATION

The value chain cooperation between Vietnam and other ASEAN countries has been established despite the underdevelopment of policy framework and incentives. Currently, Vietnam imports some solar PV components from regional partners. These are mainly solar panels from ASEAN countries, especially Malaysia and Singapore. solar PV products from Vietnam are also exported to some ASEAN countries.

Although foreign markets are not the first priority of Vietnam solar PV manufacturers, it is expected that with the development of solar PV research, the price of Vietnamese solar PV products will reduce, and will become competitive against the Chinese products that are currently available on ASEAN markets.

The approval of the draft solar power supportive mechanism is expected to be a great opportunity to open intra-ASEAN as well as global trade. Investors from ASEAN countries can enjoy the preferential power tariffs in Vietnam, which have been described as "the more-than-excellent price" by some surveyed manufacturers. Besides, once policies on Renewable Portfolio Standard (RPS) and net metering are endorsed, the solar market in Vietnam will bloom. At

[22] Direct interviews were conducted with Vietnamese stakeholders including Government authorities and manufacturers during the period of 02-12 August 2016.

that point, not only will on-grid solar power projects attract keen investors but also owners of residential buildings, industries and even householders will participate in the solar market, by investing into rooftop solar power systems and ground mounted solar farms.

If the policies and incentives of solar PV are to be comprehensively developed, ASEAN investors should be made aware of Chinese factories. There is already one Chinese invested solar PV factory under construction in the centre of Vietnam. Chinese products have the advantage of cheap price. Meanwhile, according to a survey conducted by the Institute of Energy Science on energy efficiency and renewable energy market in Vietnam, the Vietnamese customers are in favour of cheap products and a quick rate of return (i.e. over several years). However, the same customers do not normally like Chinese products (IES, 2015). The prices of ASEAN solar PV products, especially solar panels, are lower than US and EU products, but still higher in comparison to Chinese products.

06

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSIONS

Two major conclusions can be drawn from this scoping study: firstly, there are little if no intra-ASEAN tariffs for EE and RE technologies: in this context, the current EGA negotiations would not have significant implications on intra-ASEAN trade for these technologies. Secondly, a detailed analysis of the potential to further improve intra-ASEAN trade and cooperation has allowed the formulation of policy recommendations, which were reviewed by ASEAN policy makers. These policy recommendations, described in the following paragraphs, are being further developed under the ASEAN SHINE program and will lead to the adoption, by the 10 ASEAN Ministries of Energy, of action plans. Such action plans will then be implemented by the ASEAN SHINE program under the steering of the 10 ASEAN Ministries of Energy.

6.1.1 General Conclusions

Since the preferential tariffs in ASEAN are set at zero, or are otherwise very low for most products, including the aforementioned EE and RE technologies, the interest of ASEAN countries, such as Thailand, Malaysia, or Vietnam, in participating in the EGA negotiations, can be better understood from a global perspective, rather than from a regional one. The EGA would largely not contribute to improving intra-ASEAN trade and cooperation on these technologies.

In parallel, at the ASEAN level, the development of regional trade in EE and RE technologies is still highly dependent on the national regulations and policy frameworks of the six largest ASEAN countries, namely Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam. In that regard, a lack of harmonization is notably observed regarding energy performance testing methods, MEPS and labelling, as depicted below:

- MEPS and labelling requirements for the selected technologies greatly vary across the region;
- Moreover, there is a lack of enforcement (particularly for electric motors, lighting, refrigerators and distribution transformers), even for countries that have developed and implemented MEPS;
- Across the technologies studied, labelling remains in an initial stage, even for the six largest ASEAN countries.

As a result, there is limited potential for mutual recognition of energy performance when technologies are traded between countries. Such lack of mutual recognition directly limits the potential for increasing intra-ASEAN trade in energy efficiency technologies.

There is furthermore a large discrepancy in the adoption of testing standards and MEPS among ASEAN countries. This finding illustrates the interest of ASEAN countries in promoting EE and RE technologies, but also the important work that remains to be done. A summary of existing energy performance testing standards, MEPS and labelling is given in Exhibit 6.1, 6.2 and 6.3.

Exhibit 6.1 Summary of Applied Performance Testing Standard for Selected Technologies in ASEAN

Country	National Energy Performance Testing Standards			
	Air Conditioners	Refrigerators	Distribution Transformers	Electric Motors
Brunei Darussalam	Under development	N/A	N/A	N/A
Cambodia	N/A	N/A	N/A	N/A
Lao PDR	N/A	N/A	N/A	N/A
Indonesia	Aligned to ISO 5151	Aligned with 62552-3:2007 (Reference to IEC 62552-2: 2015 is currently available under SNI 62552-2-2016)	SPLN D3.002-1 : 2007 (Aligned with IEC 60076-1) (electric utilities)	SNI IEC 60034-2-1:2014 (in line with IEC 60034-2)
Malaysia	Aligned to ISO 5151 (old version)	MS IEC 62552-3:2016 (aligned with IEC 62552-3:2015)	IEC 60076-1 (electric utilities)	Aligned to IEC 60034-2
Myanmar	N/A	N/A	N/A	N/A
Philippines	- Aligned to ISO 5151- PNS ISO 5151:2014 - PNS ISO 16358-1:2014	Aligned with 62552-3:2015: DPNS 62552-3:2016	PNS IEC 60076-1:2002	PNS IEC 60034-2-2:2016
Singapore	Aligned to ISO 5151	Aligned with 62552-3:2007	IEC 60076-1 (for electric utilities)	N/A
Thailand	Aligned to ISO 5151 (old version)	TIS 455-2537 and TIS 2186-2547	IEC 60076-1 (for electric utilities), and TIS384-2453	TIS 867-2550-2007 (aligned with IEC 60034-2)
Vietnam	Aligned to ISO 5151 (old version)	TCVN 7829:2016 (on going) – in line with with IEC 62552 (1/2/3)	TCVN 6301-1: 2015 in line with IEC 60076-1: 2011	TCVN 6627-2-1:2010 in line with IEC 60034-2-1 (2007)

Exhibit 6.2 MEPS for Selected Technologies in ASEAN

Country	MEPS			
	Air Conditioners	Refrigerators	Distribution Transformers	Electric Motors
Brunei Darussalam	Under development	None	None	None
Cambodia	None	None	None	None
Lao PDR	None	under development	None	None
Indonesia	mandatory	Under development	None	None
Malaysia	Mandatory	Mandatory	None	Voluntary Energy Efficiency Standards
Myanmar	Mandatory	None	None	None
Philippines	Mandatory	None	None	None
Singapore	Mandatory	Mandatory	None	None
Thailand	Mandatory	Mandatory	None	Voluntary Energy efficiency Standards
Vietnam	Mandatory	Mandatory	Mandatory	Mandatory

Exhibit 6.3 Labelling program for Selected Technologies in ASEAN

Country	Labeling			
	Air Conditioners	Refrigerators	Distribution Transformers	Electric Motors
Brunei Darussalam	Under consideration for development - voluntary - comparative	None	None	None
Cambodia	None	None	None	None
Lao PDR	None	None	None	None
Indonesia	Under development - 1-4 stars - voluntary	Under development - voluntary - 1-4 rating	None	Under development - voluntary - 1-4 rating
Malaysia	Voluntary - endorsement	Mandatory 1-5 star rating	None	None
Myanmar	None	None	None	None
Philippines	Comparative label is mandatory	Mandatory 1-5 rating, pending implementation	None	None
Singapore	Mandatory, comparative label, 1-5 tick rating	Mandatory 1-4 tick rating	None	None
Thailand	Voluntary- comparative label	Voluntary - comparative 1-5 star rating	None	endorsement label - voluntary
Vietnam	Comparative Label is mandatory, endorsement label is voluntary	Mandatory - comparative label	Mandatory - endorsement	Mandatory - endorsement

The tables above show that there are good foundations for the harmonization of testing methods' standards: several countries make reference to (or directly use) international standards, which should be the basis for harmonization. Countries who do not have such standards would benefit from the harmonization work to adopt their national standards. The existence of MEPS and labelling programs, although not homogeneously among ASEAN countries, demonstrates the willingness of ASEAN countries to promote energy efficiency. The experience of those countries that have adopted such MEPS and labelling programs provides a good example for countries that have not done so yet. A regional approach to adopting long-term aspirational goals in terms of energy performance would provide avenues for all countries to develop and adopt MEPS and labelling programs. Such an approach was successfully followed for air conditioners under the ASEAN SHINE initiative.

Supporting value chain integration and cooperation may further facilitate the widespread diffusion of energy efficiency and renewable energy technologies in ASEAN. Regarding this aspect, the situation varies both among countries and technologies, as outlined below:

- For room air conditioners, refrigerators, lighting and distribution transformers, local manufacturing capacities are found in most of the six largest ASEAN countries. In the same manner, intra-regional trade flows are observed among all countries;
- The assembly of solar modules and panels is undertaken locally. In addition, ASEAN manufacturers of solar cells are found in Malaysia, the Philippines Singapore, and Thailand. Most of the other components of the solar PV value chain are imported.
- Most electric motors are also sourced from imports (i.e. there is no real manufacturing capacity in ASEAN countries);

- Singapore positions itself as a trading hub, by applying very low to zero tariffs for imports, meanwhile Vietnam has been increasingly attracting foreign investment to establish manufacturing facilities through its lower labor cost, in comparison to Thailand and Indonesia.

Perceptions by end-users represent another significant barrier to greater deployment of EE and RE technologies in the ASEAN region.

- In Indonesia, Thailand, Malaysia, Philippines, and Vietnam, impulse buying for cheaper products, without considering the lower operating cost and energy consumption, is still a dominant market behavior. There is therefore a need to continue to educate end-users on the life-cycle costs of energy-using equipment.
- In addition, the utilization of more energy-efficient technologies is also hindered at times by services available, namely a lack of the skilled labor to install the technology properly (e.g. the situation has been observed with solar PV installers). Such issues can affect the performance of the equipment.

6.2 RECOMMENDATIONS

6.2.1 General Recommendations

This study proposes two parallel strategies which hold the potential to support trade and to facilitate the deployment of energy efficiency and renewable energy technologies in the region.

Harmonization of energy performance testing methods for energy efficiency and performance: Harmonization of standards, in particular the standards for energy performance testing methods, is an important tangible way in which ASEAN governments can adopt to facilitate intra-ASEAN integration in EE technologies. At present, not all ASEAN countries reference their national standards to the relevant international standard, with the exception of air conditioners, where the reference used is ISO 5151:2010, paving the way for future harmonization work on other products.

Adoption and harmonization of minimum energy performance standards (MEPS): This strategy is important from the perspective of phasing out inefficient equipment from the market. The rationale here is that technologies with the lower efficiency usually have a lower initial price, limiting market opportunities for more efficient equipment.

6.2.2 Technology-Specific Recommendations

The first underlying principle for developing technology-specific recommendations was “practicality” in terms of implementation; from this perspective, draft recommendations were prepared and reviewed/discussed/finalized during a stakeholders’ consultation workshop in Bangkok on 30 August 2016, with policy makers from trade, EE and RE ministries. The second underlying principle was “potential for effective implementation in the short-term”; in this regard, the ASEAN SHINE initiative was considered as the main implementation platform (in particular, the ASEAN SHINE program has already adopted action plans for air conditioners and lighting,

so no specific recommendations were made).

The technology-specific recommendations below are being further developed under the framework of the ASEAN SHINE program. The complete policy recommendations are available in the report “Regional Policy Recommendations for the promotion of EE and RE in ASEAN”.

With respect to energy efficiency for air conditioners, lighting, refrigerators, distribution transformers and electric motors, the recommendations are:

- Harmonize ASEAN standards for the testing methods, by making reference (or adopting directly) to the corresponding international standard: this will reduce cost of compliance for manufacturers/exporters (and therefore reduce price for consumers), facilitate the harmonization of MEPS across ASEAN, as well as enable a regional approach towards monitoring, verification and enforcement (MV&E)
- Develop regional policy roadmaps that will set long-term aspirational goals in terms of standards, MEPS, and market transformation instruments; such regional policy roadmaps will constitute the foundation for the development and adoption of national policy roadmaps for effective implementation at country level
- With respect to the development of the above, conduct a detailed stakeholders analysis and define appropriate tools and approaches to, where appropriate: 1) build capacity of local manufacturers; 2) build capacity of testing laboratories; 3) create awareness among end-users.

Regarding solar PV technology, it is recommended that ASEAN countries adopt the full range of international standards (after a critical review to determine their relevance) on safety, grid-connection and performance. It is also necessary to address the lack of adequate services, particularly the lack of competency in installation and design of solar rooftop PV systems.

Regarding solar thermal applications, market information could be found only for the case of Thailand. Before further recommendations are made, it is necessary to gather more information on the market existing in the other ASEAN countries.

07

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08

APPENDICES

APPENDIX A: STANDARDS FOR ENERGY PERFORMANCE TESTING METHODS, MINIMUM ENERGY PERFORMANCE STANDARDS (MEPS), AND LABELING

A.1 Air Conditioners

Country	National Testing standard	Labeling	MEPS
Brunei Darussalam	Being developed	Under consideration for development - voluntary - comparative	None (under dev.)
Cambodia	None	None	None
Indonesia	Aligned to ISO 5151 (old version)	Under development - 1-4 stars - voluntary	(EER (BTU/hr)/COP): o Inverter: 9.01/2.64 o Non – Inverter 8.53/2.50 Mandatory
Laos	None	None	None (under dev.)
Malaysia	Aligned to ISO 5151 (old version)	Voluntary - 1-5 stars Voluntary - endorsement (ST)	EER based (BTU/hr) – mandatory
Myanmar	Being developed	None	None (under dev)
Philippines	Aligned to ISO 5151 (old version)	The law prescribing 5-stars is pending implementation Comparative Label is mandatory	EER based (BTU/hr and W/W) - mandatory
Singapore	Aligned to ISO 5151	Mandatory - 1-5 ticks	COP based (BTU/hr/W) – mandatory
Thailand	Aligned to ISO 5151 (old version)	Yes - levels 1-5 - voluntary	EER based W/W – mandatory
Vietnam	Aligned to ISO 5151 (old version)	Mandatory - comparative - 1-5 stars Voluntary - endorsement	EER based (BTU/hr, and W/W) – mandatory

A.2 Refrigerators

Country	National testing standard	Labeling	MEPS
Brunei Darussalam	None	n/a	None
Cambodia	None	None	None
Indonesia	•SNI 04-6710-2002, •SNI 04-6711-2002. •SNI 04-6958-2003	Under development - voluntary - 1-4 stars	This is currently being drafted
Laos	None	n/a	None
Malaysia	MS IEC 62552:2011	Mandatory 1-5 star rating	Based on star index (ref EEF) - mandatory - minimum 2 stars - the higher the index the higher the efficiency
Myanmar	None	None	None
Philippines	oPNS 1474 (ISO 5155 withdrawn) o PNS 1475 (ISO 7371 withdrawn) o PNS 1476 (ISO 8187 withdrawn) o PNS 1477 (ISO 8561 withdrawn)	Mandatory 1-5 star rating	EEF based - Mandatory - minimum 1 star
Singapore	IEC 62552:2007 or ISO 15502:2005 (both eligible)	Mandatory 1-5 ticks rating	Mandatory - linear energy consumption based on adjusted capacity
Thailand	TIS 455-2537	Voluntary - comparative 1-5 star rating - EGAT accepts only from level 3 and up Voluntary - endorsement label (TGL/TEI)	Mandatory - linear energy consumption based on adjusted capacity
Vietnam	TCVN 7627: 2007	Mandatory - comparative - 1-5 star rating Voluntary – endorsement (MOIT)	Mandatory - linear energy consumption based on adjusted capacity (c.f. TCVN 7828-2103)

A.3 Status of MEPS for medium-sized AC Induction Motors

Country	National testing standard	Labeling	MEPS
Brunei	None	None	None
Cambodia	None	None	None
Indonesia	SNI IEC 60034-2-1:2012 (in line with IEC 60034-2-1)	Under development: comparative (1-4 stars) - voluntary	Under development: expected to be voluntary initially
Laos	None	None	None
Malaysia	IEC 60034-2	None	Voluntary to benefit from EE Incentives minimum EFF 1 under classification of CEMEP scheme (IE2)
Myanmar	None	None	None
Philippines	None	None	None
Singapore	None	None	None
Thailand	TIS 867-2550 (2007) (aligned with AS/NZS 1359.5 (2004) Ongoing development of new standard in line with IEC 60034-2	endorsement label (TGL/TEI) - voluntary	Also determined by TIS 867-2550 covering only 0.75 kW - 185 kW, rated voltage not exceeding 1,000 V - voluntary
Vietnam	TCVN 7450-2:2005 Ongoing development on new standard in line with IEC 60034-2	Mandatory - comparative - 1-5 stars Voluntary - endorsement (MOIT)	Mandatory - in line with IE2 - covering (3-phase, asynchronous squirrel cage electric motors with voltage not exceed 400V, and rated power from 0.55-150kW)

A.4 Distribution Transformerson Motors

Country	National testing standard	Labeling	MEPS
Brunei Darussalam	None	None	None
Cambodia	None	None	None
Indonesia	SPLN 50:1997	None	• Mandatory single-phase liquid type, specifications on: >No load watt loss >load watt loss >% efficiency at 50% load • Mandatory 3-phase liquid type, specifications on: >No load watt loss >load watt loss >% efficiency (load not specified)
Laos	None	None	None
Malaysia	IEC 60076	None	Under development
Myanmar	None	None	None
Philippines	None	None	under development
Singapore	IEC 60076	None	Voluntary - Green building Certification under Green building Council - specifications: >Power efficiency @ 50% load, for 1-3 phase >no requirement on load and no load losses
Thailand	TIS 384-2543	None	• Mandatory single-phase liquid type, specifications on: >No load watt loss >load watt loss >% efficiency at 50% load • Mandatory 3-phase liquid type, specifications on: >No load watt loss >load watt loss >% efficiency (load not specified)
Vietnam	TCVN 8525: 2010 loss measurement procedures in line with TCVN 6306-1, harmonized with IEC 60076	Mandatory - comparative - 1-5 star rating Voluntary - endorsement (MOIT)	>Minimum power efficiency @ 50% load, for 3 phase liquid type - mandatory

A.5 Status of Energy Performance Testing Standards for Linear Fluorescent lamps and non-directional LED lamps

Countries	Tubular Fluorescent	Non-directional LED
Brunei Darussalam	- None	- None
Cambodia	- None	- None
Indonesia	- Reference for CFL is IEC 60969. This would also apply for Tubular flourescent	- SNI IE/PAS 62612/2013 (reference to IEC 62612)
Lao PDR	- None	- None
Malaysia	- Reference for CFL is IEC 60969. This would also apply for Tubular fluorescent	- MS IEC 62612 (reference to IEC 62612/2013)
Philippines	- No reference for testing energy performance of Tubular Fluorescent lamps	- Not yet comply with IEC 62612/2013
Singapore	- None	- Reference to IEC 62612/2013
Thailand	- Reference for CFL is IEC 60969. This would also apply for Tubular fluorescent	- No reference to IEC 62612/2013
Vietnam	- Tubular fluorescent lamps –Energy Efficiency: comply with national standard TCVN 8249:2009. No reference to International standard	- Not reference to IEC 62612/2013 and no TCVN (national standards) yet

A.6 Solar PV Standards (Ansay, 2015)

Groupings	ID (6 IEC)	MY (20 IEC)	PH (14 IEC)	SG (10 IEC)	TH (2 IEC)	VN (1 IEC)
Glossary		MS 61836:2010	PNS IEC/TS 61836:2012			
Module, Non-concentrating	RSNI4 IEC 60904-1:2010. RSNI4 IEC 60904-7:2010. SNI IEC 61730-1 : 2008 SNI IEC 61730-2 : 2008 SNI 04-6533-2001.	MS IEC 61215:2006 MS IEC 61646: 2010 MS IEC 61730-1:2010 MS IEC 61730-2:2010	PNS IEC 60904 - 1:2014 PNS IEC 60904 - 2:2014 PNS IEC 60904 - 3:2014 PNS IEC 60904 - 4:2014 PNS IEC 60904 - 5:2014 PNS IEC 60904 - 7:2014 PNS IEC 60904 - 8:2014 PNS IEC 60904 - 9:2014 PNS IEC 60904 - 10:2014 PNS IEC 61215:2014 PNS IEC 61646:2014 PNS IEC 61345:2014 PNS IEC 61701:2014	IEC 60904-1:2006 IEC 60904 - 10 ed 2.0 : 2009 IEC 61215:2005 IEC 61646:2008 IEC 61730 - 1 : 2004 IEC 61730 - 2 : 2004	TIS 1843-2542 (1999). TIS 2210-2548 (2005).	TCVN 6781:2000
System (WG3)		MS IEC 61724:2010 MS IEC 61727:2010 MS IEC 62124:2009		IEC 62446 - ed 1.0 : 2009		
BOS (WG6)		MS IEC 62109-1:2011		IEC 62109 - 2 ed 1.0 : 2011		

A.6 Solar PV Standards (Ansay, 2015)

Photovoltaic Cell (WG8)		MS IEC 61194:2009		IEC 60891:2009		
Guidelines for DRE (JWG1)		MS 62257-1:2009 MS 62257-2:2009 MS 62257-3:2009 MS 62257-4:2009				
Groupings	**ID (6 IEC)**	**MY (20 IEC)**	**PH (14 IEC)**	**SG (10 IEC)**	**TH (2 IEC)**	**VN (1 IEC)**
		MS 62257-5:2009 MS 62257-6:2009 MS 62257-7:2010 MS 62257-7-1:2010 MS 62257-7-3:2010 MS 62257-8-1:2010				

APPENDIX B. MFN AND ATIGA TARIFFS

B.1 MFN Tariff applied in HS850421, HS850422, HS850433, and HS 850490 (Distribution Transformers and transformer parts)

Country	MFN Tariff Six-digit HS Code: distribution transformers and pars (%)					
	85021	85022	85033	85034	850490	Year updated at WTO
Brunei Darussalam	5	5	5	5	4.5	2014
Cambodia	15	15	15	15	19.4	2014
Indonesia	5	5	10	10	5	2014
Lao PDR	5	5	5	5	5	2014
Malaysia	5	5	5	5	0	2013
Myanmar	1	1	1	1	1	2013
Philippines	11.5	9.4	10	5.5	2.6	2015
Singapore	0	0	0	0	0	2016
Thailand	5	10	5.5	5.5	1	2014
Vietnam	15	19	13.3	10	0.6	2014

source: www.wto.org

B.2 MFN Tariff of RAC in ASEAN (HS 841510, Air conditioning machines window or wall types, self-contained)

Country	MFN Tariff Six-digit HS Code: Air conditioning machines window or wall types, self-contained (%)	
	841510	Year updated at WTO
Brunei Darussalam	5	2014
Cambodia	15	2014
Indonesia	10	2014
Lao PDR	20	2014
Malaysia	30	2013
Myanmar	1	2013
Philippines	10	2015
Singapore	0	2016
Thailand	30	2014
Vietnam	25	2015

source: www.wto.org

B.3 MFN Tariff (HS 841821, HS 841829, Household refrigerators, compression-type & others)

Country	MFN Tariff Six-digit HS Code: Household refrigerators, compression-type & othres (%)		
	841821	841829	Year updated at WTO
Brunei Darussalam	5	5	2014
Cambodia	15	15	2014
Indonesia	10	10	2014
Lao PDR	10	10	2014
Malaysia	30	30	2013
Myanmar	10	10	2013
Philippines	10	10	2015
Singapore	0	0	2016
Thailand	30	30	2014
Vietnam	25	35	2015

source: www.wto.org

B.4 MFN Tariff (HS 850151, AC Motors, Multi-phase, of an output not exceeding 75 W; HS 850152, AC Motors, Multi-phase, of an output exceeding 750 W but not exceeding 75 kW; HS 850153, AC Motors, Multi-phase, of an output exceeding 75 kW)

Country	MFN Tariff Six-digit HS Code: HS 850151 AC Motors, multi-phase, of an output not exceeding 750 W (%) HS 850152 AC Motors, multi-phase, of an output exceeding 750 W but not exceeding 75 kW (%) HS 850153 AC Motors, Multi-phase, of an output exceeding 75 kW (%)			
	850151	850152	850153	Year updated at WTO
Brunei Darussalam	5	5	5	2014
Cambodia	15	15	15	2014
Indonesia	10	10	10	2014
Lao PDR	5	5	5	2014
Malaysia	0	15	0	2013
Myanmar	1	1	1	2013
Philippines	1	1	1	2015
Singapore	0	0	0	2016
Thailand	10	10	1	2014
Vietnam	9	4.3	0	2015

source: www.wto.org

B.5 MFN Tariff (HS 940510, Chandelier and other electric ceiling or all lighting fittings, excluding those of a kind used for lighting public open space or thoroughfares and HS 940540 Electric lamps and lighting fittings)

Country	MFN Tariff Six-digit HS Code: Chandeliers and other electric ceiling or wall lighting fittings, excluding those of a kind used for lighting public open spaces or thoroughfares		
	940510	940540	Year updated at WTO
Brunei Darussalam	5	5	2014
Cambodia	15	13.1	2014
Indonesia	7.5	8.1	2014
Lao PDR	5	5	2014
Malaysia	22.5	11	2013
Myanmar	1	1	2013
Philippines	7.8	4	2015
Singapore	0	0	2016
Thailand	20	20	2014
Vietnam	13.8	11.9	2015

source: www.wto.org

B.6 MFN Tariff (HS 854140, Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes)

Country	MFN Tariff Six-digit HS Code: 854140 Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes (%)	
	854140	Year updated at WTO
Brunei Darussalam	0	2014
Cambodia	7	2014
Indonesia	1	2014
Lao PDR	5	2014
Malaysia	0	2013
Myanmar	7.5	2013
Philippines	0	2015
Singapore	0	2016
Thailand	0	2014
Vietnam	0	2015

source: www.wto.org

B.7 MFN Tariff (HS 841990, Solar Flat Plate Collector & Solar Evacuated tube collector including parts)

Country	MFN Tariff Six-digit HS Code: Solar Flat Plate Collector & Solar Evacuated tube collector incl parts (%)	
	841990	Year updated at WTO
Brunei Darussalam	3	2014
Cambodia	15	2014
Indonesia	5	2014
Lao PDR	10	2014
Malaysia	13.8	2013
Myanmar	1	2013
Philippines	1	2015
Singapore	0	2016
Thailand	0	2014
Vietnam	0	2015

source: www.wto.org

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